

Lionheart

ECG/ARRHYTHMIA SIMULATOR

Service Manual



Lionheart 1 ECG/Arrhythmia Simulator

Service Manual

Part Number 5131008

Revision C

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Bio-Tek[®] Instruments, Inc.

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Revisions

Revision	Date	Changes
A	8/97	Released to production.
B	5/99	Added Appendix A- Field Change Notice. Added Rev E- Printed Circuit Board and Schematic.
C	6/01	Converted electronic file from Adobe® PageMaker® to Microsoft® Word. Added revised warranty. Updated drawings.

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Abbreviations

A	ampere
BPM	beats per minute
c	centi- (10^{-2})
cm	centimeter
dB	decibel
°C	degrees Celsius (centigrade)
°F	degrees Fahrenheit
DMM	digital multimeter
ECG	electrocardiograph <i>or</i> electrocardiogram
Hz	hertz
in	inch
k	kilo- (10^6)
kg	kilogram
LED	light-emitting diode
M	meg(a)- (10^6)
MHz	megahertz
μ	micro- (10^{-6})
μV	microvolt
m	milli- (10^{-3})
mA	milliampere
mm	millimeter
ms	millisecond
mV	millivolt
Ω	ohm
lb	pound
s	second
V	volt

Chapter 1: Test and Calibration

This chapter provides the Service Instructions and the Service Data Sheet for the LH 1.

Company: Bio-Tek Instruments, INC.	Title: LH-1 Service Instructions
Division: Biomed Service	Doc ID: LH-1-SI Rev 1
Location: Winooski, VT U.S.A.	Page 1 of 2

Bio-Tek personnel are responsible for ensuring the use of the current revision of this document.

Change Record

Rev	Comments	Date	Approval
0	Initial release for use in lieu of service manual instructions for calibration of LH-1. This document is based on Manufacturer's Doc 202003 Rev C and includes additional checks of Bandwidth and ECG Lead Resistance.	07-Nov-00	N. Pompar
1	Specs changed per manufacturer's ECO 2924. Deleting specs from this document since they are duplicated on the data sheet.	01-Dec-00	N. Pompar

REFERENCE: LH-1 SDS

SCOPE

THIS PROCEDURE COVERS THE TEST AND CALIBRATION OF THE LH-1.

EQUIPMENT REQUIRED

1. KEITHLEY 2000 DMM OR EQUIV.
2. STORAGE SCOPE, TEK 2212 OR EQUIV.
3. 2 BANANA TO BANANA TEST LEADS
4. 9V BATTERY ELIMINATOR (1201-0019)
5. PHILIPS FREQUENCY COUNTER PM6666 OR EQUIV.
6. 1 VOLT OUT TEST CABLE
7. TWEAKER
8. COAX BNC TO BNC CABLE

INSTRUCTIONS

1. Check board for bent or missing components and poor solder joints.
2. Check that all connectors and switches are mounted correctly.
3. Set the switches as follows:

POWER off
 AMPL 2mV
4. Connect a battery eliminator. Set the POWER switch to BATT. The LED should light up. Release the POWER switch.
5. Depress and hold the CAL switch. Set the POWER switch to BATT. Wait a second and release the CAL switch but continue to hold the POWER switch in BATT. Rotate the WAVEFORM SELECTOR switch until the LED goes out. The switch is now in position 1. Release the POWER switch.
6. Depress and hold the CAL switch. Set the power switch to ON. Wait a second then release the CAL switch. This enters the cal mode.
7. Connect a DMM to lead I (LA - RA).
8. Set the WAVEFORM SELECTOR switch to position 1. Record the DMM voltage reading.
9. Set the WAVEFORM SELECTOR switch to position 2. Refer to data sheet and adjust R28 for the voltage to equal the reading for step 8 plus 2 mV.
10. Repeat steps 8 and 9 until the reading is within tolerance. Set POWER switch to OFF then ON.

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11. O'scope to .5V per/div., .2s/div. Place Waveform Selector Switch to position 1. Connect 1 volt out cable to high level output jack. Observe a 1 V square wave (.9V to 1.1V). Record results.
 12. Disconnect cable from scope and connect it to frequency counter side A.
 13. Set frequency counter to Per A, DC. Verify a reading of 495-505ms. Record results. Disconnect 1 volt out cable from unit.
 14. Connect DMM to RA-LA of LH-1.
 15. Verify ECG LEAD amplitudes per data sheet.
 16. Disconnect DMM. Return AMPLITUDE switch to 2.0mV position.
 17. Set power switch to OFF. Depress and hold the CAL switch. Set the power switch to ON. Wait a second then release the CAL switch.
 18. DMM to VDC auto range. Using two banana-to-banana test leads measure the amplitude between the ECG leads per data sheet. For each measurement set WAVEFORM SELECT SWITCH to position 1, zero DMM reading, then set WAVEFORM SELECT SWITCH to position 2 and verify reading is in spec.
 19. Bandwidth Check
 - 19.1 Turn power off, then on.
 - 19.2 Set Waveform Selector Switch to position 3 (SINE 40Hz).
 - 19.3 Note the amplitude.
 - 19.4 Set the Waveform Selector Switch to position 6 (SINE 100Hz).
 - 19.5 Measure the difference in amplitude.
 - 19.6 Verify the difference in amplitude per data sheet.
 20. ECG Lead Resistance
 - 20.1 Turn power off.
 - 20.2 Measure the resistances between RL and all other leads. These should be 1,000 Ω (950 $\rightarrow$ 1,050).
 21. Battery Status Indicator
 - 21.1 Connect power supply battery terminals.
 - 21.2 Set power supply to 6.2 V.
 - 21.3 Place Power Switch in BATT position and check that Battery Indicator is On.
 - 21.4 Set power supply to 5.3 V.
 - 21.5 Place Power Switch in BATT position and check that Battery Indicator is Off.
 - 21.6 Disconnect power supply.
 22. Energize LH-1 and check that waveform selected matches the waveform output for each of the 24 settings.
- End

Company: Bio-Tek Instruments, Inc.	Title: LH-1 Service Data Sheet
Division: Service	Doc. ID: LH-1-SDS Rev. 5
Location: Winooski, VT	Page 1 of 2

Bio-Tek personnel are responsible for ensuring the use of the current version of this document.

Rev	Comments	Date	Approved by
1	Initial release	97.12.08	N. Pompar
2	Corrected range for ECG lead resistance.	98.09.15	N. Pompar
3	Changed reference document, deleted chart recorder and added scope to test equipment record and added paragraph reference details.	98.09.28	N. Pompar
4	Complete revision to follow newly released LH-1-SI.	00.11.07	N. Pompar
5	Updated per manufacturer's ECO	01-Dec-00	N. Pompar

REFERENCE: LH-1 SI

INSTRUCTIONS

1. This data sheet is to be used with the referenced documents for service of the specified product.
2. The items in the section below labeled data are numbered to correspond with the referenced procedure.
3. Record the product serial number, date, and your signature in the space provided.
4. Record results in Tables.

Serial Number	Technician	Date

Step	What	Requirements	Results
1	Visual check of PCB.	No damaged/missing components.	
2	Visual check of unit.	Connectors and switches are correctly and securely fastened.	
8	With Selector Switch in position 1, record voltage at LA → RA.	Record results →	
9	With Selector Switch in position 2, record voltage at LA → RA.	Record results →	
10		Results for steps 8 and 9 should be within .02 mV. If not adjust R 28 and repeat steps 8, 9 and 10 until results are within .02 mV.	
11	Check amplitude of 2 Hz square wave	0.95 → 1.05 V	
13	Check period of 2 MHz square wave	497.5 → 502.5 ms	
15	Set ECG Amplitude Switch to		
	2.0 mV	1.90 → 2.10 mV	
	1.5 mV	1.43 → 1.57 mV	
	1.0 mV	0.95 → 1.05 mV	
	0.5 mV	.48 → .52 mV	

Company: Bio-Tek Instruments, Inc.	Title: LH-1 Service Data Sheet
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18	Other leads		
	RL → RA @ 2.0 mV	1.90 → 2.10 mV	
	RL → LA @ 4.01 mV	3.80 → 4.21 mV	
	RL → LL @ 4.97 mV	4.72 → 5.21 mV	
	RL → V1 @ 4.73 mV	4.49 → 4.96 mV	
	RL → V2 @ 5.72 mV	5.43 → 6.00 mV	
	RL → V3 @ 6.61 mV	6.27 → 6.94 mV	
	RL → V4 @ 8.00 mV	7.60 → 8.40 mV	
	RL → V5 @ 6.61 mV	6.27 → 6.94 mV	
	RL → V6 @ 5.73 mV	5.44 → 6.01 mV	
19	Bandwidth check	Difference in amplitude < 20%	
	Waveform Selector Switch to pos. 3.	Record amplitude →	
	Waveform Selector Switch to pos. 6.	Record amplitude →	
		Record difference	
		Record % difference	
20	ECG lead resistance		
	RA – RL	950 → 1,050 Ω	
	LA – RL	950 → 1,050 Ω	
	LL – RL	950 → 1,050 Ω	
	V1 – RL	950 → 1,050 Ω	
	V2 – RL	950 → 1,050 Ω	
	V3 – RL	950 → 1,050 Ω	
	V4 – RL	950 → 1,050 Ω	
	V5 – RL	950 → 1,050 Ω	
	V6 – RL	950 → 1,050 Ω	
21	Battery Status Indicator		
	Power supply set for 6.2 V	Lamp is ON	
	Power supply set for 5.3 V	Lamp is OFF	
22	Check waveform selection	Waveform selected matches output for each of 24 settings. If yes, record YES. If no, repair unit.	

Chapter 2: Theory of Operation

Block Diagram Description

In the following text, words in Block Type refer to blocks in the *Lionheart 1 Block Diagram*.

The Power Switch enables voltage from the Battery or Battery Eliminator to be regulated by the Power Supply, which then supplies the operating voltage (+5 volts) to the instrument.

The Waveform Generator reads information from the Waveform Selector Switch and the Menu Selector Switch and produces the waveforms (in digital form) determined by these two switches.

The D/A (Digital-to-Analog) Converter transforms the digital information from the Waveform Generator to an analog signal.

The Amplitude Switch determines the amplitude of the analog signal and sends it to the High Level Output. In addition, the Output Attenuator Network reduces the analog signal from the Amplitude Switch and sends it to the ECG Posts.

The Cal Switch enables the Waveform Generator to execute a firmware-driven calibration procedure for the instrument.

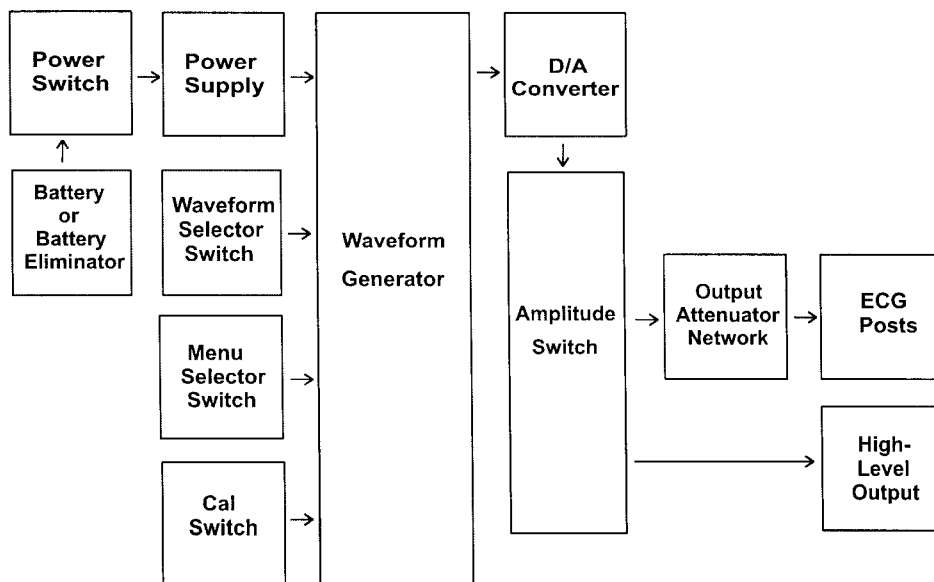


Figure 2-1. Lionheart 1 Block Diagram

Circuit Descriptions

This section explains the *Lionheart 1* circuitry depicted in the *Printed Circuit Board Schematic* in the *Technical Information* section.

Power

U1 regulates the Battery Eliminator or battery voltage to +5 V to power U2 (the microcontroller).

U1 also has a low-battery output at pin 5. U2 senses when this goes low and sets the output waveform to a sawtooth* regardless of the Waveform Selector Switch setting.

*NOTE: A sawtooth waveform is illustrated in *Power-Up* in the *Operating Instructions* section.

When the battery is low, U2 also sets pin 10 to a high-impedance state so that when S1 (the Power Switch) is set to the “BAT” position, LED1 (the Battery LED) will not light.

Y1 (the 4-MHz crystal), U2, and related components comprise the system clock. U2 internally divides the crystal frequency in half, creating a system clock of 2 MHz.

Waveform Generation

Waveform information is determined by S3 (the Waveform Selector Switch), S4 (the Menu Selector Switch), and input to U2 (pins 29-32) in binary format.

The Waveform Selector Switch position number equals the switch output code plus one. U2 generates the waveforms that are output on pins 11-19 as 8-bit digital information.

D/A (Digital-to-Analog) Converter

R31-R38 forms the D/A Converter.

The value of the resistance to ground at the output of the D/A Converter controls the waveform amplitude, which is selected by S2 (the Amplitude Slide Switch).

Resistors R1-R19 attenuate the signal at the ECG Posts to the proper levels.

The High Level Output is taken directly off the D/A Converter.

Troubleshooting

Important: Repair of the *Lionheart 1* should be done by qualified personnel only.

This unit has very few parts. Most of them are passive and therefore very reliable. A failure, most likely, is U1 or U2.

- Use the “BAT” position on the Power Switch to check the battery.
- Confirm that the Battery Eliminator is properly connected, if used.
- Check that U1 (pin 1) is at 5 V. If it is not at 5 V, then U1 has probably failed.
- Check for a waveform at the High Level Output. If no waveform is present, U2 has probably failed.

Refer to the previous section, *Circuit Descriptions*, for more information.

CAUTION: U2 is sensitive to static discharge. Be careful not to discharge static electricity into it when the unit is disassembled.

Chapter 3: Technical Information

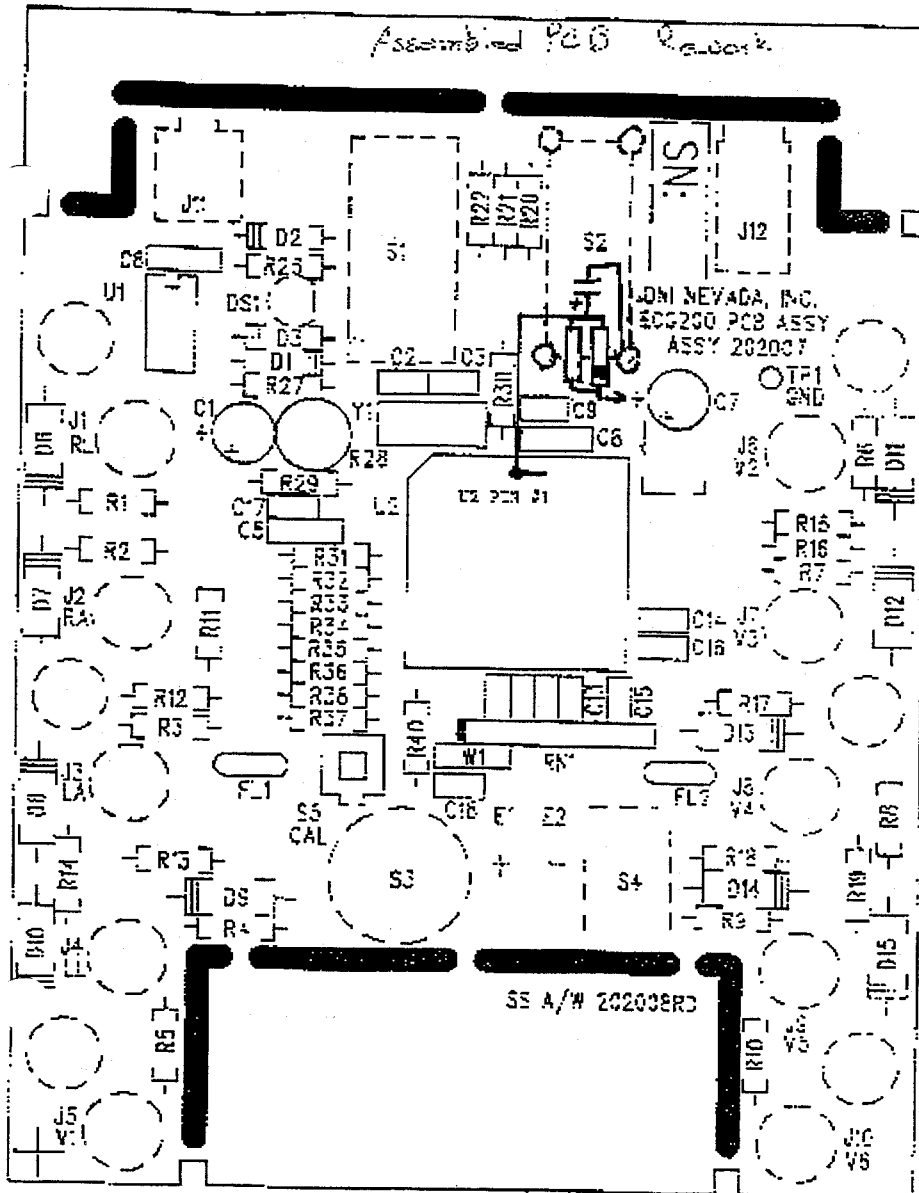
PART NUMBER	DESCRIPTION
5131000	LIONHEART 1 OPERATING MANUAL
5131008	LIONHEART 1 SERVICE MANUAL
7770111	LIONHEART 1 VINYL CARRYING CASE
42710	PHONE PLUG, 3.5 mm
48364	BATTERY ELIMINATOR, 115 VAC
48363	BATTERY ELIMINATOR, 230 VAC
48438	BATTERY ELIMINATOR, 230 VAC CE

Lionheart 1 Final Assembly Component List

REFERENCE	PART NUMBER	DESCRIPTION
ZZ02	4715-0021	SCRW 4-20 X 9/16 HEX WSHR
ZZ03	4902-0073	KNOB ALCO PKJ-50B-1/8
ZZ04	4904-0053	UNIBOX FEET
ZZ05	4919-0052	ECG POST KIT BLK (LA)
ZZ06	4919-0053	ECG POST KIT BRN (V)
ZZ07	4919-0054	ECG POST KIT RED (LL)
ZZ08	4919-0055	ECG POST KIT GRN (RL)
ZZ09	4919-0056	ECG POST KIT WHT (RA)
ZZ10	5001-0609	LIONHEART 1 TOP OVERLAY
ZZ11	5001-0322	GENERIC SERIAL NO. LABEL
ZZ12	5001-0323	LIONHEART 1 SERIAL TAG
ZZ13	5027-0174	LIONHEART 1 CASE MODIF
ZZ14	5205-0273	LIONHEART 1 PCB ASSY

Assembled PCB Layout

PCB
202037



16

S1 KSCREEN A/W 202008 REV. D SHI A

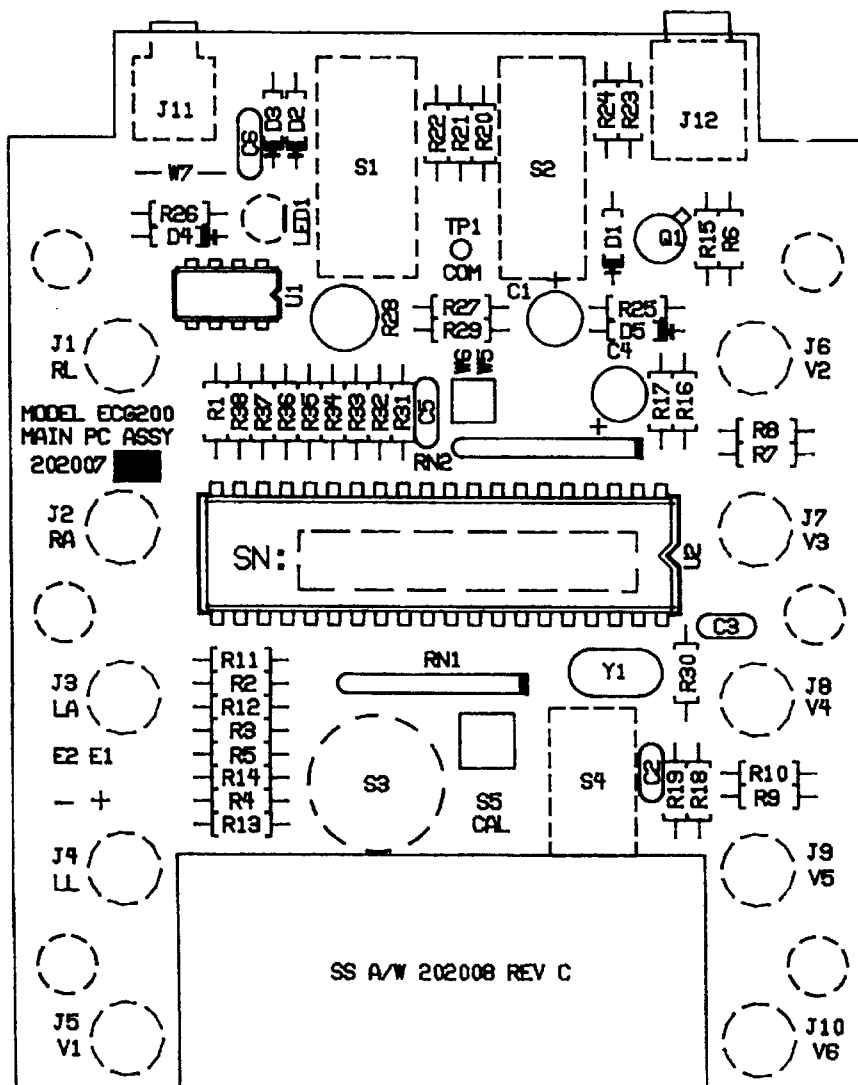


Figure 3-1. Printed Circuit Board Component Locator – Rev. C

