Force 1C

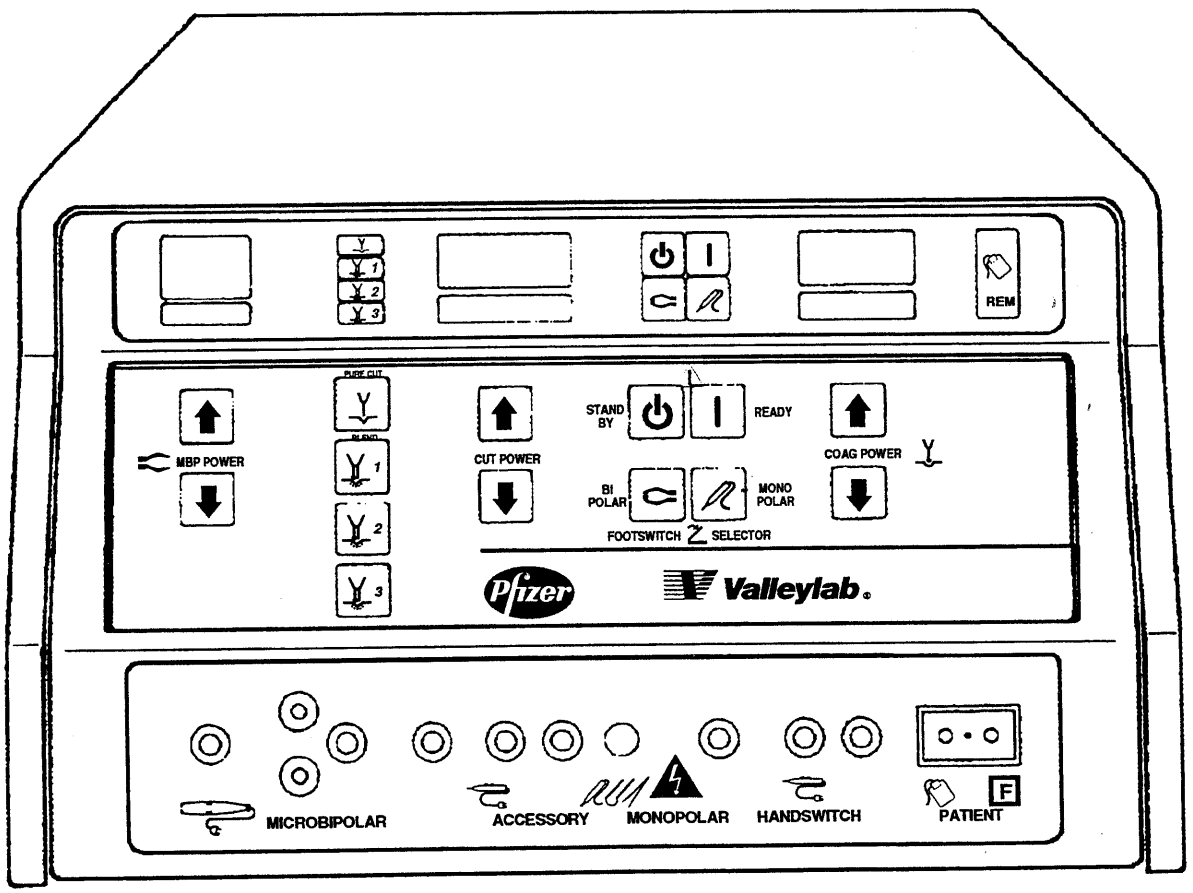
Electrosurgical Generator

Service Manual

Pfizer

Valleylab®

Section 3
Descriptions Of Controls, Indicators, and Receptacles



Front Panel

Controls

Standby - Press this button to place the electrosurgical generator in a hold mode. The generator cannot be activated, and all alarms are silenced. Power settings are retained in memory and dashes appear on the power setting display.

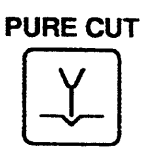
Ready - Press this button to make the power outputs, displays and alarms fully functional.

Monopolar - Press this button to select the monopolar footswitch control for activating the *Accessory* receptacle.

Bipolar - Press this button to select the microbipolar output when using the monopolar footswitch.

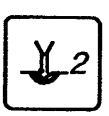
Up - Increases power in the selected mode. Press the button once to increase the power setting by one watt. Continuously pressing the button gradually increases the power to maximum.

Down - Decreases power in the selected mode. Press the button once to lower the power setting by one watt. Continuously pressing the button gradually decreases the power to minimum.

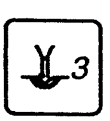


Pure Cut - Press this button to select cut with the lowest level of hemostasis.

Blend 1 - Press this button to select cut with minimum hemostasis.



Blend 2 - Press this button to select cut with moderate hemostasis.

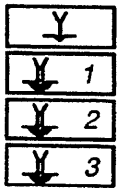


Blend 3 - Press this button to select cut with maximum hemostasis.

Indicators

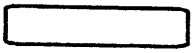
Standby Indicator - Indicates generator is on, but cannot activate outputs.

Ready Indicator - Indicates generator is ready for use.



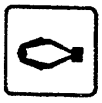
Cut Mode Indicators - One of four cut mode indicators illuminates to show the selected cut mode.

Power Setting Display - The digital power setting display is visible on the generator in the ready mode. The number displayed indicates the nominal power, in watts, which will be delivered to the patient when the mode is activated. In standby mode, dashes appear on the power setting display.



Output Power Indicators - This indicator illuminates when an output power (cut, coag, microbipolar) is activated. One of the two distinct mode indicator tones sounds in conjunction with the visual output power indicator.

Monopolar Indicator - This indicator illuminates when the generator's monopolar footswitch is selected for monopolar accessory activation.

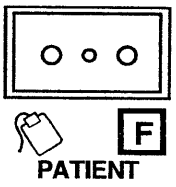


Bipolar Indicator - This indicator illuminates when the generator's monopolar footswitch control is selected to activate the microbipolar output.

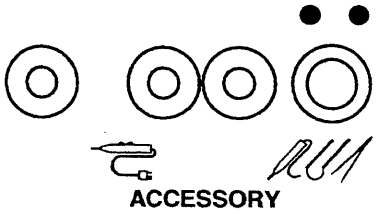
Alarms

REM Fault Indicator - This indicator illuminates when the REM Contact Quality Monitoring System senses that contact between the patient return electrode and the patient is not adequate. The tone sounds twice when the condition is first detected. The generator does not produce monopolar output power when this alarm condition exists. The alarm condition is cleared when the REM Contact Quality Monitoring System senses that the patient/return electrode contact resistance is within the acceptance range.

Receptacles



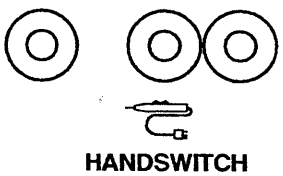
Patient Return Electrode Receptacle - This two-pin receptacle accepts the patient return electrode connector used in monopolar procedures. The receptacle accepts both REM (dual-section) and conventional patient return electrode connectors.



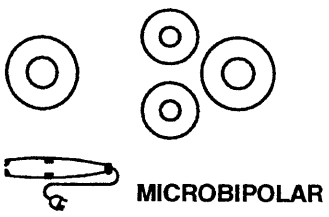
Monopolar Receptacle (Accessory) - This receptacle contains output jacks. It accepts three-pin handswitching active accessories or standard one-pin accessories which can be activated by the monopolar footswitch. Cut and coag modes may be activated at this receptacle. The handswitching pencil can be footswitch activated when connected to this output jack.

Warning

The Accessory output receptacle is designed for connecting either a handswitch (three-pin) or footswitch (one-pin) accessory, but not both at the same time. Connecting more than one accessory to the accessory output receptacle activates both accessories simultaneously.

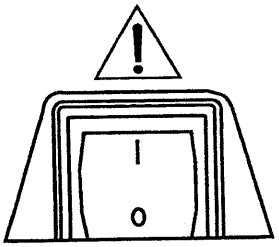


Monopolar Receptacle (Handswitch) - This receptacle accepts the three-pin handswitching active accessories. Power output from this receptacle is activated only by using the handswitch mechanism. No power is available through use of the footswitch. Cut and coag modes may be activated at this receptacle.

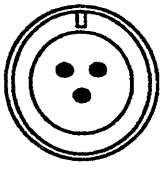


Microbipolar Receptacle - This receptacle accepts three-pin handswitching bipolar accessories. These accessories can also be footswitch activated. This receptacle also accepts two-pin bipolar footswitching accessories.

Rear Panel

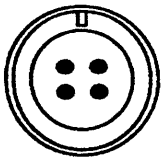


On/Off Switch - This switch includes a circuit breaker. Use the toggle to turn power on and off.



BIPOLAR
FOOTSWITCH

Bipolar Footswitch Receptacle - This three-pin receptacle accepts a single-treadle bipolar footswitch connector.



MONOPOLAR
FOOTSWITCH

Monopolar Footswitch Receptacle - This four-pin receptacle accepts a two-treadle monopolar footswitch connector.

Audio Volume Control - This control adjusts the volume of the cut, coag, and microbipolar mode indicator tones when the generator is activated. The volume for alarm conditions is not adjustable.

Section 4 Technical Specifications

In this section, "typical" refers to a specification that is within 20% of a stated value.

Specifications subject to change without notice.

Output Waveform

Cut	516 kHz sinusoid
Blend 1	516 kHz bursts of sinusoid at 70% duty cycle recurring at 31 kHz
Blend 2	516 kHz bursts of sinusoid at 45% duty cycle recurring at 31 kHz
Blend 3	516 kHz bursts of sinusoid at 20% duty cycle recurring at 31 kHz
Coag	516 kHz damped sinusoidal bursts with a repetition frequency of 31 kHz
Microbipolar	516 kHz sinusoid, unmodulated

Output Characteristics

	Maximum (open circuit) P-P voltage	Rated Load ohms	Nominal Power at rated load watts	Crest Factor at rated load (typical)
Cut	2400	300	200	1.8 @ 100 W
Blend 1	2800	300	175	2.7 @ 100 W
Blend 2	3200	300	150	3.3 @ 100 W
Blend 3	3600	300	125	4.6 @ 100 W
Coag	5200	300	75	8.0 @ 50 W
Microbipolar	900	100	50	1.8 @ 40 W

Output Configuration

Isolated output.

Input Power Source

Maximum Operating Range: 85-135 Vac or 170-270 Vac

Nominal Operating Range: 110-120 Vac or 220-240 Vac

Current:	Idle	0.5 A, max
	Cut	5.0 A, max
	Coag	3.0 A, max
	Microbipolar	2.0 A, max
Power:	Idle	60 W, max
	Cut	600 W, max
	Coag	400 W, max
	Microbipolar	180 W, max

The line frequency may vary between 50 and 60 Hz.

Line Regulation

Between 85-135 volts or 170-270 volts input, output power into nominal load will vary no more than 20% or 5 watts, whichever is greater.

High Frequency Risk Parameters

Microbipolar RF leakage current: < 150 mA

Monopolar RF leakage current: < 150 mA

Low Frequency Leakage (50-60 Hz)

All patient connected terminals tied together:

Source current normal polarity, intact chassis ground	< 10 µA
Source current normal polarity, ground open	< 50 µA
Source current reverse polarity, ground open	< 50 µA
Sink current, 135 Vac applied, all inputs	< 20 µA
Chassis source current, ground open	< 100 µA

REM Contact Quality Monitor

Measurement Frequency: 140 kHz ± 20 kHz

Measurement Current: 3.0 mA, maximum

Acceptable Resistance Ranges:

Single area pad - nominally < 20 ohms
Dual area REM pad - nominal range 5 - 135 ohms

If impedance measured is outside the acceptance range, a REM alarm sounds.

Audio Volume

The mode indicator tones are adjustable from 45 to > 65 dBA at 1 meter. The alarm tones are set to a level of > 65 dBA at 1 meter and are not adjustable.

Section 6 Maintenance Procedures

Routine Maintenance and Inspections

Valleylab recommends that the Force 1C be inspected by qualified service personnel every six months. Check the power cord assembly periodically for damaged insulation or connectors.

This service manual describes the recommended maintenance, inspection, testing, and calibration procedures. For major repairs, the generator can be returned to Valleylab. Repair parts and information are available from Valleylab. Refer to Section 8, "Service Parts List," for additional information.

Cleaning Instructions

Clean the Force 1C using standard hospital procedures. Use a mild detergent and damp cloth to clean the cover, control panel, footswitch, and cord. Do not allow fluids to enter the chassis. Do not use caustic, corrosive, or abrasive cleaning materials. The generator and all components must be completely dry before use.

The Force 1C cannot be sterilized.

Warning

Electric Shock Hazard: Do not install a wet power cord assembly into the generator or into a wall outlet.

General Testing Information

Warning

Take appropriate precautions (such as use of isolated tools and equipment, use of the "one hand rule," etc.) when taking measurements or troubleshooting the unit.

Electric Shock Hazard: Do not touch any exposed wiring or conductive surface while the generator is disassembled and energized.

Caution

The generator contains electrostatic sensitive components. When repairing the generator, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle the circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

When testing, follow proper testing procedures in order to duplicate manufacturer test data. Keep test leads as short as possible. Lead inductance and stray capacitance can affect meter readings adversely. Use of uncompensated scope probes may cause large errors in measurements. When measuring microampere leakage currents, accidental capacitive, or inductive coupling, may cause order-of-magnitude error in the observed values.

Perform the leakage current and ground resistance tests before returning the generator to clinical use.

Important

The Force 1C is not rated for continuous duty operation. (Maximum ON time at a power setting of 100 is two minutes.)

Recommended Test Equipment

You will need the following equipment to perform the checks and calibration described in this section. If substitute equipment is used, it must meet or exceed the specifications of the recommended equipment.

- Tektronix type 465 Oscilloscope, or equivalent, with 50 MHz or greater band width
- Tektronix type P6013A High Voltage Probe
- Tektronix type P6007 100X Probe
- Tektronix type P6010 10X Probe
- Fluke Model 8920A True RMS Meter
- Pearson Model 411 Wideband Current Transformer
- Simpson Model 1339 RMS RF Ammeter, 0-250mA
- Wattmeter, 0-500 watts 100, 300, and 500 ohm loads with reactive phase angle of less than 20° at 500 kHz (Valleylab E3002)
- General Radio 1192 Frequency Counter
- Fluke type 8020B DMM.

In testing RF equipment, proper test procedures must be adhered to in order to duplicate manufacturer obtained data. Keep test leads to the minimum usable length; lead inductance and stray capacitance can adversely affect readings. The selection of suitable "ground" points must be made with care to avoid ground loop errors.

Keep in mind that the meter accuracy of many RF instruments is 5-10% of full scale. Using uncompensated scope probes may cause large errors in the measurement of high voltage RF waveforms. When measuring fractional microampere leakage currents, accidental capacitive or inductive coupling may cause order-of-magnitude errors in the observed values.

Power Up Self-Test

Plug the generator into a grounded receptacle (extension cords and/or adapter plugs should not be used). Turn the power on using the ***On/Off*** switch which is located on the rear panel.

The generator conducts an internal self-test during which a tone sounds, digital displays show "8"s, and all lamps or indicators illuminate. Ensure that all digit segments, mode, alert, and power indicators illuminate. If any of these indicators do not illuminate, send the generator for service.

In five to seven seconds, following the self-test, the generator enters the standby mode with the digital displays showing dashes.

Press the ***Ready*** button. The digital display indicates one watt and the ***Monopolar Footswitch*** indicator illuminates.

Calibration

Important

RF power should be measured with the cover on.

The best performance is obtained if each adjustment is made to the exact setting. If substitute equipment is used, it must meet, or exceed the specifications of the recommended equipment. Also, all calibrations listed in the procedure are made at the manufacturer before the generator is accepted by Quality Assurance. If only RF output power needs to be recalibrated, proceed directly to steps 5-7 of the procedure.

Special care must be taken in Step 5. The 10X and 100X probes to be used should be closely calibrated with the oscilloscope to be used.

Calibration Procedure

1. Remove the cover from the Force 1C.
2. Verify proper operation of low voltage power supplies.
   a. +12 volt supply: Connect the digital multimeter between J304 pin 5 on the Power Supply Board and chassis ground. The meter should read +12V ± 0.5V.
   b. +5 volt supply: Connect the digital multimeter between J304 pin 4 on the Power Supply Board and chassis ground. The meter should read +5V ± 0.2V.
   c. -5 volt supply: Connect the digital multimeter between TP2 on the RF Output Board and chassis. The meter should read -5.0V ± 0.5V.

Caution

Use caution when working on the exposed High Voltage Board as the heatsinks and many of the components are floating at potentially harmful voltage potentials. Use the footswitching Accessory receptacle for generator output.

3. Verify proper idle condition operation of the high voltage power supply.
   a. Connect the digital multimeter between J304 Pin 1 on the Power Supply Board and chassis ground. The meter should read less than 5V.
4. Adjust the high voltage clamp.
   a. Set the coag display to 30 watts.
   b. Attach a 300 ohm load from the monopolar output to the ***Patient*** receptacle.
   c. Activate the generator in coag. Output power should be 30 W ± 5W.
   d. Remove the 300 ohm load.
   e. Adjust the coag display to 1.
   f. Attach an oscilloscope with a 100X probe between the anode of CR14 on the RF Output Board and ground. Activate the generator in coag. Slowly increase the coag power display and observe the peak positive voltage. Adjust R70 on the RF Output Board so that the maximum peak voltage is 300 (± 25) volts. Do not let the peak voltage exceed 325 volts while making this adjustment.

5. Adjust the coag output power.

   Potentiometers R73 and R76 on the RF Output Board are critical to the output power adjustments for coag. Follow steps a through d using a 300 ohm wattmeter.

   a. Set R76 (Coag ECON) to midsetting. Turn R73 (Coag ICON) fully clockwise.

   b. Set the coag display at 75W, and adjust R76 for 75W output in coag.

   c. Turn R73 (Coag ICON) counterclockwise until power starts to drop, then turn back clockwise until power returns to normal. Add 1/2 to 1 turn clockwise.

6. Adjust the cut output power.

   Potentiometer R72 and R75 on the RF Output Board are the output power adjustments in Pure Cut. Follow steps a through d using a 500 ohm wattmeter.

   a. Set R75 (Cut ECON) to midsetting. Turn R72 (Cut ICON) fully clockwise.

   b. Set Blend 2 display at 40 watts and adjust R75 for 36 watts output on Blend 2.

   c. Change wattmeter load to 300 ohms.

   d. With cut display at 200 watts, activate the generator and turn R72 (Cut ICON) counterclockwise until power drops below 200 watts, then turn back clockwise until power returns to normal. Add 1/2 to 1 turn clockwise.

7. Adjust the microbipolar output power.

   Potentiometers R71 and R74 on the RF Output Board are for the output power adjustments for microbipolar. Follow steps a through c using a 100 ohm wattmeter.

   a. Set R74 (Bipolar ECON) to midsetting. Turn R71 (Bipolar ICON) fully clockwise.

   b. Set microbipolar display at 50 watts and adjust R74 for 50 watts output in microbipolar with wattmeter load set at 100 ohms.

   c. Turn R71 counterclockwise until it affects microbipolar output in step b. Then turn R71 clockwise three turns.

REM Test Procedure

1. Connect a variable resistance across the patient terminals using a REM connector.
2. Set the resistance to 135 ohms and adjust R45 on the RF Output Board for the highest possible voltage on TP3.
3. Turn R44 counterclockwise until EREM is below 4 volts.
4. Turn R44 clockwise until the REM alarm sounds.
5. Decrease the resistance and record the value at which the REM alarm again turns on (5 ± 2 ohms).
6. Repeat step 1 using a connector that is not a REM type of connector.
7. Set the variable resistance to 5 ohms. Note that the REM alarm is off.
8. Gradually increase resistance and record the value at which the REM alarm turns on (20 ± 5 ohms). The REM alarm should remain off below this value and turn on again if above this value.

Line Frequency (50-60 Hz) Current Leakage Test Procedure

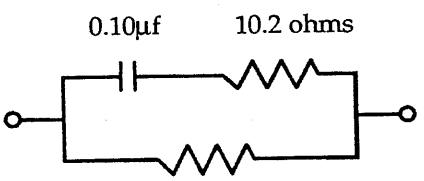
This test measures potentially dangerous 50-60 Hz leakage currents.

The Force 1C is turned on, but **not activated**.

The current is measured indirectly by observing the voltage developed across a 1k ohm resistor to ground from each front panel receptacle. A 0.01 microfarad capacitor connects across the 1k ohm resistor to remove any trace of high frequency noise generated by the oscillator inside the generator. This capacitor has little effect on the 50-60 Hz leakage current.

Leakage current is calculated from I = E/R, where R = 1k ohms and E is the voltage measured across the resistor. The maximum acceptable voltage across the 1k ohm resistor for 2.0 microamperes leakage is 0.002 volts (2 millivolts).

Input Circuit:



Important

The extreme difference in magnitude of the 50-60 Hz leakage current in the RF signals when the generator is activated, makes it very difficult to measure a 50-60 Hz leakage. When the generator is activated there can be as much as 5200 volts peak to peak of RF compared to 20 millivolts of 50-60 Hz. This ratio (110 db) of voltages would require the use of sophisticated measuring techniques. In practice, the 50-60 Hz leakage currents do not change significantly when the generator is activated.

Third wire leakage current is measured by opening the green grounding wire at the plug and connecting the 1k ohm resistor from chassis to ground. The maximum voltage across the 1k ohm resistor for 50 microamperes leakage would be 50 millivolts. Commercially available leakage testers may be used for this test.

The typical value of 50 microamperes is valid for manufacturer installed 15 foot 18/3 AWG line cords. Longer line cords or extension cords increase the third wire leakage and are not recommended. With the Force 1C turned off, the third wire leakage should be less than 10 microamperes.

The line frequency sink leakage is the current that passes into the patient leads when a 120 volt, 50-60 Hz potential is applied between a patient lead and the chassis. The voltage source should be a 110 volt isolation transformer with a 120k ohm current limiting resistor in series with a secondary.

The current is calculated from the voltage measured across a 1k ohm resistor in series with the AC volt source and the ***Patient*** or active receptacles. This current should be less than 100 microamperes.

Monopolar and Microbipolar Output RF Leakage Test Procedures

Important

The following procedure is meant to approximate the test procedure found in the International Electrotechnical Commission Standard 601-2-2 Sub-Clause 19.101b.) In applications where the IEC test must be performed, this procedure is not recommended as a direct substitute.

Do not connect the meter from one ***Monopolar*** receptacle to the ***Patient*** receptacle. Meter damage will result.

Test Setup

1. Place the Force 1C on a wooden table with no exposed metal on the surface or within one meter of the table surface.
2. Use the footswitch to activate the generator for these tests.

In this test, the RF leakage current to earth ground from the monopolar output is measured. The readings are made with an RF ammeter or 200 ohm wattmeter from a monopolar output to ground.

Microbipolar Procedure

1. Connect a 250 mA RF ammeter in series with a 200 ohm noninductive resistor from one microbipolar output receptacle to ground using a 20 foot (6.2 meters) wire.
2. Connect the other microbipolar output receptacle to a 10 foot (3.1 meters) wire held straight in front of the generator on a thick insulating surface.
3. Set microbipolar level to 50W.
4. Activate the generator in microbipolar mode. The RF leakage should not exceed 150 mA.
5. Swap the two microbipolar output connections and repeat steps a through d.

Monopolar Procedure

1. Connect a 250 mA RF ammeter in series with a 200 ohm noninductive resistor from the ***Accessory output*** receptacle to ground using a 20 ft wire.
2. Connect the ***Patient*** receptacle to a 10 foot (3.1 meters) wire held straight in front of the generator on a thick insulating surface.
3. Set cut and coag levels to 200 W and 75 W.
4. Activate the generator by shorting the active to activation receptacles using a short insulated jumper wire. The RF leakage should not exceed 150 mA.
5. Repeat steps 1 through 4 for the ***Handswitch output*** receptacle.
6. Connect a 250 mA RF ammeter in series with a 200 ohm noninductive resistor from the ***Patient*** receptacle to ground using a 20 ft wire.
7. Connect one ***Accessory output*** receptacle to a 10 foot (3.1 meters) wire held straight in front of the generator on a thick insulating surface.
8. Set cut and coag levels to 200 W and 75 W.
9. Activate the generator by shorting the active to activation receptacles using a short insulated jumper wire. The RF leakage should not exceed 150 mA.
10. Repeat steps 6 through 9 for the ***Handswitch output*** receptacle.

Chassis Ground Integrity Test Procedure

Check for the existence of a low impedance connection between the generator chassis and the third wire ground plug. To avoid any problems with contact resistance when measuring this impedance (0.1 ohm), it is recommended that a four wire resistance measuring technique be used. The recommended maximum impedance of 0.1 ohm is for the standard 15 foot, 18/3 AWG line cord. Use of longer cords is not recommended.