Trouble Shooting

The first part: Electronic parts and Machinery parts

Electronic parts

1. The car can not move

A1.Check the main contactor if it connected
Reason: The power is too strong make main contactor touching points been stock by ash and duty.
Solution: Use the grinding machine make flat for the contactor point or replace the main contactor.

A2 Check the fuse of 200A or 15A if melt.
Reason: Power is too strong.
Solution: If they are defective, replace it.

A3:Check the cable plug of the controller output point if it has brake, loose or short circuit.
Reason: Shaking when the car move can cause it.
Solution: Plug in again these loosing cable plug

A4:Check the cable of the battery and motor if any broken, loosing and short circuit.
Reason: Shaking when the car move can cause it.
Solution: Plug in again these loosing cable

A5: Check the micro-switch inside of charger if no information show on the indicator, see if the switch has problem like short circuit
Reason: Shaking when the car move can cause it.
Solution: Plug in again or replace the part.

A6: Check if the voltage been output normally from accelerator sensor, see if the cable loosing or short-circuit
Reason: Quality defective of the components
Solution: Replace the good one.

A7: Check the micro-switch cable plug see if the any short circuit
Reason: Shaking when the car move can cause it.

Solution: Replace the micro-switch

A8: Checking motor inside parts if contact the surface making the short circuit.
Reason: Out cable system defective or the motor quality defective.
Solution: Replace the motor

A9: Check the key switch and forward, reverse switch if works.
Reason: Component has quality issue
Solution: Replace the new one.

A10: Check the key switch and forward, reverse switch if any loosing or short circuit.
Reason: Shaking when the car move can cause it.
Solution: Replace the plug.

A11: The power indicator show still have 20% remain and car can not move
Reason: Controller motivate the function for protecting the battery over output.
Solution: Re-Charging

A12: Controller defective
Please refer the controller instruction part.

2. Car move and stop sometime.
B1: Check the main contactor plug point if any loosing or short circuit
Reason: Shaking when the car move can cause it
Solution: Replace the defective plug

B2: Check the controller output plug point if any loosing or short circuit
Reason: Shaking when the car move can cause it
Solution: Re-plug in the problem cable

B3: Check the accelerator sensor and micro-switch have loosing or short circuit
Reason: Shaking when the car move can cause it
Solution: Replace the defective plug or micro-switch

B4: Check the voltage in accelerator sensor if it is normal
Reason: Component has quality issue
Solution: Replace the accelerator sensor

3. Car has abnormal slow speed level and hard to speed up
C1: Check the battery voltage and power if it is normal
Reason: Over using time for battery after one time charging
Solution: Re-charging

C2: Check the fully speed can reach 100%,(use the program test)

Reason: The ground situation can cause it
Solution: Use the program re-set accelerator signal

C3: Check the speed up rate if can reach the 45%
Reason: Controller “C” plug and cable loosing or short circuit
Solution: Re-plug in and re-set the accelerator signal with the program

C4: Check the motor brush if defective
Reason: The motor is DC power and the brush will damage when time lasting
Solution: Replace the brush

C5: Over shaking when the car moving
Reason:: The signal of the accelerator is not standard
Solution: Re-set the signal with pragramma

C6: Controller problem
Please refer the controller instruction

4. The reverse beep not work
D1: Check the beep
Reason: Component has quality issue
Solution: Replace it

D2: Check the plug cable if any loosing and short circuit
Reason: Shaking when the car move and can cause it
Solution: Re-plug in or replace the plug

5. The horn is not works
E1: Check the horn
Reason: water come inside and the parts defective
Solution: Change the switch of the horn

E2: Check the plug cable of the horn switch
Reason: Shaking when the car move can cause it
Solution: Replace the plug

E3: Check the horn
Reason: Component has quality issue
Solution: Replace the horn

6. The light kits not work
F1: Check DCDC convener 15A fuse if melt
Reason: Some special period when the car move the power over 15A.
Solution: Replace the 15A fuse.

F2: Check the input side of the DCDC if can reach 48V and the output side can reach 12V
Reason: Electronic parts defective and components has quality issue.
Solution: Replace the DCDC conventer

F3: Checking the DCDC loosing or short circuit
Reason: Shaking when the car move can cause it.
Solution: Replace the defective plug

F4: Check the light kits
Reason: Components has quality issue or defective
Solution: Replace the light kits

F5: Check all switch of the light kits system
Reason: Components defective
Solution: Replace theses defective parts.

F6: Check all light kits switch if any loosing or short circuit
Reason: Shaking when the car move can cause it
Solution: Change the defective plug

F7: Check the voltage of the battery
Reason: Over lasting use cause the battery voltage too low
Solution: Re-charging

7. Charger defective
G1: The green lights flashing
Reason: AC power doesn't go through
Solution: Connect the AC power

G2: The red light flashing
Reason 1: Battery dead
Solution: Change the battery
Reason 2: Dig-board of charger defective
Solution: Replace the board

G3: Can not charging
Reason 1: Battery board stick has short circuit problem
Solution: Clean the duty area
Reason 2: Connection cable of the battery and output cable is wrong
Solution: Correct the cable connection
Reason 3: Dig-board has defective
Solution: Replace the board

G4: Charging power is too small
Reason 1: Battery dead
Solution: Replace the battery
Reason 2: AC power lower than 198V
Solution: Replace the power
Reason 3: Capacitor of the charge defective
Solution: Replace the capacitor

G5: Charger green light flashing without AC power
Reason: Fully charged and cut off AC power automatically, the device in the cutting off position
Solution: Take off AC power and plug in again

G6: Over-voltage switch can not return back to normal, machine been protected position
Reason 1: Wrong connection of the battery cable
Solution: Corrected the cable connected
Reason 2: Switch defective
Solution: Replace it

G7: Red light flashing
Reason 1: Dig-board of the battery has short circuit
Solution: Replace the battery
Reason 2: Dig-board has problem of the charger
Solution: Replace the dig-board

Machinery parts

1. Tire damage

A1. Front tires distance is not correct
Solution: Put the car at the flat ground, measure the distance of the two tires and make the marks.. Then move the car to half tire circle and marks again the distance. The result should be the rear tire distance always should been 2mm wider than the front one.

A2. The degree of the tire and ground is not right.
Solution: On the flat ground it should be the 1 to 2 degree of the tire to ground in free loading situation. It can been adjusted of the suspension cover.

A3. The front tire air pressure is not correct
Solution: Adjust it.

A4. Front axle has damaged by hit and spare parts not works normally.
Solution: Replace the damaged the parts.

2. Brake not works

B1. Free way of the brake paddle is too long

Solution: Use hand press the paddle till feel force. The normal free way distance should be 25-30mm, it can been adjusted by brake screw adjusted.

B2. Damage of the brake shoes and too much space between brake drump and brake shoes.
Solution: Loose the brake paddle screw and make the brake shoes not contact the brake drump but can run freely. The distance between two should be 0.05mm. Then make the adjust of the free way. If the brake shoes damage too much it need be replaced.

B3.Brake shoes defective.
Solution: Replace the brake shoes.

B5. The ash come into the brake cable.
Solution: Clean or replace the cable.

B6. Tire texture damaged
Solution: Replace the tire.

3. Parking not normal or the parking paddle can not return
C1. The brake stick of the screw is not adjusted to right position
Solution: Loose the screw of the brake cable and press down the paddle till the distance between of hooks and paddle is 3mm,then adjust the free way. Test the hooks for every stages can return and lock.

C2. The brake paddle screw loosing or spring loosing.
Solution: Tight the loosing screw.

C3. The rubber cover of the hooks has duty inside
Solution: Make it clean.

C4. Too tight of the parking screw.
Solution: Loose it.

C5. Accelerator screw is not in right position
Solution: Reset up the position.

C6. Hooks and paddle is damaged
Solution: Replace them.

Noise
Phenomena I. Noise when steering
1.Gear clearance is too big
Solution: Adjust the gear clearance of steering, about 1mm
2.Knuckle short
Solution: replace it with a new one

3.Screw in the arm become flexible
Solution: screw down it.
4.Nut in the universal become flexible
Solution: Screw down the nut
5.The cross spindle of gambol become flexible
Solution: replace it
6.The nut between the gambol and gear fray badly
Solution: replace the cross spindle
8. Column up and down cover fray, the clearance of column steering is a little big
Solution: Replace the Column holder cover
8.Column steering fray
Solution: replace the column steering

Phenomena II. noise when driving

1. The noise because of the cushion cover fray---there is noise when the car start, accelerate and decelerate, at this time, the car has an abvious push toward front.

Solution: Replace the cushion cover

2. The noise from the motor---the noise from the motor when driving which caused by motor circle or frayed axletree

Solution:
Replace the axletree or motor

3. The noise from the friction between the fender and brake drum----The noise from the rear tyre when driving and brake the pedal. Because the circle of brake drum is not in the same line.

Solution: Replace the brake drum
4.The noise from suspension---caused by the frayed cushion cover
Solution: Replace the cushion cover
5.The noise from the front tyre---- the wheel hub was distort
Solution: Replace the distorted components, recheck it
6.The noise from windshield retainer---The noise from the friction between the retainer and windshield
Solution: deal with the interface between them
7.The noise from the cover of brake pedal, accelerator ----It is caused by the unclean interface between the cover and body ,or the cover is used too long and frayed
Solution: deal with the interface between the cushion cover and body or replace the frayed cushion cover.
8.The noise from windshield support----It is caused by flexible nut
Solution: Screw down the nut of support
9.The noise from the rear support of proof---It is caused by the flexible nut when driving
Solution: Screw down the flexible nut
10.The noise from caddie plate and other component----It is mostly caused by the flexible nut
Solution: Screw down the nut

The Second Part: Common sense of battery maintenance

Battery is an easy-damaged components which need maintenance usually. Make proper maintainer will make the battery last long. It contains charging, adding water, keeping testing etc.
Tools when maintain: Charger. Densimeter, thermometer, cleaner, affusion, carbonated water, goggle, glove, safe shoe, especial clothe to protect from the acid.

I. Charge

Warning: It will blew out volatile gas when charging. Please obey the safe regulation:

1. Wear with the goggle and veil
2. Keep the battery away from the sparkle
3. Clear up the anode and cathode
4. Clean up the connection pole
5. Please cut off the power or turn off the charger before assembly or disassembly the clamp
6. Pay attention on the pole. Be careful when connect the clamp to the connection pole.
7. Make sure the vent is in the proper place.
8. Make sure the working area are drafty
9. Don't charge to the frozen battery. Charge after the degree come back to 15.5 °
10. Don't charge to the dry battery
11. For lead-acid battery, the degree must be below 48.9 °。Cool the battery when the degree arrives this number

Attention: The new battery can reach the best storage after a few periods(5-150weeks)

Charging balance: It is an operator that after fully charge to the lead-acid battery and charge exclusively to the battery. It can protect from stratification and **salication**(Stratification and salication can shorten battery life).So if fully charged, the proportion of electrolyte is too low or the discrepancy of proportion is above 0.15,it should be **charging balance.**

Operation Step:

1. Make sure the battery is lead-acid battery
2. Cut off the cable which is connected to the car.
3. Connect the charger to the battery
4. Adjust the charger to the **balance mode**
5. Charging
6. The gas comes out from the battery and mass of air bladder
7. Test the proportion per hour
8. It is finished if the proportion don't arise in the moment of emitting

II. Add water

If the height of electrolyte descend, Add water after charging is nearly finished or completely finished. Make sure the height of electrolyte is above pole plate. As part of the plate exposed to the salinity and permanent loss of activity. Battery water, liquid discharge port in the following 1 / 8 inches, not below the top plate. If the electrolyte plate surface is below the surface, in charge before the adequate water to surface pole plate.

Warning: Forbid to add the acid to the battery, Only the special distilled water.

III.Keeping

Deep cycle batteries should be stored in a cool, dry place and before keeping, battery must be fully charged, clean and dry .The proportion of the electrolyte should be tested in a certain period. when the battery storage capacity is less than 70% (ratio below 1.22) When the temperature is below 20 degrees Fahrenheit (-7 degrees Celsius), the electrolyte will be frozen. To prevent frozen damage Do not to let the battery discharge or custody of the severe temperature is under 7 degrees Celsius. Long preserved if not to boost battery recharging, the grid will be accelerated corrosion, and the grid line formation and activity of non-conductive material between the boundaries

IIII. Testing

1. **Eyeballing and Clean**: Check whether the battery is loose, whether the post incorrosion, whether the battery box or cover is leakage. If battery can not be repaired, Please replace the battery. If the posts is corrosion or the battery bay is rusty or the battery is dirty, please clean up. The cable brush can clean the dusty, corrosion, coatings. Dipping the carbonated water or ammonia with cloth to clean up the dust in the top of battery and make it dry. After clean up the coating in the interface, Make it clean with water and with anti-acid painting
2. **Testing the proportion and voltage:** The storage can be test by the proportion and
3. voltage. Below is proportion and voltage in different situation, the centigrade is 80 Fahrenheit(26.7 Celsius)

STATE	PROPORTION (80 Fahrenheit)	VOLTAGE		
		6battery	8v battery	12v battery
100%	1.277	6.37	8.49	12.73
90%	1.258	6.31	8.41	12.62
80%	1.238	6.25	8.33	12.50
70%	1.217	6.19	8.25	12.37
60%	1.195	6.12	8.16	12.24
50%	1.172	6.05	8.07	12.10
40%	1.148	5.98	7.97	11.96
30%	1.124	5.91	7.88	11.81
20%	1.098	5.83	7.77	11.66
10%	1.073	5.75	7.67	11.51

A. Step of testing the proportion

1. Don’t test the proportion immediately after adding the water
2. Test the temperature by thermometer and write down the temperature
3. Suct the electrolyte into the dens meter, then let them out. Remake it 2-4 times to make the dens meter temperature and electrolyte temperature same
4. Suct the enough electrolyte to push the buoyage of dens meter
5. Read and write down the value then pour into the battery box
6. Test the proportion of every battery box according to the step above
7. Close the cover of the vent, and wipe the electrolyte
8. Adjust the reading to 80 Fahrenheit (26.7 celsius).The method is as below:
   a. Add the reading 0.04 once the degree rise 10 Fahrenheit
   b. Reduce the reading 0.04 once the degree reduce 10 Fahrenheit

Check the charging state according the form above. The reading should be during 1.277+/-0.007,If below that, please check the voltage of battery, and recheck it after balance charge and test the

proportion again. If the proportion is still low, it is possible to come out the situation below:

i. The battery is aging and close to the end
ii. The battery is in the sate of discharging and last too long
iii. The electrolyte leak
iv. The battery box is damaged
v. Add too much water before testing

Change the new battery or send it to the specialist if there are some situation above

B. Test the voltage

In order to get the correct voltage, the battery must be closed at least 6 hours

1) Cut off the battery and the connection cable of the battery
2) Test the volt with volt d.c
3) Estimate the charging state compare with the form above
4) If the value show the state is below 70%,charge the battery

The third part：Battery Solution

1. The battery can be discharged when the power is cut off?

All the battery, no matter what chemical character have the auto-discharge phenomena. The ratio is decided by the type, place and temperature.

2. Can the battery be frozen?

The electrolyte will be frozen when the battery is in the moment of partly discharge. Auto-discharge is above 40%,the temperature is below-14.4 Celsuis, the battery will be frozen; The frozen temperature is -68.8 Celsius when fully charged

3. What is the common fault for battery user

Unfully charge: Generally, don't fully charge again after using out the battery. Continuous unfully charge or stock without full charge will cause the salty. It will reduce the life of battery and cause completely damage to the battery also come out the stratification

Exclusively discharge: Continuous charge will accelerate the corrosion of anode plate and consume of water

Lack of water: The water in the battery will lost when use the battery, if the electrolyte is below the bottom of the plate, it will cause completely damaged, so the height of electrolyte should be check it usually.

Excessive water: Add too much water will cause the leak of electrolyte and affect the function of battery. Meanwhile, The electrolyte will still leak before charging

4. The battery can be used out before recharging the battery.

When the storage of battery is below 80% of rated storage, battery should be charged

5. How is the temperature affect the function of the battery?

High temperature,(25 Celsuis)The storage capacity will increase, but will shorten the battery life. High temperature will increase the auto-discharge. Low temperature (Below 25 Celsuis) will reduce the storage of battery but make the life of battery long. Low temperature will reduce the auto-discharge. So use the battery about 25 Celsuis, will get a better battery function and life.

6. How does the temperature affect the proportion of the electrolyte?

The temperature rise, the volume of electrolyte expand; the temperature fall down, the volume

of electrolyte shrink. So the temperature must be adjusted once testing the proportion

7. How does the temperature affect the voltage?

The temperature rise, the voltage fall down; the temperature fall down, the voltage rise

8. How is the limit of the highest temperature when charging?

The temperature can not be above 48.9 Celsuis when charging the lead-acid battery. When the temperature reach the value, the battery should be cooled down.

The four part: Battery Lang

1. **Ampere hour:** The parameter to scale the storage of battery, Ampere hour=I*H
2. **Battery cell:** The based chemical cell to cause the current: One 8 v lead-acid battery has four battery cells, One 6v lead-acid battery has three battery cells
3. **Circular:** One discharge and one charge make of a circular
4. **Discharge:** The battery export the energy
5. **Electrolyte:** In lead-acid battery, the electrolyte is vitriol
6. **Dens meter:** A tool to test the proportion of electrolyte
7. **Proportion of battery:** The ration of vitriol and water with same volume
8. **Charging state:** The energy stocked in the battery. Express it in the percentage of fully charge
9. **LEU:** Kwh
10. **Capacity:** Discharge time(the temperature is 80 Fahrenheit) keep the battery cell above the 1.75v
11. **5 hours ampere hour:** Adopt IEC standard, the value in 86 Fahrenheit(26.7 Celsuis)
12. **20 hours ampere hour:** Ratio recognized by BCI, means in 80 Fahrenheit (26.7 Celsuis),The total ampere hour when the battery discharge to the end of battery cell—1.75v.The parameter means the most capacity of battery.

The Fifths part: Battery

Inspection

There are many tools that may help in properly caring for and maintaining batteries. Below is a list of items that Trojan recommends for this task:

Recommend Equipment:

- Wrench
- Distilled Water
- Voltmeter
- Hydrometer
- Post Cleaner
- Baking Soda
- Vaseline
- Goggles & Gloves

CAUTION: Always wear protective clothing, gloves, and goggles when handing batteries, electrolyte, and charging your battery.

Batteries should be carefully inspected on a regular basis in order to detect and correct potential problems before they can do harm. It is a great idea start this routine when the batteries are first received.

Inspection Guidelines:

1. Examine the outside appearance of the battery.
   - Look for cracks in the container.

- ·The top of the battery, posts, and connections should be clean, free of dirt, fluids, and corrosion. If batteries are dirty, refer to the cleaning section for the proper cleaning procedure.
- · Repair or replace any damaged batteries.

2. Any fluids on or around the battery may be an indication that electrolyte is spilling, leaching, or leaking out.
   - · Leaking batteries must be repaired or replaced.
3. Check all battery cables and their connections.
   - · Look closely for loose or damaged parts.
   - · Battery cables should be intact; broken or frayed cables can be extremely hazardous.
   - · Replace any cable that looks suspicious.
4. Tighten all wiring connections to the proper specification (see below). Make certain there is good contact with the terminals.

Proper Torque Values for connection Hardware:

Flooded	Automotive 50-70 in-lbs
	Wingnut 95-105 in-lbs
	LPT 95-105 in-lbs
	Stud 120-180 in-lbs
	LT 100-120 in-lbs
VRLA	Button 90 to 100 in-lbs
	LT 100-120 in lbs

WARNING: Do not overtighten terminals. Doing so can result in post breakage, post meltdown, or fire.

Testing

Visual inspection alone is not sufficient to determine the overall health of the battery. Both open-circuit voltage and specific gravity readings can give a good indication of Battery's charge level, age, and health. Routine voltage and gravity checks will not only show the state of charge but also help spot signs of improper care, such as undercharging and over-watering, and possibly even locate a bad or weak battery, The following steps how to properly perform routine voltage and specific gravity testing on batteries.

I. Specific Gravity Test

(Flooded batteries only)

1. Do not add water at this time.
2. Fill and drain the hydrometer 2 to 4 times before pulling out a sample.
3. There should be enough sample electrolyte in the hydrometer to completely support the float.
4. Take a reading, record it, and return the electrolyte back to the cell.
5. To check another cell, repeat the 3 steps above.
6. Check all cells in the battery.

7. Replace the vent caps and wipe off and electrolyte that might have been spilled.
8. Correct the reading to 80 ° F:
   - Add .004 to readings for every 10 ° above 80 ° F
   - Subtract .004 for every 10 ° below 80 ° F
9. Compare the readings.
10. Check the state of charge using Table 1.

    The readings should be at or above the factory specification of 1.277 ± .007. If any specific gravity readings register low, then follow the steps below.

    1. Check and record voltage level(s).
    2. Put battery(s) on a complete charge.
    3. Take specific gravity reading again.

    If any specific gravity readings still register low then follow the steps below.

    1. Check voltage level(s).
    2. Perform equalization charge. Refer to the Equalizing section for the proper procedure.
    3. Take specific gravity readings again.

    If any specific gravity reading still registers lower than the factory specification of 1.277 ± .007 then one or more of the following conditions may exist:

    1. The battery is old and approaching the end of its life.
    2. The battery was left in a state of discharge too long.
    3. Electrolyte was lost due to spillage or overflow.
    4. A weak or bad cell is developing.
    5. Battery was watered excessively previous to testing.

    Batteries in conditions 1-4 should be taken to a specialist for further evaluaion or retired from service.

    II. Open-Circuit Voltage Test

    For accurate voltage readings, batteries must remain idle(no charging, no discharging) for at least 6 hrs, preferably 24 hrs.

    1. Disconnect all loads from the batteries.
    2. Measure the voltage using a DC voltmeter.
    3. Check the state of charge with Table 1.
    4. Charge the battery if it registers 0% to 70% charged.

Batteries in these conditions should be taken to a specialist for further evaluation or retired from service.

TABLE 1. State of charge as related to specific gravity and open circuit voltage

	Specific Gravity	Open-Circuit Voltage					
Percentage Of charge	Corrected to 80 ° F	6V	8V	12V	24V	36V	48V
100	1.277	6.37	8.49	12.73	25.46	38.20	50.93
90	1.258	6.31	8.41	12.62	25.24	37.85	50.47
80	1.238	6.25	8.33	12.5	25.00	37.49	49.99

70	1.217	6.19	8.25	12.37	24.74	37.12	49.99
60	1.195	6.12	8.16	12.24	24.48	36.72	48.96
50	1.172	6.05	8.07	12.10	24.20	36.31	48.41
40	1.148	5.98	7.97	11.96	23.92	35.87	47.83
30	1.124	5.91	7.88	11.81	23.63	35.44	47.26
20	1.098	5.83	7.77	11.66	23.32	34.97	46.63
10	1.073	5.75	7.67	11.51	23.02	34.52	46.03

Watering

(Flooded batteries only)

Flooded batteries need water. More importantly, watering must bee done at the right time and in the right amount or else the batter's performance and longevity suffers.

Water should always be added after fully charging the battery, Prior to charging, there should be enough water to cover the plates., If the battery has been discharged (partially or fully), the water level should also be above the plates. Keeping the water at the correct level after a full charge will prevent having to worry about the water level at a different state of charge.

Depending on the local climate, charging methods, application, etc. Trojan recommends that batteries be checked once a month until you get a feel for how thirsty your batteries are.

Important things to remember:

1. Do not let the plates get exposed to air. This will damage(corrode) the plates.
2. Do not fill the water level in the filling well to the cap. This most likely will cause the battery to overflow acid, consequently losing capacity and causing a corrosive mess.
3. Do not use water with a high mineral content. Use distilled or deionized water only.

CAUTION: The electrolyte is a solution of acid and water so skin contact should be avoided.

Step by step watering procedure:

1. Open the vent caps and look inside the fill wells.
2. Check electrolyte level; the minimum level is at the top of the plates.
3. If necessary add just enough water to cover the plates at this time.
4. Put batteries on a complete charge before adding any additional water (refer to the charging section).
5. Once charging is completed, open the vent caps and look inside the fill wells.
6. Add water until the electrolyte level is 1/8 " below the bottom of the fill well.
7. A piece of rubber can be used safely as a dipstick to help determine this level.
8. Clean, replace, and tighten all vent caps. <

WARNING: Never add acid to battery.

Cleaning

Batteries seem to attract dust, dirt, and grime. Keeping them clean will help one spot trouble signs if they appear and avoid problems associated with grime.

1. Check that all vent caps are tightly in place.
2. Clean that battery top with a cloth or brush and a solution of baking soda and water.

・When cleaning, do not allow any cleaning solution, or other foreign matter to get inside the battery.

3. Rinse with water and dry with a clean cloth.

3.Rinse with water and dry with a clean cloth.

4. Clean battery terminals and the inside of cable clamps using a post and clamp cleaner.

・Clean terminals will have a bright metallic shine.

5. Reconnect the clamps to the terminals and thinly coat them with petroleum jelly (Vaseline) to prevent corrosion.
6. Keep the area around batteries clean and dry.

Storage

Periods of inactivity can be extremely harmful to lead acid batteries. When placing a battery into storage, follow the recommendations below to insure that the battery remains healthy and ready for use.

NOTE: Storing, charging or operating batteries on concrete is perfectly OK.

1. Freezing. Avoid locations where freezing temperature is expected. Keeping battery at a high state of charge will also prevent freezing. Freezing results in irreparable damage to a battery's plates and container.

Heat. Avoid direct exposure to heat sources, such as radiators or space heaters. Temperatures above 80 °F accelerate the battery's self-discharge characteristics.

Step by step storage procedure:

1. Completely charge the battery before storing.
2. Store the battery in a cool, dry location, protected from the elements.
3. During storage, monitor the specification gravity (flooded) or voltage. Batteries in storage should be given a boost charge when they show a 70% charge or less. See Table 1 in the Testing section.
4. Completely charge the battery before re-activating.
5. For optimum performance, equalize the batteries(flooded) before putting them back into service. Refer to the Equalizing section for this procedure.

The Sixth part: Charger selection

Most deep cycle applications have some sort of charging system already installed for battery charging (e.g. solar panels, inverter, golf car charger, alternator, etc.). charge must be selected. The following will help in making a proper selection.

There are many types of chargers available today. They are usually rated by their start rate, the rate in amperes that the charger will supply at the beginning of the charge cycle. When selecting a charger, the charge rate should be between 10% and 13% of the battery's 20-hour AH capacity. For example, a battery with a 20-hour capacity rating of 225 AH will use a charger rated between approximately 23 and 30 amps (for multiple battery charging use the AH rating of the entire bank). Chargers with lower ratings can be used the charging time will be increased.
Trojan recommends using a 3-stage charger. Also called "automatic", "smart" or "IEI" chargers, these chargers prolong battery life with their well programmed charging profile. These chargers usually have three distinct charging stages: bulk, acceptance, and float.

Charging

Charging batteries properly requires administering the right amount of current at the right voltage. Most charging equipment automatically regulates these values. Some chargers allow the user to set these values. Both automatic and manual equipment can pre

present difficulties in charging. Tables 2 & 3 list most of the necessary voltage setting one might need to program a charger. In either case the original instructions for your charging equipment should also be referenced for proper charging. Here is list of helpful items to remember when charging.

1. Become familiar with and follow the instructions issued by the charger manufacture.
2. Batteries should be charged after each period of use.
3. Lead acid batteries do not develop a memory and need not be fully discharged before recharging.
4. Charge only in well-ventilated area. Keep sparks or flames away from a charging battery.
5. Verify charger voltage setting are correct (Table 2).
6. Correct the charging voltage to compensate for temperatures above and below 80 ° F. (Add .28 volt per cell for every 10 ° below 80 ° F and subtract .028 volt per cell for every 10 ° above 80 ° F)

Table 2. charger voltage setting for Flooded Batteries

	System Voltage				
Charger voltage Setting	6V	12V	24V	36V	48V
Daily Charge	7.4	14.8	29.6	44.4	59.2
Float	6.6	13.2	26.4	39.6	52.8
Equalize	7.8	15.5	31.0	46.5	62.0

Table 3. Charger Voltage Settings for VRLA Batteries

Charger Voltage Setting	System Voltage			
	12V	24V	36V	48V

Daily Charge	13.8-14.1	27.6-28.2	41.4-42.3	55.2-56.4
Float	13.5	26.4	39.6	52.8

7. Check water level (see the Watering section).
8. Tighten all vent caps before charging.
9. Prevent overcharging the batteries. Overcharging causes excessive gassing (water breakdown), heat buildup, and battery aging.
10. Prevent undercharging the batteries. Undercharging causes stratification.
11. Do not charge a frozen battery.
12. Avoid charging at temperatures above 120 ° F.

Additional VRLA Charging Instructions:

1. Become familiar with and follow the instructions issued by the charger manufacture.
2. Verify charger has necessary VRLA setting.
3. Set charger to VRLA voltage settings (Table 3).
4. Do not overcharge VRLA batteries. Overcharging will dry out the electrolyte and damage battery.

WARNING: Do not equalize VRLA batteries.

Equalizing

(Flooded batteries only)

Equalizing is an overcharge performed on flooded lead acid batteries after they have been fully charged. It reverses the buildup of negative chemical effects like stratification, a condition where acid concentration is greater at the bottom of the battery than at the top. Equalizing also helps to remove sulfate crystals that might have built up on the plates. If left unchecked, this condition, called sulfation, will reduce the overall capacity of the battery.

Many experts recommend that batteries be equalized periodically, ranging anywhere from once a month to once or twice per year. However, Trojan only recommends equalizing when low or wide ranging specific gravity (± .015) are detected after fully charging a battery.

Step by step Equalizing:

1. Verify the battery(s) are flooded type.
2. Remove all loads from the batteries.
3. Connect battery charger.
4. Set charger for the equalizing voltage (See Table 2 in the Charging section).
5. Start charging batteries.
6. Batteries will begin gassing and bubbling vigorously.
7. Take specific gravity readings every hour.
8. Equalization is complete when specific gravity values no longer rise during the gassing stage.

NOTE: Many chargers do not have an equalization setting so this procedure can’t be carried out.

Discharging

Discharging batteries is entirely a function of your particular application. However, below is list of helpful items:

1. Shallow discharges are recommended.
2. 50% (or less) discharges are recommended.
3. 80% discharges are recommended
4. Do not fully discharge flooded batteries(80% or more). This will damage (or kill) the battery.
5. Many experts recommend operating batteries only between the 50% to 85% of full charge range. A periodic equalization charge is a must when using this pratice.
6. Do not leave batteries deeply discharged from any length of time.
7. Lead acid batteries do not develop a memory and need not be fully discharged before recharging.
8. Batteries should be charged after each period of use.
9. Batteries that charge up but cannot support a load are most likely bad and should be tested. Refer to the Testing section of proper procedure.

10% Discharged

100	80	60	40	20	0
0	20	40	60	80	100

0% Charged

The seventh part: others

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LEGEND

B SW	=	Belly Switch
CM	=	Common Microswitches
CPOT	=	Wiper Potemtiometer
EMB	=	Electromechanical Brake
EV	=	Lowering Valve
FORW SW	=	Forward Switch
H&S	=	Hard & Soft
HORN	=	Horn
HORN SW	=	Horn Switch

LIFT SW	=	Lifting Switch
LOW SW	=	Lowering Switch
MC	=	Main Contactor
NEMB	=	Negative Electromechanical Brake
NEV	=	Negative Lowering Value
NHORN	=	Negative Horn
NMC	=	Negative Main Contractor
NPC	=	Negative Pump Contractor
NPOT	=	Negative Potentiometer
PC	=	Pump Contractor
PEMB	=	Positive Electromechanical Brake
PEV	=	Positive Lowering Valve
PHORN	=	Positive Horn
PMC	=	Positive Main Contactor
PPC	=	Positive Pump Contactor
PPOT	=	Positive Potentiometer
REV SW	=	Reverse Switch
SR1	=	Speed Reduction 1
SR2	=	Speed Reduction 2
T SW	=	Tiller Switch

COLOUR CODES (SINGLE COLOURS)

The following Codes represent the colours of individual wires used by Zapi (unless specified otherwise).

A - Orange	M - Brown
B - White	N - Black
BB - Blue	R - Pink
C - Sky Blue	RR - Red
G - Yellow	V - Green
GG - Grey	VV - Purple

1 INTERODUCTION TO THE ZAPI-MOS FAMILY

The ZAPIMOS chopper family represents ZAPI's answer to the needs of the 90's.

To ensure that products remain on the market, without running the risk of becoming technically obsolescent, the ZAPIMOS family offers the following features.

- Advanced technology
- Economical costs.
- Maximum safety.
- Maximum flexibility
- Open to future technical innovations.
- Optimum level of protection

The design has been derived from:

- High Frequency Mos Technology
- Real time control over the internal and external components that influence the behaviour of the machine, with self diagnosis of the checking circuits themselves.

- Stored Program Machine (SPC), where the hardware is completely separate from the functions to be configured . The programme is parametric and can easily be modified by the end user.
- Various chopper configurations can be selected by the user, without the need for hardware modifications.
- Future technological updates are made easy for the user.
  The communication protocol will continue to evolve, thereby offering increasing possibilities of interaction and expansion, For this reason, the Zapimos family offers a standard dialogue mode with external systems. This allows interfacing with
  Commercially available machines. Zapi can offer a range of individually designed Console Software with various features and prices.
- SEM-1C meets the requirements of (IP54). This provides excellent protection against spray (water, acid), and against the ingress of dust or small foreign particles.
  Access to the control logic is very simple, and allows simple substitution or replacement.
- The SEM-1C family of Choppers are suitable for operating on DC Voltages from 24 to 48v inclusive, with maximum armature current up to 300A.
  The choppers may be used to control DC Separately Excited Motors with power rating from 1.0KW to 3.5 KW.

2 GENERAL CHARACTERISTICS

2.1 THECHNICAL SPECIFICATION

Chopper for separately Excited DC motors	1.0÷ 3.5kw
Regenerative Braking.	
Voltage Range	24-36-48VDC
Maximum Field Current (all the versions)	35A
Armature Switching Frequency	16KHZ
Field Switching Frequency	1KHZ
Maximum Ambient temperature	+40 ° C
Minimum Ambient temperature	-30 ° C
Maximum temperature of Chopper	+80 ° C
Fleld resistance	0.3÷0.6 Ohm

VERSIONS	MAXIMUM CURRENT	BOOSTER CURRENT	VOLTAGE DROP IN FULL CONDUCTION
24V-36V	200A (3 ′)	220A (10 〝)	0.23V a 100A, 25 ° C
24V-36V	300A (2 ′)	330A (10 〝)	0.23V a 100A, 25 ° C
48V	180A (3 ′)	2000A (10 〝)	0.18V a 100A, 25 ° C

2.2 CONTROL UNITS

2.2.a Microswitches

- Microswitches should have a contact resistance lower than 0.1 ， and a leakage current lower

than 100 A.

- When full load current is being drawn, the voltage drop across the Key Switch contact must be lower than 0.1V.
- If and Electromagnetic Brake is used, the Handle microswitch must be able to operate the Brake Coil.
- The Microswitches send a voltage signal to the microprocessor when an operating request (running) is made.

2.2.b Potentiometer

The Potentiometer should be wired in the 3-Wire Configuration.
CPOT (B1) signal ranges from 0 to 10V.
Minimum Potentiometer Resistance: 500
Maximum Potentiometer Resistance: 10k
Faults can occur if the potentiometer is out of this range.

The Procedure for automatic potentiometer signal acquisition is carried out using the Console. This enables adjustment of the minimum and maximum useful signal level (PROGRAM VACC function), in either direction. This function is unique when it is necessary to compensate for asymmetry with the mechanical elements associated with the potentiometer, especially relating to the minimum level.

The two graphs show the output voltage from a non-calibrated potentiometer with respect to the mechanical “zero” of the control lever. MI and MA indicate the point where the direction switches close. 0 represents the mechanical zero of the rotation. The left Hand graph shows the relationship of the motor voltage without signal acquisition being made. The Right Hand Graph shows the same relationship after signal acquisition of the potentiometer.

2.3 SAFETY & PROTECTION FEATURES

- Connection Errors:
  All inputs are protected against connection errors.
- Thermal Protection:
  If the chopper temperature exceeds 70 ° C, the maximum current reduces in proportion to the thermal increase. The temperature can never exceed 80 ° C (below 10 ° C, the current is reduced to 80%).
- Low Battery Charge:
  When the battery charger is low, the maximum current is reduced proportionally to the battery discharge.
- Protection against accidental Start up:
  A precise sequence of operations are necessary before the machine will start. Operation cannot commence if these operations are not carried out correctly. Requests for drive, must be made after closing the key switch.
- Protection against uncontrolled movements:
  The line Contactor will not close if :
  - The Power Unit is not functioning.

-The Logic is not functioning perfectly.

- Main / Line Contactor:
  Should be fitted to give protection to the chopper against reverse battery polarity, and safety.
- External Agents:
  The chopper is protected against dust and the spray of liquid to degree of protection meeting IP54.

2.4 DIRECTION ORIENTATION

Machines fitted with Tillers, Belly Switches, and Pulse Control Systems providing rapid reversal should conform to the requirements of Directive prEN 1175. this Directive requires that Direction Orientation should match the following drawing:

2.5 OPERATIONAL FEATURES

- Speed Control.
- Optimum sensitivity at low speeds.
- Speed Reductions in both the directions. Levels can be set using Console.
- Regenerative Braking based on deceleration ramps, in every condition.
- Three different modes of Braking : Release Braking ,Inversion Braking, Speed Limit Braking.
- Speed Control during descent : the motor speed follows the accelerator. The chopper automatically brakes if the motor speed overcomes the accelerator set point. This provides optimum performance on a gradient.
- Starts on a Ramp without roll back, even without an electric brake.
- Programmable Anti Roll Back: When the key Switch is closed, if the motor is rotating, the chopper controls the speed and automatically brakes and keeps the motor at a very low speed during descent on a gradient. This is a very useful safety feature and is not driver dependent.
- Output for Hourmeter
- The main contactor is open after 45 seconds of stand-by condition.
- Self Diagnosis with indication of fault shown via flashing Red Led.(In addition to Console Display).
- Modification of the parameters via Digital Console. See the specific description.
- Internal Hour Meter that is displayed on the Console.
- Memory of the last 5 Alarms, with relative Hour meter count and chopper temperature all displayed on the Console.
- Test Function within Console for checking main parameters. See the specific description.
- High motor and battery efficiency due to High Frequency Switching.

2.6 SEM-1C CHOPPER DIAGNOSIS

The microprocessor continually monitors the chopper and carries out diagnostic procedures on the main functions.

The diagnosis is made in 4 points:

1) Diagnosis on Key Switch closing that checks: the Watch Dog Circuits, the current sensor, VMN point, Contactor Drivers, the switch sequence for operation is correct, and the output of the accelerator or tiller is correct.
2) Standby Diagnosis at rest that checks: VMN Point, Contactor Drivers, and Current Sensor.
3) Diagnosis during operation that checks: Watchdog, VMN Point, Current, Contactor(s), and

VMN when in full conduction.

4) Continuous Diagnosis that checks: Chopper temperature, Battery Voltage.
   Diagnosis is provide in 2 ways. The Red Led connected to Connector A will flash a certain number of times for a given Alarm (See Listings), or the Digital Console may be used. A permanent Alarm will be displayed on the Console immediately and the RED LED will flash. An intermittent Alarm will be recorded in the Alarm library, but the RED LED will only flash at the time of the Alarm.

2.7 THERMAL CONSIDERATIONS

- The heat generated by the power block must be dissipated. For this to be possible, the compartment must be ventilated and the heat sink materials ample.
- The heat sink material and system should be sized on the performance requirement of the machine. Abnormal ambient air temperatures should be considered. In situations where either ventilation is poor, or heat exchange is difficult, forced air ventilation should be used.
- The thermal energy dissipated by the power block module varies and is dependent on the current drawn and the duty cycle.

2.8 GENERAL INSTRUCTIONS AND PRECAUTIONS

- Never combine SCR low frequency choppers with SEM-C modules. The filter capacitors contained in SEM-1C module will change the SCR chopper operation and subject it to excessive workload. If it is necessary to use two or more control units (eg. Lift+ traction), the choppers must be of the High Frequency Zapi family.
- Do not connect the chopper to a battery with a different nominal voltage to the value indicated on the chopper. A higher battery voltage may cause MOS failure, and a lower voltage may prevent the logic operation.
- During battery recharge, the SEM-1C must be completely disconnected from the battery. As well as altering the charge current ready by the battery charger, the module can be damaged by higher than normal voltage supplied via the charger.
- The SEM-1C module should only be supplied by a traction battery. Do not use outputs of converters or power supplies. For special applications please contact the nearest Zapi service center.
- Start the machine the first time with the drive wheels(s) raised from the floor to ensure that any installation errors do not compromise safety.
- After operation, even with the Key Switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between Battery Positive and Battery negative power terminals of the chopper using a Resistor between 10 and 100 .
  Minimum 5 W.
- the susceptibility and electromagnetic emission levels are seriously influenced by installation conditions. Take particular care with the length of cables and wires, types of electrical connections, and braided/screened wires.
  Zapi declines any responsibility for incorrect or bad operation that can be attributed to the above circumstances. Above all, the manufacture of the machine must ensure that the requirements of EN 50081-2 are met.

3 INSTALLATION

Install the chopper baseplate onto a flat metallic surface that is clean and unpainted.

Apply a thin layer of thermo-conductive grease between the two surfaces to permit better heat dissipation.

Despite that protection provided against external agents, the continuous attack of corrosive elements and substances may cause oxidization of connector contacts, resulting in bad operation. Remember this point when deciding the installation position on the vehicle.

Fix the chopper using the special holes located on the baseplate.

Verify that the wiring of the cable terminals and connectors has been carried out correctly.

Ensure that suppression devices are fitted to the coils not protected by the SEM-1C itself.

3.1 CONNECTION CABLES

For the auxiliary circuits use cables better or equal to 0.5m m² section.

For power connections to the motor armature and battery use cable of 16m m² section.

For the field connections use cable of 4m m² section.

For the optimum chopper performance, the cables to the battery should be run side by side and be as short as possible.

3.2 CONNECTION CABLES

A Line Contactor, designed for Continuous Operation should be installed. This contactor should be fitted with a coil corresponding to the battery voltage. The current absorbed by the coil must not be greater than 3A.

Suppression for this contactor using external suppression, ensure that connections are made respecting correct polarity.

3.3 FUSES

- Use a 6.3A Fuse for protection of the auxiliary circuits.
- For protection of the power unit, refer to diagrams. The Fuse value shown is the maximum allowable. For special applications or requirements these values can be reduced.
- For safety reasons, we recommend the use of protected fuses in order to prevent the speread of fused particles should the fuse blow.

3.4 DESCRIPTION SEM-1C CONNECTORS.

PIN REFERENCE	DESCRIPTION
A1 HOURMETER	Output hourmeter; it controls a load to –BATT. Maximum output current 200mA.
A2 KEY	B+ Supply into logic downstream of 10A & key switch.
A3 NMC	Negative main contactor coil.
A4 NEMB	Negative electro-brake.
A5 TILLER	Tiller micro-switch.
A6 –BATT	-BATT.
A7 PMC	Positive main contactor coil and common positive supply for REV, FORW, B SW, HORN, LIFT, LOW microswitches.
A8 H&S	Hard & Soft function input. It should be connected to A7 through the H & S

		switch. Active high (+VB).
B1	CPOT	Accelerator's potentiometer wiper, or output of inductive device.
B2	NPOT	Provides a negative supply to accelerator's potentiometer.
B3	PPOT	Provides a positive supply to accelerator's potentiometer.
B4	REV	Reverse direction input, it should be connected to A7 by a microswitch. Active HIGH (+VB).
B5	B SW	Quick inversion input, it should be connected to belly button. Active HIGH (+VB).
B6	FORW	Forward direction input. It should be connected to A7 by a microswitch ,active HIGH (+VB).

PIN	FREFERENCE	DESCRIPTION
C1	CM	Common positive supply for micro-switch SR1, SR2 (+BATT).
C2	SR1	Input for speed reduction. It should be connected to C1 by micro-switch, active LOW.
C3	SR2	Input for speed reduction. It should be connected to C1 by micro-switch, active LOW.
D1	REG SIGNAL	Regenerative braking status. Normally high, low while regenerating.
D2	PHORN	Positive horn, it should be connected to A7 by the horn micro-switch.
D3	NHORN	Negative horn, it is –BATT.
D4	PPC	Positive pump contactor; it should be connected to A7 by lifting micro-switch LIFT which provides the positive supply to the pump contactor's coil.
D5	NPC-NEV	Negative supply for pump contactor.
D6	PEV	Positive electro-value for lowering.
E1	PCLRXD	Positive serial reception.
E2	NCLRXD	Negative serial reception.
E3	PCLTXD	Positive serial transmission.
E4	NCLTXD	Negative serial transmission.
E5	GND	Negative console power supply.
E6	+VL	Positive console power supply.
E7	---	Free
E8	---	Free

3.5 DESCRIPTION OF POWER CONNECTIONS

+BATT = Positive Supply from Battery.

-BATT = Negative Supply from Battery.

VMN = Negative supply (via chopper) to Motor.

F1, F2 = Connections to Drive Motor Field Winding.

3.6 MECHANICAL DRAWING & DIMENSIONS

4 PROGRAMMING & ADJUSTMENTS USING DIGITAL CONSOLE

4.1 ADJUSTMENTS VIA CONSOLE

Adjustment of Parameters and changes to the chopper's configuration are made using the Digital. The Console is connected to the "E" connector of the SEM-1C Chopper.

Pay attention to the polarity of the Console Connector when connecting to the chopper. The bevel on the connector should be uppermost.

4.2 DESCRIPTION OF CONSOLE & CONNECTION

Digital Consoles used to communicate with SEM-1C choppers must be fitted with Eprom CK ULTRA.

4.3 DESCRIPTION OF STANDARD CONSOLE MENU

5 SEM-1C: CABLE AND CONFIGURATION

5.1 POWER DIAGRAM

5.2 CONNECTIONS

5.3 DESCRIPTION OF PROGRAMMABLE FUNCIONS (OPTIONS).

Using the CONFIG MENU of the console, it is possible to select from the following options:

SUBMENU "SET OPTIONS":

1 HOUR COUNTER:

- RUNNING: The counter registers travel time only.
- KEY ON: The counter registers when the key switch is Closed.

The A1 output for external hourmeter operates according to internal hourmeter. If the pump contactor is connected (D4). Hourmeter output (A1) is activated during lifting as well.

2 QUICK INVERSION

- BELLY: Quick inversion is activated while the Belly Button is pressed.
- TIMED Quick inversion is activated, while the Belly Button is pressed, maximum for 2 second.

3 AUX OUTPUT #1:

- FREE: A4 output is not used: the controller carry out monitor function as described at the paragraph 2.5.
- BRAKE: A4 output drives an electromechanical brake. The controller does not carry out monitor function, but locks the brake while in rest or alarm status.

4 BATTERY CHECK

- ON Is controlled the battery charge. When the battery is discharged is displayed "BATTERY LOW"
- OFF Is controlled the battery charge, but not displayed the alarms.

5 SEAT SWITCH

- HANDLE a tiller switch is present
- SEAT a seat switch is present

6 BACKING INPUT

-ON The backing function is activated

-OFF The backing function is deactivated

Flow Chart showing how to make changes to Configuration Menu using Digital Console,(Standard Eprom CK ULTRA fitted).

1) Opening Zapi Menu.
2) Press Top Left & Top Right Buttons
   Simultaneously to enter the Config. Menu.
3) The Display will show:
4) Press ROLL UP (Top Left Button) until SET OPTIONS appears.
5) The Display will show:
6) Press ENTER to go into this part of the menu.
7) The first “Option” of the menu appears on the Display.
8) Press either ROLL UP or ROLL DOWN to bring up the next option.
9) A new Option appears on the Display.
10) When the desired Option is displayed, press PARAM (Top Right) or SET (Bottom Right) button to change the configuration.
11) The new Configuration for the selected Option appears on the Display.
12) Press OUT to exit the Menu.
13) Press ENTER to accept the changes, or Press OUT if you do not accept the changes and wish to make further modifications to the particular Option.
14) The Display now shows:
15) Press OUT again. Display now shows the Opening Zapi Menu.

5.4 DESCRIPTION OF PARAMETERS THAT MAY BE PROGRAMMED

In addition to the Configuration, Parameter settings may be made by Zapi using standard default settings, settings to Customer Specifications, or the customer may make changes according to the application, using a Digital Console.

During the setting up procedure on the machine, the Console can remain connected to the chopper during travel. The Parameters can be modified in real time, during operation.

Pay attention to the polarity of the Console Connector. Refer to Page 15 of this Manual for connection details.

THE PROGRAMMING CONSOLE MUST BE PLUGGED ONLY WHEN THE KEY-SWITCH IS OFF.

The following Parameters can be modified:

1 ACC. DELAY = Determines the acceleration ramp.

2 DECELER DELAY = Determines the deceleration ramp according to the accelerator pedal position.

3 RELEASE BRAKING = Determines the deceleration ramp when the travel request is released.

4 INVERSION BRAKING = Determines the deceleration ramp the Direction Switch is inverted during travel.

5 SOFT BRAKING = Determines how much the brakings are reduced when the H&S functions is active.

6 SOFT ACCEL. = Determines how much the acceleration ramps are reduced when the H&S

function is active.

7 CUTBACK SPEED 1 = First speed reduction.

8 CUTBACK SPEED 2 = Second speed reduction.

9 H&S CUTBACK = Speed reduction active when the H&S function is active.

10 MAX SPEED FORW = Maximum Forward Speed, obtained by weakening the Field Current after it has reached 100% conduction of the Armature. With the Parameter set at level 0, the armature is in total conduction but the field current does not decrease below the Nominal value (low speed).

11 MAX SP FORW FINE = Maximum forward speed. Find adjustment.

12 MAX SPEED BACK = Maximum Forward speed, obtained by weakening the Field Current after it has reached 100% conduction of the Armature. With the Parameter set at level 0, the armature is in total conduction but the field current does not decrease below the Nominal value (low speed)

13 MAX SP BACK FINE = Maximum reverse speed. Fine adjustment.

14 COMPENSATION = Speed compensation when load is present. It reduces the difference between maximum speed laden and unladen.

15 MAXIMUM CURRENT = Maximum controller current.

16 ARMA NOM.CURR. = Nominal Armature Current is at least the Nominal Value (FIELD NOM.CURR.), regardless of accelerator position.

17 WEAK DROPOUT = This Parameter fixes a limit on the Armature Current above which the Field Current increased linearly up to the Nominal Field Current (in proportion to the armature current).

18 FIELD NOM.CURR. = Nominal Field Current. This parameter fixes the minimum Field Current when the potentiometer is between 0% and 60% without total conduction of the Armature. Adjustment should be made with reference to the Data on the Motor Label. (The indication of Nominal Field Current).

19 CREEP SPEED = Minimum Speed. This Parameter sets the minimum voltage applied to the motor at the start of travel.

20 BACKING TIUME = Activation time the backing function.

21 BACKING SPEED – Motor speed during the backing function.

5.5 TABLE OF ADJUSTMENTS

The following Table shows the different values that the SEM-1C Parameters may be adjusted to. A suitable acceleration performance assumes; FIELD CURR.NOM is set to level 5, and MAX SPEED (Fwd or Rev) is set to level 9.

	PROGRAMMED LEVEL										
PARAMETERS	UNIT	0	1	2	3	4	5	6	7	8	9
ACC.DELAY	Sec.	0.30	0.50	0.70	0.90	1.10	1.25	1.40	1.55	1.75	2.00
DEC.DELAY	*	9	8	7	6	5	4	3	2	1	0
RELEASE BRAKING	*	0	1	2	3	4	5	6	7	8	9
INVERS BRAKING	*	0	1	2	3	4	5	6	7	8	9
SOFT BRAKING	** %	50	40	33	28	25	22	20	18	16	15
SOFT ACCELERATION	*** %	50	40	33	28	25	22	20	18	16	15
CUTBACK SPEED 1	%ACC	30	38	45	51	57	64	72	80	90	100
CUTBACK SPEED 2	%ACC	30	38	45	51	57	64	72	80	90	100

H &S CUTBACK	%ACC	30	38	45	51	57	64	72	80	90	100
MAX SPEED FORW	%FCN	100	90	80	71	62	53	45	40	36	33
MAX SP FORW. FINE	**** %FCN	0	1	2	3	4	5	6	7	8	9
MAX. SPEED BACK	%FCN	100	90	80	71	62	53	45	40	36	33
MAX SP BACK. FINE	**** %FCN	0	1	2	3	4	5	6	7	8	9
COMPENSATION	**** %1	0	5	10	16	22	27	33	38	44	78
MAXIMUM CURRENT	% IMAX	82	84	86	88	90	92	94	96	98	100
ARMA CUR.NOM.(CAN)	% IMAX	45	47	50	52	54	56	58	61	63	65
WEAK DROP OUT	%CAN	40	44	48	52	57	62	66	70	75	80
FIELD CURR.NOM.(FCN)	A	7.5	8.1	8.7	9.3	10	10.6	11.2	11.8	12.5	13.1
CREEP SPEED	%Vbatt	4	5	6	7	8	9	10	11	12	13
BACKING TIME	Sec.	1.6	1.9	2.1	2.4	2.7	3.0	3.2	3.5	3.8	4.1
BACKING SPEED	%max sp.	19.6	23.5	27.4	31.3	35.3	39.2	43.1	47.0	51.0	55.0

*= If the current inclines to raise, then also the braking time raises in order to obtain a smooth braking action. Therefore, the duration of the braking depends on the type of motor and the operating conditions (laden, unladen, on plane, on gradient).

**= The values in the table indicate how much the brakings (release, inversion, deceleration) are reduced while H&S function is active.

***= The values in the table indicate how much the acceleration is reduced while H&S function is active.

****= Is a percentage of the field current which is subtracted to the value defined by the parameters MAX SPEED FORW and MAX SPEED BACK.

*****= Indicates the percentage of the armature current (while the machines is at constant maximum speed) that is subtracted to the field current.

Flow Chart showing how to make programme changes using Digital Console fitted with Eprom CK ULTRA.

1) Opening Zapi Display.
2) Press ENTER to go into the General Menu.
3) The Display will show:
4) Press ENTER to go into the Parameter Change facility.
5) The Display will show the first Parameter.
6) Press either ROLL UP or ROLL DOWN to display the next parameter.
7) The names of the Parameters appear on the Display.
8) When the desired Parameter appears, the Display will show a Level Number that will be between 0 and 9. press either PARAM (Top Right) or SET (Bottom Right) buttons to change the Level value.
9) The Display will show the New Level.
10) When you are satisfied with the result of the changes you have made, Press OUT.
11) The Display asks “ARE YOU SURE?”
12) Press ENTER to accept the changes, or Press OUT if you do not wish to accept the changes and wish to make further modifications to the parameters.
13) The Display will show:

5.7 SEQUENCE FOR SEM-1C TRACTION SETTINGS

When the Key Switch is Closed, if no Alarms or Errors are present, the Console Display will be showing the Standard Zapi Opening Display.
If the chopper is not Configured to your requirements, follow the Sequence detailed on Page 20. remember to re-cycle the Key Switch if you make any changes to the chopper's Configuration. Otherwise follow the sequence detailed below:

1) Select the options required (Chapter 5.3).
2) Select and set the Battery Voltage.
3) Confirm correct installation of all wires. Use the Console's TESTER function to assist.
4) Perform the accelerator signal acquisition procedure using the Console "PROGRAM VACC".
5) Set the TRACTION IMAX Current, taking into account any Boost requirements. Use Table on Chapter 5.5.
6) Set the Acceleration Delay requirements for the machine. Test the parameters in both directions.
7) Set the CREEP level starting from level 0. the machine should just move when the accelerator microswitch is closed. Increase the Level accordingly.
8) Set the Speed Reductions as required. Make adjustments to CUTBACK SP.1,2. Check the performance with accelerator pedal totally depressed. If the machine is a forklift, check the performance with and without load.
9) RELEASE BRAKING. Operate the machine at full speed. Release the accelerator pedal. Adjust the level to your requirements. If the machine is a forklift, check the performance with and without load.
10) INVERSION BRAKING. Operate the machine at 25% full speed. Whilst traveing invert the Direction Switch. Set a soft Level of Inversion Braking. When satisfactory, operate the machine at Full Speed and repeat. If the machine is a Forklift, repeat the tests and make adjustments with and without load. The unladen full speed condition should be the most representative condition.
11) Set MAX SPEED FORW.
12) Set MAX SPEED BACK (Reverse).
13) Set ARMA CURR. NOM.,NOM. FIELD CURR. E WEAK DROPOUT

Check the parameters meaning on Chapter 5.4.

6 SEM-1C DIAGNOSTICS

The following list shows likely problems associated with the flashing RED LED.

N °	FLASHES	MESSAGE	NOTES
	1	LOGIC FAILURE#1	Problem with Logic or Line Contractor
	1	WATCH-DOG	Logic board and/or software failure
	1	EEPROM KO	Problem with EEPROM or Logic
	2	INCORRECT STARTS	Starting sequence for travel not correct
	2	FORW + BACK	Double running requests.
	3	CAPACITOR CHARGE	Problem in Power Block
	3	VMN NOT OK	Problem with Chopper
	3	VFIELD NOT OK	Problem with Field Voltage
	4	VACC NOT OK	Potentiometer Wiper
	4	PEDAL WIRE KO	Pedal wire not OK

5	NO FIELD CUR.	Field wiring not OK or field current sensor not OK
5	HIGH FIELD CUR.	Field wiring not OK or field current sensor not OK.
5	I= 0 EVER	No current: sensor of armature current not OK.
6	CONTRACTOR DRIVER	Contactor Driver not OK.
6	COLL SHORTED	Coil contactor shorted
6	CONTACTOR CLOSED	Line Contactor contact not OK
7	TH. PROTECTION	Temperature too much high (>70°C) or low (<10°C).
32	BATTERY LOW	Battery too low.

6.1 ANALYSIS OF ALARMS DISPLAYED ON THE CONSOLE

1 LOGIC FAILURE #1

This test is carried out at the start-up.

Possible cause: failure of the logic board.

2 WATCH DOG

The test is executed at the key turn-on, at the stand-by and on running. Possible causes:

a) Watch-dog hardware circuit not OK;
b) Software not OK.

3 EEPROM OK

Fault in the area of memory where the adjustment parameters are stored. This Alarm inhibits machine operation. If the fault continues when the Key Switch is recycled, replace the logic. If the fault disappears, the previously stored Parameters will have been replaced by the default parameters.

4 INCORRECT START

Alarm generated by an incorrect Staring Sequence. Possible causes:

a) The ENABLE microswitch has welded or failed.
b) Error in the starting sequence from the operator.
c) Error in the wiring.

5 FORW + BACK

This check is made continually. The alarm is generated when forward and reverse direction are requested simultaneously. Possible causes:

a) Error in Wiring.
b) Welding or Failure of a direction switch.
c) Error in the starting sequence from the operator

.6 CAPACITOR CHARGE

This check is made during the initial diagnosis. This Alarm is generated if the Capacitors are not charged within 500ms after the Key Switch is closed. Probable cause is failure inside the power block.

7 VMN NOT OK

This test is performed at rest, with the general Contactor Closed, and also during operation. At rest if VMN is lower than battery voltage this Alarm is generated. During operation this Alarm

is generated if VMN doesn't follow the duty-cycle of the chopper. Possible causes:

a) Incorrect Motor connection.
b) Short circuit motor winding to chassis.
c) Defect in the power unit.

8 VFIELD NOT OK

This test is made at standby with the Line Contactor open. In this condition the voltage on both the connections of field must be to around VBatt. This alarm is generated if the field voltage is different from this value. Possible causes:

d) Frame fault on the motor to chassis;
e) Incorrect connection of the field winding to the controller;
f) Failure of the controller in the section relative to the field;

9 VACC NOT OK

This Alarm is generated if the accelerator output voltage differs more than 2V from the acquired minimum during the PROGRAM VACC. Possible causes:

a) the track of the potentiometer has become open.
b) The potentiometer is not wired correctly.
c) The potentiometer itself is defective.
d) The values set in PROGRAM VACC routine have not remained or made correctly.

10 PEDAL WIRE KO

This Alarm is generated if potentiometer or wiring fault is detected. (NPOT or PPOT are open circuit).

11 STBY HIGH

This test is made during the initial diagnosis and at standby. The test verifies that the current is zero. This Alarm disables the machine. Possible causes:

a) defective current sensor.
b) Logic failure. First replace the logic. If fault remains replace the power unit.

12 I = 0 EVER

This check is made during travel. If the current is not higher than a preset minimum value, this Alarm is generated and the machine disabled. Possible causes: see STBY I HIGH. Check the motor armature (brush connections).

13 HIGH FIELD CUR,NO FILD CUR

Problem detected with the field winding current. Possible causes:

a) Failure of the field current sensor.
b) Field cables not connected or incorrectly connected.
c) Failure of the Field Power Unit.

14 ACTOR DRIVER, COIL SHORTED,DRIVERS SHORTED

These Alarms are generated if there is a problem with General or Line Contactor. Possible causes:

b) The coil of the contactor is either short-circuit, open circuit, or not connected.
c) The Contactor Coil Driver is short-circuit.
d) Defect in the wiring to the contactor, or logic failure.

15 CONTACTOR CLOSED

This check is made during the initial diagnosis. With the coil of the line contactor deenergized, the capacitors should not be changed, unless there is divert resistor across the power poles.

Possible causes:

a) The line contactor power poles are welded.
b) This alarm could be generated even if the line contactor has opened, but there is a problem with either the field circuit, or a problem detected by the safety microprocessor.

16 TH.PROTECTION

If the temperature of the chopper rises higher than 70°C, this alarm is generated. The chopper current is reduced in proportion to the increase in temperature. At 80°C the chopper totally stops. If the temperature of the chopper is <-10°C, this Alarm is also generated and the current is reduced by 80%. If this alarm is displayed when the chopper is temperature is the same as ambient or better than zero degrees:

a) Check the connection of the temperature sensor.
b) The temperature sensor may be defective.
c) The logic may be defective.

17 BATTERY LOW

This Alarm is generated when the battery becomes 50% discharged from the nominal value.

6.2 TESTER DESCRIPTION OF THE FUNCTIONS

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. The following definition listing shows the relative measurements:

1) BATTERY VOLTAGE: level of battery voltage measured at the input to the key switch.
2) MOTOR VOLTAGE: the voltage appearing across the drive motor. It is measured between B + and VMN.
3) MOTOR CURRENT: the current flowing in the drive motor armature.
4) FIELD CURRENT: the current flowing in the drive motor field winding.
5) VMN: the voltage effectively dropped across the MOS. It is measured between B- and VMN.
6) TEMPERATURE: the temperature measured on the aluminum heat sink holding the MOSFET devices.
7) ACCELERATOR: the voltage of accelerator potentiometer wiper (CPOT).
   The voltage level is shown on the Left Hand Side of the Console Display and the value in percentage is shown on the Right Hand Side.
8) FORWARD SWITCH: the level of the Forward direction digital entry MA (pin B6)
   ON/ + VB = active entry of closed switch.
   OFF/GND = non active entry of open switch.
9) BACKWARD SWITCH: the level of the Reverse direction digital entry MI (pin B4).
   ON/ + VB = active entry of closed switch.
   OFF/GND = non active entry of open switch.
10) HANDLE/SEAT SWITCH: the level of the Handle/Seat Microswitch digital entry (pin A5).
    ON/ + VB = active entry of closed switch.
    OFF/GND = non active entry of open switch.
11) QUICK INVERSION: the level of the digital entry from Belly Button microswitch

(pin B5).
ON/ + VB = active entry, B SW closed.
OFF/GND = non active entry, B SW open.

12) CUTBACK SWITCH 1:the level of the Speed Reduction 1 Microswitch SR1.
ON/GND = active entry of speed reduction microswitch.
OFF/+ VB = non active entry of microswitch.
13) CUTBACK SWITCH 2: the level of the Speed Reduction 2 Microswitch SR2.
ON/GND = active entry of speed reduction microswitch.
OFF/+ VB = non active entry of microswitch.

Flow Chart showing how to use the TESTER function of the Digital Console.

1) Opening Zapi Display.
2) Press ENTER to go into the General menu.
3) The Display will show:
4) Press either ROLL UP or ROLL DOWN button until TESTER MENU appear on the display.
5) The Display shows:
6) Press ENTER to go into the TESTER function.
7) The first variable to be tested is shown on the Display.
8) Press either ROLL UP or ROLL DOWN buttons until your desired variable for measurement appears on the Display.
9) Next variable is shown.
10) When you have finished ,Press OUT.
11) The Display shows:
12) Press either ROLL UP or ROLL DOWN button to show other MENU or press OUT to finish.

Remember it is not possible to make any changes using TESTER. All you can do is measure as if you were using a pre-connected multimeter.

6.3 DESCRIPTION OF THE CONSOLE SAVE FUNCTION

The SAVE PARAM function allows the operator to transmit the Parameter values and Configuration data of the chopper into the Console memory. It is possible to load 64 different programmes.

The information saved in the Console memory can then be reloaded into another chopper using the RESTORE function.

The data that is available via the SAVE function is as follows:

- All Parameter Values (PARAMETER CHANGE).
- Options (SET. OPTIONS)
- The Level of the Battery (ADJUST BATTERY).

Flow Chart showing how to use the SAVE function of the Digital Console.

1) Opening Zapi Display.
2) Press ENTER to go into the General menu.
3) The Display will show:
4) Press either ROLL UP or ROLL DOWN button until SAVE PARAM is shown.

5) The Display will show:
6) Press ENTER to go into the SAVE function.
7) If this facility has been used before the type of chopper data stored appears on the top line with a 2 digit reference.
8) Keep pressing either ROLL UP or ROLL DOWN keys until the second line indicates a FREE storage facility.
9) Press ENTER to commence SAVE routine.
10) You can see the items that are being stored whilst the SAVE routine is happening.
11) When finished, the Console shows:
12) Press OUT to return to the Opening Zapi Display.

6.4 DECRIPTION OF CONSOLE TESTORE FUNCTION

The RESTORE PARAM function allows transfer of the Console's stored data into the memory of the chopper. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. Function.

The data that are available via the RESTORE PARAM. Function are as follows:

- All Parameter Values (PARAMETER CHANGE).
- Options (SET OPTIONS)
- The level of the Battery (ADJUST BATTERY)

ATTENTION: When the RESTORE operation is made, all data in the chopper memory will be written over and replace with data being restored.

Flow chart showing how to use the RESTORE function of the Digital Console.

1) Opening Zapi Display.
2) Press ENTER to go into the General menu.
3) The display will show:
4) Press either ROLL UP or ROLL DOWN button until RESTORE PARAM. Appears on the display.
5) The Display will show:
6) Press ENTER to go into the RESTORE PARAM. function.
7) The Display shows the type of Model stored, with a Code Number.
8) Keep pressing either ROLL UP and ROLL DOWN buttons until the desired model appears on the Display.
9) The model is shown.
10) Press ENTER to commence the Restore operation.
11) The Display will ask "ARE YOU SURE". Press ENTER for YES, or OUT for No.
12) Press ENTER to confirm (OUT to not confirm)
13) You can see the items that are being stored in the chopper memory whilst the RESTORE routine is happening.
14) When finished the Console displays:
15) Press OUT to return to the Opening Zapi Display.

6.5 DESCRITION OF ALARMS MENU.

The microprocessor in the chopper remembers the last five Alarms that have occurred. Item remembered relative to each Alarm are :the code of the alarm, the number of times the particular

Alarm occurred, the Hour Meter count, and the chopper temperature.
This function permits a deeper diagnosis of problems as the recent history can now be accessed.
Flow chart showing how to use the ALARMS function via the Digital Console.

1) Opening Zapi Display.
2) Press ENTER to go into the General menu.
3) The Display will show:
4) Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE appears on the display.
5) The display will show:
6) Press ENTER to go into the ALARMS function.
7) The Display will show the most recent Alarm.
8) Each press of the ROLL UP button brings up following Alarms.
   Pressing ROLL DOWN returns to the most recent.
9) If an Alarm has not occurred, the Display will show: ALARM NULL.
10) When you have finished looking at the Alarms, press OUT to exit the ALARMS menu.
11) The Display will ask CLEAR LOGBOOK?
12) Press ENTER for yes, or OUT for NO.
13) Press OUT to return to the Opening Zapi Display.

6.6 DESCRIPTION OF CONSOLE PROGRAM VACC FUNCTION

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions.
The operation showing how to use the PROGRAM VACC function of the Digital Console.

1) Opening Zapi Display.
2) Press ENTER to go into the General Menu.
3) The Display will show:
4) Press ROLL UP or ROLL DOWN button until PROGRAM VACC appears on the display.
5) The Display will show:
6) Press ENTER to go into the PROGRAM VACC routine.
7) The Display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.
8) Press ENTER to clear these values.
9) Display will show 0.0.
10) Select Forward Direction, close any interlock switches that may be in the system. Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltage will be displayed on the Console plus and arrow indicating the direction.
11) Select the Reverse Direction and repeat Item 10.
12) When finished ,press OUT.
13) The Display will ask: ARE YOU SURE?
14) Press ENTER for yes, or OUT for NO.
15) Press OUT again to return to Opening Zapi Menu.

7 RECOMMENDED SPARE PARTS FOR SEM-1C

Part Number	Description
C16529	Protected 125A Fuse
C16503	Protected 200A Fuse
C16520	6.3A 5X20mm Control Circuit Fuse
P99060	Red LED
C12372	8 Way Molex Connector
C12416	6 Way Molex Connector
C12371	3 Way Molex Connector
C12769	Insert for Molex Connectors
C29548	SW 80B-548 24V
C29504	SW 80B-551 36V
C29506	SW80B-552 48V

8 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDICATED

Check the war and condition of the Contactor's moving and fixed contacts.

Electrical Contacts should be checked every 3 months.

Check the Foot pedal or Tiller microswitch. Using a suitable test meter, confirm that there is no electrical resistance between the contacts by measuring the volt drop between the terminals. Switches should operate with a firm click sound.

Microswitches should be checked every 3 months.

Check the Battery cables, cables to the chopper, and cables to the motor. Ensure the insulation is sound and the connections are tight.

Cables should be checked every 3 months.

Check the mechanical operation of the pedal or tiller. Are the return springs ok. Do the potentiometers wind up to their full or programmed level.

Check every 3 months.

Check the mechanical operation of the Contractor (s). moving contacts should be free to move without restriction.

Check every 3 months.

Check should be carried out by qualified personnel and any replacement parts used should be original. Beware of NON ORIGINAL PARTS.

The installation of this electronic controller should be made according to the diagrams included in this Manual. Any variations or special requirements should be made after consulting a Zapi Agent. The supplier is not responsible of any problem that arise from wiring methods that differ from information included in this Manual.

During periodic checks, if a technician finds any situation that could cause damage or compromise safety, the matter should be bought to the attention of a Zapi Agent immediately. The Agent will then take the decision regarding operational safety of the machine.

Remember that Battery Powered Machines feel no pain.

NEVER USE A VEHICLE WITH A FAULTY ELECTRONIC CONTROLLER.