Noise-X

Noise-X has the following features:

- 4 DCOs (digitally-controlled oscillators) + mixer
- pitch and amplitude LFOs
- waveforms - sine, square, triangle, rising sawtooth, falling sawtooth, pulse, noise
- frequency modulation and ring modulation
- delay line with feedback
- flanger
- user patch (non-volatile)
- MIDI and command line interfaces

The fundamental sound generators in *Noise-X* are digitally-controlled oscillators (DCOs). Four are available and their pitch (frequency), amplitude (volume) and waveform can be individually controlled. The frequency range of the oscillators is from ~30Hz to ~8kHz (8 octaves). The four oscillators are mixed together to produce the audio output.

The available waveforms are the standard set available in many analogue synthesisers - namely sine, square, triangle, rising sawtooth, falling sawtooth, pulse, and white noise. The pulse width of the pulse waveform is continuously variable.

The pitch and amplitude of each DCO can be modulated (varied) by a pair of low-frequency oscillators (LFOs). Pitch modulation is known as vibrato and amplitude modulation is known as tremolo. The same set of DCO waveforms is available for the LFOs and the frequency and amplitude of each LFO can be independently varied.

The pushbuttons (S1 to S6) are used to select one of 12 modes. Pressing and releasing S1 selects mode #0, pressing and holding S1 selects mode #1, pressing and releasing S2 selects mode #2, pressing and holding S2 selects mode #3, and so on. Refer to the table below to see the effect of the sliders and presets in each mode. The pattern of running lights changes with the mode. Note that a pushbutton needs to be held down continuously to access its odd-numbered mode.

The presets and sliders remember their previous positions when the mode is changed and subsequent movements are relative to the previous position. To obtain the full range of values from a preset or slider it may be necessary to move it first to the two extremities of its travel.

A ring modulator is available which produces bell-like sounds rich in inharmonic partials. Pairs of oscillators can be ring modulated (their waveforms are multiplied together).

Pairs of oscillators can also be frequency modulated (the first oscillator in each pair modulates the second). This is similar in function to the pitch LFOs but the frequency of modulation is not limited to a low rate.

A flanger is available which acts as a dynamic filter removing a set of regularly-spaced frequencies from the sound spectrum (i.e. a comb filter). The position of the filter notches is under the control of a separate LFO, and the range, waveform and speed of frequency sweep are all controllable. (The flanger is implemented as a variable-length delay line and its parameters affect the instantaneous length of the delay line.)

A longer delay line is also available for reverb effects. Feedback can be applied to the delay line to produce complex non-linear effects. Reverb, particularly with feedback, is very effective at generating sci-fi type sound effects.

Additive synthesis means that the frequencies of DCOs #1, #2 and #3 are locked to respectively 2, 3 and 4 times the frequency of DCO #0 (the fundamental).

Fuzz can be used to distort the output of the mixer by clipping the waveform to a limit.

The current settings can be stored in non-volatile memory and restored later.

A number of demo sounds are pre-programmed, divided into three banks of four each.

A master volume control is provided. *Noise-X* can output an audio signal on its jack socket which has a maximum peak-to-peak of about 2 volts. This is more than capable of producing a loud sound in a pair of 32-ohm impedance headphones.

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Construction

First fit and solder the resistors (R1 to R11) to the circuit board and trim their legs. Identify the resistors by the coloured stripes on the body.

Next fit the chip sockets (IC1 and IC2) matching the notch in the socket against the notch in the symbol on the board. Care should be taken when soldering these components to avoid solder bridges between the pins. It is not recommended that the chips are soldered directly to the board.

Solder the diode (D1) matching the stripe on the body to the 'k' sign on the board.

Solder the ferrite (FERRITE) either way around.

Fit and solder the capacitors, paying attention to the polarity of the electrolytics (C1, C2, C3 and C6) (negative is marked by a stripe on the side of the body). The tantalum capacitor (C8) should be fitted such that the shorter leg is by the minus sign. The ceramic capacitors (C4, C7 and C9) and the polyester capacitor (C5) can be fitted either way around.

Bend the legs of the regulator (REG) at right angles and solder it such that the metal heatsink is flat on the board and the side with the writing is facing upwards. Solder the LEDs (LED1 to LED4) matching the shorter leg (also flat on the rim) to the hole with the line.

Solder the pushbuttons (S1 to S6).

Solder the presets (VR1 to VR4) and sliders (VR5 and VR6). Push the spindles into the presets and the knobs onto the sliders.

Solder the transistor (TR1) matching the shape to the symbol on the board.

Solder the jack socket (AUDIO), first cutting off the five small plastic lugs on the underside so it fits flush on the board.

Solder the power socket (POWER). Optionally also fit the PP3 battery snap (BATTERY). Support holes are drilled on the board for the battery snap leads. Feed the leads up through the support holes from the track side of the board and then down the solder holes. Red is positive and black is negative.

Don't fit the chips into their sockets until you have thoroughly checked your construction. Check that all the components have been inserted correctly and that there are no dry joints and no solder bridges between pins. Then match the small notch in each chip to the notch in its socket.

Attach rubber feet to the underside of the board (under the regulator, to the right of R11, the outer ends of VR5 and VR6, under the copyright notice).

Either connect a mains power supply (6-9V regulated dc, 300mA, centre +) to the power socket, or 4 AA cells to the battery snap. Note that if using a mains power supply then a transformer-based supply is preferable, from a noise point of view, to a switched-mode power supply.

The software includes a power-on self-test. The LEDs should flash twice if the board is functioning correctly.

Connect headphones or powered speakers (with a 3.5mm jack plug) to the audio output socket.

Move the two sliders up and down and you should hear a tone. Press S1 and S3 together to select the first demo patch.

MIDI interface

An expansion interface for a MIDI connection is available using the solder pads marked ‘RX’ and ‘GND’. Note that this is a ‘raw’ MIDI interface in that there is no optoisolator and no DIN socket. It is simply a direct connection to the microcontroller’s UART input pin (3.3V or 5V voltage level). It accepts a MIDI data stream in the correct format at 31250 baud.

Noise-X responds to MIDI messages on all MIDI channels. Program change messages select patches and control change messages change slider and preset settings (controller number = 0 to 71, controller value = 0 to 127).

The pitch bend wheel is also mapped to the left slider (VR5).

Command line interface

A command line interface (CLI) is also available to connect *Noise-X* to a terminal program on a host computer. The three solder pads marked ‘RX’, ‘TX’ and ‘GND’ are used for duplex communications. Typically, a USB-to-serial cable would be used with 3.3V signal levels. The format is 9600 baud, no parity, 1 stop bit, no handshaking, no echo.

Press S3 and S4 together to select the command line interface.

The CLI responds to command lines terminated by a carriage return with arguments entered in ASCII decimal.

`H[elp]` – displays command summary

`V[olume] <vol>` – sets master volume, <vol> = 0 (quiet) to 16 (loud) (default = 7)

`P[rogram] <prog>` – sets program, <prog> = 0 (user) or 1 to 14 (demo)

`C[ontrol] <cntrl> <val>` – sets control, <cntrl> = 0 to 71, <val> = 0 to 4095

`D[isplay]` – displays all controls

Pushbutton(s) pressed and released		**Pushbutton held down**	
S1	select mode 0	S1	select mode 1
S2	select mode 2	S2	select mode 3
S3	select mode 4	S3	select mode 5
S4	select mode 6	S4	select mode 7
S5	select mode 8	S5	select mode 9
S6	select mode 10	S6	select mode 11
S1 + S6	restart		
S3 + S4	toggle between MIDI (default) and CLI		
S1 + S2	save settings to memory		
S5 + S6	restore settings from memory		
S1 + S3	cycle demo bank #1		
S4 + S6	cycle demo bank #2		
S2 + S5	cycle demo bank #3		

Mode	VR1	VR2	VR3	VR4	VR5 (left slider)	VR6 (right slider)
#0	DCO #0 waveform	DCO #0 pitch LFO waveform	DCO #0 pitch LFO frequency	DCO #0 pitch LFO amplitude	DCO #0 pitch	DCO #0 amplitude
#1	DCO #0 amplitude LFO pulse width (pulse waveform)	DCO #0 amplitude LFO waveform	DCO #0 amplitude LFO frequency	DCO #0 amplitude LFO amplitude	DCO #0 pulse width (pulse waveform)	DCO #0 pitch LFO pulse width (pulse waveform)
#2	DCO #1 waveform	DCO #1 pitch LFO waveform	DCO #1 pitch LFO frequency	DCO #1 pitch LFO amplitude	DCO #1 pitch	DCO #1 amplitude
#3	DCO #1 amplitude LFO pulse width (pulse waveform)	DCO #1 amplitude LFO waveform	DCO #1 amplitude LFO frequency	DCO #1 amplitude LFO amplitude	DCO #1 pulse width (pulse waveform)	DCO #1 pitch LFO pulse width (pulse waveform)
#4	DCO #2 waveform	DCO #2 pitch LFO waveform	DCO #2 pitch LFO frequency	DCO #2 pitch LFO amplitude	DCO #2 pitch	DCO #2 amplitude
#5	DCO #2 amplitude LFO pulse width (pulse waveform)	DCO #2 amplitude LFO waveform	DCO #2 amplitude LFO frequency	DCO #2 amplitude LFO amplitude	DCO #2 pulse width (pulse waveform)	DCO #2 pitch LFO pulse width (pulse waveform)
#6	DCO #3 waveform	DCO #3 pitch LFO waveform	DCO #3 pitch LFO frequency	DCO #3 pitch LFO amplitude	DCO #3 pitch	DCO #3 amplitude
#7	DCO #3 amplitude LFO pulse width (pulse waveform)	DCO #3 amplitude LFO waveform	DCO #3 amplitude LFO frequency	DCO #3 amplitude LFO amplitude	DCO #3 pulse width (pulse waveform)	DCO #3 pitch LFO pulse width (pulse waveform)
#8	off/ring modulation/ frequency modulation on DCOs #0 and #1	reverb feedback	off/ring modulation/ frequency modulation on DCOs #2 and #3		reverb period	reverb level
#9	reverb period LFO pulse width (pulse waveform)	reverb period LFO waveform	reverb period LFO frequency	reverb period LFO amplitude		
#10	master volume	fuzz (hard clipping)	additive synthesis		flanger frequency	flanger amplitude
#11				flanger pulse width (pulse waveform)	flanger waveform	flanger base

Component list

Resistors

R1, R2, R3, R4, R9	100R (brown, black, brown, gold)
R5, R6, R10, R11	10k (brown, black, orange, gold)
R7	470R (yellow, purple, brown, gold)
R8	220R (red, red, brown, gold)
VR1, VR2, VR3, VR4	47k linear preset + spindle
VR5, VR6	10k or 100k linear slider + knob

Capacitors

C1	100uF electrolytic (blue or black)
C2	10uF electrolytic (blue or black)
C3, C6	220uF electrolytic (blue or black)
C4, C7, C9	100nF ceramic (brown, marked ‘104’)
C5	100nF polyester (yellow or blue, square)
C8	10uF tantalum (yellow/brown, beaded)

Semiconductors

TR1	ZTX689B transistor (black)
D1	1N4001 diode
REG	LD1117V33 LDO 3.3V 0.8A regulator (black/silver)
LED1, LED2, LED3, LED4	5mm blue
IC1	MCP4921 12-bit DAC + 8-pin socket
IC2	dsPIC33EP128MC202 microcontroller + 28-pin socket

Miscellaneous

FERRITE	ferrite
S1 - S6	miniature tactile pushbutton
AUDIO	3.5mm jack socket
BATTERY	PP3 moulded battery snap + 4 x AA battery box
POWER	2.1mm dc power socket

PCB
Self-adhesive rubber feet x 5