

# All Charged Up, Battery Charging/Changing Options for AGCs

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Jervis B. Webb Company's SmartCart® Automatic Guided Cart (AGC™) is a flexible and cost-effective Automatic Guided Vehicle (AGV) that is guided by magnetic tape. SmartCart AGCs are ideal for moving products on an assembly line or transporting goods throughout a plant or warehouse. They provide flexibility not only for modifying your system and guideway, but also in terms of battery charging options. There are several battery charging methods available including manual battery exchange/charging, automatic charging, opportunity charging and automatic battery exchange. The main difference between these methods is the amount of labor required to maintain and charge the batteries. The simplest but most labor intensive is manual battery exchange and manual battery charge. The most commonly used method is opportunity charging because it requires no labor. Opportunity charging also optimizes battery life because battery levels and charging are monitored automatically.

## Manual Battery Exchange

Manual battery exchange requires

labor to be available when the battery is low. The battery level is monitored by the SmartCart and Cart Management System (CMS). When the battery level is between 50% to 75% Depth of Discharge (DOD), the SmartCart is directed to a battery exchange area for manual battery exchange.

Exchanging a battery at 50% DOD extends battery life, but increases the number of battery packs and labor cost. Manual battery exchange also requires a designated area and exchange equipment.

## Manual Battery Charge

Manual battery charge also requires labor to be available when a battery is low. There are two methods for manual battery charging. With on-shift charging, the battery level is monitored by the SmartCart and CMS. When the battery level is at 50% DOD, the SmartCart is directed to a battery charge area and manually placed on a charge.

Off-shift charging involves manually plugging all SmartCarts into chargers at the end of the shift and allowing the batteries to charge during the

off-shift. This method is commonly used for single-shift and two-shift operations. It requires the SmartCarts to be at the charge station at the end of the shift. It also requires chargers and charge stations for each SmartCart in the system.

Charging a battery at 50% DOD extends battery life, but may increase the number of battery packs required on the SmartCart, which would increase initial cost.

## Automatic Charge

Automatic charge works similarly to manual battery charge, but requires no labor. There are two methods for automatic battery charging: on-shift and off-shift. With on-shift charging, the battery level is monitored by the SmartCart and CMS. When the battery level is at 50% to 75% DOD, the SmartCart is directed to a battery charge area and automatically placed on a charge.

Off-shift charging involves automatically charging all SmartCarts at the end of the shift and allowing the batteries to charge during the off-shift. This method is commonly used for single-shift and two-shift operations.

It requires the SmartCarts to be at the charge station at the end of the shift. It also requires chargers and charge stations for each SmartCart in the system.

With automatic charging, floor plates are connected to chargers and installed at designated charge locations. When a SmartCart reaches a charge location, spring-loaded shoes come in contact with the floor plates. A contactor energizes connecting the battery to the floor plates, which charges the battery. The SmartCart does not move when the contactor is energized and the spring-loaded shoes only energize when the SmartCart is in position. The charger is “smart” and detects if a battery is connected to it before it turns on, so there is no electric shock hazard associated with touching the floor contact plates.

Charging a battery at 50% DOD extends battery life, but may increase the number of battery packs required, which increases initial cost.

## Opportunity Charge

Opportunity charging is the most cost-effective method to charge SmartCart batteries. It is a proven method for extending battery life and avoiding labor cost. Opportunity charging is a more sophisticated method of automatic charging. In an opportunity charge system, chargers are placed at various stations where the SmartCarts are idle for a minimum of 50 seconds, such as work cells or load transfer stations. Char-

gers can also be strategically placed throughout the system to charge the SmartCarts as needed. Like automatic charging, all of the chargers are connected to floor plates. When a SmartCart reaches a charge location, spring-loaded shoes come in contact with the floor plates. A contactor energizes connecting the battery to the floor plates, which charges the battery. The SmartCart does not move when the contactor is energized, and the spring-loaded shoes only energize when the SmartCart is in position. The charger is “smart” and detects if a battery is connected to it before it turns on, so there is no electric shock hazard associated with touching the floor contact plates. The chargers also monitor the voltage to ensure the battery is not over charged or damaged.

The CMS monitors the batteries to determine when they are low and very low. When a battery is low, the SmartCart is directed to a charge station. When a battery is very low, the SmartCart is flagged as needing a maintenance charge. The very low condition is a rare occurrence and would only occur as a result of a component failure.

Opportunity charge systems allow the SmartCart system to run 24/7 without manual intervention. Battery DOD or discharge is maintained between 10% and 50% to optimize battery life. Typical opportunity charge systems limit the battery DOD to 10% to 20% between charges.

There are two types of opportunity charge systems – standard opportunity charge and fast charge. Both work the same, but use different types of batteries and have different charge rates.

## Standard Opportunity Charge

Standard opportunity charge system uses Group 31 Absorbed Glass Mat (AGM) batteries. Charge rate is up to 0.4 C (40 amps per 100 Amp Hour (AH)).

## Fast Charge

Fast charge system uses Group 31 Thin Plate Pure Lead (TPPL) batteries. Charge rate is up to 2 C (200 amps per 100 AH). The TPPL battery lasts 50% longer than the standard AGM opportunity charge battery, but increases the initial cost by 60 percent. The main advantage of this battery is the ability to charge at higher rates. The extended life of the TPPL batteries offset the initial cost. The TPPL battery costs are justifiable if they help reduce the number of charge stations and SmartCarts in the system. Fast charge is commonly used at facilities that have extended shifts and/or limited time during the off-shift to charge.

## Automatic Battery Exchange

In an automatic battery exchange system, the battery levels are monitored by the SmartCarts and the CMS. SmartCarts are directed to the automatic exchanger when the battery level is between 50% and 75%

DOD. The battery is automatically exchanged for a fully-charged battery. The low batteries are then automatically charged.

Automatic battery exchange is cost prohibitive for systems with a small number of SmartCarts. The initial investment includes the costs of the exchanger and at least two battery packs per SmartCart. Fast charge has proven to be a more cost-effective solution for both small and large SmartCart fleets.

Automatic battery exchange is not available as a standard option for SmartCart systems.

## Batteries

SmartCarts use either Group 31 AGM or TPPL batteries. Both batteries are maintenance free, and are the best on the market in their class. These batteries have excellent charge characteristics and can withstand 100% DOD. They are more expensive than sealed wet cell batteries, but are worth the investment because they last longer and can tolerate deep discharges. Also, these batteries do not require equalize charging. Other sealed batteries require weekly to monthly equalize charging, which will increase the number of SmartCarts in a system and the quantity of battery packs.

### Group 31 AGM Battery

- Sealed maintenance free
- Fault tolerant to 100% DOD
- Charge rate up to 0.4C (40 amps per 100 AH)
- No equalize charge required

### Group 31 TPPL Battery

- Sealed maintenance free
- Fault tolerant to 100% DOD
- Charge rate up to 2C (200 amps per 100 AH)
- No equalize charge required

## Battery and Charge Option Matrix

Charge Option	Rating	Manual Intervention	Battery Type	Battery Life	Initial Cost	Fleet Size	Long Term Cost
Manual Exchange	Fair	High	AGM	Fair to Poor (Depends on battery exchange attendant)	Low to High (Requires additional battery packs, at least 2 per Smartcart)	Minimum impact	High (Requires multiple battery packs per SmartCart. Increases battery cost for battery replacement.)
Manual Charge	Fair	Minimum	AGM	Fair	Low	Minimum impact on 1 shift operation. Maximum impact on 3 shift operation.	Low to High (Cost may increase for two-shift operation)
Automatic Charge	Fair	None	AGM	Good	Medium to High (Requires additional SmartCarts and one charge station per SmartCart)	Minimum impact on 1 shift operation. Maximum impact on 3 shift operation.	Medium
Opportunity Charging Standard	Very Good Highly recommended for two-to-three shift operations	None	AGM	Very Good	Low to Medium (Cost varies based on available idle time and impact on fleet size)	Minimum Impact	Low
Opportunity Fast Charge	Excellent Highly recommended for two-to-three shift operations	None	TPPL	Excellent	Low to Medium (Cost varies based on available idle time and impact on fleet size)	Minimum Impact	Low
Automatic Battery Exchange	Good (Not standard for SmartCart)	None	AGM/TPPL	Fair	High (Requires large fleet to justify cost. Fast charge is more cost effective)	Minimum Impact	Medium (Requires multiple battery packs per SmartCart. Increases battery cost for battery replacement.)