Engineering World Health
WWW.EWH.ORG

Electrosurgery Unit Tester v2.0
assembly
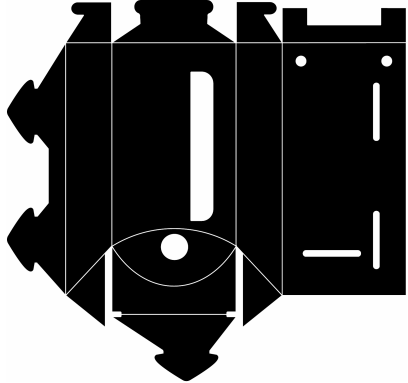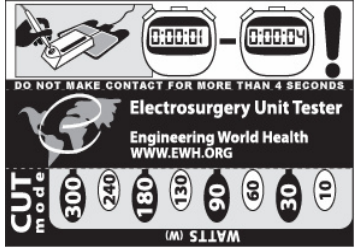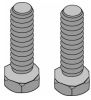# instructions
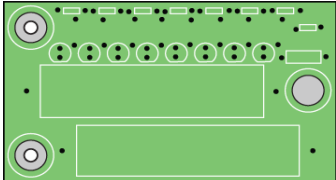
1.0 PURPOSE
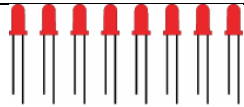
This document describes the assembly instructions for the Electro Surgery Unit (ESU) Tester.

1.1 Overview

The Engineering World Health Organization's ESU Tester v2.0 is designed to test the power output of the Hard Cut (pure sinusoid) setting of an Electro Surgery Unit. Its 8 LEDs indicate different levels of power from 0-300W.

2.0 KIT CONTENTS

Description	PCB Label	Quantity	Figure
2.1 Housing		1	 Figure 2.1
2.2 Label Sheet		1	 Figure 2.2
2.3 Hex Head Machine Screw 8-32		2	 Figure 2.3
2.4 Machine Screw Nut and Tooth Washer 8-32		2	 Figure 2.4
2.5 PCB		1	 Figure 2.5

2.6 Red 5mm LED	LED 1-8	8	Figure 2.6
2.7 Diode – Small Signal HI Conductance Fast	D1	1	Figure 2.7
2.8 Diode 2.4V	D2	1	Figure 2.8
2.9 Diode 3.9V	D3	1	Figure 2.9
2.10 Diode 4.7V	D4	1	Figure 2.10
2.11 Diode 6.0V	D5	1	Figure 2.11
2.12 Diode 7.5V	D6	1	Figure 2.12
2.13 Diode 8.7V	D7	1	Figure 2.13
2.14 Diode 11.0V	D8	1	Figure 2.14
2.15 Resistor 249Ω	R1 & R5	2	Figure 2.15
2.16 Resistor 220Ω	R2	1	Figure 2.16

2.17 Resistor 422Ω	R3	1	Figure 2.17
2.18 Resistor 402Ω	R4	1	Figure 2.18
2.19 Resistor 130Ω	R6	1	Figure 2.19
2.20 Resistor 324Ω	R7	1	Figure 2.20
2.21 Resistor 47Ω	R8	1	Figure 2.21
2.22 Resistor 15Ω ½ Watt	R9	1	Figure 2.22
2.23 Cement Power Resistor 250Ω	R10 & R11	2	Figure 2.23

3.0 EQUIPMENT

3.1 Component Kit from Engineering World Health

  3.1.1 Verify contents of kit match the "Kit Contents" shown in section 2.0 before beginning assembly process

3.2 Soldering Iron and Solder

3.3 Safety Glasses

3.4 Needle Nose Pliers

3.5 Small Wrench

3.6 Wire Cutters

3.7 Scissors
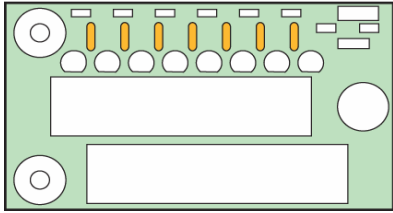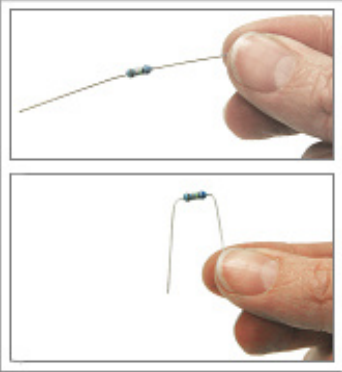
4.0 SAFETY

4.1   Perform soldering on a grounded bench.

4.2   Wear safety glasses when assembling components.

4.3   Use caution when using hot soldering iron.

5.0 ASSEMBLY

5.1   Solder resistors R8 through R2 to the PCB

- Tools and Materials
  - R8, R7, R6, R5, R4, R3, R2,
  - Soldering Iron & Solder
  - Wire Cutters
  - Safety Glasses

Instructions	Figure
5.1.1 Remove designated resistor from its bag. Start with R8 and work down the board to R2. The location of the components is labeled on the PCB. (See Appendix A for a quick reference of resistor numbers and values.)	 Figure 5.1.1: Solder R8-R2 seen in orange
5.1.2 Bend resistor wires 90°.	 Figure 5.1.2

5.1.3	Insert resistor wires into corresponding holes on circuit board. The resistor must rest on the top, labeled side of the board. It does not matter which resistor wire is placed in each of the holes in the board.	 Figure 5.1.3
5.1.4	Turn the PCB over so that the resistor is face down and the wires are exposed.	
5.1.5	Solder each resistor wire to the board. If concerned with the quality of the solder joint, the assembler may turn the board over and solder the wires from the top as well.	 Figure 5.1.5
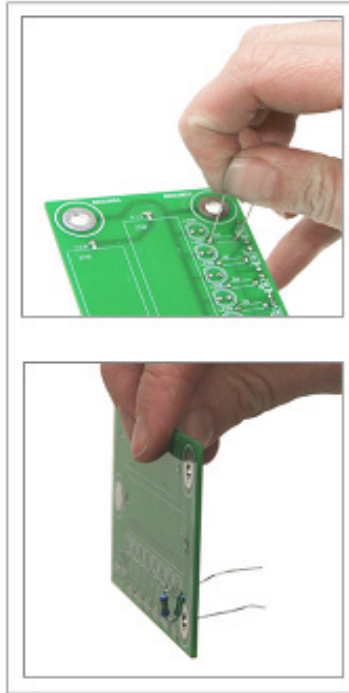
5.1.6	Using the wire cutters, cut the excess length of resistor wires as close to the board as possible. The assembler may choose to cut the excess wire after all the components are soldered to the board, depending on preference.	 Figure 5.1.6: Properly soldered and trimmed resistor.
5.1.7	Repeat steps in 5.1 until resistors R8 through R2 are assembled.	 Figure 5.1.7
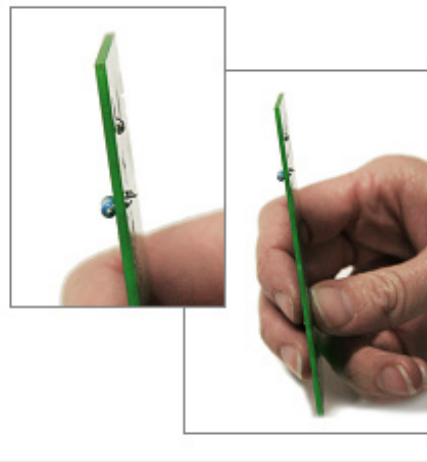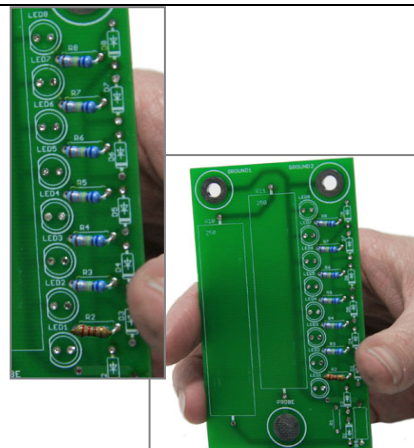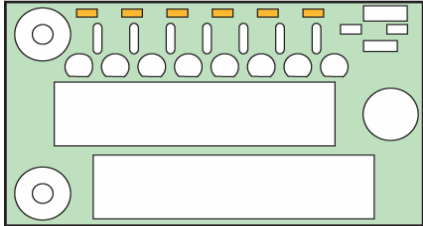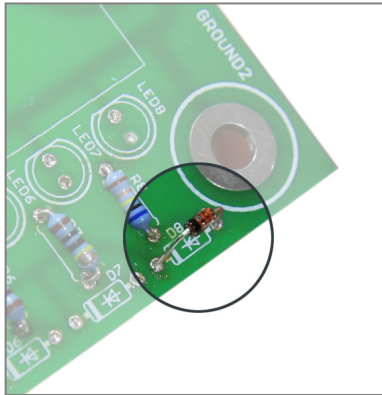
5.2 Solder diodes D8 through D3 to the PCB

- Tools and Materials
  - D8, D7, D6, D5, D4, D3
  - Soldering Iron & Solder
  - Wire Cutters
  - Safety Glasses

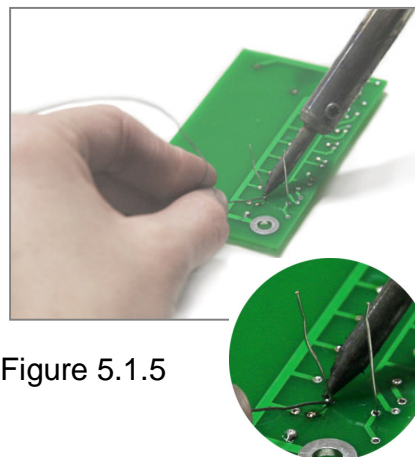| Instructions	Figures
5.2.1 Remove designated diode from its bag. Start with D8 and work down the board to D3. (See Appendix A for a quick reference of diode numbers and values.)	 Figure 5.2.1: Solder D8 through D3 seen in orange
5.2.2 Insert diode wires into corresponding holes on circuit board. **The orientation of the diode is extremely important.** Ensure the black strip on the diode is facing the same direction as the white strip printed on the PCB.	 Figure 5.2.2: Align black stripe on diode with white stripe on PCB
5.2.3 Solder the diodes and cut the excess wire as done with the resistors in step 5.1.	

	Instructions	Figure
5.2.4	Repeat steps in 5.2 until diodes D8 through D3 are assembled	 Figure 5.2.4: Diodes D8 through D3 correctly soldered to the board
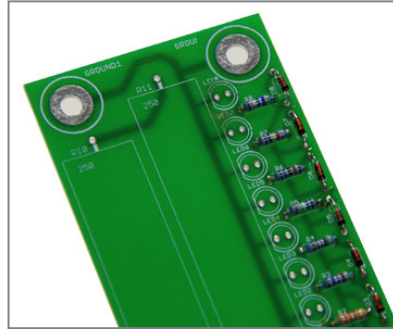
5.3   Solder R1, D2, D1, and R9 to the PCB

- Tools and Materials
    - R1, D2, D1, R9
    - Soldering Iron & Solder
    - Wire Cutters
    - Safety Glasses

	Instructions	Figure
	Instructions	**Figure**
5.3.1	Remove designated component from its bag. For simplicity, assemble the components in this order: R1, D2, D1, R9	 Figure 5.3.1: R1, D2, D1, and R9 seen in orange
5.3.2	Solder components and clip excess wire as in steps 5.1 and 5.2. **The orientation of R1 and R9 is not important, but *the orientation of D2 and D1 is essential.* Ensure the black stripes on the diode correspond to the white stripes printed on the PCB. Notice that D1 faces the opposite direction of all the other diodes.**	

5.3.3	Repeat steps in 5.3 until R1, D2, D1, and R9 are assembled.	 Figure 5.3.3: Components R1, D2, D1, and R9 assembled correctly to the board
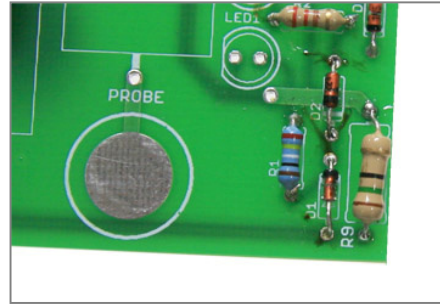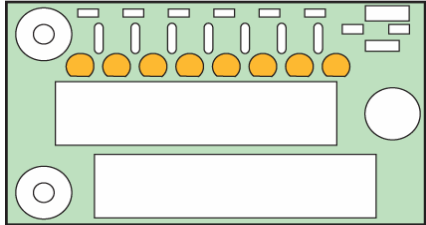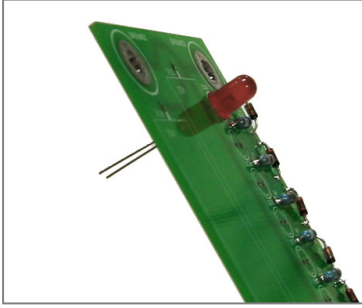
5.4   Solder LED8 through LED1 to the PCB

- Tools and Materials
  - 8 Red LEDs
  - Soldering Iron & Solder
  - Wire Cutters
  - Safety Glasses

Instructions	Figure
5.4.1 Remove LEDs from bag.	 Figure 5.4.1: LED8 – LED1 seen in orange
5.4.2 Insert the LED into position LED8 on the board, paying close attention to the flat side of the LED. **Be sure to match the flat side of the LED to the white LED footprint on the PCB.**	 Figure 5.4.2

5.4.3	Solder the LED to the PCB on the underside of the board. In order to keep the LED flush with the board, the assemble may need to re-heat the solder to adjust the LED and its wires. (For tips on how to solder these components successfully, see Appendix B.)	 Figure 5.4.3
5.4.4	Confirm that the LED is properly positioned. Cut the excess wire exposed on the underside of the board as close to the board as possible (near flush).	
5.4.5	Repeat the steps in 5.4 for LED 7, working down the board to LED1.	 Figure 5.4.5: LEDs correctly assembled to the PCB
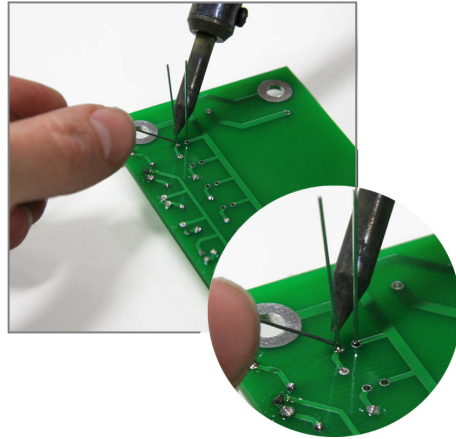
5.5   Solder resistors R10 and R11 to the PCB

- Tools and Materials
    - R10 and R11
    - Soldering Iron & Solder
    - Wire Cutters
    - Safety Glasses

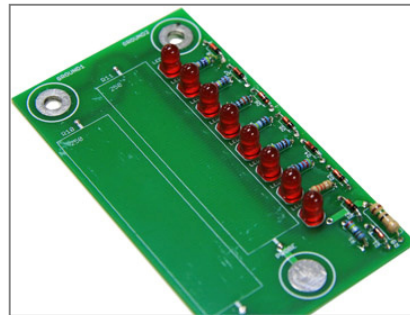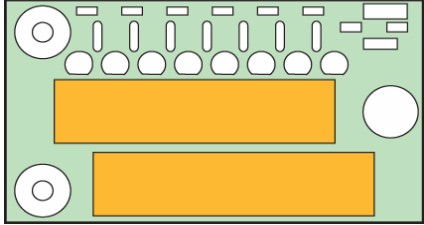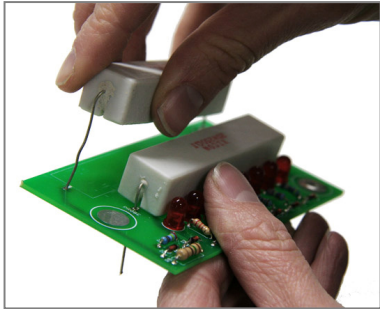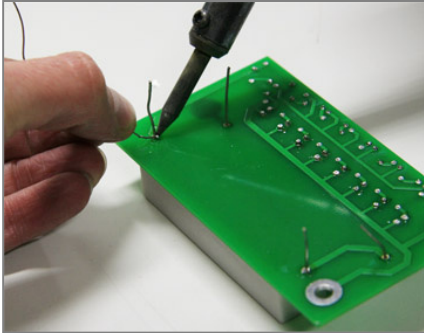| Instructions	Figure
5.5.1 Remove resistors from bag.	Figure 5.5.1: R10 and R11 seen in orange
5.5.2 Bend resistor wires 90° downward (away from the red markings on the top).	
5.5.3 Insert both resistors into the board. The orientation of the resistors is not important. Either resistor can be placed into the R10 or R11 location.	Figure 5.5.3
5.5.4 Solder the resistors to the PCB on the underside of the board. Ensure each resistor body is flush with the board. Tip: Hold the soldering iron to the wire for ~15 seconds before adding solder. These wires are thicker than those of the other components and need more time to heat up.	Figure 5.5.4

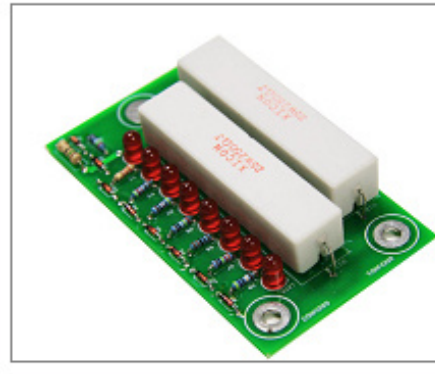| Instructions	Figure
5.5.5 Using the wire cutters, cut the excess length of the resistor wires as close to the board as possible (near flush).	Figure 5.5.5: R10 and R11 correctly assembled
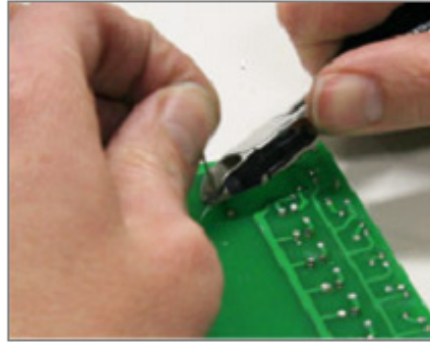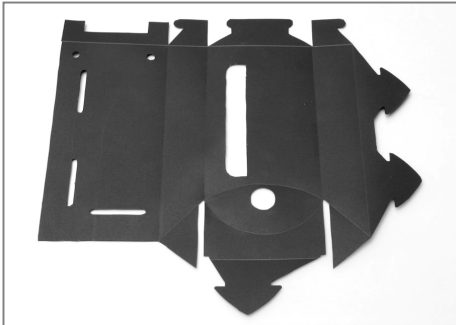
5.6 Give fully soldered PCB to supervisor to test its functionality. Make changes if necessary.

5.7 Creasing the housing

- Tools and Materials
  - Housing

Instructions	Figure
5.7.1 Lay the housing flat so that the side with the circle probe cutout is closest to you and on your right side.	Figure 5.7.1

5.7.2 Fold the plastic housing along the 4 vertical creases, always inward.	 Figure 5.7.2
5.7.3 Crease four horizontal tabs along the top of the housing.	 Figure 5.7.3

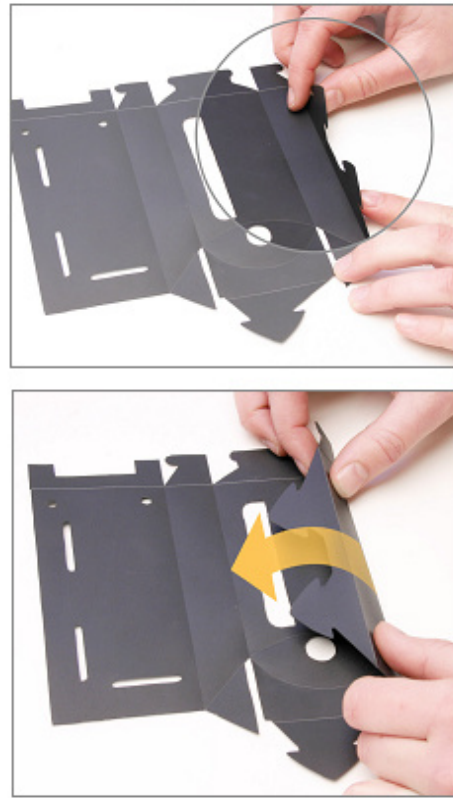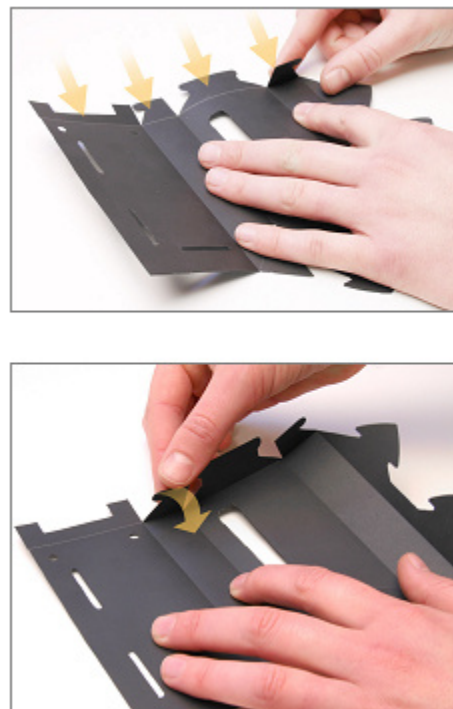|	
5.7.4 Crease two triangular tabs towards the bottom of the housing.	\n\nFigure 5.7.4
5.7.5 Crease the remaining horizontal tab along the bottom of the housing.	\n\nFigure 5.7.5
5.7.6 Crease the semi-circular arc with caution.\n\nAll other creases with be bent at 90° when assembled, but this arc will be bent at less than 45°.	\n\nFigure 5.7.6
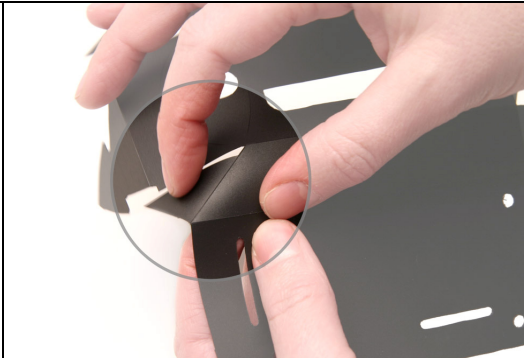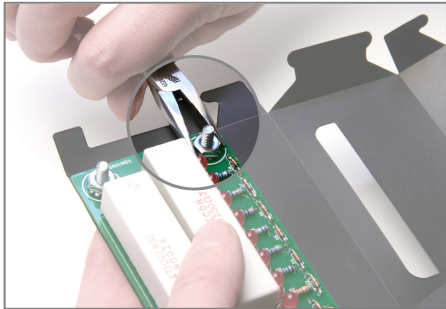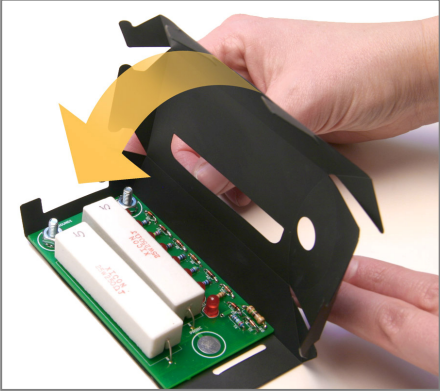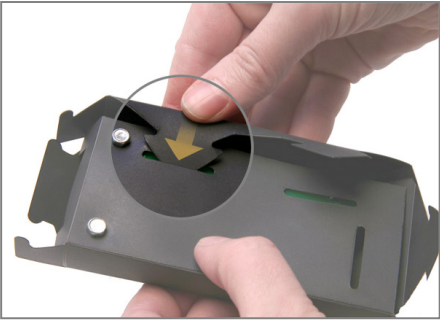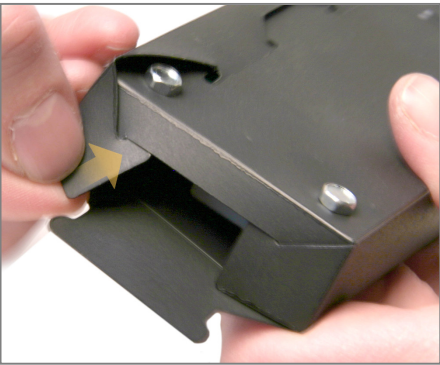
5.8 Connect the PCB and the Plastic Housing

- Tools and Materials
    - Creased housing sheet
    - Two hex head machine screws
    - Two machine screw nuts
    - Assembled PCB
    - Small wrench or pliers

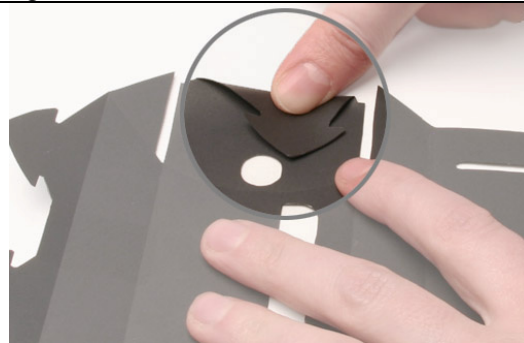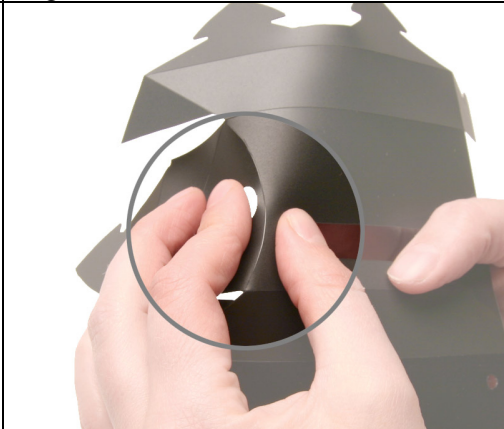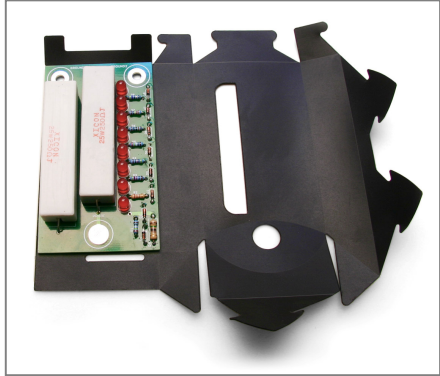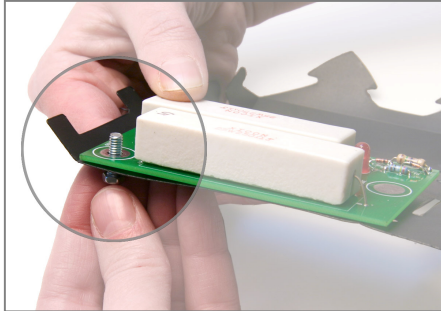| Instructions	Figure
5.8.1 Orient the creased plastic sheet so that the side with two triangular tabs is pointing to the right, and the side with one triangular tab is pointing down (Figure 5.8.2).	
5.8.2 Align the two holes in the assembled PCB with the two holes in the housing. The PCB should be facing upwards.	 Figure 5.8.2
5.8.3 Insert the screws through the bottom of the housing so that the threads emerge through the PCB.	 Figure 5.8.3
5.8.4 Thread the nuts onto the screws and use a wrench or pliers to tighten the nuts. (The screw head may need to be held with another pliers or wrench to prevent spinning while tightening.) Note: The head of the screw should be outside the housing and the nut should be in contact with the PCB.	 Figure 5.8.4

5.9 Fold the Housing around the PCB

- Tools and Materials
  - Housing with attached PCB

Instructions	Figures
5.9.1 Fold the side of the housing with the two triangular tabs around the PCB, creating a box shape.	 Figure 5.9.1
5.9.2 Tuck the two triangular tabs into the slots on the bottom of the housing (the side with the screw heads).	 Figure 5.9.2
5.9.3 Turn the housing to face the "back" side. Tuck the two side tabs into the U-shaped flap.	 Figure 5.9.3

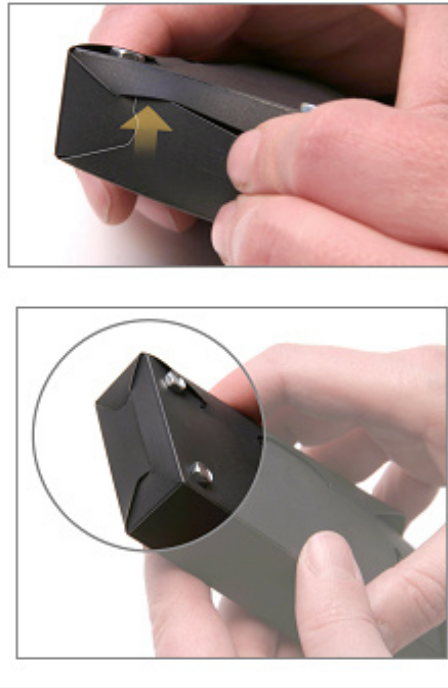|		
5.9.4	Fold the remaining back flap so that the rounded nubs fit between the already assembled side tabs and U-shaped tab.	Figure 5.9.4
5.9.5	Rotate housing to face the front opening.	
5.9.6	Fold triangular side tabs into opening.	Figure 5.9.6
5.9.7	Fold flap with triangular tab over the opening and tuck into the slot on the bottom face. Tip: If flap has difficulty sliding into its opening, try sliding one slide into the opening and then the other.	Figure 5.9.7
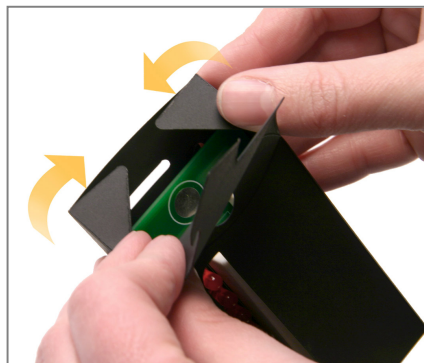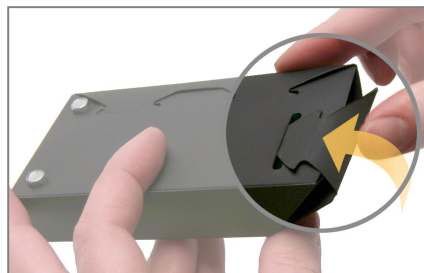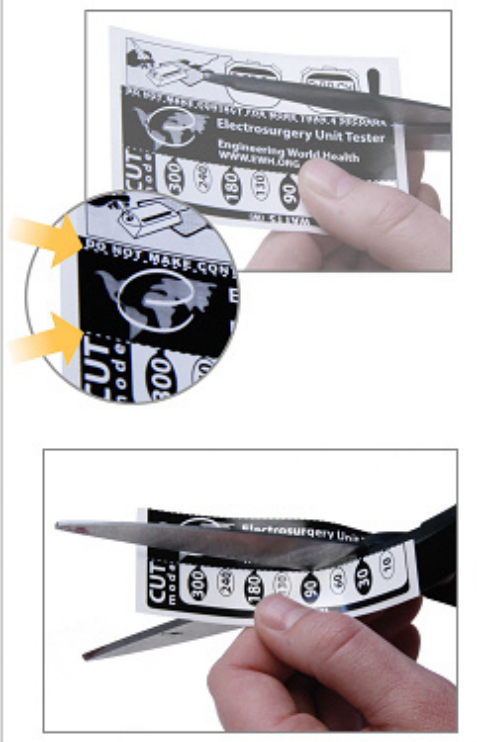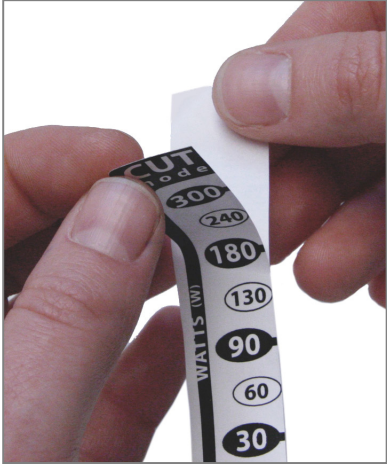
5.10 Fold the Housing around the PCB

- Tools and Materials
    - Label sheet
    - Assembled Housing and PCB
    - Scissors or Exacto Knife
    - Ruler

Instructions	Figure
5.10.1 Carefully cut the label sheet into three separate labels by cutting along the dotted white lines.	 Figure 5.10.1
5.10.1.1 Instructions Label	 Figure 5.10.1.1: Instructions Label
5.10.1.2 EWH Label	 Figure 5.10.1.2: EWH Label

5.10.1.3 Power Label		 Figure 5.10.1.3: Power Label
5.10.2	Gently Peel the white liner off the Power Label	 Figure 5.10.2
5.10.3	On the top face of the housing, match the label's right edge to the left edge of the D-shaped cutout on the housing. At the same time, align the top of the light box printed on the label to the top of the D-shaped cutout.	 Figure 5.10.3
5.10.4	Apply pressure to the entire label to ensure proper adhesion. Failure to align the label properly could result in false reading of the device.	 Figure 5.10.4: Correctly applied Power Label

5.10.5	Gently peel the white liner off the Instructions Label.	
5.10.6	When looking at the left face of the housing, place the left edge of the label near the left edge on the housing. Center the label between the top and bottom edges on the housing and apply pressure to ensure proper adhesion.	Figure 5.10.6: Correctly applied Instructions Label
5.10.7	Gently peel the white liner off the EWH Label	

| 5.10.8 | When looking at the right side of the housing, place the label approximately 0.25" from the right edge. Center the label between the top and bottom edges of the housing and apply pressure to ensure proper adhesion.

Note: If any of the labels hang off the housing edges, they should be gently removed and re-adhered to the housing surface properly. |

Image 5.10.8: Correctly applied EWH Label |

Appendix A – Quick reference for matching the print on the PCB to the component value.

PCB Label	Component Value
LED 1-8	Red 5mm LED (all LEDs are the same)
D1	Small Signal Hi Conductance Fast Diode
D2	Diode 2.4V
D3	Diode 3.9V
D4	Diode 4.7V
D5	Diode 6.0V
D6	Diode 7.5V
D7	Diode 8.7V
D8	Diode 11.0V
R1	Resistor 249Ω
R2	Resistor 220Ω
R3	Resistor 422Ω
R4	Resistor 402Ω
R5	Resistor 249Ω (same as R1)
R6	Resistor 130Ω
R7	Resistor 324Ω
R8	Resistor 47Ω
R9	Resistor 15Ω ½ Watt
R10 & R11	Cement Power Resistor 250Ω

Appendix B – Tips for Soldering LEDs to the PCB (5.4)

The LEDs are the most difficult components to solder flush against the PCB. When the assembler is soldering the LED wires on the underside of the board, the LEDs are resting on their rounded face, causing the PCB (and therefore LEDs) to tilt. Here is a tactic for soldering the LED properly against the PCB:

• Insert the LED into a designated position (LED1-8) on the PCB, paying close attention to the flat side of the LED. Be sure to match flat side to the white LED footprint on the PCB.

• Solder one wire of the LED into place.

• Turn the board upright. If the LED is crooked, have a friend hold the board for you or secure the board in an elevated PCB holder.

• While heating the solder on the secured wire, press the rounded LED face toward the board. When the solder melts, the LED will slip into place, flush against the PCB.

• Remove the soldering iron from the wire, and the solder should solidify in its new position.

• Turn the board over to the underside again, and solder the second wire.

• Cut the excess wire and repeat for other LEDs.

(If preferred by the assembler, he/she can place all 8 LEDs, turn the board over, and solder one wire of each LED into place. This may minimize the amount of time needed for a friend to hold the board while repositioning the LEDs.)