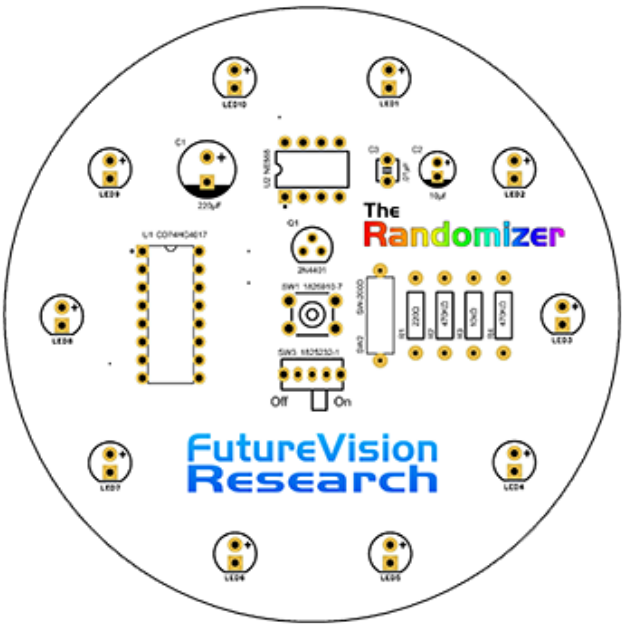
FutureVision Research Presents:

The Randomizer

Part Number 106-13

Assembly Instructions



FutureVision Research

It is very important to inventory all the parts in your kit
to make sure you have all the parts listed in the following pages.

If any parts are missing, please contact Sales@FVResearch.com right away.

Safety Notice and Disclaimer of liability:

Your safety is your own responsibility, including proper use of equipment and safety gear, and determining whether you have adequate skill and experience. Power tools, electricity, and other resources used for these projects are dangerous, unless used properly and with adequate precautions, including safety gear. Some illustrative photos do not depict safety precautions or equipment, in order to show the project steps more clearly. You are responsible for proper supervision of children. Use of the instructions, kits, projects and suggestions on FVResearch.com is at your own risk. FutureVision Research and Brian Cox disclaims all responsibility for any resulting damage, injury, or expense. It is your responsibility to make sure that your activities comply with applicable laws, including copyright. Always check the webpage associated with each project before you get started. Products sold by FutureVision Research and Brian Cox are for educational purposes only.

Tools — You'll need the following tools to build this kit:

Soldering Iron

Use a pencil style soldering iron of 25-30 watts.

If you have a variable temperature iron that isn't marked with temperatures, set it in the middle.

If your iron has a temperature setting, set it to 700F/370C for 60/40 leaded solder or 750F/400C for lead-free solder.

Never use a soldering gun on circuit boards!

Rosin Core Solder

No-Clean Rosin Recommended

60Sn / 40Pb leaded solder
or
99.3Sn / 0.7Cu lead-free solder

Safety Glasses

Always where safety glasses while soldering and trimming leads!

Flush Wire Cutters

Used to trim the leads of parts after soldering.

(But don't actually cut the leads flush!)

Long-Nose Pliers

Used to gently form (bend) leads of the parts.

Additional Useful Tools — These aren't required but they are handy!

Brass Sponge

When it comes to keeping the tip of your soldering iron clean, this is an excellent alternative to a wet sponge.

Tip Tinner

Helps remove baked-on residue from the tip of your soldering iron and helps prevent oxidation from accumulating.

De-soldering Pump or De-soldering wick

Two options for removing solder from a pad.

Isopropyl Alcohol (or flux remover) and a Soft Brush

Used to clean rosin flux residue from the PCB

Masking Tape

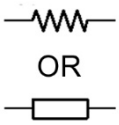
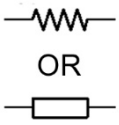
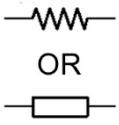
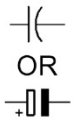
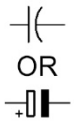
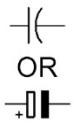
Useful for holding parts against the PCB while you solder them.

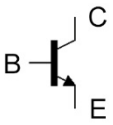
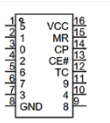
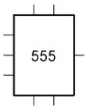
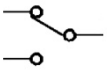
Helping Hands or a Circuit Board Holder

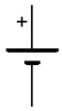
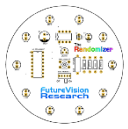
You won't need a holder for this kit because we include three clothespins which work quite well for solder badges.

Never hold parts or the PCB while soldering!

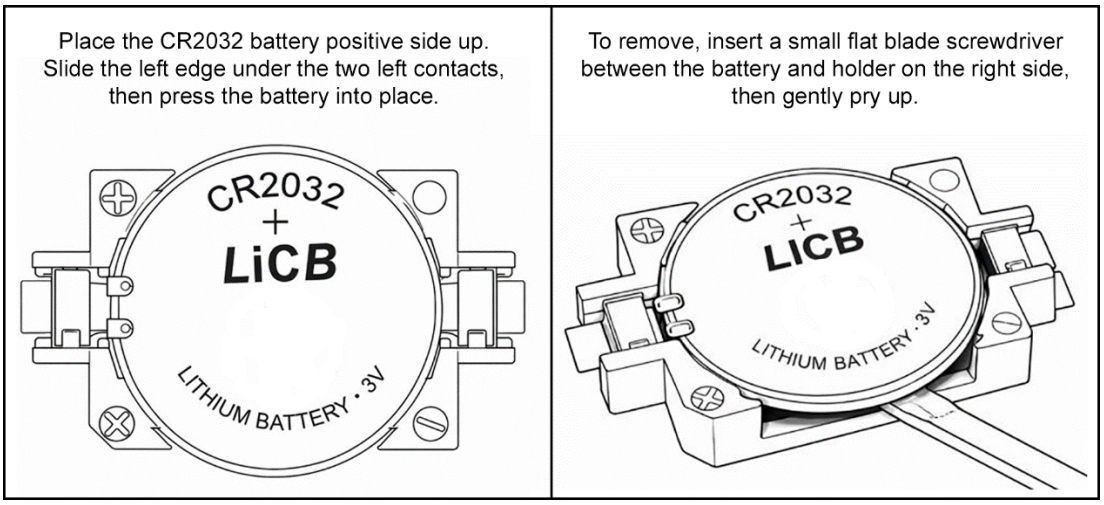
Step 1: Check your parts: This list shows all parts in this kit.
Use it as a checklist and confirm that you have everything.

Part Found?(✓)	Kit QTY	Symbol	Image	Description and Schematic Name
Resistors				
☐	1			220Ω ¼W 5% Carbon Film Resistor Red, Red, Brown, Gold **R1**
☐	1			10KΩ ¼W 5% Carbon Film Resistor Brown, Black, Orange, Gold **R3**
☐	2			470KΩ ¼W 5% Carbon Film Resistor Yellow, Violet, Yellow, Gold **R2, R4**
Capacitors Package Color May Vary				
☐	1			.01µF Ceramic Capacitor Capacitance Code 103 **C3**
☐	1			10µF Electrolytic Capacitor **C2**
☐	1			220µF Electrolytic Capacitor **C1**
LEDs (Light Emitting Diode)				
☐	2			5mm Red LED **LED1, LED6**
☐	2			5mm Green LED **LED2, LED7**

LEDs - Continued (Light Emitting Diode)				
☐	2			5mm Blue LED **LED3, LED8**
☐	2			5mm Yellow LED **LED4, LED9**
☐	2			5mm Orange LED **LED5, LED10**
Transistors and Integrated Circuits				
☐	1			2N4401 NPN BJT Transistor **Q1**
☐	1			CD74HC4017 Decade Counter IC **U1**
☐	1			NE555 Timer IC **U2**
Switches				
☐	1			Tactile Pushbutton **SW1**
☐	1			SW-200D Dual Ball Tilt Sensor (Color May Vary) **SW2**
☐	1			SPDT Slide Switch **SW3**

Batteries and Battery Connectors				
Not Included	1			CR2032 Lithium Battery (Sold Separately) (Brand will vary. **B1**
☐	1	N/A		Battery Holder **B1**
Sockets				
☐	1	N/A		16 Pin IC Socket for U1
☐	1	N/A		8 Pin IC Socket for U2
Printed Circuit Board (PCB)				
☐	1	N/A		106-10 Supercharged Science Learn to Solder PCB Includes three clothespins to be used as a solder stand.
☐	1	N/A		Isopropyl Alcohol Pad Use this to clean both sides of the board before starting.

Note: Do not install the battery until told to do so in the directions. But when you do install the battery, here is how to do it:



Step 2: Prepare the Soldering Iron and Tin the Tip.

1. Place the soldering iron in its stand and plug it in.
2. Wait for the soldering iron to heat up.
3. Wipe the tip of the iron using a moist sponge or brass sponge (preferred). This will clean the tip.
4. Melt a little solder on the tip of the iron.
    - This is called *tinning* and it will help the heat flow from the iron's tip to the joint.
    - The solder should flow onto the tip, producing a bright shiny surface.
    - If the solder will not flow onto the tip, try again to clean it by wiping it on the sponge.
    - If the solder still will not flow onto the tip, press the heated tip into tip tinner to clean residue (mentioned under additional useful tools.)
    - When tinned, wipe excess solder off on the sponge.
    - You do not need to tin the tip before every joint, but you should wipe the tip after two or three solder connections to keep it clean.
    - Check the manufacturer's instructions related to tinning the tip.
5. The tip of the soldering iron should be a shiny silver color. If it is black and pitted, and can’t be cleaned using tip tinner and a brass sponge, replace it with a new one.

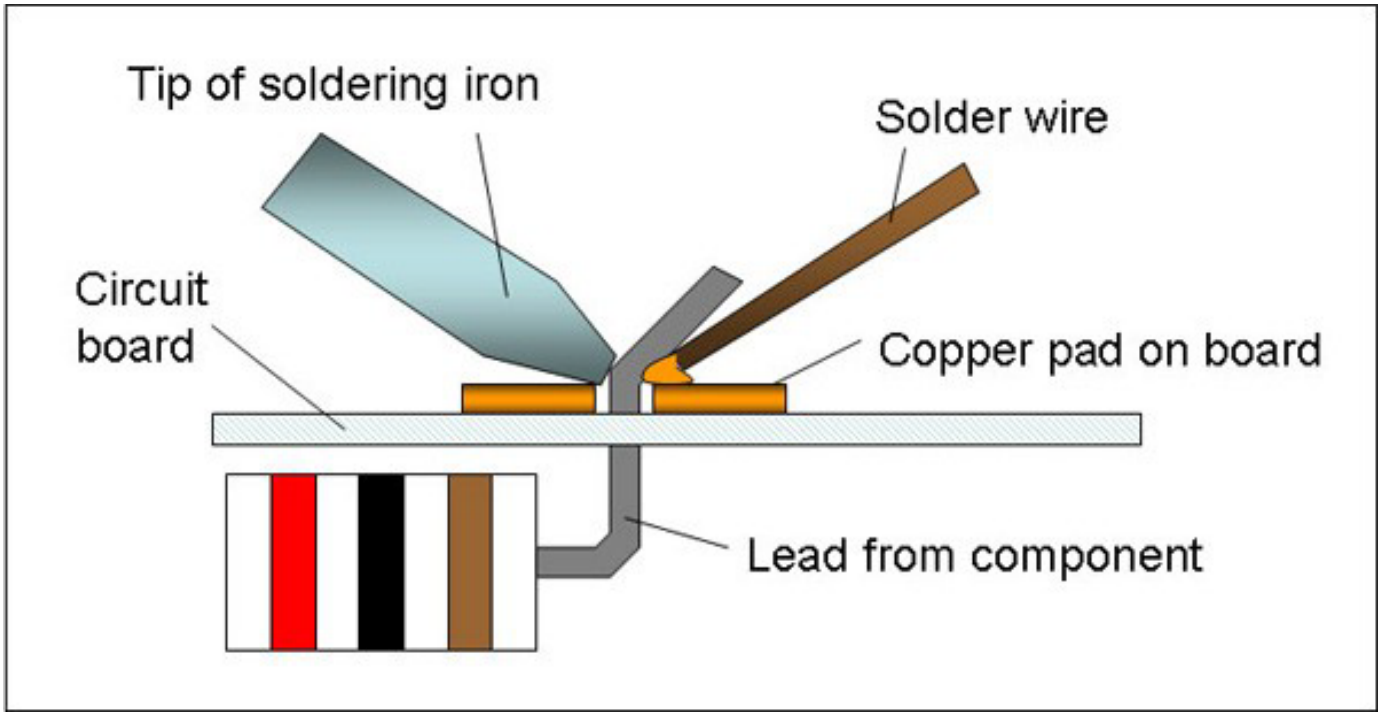
Note: If using separate tinner material, do not leave it on the tip! Despite the name, this is a cleaner and will eat away at your tip. Instead, wipe off tip tinner after use, and then tin your tip with normal solder.

Step 3: How to Solder

Note: Please review this information before soldering. The actual part placement and soldering will take place in Step 4.

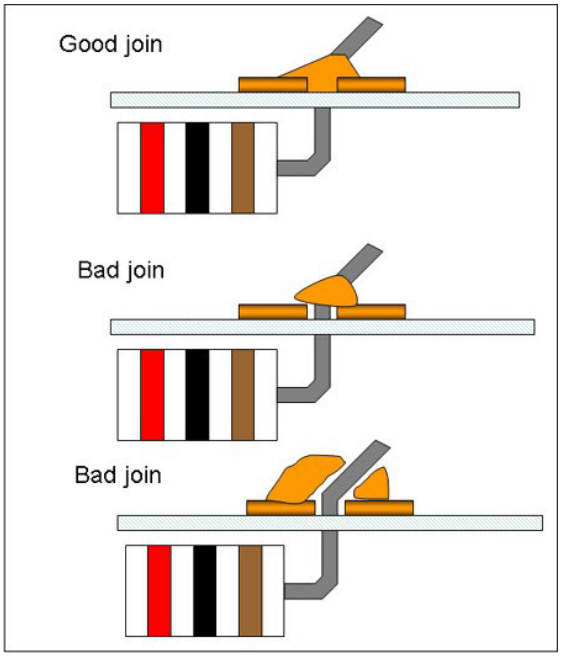
If possible, prepare the circuit board by cleaning it with isopropyl alcohol (IPA) or rubbing alcohol and a lint free towel or makeup pad to clean both sides of the circuit board.

1. To solder, heat the connection with the tip of the soldering iron for a few seconds, then apply the solder.
    - Heat the connection, *not* the solder.
    - Hold the soldering iron like a pen, near the base of the handle.
    - Both parts being soldered need to be hot to form a good connection.



The tip of the soldering iron heats both the copper pad and the lead from the electronic component. Solder melts when placed in contact with the hot metals. Feed solder on to the parts, not the iron.

2. Keep the soldering tip on the connection as the solder is applied.
    - Solder will flow into and around well-heated connections.
    - Use just enough solder to form a strong connection.
3. Feed solder into the connection until it flows all the way around the connection and slightly up the lead of the component. Remove the solder from the connection, then the iron.
    - Don't move the connection while the solder is cooling.
    - Soldering a connection should take just a few seconds.
4. Inspect the joint closely. It should look shiny (note: lead-free solder may appear dull, this is OK).
    - If you are soldering a wire (called the *lead*) onto a PC board (on the *track*), it should have a cone shape.
    - If the connection looks bad, reheat it and try again.
5. Be sure to wipe your iron on the sponge before setting it in the holder.
6. Unplug (or power off) your iron when not in use.



Step 4: Install and Solder Each Component

Clip the three clothespins onto your circuit board in a triangle pattern. The clothespins will act as a circuit board holder while you make your solder connections.

Note: All components except the battery holder should be installed on the top side of the board. (The side with the color FutureVision Research logo.)

When installing parts, is it best to start with the shortest part first.
That way taller parts aren't in the way.

Installation order:

- ☐ **R1** 220Ω Resistor (Red, Red, Brown, Gold)
- ☐ **R2** & **R4** 470KΩ Resistors (Yellow, Violet, Yellow, Gold)
- ☐ **R3** 10KΩ Resistors
- ☐ **SW2** SW-200D Dual Ball Tilt Sensor
- ☐ **SW1** Tactile Pushbutton
- ☐ **SW3** SPDT Slide Switch
- ☐ **Q1** 2N4401 NPN Transistor
- ☐ IC Sockets
- ☐ **C3** .01uF (Code 103) Ceramic Capacitor
- ☐ **C1** 220µF Electrolytic Capacitor
- ☐ **C2** 10µF Electrolytic Capacitor
- ☐ **LED1**, **LED6** (Red)
- ☐ **LED2**, **LED7** (Green)
- ☐ **LED3**, **LED8** (Blue)
- ☐ **LED4**, **LED9** (Yellow)
- ☐ **LED5**, **LED10** (Orange)
- ☐ **B1** Battery Holder

Detailed instructions are provided on the next page…

Step 4 Continued: Detailed Instructions to Install and Solder Each Component

1. Install and solder the resistors one at a time. (R1 – R4)
    a. Double check the value of each resistor and match it to the value printed on the top of the circuit board.
    b. Gently fold the two leads of the resistor down and insert them into the proper holes on the printed circuit board.
    c. Resistors are not polarized, but a best practice is to insert the resistor so you can read the color code in the same direction as the value printed on the circuit board.
    d. Each resistor should sit flush against the printed circuit board.
    e. Gently bend the leads away from each other at an angle to hold the part against the circuit board. (Do not fold the parts flush against the bottom of the board.)
2. Install and solder the motion sensor reed switch (SW2)
    a. Gently fold the two leads of the reed switch down and insert the leads into the proper holes on the printed circuit board.
    b. The reed switch should sit flush against the printed circuit board.
    c. Gently bend the leads away from each other at an angle to hold the part against the circuit board. (Do not fold the parts flush against the bottom of the board.)
3. Install and solder the tactile pushbutton switch (SW1)
    a. Insert the pushbutton into the circuit board so that it sits flush. The pins of the pushbutton will hold it in place.
    b. Solder all four pins of the switch.
4. Install and solder the slide switch (SW3)
    a. Insert the slide switch so that the knob of the slide switch faces the color FutureVision Research logo.
    b. Solder the two outside pins and confirm the slide switch is sitting flush. Then solder the three switch pins.
5. Install and solder the transistor (Q1)
    a. Slightly bend the middle lead of the transistor away from its flat side.
    b. Insert the three leads of the transistor so that its flat side (side with the writing) matches the outline on the circuit board.
    c. The transistor will not sit flush. Instead it will sit a couple millimeters off the circuit board.
    d. Gently bend the leads at an angle and solder in place
6. Install the two sockets for U1 and U2
    a. The two integrated circuits chips (U1 and U2) will not be soldered onto the board. Instead, we will solder sockets. Later, we will plug the two integrated circuit chips into those sockets.
    b. Insert each socket into the circuit board, making sure to make the indent at the top of the socket to the outline on the circuit board.

c. Use a fingernail to gently bend the leads away from the center of the socket. This helps help the socket in place for soldering.
d. If necessary, use masking tape or helping hands to hold the socket in place.
e. Solder two pins at opposite corners of the socket, then turn the board over and confirm the socket is still sitting flush.
f. Once you confirm the socket is flush, solder the remaining pins.
g. Do this for both U1 and U2

7. Install and solder the ceramic capacitor (C3)
    a. Insert the ceramic capacitor so the value printed on the part faces the value printed on the circuit board. (This is a “best practice”. Ceramic capacitors are not polarized.
    b. Gently bend the leads away from each other at an angle to hold the part against the circuit board. (Do not fold the parts flush against the bottom of the board.)
8. Install and solder the two electrolytic capacitors (C1 and C2)
    a. Electrolytic capacitors are polarized. Insert the two leads so that the capacitor’s short leads face the center of the circuit board (toward the color FutureVision Research logo). In other words, the long lead will face the positive symbol shown on both sides circuit board.
    b. Gently bend the leads away from each other at an angle to hold the part against the circuit board. (Do not fold the parts flush against the bottom of the board.)
9. Install and solder LEDs one at a time. (D1-D10)
    a. The long lead of each LED represents positive, and should be placed in the hole towards the top of the circuit board. This will match the positive symbol printed on both sides of the circuit board.
    b. The LEDs should sit flush against the printed circuit board.
    c. Gently bend the leads away from each other to hold the part against the circuit board.
    d. LEDs of the same color should be on opposite sides of the board and should match this color scheme:
    e. LED1 & LED6: Red
    f. LED2 & LED7: Green
    g. LED3 & LED8: Blue
    h. LED4 & LED9: Yellow
    i. LED5 & LED10 Orange
10. Install and solder the battery holder.
    a. Ensure that the battery is not installed in the holder.
    b. This is a surface mount part, which means no conductive leads will be inserted into the circuit board.

c. Place the battery holder on the bottom side of the board, matching the outline drawn on the board. Ensure that the two solder tabs are directly over the two pads on the circuit board.
d. Use a clothespin to hold the battery holder against the circuit board.
e. Solder in place.

A note about trimming leads on your parts:

Once you make the solder connections, the leads of your LEDs and resistors need to be trimmed before you insert the batteries. You can trim leads after soldering each part, or you can trim them all at once when you finish.

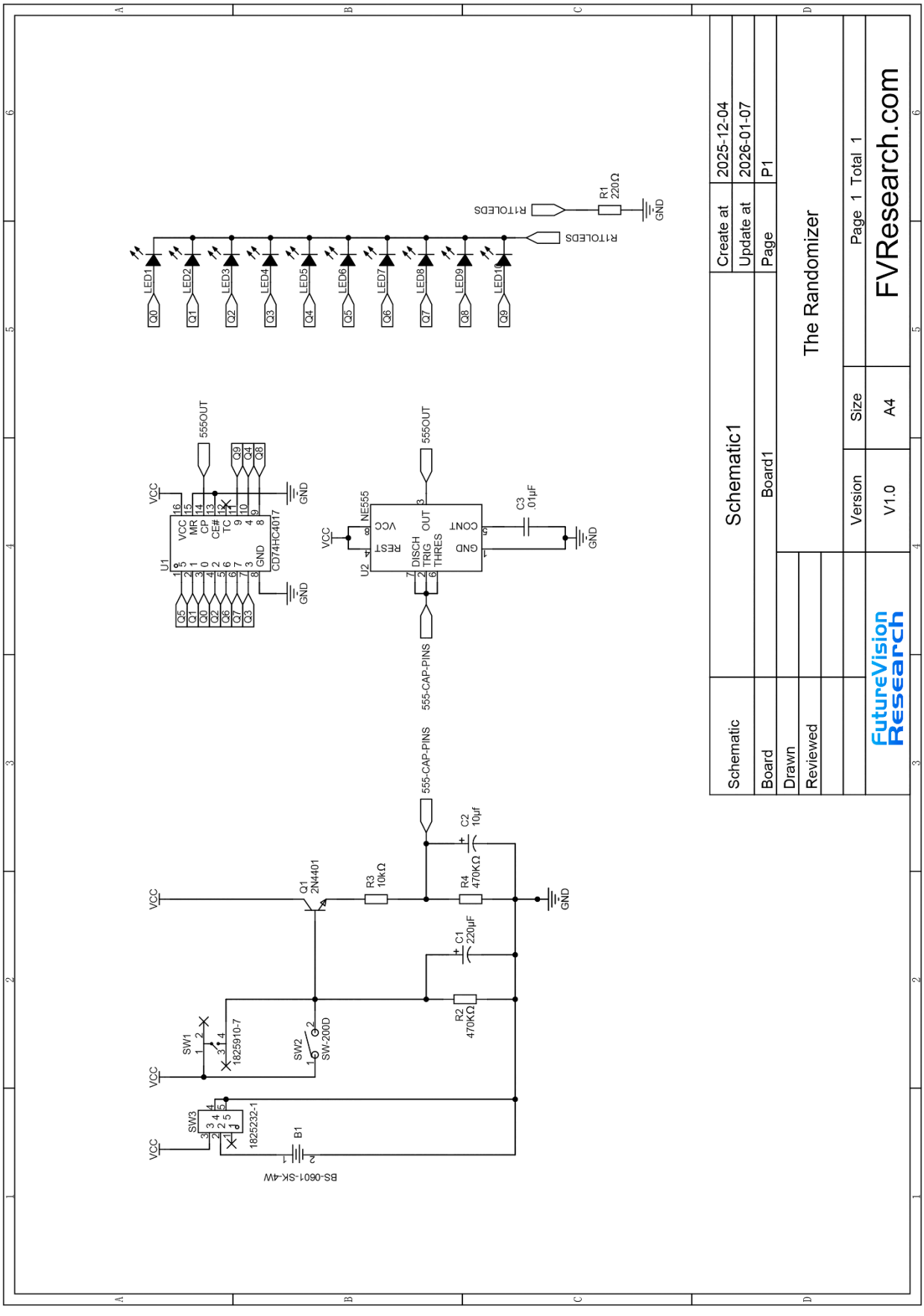
Double check that each part is in the correct place
and the right direction BEFORE trimming the leads.

The slide switch, pushbutton, IC sockets, and battery holder connections do not need to be trimmed.

Step 5: Inspect Your Work, Clean the Board, and Install the Battery

Recommended steps:

1. Ensure all component leads are trimmed
2. Inspect your solder connections and check for
    a. Poor connections
    b. Cold solder joints
    c. Solder bridges
    d. Pieces of trimmed leads that might be stuck to the PCB
3. Correct any faulty connections
4. Clean the circuit board
    a. If you used rosin core solder, (or even better, no-clean flux) cleaning the flux is not mandatory. But if you would like to clean the board, use rosin flux remover or isopropyl alcohol and a soft brush.
    b. If you used organic flux, you must clean your circuit board before applying power. To clean the board, use warm water a soft brush.
    Ensure your PCB is completely dry before continuing.
5. Insert the two integrated circuit chips into their sockets. Be sure to match pin 1 on the IC to pin 1 on the circuit board.
6. Insert the CR2032 battery with the negative side facing the circuit board.
7. Move the slide switch to the “on” position.
8. Pressing the button or gently shaking the circuit board should cause the LEDs go glow in a sequence and stop on one LED.


Schematic1
Create at 2025-12-04
Update at 2026-01-07
Page P1
Board1
The Randomizer
Schematic
Board
Drawn
Reviewed
Version V1.0
Size A4
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FutureVision Research
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LED1
LED2
LED3
LED4
LED5
LED6
LED7
LED8
LED9
LED10
R1TOLEDS
R1 220Ω
GND
U1 CD74HC4017
U2 NE555
555OUT
555-CAP-PINS
C3 .01µF
C2 10µf
C1 220µF
R2 470KΩ
R3 10kΩ
R4 470KΩ
Q1 2N4401
SW1 1825910-7
SW2 SW-200D
SW3 1825232-1
B1 BS-0601-SK-4W
VCC