# 4.2 Reliability and Life Expectancy



Varta Ni-MH button cells/batteries are safe in normal usage and under anticipated conditions of unintentional abuse. Protective devices are incorporated into the cell/batteries to ensure maximum safety. For confirmation of product safety extensive testing of typical abusive conditions has been performed. Features of the high reliability and long operating time at various applications are listed below and in Fig. 22, 23 and 24:

- **Long life expectancy:**
- Cycle application (IEC 509): >1,000 cycles
- At trickle charge:
  up to 6 years at +20°C
  up to 3 years at +45°C
  (up to 5 years at +45°C: V 110 HT)

- **Wide temperature range**
  for standard and high temperature and trickle charge applications

- **High overcharge capability**

- **Excellent cell balance**

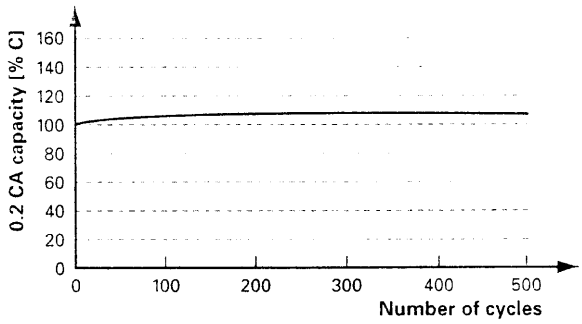



*Fig. 22: Cycling test by IEC standard 509*

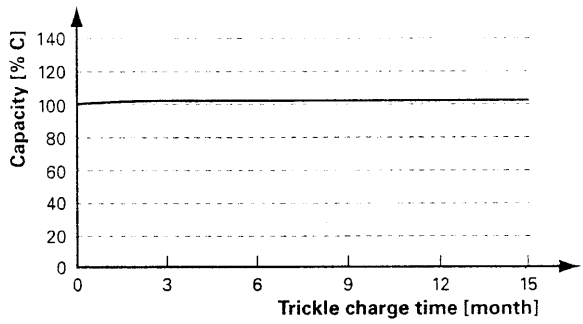



*Fig. 23: Trickle charge test at 45°C of Ni-MH button cells (trickle charge at 0.03 CA)*

Fig. 24
Bridge battery life cycle test of V 80 H cell.

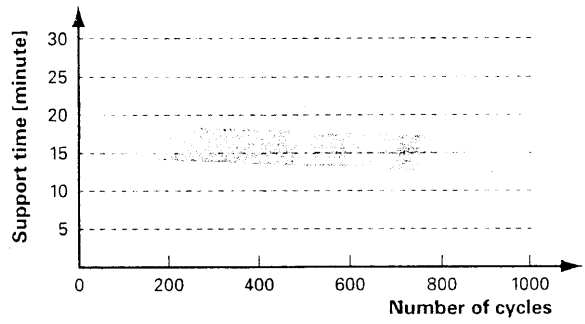
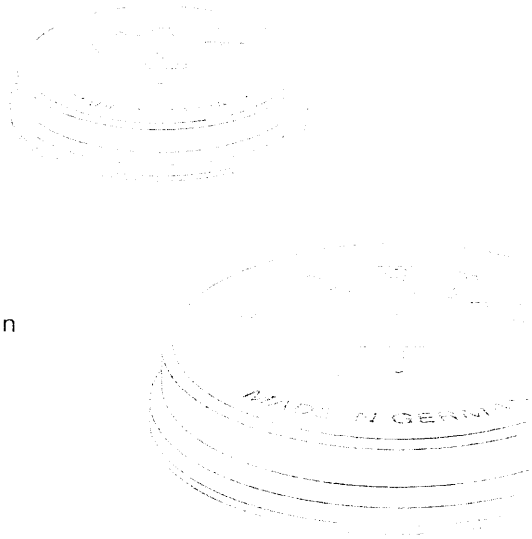



*Fig. 24: Cycling Method: Charge: 8 mA for 85 min. Discharge: 100 mA. Support Time = Discharge Time at 100mA to 0.9V per cell*

# 4.3 Handling and Safety Guidelines





Ni-MH cells are sealed designs which are maintenance free. These products may be used in any operating position. They should be kept clean and dry during storage and operation.
Normally shipped batteries or cells will be in an indefinite state of charge. Some residual capacity may be contained. Therefore caution should be exercised not to short-circuit. Cells or batteries must be charged before use. In order to ensure performance expectations, the following conditions for use and handling are recommended.

## *Charging*

Charging should be conducted as previously described in „Charging Methods" (see pages 14/15). Extended charging outside specified temperature ranges (see page 20) may have an adverse effect on cell life. Also permanent charging at the limits of specified temperature ranges may reduce the battery life. The maximum life is achieved, when charging at an average temperature of 20°C to 30°C.

## *Discharging*

The specified temperature range is from −20°C to +65°C on discharge. Repeated discharges at the extreme temperatures may affect battery life.

## *Safety Guidelines*

- Keep out of the reach of children. If swallowed, contact a physician at once
- Do not incinerate or mutilate, may burst or release toxic materials
- Do not short circuit, may cause burns
- Do not solder the battery directly
- Restrict charging current and time to the recommended value
- Observe charging temperature: 0 to +65°C
- Battery compartment should provide sufficient space for battery to expand in case of abuse
- Either battery compartment or battery connector should have a design that makes it impossible to place the battery in reverse polarity
- Equipment intended for use by children should have tamper-proof battery compartment
- Battery of different electrochemical system, grades, or brands should not be mixed
- Battery disposal method should be in accordance with local and state regulations

# 4.4 Care and Handling of Batteries Assembly

Never solder onto cells directly! Soldering of lead wires directly onto cells can damage the internal components like the sealing ring and other parts. It is recommended that a tag is spotwelded to the cell, on which lead wires can then be soldered.

**Parallel Cell Configuration**
Never parallel cells during direct charging!
Parallel charging may produce unpredictable current distribution into cells. Therefore overcharge and low performing cells may result.
Parallel discharging may result in discharging of one cell to another. Therefore, it is necessary to use blocking diodes between cells connected in parallel on discharging. When designing a battery where paralleling is needed, please consult us.

**Disassembly**
Under no conditions should cells be disassembled. Cells contain potassium hydroxide electrolyte, which can cause injury. In the event that the electrolyte gets on skin or in eyes, immediately flush with water and seek medical advice.

**Incineration**
Do not put cells or batteries in open fire!

**Mixing of Cell Types**
Do not put different cells and capacities in the same battery assembly!
The mixed use of Ni-MH cells with Ni-Cd cells, primary cells, old and new cells, cells of different sizes and capacities in one assembly can lead to either battery damage or poor performance of the device that it is intended to power.

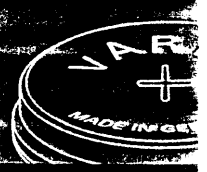
**Contact Terminals**
Battery assembly contact materials as well as contacts in battery holders should have a nickel surface for best corrosion resistance.

**Battery Position**
For optimum life batteries should be shielded or placed apart from heat sources.

**Handling**
Do not pull excessively on lead wires or connectors, as excessive force will cause product damage.

**Vented Battery Compartments**
Airtight battery compartments should be avoided. Under abuse conditions cell venting may occur releasing hydrogen gas. It is therefore necessary for compartments to have an air ventilation.





# 4.5 Storage



Sealed rechargeable Ni-MH button cells from Varta can be operated in any position. Maintenance of the cells is not necessary, they are maintenance-free. However, in operation the cells, like other electrical components, should be kept clean and dry. The cells complete the manufacturing process in the charged state. A considerable period of time can elapse due to assembly into battery units, storage and dispatch before they are taken into service by the customer. Because of self-discharge, the state of charge on receipt can not be precisely defined. Before use, therefore, sealed Ni-MH cells should be recharged.

To ensure long life and trouble-free operation, charging should be carried out as previously advised. Sealed Ni-MH cells can be stored for many years without losing irretrievable functioning in comparison to lead acid batteries for example. Cells can be stored at any state of charge and even fully discharged.
The most advantageous storage temperatures are between 0 and +35°C, at a relative humidity of approx. 50%. Cells should be protected from moisture and contamination.

Before putting into operation, stored cells should be recharged for 24 hours at the nominal charge rate or at a smaller current for a longer time. An extended charge process or a few reconditioning cycles are necessary after longer storage. In this way the cells are reactivated and will achieve their „full capacity" i.e. the activatable present capacity after storage again.

Cells stored for longer periods and which were discharged before storage at the nominal current to a final voltage of 0.9 V, need only one reconditioning cycle.

Direct soldering onto the cells can lead to damage. Ni-MH button cells/batteries from Varta are available with different connectors, e.g. ring solder tags, solder lugs and plug solder lugs for printed circuits.

Button cells and button cell batteries for printed circuit board solder application can be flow soldered in the charged state as long as the soldering time does not exceed a max. 10 secs. The preheating period should also be limited to approx. 10 secs. The specified temperature limits should also be observed with the „Burn-in" tests.

Consult our applications department with regard to the compatibility of cleaning materials for printed circuit boards.

For Ni-MH button cells from Varta there are no restrictions on their operating positions.

In general, referring to Ni-MH batteries – as for any battery – please remember:

- Do not short-circuit
- Do not damage
- Do not incinerate
- Do not handle out of specification
- Keep out of reach of children. If swallowed, contact a physician at once

# 4.6 Definitions

Unless otherwise stated the technical values and definitions based on room temperature conditions (R.T. = 20°C ± 2°C).

The specific energy density of the Ni-MH system amounts to approx. 55 Wh/kg or approx. 180 Wh/l.

**Open circuit voltage (O.C.V.):**
Equilibrium potential 1.25 V to 1.4 V on average, dependent on temperature, storage duration and state of charge.

**Nominal voltage** of sealed Ni-MH button cells is 1.2 V.

**End of discharge voltage ($V_E$):**
The voltage at the end of discharging is 1.1 V to 0.9 V per cell, depending on discharge rate.

**End of charge voltage:**
Terminal voltage after charge of 14 to 16 hours at the nominal rate 0.1 CA, about 1.45 V/cell at room temperature.

**The capacity C** of a cell is defined by the discharge current I and the discharge time t.

**C = I • t**

**I** = constant discharge current

**t** = duration from the beginning of discharge until the end of discharge voltage is reached

**Nominal capacity (rated capacity):**
The nominal capacity C denotes in quantity of electricity in mAh (milli-ampère hours) that, the cell can deliver at the 5 h discharge rate (0.2 CA). The reference temperature is 20°C ± 2°C, and the final discharge voltage 1.0 V.

**Typical capacity:**
The typical capacity is the average capacity at a discharge rate of 0.2 CA to a final discharge voltage of 1.0 V.

**Available capacity:**
Ni-MH cells deliver their nominal capacity at 0.2 CA. This assumes that charging and discharging is carried out as recommended. Factors which affect the available capacity are:

- Rate of discharge
- End of discharge voltage
- Ambient temperature
- State of charge

At higher than nominal discharge rates the available capacity is correspondingly reduced.

Charge and discharge rates are given as multiples of the nominal capacity (C) in ampères (A) with the term CA. Example:
Nominal capacity C = 100 mAh
0.1 CA = 10 mA, 1 CA = 100 mA

**Nominal Charge Current:**
The nominal charge current is the charge rate (0.1 CA) which is necessary to achieve full charge of a cell in 14 to 16 hours, if the cell has been fully discharged.

**Overcharge current:**
Overcharge of 0.1 CA continuously is possible. Permissible current 0.2 CA for occasional overcharging not exceeding 1 year. Frequent overcharge reduces cell/battery life. Overcharge is restricted to room temperature.

**Permanent charge current:**
Recommended current 0.03 CA for capacity retention (also known as trickle charge current).

**Nominal Discharge Current:**
The nominal discharge current of a Ni-MH cell is the 5 hour discharge current (0.2 CA). It is current at which the nominal capacity of a cell is discharged in 5 hours.

$$I = \frac{C}{t} = \frac{C}{5} = 0.2\ CA \text{ when } t = 5\ h$$

The ratio of effective available capacity and capacity input is denoted as charge efficiency.

$$\eta_{Ah} = \frac{\text{available capacity}}{\text{capacity input}}$$

$\eta_{Ah}$ is dependent on cell type, charge rate, cell temperature and discharge rate. In case of nominal conditions maximum $\eta_{Ah}$ value ist approximately 0.8, that means at least 125% charge input of nominal capacity is necessary. In practice a charge input of 140 to 160% at the nominal charge current is recommended.