

BATTERY MANUAL

THE PRACTICAL ADVISOR

All you ever wanted to know
about E-bike batteries.

As on: August 2017



**CHARGING
PERIOD**
BETWEEN 2
AND 6 HOURS



MAINTENANCE
EVERY 12 MONTHS



**E-BIKE
MARKET**
BY +15% IN 1 YEAR



COSTS
600 € ON AVERAGE
FOR THE SPARE BATTERY



BATTERY
AT LEAST
500 CHARGE CYCLES

ACCORDING TO THE DRIVEABILITY UP TO 150 KM

DISTANCE

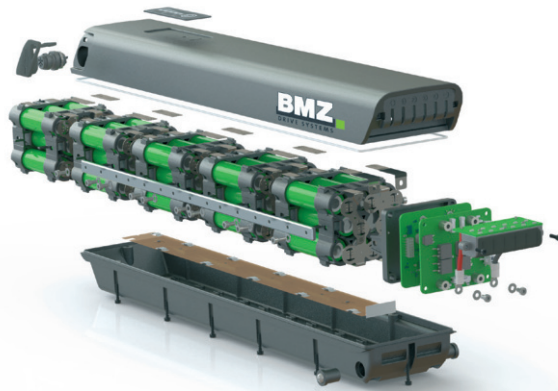


PREFACE

Only modern high-performance batteries enable the mileages of current E-bikes and Pedelecs. However, the fewest users are so familiar with the battery technology, that they know how to handle their efficient energy storage unit in every situation. This battery manual consists of detailed questions taken up and answered in everyday practice, so that you feel safe with your battery on a day-to-day basis. This knowledge provided in this manual should help you to be capable of using your bicycle without fear of contact and to fully concentrate on the actual driving experience.

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01 GENERAL INFORMATION

WHAT TYPE OF CELLS ARE USED IN E-BIKES?

WHAT IS BUILT BY BMZ?

In the foreseeable future, lithium-ion technology will remain the market-dominant system for electric bicycles. BMZ uses only upmarket cells (of Panasonic, SONY, Samsung and LG), which offer high capacities and enable safe handling. The valid standard as of today is cells of type 18650, which essentially show information on the frame size (18 mm diameter at 65.0 mm height). The most common type of cells used are type NCA (Nickel Cobalt Aluminium), NMC (Nickel Manganese Cobalt) and LCO (Lithium Cobalt oxide). The type of cell to be used depends on the requirements for each use.

DO I NEED TO WORRY ABOUT A MEMORY EFFECT?

No, Lithium-ion batteries has no classic memory effect and no lazy effect is seen in case of modern Li-ion-cells. It is recommended to charge the battery to full at the beginning of using the battery after a long break and to then drain it completely, these 1-2 recommended charge cycles. Charge cycles help to calibrate the Battery-Management-System (BMS).

WHAT IS A CHARGE CYCLE?

The statement of the available charge cycles provides information on the frequency of fully charging the battery. If a battery is charged from 0% to 100%, till 80% of the nominal capacity is available.

If the same battery is charged from 10% to 60%, then up to 30% residual capacity is ran empty and then



recharged to 80%, thus the part cycles of the battery are summed up. In this example, the battery in the sum has also experienced a similar charge cycle.

DOES THE BATTERY GET DAMAGED IF I DO NOT HAVE TIME TO FULLY CHARGE IT?

Precisely the opposite. It is optimum for the service life of the Lithium-Ion battery to use it when it is between 30% to 80% capacity. Studies of the cell manufacturer have shown that the service life of the cells extends significantly if they are not fully charged. If a battery pack is always charged to only 80%, then its service life doubles because the high voltage range is avoided, which particularly burdens the cytochemistry.

WHY IS THIS EFFECT NOT BEING USED ALREADY?

This obvious question will be explained by the requirements as of today in the applications. Just as Smartphone manufacturers are concerned about providing enough capacity for an entire working day, even bicycle manufacturers want to offer enough coverage for an extensive bicycle tour. The Li-ion battery technology may already be efficient, but it does not allow the waiver of available capacity, without limiting the essential product properties.

However, it can be foreseen that even long-lasting types can come into the market along with prospective, efficient battery generations.

02 BATTERY MANAGEMENT SYSTEM

WHAT IS A BATTERY-MANAGEMENT-SYSTEM (BMS) AND WHAT ARE ITS FUNCTIONS?

A BMS is an important part of the battery system and ensures that it is used optimally. For this purpose, it performs several functions: It monitors

the starting signals and shutdown signals of the system, prevents excess voltage and low voltages, performs a cell balance, shows the available capacity, communicates with other system components, controls temperature and logs the cell ageing.

CAN I BE INDIFFERENT TO THE TYPE OF BMS IN MY E-BIKE, OR ARE THEY NOT ALL THE SAME?

An efficient BMS ensures that the battery and its cells are protected

optimally and it cannot be damaged while charging nor while discharging. This electronic control system is solely responsible for making the battery “intelligent” and ensures an extended service life and safe use.

03 STORAGE, TRANSPORT, CARE

WHAT SHOULD I BEAR IN MIND IF I DO NOT USE MY E-BIKE FOR A LONG TIME?

If the E-bike and the battery are stored for a long time, then the point is that a potential deep discharge of the battery must be avoided. This means that the so-called final voltage (colloquially: “the battery is empty”) must not be undershot, otherwise the cells can be permanently damaged. A Li-ion-battery can be discharged up to <1% per month, without being used. The battery should be switched to the Deep-Sleep mode for a longer storage, which prevents a self-discharge. Optimum storage is 30 to 50% capacity. The battery must be fully charged again prior next usage. This helps the BMS in the calibration process and to calculate the capacity.

WHERE DO I STORE THE BATTERY IF I DO NOT NEED IT FOR LONG AND WHAT IS THE BEST WAY TO STORE IT?

The E-bike battery should be stored frost-free and cool. The optimum storage temperature is 10 degrees. At these temperatures, the decomposition reactions slow down and thus also the aging. For example, a good alternative would be dry storage in a cool basement.

HOW SHOULD I MAINTAIN MY BATTERY?

The battery pack for your E-bike is an easy-to-maintain product, which requires only little care. Remove dirt of the housing with a slightly damp cloth. The use of a steam jet should be strictly avoided, since the electronics could be damaged.

HOW SHOULD I TRANSPORT MY BATTERY?

If you are going on a holiday with your E-bike, then you can affix it to your car with the appropriate equipment just like any other bicycle. Remove the battery, protect it against short-circuit, moisture and direct sunlight in the car and transport it. In the event of rain on the motorway, the spray water can encounter the battery with a similar pressure as in the case of a steam jet. Cover the open contact sites on the bicycle in order to avoid damages. Important note: Lithium-ion batteries for E-bikes must not be shipped without special packaging and labelling by a forwarding agency or package service.

HOW USEFUL IS IT TO GIVE THE BATTERY TO THE DEALER FOR MAINTENANCE?

You must give your battery to the dealer for maintenance purposes once every year. He is able to install the latest updates of the Battery-Management-System. It can thus be ensured that your battery is optimally adapted to your system with the newest changes. The appropriate testing devices can help the dealer to ascertain that the battery works at maximum capacity utilisation and does not show any damages. Similarly, it can also perform possibly required recalibration.

04 TECHNICAL KEY DATA

WHAT DOES THE INFORMATION OF THE AMPERE HOURS STATE (AH)?

Ampere hours is the information on the nominal capacity, i.e. the amount of electricity stored, which can be obtained while discharging under defined conditions. For instance, one battery with 15 Ah can provide 1 ampere electricity for 15 hours. This information is often equated with the range, where, of course, the drive used also plays a role.

WHAT DOES THE INFORMATION OF THE WATT HOURS STATE (AH)?

The stored energy content of a battery or its nominal energy shall be stated in watt hours. If the battery can provide wattage of 1 hour then it shall supply 1 watt-hour of energy. The energy content of a battery is generated by multiplying the nominal capacity with the nominal voltage of the system (e.g. 15 Ah x 36 Volt = 540 Wh).

05 CHARGING PROCESS

CAN I LEAVE MY BATTERY CONNECTED TO THE CHARGER?

In case of our battery systems, you may leave your battery connected to the charger for a long period. The integrated BMS ensures that the end-of-charge voltage is not exceeded and any damage whatsoever is excluded. However, charging over longer period of time consumes some electricity and also does not render any benefits, which is why you should disconnect the battery and the charger from the mains after the charging is complete.

CAN I USE MY CHARGER OUTDOORS TOO? WILL I LOSE MY WARRANTY IF I USE MY CHARGER OUTDOORS?

You may use your BMZ charger outdoors, but you must bear some points in mind. In no case must the charger come into contact with moisture and water. This also applies to the charging process in the basement or the garage. There is a risk of short circuit. Similarly, an intensive solar radiation must be avoided, otherwise the permissible temperature range can be exceeded.

MAY I USE THE PUBLIC CHARGING POINTS ALONG A TOUR?

Yes, you may. Different providers of public charging infrastructure such as Bike Energy are even certified by BMZ and offer safe and reliable charging. The advantage of these solutions is not only that you do not have to carry a charger, but only need a small, certified adapter cable.

HOW LONG WILL I NEED TO FULLY CHARGE A BATTERY?

You can easily calculate the expected charging period of your system. If you have a 16 Ah-battery and the charger charges with 4 ampere, you can come to a charging period of 4 hours till your battery is fully charged once again.



WHAT IS THE COST OF CHARGING?

Your E-bike is today's affordable type of motorised movement.

The full charging of a 500 Wh battery costs around 15 cent (if a electricity charge of 30 cent/kWh is applied).

06 SERVICE LIFE

WHEN SHOULD I AND WHEN MUST I REPLACE MY BATTERY? AFTER WHICH PRESENT RESIDUAL CAPACITY IS A REPLACEMENT RECOMMENDED?

The battery should be assumed as a wearing part that is not infinitely durable. A capacity loss through usage and ageing according to the calendar cannot be avoided.

BMZ batteries are considered worn out if the residual capacity is less than 60%. However, this does not mean that you absolutely must replace the battery pack at this moment. "Worn out" is not "defective". For instance, if your original range was 80 km and you can now travel only 48 km, but the main use of your E-bike is the way to work at a distance of 10 km, then you can still use this battery for a long period. Your own claims on the preferred range shall be decisive of whether a replacement is required.

HOW MANY YEARS CAN MY BATTERY LAST?

Chemical decompositions ensure that a lithium ion battery as of today shows an average service life of 4 - 6 years. This information can vary

significantly depending on the maintenance and method of handling. The service life of a battery shall be determined by the battery ageing. This cell ageing consists of the calendrical service life and the cycles service life. The calendrical service life takes into account that the battery already loses a part of its capacity by storage alone. Cells produced before 2014 lose about 2 - 3% of their capacity per year, cells after 2014 lose about 0.5 - 1% of their capacity per year.

The exact value depends on the cytochemistry and the average temperature. An average temperature increase by 10 degrees Celsius per year doubles the rate of decomposition and disintegration, which leads to halving of the service life. The duration of the battery also depends on the place of residence.

The cycles service life considers the ageing processes of the battery developing from usage. These depend on the cytochemistry, charging statuses, charging and discharging currents and the operating temperature. The use of the battery using the partial cycles can extend the cycles service life significantly.

07 RANGE

WHAT RANGES CAN I EXPECT FOR MY BATTERY?

Since there are no standardised means of determining ranges at the moment and a large number of criteria influence the range of an electric bicycle, it is difficult to make binding statements.

The following factors have a profound influence on the expected range of the E-bike:

- Battery capacity
- Route profile
- Weight of driver
- Outdoor temperature
- Wind conditions
- Support mode
- Motor system
- Type and weight of bicycle
- Tyre pressure

All this criteria plays a role in the possible range and are different in terms of every ride.



The range of a good E-bike battery is enough to go around the world once.

DOES THE OPERATING MODE OF MY E-BIKE AFFECT THE RANGE OF THE BATTERY?

The higher the selected support degree, the more energy is used by the drive system, which shortens the range accordingly.

08 MINIMIZE RISKS

WHAT HAZARDS CAN BE CAUSED BY MY BATTERY?

Modern E-bike-batteries are very safe products that are used by millions on a day-to-day basis and thus extremely rarely pose a hazard. The statistics provide the reliability of modern battery technology.

WHOM SHOULD I ADDRESS FOR THE DISPOSAL OF MY DEFECTIVE/SCRAPPED BATTERY?

Please contact your dealer in case of questions regarding disposal. He is qualified to support you for technical disposal or he shall take back the battery.

CAN MY BATTERY LEAK?

If used normally, your battery or the cells installed in it cannot leak because it is hermetically sealed. This seal can break off by short-circuit or mechanical influence only in case of misuse. In this case, electrolytes containing skin-irritant substances can leak. Therefore, it is absolutely inadmissible to make direct contact with leaking liquids.

HOW SHOULD I REACT IF THERE ARE MECHANICAL DAMAGES IN MY BATTERY, E.G. AFTER A FALL?

Damaged or potentially damaged batteries must no longer be charged. Similarly, damaged chargers must no longer be used. Contact your dealer to know the further process.



I ALSO RIDE MY E-BIKE DURING WINTER. WHAT SHOULD I BEAR IN MIND DURING VERY COLD CONDITIONS?

+20 degrees Celsius is considered as the optimum operating temperature for the battery.

Accordingly, the battery must not be stored or charged outdoors during winter months. It is better to activate the battery only at the start of the ride.

AT WHAT TEMPERATURES CAN I USE MY BATTERY WITHOUT LIMITATIONS?

An E-bike battery typically has a reliable usage temperature from 0 to 45 degrees during charging. A temperature range from -10 to +50 degrees is allowed during the discharge process. It must be noted that the internal resistance of the battery increases

during very low temperatures and ultimately results in low usable capacity than during summer temperatures. The cold can induce a loss of up to 40% of the capacity. However, this effect is temporary and is raised again when the temperature increases.

CUSTOMER SATISFACTION IN FOCUS



BMZ stands for high-quality and innovative products. However, good products alone are not adequate to satisfy the customers over the entire service life of their products. Thus, we offer competent and friendly service throughout the entire value chain.

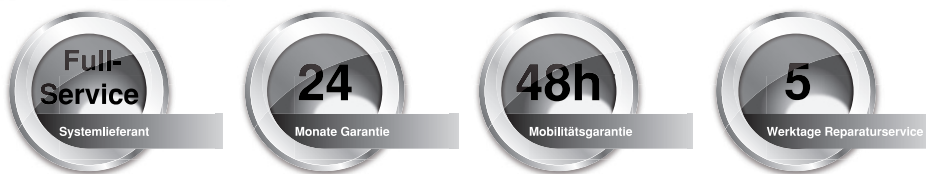
We have the best trained technicians and expert staff working at our fully equipped Service Centre with years of experience. The built-in spare parts are exclusively original components that are carefully inspected before installation.

ADDITIONAL LITERATURE AND ONLINE INFO

Do you find this battery subject interesting and wish to know more about it? You will find more information here:

- Table book of electrical engineering
- Sven Bauer: AkkuWelt
- Isidor Buchmann: Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-engineers Batteries for Non-engineers
- www.bmz-drive.de

INFO



NOTES

Presented by / Specialised dealer:

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