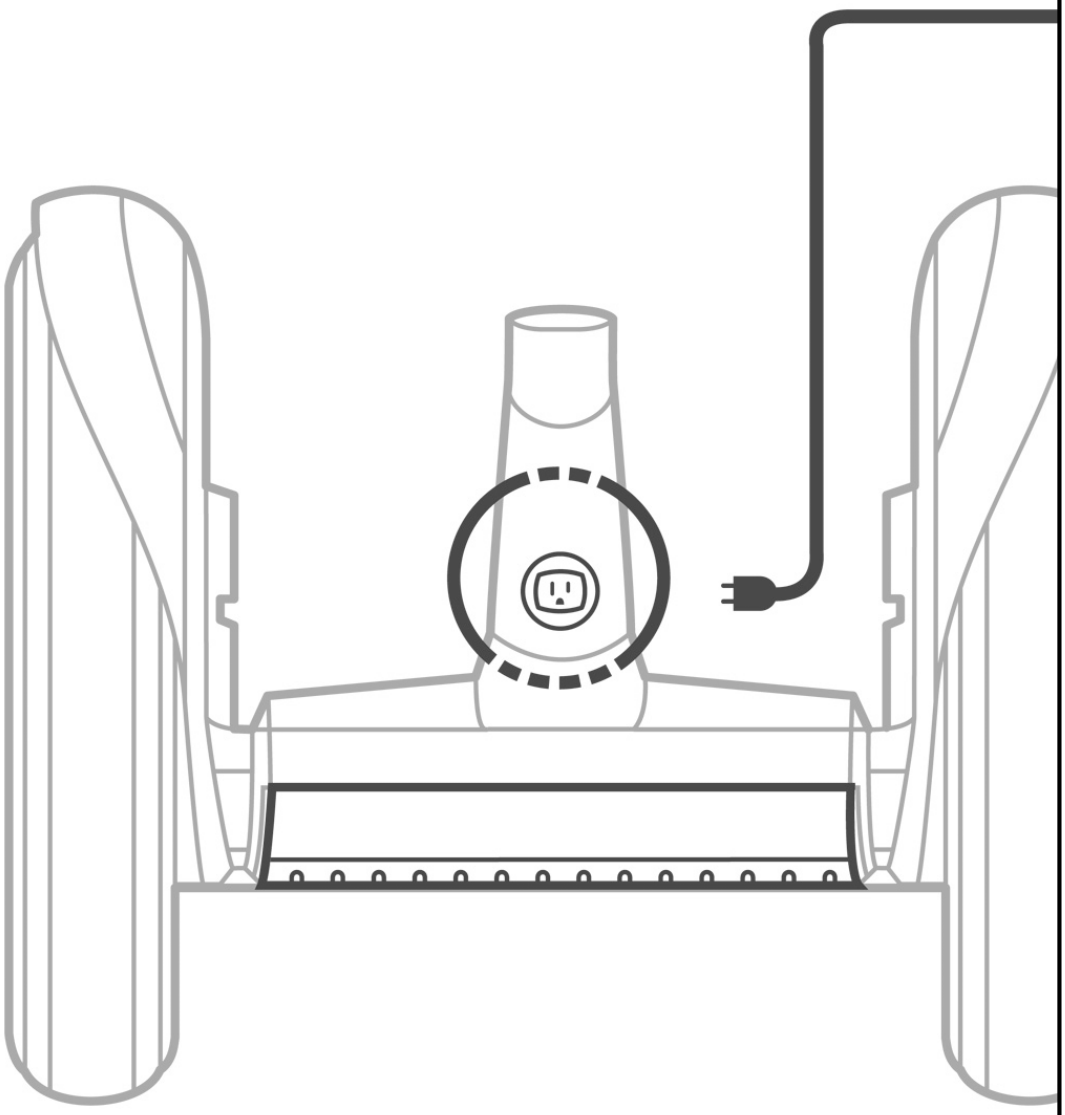
Segway Human Transporter (HT)

Battery Care Booklet
For NiMH Battery Packs



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Welcome to Segway

Congratulations on the purchase of a Segway Human Transporter (HT). You have made a significant investment in personal transportation by choosing the Segway HT. With the arrival of your new personal transportation device, we want to ensure you understand some important considerations for storing and charging your batteries.

Two large, rechargeable, nickel-metal hydride (NiMH) Battery Packs power your Segway HT and are an important component of your riding experience. We encourage you to read this document to understand the best practices for maximizing your battery performance. Over the past few years, we have learned a number of lessons about maximizing battery performance and quality. Also, the Battery Packs are a wear item on your Segway HT, and over time they will need to be replaced. By providing some care to your Battery Packs, you can greatly influence the range and longevity you can expect.

Related Documents

In addition to this document, basic information related to Battery Packs can be found in the "Segway HT Reference Manual", and the "Segway HT Riders' Guide". If you do not have these other related documents, call Segway Customer Operations at 1-866-4SEGWAY (1-866-473-4929) or download them from the Segway web site at http://www.segway.com/support/docs/.

Battery Basics

Know thy batteries:
Sealed nickel-metal hydride (NiMH) batteries offer the best option available today for powering the Segway HT. Although NiMH batteries are at a relatively early stage of maturity, many manufacturers have turned to this chemistry resulting from consumer demand for higher-energy rechargeable batteries capable of delivering longer service between recharges and replacement. Segway has chosen NiMH batteries because of their higher capacity, fast charging, and safety.

It's not a gas tank:
We all are generally familiar with common petroleum fuel storage tanks, such as the gas tank on a car. These tanks have a known, unchanging storage capacity and can usually be equipped with a reliable fuel level gauge. However, NiMH rechargeable batteries do not share these characteristics. Their storage capacity will be affected by both usage history and calendar time. Also, gauging the amount of remaining electric charge is both slow and inaccurate. Their complex electrochemistry makes for complex care requirements that can appear imprecise.

More like a muscle:
Rather than comparing your batteries to a fuel tank, consider them more similar to the muscles in your body. This helpful analogy may facilitate a better understanding of battery behavior.

Keeping healthy:
Your muscular capability depends upon your exercise history. A muscle's performance, when measured at any particular time, depends greatly upon its overall exercise history, in both the short and long term. To keep your muscles healthy, they need regular exercise designed to maintain both their strength and range of motion. Similarly, the battery maintenance guidelines in this document are designed to maximize the health of your batteries so that your Segway HT performs at its best.

Getting healthy again:
When regular exercise is missing, there will be a noticeable change in muscle performance. Getting back into shape takes both time and effort. Muscles that lay idle atrophy - they lose their strength, stamina, and range of motion. If left idle long enough, they may never regain their full potential. Batteries also exhibit similar behaviors but thankfully they can show performance improvements fairly rapidly. Getting your batteries back into shape through exercise is called battery conditioning and will be specifically outlined in this document.

New Battery Packs

Newly manufactured batteries require some exercise to achieve their full potential. When we receive them from the manufacturer their condition is like a newborn foal just mastering walking. However, within just a few charge and discharge cycles, these batteries quickly grow in both measurable capacity and strength, yielding good product range and adequate hill-climbing capability. However, during these first few cycles, some extra care helps ensure long service life. Also, your batteries may have spent some time in storage, the effect of which must be overcome for maximum performance.

During initial use of your Segway HT or with new Battery Packs, you must follow the procedure as described in “Conditioning Battery Packs”.

Storing Battery Packs

A Battery Pack, installed in a Segway HT, is considered “in storage” if it is neither being charged nor discharged for a period of over thirty days.

To ensure the health of your Battery Pack in storage, you must fully charge it before storing it. Then, fully charge the Battery Pack at least every thirty days while in storage. Otherwise, the batteries could incur permanent damage.

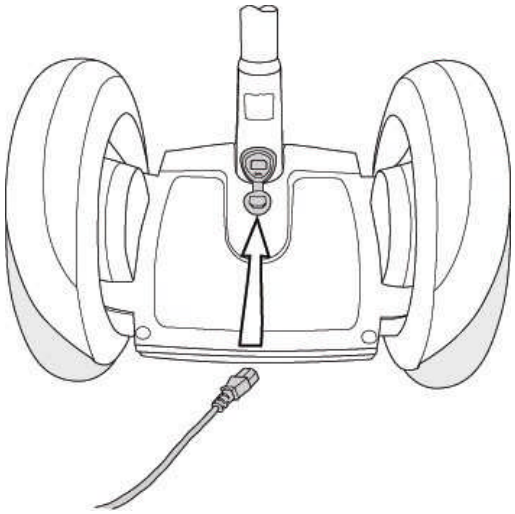
> ***Tip:*** *Battery Packs can also be recharged using the Off-Board Charger.*
>
> ***Tip:*** *Keep stored Battery Packs in a cool, dry location.*

Recovering Battery Packs from Storage

Lack of exercise during the storage period requires a deliberate but short-duration charging routine to get batteries back into shape. To do this, follow the procedure outlined in “Conditioning Battery Packs”.

Charging the Segway HT Battery Packs

Use the following steps to begin charging the Segway HT Battery Packs. In a location where the air temperature is within range, (see section "Battery & Environment Temperatures Affect Charging"):



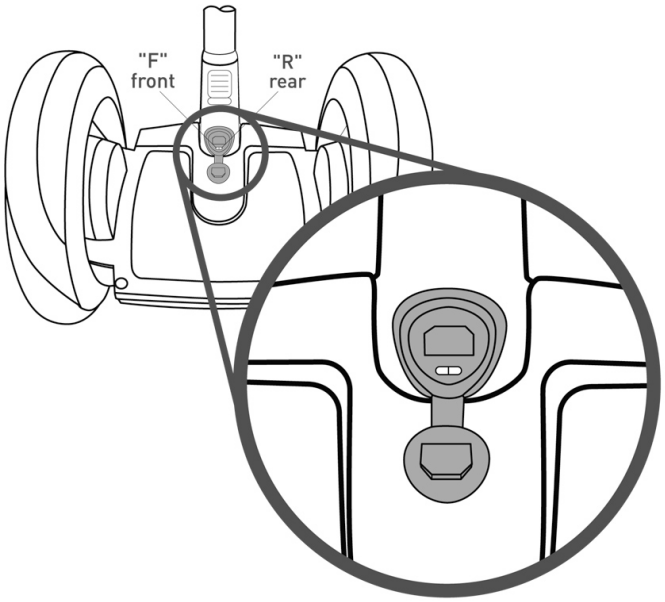
1. *Make sure the Charge Port is dry. Do not insert the Power Cord if it is wet.*

2. *Plug one end of the Power Cord (provided with your Segway HT) into the Charge Port in the Control Shaft Base.*

3. *Plug the other end of the Power Cord into a grounded AC outlet (100V to 240V; 50Hz to 60Hz). If you live in an older home your outlets may not accept this power cord and you may need an electrician to update your electrical outlets. Do not attempt to modify the Power Cord.*

Charging Indicators

The Charging Indicators are located on the Control Shaft Base just below the Charge Port. The left Charging Indicator is marked "F" and corresponds to the front Battery Pack, the right is marked "R" and corresponds to the rear Battery Pack. These Charging Indicators provide independent information regarding the charging state of each Battery Pack.



- ***Green illumination*** *from the Charge Indicator indicates normal operation. See "Four Stages of Charging" section below for detailed descriptions of normal operation.*

- ***Red illumination*** *indicates a faulty charging system or that the batteries have not been installed.*

- ***No illumination*** *indicates a faulty charging system or that AC power is disconnected.*

Four Stages of Charging

A charge cycle consists of four distinct stages to fully charge a Battery Pack. The table shown is a helpful summary and reference. A charging cycle is initiated by plugging the Segway HT or Off-board charger into an AC power outlet.

STAGE	CHARGE INDICATOR	FUNCTION
Battery Monitor	Slow green pulses	Tests battery conditions are suitable for Quick Charge stage.
Quick Charge	Solid green	Battery receives more than 95% of its charge.
Balance Charge	Rapid green pulses	Battery balances all cells equally.
Maintenance Charge	Slow green pulses	Prevents battery self-discharge.

Stage 1: Battery Monitor

Every charge cycle begins at this stage. Two seconds after beginning the charge cycle, the Battery Pack begins monitoring its internal conditions. This stage lasts at least two minutes but can last indefinitely if conditions within the battery are not suitable for beginning Stage 2. See *"Battery & Environment Temperatures Affect Charging"* to understand these conditions in detail. During this stage the Battery Pack charge indicators illuminate with a slow pattern of short green pulses.

Stage 2: Quick Charge

During this stage the battery receives the bulk of its charge, which causes the Battery Pack temperature to increase. This stage can last from a few minutes to about five hours depending upon the initial amount of charge in the battery. During this stage the Battery Pack charge indicators will illuminate solid green continuously.

Stage 3: Balance Charge

During this stage, the battery is pulse charged in a way that balances the charge equally among all cells within the battery. This stage has a fixed length of three hours. During this stage the Battery Pack charge indicators illuminate with a rapid pattern of short green pulses.

Stage 4: Maintenance Charge

During this stage the battery receives a maintenance charge. This minimal charge rate prevents self-discharge between charge cycles. This is especially important while the battery is still warm from Quick and Balance stages when self-discharge will be greatest. This stage lasts indefinitely or until the Segway HT is unplugged. During this stage the Battery Pack charge indicators illuminate with a slow pattern of short green pulses.

Keep these key points in mind:

- *The Battery Pack cannot return to a previous charging stage during **any** single charge cycle.*
- *Restarting the AC power will always restart the charging cycle to **Stage 1.***
- *The charge indicators behave identically during **Stage 1 and Stage 4.***

Battery & Environment Temperatures Affect Charging

The Segway NiMH Battery Pack will respond to certain temperature conditions in a manner that favors maximum battery life. Under these conditions, the charging cycle immediately advances to Maintenance Charge stage, which may result in less than the desired stored charge. The following discussion is intended to illustrate some expected conditions that should be carefully considered so that each charge cycle has maximum benefit.

Temperature is the most important consideration in managing the charge cycle. When your batteries are charging, they are constantly monitoring their internal temperature. Prior to beginning Quick Charge (Stage 2), they check that Battery Pack temperature is within acceptable limits. The Battery Pack will not exit Stage 1 of the charge cycle until Battery Pack temperature is between 0°C (32°F) and 40°C (104°F). During, Quick Charge (Stage 2) if Battery Pack temperature creeps beyond allowable limits then Quick Charge is immediately terminated, the Balance Charge stage is skipped, and the Maintenance Charge stage begins.Thus, charging in ambient temperatures above 32°C (90°F) will interfere with normal charging. As a result, the Battery Pack may not get fully charged.

External environments and **recent usage** greatly influence battery internal temperature. Hot environments (i.e., a Segway HT parked for a few hours in direct summer sunlight on hot pavement) or heavy usage (i.e., non-stop riding in rough terrain or uphill) will cause internal battery temperatures to rise greatly. Also, be mindful of freezing conditions where the Battery Pack is allowed to become very cold. Under these conditions, the Battery Pack is unlikely to become fully charged. Correct these conditions before attempting to charge. Bring batteries to a cool environment away from direct sunlight and allow them to stabilize before initiating a charge cycle. Allow three hours to achieve good thermal stability. Only one hour is required if a fan is used to improve air circulation.

Optimum charging conditions:

Temperature:
41°F to 68°F (5°C to 20°C)

Humidity:
5% to 95% RH

Altitude:
Sea Level to 12,000 ft (3,658 m)

NiMH batteries accept charge best at cool temperatures. That is, less charging energy is converted to heat when charged at cool temperatures. Thus, increasing air circulation during the charge cycle helps by removing heat better so Battery Pack internal temperatures remain cooler.

Tip: Bring your machine to a heated or air-conditioned room to bring it into desired temperature range more quickly.

Tip: If you believe your Batteries Packs have warmed (or cooled) out of the acceptable range, simply allow them to cool (or warm) and restart the charge cycle by reconnecting the AC power.

Battery Pack Condition Affects Range

The distance you can travel on a single charge (range) is affected by many variables.

Temperature	Storing, charging and riding within the recommended temperature parameters will improve range.
Payload	Lighter riders with less cargo will typically get better range than heaver riders with more cargo.
Tire Pressure	Riding with tire pressure below the specified limit reduces range.
Terrain	Riding on smooth and flat terrain improves range; riding on hilly terrain and unpaved surfaces decreases range.
Speed	Riding with consistent and moderate speed increases range; frequent acceleration and deceleration decreases range. Riding against the speed limiter drains batteries faster.
Wind	Riding with a tailwind increases range; a headwind reduces range.
Battery Pack Condition	Properly charged and maintained Battery Packs provide greater range; old, cold, heavily used, or poorly maintained Battery Packs provide less range.

If your range has decreased you may be able to improve performance by checking the above-mentioned variables first. Once you've considered such conditions as temperature, payload, tire pressure and riding style, try to improve range by following the tips in the other sections of this document.

Key Battery Concepts and Tips

Now that you understand the nature of NiMH batteries, the four stages of the charging cycle, and the effects of temperature, the following summary of key concepts and tips will help you to get the best performance from your Battery Packs.

1. Batteries become warm when they are used.

Tip: *Allow Battery Packs to cool before charging. Due to the mass of the Battery Pack, it takes three hours to cool (only one hour when fan cooled) prior to charging.*

2. Batteries charge most effectively when kept cool.

Tip: ***Ideal*** *ambient air temperatures for charging Segway NiMH Battery Packs range from 5°C (41°F) to 20°C (68°F). Warmer temperatures are not harmful but the amount of stored charge may be reduced.*

Tip: *The act of charging will also cause the Battery Pack to become warm. A fan blowing cool air on the batteries will cool them quickly and keep them cool while charging.*

3. Batteries can be Quick Charged and then used immediately.

Tip: *Once the Quick Charge stage is complete and Balance Stage begins, the Battery Packs are essentially full and ready for immediate use. However, during less intense usage periods, the Battery Packs should be allowed to complete the full charge cycle so that charge among all cells becomes balanced. Owners often choose to do this overnight.*

4. Batteries should be fully discharged regularly.

Tip: *A full discharge is not required every time the battery is used, but a full discharge every 10-20 cycles (or 3-4 weeks) will preserve maximum Segway HT range per cycle. This is not harmful and can be done regularly.*

Tip: *A good way to fully discharge your Battery Pack is to ride your Segway HT normally but then allow it to stand riderless against a wall in Balance Mode until it automatically powers off. Then charge normally.*

5. Do not worry about overcharging your Segway HT. Store with AC power connected.

Our bodies provide a continuous source of nutrients to our muscle cells, more during and after strenuous exercise, much less while at rest. Likewise, our batteries benefit from this same basic life support. Even a small flow of charge (Maintenance Charge) keeps the Battery Packs ready for immediate action. When that flow is halted (i.e., storage without AC power connected) the battery immediately begins losing potency, more so when connected to a Segway HT than when sitting on a shelf or pallet. When a battery is denied charge for extended periods, it may eventually self-discharge below its minimum acceptable charge level and suffer from permanent capacity loss. Keep those nutrients flowing.

Tip: *Since your Battery Packs continuously monitor temperature and voltage, you do not have to worry about overcharging. Therefore, always leave your machine plugged in when not in use. The Maintenance Charge stage within the charging cycle will keep the batteries fully charged.*

6. Surface Charge

Surface charge is a common side effect that results in inaccurate battery charge level information when you have not fully charged NiMH Battery Packs.

Whenever you do not fully charge the Segway HT's Battery Packs or when you are not drawing any power for a period of time, there is a possibility of surface charge affecting the battery charge level display. This could cause the battery charge level display to falsely show a greater charge level.

> ***Tip:*** *After you power on, allow at least three or four minutes of Segway HT riding for the battery charge level display to show an accurate estimate of actual battery charge. In cases where batteries were not fully charged, the battery charge level will change during this initial usage period to show actual charge levels.*

Conditioning Battery Packs

Fully charged batteries held for many weeks in storage will need exercise to regain their full performance. With muscles, a single workout session does more to point out deficiencies than improve their condition. In this regard, batteries are a bit more forgiving than our bodies in that they show measurable performance gains after only a few workouts. However, they may require up to five or more workout cycles to get back into peak health.

Athletic trainers teach us to perform exercise movements using a muscle's full-range motion for maximum benefits. Our batteries improve best when cycled from full to empty – their full range of motion. Customers should regularly allow their Battery Packs to become fully empty. The best way to achieve an empty Battery Pack begins by using your Segway HT as usual but rather than immediately recharging, allow the Segway HT to idle until it automatically powers off. A clever method to do this is to allow the Segway HT to stand riderless against a wall while in Balance Mode. Similar to stretching, this low-power drain eases the battery to its minimum acceptable charge levels without risking battery damage. This stretching action maintains the battery's full-range motion that you would then experience as greater usable range. Stretching, or low-power drain to empty, is not harmful to batteries so feel free to repeat this step regularly for maximum benefit.

A healthy person is much better able to endure the hardships of physical labor. Climbing a flight of stairs typically does not cause overheating and shortness of breath. But for couch potatoes, overheating and shortness of breath are frequent occurrences during physical exercise. Batteries, too, have similar characteristics. When a battery is removed from extended storage, the process of charging and discharging causes it to evolve more heat than would normally be expected. This extra heat interferes with its chemical efficiency in a way that has a measurable negative effect on battery performance. Exercise – or conditioning - improves battery efficiency, trains it to produce less heat, and thus gives better measurable performance.

If you are experiencing reduced range, or frequent low battery responses, and you have eliminated other variables (see section *"Battery & Environment Temperatures Affect Charging"*), you can apply the following conditioning procedure to your Battery Packs.

Conditioning Procedure

Before using the procedure described below please be mindful of these key points:

- Allow Battery Packs to **cool** before charging. Due to the mass of the battery, it takes three hours to cool (only one hour when fan cooled) prior to charging.

- **Ideal** ambient air temperatures for charging Segway Battery Packs range from 5°C (41°F) to 20°C (68°F). Warmer temperatures are not harmful but the amount of stored charge may be reduced.

- The charging process causes the Battery Packs to become warm. A fan blowing cool air on the batteries will cool them quickly and keep them cool while charging.

Conditioning Procedure Steps:

1. **Fully charge the batteries.** Important: Before proceeding to the next step, let Battery Packs **cool** while remaining in the Maintenance Charge stage. Allow three hours in the Maintenance Charge stage for adequate cooling or only one hour if a fan is used to improve air circulation. Expect this step to take about twelve hours total.

2. **Fully charge the batteries again:** Yes, unplug the power cord, wait ten seconds, then plug the power cord in again to restart the charge cycle. Be sure the Battery Packs have cooled adequately as described above. This step helps give weakened batteries a full charge. Expect this step to take at least six hours.

3. **Ride your Segway HT** normally to discharge the batteries. Stop riding if the low battery charge level is indicated. *Do not deep discharge by forcing repeated low-battery Safety Shutdowns.*

4. **Fully discharge the Battery Packs:** Allow the Segway HT to stand against a wall in Balance Mode until it powers down. This is a good method to fully discharge a Battery Pack. In general, this step as described, is good practice for maintaining healthy batteries. Warning: Do not attempt to discharge a Battery Pack with an external electrical load, as this will harm the Battery Pack.

5. **Repeat this process not more than five times** to recondition your Battery Pack. In general, double charge cycles (Steps 1 & 2 above) may shorten battery life if performed repeatedly. Good charging habits and regular full discharges should be adequate for maximum battery performance.

IMPORTANT: *You may be able to notice some improved performance by using this procedure. Do not repeat this process on a regular basis since it does not help the useful life of the Battery Pack. Limit using this process to only a few times per year.*

About Nickel Metal Hydride (NiMH) Batteries

NiMH batteries have become familiar to many people because they are found in many consumer devices such as cell phones and lap top computers. They are capable of storing a large amount of energy for their size, and they recharge quickly and easily. However, the Battery Packs that power your Segway HT are not just ordinary NiMH batteries.

Characteristics of Your NiMH Battery Packs

The Segway HT uses twin NiMH Battery Packs designed to deliver the highest power of any currently available NiMH chemistry, optimized to maintain the Segway HT's balance under severe conditions.

Construction and Features

Each Battery Pack consists of an array of high-capacity sub-C size cells and a custom-designed circuit board enclosed in a thermoplastic battery box. The circuit board constantly monitors the temperature and voltage within the pack. Under normal operation, the Segway HT constantly monitors both Battery Packs and automatically adjusts to drain the batteries evenly. In the unlikely event of a Battery Pack failure, the system is designed to use the properly functioning Battery Pack to operate the Segway HT and allow the Segway HT to continue balancing until it is brought to a safe stop.

Storage

Your NiMH Battery Packs will self-discharge if they are not plugged in. This is a common characteristic for all NiMH batteries. If your Segway HT will be idle for 30 days or more, be sure to read the section: Storing Battery Packs.

Expected Life Cycle

As with all NiMH batteries, over time, the cell components become unable to sustain the chemical process that produces electricity and they will wear out. Your Segway HT Battery Packs can be repeatedly charged and discharged for about 300 to 500 full cycles. As the Battery Packs age, you will notice reduced range compared to the range you experienced when they were new.

Safety

When handled as directed, your NiMH Battery Packs will provide safe operation of your Segway HT. However, all Battery Packs contain toxic materials that, if improperly released or handled, could be dangerous. Do not attempt to open the Battery Pack casing, and avoid dropping the Battery Packs or other actions that could cause damage. Additional information on handling and safe disposal of your Battery Packs is included in this document.

Storage and Transportation

The environment in which the Battery Packs are stored will affect Battery Pack performance. Avoid extremes of temperature and humidity. The specific humidity, temperature, and altitude ranges to preserve the full performance capabilities of the Segway HT are as follows:

Storage and transport conditions (less than one month only):

Temperature:
-4°F to 122°F (-20°C to 50°C)

Humidity:
5% to 95% RH

Altitude:
Sea Level to 40,000 ft (12,192 m)

Store Battery Packs indoors whenever possible to protect them from temperature extremes.

Use caution when handling and transporting Battery Packs. Ensure that Battery Packs are secured against movement and damage that could occur when in transit.

Before handling a Battery Pack, check the Battery Pack casing to ensure that it is intact. Do not handle a Battery Pack that is leaking.

ORDERING ACCESSORIES

Contact Segway LLC at 1-866-4Segway to order additional Battery Packs or chargers.

NiMH Battery (1)
NiMH single (1) replacement battery for any Segway HT. Please specify model when ordering. (Batteries are generally *sold in pairs*.)

MSRP: $295.00 (i or e Series only)
Item # 1688400002 Titanium
Item # 1000600002 Midnight Blue

MSRP: $265.00 (p Series only)
Item # 1688300002 Titanium

Off Board Charger
The off board charger is an external battery charger that allows you to charge two (2) spare batteries for use in your Segway HT. It can be used for all Segway HT battery types. Includes power cord and instructions.

MSRP: **$295.00**
Item # 1736100001

Safe Handling

Do not attempt to open the Battery Packs. Never insert any object into the Battery Packs or use any device to pry at the Battery Pack casing. Insertion of objects into any of the Battery Pack's ports or openings could result in electrocution or fire. The cells within the Battery Packs contain toxic substances. If the casing of a Battery Pack is broken or if a Battery Pack emits an unusual odor or excessive heat or leaks any substance, do not use the Battery Pack. Do not handle a damaged or leaking Battery Pack unless you are wearing disposable rubber gloves. Dispose of rubber gloves and damaged Battery Pack properly in accordance with regulations governing disposal of toxic materials.

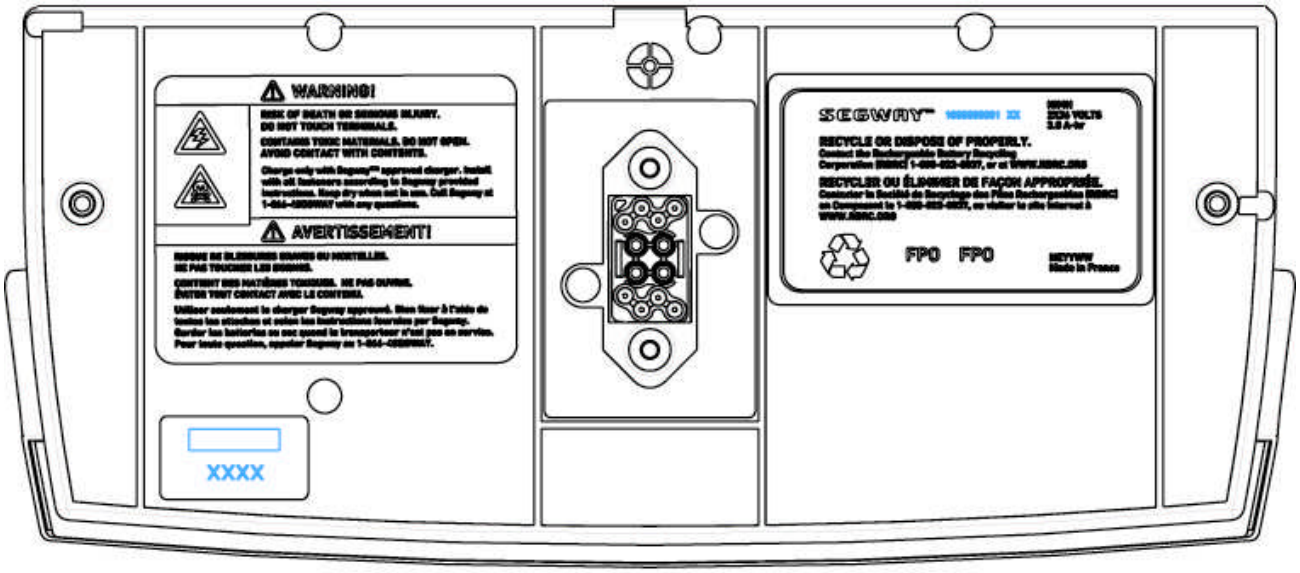
WARNING

Use care when handling Battery Packs. If you are transporting your Segway HT, be sure to protect the Battery Packs to avoid damage during shipment.

Keep Battery Packs out of reach of children and pets.

Read and follow the warning label on the Battery Packs.

Follow these instructions carefully. Failure to follow these instructions carefully could damage your Segway HT and render it unsafe to use.



DISPOSING OF NIMH BATTERY PACKS

At the end of their useful life, you should dispose of your NiMH Battery Packs through an approved recycling program. [redacted]

[redacted]

[redacted]

The foregoing information relating to a specific recycling service was intentionally redacted at that company's request.