Amptek®
Keeps it on

TECHNICAL HANDBOOK

Rechargeable Sealed Lead Acid Battery

INTRODUCTION

Fusion Power Systems is an ISO9001:2000 certified enterprise engaged in development and supply of Rechargeable Sealed Lead Acid Battery under its brand name "AMPTEK" which is among Top 10* SLA Battery brands in India. AMPTEK has nationwide sales, service and distribution capabilities, providing state-of-the-art batteries to its customers. At present, AMPTEK supplies Small Sized and Large Sized Sealed Acid Battery series in more than 60 models in 2V, 6V and 12V with rated capacity of 0.3AH - 3000AH. AMPTEK batteries strictly comply with JIS & IEC standards. The batteries are specially designed, built and tested to perform in the most difficult environment and have good stability, high capacity, small size and long service life. The application of the batteries covers UPS Systems, Telecommunications, Electronic Weighing Scales, Solar Energy, Railways, Emergency Lighting Systems, Battery operated toys and other portable electronic products. AMPTEK has an experienced team of professionals including Marketing Managers and Electronics Engineers to support its efficient operations. It has also set up state of the art battery testing facilities using advanced testing equipment and excellent quality testing procedures. It adopts strict quality control during the process of imports and shipping of batteries to guarantee full life of the products. AMPTEK batteries guarantee reliable performance and competitive price. AMPTEK has built an efficient after sales service system which can offer strong, timely, easy and effective service to the customers. AMPTEK enjoys nationwide recognition for the quality of its products, business integrity and innovative engineering skills. At AMPTEK, defective and customer returned batteries are recycled thru vendors approved by Ministry of Environment & Forests to protect environment from lead which we all know is very poisonous and hazardous. The principle of AMPTEK is "Customer Satisfaction is our Motto ", which is fulfilled with systematic information management systems, high quality products and efficient after-sales service.

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AN ISO 9001-2000 CERTIFIED COMPANY

To get optimum performance from Amptek SMF batteries please go through this manual carefully.

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DESCRIPTION OF Amptek SEALED LEAD CALCIUM MAINTENANCE FREE BATTERY

1.1 BATTERY PROPERTIES

"Amptek" Sealed Lead Calcium Maintenance Free Battery is an advanced and economic rechargeable battery. It has several properties different from other types of batteries:-

- *Maintenance Free* - As it is valve-regulated, sealed and glass-mat is utilized, acid is trapped inside. So, refilling is not needed and is leak proof.
- *High Power-To-Weight Ration* - "Amptek" SMF 6V and 12V battery ranges from 1.3AH to 250AH, weight ranges from approximately 0.3 to 72 kgs. So it can provide much power in comparison to its weight.
- *No Memory Effect* - Some batteries, say nickle-cadmium batteries, will become conditioned to provide small power after repetitious short usage/discharge.
- *Low Self Discharge* - The self-discharge rate for "Amptek" SMF battery is about 2-3% per month at room temperature compared with 20-30% for other common battery systems.
- *Long Service Life* - Utilizing thick and massive calcium grids, "Amptek" SMF battery has a long service life.
- *High Discharge Rate* - Since the internal resistance is low, the battery can provide high rate of discharge.
- *Wide Operating Temperature Range* - "Amptek" SMF battery is rated at 20^{0}C and will operate from - 60^{0}C to +60^{0}C when it is fully charged.
- *Ease of Shipment* - It is classified as dry battery and is acceptable for shipment on passenger and cargo aircraft.

1.2 APPLICATIONS

Many kinds of products will use "Amptek" SMF battery as it is convenient, reliable and has coutstanding service life and capacity. Applications can be classified as **Cycle use** as well as **Standby Use *& Solar Cell Generation*.**

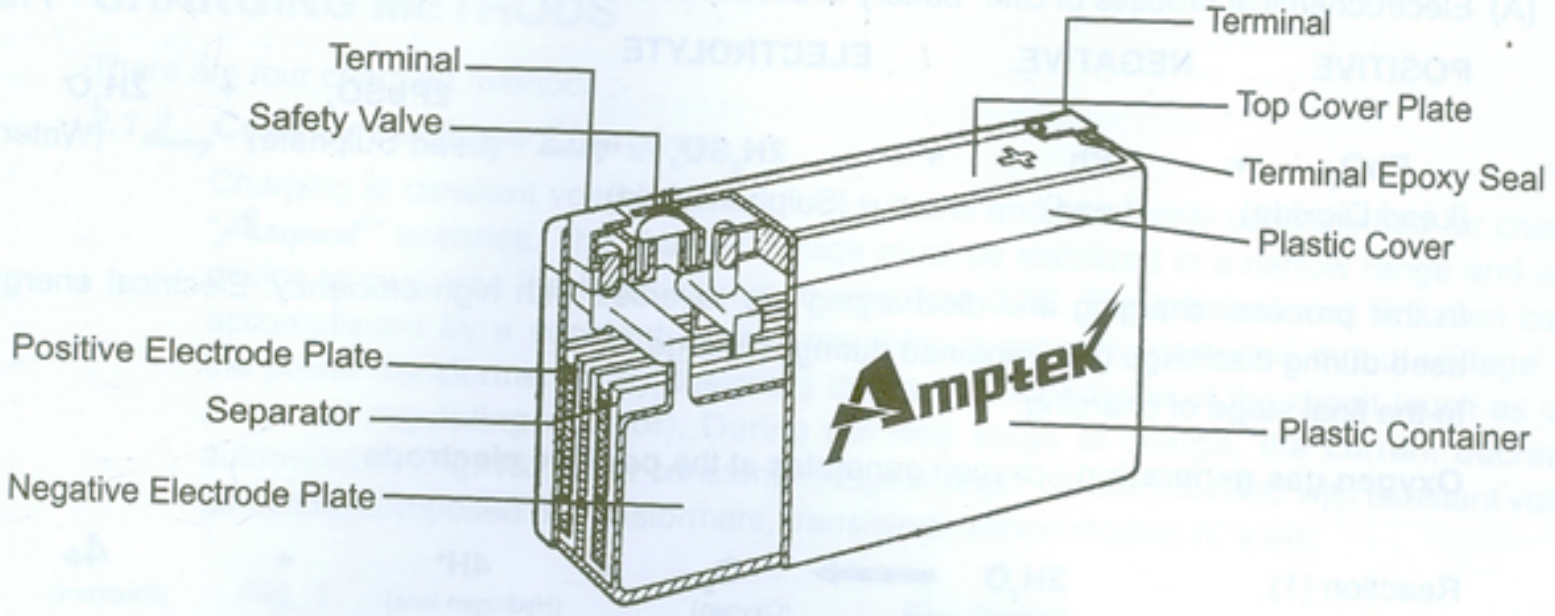
Here are some examples:-

For ***Cycle Use***
- Medical Instruments;
- Portable Powered Tools;
- Powered toys;
- Lighting Equipment;
- Electric Equipment & Telemetry equipment;
- Wireless lawn movers, vacuum cleaner and washing machine.

For ***Standby Use***
- Emergency Lighting;
- Toys and consumer electronics;
- Telecommunication equipment;
- UPS Systems;
- Fire alarm and security system;
- Portable video camera;
- Portable personal computer.

For ***Solar Cell Generation***
- Garden lighting;
- Portable power station.

1.3 BATTERY CONSTRUCTION

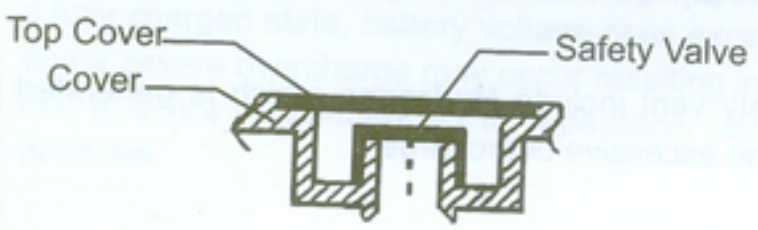


1. ***Positive plates***
   Positive plates are made from a Lead - Calcium system.

2. ***Negative plates***
   Negative plates are made from a Lead - Calcium system.

3. ***Separators***
   The glass-fibre fine mat separator in "Amptek" SMF battery are purchased from **Japan-Nippon Sheet Glass Co. ltd.** and have high resistance to acid. The high porosity of the separators retains adequate electrolyte for the reaction of active materials of the plates and prevents escape of electrolyte from the separator which causes leakage.

4. ***Low Pressure Safety vents System.***
   The vents system, which operates a 1 psi to 6 psi (0.07-0.43 kg/cm) is designed to release excess gas and keep the internal pressure within the optimum range of safety. It protects the negative plates from contamination from oxygen in the air. Resealing is automatic once the pressure returns to normal.
   Vents are 100% visually inspected during battery production



If the internal pressure is raised to an abnormal level. The safety vent opens to release gas. It thus eliminates the danger of rupture. Once it has opened, it automatically recloses in preparation for a future possible increase in pressure.

5. ***Terminals***
   Depending on the battery model, the terminal may be Faston type 187, Faston type 250 or bolts-and-nuts type.

6. ***Case materials***
   For 6V and some models of 12V series (from 12V 1.3AH to 12V 40AH and 12V 65AH) standard container are manufactured from ABS plastic resin (UL94HB).
   For 12V 41AH, 12V 50AH and model from 12V 70AH to 12V 200AH, battery containers are made of PP plastic.

1.4 ELECTROCHEMICAL PROCESS

(A) Electrochemical process of SMF battery is described below:-

POSITIVE **NEGATIVE** **ELECTROLYTE**

$$\underset{\text{(Lead Dioxide)}}{PbO_2} + \underset{\text{(Lead)}}{Pb} + \underset{\text{(Sulphuric Acid)}}{2H_2SO_4} \rightleftharpoons \underset{\text{(Lead Sulphate)}}{2PbSO_4} + \underset{\text{(Water)}}{2H_2O}$$

In this process, charging and discharging are reversed with high efficiency. Electrical energy used during discharge gets regained during recharge.
In the final stage of charging:

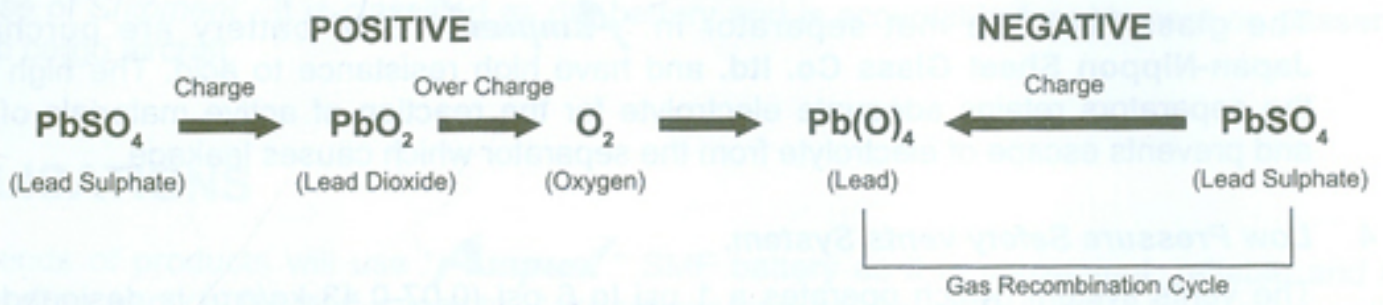
Oxygen gas generation - oxygen generates at the **positive electrode**

Reaction (1) $\underset{\text{(Water)}}{2H_2O} \longrightarrow \underset{\text{(Oxygen)}}{O_2} + \underset{\text{(Hydrogen Ions)}}{4H^+} + \underset{\text{(Electrons)}}{4e^-}$

(B) **Oxygen Gas Absorption -** Oxygen generated from the positive electrode converts to the surface of negative electrode and absorption takes place :

Reaction (2) $\underset{\text{(Lead)}}{2Pb} + \underset{\text{(Oxygen)}}{O_2} + \underset{\text{(Sulphuric Acid)}}{2H_2SO_4} \longrightarrow \underset{\text{(Lead Sulphate)}}{2PbSO_4} \quad \underset{\text{(Water)}}{2H_2O}$

The above reaction of generation and absorption can be expressed as follows :-



Since Oxygen gas generated in the final stage of charging is absorbed by the negative electrode, there is no increase in internal pressure despite the sealed construction.

However, when the charging current exceeds the specific value or when charging is conducted at less than the specific temperature, the amount of Oxygen gas generated by reaction (1) cannot all be absorbed by reaction (2). So that internal pressure increases and in the worst case, the safety vent is activated.

The gases released from the safety vent include **Hydrogen** which is generated at **negative plate** (along with Oxygen) during the excessive overcharge.

(NEGATIVE)

Reaction (3) $\underset{\text{(Hydrogen ions)}}{2H^+} + \underset{\text{(Electrons)}}{2e^-} \quad \underset{\text{(Hydrogen)}}{H_2}$

It should be noted that when the safety vent functions, electrolyte is consumed and performance deteriorates. To prevent or reduce this, it is important that charging should be conducted under recommended conditions.

CHARGING CHARACTERISTICS

2.1 CHARGING METHODS

There are four charging methods :-

2.1.1 Constant Voltage Charging

Charging at constant voltage is the most suitable and commonly used method for charging "Amptek" batteries. The charger voltage must be stabilized in a narrow range and with a device to suppress the initial current to less than 0.3C. The initial current limitation can be accomplished by a constant-current regulator, a properly designed output-voltage from the power transformer, or by designing the overall impedance of the circuit (such as using a current regulating resistor). During the final stage of charge, the current decreases automatically. Fig. 1&2 show constant voltage charger circuits provided with constant voltage functions, composed of transformers, transistors, silicon diodes, IC's etc.

Fig. 1

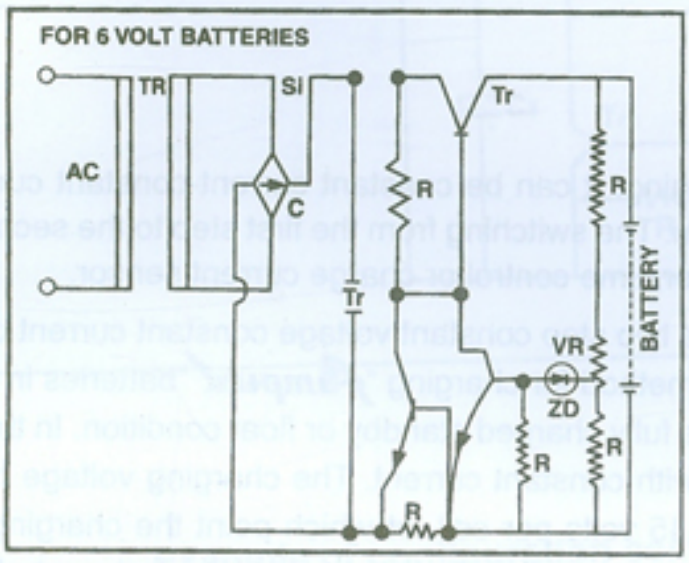
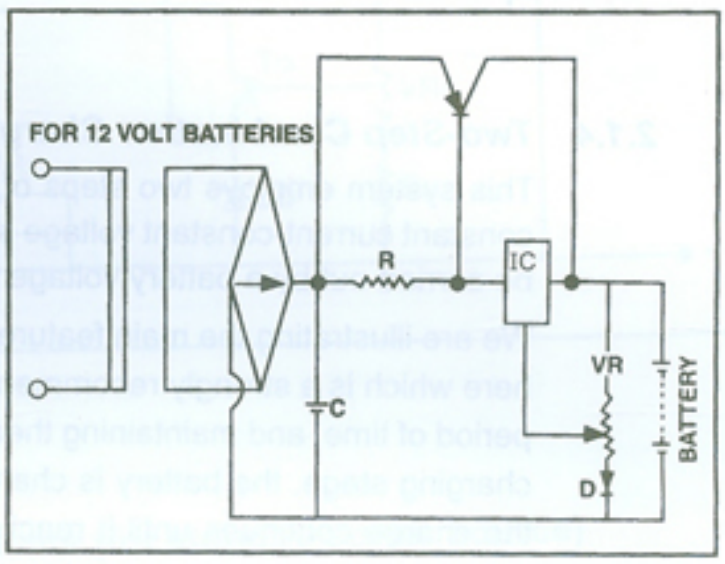


Fig. 2

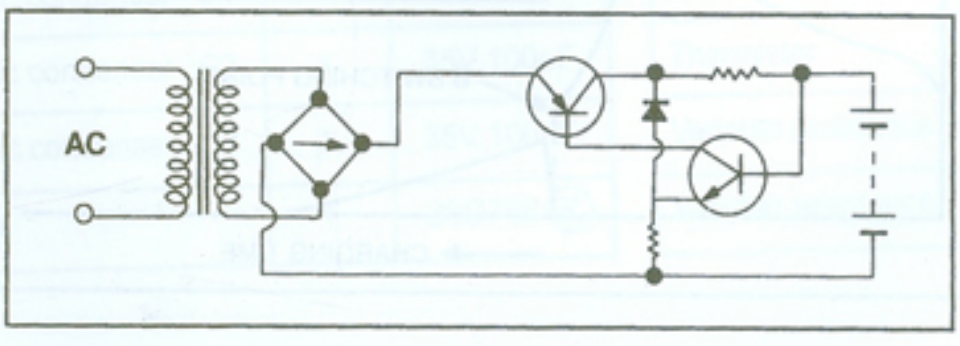


It is desirable for the charger to be temperature compensated. For more details, please refer to section 2.5 on Pg. 9

2.1.2 Constant Current Charging

It is an effective method for supplementary charge of many batteries at one time in series during storage but the charging time must be strictly controlled. It is because if the charging is continued at the same rate for an extended period of time after the battery has reached a fully charged state, battery voltage rises excessively, water decomposes, heat generates, and a severe overcharge may occur resulting in a heavy damage to the battery. For longest life, it is not recommended to repeatedly use constant current charging for refreshing batteries.

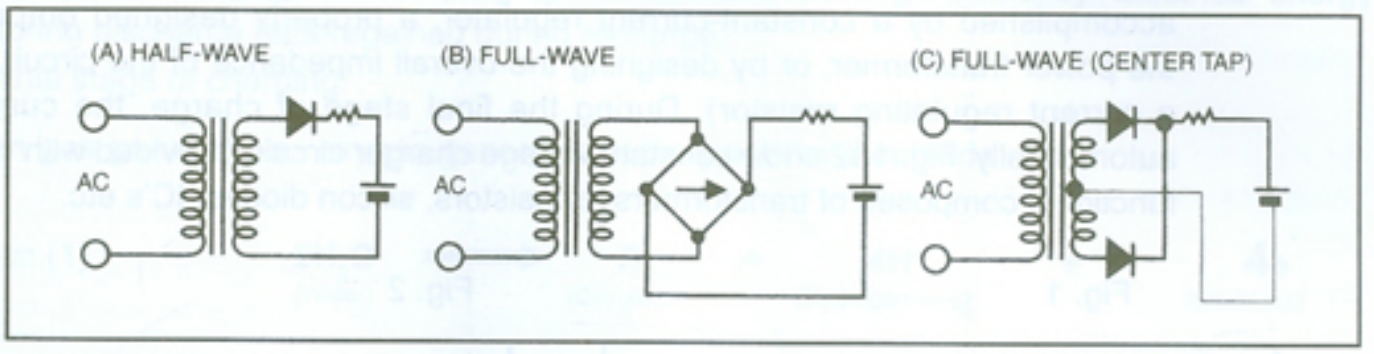
Fig. 3 CONSTANT-CURRENT CHARGING CIRCUIT



2.1.3 *Taper-Current charging*

In this system, the charging current drops gradually as the charging proceeds. It shall be accompanied by using a power transformer with a secondary voltage which is considerably higher than the battery voltage and a suitably high-resistance in the circuit for current limiting. A charging cut-off circuit should be incorporated in the charger to prevent overcharge. It can then be utilized for industrial uses for charging multiple number of batteries and for trickle charging system.

Fig. 4 TAPER-CURRENT CHARGING CIRCUITS

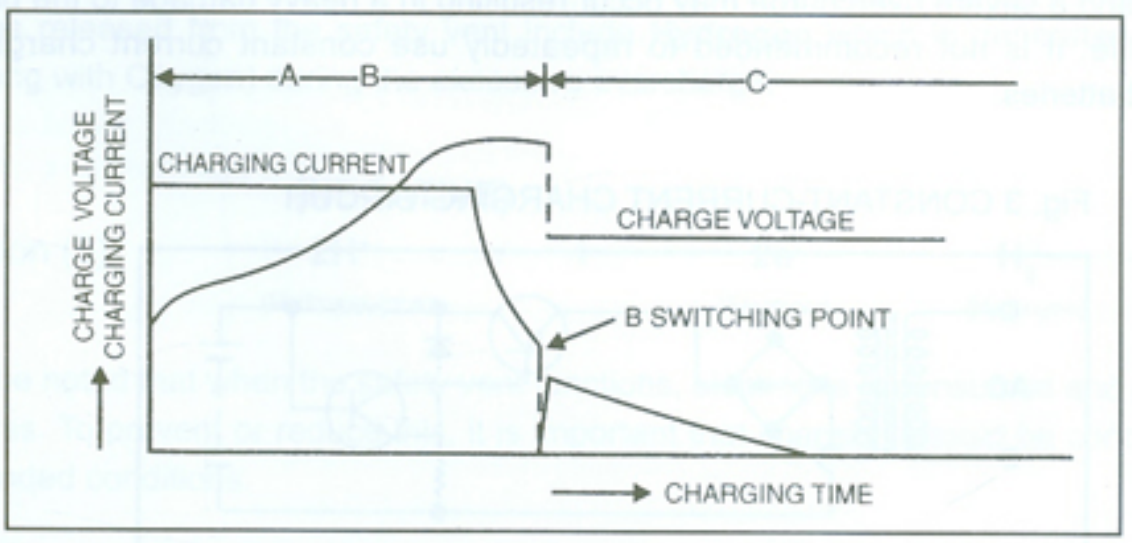


2.1.4 *Two-Step Combination Charging*

This system employs two steps of charging. It can be constant current-constant current or constant current-constant voltage system. The switching from the first step to the second can be carried out by a battery voltage sensor, time control or charge current sensor.

We are illustrating the main features of a two step constant voltage constant current charger here which is a strongly recommended method for charging "Amptek" batteries in a short period of time, and maintaining them in a fully charged standby or float condition. In the initial charging stage, the battery is charged with constant current. The charging voltage rises as the charge continues until it reaches 2.45 volts per cell, at which point the charging mode automatically changes to constant voltage charging. During the constant current charging stage [A-B], the charging current which has decreased to point B is sensed, and the charging voltage is switched to the float level of 2.3 volts per cell from the recovery level [B-C] of 2.45 volts per cell. The switch over to constant voltage trickle charging occurs after the battery has recovered approximately 80% of the rated capacity over a given period of time. This method is one of the most efficient. The recharge time is minimized during the initial charging stage whilst the battery is protected from overcharge by switching over to float charge at the switching point B.

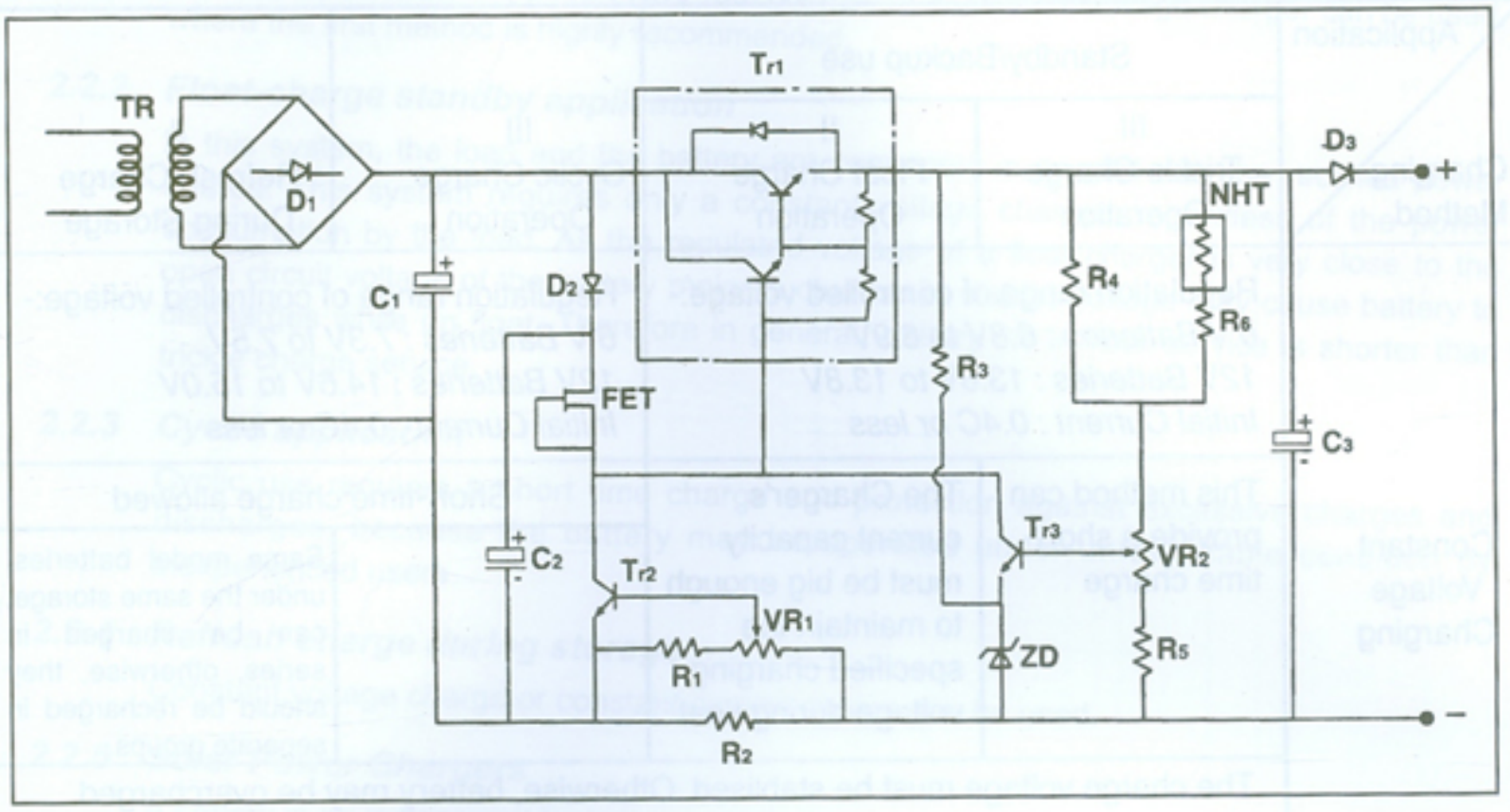
Fig. 5 CHARGING CHARACTERISTICS OF A TWO STEP CONSTANT-VOLTAGE CHARGER



2.1.5 *Regulated charger with temperature compensation*

Where cost is of no consequence and a well regulated charger offering temperature compensation with overcharge protection is desired, we recommended the following circuit.

Fig 6 EXAMPLE OF CHARGING CIRCUIT DESIGN



Example of configuration components (for standby power source)

Output voltage: 13.65V Output current : 0.65A

Part Name		Qty.	Rating
Transformer	TR	1	16.5V 1A
Rectifier diode	D1	4	100V 1A
Diode	D2	1	100V 1A
Diode	D3	1	100V 1A
Zener diode	ZD	1	6.2V
FET		1	2SK40
Electrolytic condenser	C1	1	35V 2,200μF
Electrolytic condenser	C2	1	35V 100μF
Electrolytic condenser	C3	1	35V 100μF
Transistor		1	2SD768 (K)

Part Name		Qty.	Rating
Transistor	Tr2 to Tr3	1	2SC458
Resistance	R1	1	100Ω 1/4W
Resistance	R2	1	1Ω 2W
Resistance	R3	1	6.8Ω 1/4W
Resistance	R4	1	6.8Ω 1/4W
Resistance	R5	1	6.8Ω 1/4W
Resistance	R6	1	27Ω 1/4W
Thermistor	NHT	1	30k
Variable resistance	VR1	1	500Ω 1/4W
Variable resistance	VR2	1	1KΩ 1/4W

2.2 CHARGING APPLICATION TIPS

Battery life is affected by the charger's performance and the battery's operating conditions. Charger selection depends on the battery usage which may be cycle use or standby use (either under trickle charge or float charge operation). Please refer to table 1.

Table 1 Charging method and battery application

<table>
<tr><th rowspan="2">Application / Charging Method</th><th colspan="2">Standby/Backup use</th><th rowspan="2">III
Cyclic Charge Operation</th><th rowspan="2">II
Refresh Charge During Storage</th></tr>
<tr><th>III
Trickle Charge Operation</th><th>II
Float Charge Operation</th></tr>
<tr><td rowspan="4">Constant Voltage Charging</td><td colspan="2">Regulation range of controlled voltage:-
6 V Batteries : 6.8V to 6.9V
12V Batteries : 13.6V to 13.8V
Initial Current : 0.4C or less</td><td colspan="2">Regulation range of controlled voltage:-
6 V Batteries : 7.3V to 7.5V
12V Batteries : 14.6V to 15.0V
Initial Current : 0.4C or less</td></tr>
<tr><td>This method can provide a short-time charge</td><td>The Charger's current capacity must be big enough to maintain the specified charging voltage during float</td><td colspan="2">Short-time charge allowed</td></tr>
<tr><td colspan="2"></td><td>Same model batteries, under the same storage, can be charged in series, otherwise, they should be recharged in separate groups.</td></tr>
<tr><td colspan="4">The charge voltage must be stablised. Otherwise, battery may be overcharged. The charge should be temperature compensated when using battery in a wide range of ambient temperature.</td></tr>
<tr><td>Constant Current Charging</td><td>Not Recommended</td><td>Not applicable</td><td>Not Recommended</td><td>Charging current:- approx. 0.1C
Charging time control is strictly recommended because an over charge is more to occur.
No temperature compensation is needed.</td></tr>
<tr><td>Tapered Current Charging</td><td>Not Recommended</td><td>Not applicable</td><td>Not Recommended</td><td>Not Recommended</td></tr>
<tr><td>Two-Steps Combination Charging</td><td>Two-Step constant current charge is highly recommended : 1) Approx. 0.4C at the first step.
2) 0.002C-0.005C at the second step. A time control or a charging voltage detection device is required to transfer from the first step to the second.</td><td></td><td></td><td></td></tr>
</table>

Note : All at 20^{0}C, 68^{0}F)

Note : C rate in the table refers to current as a percentage of nominal capacity.
Example : For model LT 12-7.2 (7.2Ah),
0.3C = 0.3 x 7.2Ah = 2.16 Amp.

2.2.1 *Trickle-charge standby application*

Under standby use, batteries are normally kept in fully charged condition, and serves as a power supply to the load when AC power fails. Under trickle charge operation, AC power is normally supplied for operating the equipment, while charging the batteries which are not connected to the load. If the AC power fails, a relay circuit connects the batteries to the load and battery power is supplied. A two-rate charger or a constant voltage charger can be used, where the first method is highly recommended.

2.2.2 *Float-charge standby application*

In this system, the load and the battery are connected in parallel with the rectified power source. This system requires only a constant voltage charger, regardless of the power consumption by the load. As the regulated voltage of a float charger is very close to the open circuit voltage of the battery major fluctuation in charge voltage may cause battery to discharges while on float. Therefore in general, battery life in float service is shorter than trickle charge service.

2.2.3 *Cyclic application*

Cyclic use requires a short time charge and protection against excessive charges and discharges, because the battery may be operated under unfavourable condition by inexperienced users.

2.2.4 *Refresh charge during storage*

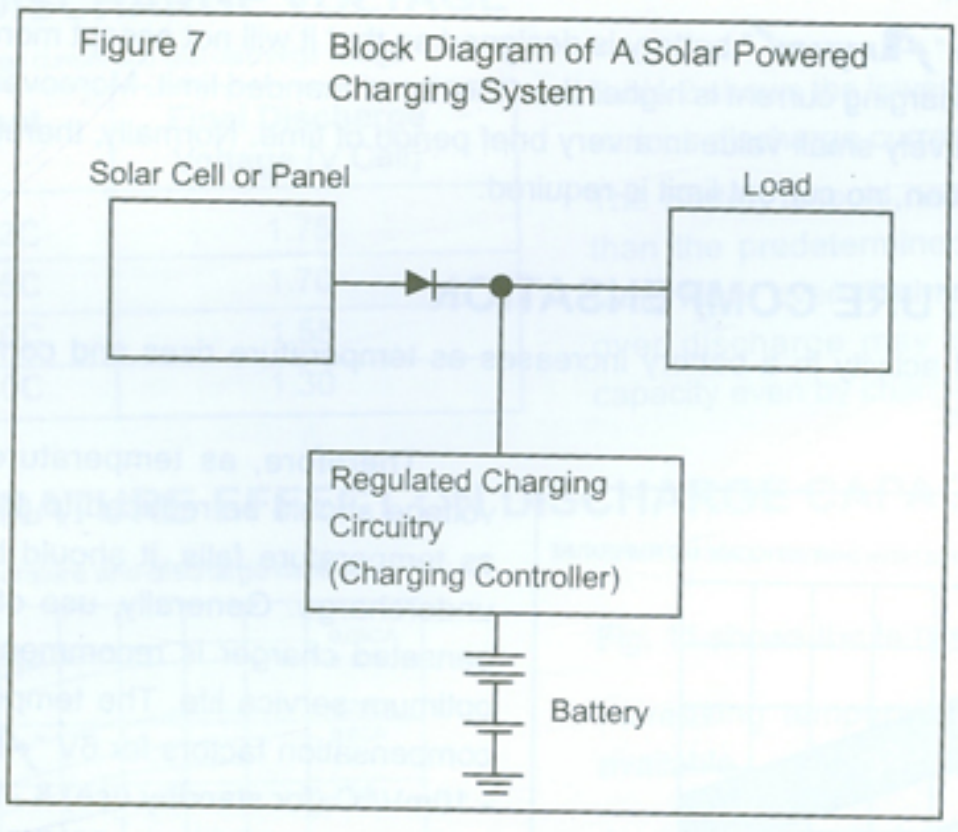
Constant voltage charge or constant current charge can be used.

2.2.5 *Solar Power Chargers*

A battery is an indispensable component of any solar powered system.

Naturally, in case where the output of the solar array exceeds the capacity of the battery, and weather conditions are such that there is potential for overcharging the battery, appropriate regulated circuitry between the solar panels and the battery is recommended. "Amptek" battery can be charged by the solar array using regulated circuitry as shown in fig.7

Figure 7 Block Diagram of A Solar Powered Charging System



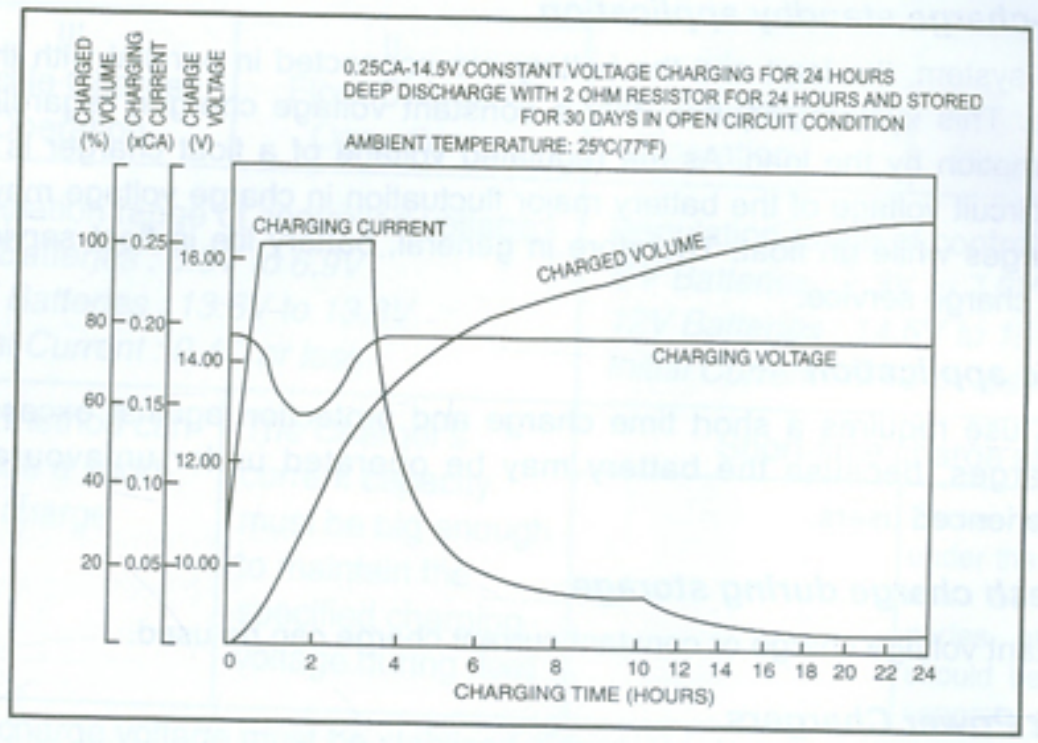
As the system is exposed to direct sunlight, usually a highly reflective, heat-resistant surface material is needed.

In general when designing a solar powered system, consultation with the manufacturers of both the solar panel and the battery are strongly advised.

2.3 RECOVERY CHARGE AFTER DEEP DISCHARGE

A battery has been subjected to deep discharge/over discharge when it is discharged below specified cut-off voltage. Battery life would be shortened and it requires a longer charging period than normal. Please note from fig. 8 that as a result of high internal resistance, the charging current accepted by an over discharged "Amptek" battery during initial stage of charging will be quite small but will increase after about 30 minutes until the internal resistance has been overcome. Then normal and full recovery charging characteristic resume.

Fig. 8



2.4 INITIAL CHARGE CURRENT LIMIT

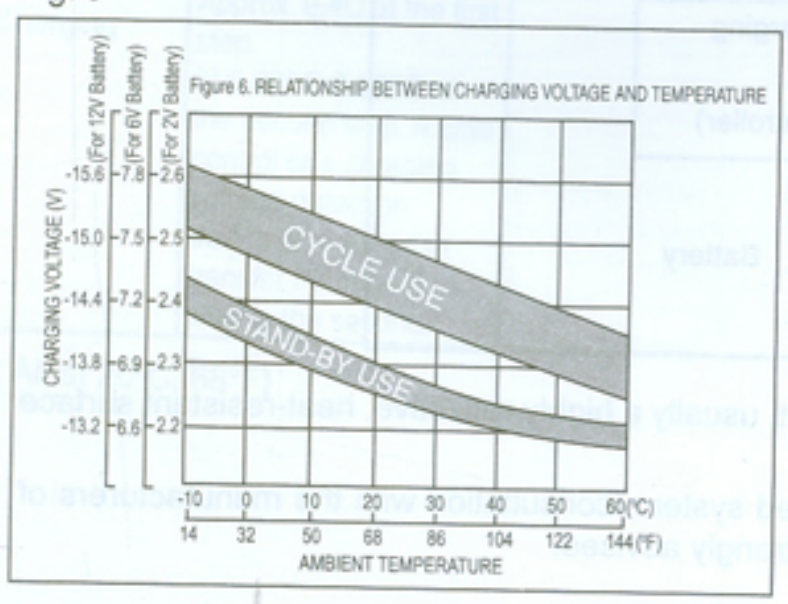
A discharged battery will accept a high charging current at the initial stage of charging. But continuously high charging-current can cause abnormal internal heating which may damage the battery. Therefore, it is necessary to limit the initial charging current to 0.3C or below under constant voltage charge for cyclic application.

For standby use "Amptek" battery is designed so that it will not accept more than 2C Amps even if the available charging current is higher than the recommended limit. Moreover, the charging current will fall to a relatively small value in a very brief period of time. Normally, therefore, in the majority of standby application, no current limit is required.

2.5 TEMPERATURE COMPENSATION

Electrochemical activity in a battery increases as temperature rises and conversely decreases as temperature falls.

Fig. 9



Therefore, as temperature rises, the charging voltage should be reduced to prevent overcharge and as temperature falls, it should be increased to avoid undercharge. Generally, use of a temperature compensated charger is recommended in order to attain optimum service life. The temperature recommended compensation factors for 6V "Amptek" battery are - 10mV/°C (for standby use) & -15V/°C (for cyclic use), when temperature is not 20°C/68°F.

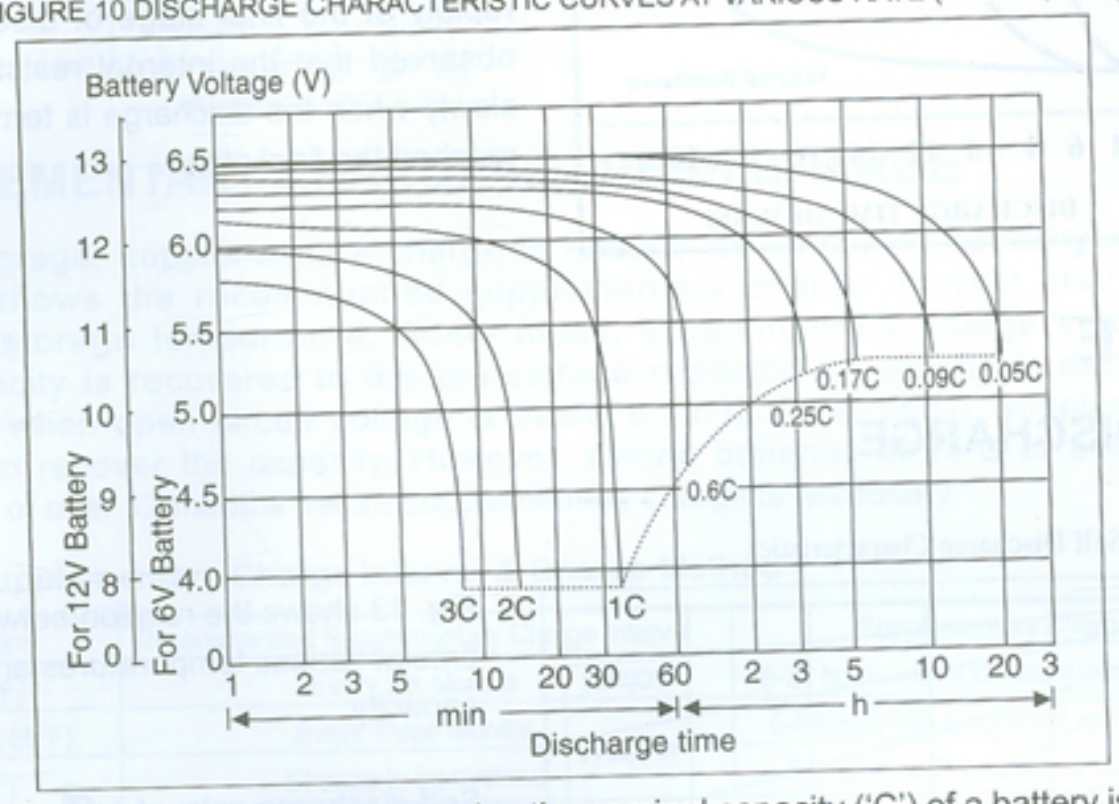
Fig. 9 shows the relationship between temperature and charging voltage in both standby and cyclic applications.

DISCHARGE CHARACTERISTICS

3.1 DISCHARGE CHARACTERISTICS AT DIFFERENT DISCHARGE RATE

Ampere hour capacity of the battery depends on the discharge rate being used. "Amptek" battery is rated at 20 hour discharge rate which is defined as the nominal capacity or 100% capacity point. Fig. 10 shows the discharge performance at the various discharge rates. When the loading on the battery is increased, the available capacity drops.

FIGURE 10 DISCHARGE CHARACTERISTIC CURVES AT VARIOUS RATE (AT 25°C, 77°F)



The standard industry practice to determine the nominal capacity ('C') of a battery is to discharge it at a 20 - hour rate of final voltage of 1.75V per cell.

3.2 FINAL DISCHARGE VOLTAGE

Table 2 Discharge current and final discharge voltage

Discharge Current (A)	**Final Discharge Voltage** (V Cell)
(A) < 0.2C	1.75
0.2C≤ (A) < 0.5C	1.70
0.5C≤ (A) < 1.0C	1.55
(A) ≥ 1.0C	1.30

Table 2 shows the lowest final discharge voltage at various discharge current.

The Battery should never be discharged to less than the predetermined final discharge voltage. Otherwise, over discharge may result. Repeated over discharge may cause failure to recover capacity even by charging.

3.3 TEMPERATURE EFFECT ON DISCHARGE CAPACITY

Fig. 11 Temperature and discharge capacity.

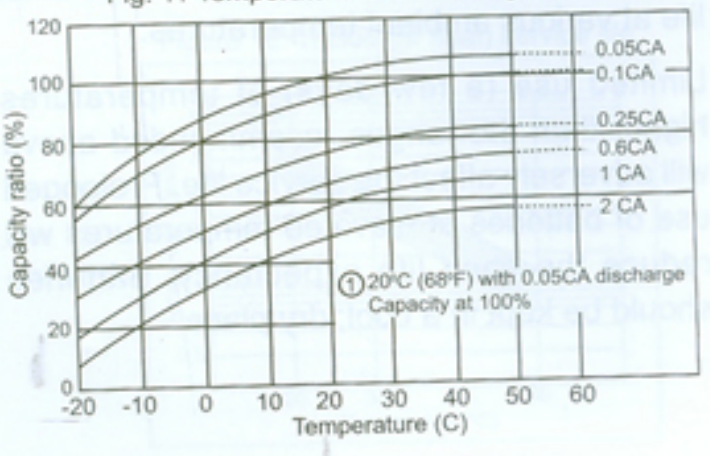


Fig. 11 shows the temperature effects.

Increasing temperature increased the capacity available.

Avoid to operate battery below -15°C (5°F) or beyond 50°C (122°F), since this may damage the battery, even it may still operate

3.4 INTERNAL RESISTANCE CHANGE

Figure 12 Internal Resistance

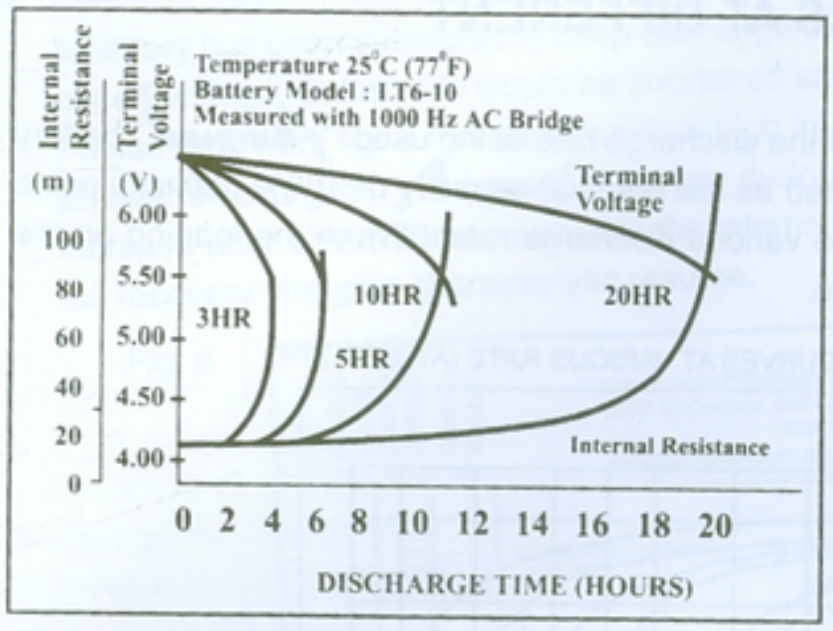


Fig.12 shows the internal resistance of "Amptek" battery measured through a 1000Hz AC bridge

Internal resistance of a "Amptek" Battery is the smallest when the battery is charged completely and it increases slowly as discharge progress but rapidly at the final stage of discharge. It will be observed that the internal resistance decreases slowly when the discharge is terminated as it has reached the final stage.

STORAGE

4.1 SELF DISCHARGE

Figure 13 Self Discharge Characteristics

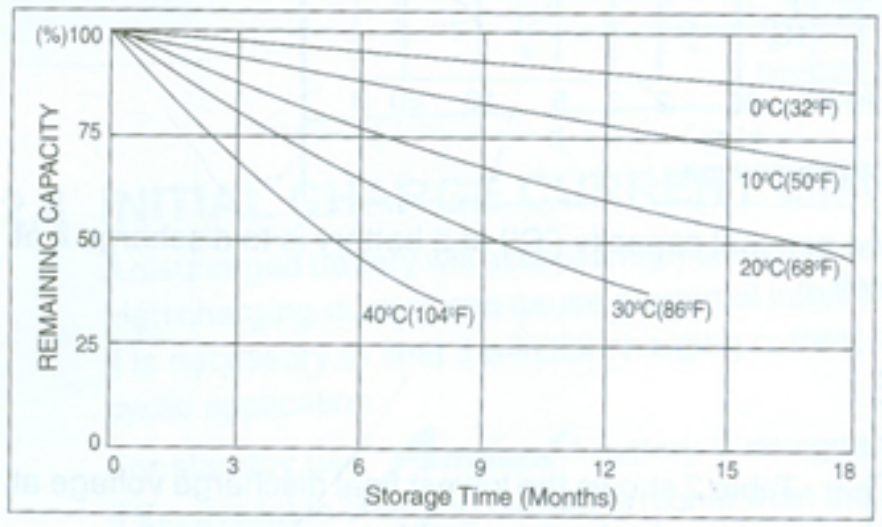


Fig. 13 shows the relation between the storage time at various temperatures and the remaining capacity.

Self-discharge rate of "Amptek" battery is approximately 3% per month when batteries are stored at an ambient temperature of 20°C (68°F). The self-discharge rate varies with ambient temperature.

4.2 SHELF LIFE

Shelf life is the life of a battery when stored in the unused condition. Generally, **Lead Sulphate** is formed on the negative plates which is referred to as "**sulphation**" when lead acid battery is stored in a discharged condition for an extended period of time. Higher temperature will accelerate sulphation. Since the lead sulphate acts as an insulator, sulphation decreases the battery charge acceptance.

Table 3. Shelf life at various temperatures

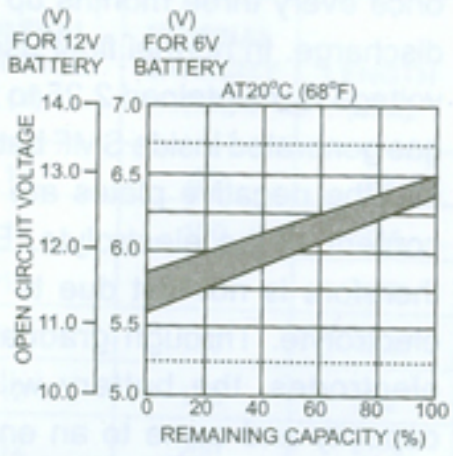
Temperature	Shelf life
0°C (32°F) to 20°C (68°F)	12 Months
21°C (70°F) to 30°C (86°F)	9 Months
31°C (88°F) to 40°C (104°F)	5 Months
41°C (108°F) to 50°C (122°F)	2.5 Months

Table 3 shows the normal storage time or shelf life at various ambient temperatures.

Limited use (a few days) at temperatures higher than the ranges recommended above will adversely affect the service life. Prolonged use of batteries at elevated temperatures will reduce the shelf life expectancy. Batteries should be kept in a cool, dry place.

4.3 CAPACITY MEASUREMENT BY OPEN CIRCUIT VOLTAGE

FIGURE 14. OPEN CIRCUIT VOLTAGE VS. REMAINING CAPACITY



The approximate remaining capacity of "Amptek" battery can be empirically determined from Fig. 14.

4.4 SUPPLEMENTARY CHARGE/REFRESH CHARGE

During storage, supplementary charge is needed as remaining capacity is 80% or less. Table 4 shows the recommended supplementary charge interval and method under different storage temperature. Some times, supplementary charge shall be repeated until capacity is recovered to the pre-storage capacity. If capacity is decreased to over 60% (i.e. when open circuit voltage is below 6.3V/12.6V at 25°C), supplementary charge may fail to recover the capacity. However, storing batteries at 15°C or below when given a shelf life of over 12 months before supplementary charge is necessary.

Table 4 Supplementary Charge Interval & Charge Method

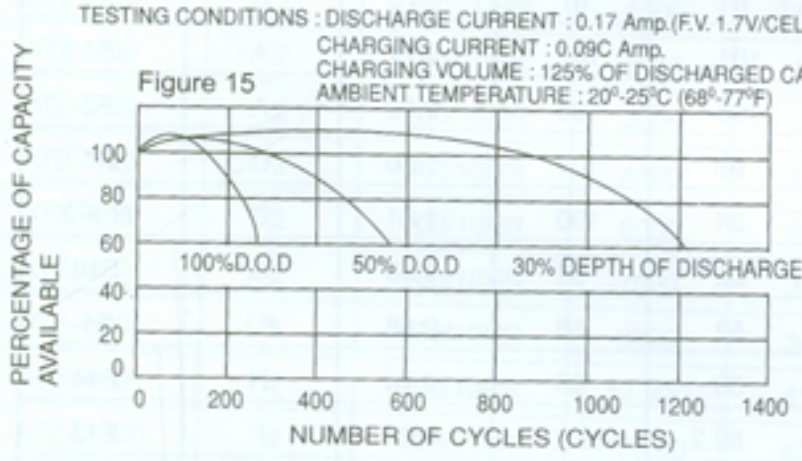
Storage Temperature	Recommended Supplementary Charge Interval	Supplementary Charge Method
Below 20°C (<68°F)	Every Six Months	16-24 hours with a constant voltage of 2.275 V/cell
20°C to 30°C(68°F to 86°F)	Every Three Months	5-8 hours with a constant voltage of 2.34 V/cell
Over 30°C(>86°F)	Storage to be avoided	5-8 hours with a constant voltage of 0.05 CA

SERVICE LIFE

5.1 CYCLE SERVICE LIFE

TESTING CONDITIONS : DISCHARGE CURRENT : 0.17 Amp.(F.V. 1.7V/CELL)
CHARGING CURRENT : 0.09C Amp.
CHARGING VOLUME : 125% OF DISCHARGED CAPACITY
AMBIENT TEMPERATURE : 20°-25°C (68°-77°F)

Figure 15



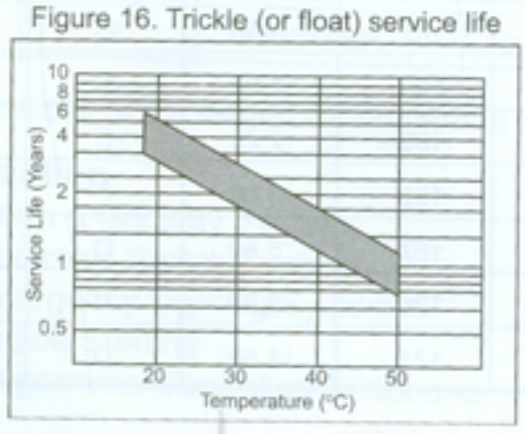
The most important factor is the depth of discharge with has a reverse effect on cycle service life.

Fig. 15 shows the effect of depth of discharge on cyclic life.

The discharge capacity has the trend to increase in the initial stage of the cycle and it reaches the maximum at about 50 cycles.

5.2 TRICKLE/FLOAT SERVICE LIFE

Figure 16. Trickle (or float) service life



"Amptek" battery is designed to operate in Float standby use up to 8 years on the basis of accelerated tests in which float charge voltage is maintained between 2.25 and 2.30 volts per cell at an ambient temperature of approximately 20°C.

Fig. 16 shows temperature effect on float life.

Figure 17. Float Service Life

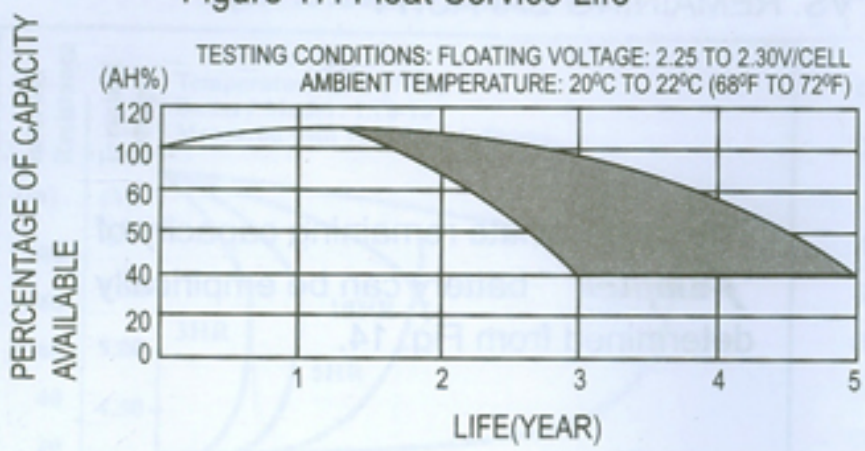


Fig. 17 shows the float life characteristics of "Amptek" SMF batteries when discharge once every three months up to 100% depth of discharge. In normal float use, where charging voltage is maintained 2.25 to 2.30 volts per cell, gas generated inside SMF battery is recombined into the negative plates are returned to water content of the electrolyte. Electrical capacity therefore is not lost due to "drying up" of the electrolyte. Through gradual corrosion of the electrodes, the battery will eventually lose capacity and come to an end of life. It should be noted that the process will be accelerated by higher ambient operating temperatures and/or higher charging voltages. When designing a float system, one must bear in mind that length of life will be directly affected by the number of discharge cycles, the depth of discharge, the ambient temperature and the charging voltage.

BATTERY LISTS & SELECTION GUIDE

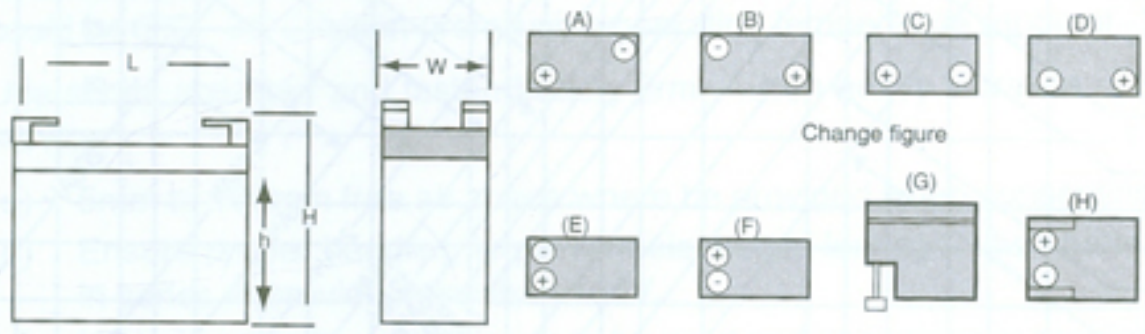
6.1 Small-Sized Sealed 6V/12V Battery Series

BATTERY MODEL	NOMINAL VOLTAGE (V)	NOMINAL CAPACITY (Ah)	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	TOTAL HEIGHT	WEIGHT (Kg)	TERMINAL POSITION	TERMINAL TYPE
AT6-1.3	6	1.3	97	24	52	58	0.30	C	F1
AT6-3.2	6	3.2	125	33	60	66	0.64	C	F1
AT6.3.3	6	3.3	134	34	61	67	0.70	C	F1
AT6-4.5 STD	6	4.5	70	47	101	107	0.72	A	F1
AT6-4.5 PUSH	6	4.5	70	47	104	105	0.72	A	F3
AT6-7	6	7	151	34	95	101	1.30	C	F1
AT6-10	6	10	151	51	94	100	1.81	C	F1/F2
AT12-0.8	12	0.8	96	25	62	62	0.38	G	F10
AT12-1.3	12	1.3	97	43	52	58	0.58	E1	F1
AT12-2.0 VIDEO	12	2	143	24	65	65	0.74	H	F14
AT12-2.0 S	12	2	151	20	89.2	89.2	0.74	F	F13
AT12-2.3 VIDEO	12	2.3	182	24	61	61	0.79	H	F14
AT12-3.3	12	3.3	134	67	62	67	1.25	E1	F1
AT12-4.5	12	4.5	90	70	101	107	1.55	C	F1
AT12-7.2	12	7.2	155	66	95	100	1.92	F	F1/F2
AT12-7.5	12	7.5	155	66	95	100	2.20	F	F2
AT12-12	12	12	152	99	96	102	3.80	F	F2
AT12-18	12	18	181	76	167	167	5.50	D	F7/F9
AT12-28	12	28	166	175	126	126	8.50	D	F8
AT12-42	12	42	198	165	171	171	14.50	D	F8/F9

6.2 Large-Sized Sealed 12V Battery Series

BATTERY MODEL	NOMINAL VOLTAGE (V)	NOMINAL CAPACITY (Ah)	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	TOTAL HEIGHT	WEIGHT (Kg)	TERMINAL TYPE
AT12-65	12	65	350	167	178	178	21.5	F8/F9
AT12-100	12	100	331	174	219	219	30	F8/F9
AT12-120	12	120	407	174	210	233	34.5	F8/F9
AT12-150	12	150	484	171	241	241	45	F8/F9
AT12-180	12	180	532	209	214	220	57	F8/F9
AT12-200	12	200	522	240	219	225	62	F8/F9
AT12-250	12	250	520	268	220	225	72	F8/F9

Dimensions & Terminal Positions



6.3 2V Sealed Battery Series

BATTERY MODEL	NOMINAL VOLTAGE (V)	NOMINAL CAPACITY (Ah)	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	TOTAL HEIGHT	WEIGHT (Kg)	TERMINAL TYPE
AT2–100	2	100/10HR	1500	171	72	205	222	T5
AT2–150	2	150/10HR	2250	172	102	205	222	T5
AT2–200	2	200/10HR	3000	171	110	330	367	T5
AT2–300	2	300/10HR	4500	171	150	330	365	T5
AT2–400	2	400/10HR	6000	210	176	332	368	T5
AT2–500	2	500/10HR	7500	241	172	330	366	T5
AT2–600	2	600/10HR	9000	301	175	331	368	T5
AT2–800	2	800/10HR	12,000	410	175	330	365	T5
AT2–1000	2	1000/10HR	15,000	474	175	327	366	T5
AT2–1500	2	1500/10HR	22,500	401	351	342	378	T5
AT2–2000	2	2000/10HR	30,000	491	351	344	383	T5
AT2–3000	2	3000/10HR	45,000	711	353	342	382	T5

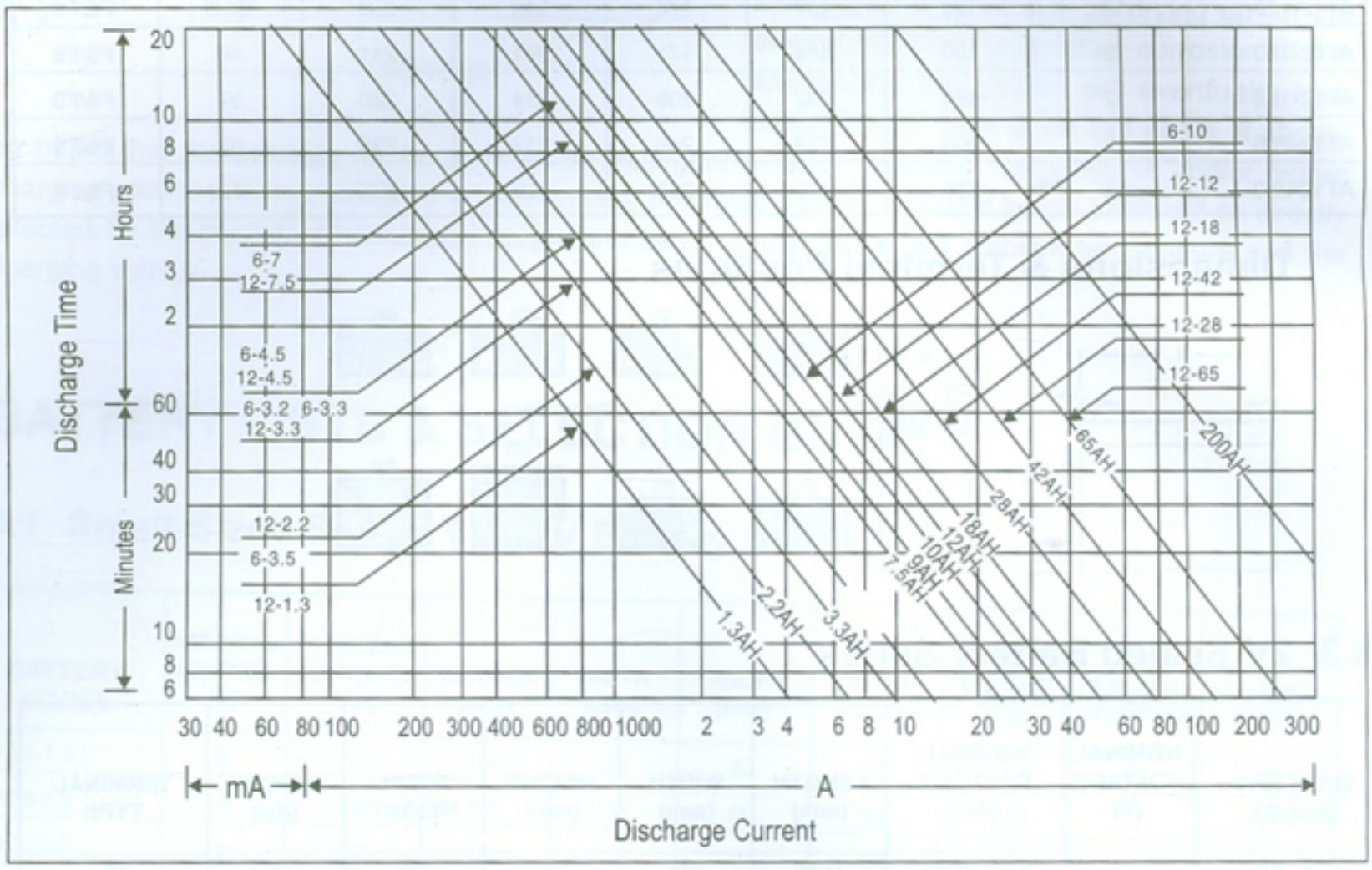
For further details of 2V sealed rechargeable batteries, please contact our stockist or our sales department

- **Utilization**
  - Alarm & Security System
  - Electronic Switch System
  - Emergency Lighting System
  - Engine Starting
  - Programme-Controlled Telephone
  - Ship Equipment
  - Solar Power System
  - Switch Controller for Power Generation Station
  - Telecommunication
  - Uninterruptible Power Supply

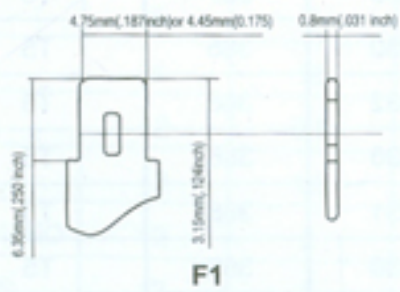
6.4 Capacity Selection Guide

Fig. 18 below may be used to select the minimum battery capacity in 20-hour rate for a specific discharge current and the required discharge time. Find the specific current and time on the chart. The point where the current and time lines intersect on the chart with the diagonal AH line is the minimum capacity required for the application. In addition, it is recommended that Fig. 15 (Cycle Service Life) and Fig. 16 (Float Service Life), and the individual battery model specification sheet be considered prior of final section.

Figure 18. Capacity Selection Chart (At 20°C / 68°F)



Terminal Type {mm(inch)}



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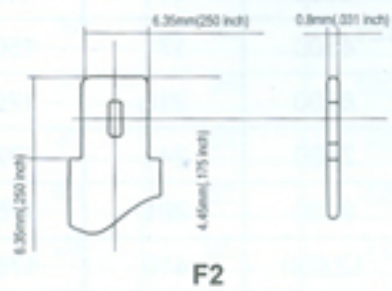

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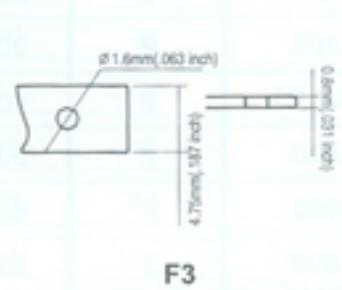

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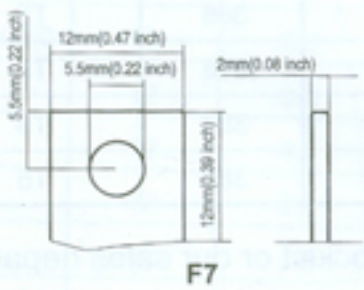

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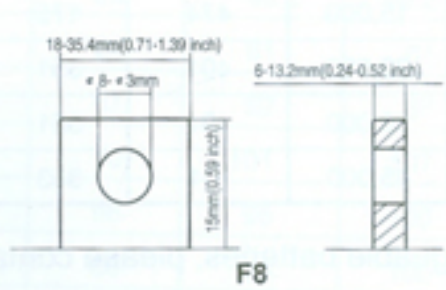

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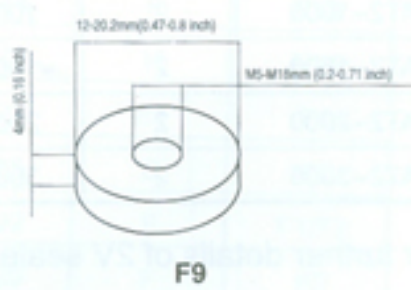

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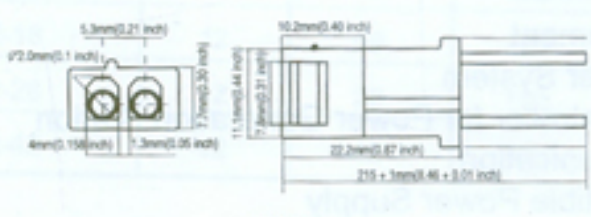

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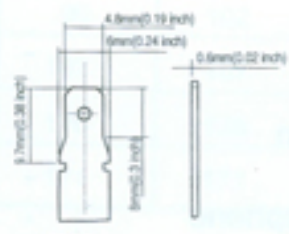

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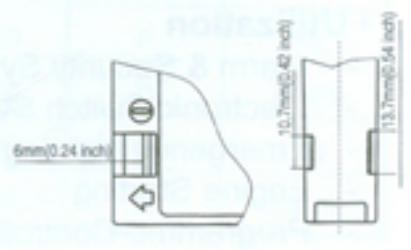
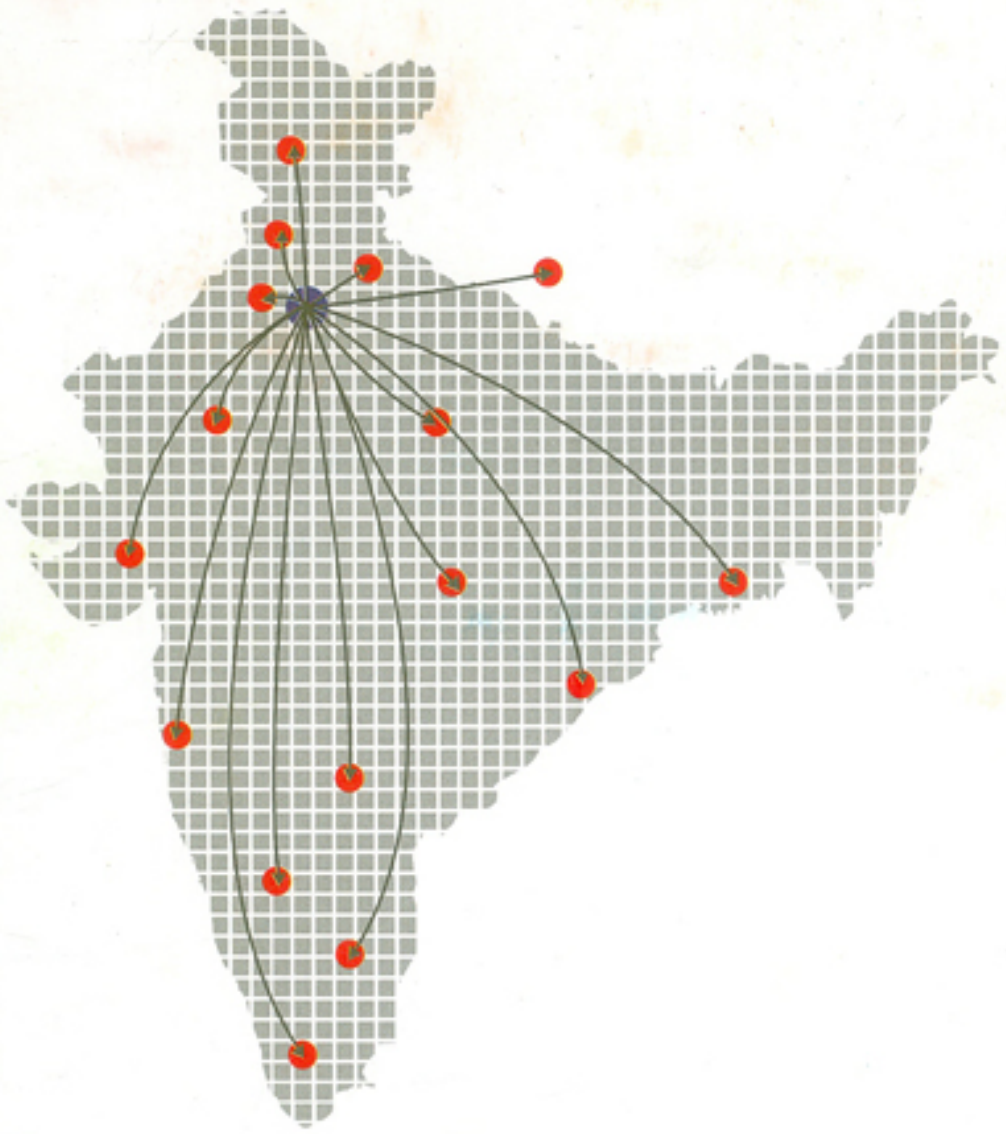


F14

HANDLING PRECAUTION AND APPLICATION TIPS TO MAXIMIZE SERVICE LIFE & CAPACITY

1. Do not short the battery which would result in burning out the battery and the damaging the equipment.
2. Never place the battery near or in fire, preventing from a rupture as the battery may produce a combustible gas
3. If battery is used in a sealed container then during overcharging, Oxygen and Hydrogen would be generated in the container. In the worst case, container may explode due to excessive internal pressure. Therefore, do not use battery in an airtight room or enclosure.
4. Avoid solder connection. If unavoidable, it should be done as quickly as possible within 3 seconds using a 100 watt soldering iron.
5. Heat destroys batteries. You must avoid placing batteries in close proximity to heat sources of any kind. You will enjoy longer service life if ambient temperature is retained at 20^0C - 25^0C though it could be 5^0C - 35^0C within premissible operating temperature range of -15^0C - 50^0C.
6. Use shock absorber and fasten battery firmly when heavy vibration or shock is expected during service.
7. (a) 5mm to 100mm free air space where be provided when connecting the batteries.
   (b) Ensure proper handling to prevent electrolyte leakage when batteries are to be assembled in series to provide more than 100V.
   (c) If 2 or more battery groups are to be used and connected in parallel, they must be connected to the load through lengths of wire, cables or busbars which have the same loop line resistance as each other.
   (d) Mixed use of batteries with different capacities, histories and/or manufacturers is liable to cause damaged or shorten life of new batteries. If this is unavoidable please consult our engineering department.
8. (a) Never store a battery in a discharge state as it may damage the battery.
   (b) If storage is necessary, store in a cool, dry place to reduce self-discharging and before using a stored battery, carry our supplement recharge. Recharge at least every six months. After using/discharging, charge as soon as possible.
9. (a) Never disassemble the battery, as its acid electrolyte may ruin your skin and cloth.
   (b) Clean any dust with a dry or water - dampened cloth. Never use organic solvents (such as gasoline and thinner) which may develop cracks on the container.
   (c) If the battery is accidentally broken or sulphuric acid leaks out, wipe it with a cloth, neutrilize the acid with some alkaline substance (such as ammonium solution, baking power and sodium hydrogen carbonate). If acid electrolyte contacts skin, immediately flush with a lot of water and consult a doctor.
10. (a) Wear rubber gloves before inspection or regular service as touching electrically conductive parts might result in an electric shock.
    (b) Daily check and service.
11. When the batteries are used in an UPS system,
    (a) Where D.C. input exceeds 60 volts, each battery should be insulted from the battery stand by using suitable polypropylene or polyethlene material.
    (b) In high voltage systems, the resistance between battery and stand should always be greater than 1 Megohm. An appropriate alarm circuit could be incorporated to monitor any current flow.
12. To obtain maximum life-the ripple current at R.M.S. should be regulated to less than 0.1C(A).



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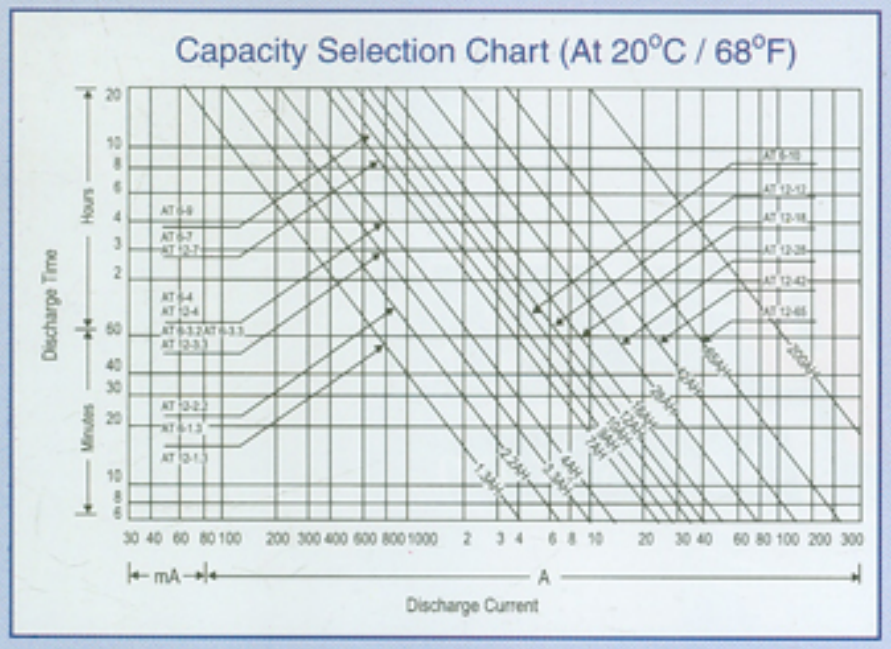
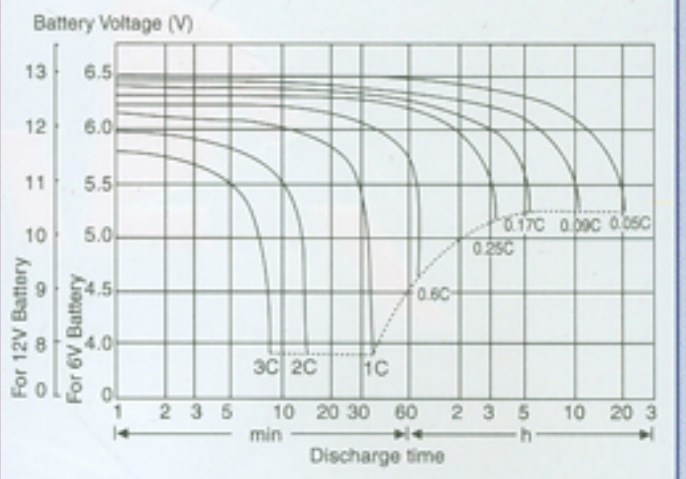
• Security Systems • Toys • Electronic Weighing Scales • EPABX • PCO Machines
• Communication Equipment • Portable Video Camera • Electronic Cash Register etc.

Capacity Selection Chart (At 20°C / 68°F)



Discharge Characteristics Curves at various rate (At 25°C / 70°F)



BATTERY LIST & SELECTION GUIDE

Battery Model	Nominal Voltage (V)	Rated capacity (AH)				Dimensions (mm)				Approx. Weight (KG)	Unit per Box (PCS)
		20 Hr. Rate	10 Hr. Rate	5 Hr. Rate	1 Hr. Rate	Height(H) Including Terminal	Height (H)	Length (L)	Width (W)		
AT 6-1.3	6	1.30	1.20	1.10	0.88	55	50	97	24	0.30	40
AT 6-3.2	6	3.20	3.00	2.70	1.92	66	61	125	32	0.62	20
AT 6-3.3	6	3.30	3.10	2.80	1.94	66	61	134	33	0.65	20
AT 6-4.2 STD	6	4.00	3.72	3.40	2.40	105	101	70	47	0.72	20
AT 6-4.2 PUSH	6	4.00	3.72	3.40	2.40	105	104	70	47	0.72	20
AT 6-4.5 STD	6	4.50	4.20	3.80	2.70	105	101	70	47	0.78	20
AT 6-4.5 PUSH	6	4.50	4.20	3.80	2.70	105	104	70	47	0.78	20
AT 6-6	6	6.00	5.60	5.10	3.40	105	100	85	42	0.80	24
AT 6-7	6	7.00	6.50	6.00	4.20	99	94	151	34	1.30	14
AT 6-10	6	10.00	9.30	8.50	6.00	100	95	151	51	2.00	10
AT 6-12 Vertical	6	12.00	11.20	10.20	7.20	117	117	98	55	2.10	10
AT 8-3.3	8	3.30	3.10	2.80	1.73	91	91	67	46	0.75	20
AT 12-0.8	12	0.80	0.74	0.68	0.48	62	62	96	25	0.35	40
AT 12-1.3	12	1.30	1.20	1.10	0.78	58	53	97	48	0.58	20
AT 12-2.2	12	2.20	2.00	1.90	1.30	66	61	178	36	1.00	20
AT 12-2.0 Video	12	2.00	1.80	1.74	1.13	65	65	144	24	0.65	20
AT 12-2.3 Video	12	2.30	2.10	2.00	1.30	65	65	182	24	0.85	20
AT 12-3.3	12	3.30	3.10	2.80	1.90	67	62	134	67	1.30	10
AT12-4.5	12	4.50	4.20	3.80	2.60	103	100	91	71	1.50	10
AT 12-7.2	12	7.20	6.70	6.10	4.30	100	95	151	66	2.20	5
AT 12-7.5	12	7.50	7.00	6.40	4.50	100	95	151	66	2.35	5
AT 12-12	12	12.00	11.00	10.20	7.20	100	95	99	151	3.80	4
AT 12-18	12	18.00	16.70	15.30	10.80	168	168	180	77	6.10	3
AT 12-28	12	28.00	25.80	23.60	17.10	125	125	166	175	8.90	2
AT 12-42	12	42.00	40.00	36.00	26.00	171	171	198	166	14.00	2
AT 12-65	12	65.00	66.20	60.70	42.30	178	178	348	168	22.50	1
AT 12-100	12	100.00	93.80	78.20	52.40	217	214	328	172	34.00	1

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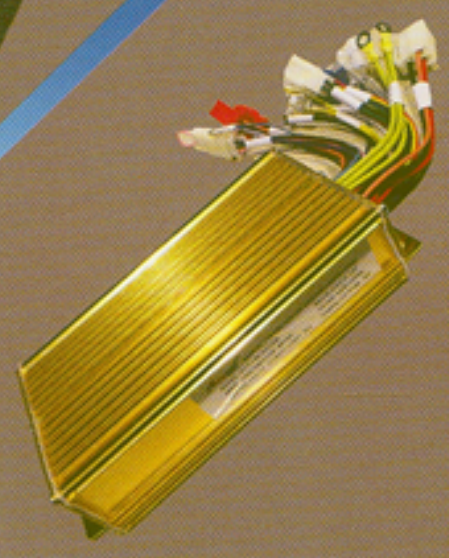
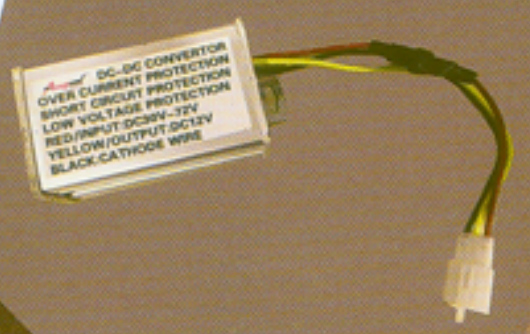
MOTOR CONTROLLER



Amptek Electric Vehicle Accessories



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