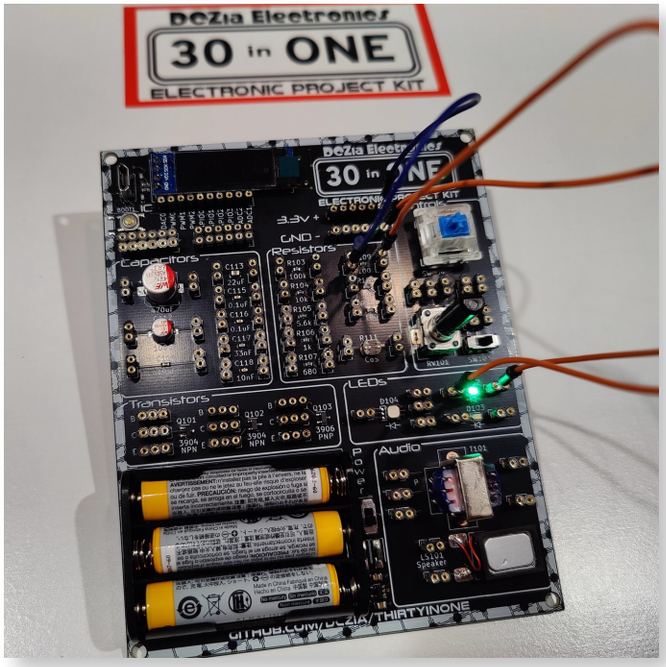
DeZia Electronics

30-in-ONE

ELECTRONIC PROJECT KIT



INSTRUCTION MANUAL

FUELED BY

SOLDER & GREEN CHILE

PROJECT INDEX

INTRODUCTION

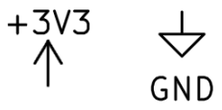
The **DCZia Electronics** 30-in-ONE Electronic Project Kit is a retro homage to electronic kits of the past — now in the portable form of a badge! Those kits taught many of us how to experiment with the strange little bits of ceramic, silicon, and solder we found inside the radios, toys, and other things we couldn't help taking apart as kids.

Each project in this book has a description, a schematic, and a wiring diagram. The schematic is a blueprint that uses standard symbols to show how the various components in the circuit are connected to create the circuit. The wiring diagram is a visual guide for making the physical wire connections on the 30-in-ONE badge. You will use the jumper wires included in the kit to make connections to the through hole sockets in the board as indicated in the diagram. There is a master power switch to the right of the middle battery that will save power and let you connect components without accidental shorting.

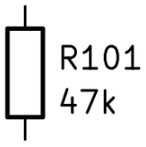
We hope you enjoy! The DCZia Crew

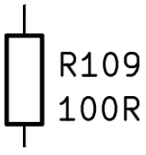
DEVRESERSGNORWLLATFELYPOC

COMPONENTS (1 OF 2)

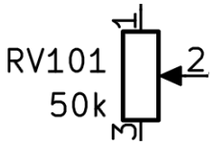


These are power symbols. 3.3V is plus, or positive. GND is ground, or negative.

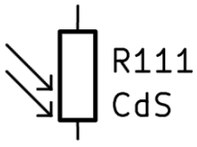




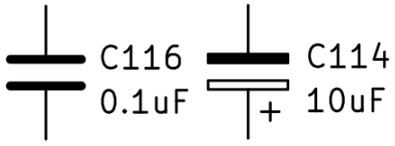
Note that the symbols have a letter and a number. The letter is the type of component. This is a Resistor. The number uniquely identifies the part on the schematic. Together, this is called the Reference Designator or RefDes. Sometimes a component value is present as well. 100R means 100 ohms and 47k means 47,000 ohms.



This is a special resistor that is variable, a potentiometer. You twist the knob to change the value. Terminals 1 and 3 measure 50k ohms on this one, and are constant. Terminal 2 is a wiper that moves along the fixed part. As you twist the knob, the resistance value at 1-2 changes in one direction as the value at 2-3 changes in the other direction.

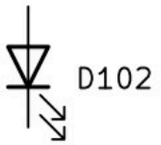


This special resistor is also variable. The resistance decreases as the amount of light it ‘sees goes up.

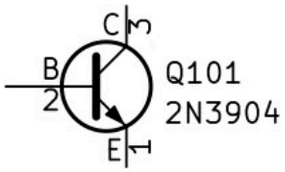


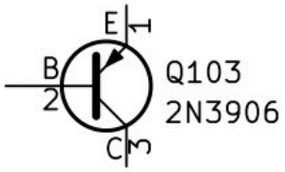
These are capacitors. A capacitor stores energy and smooths changes in voltage. Some capacitors have a polarity, meaning current should only flow in one direction. Connecting a polarized capacitor backwards can damage it.

COMPONENTS (2 OF 2)

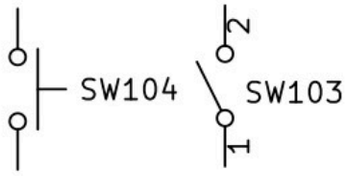


This is an LED, or Light Emitting Diode. It converts electricity into light. It has a polarity and will only light in one direction.

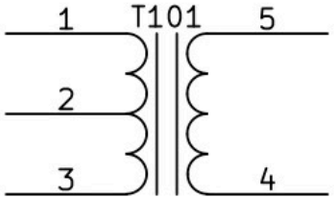




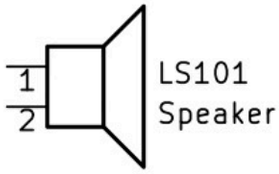
These transistors allow a very small current to “switch” a much larger current. Bi-polar transistors come in 2 different forms. Q103 is PNP, and Q101 is NPN. Remember the arrow is “Not Pointing In” on an NPN transistor. P is a positively doped layer in the transistor, and N is negatively doped. The 3 terminals are the Base, Collector, and Emitter.



These are switches. They interrupt the flow of current. SW104 is a push button switch, or key switch. The other switch latches closed or open. It has a single “pole” and is called a “Single Pole, Single Throw” switch (SPST).

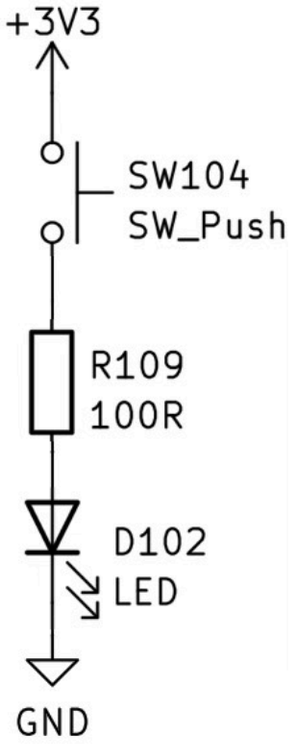


This is a transformer. It transforms the magnitude of the signal from the primary to the secondary winding. The voltages at the two sides are magnetically coupled as opposed to directly coupled. This is called “galvanic isolation.”

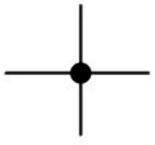


This is a speaker. It converts an alternating voltage into sound using a magnetic coil wrapped around a thin membrane that moves with the magnetic field to make sound.

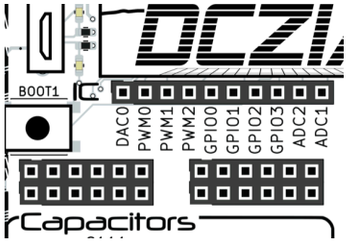
READING SCHEMATIC DIAGRAMS

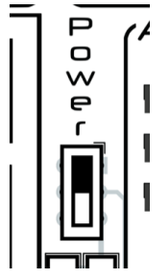


Throughout this manual, you will find schematics for each project, as well as wiring diagrams. Let's take a look at a simple schematic. It is a visual diagram that shows how a circuit is wired. To construct this circuit, you simply attach the wires to connect the components shown. When you see a (+) symbol, that means the component has a polarity (set direction) and the positive current should attach only to that pin. Some components don't have a polarity, so you can choose the direction they are wired in the way that makes your wiring paths simplest. Note that wires may cross in the schematic or wiring diagrams. Those wires are not connected to each other unless there is a circle or dot at the intersection as shown on the left.



The top left corner of the badge includes a USB port, a reset switch to reboot the microcontroller, a set of header connectors for the MCU, and a bank of horizontally connected sockets that can be used as connector bars to minimize the rats nest of wires. Additionally, there is a power switch for the entire badge to the right of the battery bank.





CREDITS AND CODE OF CONDUCT

The following people made this badge happen: hamster, skafreak, syntax, luna, willyk, beardbyte, ancients, lithochasm, jrock, bab, _bv, toasty, irishmasms, gateherder, luanhanzi, and pictographer. The entire DCZia crew got together and planned the badge physically and virtually over the span of many months.

Please let us know what you think @DCZia505

DCZia is a cohesive group of individuals with diverse backgrounds, heritages and experiences whose mission is to educate members in information security and related technical subjects. We want a constructive and positive space for members to be productive, share ideas and learn. DCZia strongly believes in free speech. However, this requires that everyone participating be conscious of how their statements may be interpreted by others, especially those which may cause participants to feel uncomfortable or unwelcome.

We do not tolerate any harassment or insulting of our members of any kind. This includes, but is not limited to sexual, verbal, physical or psychological types of harassment. We do not tolerate hate speech. We respect the privacy of everyone.

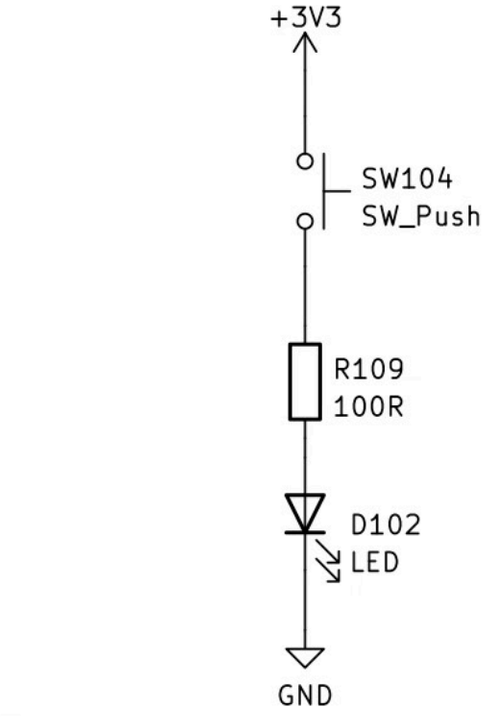
1. LIGHT THE LED

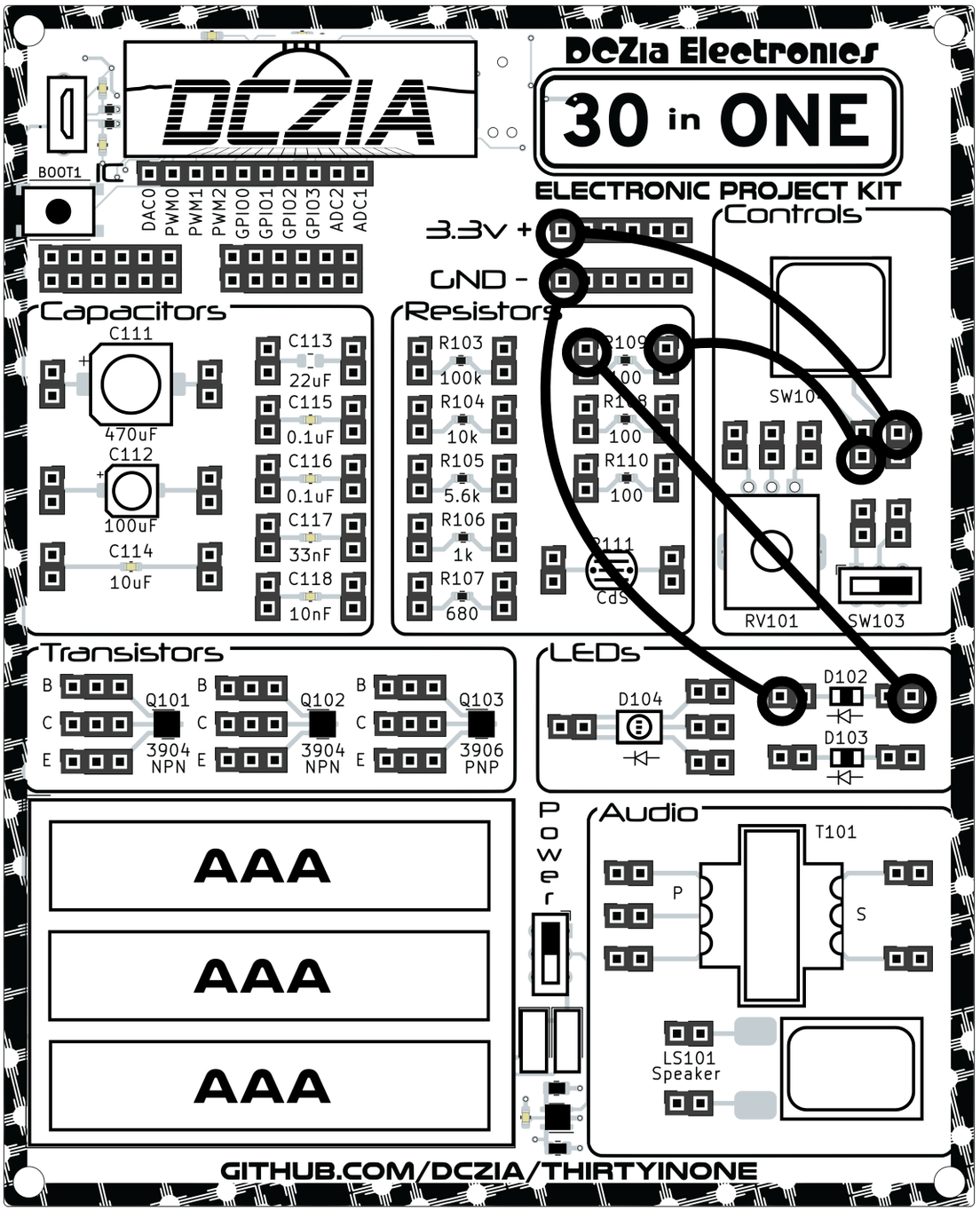
This first project is a fun and easy warm-up. The Light Emitting Diode (LED) produces light when current passes through it.

Although this is a simple project, you can learn a lot from it. Try changing the value of the resistor. Or connect two LEDs in series. Try using the push button to tap out Morse code.

Question: What is the highest resistance value you can use before the LED completely turns off?

NOTES



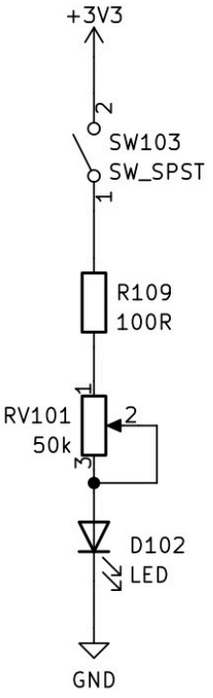

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R110
100
R111
CdS
Controls
SW101
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
B
C
E
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

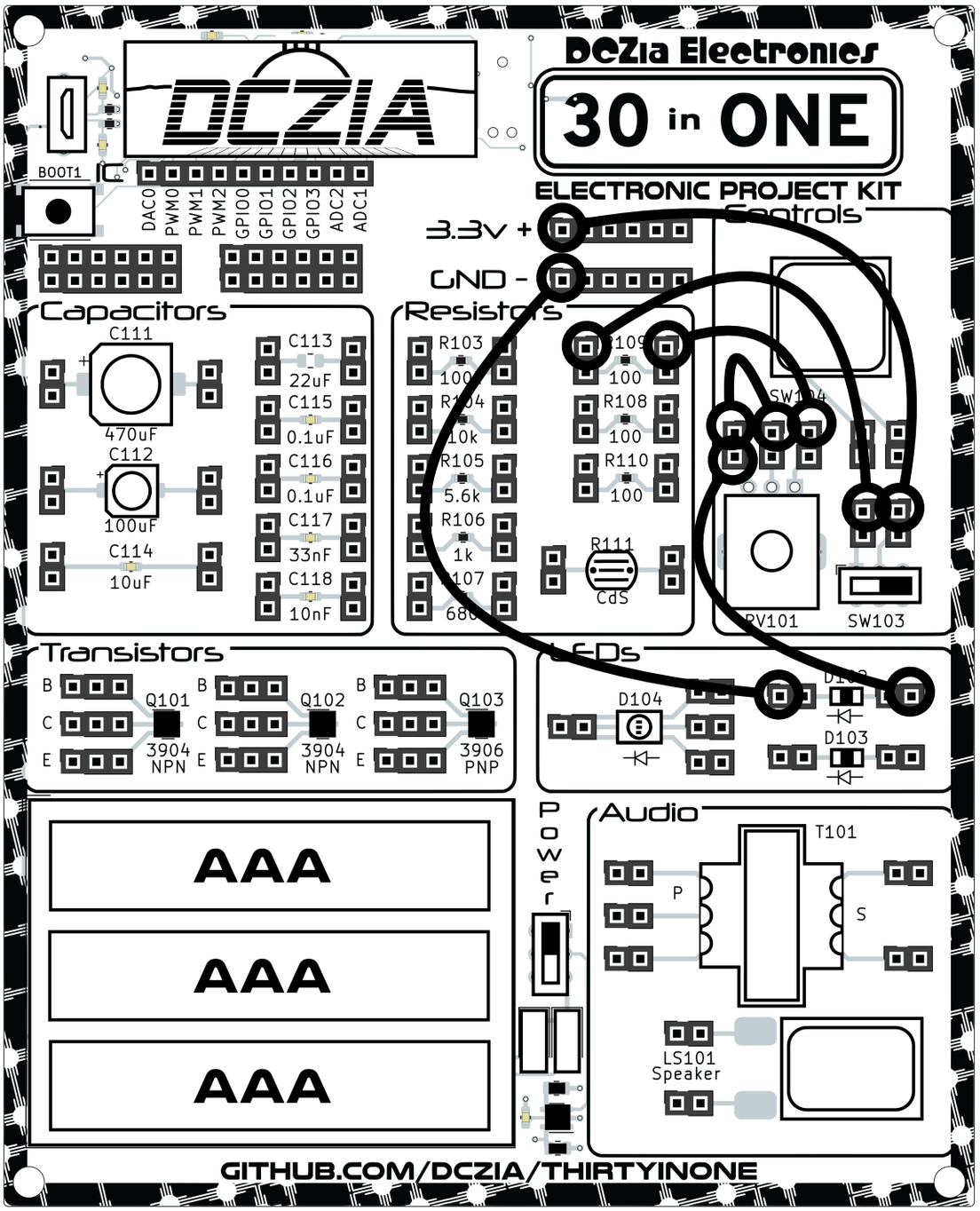
2. LEDS AND RESISTORS

Now you will add a variable resistor (also called a potentiometer) to the previous circuit. This will let you dial the resistance up and down. What happens?

What are some of the other applications you can think of for a potentiometer? If the potentiometer is a resistor, why does this circuit use a 100 Ohm resistor as well?
[Ignore me for now ~!@#$%^&*()_+[]\{}|;',./:"<>?`]

NOTES




DCZia Electronics
30 in ONE
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PWM0
PWM1
PWM2
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GPIO3
ADC2
ADC1
3.3V +
GND -
Controls
SW104
PV101
SW103
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R108
100
R110
100
R111
CdS
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D103
Power
AAA
AAA
AAA
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

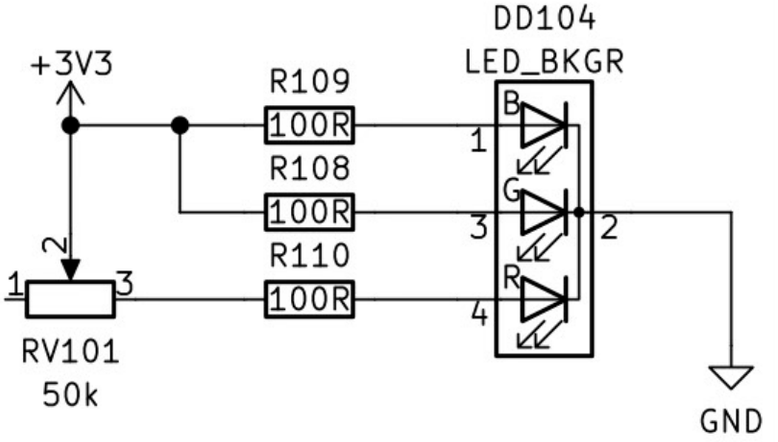
3. RGB MIXING

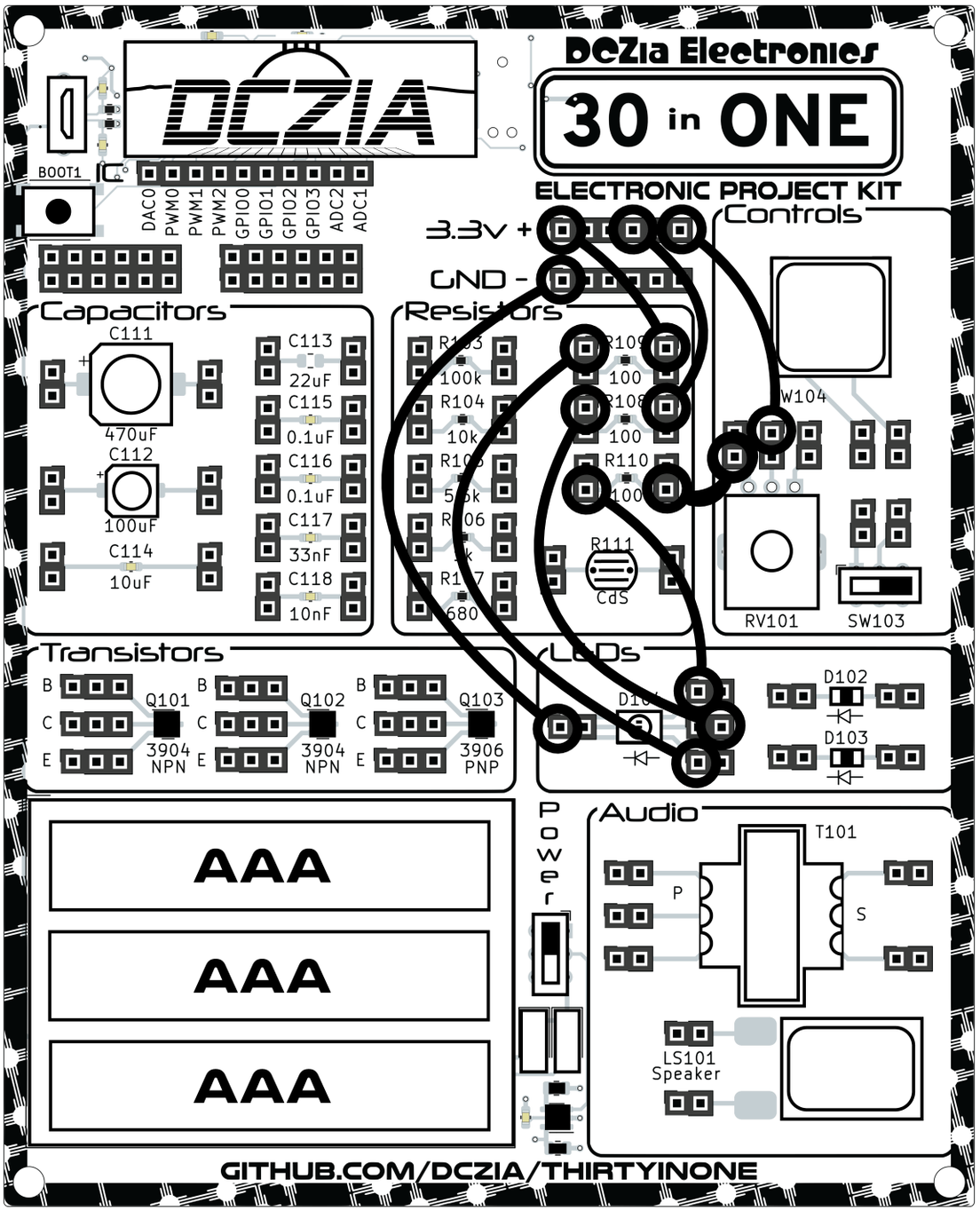
So far we have used an LED that emits only one color. You have turned it on and off, and varied the brightness. But how do color changing LED lights work? It's really very simple: they contain Red, Green, and Blue LEDs that can be mixed by increasing or decreasing the output of each color.

This project varies the brightness of only one of the three LED colors. Can you tell which one? Notice how similar this is to project 2.

How can you vary one of the other two colors? With the parts on this board, can you vary more than one color?

NOTES




DCZia Electronics
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DCZIA
BOOT1
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C112
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10uF
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C116
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C117
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C118
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Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
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NPN
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PNP
B
C
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LEDs
D104
D102
D103
AAA
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AAA
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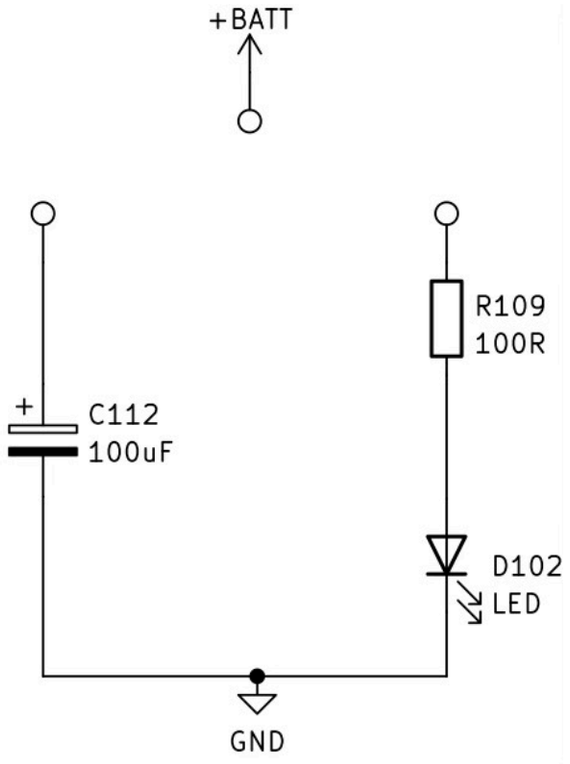
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

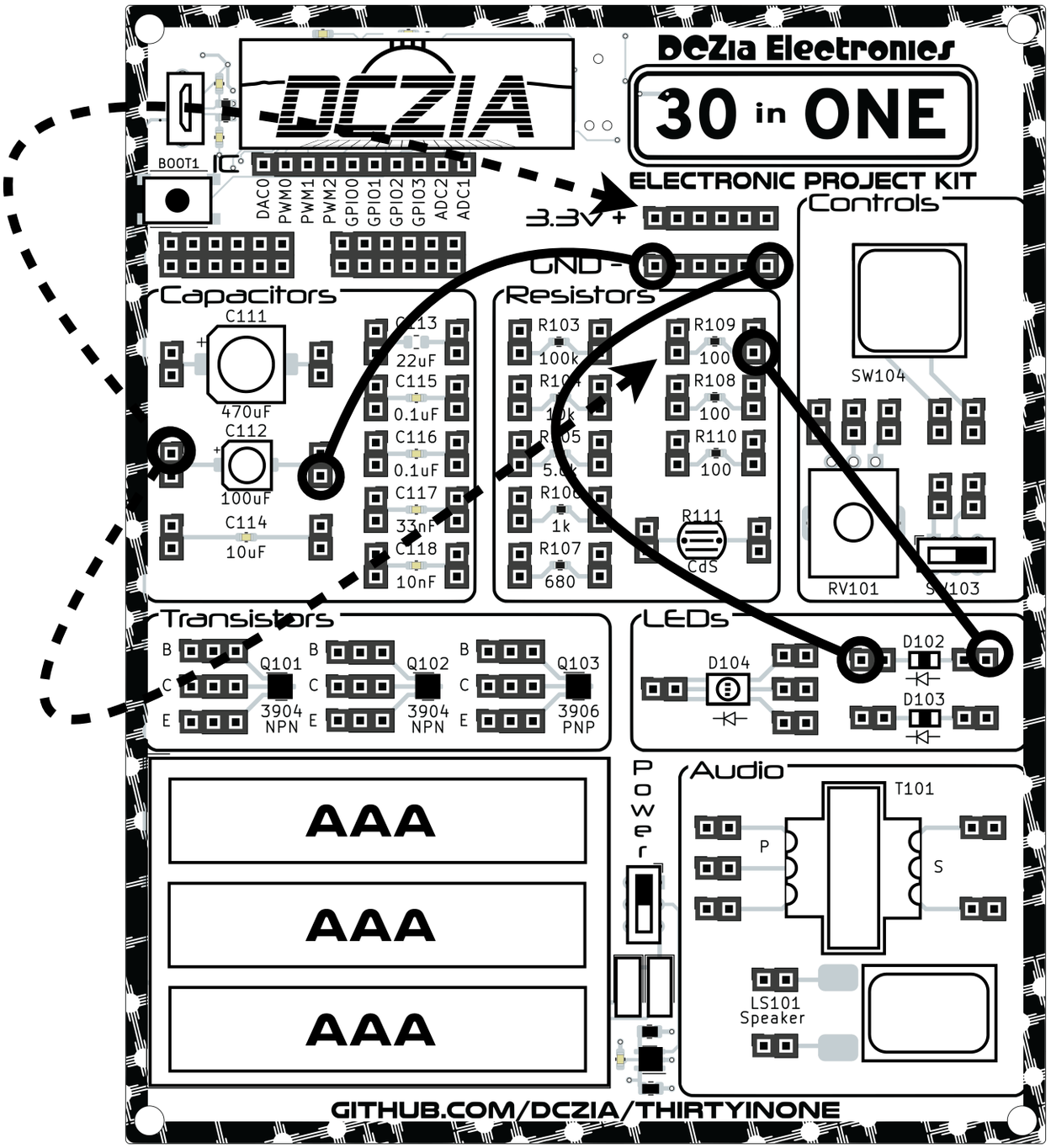
4. STORAGE TANK

This project explores the storage capabilities of capacitors. These handy components store electric charge until activated. Once activated, they release the energy very quickly.

First connect the a jumper from a 3.3v+ battery terminal to the **(+) side** of the 100uF capacitor C112 (NOTE: connecting C112 backwards will damage the capacitor). What happens when you first wire up this circuit? After a few seconds, remove the jumper from the battery and connect it to the resistor R109 and note what changes. How does this circuit work? Think about water flowing and the path it takes. How is the capacitor like a dam?

NOTES




DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
DAC0
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D102
D103
AAA
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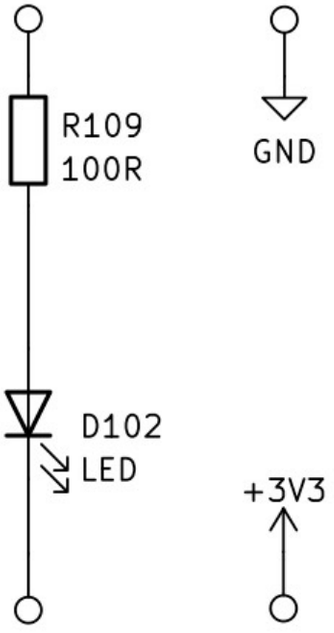
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

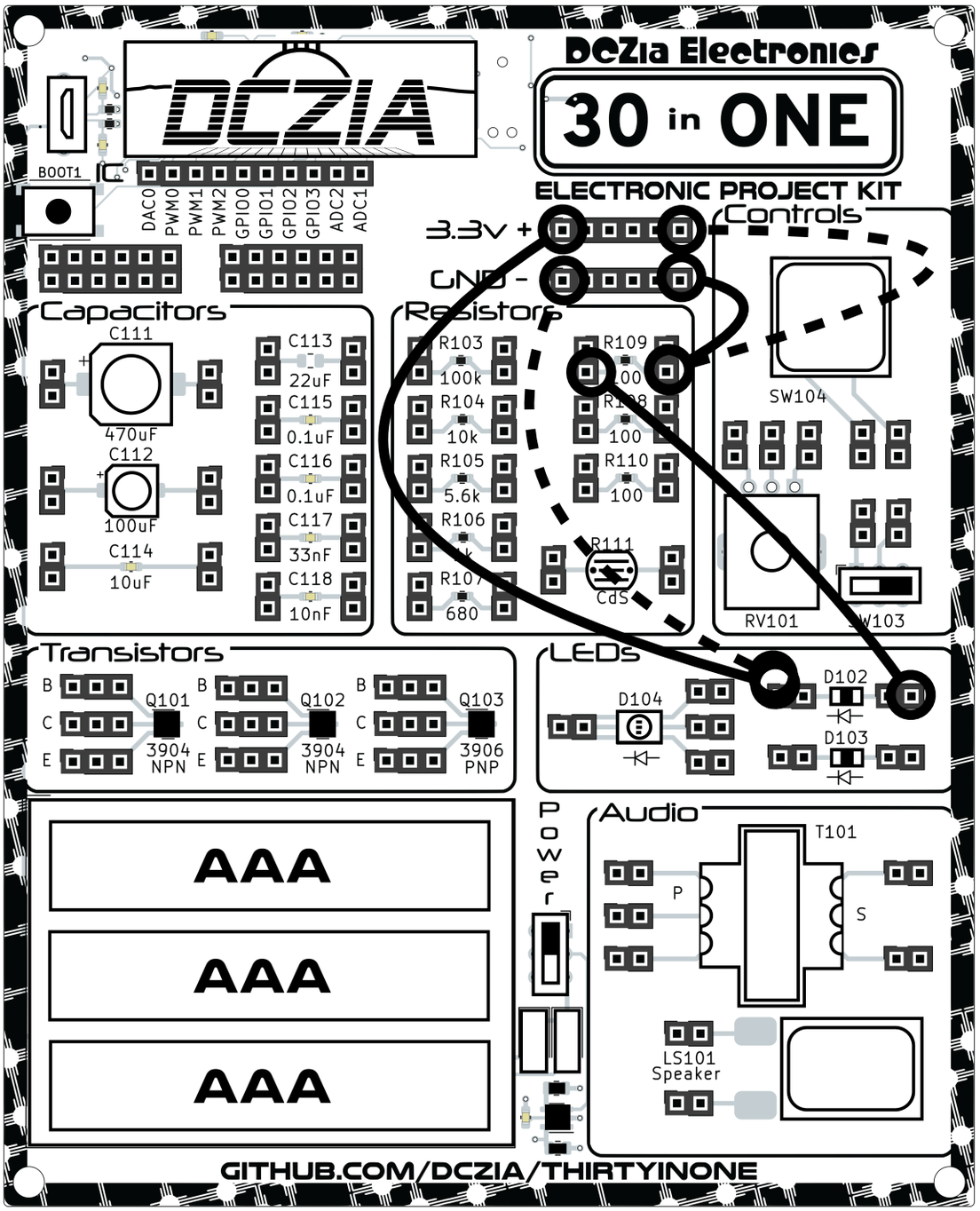
5. DIODES

It's pretty clear what "light emitting" means in LED, but what is a diode? The symbol for a diode has a hint: it looks like an arrow. First wire up this project by connecting D102 to the battery (3.3v+) to R109 to ground (GND-). Then swap those power connections. This changes the direction of current flow in the circuit.

What changed? What does this tell you about how a diode works?
[No, really ignore me for now ~!@#$%^&*()_+[]\{}|;',./:"<>?`]

NOTES




DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0 PWM0 PWM1 PWM2 GPIO0 GPIO1 GPIO2 GPIO3 ADC2 ADC1
3.3V +
GND -
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D102
D103
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T101
P
S
LS101
Speaker
AAA
AAA
AAA
GITHUB.COM/DCZIA/THIRTYINONE

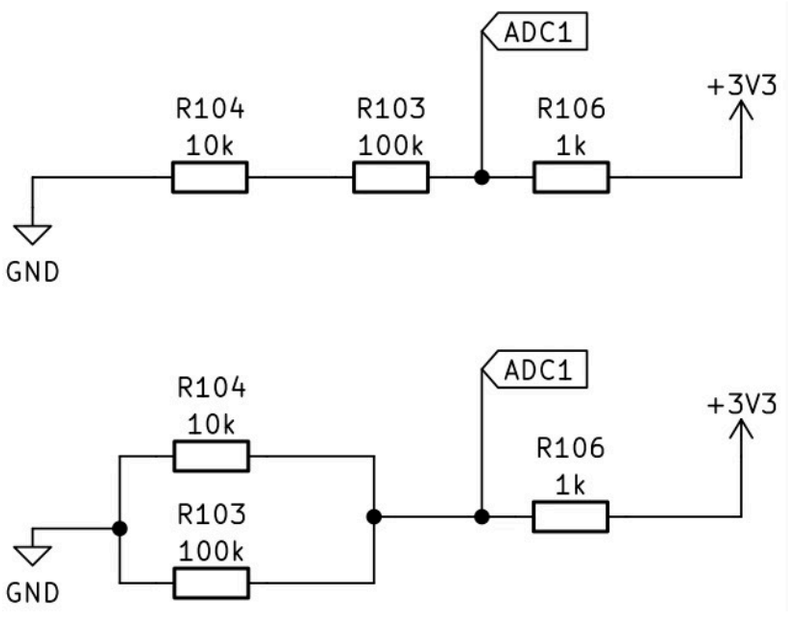
6. RESISTORS IN SERIES/PARALLEL

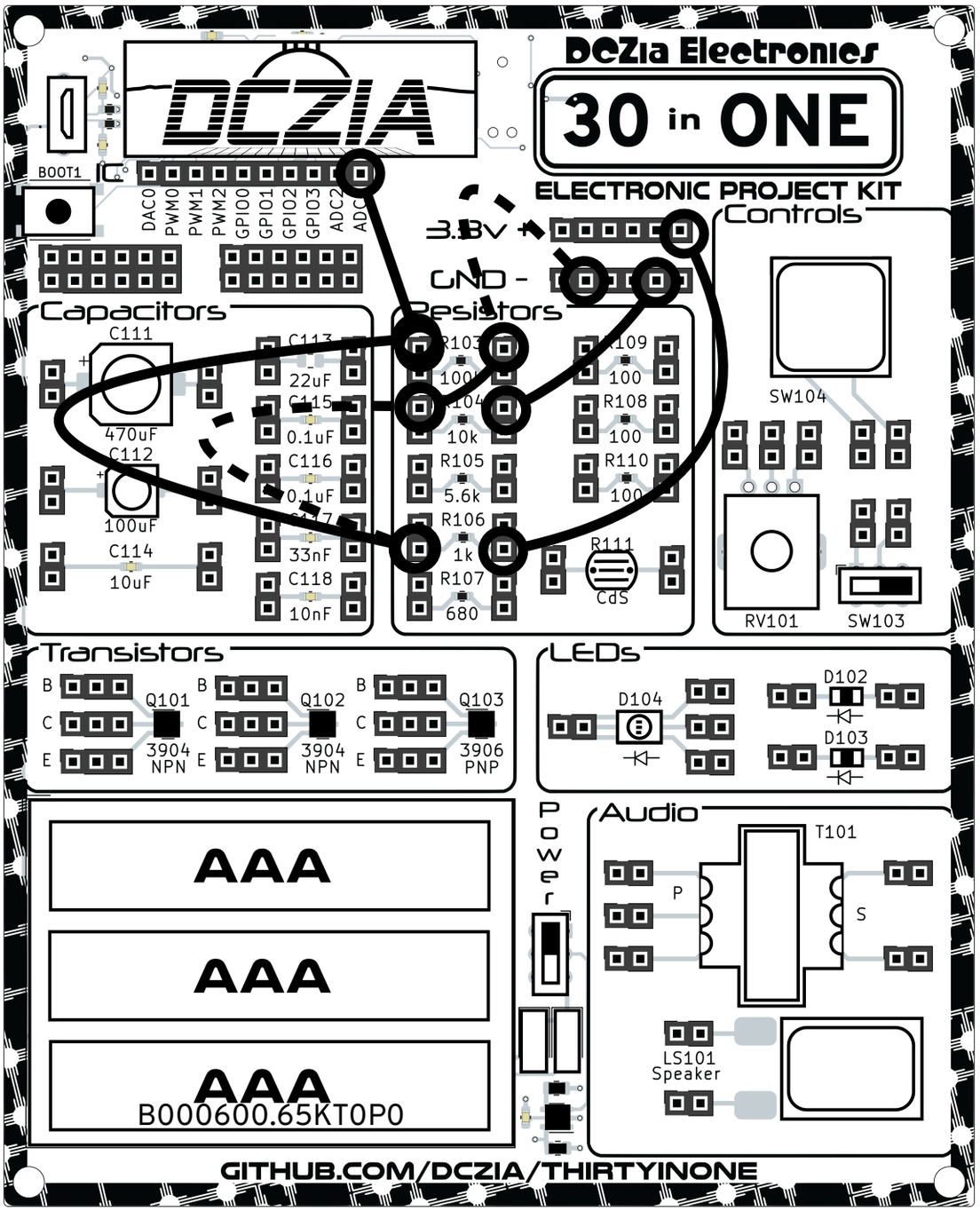
Resistors impede the flow of electricity in a circuit. This is why the measurement of resistance is called ohms of impedance (named after German physicist Georg Ohm).

Below are two different schematics . Connect the wires for the top one first. Use ADC1 to measure the voltage at the test point.

Next build the bottom circuit below by adding jumpers where there are dashed lines in the wiring diagram and **removing** the short jumper connecting R103 to R104. Why are the voltages different? What do the terms series and parallel mean?

NOTES




DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
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BOOT1
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GPIO1
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C118
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R103
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R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
B
C
E
LEDs
D104
D102
D103
AAA
AAA
AAA
B000600.65KT0P0
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

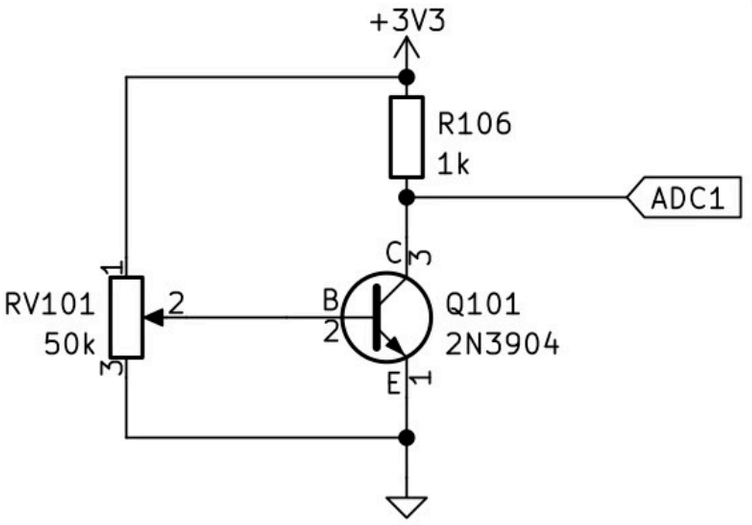
7. TEMPERATURE SENSOR

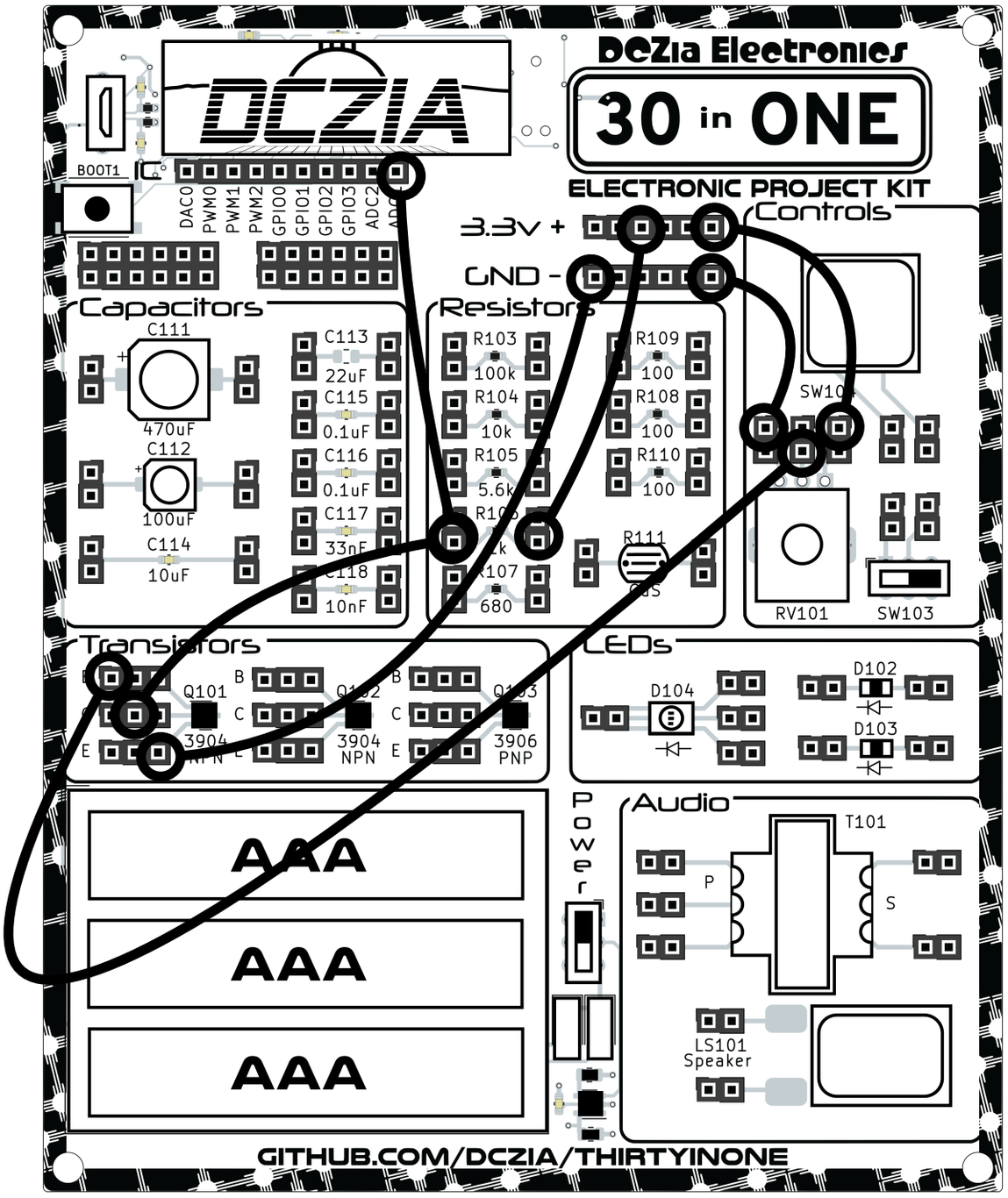
This project demonstrates the practical application of electronics to the physical world. It also introduces you to a fascinating use of transistors.

After following the wiring diagram, adjust the potentiometer RV101 until ADC1 measures about 3 volts. Now hold your finger against the Q101 transistor. What happens to the voltage? Why does this happen?

NOTE: In the schematic, the connections to the transistor are: 2=Base, 3=Collector, 1=Emitter, which correspond to the B, C, and E through holes on the board.

NOTES

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30 in ONE
ELECTRONIC PROJECT KIT
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BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R107
680
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R108
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R110
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R111
CDS
Controls
SW102
RV101
SW103
Transistors
Q101
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NPN
Q102
3904
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Q103
3906
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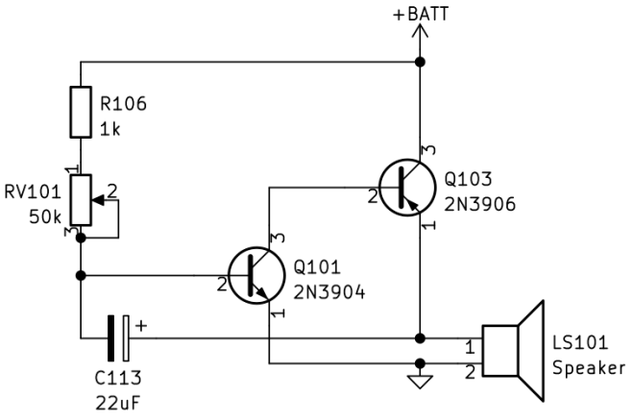
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

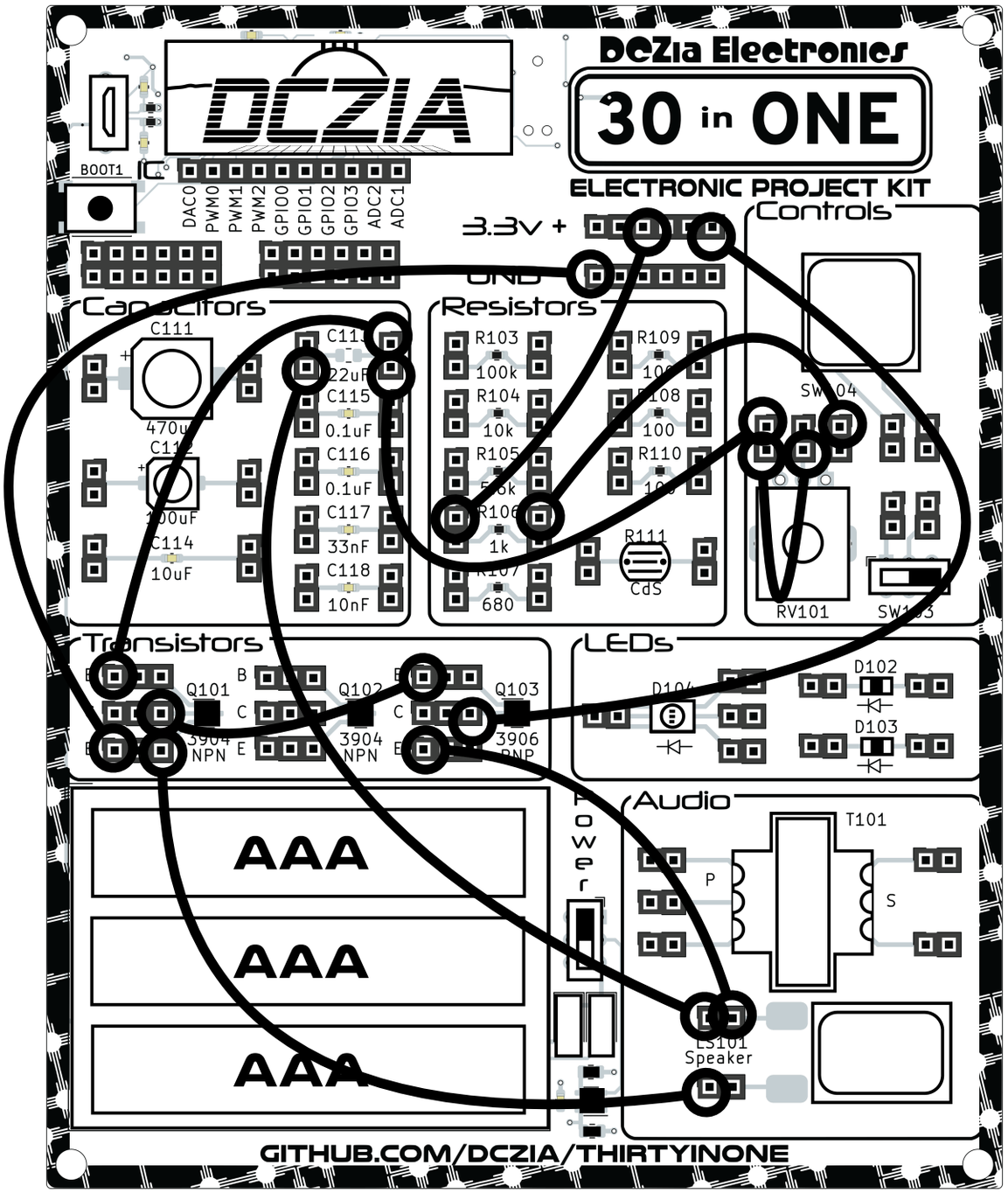
8. METRONOME

A metronome is a tool to set the tempo of music and help musicians keep that tempo. A pendulum is a sort of mechanical metronome that oscillates back and forth. In this project you will make an electronic metronome that plays a rhythmic click through the speaker LS101.

The two transistors in this circuit (one NPN and one PNP) form an oscillator. The potentiometer will let you control the rate of the tempo. You can replace R106 with other resistor values to increase or decrease the rate even more. How do you think the oscillator works?

NOTES

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30 in ONE
ELECTRONIC PROJECT KIT
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AAA
AAA
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T101
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LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

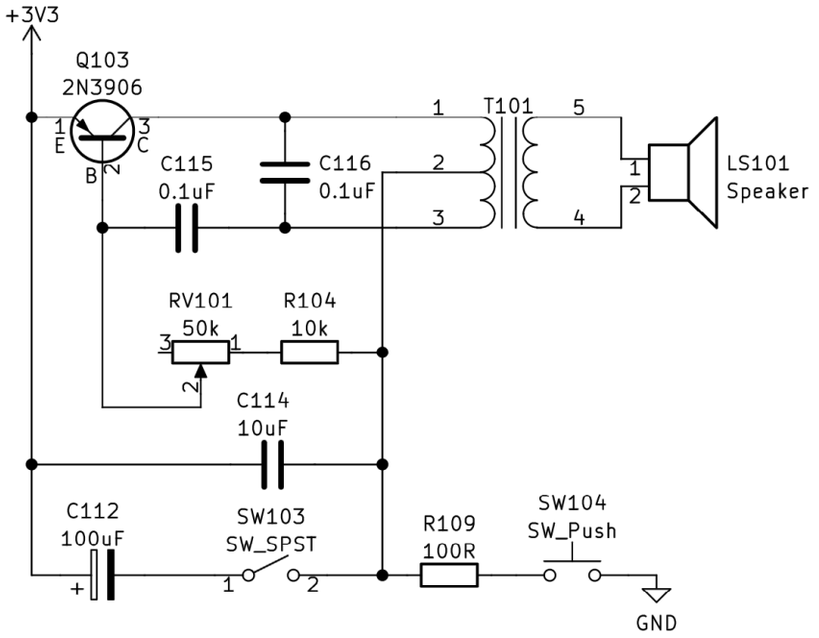
9. ELECTRONIC CAT

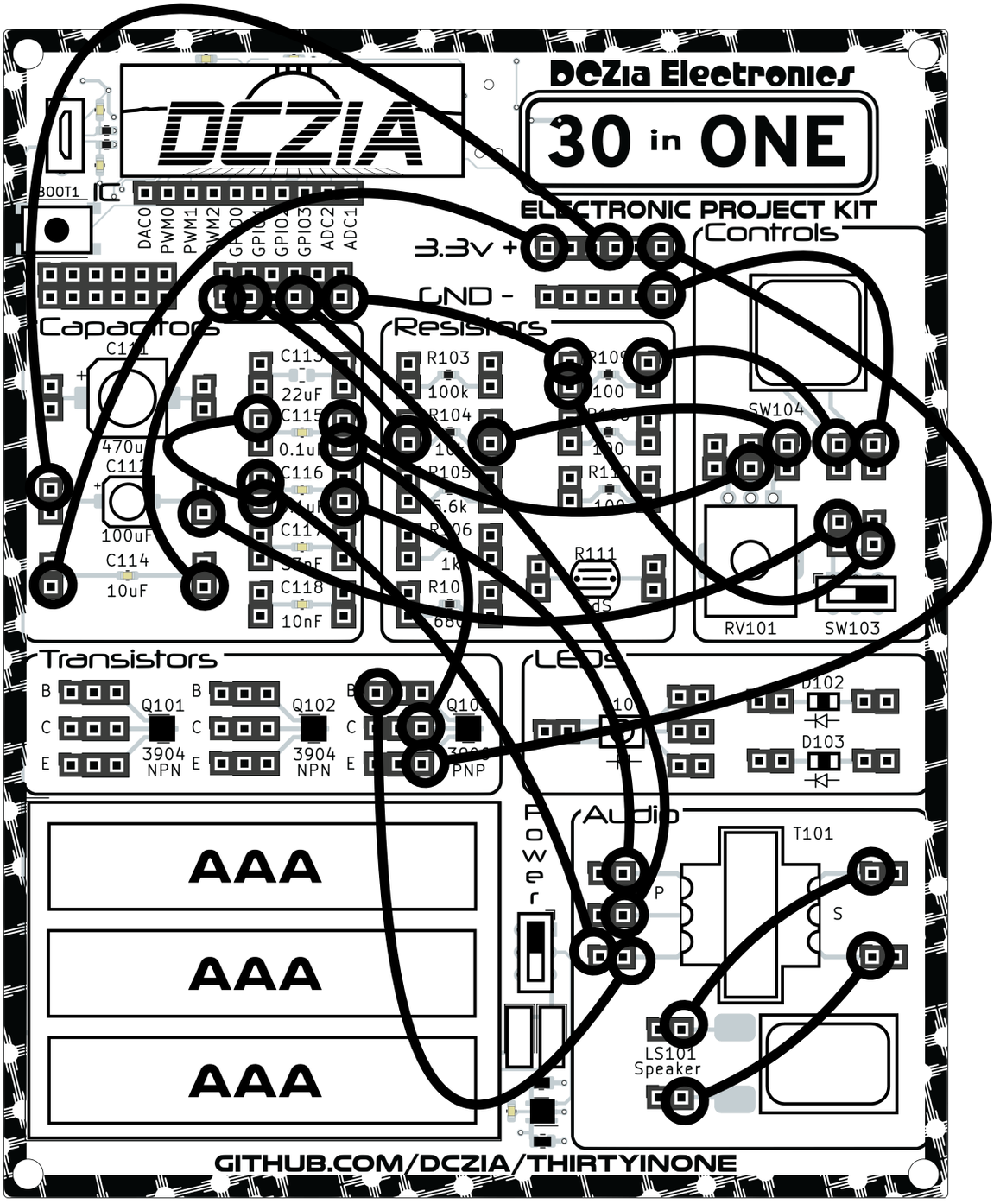
Do you have a cat? If not, here is one that requires no feeding but might produce a meow realistic enough to make people think you do. If you already have cats, this is guaranteed to get their attention!

Start with switch SW103 in the closed position. Press the SW104 key switch and release immediately to see what happens. Adjust the potentiometer to change the sound. Next switch SW103 to the open position. Try all combinations to see if you can get a more realistic (or interesting) sound.

How do the combination of components used in this project cause the sound to vary over time?

NOTES



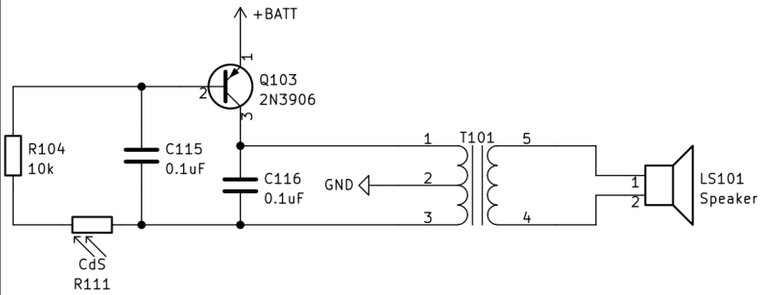

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
3.3V +
GND -
Capacitors
Resistors
Controls
Transistors
LEDs
Power
Audio
AAA
AAA
AAA
SW104
RV101
SW103
T101
LS101
Speaker
Q101
Q102
3904
NPN
PNP
D102
D103
GITHUB.COM/DCZIA/THIRTYINONE

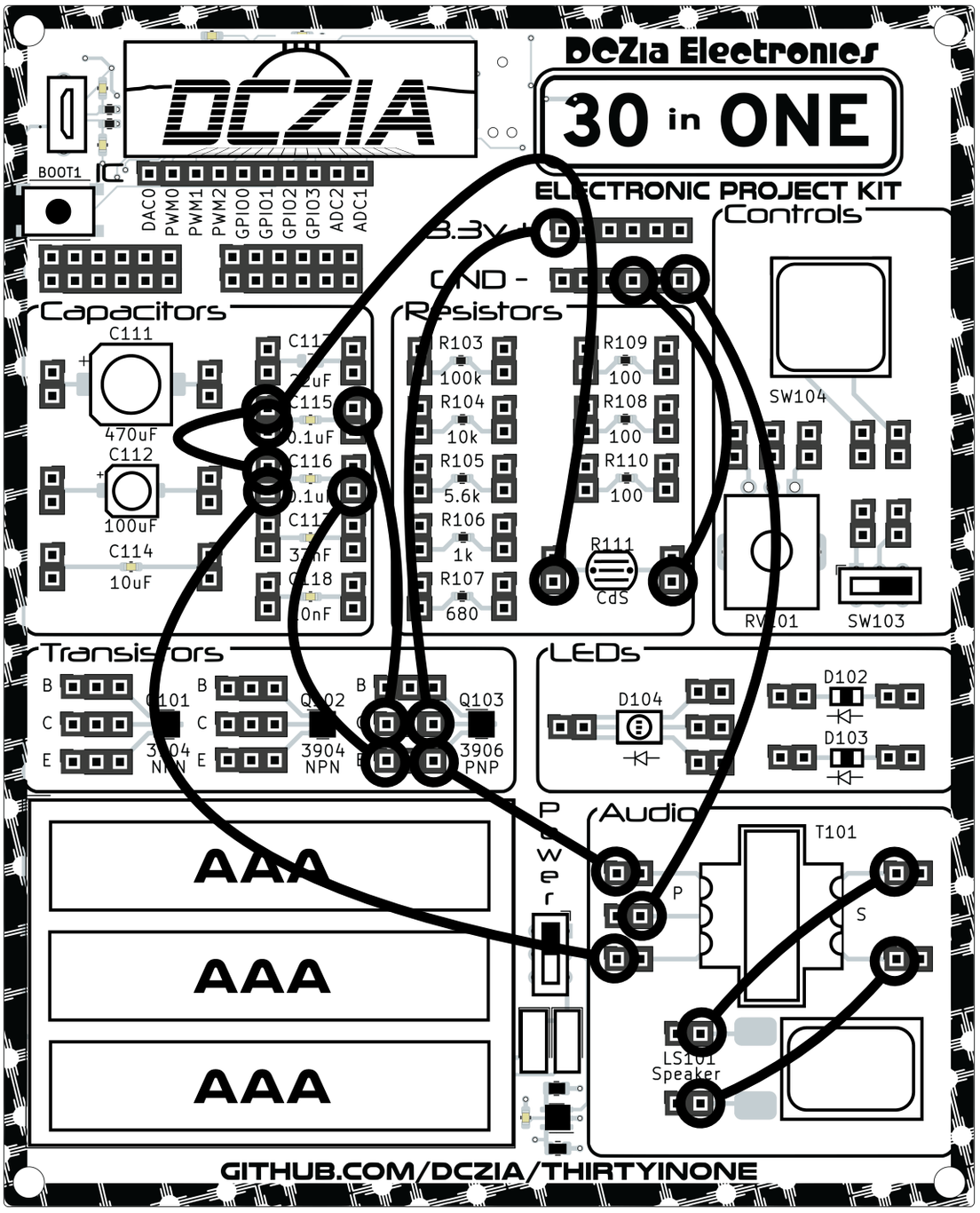
10. ELECTRONIC MOTORCYCLE

Vroom… VROOM! Can you make this circuit rev like a motorcycle? The CdS photocell is a resistor that changes resistance based on the amount of light it receives.

Start this up next time you are cruising in your friend's electric car and see if anyone gives you strange looks.

NOTES

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ELECTRONIC PROJECT KIT
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PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V
GND
Capacitors
C111
470uF
C112
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C116
C118
Resistors
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R106
1k
R107
680
R109
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R108
100
R110
100
R111
CdS
Controls
SW104
RV101
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Transistors
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3904
NPN
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3904
NPN
Q103
3906
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LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
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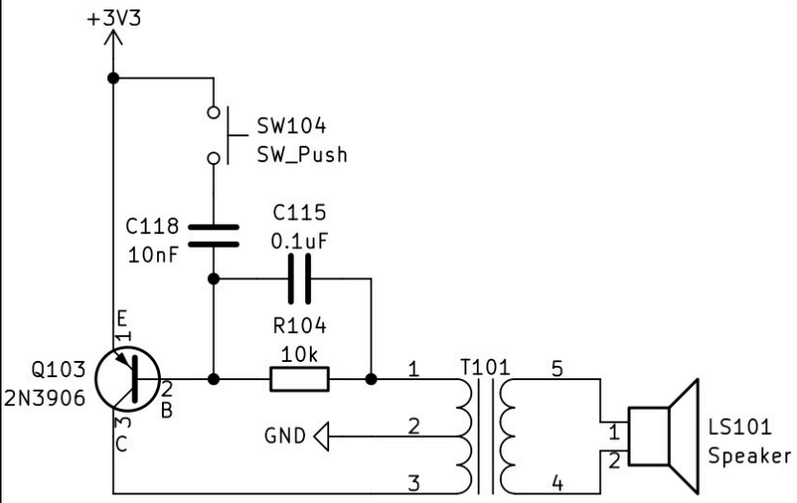
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

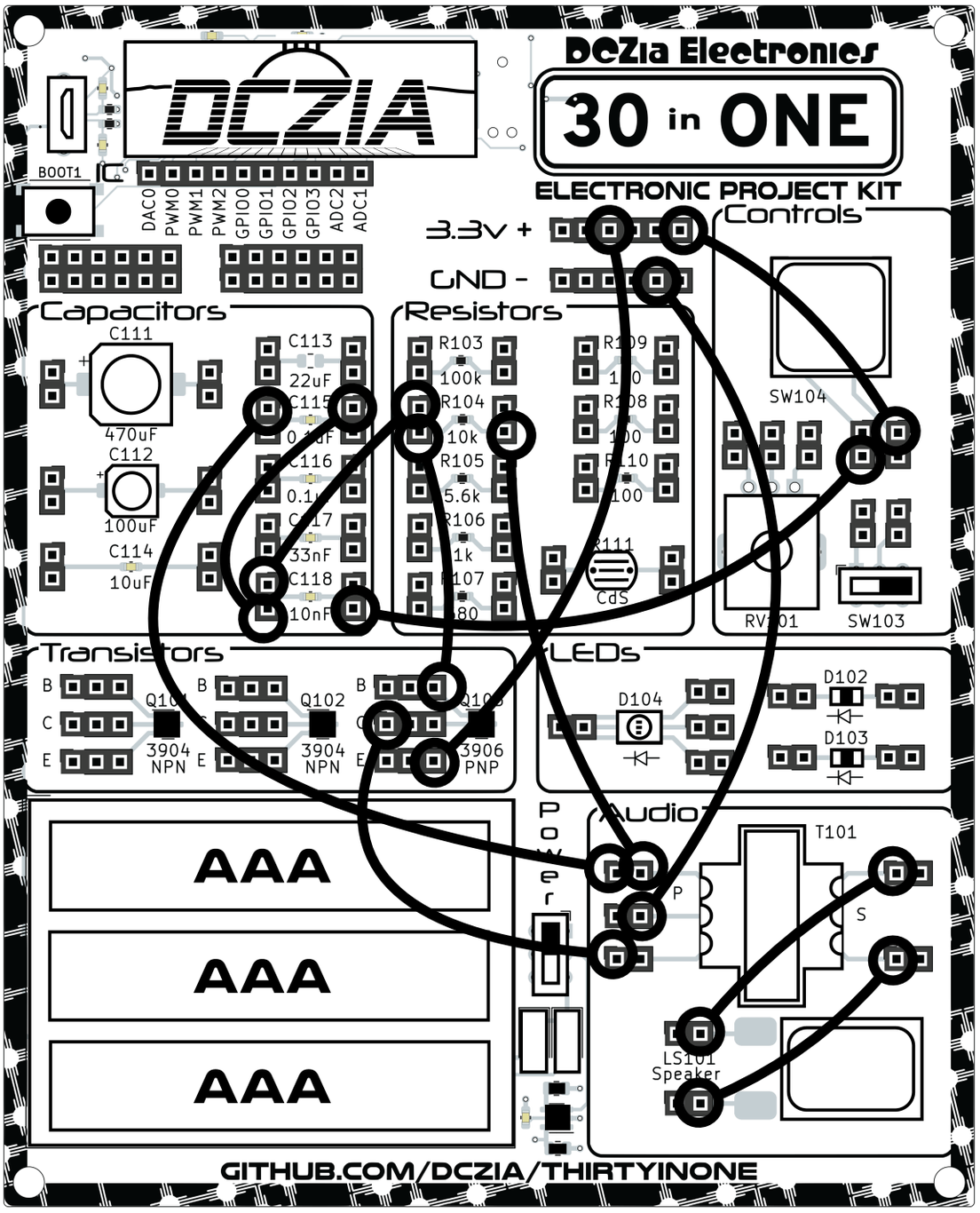
11. PATROL CAR SIREN

Is this circuit even legal? This project makes a loud siren sound that starts with a high pitch at first, but decreases when you press the key switch. Try playing with the timing of key presses to see if you can imitate the sound of a police or ambulance siren. Because the base-bias resister is only 10k Ohms and included in the feedback path, the oscillations are very strong and produce a loud siren. However, this a high battery current that drains the batteries quickly.

NOTE: To prevent damage to the transistor, remove the 3.3V lead before making any changes, and **do not** reduce the value of the resistor below 10k.

NOTES

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DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
R109
R108
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
B
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Q101
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Q102
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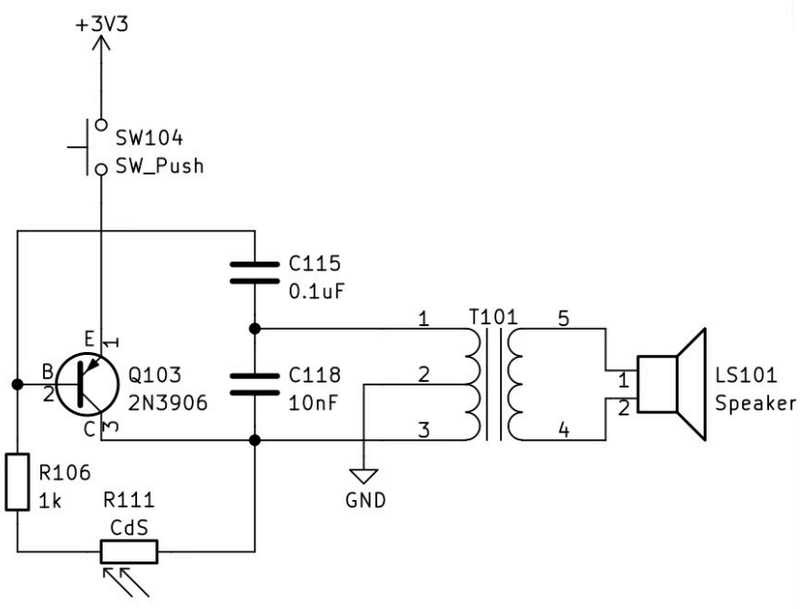
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

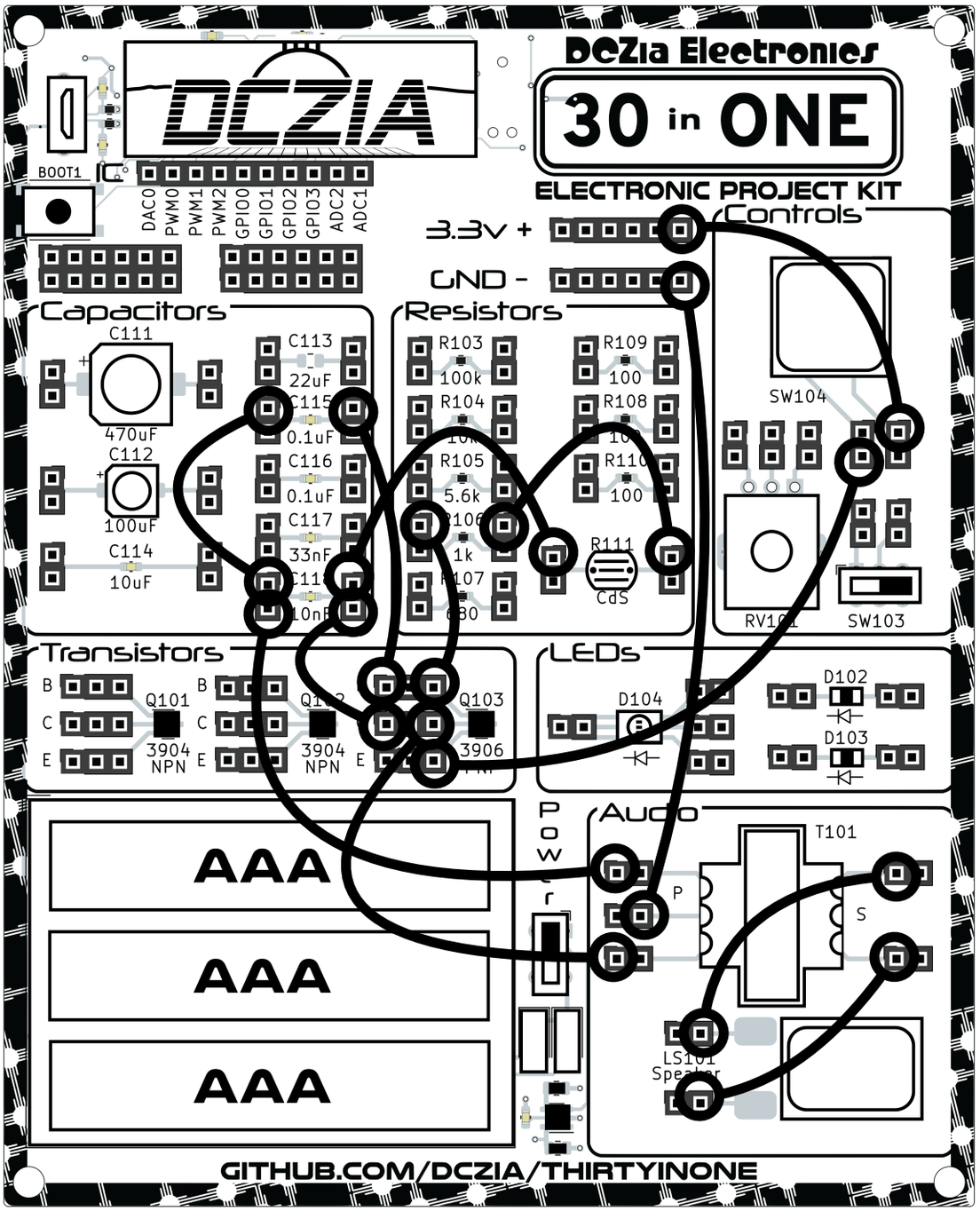
12. LIGHT THEREMIN

Can you use light to play a song? Another name for the circuit in this project is Light Harp. Try giving it a “pluck” by covering and then uncovering the photoresistor R111. Use brighter light to see how much the sound changes.

After you have fun with this circuit, read up on the eponymous inventor, Leon Theremin. He was a Russian inventor (perhaps even a hacker) who created a number of interesting inventions, including possibly the most famous covert listening device of all time, nicknamed “The Thing.”

NOTES




DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
Resistors
R103
100k
R104
R105
5.6k
R106
1k
R107
R109
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R108
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
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NPN
Q103
3906
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

[856M3475+H5]

13. SUNSET/SUNRISE

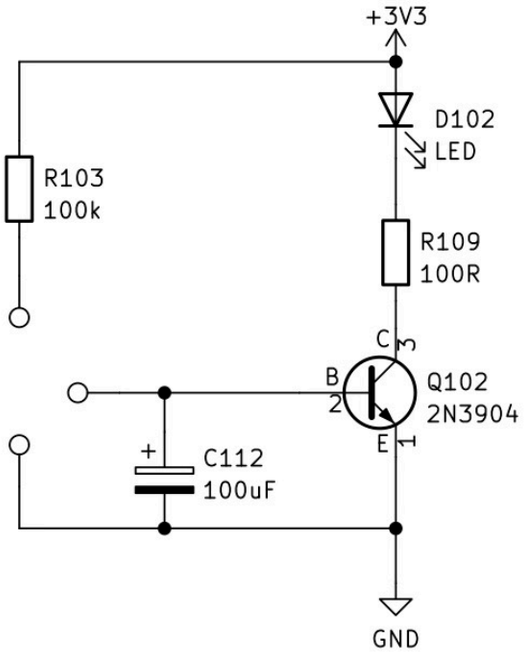
Connect Q102 to R103 with a wire. The LED will slowly light… like a sunrise.

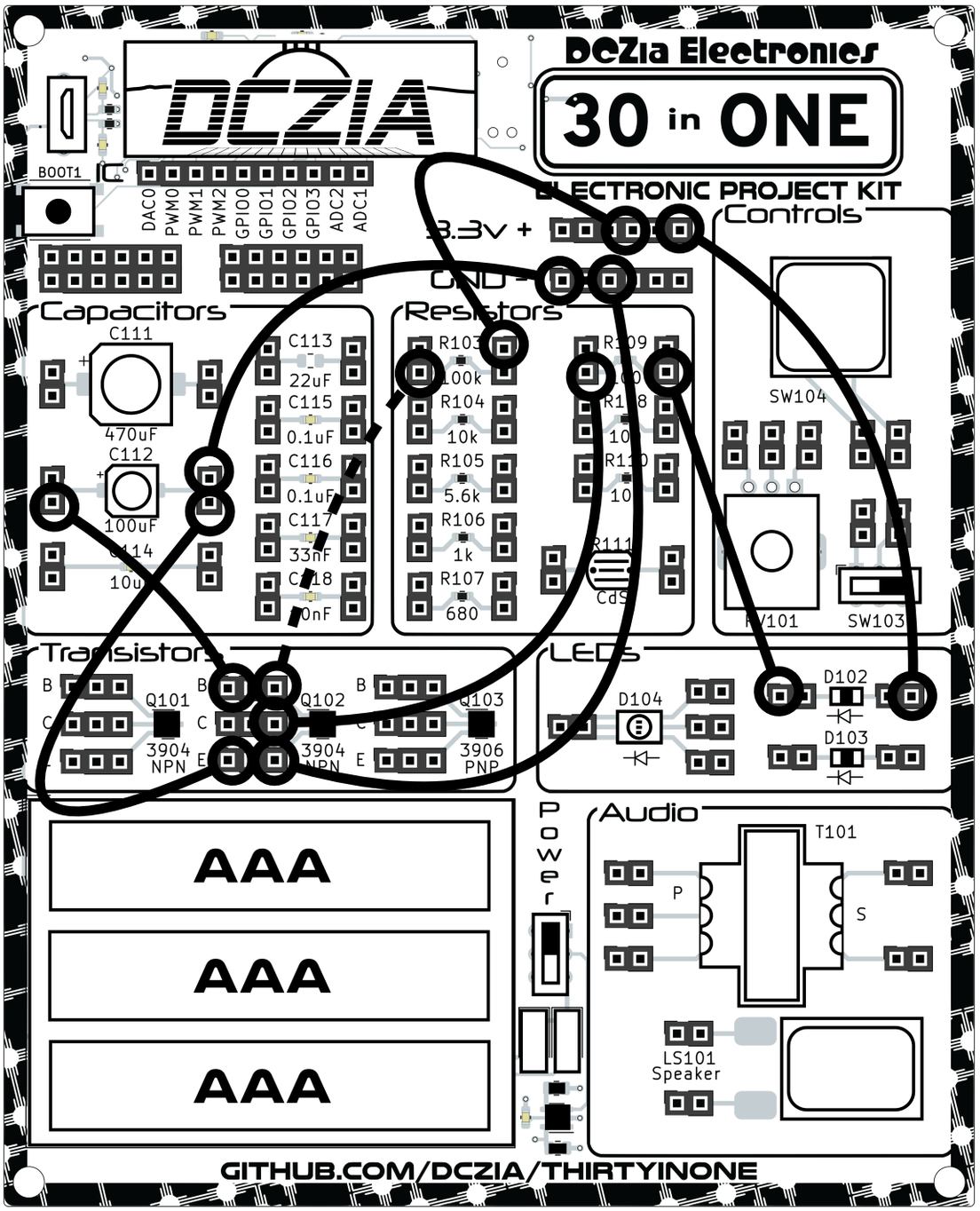
Now remove the wire. The LED will slowly turn off… like a sunset.

Touch the wire to ground to quickly turn off the light. Why did this happen? Remember what you learned about capacitors in project 4. Is the dimming light like a draining dam?

Try adding the SW104 to this circuit to make it easier to start the sunrise.

NOTES





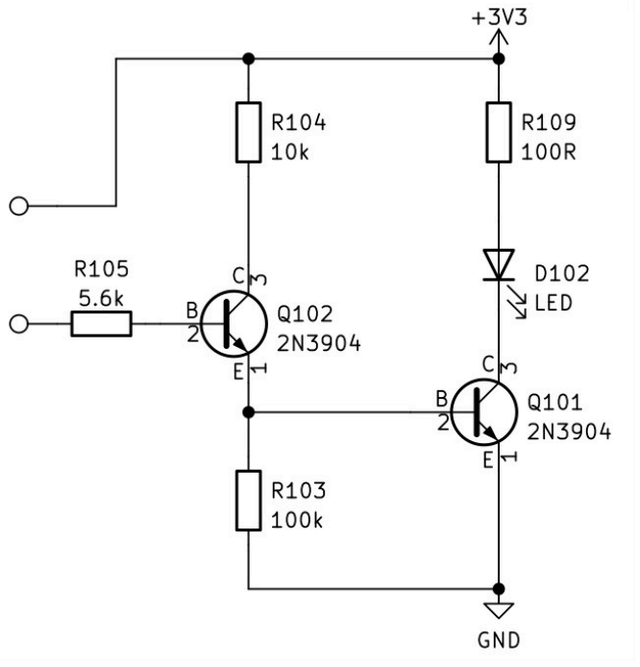
MCMXIXCOWTOWN

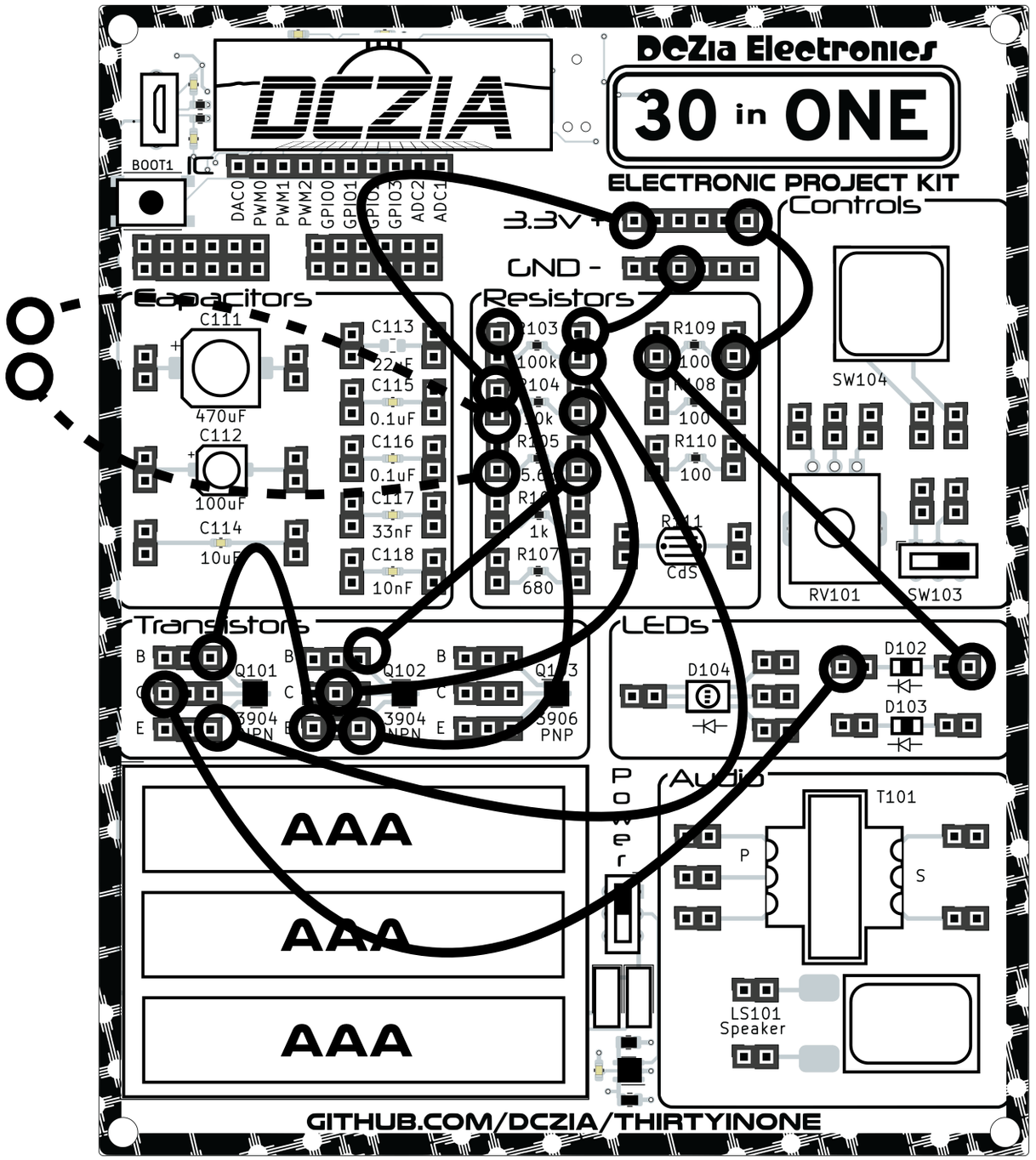
14. TOUCH CIRCUIT

After completing the circuit, don't touch the ends of the wires from R104 and R105 together, but hold them in one hand. Did the LED light?

Does the LED light if you hold the wire ends in two different hands? Why or why not? If your hands are wet or sweaty, the conduction of energy change. This is called skin conductive response, or galvanic response. Can you think of another device that measures galvanic skin response?

NOTES

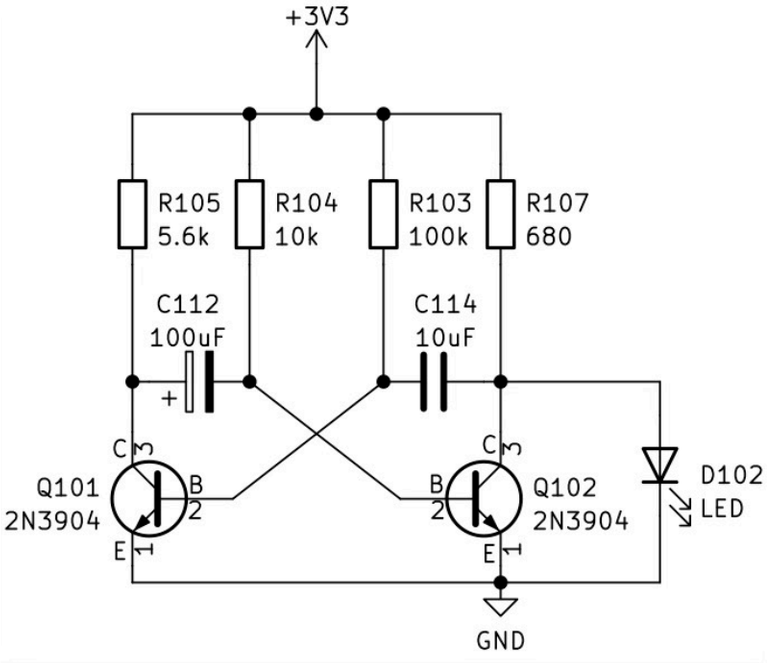


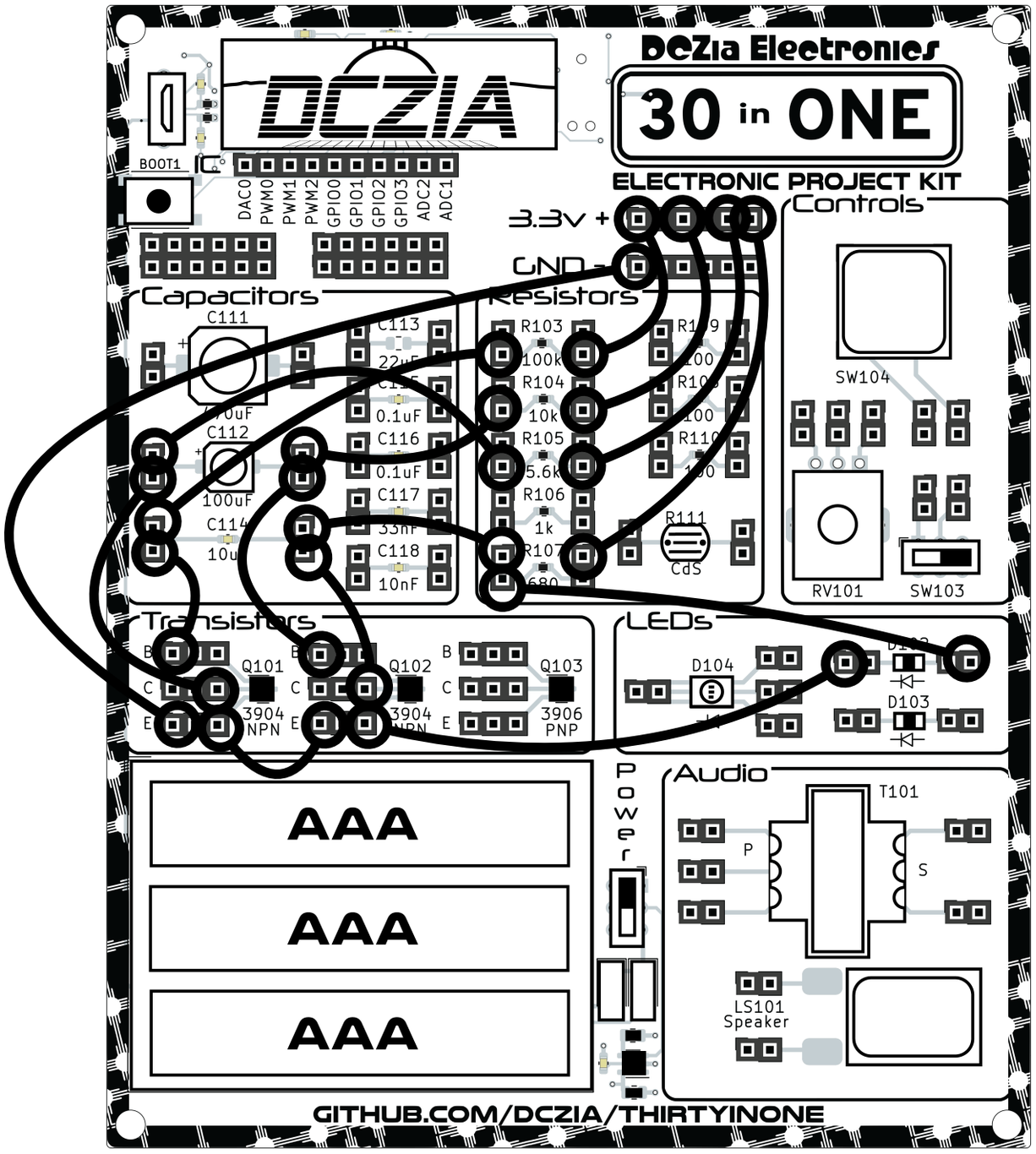

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22nF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6
R106
1k
R107
680
R109
100
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
Power
AAA
AAA
AAA
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

15. THE BLINKER

The transistors in this circuit take turns conducting and making the LED blink. The effect should remind you of the turn signal in a car. Because the transistors constantly switch back and forth (or vibrate), this type of circuit is often referred to as an “astable multivibrator.” Try replacing C112 with C111. What happens?

NOTES




DCZia Electronics
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ELECTRONIC PROJECT KIT
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LS101
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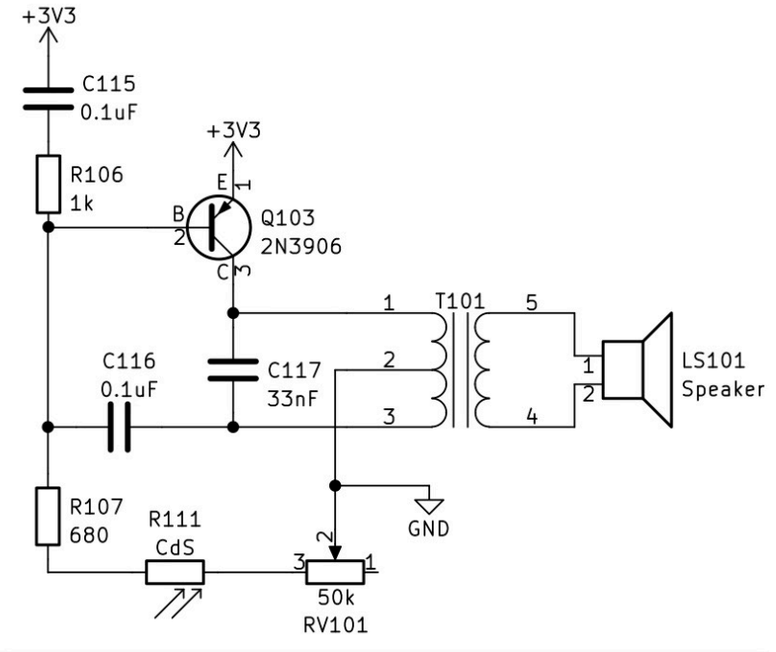
GITHUB.COM/DCZIA/THIRTYINONE

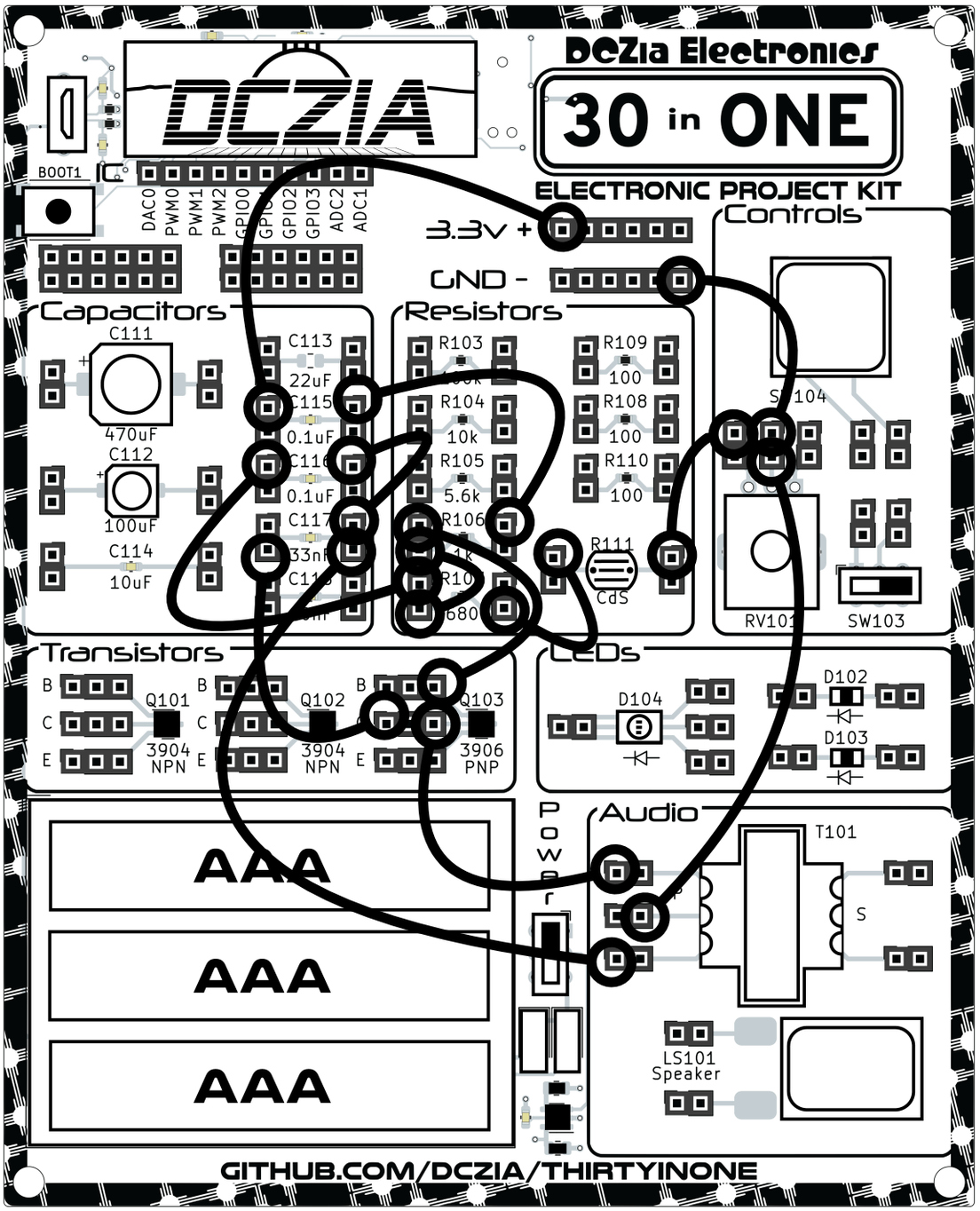
16. EARLY BIRD

What happens when the sun comes up? Try starting this circuit in a dark room and then turning on the light or shining a flashlight on the CdS photocell.

Turn the potentiometer dial up and down to see what happens. What do you hear? Is that the tweet sound of success?
mmmmmmmmmmmm^MmMhmmmiSmhmM

NOTES




DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
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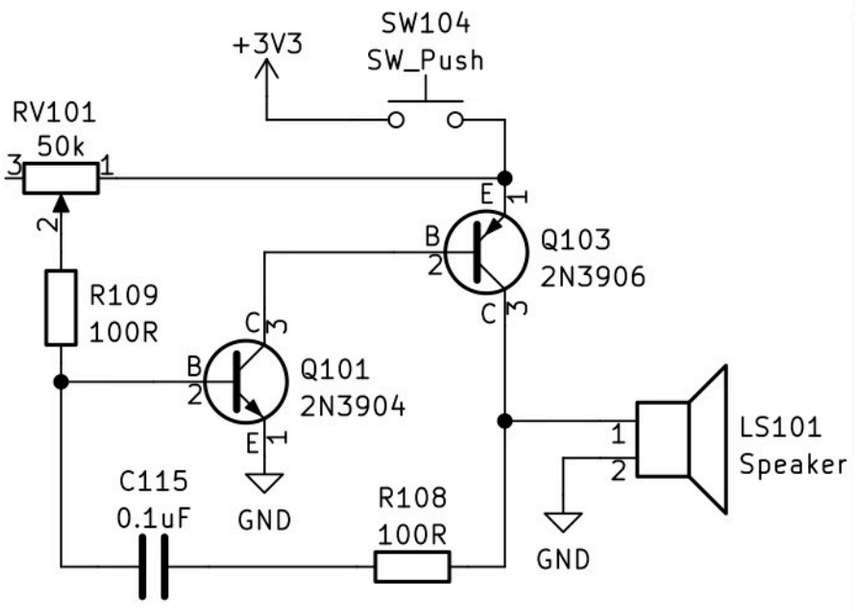
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

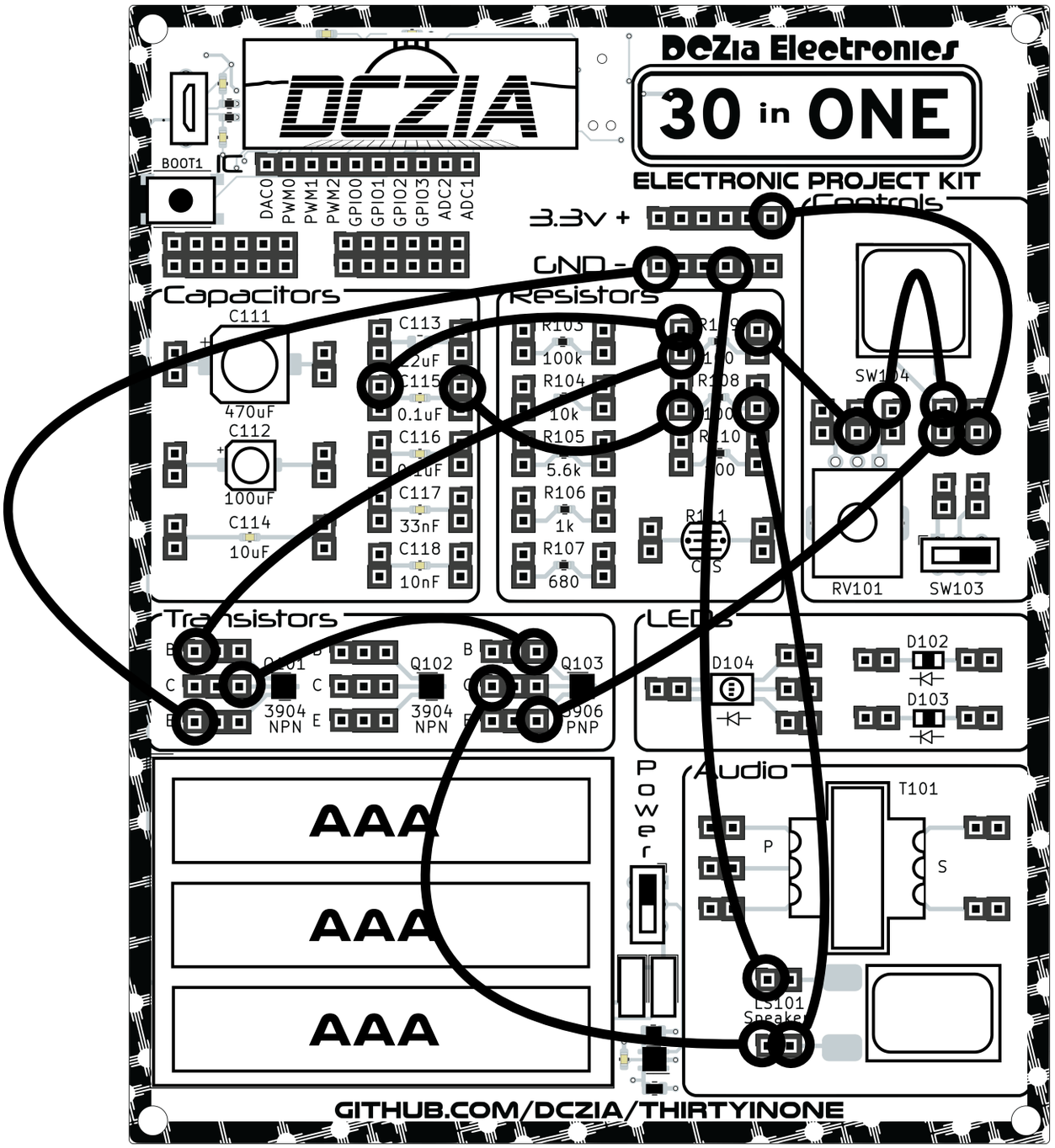
17. AUDIO OSCILLATOR

You can find this design in many electronic designs. The two transistors form an amplifier that allows a circuit with a relatively small power supply to produce a surprisingly high gain. In this case, you might want to warn your neighbors before pumping UP the volume!

Use the potentiometer dial to modify the sound and tap the key switch. What is the name for the change the dial makes?

NOTES




DCZia Electronics
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AAA
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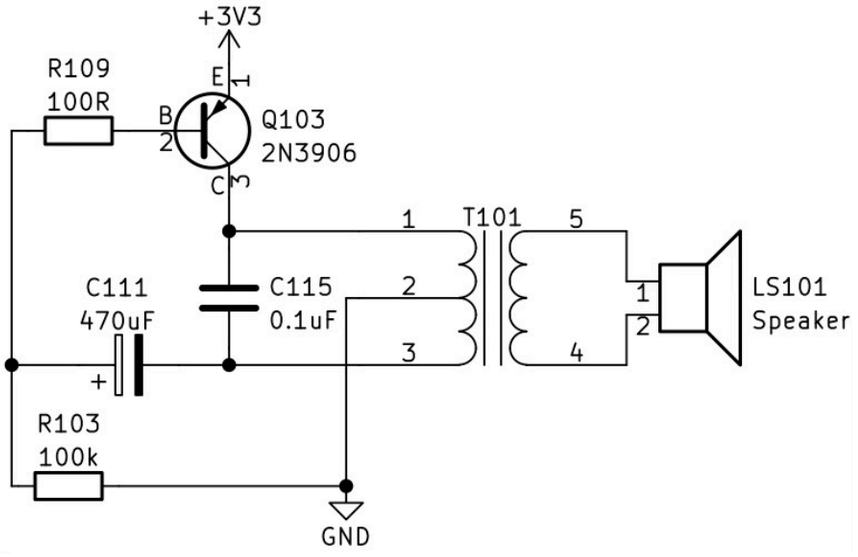
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

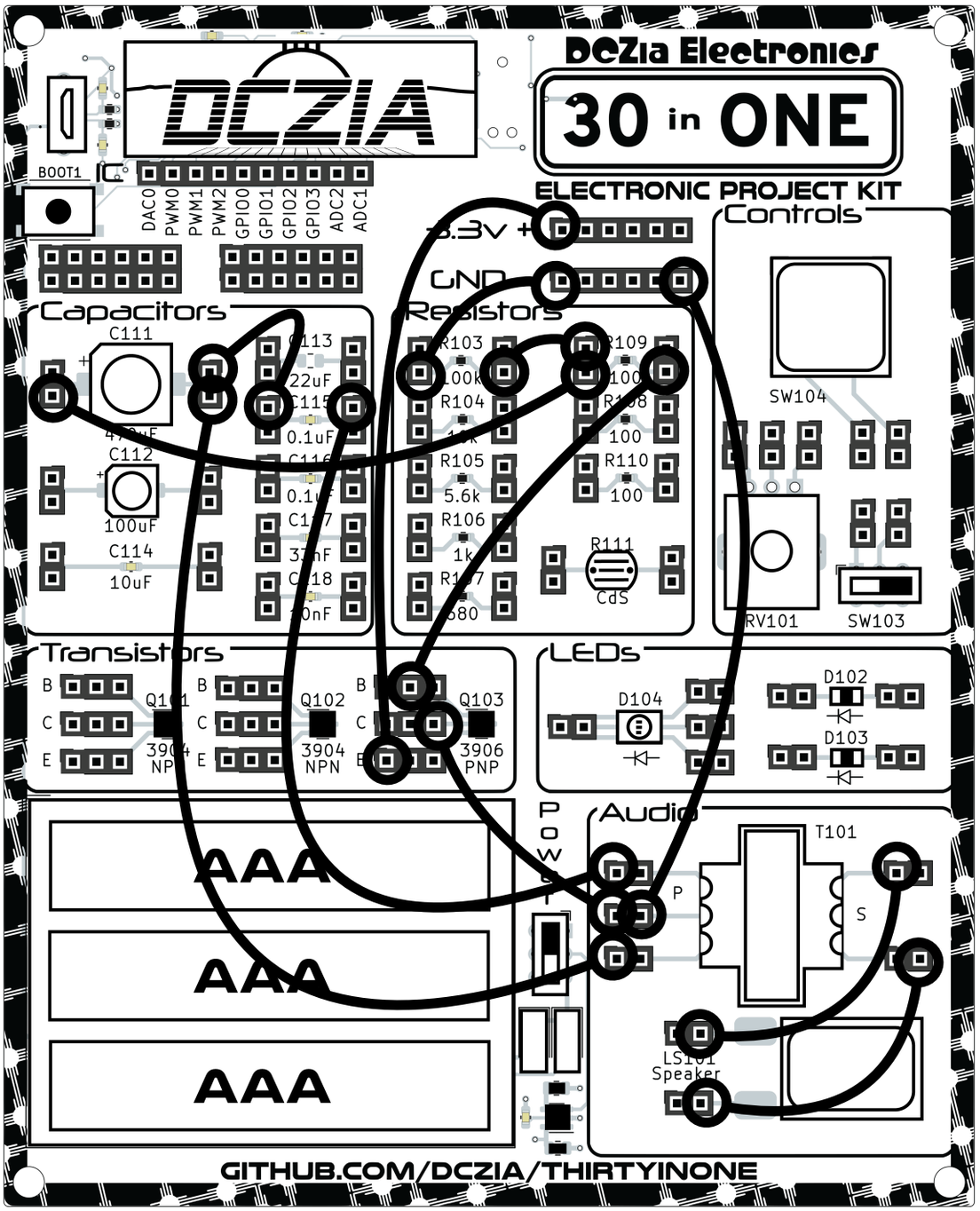
18. GRANDFATHER CLOCK

You might not be able to keep time with this circuit, but it will probably feel nostalgic if you've ever heard a vintage grandfather clock. If you listen quietly for awhile, the rhythmic ticking is also hypnotic. Before you fall asleep, see if you can make the it pause briefly by yelling into the speaker. How does that work??? Hint: What direction is the current flowing at the P coil side of the transformer (T101)? Is it always flowing in the same direction?

What happens if you swap R103 for a resistor with a different value?

NOTES

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ELECTRONIC PROJECT KIT
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GPIO0
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3.3V
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R110
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D103
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AAA
AAA
Audio
T101
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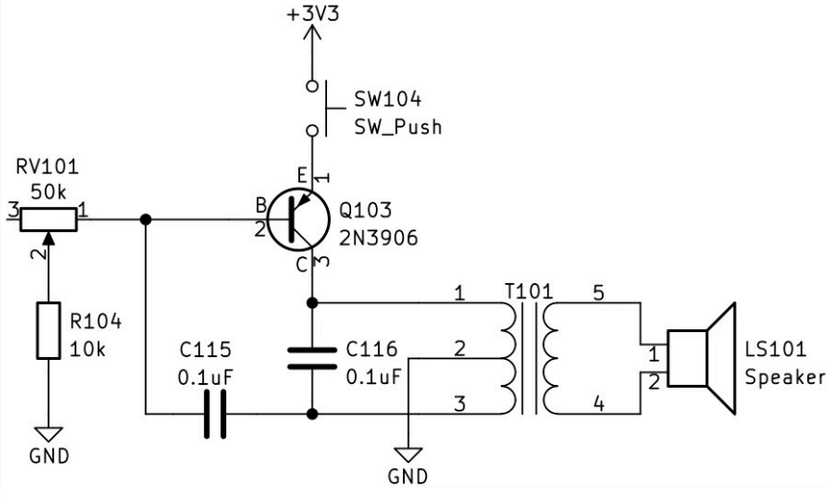
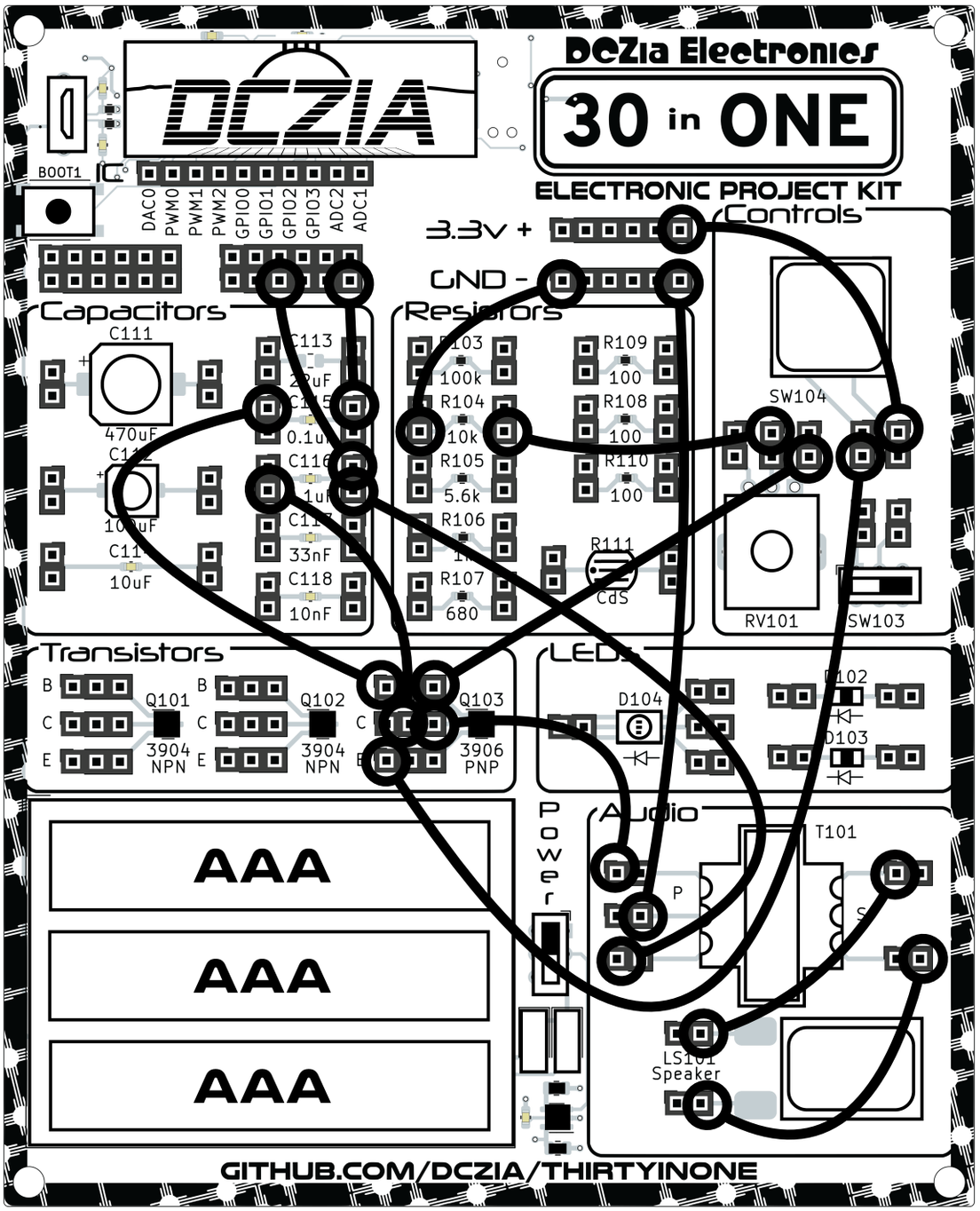
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

19. PULSE OSCILLATOR

This circuit combines features of project 17 and 18. This is an oscillator, but in this case, the oscillations are being driven by the charging/releasing of the capacitors and the switching action of the single transistor. This causes a rapid changing in the polarity (direction of current flow) through the transformer coil. The alternating current direction induces a magnetic field on the second coil in the transformer and the current flowing to the speaker creates sound. The result is like a very crude electronic organ. Try adjusting the potentiometer RV101 while tapping the key switch SW104. What kind of sounds and notes can you create?

NOTES

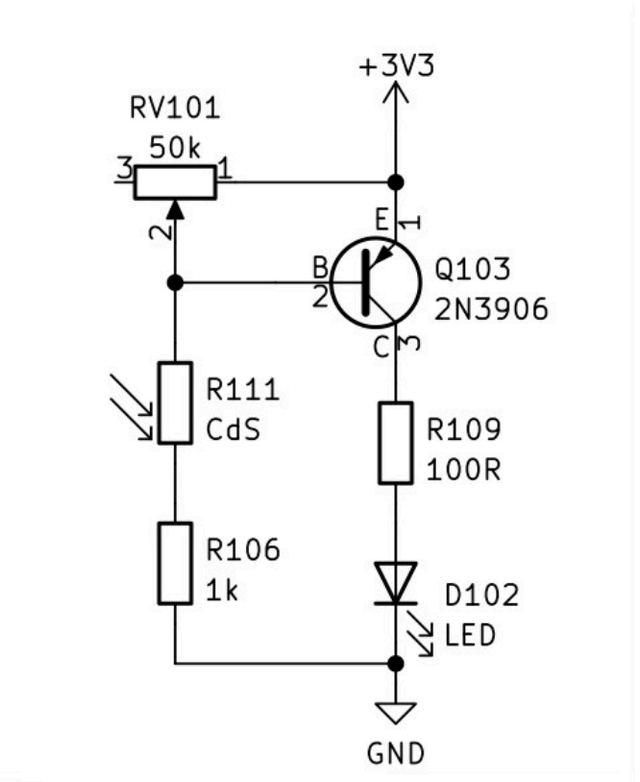


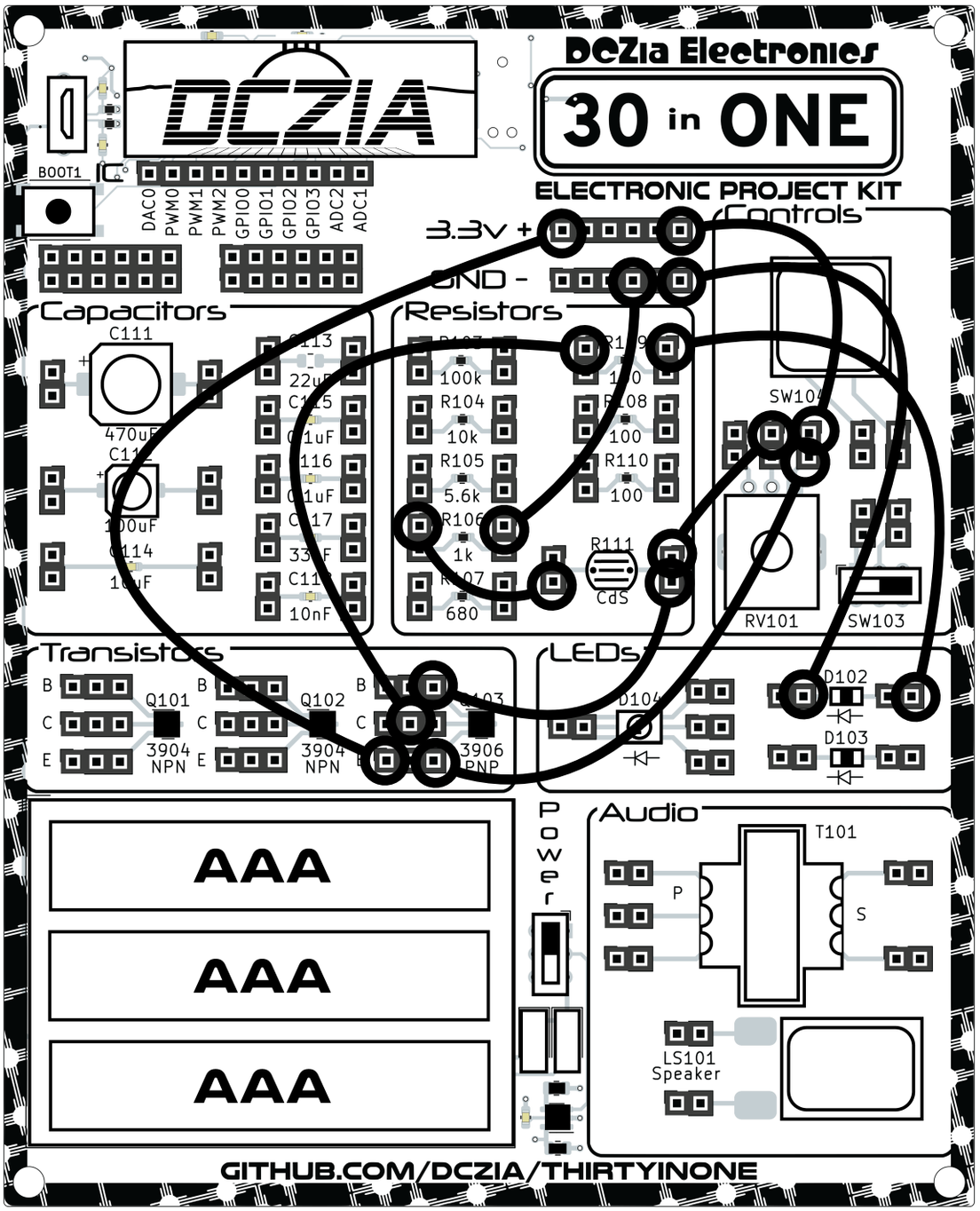

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C113
22uF
C115
0.1uF
C116
1uF
C117
33nF
C118
10nF
C11
10uF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1M
R107
680
R109
100
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
Power
Audio
T101
LS101
Speaker
AAA
AAA
AAA
GITHUB.COM/DCZIA/THIRTYINONE

20. LIGHT CONTROLLED SWITCH

Other projects in this kit have used the photoresistor cell R111, but one thing they all have in common is that the amount of current flowing to the output device (speaker, LED, etc.) varies with the amount of light in a very analog fashion (like a dimmer switch). It's very popular to see lights that are controlled by photocells so that they go on at sunset and off at sunrise (rather than dimming). This circuit shows how to accomplish this binary switching based on light level. How does RV101 change that behavior?

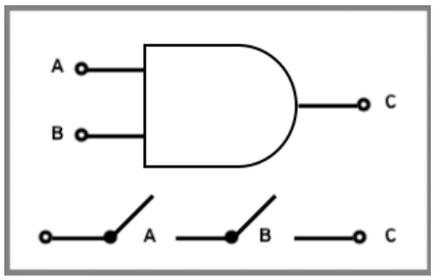
NOTES




DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33pF
C118
10nF
Resistors
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R108
100
R110
100
R111
CdS
Controls
SW102
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

21. AND WITH SWITCHES

Now it's time for a little Boolean logic. SW103 **AND** SW104 need to be closed to light the diode. This is the symbol for an AND gate that shows how the inputs and outputs map to the switches in the schematic. To figure out whether the LED will turn on or not, you can obviously just try all of the switch combinations.



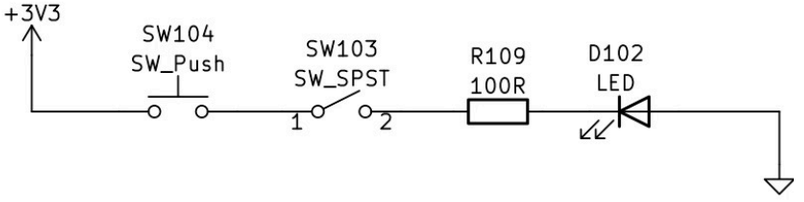
AND gate and switches

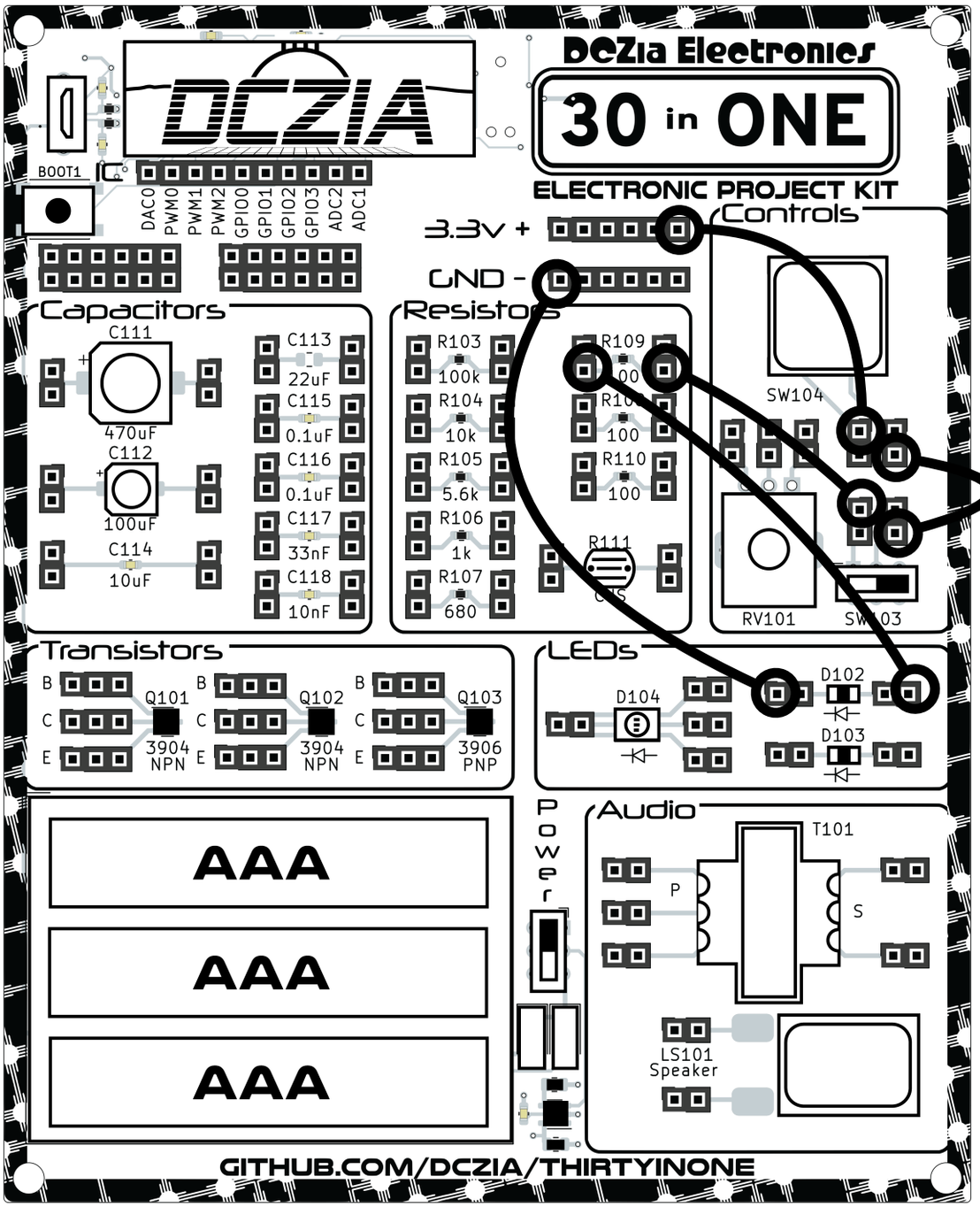
To make it easier to design circuits with logic gates, you can use a truth table like the one on the right to map out what input combinations produce what output values.

A	B	C (output)
0	0	0
0	1	0
1	0	0
1	1	1

AND Truth Table

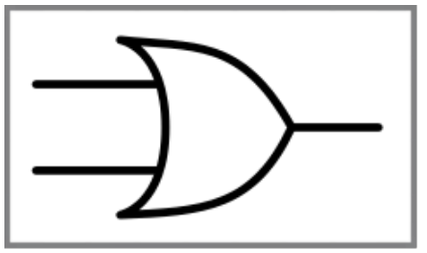
NOTES




DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R110
100
R111
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

22. OR WITH SWITCHES

This is how a logical OR gate works: If either SW103 **OR** SW104 are closed, the LED will light. This is another basic building block of more complex logic devices. This circuit works because the current can take two different paths to light the LED — either the path through SW104 or SW103.

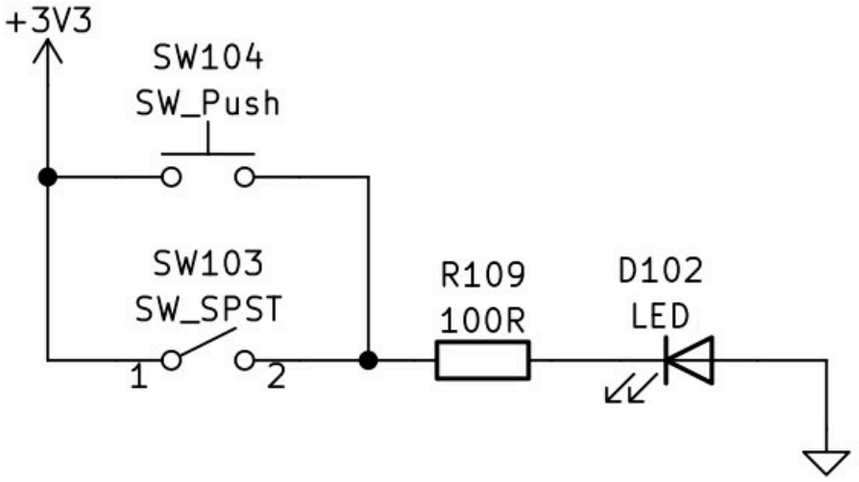


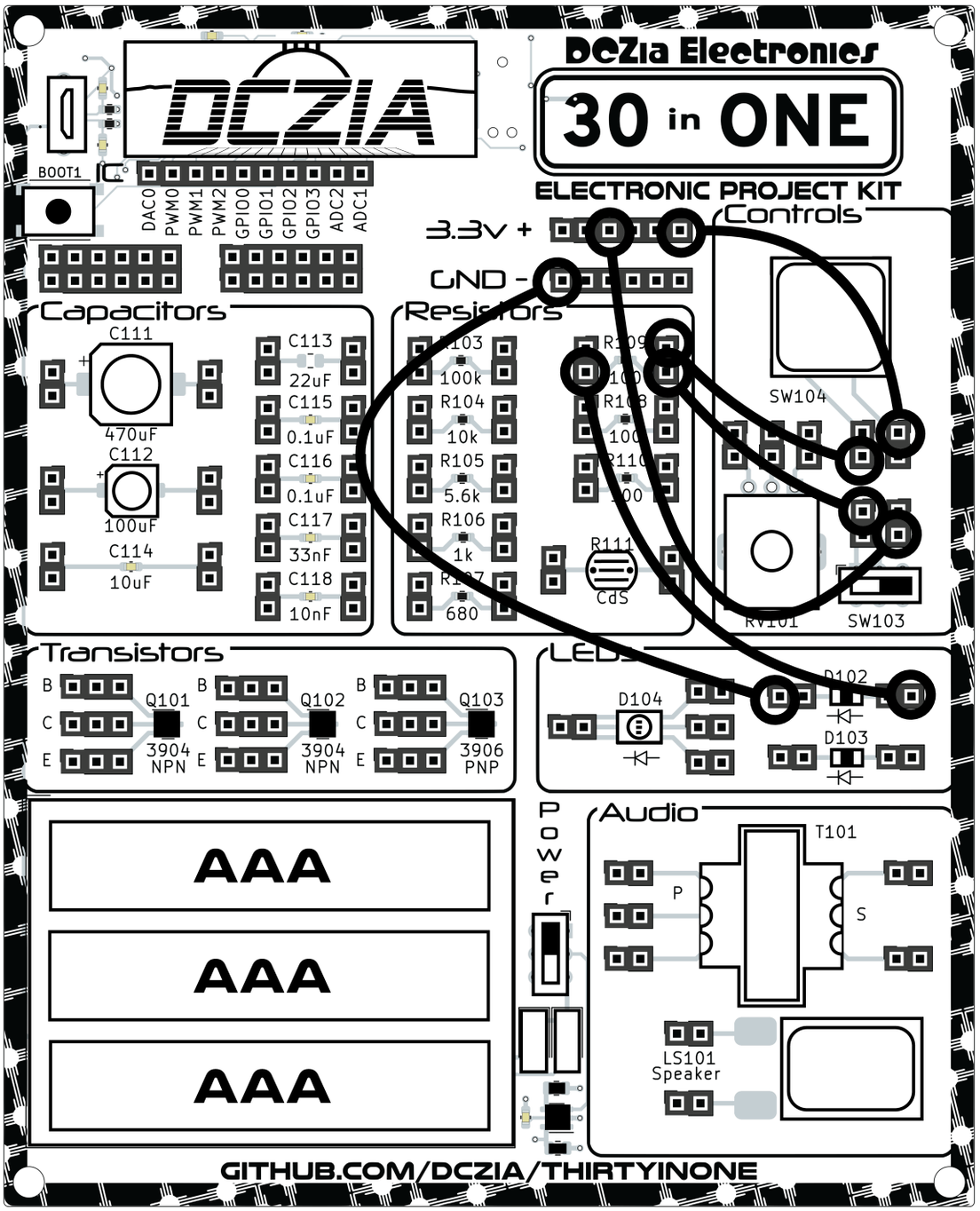
OR gate

A	B	C (output)
0	0	0
0	1	1
1	0	1
1	1	1

OR Truth Table

NOTES

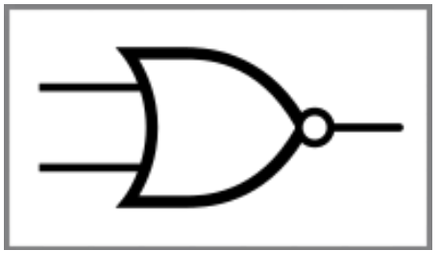




TOMMY3:14BEANTOWN

23. NOR WITH SWITCHES

The LED will light only when neither SW103 NOR SW104 is switched on. Another way to read this circuit is that current flows to the LED only when both SW103 and SW104 are off (open). When they are both open the current stops flowing to the base terminal of the transistor, which causes the transistor to switch closed, forcing the current from R106 to flow through the diode. Note how the NOR gate it is similar to the OR gate, except that it has a small circle that symbolizes negation at the output.

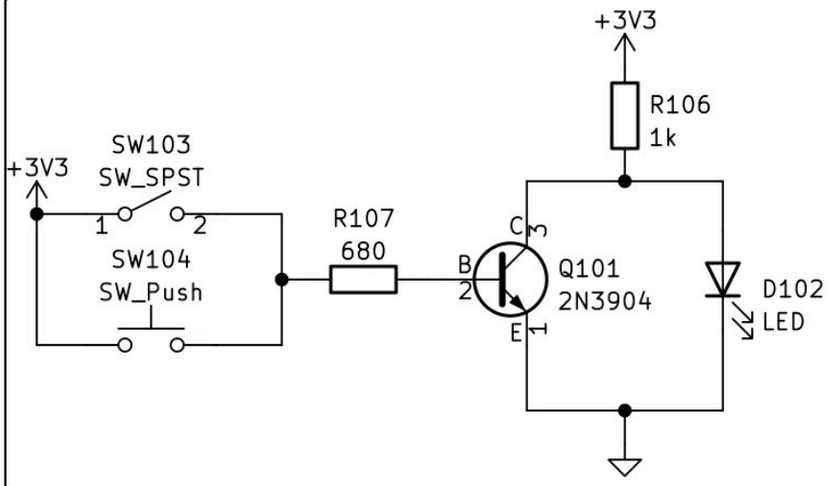


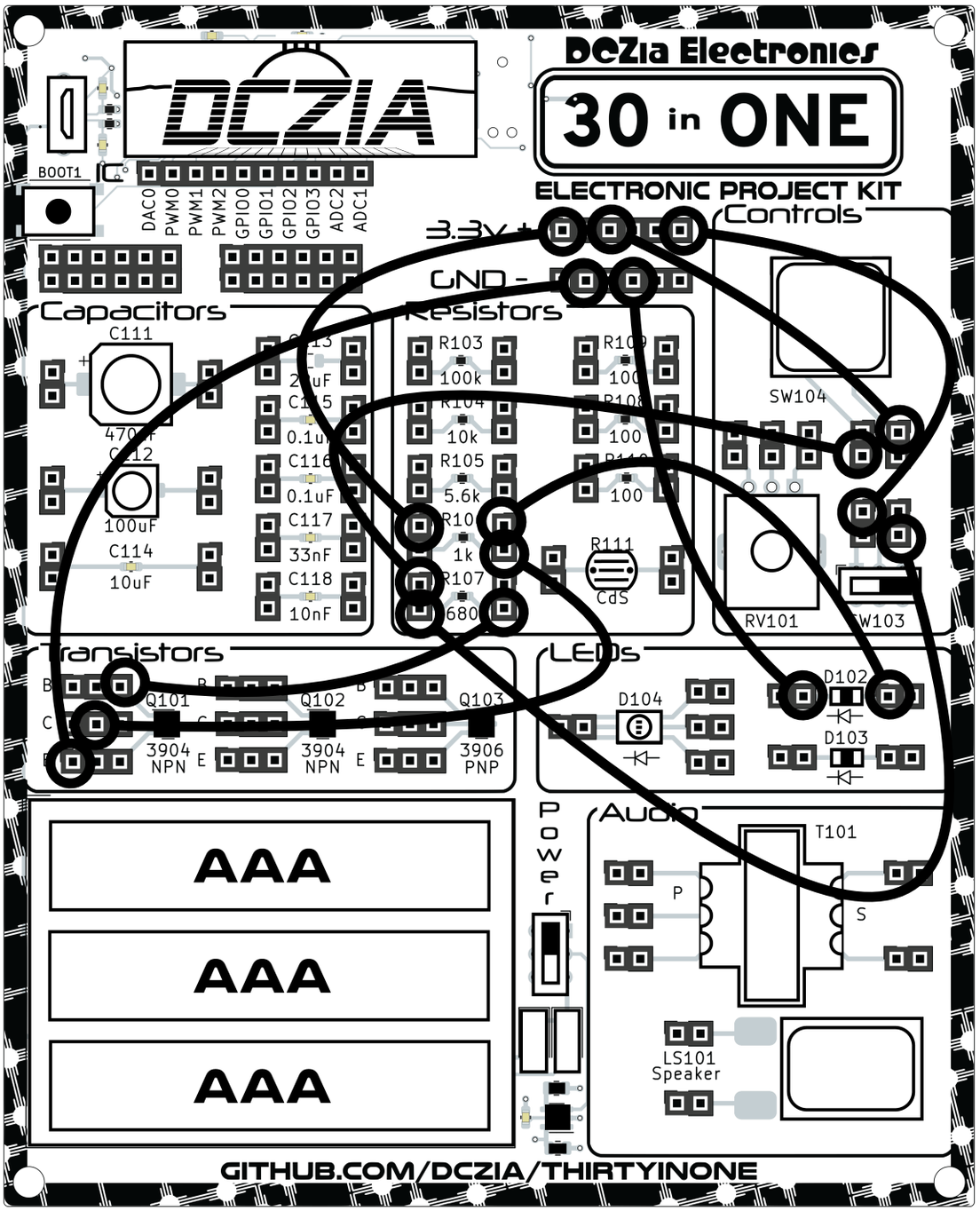
NOR gate

A	B	C (output)
0	0	1
0	1	0
1	0	0
1	1	0

NOR Truth Table

NOTES



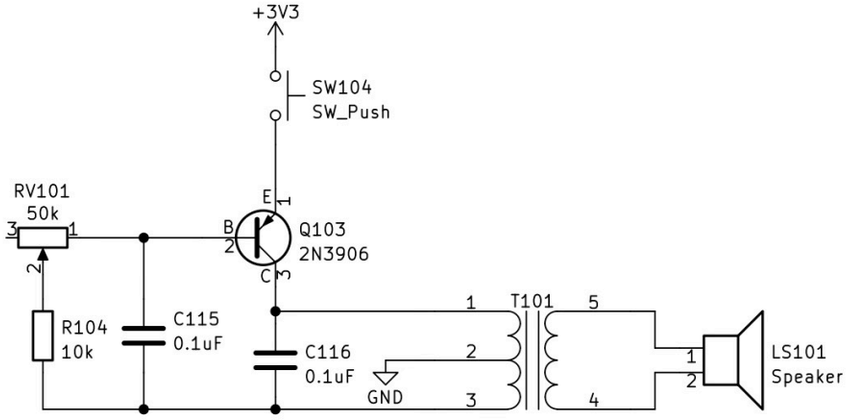

DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R108
100
R109
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

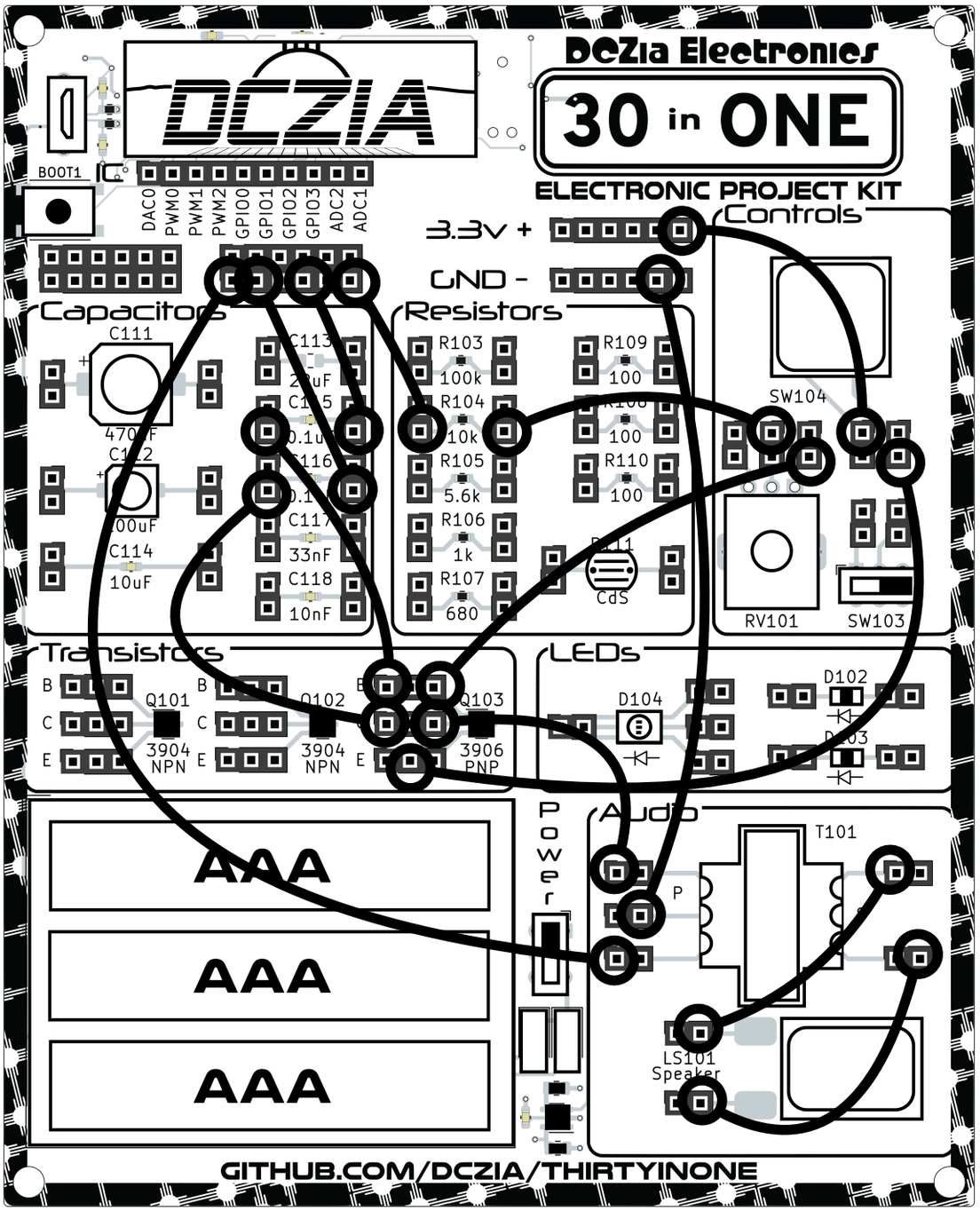
24. CODE PRACTICE

It's time to practice your Morse code! This circuit creates a simple telegraph you can hear through the speaker. Here is the Morse alphabet to try your tapping skills:

. - / - . . . / - . - . / - . . / . / . . - . / - - . / . . . . / . . / . - - - / - . - / . - . . / - - / - . /
- - - / . - - . / - - . - / . - . / . . . / - / . . - / . . . - / . - - / - . . - / - . - - / - - . .

NOTES



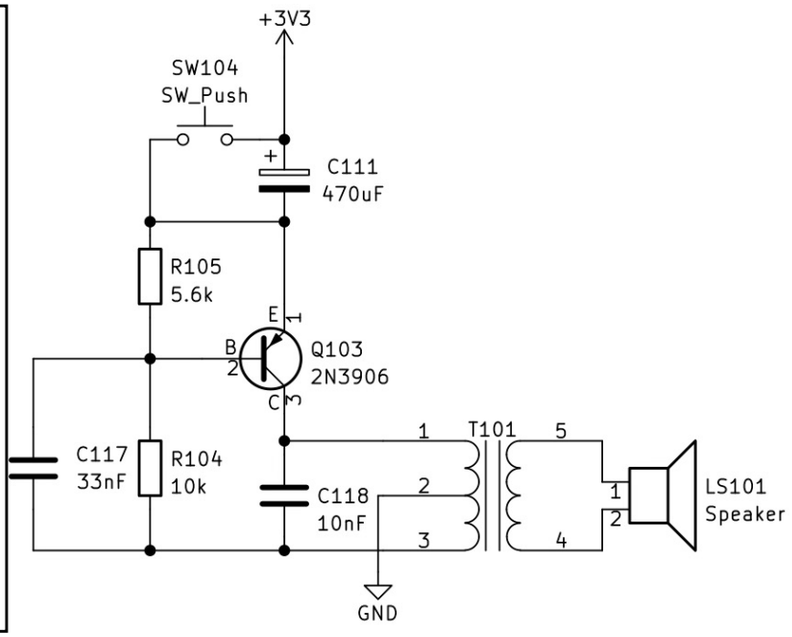

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C114
10uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R110
100
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

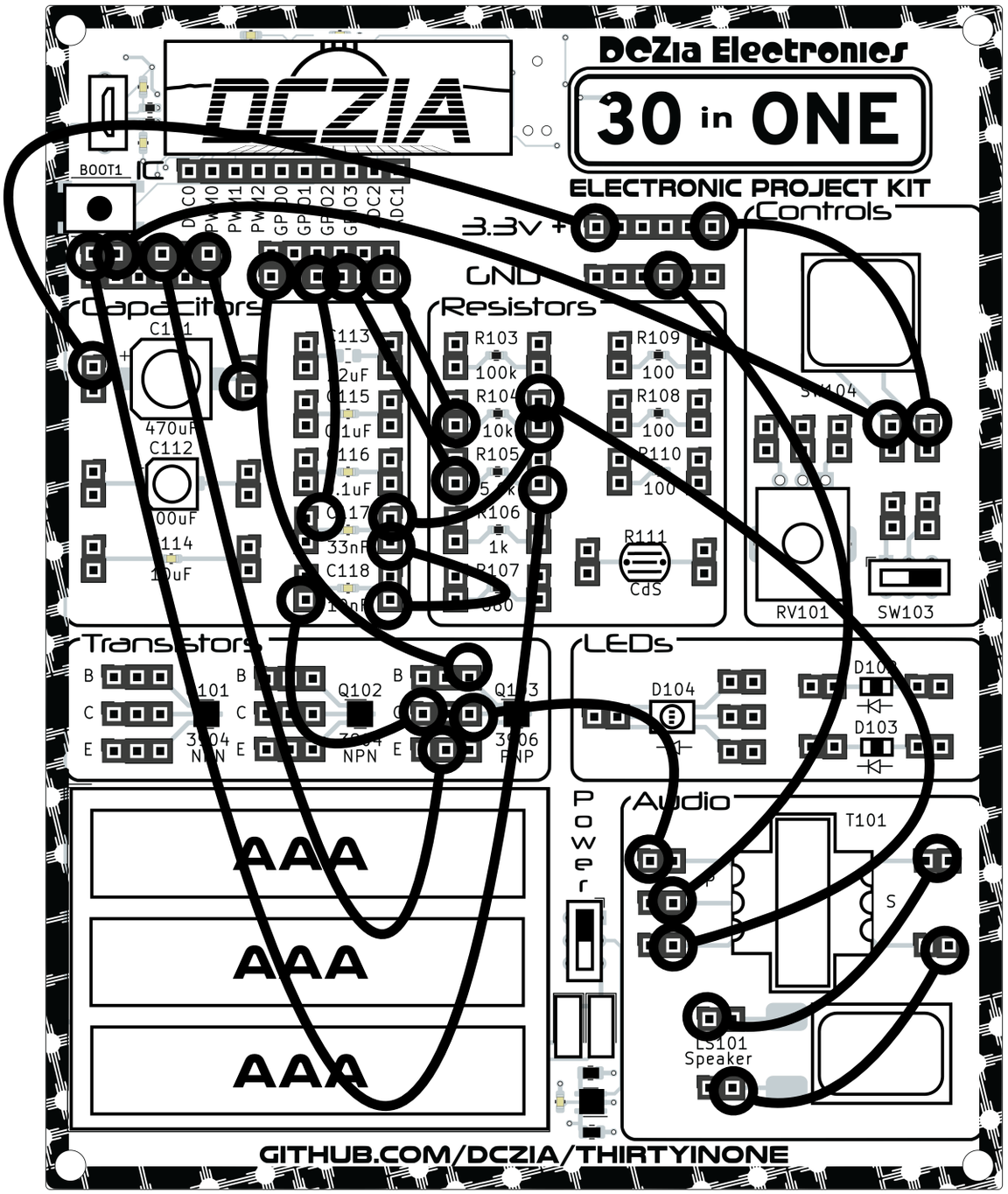
25. TURN-OFF DELAY OSCILLATOR

Press the key switch and then release. Why does the speaker remain on?

This circuit is an oscillator (like several previous projects), with a turn-off delay that is created by the 470 microfarad capacitor. The discharged capacitor with no current flowing has an equal number of electrons in the (+) and (-) electrodes. When the switch is pressed, electrons move from the (+) electrode (making it more positive) and to the (-) electrode (making it more negative). The current flow required to make this happen is called the charging current. When the circuit is discharged, and equal amount of current must flow in the opposite direction (the discharge current) to return the capacitor electrodes to their equilibrium state.

NOTES



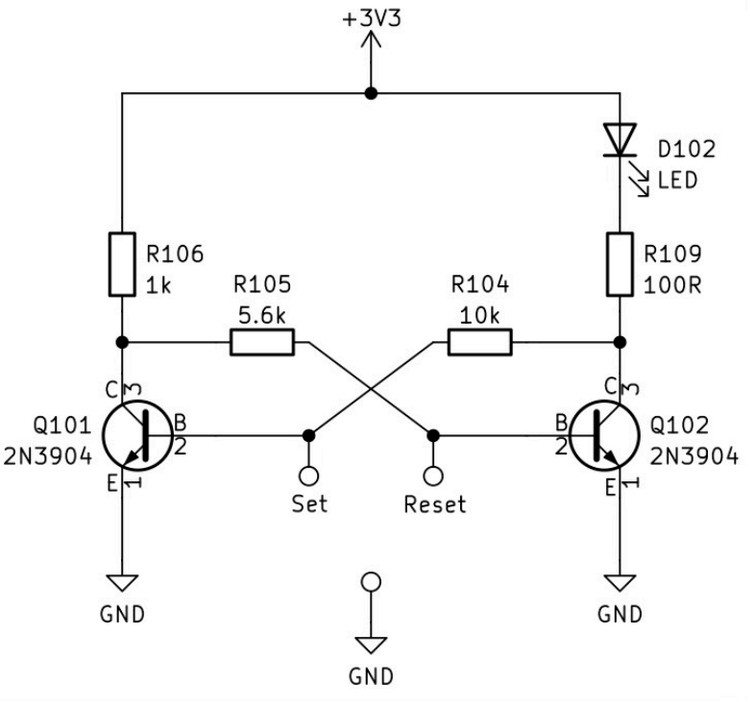

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
3.3V
GND
Capacitors
Resistors
Controls
C111
470uF
C112
C113
C115
C116
C117
33nF
C118
R103
100k
R104
10k
R105
R106
1k
R107
R108
R109
100
R110
R111
CdS
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
Q103
3906
PNP
LEDs
D104
D103
Power
AAA
AAA
AAA
Audio
T101
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

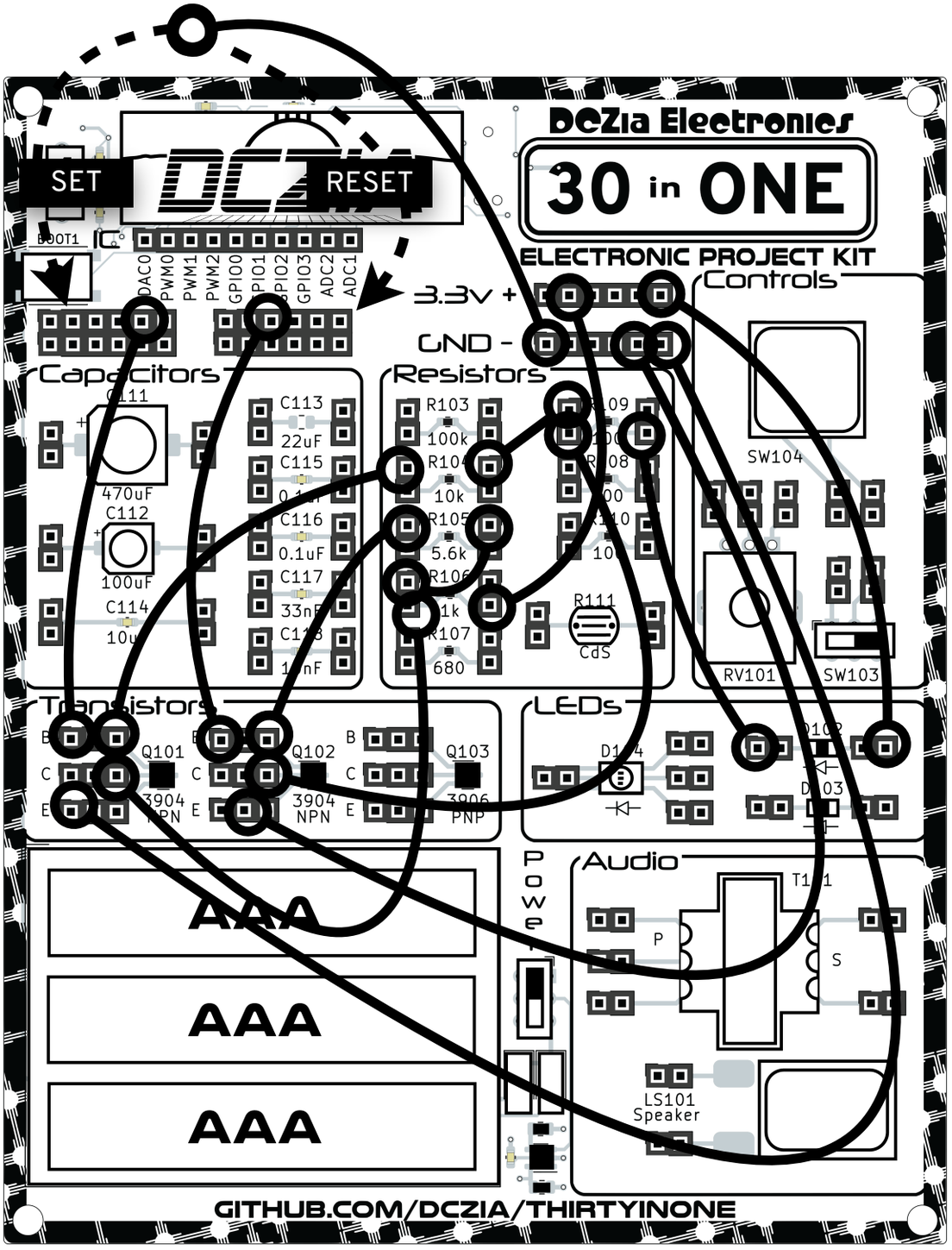
26. RS FLIP FLOP

Well, congratulations! In this project, you are going to create a binary storage device! In electronics, a flip flop is a bi-stable circuit — meaning that it has two different stable states that it can store. The states in this circuit are referred to as RESET and SET (hence the name RS flip-flop). Once the circuit is in one of these two states, it will stay that way as long as power is supplied. To change the state to SET, briefly connect GND to Q101 B. What happened? How is this memory? Next, connect GND to Q102 B (RESET).

Imagine that RESET stands for 0 (zero) and SET stands for 1 (one). This circuit is a one bit storage device! So, how many R-S flip-flops would be required to store the binary number 10101011?

NOTES




SET
RESET
DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
3.3V +
GND -
Capacitors
Resistors
Controls
Transistors
LEDs
Audio
Power
AAA
AAA
AAA
SW104
RV101
SW103
Q101
Q102
Q103
3904 NPN
3904 NPN
3906 PNP
LS101 Speaker
GITHUB.COM/DCZIA/THIRTYINONE

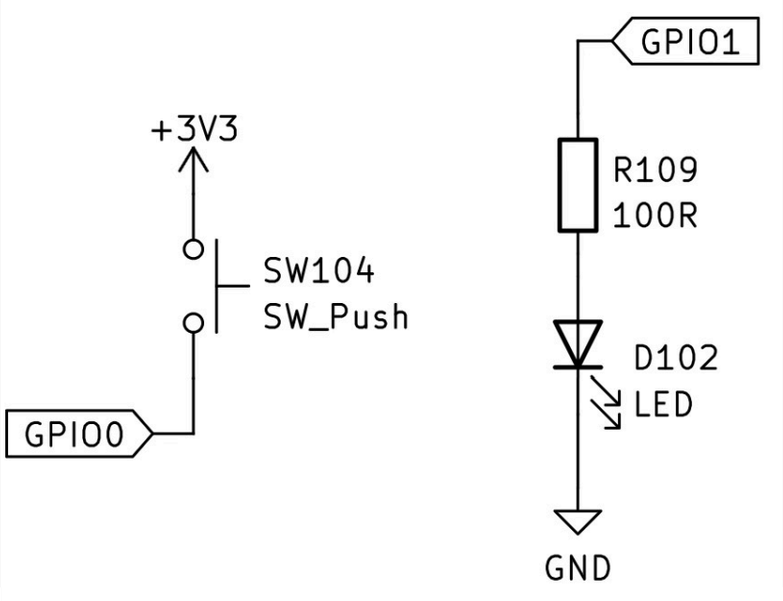
CRRX(0125U)

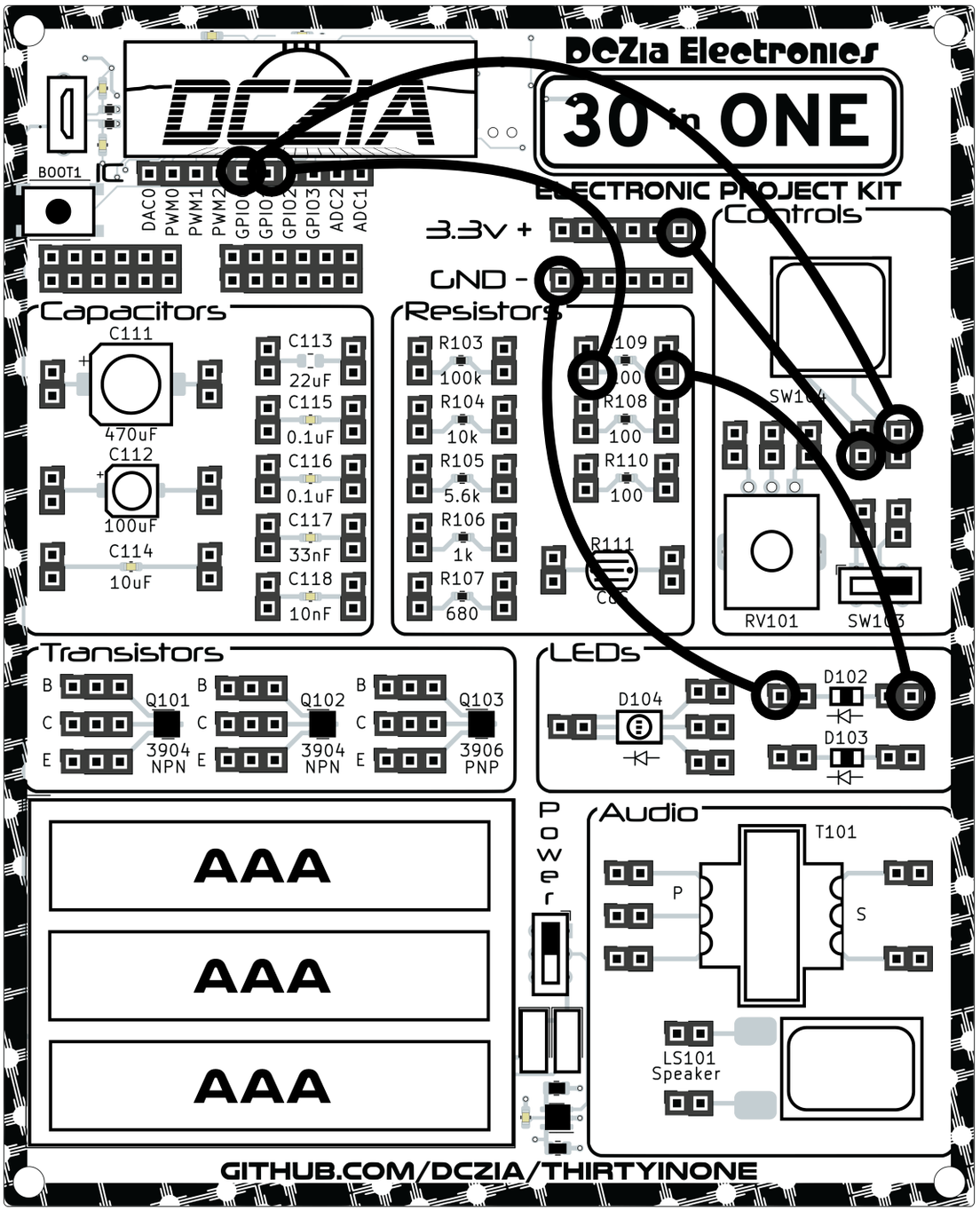
27. MICROCONTROLLER GPIO

Your badge includes a little magic not found in the original 30-in-ONE kits: a low-power SAM D21 microcontroller with an ARM® Cortex® processor. The through holes at the top of the badge provide access to the MCU interfaces.

Wire up this simple-seeming circuit. What happens when you press the switch?

NOTES



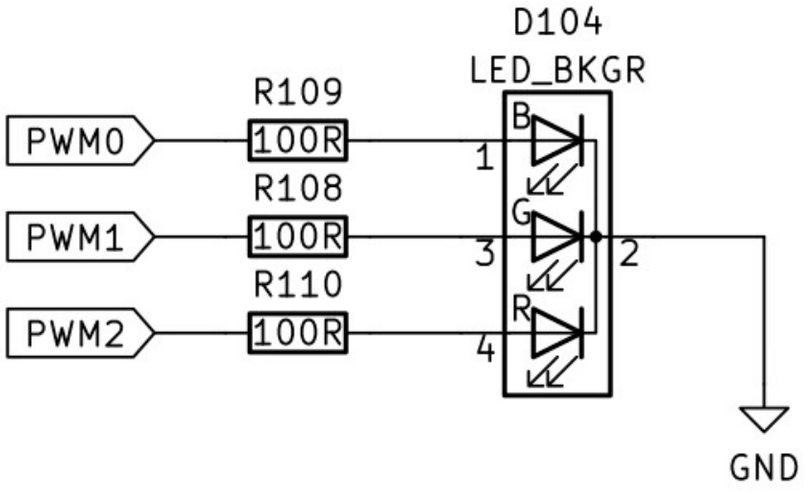

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO
GPIO
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R109
100
R108
100
R110
100
R111
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

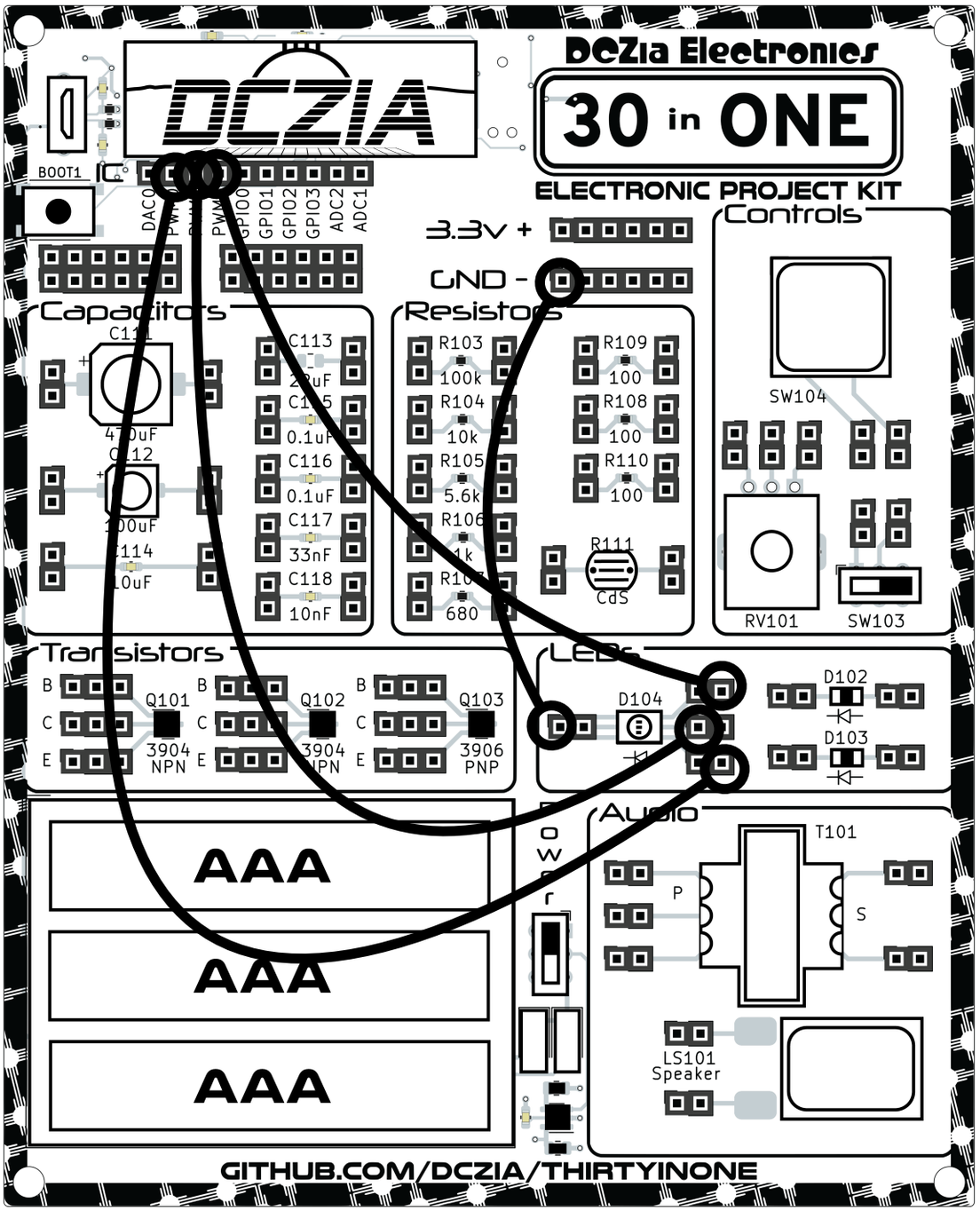
28. MICROCONTROLLER RGB

Event though nothing is wired to the 3V+ battery terminal, something is making the RGB diode cycle color. What do you think PWM stands for? What in the microcontroller could be controlling this sequence?

The magic is getting more “magicky” here.

NOTES

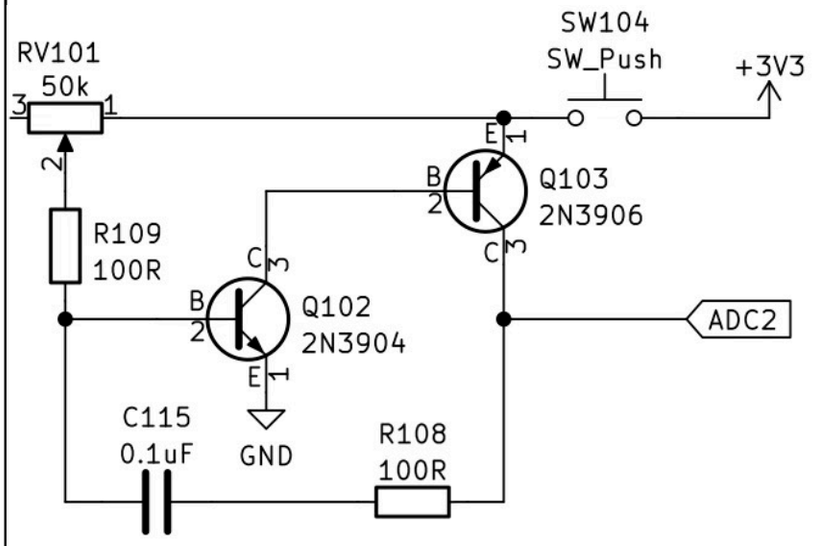


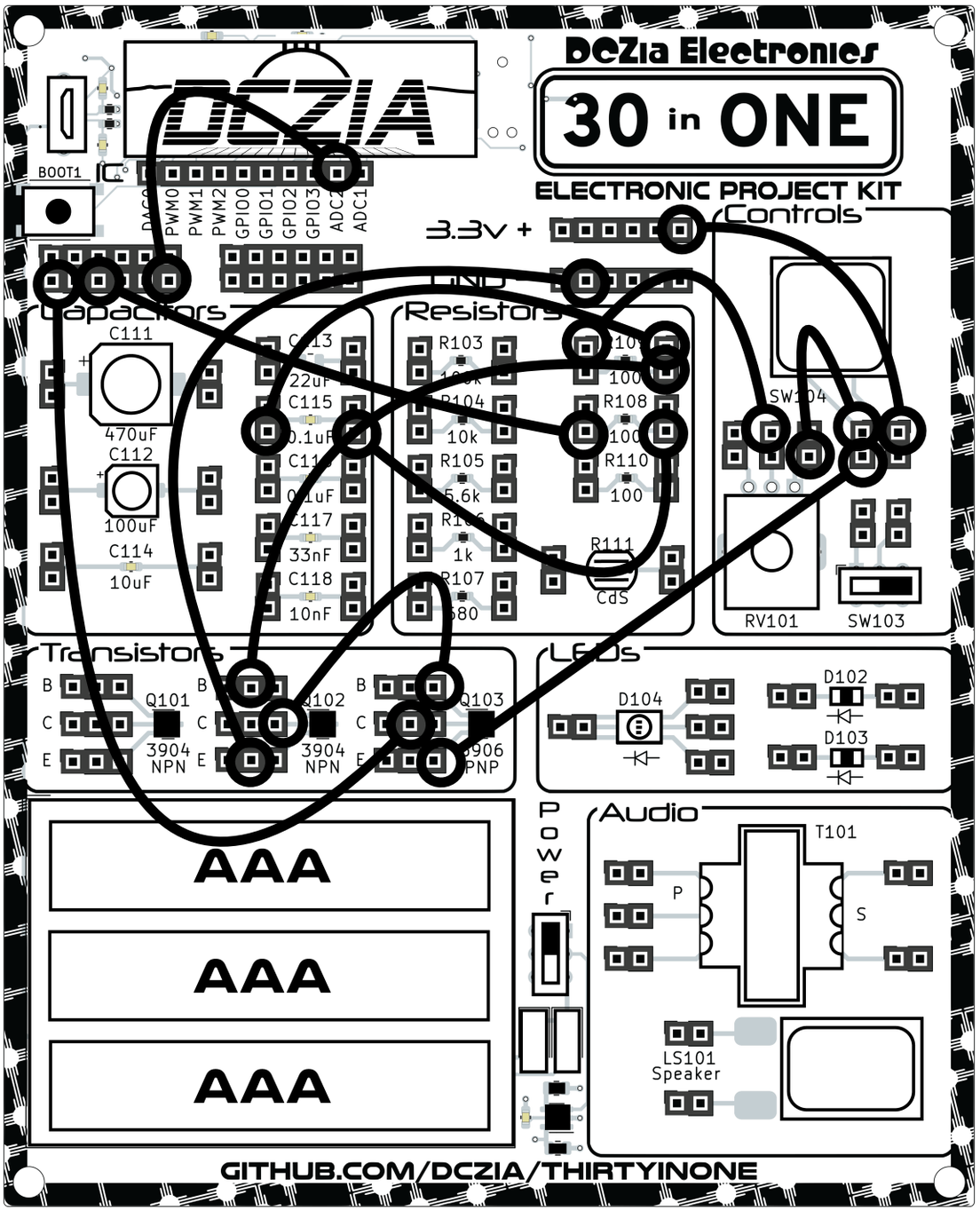

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
3.3V +
GND -
Capacitors
Resistors
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
Audio
T101
LS101
Speaker
AAA
AAA
AAA
GITHUB.COM/DCZIA/THIRTYINONE

29. MCU FREQUENCY COUNTER

This is the same circuit as project 17. The difference is, that you are connecting it to the microcontroller's Analog-to-Digital Converter (ADC) interface instead of the speaker. Can you use this circuit to measure the frequency change as you turn the potentiometer dial?

NOTES

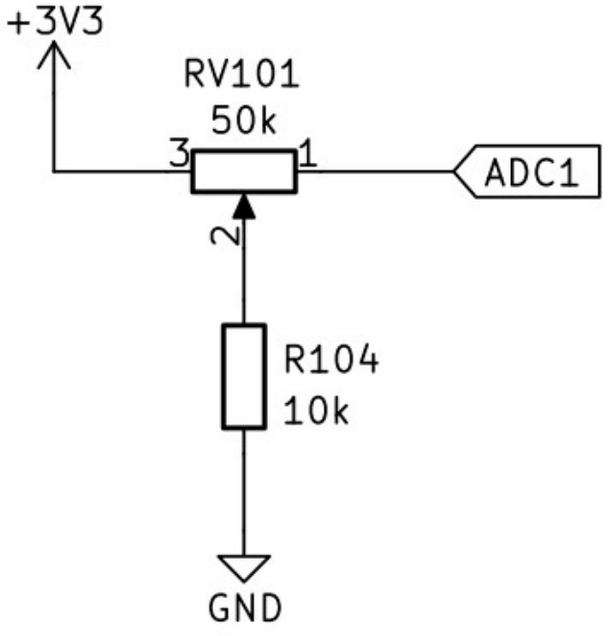


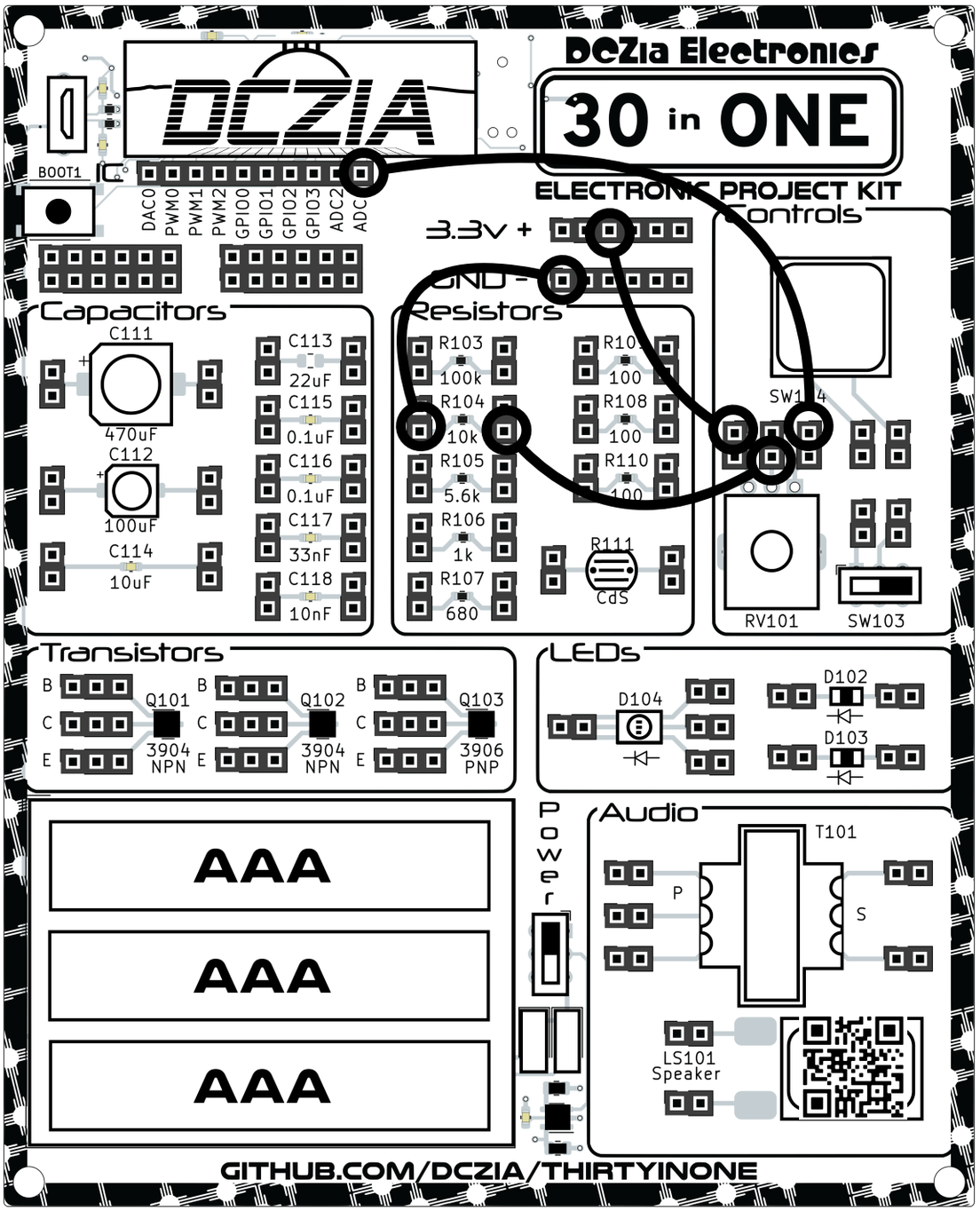

DCZia Electronics
30 in ONE
ELECTRONIC PROJECT KIT
DCZIA
BOOT1
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC1
3.3V +
GND
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
R104
10k
R105
5.6k
R106
1k
R107
680
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
LEDs
D104
D102
D103
AAA
AAA
AAA
Power
Audio
T101
P
S
LS101
Speaker
GITHUB.COM/DCZIA/THIRTYINONE

30. MICROCONTROLLER ADC

What does an ADC do? What happens when you connect the battery? What happens when you turn the potentiometer clockwise or counter-clockwise? Can you think of any other components to add to make this more interesting?

NOTES




DCZia Electronics
DCZIA
30 in ONE
ELECTRONIC PROJECT KIT
BOOT1
DAC0
PWM0
PWM1
PWM2
GPIO0
GPIO1
GPIO2
GPIO3
ADC2
ADC
3.3V +
GND -
Capacitors
C111
470uF
C112
100uF
C114
10uF
C113
22uF
C115
0.1uF
C116
0.1uF
C117
33nF
C118
10nF
Resistors
R103
100k
R104
10k
R105
5.6k
R106
1k
R107
680
R108
100
R110
100
R111
CdS
Controls
SW104
RV101
SW103
Transistors
Q101
3904
NPN
Q102
3904
NPN
Q103
3906
PNP
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C
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