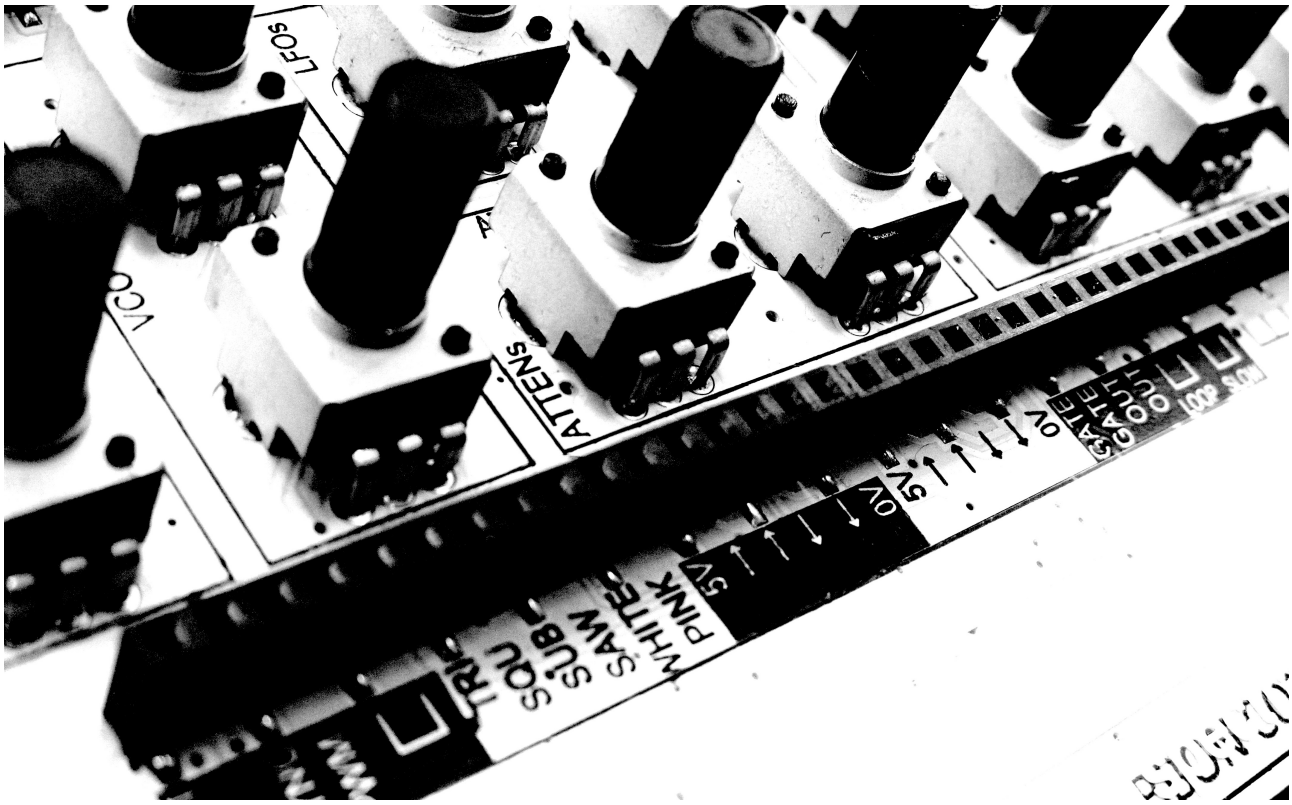
soundmachines

NS1nanosynth

Experimenter's Kit Manual



V1.0 January 2016 by Davide Mancini

Designed and crafted in Italy

CE

IMPORTANT INFORMATION: Care and Feeding:

Please, before connecting your experimental circuits to the NS1nanosynth read the NS1 manual!

The experimenter's kit contains a breadboard friendly power supply. Connect this to a 9-12Vdc wall wart and setup the jumper to output 5V (that is the default position of the jumpers). In this configuration, you still have to make a 'reference' connection between your breadboard and the NS1nanosynth. You do this by connecting the ground (0V) of the breadboard to the far right 0V patch point f the NS1nanosynth.

Alternatively, and up to 200mA of current, you can use the 5V and 0V connection on the right side connectors of your NS1nanosynth. Altough those power supply sources are protected with a resettable fuse, please make sure that you don't invert the polarity or apply short circuits or wrong voltages (i.e. higher than 5V) to the NS1 header connections!!!!!

Tipically, make sure avoid connecting the NS1 to any source of voltages that exceed the 0V-5V range.

If you need to do that you can use our NS1nanobridge board that include some protection to interface with potentially higher voltages like the ones used in standard eurorack modules. Connect the 0V and 5V patch points of the NS1nanobridge to the far right 0V and 5V patch points on the NS1nanosynth (the one in the SB1 and SB2 modules).

Introduction:

The NS1nanosynth experimenter's kit is a set of components, wires and supports to build many different synth related circuits. From simple oscillators to envelope generators, sequencers, filters, you can augment the NS1nanosynth experience with circuits made by yourself! Electronic circuits for generating sounds are not so difficult and with a little bit of documentation and ingenuity you can easily build a set of functions that are, other than complex and musically appealing, completely yours!!!

Don't be afraid to experiment, as long as you are using a 5V power supply and you are not making short circuits around, the experimenter's kit is a safe way to get your hands dirty with musical electronics!!!

This short manual will describe what's inside the kit and several useful and fun circuits you can build, to work either alone or connected with the NS1nanosynth!

To make it easy to understand, build, modify and share the circuits we adopted Fritzing as the platform to draw the schematics and share the circuits. Fritzing is a powerful environment to design, document and even 'fabricate' your circuits!

You can download Fritzing while reading this, so you will be ready to open the circuit files that you find on our website. Check out the link in the references at the end of this doc!

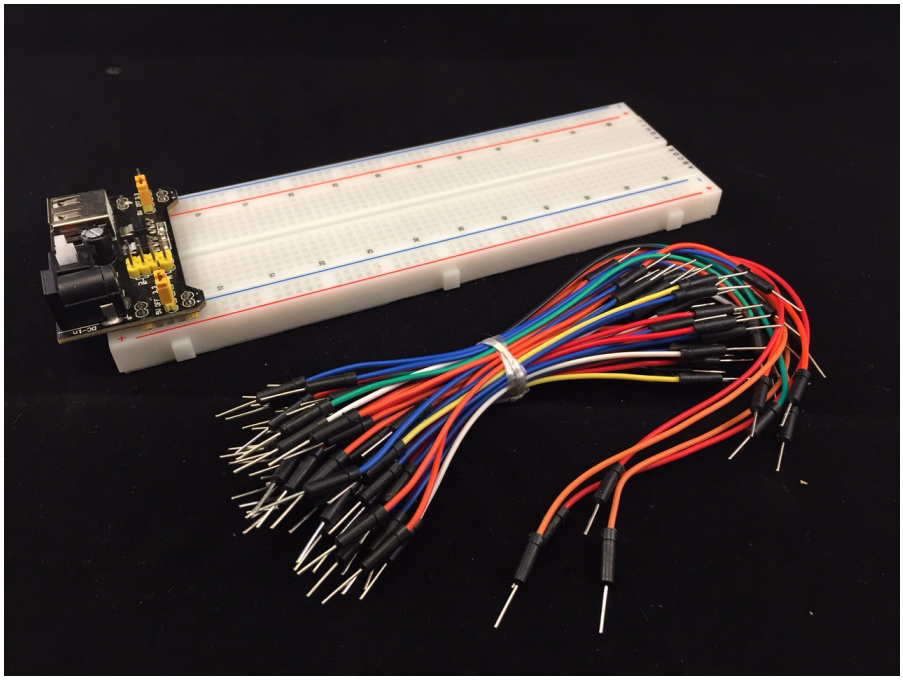
Table of contents:

Kit's Contents:

The experimenter's kit contains a quantity of electronic components and tools to offer an immediate diving into the Synth DIY world, especially related to accessory circuits for our NS1nanosynth modular synthesizer.

The breadboard and power supply:

The breadboard is a well known tool in the electronic laboratory. It allows you to mount components and connections, implementing electrical circuits, without having the need to solder and burn your fingers, breathing fumes etc... For circuits that doesn't have much to do with high frequency and controlled impedance, the breadboard is very much like the 'real thing', the printed circuit board.



Our breadboard is a standard 64-holes one, capable of hosting few integrated circuits across the middle axis. The 'secret' of the breadboard is the 'direction' of the connections: The five holes between the middle line (where you put integrated circuits, normally) and the horizontal colored lines (blue and red, for negative and positive supply voltages) are connected VERTICALLY, while the power supply lines are connected HORIZONTALLY, from end to end.

You noticed that in the kit is present an electronic board with a DC barrel jack. This board is a power supply that you can use (for example if you don't plan to use the NS1nanosynth) with an external, not supplied 9/12Vdc wall wart to power your circuits. As you can see the bottom of the board presents two sets of pins that fits in the horizontal power distribution lines of the breadboard.

Wires:

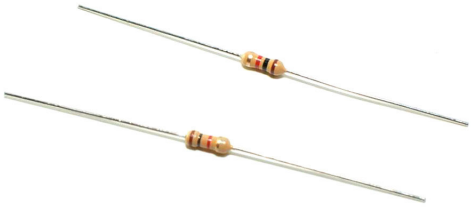
If you bought an NS1nanosynth you already know those nano patch wires very well. They are the same type and quality of the NS1 ones and you will use them either to build your circuits and connect those circuits to the NS1nanosynth!

Electronic Components:

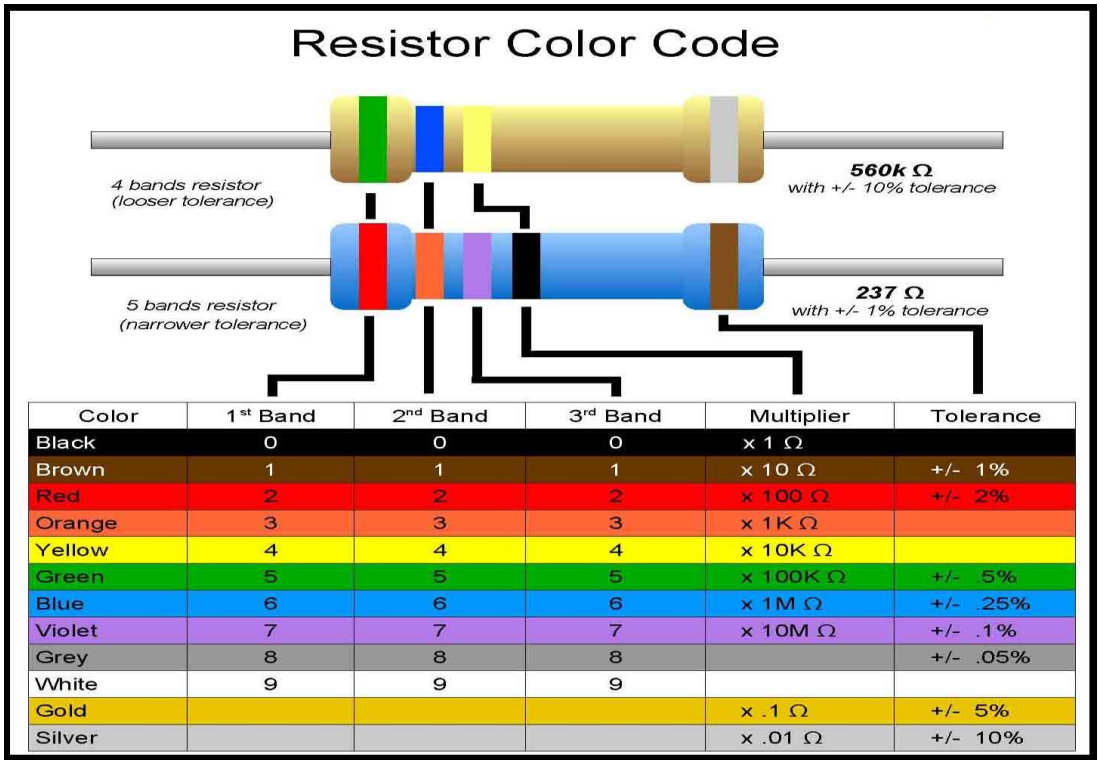
Included in the kits there are many electronic components. We choose a significative sets of IC (integrated circuits), passive, electromechanical and sensor devices that can guarantee hours of explorations and tons of fun!

Resistors

Resistors are those iconic cylinder shaped, multi-striped component that lays in line on many printed circuit boards of the past. A resistor is a component that present a 'resistance' to the flow of current through it. The higher the value, the lower the current that flows through the component. Today most components are SMT and resistors are tiny black boxes with fine prints on them (the value). We put in our kit the traditional mount 'long legged' resistor, to be able to insert them in the breadboard holes so you don't have to squirm your eyes and/or buy new glasses....

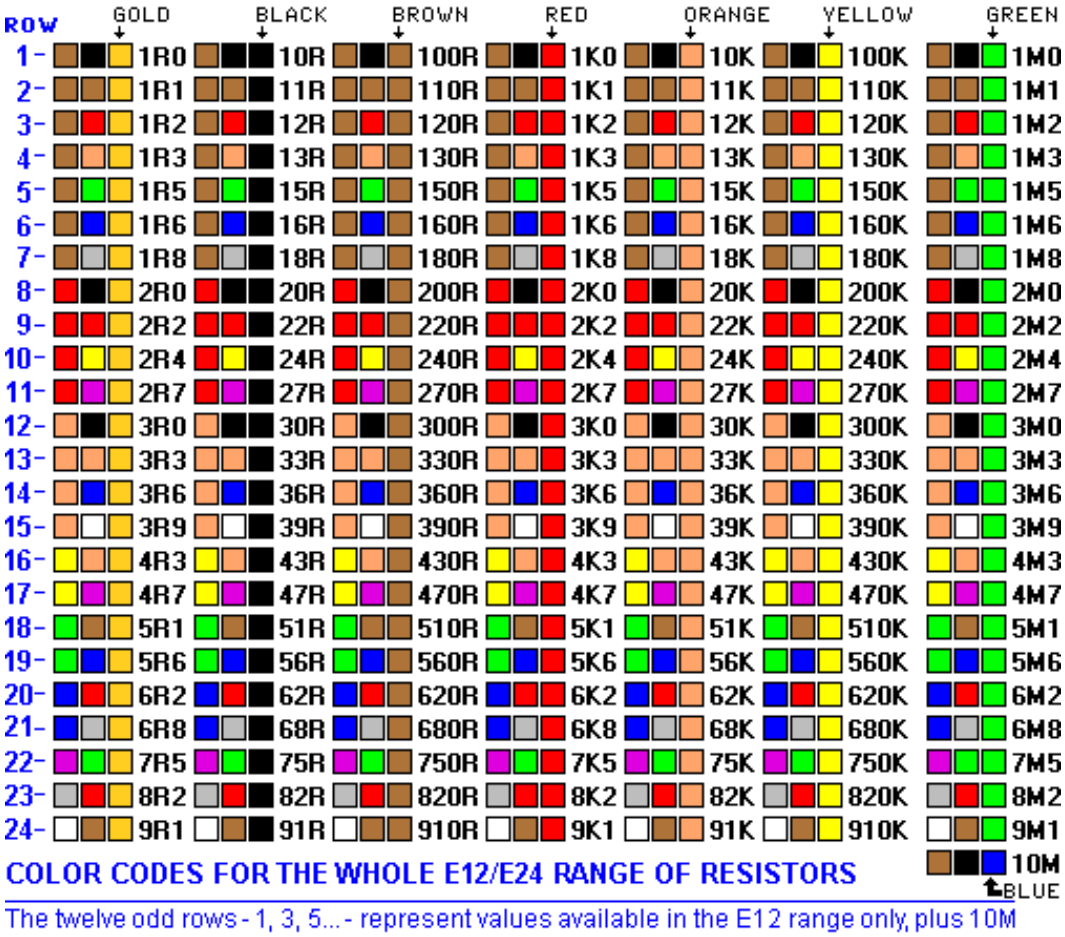


The colours on the body of the resistor tells the resistance values and it could be either four or five stripes, depending on the tolerance of the component (the tolerance, measured in percentage of the nominal value, is the 'precision' of the component). You will quickly get used to read the colours!!



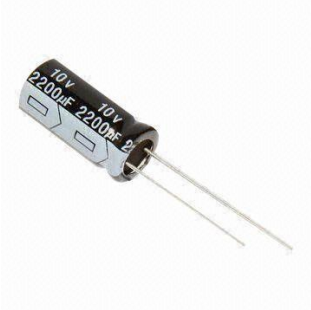
Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

And a few examples for the four bands type:



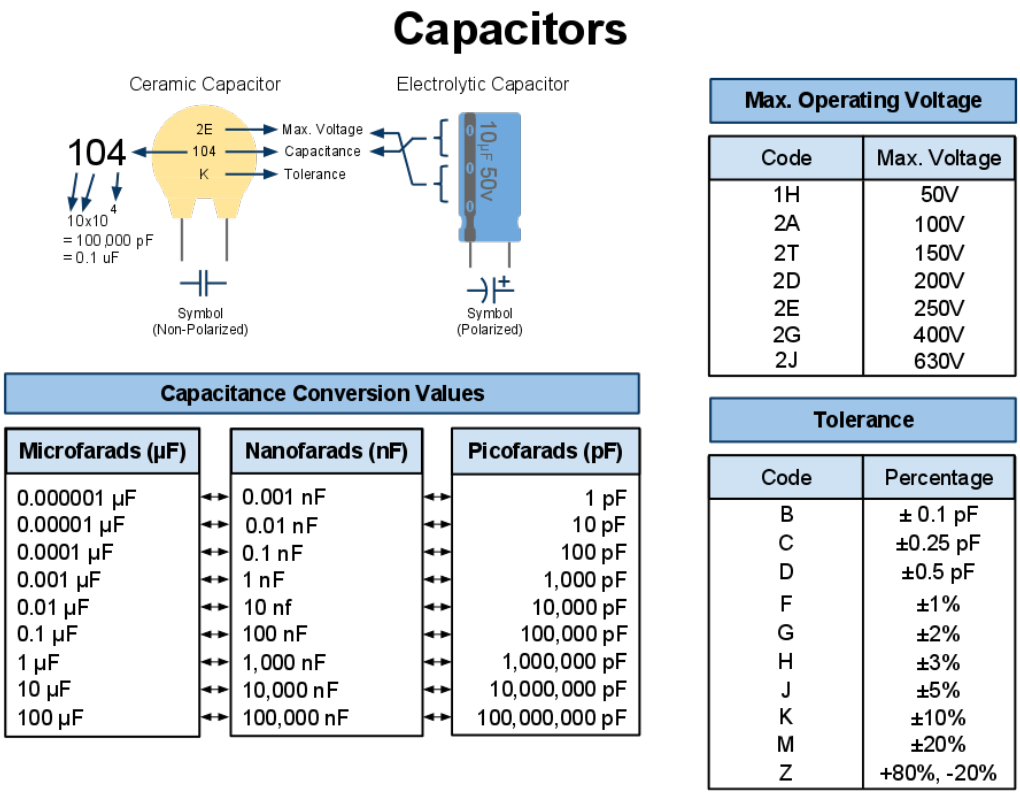
Capacitors

Capacitors are small charge reservoirs. Their purpose is to act like little tanks, accepting and giving charges (and hence, currents) at different rates. The smallest capacitors (either in dimensions and values) are ceramic ones. they are made of layers of conductive material and dielectric (ceramic based) one to create the charge capacity, measured in Farads (or better yet, nanoFarads! !!). The cylindric ones are electrolytics capacitors. They sport a much higher charge capacity values (typically from 1 microFarad to several thousands microFarads) by using a 'gel' dielectric and aluminum sheets to store charges. They have one drawback, tough, they are polarized. The white stripe on the body signals the negative (-) terminal of the capacitor.



Reading capacitor values:

Electrolytic capacitors have the capacity value stamped on the body (along with the rated voltage) so you don't have to guess or to interpretate strange codes. The smaller, ceramic, non polarized capacitors have a coded value on them. In the next picture a synthesis of coding for this component.



Capacitance Conversion Values

Microfarads (µF)	Nanofarads (nF)	Picofarads (pF)
0.000001 µF	0.001 nF	1 pF
0.00001 µF	0.01 nF	10 pF
0.0001 µF	0.1 nF	100 pF
0.001 µF	1 nF	1,000 pF
0.01 µF	10 nf	10,000 pF
0.1 µF	100 nF	100,000 pF
1 µF	1,000 nF	1,000,000 pF
10 µF	10,000 nF	10,000,000 pF
100 µF	100,000 nF	100,000,000 pF

Max. Operating Voltage

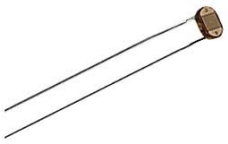
Code	Max. Voltage
1H	50V
2A	100V
2T	150V
2D	200V
2E	250V
2G	400V
2J	630V

Tolerance

Code	Percentage
B	± 0.1 pF
C	±0.25 pF
D	±0.5 pF
F	±1%
G	±2%
H	±3%
J	±5%
K	±10%
M	±20%
Z	+80%, -20%

CDS photocells:

Those components are based on Cadmium Sulfide and they present the characteristic of being sensitive to light intensity! The more the light on the CDS surface, the smaller the resistance across the terminals. This component is used to produce the famous Vactrols. Just add a led diode and some black tape :) They have no polarity!



Silicon Diodes:

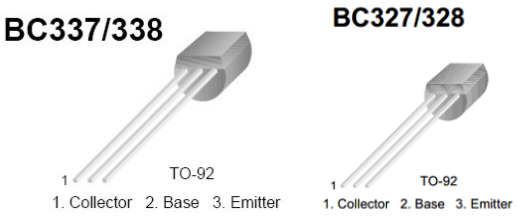
This is the simplest active component on earth. It's a simple P-N junction that let the current flow only in one direction. It has many uses and , albeit its simplicity, you will find it extremely useful. You can decode the polarity remembering that the 'ring' on the body of the component is always the CATHODE.

Led diodes:

Those are the blinky components that are scattered on the surface of any synthesizer and serves their main purpose as function indicator. Be aware that they can be used also to implement circuits like waveshaping, distortion and the aforementioned Vactrols! You can decode the polarity in three different ways. The CATHODE (-) is the terminal that become a bigger chunk of metal inside the LED, the terminal with the shorter length and, finally, the terminal on the flat side of the led encapsulation.

Transistors:

NPN and PNP, the transistor is the basis of everything electronic. Each IC is made of transitors, that is the 'atomic' component of logic and analog IC. In our bag you can find bipolar (not mosfet) transistors that can be used to amplify, rectify, switch and in general, modify signals! BC337 (NPN) and BC327 (PNP) are the part number shipped with the kit.

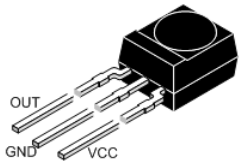


Potentiometers:

You know those knobs. Behind the knobs there is a variable resistor called a potentiometer. Our are standard 9mm linear taper 100kohm pots! Ten of them!

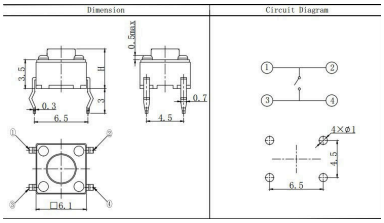
IR remote receiver:

Just for fun we add those small component that will let you hear the 'voice' of your TV remote control, or better yet, use the Arduino Leonardo to send command to the NS1! Our model is the TSOP4836. See the pinout below:



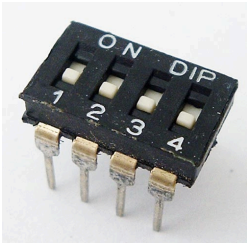
Pushbuttons

Simple momentary buttons! You can use them to trigger stuff, to mute signals and to blink some leds :) The electrical contact takes place, upon pushing the button, between the nearer pair of terminals.



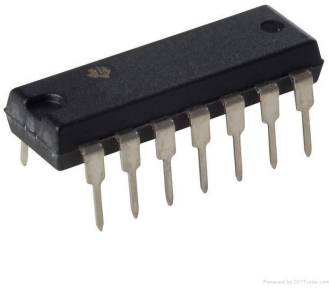
Dip Switches

Two 4-ways dip switch. Those are tiny on-off swithces in a DIL (dual in line) breadboard friendly package. We put those in the kit to implement programmable attenuators, a gate sequencer or to add the 'slide' to a stepsequencer or more than this.



Integrated Circuits:

In the experimenter's kit are included a good deal of analog and digital integrated circuits. Those are the most complex and important parts of every electronic device. In the last 40 years the technology boosted from simple analog integration to mixed signal with a density of *tens of millions of transistors* in few square millimeters... The components that we put in the kit are not cutting edge technology, they are in fact pretty traditional ICs but really easy and friendly to use to obtain suprisingly good results in the audio and sound generation area!



This is the list of the components that you can find in the experimenter's kit! If you need more informations about the details you can easily obtain the 'datasheets' through a web search.

- CD4011BE is a quad NAND gate. NAND is a type of logic gate used also to 'synthesize' other ports like AND, OR, NOTs, etc... One of the circuits in this document uses this IC to implement a simple, digital ring modulator with the four ports contained in one of those ICs.
- CD4051BE is a 8 way analog mux/demux. Is like having a digitally controlled selector. You can digitally (three bit input) choose which of the 8 inputs gets connected to the single output (or the converse, in fact the internal switches are bi-directional!). You can, along with a digital counter, use this IC to implement a rough 'wavetable' oscillator or a sequencer.. You can use this chip also as a single analog switch, for example to implement a sample and hold circuit or a controlled portamento (like the slide on the TB303 ;-)) module.
- CD40106BE contains six inverter gates. A pretty underwhelming function could actually held some great and complex results... In fact this 14 pins chip could become a fuc*ing huge sounding six oscillators drone machine. Add a filter on the mixed output and you are

ready to fill the mix, or the venue, with colliding square waves! Check out the 'drone machine' schematic! With a little ingenuity you can also obtain drum sounds!

- CD4024BE is a binary counter/divisor. It is the chip that implements the CLOCKDIV module in the NS1nanosynth (and in ALL the clock divisors modules) and it gives you a "divide by 2" up to "divide by 64" outputs! Apart from generating really low frequency from a VCO, it is also a binary counter that can be used to drive, for example, the mentioned analog MUX/DEMUX. Another intereseting use is the generation of a 'digital' saw wave by using weighted resistors (like in a DAC).
- CD4017BE is basically a stepsequencer in a chip!! With this IC, some diodes and one potentiometer per step you have built a cheap and chic analog stepsequencer with variable length (from 2 to 10 steps) sequence! In reality, tough, this is called a "decade counter".
- NE555 let us venture into analog territory. This immensely famous integrated circuit is a "precision timer" capable of working in both astable (free running) and monostable (one shot) modes. The first one can be seen as an oscillator (with both rectangular and ramp outputs) and the last one as a 'trigger to gate' processor, musically speaking. Together they form the famous Atari Punk Console audio gizmo. You can find the circuit in the selection at the end of this doc. Another use of this seemingly simple IC is a standard envelope generator (ADSR). A mid eighties application note included in an electronic magazine described the circuit that is today implemented in many analog synthesizers and eurorack modules (including our NS1nanosynth). A little trivia: the name '555' comes from the string of three resistor (5 Kohm each) that sets the internal thresholds for the circuit.
- MCP6004 is a quadruple low voltage, rail to rail operational amplifier. This components is the building block for almost every analog electronic circuits. From amplifiers to oscillators to filters, the op-amp is one of the most brilliant inventions in circuit abstraction and generalization. This will be the central IC for all your AUDIO and CV manipulation, but is also capable of implementing mathematical functions (like sum, sub, logarithms...) and merge them together!

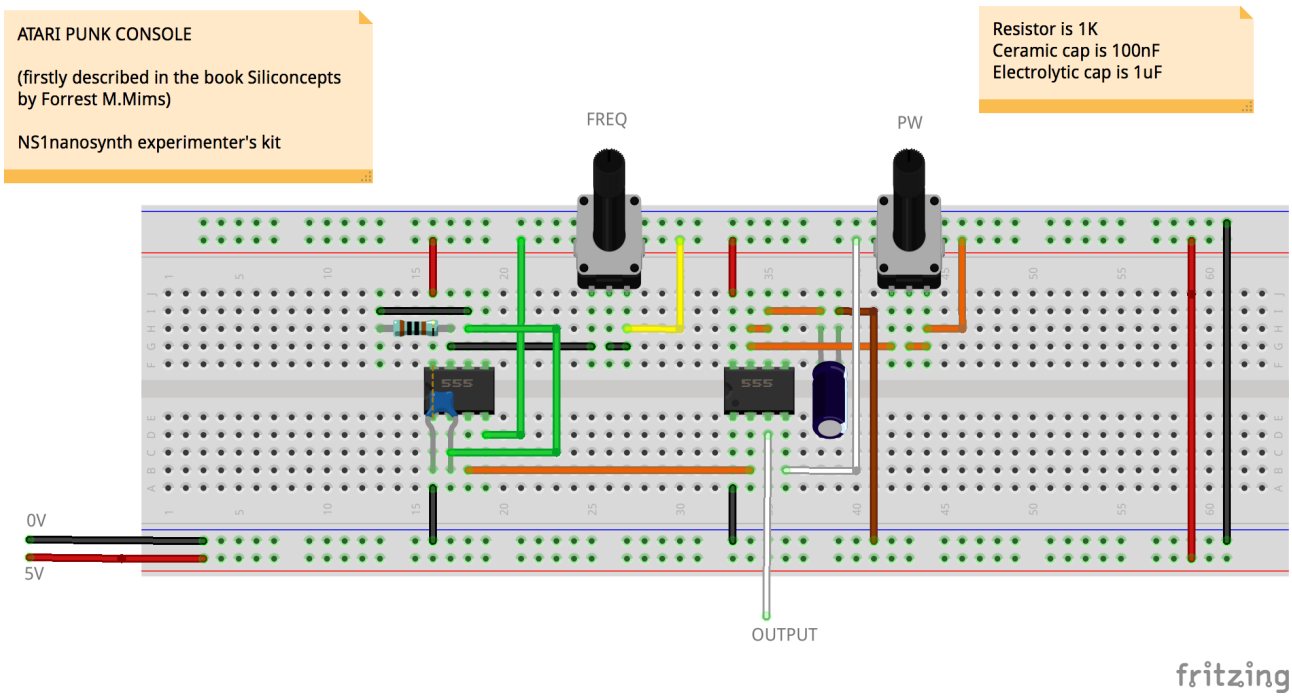
Circuits:

NOTE: please, as mentioned before, download for free the Fritzing sofware (http://fritzing.org/home/). By downloading it and our own Fritzing sketch you will be able to work much better by inspecting component values, zooming in and out and, last but not least, potentially create your own versions of the circuits and adding new functions!!!!!!!

All the circuits below are downloadable from the official repository on our GitHub account: http://github.com/SOUNDMACHINES/Experimenter-s-kit-Circuits

Atari Punk Console

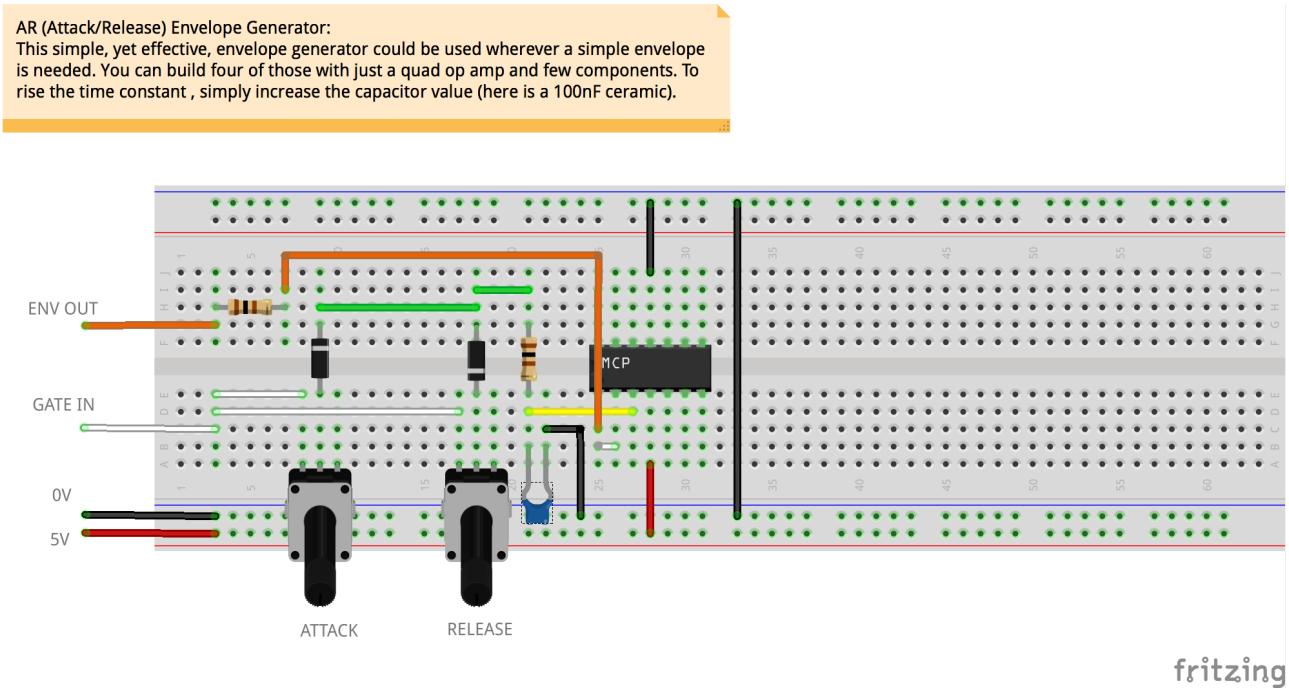
The Atari Punk Console (commonly shortened to APC) is a popular circuit that utilizes two 555 timer ICs or a single 556 dual timer IC. The original circuit, called a "Sound Synthesizer", was published in a Radio Shack booklet: "Engineer's Notebook: Integrated Circuit Applications" in 1980 and later called "Stepped Tone Generator" in "Engineer's Mini-Notebook - 555 Circuits" by its designer, Forrest M. Mims III (Siliconcepts, 1984). It was named "Atari Punk Console" (APC) by Kaustic Machines crew because its "low-fi" sounds resemble classic Atari console games from the 1980s, with a square wave output similar to the Atari 2600. Kaustic Machines added a -4db line level output to the circuit which was originally designed to drive a small 8 ohm speaker.
Our rendition is a pretty faithful recreation of this last version. The output is straight 0-5V so you can connect directly (for example..) to the VCF input of the NS1nanosynt:



AR (attack/release) envelope generator

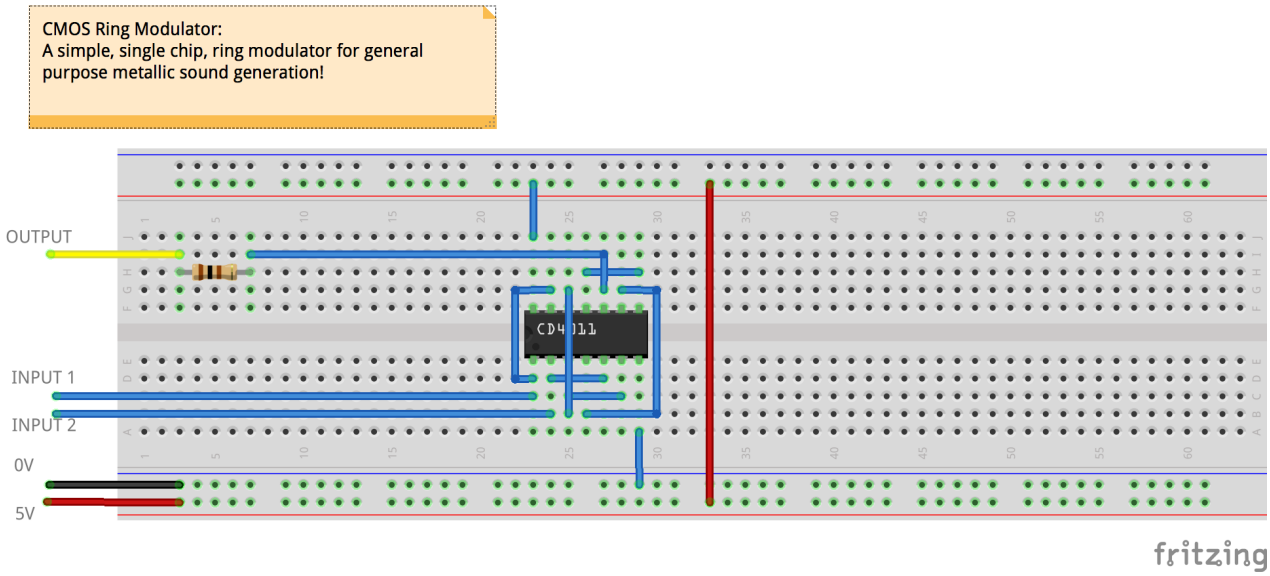
This is a very simple and useful envelope generator that uses one opamp and few components. It basically charge and discharge a capacitor through different resistor values (the pots) because of

the presence of the diodes. The diodes conducts only in one 'direction' so you can regulate the attack and release phase. The sustain level is exactly the level of the 'gate' signal!



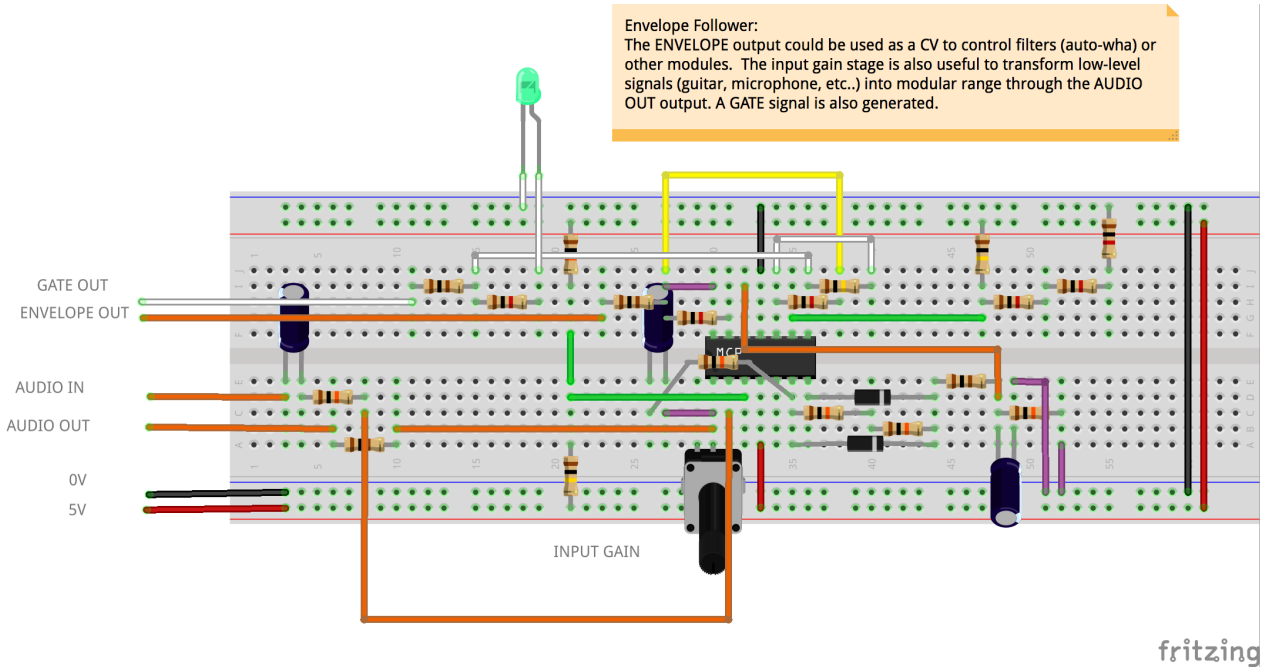
CMOS ring modulator

This circuits, even though completely digital and quite simple in its form, helds really interesting sonic results with rectangular waves at his inputs. The ring modulator stems from radio technology and was invented to implement the 'heterodyne' processing of frequency mixing. The output signal of an audio range ring modulator is normally associated with 'metallic' or 'bell-like' tones and, indeed, is extremely useful in a synthesizer environment. We will implement the ringmod (nickname!) with the NAND gates IC! You can use the circuit applying two different frequency rectangular/square waves to its inputs... :



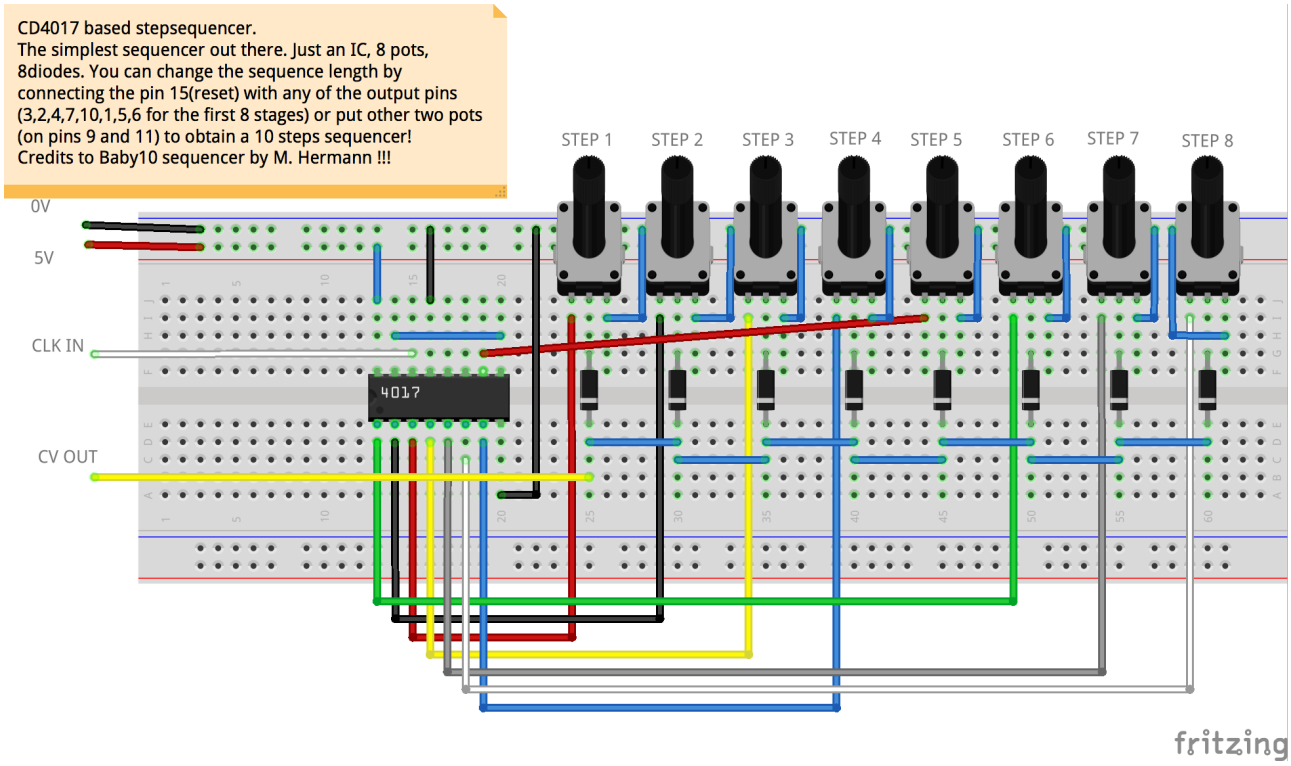
Envelope follower

This circuit is one of the most complex that we will include in this manual and a really useful one to implement. The envelopw follower, as the name implies, 'extract' the amplitude envelope from an input signal making it possible to use an external audio signal (mp3 player, dynamic mic, another synth...) as a modulation source in your system. You certainly know or have heard the 'auto-wha' effect. This kind of effect is, in its simplest form, an envelope follower that modulates the cutoff frequency of a resonant low pass filter! The circuit includes three different parts: an amplifier, to rise the input signal to useful levels, a rectifier/time constant and finally a comparator to generate a gate signal!



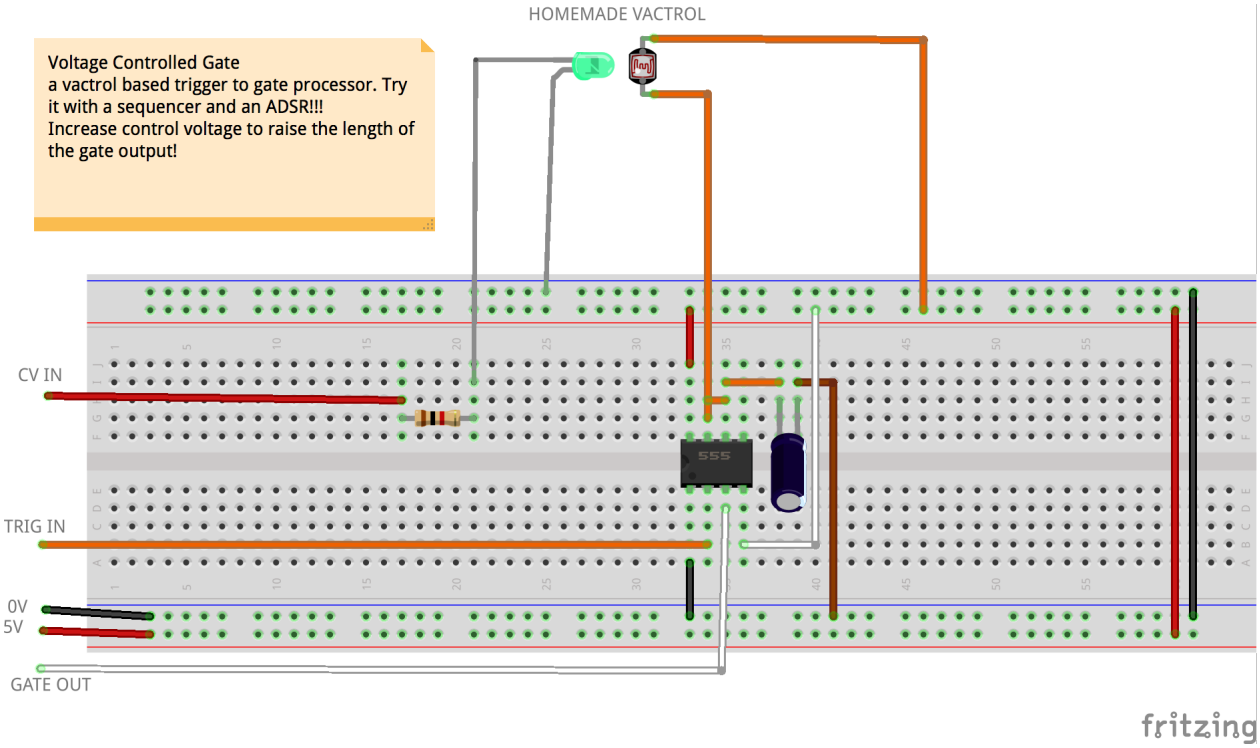
Stepsequencer

The following circuit is a great, simple but fun, step sequencer. You can program the eight steps voltage values and then output sequentially following the speed of an input clock. The IC itself could be used for 2 to 10 steps (it's a 'decade counter') and you can easily change the number of steps connecting the 'last step' you need the the reset input. An example application of this is to generate a tonal sequence on the NS1nanosynth. Connect the clock input to the square output of one of the LFOs (this will generate the 'tempo' of the sequence) and the CV output to the V/oct input of the VCO! Another use is to modify the VCF cutoff frequency to implement very interesting rhythmic 'movements' to a droning or fixed pitch sound.



Voltage controlled gate

This is, albeit simple, a more sophisticated circuit and we choose to implement this function to show the 'vactrol-like' behaviour that you can achieve with a LED and a CDS photocell. First of all, the construction of the 'vactrol' implies that you 'couple' the lens of the led and the cover of the photocell and protect it from outside light with a round of black tape (the 'electrician' type is very good at this). The voltage controlled gate modifies the lenght of the output gate signal as the control voltage at its input varies. It could be used to 'modify' a fixed gate lenght coming from a midi sequencer (for example) to introduce sound modifications that render the sound more interesting and curious...


HOMEMADE VACTROL
Voltage Controlled Gate
a vactrol based trigger to gate processor. Try it with a sequencer and an ADSR!!!
Increase control voltage to raise the length of the gate output!
CV IN
TRIG IN
0V
5V
GATE OUT
555
fritzing

Contacts, links and references

- soundmachines website:

  http://www.sound-machines.it

- soundmachines facebook page:

  http://www.facebook.com/Soundmachines-175438249266376/

- soundmachines github repository

  http://github.com/SOUNDMACHINES

- Fritzing website

  http://fritzing.org/home/

- Synth DIY websites:

  http://electro-music.com/forum/forum-112.html

- MuffWiggler forum:

  http://www.muffwiggler.com/forum/index.php