

POWERCART – PC2

USER MANUAL

PRIME HEAT, INC

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SYSTEM OVERVIEW

The Prime Heat PC2 Production Line consists of eight key components: Track, PC2s, a CartCom Laptop, a CartLord Monitor, Charge Rails, Track Switches, and Cart Stops.

The PC2 is an ETL listed product, conforming to ANSI/UL-583 for use in Class 1 Division 1 Hazardous locations. Other track items are labelled UL-508A where applicable. Three explosion-proof boxes house the controls for the cart: one for the battery, another for the Microcontroller, and a third for the Intrinsically Safe circuit. Each cart is powered by a **12v Direct Current (DC) Sealed AGM Battery** and propelled by a direct-drive gearbox and an explosion-proof permanent magnet 12v DC motor. The cart is controlled by a Prime Heat Microcontroller with ZigBee Communication and wireless programming capabilities.

There are two types of sensors on the cart. There are a total of 4 Magnetic Reed (MR) switches on the cart. Two MR switches provide ON/OFF operation as Kick Switches on each side of the cart, one Normally Closed MR switch stops the cart if the Tabletop is turned, and one MR switch controls Track Magnet stops around the production line. A 2lbs. Touch Bumper sensor stops the cart when in contact with something on the front bumper.

The **maximum load** of a standard cart is **550 lbs.**, and the cart operates at **~33-36 feet per minute (FPM)**. The standard table-top is 3' x 8' and is generally covered with a sheet of standard ½" OSB. The Bumpers extend ~6" on each end. A cart with an 8' Tabletop would thus have an overall length of 9' bumper to bumper.

The track is ¾" tall and 1" wide extruded ABS plastic. It is used throughout the cart line. 3/4" by 1" Steel track is sometimes used for track radii, inside Prime Heat ovens, and spray booths.

The cart should be charged on an inline Charge Rail for **3 minutes per every 100 feet**. The Charge Rails are supplied with a current maximizing Prime Heat Charger with an output voltage of 15.5 VDC. The Charging Rails are located predominantly inside the Prime Heat HALCON curing oven but may be located anywhere **EXCEPT within ten feet of a spray booth opening**. The cart must stop on the rail by an in-track magnet to charge.

CartCom laptops are mobile diagnostic and programming devices for the carts. It lists the nearest 8 carts and diagnostic information on each, including: battery voltage, charging status, Bumper and Table-Top status, and the Kick Switch status. Following the onscreen directions will lead to more diagnostic and programming options, as well as the ability to Reboot a cart's Microcontroller if necessary. In addition, the CartLord is a fixed position monitoring system. It displays information on every cart in range, including battery status, charging status, Bumper and Table-Top status, and the Kick Switch status. It updates itself every 3 minutes or when refreshed by an operator. It can START/STOP all carts at the end of shift, as well. Some facilities may need a Signal Repeater for START/STOP due to signal interference or distance.

Track Switches allow the line to diverge into multiple lines or the multiple lines to merge into one. The carts are stopped prior to diverging and released when the controller receives a signal that a side of the track is empty. The carts are also stopped prior to merging together to allow only one cart to enter the merge line at a time. The switches are pneumatic actuators with 12v solenoid air valves that are controlled by a Track Switch Control Box. Floor mounted Metal Proximity Sensors and RFID Antennae provide cart presence information to the Track Switch Control Box, automation displays such as Load/Unload Stations, and Cart Stops.

SAFETY

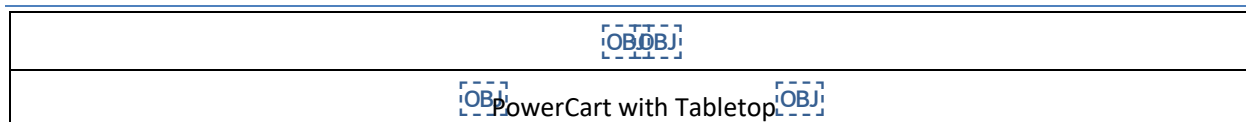
IMPORTANT

DO NOT CHARGE CARTS WITHIN
HAZARDOUS AREAS

CHARGING STATIONS MUST BE LOCATED A
MINIMUM OF 10 FEET FROM HAZARDOUS
AREAS AND MUST BE SUPPLIED WITH FREE
AIR VENTILATION

CHARGING SYSTEM UTILIZES 120 VAC
NEMA 1 CONFIGURATION
THIS NOTICE COMPLIES WITH NFPA-70 &
NEC-2005
MAXIMUM LOAD 550 LB.

POWERCART OVERVIEW



The **PC2 PowerCart** is extremely user friendly when well maintained. For the cart to run both Kick Switch Sensors must be in the *ON* position, the Touch Bumper must not be in contact with anything, and the Tabletop must be in the *détente* position aligned with the sides of the PC2's bumper and body. There are two Kick Switch Sensors on the PC2, located in the middle under both sides of the cart body. When the Kick Switch Plate is pushed *inward* the Kick Switch is in the *ON* position; when the Plate is *flat*, the Kick Switch is in the *OFF* position.

When running, the Touch Bumper should stop the cart indefinitely when in contact with an object in front of it. After being disengaged, the cart will delay one second before slowly ramping up to full speed (Soft Start) over a period of ~3 seconds.

The cart can be stopped for programmable time increments anywhere on the production line by installing a magnet into the track. To install a magnet into the track, use a 5/8" drill bit to drill into the track. Countersink the magnet until it sits about 1/4" above the top of the track. Glue the magnet into the track using epoxy. Let the glue dry before operating the line.

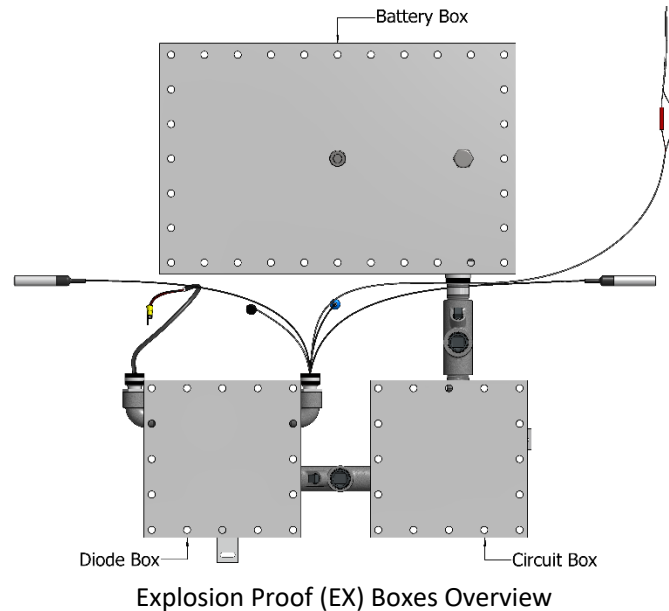
The Tabletop should be centrally loaded for easy rotation. Following photo illustrates the correct loading of a PC2.

To stop a cart for a production operation, the user can toggle the Kick Switch to the *OFF* position and complete the operation. When finished, activate the PC2 by toggling the Kick Switch to the *ON* position. The cart will move to the next station. Perform the operation procedure and keep the line moving in sync with the carts in front. Keeping the carts spaced out will help maintain a consistent production through-time.

The following sections explain how all PowerCart components are tied together to make the system work. If something has gone wrong with the cart refer to the troubleshooting guide at the end of the manual.

EXPLOSION PROOF (EX) BOXES

The PowerCart has 3 main boxes: The **Battery**, **Diode**, and **Circuit Boxes**.



The EX Boxes are connected to each other via potted EX-rated conduit to isolate the components of each.

EX Box	Purpose
Battery Box	Houses 12V AGM Battery, has Breather for ventilation
Diode Box	Houses Charge Circuit, Intrinsically Safe Board, and the Cart's Sensor bundle
Circuit Box	Houses Microcontroller, Battery Leads, and the main Battery Fuse

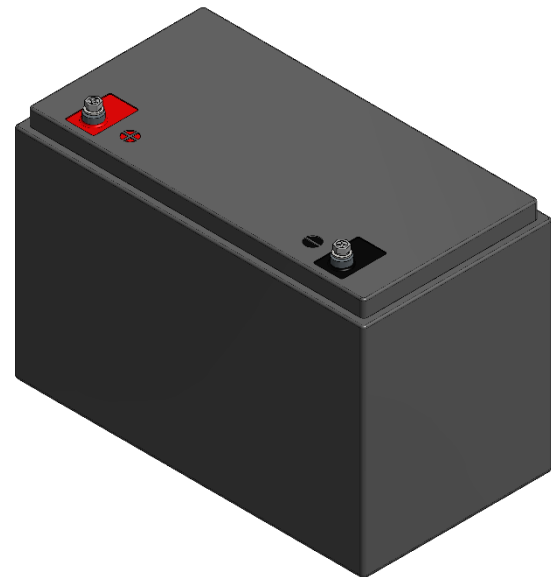
BATTERY

Under normal operation the cart batteries will recharge during stops on the Charge Rails. The battery **MUST** charge for at least **3 minutes per 100 feet**, as a rule, and **MUST** be simultaneously on a magnet and a Charge Rail to charge. The Charge Rail stop times vary according to the number of rails, cycle time, and load placed on the PowerCart.

DO NOT charge any batteries inside, or within 10 feet of the opening, of a spray booth or other hazardous area.

A deep cycle **12 Volt Absorbed Glass Mat (AGM) Battery** is used to power the cart. **ONLY an AGM battery can be used with the cart.** The battery is in an explosion-proof Battery Box equipped with a breather mounted onto the lid. The battery should be maintained at above 95% of charge (above 12VDC).

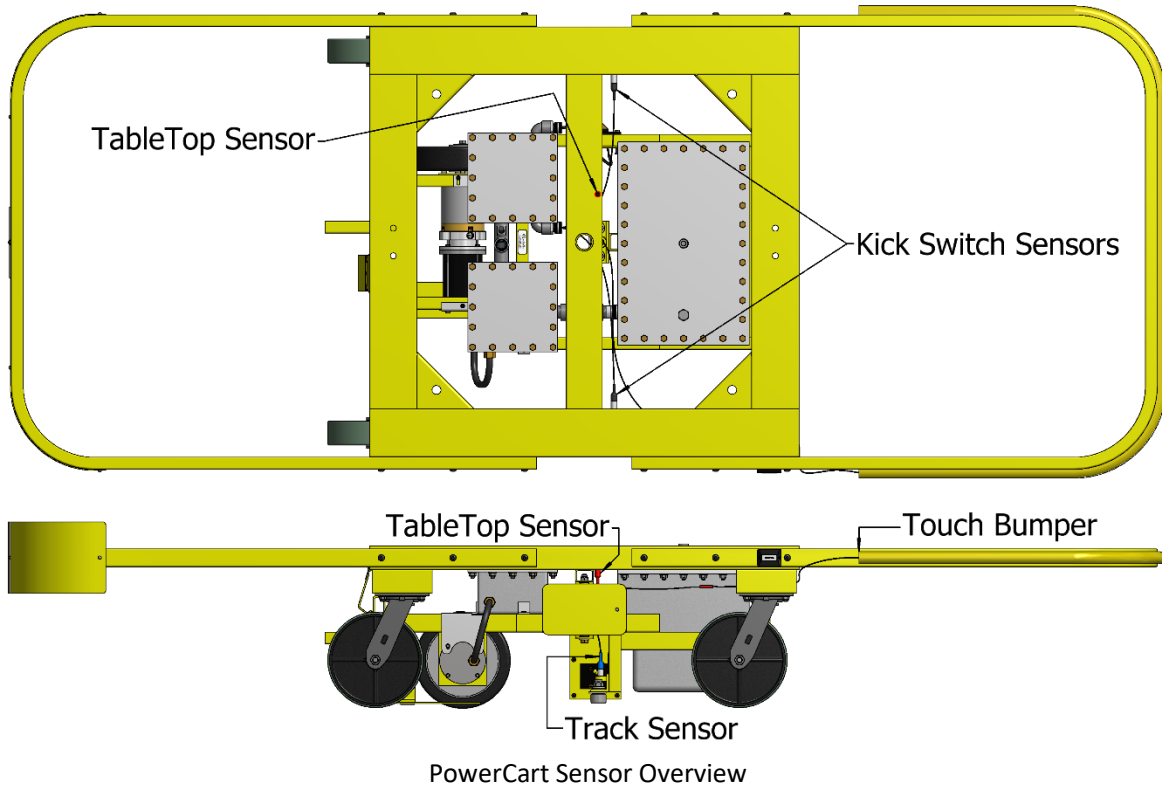
There is a wood board over the Battery inside the Battery Box which prevents the terminals of the Battery from contacting the Lid of the Battery Box. It must stay in place.



12V AGM Battery

MAGNETIC REED SWITCH

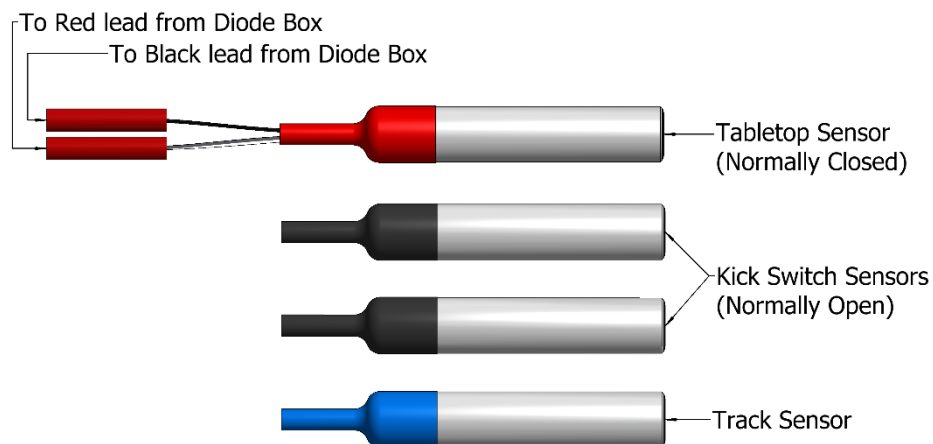
The magnetic reed (MR) switches are manufactured by Prime Heat and most operate normally open. The circuit is closed when the MR switch is in front of a magnet. The operating gap is ~five-eighths (5/8") of an inch.



The PC2 is equipped with four MR switches. The **Track Sensor** on the cart is used for sensing Track Magnets. It has a blue line or blue shrink-wrap on it to differentiate it from the Kick Switch Sensors. When the cart runs over a magnet mounted in the track, the motor will stop for a set amount of time. The Track Sensor should be flush with the bottom of the bearing mounting plate, to prevent the head from shearing off.

The **Kick Switch Sensors** are located on the bottom of either side of the cart and are kicked off to stop the cart. The **Tabletop Sensor** is in the middle of the cart body, shrink-wrapped Red, flush with the surface of the body's crossbar, and stops the cart upon the Tabletop being out of alignment. The Tabletop Sensor operates normally closed, unlike the rest of the cart's switches. Its operating gap is 1/8" inch.

Magnetic Reed Switch Differentiation					
NAME	TYPE	RANGE	COLOR	QTY	PH STOCK #
Track Sensor	Normally Open (NO)	5/8"	Blue	1	19450
Kick Switch Sensors	Normally Open (NO)	5/8"	Black	2	19450
Tabletop Sensor	Normally Closed (NC)	1/8"	Red	1	19460

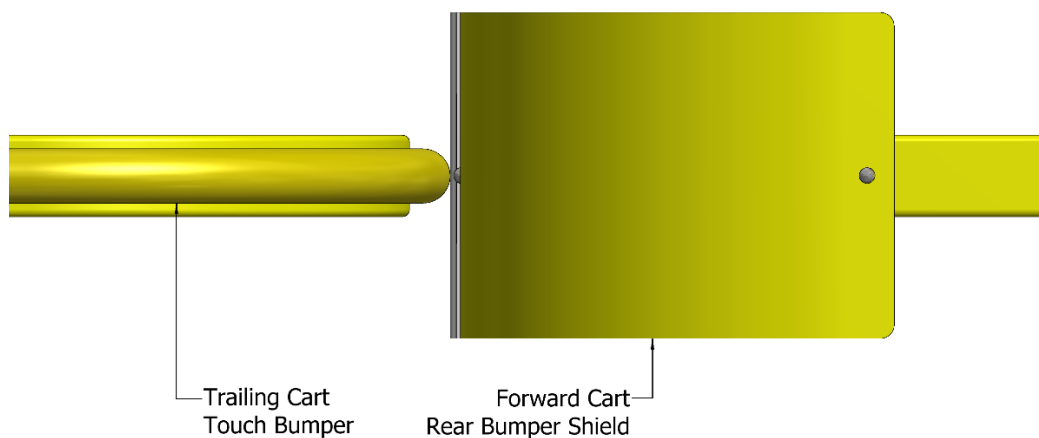


Magnetic Reed Switch Overview (Wires Not Shown)

A damaged MR switch will remain either open or closed and will need to be replaced. To verify if a switch is damaged use a multimeter and a magnet to check switch continuity. To replace an MR switch simply cut off the broken switch and splice on a new one using two 18-22 AWG wire connectors. There is a set-screw in the aluminum collar that holds the sensor in place. Loosen the set-screw when replacing the reed switch. DO NOT over-tighten the set-screw when securing the replacement switch, as this may damage the switch's head. Leave a $\frac{1}{2}$ " gap between the switch end and the magnet with the Kick Switch assembly in the ON position.

TOUCH BUMPER

The Touch Bumper is activated by two pounds of pressure. The bumper is **Normally Open** and closes when experiencing two pounds of pressure on the face of the sensor. These units can be damaged by external cuts or internally shorting and a damaged bumper will prevent the cart from operating. If the bumper is too tight at the corners, it will false trigger and the cart will not move. It is recommended that the bumper be covered in some fashion to prevent overspray. Prime Heat recommends **ballistic nylon wrap**.



Touch Bumper Stopping on a Rear Bumper Shield

Refer to Sections: (Maintenance) Sensor Checks-Touch Bumper and Removal & Replacement of a Touch Bumper for diagnosis and replacement.

TABLETOP

PowerCarts can be equipped with a rotating **Tabletop**. The Tabletop can support eight hundred pounds centrally located on the Tabletop. Keep in mind the PC2 is only rated for 550 lbs. The standard Tabletop can rotate a full 360 degrees on four wheels and indexes on 90-degree interval detent positions. If the cart is loaded incorrectly the cart may tip causing permanent damage to the product, PowerCart Body, and Drive Frame.

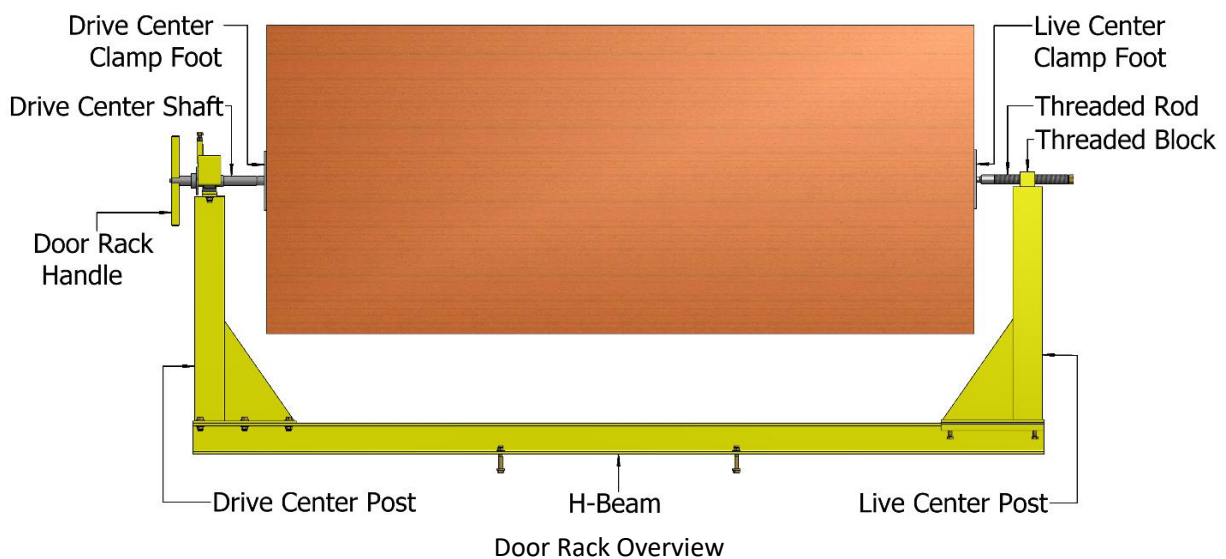
Pic
Tabletop Overview

Two magnets are installed on the underside of the Tabletop to control ON/OFF for the Top Switch. If removed the cart will not operate and a magnet will need to be reinstalled.

The Tabletop and Touch Bumper are wired together in the Diode Box. If the Tabletop is turned, as shown below, the Touch Bumper will read "ON" using either CartLord or CartCom.

DOOR RACK

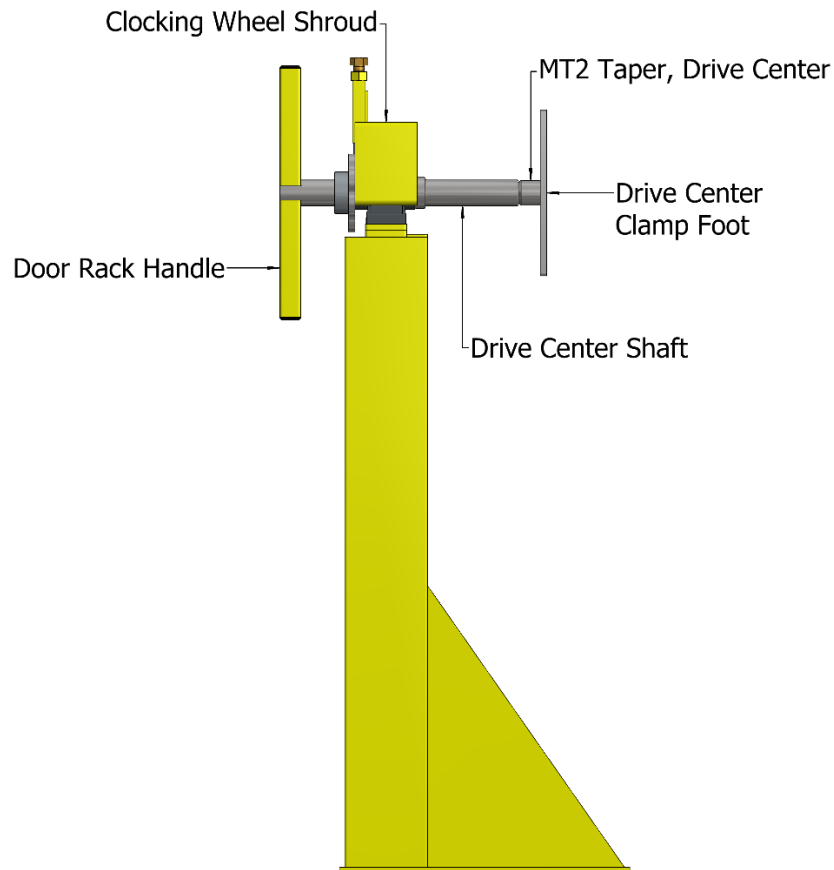
PowerCarts can be equipped with a Tension-based **Door Rack** instead of a Tabletop. The rotating Tabletop is replaced with an **H-Beam** to mount the Door Rack system. The rear of the PowerCart/H-Beam has a fixed **Drive Center Post** with a turn handle and the 8" **Drive Center Clamp Foot**. The forward end of the PowerCart/H-Beam has a sliding post called the **Live Center Post** with a **Threaded Rod & Threaded Block** to tension the spinning 8" **Live Center Clamp Foot**.



When loading, the door is positioned flat for tensioning using a **Door Loader System**. The Door Loader System adjusts on 3 axes to properly align the door to the clamp feet of the Door Rack. To tension the Live Center Clamp Foot to the door, the operator uses a Drill or Socket Wrench with a 1-1/8" Socket Adaptor on the 1/2"-13 nut of the threaded rod. It is recommended to use a Digital Torque Adaptor to precisely set the FT/lbs. of torque necessary for each door. Each door's tension requirements are different and should be tested thoroughly before being made standard.

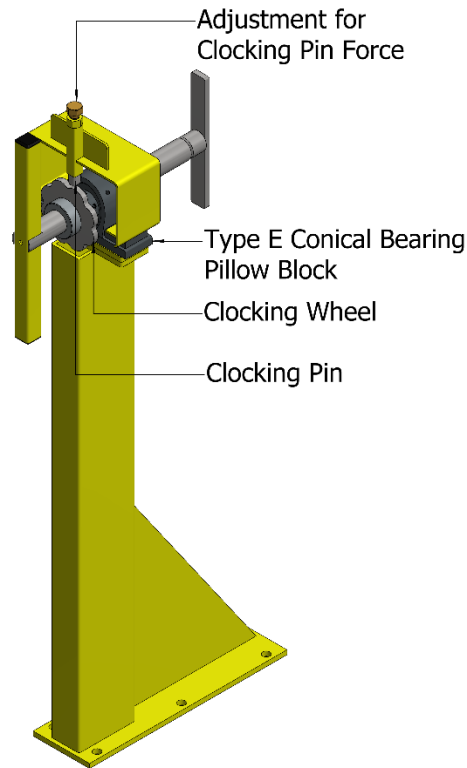
Drive Center Post

The **Drive Center Post** is fixed into position toward the rear of the PowerCart. It is fixed to make it a set point both for Load/Unload of doors and for Robotic Spraying Integration and its location must be consistent among all PowerCarts.



Drive Center Post Overview

The **Door Rack Handle** is attached to the **Drive Center Shaft**, which is mounted with a **1-1/4" Type E Conical Bearing Pillow Block**. The Conical Bearing will have slight slack when it is free of load but will sit into place correctly once load or tension is applied. The Drive Center Shaft also holds the Drive Center Clamp Foot, which is fixed vertically in-line with the Door Rack Handle.



Clocking Wheel Overview

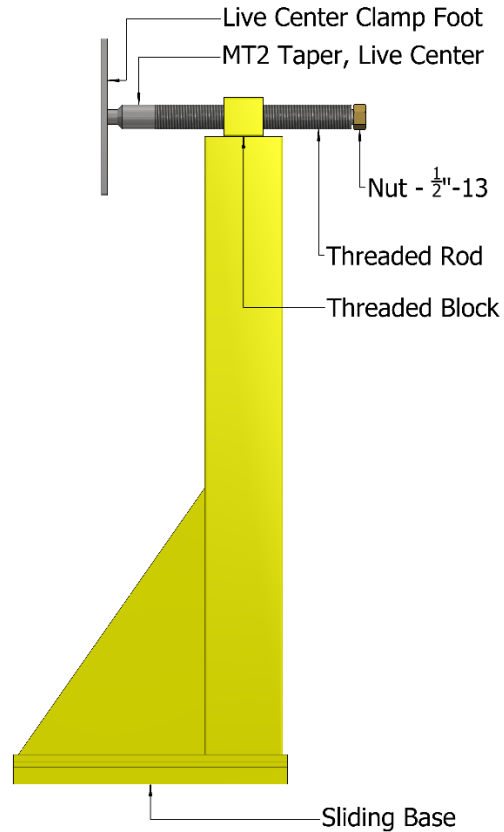
The Drive Center Handle and Clamp Foot can index into different detent positions with the **Clocking Pin** and **Clocking Wheel** also mounted on the Drive Center Shaft. When turning the Door Rack Handle, the operator should adjust the Clocking Pin's force with the bolt above it so that the Clocking Pin smoothly moves from one detent to the next. If too much force is applied, the Clocking Pin may start to wear down and need replacement.

The Clocking Wheel and Clocking Pin should be protected against overspray and should be lubed with Bearing Grease often to prevent damage to the assembly.

Live Center Post

The **Live Center Post** can slide along the H-Beam to accommodate multiple door sizes. It is fixed into position with tension handles at its sliding base. Its function is to tension the door with its Clamp Foot. The Live Center Clamp Foot can spin to adjust its position against the door's edge and to move properly with the Threaded Rod.

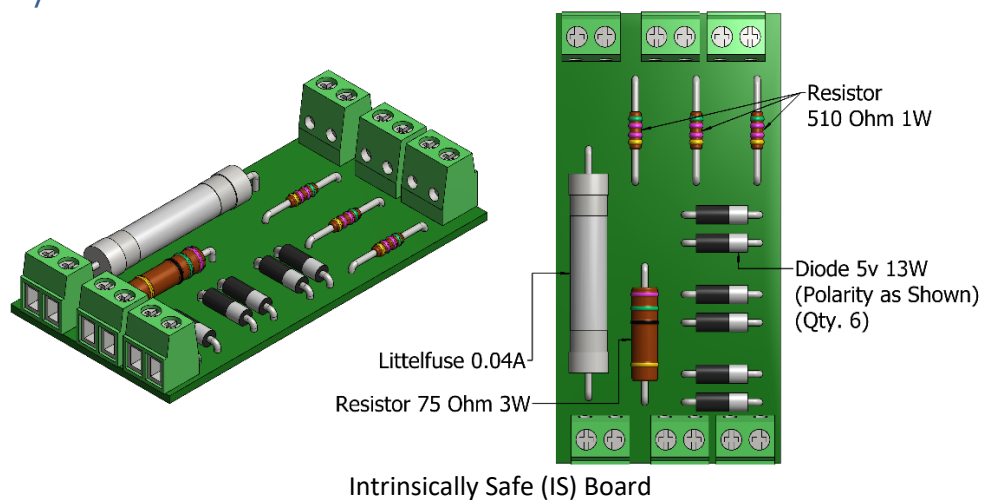
Do NOT use an Impact Driver to tension the Threaded Rod as it will ruin the threads of both the Threaded Rod and the Threaded Block. Only a Drill or Socket Wrench should be used to tension the Threaded Rod.



Live Center Post Overview

The Threaded Rod and Threaded Block should be protected against overspray and should be lubed with Bearing Grease often to prevent damage to the threads.

IS BOARD/BARRIER

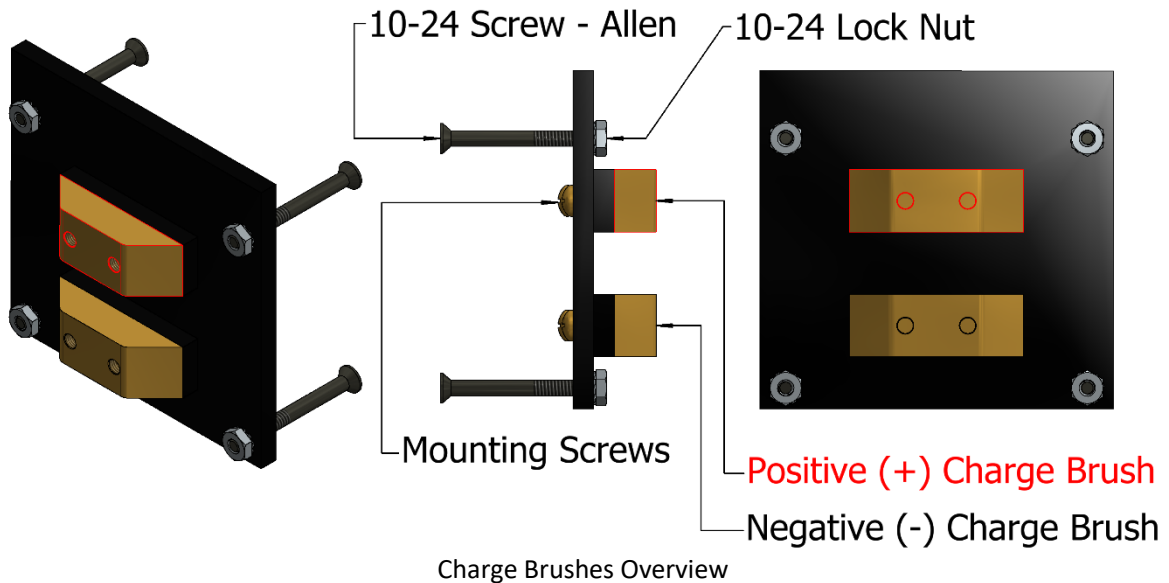


The **Intrinsically Safe (IS) Barrier** is located inside the Explosion-Proof Diode Box. The PowerCart's Sensor leads terminate to one side of the IS Barrier. The IS Barrier runs an intrinsically safe 12-volt signal to one lead of the sensor. When the sensor is closed the circuit is complete, returning the signal back to the PC2 microcontroller. For wiring information, ***Refer to Wiring Diagram A: Diode Box.***

If a sensor is not responding and is not visibly damaged, the IS Barrier might be damaged. Remove the cart from operation and refer to the troubleshooting section. The IS Board cannot be serviced and should a part fail the Is Board will need to be replaced.

THE CHARGING CIRCUIT & BLOCKING DIODES

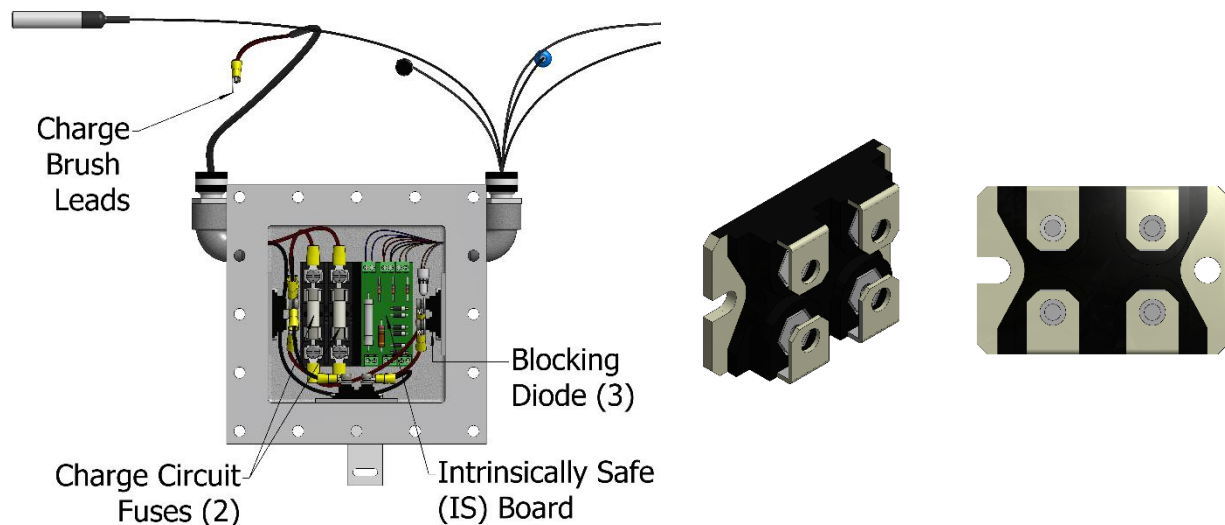
The PC2 Charge Brushes contact the Charge Rail to charge the Battery. They are spring loaded for the cart to contact the charge rail without pushing the cart away. The Charge Brushes will wear over time and should be maintained or changed as necessary to keep an efficient line running. A cart that is not charging will die after about ten hours of operation.



To replace worn charge brushes, unscrew the bronze contacts from the back and replace them. When reattaching the leads from the Diode Box, **Positive (red wire) is always on top, Negative (black wire) is always on bottom.**

The protection method used for the charge brushes is Intrinsic Safety (IS). The Positive brush is connected to a KTK-15 Fuse, then runs through three blocking diodes, and then to another KTK-15 Fuse. Two other blocking diodes prevent the battery from crossing over to the negative (COM) lead. These connections are in the Diode Box. From the Diode Box the positive brush is connected to a relay on the PC2 microcontroller.

If a PowerCart will not accept charge, make sure the Charge Relay located on the Microcontroller is not damaged (*see Section: Microcontroller with Zigbee Communication*) and that all connections through the circuit are tight. Start checking continuity through fuses, then through the blocking diodes individually. Make sure when the charge relay is open on the Microcontroller the Battery has continuity all the way through to the charge brush.

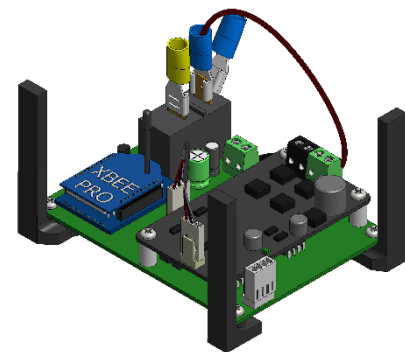


Diode Box – Charging Circuit

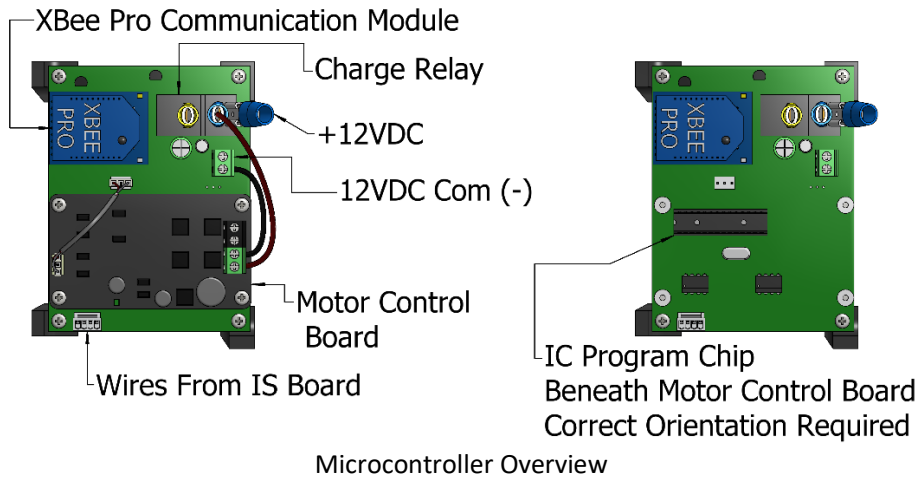
Blocking Diode

MICROCONTROLLER WITH ZIGBEE COMMUNICATION

The controls for the PC2 are in the explosion-proof Circuit Box isolated from the Battery Box and the Diode Box via potted seal-offs. The PC2 is controlled by a Microcontroller board designed and manufactured by Prime Heat. The PowerCart's motor is speed regulated by a Motor Control Board seated atop the Microcontroller. The controller is equipped with an XBee Pro 3 radio module for wireless communication of the Zigbee protocol.

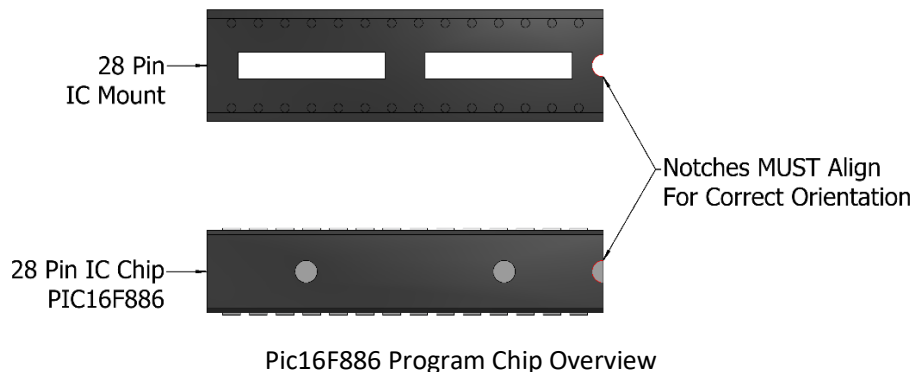


Microcontroller



Issues that can arise with the controller are limited. The microcontroller or parts will have to be replaced if any of the following symptoms are present:

Microcontroller Issues	Symptoms
Charge Relay mechanically stops working.	This would be evident if CartCom Laptop registers the relays are <i>closed</i> with no output voltage while the PowerCart is on a Charge Rail. The PC2 will not charge.
Pic16F886 program chip stops running.	The PowerCart program stops running, the PC2 stops functioning, and the program cannot be rebooted by the CartCom laptop or power reset. May need new program chip or Microcontroller may be compromised.
XBee Module not communicating.	The PowerCart does not show up on CartCom or CartLord. Check that the pins are seated correctly, and the power LED indicators are on. Xbee may need replacement.
Motor Control Board not running.	PowerCart motor will not run. Replace the Motor Control Board.
Electrical Component Failure	PowerCart will not function. Replace Microcontroller.

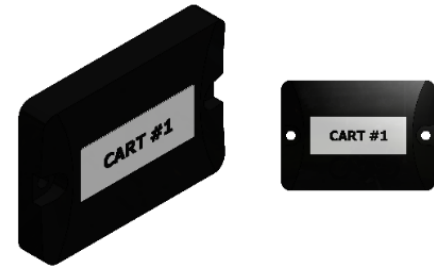


To replace a microcontroller board simply pull the power fuse out of the holder. Unhook the spade connectors from the relays. Unscrew the terminals and remove the wires. Take out the old Microcontroller. Unplug the XBee Module and install it onto the new Microcontroller. **Refer to Wiring Diagram B: Circuit Box.**

Install the Battery Fuse and the XBee Transmitter should temporarily display a red light. Check the cart operations with the CartCom Laptop for normal operation.

RFID TAG

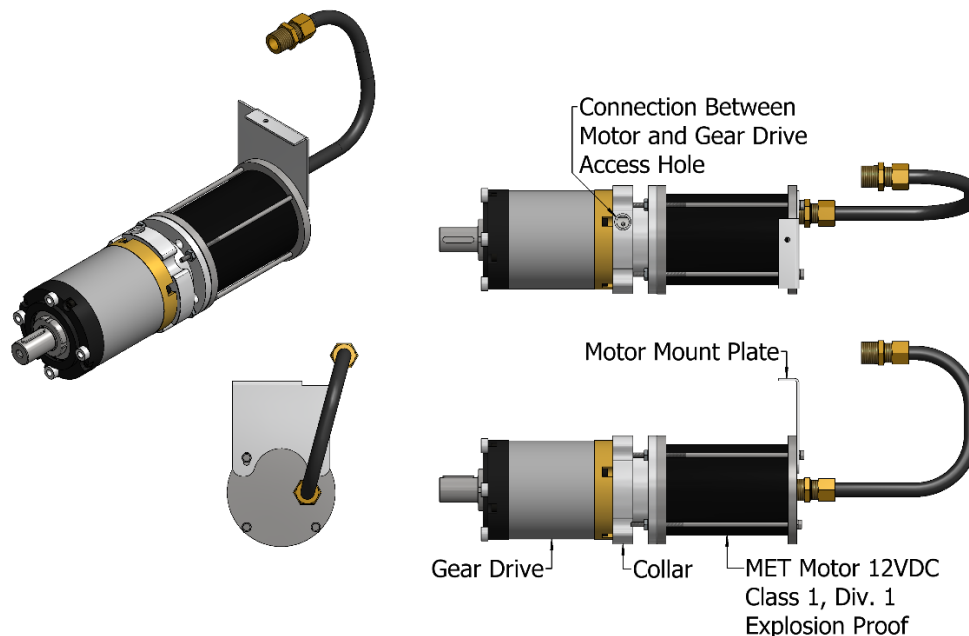
Carts that can be programmed or monitored remotely will have an RFID (Radio Frequency Identification) tag. It helps the cart communicate with the track switches, tunnels, and robots found on a Prime Heat Finishing System. There are no serviceable parts on the RFID Tag, however, if removing a bumper for maintenance be sure to replace the RFID tag in the **exact** same location. If it is too far removed from its original location it may not be read by the programmer.



RFID Tag

MOTOR & GEAR-DRIVE ASSEMBLY

The PowerCart is propelled by an MET 12-volt Permanent Magnet Direct Current (PMDC) motor connected to a gearbox. The motor is listed for product use in **Class 1 Division 1 Hazardous Locations**. It has a Mineral Insulated (MI) cable and brushes that connect the 12 volts of the commutator for motor operation. An operating motor should draw around 2 to 5 Amps depending on the product weight and the course of the track (i.e. higher amperage around curves). The white lead is Positive (+12VDC) and the black lead is Negative (COM).



Motor & Gear Drive Overview

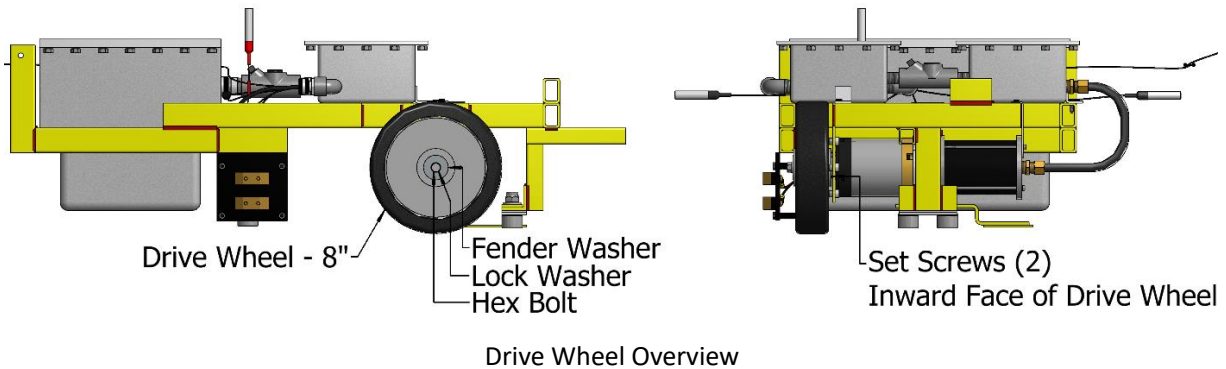
If incorrectly joined, the connection between the Motor and Gear Drive may loosen and cause the motor to slip.

The PMDC motor has brushes that may over time wear out causing the motor to run slow, sluggish or intermittently. This motor will need to be replaced.

The Gear Drive is internally geared and, though rare, if it should fail it will need to be replaced.

DRIVE WHEEL

The Drive Wheel is attached to the Motor & Gear-Drive assembly.



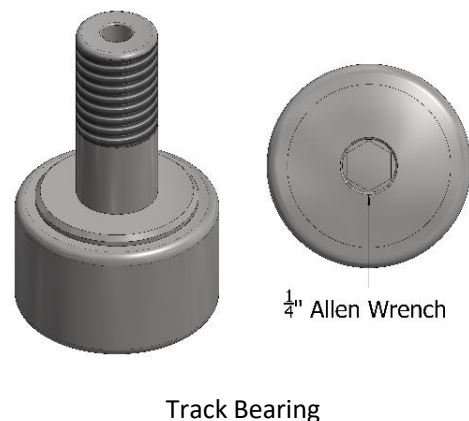
Floors should be kept dry and debris free so as not to impede the wheel or cause it to slip. If a floor has many peaks and valleys, the cart may stick in places. Grind out peaks in the floor and gently raise valleys with concrete patch. To prevent unnecessary wear and battery drain from spinning in place due to some impediment, the cart will automatically shut off after 8 minutes. This timing is adjustable under ***Slip Minutes*** in CartCom's Single Cart Diagnostic; 8 minutes is the factory-set default. As the Drive Wheel wears down over the years, it will need to be replaced. ***Refer to Section: Removal & Replacement of a Motor & Gear Drive > Procedure: Remove Motor & Gear Drive > Step 4.***

PARTS – DRIVE WHEEL	
Drive Wheel	8" Diameter, 2 Set-Screw holes
Set-Screw	¼-20 x ¾" (2), Inward face of Drive Wheel
Hex Bolt	M8 x 1.25 x 45
Lock Washer	M8
Fender Washer	1.5" X 5/16"
Gear Drive Extension	ABS spacer to prevent warp of Fender Washer

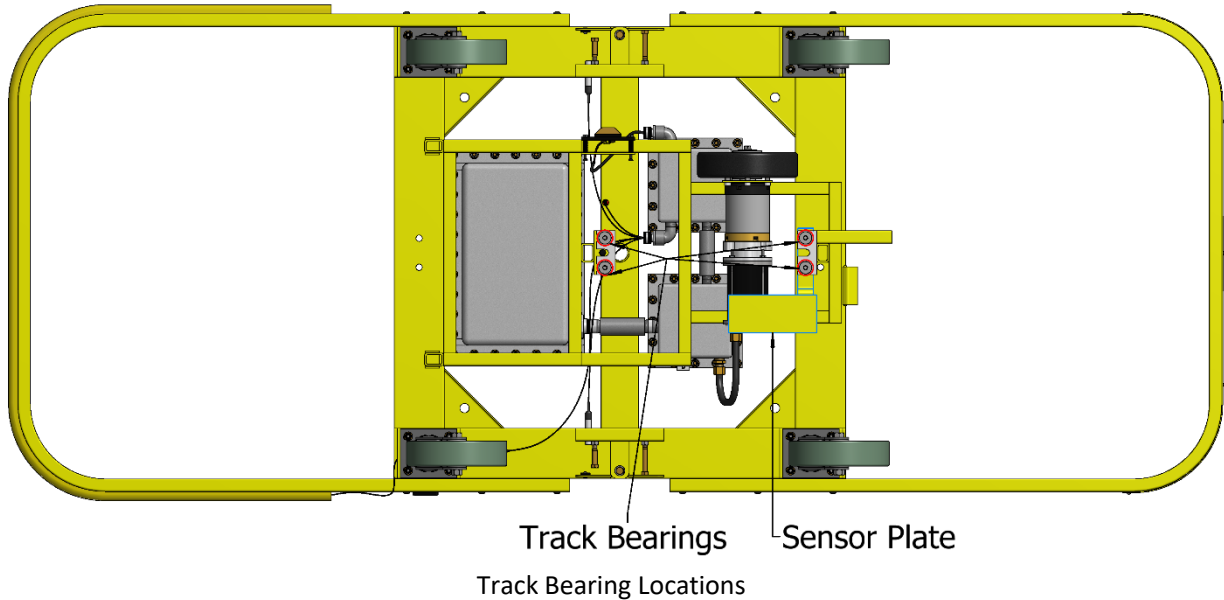
TRACK BEARINGS

The **Track Bearings** are four cam rollers that guide the PowerCart around the track. They are mounted in pairs at two locations on the cart. The front Track Bearings are in the middle of the Drive Frame. The rear Track Bearings are mounted at the back of the Drive Frame to the Rear Bearing Post. The bearings should be about 3/16" to ¼" above the ground. They are not adjustable any further up.

Unlevel floors may have locations where the bearings drag on the concrete or places where the carts are prone to fall off the track. If the bearings are too low in some locations try grinding the concrete or raising the drive wheel with a plate in that location. If the track seems too low in some locations try raising the level of the concrete with concrete patch or filler.



Track Bearing



There is a floor mounted Metal Proximity Sensor at each Cart Stop, Track Switch, Loading Station, etc. It is activated by the Sensor Plate attached to the Rear Bearing post. The Sensor Plate being sensed by the Proximity Sensor signals the Track item's logic processor that a cart is **Present or Clear** at the Cart Stop, Track Switch, Load Station, etc. for efficient routing of the carts throughout the line. **It is important that the plate is not damaged, as the cart may not register with the sensor if bent or moved.**

FUSES

The PC2 is equipped with three different fuses.

Fuses	PH Stock #	Part #	Location	Size	Type	Qty.
Battery Fuse	19180	0326020	Circuit Box	20A	Slow-Blow	1
Charge Circuit Fuses	40615	KTK-15	Diode Box	15A	Fast-Acting	2
IS Barrier Fuse	N/A	0315.40.HXP	Diode Box	0.04A	Littelfuse	1

The Battery Fuse is one 20 Amp slow-blow located in the explosion-proof Circuit Box inside of the Battery Fuse Block. The Battery Fuse should be removed if a cart is expected to be offline for more than a few days.

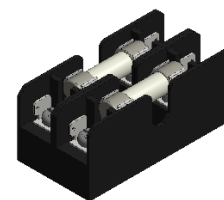


Battery Fuse Block with Battery Fuse 20A Slow Blow

Note: The Battery Fuse is removed before shipment to the customer and must be reinserted for the cart to operate.

The Charging Circuit has two 15-Amp BUSS KTK-15 Limitron Fuses located in the explosion-proof Diode Box.

A 0.04A Littelfuse is included on the Intrinsic Safety Barrier PCB located in the Diode Box.



Charging Circuit Fuse Block and KTK-15 Fast-Acting Fuses

MAINTENANCE

Maintenance Topics
Battery – Offline Charging
Overspray
Sensor Checks
Removal & Replacement of a Magnetic Reed Switch
Removal & Replacement of a Touch Bumper
Removal & Replacement of a Motor & Gear Drive
Charge Rail Voltage Check
Greasing and Oiling of Threaded or Pneumatic Components
Track Installation & Replacement

BATTERY – OFFLINE CHARGING

If a battery is getting low on charge the cart should be placed on a charge rail for an extended period. The charging will time out after 4 hours continuous, so lower battery carts can be left on charge rails overnight to be ready by the morning. Use **CartCom** or **CartLord** to verify that the cart is in fact charging. The **ChgRelay** status should display as **OPEN** and the battery voltage should read higher than before reaching the Charge Rail.

If the battery is below ~11 volts, it may require being charged offline from inside either the Circuit Box or Battery Box. It is possible that the CartCom laptop will show **ChgRelay Open** however the battery voltage will remain low. This means the Battery voltage is too low and the charge relay will not function.

Battery – Charging Offline Through Circuit Box
1. Toggle a Kick Switch on the PowerCart into OFF position.
2. Remove the PowerCart from the track.
3. Remove the Tabletop.
4. Unbolt Circuit Box Lid. <ol style="list-style-type: none"> ½" Wrench, ½" Socket on Impact Driver
5. Remove the Battery Fuse from the Battery Fuse Block.
6. Unscrew the Negative Lead from the terminal block. <ol style="list-style-type: none"> If mounted on the side of the box, use a small socket wrench with a flathead bit to unscrew
7. Expose the contact point of the Battery Fuse Block from the <i>Battery Side</i> not the Microcontroller side.
8. DO NOT allow the Battery Leads to touch each other or any metal surfaces.

9. Attach the AGM Battery Charger <ol style="list-style-type: none"> Attach the Red Positive (+) clamp to the Battery Fuse Block contact point on the Red Positive (+) Battery Lead. Attach the Black Negative (-) clamp to the Black Negative (-) Battery Lead Plug in AGM Charger only <i>after</i> the clamps are in place and not contacting each other or metal surfaces.
10. Charge the PowerCart. Depending on starting Battery voltage this may take 10+ hours. <ol style="list-style-type: none"> If Battery is below 10V, charge at 2A rate If Battery is above 10V, charge at 10A rate Many Battery Chargers automatically select the charge rate, including the one recommended in the Tools – Battery Charging Offline table below.
11. Once charging completes, unplug the Battery Charger and disconnect its clamps.
12. It is recommended to perform a Load Test on the battery to verify it holds the charge. <ol style="list-style-type: none"> If it fails the Load Test, the Battery should be replaced.
13. Pull the Battery Fuse Block contact point back within its cover.
14. Reconnect the Black Negative (-) Battery Lead into the Terminal Block.
15. Reinsert the Battery Fuse into the Battery Fuse Block.
16. Reattach the Circuit Box Lid.
17. Refer to Wiring Diagram B: Circuit Box

Battery – Charging Offline Through Battery Box

1. Toggle a Kick Switch on the PowerCart into <i>OFF</i> position.
2. Remove the PowerCart from the track.
3. Remove the Tabletop or Door Rack.
4. Unbolt Battery Box Lid. <ol style="list-style-type: none"> ½" Wrench, ½" Socket on Impact Driver
5. Remove the wood board seated atop the Battery.
6. Attach the AGM Battery Charger <ol style="list-style-type: none"> Attach the Red Positive (+) clamp to the Battery Fuse Block contact point on the Positive (+) Battery Post. Attach the Black Negative (-) clamp to the Black Negative (-) Battery Lead Plug in AGM Charger only <i>after</i> the clamps are in place and not contacting each other or metal surfaces.
7. Charge the PowerCart. Depending on starting Battery voltage this may take 10+ hours. <ol style="list-style-type: none"> If Battery is below 10V, charge at 2A rate If Battery is above 10V, charge at 10A rate Many Battery Chargers automatically select the charge rate, including the one recommended in the Tools – Battery Charging Offline table below.
8. Once charging completes, unplug the Battery Charger and disconnect its clamps.
9. It is recommended to perform a Load Test on the battery to verify it holds the charge. <ol style="list-style-type: none"> If it fails the Load Test, the Battery should be replaced.
10. Reinsert wood board. <ol style="list-style-type: none"> This board prevents the Battery from shorting against the metal Lid. <i>It MUST be reinserted.</i>
11. Reattach the Battery Box Lid.
12. Refer to Wiring Diagram B: Circuit Box

Tools – Battery Charging Offline

½" Socket Head
½" Wrench
Impact Driver
Small Socket Wrench with Flathead Screwdriver Head
Small Flathead Screwdriver
Small Phillips Screwdriver
12v AGM Battery Charger – Noco Genius 10 or equivalent recommended
Multimeter
Load Tester

OVERSPRAY

If overspray can be limited to an acceptable amount the PC2 maintenance will be minimal. The main area of concern for the PowerCart is the **Touch Bumper**. It is recommended to wrap the Touch Bumper with a protective layer such as **ballistic nylon**. Note: If wrapped too tightly on the corners of the Bumper, the bumper may falsely trigger and prevent cart operation. Another area of concern is the **Kick Switch**. If not maintained, the switches may become harder to activate. Painters should practice good painting techniques.

For PowerCarts equipped with a **Door Rack**, the **Clocking Wheel** and **Clocking Pin** assembly on the **Drive Center Post** as well as the **Threaded Rod** and **Threaded Block** of the **Live Center Post** should be covered to prevent overspray.

SENSOR CHECKS

A frequent sensor check will keep the line and carts running. The following subsections detail how to test each type of sensor on a PowerCart.

TRACK & KICK SWITCH SENSOR CHECK

The **Track** and **Kick Switch Sensors** are both **Normally Open** magnetic reed switches.

The **Track Sensor** can be damaged by running over something sitting on or sticking up from the track like a Nail Anchor head, Track Magnet set too high, or hardware used on the line. To check the sensor, watch and verify the cart stops on the track magnet. If it 'skips' a track magnet, the Track Magnet may be too low, or the Track Sensor may need to be adjusted down. The Track Sensor head should be flush with the bottom of the Track Bearing spacer plates. If it still fails to stop, replace the Track Sensor.

Sensor Check – Track Sensor	
13.	Remove the PowerCart from the track and latch Drive-frame in "Up" position. Note its cart #.
14.	Press <i>Suspend Updates</i> on the CartLord Monitor.
15.	Start the CartCom Program on the CartCom Laptop.
16.	CartCom: Press <i>Enter</i> on the first screen to Find Nearby Carts.
17.	Find the PowerCart being checked.
18.	Note the status of <i>TMagnet</i> . <ul style="list-style-type: none"> a. Does <i>TMagnet</i> display <i>Off</i>? This means the Track Sensor has not seen a magnet in the track.
19.	Place a magnet against the head of the Track Sensor. <ul style="list-style-type: none"> a. Repeat Steps 4-6. b. If <i>TMagnet</i> status changes to <i>On</i> the Track Sensor is functioning correctly.

c. If <i>TMagnet</i> status remains <i>Off</i> the Track Sensor is functioning incorrectly.
20. Remove the Magnet from the head of the Track Sensor.
21. Refer to section Removal & Replacement of a Magnetic Reed Switch.

The two **Kick Switch Sensors** are harder to damage, however if one is damaged the cart will not run. The sensors are activated by being within 5/8" of the ceramic magnet attached to the back side of the Kick Switch Plate. Over time the sensors may loosen within the collar that holds them and may need to be adjusted back into position.

Kick Switch Sensor Position	
Too Close to Kick Switch Plate	The cart will not stop when the Plate is pushed into the <i>OFF</i> position.
Too Far from Kick Switch Plate	The cart will not run when the Plate is pushed into the <i>ON</i> position.
Correct Distance	The cart operates normally.

Sensor Check – Kick Switch Sensors	
1.	Remove the PowerCart from the track and latch Drive-frame in "Up" position. Note its cart #.
2.	Press <i>Suspend Updates</i> on the CartLord Monitor.
3.	Start the CartCom Program on the CartCom Laptop.
4.	CartCom: Press <i>Enter</i> on the first screen to Find Nearby Carts.
5.	Find the PowerCart being checked.
6.	Toggle both Kick Switch Plates into the <i>OFF</i> position (Flat against the PowerCart body)
7.	Note the status of <i>KickSw</i> . <ol style="list-style-type: none"> Does <i>KickSw</i> display <i>Off</i>? This means the Kick Switch Sensors are likely far enough away from the magnet of the Kick Switch Plate.
8.	Toggle both Kick Switch Paddles into the <i>ON</i> position. <ol style="list-style-type: none"> Repeat Steps 4, 5, 7. If <i>KickSw</i> status changes to <i>On</i> the Kick Switch Sensors are functioning correctly. If <i>KickSw</i> status remains <i>Off</i>, then <i>at least one</i> Kick Switch Sensor is functioning incorrectly.
9.	Determine if the Kick Switch Sensors are the correct distance away. <ol style="list-style-type: none"> If the status of Step 8 is <i>Off</i>, leave the Kick Switch Plates in the <i>ON</i> position. Loosen both Kick Switch Sensors from their set screw collars with a 1/8" Allen Wrench. Move both Kick Switch Sensors close to their respective magnet.
10.	CartCom: Press <i>Enter</i> on the first screen to Find Nearby Carts. <ol style="list-style-type: none"> Does <i>KickSw</i> read <i>On</i>? The sensors are likely functioning correctly but were too far away from the magnet. <ol style="list-style-type: none"> Set the Kick Switch Sensors to the correct distance.
11.	If a Kick Switch Sensor is not functioning correctly: <ol style="list-style-type: none"> Refer to section Removal & Replacement of a Magnetic Reed Switch.

Tools – Sensor Check
CartCom
Magnet
1/8" Allen Wrench

TABLETOP SENSOR CHECK

The **Tabletop Sensor** is a **Normally Closed** magnetic reed switch. **It is a different type of sensor than the Track and Kick Switch Sensors and it is important not to confuse the two types as the PowerCart will not function if incorrectly replaced.** It will stop the cart when the tabletop is turned out of alignment with the magnet it faces. The magnet is attached in two positions to the underside of the Tabletop. The PC2 motor should start again after 3 seconds once it is either reset to its original position or to 180 degrees. If the Tabletop is removed completely the cart will not run and **Bumper** on CartCom and CartLord will read **On**.

Note: The Tabletop Sensor and Touch Bumper are wired together and the CartCom status **Bumper** will read **On** if either the Tabletop is out of position/removed, or the Touch Bumper is engaged.

Sensor Check – Tabletop Sensor	
1.	Remove the PC2 from the track and latch Drive-frame in “Up” position. Note its cart #.
2.	Press <i>Suspend Updates</i> on the CartLord Monitor.
3.	Start the CartCom Program on the CartCom Laptop.
4.	CartCom: Press <i>Enter</i> on the first screen to Find Nearby Carts.
5.	Find the PC2 being checked.
6.	Verify the Tabletop is on the cart. Align the Tabletop into normal position with the Tabletop in its detent position not overhanging the sides of the PC2 body.
7.	Verify the Touch Bumper is not in contact with anything and is functioning correctly. <ol style="list-style-type: none"> a. Refer to section Touch Bumper Check
8.	Note the status of <i>Bumper</i> . <ol style="list-style-type: none"> a. The Tabletop Sensor and Touch Bumper are wired together and the CartCom status <i>Bumper</i> will read <i>On</i> if either the Tabletop is out of position/removed, or the Touch Bumper is engaged.
9.	Press <i>Enter</i> on the first screen to Find Nearby Carts. <ol style="list-style-type: none"> a. Does <i>Bumper</i> read <i>On</i>? The PC2 motor will not run. b. Does <i>Bumper</i> read <i>Off</i>? The PC2 motor can run.
10.	Toggle the Kick Switch Plates into <i>ON</i> position. The PC2 motor should run if all other sensors are functioning. <ol style="list-style-type: none"> a. If the motor does not run: <ol style="list-style-type: none"> i. Check that the magnet on the underside of the Tabletop is correctly over the Tabletop Sensor head. ii. Check that the Tabletop Sensor is flush to the top of the PC2 body’s crossbar. <ol style="list-style-type: none"> 1. If necessary, adjust slightly with 1/8” Allen Wrench.
11.	Turn the Tabletop out of alignment. The motor should immediately stop.
12.	CartCom: Press <i>Enter</i> on the first screen to Find Nearby Carts. <ol style="list-style-type: none"> a. The <i>Bumper</i> status should read <i>On</i>.
13.	Turn the Tabletop 180 degrees to its detent position. <ol style="list-style-type: none"> a. After 3 seconds at normal alignment the cart should start again. The Tabletop Sensor is functioning.
14.	If a Tabletop Sensor is not functioning correctly: <ol style="list-style-type: none"> a. Refer to section Removal & Replacement of a Magnetic Reed Switch.

Tools – Tabletop Sensor Check

CartCom

1/8” Allen Wrench

TOUCH BUMPER CHECK

If the **Touch Bumper** does not properly stop the PowerCart investigate the entirety of the Touch Bumper for physical damage. A cart that is undamaged, and not in contact with anything, but is not running (because the Touch Bumper is false triggering) might be too tight around the corners of the bumper.

Physical Check – Touch Bumper
15. Remove the PowerCart from the track and latch Drive-frame in “Up” position.
16. Examine Touch Bumper for any large cuts.
17. With motor running, press hard on the Touch Bumper. <ol style="list-style-type: none"> If motor stops running, the Touch Bumper is correctly operating. If motor does NOT run at any point, the Touch Bumper may be broken.
18. If the Touch Bumper is deeply cut and does not respond to touch, it is likely broken.
19. If the Touch Bumper is carefully loosened at the radii and still does not respond, it is likely broken.
20. Refer to section Removal & Replacement of a Touch Bumper.

Electrical Check – Touch Bumper
1. Remove the PowerCart from the track and latch Drive-Frame in “Up” position.
2. Find and disconnect the butt-splices between the Diode Box lead and lead from Touch Bumper <ol style="list-style-type: none"> Likely secured to the right-hand side of Drive-Frame within the cart body
3. Use a multimeter on the Ohm setting (Ω symbol) and touch the red lead onto one lead of the bumper and touch the black lead to the other lead of the bumper. <ol style="list-style-type: none"> Note: On some multimeters, you must enable the sound by cycling through settings. It is generally denoted with a sound-wave symbol.
4. If the bumper is OK: the multimeter will beep to indicate continuity.
5. If the Bumper is broken: the multimeter will not beep. The continuity is broken.
6. If the meter does not beep, the switch is to be considered broken and must be replaced.
7. Refer to section Removal & Replacement of a Touch Bumper.

Tools – Touch Bumper Replacement
Crimpers
Wire Strippers – 22AWG
18-22AWG Butt-splice (2)
Multimeter
Zip-Ties – Long (6)
Knife

REMOVAL & REPLACEMENT OF A MAGNETIC REED SWITCH

The Track Sensor and Kick Switch Sensors are identical, and spares of the same type (**Normally Open**) can be used interchangeably.

The **Tabletop Sensor** is **different** from the Track and Kick Switch Sensors (it is **Normally Closed**) and the PowerCart **will not function** if a spare Track or Kick Switch Sensor is used to replace a broken Tabletop Sensor.

Remove MR Switch
1. Cut the wire lead a few inches behind the head of the MR Switch.

2. Strip the wire lead shrink-wrap back ~1.5".
3. Strip the ends of the wire leads.

Replace MR Switch

1. Strip the ends of the replacement MR Switch wire leads.
2. Crimp a butt-splice to each wire lead.
3. If connection will be shrink-wrapped, place the tubing over the leads from the Diode Box.
4. Crimp the wire leads together.
 - a. *If Track or Kick Sensor:* Leads are interchangeable.
 - b. *If Tabletop Sensor:* Wire for Normally Closed (NO). The Tabletop Sensor Leads are Black and White (Red is unused), the wire leads to the Diode Box are Black and Red. Wire Black-Black, White-Red.
5. Do a "Pull Test" to verify wires are securely spliced.
6. Wrap the connection with electrical tape (if not shrink-wrapped).
7. Zip-Tie any loose wire to prevent snagging.
8. Test the Sensor, check with CartCom.

Tools – MR Switch Replacement

Crimpers

Wire Strippers – 22AWG

18-22AWG Butt-splice (2)

Zip-Ties – Long (6)

Knife

REMOVAL & REPLACEMENT OF A TOUCH BUMPER

If a Touch Bumper is internally or externally damaged it will need to be replaced.

Remove Touch Bumper

1. Tear broken Touch Bumper off the bumper. Remove existing 3M VHB double-sided tape.
2. Clean the metal bumper with Acetone to clear dirt or oils
3. Disconnect the 18-22 AWG Butt splices joining the Diode Box lead to the Touch Bumper Lead.
 - a. Do *Not* cut the Diode Box lead back
4. Discard broken Touch Bumper

Replace Touch Bumper

1. Clean the back of the new Touch Bumper with Acetone to clear dirt or oils.
2. Adhere new 3M VHB Double-Sided Tape to back of Touch Bumper
3. Mark the center of the Touch Bumper and the metal bumper
4. Lightly adhere the Touch Bumper to the metal bumper from the center point
5. **Do not pull the Touch Bumper ends around the metal bumper radii**
 - a. If the Touch Bumper ends are too tight it will false trigger, the PC2 will report *Bumper status On*, and will not run
6. Cut the Touch Bumper lead to an appropriate length of slack
7. Connect the Diode Box lead to the Touch Bumper lead. Perform a *Pull Test* to verify connection

a. 18-22 AWG Butt Splice (2)
8. Shrink-wrap or wrap connection with electrical tape
9. Test the Bumper. <ul style="list-style-type: none"> a. Refer to Table Physical Check – Touch Bumper of Section Touch Bumper Check
10. After testing, press the Touch Bumper along length to better bond with VHB Tape
11. Zip-Tie any loose wire to prevent snagging
12. With the motor running and the Drive-Wheel in the <i>UP</i> position, wrap the Touch Bumper with a protective layer. If wrapped too tight the motor will stop running. Simply reduce tightness of wrap. <ul style="list-style-type: none"> a. Ballistic Nylon is recommended as a base layer b. Cellophane over the Ballistic Nylon as a sacrificial layer is also recommended.

Tools – Touch Bumper Replacement
Crimpers
Wire Strippers – 22AWG
18-22AWG Butt-splice (2)
Multimeter
Zip-Ties – Long (6)
Knife
Acetone
3M VHB Double-Sided Tape
Ballistic Nylon Wrap
Cellophane

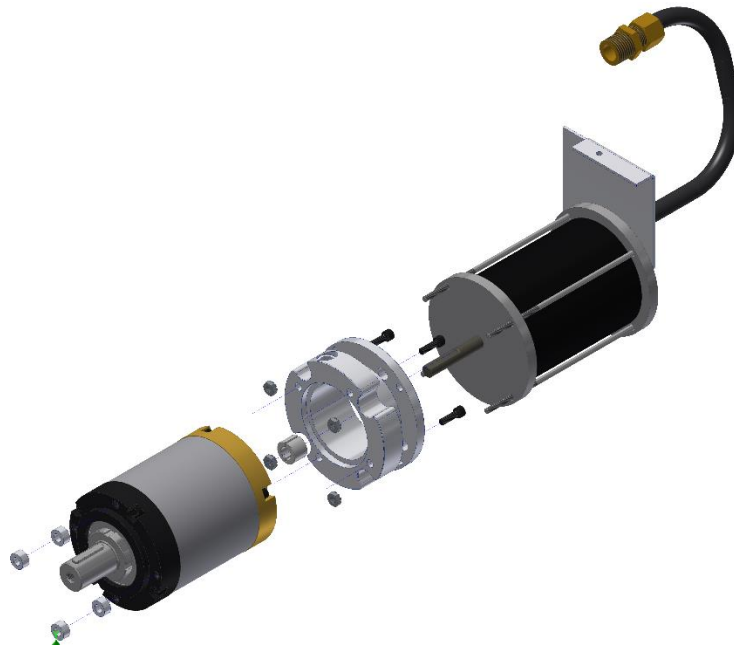
REMOVAL & REPLACEMENT OF A MOTOR & GEAR DRIVE

Procedure: Remove Motor & Gear Drive
1. Remove the Tabletop or Door Rack H-Beam
2. Open the Circuit Box <ul style="list-style-type: none"> i. Impact Driver ii. ½" Socket iii. ½" Wrench
3. Unwire the Motor's leads. <ul style="list-style-type: none"> a. Refer to Wiring Diagram B: Circuit Box
4. Remove the Drive-Wheel <ul style="list-style-type: none"> a. Remove the bolt and fender washers attached through Drive-Wheel into Gear Drive <ul style="list-style-type: none"> i. ½" Socket with Impact Driver b. Loosen the Drive-Wheel's Set Screws (2) on the inward face of the Drive-Wheel <ul style="list-style-type: none"> i. 1/8" Allen Wrench c. Do not lose Gear Drive Extension ABS piece
5. Unbolt the Gear Drive from the Drive Frame <ul style="list-style-type: none"> a. Remove the 4 bolts, do not lose the ¼" Spacers behind the plate <ul style="list-style-type: none"> i. 5/32" Allen Wrench
6. Remove the Screw of the Motor Mount Plate

<ul style="list-style-type: none"> i. 5/16" Hex Head
7. Disconnect MI Cable from Circuit Box <ul style="list-style-type: none"> a. 7/8" Wrench
8. Carefully lift the Motor & Gear Drive Assembly off the Drive Frame

Procedure: Separate Motor & Gear Drive Assembly

<ul style="list-style-type: none"> 1. Loosen the Allen Bolt joining the Motor to the Drive Frame within the Collar between them <ul style="list-style-type: none"> a. Gently nudge the compression collar with an Allen Wrench through the Access Hole to position Allen Bolt correctly <ul style="list-style-type: none"> i. 5/32" Allen Wrench
<ul style="list-style-type: none"> 2. Remove the 10-32 Lock Nuts holding the Collar to the Motor <ul style="list-style-type: none"> a. 3/8" Wrench
3. Pull Motor away from Collar
4. Do Not lose the circular clamp piece that may be stuck to the Motor shaft. Keep it with the Gear Drive. It clamps the Gear Drive to the Motor shaft.



Motor & Gear Drive Assembly Exploded View

Procedure: Reattach Motor and Gear Drive

<ul style="list-style-type: none"> 1. Attach new Motor to Gear Drive (or inverse) <ul style="list-style-type: none"> a. Refer to Procedure: Separate Motor & Gear Drive Assembly <ul style="list-style-type: none"> i. Reverse the steps. Be sure to tightly secure the Motor and Gear Drive together through the Access Hole of the Collar.
<ul style="list-style-type: none"> 2. Attach Motor and Gear Drive to Drive Frame <ul style="list-style-type: none"> a. Refer to Procedure: Remove Motor & Gear Drive <ul style="list-style-type: none"> i. Reverse the steps

Tools – Motor & Gear Drive

½" Socket

½" Wrench

Impact Driver

Crimpers

Wire Strippers

7/8" Wrench

3/8" Wrench

1/8" Allen Wrench

5/32" Allen Wrench

5/16" Hex Head

CHARGE RAIL VOLTAGE CHECK

The Charge Rail should be periodically checked to ensure the power supplies are outputting adequate **DC** voltage for charging. The Charge Rail's voltage should range from **14.5VDC to 15.5VDC**. To check the Charge Rail voltage, use a multimeter across the two long portions of copper on the charge rail. Upper copper strip is Positive (+) and lower copper strip is Negative (-).

Procedure: Charge Rail Voltage Check

1. Put a Multimeter on DC Volts setting
2. Touch the Red Positive (+) lead to the upper copper contact of the Charge Rail
3. Touch the Black Negative (-) lead to the lower copper contact of the Charge Rail
4. The Charge Rail should read 15VDC or higher
5. If the Charge Rail reads less than 15VDC, turn the voltage up at the Charge Rail PSU
6. If the Charge Rail reads NO voltage:
 - a. Verify the Charge Rail PSU is supplied with 110VAC
 - b. Verify the Circuit Breaker on the Charge Rail PSU Box is toggled *ON*

It is also sometimes necessary to check that the Charge Rail's voltage is carrying through the PowerCart's charge circuit into the Battery.

Procedure: Verify Charge Rail Voltage to Battery

1. Find the DC voltage of the Charge Rail using *Procedure: Charge Rail Voltage Check* immediately preceding this Procedure.
2. Note the DC Voltage of the Charge Rail. It should be ~15VDC.
3. Position the PowerCart either onto a Charge Rail or use a 12V PSU like the Noco Genius 10 to supply power to the Charge Brushes.
4. Unbolt Circuit Box Lid.
 - a. ½" Wrench, ½" Socket on Impact Driver
5. Put a Multimeter on the DC Volts setting.
6. With the Charge Brushes seeing voltage (either on a Charge Rail or a PSU)
 - a. Touch the Multimeter's Red Positive (+) lead to the fuse side of the Charge Relay on the Microcontroller.
 - b. Touch the Multimeter's Black Negative (-) lead to the common Terminal Block in the Circuit Box.
7. Note the DC voltage. It should match the voltage being output by the Charge Rail.

a. Verify that CartCom's ChgRelay status is <i>Open</i>
8. If the voltages do NOT match, it is likely that the Charge Relay is not opening.
a. Verify that CartCom's ChgRelay status is <i>Closed</i>
9. If the ChgRelay status is <i>Closed</i> , these are the likeliest reasons the Charge Relay is not opening:
a. The PowerCart's Battery is too low to open the Charge Relay (less than 11VDC)
i. Charge the Battery Offline, then redo this Procedure
b. The Charge Circuit Fuses (KTK-15) are blown
c. The Charge Brushes are not correctly contacting the Charge Rail
d. The Charge Relay is broken.
i. Replace the Microcontroller Board
e. A Blocking Diode is broken

Tools – Charge Rail Voltage Check
½" Socket Head
½" Wrench
Impact Driver
12v AGM Battery Charger – Noco Genius 10 or equivalent recommended
Multimeter
CartCom Laptop

GREASING & OILING OF THREADED OR PNEUMATIC COMPONENTS

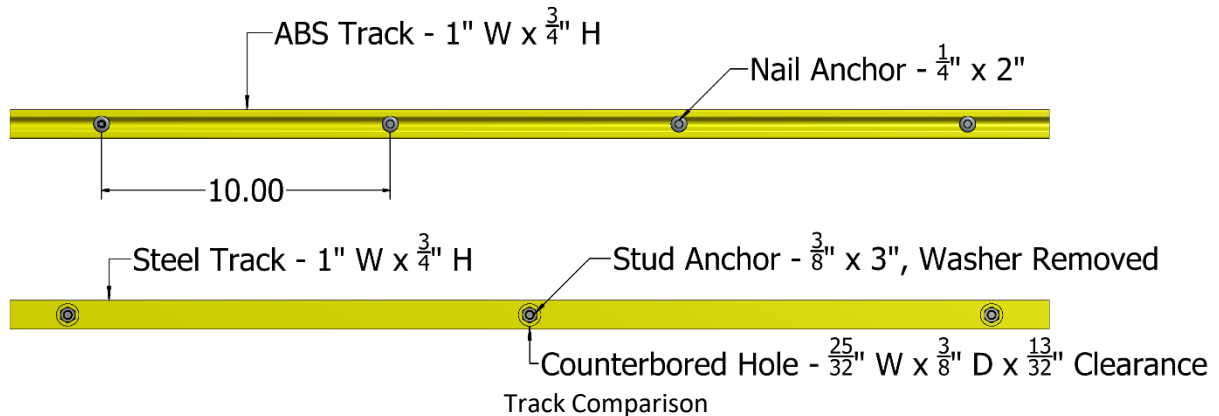
The Cart Stops and Track Switches should be lubricated on a regular basis. Simply putting a few drops of oil in the air-line will lubricate pneumatic components. The Cart Stop extension arms should be greased occasionally for smooth operation.

PowerCarts equipped with a **Door Rack** should be regularly greased with **Bearing Grease** to both ensure smooth operation and prevent overspray from adhering to the threads. The **Threaded Rod** and **Threaded Block** of the **Live Center Post**, as well as the **Clocking Wheel** and **Clocking Pin** assembly of the **Drive Center Post**, are the most important to regularly grease. Any other exposed threads should be covered to protect against overspray, as well.

Tools – Greasing & Oiling
Bearing Grease
Oil

TRACK INSTALLATION & REPLACEMENT

PowerCart production lines use a mixture of **ABS** and **Steel track**. ABS is used for straight sections or gentle curves. Steel Track is used for curves, spray booths, Load/Unload sections, and production lines with carts carrying heavier loads. The dimensions of each type are the same: **1" W x ¾" H**.



ABS Track is secured to the floor with $\frac{1}{4}$ " x 2" Nail Anchors spaced ~8-10" apart on straight sections and ~6" or closer on curves as needed to prevent breakage. The max length of one section is 20'.

Steel Track is secured to the floor using $\frac{3}{8}$ " x 3" Stud Anchors with Hex Nut through counterbored holes in the track so that the head of the anchor is flush or below the top of the track. The max length of one section is 12'.

TRACK INSTALLATION

Procedure – Track Installation

1. Chalk out the path of the track to the **inside** edge (to be visible when installing).
2. Place the track on the ground at the edge of the chalk line. Place both feet on the track on each side of the Hammer Drill.
3. **ABS:**
 - a. Cut ABS section to length with Grinder (if necessary)
 - b. Hammer Drill directly through the ABS and into the concrete until the bit is bottomed out
 - c. Place a $\frac{1}{4}$ " x 2" Nail Anchor into hole
 - d. Hammer down the Nail Anchor until the head of the nail is flush and the anchor is ~ $\frac{1}{4}$ " over flush with the track
 - i. Take care not to "Fold Over" the Nail head which might protrude too far over the track and interfere with a PC2
 - e. At the beginning and end of each section of ABS track, place two Nail Anchors ~4" apart to prevent breakage at the joint between sections
4. **Steel Track:**
 - a. Hammer Drill directly through the **counterbored hole** of the steel track and into the concrete until the bit is fully through the concrete*
 - i. *Receive approval from building maintenance dept. before drilling through the slab
 - b. Place a $\frac{3}{8}$ " x 3" Stud Anchor into hole
 - c. Hammer down the Stud Anchor until the head of the bolt is flush with the track
 - d. Use another bolt, place on the head of the positioned bolt, tap down the bolt until the nut of the sunk bolt meets the steel track's counterbored face
 - e. Tighten the nut of the Stud Anchor to the anchor manufacturer specified Ft/Lbs. torque using an Impact Driver with a $\frac{1}{2}$ " Socket.
5. Vacuum any concrete dust

Tools – Track Installation	
ABS Track	Steel Track
Hammer Drill	Hammer Drill
¼" x 6" Concrete Drill Bit	3/8" x 12" Concrete Drill Bit
¼" x 2" Nail Anchor	3/8" x 3" Stud Anchor
Hammer or Mallet	Hammer or Mallet
Grinder	Grinder
Wet/Dry Vacuum	Wet/Dry Vacuum
	Impact Driver
	½" Socket

TRACK REPLACEMENT

This section covers replacement of ABS track as Steel track generally does not require replacement due to breakage and can simply be lifted once the nuts of the Stud Anchors are removed.

Procedure: Track Replacement
1. Stop a cart well before the broken track section and assess the damage.
2. Cut the broken section of track back to the nearest undamaged Nail Anchor on each side using a grinder
3. Remove all affected Nail Anchors using a hammer/mallet and a wide-head chisel. Place the chisel head at the base of the track, flush to the concrete, and midline of a Nail Anchor that needs to be removed.
4. Hammer the chisel trying to push the Nail Anchor "over". The track should begin to "turn over" and increase the gap between its bottom and the concrete.
5. Once the gap is large enough use a pry bar to pop the Nail Anchor out of its hole. If it will not come out, repeat Step 4 until it either breaks or pops out.
6. Once all affected pins are removed, repeat Steps 1-3 of the Track Installation section.

Tools - Track Replacement
Hammer Drill
¼" x 6" Concrete Drill Bit
¼" x 2" Nail Anchor
Hammer or Mallet
Wide-Head Chisel
Pry-Bar
Grinder

TRACK MAGNET INSTALLATION

Track Magnets cannot be repaired when broken, only replaced. They can also be added to the track at any time to stop a PC2. The two processes are identical.

Procedure – Track Magnet Installation
1. <i>If Replacing:</i> Pry out shards of existing magnet.
2. Position drill bit <i>wedged</i> into the top slot of the track to prevent drill bit from walking.
3. Drill new slot for Magnet into track ~1/4" from top of track to outer edge of drill point. <ol style="list-style-type: none"> Do NOT drill completely through the track.

4. Clear Track debris.
5. Determine Magnet polarity, often marked on the Magnet such as a red dot.
6. Press Magnet into slot until the top sits 1/8" above the track
7. Epoxy into position

Tools – Track Magnet Installation
Drill
5/8" Drill Bit
Flathead Screwdriver
Magnet - 5/8" W x 3/8" H, Round, Ceramic Disc Hard Ferrite
Epoxy

THE CARTCOM LAPTOP

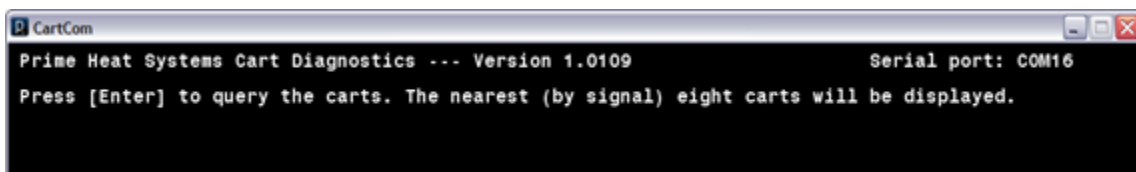
The **CartCom Laptop** is a stand-alone system used to communicate with the PC2. Using this system, cart maintenance and troubleshooting is as easy as turning on the supplied laptop. All aspects of the cart operation are displayed and timers used in the operation of the carts can be set or changed. **Make sure to "Suspend Updates" on CartLord before using the CartCom Laptop.**

SETUP

1. Prior to turning on the computer, attach the XBee Communication Module to the left USB port on the CartCom Laptop. The Module **MUST** be attached to the USB port.
2. Turn the Laptop ON. Select the CartCom icon. If the Module is misplaced or not attached to the correct USB port, the CartCom program will not run and a blank desktop will appear. Check your connections and restart the computer.

USING THE CARTCOM PROGRAM

1. The CartCom Program will load the following start screen:

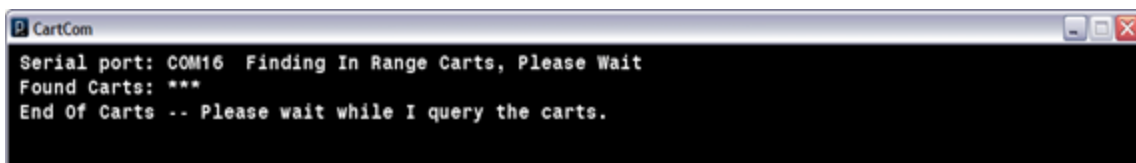


```

CartCom
Prime Heat Systems Cart Diagnostics --- Version 1.0109          Serial port: COM16
Press [Enter] to query the carts. The nearest (by signal) eight carts will be displayed.

```

2. Click "Find Nearby Carts" to find carts within range of the Zigbee Communication Module connected to the laptop. A status dialog showing the progress of the operation will appear.



```

CartCom
Serial port: COM16 Finding In Range Carts, Please Wait
Found Carts: ***
End Of Carts -- Please wait while I query the carts.

```

3. When the program has found all the carts in range it will proceed to start querying cart information from each of the carts it found. A status dialog showing the progress of the querying operation will appear.

```

CartCom
Press [Enter] to (Re)Load Carts -- Press [s] for Single Cart Diagnostics
CartID      Cart #   BVolts   KickSw   Bumper   TMagnet   ChgRelay   Motor   RS
PH_SHOP-01  1       14.3     On       Off      Off       Closed     On      36
PH_SHOP-03  3       12.1     Off      Off      Off       Open       Off     38
PH_SHOP-02  2       12.1     Off      Off      Off       Closed     Off     47

```

- Once querying is completed, the found carts will be displayed on the screen along with the below information about each cart. The carts are displayed in order based on return signal strength, with carts closer to the computer being displayed at the top of the list, and carts further away from the computer being displayed at the bottom of the list.

CartCom Basic Information Columns	
Label	Description
Cart ID	The unique internal cart identification.
Cart #	The Cart Number.
BVolts	The current battery voltage.
KickSw	Kick Switch status, <i>On</i> – Magnet in front of MR Switches/ <i>Off</i> – No Magnet.
Bumper	Bumper Status, <i>On</i> – Bumper is engaged, <i>Off</i> – Bumper is free. **The Tabletop Sensor is joined to the Bumper, so if the Tabletop is out of alignment "Bumper" will read <i>On</i> **
TMagnet	Track Magnet, <i>On</i> – Track MR Switch is on a Magnet, <i>Off</i> – No magnet present.
ChgRelay	<i>Open</i> – Cart voltage is present on the charge brushes, will charge if on a charge rail. <i>Closed</i> – Cart is not charging.
Motor	<i>On</i> – Motor should be running; <i>Off</i> – Cart motor is off.
NOTES	<i>TMagnet</i> may indicate <i>Off</i> when the cart has been stopped by a magnet. This is because the cart while stopping rolled past the magnet just enough for the MR switch to not read the magnet. The cart will resume travel after the magnet timer elapses.

- Press "S", then click on an entry for a cart in the 'Cart List' to switch to the 'Cart Settings' screen. The program will retrieve the settings for the selected cart. A status dialog showing the progress of the operation will appear.

```

CartCom
Press [Enter] to (Re)Load Carts -- Press [s] for Single Cart Diagnostics

CartID      Cart #   BVolts   KickSw   Bumper   TMagnet   ChgRelay   Motor   RS
PH_SHOP-03  3       14.5    Off      Off      Off       Open       Off     36
PH_SHOP-01  1       11.9    On       Off      Off       Closed     Off     51
PH_SHOP-02  2       11.9    Off      Off      Off       Closed     Off     55

Click on the Cart Number you wish to further query, on any blank space to reload.
Note: Kick Switch must be in OFF position for single cart diagnostics.

```

6. After the settings are retrieved, the following Cart Settings detail screen will be displayed.

```

CartCom_205C
Press [Enter] to Reload Carts -- Press [t] to change settings, Press [r] to reboot this cart.

CartID      Cart #   BVolts   KickSw   Bumper   TMagnet   ChgRelay   Motor   RS
SHOP_0003   3       11.7    Off      Off      Off       Closed     Off     75

Emergency Charge is: Off
Motor Slip is: Off
Bumper On Delay: 1
Magnet Delay: 30
On Rail Delay: 180

Battery Volts: 11.6
Slip Minutes: 8
Magnet Off: 350
Battery Low: 718
Baterly OK: 765
Motor Speed: 100
Soft Pause: 210
Soft Delay: 400
Charge Count: 774
Version: 22

```

- If the details do not display and the status area shows a red error message “Unable to retrieve settings from cart...” press the Enter key to reload the carts. Repeat Step 5.
- If reloading the carts does not work, verify that the cart is still physically near the CartCom computer (and has not moved out of range).
- If the cart is still physically near the CartCom computer, press ‘R’ to reboot the cart, wait a few seconds and then press ‘Enter’ again. Repeat Step 5 to verify the cart’s program is running. (The reboot command simply restarts the program running in the cart; it is just like rebooting a computer)

CartCOM Laptop Individual Cart Information Screen

Label	Description
-------	-------------

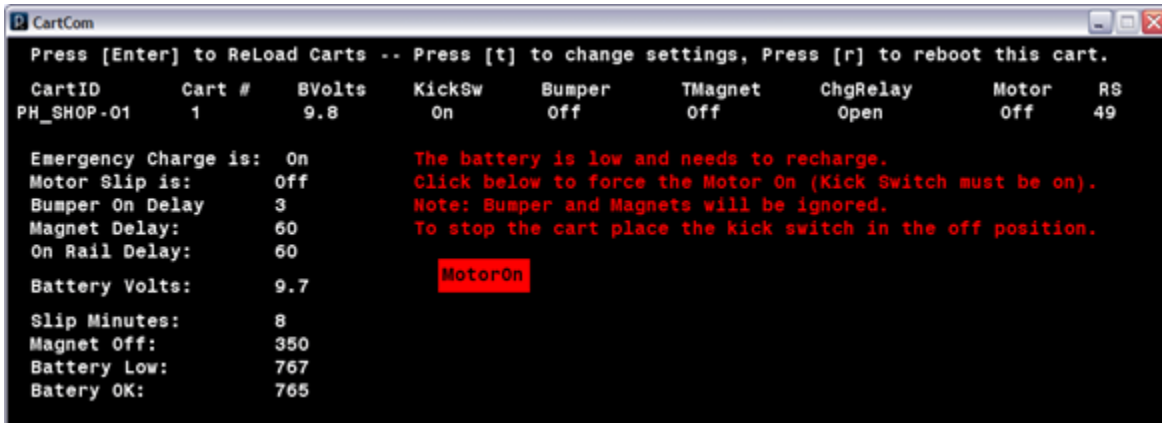
Emergency Charge:	<i>On</i> – Cart battery needs to be charged; cart will not operate normal. <i>Off</i> – Cart is operating normally.
Motor Slip:	<i>On</i> – Cart motor has been on for more than the setting in “Slip Minutes” and needs to be reset by cycling the Kick Switch. <i>Off</i> – Cart is operating normally.
** Bumper On Delay:	Time in seconds the cart will delay after the bumper has been disengaged.
** Magnet Delay:	Time in seconds the cart will stop at each magnet when <i>NOT</i> on a charge rail.
** On Rail Delay:	Time in seconds the cart will stop when sensing Magnet <i>and</i> Voltage, i.e., a Charge Rail.
Battery Volts:	Current cart battery voltage.
**Slip Minutes:	Time in minutes the motor will run continuously uninterrupted before timing out.
**Magnet Off:	Time in milliseconds that the cart will ignore magnets after magnet time out.
Battery Low:	Battery Low setting.
Battery OK:	Battery OK setting.
**Motor Speed:	Setting is percentage of full motor speed. Cart will normally travel at this speed.
**Soft Pause:	Speed at which the cart will move during the soft start. Setting is from 0-255, 0 is full speed, 255 is stopped.
**Soft Delay:	Time in hundredths of a second that the cart will remain at the soft pause speed before accelerating to the speed set by Motor Speed.
Charge Count:	Number of times this cart has charged. Used by cart watch. No meaning if cart watch not installed.
Version:	Current software version of this carts operating system.

**** Indicates modifiable settings that can be adjusted. One Kick Switch must be ‘OFF’ to adjust.**

To change a modifiable setting, press **T**, then click on the value for a setting, and use the keyboard to delete the existing and enter the new value shown in Red. The new value entered must be within the limits shown for that setting. Press **Enter** to save the setting to the cart.

7. If the setting is saved successfully to the cart, the new setting value will be reflected on the screen.
8. To return to the **Cart List** screen at any time, press **Enter**.
9. **Serial Error** - If at any point the status area displays a red error message **ERROR: Serial error communicating with radio, please verify radio is connected**, verify that the Communication Module is attached to one of the USB ports on the right side of the CartCom Laptop, then try repeating the operation.
10. **Emergency Charge** – If a Battery drops below **11VDC** a very rapid voltage drop occurs. **Below 11VDC the Microcontroller’s Charge Relay may not Open and this will make charging the battery through the brushes impossible.** The PowerCart will need to be charged directly to the battery leads inside the Circuit Box or directly to the Battery in the Battery Box. To prevent having to open the Circuit or Battery Box the PowerCart will enter an emergency charge state if the battery voltage is registered lower than 10.7 volts. Since the number of Charge Rails and placement has been designed to provide adequate charge the PowerCart should be checked for physical damages. The Charge Brushes might be bent or disconnected. Follow the troubleshooting guide in the back of the manual for a complete list of things to check. The PC2 must be fully charged. If the voltage is too low the Charge Relay may

not function. *Refer to Sections: The Charging Circuit & Blocking Diodes and Battery – Offline Charging.*



```

CartCom
Press [Enter] to ReLoad Carts -- Press [t] to change settings, Press [r] to reboot this cart.
CartID      Cart #    BVolts    KickSw    Bumper    TMagnet    ChgRelay    Motor    RS
PH_SHOP-01  1        9.8       On        Off       Off        Open        Off      49

Emergency Charge is: On
Motor Slip is: Off
Bumper On Delay: 3
Magnet Delay: 60
On Rail Delay: 60
Battery Volts: 9.7
Slip Minutes: 8
Magnet Off: 350
Battery Low: 767
Battery OK: 765

The battery is low and needs to recharge.
Click below to force the Motor On (Kick Switch must be on).
Note: Bumper and Magnets will be ignored.
To stop the cart place the kick switch in the off position.

MotorOn
  
```

THE CARTLORD MONITOR

The CartLord Monitor is a stand-alone console using ZigBee Communication protocol to update PC2 information over a whole production line every three minutes. The monitor will display the same information as the CartCom Laptop, but without the ability to get cart timing settings, as seen in the table below. Some carts will not update every three minutes due to their location in the production line. Only one Xbee transmitter is used for the monitor information and some carts may be out of the communication range.

“Suspend Updates” when using the CartCom Laptop, due to interference.

CartLord Monitor Columns	
Label	Description
Cart #	The Cart Number
Status	<i>Green</i> –Bvolts ≥ 11.5 V; <i>Yellow</i> – $11.5 \geq$ BVolts ≥ 10.6 V; <i>Red</i> – 10.6 V \geq BVolts
Update	Time stamp from the last time the corresponding Cart# was updated.
BVolts	The current battery voltage.
KickSW	Kick Switch status, <i>On</i> - Magnet in front of Kick Switch Sensors, <i>Off</i> - No Magnet
Bumper	Bumper Status, <i>For Touch Bumper: On</i> – Touch Bumper is engaged, <i>Off</i> – Touch Bumper is free. <i>For Tabletop: On</i> – Tabletop is out of alignment, <i>Off</i> – Tabletop in alignment
TMagnet	Track Magnet, <i>On</i> – Track Sensor is on a Magnet, <i>Off</i> – No magnet present
ChgRelay	<i>Open</i> – Cart voltage is present on the charge brushes, will charge if on a charge rail
Motor	<i>On</i> – Motor should be running; <i>Off</i> – Cart motor is off.

CartLord Monitor Buttons	
Label	Description
Start	Starts all carts in range.
Stop	Stop all carts in range.

Suspend Updates	Prevents CartLord from sending update signal. CartLord should be suspended when the CartCom Laptop is in use, due to interference.
Force Update	Forces CartLord to update information on each cart in range.
NOTE	Turn the automatic updates <i>OFF</i> (press Suspend Updates) if using the CartCom Laptop. The laptop signal will be interrupted every three minutes when the monitor updates, and the program will need to be refreshed.

RF ANTENNA

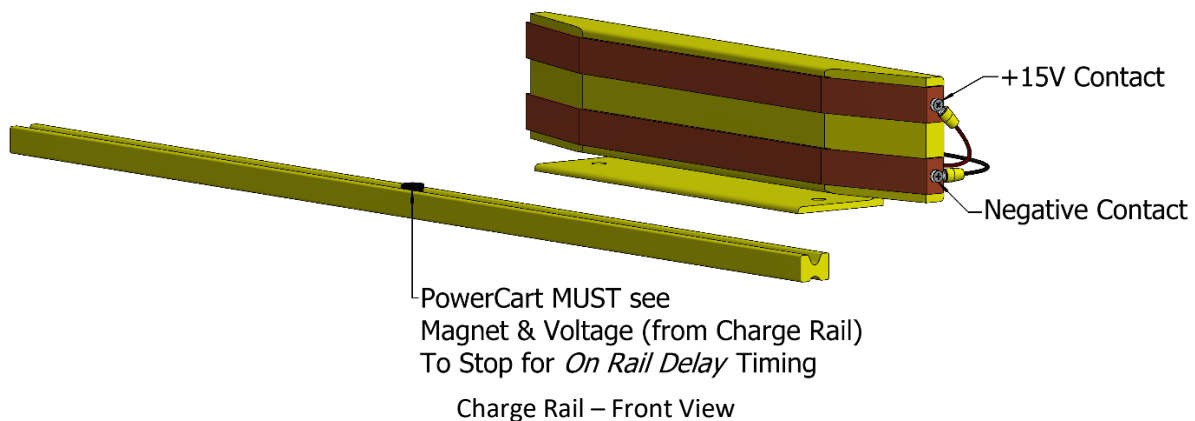
CartLord's signal strength can be boosted with a 2.4 GHz 9 dBi Omni Antenna. For robotic cell integration, it is necessary to have an RF Antenna at each cell for the Robot Integration CP to "take control" of the PowerCart in the cell without error. For large facilities with many obstructions, it is recommended to use an RF Antenna at the CartLord Monitor.

RF REPEATER

CartLord's range can be extended using an RF Repeater. It is manufactured by Prime Heat and, as every facility has different challenges, it is used on an "as needed" basis. Its primary function is to repeat CartLord's **Start** and **Stop** commands to all carts if they temporarily exceed CartLord's range.

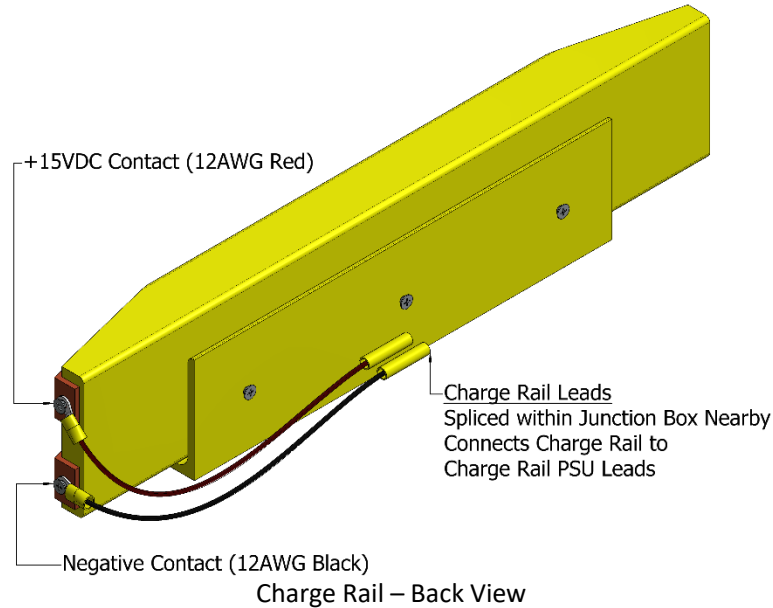


CHARGE RAILS



Charging Rails are predominately located inside Prime Heat Tunnels. A track magnet must be present to stop the carts on the charge rails. **ONLY when a cart both A) Stops on a magnet and B) Reads voltage will the cart delay using the "On Rail Delay" timing and charge correctly.**

The UL-Listed, **Allen Bradley 1606-XLS180B** Power Supply to the Charge Rail **requires 120 VAC 2.1-0.9A** power and has an **output of 15.5 VDC 15-13.5A**, with a current maximizing circuit that varies the voltage depending on the battery that is drawing charge. There are no serviceable parts inside the power supply boxes and they should always remain plugged in with selectable voltage set to 15V. The **Positive (+) RED WIRE** is always attached to the top contact, the **Negative (-) BLACK WIRE** is always the bottom contact.



The cart should be charged **no less than three minutes per hundred feet of track**. The charge rails should be checked periodically to ensure that there is 15 Volts across the contactors. **Refer to Wiring Diagram C: Charge Rail PSU.**

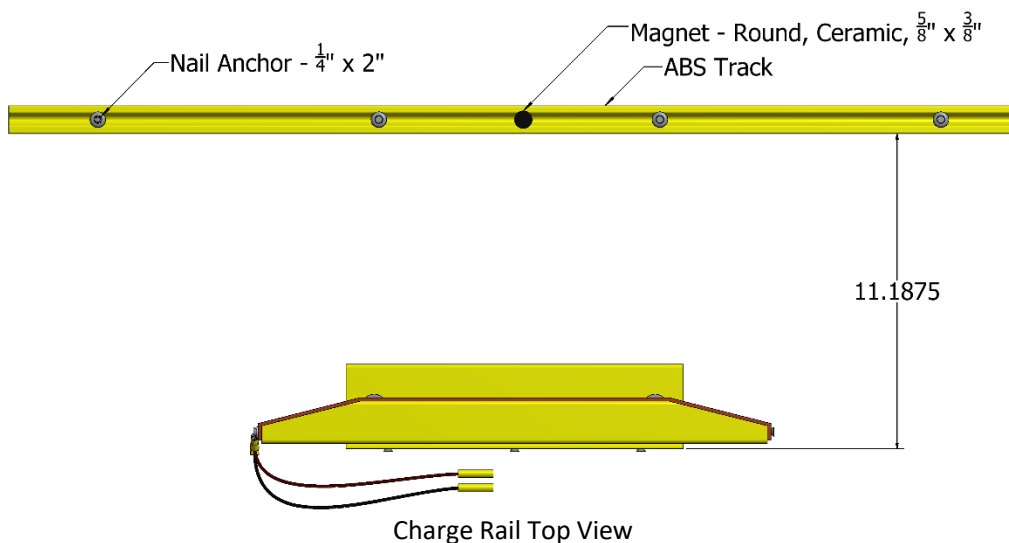
To determine how many Charge Rails are necessary for 3 Mins of charge per 100 FT of a *specific route*, as PowerCarts can take multiple paths, use the following formula:

$$(\text{Total Track of Route} \div 100 * \text{Minutes per 100 FT}) \div \text{On Rail Delay Timing}.$$

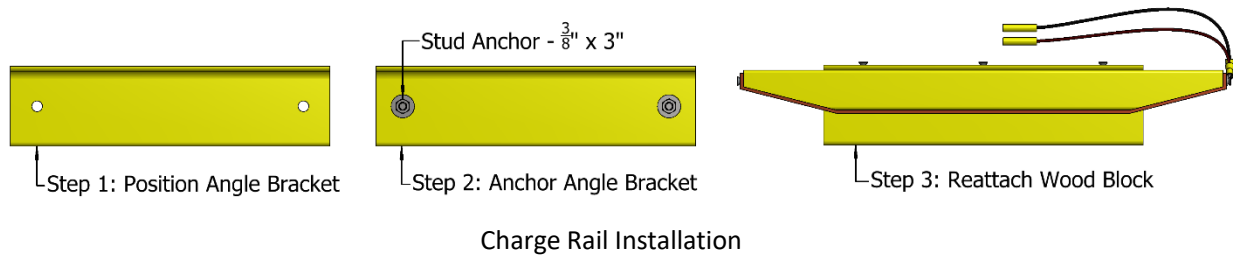
*Ex: Route 1: (650 FT of Track \div 100*3 Mins per 100 FT) \div 2 Minutes On Rail Delay Timing = 10 Charge Rails*

CHARGE RAIL INSTALLATION

Charge Rails should be installed on the left side of the track, ~11.1875 inches from the back of the Charge Rail's angle-bracket mount to the near edge of the track.



The power supply should be mounted outside the path of the carts, generally on the outside wall of the tunnel. The 12 AWG wires running to the Charge Rail's power supply should be protected from damage by being installed in Schedule 80 RMC along the length of the track or within a channel cut in the concrete to cross the PC2's drive wheel and casters. The channel can then be capped with silicon, concrete, etc., provided it does not interfere with the PC2 wheels.



TRACK SWITCHES

There are three types of Track Switch configurations: **Auto**, **Smart**, and **Manual**.

Track Switch Types	
AUTO	Automatically senses and routes carts by simply alternating Left/Right.
SMART	Automatically senses and routes carts along a programmed route.
MANUAL	Manually operated by worker.

There are two types of Track Switch routes, **Diverge** and **Merge**.

Track Switch Routes	
DIVERGE	Split the track from one line into two lines.
MERGE	Merge two tracks into one line.

By combining these the Track Switch system has **six configuration options**:

Track Switch Configuration Options
1. Auto Diverge
2. Auto Merge
3. Smart Diverge
4. Smart Merge
5. Manual Diverge
6. Manual Merge

AUTO TRACK SWITCH

Auto Track Switches use electrical and air-actuated components and operate without supervision. They can be Auto Merge or Auto Diverge. The Auto Diverge simply has one more Cart Stop.

Requirements – Auto Track Switch
<ul style="list-style-type: none"> • Air Drops: <ul style="list-style-type: none"> • 1 Shop Pressure ~90-120 PSI, ideally to back of Track Switch Control Box. • If Auto Merge: 1 Additional Shop Pressure drop to furthest Cart Stop from Track Switch Control Box.
<ul style="list-style-type: none"> • Electrical Drop: <ul style="list-style-type: none"> • 110VAC 20A to Back of Track Switch Control Box
<ul style="list-style-type: none"> • Proximity Sensors: <ul style="list-style-type: none"> • Auto Diverge: <ul style="list-style-type: none"> ▪ Present Sensor: 1 ▪ Clear Sensor: 2 • Auto Merge: <ul style="list-style-type: none"> ▪ Present Sensor: 2 ▪ Clear Sensor: 1
<ul style="list-style-type: none"> • Optional: <ul style="list-style-type: none"> • If Auto Merge after Station Stop: <ul style="list-style-type: none"> ▪ Station Buttons: 1 Per Station/Line ▪ Strut to mount Station Buttons

SMART TRACK SWITCH

Smart Track Switches use electrical and air-actuated components and automatically route carts along programmed routes. They can be Smart Merge or Smart Diverge. The Smart Diverge simply has one more Cart Stop.

Requirements – Auto Track Switch
<ul style="list-style-type: none"> • Air Drops: <ul style="list-style-type: none"> • 1 Shop Pressure ~90-120 PSI, ideally to back of Track Switch Control Box. • If Smart Merge: 1 Additional Shop Pressure drop to furthest Cart Stop from Track Switch Control Box.
<ul style="list-style-type: none"> • Electrical Drop: <ul style="list-style-type: none"> • 110VAC 20A to Back of Track Switch Control Box
<ul style="list-style-type: none"> • Proximity Sensors: <ul style="list-style-type: none"> • Smart Diverge: <ul style="list-style-type: none"> ▪ Present Sensor: 1 ▪ Clear Sensor: 2 • Smart Merge: <ul style="list-style-type: none"> ▪ Present Sensor: 2 ▪ Clear Sensor: 1
<ul style="list-style-type: none"> • RFID Antennae: <ul style="list-style-type: none"> • If Smart Diverge: 1 • If Smart Merge: 2

MANUAL TRACK SWITCH

Manual Track Switches use only air-actuated components and are controlled by an operator. There can be Manual Merge or Manual Diverge. The Manual Diverge simply has one more Cart Stop.

Requirements – Auto Track Switch
<ul style="list-style-type: none"> • Air Drops: <ul style="list-style-type: none"> • 1 Shop Pressure ~90-120 PSI, ideally to Toggle Tower.
<ul style="list-style-type: none"> • Air Toggles: <ul style="list-style-type: none"> • Track Switch: 1 • Manual Diverge: 1 additional Air Toggles for Cart Stop. • Manual Merge: 2 additional Air Toggles for Cart Stops of each line.
<ul style="list-style-type: none"> • Toggle Tower or Strut to mount Air Toggles
<ul style="list-style-type: none"> • Does NOT require: <ul style="list-style-type: none"> • Power • Proximity Sensors • Control Box Display • RFID Antennae

DIVERGE SWITCH

Every PC2 will be stopped prior to a Diverge Switch by a Cart Stop. When the Track Switch Control Box has set a track direction, the cart will be released from the Cart Stop. The Cart Stop head will extend out when the cart is clear to stop the next cart in line.

Floor mounted proximity sensors monitor the status of a PC2 up to and past a Track Switch. The **“Present”** proximity sensor indicates a PC2 is waiting at a Cart Stop before the Track Switch. Once a cart has been released the controller will wait until the **“Clear”** proximity sensor is activated then reset, informing that the cart reached a point clear of the switch and that it is safe to release the next cart.

MERGE SWITCH

The Merge Switch stops carts on both track directions prior to the track switch. **“Present”** proximity sensors are located at each Cart Stop to inform the controls that a cart or carts are ready to merge. A **“Clear”** proximity sensor relays full or empty line information after the Track Switch.

When a released cart clears this point the controls will continue by setting track switch direction and then releasing the next cart in sequence. The control will alternate sides unless a cart is not present on the opposing side.

PROXIMITY SENSORS

12VDC Floor mounted metal proximity sensors monitor the status of a PC2 at every Auto Cart Stop and Auto Track Switch. The sensors trigger off the **Sensor Plate** attached to the bottom of the PC2 Drive-frame. The sensors are protected by a rubber sleeve and inset into the concrete using a 1-1/8” hammer drill bit. Connected to Controller Board inside Track Switch Control Box by 22 AWG signal wire run in ground.

If any of the proximity sensors are not operating in a stable mode, the controls system will fail. It may need to be rebooted with all carts clear of any Track Switch related items such as Cart Stops, the Track Switch swing-arm, and all floor mounted proximity sensors.

****Do NOT switch from Manual to Auto Mode with carts still progressing through the Track Switch. This will reset the Clear Sensor “Waiting” status and lead to a failure condition****

PRESENT SENSOR

A **Present Sensor** indicates a PC2 is waiting at a Cart Stop.

- When a cart is in position at the Cart Stop the status of the Control Box Display should read **“Present”** at that Cart Stop
- When a cart is **NOT** in position at the Cart Stop the status of the Control Box Display should read **“Clear”** at that Cart Stop.

CLEAR SENSOR

A **Clear Sensor** relays full or empty line status information after the Track Switch.

- When a cart is **moving** through the Track Switch, but has not passed the **Clear Sensor**, the status of **“Cart Clear”** on the control box display will read **“Waiting”**.
- When a cart is fully past the **Clear Sensor** the status of **“Cart Clear”** on the control box display will read **“Clear”**.

TRACK SWITCH CONTROL BOX

All track switches have a Track Switch Control Box that houses a 6” pneumatic actuator to move the swing-arm to either side.

AUTO/SMART TRACK SWITCH CONTROL BOX

Auto and Smart Track Switch Control Boxes are identical except for the controller board they each house.

AUTO/SMART TRACK SWITCH CONTROL BOX MODES

Manual Mode allows the user to choose a direction for the cart to proceed. The Cart Stops can also be controlled in Manual Mode. All proximity sensors are disregarded.

Auto Mode allows the Track Switch to choose a direction for the cart to proceed through tracking the status of the “Present” and “Clear” proximity sensors. Cart Stops are automatically activated and so cannot be user controlled.

MANUAL TRACK SWITCH CONTROL BOX

Manual Track Switches have no electrical or electronics and do not require a UL-508A label. They have a single 6” pneumatic actuator inside to control track switching. The actuator is controlled by a nearby Toggle Tower with an Air Toggle used by the operator.

CLEARING A TRACK SWITCH

If a track switch malfunctions, follow the procedure listed below:

Procedure – Clearing a Track Switch	
1.	Turn any PowerCarts involved OFF using the Kick Switch of each PowerCart
2.	At the Track Switch Control Box display, press Auto to toggle it to Manual Mode .
3.	If you need to move a Cart Stop, you can: <ol style="list-style-type: none"> With the Track Switch in Manual Mode, press Hold of the Cart Stop you need to move. The button will switch to Release, and the Cart Stop head will retract. Or, turn off the air pressure and manually move it. Unhook the air hose from the supply maneuver the stop arm. Reconnect when finished and ready for normal operation.
4.	Maneuver the PowerCarts off the Track Switch.

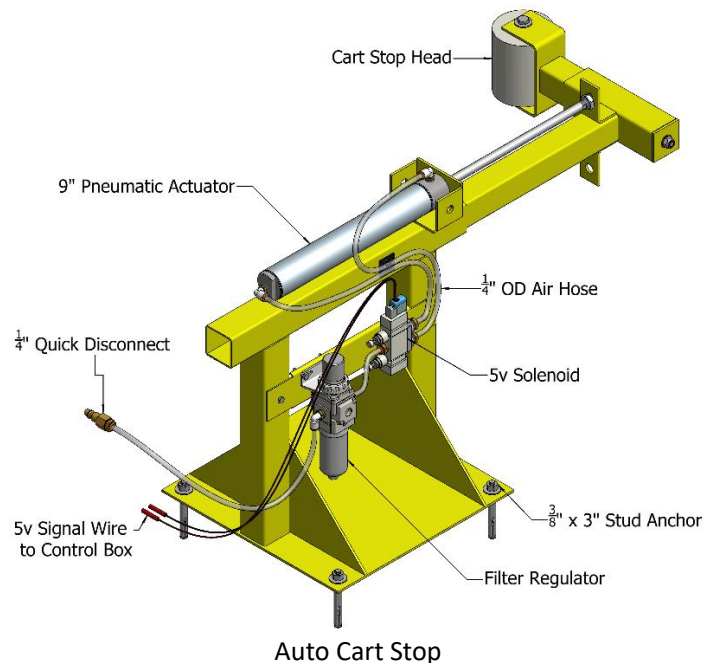
- a. If the PowerCart can move with the Cart Stop head clear, toggle it **ON** and let it proceed clear of the Track Switch area and **Clear Sensor**
 - b. Or, lift the handle of the PowerCart's Drive-Frame until it is safely latched and the bearings are free of the swing-arm of the Track Switch. Push the PowerCart clear of the Track Switch area, including past any floor mounted proximity sensors.
5. Position all PowerCarts clear of the Cart Stops, Track Switch, AND floor mounted Proximity Sensors.
 - a. ****Do NOT switch from Manual to Auto Mode with carts still progressing through the Track Switch. This will reset the Clear Sensor "Waiting" status and lead to a failure condition****
 6. Once carts are clear, at the Control Box display press **Manual** to toggle the switch into **Auto Mode**.
 7. Turn on the carts then observe normal operation.

CART STOPS

Cart Stops prevent PC2s from advancing at certain points along the route. They are used to stop at Track Switches, Spray Booths, Workstations, Load/Unload Stations, etc. The **Cart Stop Head** uses a compression spring to gently contact the Touch Bumper of a PC2 and stop it. The head moves **In/Out** by a **9" pneumatic actuator** fed by **1/4" OD Air Hose** with "Shop Pressure" **~90-120 PSI**. The Cart Stop should be **placed ~27" from the inside edge of the track**, although for positioning near a radius this dimension may need adjustment and may need to be based off the track's straight line as it continues past the radius (tangent to it).

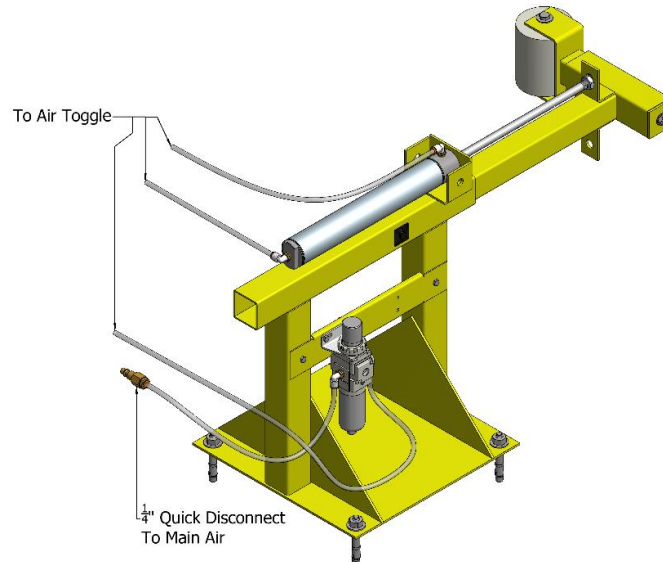
AUTO CART STOP

Auto Cart Stops are controlled by a separate control box such as a Track Switch Control Box, Load/Unload Station, Robot Integration Station, etc. The control box retracts/extends the Cart Stop Head based on the status of Proximity Sensors sending 12VDC signal to the controller board within the control box, which then triggers a **5VDC signal to a Solenoid** either located on the Cart Stop or within the control box itself.



MANUAL CART STOP

Manual Cart Stops are **Air-Only** and controlled by an operator using a Toggle Tower or Cart-on-Demand Box. Instead of a Solenoid the Manual Cart Stop uses an **Air Toggle** to move the Cart Stop Head In/Out.



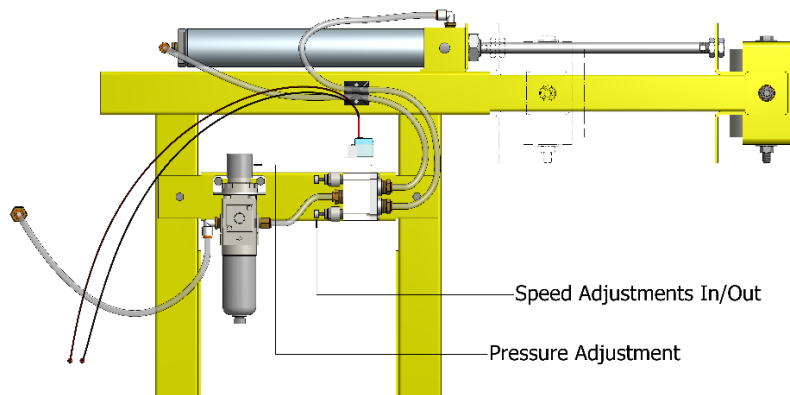
Manual Cart Stop

CART STOP ADJUSTMENTS

Auto and Manual Cart Stops are adjusted identically.

The **pressure** of the pneumatic actuator can be adjusted at the **Filter Regulator** of the Cart Stop, which is generally located on the Cart Stop itself but could also be located in whichever type of control box it is connected to. The pressure is by default set to 100%.

The **speed** of the the pneumatic actuator moving In and Out can be adjusted either with the **Solenoid** of the Auto Cart Stop or **Air Toggle** of a Manual Cart Stop by turning the **Valve Silencers**. **Clockwise=Slower, Counter-Clockwise=Faster**.



Cart Stop Adjustments

*****It is recommended to leave the Pressure and Speed settings of a Cart Stop at the values chosen by the installer team when installed*****

CART ON DEMAND

The cart on demand is a simple **AIR-ONLY**, manually operated system to stop carts at a given location prior to a finishing operation. The user is in full control of this manual switch. The stop operation is activated with an **Air Toggle** either in a Cart on Demand Box mounted to a spray booth wall, Toggle Tower, or other control box. The stop arm is either out or in depending on which way the Air Toggle switch is flipped. When the operator is ready for the next cart to enter, they will flip the switch. Once the cart has passed the Cart Stop the switch will have to be flipped again to stop the next cart inline.

TROUBLESHOOTING

POWERCART SENSOR RELATED

Problem	Possible Solution(s)
Track Sensor stops correctly on most magnets, but bypasses a few.	1. The Sensor may be too high above the track. Lower the sensor using a 1/8" Allen wrench. The sensor has a 5/8" operating gap. Do not tighten past 'snug'.
Track Sensor does not stop on any magnet.	1. The Sensor may be broken. If set too low, the sensor head may be sheared off. If over tightened by the set screw, it might have been damaged as well. Replace the sensor. Cut the sensor wire close to the tube. Using 18-22 AWG butt-connectors, wire a new sensor head onto the existing wire. Wire association does not matter.
One or both of the Kick Switches do not work.	1. Check that the Kick Switch's magnet is not broken or out of place. 2. Check that the sensor is not physically broken.
Tabletop Sensor not working correctly.	1. Check that the magnet is correctly above the sensor when the Tabletop is spun both ways. If correct, take the Table-Top off and start the cart. 2. Next, place a magnet directly over the sensor. The cart should start in 4 seconds if the switch is working. 3. The Sensor may be broken. Cut the sensor wire below the existing butt connectors (the bulge slightly below the sensor tube). Using 18-22 AWG butt-connectors, wire a new sensor head onto the existing wire. Black to black, red to red.
Touch Bumper Switch is not working correctly.	1. The Bumper may be broken. Visually inspect for cuts. Using a multimeter on Ohm Setting (Ω), check that the Bumper is good. Unplug/Cut the Bumper leads from the leads to the Diode Box. Either lead of the meter can go to either lead of the bumper. The meter should Beep (showing continuity) if the Bumper is good.

Touch Bumper checks as good, but Bumper still isn't working correctly.	<ol style="list-style-type: none"> 1. The Bumper may be too tight around the corners of the Bumper Frame. Loosen the ends of the Bumper, check if the cart runs normally. If so, re-tape the bumper ends on but lessen the pressure on the corners (the bumper is being accidentally triggered by pressure). 2. Check the leads going into the Diode Box for possible loose wire.
Touch Bumper is shown ON by CartLord and CartCom but is not in contact with anything.	<ol style="list-style-type: none"> 1. The Table-Top magnet may be out of position or turned. The Bumper and Table-Top are wired together inside the Diode Box. So when the Table-Top is turned, the Bumper will be shown as "ON".
Cart will not start, but all Switches appear wired correctly.	<ol style="list-style-type: none"> 1. It might be too tight around the corners of the bumper. Try loosening the ends individually until the bumper radii to see if the cart will run.

MOTOR/GEARBOX/DRIVE-WHEEL RELATED

Problems	Possible Solution(s)
The Drive-Wheel is slipping in certain areas.	<ol style="list-style-type: none"> 1. Check the floor along the track for slick surfaces, inclines, or fluids. Floors are rarely level, and sudden inclines coupled with slick concrete or wood can lead to slippage. Grip tape strips may be needed to provide better traction. 2. The wheel may be bald to the point it needs to be replaced. 3. The connection between the Motor and Gear Drive might be loose and causing the motor to slip.
The Drive-Wheel spins in the air but when placed on the ground does not spin.	<ol style="list-style-type: none"> 1. The connection between the Motor and Gear Drive might be loose and causing the motor to slip.
The cart is moving slowly, and it sounds like it is grinding or dragging.	<ol style="list-style-type: none"> 1. Turn the Cart OFF. Check the front and back Track Bearings. A loose item along the track may have lodged itself between the bearing and the track or floor.
The motor is running slow, sluggish or intermittently.	<ol style="list-style-type: none"> 1. The connection between the Motor and Gear Drive might be loose and causing the motor to slip. 2. The motor brushes may be worn out. This motor will need to be replaced. Refer to the maintenance section.
The Drive-Wheel will not turn, but the motor is trying to run.	<ol style="list-style-type: none"> 1. The connection between the Motor and Gear Drive might be loose and causing the motor to slip. 2. The Gearbox is internally geared, and if it should fail, will need to be replaced. Refer to the maintenance section.
The PowerCart stops in random areas, does not react to Kick Switch being toggled.	The battery is low (below 11VDC). The cart has entered a power saving mode. Refer to "7. Emergency Charge" under <i>Section: Using the CartCom Program</i> .

Pre-2020 PowerCart: The PowerCart runs 4 seconds, then stops, then when activated by Kick Switch it repeats that cycle.

The battery is low (below 11VDC). The cart has entered a power saving mode. Refer to “7. Emergency Charge” under *Section: Using the CartCom Program*.

POWERCART RELATED

Problems	Possible Solution(s)
<p>The cart is not working.</p>	<ol style="list-style-type: none"> 1. The Battery is under 11VDC. The PowerCart has entered <i>Emergency Charge Mode</i> and will stop operation until charged above 11VDC. It should be recharged offline to 12.6VDC. <ol style="list-style-type: none"> a. If the Battery Voltage falls too low (under 10.5VDC), the Charge Relay of the Microcontroller will not be able to open, and the cart will not charge on the Charge Rail. It must be charged through the Circuit Box or Battery Box. Refer to maintenance <i>Section: Battery - Offline Charging</i>. 2. The cart might simply need to be Rebooted using CartCom. Toggle the Kick Switch <i>OFF</i>. Select the cart in CartCom by pressing “S” and then clicking on the cart name. Next (in the single cart diagnostic screen) press “R” to reboot the cart. Wait 10 sec. and try to run the cart. 3. A Sensor may be in a fault or engaged state. Refer to maintenance <i>Sections: Sensor Checks</i> <ol style="list-style-type: none"> a. Track & Kick Switch Sensor Check b. Tabletop Sensor Check c. Touch Bumper Check 4. The program may not be running. The program is housed on a black 28 pin IC chip on the microcontroller in the Circuit Box. Swap it with a working cart’s chip. If the cart works, the non-working chip will need to be replaced. 5. The microcontroller board may need replacement.
<p>The cart stops on the Charge Rail as specified, but the Battery Voltage has fallen/continually falls below acceptable levels.</p>	<ol style="list-style-type: none"> 1. The Battery isn’t holding a charge anymore and must be replaced. Use only Absorbed Glass Mat Batteries. Refer to the Battery – Offline Charging section. 2. The Charge Brushes aren’t in contact with the Charge Rail. <ol style="list-style-type: none"> a. The magnet may be set too far back. Visual inspection should suffice to diagnose. Reset the magnet and glue down. b. The Charge Rail itself may be too far back from the Track. c. The Charge Brushes may be too worn to reach the Rail. Replace the brushes.

	<ol style="list-style-type: none"> 3. Use CartLord to verify that the ChgRelay is listed OPEN next time the cart stops on the Rail. 4. Verify the Charge Rail PSU is plugged in and delivering 15V to the Charge Rail.
The cart stops on the Charge Rail, but for less time than programmed.	<ol style="list-style-type: none"> 1. The cart is likely only stopping for the Magnet Delay timing instead of the On Rail Delay timing. <ol style="list-style-type: none"> a. The cart is not seeing the magnet <i>AND</i> voltage from the rail, so it stops for the Magnet Delay timing of a regular magnet in the trak. <ol style="list-style-type: none"> i. Verify the Charge Rail is supplying 15V ii. The Charge Brushes may be too worn to reach the Rail. Replace the brushes. iii. The Charge Relay of the Microcontroller may not be opening. This happens when the Battery Voltage is too low.
CartLord lists the ChgRelay OPEN, but the cart does not seem to charge.	<ol style="list-style-type: none"> 1. One of the Blocking Diodes may have shorted. This part cannot be accessed. The Diode Box may need to be replaced. Charge the cart offline through the Battery or Circuit Box, reboot the cart, then determine if the cart actually charges throughout the day.
Rusted Track Bearings	Bearings rust when subjected to harsh floor cleaning solvents. Clean any spills or puddles of solvents along the track. Replace the bearings.
The Track Bearings are too low or high for certain areas of the factory.	<ol style="list-style-type: none"> 1. Fix the floor in those areas either with grinding if too high, or patch if too low. 2. Bearings can be slightly adjusted with washers.
The Front and Back metal Bumper Frames have become loose.	Never lift the cart over track from the Bumper. Always lift from the corner of the body. Tighten the bumper bolts with a 3/16" Allen Wrench.

MICROCONTROLLER/CARTCOM/CARTLORD RELATED

Problem	Possible Solution(s)
The microcontroller isn't working and reboot does nothing.	The board will need to be replaced.
The microcontroller board's charge or motor relay mechanically stops working. This would be evident if CartCom Laptop registers the relays as CLOSED and there is no output voltage.	The board will need to be replaced.
If the ZigBee Transmitter on the microcontroller is not communicating with the CartCom Laptop.	The board or ZigBee will need to be replaced.

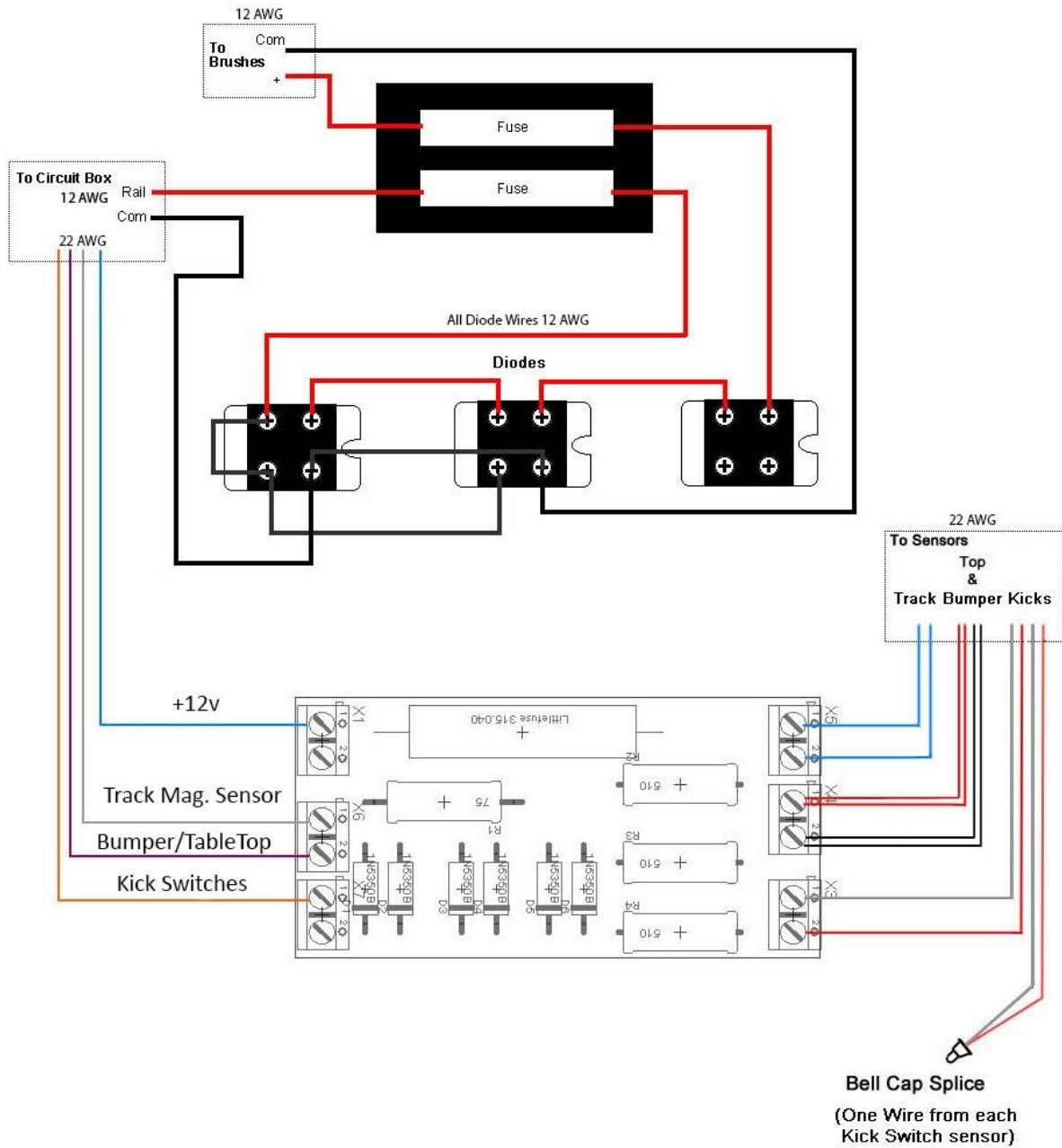
The microcontroller board's electrical components fail.	The board will need to be replaced.
Power to the battery was hooked up backwards. The micrcontroller has been fried.	The board will need to be replaced.
CartCom suddenly becomes cluttered with overlapping text.	While using CartCom, make sure to <i>Suspend Updates</i> on CartLord. The overlapping text results from CartLord querying the carts every 3 minutes.
CartCom won't return any results.	Make sure the ZigBee Chip on the CartCom laptop is plugged into the USB correctly on both ends. Also, if removed and reinserted it may be necessary to Restart the laptop.
CartCom Laptop went to sleep and when woken will not display new information.	Close the CartCom program and restart the program.
Pressing "T" to change settings in the Single Cart Diagnostic screen in CartCom does nothing.	One of the cart's Kick Switches must be <i>OFF</i> to change settings in CartCom.
CartLord updated, but didn't update the statuses of a few carts.	The carts may be out of range. It will update in 3 minutes, when the carts should be closer.
CartLord program is Frozen or Unresponsive.	Restart the program, if necessary, also the computer.

TRACK SWITCH/CART STOP RELATED

Problems	Possible Solution(s)
The Track Switch is hitting the other side too hard.	The Track Switch system uses Solenoid Valves with restrictors/diffusers. The restrictors/diffusers are attached to the solenoid within the Track Switch Control Box. To slow down the Track Switch, adjust the restrictors/diffusers clockwise.
The PowerCart is not stopping and continually bumping the cart stop.	The Cart Stop may need to be repositioned. Grind out or pound down the heads of the concrete anchors holding it down. Position it so that it will hit around the curve to the flat side of the bumper, ~27.5" from inside edge of Track to front edge of Cart Stop.
The PowerCart passes a Proximity Sensor, but the Cart Stop Arm does not extend.	The Proximity Sensor may need replacement or repositioning. It must be within ~1/2 inch of the Sensor Plate of the cart. It may be too low.
A PowerCart has timed out while the Stop Arm retracted, then the arm extended again and the cart can't move.	The switch thinks a cart was released and is waiting for it to <i>Clear</i> the proximity sensor. Hold a metal piece up to the <i>Clear</i> proximity sensor to tell the Track Switch to let the next cart through.

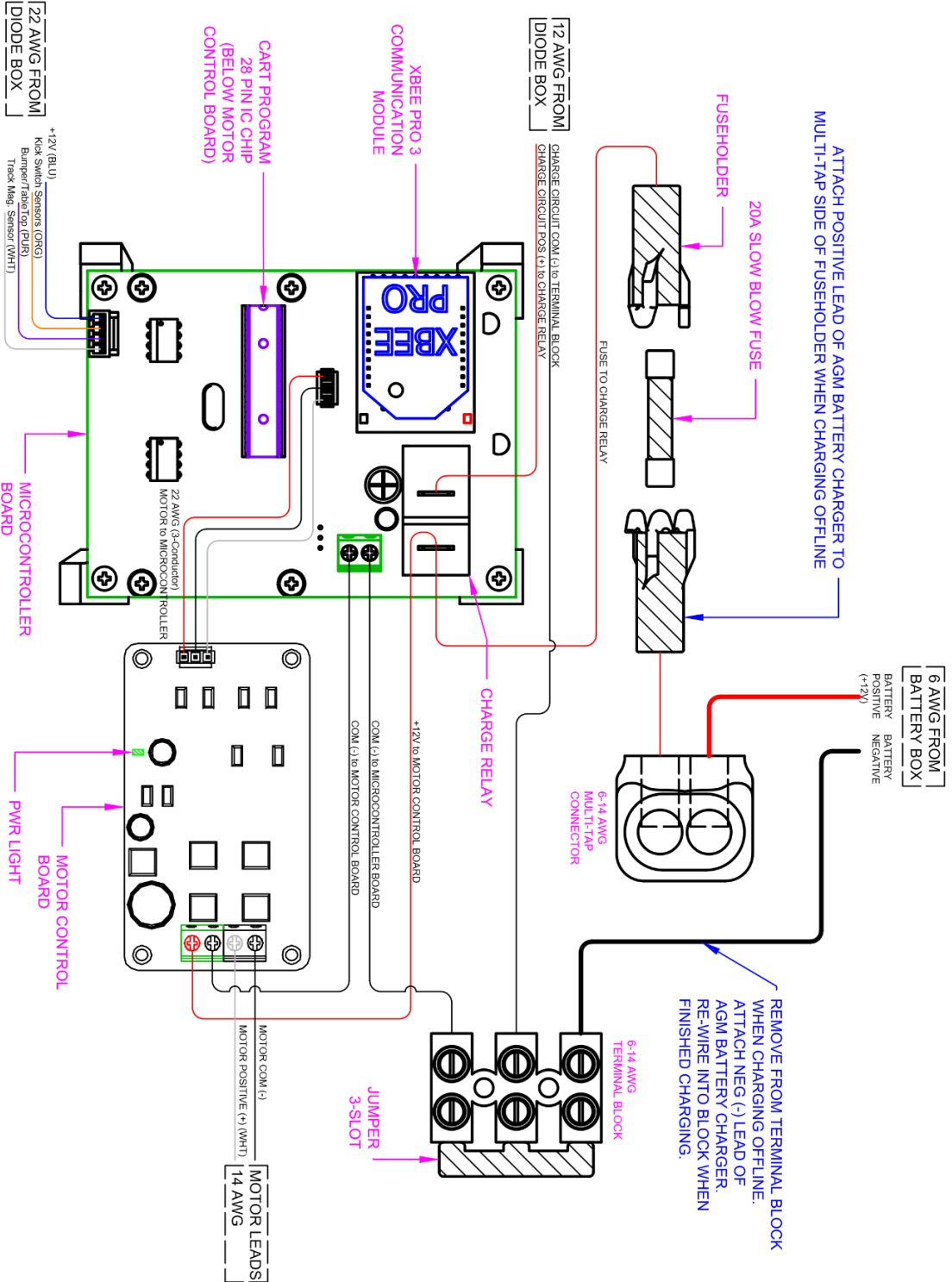
WIRING DIAGRAM A: DIODE BOX

PRIME HEAT SYSTEMS POWERCART IS/DIODE BOX



WIRING DIAGRAM B: CIRCUIT BOX

WIRING DIAGRAM B: CIRCUIT BOX (2021)



WIRING DIAGRAM C: CHARGE RAIL PSU

WIRING DIAGRAM C: "CHARGE RAIL PSU"

FOR PSU INFO: REFER TO 1606-XLS180/240 Instruction Manual or Read Side of PSU
INPUT: AC 100-240V, 2.1-0.9A, 50-60 HZ OUTPUT: DC 12-15V, 15.0-13.5A

