PIERDZIDEŁKO

sound generator DIY kit

operation/assembly instructions

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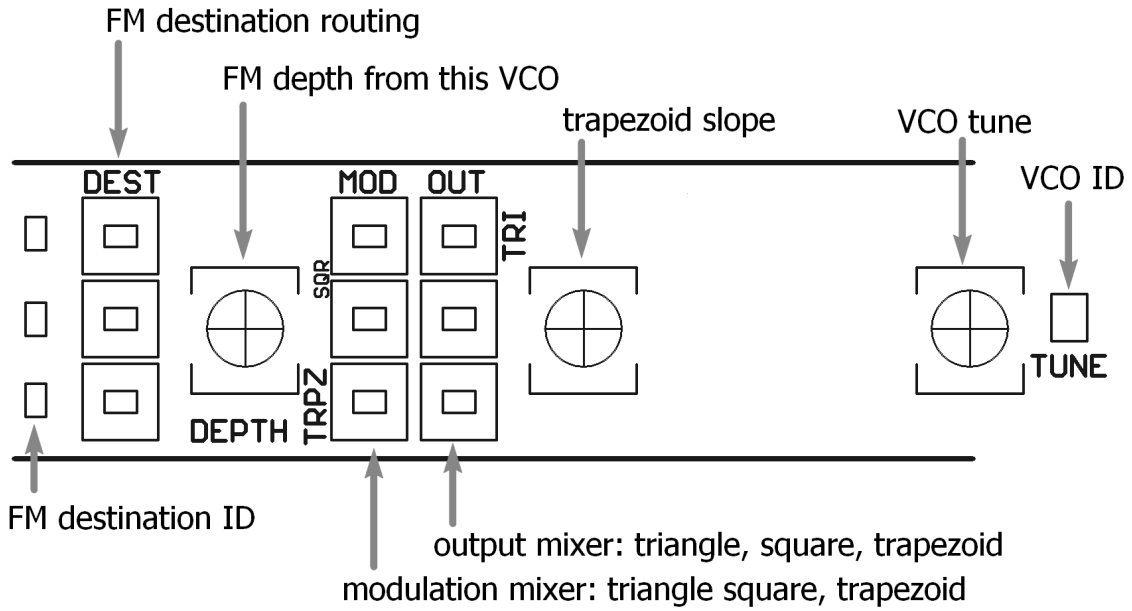
Functional description

Pierdzidełko[1] is a small sound generator, made of simple blocks, but capable of reach textures thanks to frequency modulation. It may look complex with so many switches, but it all becomes clear when you get familiar with their functions, which there are only three.

It consists of 4 identical oscillators, or call it VCOs. Each oscillator generates 3 different waveforms – square, triangle and trapezoid. That makes 12 signals that can be mixed together to audio output. Mixing is done in 2 steps only – either fully on or off, by means of 12 switches. The same signals can be also used to modulate other oscillators, and as modulation source, waveforms can be also mixed within one VCO by switches from square, triangle and trapezoid. So modulating source mix is where next 12 switches came from. Each VCO can modulate remaing three, meaning each of 4 VCOs can be routed to 3 destinations – yet another 12 switches. Modulation source can be attenuated, so it's possible to adjust modulation depth from no modulation at all, to 100%, up to blocking the modulated VCO.



Another controls available are frequency and trapezoid's slope. The slope can be changed with a potentiometer from triangle up to nearly square.

1 „pierdzidełko” in Polish is a word that can be translated as „a little something that makes farting noises”

There's also one more control – PITCH potentiometer, that drives all 4 oscillators at once. So when you tune them all in some intervals, or unisono, they will all track that one PITCH pot, keeping the intervals set.

It's also possible to control Pierdzidełko from external Control Voltage, in that case the Pitch pot is best turned counterclockwise to minimum. Control Voltage must be in Hertz per Volt scale.

A little bit on how it works

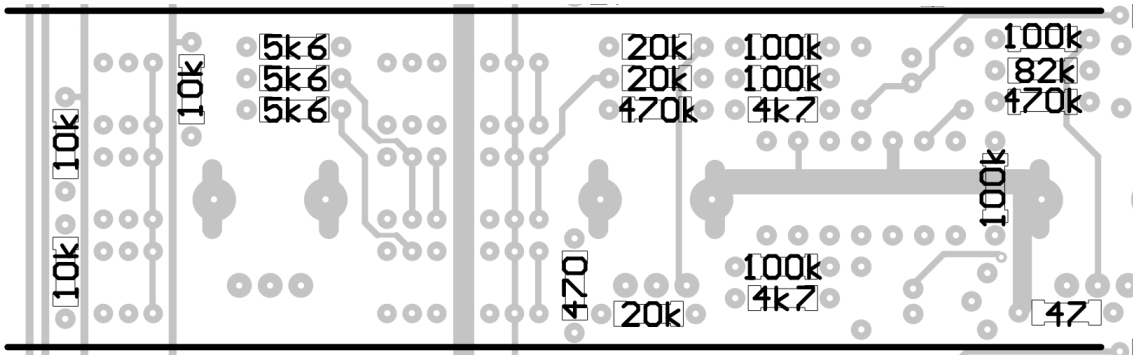
Each oscillator is a classic triangle core oscillator with integrator toggling Schmitt flip-flop, which then again changes polarity of voltage fed to that integrator. To make it voltage controlled, comparator output does not drive the integrator directly, but with use of a transistor it changes topology of additional amplifier – between inverting and non-inverting. So any voltage applied to input of this amplifier will be forwarded to integrator's input as either positive or negative, flipped with frequency of the oscillator. So basicaly amplifier's input is CV input for oscillator's frequency.

That input is obviously used by master PITCH knob controlling frequency of all 4 VCOs, and also by CV input on 3.5mm jack. Not surprisingly it's the same input where mixed modulation sources are finally routed. So for example VCO1 can be controlled by PITCH knob, CV input, and outputs of VCO2, VCO3, VCO4.

Assmebly guide and few more ramblings about the way it works

Start with resistors. There are a lot of them, so it may be worth to split them in few groups, otherwise you might find it inconvinient to solder everything in dense forest of resistor leads. Some people prefer soldering from top side, so there's no pin forest to bother then.

Here's little drawing with marked values for each resistor in VCO. Remember all 4 are identical, so only 1 is shown.

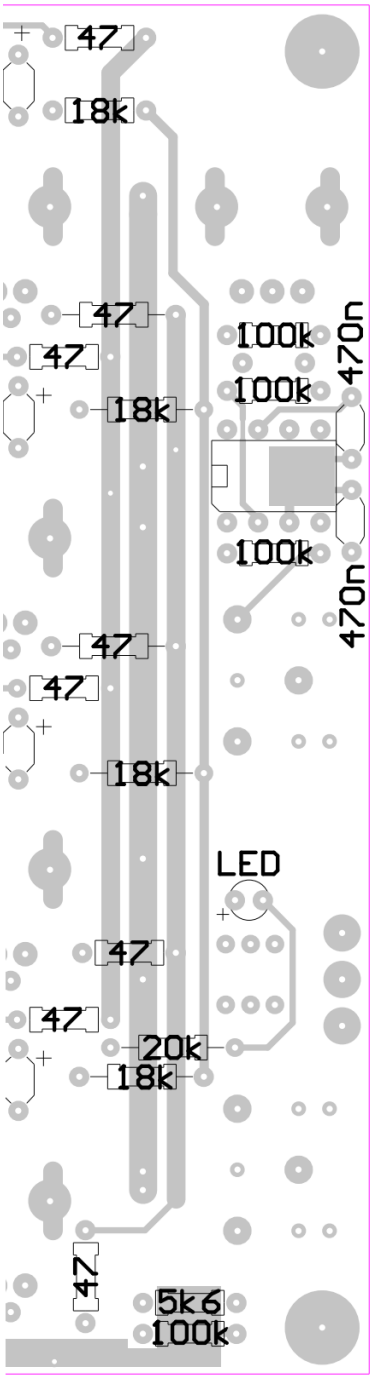


Another drawing shows the right side of the board, which contains master tune section, power input and audio out.

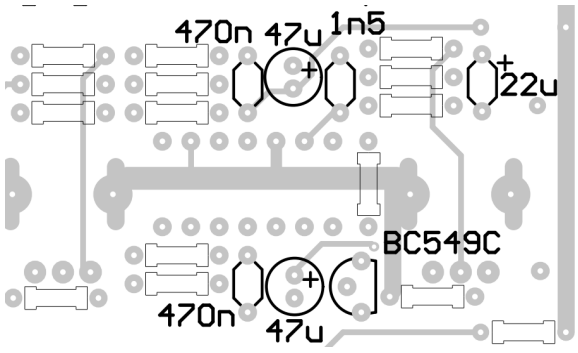
If you're more comfortable with parts designators, there's full list of components at the end of this manual.

Next components in order by height are the integrated circuits and 3.5mm jacks. If you're affraid to solder ICs directly, or want to have an option of easy replace/repair, it may be wise to add sockets. However they are not necessary and may introduce probles after couple of years. Those chips can be safely soldered by hand if you take general basic precautions, meaning if you know how to solder, you'll know what to do. Orientation of the ICs are marked on the board, all 5 are oriented the same way. 4 bigger ones are the same, so showing you a drawing with their locations would be an insult.

Next are small, yellow capacitors. They are all 470uF used for power decoupling. Why 470n and not 100n that everybody else seem to use? Well, I'm not everybody, and 470uF are the biggest ceramic THT capacitor I could get in reasonable size and price, and they work 4.7 times better to bypas medium-high frequency ripple than 100n. The 100n cap rule of thumb probably came from old TTL digital circuitry, where every chip generated very fast transients,



in range of nanoseconds. The opamps used in this circuit are not nearly capable of making anything comparable as far as transients go, so we should size the capacitors accordingly.



In the next batch you might solder all remaining components at once, that is electrolytic capacitors, film capacitors, transistors and LED. Yes, there's one LED onboard, showing actually only if power is on. That's because no circuit is completed without at least one light source. Better yet if it blinks, but not in this case, as it's connected straight to power line via resistor.

The bigger (47uF) capacitors are also used for power supply decoupling, together with previously mentioned 470n, and 47 ohm resistors. 47uF helps a lot in lower end of the spectrum, and with 47 reistor forms a low pass filter with corner frequency of about 70Hz. Such extreme power decoupling helps to reduce influences between oscillators. When they are tuned to nearly the same frequency it doesn't take much to sync them, and we would like to avoid that, right?

Now it's time for the most boring part – soldering 37 switches, each of which has 6 leads in tight spacing. You can insert and solder them one by one, or put all of them or at least a few, then place a piece of foam/sponge on top of them, then flip the board, gently push down and solder. The sponge should nicely push the switches to PCB to ensure flat, even leveling. Even so, it's good to solder only one pin per switch first, then check if they are sitting firmply on PCB, and if needed, reflow that pin and push the switch towards PCB.

THE MOST IMPORTANT about switches – they are not symetrical, and if you solder then backwards, their on-state will be reversed, so signal will pass when actuator is up. On two sides of the switch there are clips. One

clip has one slot, the other has 2 slots. All switches must be soldered facing 2-slotted side towards the side of PCB where jacks and power entry is.

Now the most pleasing part – potentiometers. You may need to wobble them a bit and push with reasonable force so they lock in the mounting holes. Then solder pins and side holders. All 13 potentiometers are of the same kind.

It's time now for adding power. This board can work supplied from anything between +/-1V to +/-3V, so it can be either regulated bipolar power supply, or 2 battery packs. Two dual AA battery packs are perfect for this. Current consumption is merely a few mA, so it can work on one set of batteries for long hours. And since you have power switch and power LED onboard, it's easy to make sure it's not draining power when not in use. It's very important to keep the same betteries in both packs. Differencies in positive and vegative voltages may inhibit the oscillators from operating.

Do not connect voltage higher than +/-3V or simply 6V between „+3V” and „-3V” terminals, it may damage the integrated circuits, while supplying it with anything higher than 7V will cause spectacular damage to the chips. Likewise, watch for correct power polarity. Connecting in reverse may as well cause it to blow.

Modifications

This is very simple circuit, and as such it has limitations. The FM is by far not that precise as for example in digital synths, but it's not about keeping perfect pitch, right? This will make interesting, maybe even unexpected noises, and sometimes rhythmic melodies. Because it's not thru-zero FM, overloading an oscillator with too much modulation will make it stop, until modulation source changes with the cycle. In this build modulation sources and destinations are linked with 22uF capacitor. You can experiment with that component by replacing it with something else, like resistor, or a green LED. Tuning might not work the way you'd expect then, but modulation noises will definitely sound different.

Parts list

Sorted by value

RESISTORS													
47R	R17	R36	R41	R42	R48	R49	R51	R89	R90	R92	R94	R95	
470R	R18	R37	R50	R93									
4k7	R1	R8	R28	R35	R52	R59	R79	R91					
5k6	R14	R15	R16	R20	R21	R22	R65	R66	R67	R68	R69	R70	R98
10k	R38	R39	R40	R43	R44	R45	R73	R74	R75	R85	R86	R87	
18k	R19	R46	R96	R47									
20k	R11	R12	R13	R23	R24	R25	R62	R63	R64	R71	R72	R76	R104
82k	R5	R31	R56	R82									
100k	R2	R3	R7	R9	R10	R26	R27	R29	R33	R34	R53	R54	R58
	R60	R61	R77	R78	R80	R84	R88	R97	R100	R101	R102		
470k	R4	R6	R30	R32	R55	R57	R81	R83					
CAPACITORS													
1n5	C1	C11	C14	C23									
470n	C2	C4	C8	C10	C15	C17	C20	C22	C26	C27			
22u	C6	C12	C13	C24									
47u	C3	C5	C7	C9	C16	C18	C19	C21					
SEMICONDUCTORS													
BC549C	T1	T2	T3	T4									
MCP6004	U1	U2	U3	U4									
MCP6241	U5												
POTENTIOMETERS													
10k	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13

Sorted by designator

C1	1n5
C2	470n
C3	47u
C4	470n
C5	47u
C6	22u
C7	47u
C8	470n
C9	47u
C10	470n
C11	1n5
C12	22u
C13	22u
C14	1n5
C15	470n
C16	47u
C17	470n
C18	47u
C19	47u
C20	470n
C21	47u
C22	470n
C23	1n5
C24	22u
C26	470n
C27	470n

P1	10k
P2	10k
P3	10k
P4	10k
P5	10k
P6	10k
P7	10k
P8	10k
P9	10k
P10	10k
P11	10k
P12	10k
P13	10k
R1	4k7
R2	100k
R3	100k
R4	470k
R5	82k
R6	470k
R7	100k
R8	4k7
R9	100k
R10	100k
R11	20k
R12	20k
R13	20k
R14	5k6
R15	5k6
R16	5k6
R17	47R
R18	470R
R19	18k
R20	5k6
R21	5k6
R22	5k6
R23	20k
R24	20k
R25	20k
R26	100k
R27	100k
R28	4k7
R29	100k
R30	470k
R31	82k
R32	470k
R33	100k
R34	100k
R35	4k7
R36	47R
R37	470R
R38	10k
R39	10k
R40	10k
R41	47R
R42	47R
R43	10k
R44	10k
R45	10k
R46	18k
R47	18k
R48	47R
R49	47R
R50	470R
R51	47R
R52	4k7
R53	100k
R54	100k
R55	470k
R56	82k
R57	470k
R58	100k
R59	4k7
R60	100k
R61	100k
R62	20k
R63	20k
R64	20k
R65	5k6
R66	5k6
R67	5k6
R68	5k6
R69	5k6
R70	5k6
R71	20k
R72	20k
R73	10k
R74	10k
R75	10k
R76	20k
R77	100k
R78	100k
R79	4k7
R80	100k
R81	470k
R82	82k
R83	470k
R84	100k
R85	10k
R86	10k
R87	10k
R88	100k
R89	47R
R90	47R
R91	4k7
R92	47R
R93	470R
R94	47R
R95	47R
R96	18k
R97	100k
R98	5k6
R100	100k
R101	100k
R102	100k
R104	20k

T1	BC549C
T2	BC549C
T3	BC549C
T4	BC549C
U1	MCP6004
U2	MCP6004
U3	MCP6004
U4	MCP6004
U5	MCP6241