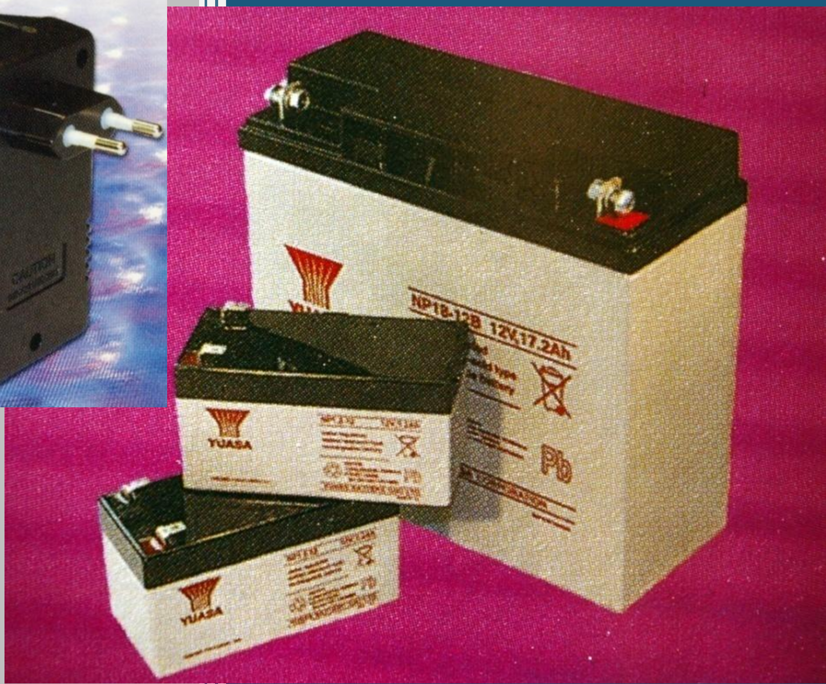
Astrosyn

Guide to Battery Management



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Introduction

Our standard range of battery chargers caters for sealed lead acid, nickel cadmium and nickel metal hydride battery types. Each cell type has certain advantages, and the decision which to use in a particular application may depend on economic considerations as much as technical desirability. A compromise is often needed.

Characteristic	SLA	NiCd	NiMH
Energy Density (Wh/kg)	30	40	60
Volts/cell (nominal)	2.0	1.2	1.2
Operating cycles (typical)	500	1000	800
Self discharge (%/month)	3%	30%	30%
Equivalent series resistance	low	very low	medium
Operating temperature (° C)	5 to 35	10 to 45	10 to 40
Maximum charge rate	0.25C	2C	1C
Charge method	CV	CC	CC
Memory effect	No	Yes	Yes

Battery Charging

The operating life of all rechargeable batteries is determined by four major factors:

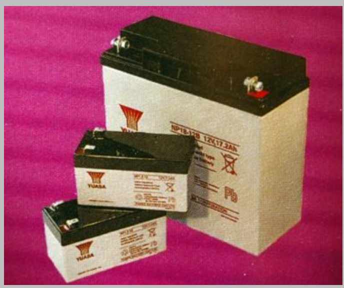
- Rate of discharge
- Depth of discharge
- Operating and ambient temperature
- Charging technique: constant voltage (CV) or constant current (CC).

The first three are determined by the equipment designer, but if the incorrect charging technique is adopted, the benefit of good design is minimised, resulting in battery service life and performance being significantly degraded.

With all types of cells, it is only possible to achieve optimum performance when operating within the correct management of charge and discharge characteristics.

To prevent overcharging, accurate charge termination is achieved by using proven techniques. In addition, intelligent chargers have to accommodate the erratic characteristics of abused, unformed or old cells, as well as the effects of protection circuitry and variations in operating temperature and contact resistance.

Generally the problems are not as pronounced in the constant voltage charging of sealed lead acid cells compared with constant current charging of nickel cadmium and nickel metal hydride cells charged at higher C rates.



SLA Battery Charging

Sealed lead acid batteries require current limited constant voltage charging. Cells should not be charged in less than four or five hours for optimum life (C/4 rate). Accurate charge voltage control is essential.

The charger model is determined by the following application parameters:

- Charge time required
- Cyclic or standby operation
- Operating temperature

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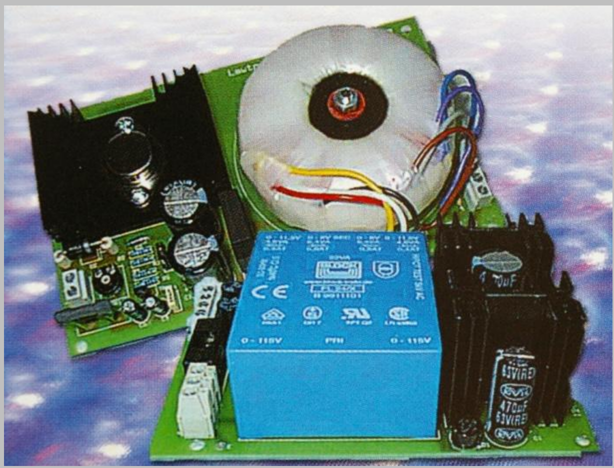
- Initial current limit
- Permissible overcharge



Manufacturers of SLA batteries recommend constant voltage current limited charging either from a basic single voltage taper charger or a multistage charger.

Standby Application

Where the SLA application is for standby use and the battery is seldom required to deliver power a single stage current limited float charger preset to 2.25V/cell at normal temperatures is adequate. At this potential, the battery will not overcharge and may remain connected indefinitely without incurring damage.

Standby and Cyclic Application

The maximum charge voltage recommended by most battery manufacturers is 2.45V/cell with a maximum in-rush current of 0.25C Amps. This limits the safe charge time to approximately 5 hours to reach 90% capacity. Exceeding the voltage or current limit is detrimental to battery life. Some SLA manufacturers permit a larger in-rush current, but the additional cost of the enhanced charger may not be acceptable.

If a single stage charger set at 2.45V/cell remains connected to a battery, the high residual value of trickle current causes overcharge which cannot be absorbed into cells. The excess energy is dissipated as heat, resulting in reduced operating life and performance. Reduction in cell voltage to the float value of 2.25V minimises the overcharge current to a safe, sustainable level, at the cost of increased charge time.

Optimum fast charging is obtained by combining the cyclic and standby modes in a multistage managed charger with a re-forming mode for initial recovery.

If the battery is fully or deeply discharged, a multistage charger initially generates a small forming current to restore the battery to 1.75V/cell (e.g. 10.5V in a 12V battery), before increasing the bulk current to the maximum design limit. The battery voltage then rises towards the limit of 2.45V/cell (14.7V), and the current starts to decay.

When the battery voltage limit is achieved, the charger voltage reduces to 2.25V/cell (13.5V), and the current continues to fall to a trickle. Full battery capacity is recovered when the trickle current falls to 0.01C Amps.

The trickle current continues to decay until the natural maintenance level of approximately 0.001C Amps is reached.

The battery can remain connected to the charger in this state continuously.

In summary, the multistage SLA charging process sequence is:

Step 1

Forming current until discharged cell voltage rises to 1.75V/cell.

Step 2

Bulk charge to 2.45V/cell (approximately 80% returned capacity).

Step 3

Continuous trickle charge at 2.25V/cell, reaching 90% of capacity after 5-6 hours.

SLA Battery Charge Time

The approximate charge time for an SLA battery in good condition and not over-discharged can be calculated as:

Time (h) = (Battery Ah Capacity / Max Charger Current A) + 2h

NiCd and NiMH Battery Charging

Standard Charge

For many applications using NiCd and NiMH batteries, a standard overnight constant current charge for a period of 14 hours is suitable. This equates to a rate of C/10, where C is the Ampere hour capacity of the cell. Extended constant current charge at the C/10 rate has little effect on the overall performance or operating life of NiCd and NiMH batteries. It is however good practice to discontinue the charge within 24 hours to minimise long term effects, particularly when using NiMH cells.
If accelerated fast charge is required at rates of typically C/5 to 2C, the correct management of the charge characteristic is vital to prevent battery damage.

NiCd and NiMH Battery Charge Time

The approximate charge time for NiCd and NiMH batteries in good condition and not over-discharged can be calculated as:

Time (h) = (Battery Ah Capacity / Max Charger Current A) + 20%

Voltage Depression Memory Effect

One effect of continual overcharge and high temperature operation is voltage depression. The voltage of each cell in the battery pack may be reduced by up to 150mV reducing useful operating hours significantly.

This is a more probable reason for loss of capacity

than the near mythical "memory effect", which is only apparent after a cell has been subjected to precise repetitive shallow cycling.

Both voltage depression and memory effect can be removed by a controlled conditioning discharge to a known end point voltage.

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