OWNER'S MANUAL

Model: PST-1000
Carbon Pile Charging System Analyzer
For 6 and 12 Volt Batteries

ELECTRIC CORPORATION
MT. PROSPECT, IL 60056

Send Warranty Product Repairs To:
Customer Returns
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Questions? Call Customer Service
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PST-1000 IMPORTANT OPERATING & SAFETY NOTES

READ BEFORE PROCEEDING WITH TESTS

1. Always work in a well ventilated area. Never start a vehicle's engine in an enclosed area.
2. Never smoke or allow any other open flame to come within 25 feet of the vehicle being tested.
3. Always insure that everyone within close proximity of the vehicle being tested is correctly wearing approved safety / protective glasses before proceeding with any testing or adjustments.
4. Always insure that the vehicle's engine is turned OFF when connecting or disconnecting any and all test equipment.
5. Always exercise extreme caution to insure that hands, arms, clothing and tester leads are kept well away from all moving engine parts.
6. Because the battery may produce highly explosive gases, it is extremely important that you carefully observe the following precautions:
   A. **DO NOT** smoke or allow any other open flame or spark within 25 feet of the battery.
   B. **NEVER DIRECTLY CONNECT THE POSITIVE AND NEGATIVE** battery posts with any single conductive material such as a screwdriver, jumper lead, etc. , as this will cause a short circuit and spark which could result in an explosion.
7. Battery acid and corrosion can be extremely dangerous and **MUST BE DEALT WITH VERY CAREFULLY.**
   A. **DO NOT** allow battery acid or corrosion to come in direct contact with skin or eyes. If it does, thoroughly wash skin with warm, soapy water **IMMEDIATELY** and/or rinse eyes with clear water for 15 – 20 minute. **CONTACT PHYSICIAN IMMEDIATELY**.
   B. Extreme caution must be exercised to avoid ingestion of battery acid or corrosion. If ingestion does occur, drink large quantities of milk**, (DO NOT INDUCE VOMITING). CONTACT PHYSICIAN IMMEDIATELY.**
8. Tremendous back pressure can be developed in the radiator, and taking the radiator cap off improperly can result in a sudden release of scalding hot fluid, and subsequent serious burns. You **MUST** refer to proper vehicle manufacturer's service manual for correct procedure.
9. Before working on a vehicle set the brakes and block the wheels. Beware of automatic parking brake release. **Due to the inherent dangers with even the simplest automotive maintenance procedures, the manufacturer and all parties involved in the distribution and/or sale of this automotive test product will NOT be held liable or responsible, wholly OR partially, for ANY injuries, damages or claims resulting from the performance of testing or adjustment procedures included in this instruction guide and/or the use of this automotive test product.**
10. Avoid electrical shocks caused by getting too close to live ignition wires or touching the coil TACH terminal. A person's reaction near a running engine can be more damaging than the shock itself.
11. Keep spark producing devices at least 18" (0.5m) above the floor to reduce the hazard of igniting gasoline vapor.
12. Route test leads away from belts and pulleys before starting engine to avoid damage and possible injury.
13. Remove finger rings and metal wrist bands. They can short on active current sources and become very hot from electric current passage and cause sever burns.

The charging system Analyzer is a rugged, professional quality tool designed for extra heavy duty use. The convenient hook up and test sequence allows a complete check in minutes of the:

Battery	Alternator/Generator
Starter motor	Voltage Regulator
Starter Solenoid	All Interconnecting cables

With 6 to 24 volts batteries, it is a portable digital readout analyzer.

OUTSTANDING FEATURES OF THE CHARGING SYSTEM ANALYZER ARE:

A. Rugged Construction: Designed for an extra heavy duty use and maximum reliability.

B. Convenient Hook Up: All connections simply clamp on; no time consuming cable disconnection are required on most vehicles.

C. Large easy to read 3/4-inch digital displays for both amps and volts:
   1. Voltage Scale ±4V – ±16V for battery, ±0V – ±199.9V for EXT
   2. Current Scales ±0 – ±1999A
   3. Good/Bad LED for Alternator Diodes

D. 12,000 watts Carbon pile for battery load testing.

E. An easy control carbon pile load, an inductive "Hall-effect" amp probe which is plug-in replaceable, a beeping signal for "time-out", a high efficiency cooling fan and extra heavy duty battery terminal clamps and cables

ANALYZER FEATURES

BATTERY CABLES

The Battery Cables do three things:

1. They conduct power to the analyzer from the battery under test. The analyzer will measure accurately for voltages from ±4 to ±16 volts and ±0 – ±1000 Amps at the battery clamps.
2. They carry the 12,000 watts of resistance load from the carbon pile stack.
3. They provide battery voltage reading connections when the display selector is on the battery volts position.

Note: Each load cable has a voltage sensor wire which is independent of the extra heavy cable. The battery clamps are color coded: Red for battery POS (+) and Black for battery NEG (-).

VOLTS DISPLAY AND SELECTOR

This liquid crystal display shows the voltage selected by the switch below. A ±16.0 volt range with 0.1 volt steps are provided for Battery Volts and External ±199.9V. If more than ±199.9 volts are applied, the display will show "1".

EXTERNAL VOLTS LEADS (1 mg ohms)
These leads may be used for measuring any DC voltage on a vehicle when the test selector switch is placed in External position. The voltmeter circuit is isolated and has an automatic polarity indication. Typical applications are for measuring load voltages and cable connection voltage drops.

AMPS DISPLAY
The display shows the amperage sensed by the Amp Probe. The readout is in 1 amp steps and has a working range up to ±1999 Amps.

AMP PROBE LEAD AND ZERO KNOB
The inductive Amp Probe senses current in a wire without having to disturb any connections. Place the wire through the opening and check that the probe jaws close fully. The + - sign on the probe indicates the direction of conventional currents, which will give a positive display reading. Reversed currents will show a minus sign. For example, if the probe is on a negative ground alternator output wire with the + sign towards the alternator, the reading will be positive. Switch to 1000A position and use the zero auto adjust knob (on probe top) to cancel offset before probe hookup.

Note: The probe works by sensing magnetism around a wire. To avoid errors keep it away from the back of the alternator and other strong magnets. Probe uses a 9 volt battery inside of the back.

DIODE/STATOR LAMP
This lamp will be on steady when there is alternator output of at least 20 amps and excessive "ripple" is detected in the battery cable. Ignore momentary flashes. Alternator output with ripple current are usually caused by a bad diode or stator winding.

LOAD CONTROL KNOB
This load is suitable for 6 to 24 volt automotive battery systems. The Load control knob is used to adjust the battery test current. The load is a carbon pile capable of drawing 1000 Amps. Draws of over 100 amps must be limited to 15 seconds with a minimum of 60 seconds off between tests to avoid heat buildup. The fan will come on when the test load reaches 50 amps and will remain on until the temperature drops below 60°C. If the fan air feels warm, allow it to run after testing to reduce the damaging effects of high temperatures.

AVOID DANGEROUS SPARKS
Always turn the Load Knob "OFF" before connecting or moving the battery clamps.

LOAD-ON LAMP
When the lamp is lighted, the carbon pile is drawing at last 50 amps from the battery and it is a reminder to turn off the load when the test is complete or before changing battery connections.

Note: The Load-On lamp will not be bright enough to see during 6V battery tests.

TIMER BEEPER AND TIME OUT LAMP
When the Load-On lamp begins lighting, an internal timer waits 15 seconds and then begins sounding an audible beep and the "Time-Out" lamp illuminates. Both are reminders to turn off the load before removing or moving the battery cable clamps from the battery.

ANALYZER HOOK UP
All of the test procedures of a vehicle's equipment presume that the battery will perform well enough. **The battery test should always be completed before performing other diagnostic tests.**

General specifications given in this manual are for 6–12 volts systems and give satisfactory performance references for most vehicles. However, there are some vehicles which will require the actual vehicle manufacturer's service specification values for more accurate test conclusions.

When hooking up the analyzer, always do the following steps:

1. Be sure the load knob is turned to OFF before connecting the analyzer cables to the battery. Take note of the safety precautions on the front page of this manual.
2. Connect the analyzer Battery Clamps to the battery terminals; Red to positive (+), Black to negative (-) They may be reversed to get a minus volts reading. The clamp jaw from each cable must have a solid connection to the battery terminal to assure good voltage measurements and to prevent arching during adapter attachment or high current load testing.
3. Set the volts (source) selector to Battery Volts. The analyzer will show the battery voltage. The display will work from ±4.0 to ±16.0 volts so that 6 to 12 volt batteries can be tested.
4. With the Amps Probe jaws closed and not around any wires, switch to the "1000A" position and push the Zero Amps Knob until the Amps Display reads "000".

NOTE
This manual assumes that Negative Ground battery systems are being tested since Positive Ground batteries exist only on antique or unusual vehicles. This affects the circuit troubleshooting procedures.

BATTERY CAUTION
1. Always wear safety glasses when working around batteries.
2. Do not break live circuits at the battery terminals.
3. Avoid accidentally shorting the insulated battery terminal to any ground metal. Never put a wrench on a live battery terminal. Severe burns may result. Always disconnect the battery chassis ground cable first.

BATTERY TESTING
The battery test has three steps:

I. Visual Inspection

II. State of Charge Check

III. Load Test

A battery must be tested with a load to determine its ability to perform. Specific gravity or open circle voltage tests do not completely gauge a battery's performance.

Sealed batteries can be tested like open vent batteries except for the specific gravity test.

VISUAL INSPECTION
1. Corroded or damaged cable connectors.
2. Loose or damaged battery posts.
3. Damaged battery cases which allow the loss of electrolyte.
4. The battery fluid must completely cover the cell plates in all cells. If water is added to the battery before specific gravity

readings are taken, the battery should be charged five minutes to stimulate mixing. (Refer to battery manufacturer's instructions regarding removal of vent caps while charging battery).

ELECTROLYTE CAUTION

Battery electrolyte is SULFURIC ACID. It can eat holes in clothes and skin. Flush spills with water.

STATE OF CHARGE CHECK

By Specific Gravity (open vent battery only)

Sample, measure and return the electrolyte from each cell with a hydrometer.

1. The specific gravity should be at least 1.230 in all cells. If not, charge the battery. If charging the battery does not bring the specific gravity up to 1.230, then the battery should be replaced.
2. The specific gravity readings should not vary more than 50 points (.050) between all cells. If the difference is greater, replace the battery.

By Open Circuit Voltage (any lead-acid battery)

Measure the open circuit (no load) stabilized voltage. A stabilized battery has no "surface charge", which means that the electrolyte has had a chance to remix and shed gas bubbles after current flow has stopped.

Open Circuit Volts	12.6	12.4	12.2	12.0
% of Charge	100	75	50	25

If the measured voltage is less than 12.4 volts, first recharge the battery. With a low % of charge, performance will be reduced and any load test results may be invalid.

LOAD TEST

A battery must have the capability to crank an engine while maintaining enough voltage to power the ignition. To give consistent results, these tests require that a battery be at least 75% charged and must not have been heavily used within the last 10 minutes.

The standard battery performance test is based on battery ratings provided by the manufacturer. If the test load amperage is known, use it, otherwise use one of the following:

1. Cold Cranking Amperes at 0°F. (CCA) - When using CCA, divide the given value by 2 to obtain the load. FOR example, 1000 CCA divided by 2 equals a 500 amperes test load.
2. Ampere Hour Rating (Ah) - If only the Ampere Hour rating is known, multiply the value by 3 to obtain the load. For example, a 200 Ah battery times 3 equals a 600 amperes load.
3. BATTERY WATTS - When only the battery rating in watts is known then use Table 1 (below) as a guide to determine what battery load or cranking amps would be normal. FOR EXAMPLE: A battery load or cranking amps for a battery rated at 2400 watts would be 125 to 200 amps.

TABLE 1

Engine Size	Cubic Inches	Cubic Centimeters	Battery Load or Cranking Amp Rating	Watt
Small	100 to 200	1600 to 2400	100-150 Amps	1200 to 1800
Medium	200 to 350	2400 to 5600	125-200 Amps	1500 to 2400
Large	350 to 500	5600 to 8000	175-300 Amps	2100 to 3600

Ratings can be found on the battery, in the vehicle manual or in a replacement battery application guide. In the battery performance load test, the rated amperage is drawn from the battery for 15 seconds while watching the battery voltage. At 70°F and higher, a good battery will maintain an output of 9.6 volts or more during the load testing period (4.8 volts for 6 volt battery). When a battery is cooler than 70°F, the output voltage requirement is reduced to give equivalent test conclusions per the following (Table 2):

Table 2	ELECTROLYTE TEMP –°F–	–°C–	MINIMUM LOADED VOLTS
	70	21	9.6
	60	16	9.5
	50	10	9.4
	40	4	9.3
	30	-1	9.1
	20	-7	8.9
	10	-12	.7
	0	-18	8.5

NOTE: DIVIDE MINIMUM TEST VOLTAGE IN HALF FOR 6 VOLT BATTERIES.

LOAD TEST CAUTION

If the amperes display goes out while loading a battery, the voltage has fallen below 4.0 volts. TURN THE LOAD OFF IMMEDIATELY.

The battery could become overheated. If a battery smokes while being loaded, immediately discontinue using it. It is not safe.

Zero Amp Meter. Then Place AMP PROBE around either analyzer cable.

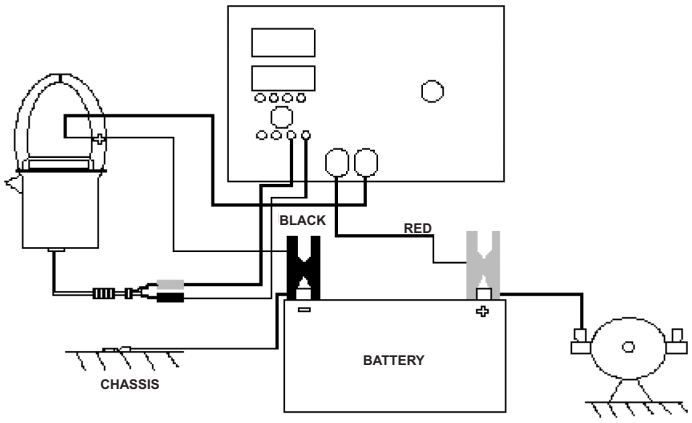

Figure 1
Connection for LOAD TEST

1. Have the Load knob turned to "OFF" before connecting.
2. Connect analyzer Battery Clamps to battery terminals, Red to POS (+), Black to NEG (-) the cables can be reverse. Wiggle clamps to be sure that the clamp jaws make good contact with battery terminals.
3. Set the Volts Selector to "Battery Volts". The analyzer should show battery voltage over 12.4V. (6.2V)

4. Switch Amps probe to 1000A position, Adjust Amp Meter to read zero using the Zero Amps knob. Be sure the Amp Probe jaws are clean and fully closed. (If Amps probe battery is low, replace it with new one first.)
5. Place the Amp Probe around either analyzer Battery Cable.
6. Determine the battery load test amperes from the battery test specification, CCA, or Ah ratings.
7. Turn the Load Control Knob clockwise until the amps reading gradually reaches the required load. While the load is being applied, watch the battery voltage. After 15 seconds at the test amperage, or if the voltage goes below the minimum value, (Table 2) turn the load off.

   NOTE: The Time out lamp will light and the beeper will sound after 15 seconds of the load testing.
8. **Test Conclusion :** If the battery voltage went below the minimum voltage from the table during the test the battery is either discharged or defective. Recharge and test again if test results are marginal.

   Note: MAINTENANCE FREE AND SEALED BATTERIES-can be tested like any other ordinary battery except for the specific gravity test. They have a sealed cover and carry a lifetime supply of electrolyte. One type has the negative and positive terminals on the top and another has them on the side. The side terminal type have threaded terminal connections which are sealed against corrosion where the cables are attached.

   Freedom batteries may be charged or tested on-the-vehicle using the existing terminals. However, when the battery is out-of-the-vehicle, adapters for the side terminal models are required.

   Freedom batteries have an indicator built into the battery cover. The color of this indicator verifies the gravity condition of the battery.

EXAMPLE: Top side of battery:

- If the green ball is visible, the battery is charged.
- If the indicator is dark and the green ball is not visible, the battery is partially discharged
- If the indicator is light yellow, the battery is low on fluid and near the end of its useful life. **DO NOT ATTEMPT RECHARGING OR TESTING IF THE INDICATOR IS YELLOW.**

STARTER CRANKING TESTS

When testing the starting system, first test for battery performance. With a known good battery, the starter motor, cables and starter solenoid can be checked by doing the Diagnostic Test Procedure.

The test procedure consists of cranking the engine for 15 seconds while watching the starter draw amperage and the battery voltage. Starter amps should not exceed the maximum specified for the vehicle being tested, and the cranking RPM should be satisfactory. Causes for engines failing the Starter Cranking Test can be determined by using the following troubleshooting test procedures. These tests pinpoint high resistance cable connections to the solenoid, switches and starter. High resistance can cause slow cranking.

The starting system's main electrical circuit is from the battery POS (+) post, to a starter solenoid relay, to the starter motor, to frame ground and back to the battery NEG (-) ground post. The solenoid is controlled by the ignition switch and usually has a transmission safety switch.

Corroded or loose terminals, broken switches and damaged cables will cause voltage losses. Voltage drops (losses) are measured by connecting a voltmeter across the circuit parts and then reading the voltage while the circuit is operated.

For all of these tests, the analyzer battery clamps must be connected to the vehicle battery to power the voltmeter and ammeter.

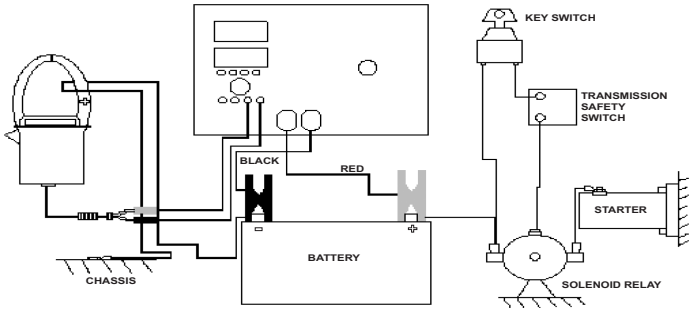

Figure 2
Connections For STARTER TEST

DIAGNOSTIC TEST PROCEDURE

1. Engine should be at normal operating temperature.
2. Hook-up the analyzer as described in the general instructions. This includes having the load "OFF", the Battery Clamps connected to the battery, the Battery Volts checked and Amps (reading) zeroed.
3. Perform starter test only with a good battery. Confirm the condition of the battery by first conducting the Battery Load Test Procedure as detailed earlier.
4. Make sure all lights and accessories are off and vehicle doors are closed.
5. Place the Amp Probe around either of the engines battery cables.
6. Set the Volts Selector to Battery Volts.
7. Disable the ignition by either disconnecting its power, unplugging the coil primary, or grounding the coil secondary wire.
8. Crank engine for 15 seconds (with ignition key and note the cranking amperage reading. Also, watch to see that the battery voltage stays above 9.6V. If a repeat of this test is required, allow the starter motor several minutes to cool before retesting.

TYPICAL STARTER CRANKING DRAW

ENGINE SIZE		
Cubic Inches	**Liters**	**Amperes**
100 to 200	1.6 to 3.2	100 to 200
200 to 350	3.2 to 5.6	125 to 250
350 to 500	5.6 to 8.0	150 to 300

NOTE: Higher starter amps may be encountered if engine temperatures are extremely hot or cold.

9. **Test Conclusion:** The system is good if the cranking speed is satisfactory and the battery voltage stayed above 9.6 volts If cranking speed was slow, use the following chart.

VOLTAGE	AMPS	LIKELY CAUSE
Below 9.6	High	Bad starter or a very hot or cold engine
Below 9.6	Low	Bad Battery or Loose Battery Terminals
Above 9.6	Low	Bad Connections at Starter or Solenoid

INSULATED-POS CIRCUIT TEST

1. Set the Volts Selector to "External" (±199.9V. scale)
2. Connect Volt test leads as shows in the following (Figure 3). Clip from battery POS (+) post to the input terminal on the starter motor.

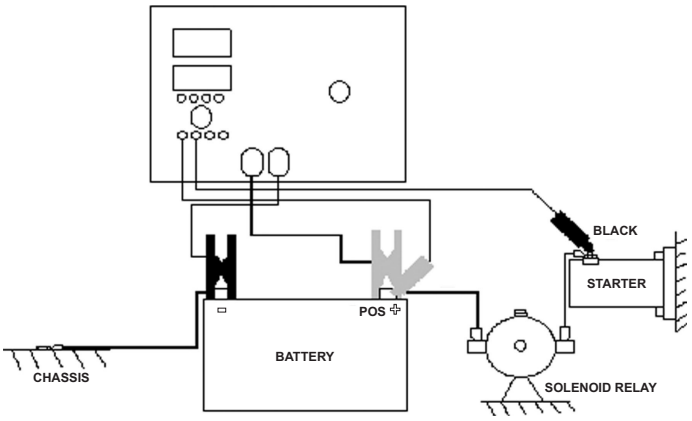

Figure 3
Connections For INSULATED-POS CIRCUIT TEST

1. Disable ignition (as described earlier) to prevent engine from starting during test.
2. Operate starter and read voltmeter while cranking.
3. **Test Conclusion:** Good circuits drop less than 0.4 volt on a 6 volt system and less than 0.5 volt on 12 volt systems. If okay, go to the Ground Circuit Test. If an excessive voltage drop is detected, further isolate the problem by retesting across the individual circuit components.

12 VOLT CRANKING CIRCUIT
TYPICAL VOLTAGE DROP MAXIMUMS

Each Cable	0.2 volt
Each connection	0.1 volt
Solenoid Switch	0.3 volt

GROUND-NEG CIRCUIT TEST

Trouble can be caused by a poor ground connection, a loosed starter motor mounting bolt, a bad battery terminal post connector, or a damaged cable from battery to engine block.

1. Select External Volts (±199.9V display)
2. Connect Volt test leads to battery NEG (-) post and starter motor case. Scratch through paint with clip if necessary for good connection.

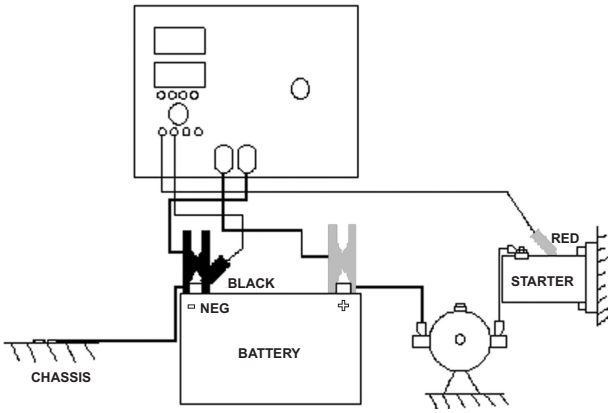

Figure 4
Connection For GROUND-NEG CIRCUIT TEST

3. With ignition disabled, crank engine and watch voltmeter to see that reading is not too high.
4. **Test Conclusion:** A good circuit will typically have less than 0.2 volt drop. If okay, go to Solenoid Control Switch Test, but if not, isolate the cause of excess voltage drop by testing across each circuit part.

SOLENOID CONTROL SWITCH TEST

1. Selection External ±199.9V display
2. Connect Volts test leads to both solenoid switch terminals. Battery voltage should be seen at this time
3. Disable the ignition so the vehicle will not start.
4. Turn the key switch to crank the engine while reading the voltage
5. Test Conclusion : **Less than 0.5 volt drop indicates good connections. If the voltage drop is higher, measure the voltage across the switches and wires along the circuit to further isolate.**

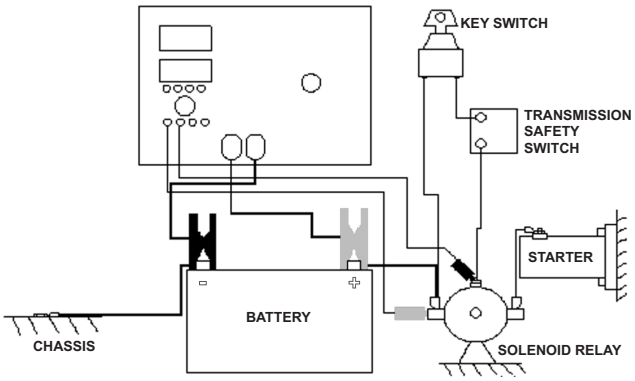

Figure 5
Connection For SOLENOID CONTROL SWITCH TEST

ALTERNATOR SYSTEM TESTS

The following test procedures will determine if there is a problem in the diode stator, voltage regulator, electrical load requirements, or in the alternator amperage output. The tests can pinpoint problems to the wires and connection between the charging output terminal, the regulator, the field, and the battery.

Always compare test results with manufacturer's specifications before coming to conclusions regarding the performance or efficiency of charging systems and their components. Look up the engine's alternator rating in a service manual. Check the alternator case for the output amperage rating. Be aware that remanufactured alternators might not be marked correctly.

An alternator may have output amps nearly to specification even though it has an open circuit diode. An open diode can overload the remaining good ones leading to their eventual failure. To avoid the possibility of overlooking this type of defect, the Analyzer includes a Diode/Stator indicator which senses missing volt cycles (called ripple) when at least 20 output amps are being measured.

The lamp will come on bright and steady when it senses excessive ripple. Disregard momentary flashes and the normal faint glow of the lamp.

TERMINAL CAUTION

Never put a wrench on a live battery wire terminal. Burns may result. Disconnect the battery ground cable first.

DIAGNOSTIC TEST PROCEDURE

If a cause for charging failure is found, correct it, and then continue this sequence to confirm system performance.

A. IF BATTERY HAS LOW CHARGE:

(If okay skip to B.) Always perform battery tests with ignition switch in "OFF" position.

Check battery post connections. Check alternator drive belt, and wire connections.

Test battery: If OK, Perform AMPERAGE OUTPUT TEST.

If OK, Check for excess (ignition switch OFF) battery drain.

B. RUN ENGINE WITH ACCESSORIES OFF:

Measure battery volts and observe car's Charge Indicator lamp. First test with engine stopped and ignition in the "RUN" position, then start engine and observe at 1500 to 2000 rpm.

C. BATTERY IS NEVER ABOVE 13V AND CHARGE LAMP IS ALWAYS ON; (If not; skip to D.)

Disconnect charge lamp wire at regulator.

(This may be in a connector with several wires.), (on Chrysler cars check the field winding continuity.)

Then with engine stopped and ignition switch in RUN" position

If lamp stays on; **look for a short to ground on the disconnected wire.**

If lamp stays off**; Check alternator field circuit for a short circuit, and check regulator for defect.**

D. BATTERY IS NEVER ABOVE 13V AND CHARGE LAMP NEVER LIGHTS; (If not; skip to E.)

Check instrument panel fuse.

Check field winding resistance to be between 2 and 10 ohms. Brushes or winding may be open. Turn rotor while measuring.

Consult wiring diagram for car's instrument panel to verify that charge lamp circuit is good.

E. BATTERY GOES ABOVE 16V.

Regulator not working; field current always on full. If external regulator, look for a wiring harness short or a bad regulator ground connection. **See REGULATOR GROUND TEST**

F. DO AN AMPERAGE OUTPUT TEST

G. DO A LOAD REQUIREMENT TEST

END PROCEDURE

AMPERAGE OUTPUT TEST

The key to this test is to run the engine at an adequate speed, and then load the alternator output to just below the regulated voltage level so that the regulator applies maximum field current.

1. Hook up the Analyzer as described in the general instructions. This includes having the Load OFF, the Battery Clamps connected to the battery and the Amp Meter zeroed. The battery should also have been verified to be good.

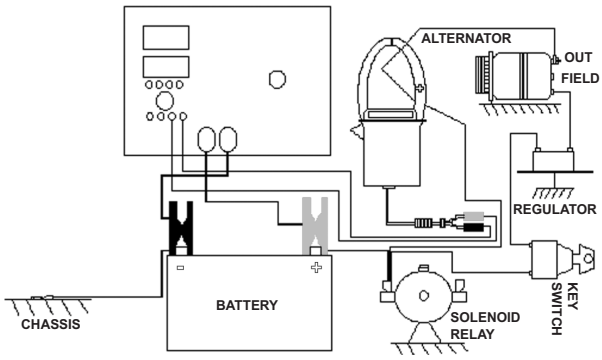

Figure 6
Connection For AMPERAGE OUTPUT TEST

1. Place the Amp Probe around the alternator output wire. Try to position the probe away from strong magnetism near the back (shaft) end of the alternator to avoid measurement error.
2. Display Battery Volts on the Analyzer.
3. Start and run the engine at about 2000 RPM.
4. Turn the Load ON and increase until the battery voltage decreases to be between 12.5 to 13.5 volts while reading the output amperage.
5. Turn Load OFF and reduce RPM.
6. **Test Conclusion**
   a. If the Diode/Stator lamp stayed on during the output test, replace the alternator.
   b. If the amperage abruptly decreased during the test, check for a loose belt.
   c. If output was less than 90% of rating, go to the Output Resistance Tests.

OUTPUT RESISTANCE TESTS

These tests are appropriate if the Charging Output Amperage is too low.

Circuit voltage drop measurements are made to determine if high resistance is limiting the system's amperage. The connections to test are:

a. Charging output terminal to the battery POS (+) post.

b. Alternator housing to the grounded battery NEG (-) post.

Causes of high voltage drops can be from LOOSE OR CORRODED CONNECTIONS at the output terminal of the alternator, the car's ammeter, battery terminal connection on the starter solenoid, battery cable connections, faulty wiring from alternator to regulator, to ammeter, to starter solenoid, or between the alternator and the engine.

Hook up the Analyzer as for all of the tests, with the Battery Clamps on the battery terminals.

1. Set Volts Selector to external ±199.9V.
2. Run engine at about 1500 RPM
3. Turn blower motor and headlights to high.
4. Measure Insulated Circuit voltage drop by connecting voltmeter from battery POS post to the alternator output terminal. See Figure 7. Over ±0.5V shows bad connections.

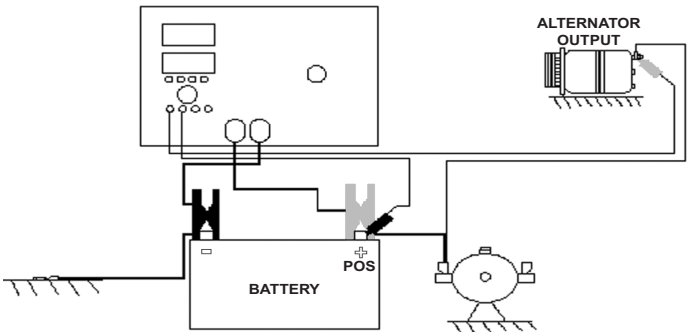

Figure 7

5. Measure Ground Circuit voltage drop by connecting voltmeter from battery NEG post to the alternator case. Over ±0.2V shows bad connections. See Figure 8.

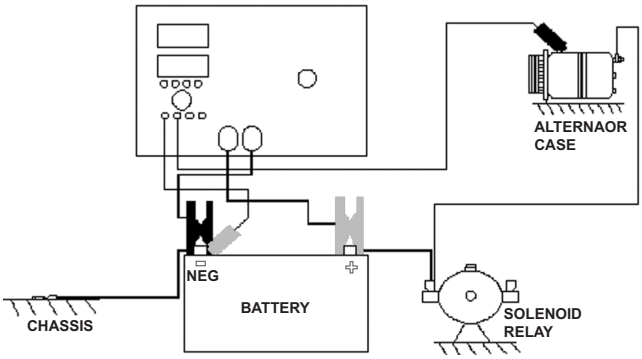

Figure 8

6. **Test conclusion :** If the circuit resistance voltage drops are high, repair the bad connections.

   Typical ratings for total circuit voltage drops at full output current:

General Motor	0.7V
Chrysle	0.9V
Ford Motors	0.4V with lamp
Ford Motors	0.8V w/ammeter

   If the voltage drops are not the problem, go to the Regulator Ground Test.

REGULATOR GROUND TEST

Perform this test if the charging voltage is too high or varies more than 0.2V with steady RPM and electrical loading.

1. Set Voltmeter to External ±199.9V
2. As shown below in Figure 9, connect the External Volt Leads from the voltage regulator case ground to the alternator case.

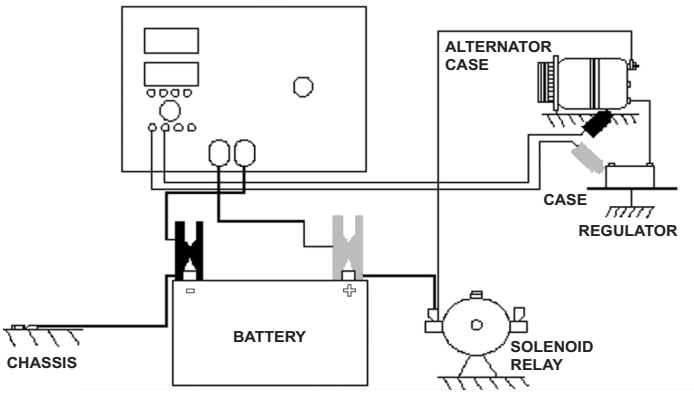

Figure 9

3. Run the engine at idle, but first momentarily boost it to 2000 Rpm to be sure the regulator has "cut in".
4. **Test Conclusion :** The voltage reading should be less than 0.1 volt. If not, look for loose bolts, a damaged ground strap or corrosion.

EXTERNAL REGULATOR CAUTION

Always disconnect the regulator before checking alternator output with full field jumpers. Always disconnect the connector plug from the regulator before removing the regulator mounting screws. Removing the connection from an ungrounded regulator with the ignition switch on may destroy the regulator. Be sure to disconnect electric choke wire from stator terminal of alternator when diagnosing charging system.

Check electric choke wire for a bad ground condition.

LOAD REQUIREMENT TEST

This test indicates if the charging output is enough to supply the vehicle accessory load requirement.

1. While running the car, turn on all lights, air conditioning, fan, wipers, sound system, and any other accessories that will run continuously.
2. Operate the engine about 2000 RPM. The Battery Volts readout must be greater than the battery voltage at rest to show that all the current is being supplied by the charging output (over 13.0V is good).
3. If low, switch off extra loads one at a time to determine the output shortage.

FULL FIELDING AMPERAGE TEST

This test disconnects the voltage regulator and applies alternator full field current directly to the battery, to see if the alternator windings and diodes are okay. External and internal regulator units can be tested as follows:

DO NOT GUESS ABOUT TERMINALS. WRONG CONNECTIONS MAY RUIN AN ALTERNATOR.

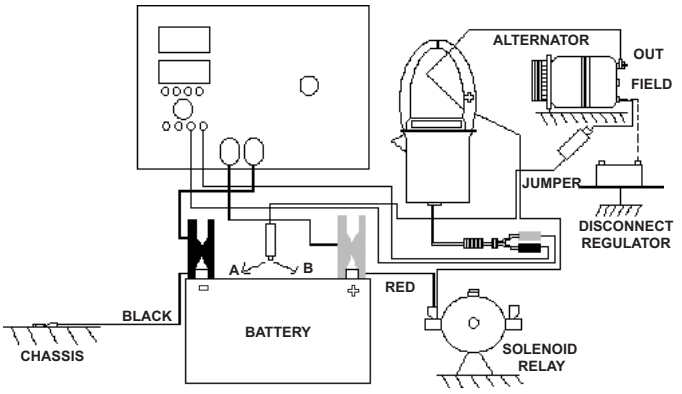

Figure 10

STEPS FOR EXTERNAL REGULATOR (TYPE) ALTERNATOR

1. Make connections according to figure 10 above.
2. With ignition key OFF, **unplug regulator or disconnect field wire.**
3. Measure voltage at alternator field terminal. If at battery volts, jumper the field terminal to the alternator case. If no volts, jumper to the alternator output terminal. If there is no spark when making this connection the field circuit is broken.

   Continue to step 4.

STEPS FOR INTERNAL REGULATOR (TYPE) ALTERNATOR

1. Make connections according to figure 10 (above).
2. This test can only be done if the alternator has a terminal for full fielding. **Be sure to have specific knowledge of the alternator's terminals. Grounding the wrong point can damage some alternators or burn up jumpers.** A 10 amp (inline) fused jumper can help minimize accidental damage.
3. Apply, or prepare to apply the field excitation when the engine is at idle. Get a helper if necessary.

   Continued from step 3
4. Start the engine and slowly bring RPM to 2000. Keep battery voltage between 12.5V and 13.5V by applying loading from the analyzer.

   Never let the voltage exceed 16 volts.
5. Remember the amps reading, and return to idle.
6. Shut off the engine, the battery load, and the alternator field.
7. **Test Conclusion**

   a. If output was less than 90% of rating, go back to the Output Resistance Test.

   b. Otherwise if the output is okay, the problem must be in the regulator or its wiring.

CAPABILITIES FOR 24V SYSTEM

The PST-1000 is capable of performing Battery Load tests, Starter Draw tests, and Alternator Current Output tests on 24 volt electrical circuit.

CAUTION

Working with batteries can be hazardous! Please read the SAFETY PRECAUTIONS on the front page of the PST-1000 manual.

CIRCUIT ARRANGEMENTS

Most 24 volt circuits utilize combinations of 12 volts batteries to provide 24 volts to the starter motor, controls and accessories. A CHASSIS battery (or bank of batteries) is used for the engine's 12 volt circuits, and a CRANKING battery (or bank of batteries) is added to the circuit to provide 24 volts to the starter motor.

Occasionally you may encounter banks of six volt batteries, or even a single 24 volt battery. Six volt batteries may be Load tested individually or in pairs, if wired in series. **NEVER attempt to Load test a 24 volt battery with the PST-1000.**

The two most common charging/starting arrangements are the TRANSFORMER-RECTIFIER, used on most newer engines, and the SERIES-PARALLEL switch.

Always refer to the engine manufacturer's instructions prior to conducting any tests, as some engines may have components and circuit arrangements that are not included in these examples.

TRANSFORMER RECTIFIER

In a TRANSFORMER-RECTIFIER circuit, the CRANKING battery is always wired in series with the CHASSIS battery. The TRANSFORMER-RECTIFIER alternator provides two separate voltage outputs. A high current 12 volt output charges the CHASSIS battery, and a low current 24 volt output charges the CRANKING battery. The TRANSFORMER-RECTIFIER regulates the charging voltage to both batteries automatically.

SERIES PARALLEL SWITCH

While charging, the CHASSIS battery and CRANKING battery are switched in parallel. During cranking, the SERIES-PARALLEL switch connects the CRANKING battery in series with the CHASSIS battery, providing 24 volts to the starter motor.

The following procedures and diagrams apply to circuits with a negative ground, a CHASSIS battery, a CRANKING battery, and either a TRANSFORMER-RECTIFIER alternator or a SERIES-PARALLEL switch.

BATTERY LOAD TEST

Batteries wired in series may be Load tested without disconnecting cables. Those wired in parallel MUST be disconnected prior to Load testing. Failure to do so will result in loading more than one battery at a time and will yield inaccurate results. Perform Load tests described earlier in the PST-1000 manual.

CAUTION

Always be sure that the Load is OFF before connecting the analyzer's Load cables to a battery.

To prevent damage to the SERIES-PARALLEL switch by high current flow, batteries must be disconnected from the circuit prior to Load testing.

STARTER DRAW TEST

This test measures the amount of current drawn by the starter motor during cranking. The procedures apply to both TRANSFORMER-RECTIFIER and SERIES-PARALLEL circuits. To prevent the engine from starting, disable the ignition or fuel supply, as recommended by the engine's manufacturer.

TEST PROCEDURES

1. Connect the analyzer's Load cables across any 12 volt battery.
2. Make sure all lights and accessories are off and vehicle doors are closed

3. Place the Amp Probe around the starter cable.
4. Connect the external volts positive lead to the positive terminal of the starter.
5. Connect the external volts negative lead to the starter ground.
6. Set the Volts Selector to External Volts ±199.9 volt range.

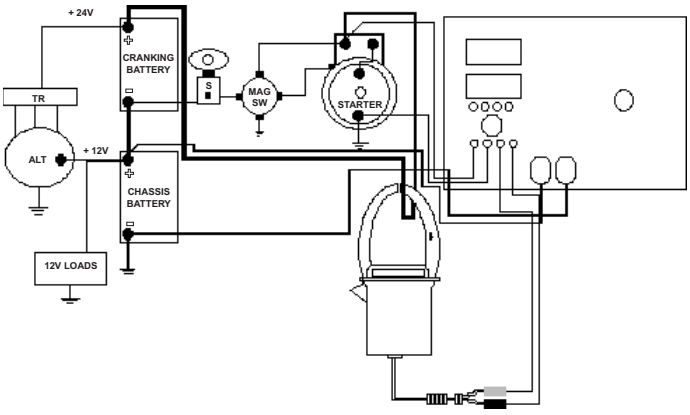

Figure 11
Transformer Rectifier Starter Draw Test

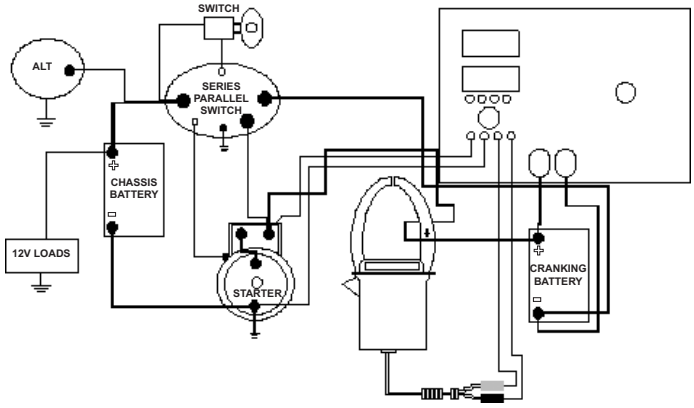

Figure 12
Series-Parallel Switch Starter Draw Test

Crank the engine for 15 seconds, and note the cranking amperage reading. Also, watch to see that the starter voltage stays above 19.2 volts. Never crank the engine longer than 30 seconds. Wait at least two minutes for the starter to cool, if the test is to be repeated.

In some medium-duty applications, where there are two banks of CRANKING batteries, it may be necessary to connect the Amp Probe around both wires at once to read total current draw. If the wires are too far apart for the Amp Probe, simply measure the draw in each wire and add the results.

TEST CONCLUSIONS

The circuit is good if cranking speed was satisfactory and battery voltage at the starter stayed above 19.2 volts. Slow cranking speed is often caused by poor connections in the cranking circuit. Refer to the PST-1000 manual for troubleshooting information. In a 24 volt circuit, acceptable voltage drops are twice those for 12 volt circuits. If testing of the magnetic switch, solenoid, and other components reveal no problems, the starter should be replaced.

ALTERNATOR OUTPUT CURRENT TEST

TRANSFORMER RECTIFIER

There are two separate output wires. A 12 volt, high current output feeding the CHASSIS battery and a 24 volt, low current output, feeding the CRANKING battery. (See diagram below).

TEST PROCEDURE

12 Volt Output

1. Connect the Analyzer's load cables across the CHASSIS battery.
2. Place the Amp Probe around the 12 volt output wire.

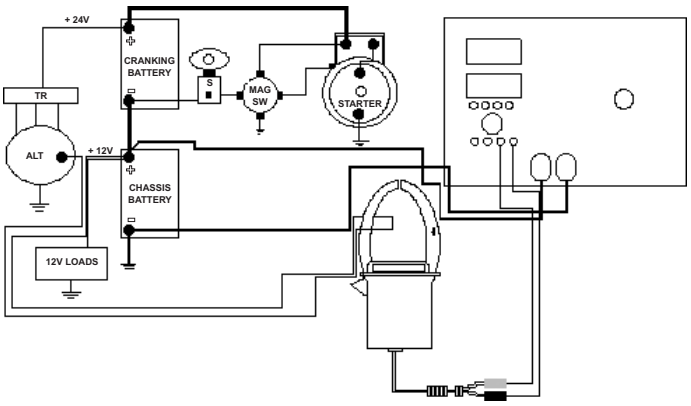

Figure 13
Transformer-Rectifier Alternator Output Test-12V

3. Set the Volts Selector to Battery Volts.
4. Run the engine at about 2000 RPM.
5. Turn the Load ON and increase until the battery voltage is between 12.5 and 13.5 volts while reading the output amperage.
6. Turn the Load OFF and reduce RPM.

TEST CONCLUSIONS

1. If the Diode/Stator lamp stayed on during the output test, replace the alternator.
2. If the amperage abruptly decreased during the test, check for a loose belt.
3. If output was less than 90% of rating, see PST-1000 manual for output resistance test procedures.

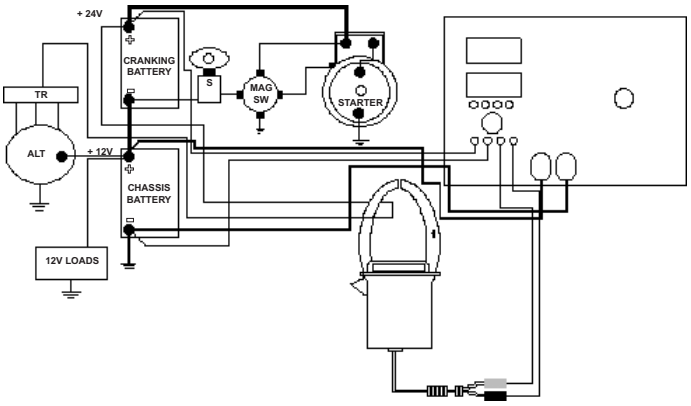

Figure 14
Transformer-Rectifier Alternator Output Test-24V

24 Volt Output

The 24 volt TRANSFORMER-RECTIFIER output only charges the CRANKING battery after the starter motor has drawn current from the battery. The following procedure should be used to simulate a recent starter draw and test for output current.

1. Stop the engine.
2. Connect the Analyzer's Load cables across the Cranking battery.
3. Place the Amp Probe around either Analyzer Load cable.
4. Apply a 200-300 ampere Load to the CRANKING battery for 15 seconds to simulate a recent start attempt. This will ensure that a charging current is delivered to the battery when engine is started.
5. Relocate the Amp Probe to be around the 24 volt output wire.
6. Connect the External Volts positive lead to the CRANKING battery Positive (+) terminal.
7. Connect the External Volts negative lead to the CHASSIS battery Negative (-) terminal.
8. Set the Volts Selector to External Volts, ±199.9 volt range.
9. Run engine at about 2000 RPM. Current should be at least 5 amps at 25-28 volts.

CAUTION

It is essential that Analyzer's Load cables are connected to the proper battery during these tests. The instructions will clearly state CHASSIS, or CRANKING battery.

SERIES PARALLEL CIRCUIT

CAUTION

To prevent drawing high current through the SERIES-PARALLEL switch, the Load must be applied to the CHASSIS battery during this test. Do not draw voltage below 12 volt.

TEST PROCEDURE

1. Connect the Analyzer's Load cable across the CHASSIS battery.
2. Place the Amp Probe around the 12 volt output wire.
3. Set the Volts Selector to Battery Volts.
4. Run the engine at about 2000 RPM.
5. Turn the Load ON and increase until the battery voltage is between 12.5 and 13.5 volts while reading the output amperage.
6. Turn the Load OFF and reduce RPM.

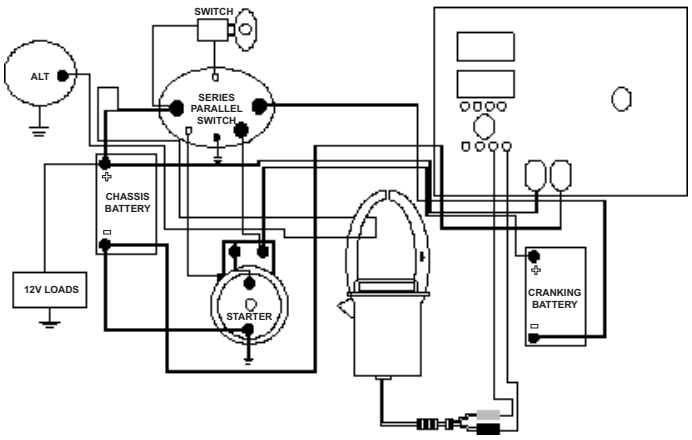

Figure 15
Series Parallel Switch Alternator Output Test

TROUBLESHOOTING

Procedures for troubleshooting cables and connections in the charging and starting circuits are included in the PST-1000 manual. Always refer to the engine manufacturer's instructions before performing any tests with which you may be unfamiliar.

ANALYZER CARE

- When cleaning the Analyzer and leads, use a mild cleaner such as waterless hand cleaner. Never use gasoline, lacquer thinner, carburetor cleaner, or other aromatic solvents.
- Store Analyzer indoors
- Do not place heavy objects above the case.

UNUSUAL ANALYZER OPERATION

If the analyzer battery clamps are connected to an excessively high voltage the display may blank out. Disconnect the analyzer as soon as possible and shut off the engine.

Check the battery terminal connections visually and also with a Volt meter to verify good connections before the alternator is run.

This situation can happen on a 12 or 6 volt system if a battery cable is intermittently loose and the alternator is running. During the moment that the battery connection opens there may be an over voltage that can be damaging to anything powered by the system. A vehicle battery with a bad internal link can do the same thing, but could also be an explosion hazard if charging gas is permitted to build up and a spark occurs at the break.

In general, if the analyzer is not reading right, disconnect for a few seconds and then try it again. This resets the internal protectors.

If the carbon pile is used so much it become red hot, (as viewed through the case side vents), turn it off. Allow the fan to run for few minutes to cool the carbon pile. The pile plates may have to be replaced if exposed to red heat too long. If the pile is used normally it should never reach such an extreme temperature.

SHIPPING:

To avoid shipping damage to the Carbon Pile Load during shipment, it is important that the Large Control Knob Be Turned Full Increase (Clockwise) Before Shipping.

NOTICE:

The information in this manual is true and complete to the best of our knowledge. Because design matters, Engineering changes and methods of application are beyond our control. The authors and publisher disclaim any liability incurred in connection with the use of this data or specific details.

LIMITED WARRANTY

SCHUMACHER ELECTRIC CORPORATION, 801 BUSINESS CENTER DRIVE, MOUNT PROSPECT, ILLINOIS 60056-2179 MAKES THIS LIMITED WARRANTY TO THE ORIGINAL PURCHASER AT RETAIL OF THIS PRODUCT. THIS LIMITED WARRANTY IS NOT TRANSFERABLE.

Schumacher Electric Corporation warrants this battery tester for one year from date of purchase at retail against defective material or workmanship. If such should occur, the unit will be repaired or replaced at the option of the manufacturer. It is the obligation of the purchaser to forward the unit together with the original sales receipt, transportation and/or mailing charges prepaid to the manufacturer or its authorized representative.

This limited warranty is void if the product is misused, subjected to careless handling, or repaired by anyone other than the manufacturer or its authorized representative.

The manufacturer makes no warranty other than this limited warranty and expressly excludes any implied warranty including any warranty for consequential damages.

THIS IS THE ONLY EXPRESS LIMITED WARRANTY AND THE MANUFACTURER NEITHER ASSUMES NOR AUTHORIZES ANYONE TO ASSUME OR MAKE ANY OTHER OBLIGATION TOWARDS THE PRODUCT OTHER THAN THIS EXPRESS LIMITED WARRANTY. THE MANUFACTURER MAKES NO WARRANTY OF MERCHANT ABILITY OR FITNESS FOR PURPOSE OF THIS PRODUCT AND EXPRESSLY EXCLUDES SUCH FROM THIS LIMITED WARRANTY.

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LENGTH OF IMPLIED WARRANTY SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

WARNING: Handling the cord on this product or cords associated with accessories sold with this product, will expose you to lead, a chemical known to the State of California to cause cancer and birth defects or other reproductive harm. ***Wash hands after handling***.