Dual-Wave LFO

TRIANGLE AND SQUARE FROM ONE CHIP, ON A BREADBOARD // BREADBOARD BUILD SHEET // MESS O' PEDALS

Build a dual-wave LFO on a breadboard - one NE5532, a triangle and a square that chase each other forever, a rate knob and a blend knob. Twenty-seven steps, no soldering, a printable build sheet, a troubleshooting table, and the meter readings that prove each half is alive.

Parts

	1x NE5532 dual op-amp, DIP-8 - spot it: 5532 in the part number on top, a notch at one end and a dot beside pin 1. An LM358 is the same pinout and is actually specified for a 9V supply - see the supply note
	1x 47K resistor - sets the fast end of the rate sweep. Spot it: bands yellow-violet-orange
	1x 68K resistor - trigger window, triangle side. Do not swap with the 100K. Spot it: bands blue-gray-orange
	2x 10K resistors - the mid-rail divider; a matched pair matters more than the exact value. Spot them: bands brown-black-orange
	1x 100K resistor - trigger window, feedback side. Spot it: bands brown-black-yellow
	1x 1 uF film cap - the integrator cap; it sets the rate, so film, not ceramic. Spot it: a little box or oblong, either way round
	1x 47 uF electrolytic , 16V or higher - bias decoupling. Spot it: a little can; the stripe marks the minus leg
	1x 100nF ceramic - supply decoupling, not on the stripboard layout ; added here because the NE5532 is a fast part and long breadboard rails are an invitation. Spot it: printed 104
	1x 100K linear pot - rate. Spot it: marked B100K . Only the wiper and lug 3 are used
	1x 1K linear pot - blend. Spot it: marked B1K or B102 . All three lugs; its wiper is the LFO output and never touches the board
	A breadboard - all of it this time: both banks and both rail pairs. The build spans columns 2 to 22, so a half-size board fits. Plus about 11 jumpers , at least one of them insulated wire rather than a bare leg
	1x output lead - tip and sleeve, to whatever you are wobbling
	9-15V DC supply - a 9V battery works, but 12 to 15V is the better choice here and costs nothing in rate (see the supply note). Four salvaged vape cells in series land at 14.8V nominal, inside that window - untested on this build, so meter it first

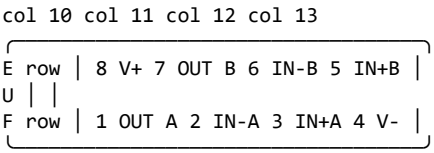
Before you start

Two parts care which way round they go : the chip (pin 1, the corner with the dot, goes in F10 - anywhere else and nothing works) and the electrolytic (the stripe marks the minus leg).

Two resistors must not swap. The 68K and the 100K set the trigger window between them; exchanged, the window is wider than the chip can swing and the LFO never starts. Meter them rather than trusting the bands in bad light.

Build with the supply off. The two meter checks near the end are there so the first power-up is boring, and hole D17 stays empty on purpose - it is your probe point for the 4.5V bias that everything else is judged against.

The chip, from above



Notch toward column 10, pin 1 - the dot corner - in F10. Op-amp A (the F row) is the integrator that draws the triangle; op-amp B (the E row) is the trigger that snaps the square. Hole D17 stays empty - it is the bias probe point.

What the rate pot gives you

The 47K plus the dialed-in part of the 100K pot set the ramp current. The film cap is the coarse control: 470nF roughly doubles every figure here, 2.2 uF roughly halves them.

RATE POT	TOTAL RESISTANCE	FREQUENCY
fully down	47K	7.8 Hz
quarter	72K	5.1 Hz
half	97K	3.8 Hz
fully up	147K	2.5 Hz

What the meter should say

Every reading is judged against the bias at D17. On a 9V supply, bias is 4.5V; on 12V it is 6V - always half the rail.

POINT	EXPECTED
D17	Half the rail, steady - the bias. Everything else is judged against this.
Pin 3 (F12), pin 6 (E12)	Bias, steady.
Pin 2 (F11)	Bias, steady. It is a virtual earth - if it wanders, the integrator isn't in control.
Pin 1 (F10)	Wobbling around bias - the triangle, roughly ±2V.
Pin 7 (E11)	Wobbling around bias - the square, swinging as close to the rails as the chip manages.

Build

Step 1 The chip

The whole circuit hangs off eight pins, so this is the step to get exactly right. Every other part is measured from these four columns.

	STEP	DO
☐	1	Seat the NE5532 across the center channel at columns 10 to 13 , notch toward column 10, pin 1 - the dot corner - in F10 . The F row then reads F10 = 1, F11 = 2, F12 = 3, F13 = 4, and the E row reads E10 = 8, E11 = 7, E12 = 6, E13 = 5

Steps 2-12 The jumpers

Eleven of them: two rail bridges, power to the chip, the bias distribution, and the four signal buses that carry the op-amp pins out to where the parts live.

	STEP	DO
☐	2	Jumper: A-side red rail to J-side red rail
☐	3	Jumper: A-side blue rail to J-side blue rail
☐	4	Jumper: A-side red rail to A10 - power to pin 8
☐	5	Jumper: G13 to the J-side blue rail - pin 4 to ground
☐	6	Jumper: E17 to F17 - hops the channel so the bias reaches both halves of the chip
☐	7	Jumper: C17 to C12 - bias to pin 6
☐	8	Jumper: G17 to G12 - bias to pin 3
☐	9	Jumper: G10 to G7 - pin 1, the triangle, out to its bus
☐	10	Jumper: H11 to H5 - pin 2 out to the integrator bus
☐	11	Jumper: D13 to D7 - pin 5 out to the trigger bus. This one passes over the chip, so use insulated wire , not a trimmed component leg
☐	12	Jumper: B11 to B22 - pin 7, the square, out to its bus

Steps 13-17 The resistors

The matched pair first, then the three that set the speed and the trigger window.

The 68K and the 100K set the trigger window between them: the 68K carries the triangle into pin 5, the 100K carries the square back into the same node. Swap them and the window comes out wider than the chip can swing, and the LFO never starts. If the bands are hard to read, meter them.

	STEP	DO
	13	Resistor 10K (brown-black-orange): A17 to the A-side red rail
	14	Resistor 10K (brown-black-orange): B17 to the A-side blue rail
	15	Resistor 47K (yellow-violet-orange): J5 to J2
	16	Resistor 68K (blue-gray-orange): F7 to E7 . It stands upright across the center channel at column 7 - one bank to the other, same column
	17	Resistor 100K (brown-black-yellow): C7 to C11

Steps 18-19 The small caps

	STEP	DO
	18	Cap 100nF ceramic (printed 104): B10 to the A-side blue rail . Keep it short and right at the chip - it is the supply decoupling
	19	Cap 1 uF film : I5 to I7 . Either way round

Step 20 The electrolytic

	STEP	DO
	20	Cap 47 uF : + leg into H17 , striped - leg to the J-side blue rail

Steps 21-23 Off the board: pots and output

Both pots fly off the board on leads. The blend pot's wiper is the LFO output itself - it never touches a breadboard hole.

Both pots here are wired unlike anything else in the series: the rate pot is a rheostat that uses the wiper and lug 3 only, and the blend pot is a divider whose two ends sit on two different signals - triangle on one lug, square on the other - so its wiper sweeps between the waveforms instead of between a signal and silence.

	STEP	DO
	21	Rate pot 100K : wiper into H2 , lug 3 into C22 . Lug 1 is genuinely unused - tying it to the wiper at the pot is harmless good practice
	22	Blend pot 1K : lug 1 into J7 (the triangle side), lug 3 into D22 (the square side)
	23	Output lead: tip to the blend pot's wiper , sleeve to a blue rail

Steps 24-27 Checks, then power

Two meter checks with the supply off, then power, then the reading that proves the heart of it is alive.

If D17 does not read half the rail, stop there - the bias is what every other voltage in the circuit is judged against, and nothing downstream can work until it is right. At these speeds a cheap DMM is scope enough: 2 to 8 Hz shows up as a reading that will not sit still.

	STEP	DO
	24	Continuity, supply off: column 17 in the A-to-E bank to column 17 in the F-to-J bank (through the E17-F17 jumper), and both to C12 and G12 . Then confirm C12 does NOT reach G12 by any route other than through column 17 . Finally A10 to the red rail and G13 to the blue rail
	25	Resistance from the red rail to the blue rail : roughly 20K - that is the two 10Ks in series, a useful sanity figure. Anything near zero is a short: find it before you power up
	26	Supply off: positive to the red rail , negative to the blue rail . 9V minimum, 12-15V better - see the supply note below
	27	Power on with the rate pot at mid-travel and put the meter on D17 , DC volts: it should read half the supply, steady - 4.5V on a 9V rail. Then probe F10 and E11 : both should visibly wobble rather than settle

If it doesn't work

SYMPTOM	CHECK
The bias at D17 isn't half the rail.	The 10K divider, or a missing rail bridge. Fix this first - nothing downstream can work. Check both rail bridge jumpers.
Bias good, but pin 1 (F10) and pin 7 (E11) both sit dead still at bias.	The loop never starts - usually the 68K and 100K swapped. The 68K goes from the triangle to pin 5, the 100K from pin 7 back to pin 5.
Pin 7 latched hard at one rail and staying there.	The 68K is open or its cross-channel legs aren't seated. Without it the triangle can never pull pin 5 back - check both ends of the upright resistor at column 7.
Pin 1 drifts slowly to a rail and parks.	The 1uF isn't making contact, so the integrator runs open-loop. Reseat it at I5 / I7 and confirm continuity from column 5 to pin 2.
Runs, but the rate pot does nothing.	The rate pot's wiper and lug 3 are swapped, or the wiper lead is in the wrong column. Wiper goes to H2, lug 3 to C22.
Only one waveform across the whole blend sweep.	A blend pot lug in the wrong place. Lug 1 to J7 (triangle), lug 3 to D22 (square).
Waveform has fuzz or steps riding on it.	No supply decoupling - that is what the 100nF is for. The NE5532 is a fast part and long breadboard rails are an invitation.
Runs, but the swing looks squashed and clipped.	The 9V problem - see the supply note. Raise the supply to 12-15V.

Things to try

- Give it an eye. Hang a 4.7K resistor from column 22 (the square bus) to a spare column, and an LED from there to the blue rail - it pulses in time. The square is about 1.5x the triangle's size, so don't expect the blend to feel like a level-matched crossfade; that asymmetry is the design.
- Change the span. Swap the 1uF film for 470nF and every rate roughly doubles; 2.2uF and everything halves. The rate range is the one thing the supply voltage cannot touch.
- Wobble something. The output sits at half the rail - perfect as a control voltage into anything with a CV input. Into a pedal or an amp input, put a series cap after the wiper first, or the DC will thump.
- Feed the family. Point it at the Hive 's inputs or an Optical Theremin 's photocell (LED taped to LDR = homemade vactrol) and the LFO starts earning its keep.