# TECHNICAL MANUAL Pulse Oximeter Tester Model SRC-2



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# INTRODUCTION

Electromagnetic Interference Unpacking and Inspection Manual Introduction Tester Description

## ELECTROMAGNETIC INTERFERENCE

This device has been tested and found to comply with the limits of the Electromagnetic Compatibility Directive 89/336/EEC. These limits are designed to provide reasonable protection against harmful interference in a typical installation. However, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise in the health-care and home environments (for example, cellular phones, mobile two-way radios, electrical appliances), it is possible that high levels of such interference due to close proximity or strength of a source, may result in disruption of performance of this device.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference with other devices in the vicinity. Disruption or interference may be evidenced by erratic readings, cessation of operation, or other incorrect functioning. If this occurs, the site use should be surveyed to determine the source of this disruption, and actions taken to eliminate the source.

The user is encouraged to try to correct the interference by one or more of the following measures:

Turn equipment in the vicinity off and on to isolate the offending equipment.

- Reorient or relocate the other receiving device.
- Increase the separation between the interfering equipment and this equipment.

If assistance is required, contact Mallinckrodt's Technical Services Department or your local Mallinckrodt representative.

#### UNPACKING AND INSPECTION

Upon receipt, inspect the shipping container, if it is damaged, immediately notify the carrier. The shipping container holds one SRC-2, one ECG patch cord cable Type L, and one service manual. Inspect each item, if the SRC-2, the patch cord cable, or the service manual is missing or damaged, immediately contact Mallinckrodt's Technical Services Department or Mallinckrodt's local representative.

## MANUAL INTRODUCTION

WARNING: Carefully read the operating instructions and all precautionary information (set in **boldface type**) before use.

This manual provides service information for the Nellcor pulse oximeter tester, model SRC-2. The SRC-2 is not intended for use with Nellcor pulse oximeter models N-10, N-30, or the 4-button N-100.

Note: This information is intended only for use by qualified service personnel.

The first three sections describe the SRC-2, give instructions for using it to test pulse oximeters, and provide a circuit description. The remaining sections describe troubleshooting, disassembly, test and calibration verification procedures, and provide a schematic diagram and a spare parts lists.

#### **TESTER DESCRIPTION**

The SRC-2 tests the light emitting diode (LED) drive circuits and internal detect circuits of Nellcor pulse oximeters. The SRC-2 is powered by the oximeter LED drive signals. Switches allow the selection of RATE, LIGHT, and MODULATION levels, mode of operation and RCAL. (RCAL is a parameter used to select the calibration curve.) LEDs provide an indication that drive signals from the oximeter are active.

- Note: This device is designed to verify the calculated SpO2 value at  $81\% \pm 2$ , and not any other values.
- Note: Due to the pulse wave shape generated by the SRC-2 tester and Nellcor's oximetry sampling technique, the pulse rate tolerance at high pulse rates slightly exceeds the oximeter's pulse rate accuracy specification. The oximeter's pulse rate specification is based on the clinical performance with physiological pulses rather than the square wave pulses generated by the SRC-2 tester.
- Note: The SRC-2 is intended to be used to assist verification of the operation of Nellcor oximeters and is **not** to be used to verify calibration of these oximeters. Refer to the oximeter's service manual for calibration instructions, if applicable.

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# **GUIDE TO OPERATION**

Front Panel Switches and Indicators Basic Operation with Oximeter





#### **Figure 1: Front Panel**

- 1. IR LED drive input indicator.
- 2. Standard oximeter connector.
- 3. RED LED drive input indicator.
- 4. Pulse RATE selector switch (38, 112, 201)
- 5. LIGHT output switch (low, high 1, high 2)
- 6. MODULATION selector switch (off/low/high)
- 7. RCAL/MODE selector switch
- 8. *C-Lock*<sup>®</sup> TEST input connector

#### SWITCHES AND INDICATORS

The SRC-2 front panel has four switches and two LED indicators.

- The IR LED drive indicator (1) and the RED LED drive indicator (3) illuminate when the OXIMETER is switched ON and the SRC-2 is connected to it. The LEDs indicate that the oximeter LED drive circuit signals are functional.
- The RATE switch (4) sets internally generated pulse rates: 38 beats/minute (bpm), 112 bpm, and 201 bpm.
- The LIGHT switch (5) has three positions (low, high 1, and high 2). Low simulates a condition of dark-colored skin or thick tissue between the sensor LEDs and the photo detector. The two high settings simulate conditions of light-colored skin or thin tissue between the sensor LEDs and the photo detector.
- The MODULATION switch (6) has three positions (off, low, and high) and controls amplitude of modulation. The high setting is equivalent to strong pulse signals detected by an oxygen transducer, and low setting is equivalent to weak pulse signals.
- The RCAL/MODE switch (7) selects SRC-2 controlled pulse rates, light level, and modulation when set to LOCAL, while also testing the RCAL 63 resistor. When set to REMOTE, local functions are disabled. When set to RCAL 64, this resistor is selected.
  - Note: REMOTE mode is reserved for future use. Do not use this mode with test procedures in this manual.

## **BASIC OPERATION WITH OXIMETER**

- 1. Turn the oximeter off.
- 2. Connect the SRC-2 to the sensor connector.
- 3. Turn the oximeter on.

Ensure that the SRC-2 IR and RED LED drive indicators are both lit.

- 4. Set the RCAL/MODE switch to RCAL 63/Local.
- 5. Set the LIGHT and MODULATION switches as required by test procedures 1–4 listed on the following page. Allow the oximeter a few seconds to obtain a steady reading.
- 6. Observe and record the OXIMETER SpO2 readings for saturation and pulse rate. These readings should be within the specifications defined in each of the tests listed below.

## Test 1

- 1. Set the LIGHT switch to HIGH 1.
- 2. Set the MODULATION switch to HIGH.
- 3. Set the RATE switch to 112.
- 4. Verify the following readings on the oximeter:

Saturation (%):  $81 \pm 2$ 

Rate (bpm):  $112 \pm 2\%$  (110 to 114)

## Test 2

- 1. Set the LIGHT switch to LOW.
- 2. Set the MODULATION switch to LOW.
- 3. Set the RATE switch to 201.
- 4. Verify the following readings on the oximeter:

Saturation (%):  $81 \pm 2$ 

Rate (bpm):  $201 \pm 3\%$  (195 to 207)

#### Test 3

1. Set the LIGHT switch to HIGH 2.

Note: For the N-100C oximeter, use the high 1 setting.

- 2. Set the MODULATION switch to LOW.
- 3. Set the RATE switch to 38.
- 4. Verify the following readings on the oximeter: Saturation (%): 81 ±2 Rate (bpm): 38 ±2% (37 to 39)

### Test 4

- 1. Set the LIGHT switch to LOW.
- 2. Set the MODULATION switch to HIGH.
- 3. Set the rate switch to 201.
- 4. Verify the following readings on the oximeter: Saturation (%): 81 ±2 Rate (bpm): 201 ±3% (195 to 207)

## Test 5

- 1. Set the modulation switch to OFF.
- 2. Set the RCAL switch to RCAL 63.
- 3. On the oximeter, locate the applicable memory location:

Oximeter	Memory Location		Procedure for finding correct memory location.
N-20 Series			Note: The RCAL value cannot be displayed on N-20 series oximeters.
N-100C	9	1.	On the oximeter, press the high sat and audio alarm off buttons simultaneously.
N-200	9	2.	Rotate the control knob until "9" ("3" for the N-180/N-185) appears in the SAT display field.
N-180/N-185	3	3.	Note the RCAL value displayed in the Rate display field.
N-1000/	9	1.	From the main menu, press SETUP.
N-2500		2.	Press OFFLINE MENU.
		3.	Move the curser to ENGINEERING MENU, then press EXECUTE.
		4.	Move the cursor to EXAMINE SAT MEMORY, then press EXECUTE.
		5.	Rotate the control knob clockwise to reach item #9.
		6.	Note the displayed RCAL value.
N-6000/	Service	1.	On the monitor, press the FREEZE button.
N-6000B	Screen SpO2	2.	Press unlabeled menu soft keys 2 and 4 simultaneously.
	board	3.	Press "Service" soft key.
		4.	Press "SpO2" soft key.
		5.	Note displayed "CALIB. INDEX" RCAL value.
N-3000	Service Menu, item #30	1.	While simultaneously holding down the upper and lower limit buttons and the print button, turn the oximeter on.
		2.	After the tone, release the three buttons.
		3.	Press the print button again to confirm that you are in the service mode.
		4.	Rotate the control knob to reach item #30.
		5.	Press the upper limit key.
		6.	Note displayed RCAL value.

- 4. Verify displayed value to be 63.
- 5. Change the SRC-2 RCAL switch to RCAL 64.
- 6. On the monitor, verify that the displayed value changes to 64 within 10 seconds.

#### Test 6

- Note: Test 6 is used only on the N-200, N-1000/N-2500, and N-6000 series monitors.
- 1. Use the PC-L cord to connect the SRC-2 *C-Lock*<sup>®</sup> TEST connector to the oximeter *C-Lock* or ECG IN connector.
- 2. Power up the oximeter.
- 3. Set the LIGHT switch to LOW.
- 4. Set the MODULATION switch to LOW.
- 5. Set the RATE switch to 201.
- 6. Set the RCAL switch to RCAL 63.
- 7. Verify the following readings on the oximeter:

Saturation (%):  $81 \pm 2$ 

Rate (bpm):  $201 \pm 3\%$  (195 to 207)

8. Ensure that the "*C-Lock*" or "ECG in Use" indicator lights up on the oximeter.

# **CIRCUIT ANALYSIS**

Introduction Input Rectifier and Power Circuit Light Amplitude and Modulation Circuits Oscillator and Pulse Generator ECG Trigger Output (not used on N-20 series) Calibration Resistor

#### INTRODUCTION

This section discusses SRC-2 operation at the block diagram level. Refer to Figure 2 and the schematic diagram.



#### Figure 2: Overall Block Diagram

This section is divided into the following circuit subsections:

- Input rectifier and power circuit
- Light amplitude and modulation circuits
- Oscillator, divider, and pulse generator
- ECG trigger output.
- Calibration resistor (RCAL)

#### INPUT RECTIFIER AND POWER CIRCUIT

Schottky diodes CR4 and CR5 shunt the LED drive signal at J1–5 and J1–6 to ground, and provide a power source of approximately 4.5 V. The full wave bridge rectifier (DS1, DS2, CR2, CR3, and the parallel load resistors R4 and R5) transforms the LED drive signal to an offset unipolar signal, which is sensed at the differential amplifier U4.

The output, measured at U4–14, is 5 mV per mA of input current. The output of the following amplifier U4–1, measured at (TP4), has a gain of four. The output waveform at U4–1 corresponds to the absolute value of the incoming LED drive current, with a resultant voltage output to current input conversion ratio of 20 mV/mA.

The LED drive signal may be sent directly to the output connector through S4–3, 2 (REMOTE) to J2–1; or, it may be routed through the light amplitude and modulation circuitry to create pulses before being sent to the output connector through S4–1, 2 (LOCAL) to J2–1.

#### LIGHT AMPLITUDE AND MODULATION CIRCUITS

The signal at U4–1 is routed through S2–6 and R12 to voltage follower U4–5, 6, 7. When Q1 is off (Q1 gate/TP5 low), both R13 and R14 are out of the circuit and the signal passes straight to the output at U4–7. This allows the relative light level to be selected using S2–1.

The HIGH light level signal from U4–7 passes through R8 in HIGH 2 setting and through the series combination of R8 and R30 in HIGH 1 setting. The signal is routed to S2–3 with a scale factor of 267 nA/mA or 100 nA/mA of LED drive, respectively.

The LOW light level signal is created by dividing the HIGH light level signal by 11 through voltage divider R19 and R20. The LOW light level signal from U4–8 passes through R7, and is routed to S2–3 at a scale factor of 7 nA/mA.

The signal at U4–1 is modulated when Q1 is switched on by the oscillator circuitry (TP5 high) to create a voltage divider.

R14 in conjunction with R12 creates a reduction in signal level corresponding to the HIGH modulation setting.

R13 in conjunction with R12 creates a reduction in signal level corresponding to the LOW modulation setting.

The shape of the modulating wave is modified from a square wave by high pass network C12 and R36.

#### OSCILLATOR, DIVIDER, AND PULSE GENERATOR

The pulse rate signal used to switch the gate of Q1 is derived from the oscillator and divider circuits consisting of U1, U2, U3, Y1, and RATE switch S1.

The oscillator circuit consists of the 32.768 kHz crystal Y1, the fourteen stage counter U3, and the NAND gate U1. U3 is used to divide down the high frequency. It does this by combining the outputs Q13 (4096), Q12 (2048), Q10 (512), Q9 (256) and Q6 (32) in a four-bit word at U1, which resets the counter at the required frequency.

This frequency is determined by the RATE switch S1 pins 1, 2 & 4. The 32,768 Hz crystal input signal is divided by 4896 to 6.6928 Hz (201), 4384 to 7.4745 Hz (112) and 6432 to 5.0945 Hz (38), which is provided as the input to the U2 ripple counter.

The U2 ripple counter divides the oscillator signal to achieve the selected pulse generator output RATE, via S1 pins 5, 7, & 8, which drives the modulator circuitry.

With the RATE setting of 201, U2 divides the 6.6928 Hz signal by 2 to 3.3464 Hz, which equals 200.784 bpm. With the RATE setting of 112, U2 divides the 7.4745 Hz signal by 4 to 1.8686 Hz, which equals 112.1175 bpm. And, with the RATE setting of 38, U2 divides the 5.0945 Hz signal by 8 to 0.6368 Hz, which equals 38.20875 bpm. These signals are selected by the RATE switch S1 and routed from S1–6 to the gate of Q1 for modulating the U4–1 signal output.

The Pulse Generator circuit is disabled when the MODULATION switch S3 is placed in the OFF position. In the OFF position, U2 is placed in the RESET state when Vcc is applied to pin U2-2 via S3-6 and S3-8.

#### ECG TRIGGER OUTPUT

Note: ECG Trigger Outpug is used only on the N-200, N-1000/N-2500, and N-6000-series monitors.

The ECG trigger output is formed by wave-shaping the rising edge of the gate drive pulse output from S1–6. This signal is capacitively coupled through C10 to R23 where it exponentially decays at a time constant of 25 ms. This 4.2 V peak signal is then divided by two through R24 and R25 and presented at the base of Q2.

Q2 is an emitter follower, supplied by an approximate 0.6 V supply consisting of R28 and forward-biased CR6. This limits the positive peak of the output signal to approximately 0.5 V once the saturation voltage of Q2 is subtracted. This signal at output (TP10) is approximately 25 ms wide.

#### **CALIBRATION RESISTOR (RCAL)**

R9 is a 768 $\Omega$  resistor that notifies the oximeter that an SRC-2 is attached (RCAL 63), and allows the oximeter diagnostics to be activated. R31 is a 6.04 k $\Omega$  resistor used when RCAL/MODE switch is set to RCAL 64.

# **ROUTINE MAINTENANCE**

Service Cleaning Instructions Technical Assistance Returning the SRC-2 Environmental Statement

### SERVICE

WARNING: Carefully read the operating instructions and all precautionary information (set in **boldface type**) before use.

The SRC-2 requires no routine service other than that which is mandated by your local institution.

#### **CLEANING INSTRUCTIONS**

Caution: Do not immerse the SRC-2 in liquid or use caustic or abrasive cleaners.

To clean the SRC-2 surfaces, dampen a cloth with a commercial, nonabrasive cleaner and wipe the surfaces lightly. Do not spray or pour any liquid directly on the SRC-2. Do not allow any liquid to penetrate switches, connectors, or openings in the chassis.

## TECHNICAL ASSISTANCE

For technical information and assistance or to order parts, contact Mallinckrodt's Technical Services Department or Mallinckrodt's local representative.

#### **RETURNING THE SRC-2**

If it is necessary to return the SRC-2, call Mallinckrodt's Technical Services Department for shipping instructions.

Pack in the original shipping carton. If the carton is not available, use a suitable box with an appropriate amount of packing material.

#### ENVIRONMENTAL STATEMENT

Follow local governing ordinances and recycling plans regarding disposal or recycling of device components.

# TROUBLESHOOTING

Introduction

### INTRODUCTION

This section describes troubleshooting for the SRC-2. If questions arise, contact Mallinckrodt's Technical Services Department or your local Mallinckrodt representative.

#### 1. No saturation or pulse rate readings.

- Ensure that the MODE switch is in the LOCAL/RCAL 63 position.
- MODULATION switch is in the OFF position. Select LOW or HIGH setting.
- Try the SRC-2 on another oximeter.
- Refer to test and calibration procedures.

## 2. Saturation or pulse rate readings are too high or too low.

- Ensure that the MODE switch is in the LOCAL/RCAL 63 position.
- Try the SRC-2 on another oximeter.
- Refer to the applicable oximeter service manual for further troubleshooting information.
- 3. No C-Lock
  - Ensure PC-L cable is plugged in at both ends.
  - Check cable for continuity.
  - Try another oximeter.

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# DISASSEMBLY GUIDE

Introduction Disassembly Procedure Assembly Procedure

#### INTRODUCTION

This section describes how to disassemble the SRC-2 for troubleshooting or testing. An assembly procedure is also included. Figure 3 shows the SRC-2 exploded view.

### DISASSEMBLY PROCEDURE

- 1. Slide all switches fully toward the center of the top cover.
- 2. Using a No. 2 Phillips screwdriver, remove the screw from the back of the case.
- 3. Hold the SRC-2 together and turn it topside up. Separate the two halves of the case by pulling gently on the top and the bottom covers. Set the top cover assembly aside.
- 4. Remove the printed circuit board assembly from the bottom cover's PCB locating pins by pulling gently straight up.
- 5. Disconnect the cable from the PCB.
- 6. To replace the oximeter connector cable, remove the cable assembly from the bottom cover by lifting straight up.
- 7. To replace the bottom cover, the end plug may be removed from the bottom cover by pulling upward.
- 8. To replace the switch caps:
  - Remove the top cover.
  - Slide the switch cap toward the outer edge of the top cover.
  - Lift out the end of the cap that points toward the center.



Figure 3: SRC-2 Exploded View

- 1. Switch label
- 2. Switch caps
- 3. Top cover
- 4. Main PCB assembly
- 5. Oximeter D-connector assembly
- 6. Bottom cover
- 7. Product Label
- 8. Pan head screw
- 9. End plug
- 10. Ten-position header connector

#### ASSEMBLY PROCEDURE

- 1. Refer to Figure 3 for proper orientation of the parts within the final assembly.
- 2. Slide the end plug into the bottom cover at the end nearest the small half-round cutout *C-Lock* test jack in the cover side edge.
- To install the oximeter connector cable assembly, ensure that the
   9-pin D-connector is aligned with the row of five pins at the top. Align the slot in the bottom cover between the ribs on the connector and push downward.
- 4. Loop the cable around the molded screw boss so that the cable lies in the center of the cover. Plug the 10-position connector end into J2 on the PCB.
- Position the PCB such that the LEDs are at the same end as the D-connector. Then press the PCB gently down over the three locating pins.
- 6. Carefully align and apply the top cover label.
- 7. With the top cover outer surface facing up, install the four switch caps in the slots by tipping them into the slots. Slide the caps fully toward the outside edge of the cover before pressing them into place. Note that the slot closest to the halfround cutout in the cover edge is left empty.
- 8. Position the four switches (S1, S2, S3, S4) on the PCB in the center location. Position S5 in the Right location.
- 9. Position the switch caps toward the center of the switch slot.
- 10. Place the top cover assembly over the bottom cover assembly, ensuring that the switches (S1–S4) on the PCB are in the center position, and aligned with the switch caps.
- 11. Press the top and bottom covers together. Turn over the assembly and replace the screw. Using a No. 2 Phillips screwdriver, tighten until firm (about 8–9 in-lb torque).
- 12. Reapply bottom cover label.

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# **TESTING AND VERIFICATION**

Introduction Test Equipment Required Connector Continuity Test RCAL Resistor Test Power Distribution Tests Oscillator Circuit Tests Gain/Modulation Verification

## INTRODUCTION

This section outlines procedures for testing SRC-2 operation. Testing involves disassembling the unit to gain access to test points on the PCB and pins on J2.

## TEST EQUIPMENT REQUIRED

Testing the SRC-2 requires the following commercially available test equipment.

Equipment	Characteristics
Oscilloscope: Tektronix Model 465, or equivalent	<ul> <li>Bandwidth: 15 MHz.</li> <li>Input impedance: &gt;10 MΩ</li> <li>Vertical sensitivity: 10 mV/div.</li> </ul>
Frequency Counter: Hewlett-Packard Model 5314A, or equivalent	<ul> <li>Frequency: 1 MHz, minimum.</li> <li>Input impedance: &gt; 1 MΩ.</li> <li>Minimum sensitivity:</li> <li>100 mV p-p.</li> </ul>
Digital Multimeter: FLUKE Model 8840A, or equivalent (Note: two meters are required.)	<ul> <li>Accuracy: ± 0.5%.</li> <li>DC voltage measurement range: 200 mV to 10 V, full scale.</li> <li>Resolution: 4 digits.</li> <li>DC current measurement range: 200 μA to 1 A, full scale.</li> <li>Resistance measurement range 200 Ω to 20 MΩ, full scale.</li> </ul>
DC Power Supply: Topward Model TPS-4000D, or equivalent.	• Output: 0 to 5 V, 0 to 100 mA.
Variable Resistor:	• Resistance: 0 to 100 $\Omega$ .

#### CONNECTOR CONTINUITY TEST

Measure continuity from the nine-position oximeter D-connector to the ten-position header P2 on the SRC-2. (Refer to Table 1.) Verify resistance at 0.5 ohms maximum, between connector pins.

Refer to the illustrations below for connector and header pin locations. Note that these views are looking into the cable connector at each respective end.



Figure 4: Ten-Position Header Connector P2

Figure 5: Nine-Position Oximeter D-Connector

Note: One version of the SRC-2 has a D-connector with only seven pins present, as compared to nine pins on the older version. Determine the connector type and use the information in the following table to test continuity, as appropriate, between the oximeter D-connector pins and the pins on 10-position header connector P2.

Nine-Position Oximeter D-connector Pins	Ten-Position Header Connector P2 Pins
1	2
2	6
3	5
4*	7
5	1
6	3
7	9, 10 (inner, outer shield)
8*	8
9	No connection
No connection	4 (key)

### Table 1: Connector Pins

<sup>\*</sup> These pins are not present in newer connectors. If all nine pins are present and the sockets or holes for pins 4 and/or 9 are not present in your cable, contact Mallinckrodt's Technical Services Department or your local Mallinckrodt representative for further instructions.

### CALIBRATION RESISTOR TEST

- 1. Orient the Printed Circuit Board Assembly (PCBA) with the component side up and connectors J1 and J2 on the left hand side.
- 2. Set the actuators (contacts) on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT not used)

- 3. On the PCBA, connect a digital multimeter between J2, pins 2 and 3. Verify that the resistance is between 760  $\Omega$  and 776  $\Omega$ .
- 4. Slide the actuator on S4 to the middle position (REMOTE). Verify that the resistance is between 760  $\Omega$  and 776  $\Omega$
- 5. Slide the actuator on S4 to the far left position (RCAL 64). Verify the resistance is between 5.98 k $\Omega$  and 6.10 k $\Omega$ .
- 6. Slide the actuator on S4 back to the far right position (LOCAL/RCAL 63).
- 7. On the PCBA, connect the digital multimeter between J1, pins 2 and 3. Verify that the resistance is between 760  $\Omega$  and 776  $\Omega$ .
- 8. On the PCBA, connect the digital multimeter between J1, pins 7 and 8. Verify that the resistance is between 3.88 k $\Omega$  and 3.92 k $\Omega$ .
- 9. On the PCBA, connect the digital multimeter between TP6 and TP11. Verify that the resistance is between 74.3 k $\Omega$  and 75.8 k $\Omega$ .
- 10. Move the actuator on S2 to the middle position (LIGHT = HIGH). Verify that the resistance is between 197 k $\Omega$  and 201 k $\Omega$ .

- 11. On the PCBA, connect the digital multimeter between TP3 and TP11.
- 12. Move the actuator on S2 to the far left position (LIGHT = LOW) Verify that the resistance is between 198 k $\Omega$  and 202 k $\Omega$ .
- 13. On the PCBA, connect the digital multimeter between TP4 and TP11.
- 14. Move the actuator on S4 to the middle position (REMOTE). Verify that the resistance is between 198 k $\Omega$  and 202 k $\Omega$
- 15. On the PCBA, connect the digital multimeter between TP7 and TP11.
- 16. Move the actuator on S4 to the far left position (RCAL 64). Verify that the resistance is between 198 k $\Omega$  and 202 k $\Omega$ .

## POWER DISTRIBUTION TESTS

- 1. Orient the Printed Circuit Board Assembly (PCBA) with the component side up and connectors J1 and J2 on the left hand side.
- 2. Set the actuators (contacts) on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT)

- 3. On the PCBA, connect the negative output from the power supply to J2, pin 10.
- 4. Connect the positive output to J2, pin 6.
- 5. On the power supply, set the output to 4.5 volts.
- 6. On the PCBA, connect a digital multimeter between TP7 and TP8. Verify that the voltage is greater than 4.2 volts.

- 7. On the power supply, disconnect the lead from the positive output.
- 8. Connect an ammeter in series between the power supply positive output and J2, pin 6. Verify that the current is less than 6 mA.
- 9. Remove the ammeter from the circuit.
- 10. On the PCBA, connect the positive output of the power supply to J2, pin 5.
- 11. Connect a digital multimeter between TP7 and TP8. Verify that the voltage is greater than 4.2 volts.
- 12. Disconnect the lead from the positive output on the power supply.
- 13. Connect an ammeter in series between the power supply positive output and J2 pin 5. Verify that the current is less than 6 mA.

#### **OSCILLATOR CIRCUIT TESTS**

- 1. Orient the Printed Circuit Board Assembly (PCBA) with the component side up and connectors J1 and J2 on the left hand side.
- 2. Set the actuators (contacts) on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT)

- 3. On the PCBA, connect the negative output from the power supply to TP7.
- 4. Connect the positive output from the power supply to TP1.
- 5. On the power supply, set the output to 4.5 volts.

- 6. On the PCBA, connect the input lead of a frequency counter to TP2.
- 7. Connect the ground (shield) of this lead to TP7. Verify that the oscillator frequency is between 32,728 and 32,808 Hz.
- 8. On the PCBA, connect the input lead of an oscilloscope to TP5.
- 9. Connect the ground (shield) of this lead to TP7. Verify that the signal, which approximates a square wave, has an amplitude greater than 3.5 volts peak-to-peak.
- Disconnect the frequency counter lead at TP2, and reconnect it to TP5. Verify that the frequency is between 3.342 and 3.350 Hz.
- 11. Move the actuator on S1 to the middle position (112 BPM). Verify that the frequency is between 1.867 and 1.871 Hz.
- 12. Move the actuator on S1 to the far left position (38 BPM). Verify that the frequency is between 0.6361 and 0.6377 Hz.

#### GAIN/MODULATION VERIFICATION

1. Orient the Printed Circuit Board Assembly (PCBA) with the component side up and connectors J1 and J2 on the left hand side.

2. Set the actuators on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT)

- 3. On the power supply, connect two test leads to the positive output.
- 4. On the PCBA, connect one of the positive power supply leads to TP1 and the other to TP9.
- 5. Connect the negative power supply output to TP7.
- 6. On the power supply, set the output voltage to 4.5 volts.
- 7. On the PCBA, verify that both LEDs are *not* illuminated.
- 8. Using the digital multimeter:
  - connect the positive lead to TP5 on the PCBA, and
  - connect the negative lead to TP7.

Verify that the voltage is  $0 \pm 0.25$  volts.

- 9. On the PCBA, connect the positive lead of the multimeter to J2, pin 1. Verify that the voltage is  $0 \pm 0.10$  volts.
- 10. Connect the positive lead of the multimeter to TP4. Verify that the voltage is less than 0.2 volts.
- 11. Disconnect the positive power supply lead from TP1. Only TP9 should now have a positive power supply lead attached.
- 12. Connect a variable resistor and an ammeter in series between TP1 and TP7.
- 13. Adjust the resistance to obtain a reading of 50 mA. Verify that DS1 (left side LED) is illuminated.
- 14. Connect the positive lead of the multimeter to TP1 on the PCBA. Verify that the voltage is greater than 2.0 volts.
- 15. Connect the positive lead of the multimeter to TP4 on the PCBA. Verify that the voltage is between 0.94 and 1.10 volts.
- 16. Connect the positive lead of the multimeter to TP6 on the PCBA. Verify that this voltage is the same voltage as TP4  $\pm$  0.01 volts.

- 17. Connect the positive lead of the multimeter to TP3 on the PCBA. This voltage should equal 0.09 times the voltage at TP6  $\pm$  0.01 volts.
- 18. Disconnect the ammeter and variable resistor from TP1.
- 19. Disconnect the power supply lead from TP9 and connect it to TP1.
- 20. Connect the ammeter and variable resistor in series between TP9 and TP7.
- 21. Adjust the resistance to obtain a current of 50 mA. Verify that DS2 (right side LED) is illuminated.
- 22. Connect the positive lead of the multimeter to TP9 on the PCBA. Verify that the voltage is greater than 2.0 volts.
- 23. Connect the positive lead of the multimeter to TP4 on the PCBA. Verify that the voltage is between 0.94 and 1.10 volts. Record this measurement. This is the base voltage used to calculate modulation.
- 24. Orient the printed circuit board assembly (PCBA) with the component side up and connectors J1 and J2 on the left- hand side.
- 25. Set the actuators on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT)

- 26. Connect the oscilloscope input to TP6 on the PCBA.
- 27. Connect the oscilloscope ground to TP7 on the PCBA.

- 28. Set the oscilloscope as follows:
  - Vertical Gain = 20 mV/div.
  - AC coupled
  - Bandwidth Limit = ON
  - Horizontal Sweep = 20 mS/div.
- 29. Measure the peak of the positive pulse. Record the measurement.
- 30. Calculate the % modulation from the formula:

%Modulation = <u>Voltage at TP6 (recorded in step 29</u>) X 100% Voltage at TP4 (recorded in step 23)

Verify that the modulation is between 9% and 11%.

- 31. Move the actuator on S3 to the middle position (MODULATION = LOW).
- 32. Change the Vertical Gain on the oscilloscope to 5mV/div.
- 33. Measure the peak of the positive pulse and record the measurement.
- 34. Verify that the peak negative voltage is, at least, 9mV.
- 35. Calculate the % modulation from the formula:

%Modulation = <u>Voltage at TP6 (recorded in step 33</u>) X 100% Voltage at TP4 (recorded in step 23)

Verify that the modulation is between 0.8% and 1.2%

### ECG TRIGGER OUTPUT TESTS

1. Orient the Printed Circuit Board Assembly (PCBA) with the component side up and connectors J1 and J2 on the left hand side.

2. Set the actuators on the switches as follows:

S1	FAR RIGHT	(RATE = 201 BPM)
S2	FAR RIGHT	(LIGHT = HIGH 2)
S3	FAR RIGHT	(MODULATION = HIGH)
S4	FAR RIGHT	(LOCAL/ RCAL 63)
S5	RIGHT	(CONTACT)

- 3. On the PCBA, connect the negative output from the power supply to TP7.
- 7. Connect the positive output of the power supply to TP1.
- 8. On the power supply, set the output to 4.5 volts.
- 9. Connect the oscilloscope input to TP10 on the PCBA.
- 10. Set the oscilloscope as follows:
  - Vertical Gain = 0.1V/div.
  - DC coupled
  - Bandwidth Limit ON
  - Horizontal Sweep = 20 mS/div.
- 8. Verify that the pulse is positive with a peak amplitude between 0.3 to 0.7 Volts.
- 9. Verify that the pulse decays to 0 volts between positive peaks.
- 11. Verify that at 50% of the peak voltage, the pulse at TP10 is between 20 to 50 mS wide.

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# **SPARE PARTS**

Overview

#### OVERVIEW

This section contains a list of spare parts for the SRC-2. Refer to the SRC-2 exploded view shown in Figure 3.

Кеу		
Number	Description	Part No.
1	Switch label	040868
2	Switch caps	028997
3	Top cover	024381
4	Main PCB assembly	029318
5	Oximeter D-connector assembly	044207
6	Bottom Cover	024380
7	Product Label Not	Available
8	Pan head screw, $6-32 \ge 7/8$	802088
9	End plug	024382
10	Cable/10-Position Header Connector	044207
Accessory	ECG patch cord, Type L	PC-L

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# **SPECIFICATIONS**

Controls Input/Output Connectors Calibration Resistor Accuracy Signal Output Environmental Mechanical

### CONTROLS

## **RATE Switch**

### Three positions:

38, 112, 201 beats per minute

## LIGHT Switch

## Three positions:

Detected LED light level simulation Low, High 1, and High 2

## **MODULATION Switch**

#### Three positions:

Output signal modulation Off, Low, and High

#### **RCAL/MODE Switch**

#### Three positions:

Local for internally generated rate, signal level, modulation, and RCAL 63

Remote for testing the SRC-2

RCAL: 64

## INPUT/OUTPUT CONNECTORS

### **Oximeter Input/Output**

Nine-pin D-connector

### **CALIBRATION RESISTORS**

768 Ω (RCAL 63)

6.04 kΩ (RCAL 64)

#### ACCURACY

### Rate

 $38 \pm 2\%$  (37 to 39)

112 ±2% (110 to 114)

201 ±3% (195 to 207)

## SIGNAL OUTPUT

## **High 2 Light Switch Setting**

~267 nA/mA of input current from oximeter

## **High 1 Light Switch Setting**

~100 nA/mA of input current from oximeter

## Low Light Switch Setting

~9 nA/mA of input current from oximeter

## **Modulation Switch Setting**

10% in high position1% in low position

## **ECG Trigger Output**

 $0.5~\mathrm{V}$  peak; at least 20 ms wide at 50% amplitude; less than 50 ms wide after pulse rising edge

#### **EMISSIONS COMPLIANCE**

Emissions Classification: CISPR II, Group 1, Class B

#### ENVIRONMENTAL

### Temperature

32 to 104°F (0 to 40°C)

### Humidity

Non-condensing

#### Elevation

0 to 20,000 ft. (0 to 6,100 m)

#### MECHANICAL

#### Size

5.0 in. (130 mm) long 2.6 in. (66 mm) wide 1.4 in. (36 mm) deep

## Weight

4.3 oz (123 g)

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# SCHEMATIC DIAGRAM

Overview

#### OVERVIEW

This section contains the SRC-2 component location drawing (Figure 6) and the SRC-2 schematic diagram (Figure S-1).



Figure 6: Main PCB Component Location

