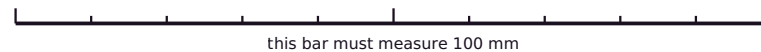


PAPER CICADA

four CD4093 voices with touch gates as a paper circuit · fold sheet, print at 100% / Actual size

Onion Madder // messopedals.com · paper-circuit method after Peter Blasser / Ciat-Lonbarde

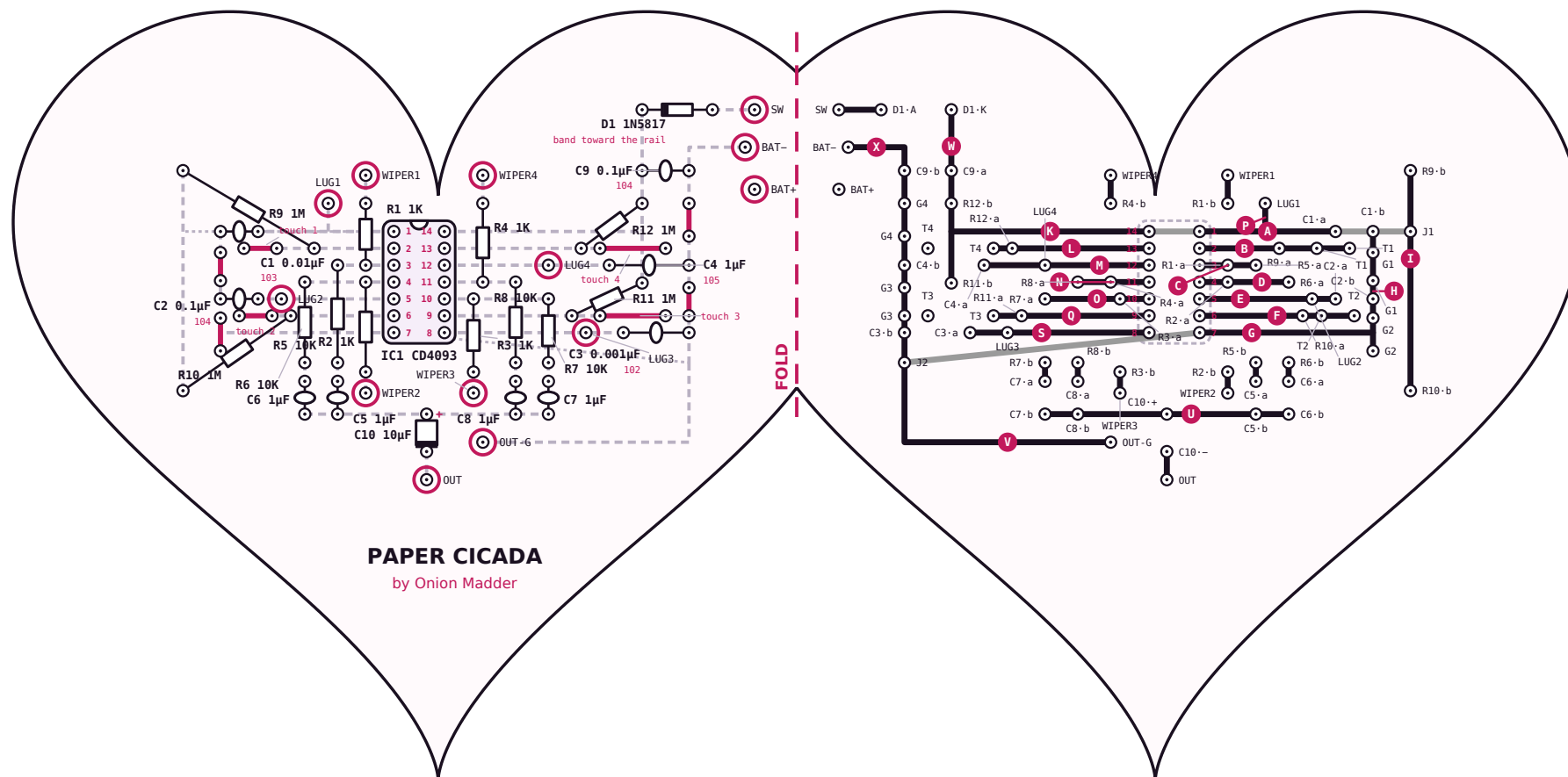


FRONT - parts side

parts go in from this face · touch a gate staple and its ground staple together to stop that voice

BACK - solder side

folds behind the front · mirror image · bare wire along every line



∞ glue up first, then cut along the heart outline through all four layers · don't cut the fold

build-up: blank sheet folded + glued as the core, then this sheet folded around it and glued = 4 sheets thick

Paper Cicada

four CD4093 voices with touch gates, rebuilt as a heart-shaped paper circuit

A paper circuit is a circuit board you print: the drawing is the board, the holes are poked with an awl, and the traces are bare wire laid along the lines on the back. This is the **Cicada** on paper. A CD4093 holds four Schmitt NAND gates, and a NAND with one input tied into a cap and a resistor is an oscillator; the other input is the gate, so every voice has a pitch knob and a gate.

Here every gate is a **touch plate**: a bare-wire staple on the gate beside a staple on ground. Every voice runs until you pull its gate low, so a fingertip across a pair stops that voice, and lifting it lets the voice back in. The four pitch pots hang off the board on wires, the way my built one has them.

64 steps. Page 1 is the fold sheet; everything after it is the recipe.

Reading the sheet

Front: each part is drawn where it sits, with its value printed next to it. The faint dashed lines are only a preview of what connects on the back. The pink staples are the touch plates. The ringed holes are for wires going off the board: BAT+, BAT– and SW for power, LUG and WIPER for each pot, OUT and OUT-G for the jack.

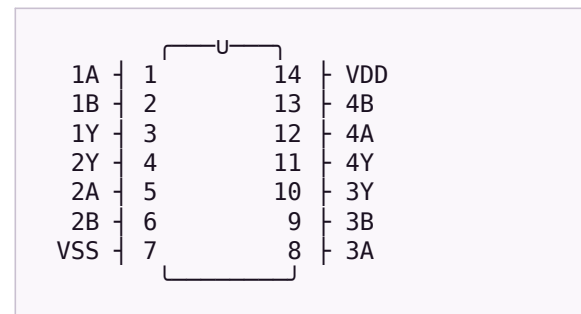
Back: every bold black line is bare wire or a bent part leg. The lines with a pink letter are bare wire, and the steps name them by that letter; the short unlettered ones are a part's own leg, bent along the line. The two gray diagonals are the insulated wires J1 and J2. Small pink numbers beside the chip holes are its pin numbers.

The four-voice CD4093 drone is my Cicada; the NAND-as-oscillator trick is old and everywhere. The paper-circuit method is Peter Blasser's / Ciat-Lonbarde's. This layout and the words are Onion Madder's.

What you'll need

- **1× CD4093 quad Schmitt NAND** · *spot it:* 4093 printed on top, notch or dot at pin 1. It solders straight to the paper, no socket.
- **4× B1M pots (pitch)** · *spot it:* marked B1M, B = linear. They hang off the board on wires: one outer lug to LUG, the middle lug to WIPER, the third lug left empty.
- **4× 1K resistors (R1-R4)** · *spot it:* brown-black-red. One in series with each pot; not optional.
- **4× 10K resistors (R5-R8)** · *spot it:* brown-black-orange. The mix.
- **4× 1M resistors (R9-R12)** · *spot it:* brown-black-green. The gate pull-ups.
- **Timing caps: 0.01 µF (C1), 0.1 µF (C2), 0.001 µF (C3), 1 µF (C4)** · *spot it:* printed 103, 104, 102 and 105. One per voice, from mid to growl to whistle to slow tick.
- **4× 1 µF non-polar (C5-C8)** · *spot it:* film or ceramic, printed 105. Audio swings both ways, so not electrolytics.
- **1× 0.1 µF ceramic (C9)** · *spot it:* printed 104. Across the supply.
- **1× 10 µF electrolytic (C10)** · *spot it:* little can, stripe marks the – leg. The output cap.
- **1× 1N5817 Schottky diode (D1)** · *spot it:* small black body, gray or silver band marks the cathode
- **Bare tinned wire, and insulated white wire** · *spot it:* the bare wire makes the traces and the eight touch staples; the white wire is J1 and J2
- **SPST toggle, 9V battery and snap, a jack** · *spot it:* they hang off the board on wires; the CD4093 output is quiet on its own, so go into an amp
- **A second sheet of plain printer paper, glue stick, an awl** · *spot it:* the blank sheet becomes the core; any sharp point works in place of an awl

The chip, from above



The chip sits on the sheet exactly like this, notch toward the top edge. In each voice, input A is the timing node (pot and cap), input B is the gate (pull-up and touch plate) and Y is the output.

Before you start

Paper burns. Keep the iron moving, quick joints, and don't rest it on the sheet. Work over something that isn't flammable, and keep a damp sponge handy.

Chip straight in. The CD4093 is soldered straight to the paper with no socket, and most parts end at one of its pins. Keep each joint quick: touch, flow, lift.

CMOS inputs never float. Every gate input has its 1M pull-up for a reason: a loose one picks up hum and makes the voice stutter. Solder all four.

Parts bridge the rails. Some caps and resistors lie across a rail or another line on the front. Only their legs go through the paper, so they don't touch what they cross.

Print, fold, glue, poke

The sheet is the circuit board, and it's four sheets of paper thick. A plain sheet folded in half and glued to itself makes the core, then the printed hearts fold around the core and glue on, one heart on each face.

Print at 100% / "Actual size". Fit-to-page shrinks it and the holes stop matching the chip's legs.

STEP	DO
1	Print page 1 on plain printer paper at 100% / Actual size.
2	Measure the 100 mm bar at the top right of the sheet. If it isn't 100 mm, fix the print scale and print again.
3	Fold a second, blank sheet of printer paper in half.
4	Glue-stick the whole inside of the blank sheet, close it, and press it flat. That's the core: two sheets thick.
5	Fold the printed sheet along the FOLD line, printing on the outside, so the two hearts sit back to back.
6	Unfold it again and glue-stick the back of the FRONT heart.
7	Press the core onto the glued back of the FRONT heart.
8	Glue-stick the back of the BACK heart, fold it over onto the other face of the core, and press it flat. Now it's four sheets thick.
9	Let the glue set for a few minutes, then cut along the heart outline through all four layers. Don't cut across the FOLD hinge.
10	Poke the 14 chip holes from the front with an awl or other sharp point, straight down through all four layers.
11	Poke the other 77 dots the same way. Check the back and open any hole that didn't come all the way through.

Start in the middle: the chip and its two wires

Everything builds outward from the chip. J1 carries the supply across to the left rail and J2 carries ground across to the right one, so neither rail has to cross the other.

Quick dabs only. Paper scorches if you sit on it: touch, flow, lift.

STEP	DO
12	Push the CD4093 into the IC1 holes from the front, notch toward the top edge (the drawn notch).
13	On the back, bend pins 1, 7, 8 and 14 outward slightly so the chip can't fall out.
14	Insulated white wire J1 from pin 14 across to the J1 hole on the left rail. Solder at both ends.

- 15** Insulated white wire J2 from pin 7 across to the J2 hole on the right rail. Solder at both ends.

The pin lines

One straight bare wire runs out from each pin, picking up every hole it passes. Solder each at its pin now; the holes along it get soldered as their parts go in.

STEP	DO
16	Trace A: bare wire from pin 1 out along the line to C1·a. Solder at pin 1.
17	Trace P: short bare wire from trace A up to the LUG1 pad. Solder at LUG1 and where it meets A.
18	Trace B: bare wire from pin 2 out along the line through R9·a to the two T1 holes. Solder at pin 2.
19	Trace C: bare wire from pin 3 out through R1·a to R5·a. Solder at pin 3.
20	Trace D: bare wire from pin 4 out through R2·a to R6·a. Solder at pin 4.
21	Trace E: bare wire from pin 5 out through the LUG2 pad to C2·a. Solder at pin 5 and at LUG2.
22	Trace F: bare wire from pin 6 out through R10·a to the two T2 holes. Solder at pin 6.
23	Trace G: bare wire from pin 7 out to the left ground rail. Solder at pin 7.
24	Trace L: bare wire from pin 13 out through R12·a to the first T4 hole. Solder at pin 13.
25	Trace M: bare wire from pin 12 out through the LUG4 pad to C4·a. Solder at pin 12 and at LUG4.
26	Trace N: bare wire from pin 11 out through R4·a to R8·a. Solder at pin 11.
27	Trace O: bare wire from pin 10 out through R3·a to R7·a. Solder at pin 10.
28	Trace Q: bare wire from pin 9 out through R11·a to the first T3 hole. Solder at pin 9.
29	Trace S: bare wire from pin 8 out through the LUG3 pad to C3·a. Solder at pin 8 and at LUG3.

The rails

Two rails down each side. On the left, ground is the inner rail and the supply the outer; on the right it is the other way around.

STEP	DO
30	Trace H, left ground rail: bare wire from C1·b straight down past the G1 and G2 holes to its end. Solder where trace G meets it.
31	Trace I, left supply rail: bare wire from R9·b straight down through the J1 hole to R10·b. Solder where J1 lands.
32	Trace K: bare wire from pin 14 out to the right supply rail and down it to R11·b. Solder at pin 14.
33	Trace W: bare wire from D1·K straight down the right supply rail through C9·a and R12·b to trace K. Solder where it meets K.
34	Trace X, right ground rail: bare wire from the BAT– pad across and straight down the outer rail to the J2 hole. Solder at BAT– and where J2 lands.

- 35** Trace V: bare wire from the J2 hole on down the right ground rail, then across to the OUT-G pad. Solder at OUT-G.

Timing caps and pull-ups

Each timing cap runs from its input A out to the ground rail; each 1M pull-up runs from its gate to the supply. The ones that lie across another rail just lie on top of it on the front.

C3 and C4 lie across the right supply rail: their legs land on either side of it, never on it.

STEP	DO
36	C1, 0.01 μ F (103): legs into C1·a and C1·b. Solder both.
37	C2, 0.1 μ F (104): legs into C2·a and C2·b. Solder both.
38	C3, 0.001 μ F (102): legs into C3·a and C3·b, across the right supply rail. Solder both.
39	C4, 1 μ F (105): legs into C4·a and C4·b, across the right supply rail. Solder both.
40	R9, R10, R11 and R12, 1M (brown-black-green): legs into their a and b holes. Each one's a leg is on its gate line and its b leg on a supply rail. Solder all eight legs.

The touch plates

Eight short bare-wire staples on the FRONT: one on each gate, one on ground beside it. A fingertip across a pair pulls that gate low and stops the voice.

Press each staple flat to the paper before soldering, so a finger lies across both of a pair at once.

STEP	DO
41	Bend a staple of bare wire and push its legs through the two T1 holes from the front. Solder both legs on the back.
42	A staple through the two G1 holes beside it, on the ground rail. Solder both.
43	Staples through the T2 holes and the G2 holes. Solder all four legs.
44	Staples through the T3 holes and the G3 holes. On the right, the gate staple reaches over the supply rail to sit beside its ground staple.
45	Staples through the T4 holes and the G4 holes. Solder all four legs.

Pitch: the 1K and the pot pads

Each output goes through a 1K to its pot's WIPER pad; the pot's other lug comes back on the LUG pad, which is already on input A.

The 1K is what keeps a pot turned to zero from shorting its output straight into its own input.

STEP	D0
46	R1, 1K (brown-black-red): legs into R1·a and R1·b. Solder R1·a on trace C; bend R1·b's leg up to WIPER1 and solder at both.
47	R2, 1K: legs into R2·a and R2·b. Solder R2·a on trace D; bend R2·b's leg down to WIPER2 and solder at both.
48	R3, 1K: legs into R3·a and R3·b. Solder R3·a on trace O; bend R3·b's leg down to WIPER3 and solder at both.
49	R4, 1K: legs into R4·a and R4·b. Solder R4·a on trace N; bend R4·b's leg up to WIPER4 and solder at both.

The mix and the output

Each output also feeds a 10K and a 1 μ F into the mix bus under the chip, and the bus goes out through C10.

STEP	D0
50	R5, R6, R7 and R8, 10K (brown-black-orange): legs into their a and b holes. Each a leg solders on its pin line.
51	C5, C6, C7 and C8, 1 μ F (105): legs into their a and b holes. Bend each 10K's b leg down to its cap's a leg and solder.
52	Trace U, mix bus: bare wire along the line under the chip from C6·b through C5·b, C10·+ and C8·b to C7·b. Solder at every cap leg.
53	C10, 10 μ F: long + leg into C10·+ on the bus, striped leg into C10·—. Bend C10·—'s leg down to the OUT pad and solder at both.

Power corner

Power comes in at the top right. D1 only lets current through one way, so a battery clipped on backwards does nothing.

D1's band goes in D1·K, the end on the supply rail.

STEP	D0
54	D1, 1N5817: band end into D1·K, plain end into D1·A. Bend D1·A's leg right to the SW pad and solder at both; solder D1·K on trace W.
55	C9, 0.1 μ F (104): legs into C9·a and C9·b, across the gap between the right rails. Solder both.
56	Snip every leg tail that sticks past its joint.

Off the board

The battery clips onto the board; the toggle, the four pots and the jack hang off pads on flying leads.

Leave the battery unclipped until the meter checks.

STEP	DO
57	Battery snap red (+) to the BAT+ pad, black (–) to the BAT– pad.
58	A wire from the BAT+ pad to one lug of the SPST toggle, and from its other lug to the SW pad.
59	Each pot: one outer lug to its LUG pad, the middle lug to its WIPER pad, the third lug left empty.
60	Jack tip to the OUT pad, jack sleeve to the OUT-G pad.

Check, then play

Meter it before you play it. These readings are with the chip in.

STEP	DO
61	Clip the battery on, toggle on. Meter pin 14 to pin 7: battery voltage minus about 0.3 V.
62	Meter each gate to pin 7: pins 2, 6, 9 and 13 should all read the same as pin 14.
63	Touch a gate staple and its ground staple together and meter that gate again: it should drop toward zero.
64	Turn your amp down, then up slowly. Four voices drone; sweep each pot, then touch the plates to stop and start them.

Voltage check

METER BETWEEN	EXPECT (toggle on)
BAT+ pad → BAT– pad	battery voltage
pin 14 → pin 7	battery voltage minus about 0.3 V
pins 2, 6, 9, 13 → pin 7	the same as pin 14 (the gates, pulled up)
a gate → pin 7, touching its plate	toward zero

If it won't sing

SYMPTOM	CHECK
Dead, nothing at all	D1 in backwards (the band goes in D1·K), the battery snap reversed, the toggle wires not on BAT+ and SW, or J1 or J2 not soldered at both ends.
One voice silent	Its gate (should read the supply), its pot wires on LUG and WIPER, and its timing cap.
A voice won't stop when touched	Touch both staples of the pair at once. A dry fingertip may not pull the gate low through the 1M; a slightly damp one does.
A voice stutters or hums	Its 1M pull-up is not soldered, so the gate is floating.

SYMPTOM	CHECK
Silent, chip warm	Two bare traces touching on the back. Hold the heart up to a light and look between the pin lines.
Very quiet	The CD4093 outputs are quiet on their own. Go into an amp.
Paper scorched or a hole tore	Glue a scrap of paper over the back, re-poke, carry on. It is paper.

Things to try

- Swap a touch plate for something else across the same holes: a toggle to ground is an on/off per voice, and a photocell is a light-gated voice.
- Change a timing cap to move a voice: the ladder runs from 102 (high whistle) through 103 and 104 up to 105 (slow tick).