Professional Quality Training

RECOIL

9/11/2012

Safety

For any questions on material contained in this manual, contact an authorized representative for clarification.

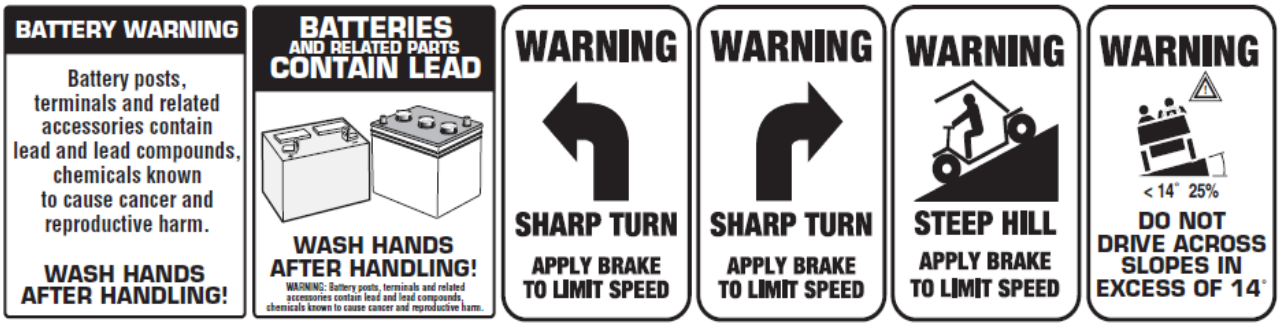
Read and understand all labels located on the vehicle. Always replace any damaged or missing labels.

On steep hills it is possible for vehicles to coast at greater than normal speeds encountered on a flat surface. To prevent loss of vehicle control and possible serious injury, speeds should be limited to no more than the maximum speed on level ground. See GENERAL SPECIFICATIONS. Limit speed by applying the service brake.

Catastrophic damage to the drivetrain components due to excessive speed may result from driving the vehicle above specified speed. Damage caused by excessive speed may cause a loss of vehicle control, is costly, is considered abuse and will not be covered under warranty.

Use extra caution when towing the vehicle(s). Do not tow a single vehicle at speeds in excess of 12 mph (19 kph). Do not tow more than three vehicles at a time. Do not exceed 5 mph (8 kph) while towing multiple vehicles. Towing the vehicle at above the recommended speed may result in personal injury and/or damage to the vehicle and other property. Vehicles equipped with the AC Drive motor must be towed with the Run-Tow/Maintenance/Storage switch, located under the passenger seat, in the 'Tow/Maintenance/Storage' position.

If the vehicle is to be used in a commercial environment, signs similar to the ones illustrated should be used to warn of situations that could result in an unsafe condition



Observe these **NOTICES, CAUTIONS, WARNINGS** and **DANGERS**; be aware that servicing a vehicle requires mechanical skill and a regard for conditions that could be hazardous. Improper service or repair may damage the vehicle or render it unsafe.

NOTICES, CAUTIONS, WARNINGS AND DANGERS

NOTICE

Address practices not related to personal injury.

⚠ CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

⚠ WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Please observe these **NOTICES, CAUTIONS** and **WARNINGS and DANGERS;** be aware that servicing a vehicle requires mechanical skill and a regard for conditions that could be hazardous. Improper service or repair may damage the vehicle or render it unsafe.

⚠ WARNING

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

Table of Contents

*This training manual covers basic information pertaining to 72V Recoil IS models.

Contact Information:
Bad Boy Buggies – Customer Care 1-800-774-3946

⚠ CAUTION

Never modify the vehicle in any way that will alter the weight distribution of the vehicle, decrease its stability or increase the speed beyond the factory specification. Such modifications can cause serious personal injury or death. Bad Boy Buggies prohibits and disclaims responsibility for any such modification or any other alteration which would adversely affect the safety of the vehicle.

GENERAL INFORMATION

It is impossible to anticipate and warn against every possible combination of circumstances that may occur. No warnings can take the place of good common sense and prudent driving practices.

Good common sense and prudent driving practices do more to prevent accidents and injury than all of the warnings and instructions combined. BB Buggies Inc. strongly suggests that all users and maintenance personnel read this entire manual paying particular attention to the CAUTIONS, WARNINGS and DANGERS contained therein.

If you have any questions, please contact your closest Bad Boy Buggies representative.

This vehicle conforms to the current applicable standard(s) for safety and performance requirements.

This vehicle is to be operated by licensed drivers only.

BB Buggies Inc. is not liable for errors in this manual or for incidental or consequential damages that result from the use of the information contained in this manual.

This vehicle is designed and manufactured for off-road use. It does not conform to Federal Motor Vehicle Safety Standards and is not equipped for operation on public streets.

Make certain that all electrical accessories are grounded directly to the battery set. **Never use the chassis or body as a ground connection.**

Never modify the vehicle in any way that will alter the weight distribution of the vehicle, decrease its stability or increase the speed beyond the factory specification. Such modifications can cause serious personal injury or death. Bad Boy Buggies prohibits and disclaims responsibility for any such modification or any other alteration which would adversely affect the safety of the vehicle.

GENERAL OPERATION

ALWAYS:

- use the vehicle in a responsible manner and maintain the vehicle in safe operating condition
- read and observe all warnings and operation instruction labels affixed to the vehicle
- follow all safety rules established in the area where the vehicle is being operated
- leave the vehicle when there is a risk of lightning.
- reduce speed to compensate for poor terrain or conditions
- apply brake to control speed on steep grades
- maintain adequate distance between vehicles
- reduce speed in wet areas
- use extreme caution when approaching sharp or blind turns
- use extreme caution when driving over loose terrain
- use extreme caution in areas where pedestrians are present

MAINTENANCE

ALWAYS:

- replace damaged or missing warning, caution or information labels
- maintain the vehicle in accordance with the manufacturer's periodic service schedule
- ensure that repairs are performed by trained and qualified personnel
- follow the manufacturer's maintenance procedures
- insulate any tools used within the battery area in order to prevent sparks or battery explosion
- check the polarity of each battery terminal and be sure to rewire the batteries correctly
- use specified replacement parts, NEVER use replacement parts of lesser quality
- determine that tools and procedures not specifically recommended by the manufacturer will not compromise the safety of personnel nor jeopardize the safe operation of the vehicle
- support the vehicle using jack stands when performing any service work that requires unit to be tested, NEVER get under a vehicle that is supported by a jack, lift the vehicle in accordance with the manufacturer's instructions
- maintain the vehicle in an area away from exposed flame or persons who are smoking
- be aware that a vehicle that is not performing as designed is a potential hazard and must not be operated
- test drive the vehicle after any repairs or maintenance in a safe area that is free of both vehicular and pedestrian traffic
- keep complete records of the maintenance history of the vehicle

The manufacturer cannot anticipate all situations, therefore people attempting to maintain or repair the vehicle must have the skill and experience to recognize and protect themselves from potential situations that could result in severe personal injury or death and damage to the vehicle. Use extreme caution and, if unsure as to the potential for injury, refer the repair or maintenance to a qualified mechanic.

VENTILATION

Hydrogen gas is generated in the charging cycle of batteries and is explosive in concentrations as low as 4%. Because hydrogen gas is lighter than air, it will collect in the ceiling of buildings necessitating proper ventilation. Five air exchanges per hour is considered the minimum requirement.

NEVER smoke around a vehicle while batteries are charging.

NEVER charge a vehicle in an area that is subject to flame or spark. Pay particular attention to natural gas or propane water heaters and furnaces.

Always use a dedicated circuit for each battery charger. Do not permit other appliances to be plugged into the receptacle when the charger is in operation.

Chargers must be installed and operated in accordance with charger manufacturers recommendations or applicable electrical code (whichever is higher).

Safety

Always wear personal protective equipment.

Wrap battery wrenches to prevent accidental connection.

Use proper lifting techniques. Batteries weigh 80 lbs a piece!

⚠ WARNING

The parking 'PARK' brake should always be set, except for cases where the powertrain must be allowed to rotate or service is being performed on the brake system.

Safe Buggy Lifting

Lifting The Buggy

Remove payload vehicle before lifting. No person(s) should be in or on the vehicle while lifting.
To raise the entire vehicle. Place a floor jack securely under the rear axle tube just to the right of the differential, raise the vehicle and position the jack stands under the rear axle in locations indicated below.
Lower the floor jack and test the stability of the vehicle on the two jack stands.
Place the Jack under the front of the skid plate. Raise the vehicle and position the jack stands under the frame as indicated below.
Lower the jack and test the stability of the vehicle on all four jack stands
To raise only the front or rear of the vehicle. Place wheel chocks in front and behind the wheels not being raised.
Lower the vehicle by reversing the lifting sequence.

Lifting the Rear

Place a sufficiently rated floor jack securely under the rear axle just to the left of the differential. Lift the vehicle.

Place jack stands under the rear axle tubes, close to the outside edge. Use sufficiently rated jack stands to help support the Buggy.

Lifting the Front

Place a sufficiently rated floor jack securely under the center of the front differential skid pan. Lift the vehicle.

Locate the frame rail just behind the front sub frame. Use sufficiently rated jack stands to help support the Buggy.

Always lift the entire vehicle to perform service work!

Operation Controls

1. With the key in the OFF position, make certain that the direction selector switch is in neutral.

2. Make certain that no pressure is being applied to the accelerator pedal.

3. Turn the key to the On position.

4. Wait 3 to 5 seconds for the line contactors to close.

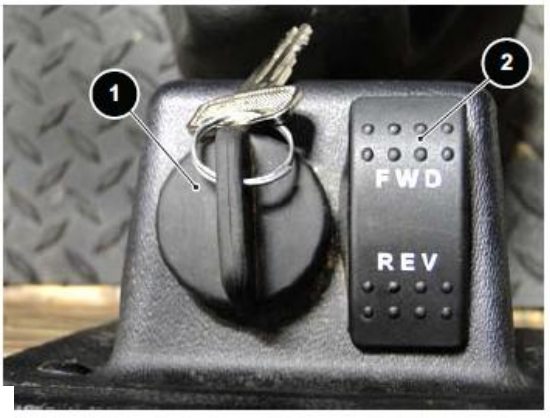
5. Place the direction selector into the desired direction.

6. Depress the accelerator to go.

OPERATOR CONTROLS

1. Key Switch

Located on the on the seat panel between the driver and passenger seats, this key operated switch enables the basic electrical system of the vehicle to be turned on and off. Rotate the switch clockwise to power the electrical system ON and counterclockwise to turn the power OFF.

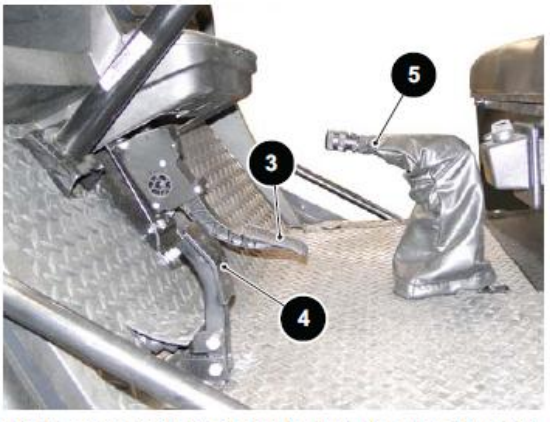


2. Direction Selector

Located on the on the seat panel between the driver and passenger seats, this three position switch is used to select either FWD (forward), REV (reverse) or neutral for vehicle direction. Before turning the key to the ON position the direction selector must be set to neutral. **The switch should be left in neutral when unattended.**

3. Accelerator Pedal

With the key switch 'ON', depressing the accelerator pedal starts the electric motor. When the pedal is released, the motor will stop and the vehicle will slow down. To stop the vehicle more quickly, depress the brake pedal.



4. Brake Pedal

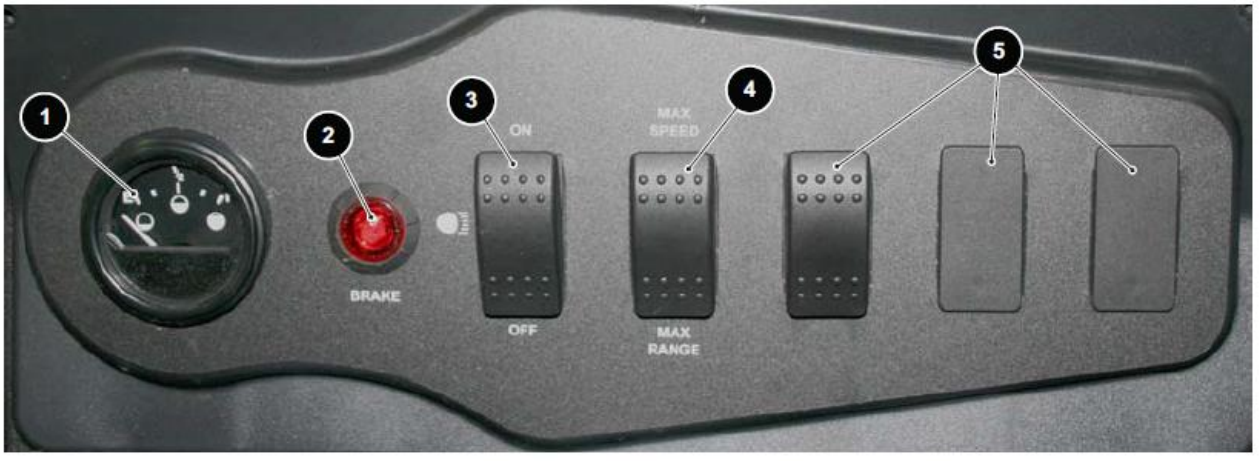
Depress the brake pedal to slow and stop the vehicle. This vehicle is equipped with four wheel hydraulic brakes; disc brakes on all four wheels.

5. Park Brake

The hand operated park brake is located on the floor to the right of the driver. The brake is engaged when the handle is pointed upward and disengaged when the handle is almost parallel to the floor. When leaving the vehicle unattended, engage the park brake by raising the handle until it is locked in place. To release the park brake push the handle down towards the floor.

The Run / Maintenance – Storage switch is located next to the battery set on the right rear splash guard. It is used as described to interrupt logic voltage to the controllers and to enable complete controller power – down.

FEATURES



1. State of Charge Meter/Fuel Gauge

Electric fuel gauge located on the left side of the dash panel, indicates the amount of charge remaining in the battery pack when the key switch is in the ON position.

2. Brake Light

The indicator light illuminates to indicate that the parking brake is engaged when key switch is in the ON position.

3. Headlight Switch

Located on the dash panel to the right of the brake light. The switch has two positions, ON and OFF. In the ON position the headlights and all dash panel lights will be on, the OFF position will turn off the lights.

4. Max Range/Max Speed

Two position switch located in the dash panel. The Max Range setting limits the top speed of the vehicle to 16 MPH, saving battery power to extend the range of the vehicle when operated at full speed. The Max Speed setting allows the vehicle to travel up to 24 MPH and sacrifices distance for speed.

5. Auxiliary Switch Positions

There is space for the addition of three rectangular toggle switches to control additional lights or accessories.

6. Winch Switch (if equipped)

Located in the driver side glove box.

Operation Features

7. 12 Volt Power Outlet

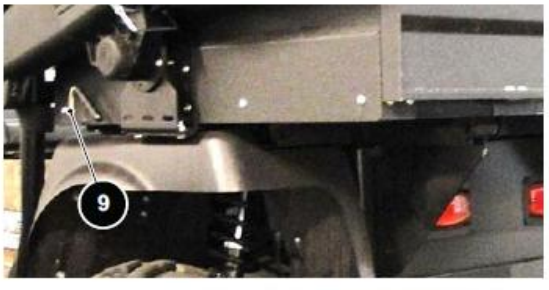
Located in the passenger side glove box. The 12 volt outlet will supply a constant power supply for accessories equipped with a 12 volt plug.

8. Charger Receptacle

The polarized charger receptacle for the electric battery pack is located in the seat wrap panel below the seat on the driver side. Always check to be sure the receptacle is free from dirt and debris before connecting the charger cord.

9. Truck Bed Latch

Located at the front of the manual lift truck bed. To release the latching mechanism pull the handle upward then raise the front of the truck bed up.



10. Truck Bed

Two truck beds are available, a molded plastic bed or an aluminum bed.

11. Tail Lights

The tail lights are located in the rear below the truck bed. The tail lights will illuminate

Operation Features

13. Head Protection

Rubber pads to protect the head when driving over rough terrain.

14. Side Nets

Side nets are a standard safety feature provided with the vehicle and must be properly secured before operating vehicle.

15. Rear Seat / Load Deck (if equipped)

The rear facing seat is designed for two occupants, one on each side of the seat. The load deck is created by unfolding the bottom of the rear facing seat. The seat/load deck is limited to a maximum of 400 lbs. (181 Kg).

Periodic Service Chart

PERIODIC SERVICE SCHEDULE

✓ - CHECK **C&A** - CHECK & ADJUST **CL** - CLEAN **R** - REPLACE

REMARKS	before each use DAILY	250 miles/415 kms MONTHLY	750 miles/1250 kms QUARTERLY	1500miles/2500 kms SEMI-ANNUAL	3000miles/5000 kms ANNUAL	REPLACE AFTER
Tires - pressure, condition of tires and rims	✓	✓	✓	✓	✓	
Hardware - loose or missing	✓	✓	✓	✓	✓	
Overall Vehicle Condition	✓	✓	✓	✓	✓	
Batteries - state of charge, condition, loose terminals, corrosion, hold down and hardware		✓	CL	CL	CL	
Batteries* - check electrolyte level, fill after charging if required (if plates are exposed before charging add only enough water to cover any exposed plates and fill after charging)		C&A	C&A	C&A	C&A	
Brakes - check fluid level in master cylinder		✓	✓	✓	✓	3000 mi/5000 km
Brakes - smooth operation of pedal, stopping distance	✓	✓	✓	✓	✓	
Park Brake - does brake hold on a hill		C&A	C&A	C&A	C&A	
Accelerator - smooth operation	✓	✓	✓	✓	✓	
Wiring - loose connections, broken or missing insulation		✓	✓	✓	✓	
Charger Receptacle - inspect and clean receptacle at each charge		CL	CL	CL	CL	
Steering Assembly - excessive play, loose or missing hardware		✓	✓	✓	✓	
Tie Rods - excessive play, bent rods, loose or missing hardware		✓	✓	✓	✓	
Front and Rear Axle - oil leakage, noise, loose or missing hardware		✓	✓	✓	✓	
Front and Rear Axle - drain and replace fluid						5000 mi/8000 km
Front Suspension - strut oil leakage, excessive play in hubs or king-pins, worn bushings, loose or missing hardware		✓	✓	✓	✓	
Front and Rear Wheel Alignment - unusual tire wear			C&A	C&A	C&A	
Rear Suspension - strut oil leakage, worn bushings, loose or miss-ing hardware			✓	✓	✓	
*Use only distilled or purified water that is free of contaminants to fill batteries.						

NOTE: Some maintenance items must be serviced more frequently on vehicles used under severe driving conditions.

Wheels & Tires

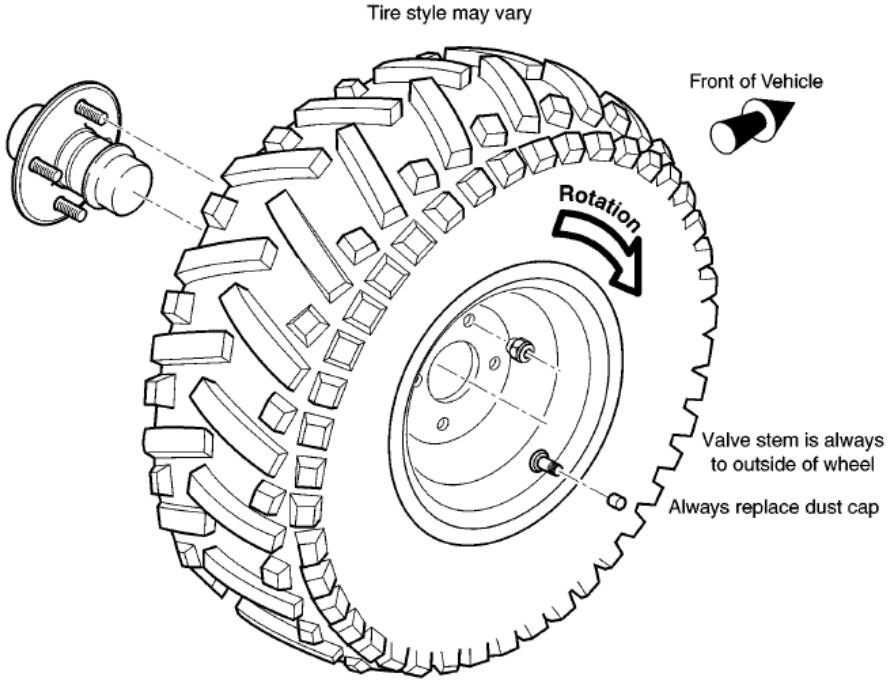
Notes:

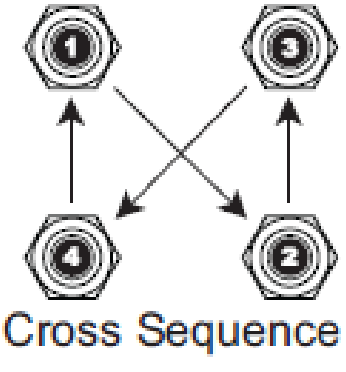
Wheels & Tires

Tools Required	Qty. Required
Calibrated ½" Drive Torque Wrench	1
½" Drive 6" Socket Extension	1
½" Drive 17mm Impact Socket (Aluminum wheels)	1
1/2" Drive ¾" impact Socket (Steel wheels)	1

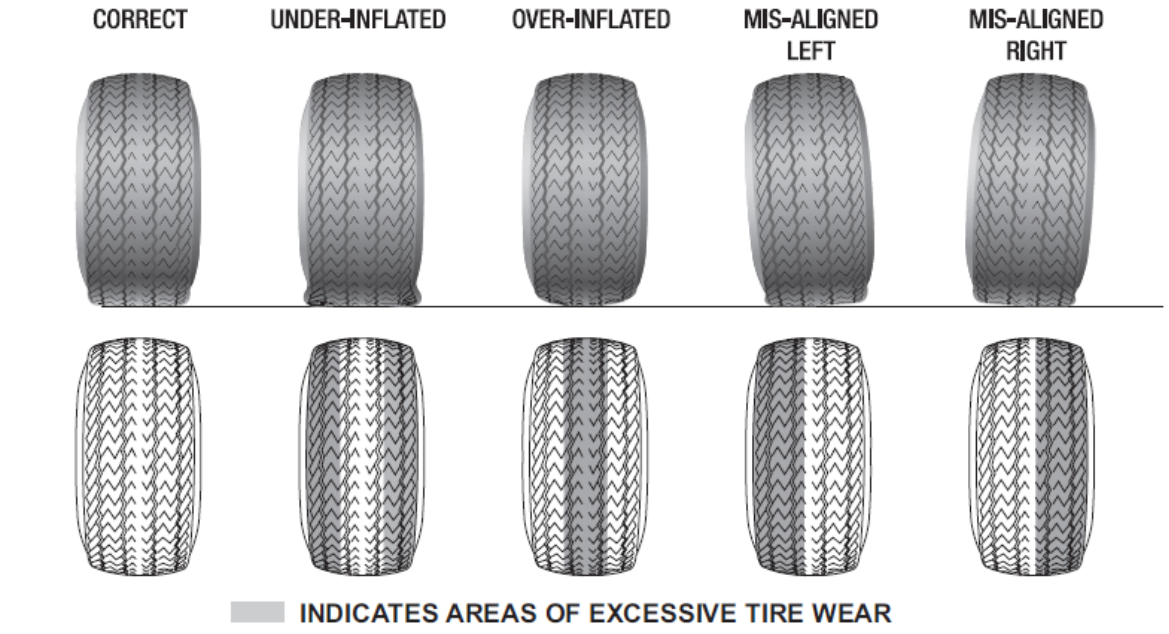
⚠ CAUTION

To reduce the possibility of component damage, do not tighten lug nuts to more than 85 ft. lbs. (115 Nm) torque.





Tire Wear Diagnosis



Note: Knobby / Off Road tires will wear rapidly when used on hard surfaces.

Inflate tires to 12psi. Do not overinflate. Always use the inflation pressure listed on the sidewall.

Front Suspension & Steering

Notes:

Front Suspension & Steering Inspection

Begin suspension inspection by grasping the tire at the 12 O'clock and 6 O'clock positions. Move the tire in and out to check for play in the bushings.

Continue the steering inspection by grasping the tire at the 3 O'clock and 9 O'clock positions. Move the tire in and out to check for play in the rod ends.

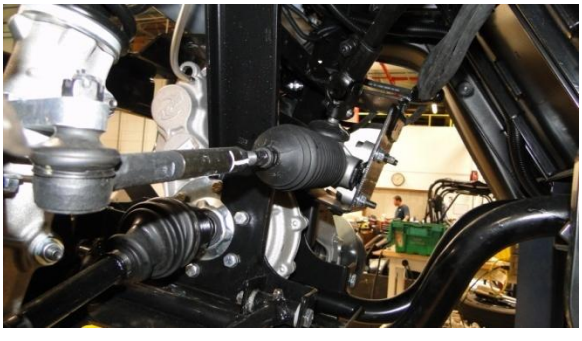
Inspect the inner and out CV joint boots for damage.

Replace the CV shaft if contamination has entered the joint through a torn boot.

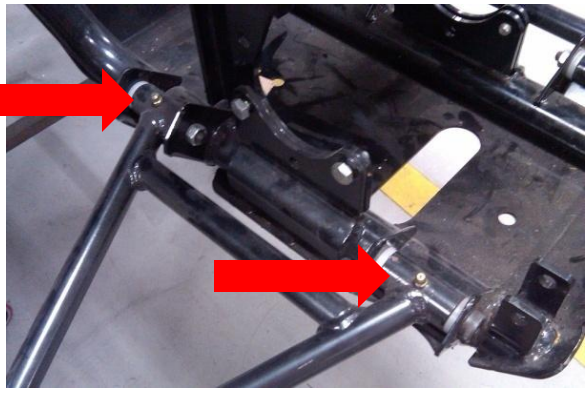
Front Suspension & Steering Inspection

Inspect the strut cartridge for leaks at the seal. Replace if leakage is found.

Inspect for damage to the steering housing and the intermediate shaft. Check for excessive play in the intermediate shaft joint or steering unit. Verify by rocking the steering wheel back and forth.



Lubrication Points on the Recoil Model



Lubrication points can be found on the lower A-arm and on the lower strut. Use no more than 3 shots of grease per fitting. The tie rod ends are sealed and do not require lubrication. The steering unit is also sealed and requires no additional lubrication.

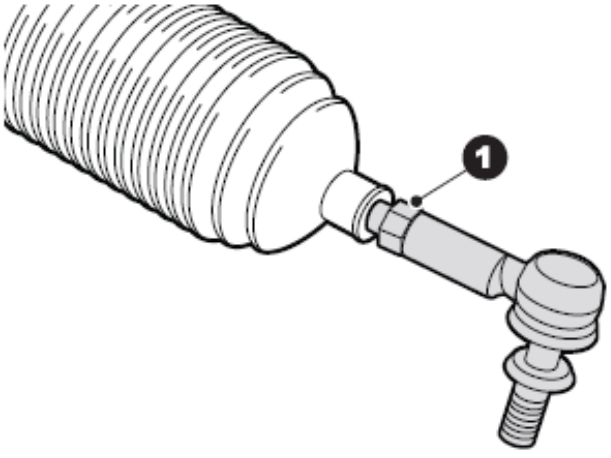
Front Suspension & Steering Adjustment

1. Center the steering unit in the middle of its travel. This may be accomplished by pushing the vehicle forward 5ft and allowing the unit to center itself. An alternate method is to turn the steering wheel to the left until the stop is contacted. Rotate the wheel to the right while counting the number of turns required to contact the right hand stop. Divide the number of turns by two. This will indicate the number of steering wheel turns to achieve center.

2. With the Buggy on the floor; measure the center tread distance at the front of the tires. Measure as close to parallel with the front differential as possible.

3. Now measure the center tread distance on the rear of the tires. The measuring tape should be routed just under the frame rails. The correct measurement is 0” to 1/8” toe in.

Front Suspension & Steering Adjustment



4. Using a 12mm wrench; hold the hex form on the tie rod. Then use a 17mm wrench to loosen the jam nut against the rod end. (Item 1)

5. If tie rods or ends have been replaced; adjust both rods the same distance prior to reinstalling on the Buggy. Counting threads or measuring thread distance are two methods to equalize tie rod length.

6. Re-verify toe in measurement with each adjustment change. Correct measurement is 0” to 1/8” toe in.

Note: Failure to adjust the tie rod ends equally will negatively affect turn radius.

Batteries & Charging

Notes:

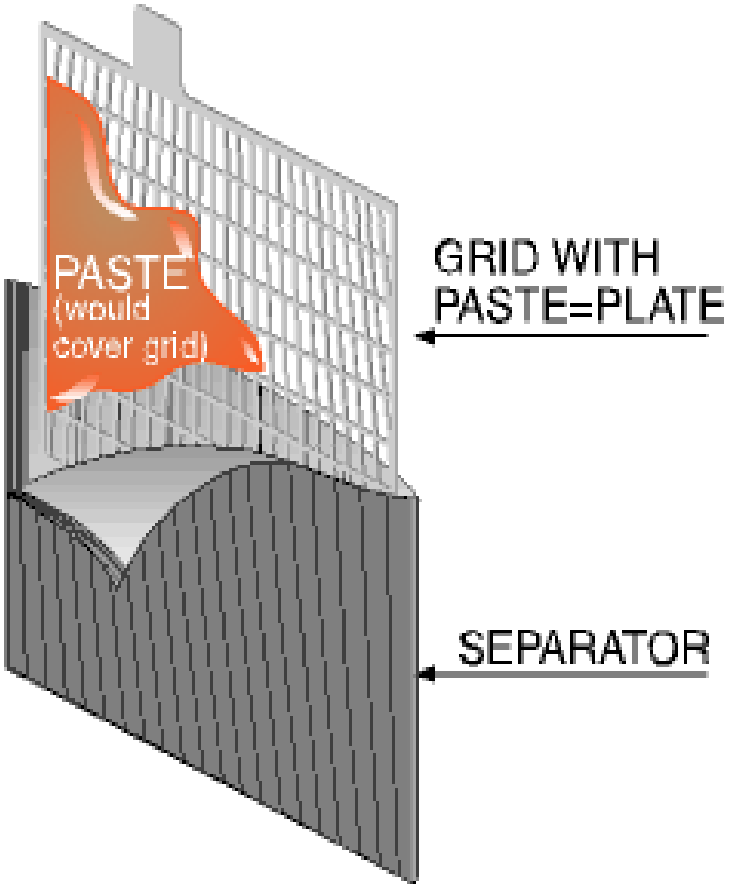
What is a battery?

Answer: Two unlike metals immersed in an acidic solution.

Plate Construction

Positive Grid: Made from a lead / antimony alloy.

Negative Grid: Made from a lead / tin alloy.



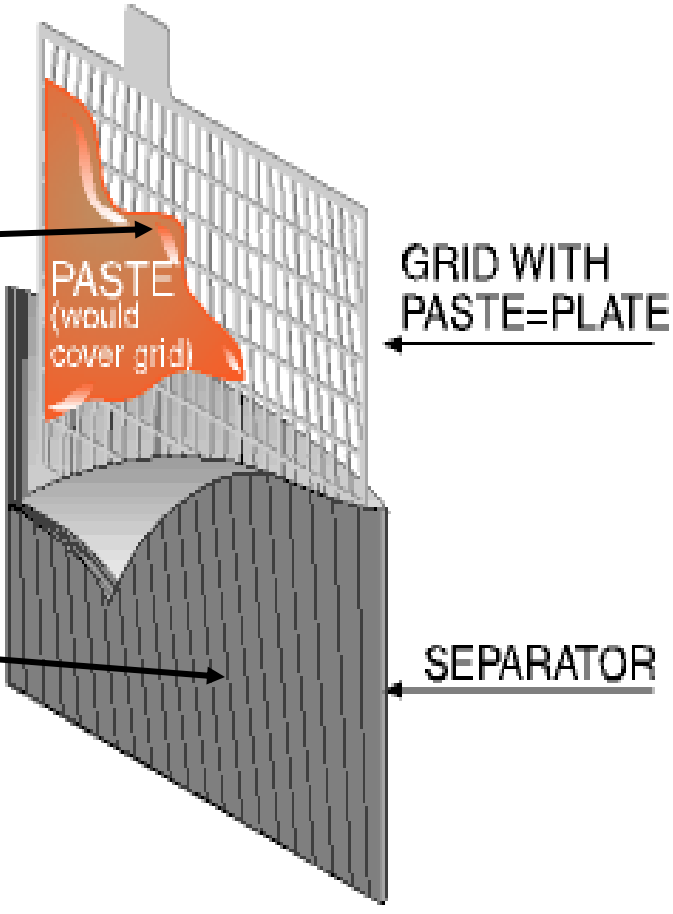
The function of the grid is to collect electrical current.

Plate Construction

Positive Plate: Ground lead oxide & water are mixed with dilute sulfuric acid to form paste material.

Negative Plate: Ground lead oxide, water, sulfuric acid, and expander material form the negative plate material.

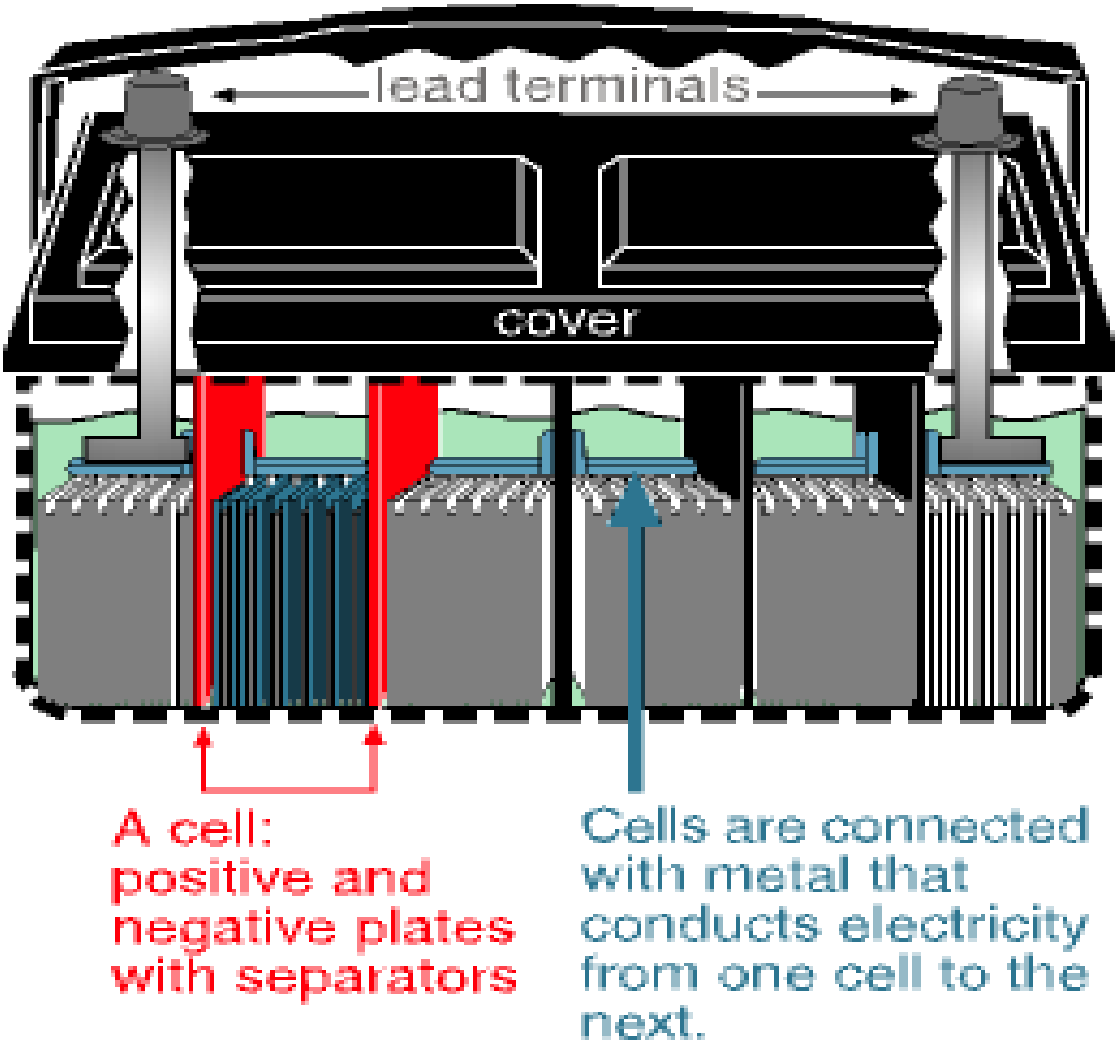
Plates are cured in a temperature controlled environment.



Separators prevent metallic conduction between two plates.

Battery Cells

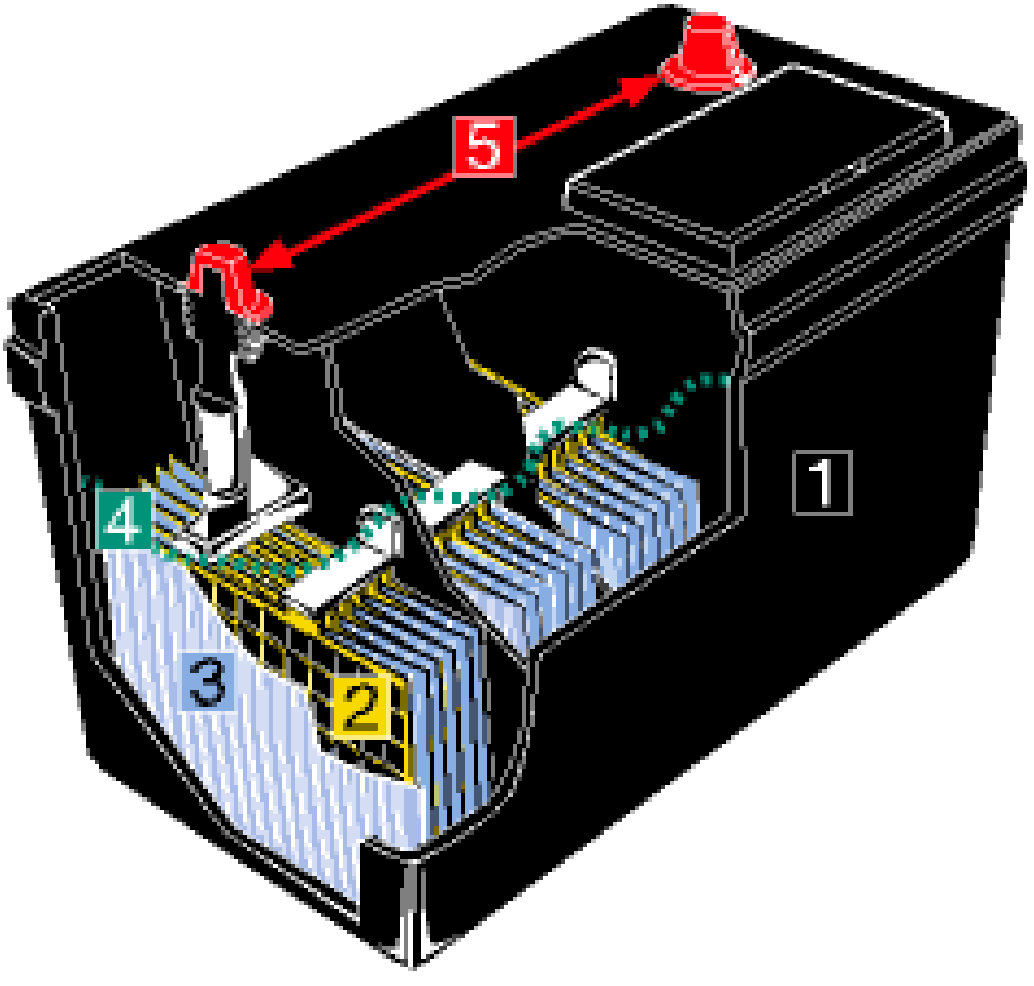
Grid units are combined to produce 2.11 volts per cell.



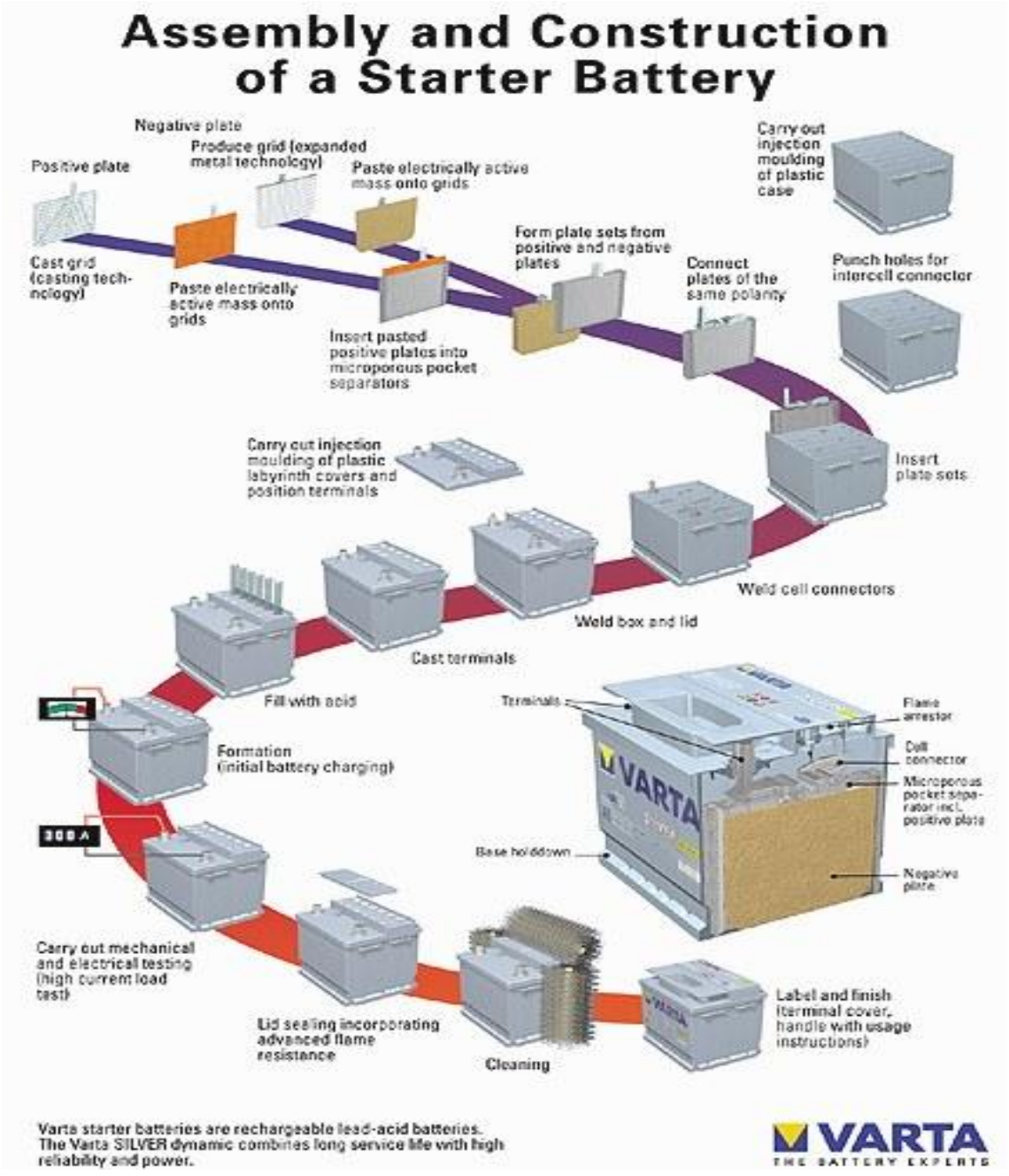
Battery Formation

The battery is filled with dilute electrolyte and charged @ 10 – 15 amps.

This is the point where the positive plate becomes lead dioxide and the negative becomes sponge lead.

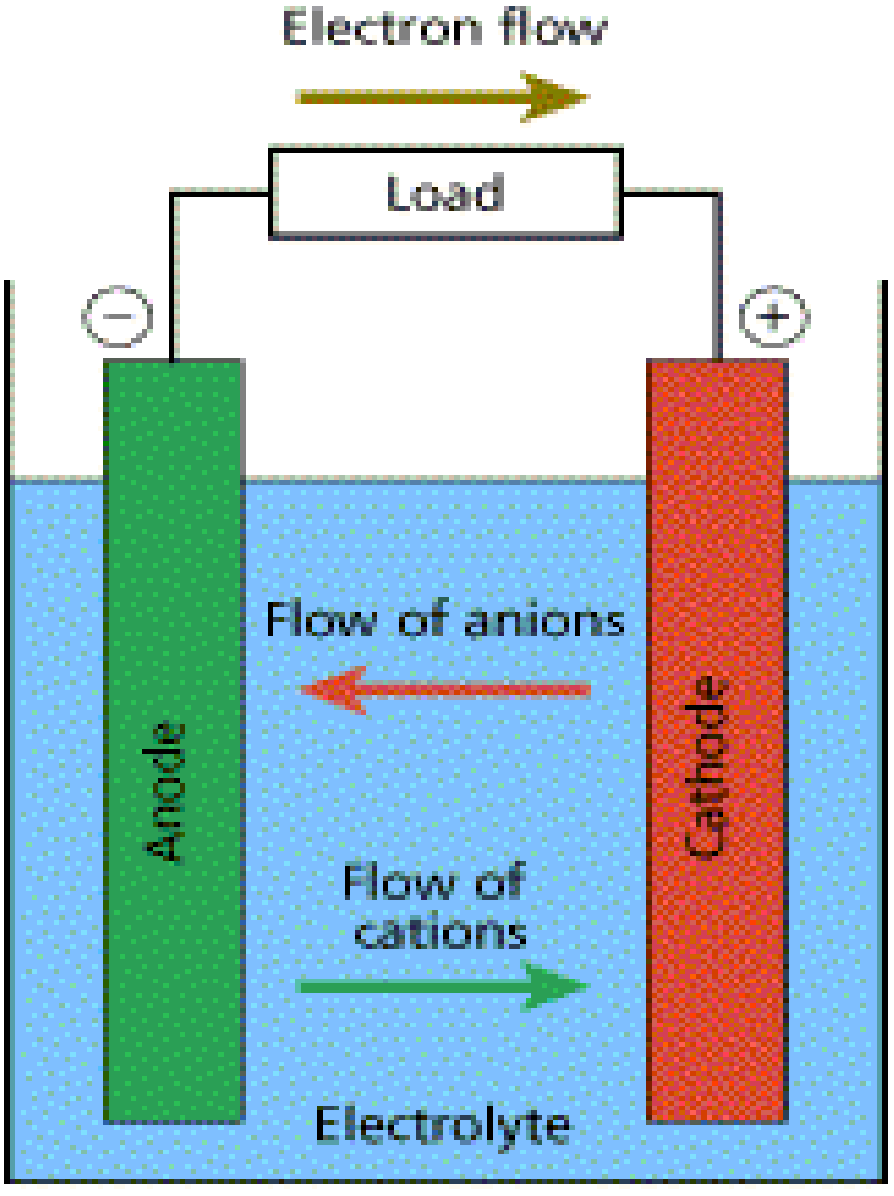


Battery Assembly Process



Battery is ready for sale when the specific gravity is corrected to 1.280 and an electrical check is performed.

Charging & Discharging



Charging: Electricity is forced through the plates to expel electrolyte. This “diffusion” starts a chemical reaction that produces a charge.

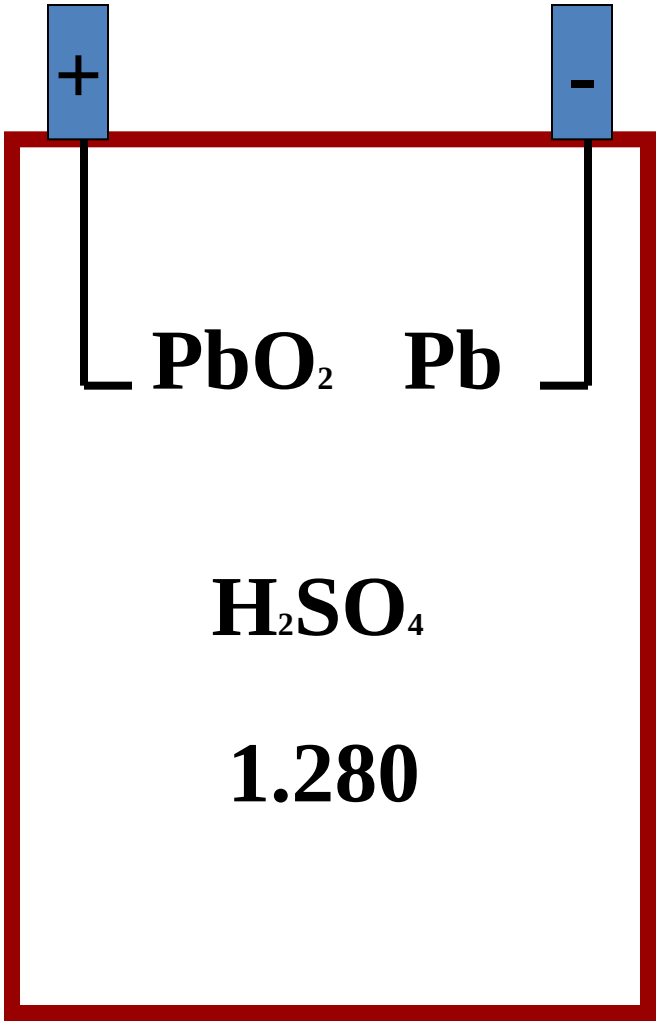
Fully Charged Battery

The positive plates chemically change from lead sulfate to lead dioxide.

The negative plates chemically change from lead sulfate to sponge lead.

Gassing occurs when the sulfate ions return to the battery case.

Heat is generated during the charge and is concentrated in the center of the battery.

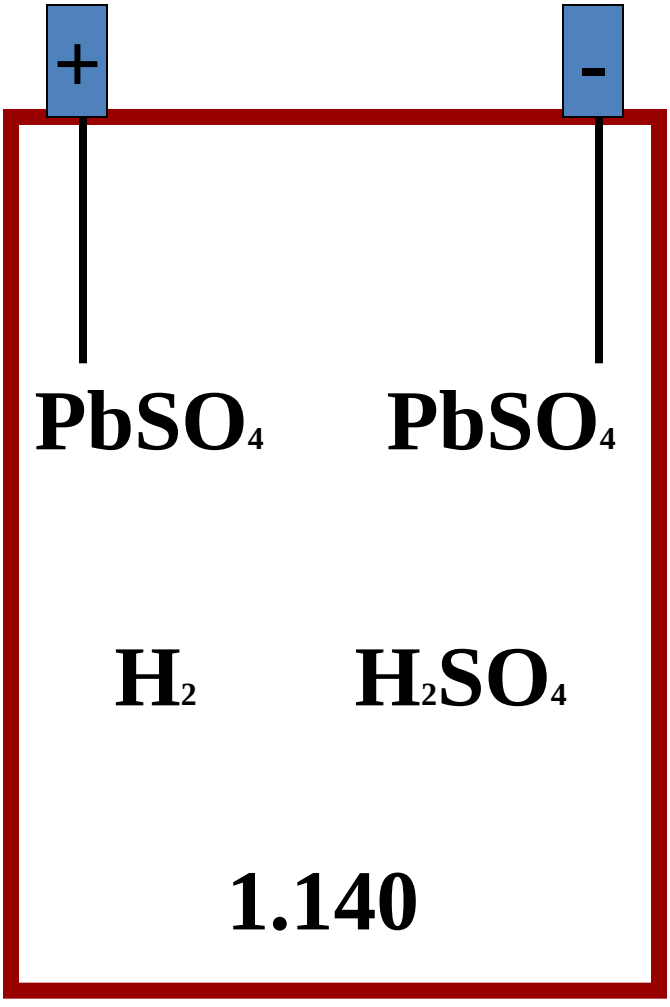


Fully Discharged Battery

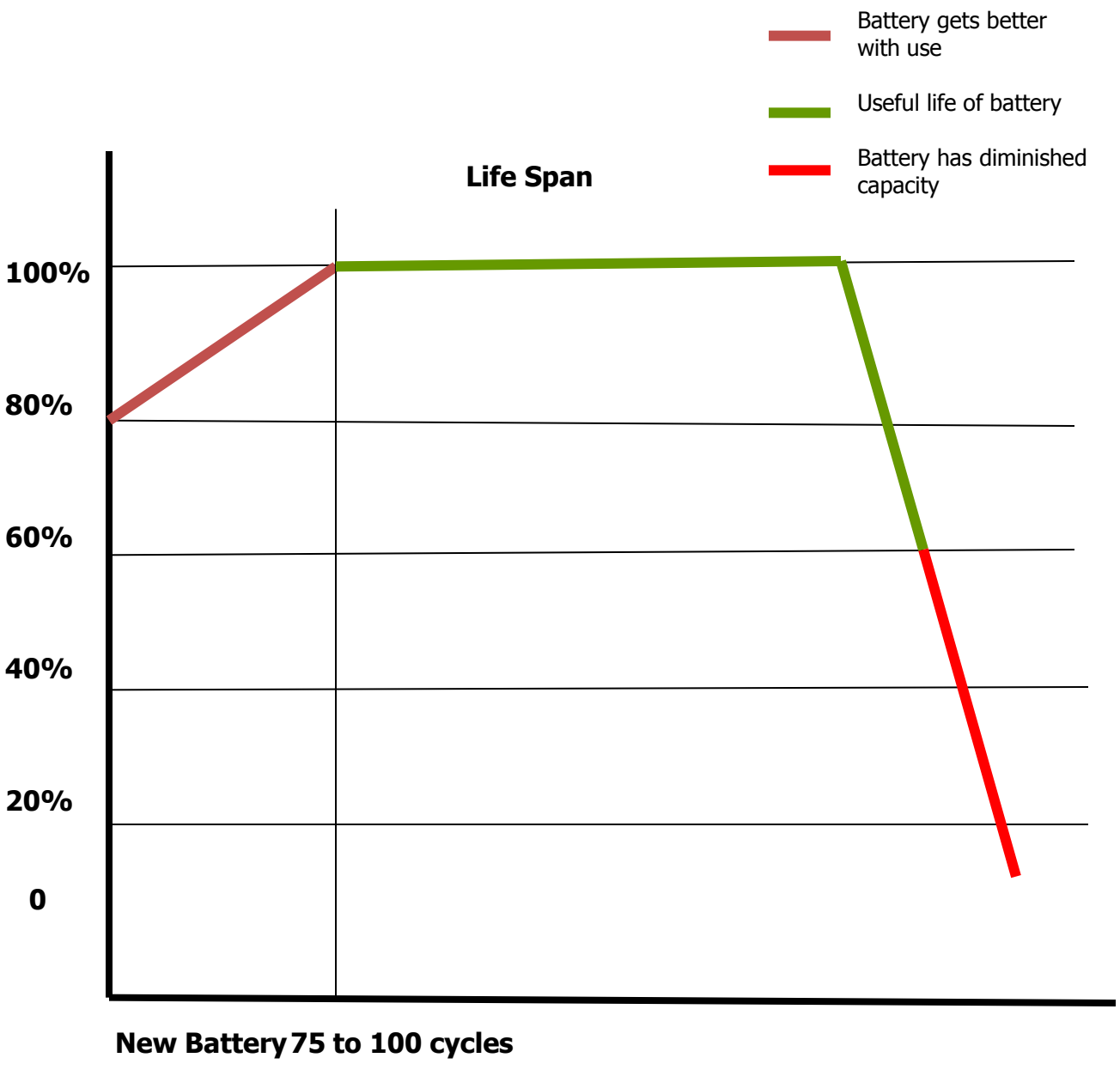
Plates return back to the original lead sulfate.

Discharge time is dependant upon the load placed on the battery.

Sulfate ions return back to the lead plates.



Battery Life Span



Maximizing Battery Life

Proper Watering

Proper Charging

Proper Cleaning

Periodic Testing

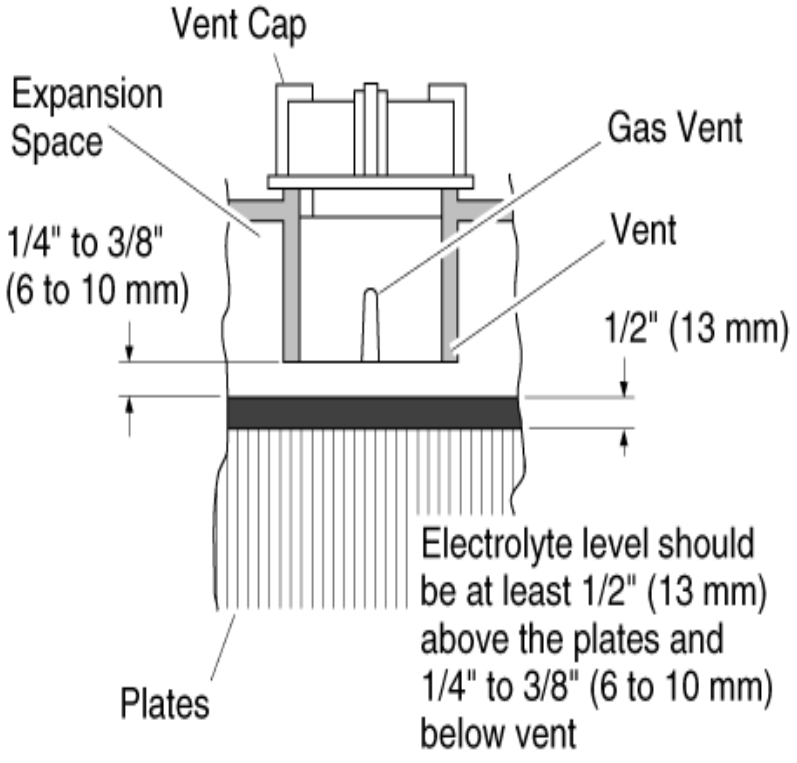
Maintain Hardware

Proper Storage

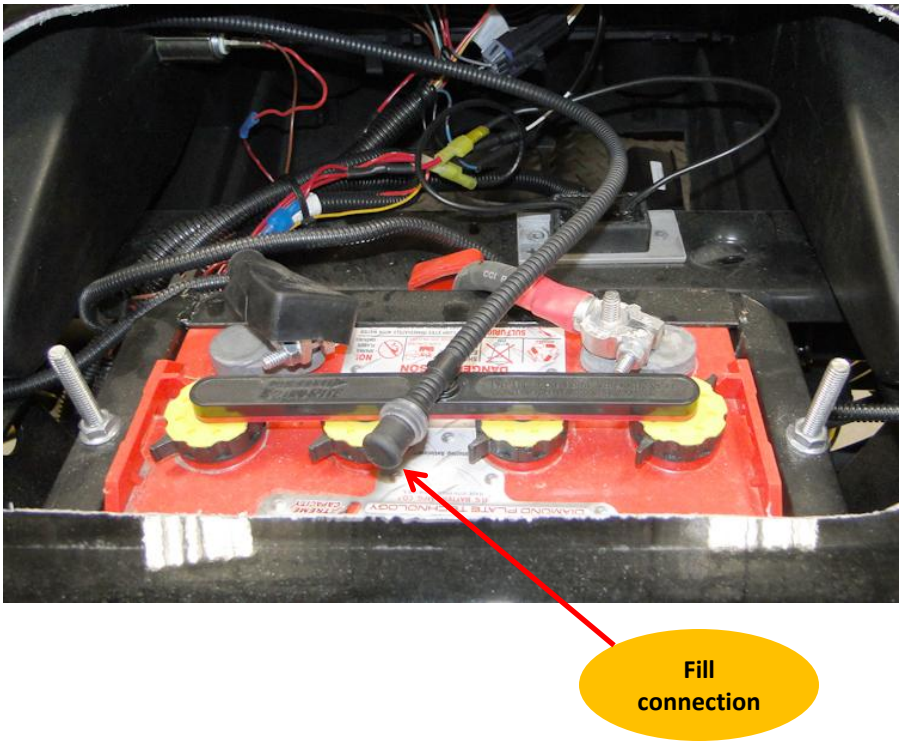
- PPE
  - Safety glasses-protect your sight
  - Gloves
  - Tools- to prevent shorting, wrap with electrical tape.
- Cautions
  - Electrolyte is corrosive
  - Lead poisoning-Wash hands
  - Hydrogen sulfide gas is explosive

Battery Watering

Water Batteries 1 time per month. Water more often during warm conditions. Use distilled water or an approved water source.



- Batteries should always be watered <u>after</u> charging.
- Over watering causes acid dilution and overflow. (Stains on floors & rust on chassis, battery wire corrosion)
- Under watering causes plate damage due to air exposure. (Significantly reduces run-time)



Water fill connection, located under the seat panel.

Proper Charging

The battery charger used in current Bad Boy Buggy- 72 Volt applications is the Diversified Power International (DPI).

PORTABLE CHARGER

⚠ WARNING

Use charger ONLY on 72 volt battery systems. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging. Never charge a frozen battery. Study all battery manufacturers' specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.

⚠ DANGER

Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock – do not use ground adapters or modify plug. Do not touch uninsulated portion of output connector or uninsulated battery terminal. Disconnect the DC supply before making or breaking the connections to the battery while charging. Do not open or disassemble charger. Do not operate charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way – refer all repair work to qualified personnel. Not for use by children.

Follow the directions listed on the next page to safely charge the Buggy.

Proper Charging

Note: The Buggy should be recharged at approximately 50% depth of discharge to ensure long battery life.

Warning: Disconnect the charger plug prior to operating the Buggy.

1. Place the charger in a well ventilated area. Plug the AC cord into a GFI 120V outlet. The power on and detection light will illuminate.

2. Fully connect and seat the DC plug to the receptacle. Periodically inspect the charger plug and receptacle for damage or debris.

Proper Charging

3. To ensure the charger is operating properly, check for amp meter operation and the indicator lights on the front of the charger.

Under normal charge circumstances, the L.E.D.s operate as follows:

○ Power On (Red) Illuminates continuously when AC power is present. Refer to the section 'TROUBLESHOOTING' if Flashing.

○ Abnormal Shutdown (Red) Normally not illuminated. Refer to 'TROUBLESHOOTING' if Flashing.

○ Detection Error (Red) If connected to A.C. Power, but not connected to a battery pack, or battery pack is discharged to near 0V, L.E.D. will illuminate to indicate the charger cannot 'see' a battery connected. Refer to 'TROUBLESHOOTING' if Flashing.

○ Charging (Yellow) Charge Status Indicator – it flashes or illuminates during the 5-Stage Charge Process.

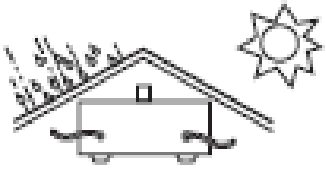
○ Charged (Green) Illuminates continuously during the 4th Stage of the Charge Process. .

Proper Charging - Hardware Inspection

The charger should be plugged into it's own dedicated 20A circuit. Do not over load receptacles!

Inspect the AC plug for damage or bent prongs. Do not remove the auxiliary ground prong.

Inspect the charge receptacle and charger DC handle for damage periodically.



Keep cooling fins clean and free of dirt and debris

NEMA 15 - 5R Grounded AC Receptacle
110 - 120 VAC. Dedicated **20 AMP Circuit**

Locations outside the US and Canada: Reference appropriate local electrical code and charger manufacturer recommendations for AC power requirements

Proper Charging - Trouble Shooting

The charger has a self diagnostic feature. Flash codes can be observed by the indicator lights if a problem is detected.

Condition	LED Detection
Battery Voltage High	Off – Off – Flash
Battery Polarity Reversed	Off – Flash – Off
Output Overload	Off – Flash – Flash
Charge Level Unbalanced	Flash – Off – Off
Excessive Charge Time	Flash – Off – Flash
Excessive Overload	Flash – Flash – Off
Excessive Discharge	Flash – Flash - Flash

Proper Charging - Trouble Shooting

•Battery Voltage High. Charger's DC cord set possibly connected to a battery pack with voltage higher than the output rating of the charger.

•Battery Polarity Reversed. Check output connector and ensure proper polarity. Remake connections.

•Output Overload. While charging, and, for example, under severe motor loading, charger may shut down. This error is not very likely to occur.

•Charge Level Unbalanced. Caused by unbalanced battery condition. Example: some batteries are at a much higher state of charge than others. This may require replacement of the batteries. Refer to the Equipment's Operators manual for instructions on servicing the battery pack.

•Excessive Charging Time. Occurs when charging took too long. Possible causes include: use of a battery load that is draining energy from the battery while the charger is trying to charge that same battery, aged or unbalanced battery conditions, etc.

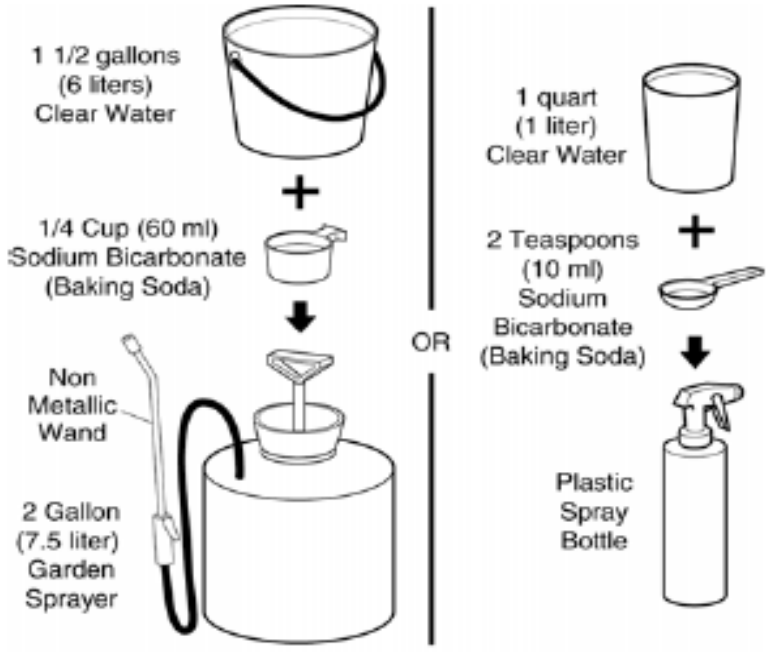
•Excessive Overload. In the unlikely event that a heavy load is placed across the battery pack while the charger is trying to charge the battery and the charger cannot keep up with supplying energy to both the battery and the load, then, the battery voltage will decrease. Further charging is terminated.

•Excessive Discharged. This error is only generated by a condition found during the Pre-Qualification Test Stage. If a severely discharged battery pack did not charge up to 42v within 5 hrs, this error occurs.

Warning: ENSURE THAT EACH INDIVIDUAL BATTERY, IN THE BATTERY PACK, IS AT THE SAME STATE OF CHARGE AS ALL OTHER INDIVIDUAL BATTERIES AND THAT ALL BATTERIES ARE: equal condition, same size, and same rating. Use a voltmeter to check the voltage across each battery and confirm that no battery is higher or lower in voltage than other batteries by more than +/-0.2Vdc. DO NOT MIX DIFFERING SIZES OR TYPES or Manufacturers or mix Old with New in the same pack. Doing so may damage the battery pack.

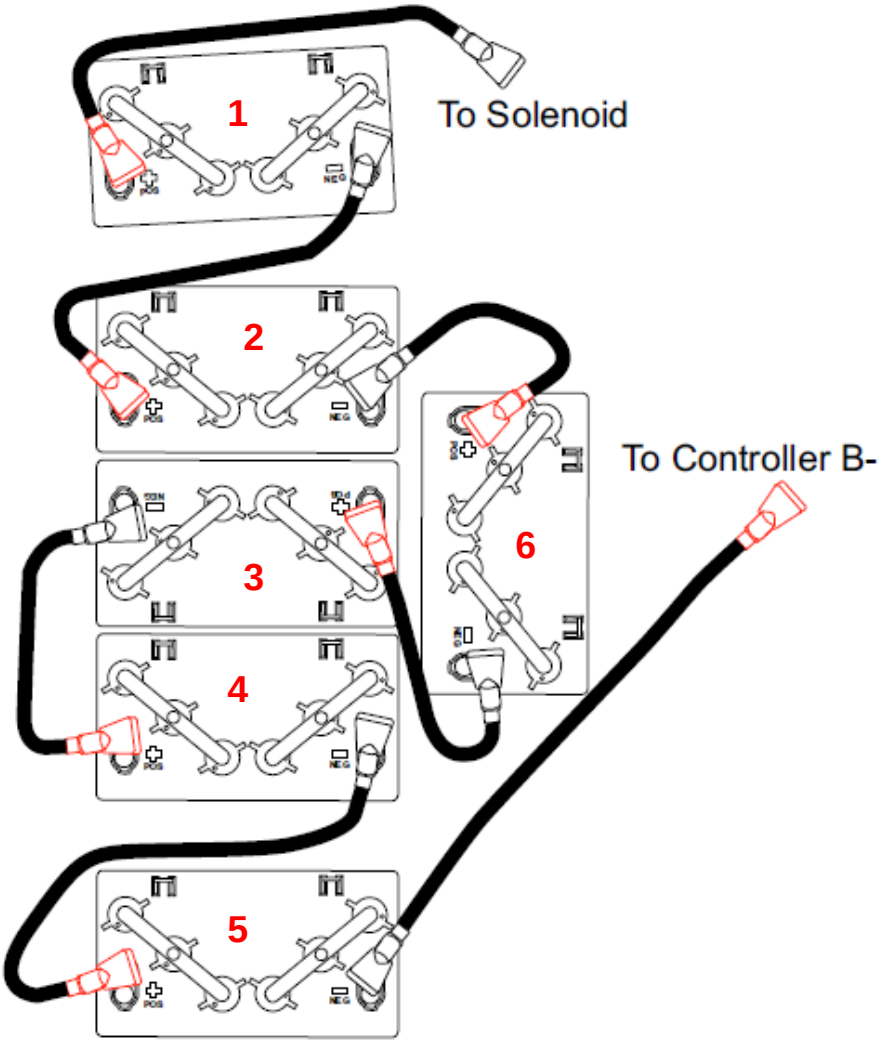
Cleaning

Clean batteries 1 time per month. Use baking soda and water solution. Clean more often as required by conditions.



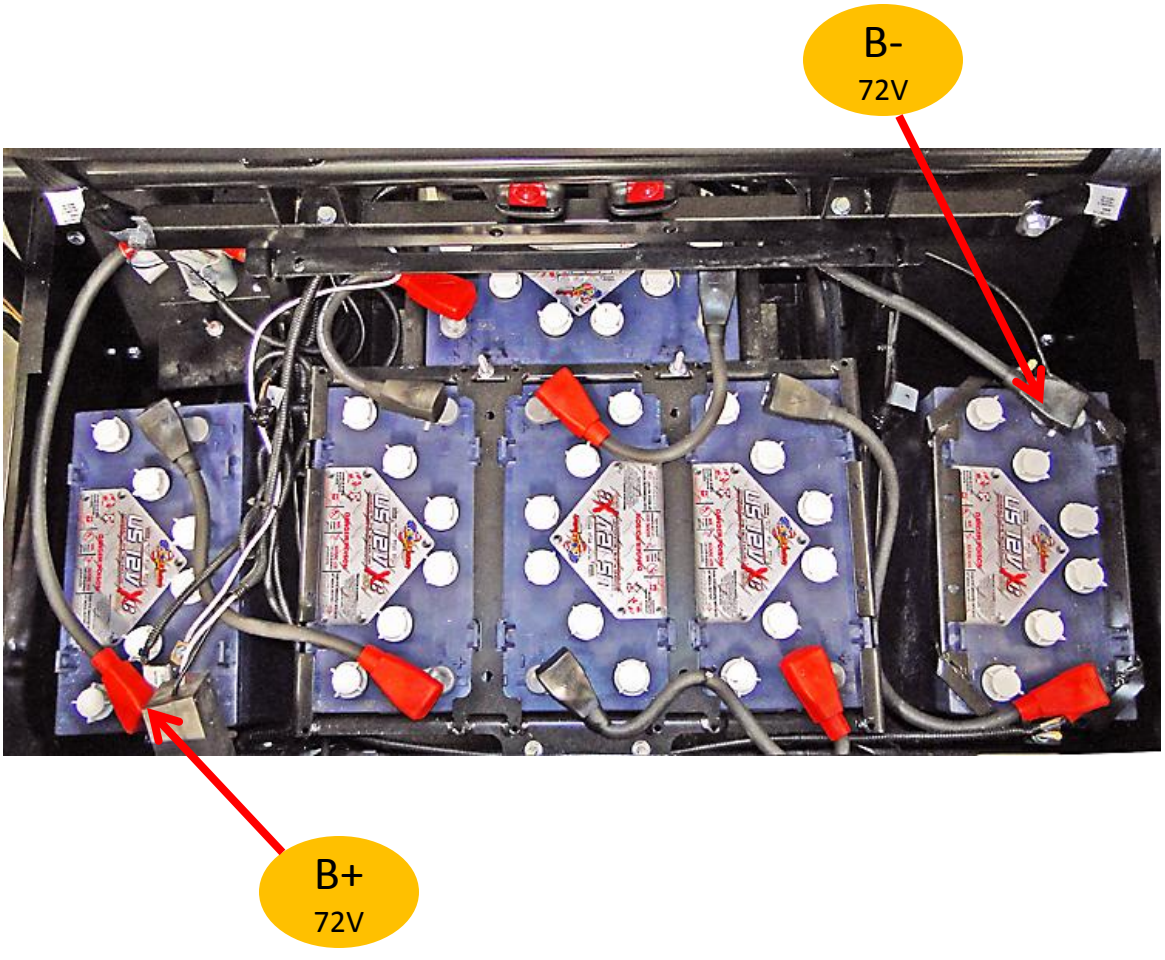
- Wash with baking soda / water solution monthly.
- Use non metallic or brass bristle brush to clean terminals.
- Dirty / corroded batteries promote self discharge and damaged hardware.
- Coat terminals with a commercially available protectant.
- Poor maintenance can void battery warranty.

- Battery terminal clamps should be kept clean and tight.
- Periodically check charger strain relief's.
- Clean charger DC connection quarterly or more often under harsh conditions.
- Ensure that the charger turns on with handle insertion.
- Inflate tire to proper pressure to minimize rolling resistance.
- Check front end alignment.
- Check for brake drag or any other condition that would cause rolling resistance.



Battery Layout

The Recoil uses 6 12 volt batteries connected in series.



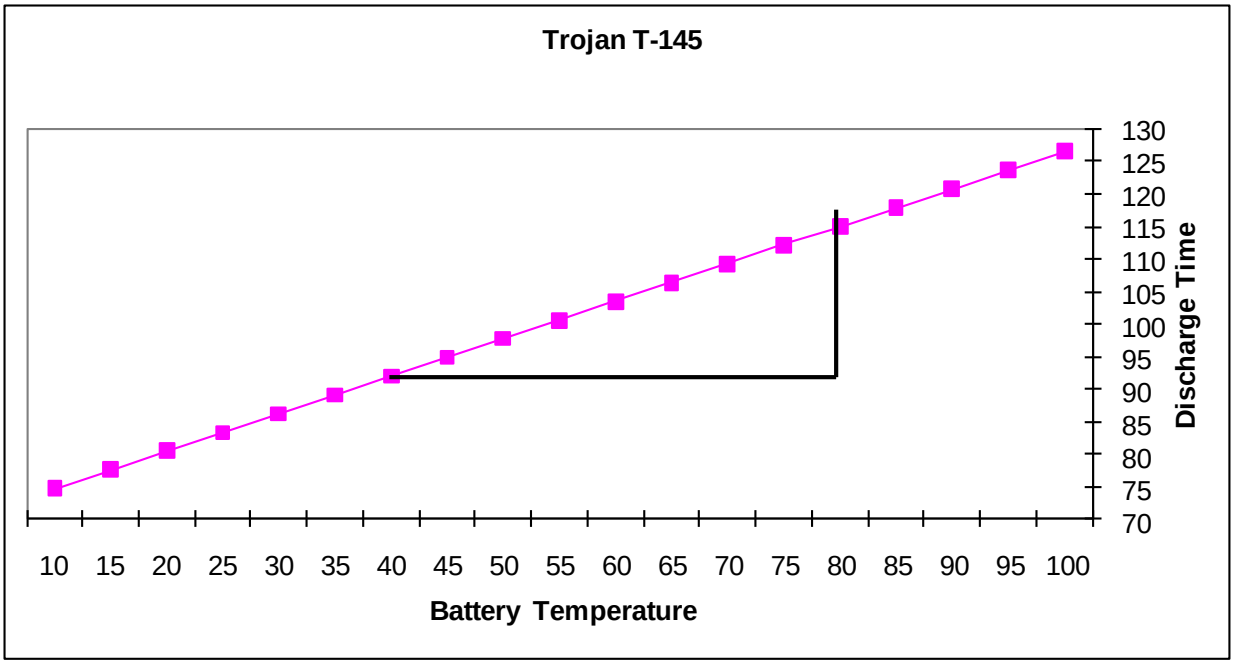
Battery Storage

- Avoid freezing temperatures.
- Avoid exposure to heat sources.
- Batteries should be stored in a cool dry place at full charge.
- Charge periodically during storage times longer than 1 month and based upon battery voltage.
- Eliminate parasitic electrical load by turning off or disconnecting all accessories when not in use.
- Fully charge batteries prior to returning vehicle to service.

Battery Temperature

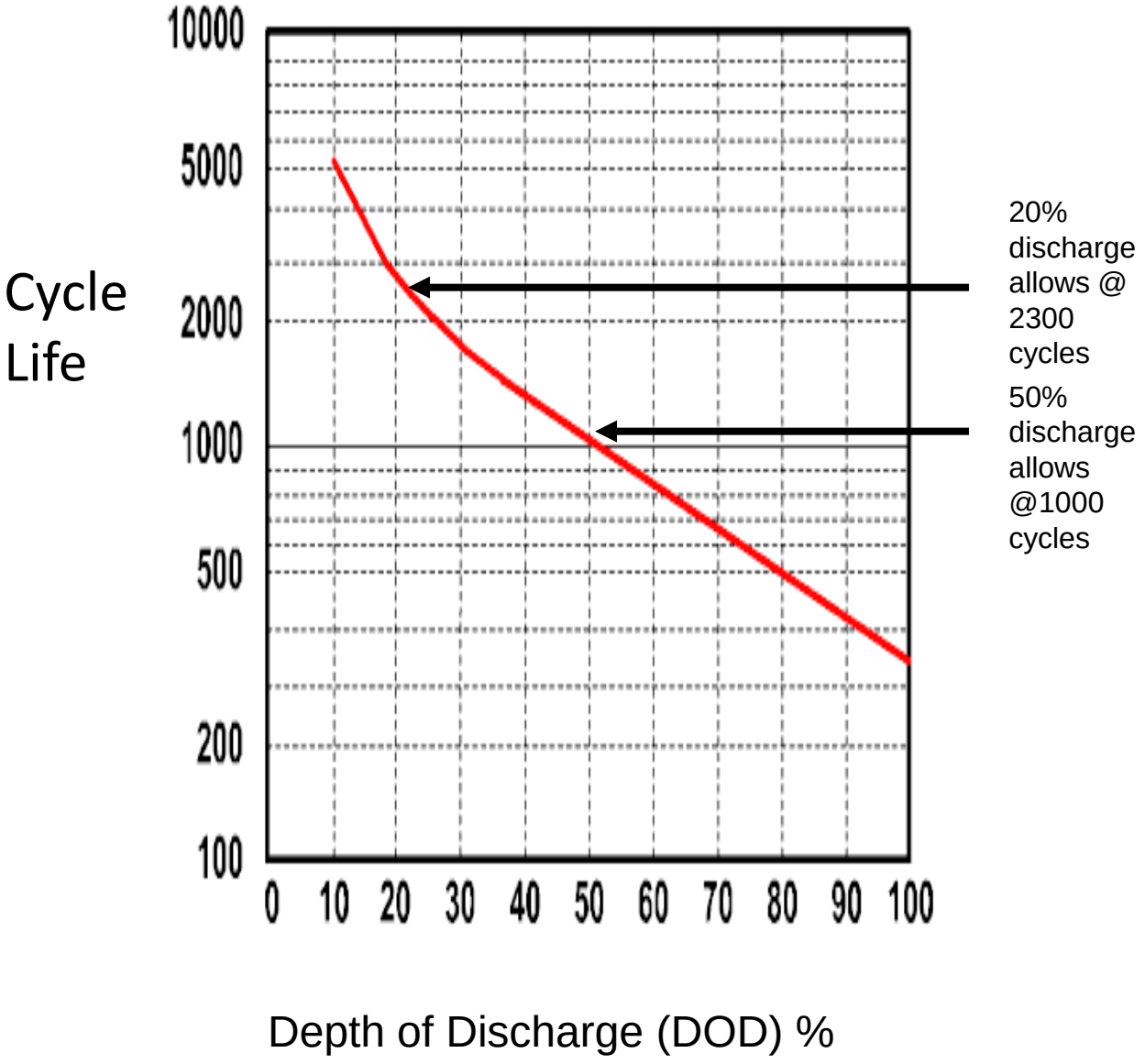
Chemical reactions are much faster in warmer temperatures.

- Colder battery temperatures
  - = Longer charge times
  - = Shorter run times
  - = Slower self discharge
- Warmer battery temperatures
  - = Shorter charge times
  - = Longer run times
  - = Faster self discharge



A 40-degree temperature reduction results in a 20% runtime loss

Cycles vs Life Expectations



Discharge & Hydrometer Testing

Discharge Testing

72V Chart Using 9 - 8 Volt Batteries

	S/N		Serial #		Discharge Min.				
Battery #	1	2	3	4	5	6	7	8	9
Date Code									
On-Charge V									
Cell Temp		On-Charge Set Voltage →							
SpGr + Cell									
SpGr Mid Cell									
SpGr Mid Cell									
SpGr -- Cell									
Discharge V									

72V Chart Using 6 - 12 Volt Batteries

	S/N		Serial #		Discharge Min.	
Battery #	1	2	3	4	5	6
Date Code						
On-Charge V						
Cell Temp		On-Charge Set Voltage →				
SpGr + Cell 1						
SpGr Cell 2						
SpGr Cell 3						
SpGr Cell 4						
SpGr Cell 5						
SpGr-Cell 6						
Discharge V						

Instructions:
1. Charge the vehicle until the charger turns itself off.
2. Start charger, run for up to 15 minutes.
3. Make sure the charge is greater than 80% at the time of testing.
4. Record on charge set voltage, individual on-charge voltages, serial number, and date codes of batteries.
5. Record cell temperature in battery #2 negative cell. Unplug charger.
6. Record specific gravity for each battery cell starting with battery 1 positive cell through battery 6 or 9 negative cell.
7. Start discharge machine, and record minutes to discharge when the machine shuts down.
8. Restart discharger and record individual battery voltages at 63 volts (72 volt units).

8V Diagnostics:
US 8 volt batteries are advertised to run 90 minutes on 72V application when discharged at a 75A rate.
US 8 volt battery run time is not considered deficient until the discharger will not run 45 minutes.
Discharges above 45 minutes are considered good.
Individual end discharge voltages should = 7 volts per battery. Replace the battery if it falls .5Volts below the set average.

12V Diagnostics:
US 12 volt batteries are advertised to run 77 minutes on a 72V application when discharged at a 75A rate.
US 12 battery run time is not considered deficient until the discharger wil not run 38 minutes.
Discharges above 38 minutes are considered good.
Individual end discharge voltages should = 10.5 volts per battery. Replace the battery if it falls .5Volts below the set average.

See the service manual or the training guide to trouble shoot using a hydrometer.

Hydrometer Testing

Specific gravity is the measurement of a liquid that is compared to a baseline. The baseline is water which is assigned a base number of 1.000. The concentration of sulfuric acid to water in a new golf car battery is 1.280 which means that the electrolyte weighs 1.280 times the weight of the same volume of water. A fully charged battery will test at 1.275 - 1.280 while a discharged battery will read in the 1.140 range.

NOTICE

Do not perform a hydrometer test on a battery that has just been watered. The battery must go through at least one charge and discharge cycle in order to permit the water to adequately mix with the electrolyte.

The temperature of the **electrolyte** is important since the hydrometer reading must be corrected to 80° F (27°

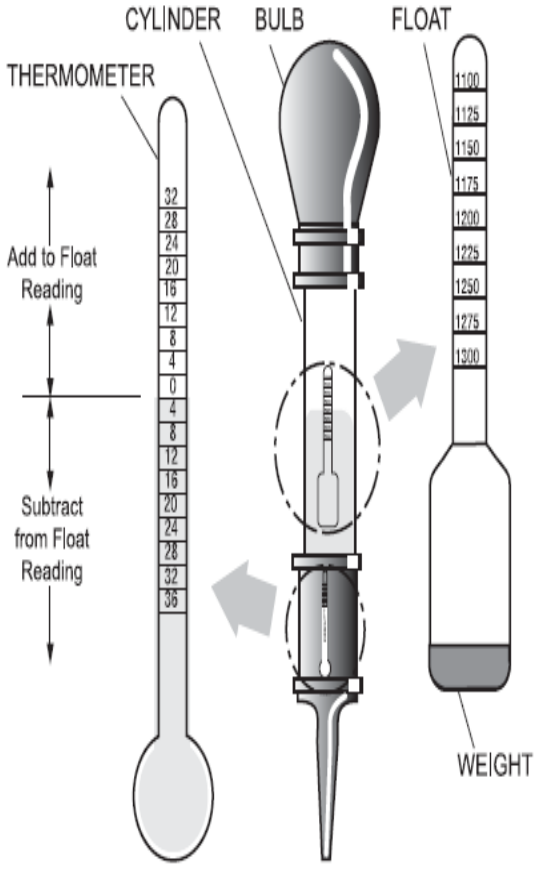
Using A Hydrometer

1. Draw electrolyte into the hydrometer several times to permit the thermometer to adjust to the electrolyte temperature and note the reading. Examine the color of the electrolyte. A brown or gray coloration indicates a problem with the battery and is a sign that the battery is nearing the end of its life.

2. Draw the minimum quantity of electrolyte into the hydrometer to permit the float to float freely without contacting the top or bottom of the cylinder.

3. Hold the hydrometer in a vertical position at eye level and note the reading where the electrolyte meets the scale on the float.

Hydrometer Testing



4. Add or subtract four points (.004) to the reading for every 10° F (6° C) the electrolyte temperature is above or below 80° F (27° C). Adjust the reading to conform with the electrolyte temperature, e.g., if the reading indicates a specific gravity of 1.250 and the electrolyte temperature is 90° F (32° C), **add** four points (.004) to the 1.250 which gives a corrected reading of 1.254. Similarly if the temperature was 70° F (21° C), **subtract** four points (.004) from the 1.250 to give a corrected reading of 1.246.

5. Test each cell and note the readings (corrected to 80° F or 27° C). A variation of fifty points between any two cell readings (example 1.250 - 1.200) indicates a problem with the low reading cell(s).

As a battery ages the specific gravity of the electrolyte will decrease at full charge. This is not a reason to replace the battery providing all cells are within fifty points of each other.

Since the hydrometer test is in response to a vehicle exhibiting a performance problem , the vehicle should be recharged and the test repeated. If the results indicate a weak cell, the battery or batteries should be removed and replaced with a good battery of the same brand, type and approximate age.

Controller & Trouble-Shooting

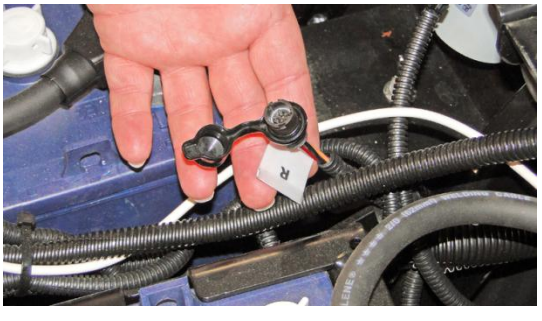
Notes:

HOW TO USE THE HANDHELD PROGRAMMER

The Curtis handheld Programmer is used for programming, testing, troubleshooting, tuning, diagnosing and parameter adjustments for speed controller and auxiliary devices.

⚠ WARNING

Plug the Curtis handheld programmer into Curtis programmer port only. If plugged into the wrong port, voltage from other interface circuits may result in permanent damage to the programmer.



NAVIGATION

A blinking square on the left edge indicates the position of the cursor and the blinking square moves up or down when up or down navigation key is pressed. Press the right arrow on the navigation key to display a column of sub-menus and again press down the right arrow for more than one level of sub-menus to be displayed. Press the left arrow once or more on the navigation key to display the main menu.

CHANGING DATA VALUE

Press the Data Increase or Data Decrease key to change the value of the parameter.

BOOKMARK

To set a position in the Menu, hold a Bookmark Key down for four seconds, until the Bookmark set screen is displayed. To jump to a selected Bookmark position, press the appropriate Bookmark Key.

MAIN MENU DEFINITIONS

- PROGRAM - Shows vehicle profile setting and adjustability.
- MONITOR - Shows vehicle real-time diagnostics
- FAULTS - Shows active and past faults
- FUNCTIONS - Shows parameter setting uploads and downloads
- INFORMATION - Shows controller information
- PROGRAMMER SETUP - Shows handheld information and adjustment

Curtis Controller Fault Code Chart

DIAGNOSTICS

Diagnostics information can be obtained in either of two ways: (1) by reading the display on a 1311 programmer or (2) by observing the fault codes issued by the Status LEDs. See Table 4 for a summary of LED display formats. The 1311 programmer will display all faults that are currently set as well as a history of the faults that have been set since the history log was last cleared. The 1311 displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code consists of two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the 1311 programmer, the words **Undervoltage Cutback** will be displayed; the real-time battery voltage is displayed in the Monitor menu ("Keyswitch Voltage").

The controller's two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	* *	* *	* * *
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in the troubleshooting chart (Table 5), which also lists possible fault causes and describes the conditions that set and clear each fault.

Curtis Controller Fault Code Chart

Summary of LED display formats
The two LEDs have four different display modes, indicating the type of information they are providing.

Table 4 TYPES OF LED DISPLAY

DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

Curtis Controller Fault Code Chart

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default Value
Program	Reset Controller			0-1	0
Monitor	Solenoid Coil			On-Off	On
	Rear Node Select			On-Off	On
	Solenoid PWM			0_100	0%
	Rear Controller	Run/Tow Switch		On-Off	Off
		Key Switch		On-Off	Off
		Economy Mode Switch		On-Off	Off
		Forward Switch		On-Off	Off
		Reverse Switch		On-Off	Off
		Throttles	Raw Primary Throttle	0.00-5.00	0.73V
			Mapped Primary Throttle	0-100	0.00%
			Raw Redundant Throttle	0.00-5.00	0.37V
			Mapped Redundant Throttle	0-100	0%
	Inputs	Throttle Command		0-100	0%
		Mapped Throttle		0-100	0%
		Throttle Pot		0.00-5.50	0.73V
		Pot2 Raw		0.00-5.50	0.37V
		Interlock		On-Off	Off
		Analog 2		0.00-10.00	1.24V
	Outputs	5 Volts		0.00-6.25	4.94V
		12 Volts		0.00-12.00	12.42V
		Ext Supply Current		0-200	63mA
		Pot Low		0.00-6.25	0.20V
	Battery	BDI		0-100	75%
		Capacitor Voltage		0.0-105.0	3.1V
		Keyswitch Voltage		0.0-105.0	77.0V
	Motor	Motor RPM		-12000-12000	0 RPM
		Temperature		-100-300	29*C
		MotorSpeed A		-12000-12000	0 RPM
		MotorSpeed B		-12000-12000	0 RPM
	Controller	Current (RMS)		0.0-1000.0	0.1A
		Modulation Depth		0.0-100	0.00%
		Frequency		-300.0-300.0	0.0Hz
		Temperature		-100-300	33*C
		Regen		On-Off	On
		Cutbacks	Motor Temp Cutback	0-100	100%
			Controller Temp Cutback	0-100	100%
			Undervoltage Cutback	0-100	0%
			Overvoltage Cutback	0-100	100%
	Vehicle	Vehicle Speed		-3276.8-3276.7	0
		Vehicle Odometer		0.0-10000000.0	0
		Braking Distance		0.0-1000000.0	0
		Distance Since Stop		0.0-1000000.0	
Faults	System Faults			Display active faults.	
	Fault History			Display non-active faults	
	Clear Fault History			Yes-No	
Functions	Settings	Get Settings From Controller		Ok-Abort	
		Write Settings To Controller		Ok _Abort	
		Reset All Settings		Yes-No	

Curtis Controller Fault Code Chart

Menu	Submenu 1	Submenu 2	Submenu 3	Data Range	Default Value
Controller Information	Model Number			Display the controller model number	
	Protocol Version			Display the controller protocol version	
	Model Number			Display the controller model number	
	Serial Number			Display the controller serial number	
	Mfg Date Code			Display controller date of man.	
	Hardware Version			Display the controller hardware version	
	OS Version			Display controller operating system	
	Build Number			Display controller OS build number	
	SM Version			Display controller SM version	
	Parameter Block Version			Display controller PB version	
	VCL App Version			Display VCL App Version	
Programmer Setup	Program	LCD Contract	-300		0
		Language		English	English
		Set Security Code		Set user lock code	
	Faults	Fault History		Display faul;t history of HANDHELD	
		Clear Fault History		Yes/No	
	Information	OEM Info		Display OEM information	
		*Reconfigured		Display reconfigure status	
		Model Number		Display handheld model number	
		Serial Number		Display handheld serial number	
		Manufacturing Date		Display handheld manufacture date	
		Software Version		Display handheld software version	
		Hardware Version		Display handheld hardware version	
		MC-Protocol Version		Display MC-Protocol version	
		ES-Protocol Version		Display ES-Protocol version	
		S-Protocol Version		Display S-Protocol version	
		Device Type		Display device type	

Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
1-2	**Controller Over current**	Phase Current exceeded current limits	Vehicle Disabled	KSI Cycled	1. External short of phase U,V or W 2. Check wiring 3. Motor parameters are mis-tuned 4. Defective controller 5. Speed encoder noise problems
1-3	**Current Sensor Fault**	Controller current sensors have invalid offset reading	Vehicle Disabled	KSI Cycled	1. Short to car frame from phase U,V or W. 2. Controller defective
1-4	**Precharge Failed**	Capacitor bank failed to charge at KSI voltage	Vehicle Disabled	Cycle interlock	1. See handheld monitor menu - battery: capacitor voltage 2. External load on capacitor bank preventing capacitor charge 3. Check wiring 4. Check brake sensor if other faults are found
1-5	**Controller Sever Undertemp**	Heat sink temperature below -40*C	Vehicle Disabled	Raise controller temp to above -40*C and cycle KSI or interlock	1. Controller is operating in an extreme environment 2. See monitor menu - controller: temperature
1-6	**Controller Sever Over temp**	Heat sink temperature above +95*C	Vehicle Disabled	Reduce heat sink temperature below 95*C and cycle KSI or interlock	1. Controller is operating in an extreme environment 2. See monitor menu - controller: temperature 3. Excessive load on vehicle 4. Improper mounting of controller
1-7	**Severe Under voltage**	Capacitor voltage dropped below limit	Reduced Drive torque and speed	Condition clears	1.Battery menu parameters are misadjusted 2. Non-controller system drain on batteries 3. Battery resistance too high 4. Battery disconnected while driving 5. See monitor menu - Battery: capacitor voltage 6. Blown B+ fuse or main contactor did not close
1-8	**Severe Overvoltage**	Capacitor bank voltage exceeded limit	Vehicle Disabled	Condition clears and KSI cycled	1. See monitor menu-Battery: capacitor voltage 2. Battery menu parameters are misadjusted 3. Battery resistance too high for given regen current 4. Battery disconnected while regen braking
2-2	**Controller Over temp Cutback**	heat sink temp exceeded 85*C	Reduced drive and brake torque	Condition clears	1.See monitor menu - Controller: temperature 2. Controller is performance-limited at this temperature 3. Controller is operating in an extreme environment 4. Excessive load on vehicle
2-3	**Under voltage Cutback**	Capacitor bank voltage dropped below limit	Reduced Drive torque and speed	Condition clears	1. Normal operation. Fault shows that batteries need recharging 2. Battery parameters are misadjusted 3. Non-controller system drain 4. Battery resistance to high 5. Battery disconnected while driving 6. See Monitor menu-Battery: capacitor voltage 7. Blown B+ fuse or main contactor did not close

Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
2-4	**Overvoltage Cutback**	Capacitor bank voltage exceeded overvoltage limit	Reduced brake torque	Condition clears	1.Normal operation. Fault shows that the regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage 2. Battery parameters are misadjusted 3. Battery resistance too high for given regen current 4.Battery disconnected while regen braking 5.See Monitor menu - Battery: ca[capacitor voltage
2-5	**+5V supply Failure**	+ 5 V supply (pin 26) outside the +5V + or - 10% range	None: Check VCL	Condition clears	1. External load impedance on the + 5 V supply is too low 2.See Monitor menu-Outputs: 5 volts and ext supply current
2-6	**Digital Out Over current**	Digital output 6 (pin 19) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig out to turn driver on again	1. External load impedance on Digital Output 6 (pin 19) is too low
2-7	**Digital Out 7 Over current**	Digital output 7 (pin 20) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig Out() to turn driver on again	1. External load impedance on Digital Output 7 (pin 20) is too low
2-8	**Motor Temp Hot Cutback**	Motor temp is at or above Hot parameter setting	Reduced Drive torque and speed	Condition clears	1.Motor temperature is at or above the programmed temperature Hot stetting, and the requested current is being cut back 2. Motor temperature control menu parameters are mis-tuned 3. See Monitor menu-Motor: temperature and - Inputs: analog 2 4. reduce load on motor
2-9	**Motor Temp Sensor Fault**	Motor thermistor input (pin8) is at voltage rail (0 or 10v)	Reduced speed, Motor temp cutback disabled	Condition clears	1. Motor thermistor is not connected 2. Check sensor
3-1	**Coil 1 Driver Open or Short - also can be Main Open or Short**	Driver 1 (pin6) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 1	Correct condition and cycle driver	1. Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-2	**Coil2 Driver Open or Short**	Driver 2 (pin5) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 2	Correct condition and cycle driver	1. Open or short on driver load 2. Dirty connector pins 3. Bad crimps or faulty wiring
3-3	**Coil3 Driver Open or Short**	Driver 3 (pin4) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 3	Correct condition and cycle driver	1. Open or short on driver load 2. Dirty connector pins 3. Bad crimps or faulty wiring

Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
3-4	**Coil4 Driver Open or Short**	Driver 4 (pin3) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 4	Correct condition and cycle driver	1. Open or short on driver load 2. Dirty connector pins 3. Bad crimps or faulty wiring
3-5	**PD Open or Short**	The Proportional driver (pin2) is either open or shorted. This fault can only be set when main enable =off	Shutdown PD driver	Correct condition and cycle driver	1. Open or short on driver load 2. Dirty connector pins 3. Bad crimps or faulty wiring
3-6	**Encoder Fault**	Motor encoder phase failure detected.	Throttle Shutdown	KSI cycled	1. Motor encoder failure 2. Bad crimp or faulty wiring 3. See Monitor menu - Motor: motor rpm
3-7	**Motor Open**	Motor Phase U,V or W detected open	Vehicle Disabled	KSI cycled	1.Motor phase is open 2. Bad crimps or faulty wiring
3-8	**Main Contactor Welded**	Prior to main contactor closing, capacitor bank voltage was loaded for a short time and did not discharge	Vehicle Disabled	KSI cycled	1. Main contactor tips are welded closed 2. Motor phase U or V is disconnected or open 3. an alternate voltage path is providing a current to the capacitor bank (B+ connection terminal)
3-9	**Main Contactor Did Not Close**	With the main contactor commanded closed, the bank voltage(B+ connection terminal) did not charge to B+	Vehicle Disabled	KSI cycled	1. Main contactor did not close 2.Main contactor tips are oxidized, burned, or not making a good contact 3. External load on capacitor bank(B+ connection terminal) that prevents capacitor bank from charging 4. Blown B+ fuse
4-1	**Throttle Wiper High**	Throttle pot wiper (pin16) voltage is higher than high fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2. Throttle pot wiper voltage too high
4-2	**Throttle Wiper Low**	Throttle pot wiper (pin16) voltage is lower than low fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2. Throttle pot wiper voltage too low
4-3	**Pot2 Wiper High**	Pot2 wiper (pin17) voltage is higher than high fault setting	Full Brake	Condition clears	1.See Monitor menu-Inputs: pot2 raw 2. Pot2 wiper voltage too high
4-4	**Pot2 Wiper Low**	Pot2 wiper (pin17) voltage is lower than low fault setting	Full Throttle	Condition clears	1.See Monitor menu-Inputs: pot2 raw 2. Pot2 wiper voltage too low
4-5	**Pot Low Over current**	Pot low (pin 18) current exceeds 10mA	Shutdown Throttle and full Brake	Condition clears and KSI cycled	1.See Monitor menu-Outputs: pot low 2. Combined pot resistance connected to pot low is to low

Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
4-6	**EEPROM Failure**	Controller operating system tried to write to EEPROM memory and failed	Vehicle Disabled	Download correct software(OS) and matching parameter default settings into the controller and c	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into controller
4-7	**HPD/Sequencing Fault**	HPD sequencing fault caused incorrect sequence of KSI, interlock, direction and throttle input	Shutdown Throttle	Reapply inputs in correct sequence	1. KSI, interlock, direction and throttle inputs applied in incorrect sequence 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu-Inputs
4-8	**Emer Rev HPD**	At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral	Shutdown Throttle	If EMR_interlock=On, clear the interlock, throttle and direction inputs. If EMR_Interlock=Off, clear the throttle and direction inputs.	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral
4-9	**Parameter Change Fault**	Adjustment of a parameter setting that requires cycling of KSI	Vehicle Disabled	KSI cycled	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI id cycled.
5-2	**Traction Throttle Mismatch**	Throttle input/output mismatched	Throttle Shutdown	Condition Clears	1.See Monitor menu-Inputs: Throttle 2. Check throttle return
5-3	**Throttle Input Out of Range**	Throttle input out of range	Throttle Shutdown	Condition Clears	1.See Monitor menu-Inputs: Throttle 2. Check throttle return 3. Check for water intrusion of throttle wiper
5-4	**Park Brake Set**	Park brake engaged when traction pedal was activated	Throttle Shutdown	Condition cleared	1. Park brake was engaged when throttle was activated. 2.release park brake and operate unit 3.Check park brake switch
5-5	**HPD/SRO Fault**	High pedal disable/static return to off	Vehicle Disabled	Condition cleared. Correct start sequence applied	1. verify correct start sequence. Unit must be in neutral prior to key on
5-6	**Solenoid Coil Open/Short**	Driver does not turn OFF	Vehicle Disabled	KSI cycled	1. Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring 4. When found in history, does not necessarily indicate a problem.
6-8	**VCL Run Time Error**	Runtime VCL code error condition	Vehicle Disabled	KSI cycled or install new software to match parameters	1. VCL code encountered a runtime VCL error 2. See Monitor menu -Controller: VCL error module

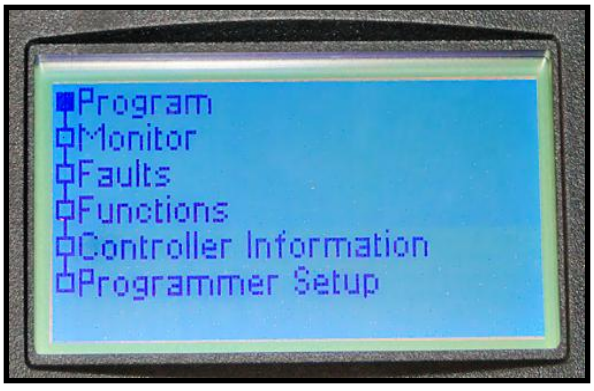
Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
6-9	**External Supply out of Range**	The external 5v and 12V supply is out of range.	None: Check VCL	External supply current within range	1.External load on the 5V and 12V supplies draws either too much or too little current 2. Fault checking menu parameters Ext. supply max and Ext. supply min are mis tuned 3. See Monitor menu-Outputs:ext supply current
7-1	**OS General**	Internal controller fault detected	Vehicle Disabled	KSI Cycled	1. Internal controller fault detected 2. Cycle KSI
7-2	**PDO Timeout**	Time between CAN PDO messages received exceeded the PDO timeout period	Shutdown Interlock. Set CAN NMT state to pre-operational	Cycle KSI or Cycle F&R	1.Time out period exceeded because of no inputs from throttle or controls 2. Cycle KSI and or F&R switch
7-3	**Stall Detected**	No Motor encoder movement detected	Vehicle Disabled	Cycle KSI	1. Stalled motor. 2. Motor encoder failure 3. Bad crimps or faulty wiring 4. Problems with power supply for the motor encoder 5. See Monitor menu-Motor: motor rpm
7-4	**Fault on Other Traction Controller**	Fault found on slave controller	Depends on fault	KSI cycled	1. Check slave controller faults with handheld via direct connection to slave controller
7-5	**Dual Severe Fault**	Sever fault found on slave controller	Vehicle Disabled	KSI cycled	1. Check slave controller faults with handheld via direct connection to slave controller
8-7	**Motor Characterization Fault**	Motor Characterization failed during motor characterization process	Vehicle Disabled	KSI cycled or fault corrected	1. Motor characterization failed during MC process. See Monitor menu - Controller: motor characterization error for cause: 0=none 1-encoder signal seen, but step size not determined: set encoder step size manually 2=motor temp sensor fault 3=motor temp hot cutback fault 4=controller over temp cutback fault 5=controller under temp cutback fault 6=under voltage cutback fault 7=severe overvoltage fault 8=encoder signal not seen, or one or both channels missing 9=motor parameters out of characterization range
8-9	**Motor Type Fault**	Motor type parameter value is out of range	Vehicle Disabled	KSI cycled and or correct fault	1. Motor Type parameter value is out of range 2. Check controller command on hand held
9-1	**VCL/OS Mismatch**	VCL and OS software do not match, when Ski is cycled a check is made to verify that they match and a fault is issued when they do not	Vehicle Disabled	Condition clears	1. The VCL software in the controller does not match the OS software in the controller- re-install software

Curtis Controller Fault Code Chart

LED Code	1311 Display	Explanation	Controller Response	Recover When	Possible Cause
9-3	**Encoder LOS (limited operating strategy)**	Encoder fault(code36) or stall detect fault (code73) was activated and brake or interlock has been applied to activate LOS control mode, allowing limited motor control	Vehicle Disabled	KSI Cycled or Fault cleared	1. limited Operating Strategy control mode has been activated, as a result of either an encoder fault or stall detect fault 2. Motor encoder failure 3. Bad crimps or faulty wiring 4. Motor stalled
9-4	**EMER Rev Timeout**	Emergency reverse was activated and ran until the EMR timeout timer expired.	Throttle Shutdown	Condition clears	1. Emergency reverse was activated and concluded because of EMR timeout 2. The emergency reverse input is stuck on
9-8	**Illegal Model Number**	Model Number *variable, cycles a check is made to confirm a legal model number is found, a fault is issued if not*	Vehicle Disabled	Appropriate software downloaded	1. Model number variable is illegal for controller type 2. Software and hardware do not match 3. Defective controller
9-9	**Dual motor Parameter Mismatch**	Mismatch of front and rear motors	Vehicle Disabled	Condition clears	1. Check Wires and connections 2. Check for mechanical bind 3. Check for high mechanical load 4. Verify motor encoder 5. Check faults on handheld for both controllers

Curtis Handheld Diagnostic Tool Function



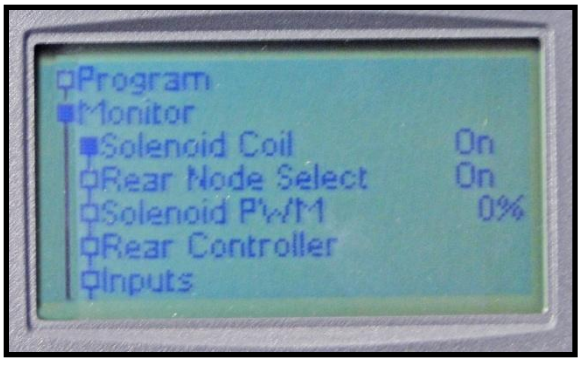
The first screen observed will be the menu options list.

The program selection does not offer a controller program option. The default parameter is 0.

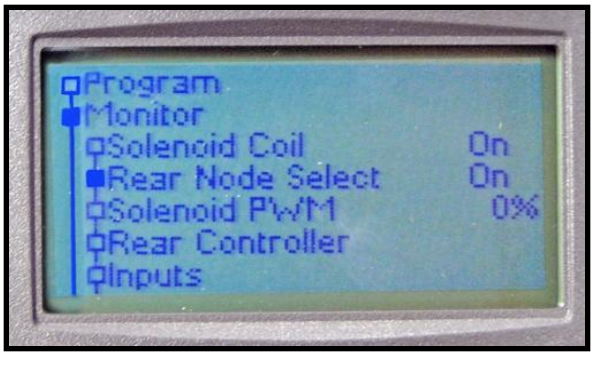
Here is the view of the reset controller function. Normal values are 0 or 1

Curtis Handheld Diagnostic Tool Function

The monitor menu selection allows the viewing of controller functions, inputs, and outputs.

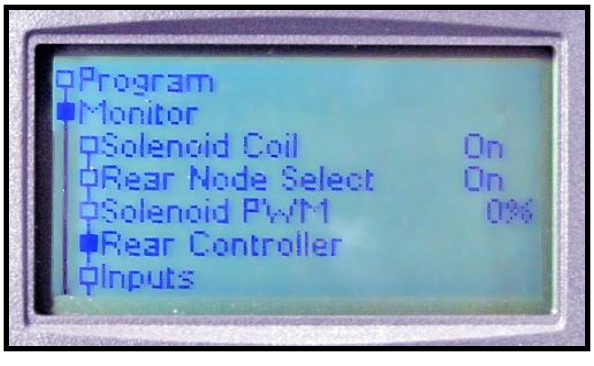


Solenoid Coil indicates power to the main solenoid.



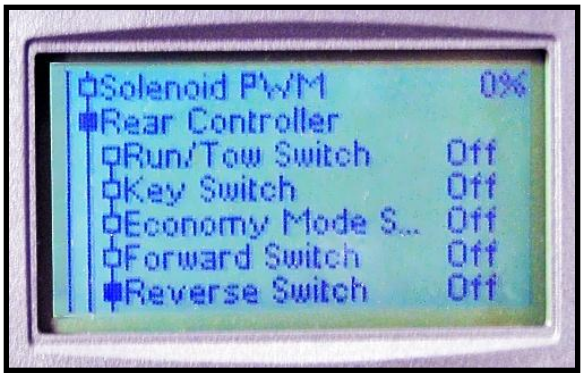
Rear node select will show the rear controller command. It will indicate on or off.

Solenoid PWM shows the % of solenoid command. It will typically show 100% when the controller is on.



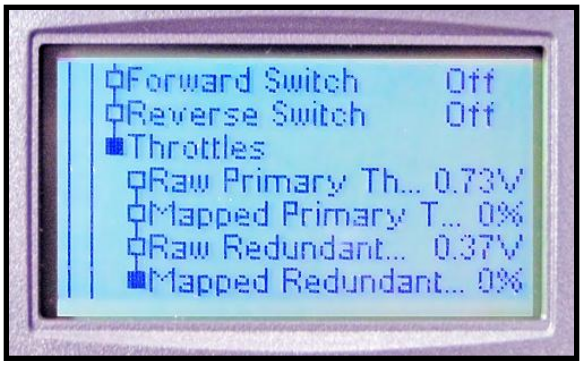
Rear Controller allows access to a sub menu to view rear controller inputs. Remember the front controller is a SLAVE controller and is controlled by the rear controller.

Curtis Handheld Diagnostic Tool Function



The rear controller sub-menu allows viewing of the run/tow switch input, key switch input, economy or max range – max speed switch input, forward input and reverse input.

Each sub menu screen of the inputs allow for viewing larger text.



Throttles is the next sub-menu . This selection allows viewing of throttle voltage range and % of throttle travel.

Inputs may be viewed from the input menu and the sub-menus.

Curtis Handheld Diagnostic Tool Function

Throttle command shows the % of throttle requested at the acccelerator pedal. Values should range from 0 – 100%.

Mapped throttle request ranges from 0 – 100% with accelerator pedal travel.

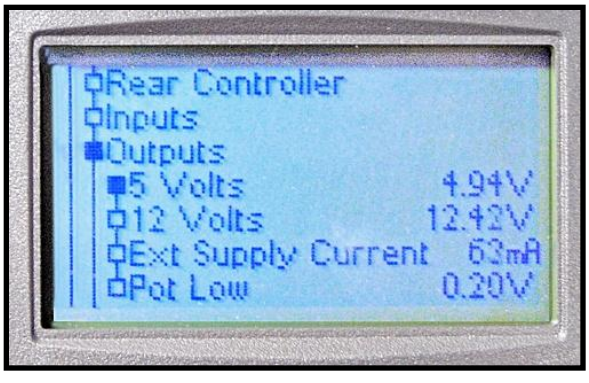
Throttle pot (pin 16) and Pot 2 (pin 17) raw indicate voltage values from 0 – 5.50V. This will range with throttle depression.

Interlock input on or off. The interlock turns on or off with key switch activation.

Curtis Handheld Diagnostic Tool Function

Voltage at analog 2 (pin8). This value will range from 0 – 10V. This particular input drives motor temperature readings.

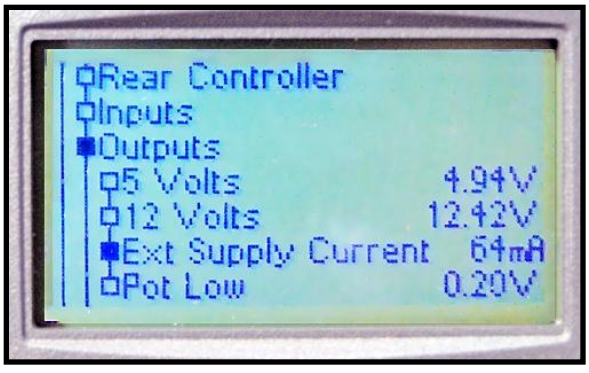
The output menu allows viewing of controller outputs and their sub-menus.



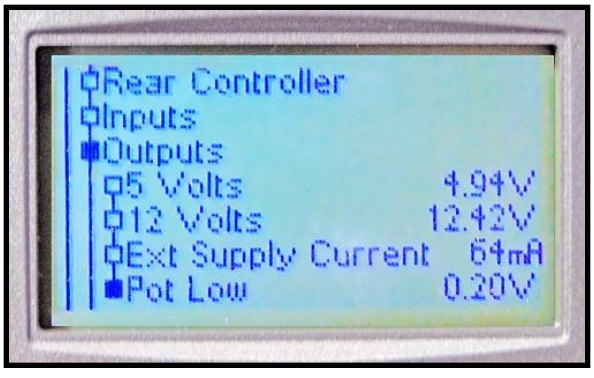
Voltage at + 5 volt output (pin26). This circuit drives speed and throttle sensors.

Voltage at +12 volt output (pin 25). This circuit drives the rear serial (data) port, key switch, and SOC meter.

Curtis Handheld Diagnostic Tool Function



Combined current of the external + 12 volt and + 5 volt supplies (pins 25 and 26)



Voltage at pot low. This value ranges between 0 – 6.25V.

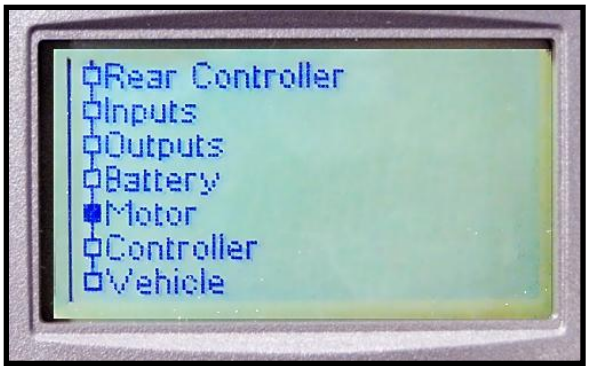
Battery menu allows view of state of charge (BDI), capacitor voltage, and KSI voltage.

BDI (battery discharge indicator) displays state of charge percentage.

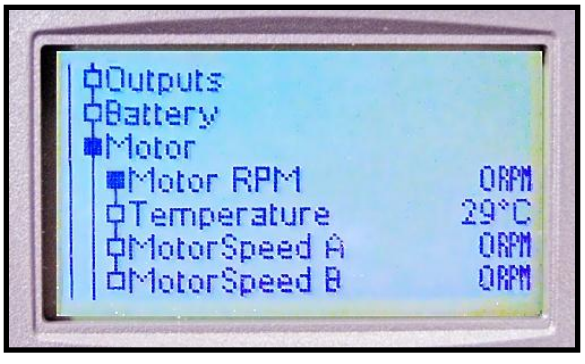
Capacitor voltage is the voltage of a controllers' internal capacitor bank at B+ terminal.

Key switch voltage is the voltage at KSI (pin1).

Curtis Handheld Diagnostic Tool Function

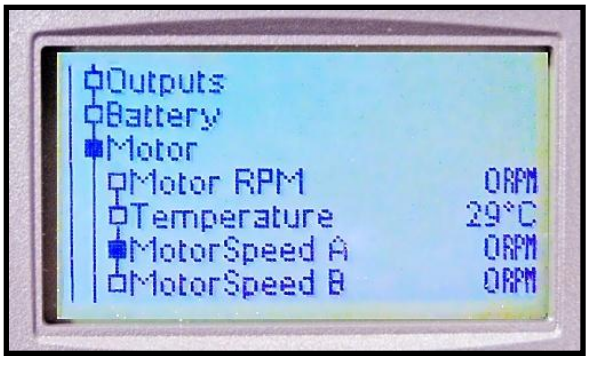


This menu selection allows the viewing of motor conditions as well as component inputs.



Motor RPM equals speed in revolutions per minute.

Temperature is measured in Celsius.



Motor encoder phase A speed in revolutions per minute.

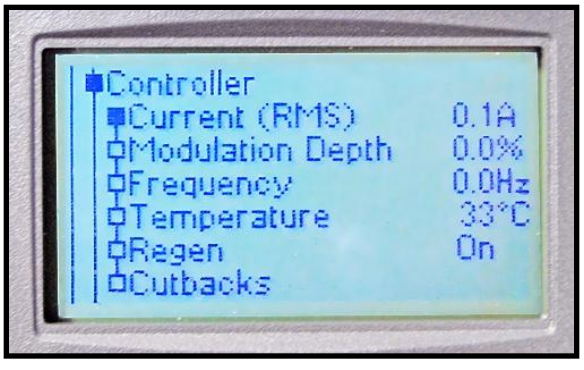
This can be used to verify that phase A of the encoder is operating correctly. Motor speed A should equal Motor speed B in a properly operating power train.

Motor encoder phase B speed in revolutions per minute.

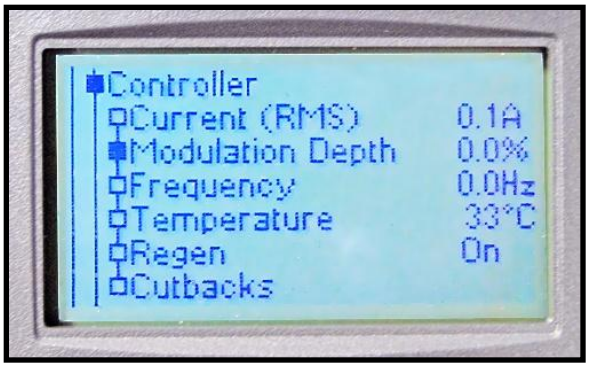
This can be used to verify that phase B of the encoder is operating correctly. Motor speed B should equal Motor speed A in a properly operating power train.

Curtis Handheld Diagnostic Tool Function

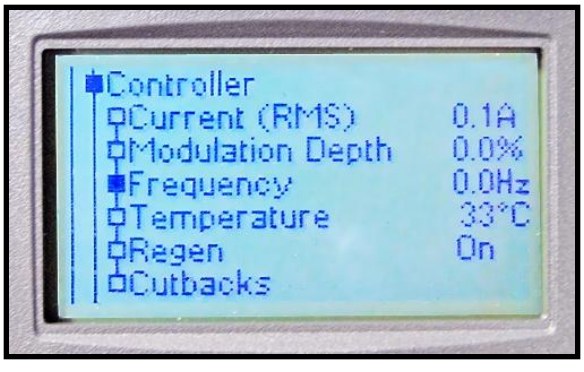
The controller operation can be viewed in this section of sub menus.



RMS current of the controller, taking in all three phases into account (amp draw).



Percentage of available voltage being used.

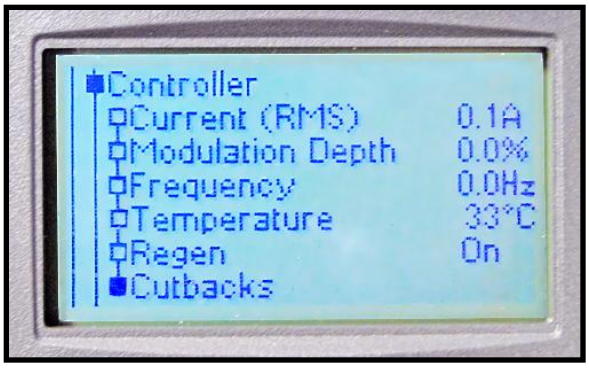


Controller electrical frequency.

Temperature indicates internal controller temp.

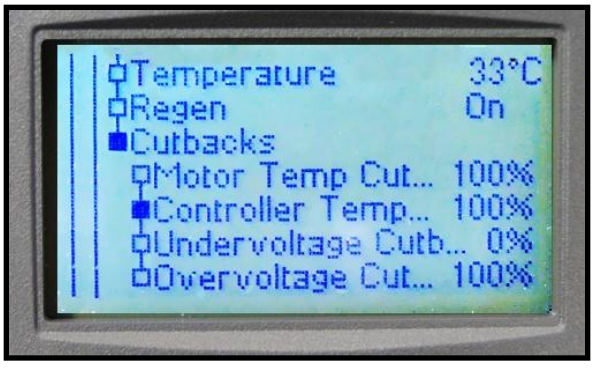
Regen will turn “on” when braking is taking place. Will turn “off” when it is not.

Curtis Handheld Diagnostic Tool Function



The Cutbacks menu selection allows viewing of voltage reductions and the reasons.

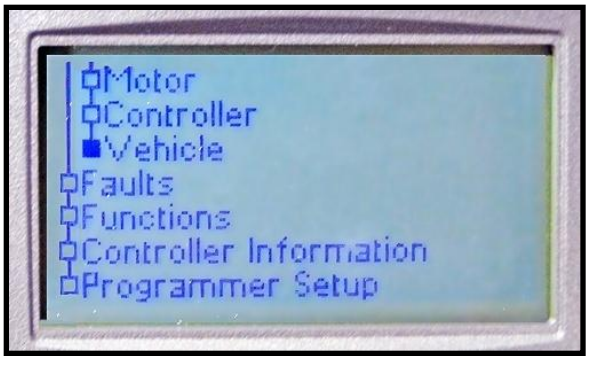
Displays the current available as a result of the motor temperature cutback function. A value of 100% indicates NO cutbacks.



Displays the current available as a result of the controller temperature cutback function. A value of 100% indicates no cutback in current.

Overvoltage or under voltage cutback displays the current available as a result of the condition. A value of 100% indicates no cutback in current.

Curtis Handheld Diagnostic Tool Function



This menu selection allows the viewing of vehicle drive operations.

Vehicle speed, in units of MPH. For accurate speed estimates, the speed to RPM parameters must be set correctly.

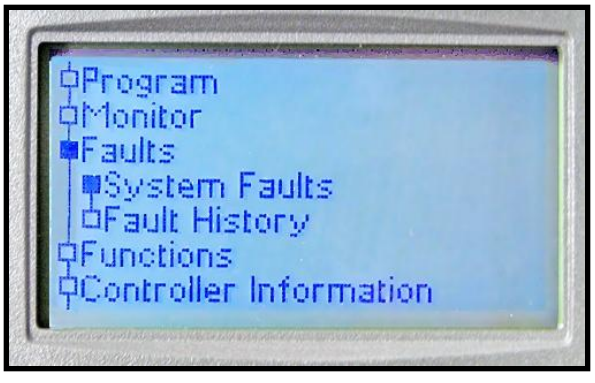
Vehicle distance traveled in units of miles. For accurate distance measurements, the speed to RPM parameters must be set correctly.

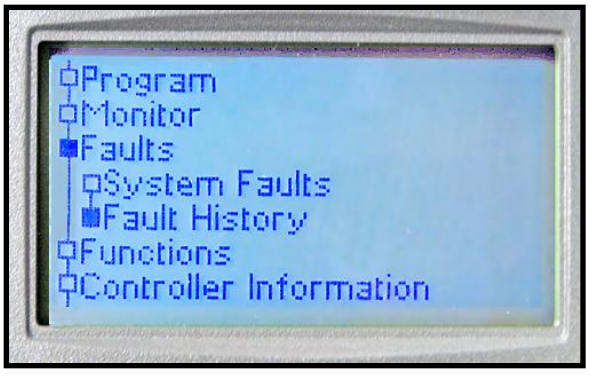
Distance traveled by the vehicle starting with vehicle braking (initiated by throttle reversal, brake pot, VCL Brake, or interlock braking) and ending when motor RPM = 0. Units are measured in feet.

Curtis Handheld Diagnostic Tool Function

Distance traveled by the vehicle starting from a stop. In effect, the vehicle is used as a tape measure. In other words if you travel 300 feet in forward and then 300 feet in reverse the distance would be 600 feet. The distance is continuously updated and will stop and restart when motor RPM = 0

Faults is the next menu selection that can be viewed. If a fault is detected at the time of testing, it will be viewed under system faults. See Menu Guide for a list of faults.

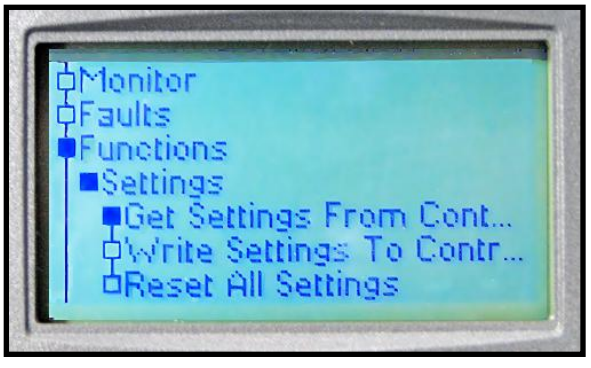




Fault history shows faults encountered by the controller in the past. It will list in run time hours when the fault occurred.

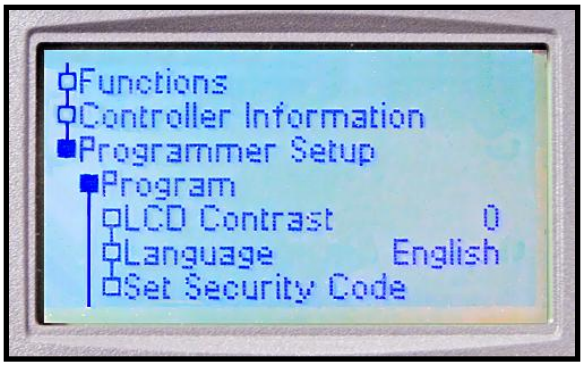
Curtis Handheld Diagnostic Tool Function

The Function menu allows for the technician to upload settings from one controller and then to download the same settings to another controller. This is referred to as Cloning.



The cloning function is not allowed by Non-OEM hand-helds.

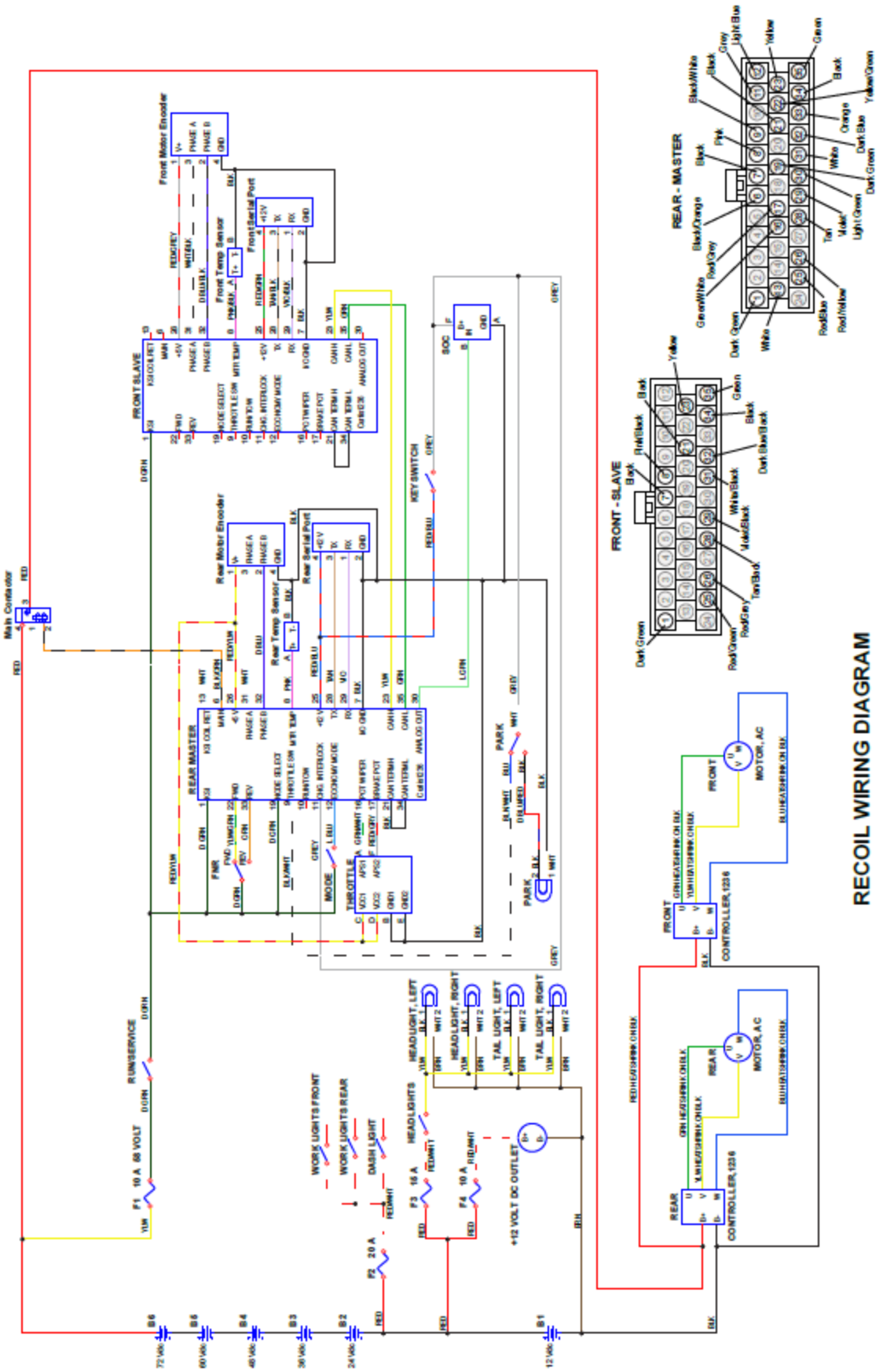
This menu allows detailed viewing of the Controller information, such as Model number, serial number, mfg date code, hardware version, OS version, build number, SM number, parameter block, VCL application version.

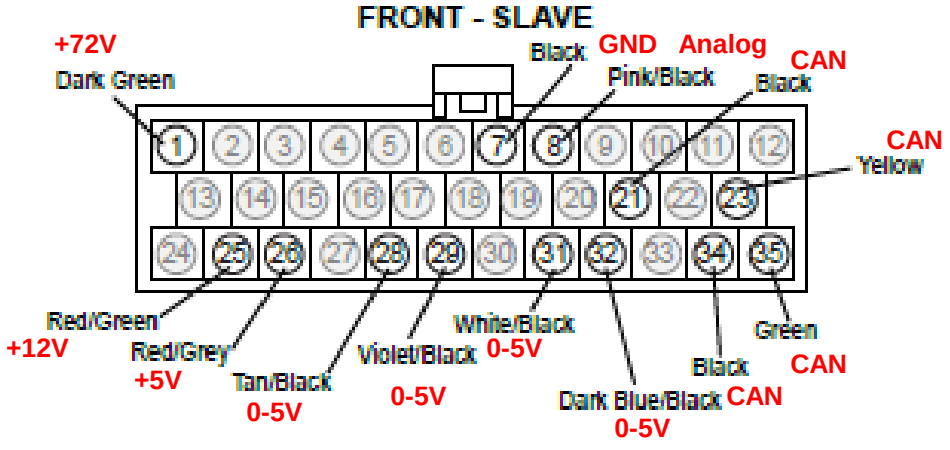


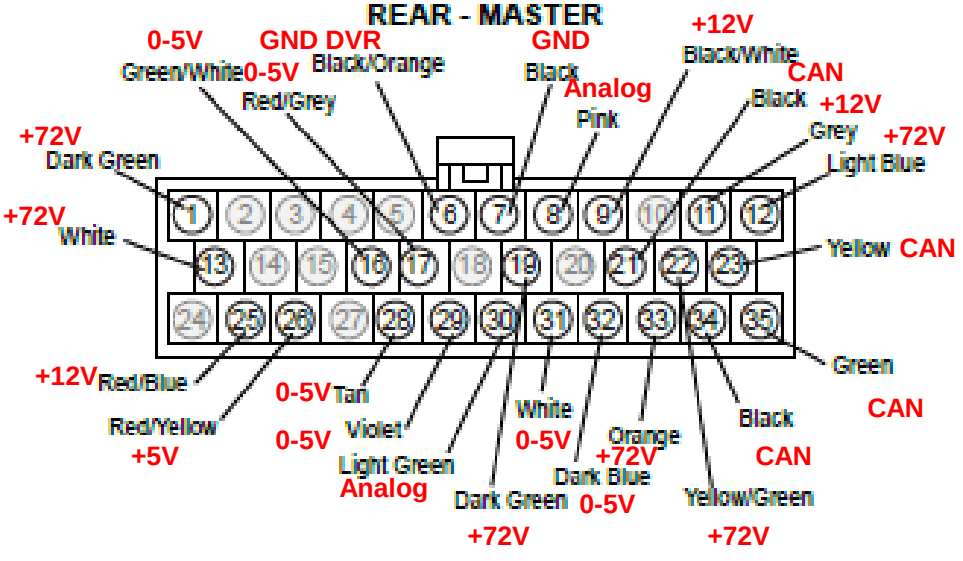
Programmer setup menu allows user defined settings for the handheld, LCD screen settings, language settings as well as a user defined security code.

The faults sub-menu located under programmer set up, will list faults that the handheld has encountered. This is not Faults the controller but only the handheld.

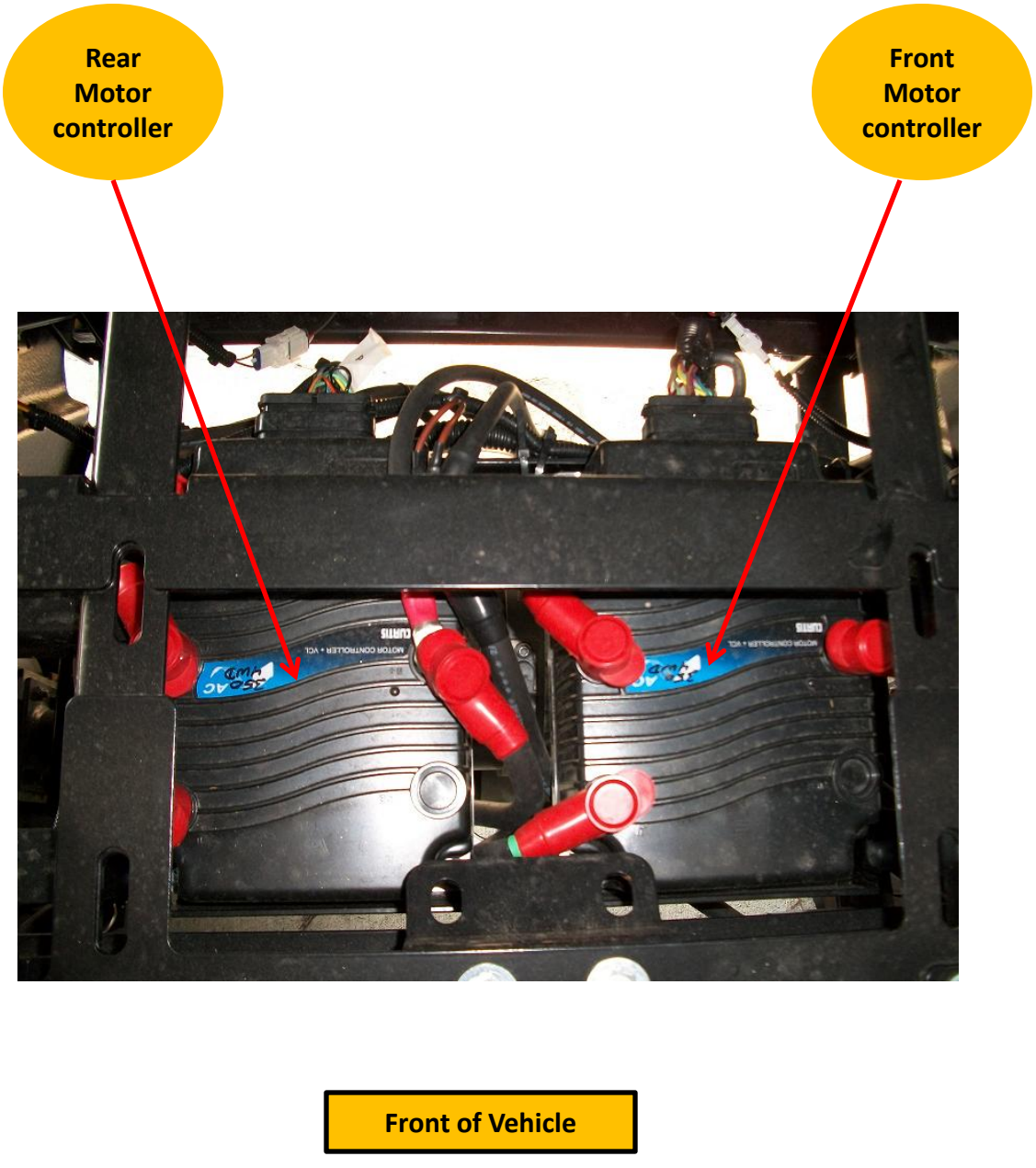
Electrical Information – Recoil




FRONT - SLAVE
+72V
Dark Green
Black
GND
Analog
Pink/Black
CAN
Black
CAN
Yellow
Red/Green
+12V
Red/Grey
+5V
Tan/Black
0-5V
Violet/Black
0-5V
White/Black
0-5V
Dark Blue/Black
0-5V
Black
CAN
Green
CAN


REAR - MASTER
0-5V
Green/White
GND DVR
0-5V
Red/Grey
Black/Orange
GND
Black
Analog
Pink
+12V
Black/White
CAN
Black
+12V
Grey
+72V
Light Blue
+72V
Dark Green
+72V
White
Yellow
CAN
+12V
Red/Blue
Red/Yellow
+5V
0-5V
Tan
0-5V
Violet
Light Green
Analog
Dark Green
+72V
White
0-5V
Orange
+72V
Dark Blue
0-5V
Black
CAN
Yellow/Green
+72V
Green
CAN

Recoil IS controller location and mounting configuration



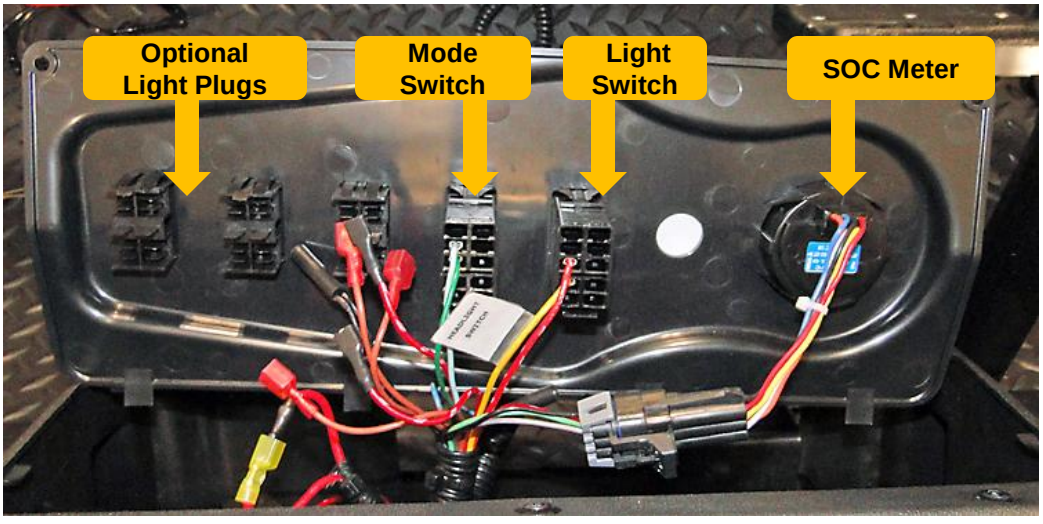
Component Testing

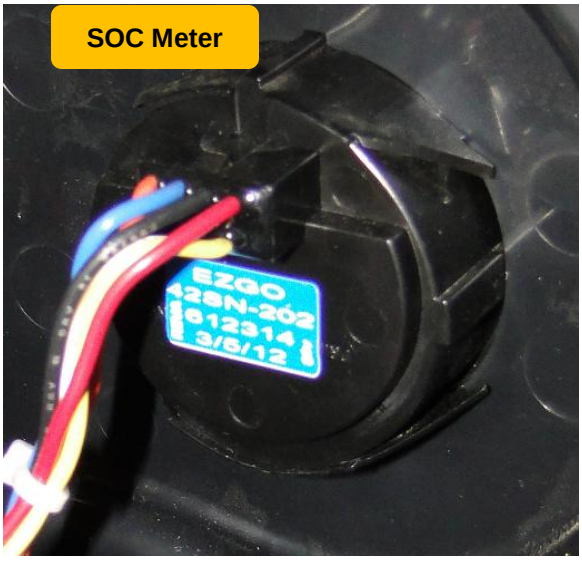
In order to properly trouble – shoot the Recoil IS electrical components, a digital volt / ohm meter will be required. Don't forget that switch inputs and outputs can be seen on the hand-held while in operation.

Always wear personal protective equipment!

Always check the fuses to make sure that components are properly powered.

Component Testing - Instrument Panel

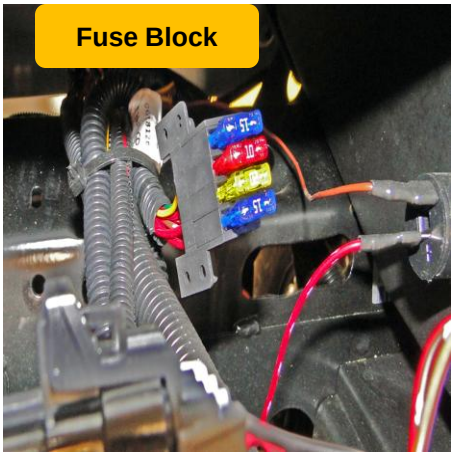




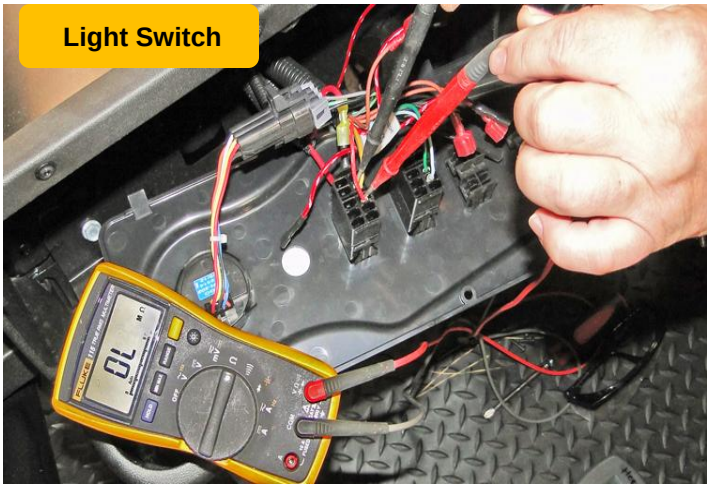
1. Place the positive meter probe on the red terminal. Place the negative probe on the black terminal. Battery voltage should be observed. If not; check the batteries and harness.

2. The yellow wire is a 0 – 5V circuit that will range with sate of charge.

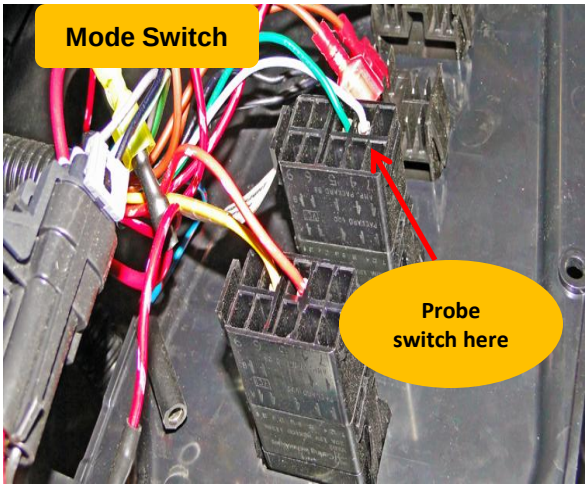
Component Testing - Instrument Panel



Begin component trouble shooting by first checking the fuses in the fuse block. Make sure they are making good connection and are sized properly for the circuit load.



The light switch can be verified by back probing the terminals. Set the DVOM for continuity. Operate the switch to test for circuit completion.



The mode switch can also be verified by back probing the terminals. Set the DVOM for continuity. Operate the switch to test for circuit completion.

Component Testing - Instrument Panel

The easiest method to trouble – shoot the key switch and the direction selector is to verify operation on the hand held diagnostic tool. View the inputs on the monitor menu. Operate the switch or selector to change its status. This will confirm a failed switch or a bad circuit.

A DVOM may be used to test the key switch. Verify the circuit pins per the wiring diagram.

Tech Tip: This test can also be performed using the hand held tool and scrolling down to the direction functions in the Monitor Menu

Component Testing - Solenoid

In order to check the electronic speed controller solenoid for energy; perform the following:

1. Place the positive meter probe on the white wire primary circuit terminal Place the negative meter probe on the black / orange primary circuit terminal. 72V should be observed on the meter with the key on and the direction selector in gear. The run / storage switch must be in the run position. If not; check the hand held Monitor Menu for the solenoid driver circuit. If it says “Main contactor ON” then check wiring and connections to the solenoid. If the hand held says “Main contactor OFF”, then check all controller inputs.

2. Place the negative meter probe on controller B- or the negative 72V battery terminal. Now place the positive probe on the secondary circuit battery side terminal. 72V should be observed. If not; check battery voltage and wiring.

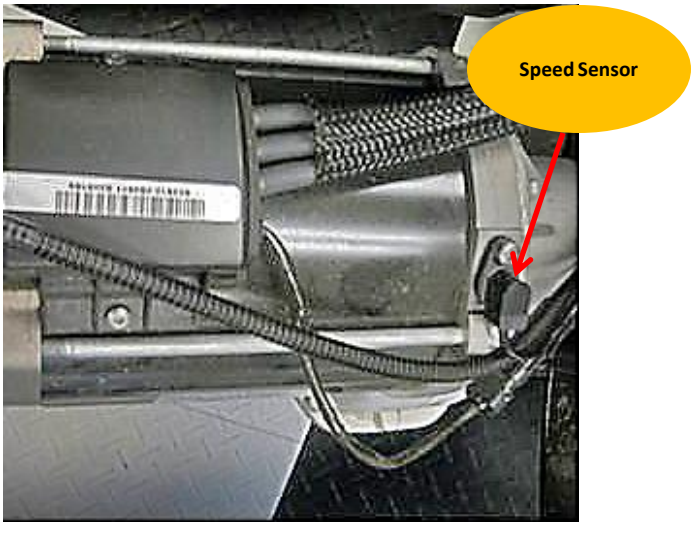
3. Place the positive probe on the secondary circuit controller side terminal. 72V should be observed with the Recoil in gear, the key on, and the run / storage switch in run. If not; check all controller inputs then replace the contactor. If 72V is observed without closing the input switches; replace the solenoid as it is welded.

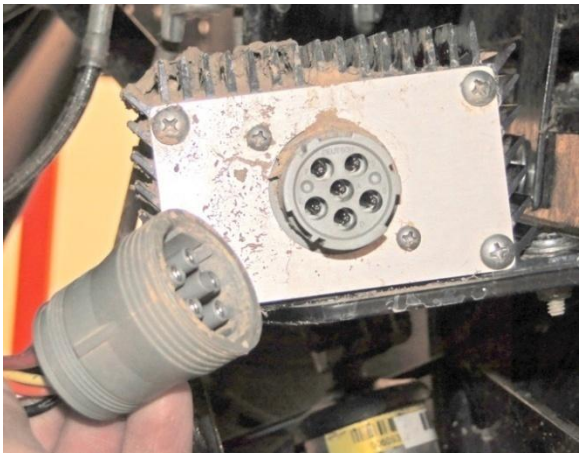
Tech Tip: This test can also be performed using the hand held tool and scrolling down to the Monitor Menu. Check inputs and out puts for change in status. Also check for contactor related faults in the faults menu.

Component Testing - Speed Sensor & Convertor Plug

1. Use the volt / ohm meter pin probes to check the motor speed sensor while the connector is plugged in. With the key on and the direction selector in gear; place the positive meter probe in the red wire connection. Place the negative meter probe in the black wire connection. 5V should be observed. If not; check the wiring and the signal from the controller. Replace the speed sensor if these are good.

2. Place the negative meter probe in the black wire connection. Place the positive meter probe in the green wire connection. A 0 – 5V flash signal should be observed when the motor armature is rotated slowly. If not, check the sensor magnet in the motor then replace the speed sensor.

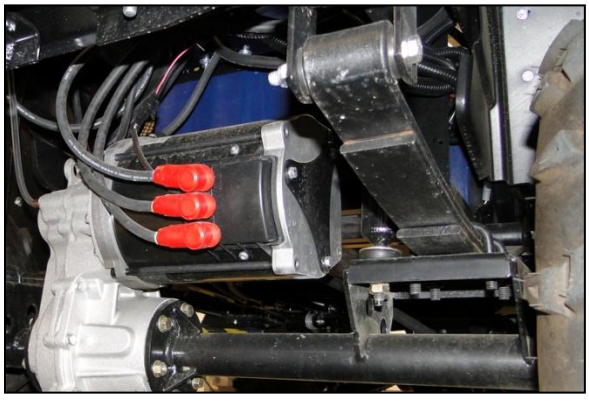




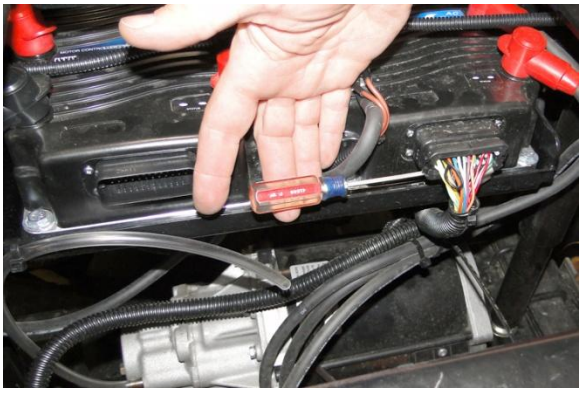
The DC to DC convertor plug should be checked periodically for dirt and debris. Voltage can be verified at the accessory light harness for correct operation.

NOTE: Back Probe Pins are required to perform electrical tests via wire harness connectors.

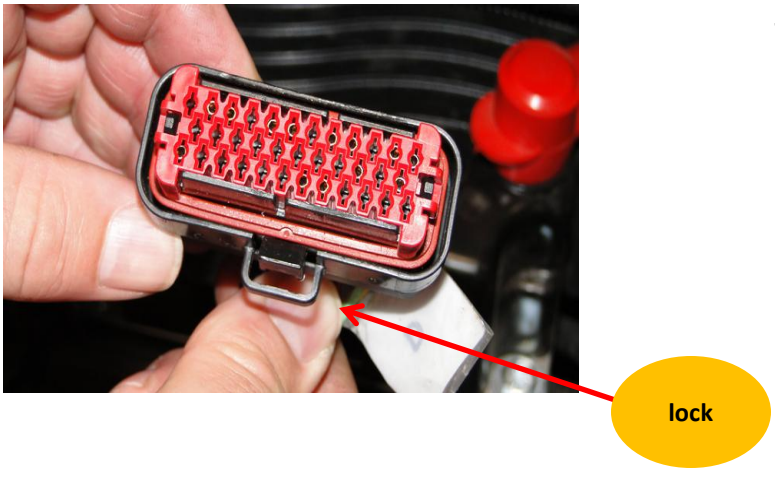
Motor Access and Controller Connector



The AC drive motor on the recoil is mounted directly to the rear differential. The UVW terminals are easily accessed underneath from the rear of the vehicle.



The main harness connector to the controller is held on with a lock. Slide a small standard screw driver under the connector and into the release mechanism, this will allow you to unplug the connector from the controller.



The main harness connector to removed from the controller. Note: the locking mechanism

Brake Systems

Notes:

Brake Fluid Inspection

Tool List	Qty.
Shop Rag	A/R
Flashlight	1
Transmission Fluid Funnel	1

NOTICE

Hydraulic brake systems must be totally flushed if the fluid becomes contaminated with water, dirt or other corrosive chemicals. To flush, bleed the entire system until all brake fluid has been replaced with fresh DOT 3 standard automotive brake fluid.

Check Brake Fluid

The brake fluid should be checked at regular intervals (as specified in the Periodic Service Schedule) or immediately if fluid leaks are found. The easiest way to check fluid level is to clean the cap with a shop rag and remove the cap. Check fluid level if the level has fallen below the MIN marking add enough brake fluid to bring the level up to the MAX marking.

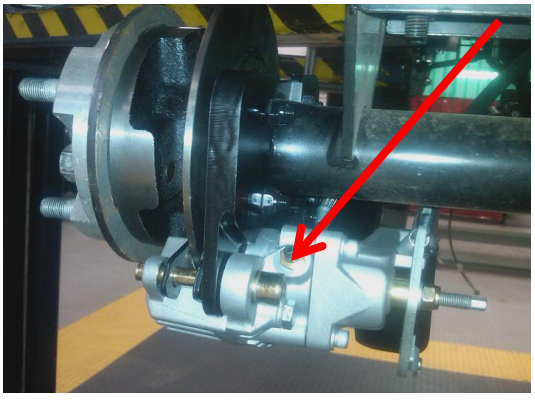
Warning: Brake fluid will damage the finish of the Buggy.

The brake fluid master cylinder can be accessed in the driver side fender well compartment.

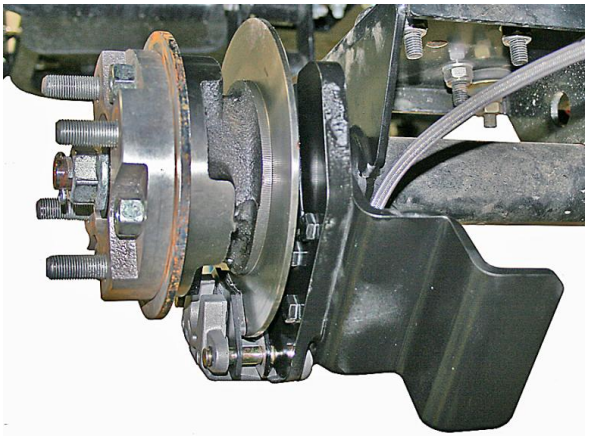
Rear Brake Pad Replacement

Tools Required	Qty. Required
Calibrated ½" Drive Torque Wrench	1
½" Drive 6" Socket Extension	1
½" Drive 17mm Impact Socket (Aluminum wheels)	1
1/2" Drive ¾" impact Socket (Steel wheels)	1
3/8" Allen Wrench	1

1. Remove wheel & tire assembly.



2. Loosen the Allen head retention bolts using the 3/8" Allen wrench.



3. Remove the retention bolts. This will free the caliper from the bracket. The brake fluid hose does not need to be removed.

⚠ WARNING

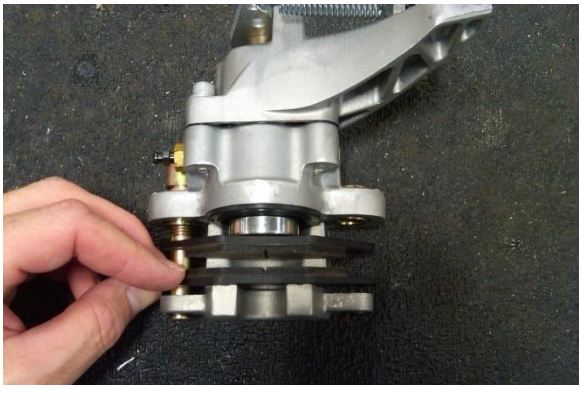
Never work on a vehicle supported by a jack alone. To prevent possible personal injury, the vehicle must be supported on jack stands during this procedure.

Rear Brake Pad Replacement

4. The brake pads can now be removed from the caliper. Inspect the rotor for damage. See rotor inspection section.

5. Coat the new brake pads with commercially available disc brake quite.

6. Compress the caliper piston using a C-clamp or locking pliers. Be careful not to damage the piston.



7. Place the pads back in their original positions making sure to place the friction material against the rotor.

8. Torque the Allen head bolts to 20-22 ft-lbs. Check park brake adjustment.

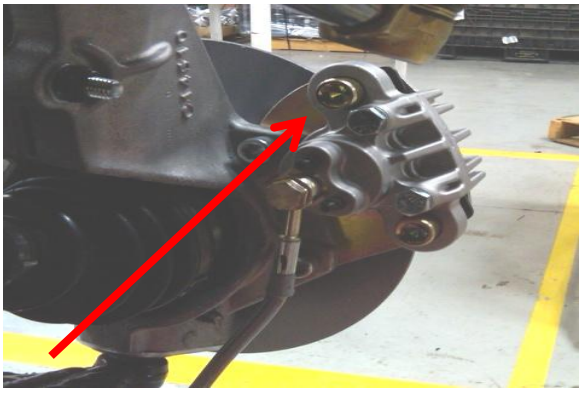
Unless fluid is lost or a brake line is disconnected, there is no need to bleed the system.

Brake System - Front

Tools Required	Qty. Required
Calibrated ½" Drive Torque Wrench	1
½" Drive 6" Socket Extension	1
½" Drive 17mm Impact Socket (Aluminum Wheels)	1
1/2" Drive ¾" impact Socket (Steel wheels)	1
3/8" Allen Wrench	1

Replacing the front brake pads is very similar to replacing the rear. The front calipers are different and can be used on either side.

1. Remove wheel & tire assembly



2. Loosen the Allen head retention bolts using the 3/8" Allen wrench. Remove the caliper from the strut mount.

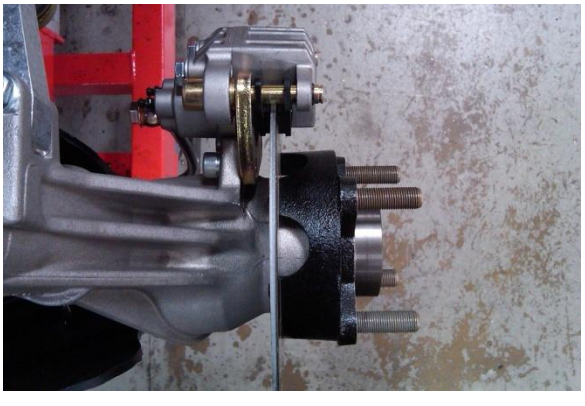
3. The caliper can now be inspected for damage. It is not necessary to remove the hydraulic brake line.

4. Install the new brake pads in the caliper Use disc brake quite as illustrated previously.

5. Reinstall the caliper on the front strut mount. Torque the Allen head retention bolts to 20-22 ft-lbs.

⚠ WARNING

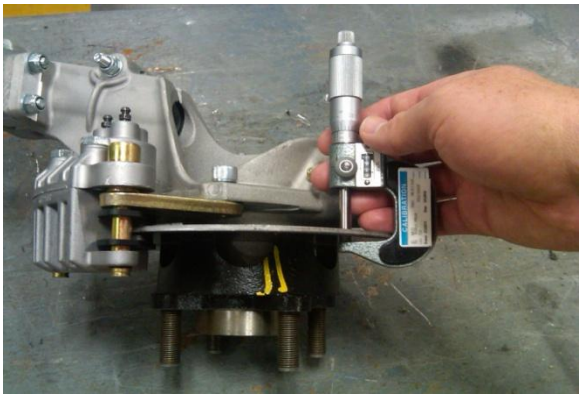
Never work on a vehicle supported by a jack alone. To prevent possible personal injury, the vehicle must be supported on jack stands during this procedure.



Brake Rotor Inspection

Front & Rear brake rotors should be inspected periodically as well as any time brake service work is performed.

1. Inspect the outer surface of the rotor for bluing, gouges, and other surface damage. Replace the rotor if damage is evident.



2. The standard thickness of the brake rotor is .150” +/- .005”. Replace the rotor if specs fall below this range.

3. The hub and rotor will have to be pressed out from this side of the strut if replacement is required. Always press from the center of the bearing hub.

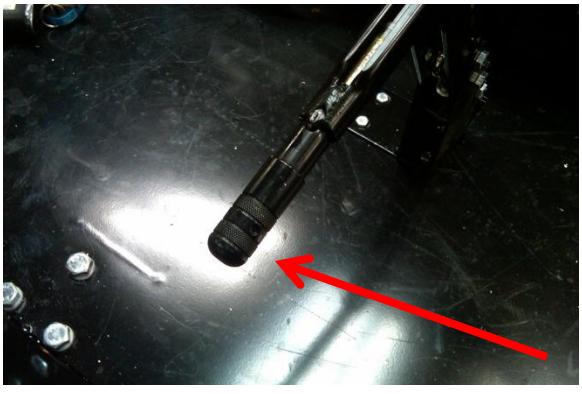
Warning: Do not attempt to turn rotors on a lathe in order to resurface. Replace the rotor.

Rear hub / rotor assembly – Follow the same inspection procedure as the front rotors.

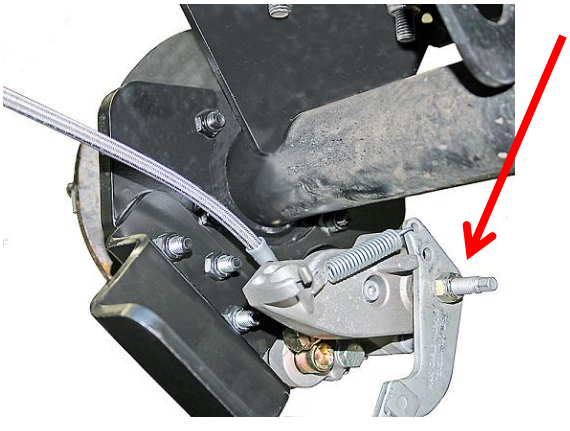
It’s a good idea to replace the hub bearing anytime the hub is pressed out.

Park Brake Adjustment

The park brake must be adjusted periodically or anytime brake service work is performed.



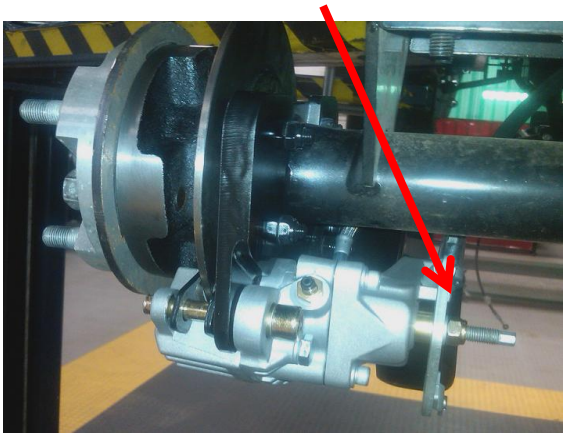
1. Lower the park brake lever to the down position. Rotate the adjuster counter clockwise to relieve cable tension.



3. Loosen the jam nut on the left side caliper adjuster. Turn the hex head adjustment screw in (clockwise) until the rear wheel brake begins drag – then lock.

5. Return park brake lever to the down position. Check for brake drag at the rear wheels. Make final adjustment at the lever know by turning clockwise to give proper cable tension.

2. Raise the park brake lever to the upright (engaged) position.



4.Repeat the procedure on the right side caliper. Tighten both jam nuts when adjusters are set.

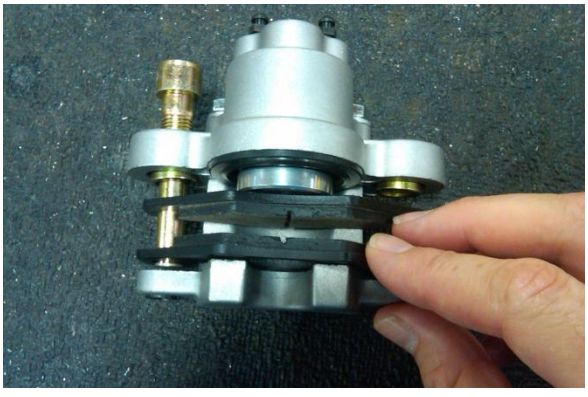
Brake System – Adjustment

Make certain that the park brake does not drag when the lever is in the down position!

Hydraulic Brake Tech Tips

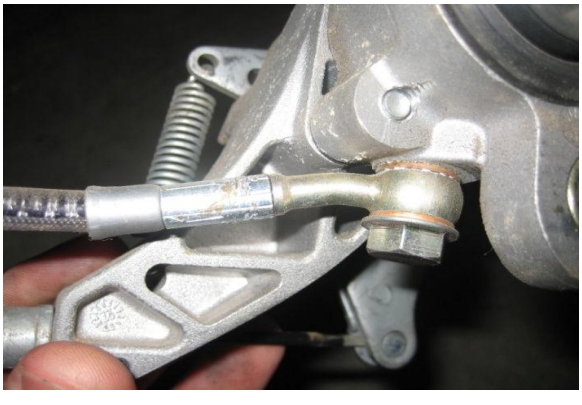
Brake Drag:

1. Inspect the brake pedal actuator rod to ensure pressure is not being applied to the master cylinder.



2. Inspect the calipers for stuck pistons. Replace if necessary

3. Verify park brake adjustment procedure.



Brake fluid leaks:

1. Inspect for leakage around banjo fitting crush washers. Replace if necessary.

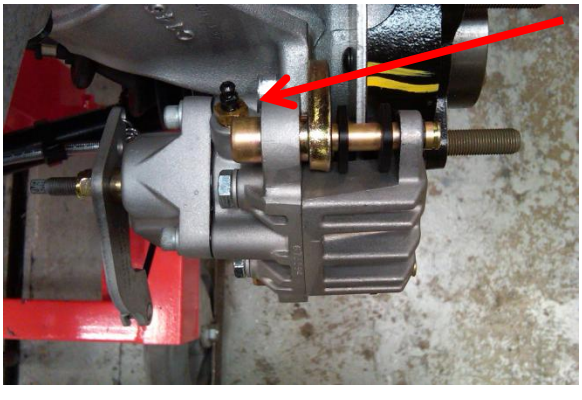
2. Never reuse crush washers. Check bleeder valves for leakage too.

Bleeding the Brake System:

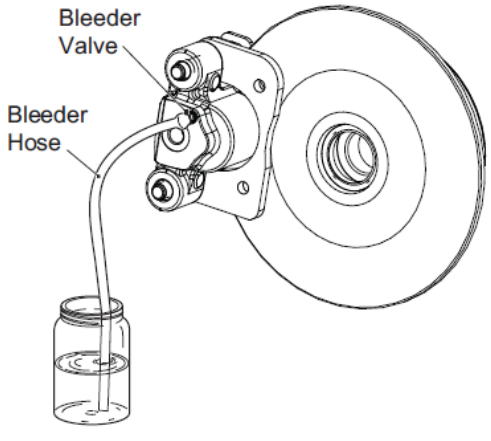
The brake system must be bled anytime the brake lines are removed or leakage is evident. Air in the brake system will result in a “low” brake pedal or a “spongy” brake pedal feel.

1. Verify that the master cylinder is filled with clean / fresh DOT 3 brake fluid.

2. Pump the brake pedal several times in order to build pressure. Have an assistant hold the pedal down.



3. Access the bleeder screws on each caliper. Start with the right rear. Open the bleeder screw to allow air to escape. Use a container to capture lost fluid.



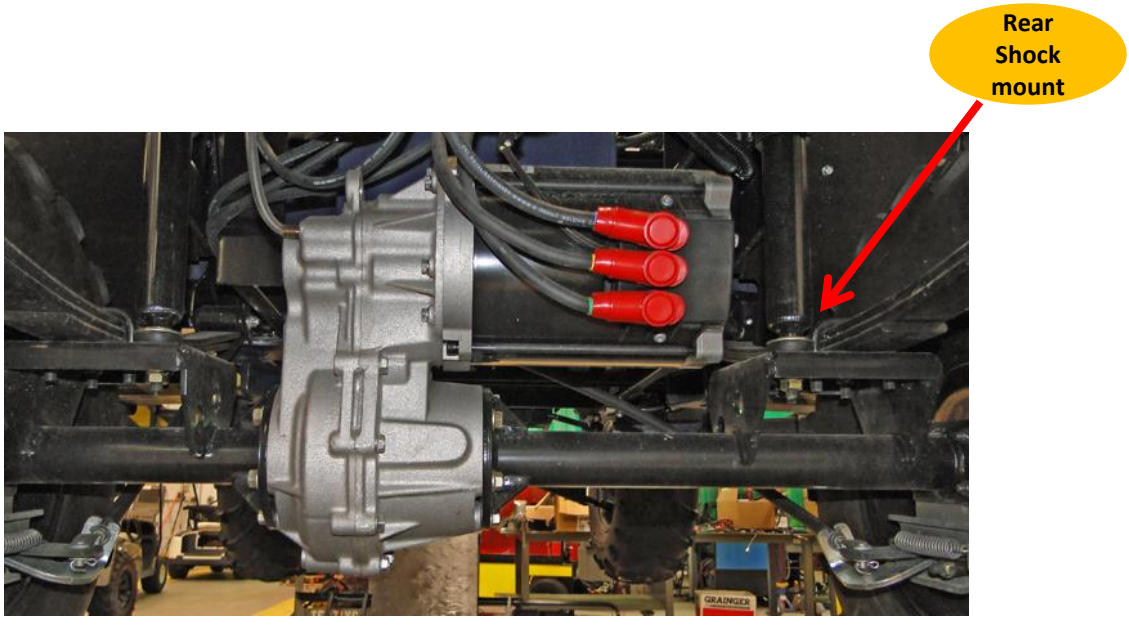
4. Do not release the brake pedal while the bleeder screw is open. Close the bleeder screw then release the pedal. This procedure may require several tries per caliper. Proceed to left rear then right front. The left front caliper should be the last one bled.

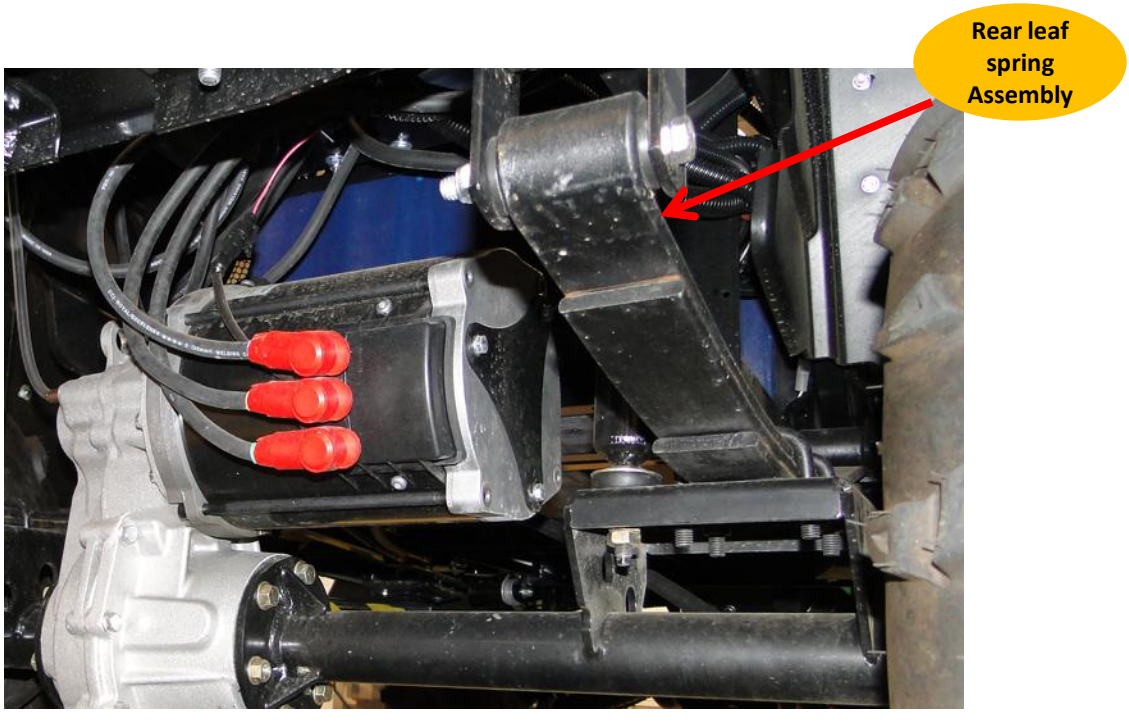
Rear Suspension

Notes:

Recoil Rear Suspension Inspection

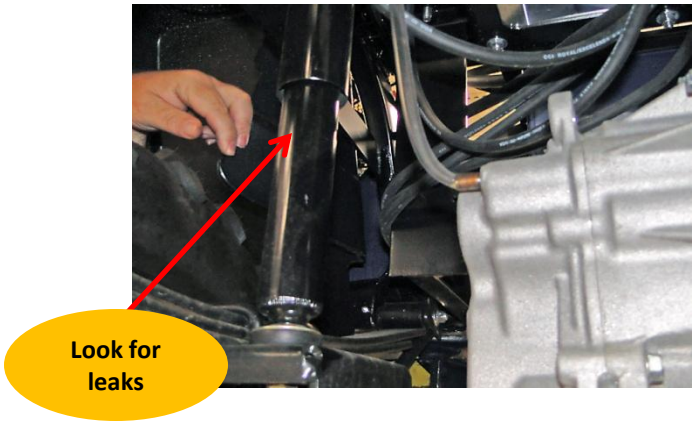
The Bad Boy Recoil model uses an open style Team differential mounted to leaf spring suspension on the rear of the vehicle. Regular inspection of bolts and hardware is required.



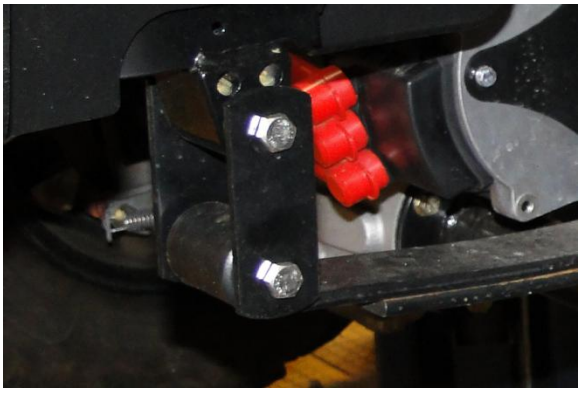


Rear Suspension

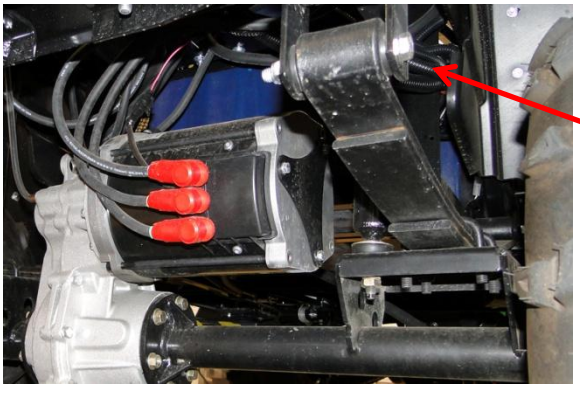
Rear Suspension Inspection:



1. Inspect both rear shock absorbers for oil leakage or other damage. Replace if shock studs appear bent or oil leakage is evident.



2. Inspect both rear shackles for correct and equal angularity. Unequal angularity may indicate a weak spring or bent frame. Use anti-seize lubricant when replacing rear shackle bushings to prevent noise and wear.



3. Inspect both front spring eyelets. Check for hardware placement and noise.

Differential Service - Front

Always follow proper lifting procedures!

1. Lift the Buggy from the front and chock the rear tires. Use jack stands to help support.

2. Locate the differential drain plug toward the bottom of the differential gear case. It can be best accessed from behind the front differential. The plug is located between the case and the differential mounting plate.

3. Modify a 5/16" Allen wrench to gain access to the drain plug. This can be accomplished by cutting off the wrench and leaving approximately 5/8" to engage the plug hex opening.

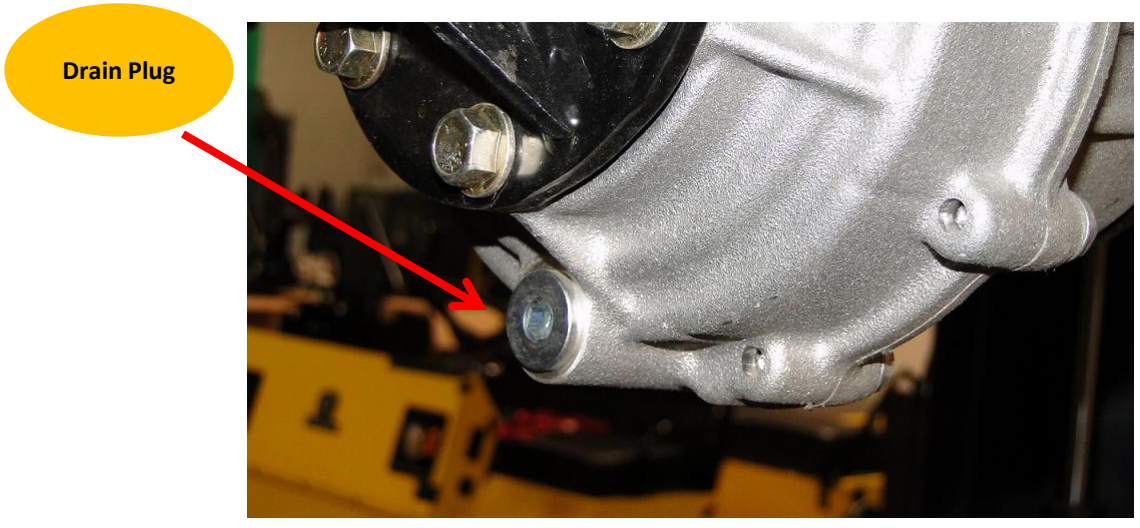
4. Remove the drain plug and allow all fluid to drain. Replace the plug after draining is complete.

5. Refill the differential assembly with high quality 90 wt gear oil. A funnel and hose will aid oil filling.

Differential Service - Rear

The correct differential fluid used in the Recoil axle assembly is 90 wt gear oil. The capacity is 13.8 ounces. Follow the procedure below to replace the differential fluid:

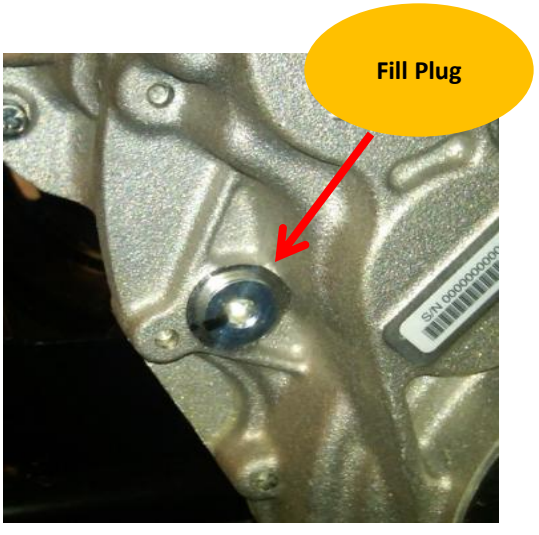
1. Lift the Buggy from the front and chock the rear tires. Use jack stands to help support.



2. Locate the differential drain plug toward the bottom of the differential gear case. It can be best accessed from behind the front differential. The plug is located between the case and the differential mounting plate.

3. Remove the drain plug and allow all fluid to drain. Replace the plug after draining is complete.

4. Refill the differential assembly with high quality 90 wt gear oil. A funnel and hose will aid oil filling.



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