



Support Note

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BEST PRACTICES FOR GETTING THE MOST OUT OF YOUR LITHIUM-ION BATTERIES

Introduction

Lithium-ion batteries are chosen to power devices because of their high energy density, energy efficiency, stable chemistry, ability to handle harsh conditions, and fast charging capabilities.

This support note assists users in understanding factors that affect performance as well as outlining best practices to enable batteries to perform to design specification.

This document is a suitable reference for Trimble data collection devices including tablets, survey controllers, and handheld devices that use lithium-ion batteries, and recognizes that while batteries can vary in size, shape and capacity, there are general guidelines that can be applied to assist in getting the most out of the batteries.

Some sections of this document may not be applicable for all devices depending on the battery configuration of a specific device. For example, mention of external chargers or removing batteries will only be applicable to devices that have removable batteries.

For specific device and battery specifications, please refer to the device user guide, data sheet and support documentation.

Temperature

Lithium-ion batteries are sensitive to extreme temperatures, either high or low; extreme heat and/or cold can affect a battery's ability to store and release energy.

Heat

It is advised to keep the device's batteries out of direct sun for long periods, and not to leave batteries in hot spaces, e.g. on a dashboard of a vehicle in full sun, or any environment where the device is exposed to direct sunlight or high temperatures for prolonged periods. Exposure to direct sunlight equally applies

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to the use of devices in the field as well as during storage and transportation, and it is recommended (where possible) to avoid periods of prolonged direct sunlight exposure.

The long term effect of batteries being stored or operated outside of their specified temperature ranges is a shortened battery life. Immediate effects users may experience if the interior temperature of the device exceeds normal operating temperatures include:

- Device may go into a sleep state until the batteries cool
- Device may not have the ability to charge
- Batteries protective heat fuse may blow, causing battery to cease functioning

If you experience this, it is recommended that you move the device to a cooler location out of direct sunlight and wait a few minutes before trying to use the device again. If the device no longer operates, contact your local support representative.

Cold

In extreme cold, users can also experience reduced run-time of a device. Cold temperatures primarily increase the internal resistance and lower the capacity of the battery. Long term, this leads to reduced battery life due to the battery requiring more frequent charging.

It is recommended that batteries not be stored in extreme cold, and optimally be allowed to warm to room temperature before use to maximize performance.

To improve the battery performance in very cold conditions, consider increasing the load on the battery, such as by adjusting the backlight of the handheld or tablet to full brightness. Increasing the battery load causes the battery to generate heat, thus warming the battery and improving the performance.

Other environmental conditions

When correctly inserted in a device, batteries are sealed from water and dust¹, and are tested for protection from drops, but can still be susceptible to damage in extreme conditions, or if not correctly cared for.

To protect batteries and prolong the life of a battery, it is critical to dry the battery if it becomes wet, especially if battery contacts are exposed to moisture. Make sure contacts are clean and dry before use. Do not intentionally submerge the battery, and take care to avoid unnecessary drops, mechanical shocks, and vibrations.

Charging

Batteries can be recharged at any time; the battery does not need to be empty or low before you recharge it, and while lithium-ion batteries can be over-discharged, it is best to let the battery run to below 10 percent at least once a month before you recharge it.

Battery recharging temperature limits and charging times vary slightly from device to device, however as a general rule, it is advised to charge batteries at room temperature (around 20° Celsius (68° Fahrenheit)).

To ensure correct and safe charging, it is important that only manufacturer-designed charging accessories are used to recharge batteries.

¹ Please refer to device data sheets for environmental protection specifications.

Note - when charging batteries, whether the batteries are inside a device or in an external charger, it is normal for the device and batteries to get warm. However, if a battery gives off extreme heat or a burning odour, discontinue charging. If batteries appear to be damaged, leaking, or if they appear enlarged or to be bulging, discontinue charging and use.

Occasionally a battery may not charge. Reasons for this can include:

- The battery is “dead”. Over time, Lithium-ion will degrade with use. This is a function of the number of charge cycles, how the batteries are charged and discharged, and how they are stored. As the effective capacity decreases, the performance will degrade. You may observe performance slowdown and decreased use-time on a single charge. Eventually as the battery degrades, it will become unusable and will need to be replaced.
- The battery is overheated, or too cold. If you have been using or storing the battery and/or device in a particularly hot or cold environment, the battery may be outside the safe charging temperature range. Sensors in the battery will prevent the battery from charging until its temperature returns to a normal level.
- The battery is stored too long in a device without charge. Even if you have shut down a device, the battery has a circuit that is live as well as an EC (Embedded Controller) in the controller device which will consume a very small amount of power. If the battery is low and a device is stored for extended periods of time without being charged, then the voltage can drop to a point where the EC will not operate. The battery circuit will remain live and keep draining power from the battery pack. Eventually the battery voltage can drop to a point where it may not charge, even when the device is plugged in. See the section below for best practices for storing batteries.
- The battery has malfunctioned. Contact your local support representative to discuss if you suspect that the battery has malfunctioned.

Storage and improving battery shelf life

Always store batteries within the recommended temperature limit of the battery, and for optimal use and longevity, store batteries at room temperature.

The general protocol for any Lithium-ion battery is to make sure the batteries are not fully depleted while in storage, and to store them at ~40% charge.

At a minimum, it is recommended that batteries be checked quarterly.

Make sure when devices are stored, that they are powered down, and wherever possible, remove the batteries from the device to isolate them for long term storage.

Whether stored separately or stored in a device, the battery shelf life will depend on what temperature the batteries are stored at and at what level of charge. Batteries stored in either very high or low temperatures and at a full charge level will hasten permanent capacity loss.

For systems with integrated batteries, put the batteries in 'shipping mode', which disconnects them from the system electrically, reducing parasitic loads to only the battery internal protection circuit.

In general a Lithium-ion battery will have a 2-3 year shelf life whether used every day or stored on the shelf because aging is also a factor in battery shelf life.

Battery saving tips: recommendations for maximizing battery run-time

Battery capacity (and run-time) will decrease slightly with each charge/discharge cycle, so run-time will depend on how often you charge/discharge the battery, as well as other factors such as age of battery, and frequency of full discharge. Frequent short discharges are preferable to consistently fully discharging the battery.

Checking which applications are using the most battery

On devices powered by the Windows® 10 operating system, the OS allows you to see which applications are draining your battery the most. It does this by tracking CPU usage over time, then listing which programs are using the most power.

To access this list, go to **Settings > System > Battery > Battery Usage By App**. This screen shows which applications are using the most battery, and can help guide you on which applications to run (or not run) to maximize battery life. You may want to consider switching to more power-friendly applications if something is unusually heavy, or close background applications that seem to use a lot of power even when you're not actively using them.

Power Save Mode

If you want to extend your battery life devices powered by the Windows 10 operating system, you can enable the Windows 10 Battery Saver mode. Windows automatically enables this feature when you're down to 20% battery by default, but you can manually enable it whenever you like. Examples of how battery saver mode optimizes battery life is by limiting background activity and lowering screen brightness.

To enable Battery Saver mode, click the battery icon in your notification area and drag the Power mode slider to the **Best battery life** point on the left.

To customize when Windows automatically enables battery saver, go to **Settings > System > Battery**.

On devices powered by the Android™ operating system, power saving mode is usually found in the device's settings; go to **Settings > Device maintenance**, then tap the battery icon (bottom left).

There are several other ways to reduce power consumption and extend the battery life, including:

- Minimize the Power & Sleep timeout settings
- Reduce the display backlight
- Offload unused or infrequently used apps
- Turn off sound and vibration (where applicable)
- Lock the screen rotation
- Turn off the radios (Wi-Fi, WWAN, Bluetooth® wireless technology, long range radio modules) when you are not using them.
- Change sync settings (Settings / Accounts / Sync your settings). Deselect the items you don't need.
- Check your location services settings. You may want to turn this feature off if you are not using it.

More Information

If you want to empower knowledge on all things Lithium-Ion batteries, check out <https://batteryuniversity.com/>. It has charts that illustrate different scenarios for battery shelf life and capacity loss of Lithium-Ion batteries. There are suggestions on how to prolong battery life here: https://batteryuniversity.com/index.php/learn/article/how_to_prolong_lithium_based_batteries

General battery warnings

Safe temperature ranges: Always operate devices within the specified temperature ranges, and exercise caution when handling devices in extreme weather conditions.

WARNING – Do not disassemble or open, crush, bend or deform, puncture, or shred a battery. Do not modify or remanufacture, attempt to insert foreign objects into the battery, immerse or expose to water or other liquids, or expose to fire, explosion, or other hazard. Do not expose to temperatures outside of specified limits.

WARNING – Battery safety Lithium-Ion batteries are classified by the U. S. Federal Government as non-hazardous waste and are safe for disposal in the normal municipal waste stream. These batteries contain recyclable materials and are accepted for recycling. Dispose of used batteries in accordance with local regulations.

WARNING – Short circuit potential: Avoid short circuiting of the battery by connecting any of the exposed battery contacts. A short circuit of the battery may cause release of gas and may pose burn hazard.

WARNING – Avoid dropping the device or battery. If dropped, especially on a hard surface, and the user suspects damage to the battery, take it to a service center for inspection. In the event of a battery leak, do not allow the liquid to come in contact with the skin or eyes. If contact has been made, wash the affected area with large amounts of water and seek medical advice.

WARNING – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.

To prevent injury or damage:

- Charge only with dedicated/specific chargers designed for this battery.
- Do not charge or use the battery if it appears to be damaged or leaking.
- Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
- Discharge within the temperature limits of the battery detailed in the specification.
- Discontinue charging a battery that gives off extreme heat or a burning odor.
- Use the battery only in Trimble equipment that is specified to use it.
- Use the battery only for its intended use and according to the instructions in the product documentation.

More Information

Contact your Trimble Regional Sales Manager or local Trimble Distribution Partner for more information.