# Optical Theremin

A LIGHT-CONTROLLED CD40106, ON A BREADBOARD // BREADBOARD BUILD SHEET // MESS O' PEDALS

Build a light-controlled optical theremin on a breadboard from one CD40106 - wave a hand over the photoresistor and the pitch follows your shadow. Row-by-row recipe, pinout, troubleshooting table, and mods to add more voices. No soldering at all.

## Parts

| | |
|---|---|
| | 1x CD40106BE hex Schmitt-trigger inverter, 14-pin DIP - spot it: CD40106 printed on top; a notch marks pin 1 |
| | 1x LDR (GL5528 or similar) - spot it: the little disc with the wavy orange trace across its face. Add one more per extra voice. |
| | 1x 100K resistor - the range stop (swap for a pot later, see the mods). Spot it: bands brown-black-yellow, or meter it. One more per extra voice. |
| | 1x 10nF ceramic - the timing cap, and what sets the range. Spot it: printed 103 |
| | For a second voice: 1x 15nF ceramic (22nF also fine) - a different value from voice 1 is the point. Spot it: printed 153 (22nF is 223 ) |
| | 1x 10 uF electrolytic - output coupling. Spot it: a little can; the stripe marks the minus leg , longer leg is +. One more per extra voice. |
| | 2x 10K resistor - one mixing, one bus load. Spot it: bands brown-black-orange. One more mixing resistor per extra voice. |
| | 7x jumper wire - two for power, five to ground the inputs you are not using |
| | Breadboard, 9-12V supply, output jack |
| | For Mod 2 (power LED): 1x LED and 1x 1K resistor - spot it: the LED's long leg is + ; the 1K reads brown-black-red |
| | For Mod 3 (range pots): 1x 100K pot per voice (marked B100K ) on flying leads |

## Before you start

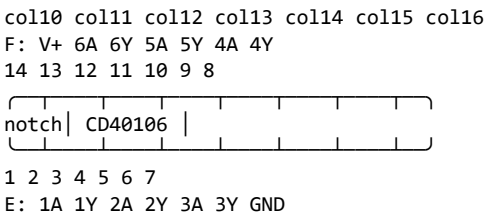
No iron needed for the basic build - everything pushes into the breadboard. Only the range-pot mod at the end asks for solder.

CMOS has one hard rule: never leave an unused gate input floating. Steps 4-8 ground the five inverters we're not using - skip them and the chip squeals on its own and ignores the photoresistor.

Mind polarity on the 10 uF electrolytic - the stripe marks the minus leg - and on your power leads.

If you power it from a salvaged lithium pack, the usual cell cautions apply - see Do You Want to Survive the Vapocalypse?

## The chip, from above




*"A" = input, "Y" = output. Notch marks pin 1, and pin 1 goes in E10 - then every pin lands on the hole shown. Voice 1 is inverter 1, voice 2 is inverter 2; the other four inputs get grounded.*

## Build

### Steps 1-8 The chip and its jumpers

Pin 1 is at the notched end, marked with a dot. Everything in this guide assumes it lands in E10 - put it anywhere else and every hole in this guide shifts. Then all seven jumpers in one pass: two for power, five grounding the inverters you are not using yet.

*Steps 2-3 are the chip's power. Steps 4-8 ground the five unused inputs - CMOS inputs must never float, and skipping these is why a 40106 build squeals on its own and ignores the photoresistor. Row 12 left is one of them now ; that is where a second voice goes, so its jumper comes out again if you build the mod.*

*Power up and wave a hand over the photocell. That is the whole build - seventeen steps and no solder. Everything below is optional.*

| | STEP | DO |
|---|---|---|
| | 1 | Seat the CD40106 across the center channel, notch to the left: pin 1 in E10 , pin 7 in E16, pin 8 in F16, pin 14 in F10 |
| | 2 | Jumper: J10 to the top + rail |
| | 3 | Jumper: A16 to the - rail |
| | 4 | Jumper: A12 to the - rail |
| | 5 | Jumper: A14 to the - rail |
| | 6 | Jumper: J11 to the top - rail |
| | 7 | Jumper: J13 to the top - rail |
| | 8 | Jumper: J15 to the top - rail |

### Steps 9-12 The resistors and the photocell

The 100K is the range stop, the photocell is your hand, and the two 10K resistors are the mixing resistor and the bus load. Everything that resists, in one pass.

| | STEP | DO |
|---|---|---|
| | 9 | Resistor 100K : C10 to C4 |
| | 10 | LDR : D4 to D11 |
| | 11 | Resistor 10K : C20 to C26 |
| | 12 | Resistor 10K : B26 to the - rail |

### Steps 13-14 The capacitors

The 10nF is the timing cap and sets the range; the 10 uF carries the voice off to the mix bus and keeps its DC behind.

| | STEP | DO |
|---|---|---|
| | 13 | Cap 10nF : B10 to the - rail |
| | 14 | Cap 10 uF , + leg in B11 , other leg in B20 |

### Steps 15-17 Out to the jack, and power up

| | STEP | DO |
|---|---|---|
| | 15 | Wire: A26 to the jack tip |
| | 16 | Wire: - rail to the jack sleeve |
| | 17 | Power: 9-12V positive to the + rail , negative to the - rail - and both rail pairs fed (bridge + to + and - to - at the free end if your supply lands on one pair) |

### Demo What it actually sounds like

Filmed with one voice built , before the second went in. A hand moving over the single photocell - the pitch follows the light, so every shadow you cast is a note. Build the second voice and you get two of these beating against each other.

Filmed by Onion Madder on the actual breadboard, at the one-voice stage. 21 seconds, sound on.

### Mod 1 Add a second voice

The same five parts as the first voice, one inverter down, with a 15nF cap instead of 10nF. A different value is the whole point: two voices in different ranges beat against each other, grab, lock and break apart as your hand moves. Two the same just sound like one fat buzz.

*Step 1 is the one people miss. Leave that jumper in and you have shorted your new voice's input to ground, so it sits there silent while everything else works.*

Want more? There are six inverters on the chip. Keep going and you are building the Breadboard Hive - the same five parts per voice, six times, with pots in place of photocells.

| | STEP | DO |
|---|---|---|
| ☐ | 1 | Pull the grounding jumper from step 4 (A12) - column 12 is about to become an input again |
| ☐ | 2 | Cap 15nF : B12 to the - rail |
| ☐ | 3 | Resistor 100K : C12 to C6 |
| ☐ | 4 | LDR 2 : D6 to D13 |
| ☐ | 5 | Cap 10 uF , + leg in B13 , other leg in B24 |
| ☐ | 6 | Resistor 10K : C24 to D26 |

### Mod 2 A power LED

Two parts, no soldering, and worth it the first time you spend ten minutes debugging a build that simply was not powered. It tells you the rails are live and nothing else.

*The resistor is not optional - an LED straight across 9V draws whatever it likes and dies. 1K gives a clearly visible glow at 9V; drop to 470 ohms if you want it brighter, or go up to 4.7K if it is dazzling you on a dark bench. The long leg is the anode and goes to +; the flat spot on the rim marks the other side.*

It doubles as something to play the theremin with, if you bend it over toward the photocell.

| | STEP | DO |
|---|---|---|
| ☐ | 1 | Resistor 1K : + rail to any free column - say A40 |
| ☐ | 2 | LED : long leg (+) in B40 , short leg to the - rail |

### Mod 3 Range pots

The 100K resistor sets how far the pitch can climb. Swapping it for a pot lets you slide the playable window up and down while you play . A panel pot will not sit in a breadboard, so it goes on flying leads - this is the one part of the build that wants a soldering iron.

| | STEP | DO |
|---|---|---|
| ☐ | 1 | Remove the 100K resistor placed in step 9 |
| ☐ | 2 | Solder a bridge between the pot's middle lug and either outer lug . Use the middle lug and the other outer lug as your two connections |
| ☐ | 3 | Wire: A10 to the pot's free outer lug |
| ☐ | 4 | Wire: A4 to the pot's middle lug |
| ☐ | 5 | If you built Mod 1, repeat for that voice: remove its 100K, then wire A12 and A6 to a second pot the same way |

## If it doesn't work

| SYMPTOM | CHECK |
|---|---|
| No sound at all | Steps 2 and 3. This is the fault nine times out of ten. |
| Constant squeal, ignores the LDRs | Steps 4-7. An unused input is floating. |
| Sound but no pitch change | The 100K and the photocell - the chain isn't reaching back to column 11. |
| Pitch far too high, barely audible | Too much light, or the 100K range stop in step 9 is missing. |
| Pitch too low, clicking | Timing cap too large. Drop the 10nF in step 13 to 4.7nF (printed 472 ). |
| One voice only | That voice's 10 uF is missing or in backwards, or its 10K into the mix bus is not in. |
| Built Mod 1 and the new voice is silent | Mod 1 step 1 - the grounding jumper from step 4 is still in, holding its input at ground. |

| | |
|---|---|
| Built Mod 1 and both voices sound identical | Mod 1 step 2 - wrong value, both timing caps are 10nF. They have to differ. |

## Things to try

- Swell, don't jump. Cup a hand over the LDR for a slow swell instead of a jump.
- Play it with a flashlight. A phone light gives you far more range than shadow alone, and a much steadier hand.
- Swap the timing cap. 1 uF in place of the 10nF drops the whole thing below hearing, into a slow click you can watch. 1nF sends it up into a whistle.
- With Mod 1 built: chase the lock. Get the two voices to nearly the same pitch. They grab each other, lock, then break apart as you move your hand. That lurch is the best sound the circuit makes.
- With Mod 1 built: cover both at once - the beat rate changes, not just the pitch. And swapping one voice's cap for 1 uF turns it into a slow click that stutters the other.
- Fill the chip. There are six inverters. Keep adding voices on rows 14 left, 11 right, 13 right and 15 right and you arrive at the Breadboard Hive , or its soldered twin the Dead-Bug Hive .