

**ELECTRICAL
SAFETY
ANALYZER**

USER'S GUIDE

505 Pro

BIO-TEK INSTRUMENTS
A DIVISION OF FLUKE BIOMEDICAL CORPORATION



BIO-TEK[®] INSTRUMENTS
A division of Fluke Biomedical Corporation

505 Pro[™] Series Electrical Safety Analyzer

User's Guide

Part No. 5031000
Revision D
November 2002

Notices

©Copyright Fluke Corporation
Fluke Biomedical
6920 Seaway Blvd.
Everett, WA 98203
Sales & Customer Service
775-883-3400 • 800-648-7952

Service and Repair
Please call for RMA number before shipping
1420 75th Street SW
Everett, WA 98203
888-99FLUKE (888-993-5853) • 425-446-5560

<http://www.flukebiomedical.com> • sales@flukebiomedical.com

All Rights Reserved Copyright © 1998

This publication is protected by copyright and all rights are reserved. No part of this manual may be reproduced or transmitted in any form, or by any means electronic or mechanical, including photocopying and recording, for any purpose other than the purchaser's personal use without the written permission of the product manufacturer.

Restrictions and Liabilities

Information in this document is subject to change, and does not represent a commitment by Bio-Tek Instruments. Changes made to the information in this document will be incorporated in new editions of the publication. No responsibility is assumed by Bio-Tek for the use or reliability of software or equipment that is not supplied by Bio-Tek, or its affiliated dealers.

Trademarks

Bio-Tek is a registered trademark, and 505 Pro is a trademark of Bio-Tek Instruments.

LIFEPAK 9P is a registered trademark of Physio-Control.

Revision Appendix

REVISION	DATE	PAGE	CHANGES
A	4/97		First Issue
B	3/98	iii	Added Safety Symbol and Precautions.
		1-3, 1-4, 1-5	Revised specifications.
		1-7	Revised Front Panel description.
		1-8, 1-9	Revised Rear Panel label and description.
		2-9, 2-15	Revised ISO current rating.
		5-3	Revised Trouble-shooting Table.

Revision Appendix (Cont.)

REVISION	DATE	PAGE	CHANGES
C	8/98	1-7	Clarified Test Receptacle operation.
		1-9	Added parallel printer connector information.
		1-10	Changed part numbers for printer and serial cables.
		2-2	Revised Test Lead Calibration section.
		2-18	Added Note describing data response when RS-232 cable or printer is detected.
		3-1	Replaced Section 3 in its entirety.
D	11/02		ECO 3285

Safety Symbols

This instrument and related documentation must be reviewed for familiarization with safety markings and instructions before operating the instrument.



The symbol to the left is the operator's manual symbol. When you see this symbol on the instrument, refer to the operator's manual.

Precautions

⚠ **Warning!** This sign denotes a hazard. It calls attention to a procedure or practice, which, if not correctly performed, could result in personal injury. Do not proceed beyond a ⚠ **Warning!** sign until the indicated conditions are fully understood and met.

⚠ **Caution:** This sign denotes a hazard. It calls attention to a procedure or practice which, if not correctly performed, could result in damage to or destruction of part or all of the instrument. Do not proceed beyond a ⚠ **Caution:** sign until the indicated conditions are fully understood and met.

Contents

Section 1 Introduction and Specifications	1-1
Upgrading the 505 Pro	1-1
Specifications	1-2
Description	1-6
Front Panel	1-6
Rear Panel	1-8

Section 2 Operation	2-1
Power-up Sequence	2-1
Test Lead Calibration	2-2
Manual Operation (505 Pro Series)	2-3
Resistance	2-3
Single-Lead Resistance (Ground Wire Resistance)	2-3
Dual-Lead Resistance	2-3
Leakage	2-4
Single-Lead Leakage (Chassis Leakage)	2-4
Ground Wire Leakage	2-5
Dual-Lead Leakage	2-6
Current	2-6
Voltage	2-7
Mains Voltage, Single Lead	2-7
Dual-Lead Voltage	2-7
ECG Leakage	2-8
Interlead Leakage Currents	2-9
ECG Lead Isolation	2-9
ECG Performance	2-10
Program Mode (505 Pro RS)	2-12
Restoring Factory Defaults	2-13
Viewing, Modifying or Defining Programs	2-13
Modifying ECG Leakage Selections	2-14
Modifying ECG Waveform Selections	2-15
Automatic Operation (505 Pro RS)	2-16

Contents (Cont.)

Section 3 Printer/RS-232 (505 Pro RS)	3-1
Printer Connection	3-1
Printing a Heading	3-2
Printing Data	3-2
Serial Communications Interface (505 Pro RS)	3-3
Overview of Serial Communications	3-3
Feedthrough Mode and the COM2 Serial Port	3-4
Computer Command Information	3-5
Serial Port Buffers, Handshaking, and Flow Control	3-7

Section 4 Applications	4-1
Testing Portable Devices Used in Isolated Power Areas	4-1
Three-Phase Portable Devices	4-2
Fixed Equipment (Permanently Wired Devices)	4-2
Isolated Power Systems	4-3
Macro Fault	4-3
Trip Point	4-3
Balanced Trip Point	4-3
Setup	4-3
Ground Fault Interrupters	4-5
Double-Insulated Devices	4-5

Section 5 Troubleshooting and Service	5-1
Warranty	5-1
Troubleshooting	5-3
Returning the 505 Pro for Service	5-4

Introduction and Specifications

Section 1

Bio-Tek's 505 Pro Series Electrical Safety Analyzers are portable instruments designed to perform all routine tests to determine if electrical devices, conductive surfaces, and receptacles meet recognized electrical safety standards, such as NFPA 99 and AAMI ES1.

505 Pro Series Safety Analyzers contain an internal resistance that simulates the lowest impedance (also referred to as the AAMI LOAD) that the human body offers to electrical current. The 505 Pro's test results indicate the actual current levels that would pass through the body if it were to offer a path for leakage currents. The 505 Pro Series also contain the IEC Test Load, which is a modified version of the AAMI Load. The IEC Test Load allows for testing leakage currents to the IEC 601-1, Medical electrical equipment, Part 2, General requirements for safety.

To precisely determine electrical safety parameters, 505 Pro Series Analyzers accurately measure leakage currents, ground wire resistance, line voltage and polarity, and ECG lead leakage. The 505 Pro is powered from 120V or 220 VAC for complete equipment testing.

The 505 Pro can function as an autoranging digital multimeter capable of measuring voltages from 0 to 5 volts, current consumption from 0 to 20 amperes, and resistance from 0 to 5 ohms.

During testing and calibration of ECG devices, the 505 Pro can output ECG and performance waveforms, such as low-frequency sinewaves, pulses, and squarewaves. These waveforms can be used to adjust the frequency response of strip chart recorders and bedside monitors.

Upgrading the 505 Pro

The 505 Pro may be upgraded to a 505 Pro RS at any time via a simple field upgrade. This can be performed by the user or by Bio-Tek's Service Department at calibration time. Note: Calibration is not required for this update. The 505 Pro RS includes Program and RS-232/Printer Options.

Specifications

Display

Digital (Full 4-digit)

Leakage Current

Ranges: 0-500, 450-5000 μ A True RMS

Accuracy: $\pm 5\%$ of Reading $\pm 1 \mu$ A
DC - 100 kHz

Input Impedance: AAMI ES1 1993

Frequency Response: DC - 1 MHz per AAMI

DC-Only Response: Maximum cutoff frequency (3 dB frequency) is 5 Hz when pressed.

ECG Leakage/Isolation

Ranges: 0-500, 450-5000 μ A True RMS

Accuracy: $\pm 5\%$ of Reading $\pm 1 \mu$ A
DC-100 kHz

Frequency Response: DC - 1 MHz per AAMI

Lead Isolation: Limited to 1 mA

Resistance

Measured via a two-lead technique using an auto zero resistance compensation with a 100 mA DC current source.

Range: 0-5.000 Ohms

Accuracy: $\pm 1\%$ full scale ± 1 LSD

Measurement Leads: Measurement to be taken between one test lead and the appropriate receptacle ground pin, or between two test leads.

Outlet Check

Line Voltage Measurement: HOT-NEU, NEU GND, HOT-GND

Range: 0-5.00, 5.00-50.0, 50-275 VAC/
VDC True RMS

Accuracy: $\pm 1\%$ full scale ± 1 LSD
DC-100 Hz

Current Consumption

Range: Measured in Neutral Lead
0.0-20.0 Amps

Accuracy: $\pm 5\%$ full scale ± 1 LSD true
RMS

Options: 10A max @ 230V

20A max @ 115V with a duty cycle of 20 % (2 minutes ON, 8 minutes OFF)

16A max @ 115V continuous current

ECG Simulation/Performance Testing

Accuracy: $\pm 2\%$ of reading for rate and
 $\pm 5\%$ of reading for amplitude,
fixed @ 1 mV Lead II
configuration.

Available Waveforms: Squarewave: 0.125, 2.0 Hz (50%
duty cycle); Sinewave: 10, 40,
50, 60, 100 Hz; Trianglewave: 2
Hz; ECG Complex: 30, 60, 120,
180, 240 BPM; Pulse: 30, 60
BPM (63 ms pulse width), 6-7
 μ sec rise and fall time;
Ventricular Fibrillation

Voltage

Range: 0-5.00 V AC/DC True RMS

Accuracy: $\pm 1\%$ of scale ± 1 LSD,
DC-100 Hz

Current Capacity

15 Amps @ 100/115 VAC
20 Amps @ 100/115 VAC
10 Amps @ 100/115/230 VAC

Size and Weight

10" x 10" x 5"; 8 lb.
25.4 x 25.4 x 12.7 cm; 3.61 kg

Electrical - 505 Pro

- Auto switching
100/115/230 VAC
50/60 Hz
- 20 Amps @ 100/115 VAC
10 Amps @ 100/115/230 VAC
- 505 Pro current consumption
less than 1 Amp
- Open-Neutral test to UL544
Requirements
- Calibration indirectly traceable
to U.S. National Institute of
Standards and Technology
(NIST)

Environmental

- Operating Temperature
10° to 40°C (50° to 104°F)
- Storage Temperature
-25° to 50°C (-13° to 122°F)
- Humidity: 10% to 90% Non-
Condensing
- Operating altitude up to 2,000
meters (6,562 feet)

Cleaning

Clean the 505 Pro with a damp cloth using mild detergent solution. Do not spray or soak the instrument.

Description

Front Panel

Figure 1-1 shows the front panel of the 505 Pro Series. A corresponding list of front panel components follows.

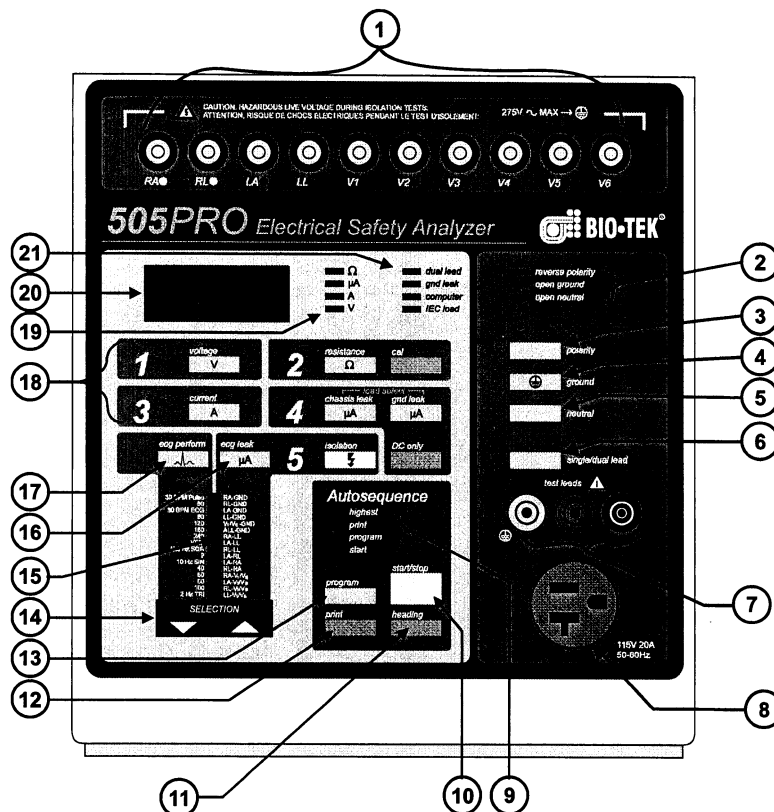


Figure 1-1: 505 Pro front panel

1. Universal ECG Jacks: Receptacles for ECG snap or banana jack.
2. Receptacle Status Indicators: The LED indicators illuminate to indicate test receptacle configuration and mode of operation.
3. Polarity Key: The polarity key reverses the polarity of the test receptacle.

4. Ground Key: The ground key opens the ground wire to the test receptacle.
5. Neutral Key: The neutral key opens the neutral line to the test receptacle.
6. Single/Dual Key: The lead key allows for selection of single- or dual-lead testing.
7. Red/Black/Green Input Jacks: The signal to be measured is applied between the red and black input jacks during dual-lead measurements. Use the red jack for single-lead measurements.
8. Test Receptacle: The 115V (15/20A) test receptacle provides power to the device being tested during single-lead testing. It is enabled when the 505 Pro is powered at line voltages less than 140 VAC.
9. Auto Sequence Status Indicators (valid with 505 Pro RS).
10. Start/Stop Key: Initiates or terminates operation of automatic mode (valid with 505 Pro RS).
11. Heading Key: Enables printing of instrumentation headings to be filled in by the operator (valid with 505 Pro RS).
12. Print Key: Enables printing capability (valid with 505 Pro RS).
13. Program Key: Allows the user to enter program mode and modify automatic test sequences (valid with 505 Pro RS).
14. UP/DOWN Arrow Keys: Upward and downward arrow keys move cursor to select ECG leakage combinations or ECG performance options.
15. LED Cursor Display: LED indicates status (On/Off) of ECG leakage combinations or ECG performance options.
16. ECG Leak Key: Allows selection of ECG leads to test for leakage.
17. ECG Performance Key: Allows selection of ECG performance waveforms to be output to ECG jacks.

18. Test Mode Keys: Test mode keys are used to select resistance, chassis leakage, ground wire leakage, current, voltage, DC-only, isolation and calibration tests to be performed. Additionally, the chassis leakage and ground leakage keys can toggle the test load between the AAMI and IEC loads.
19. Units of Measure: The LED indicators display units of measurement and illuminate to indicate ohms, micro-amps, amps, and volts.
20. Digital Display: Four LED digits indicate the magnitude of the measurements.
21. System Indicators: LED will illuminate to indicate selection in operation.

☛ **Note:** Numbers 9-13 are valid only with the 505 Pro RS.

Rear Panel

Figure 1-2 shows the rear panel of the 505 Pro Series. A corresponding list of rear panel components follows.

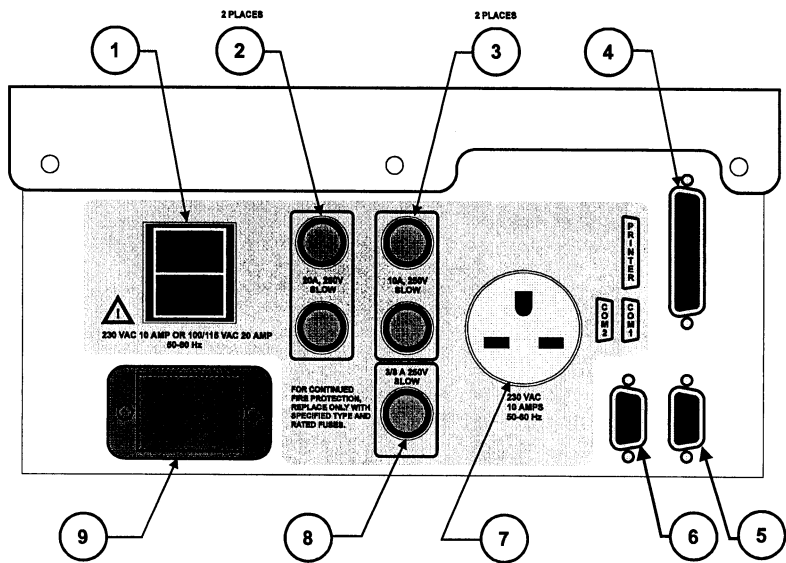


Figure 1-2: 505 Pro Rear Panel

1. On/Off Switch: Used to power the 505 Pro Series.
2. 20A Fuses: The 20A fuses are used for the protection of the front 100/115 VAC receptacle.
3. 10A Fuses: The 10A fuses are used for the protection of the rear 230V receptacle.
4. Printer Connector: Parallel interface for compatible printer.
5. COM1 Connector: RS-232 style serial port for computer connection.
6. COM2 Connector: RS-232 style serial port for feedthrough to other instruments.
7. 230V Receptacle : Similar function as the front panel test receptacle. It is enabled when the 505 Pro is powered at line voltages greater than 140 VAC.
8. 3/8A Fuse: The system power fuse.
9. Power cord connector, IEC type 320.

☛ **Warning!** For continued current protection, use a 15A fuse when connecting to 15 Amp outlets (15A Slow Blow Fuse, P/N 46007).

Accessories

Description		Supplied	Part Number
Test Leads (Blk. & Red)		1 Set	48016, 48017
User's Guide		1	5031000
Fuses:	Ref. No.:		
3/8A, 250V Slow (T)	8	1	46028
10A, 250V Slow (T)	3	1	46090
15A, 250V Slow (T)	2	1	46007
20A, 250V Slow (T)	2	1	46091
Large Clamp		1	7770014
Probe		1	48031

Optional Accessories

Description	Part Number
Fuses:	
10A, 250V Slow (T)	46090
20A, 250V Slow (T)	46091
15 Amp Power Cord	75033
20 Amp Power Cord	75058
220 Volt Power Cord	75057
Test Leads (Gold)	48032, 48033
Carrying Case	5022010
Printer (dot matrix)	97042
Printer Cable	71072
Serial Cable	6020503

This section details setup, calibration and operation of the 505 Pro Series.

Operation comprises the following subsections:

- Manual Operation
- Program Mode
- Automatic Operation

Power-up Sequence

1. Power on the 505 Pro.
2. Upon power-up, the 505 Pro will display the software revisions in an X.XX format, then automatically begin self-diagnostics; a one-second lamp test of all LEDs is performed as well as a one-second tone generation. The internal program memory and data memory also are tested for integrity.
3. The 505 Pro measures the line polarity and the voltage of the outlet it is plugged into at power-up, and indicates an error if the polarity is incorrect. If the polarity of the wall receptacle is reversed or the ground is open, the four-digit display will indicate **POL** or **GND**. If both conditions occur, the display will indicate **GND**.
4. If the wall receptacle polarity is reversed, the **REV POL** LED will flash when a reverse polarity test is performed on the device under test. If the wall receptacle ground is open, then the **GND** LED will flash during an open ground test on the device. The unit will not power-up if neutral line is open.

5. After initialization is complete, the 505 Pro will default to the single lead ground wire resistance test. In this test the circuit ground will be internally connected to the ground pin of the front panel outlet. The power to the front panel receptacle will be off and if the red lead is left not connected to anything the display will flash **OR**.

Test Lead Calibration

The 505PRO resistance tests measure the total resistance in the circuit (including the resistance of the test leads), and display this value minus a resistance previously measured as the test lead calibration resistance. The operation of measuring the test lead resistance is sometimes referred to as “zeroing” or “nulling” the test lead resistance. It is referred to here as Test Lead Calibration, and should be performed at the start of each test session or whenever test lead sets are changed.

To calibrate the 505 Pro for **single-lead resistance** measurements:

1. Use the red test lead to connect the red input jack to the front panel receptacle ground pin.
2. Press the **CAL** key to measure the resistance between the red input jack and the receptacle ground. This value will be stored in memory and automatically subtracted from the ground wire resistance measurement. The display will indicate **CAL** until the calibration is complete and 0.000 ohms is seen on the display.

To calibrate for **dual-lead resistance** tests:

1. Press the **SINGLE/DUAL** key to illuminate the **dual LED**.
2. Connect the red and the black leads to the respective input jacks, then short the ends together. Press the **CAL** key to perform the dual-lead calibration.

☛ **Note:** Calibration will fail (the display will flash **CAL** and the unit will beep) if the lead resistance is more than 0.5 ohms in single or dual lead mode.

Manual Operation (505 Pro Series)

Resistance

When measuring the resistance of devices with large inductive components, in either single or dual lead resistance tests, pressing the **dc only** key may give a lower reading. The lower reading is the correct one.

Single-Lead Resistance (Ground Wire Resistance)

Single-lead or ground wire resistance is the measurement of the resistance to the flow of a 100 mA current from the red lead to the ground connector in the 505Pro test receptacle.

1. Plug the device under test into the appropriate receptacle on the 505 Pro.
2. Plug the red lead into the red input jack on the front panel of the 505 Pro. Connect the other end to the equipotential point of the device under test.
3. Press the **resist** key. The Ω LED will illuminate, indicating resistance is selected.
4. Press the **single/dual** key, turning off the dual LED. This indicates that single lead is selected.
5. Ground wire resistance is displayed.

Dual-Lead Resistance

Dual-lead resistance measures the resistance to the flow of a 100 mA current from the red lead to the black lead. During Dual-Lead Resistance measurements between ground and another point, the black jack is connected to ground.

1. Plug the red and black leads into the red and black input jacks on the front panel of the 505 Pro.
2. Press the **resist** key. The LED will illuminate, indicating resistance is selected.

3. Press the **single/dual** key. The dual LED will illuminate, indicating dual lead is selected.
4. Resistance is measured between red and black leads.

Leakage

During all single- or dual-lead leakage tests, the DC component of the signal being measured may be displayed by pressing the **dc only** key. The display will show only the DC component of the measured leakage for 3 seconds or until another key is pressed.

- ☛ **Caution:** When testing motorized equipment and other capacitive or inductive loads, shut off power to the piece of equipment before reversing polarity to avoid damaging the device under test and the 505 Pro.

Before performing a leakage measurement, select a test load that simulates the body's impedance. The 505 Pro has two such loads on board. Upon startup, the 505 Pro defaults the test load to AAMI. Pressing the **chassis leak** and **gnd leak** keys simultaneously toggles the test load between AAMI and IEC 601-1.

Single-Lead Leakage (Chassis Leakage)

Single-lead leakage is the measurement of the current flowing from the chassis through the AAMI or IEC load to power source ground.

1. Plug the device under test into the appropriate receptacle on the 505 Pro.
2. Plug the red lead into the red input jack on the front panel of the 505 Pro. Connect the other end to the chassis of the device under test.
3. Press the **chassis leak** key. The μA LED will illuminate, indicating leakage is selected.
4. Press the **single/dual** key, turning off the dual LED. This indicates single lead is selected.

5. Select the receptacle configuration.
 - To select reverse polarity, press the **polarity** key and the **rev pol** LED will illuminate. To select normal polarity, press **polarity** key. The LED will turn off.
 - To select open ground, press the **ground** key and the **open gnd** LED will illuminate. To select closed ground press **ground** key again. The LED will turn off.
 - To select open neutral, press the **neutral** key. The **open neu** LED illuminates. To select closed neutral, again press the **neutral** key. The LED will turn off.

Several combinations of receptacle status may be selected.

6. The chassis leakage measurement for the configuration will be shown in the display. Measurement is the leakage current between the red input jack and earth ground.

Ground Wire Leakage

Ground wire leakage is the measurement of the current flowing through the AAMI or IEC load in series with the ground wire. This is performed when there is no equipotential connector on the device under test.

1. Plug the device under test into the appropriate receptacle on the 505 Pro.
2. Press the **gnd leakage** key. The **μA**, **open gnd**, and **gnd leak** LEDs will illuminate, indicating gnd leakage is selected.
3. Select receptacle configurations as in **Single-Lead Leakage** (Chassis Leakage).

Dual-Lead Leakage

Dual-lead leakage is the measurement of current flowing through the red lead, the AAMI or IEC load and the black lead.

1. Plug the red and black leads into the red and black input (test lead) jacks on the front panel of the 505 Pro.
2. Press the **chassis leak** key. The μA LED will illuminate indicating leakage is selected.
3. Press the **single/dual** key. The dual LED will illuminate, indicating dual-lead testing is selected.
4. Leakage is measured between the red and black leads.

Current

Current measurement is the current that flows through the neutral wire of the DUT.

1. Plug the device under test into the appropriate receptacle on the 505 Pro.
2. Press the **current** key. The LED will illuminate, indicating current is selected.
3. Measurement of current consumption will be displayed.

Note: Dual current measurements are not available.

Voltage

Mains Voltage, Single Lead

1. Press the **voltage** key. The **V** LED will illuminate, indicating voltage is selected.
2. Press the **single/dual** key, turning off dual LED. This indicates single lead is selected.
3. The line voltage is measured three ways:

- The first voltage is measured from **HOT-NEUTRAL**.
Example:

H - n (Displayed for 2 seconds)	121.1 (Displayed for 2 seconds)
--	--

- The second voltage is measured from **HOT-GROUND**.
Example:

H - Gn (Displayed for 2 seconds)	120.0 (Displayed for 2 seconds)
---	--

- The third voltage is measured from **NEUTRAL-GROUND**. Example:

n - Gn (Displayed for 2 seconds)	00.1 (Displayed for 2 seconds)
---	---

Dual-Lead Voltage

The range for Dual-Lead Voltage is limited to 0-5 volts. The 505 Pro will display **OR** if a voltage higher than 5 volts is applied.

1. Plug the red and black leads into the red and black input jacks on the front panel of the 505 Pro.
2. Press the **voltage** key. The **V** LED will illuminate, indicating voltage is selected.

3. Press the **single/dual** key. The **dual** LED will illuminate, indicating dual lead is selected.
1. Voltage measurement is between the red and black input leads.

ECG Leakage

ECG leakage is the measurement of current flowing from the patient leads through the AAMI or IEC load to power ground, or between any patient connection and any other patient connection, or between all patient connects tied together and power ground.

☛ **Note:** The V leads in the 505 Pro are all shorted together. This is to reduce the complexity of the product. Also, the number of 3- and 5-patient lead devices outnumber the 10-patient lead devices in most hospitals. An application note is available explaining how to test 10- and 12-lead ECG monitors.

1. Plug the ECG device to be tested into the appropriate receptacle on the 505 Pro.
2. Press the **ecg leak** key. The LED below the key will illuminate indicating ECG leakage has been selected. The **μA** LED will also illuminate, indicating the leakage current measurement mode.
3. Connect RA, RL, LA, LL, V1-V6 leads from the ECG device into the corresponding input jacks on the 505 Pro.
4. The cursor LED will appear at the top position of the LED cursor display.
5. Pressing the ▼ key advances the cursor one position down while the ▲ key advances the cursor up one position. Continuously pressing either arrow will advance the cursor quickly.

The ECG leakage test selections are:

RA-Gnd	RL-LL
RL-Gnd	LA-RL
LA-Gnd	LA-RA
LL-Gnd	RL-RA
V1/V6-Gnd	V1/V6-RA
ALL-Gnd	LA-V1/V6
RA-LL	RL-V1/V6
LA-LL	LL-V1/V6

Select the receptacle configuration as detailed in **Single-Lead Leakage** (Chassis Leakage), page 2-4. After the desired selection has been made, the measurement will be shown on the display.

Interlead Leakage Currents

Interlead Leakage Currents measured with the 505 Pro require that all individual lead to ground and isolation tests pass to ensure interlead leakage current measurements.

ECG Lead Isolation

- **Warning!** During isolation, line voltage is present at the ECG Terminal(s) being tested. Up to 1 mA at 115V or 2 mA at 230V may flow.

The ECG lead isolation test is the measurement of the current in a patient connection when a source voltage is applied through the AAMI load to power ground. The isolation test may be performed during all earth-referenced ECG leakage tests (RA-Gnd, RL-Gnd, LA-Gnd, LL-Gnd, V1/V6-Gnd, ALL-Gnd).

1. Plug the ECG device to be tested into the appropriate receptacle on the 505 Pro.
2. Connect RA, RL, LA, LL, V1-V6 leads from the ECG device into the corresponding input jacks on the 505 Pro.
3. Press the **ecg leak** key. The LED below the key will illuminate, indicating ECG leakage has been selected. The **μA** LED will also illuminate, indicating the leakage current measurement mode.
4. The cursor LED will appear at the top position of the LED cursor display.
5. Pressing the **▼** key advances the cursor one position down while the **▲** key advances the cursor up one position. Continuously pressing either arrow will advance the cursor quickly. The test begins 0.5 seconds after the last depression.
6. Press and hold the **isolation** key.
7. The 505 Pro will apply line voltage to the selected ECG lead, limiting maximum current flow to 1 mA. The 505 Pro will beep for 3 seconds after the isolation key has been pressed, to notify the user there is line voltage on the ECG jacks. The display will be blank for a short while during this test.
8. The measurement of the leakage current to earth ground will be displayed.

ECG Performance

1. To test the performance of an ECG monitor/machine, the ECG performance waveforms are used.
2. Plug the ECG device to be tested into the appropriate receptacle on the 505 Pro.
3. Connect RA, RL, LA, LL, V1-V6 leads from the ECG device into the corresponding input jacks on the 505 Pro.

4. Press the **ecg perform** key. The LED below the key will illuminate indicating ECG performance has been selected.
5. The cursor LED will appear at the top position of the LED cursor display.
6. Pressing the ▼ key advances the cursor one position down while the ▲ key advances the cursor up one position. Continuously pressing either arrow will advance the cursor quickly. The test begins 0.5 seconds after the last depression.
7. During the ECG performance, other available tests except ECG leakage may be performed. Do not perform resistance measurements tests since it will shut off the power to the ECG machine.
8. To turn off the ECG performance test, press the **ecg perform** key. The LED will turn off, indicating exit from the test.
9. The ECG performance waveform selections are as follows:

30 BPM Pulse	0.125 Hz Sqr
60	2
30 BPM ECG	10 Hz Sin
60	40
120	50
180	60
240	100
Vfib	2 Hz Tri

Program Mode (505 Pro RS)

The 505 Pro can be used as a powerful automated safety analyzer capable of performing most manual tests automatically. To facilitate rapid testing of different types of equipment, 10 user-defined independent programs are available in the 505 Pro RS model. The 505 Pro may be retrofitted with the programmable mode of operation. See *Section 1, Upgrading the 505 Pro*.

Programs 0-2 have been assigned default values which may be easily customized by the user. All programs are stored in a non-volatile memory for quick retrieval. Programs 3-9 have been left open for user-defined programs.

PRO0	Resistance, chassis leakage, gnd leakage
PRO1	Resistance, voltage, current, chassis leakage, gnd leakage, ECG leakage, ECG performance
PRO2	Resistance, voltage, current, chassis leakage, gnd leakage, ECG Leakage
PRO3	Open
PRO4	Open
PRO5	Open
PRO6	Open
PRO7	Open
PRO8	Open
PRO9	Open

☛ **Note:** *Dual lead cannot be programmed. Isolation cannot be programmed, but is automatically performed when ECG Leak is selected in a Program.*

Restoring Factory Defaults


1. Press the **program** key to enter program mode.
2. Press the **program** key repeatedly until the display indicates the program **BEFORE** the one you want to set to the default settings.
3. Press the **program** key again and hold down for 10 seconds. The unit will start to beep at three seconds and continue until the defaults are retrieved and the display reads **DEF**. The factory settings are now restored for that program, only; all other programs remain the same.


☛ **Important:** Releasing the **program** key during the 10-second restoration period will terminate the retrieval and advance to the next program. For Programs 3 through 9, the factory default is open.

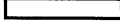
Viewing, Modifying or Defining Programs


1. Press the **program** key to enter program mode. The **program** LED will flash, confirming the selection.
2. The four-digit display will specify the program selected for modification, i.e., **PRO0, PRO1, PRO2, PRO3, PRO4, PRO5, PRO6, PRO7, PRO8, PRO9**.
3. Upon entry into the program mode, the display will read **PRO0** and the status indicators will illuminate, indicating tests that have been selected. The unit's LEDs next to the display indicate the tests that will be performed.

For example:

 **V** Indicates that line voltage measurement is programmed

 **A** Indicates that current consumption is programmed

 **μA** Indicates that chassis leakage test is **NOT** programmed

 **Ω** Indicates that ground wire resistance is programmed

☛ **Note:** All tests during auto operation are done as single lead. All tests are performed using the receptacle configurations selected, starting with the normal configuration. If the print **LED** is **ON**, the printer will record all test results.

4. To turn a test **ON** or **OFF**, press the associated key to toggle the state of the test.
5. If the **ecg leak** LED and/or the **ecg perform** LED are on, one or more of these tests and /or waveforms are selected. Any or all of the selections are valid and can be programmed as described below.
6. To save a modified program, press the program key after all test selections are made.

Modifying ECG Leakage Selections

- Press the **ecg leak** key.
- The **ecg leak LED** will flash.

- The bargraph indicator LEDs will illuminate if a test is selected for a particular combination of leads.
 - The cursor will blink, indicating its position.
 - If the cursor blinks at a **steady rate**, the test is **selected**.
 - If the cursor blinks at a **syncopated rate**, the test is **NOT selected**.
 - To toggle the selection, press the **ecg leak** key again. The cursor blink rate will change indicating the change of state.
- **Warning!** The isolation test is performed on all ECG leakage tests chosen during automatic operation. During isolation, line voltage is present at the ECG Terminal(s) being tested. Up to 1 mA at 115V or 2 mA 230V may flow.

Modifying ECG Waveform Selections

To program the ECG performance waveform selections, press the **ecg perf** key and modify the selections, following the instructions in *Modifying ECG Leakage Selections*, page 2-14.

1. After programming is complete, press the **start** key to initiate automatic testing.
2. Press the **program** key again to advance to another program or to exit Program Mode without starting an automatic test.
3. The four-digit display changes to read **PRO1** designating the second program. This continues until **PRO9** is reached. If the **program** key is pressed again, the 505 Pro will exit the Program Mode and go into the single-lead resistance (ground wire resistance).

The following keys have no function during the program mode and will cause three tones to sound when pressed:

- DC only
- Isolation
- Single/Dual
- Cal

Tests that cannot be performed in the program mode include:

- ECG leakage (in reverse polarity mode)

Automatic Operation (505 Pro RS)

To run preprogrammed test sequences:

1. Follow the instructions in the **Setup** section at the beginning of this chapter.
2. Plug the device under test into the appropriate 505 Pro receptacle.
3. Plug the red lead into the red input jack on the front panel of the 505 Pro. Connect the other end to the chassis of the device under test.
4. Attach the ECG leads if applicable.
5. Power up the device under test.
6. Select the desired 505 Pro program by pressing the **program** key until the display indicates the desired program (PRO0 - PRO9).
7. Press the **start/stop** key to start the automatic test sequence.
8. To stop the testing before completion, press the **start/stop** key. **ABOR** will be displayed.

- ☛ **Note:** Pressing the **start/stop** key stops automatic operation. The display will read **ABOR** indicating the test has been discontinued. The testing will restart if the **start/stop** key is pressed again. The **start/stop** key is the only valid key during automatic operation.
 - ☛ **Note:** Pressing **resistance, chassis leak, gnd leak, current, voltage, eeg leak or eeg perform** when **ABOR** is displayed will abort the autosequence.
9. The **start** LED flashes and the program LED illuminates, indicating that an automatic test is in progress.
 10. The status indicator LEDs will display the outlet configuration that is presently being performed.
 11. The four-digit display will display the value of the parameter being tested.
 12. If an OR reading is measured for ground wire resistance, the 505 Pro will beep until the value reduces to below 0.5 ohms.
 13. Testing will continue until all selected tests have been performed.
 14. At the end of the automatic test sequence, the four-digit display will read **DONE**.
 15. To exit Automatic mode, press the **resistance, chassis leak, gnd leak, current, voltage, eeg leak or eeg perform** keys.
- ☛ **Note:** When performing ECG leakage tests in the Program Mode, the 505 Pro will cycle through all ECG lead combinations programmed, then display only the highest reading on the display as indicated by the highest LED illuminator.
 - ☛ **Note:** When performing ECG leakage tests in the Program Mode, the 505 Pro will automatically perform isolation leakage tests.
 - ☛ **Note:** During automatic operation, the 505 Pro senses if an RS-232 cable or a printer is attached, and sends the data

to the appropriate device. If neither is attached, the display will show all of the measurements including the ECG leakages.

Printer/RS-232 (505 Pro RS)

Section 3

The 505 Pro RS model incorporates bidirectional RS-232 and print functionality, allowing data output to a compatible Centronics printer, and electronic data transfer and communications with a personal computer.

Printer Connection

The parallel printer port on the rear panel of the 505 Pro RS may be connected to a compatible printer with a standard IBM Personal Computer style parallel printer cable (available from Bio-Tek). Bio-Tek also can supply a printer and provide information on the compatibility of other printers.

The parallel printer connector consists of a D-Subminiature 25-circuit female connector with the following pin assignments:

Pin 1	Data Strobe (output)
Pins 2-9	Data Bits 0-7 (output)
Pin 11	Busy (input)
Pin 15	Printer Error (input)
Pins 18-25	Signal Return

Duplicate printout information is sent to the printer port and transmitted from the COM1 serial port. If both the printer port and the serial port have been selected for output and either port is not connected, off-line, or not functioning, output will still be made to the functioning port.

Printing a Heading

If the "heading" key is pressed (by the operator in the manual mode, or by the 'H' command in the computer control mode), a heading form similar to that shown below will be printed. A heading can also be printed at the start of an autosequence by pressing the "heading" key before pressing the "start" key:

Bio-Tek Instruments	
TIME	_____
DATE	_____
OPERATOR	_____
CONTROL #	_____
SERIAL #	_____
MANF	_____
MODEL	_____
LOC	_____
Comments:	

Printing Data

If the "print" key is pressed (by the operator in the manual mode, or by the 'P' command in the computer control mode), a test description, results, and units will be printed for the most recent test. In an autosequence test, data for all tests will be printed if the "print" key is used to toggle the Print LED ON before starting the autosequence.

A sample printout from an autosequence test follows:

Sample Printout

Gnd Wire Resistance:	0.055	Ohms
Line Voltage:		
Hot to Neutral	120.6	Volt
Hot to Ground	119.9	Volt
Neutral to Ground	0.3	Volt
Current Consumption:	0.32	Amps
Chassis Leakage:		
Normal Pol., w/Ground	0.0	mA
Normal Pol., no Ground	24.2	mA
Reverse Pol., no Ground	26.0	mA
Reverse Pol., w/Ground	0.0	mA
Ground Wire Leakage:		
Normal Pol., no Ground	24.2	mA
Reverse Pol., no Ground	26.0	mA
Patient Lead Leakage:		
Normal Pol., w/Ground		
RA-GND	0.0	mA

Serial Communications Interface (505 Pro RS)

Overview of Serial Communications

The 505 Pro RS is capable of operating in a manual mode, responding to the front panel keys, and in a computer control mode, responding to commands received by the serial port. The unit powers-up in the manual mode. Computer control mode is entered when the Enter Computer Control command '\$' is received, and exited when the Exit Computer Control command 'X' is received. The 505 Pro RS will remain in the test being executed after it exits the computer control mode. The "computer" LED on the front panel is unlit in manual mode and lighted in computer control mode.

When operating in the manual mode, the 505 Pro RS ignores all characters received by the COM1 serial port except the command to enter computer control, the XON character, and the XOFF character.

When operating in the computer control mode:

- All front panel keys are disabled and no sound occurs if they are pressed.
- The short single tone representing a "valid key click" is generated whenever a valid command is received.
- Three rapid tones representing an "invalid key click" are generated whenever an invalid command is received or a valid command is received but the output buffer is full. The command will be ignored.
- The "computer" LED on the front panel will light up.

If the "print" or "heading" keys are pressed (by the operator in the manual mode, or by the appropriate commands in the computer control mode), duplicate information is sent to the printer port and transmitted from the COM1 serial port. If both the printer port and the serial port have been selected for output and either port is not connected, off-line, or not functioning, output will still be made to the functioning port.

Feedthrough Mode and the COM2 Serial Port

The 505Pro-RS is capable of passing serial information between COM1 and COM2 while ignoring the content of the information. This is called feedthrough mode. The '%F' command sets the 505 Pro RS into the feedthrough mode and the '~' character (tilde) removes it from the feedthrough mode. When in the feedthrough mode, the display indicates "FEED", all LEDs are off except the computer LED, and the 505 Pro RS will ignore all characters passing through the ports in either direction except for the tilde character. The port parameters remain in effect.

Computer Command Information

Commands received at the COM1 serial port act like manual mode key presses with the following exceptions:

- Outlet configuration commands set and reset outlet functions instead of toggling them.
- The "DC only" and "isolation", commands activate the tests for about three seconds. To retrieve data from a "DC only" or "isolation" test, a print command must be received while the test is active.
- The computer commands are capable of running an autosequence, but are not capable of programming an autosequence (except for restoring the factory defaults).
- Several special-purpose commands exist to enter and exit the feedthrough mode and perform other functions as defined in the command list.

The commands are case-sensitive, and all are upper case.

Special Commands:

\$	Enter Computer Control Mode
X	Exit Computer Control Mode
QX	Select the AAMI Leakage Test Load
QY	Select the IEC Leakage Test Load
%F	Enter Feedthrough mode
~	Exit Feedthrough mode

Simulated "key press" Commands

Function	Command	Function	Command
Ground Leak	W	Chassis Leak	L
Resistance	R	DC Only	O
Current	C	Voltage	V
Cal	K	Isolation	I
Normal Polarity	Y	Reverse Polarity	E
Closed Ground	G	Open Ground	F
Open Neutral	J	Closed Neutral	N
Single	S	Dual	T
Program	M	Start/Stop	A
Print	P	Heading	H
Up Arrow	U	Down Arrow	D
Restore Defaults	B		

ECG Waveforms Selection

ECG Leakage Test Selection

Function	Command	Function	Command
30 BPM Pulse	ZA	RA-GND	QA
60 BPM Pulse	ZB	RL-GND	QB
30 BPM ECG	ZC	LA-GND	QC
60 BPM ECG	ZD	LL-GND	QD
120 BPM ECG	ZE	VLEAD-GND	QE
180 BPM ECG	ZF	ALL-GND	QF
240 BPM ECG	ZG	RA-LL	QG
VFIB	ZH	LA-LL	QH
0.125Hz SQ	ZI	RL-LL	QI
2 Hz SQ	ZJ	LA-RL	QJ
10 Hz SIN	ZK	LA-RA	QK
40 Hz SIN	ZL	RL-RA	QL
50 Hz SIN	ZM	VLEAD-RA	QM
60 Hz SIN	ZN	VLEAD-LA	QN
100 Hz SIN	ZO	VLEAD-RL	QO
2 Hz TRI	ZP	VLEAD-LL	QP

Serial Port Buffers, Handshaking, and Flow Control

A circular serial input buffer of 50 bytes is maintained. When the input buffer is full, any further characters received are ignored.

A circular serial output buffer of 1024 bytes is maintained. When the serial output buffer is full, further operation is delayed until space in the buffer is available. While delayed, any key presses (manual or via the computer) are acknowledged with the invalid key-click sound instead of the normal key press sound, but the key press has no further effect.

The 505 Pro RS has XON/XOFF output flow control. If an XOFF character is received, the serial transmission will stop (and data will accumulate in the output buffer). If an XON character is received, the contents of the output buffer will be transmitted from the COM1 serial port as fast as the port parameters allow. Upon power-up, the COM1 serial transmitter is set to the ON state.

Serial Port Parameters (both ports):

Baud Rate: 2400

Parity: NONE

Data Bits: 8

Stop Bits: 1

COM1 and COM2 Connector Pin Assignments (DTE):

Pin 2 RX (Input)

Pin 3 TX (Output)

Pin 5 Ground

All other pins left open

Applications

Section 4

This section details several different applications for the 505 Pro's test protocols.

Testing Portable Devices Used in Isolated Power Areas

1. Devices used in areas with isolated power systems (IPs) should be tested in an area with a grounded (conventional) power system. The IPS can decrease leakage current values substantially. In addition, leakage current standards are defined for a grounded power system operation.
2. Remove the device to be tested to an area with ground-referenced power.
3. Plug the device into an adapter cord with a female explosion-proof receptacle on one end. Connect the other end of the adapter cord to the receptacle on the 505 Pro's front panel.
4. Plug the 505 Pro line cord into a wall receptacle.
5. The device can now be tested for chassis leakage, ground wire resistance, lead leakage and isolation.

Three-Phase Portable Devices

1. Plug the device under test into an adapter that has an interrupted ground, but still provides power.
2. Plug the 505 Pro into a conventional outlet. The outlet should have the same ground potential.
3. The device can now be tested for chassis leakage and ECG leakage.

Fixed Equipment (Permanently Wired Devices)

Permanently wired devices can only be tested with the device in either the **ON** or **OFF** state. (This contrasts with portable units, which can plug directly into the 505 Pro's front panel receptacle and have receptacle conditions varied using 505 Pro front panel switching.)

If a power outlet is available that has a common ground with the device under test, or an adapter cord is available with a short ground wire, tests can be performed for chassis leakage, ground wire resistance, lead leakage, and isolation.

If a power outlet is not available with a common ground or an adapter cord is not available, tests can be performed for chassis leakage, lead leakage, and isolation (dual lead).

Isolated Power Systems

The 505 Pro can be used with the **Bio-Tek Universal Isotester** to test LIMs for the following conditions:

Macro Fault

The 505 Pro measures the total leakage in the IPS unit on either Line A or B. The 505 Pro measures the Macro Fault directly as a reading from 0 - 25 mA. (The 505 Pro reading should be multiplied by 10.)

Trip Point

The Universal Isotester tests the LIM's audible or visible alarms by simulating a variable fault-to-ground. The 505 Pro measures the leakage-to-ground from Lines A and B independently. The Trip Point is read directly from the calibrated Universal Isotester.


Balanced Trip Point

The Universal Isotester tests the Trip Point of the LIM under simultaneous fault conditions. The fault current (resistance) is varied simultaneously on Lines A and B. The Trip Point is read directly from the calibrated Universal Isotester.

Setup

1. Plug the Universal Isotester into the 505 Pro's front panel receptacle.
2. Connect the red lead from the red input jack of the 505 Pro to the red input jack on the Isotester. Connect the black test lead of the 505 Pro to the black input jack on the Isotester.

3. Connect the 505 Pro's plug to an appropriate adapter that can be connected to the IPS.
4. Press the **single/dual** key on the 505 Pro. The dual LED will illuminate, indicating that dual-lead testing is active.
1. Press the **leakage** key on the 505 Pro. The \odot A LED will illuminate, indicating leakage is active.

 **Note:** Record the LIM meter reading:

2. Push in the **MACRO A** button on the Universal Isotester. The 505 Pro will indicate 1/10 the total leakage-to-ground of the IPS. This reading should be approximately equal to the LIM meter reading.
3. Push in the **MACRO B** button on the Universal Isotester. The resulting measurements should be the same as that in Step 5.
4. Rotate the Universal Isotester **LIM TRIP POINT** knob full counterclockwise.
5. Push in the **LIM TRIP A** button on the Universal Isotester.
1. Slowly rotate the Universal Isotester **LIM TRIP POINT** knob clockwise.
2. Record the knob reading on the Isotester when the alarm sounds.
3. Repeat Steps 4 through 7 with the **LIM TRIP B** button pushed in.
4. Push in the **LIM TRIP A** and **B** buttons simultaneously; this introduces a balanced fault on each line-to-ground. The reading should be similar to the reading obtained in the preceding Side A and Side B tests. This test can be used to calibrate the LIM trip point.

Ground Fault Interrupters

1. When used with the Universal Isotester, the 505 Pro can thoroughly test GFIs for actual trip points. The section, *Isolated Power Systems*, describes what parameters are measured when the 505 Pro is used in conjunction with Bio-Tek's Universal Isotester.
2. Attach the Universal Isotester to the 505 Pro as described in *Isolated Power Systems*, page 4-3.
3. Rotate the Universal Isotester's **GFI TRIP POINT** knob full counterclockwise.
4. Plug the 505 Pro into the GFI being tested.
1. Slowly rotate the **GFI TRIP POINT** knob clockwise until the GFI is tripped.
2. Record the knob reading when the alarm sounds.

Double-Insulated Devices

To obtain leakage measurements when testing double-insulated devices (plastic housing with no exposed metal), leakages must be measured through the ground wire.

1. Plug the device under test into the appropriate receptacle on the 505 Pro.
2. Select **gnd leak** on the front panel. All connections will be made inside the 505 Pro. There is no need to connect the Red Lead anywhere.
3. Open the **neutral** line and record the results.

Troubleshooting and Service

Section 5

This section provides a brief troubleshooting guide to help you pinpoint potential problems with the 505 Pro, and if necessary, obtain service or technical assistance from Bio-Tek.

Warranty

This Warranty is limited and applies only to new products, except for computer-based software which is covered under a separate Warranty Policy, manufactured by Bio-Tek Instruments (“Bio-Tek”). Bio-Tek makes no warranty whatsoever regarding the condition of used products.

Bio-Tek warrants the 505 Pro (hereinafter collectively referred to as “Products” or “Product”) for a period of one (1) year from the original purchase date against defective materials or workmanship. This Warranty is limited to the original purchaser (the “Purchaser”) and cannot be assigned or transferred. All claims under this Limited Warranty must be made in writing to Bio-Tek, Attention: Service Department. Purchaser must ship the Product to Bio-Tek, postage pre-paid. Bio-Tek shall either repair or replace, at its option and without cost to the Purchaser, any Product which in Bio-Tek’s sole judgment is defective by reason of defects in the materials or workmanship.

This Warranty is VOID if the Product has been damaged by accident or misuse, or has been damaged by abuse or negligence in the operation or maintenance of the Product, including without limitation unsafe operation, operation by untrained personnel, and failure to perform routine maintenance. This Warranty is VOID if the Product has been repaired or altered by persons not authorized by Bio-Tek, or if the Product has had the serial number altered, effaced, or removed. This Warranty is VOID if any of the Products has not been connected, installed or adjusted strictly in accordance with written directions furnished by Bio-Tek. Batteries and fuses used in any of the Products are not covered by this Warranty. Software utilized in conjunction with any of the Products is not covered by the terms of this Warranty but may be covered under a separate, Bio-Tek software warranty.

Bio-Tek reserves the right to discontinue any and all models of the Products at any time or change specifications, price or design, without notice and without incurring any liability. Bio-Tek will continue to stock service parts for a maximum period of five (5) years after the manufacture of any Product has been discontinued. Parts shall include all materials, charts, instructions, diagrams and accessories that were furnished with the standard models of any discontinued Product.

PURCHASER'S EXCLUSIVE REMEDY FOR DEFECTIVE MATERIALS OR WORKMANSHIP IS THE REPAIR OR REPLACEMENT, AT BIO-TEK'S OPTION, OF THE PRODUCT. UNDER NO CIRCUMSTANCES SHALL BIO-TEK BE LIABLE TO PURCHASER OR ANY OTHER PERSON FOR ANY DIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER ARISING OUT OF BREACH OF WARRANTY OR OTHERWISE.

PURCHASER AGREES TO ASSUME ALL LIABILITY FOR ANY DAMAGES AND/OR BODILY INJURY OR DEATH WHICH MAY RESULT FROM THE USE OR MISUSE OF ANY PRODUCT BY THE PURCHASER, ITS EMPLOYEES, AGENTS, OR CUSTOMERS.

THIS WARRANTY CONTAINS THE ENTIRE OBLIGATION OF BIO-TEK. NO OTHER WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY ARE GIVEN. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR ANY PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED AND DO NOT APPLY TO THE PRODUCTS.

THIS WARRANTY SHALL NOT AND CANNOT BE CHANGED OR MODIFIED IN ANY WAY WITHOUT THE EXPRESS WRITTEN CONSENT OF AN OFFICER OF BIO-TEK.

Troubleshooting

The following chart provides basic troubleshooting information for the 505 Pro. Other problems should be referred to the Service Department at (800) 265-7586.

Symptom	Possible Cause	Action
Unit fails to power up	Blown fuse	Check 3/8A fuse
115V DUT doesn't power up when in current test mode	Blown 115V receptacle fuse	Check 115V 20A fuse
Display reads FUSE	Blown current	Check 3/8A fuse
Display reads ERR1	Outlet voltage out of tolerance	Check outlet voltage
Display reads ERR2	RAM/ROM failure	Call factory
Display reads ERR3	Current calibration error	Call factory
Display reads POL	Reverse polarity in wall outlet	Check outlet
Display reads GND	Open ground	Check outlet
Display reads USER	Leads not calibrated	Perform Ohms lead calibration
Display reads -bf-	NVRAM. Battery failure	Call factory
Display reads ERR6	Unit requires calibration	Call factory

Returning the 505 Pro for Service

Service and Repair
1420 75th Street SW
Everett, WA 98203
888-99FLUKE (888-993-5853) • 425-446-5560
<http://www.flukebiomedical.com> • sales@flukebiomedical.com

505 Pro