®AccuCell
by müller-Germany

What is AccuCell ?

AccuCell is an alkaline-manganese battery system that allows recharging while preserving the advantages of disposable alkaline cells. The first batteries of this kind were developed in 1993. The constant improvements in our own and independent laboratories (Research & Development) and dozens of thousands of batteries sold in Germany and across Europe have proved the reliability of the product.

What are the technical features and performance of the AccuCell system?

AccuCell has distincly higher capacity than NiCd batteries in the same size and contains an insignificant percentage of toxic pollutants. It can replace alkaline batteries in nearly all cases. No memory effect and very low self-discharge permit the usage in low drain devices (clocks, backup systems, etc.). The 1.5V voltage is an advantage for use in cameras, pocket computers, electronic toys, calculators and a lot other high tech devices. The use of a special AccuCell charger is essential to maintain the qualities of AccuCell together with avoiding short-circuit or complete drain (<0.9V).

- rechargeable battery with 1.5 Volt
- opens up the world formerly exclusive to diposable batteries: cameras, pocket computers, measuring devices, toys, clocks, backup systems etc.
- similar qualities to alkaline batteries
- highly ecological – contains an insignificant percentage of toxic polluants
- money-saving – few cycles compensate the initial costs against non-rechargeable batteries
- linear discharging – 2/3 longer than other cells (NiCd / NiMH)
- no memory effect at all – no need for discharging before recharging
- insignificant self-discharging – less than 0.2% per month
- comes pre loaded – ready to use immediately
- up to 100 recharging cycles (depending on application)
- requires special (impulse charger)
- should not be repeatedly discharged below 0.9 Volts and should not be left in devices where complete discharge can occur. Short circuit or high current drain damages the cell.
- cannot be used for high power drain devices (e.g. electrical engines in RC models etc.)
- charging with solar cells possible

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SYSTEM – GUIDE:

	Alkaline	Zink-Carbon	NiMh	NiCd	®AccuCell by müller-Germany
Voltage	**1,5 V**	**1,5V**	**1,2V**	**1,2V**	**1,5V**
Self discharge rate (21°C Temperature)	ca. 0,2 %	ca. 0,4 %	ca. 25 %	ca. 20 %	**ca. 0,2 %**
Charged when Purchased	YES	YES	Must be charged before initial use	Must be charged before initial use	**YES**
Disposal Hazard	High	High	Medium	High	**Very low**
Cycle Life	1	1	50-500+	50-500+	**50-500+**
Memory-Effect	Not applicable	Not applicable	low	Yes	**No**
Solar charging	Not applicable	Not applicable	Not suitable	Not suitable	**Yes**
Applications:	Low and medium Power	Low and medium Power	Cordless Phones GSM, Camcorder, Computer	Cordless Phones GSM, Power Tools	**Low and medium Power**
Startcapacity: (depending of application) Micro / AAA Mignon / AA Baby / C Mono / D	 900 2200 5000 12000	 200 500 1500 3000	 480 1200 2500 5000	 250 800 2200 4000	 **750** **1800** **4000** **8000**
Capacity normalized to NiCd performance (capacity in amp-hours)	-	-	about 1.5 (1.0)	about 1.0 (0.6)	**about 2.6 (1.7)**
Weight: **AAA** **AA** **C** **D**	 - 	 - 	 - 	 - 	 **11,2g** **22,0g** **68,0g** **123,0g**

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TYPICAL APPLICATIONS

- Portable radios, Cassette/CD Players
- Sub Notebook Computers
- Medium Power Video Cameras
- Cordless Phones (with AccuCell charging technology)
- Medium Power Cameras and Photoflash
- Portable LCD Television
- Flashlights and Lanterns
- Electric Shavers
- Electronic Toys/Games
- Calculators and Personal Digital Assistants
- Emergency Lighting Systems
- Pocket Pagers, Remote Control Units

Advantages of AccuCell

AccuCell batteries with real 1.5 Volt alkaline power
AccuCell batteries leave the factory fully charged and as delivered have a shelf life of up to five years. Most other systems require extended charging prior to initial use.
AccuCell batteries have good charge retention when stored in the recharged state at temperatures of up to 150 degF (65 degC); Ni-Cd batteries lose their charge within days at that temperature.
AccuCell batteries can be charged at high ambient temperatures (e.g. 113 degF); Ni-Cd batteries have poor or no charging capability at that temperature. Since batteries heat up in solar charges, AccuCell batteries are better suited for solar charging.
AccuCell batteries not suffer from the memory effect and in fact perform better when frequently charged.
AccuCell batteries operated equipment can run longer between recharges due to the higher capacity of the AccuCell battery.
AccuCell batteries reduced pollutants for environmental saftey
AccuCell Low-battery warning circuitry can be simpler due to the shape of the alkaline cell discharge curve.

Technical Data Summary

System : Rechargeable Zinc/Alkaline/Manganese Dioxide
Nominal voltage : 1.5 Volts
Maximum Continuous Discharge Current : up to 1 Amp
Temperature Range : -10 degC to 60 degC
Capacity Retention : >95% after one year at 21 degC

AccuCell Chemistry

Manganese dioxide cathode reaction: $MnO_2 + H_2O + e^- \Longleftrightarrow MnOOH + OH^-$
Zinc powder anode reaction: $Zn + 2OH^- \Longleftrightarrow ZnO + H_2O + 2e^-$
Overall cell reaction: $Zn + 2MnO_2 + H_2O \Longleftrightarrow ZnO + 2MnOOH$
Aqueous potassium hydroxide electrolyte

AccuCell Performance

First Discharge performance

In order to make AccuCell batteries function reliably in rechargeable operation, they are designed differently than single-use Primary Alkaline Manganese cells. AccuCell performance on first discharge is approximately 80% of the performance of single-use Alkaline cells.

Sloping Discharge Curve

AccuCell batteries have a sloping discharge curve at all current rates as shown in figures 1a and 1b. This provide a warning that cells need charging, for example, by distorted sound, slower motor speed, dimmer light, etc. It also permits the use of simple low-battery warning circuitry. The effect of lower end-point or cut-off voltage resulting in increased first discharge performance is also demonstrated in figures 1a and 1b. The cut-off voltage at which a discharge is stopped controls the depth of discharge of the cell. The lower the cut-off voltage, the deeper the discharge.

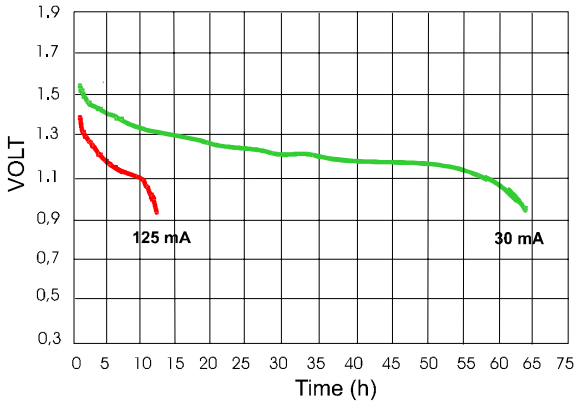

Fig 1a : Initial Performance of AccuCell AA Cells at low to medium Current Discharge

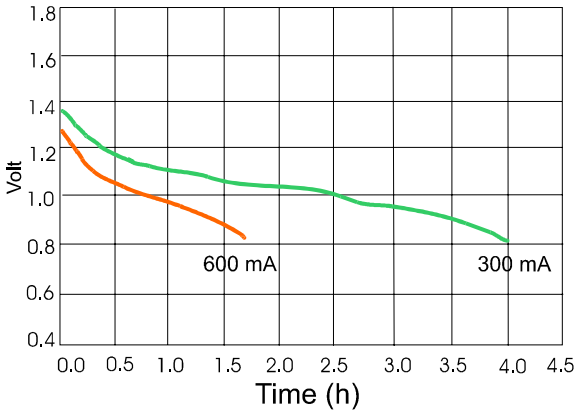

Fig 1b : Initial Performance of AccuCell AA Cells at Moderate to High Current Discharge

Effect of Current Rate

The Ampere-hour (Ah) capacity of AccuCell cells increases with decreasing current rate as shown in figure 2. This also means that the depth of discharge increases with decreasing current rate. Not cut-off voltage.

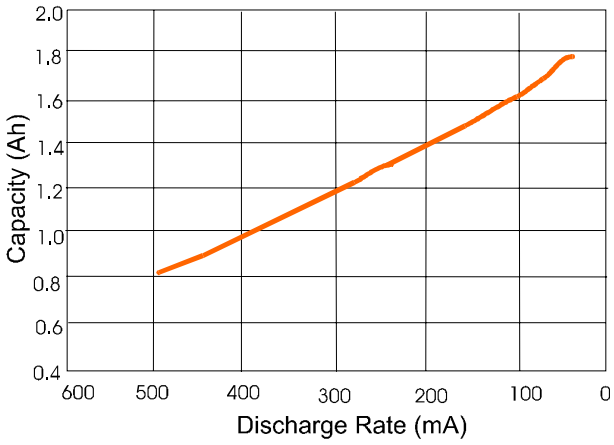

Fig 2 : Initial Capacity of AccuCell AA Cells as Function of Discharge Rate.

Deep Discharge Cycling Capacity Fade

In figure 3, AccuCell'AA' cells are repeatedly deep discharged to 0.9 volts and then recharged. The discharge time and capacity of AccuCell cells decreases or fades with increasing number of discharge/charge cycles. Note that performance would be different to different end-point voltages. Graphics to follow will demonstrate this. In deep-discharge cycling, cumulative performance of AccuCell over 25 cycles is usually 8 to 10 times the performance of single-use Alkaline cells.

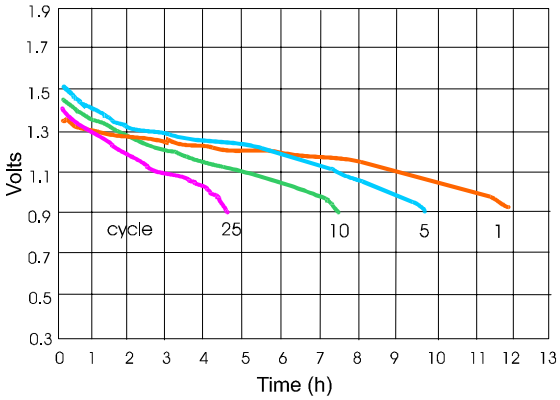

Fig 3 : Deep Discharge Voltage Profile at a Current Drain Rate of 125mA.

Shallow Discharge Cycling Voltage Fade

Figure 4 demonstrates shallow discharge of AccuCell AA cells to one-third of their first discharge capacity

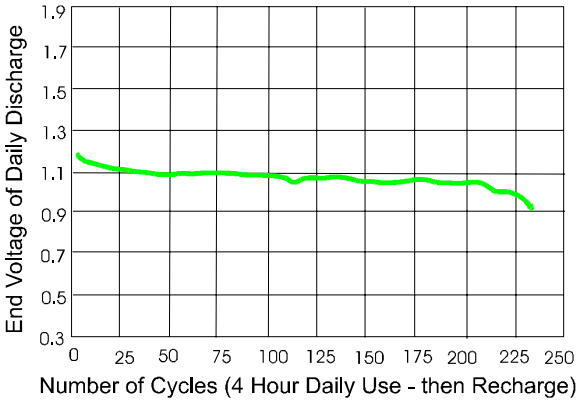

Fig 4 : Cycle Life of AccuCell 'AA' Cells on a 4 Hour Daily Use Pattern at a Drain Rate of 125mA. (e.g. Personal Cassette Player)

Effect of Depth of Discharge

The effect of depth of discharge in shallow discharge cycling is shown in figure 5. As depth of discharge, represented by capacity, decreases, the number of cycles increases, and the cumulative capacity increases. The curves represent 125 mA discharge of AccuCell AA cells to the 0.9 volt cut-off voltage. Graphs to follow will demonstrate the effect of different discharge current rates and cut-off voltages.

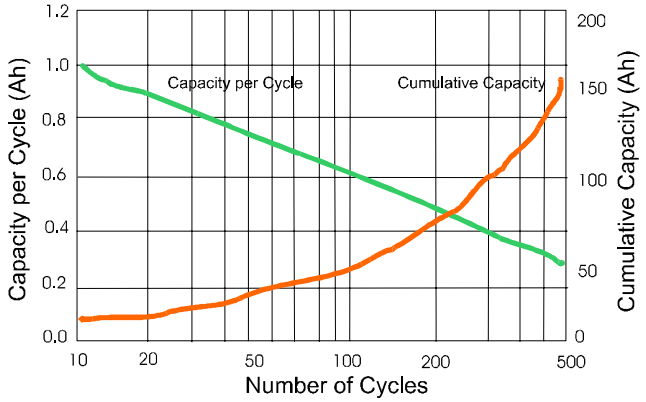

Fig 5 : Performance of AccuCell AA Cells as Function of Depth of Discharge on Cycling (e.g. 0.83 Ah results in 30 Cycles). Recharging after each Discharge.

Effect of Temperature

Figure 6 shows that at low temperatures down to minus 20 degC AccuCell cells function but performance is decreased. The decrease is more severe for moderate and higher rates. At higher temperatures to 50 degC low rate performance is unchanged but performance at moderate and higher rates is improved.

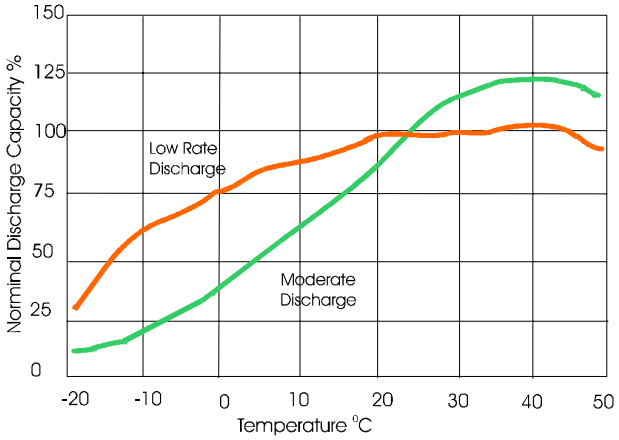

Fig 6 : Effect of Temperature on Capacity of AccuCell Cells

AccuCell Chargering

AccuCell cells can be charged in constant voltage(taper) and pulse chargers.
Both methods limit the end of charge cell voltage to 1.65+/-0.05V. Due to these voltage-controlled charging techniques, no overcharge of AccuCell cells takes place. Therefore cells could be left in the charger for several weeks without diminshing cell performance.

Constant Voltage(Taper) Charging

This is a popular method of charging AccuCell cells as only low cost components are necessary to effectively control the voltage. These chargers perform as shown below in Fig 7

A constant voltage of 1.65+/-0.05V is maintained across the output terminals of the charger. When discharged cells are placed in the charger, the charge voltage drops and maximum current is supplied to the cells. As the cells charge, the charge current tapers off to a trickle and the cell voltage increases towards 1.65V+/-0.05V. Charging times range from 8 to 16 hours for fully discharged 'AA' cells. The actual charge time depends on the size and number of cells, the current supplied by the charger circuitry and the depth of the preceding discharge.

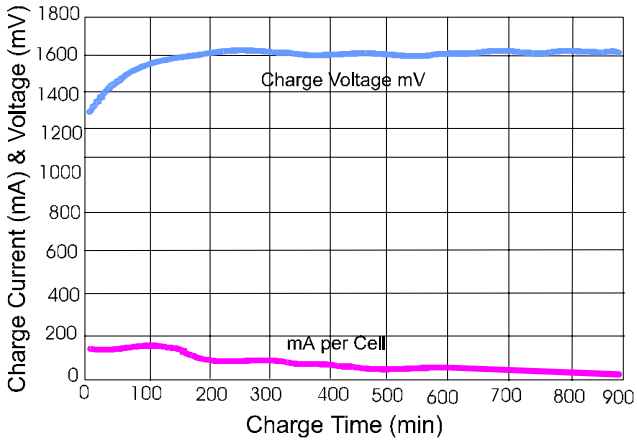

Fig 7 : Typical Charge Curves for Taper Charge of AccuCell 'AA' Cells to 1.65V

Pulse Charging

This is a fast method of charging AccuCell batteries, however relatively expensive microchip charge controls are required. High voltage pulses, usually exceeding the maximum allowable continuous cell voltage of 1.7V are applied to the cells for very short periods of time (typically milli-seconds). When cells are in the fully discharged state, the maximum number of charge pulses are applied for a given time. The actual cell voltage known as the resistance free voltage(RFV), is measured during the interval between pulses. As the cell reaches a fully charged status, the charge pulse rate decreases towards zero. Ideally, a fully charged cell should maintain its RFV at a constant level. However, in practice the cell's RFV drops slightly and charger continually "tops-up" the voltage with 1.7V pulses accordingly.

The characteristics of pulse chargers with microchip charge control are demonstrated in figure 8. Charging times range from 2 to 8 hours, for fully discharged 'AA' cells. Again the charge time depends on the size and number of cells, the current supplied by the charger and the depth of the preceding discharge.

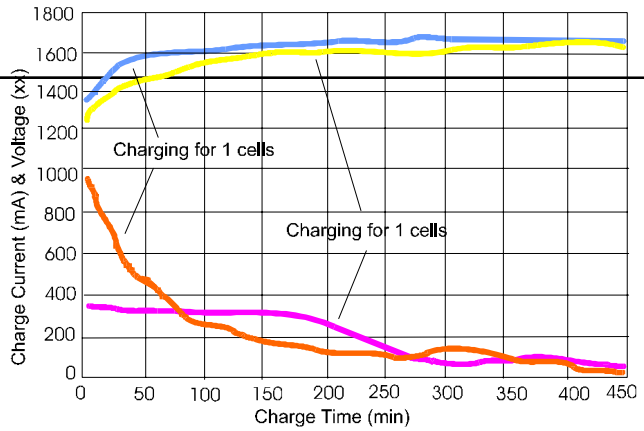

Fig. 8 : Typical Pulse Charge Curves of AccuCell 'AA' Cells in a 4-Up Pulse Charger.

Parallel and Series Charging

AccuCell batteries can be charged in series, parallel or in a combination of both configurations. Whether the cells are charged in series or parallel and where the circuit shall be located is determined by the type, construction, consumer usage and electrical characteristics of the application.

Parallel charging is common when a number of individual cells are being charged. As the number of cells increases, the more powerful and expensive the circuitry becomes. AccuCell has developed several mains and solar powered battery chargers and customer circuits. Special applications, OEM-design can be carried out shortly.

AccuCell batteries are connected in series to increase the power source voltage for many OEM applications, where voltage requirements are greater than 1.5V. These series connected cells are often contained in single battery units, known as battery packs to suit the application. The charge/discharge profile of series connected cells to be used in OEM applications is managed by specialized control circuitry.Such circuits must satisfy certain criteria and are avaliable from AccuCell-Deutschland in various designs. Don`t hesitate to contact for your special application.

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