3. Charging/Discharging

3.1 Charging Methods

The most suitable method to fully charge sealed rechargeable Ni-MH button cells is the constant current charge for a timed period.

Standard Charge

Applicable for all button cell series. Charging is with constant current: 14 h at 0.1 CA.
Occassional overcharging at the nominal charge current (see page 16) is permissible.
In special cases, a 24 hour charge at the nominal current is recommended, to achieve or restore the full performance of the cell or battery. This is a normal measure for:

- First charge to put into operation
- First recharge after prolonged storage
- Deep-discharged cells and batteries, particularly those which have been discharged into reserve unintentionally

Accelerated charge

Accelerated charge means charging 7 hours at 0.2 CA. It is recommended that charging is controlled by means of a timer.

Limited Fast Charge with Voltage Control

Ni-MH button cells can be fast charged with the charge rate, specified for each cell. Because of the relatively low charge current values this is called a limited fast charge (0.5 CA). It is possible to recharge more than 80% of the nominal capacity within 3 h. Charging must be disconnected by 3 hours. The cells must be fully discharged before charged with this method. Limit fast charge is recommended only at room temperature application.

Trickle Charge

Ni-MH button cells are also suitable for trickle charging.
A large number of applications need the use of cells or batteries which are kept at all times in a fully charged state to guarantee an emergency power supply or a standby operation.
To correctly specify a suitable constant charge current regime the following criteria apply:

- Maximum permissible trickle charge current (see page 16)
- Adjustment of the losses of capacity resulting from self-discharge
- Consideration of the charging efficiency as a function of the temperature and charge current
- Minimum recharge time from full discharge

To compensate the constant losses by self-discharge and to be able to recharge a discharged battery, for example due to a mains failure, a trickle charge current of 0.03 CA is recommended.
At these charge rates a life of up to 6 years is to be expected.
A reasonable reduction in life expectancy must be considered, when the battery will be overcharged at the max. permitted over-charge current.

Intermittent Trickle Charge

Ni-MH button cells can also be charged with this method.
As the specified trickle charge is insufficient to fully charge a discharged battery at high temperatures and a constant overcharge at the specified rate or higher limits the life, a modified charging method can be adopted.
The following conditions must be observed:

- Charging of the discharged battery should take place time-controlled with a high rate possible, e.g. 0.2 CA, to recharge the battery quickly after a mains failure
- The following trickle charge should only cover the losses due to self-discharge and bilise the available capacity

For this purpose a two-rate charge is applied, one to fully charge the battery and a second to equalize the battery. The first charge is terminated by a simple timer circuit.
After every discharge of the battery, regardless of the duration, a full charge is applied, e.g. charging for 6 to 7 hours at 0.2 CA. The trickle charge is however different from the previous methods and takes place at intervals.

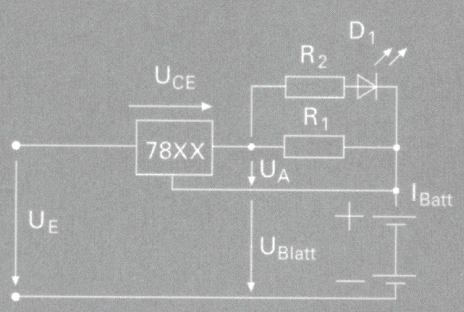
It is recommended that the intervals last at least 1 minute per hour and are at the accelerated charge rate, e.g. 0.2 CA.
In the interests of the life of the battery, however, no more than 10% of the nominal capacity should be recharged per day. This is sufficient to recover completely losses due to self-discharge, which is less than 5% per day.
While the component cost for the electronic timing control is not excessive, the necessary transformer for full charge may not be available in every case. Compromises are therefore necessary and may lead, for example, to the reduction of the charge rate in the full charge stage to 0.1 CA.

Note: Charging of cells connected in parallel must be avoided (Blocking by diodes).

3.2 Recommended Charging Circuits

Standard/Accelerated Charge

Charge circuit for charging cells/batteries at constant current at normal charge and accelerated charge. The charge process has to be interrupted by a timer at the end of the charging period.



$$R_1 = \frac{U_A}{I_{Batt}}$$

$R_2 >> R_1$

$U_E = U_{CE} + U_A + U_{Batt}$

$U_{Batt\ max.}$ at $U_{CE} = 0\ V$

Fig. 9

Trickle Charge

$$R_C = \frac{U_E - U_{Batt\ max.}}{I_C}$$

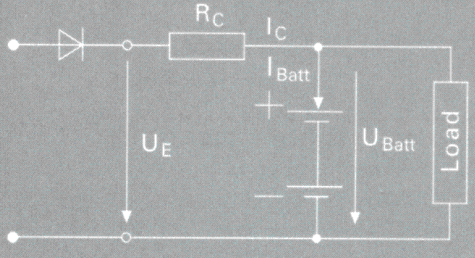


Fig. 10

$$R_E = \frac{2 \times U_{Diode}}{I_C}$$

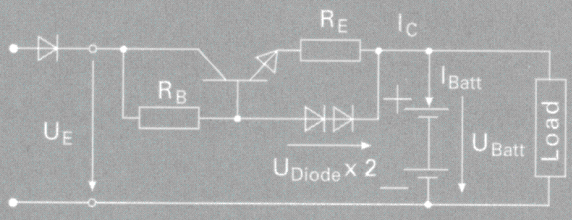


Fig. 11