BLEEP-O-TRON

Bleep-o-tron has the following features:

- monophonic
- 2 x oscillators (timbres)
- 8 x phase-modulation waveforms + combinations (36 in total)
- white noise
- 6 x ADSR (attack-decay-sustain-release) envelopes
- 6 x LFO's (low-frequency oscillators)
- 6 x LFO waveforms (sine, square, triangle, rising sawtooth, falling sawtooth, noise)
- detuned second oscillator by octaves, semitones or cents
- connects to standard MIDI keyboard (velocity sensitive)
- keyboard transpose (up to +/– 2 octaves)
- keyboard split
- play notes using PS/2 PC keyboard
- pitch bend and modulation using PS/2 PC mouse
- ring modulator
- oscillator synch
- flanger (swept comb filter)
- portamento (constant rate and constant time)
- selectable MIDI channel #1 to #16
- 16 x preset patches
- 8 x user patches (non-volatile)
- master volume control + gain x 2

Construction

Construction is relatively straightforward. First fit and solder the resistors R1 to R19 and trim their legs. Identify the resistors by the coloured stripes on the body.

Next fit the chip sockets IC1, IC2 and IC3 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 pcb.

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

Then fit the diode D1 and transistor TR1. The cathode end of the diode is marked by a stripe on the body of the component and on the pcb by a line on the symbol and a small 'k'. The symbol on the pcb indicates the orientation of the transistor (flat side of the component against the flat side of the symbol).

Solder the regulator REG to the board matching its metal heatsink side to the solid part of the symbol on the pcb. Solder LED1 matching the shorter leg (also flat on the rim) to the hole with the line.

Solder the PS/2 sockets MOUSE and KEYBOARD, and MIDI socket. 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 pcb 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 three 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 or circular recess in each chip to the notch in its socket. Make sure you get the correct 8-pin chip in the correct socket, and be careful when inserting IC3 as its legs are liable to break.

Either connect a mains power supply (9-12V dc, 300mA, centre +) to the power socket, or a 9V PP3 battery to the battery snap. If a battery is used it should be a good quality alkaline type (such as a Duracell) or rechargeable NiMH or NiCd type.

The software includes a power-on self-test. The LED 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, and a PS/2 PC keyboard to the KEYBOARD socket. Optionally connect a PS/2 PC mouse to the MOUSE socket, and a MIDI keyboard to the MIDI socket using a standard 5-pin DIN MIDI cable.

Press a key on your MIDI keyboard or PC keyboard and you should hear a note. Try pressing the function keys F1 to F12 to select the various preset sounds available.

How to Use

The fundamental sound generators of *Bleep-o-tron* are a pair of oscillators or 'timbres'. Different waveforms are available for each of these oscillators and they can be combined to produce more complex sounds. In addition each oscillator can output white noise.

The amplitude (volume) and pitch (frequency) of each timbre oscillator is under the dynamic control of both an envelope and a low-frequency oscillator. The modulation (the degree to which the oscillator outputs a simple sine wave or a more complex waveform) is also controllable by the same means. (Modulation is equivalent to low-pass filtering in a traditional analogue synthesiser.)

The second oscillator can be detuned or offset relative to the first. This can be used to further 'thicken' a sound. Detuning can be done by fractions of a semitone (known as 'cents'), and can cause tremolo-type effects as the two oscillators move into and out of phase with each other. Offsetting by a whole number of semitones is equivalent to a two-note chord. Some intervals are very discordant. Whole octave intervals can add body to a sound.

The gain or amplitude of each timbre can be independently adjusted. This is useful for making one component of a sound dominant relative to the other. The default timbre gain is ¾ of the maximum.

Classic four-stage attack-decay-sustain-release envelopes are available for both oscillators to control their amplitude, pitch and modulation. The level and period of the four stages can be individually adjusted for all six envelopes. Editing an envelope involves first selecting the envelope (**1**, **2**, **3**, **4**, **5**, **6**) then selecting a component (**shift B**, **A**, **D**, **S**, **R**).

If the release period is set to the maximum (the default) then a note is sustained for as long as a key is held down.

An entire envelope, or a single stage, can be copied from one envelope to another.

Low-frequency oscillators, or LFO's, allow effects such as tremolo and vibrato. The amplitude, frequency and waveform of each LFO can be independently controlled. Six LFO waveforms are available - sine, square, triangle, rising sawtooth, falling sawtooth and noise.

There is an option to delay an LFO until the sustain period of its associated envelope.

One LFO can be copied to another.

Note that selecting an LFO enables it.

The operation of *Bleep-o-tron* is divided into a number of modes - a mode to edit the envelopes, a mode to edit the LFO's, and so on. The mode is selected by pressing the **shift** key and the **C**, **T**, **E**, **L** or **X** keys. Within each mode a number of different commands and options are available and these are detailed below.

Notes can be played on the PC keyboard (although a proper MIDI keyboard is preferable) over a range of three octaves. This three-octave window can however by moved up and down (by up to two octaves in either direction) over the octave range that *Bleep-o-tron* supports.

When an option is enabled the LED's on the PC keyboard flash slowly, and when an option is disabled they flash quickly.

Portamento is available which causes a glide between pitches when two notes are pressed in succession (as opposed to the normal discrete jump from one pitch to the other). There are two types of portamento - constant rate which means that small spans on the keyboard are covered more quickly than longer spans, and constant time which means that glides take the same amount of time irrespective of the span length.

'Retrigger' causes all envelopes and LFO's to be restarted when a second note is pressed before a first has finished playing. It can result in glitches when notes are pressed in quick succession so is not normally used, but might be useful in certain circumstances.

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.) The sound of the flanger is hard to describe but there are several built-in patches that demonstrate its use.

A ring modulator is available which produces bell-like sounds rich in inharmonic partials.

The output of the flanger and ring modulator can optionally be mixed with the original waveform (at 50% of each).

'Oscillator synch' is a technique for locking the two timbre waveforms, causing timbre #2 to be restarted when timbre #1 cycles.

A collection of settings (waveforms, LFO's, envelopes etc.) making a particular sound is known as a program or 'patch' (from the days when synthesisers were controlled by patch leads and plug boards). There are a number of patches built in to *Bleep-o-tron* which can be selected using the function keys on the PC keyboard (and also program buttons on a MIDI keyboard). Some of these patches can be overwritten with patches of your own. These user patches are retained when power is removed from the board. The set of patches however can be restored to the default factory settings (which means that any user patches that you have created will be lost).

Bleep-o-tron connects to standard MIDI equipment such as a keyboard or sequencer. (Note that there is no MIDI THRU socket.) Patches can be selected using the program change buttons on the keyboard, and keyboard pitch and modulation wheels are supported. A specific MIDI channel can be selected causing *Bleep-o-tron* to ignore MIDI notes and commands sent on other channels, or it can be set to disregard MIDI channel information altogether and respond to notes and commands on all channels. The default behaviour is to respond to MIDI channel #1 only.

MIDI velocity (volume) data is supported, or it can be ignored causing all notes to sound at maximum volume. Velocity sensitivity is enabled by default. The MIDI keyboard can also be split into two halves (at the note middle C or C4) causing timbre #1 to sound when notes below C4 are pressed and timbre #2 to sound when notes above C4 are pressed. This is a simple form of polyphony allowing a bass line to be played with the left hand and a melody to be played with the right.

A PS/2 mouse can also be connected to *Bleep-o-tron* and used to emulate a pitch bend wheel and a modulation wheel. Pressing the left button on the mouse and moving it horizontally left and right bends the pitch of a note, and pressing the right button and moving the mouse vertically up and down controls the modulation of a note (conceptually equal to opening and closing the filter). When the mouse buttons are released the pitch bend or modulation effect is released.

Bleep-o-tron can output an audio signal on its jack socket which has a peak-to-peak maximum of about 3 volts. This is more than capable of producing a loud sound in a pair of 32-ohm impedance headphones. There are two methods for changing the output sound level (ignoring things like the volume of a particular timbre or how hard a key on a velocity-sensitive keyboard is pressed). There is a master volume control using the **ctrl** key and the **UP** & **DOWN ARROW** keys, and there is also a x2 output boost toggled using **shift G** (disabled by default). Don't set the volume too high when using headphones.

All modes

shift C	select configuration mode
shift T	select timbre mode
shift E	select envelope mode
shift L	select LFO mode
shift X	select FX mode
ctrl DOWN ARROW	decrement master volume
ctrl UP ARROW	increment master volume
ctrl HOME	reset current patch (default all settings)
F1 to **F12**	load preset patch #1 to #12
shift F1 to **F8**	load user patch #1 to #8
shift F9 to **F12**	load preset patch #13 to #16
ctrl shift F1 to **F8**	save user patch #1 to #8

Configuration mode

shift V	toggle MIDI keyboard velocity sensitivity
shift S	toggle keyboard split (split at C4)
shift K	toggle alternate PC keyboard notes `(note 1)`
shift O	toggle octave transpose (cycle through <+1> <+2> <–2> <–1> <off>)
shift P	toggle portamento (cycle through <constant rate> <constant time> <off>)
shift R	toggle retrigger
shift G	toggle gain x 2 (double output voltage)
1 to **8**	select MIDI channel #1 to #8
shift 1 to **8**	select MIDI channel #9 to #16
shift A	select all MIDI channels (i.e. ignore MIDI channel information)
ctrl shift F	restore factory settings (overwrite all user patches)

Timbre mode

1	select timbre #1 for editing
2	select timbre #2 for editing
LEFT ARROW	fine decrement timbre #2 offset (–1 semitone)
shift LEFT ARROW	coarse decrement timbre #2 offset (–12 semitones = –1 octave)
RIGHT ARROW	fine increment timbre #2 offset (+1 semitone)
shift RIGHT ARROW	coarse increment timbre #2 offset (+12 semitones = +1 octave)
ctrl LEFT ARROW	decrement timbre #2 detune (approx. –1 cent = –1/100 semitone)
ctrl RIGHT ARROW	increment timbre #2 detune (approx. +1 cent = +1/100 semitone)
PAGE UP	next timbre waveform (cycle through 36 waveforms + noise)
PAGE DOWN	previous timbre waveform (cycle through 36 waveforms + noise)
DOWN ARROW	fine decrement current timbre gain
shift DOWN ARROW	coarse decrement current timbre gain
UP ARROW	fine increment current timbre gain
shift UP ARROW	coarse increment current timbre gain
shift M	toggle timbre mute
ESC	undo changes to current timbre
HOME	re-initialise current timbre (default waveform and gain, no offset/detuning)
ctrl 1 to **2**	copy timbre to current timbre

Envelope mode

1	select timbre #1 amplitude envelope for editing
2	select timbre #1 pitch envelope for editing
3	select timbre #1 modulation envelope for editing
4	select timbre #2 amplitude envelope for editing
5	select timbre #2 pitch envelope for editing
6	select timbre #2 modulation envelope for editing

shift B	select Base component for editing
shift A	select Attack component for editing
shift D	select Decay component for editing
shift S	select Sustain component for editing
shift R	select Release component for editing
LEFT ARROW	fine decrement current envelope/component period
shift LEFT ARROW	coarse decrement current envelope/component period
RIGHT ARROW	fine increment current envelope/component period
shift RIGHT ARROW	coarse increment current envelope/component period
DOWN ARROW	fine decrement current envelope/component level
shift DOWN ARROW	coarse decrement current envelope/component level
UP ARROW	fine increment current envelope/component level
shift UP ARROW	coarse increment current envelope/component level
END	copy decay level to sustain level for current envelope
DELETE	zero current envelope/component period
ESC	undo changes to current envelope
HOME	re-initialise current envelope (default periods and levels)
ctrl 1 to **6**	copy envelope to current envelope
ctrl B	copy Base level to current component level
ctrl A	copy Attack level to current component level
ctrl D	copy Decay level to current component level
ctrl S	copy Sustain level to current component level

LFO mode

1	select timbre #1 amplitude LFO for editing
2	select timbre #1 pitch LFO for editing
3	select timbre #1 modulation LFO for editing
4	select timbre #2 amplitude LFO for editing
5	select timbre #2 pitch LFO for editing
6	select timbre #2 modulation LFO for editing
PAGE UP	next LFO waveform `(note 2)`
PAGE DOWN	previous LFO waveform `(note 2)`
LEFT ARROW	fine decrement current LFO frequency
shift LEFT ARROW	coarse decrement current LFO frequency
RIGHT ARROW	fine increment current LFO frequency
shift RIGHT ARROW	coarse increment current LFO frequency
DOWN ARROW	fine decrement current LFO amplitude
shift DOWN ARROW	coarse decrement current LFO amplitude
UP ARROW	fine increment current LFO amplitude
shift UP ARROW	coarse increment current LFO amplitude
shift D	toggle LFO delay (LFO doesn't start until sustain of associated envelope)
DELETE	disable current LFO
ESC	undo changes to current LFO
HOME	re-initialise current LFO (default waveform, frequency and amplitude)
ctrl 1 to **6**	copy LFO to current LFO

FX mode

shift R	toggle ring modulation
shift S	toggle oscillator synch
shift F	toggle flanger
PAGE UP	next flanger waveform `(note 2)`
PAGE DOWN	previous flanger waveform `(note 2)`
LEFT ARROW	fine decrement flanger sweep frequency
shift LEFT ARROW	coarse decrement flanger sweep frequency

RIGHT ARROW	fine increment flanger sweep frequency
shift RIGHT ARROW	coarse increment flanger sweep frequency
DOWN ARROW	fine decrement flanger amplitude
shift DOWN ARROW	coarse decrement flanger amplitude
UP ARROW	fine increment flanger amplitude
shift UP ARROW	coarse increment flanger amplitude
alt DOWN ARROW	fine decrement flanger base level
alt shift DOWN ARROW	coarse decrement flanger base level
alt UP ARROW	fine increment flanger base level
alt shift UP ARROW	coarse increment flanger base level
DELETE	disable flanger
ESC	undo changes to flanger
HOME	re-initialise flanger (default waveform, frequency and range)
shift M	toggle FX mix (mix ring modulator and flanger output with original signal)

Notes:

1. The default keyboard layout covers about three octaves (C3 onwards) using three rows of the standard QWERTY keyboard. Specifically the keys **Q W E R T Y U I O P [ ] A S D F G H J K L ; ' \ Z X C V B N M , . /** in ascending order. The alternate keyboard layout covers about one and a half octaves (C4 onwards) using two rows of the standard QWERTY keyboard with white notes on the bottom row and black notes above. Specifically the keys **Z S X D C V G B H N J M , L . ; /** in ascending order.
2. Waveforms are sine, square, triangle, rising sawtooth, falling sawtooth and noise.

Default patches

F1 - simple piano, velocity sensitive
F2 - square wave lead
F3 - breathy organ
F4 - lead with portamento
F5 - strings
F6 - two oscillators 4 semitones apart
F7 - flanger demo
F8 - bell (ring modulation)
F9 - harsh strings
F10 - simple lead
F11 - bass lead
F12 - organ
shift F1 - shaped resonant waveform
shift F2 - sawtooth lead with split keyboard, velocity sensitive
shift F3 - LFO demo
shift F4 - split keyboard, sea and gulls
shift F5 - split keyboard, drum + hi-hat
shift F6 - LFO demo, pitch bend
shift F7 - experimental
shift F8 - slightly discordant
shift F9 - rasp (oscillator synch)
shift F10 - experimental, modulation bend low notes
shift F11 - experimental, looping
shift F12 - experimental, time development

Component List

Resistors

R1, R9, R10, R12, R13, R18, R19	0R (black)
R2	4R7 (yellow, purple, gold, gold)
R3	100R (brown, black, brown, gold)
R4, R5, R11	10k (brown, black, orange, gold)
R6	10R (brown, black, black, gold)
R7, R8	470R (yellow, purple, brown, gold)
R14, R15	47k (yellow, purple, orange, gold)
R16	1k (brown, black, red, gold)
R17	220R (red, red, brown, gold)

Capacitors

C1, C2	220uF electrolytic (blue or black)
C3, C6, C8	100nF ceramic (brown, marked '104')
C4	10uF electrolytic (blue or black)
C5	100nF polyester (yellow or blue, square)
C7	100uF electrolytic (blue or black)

Semiconductors

TR1	ZTX689B transistor (black)
D1	1N4148 diode (orange)
REG	L7805CV regulator (black/silver)
LED1	red
IC1	MCP4921 DAC + 8-pin socket
IC2	dsPIC30F3012 microcontroller (A61X) + 18-pin socket
IC3	6N138 optoisolator + 8-pin socket

Miscellaneous

MOUSE, KEYBOARD	PS/2 sockets
MIDI	MIDI socket
AUDIO	3.5mm jack socket
BATTERY	PP3 moulded battery snap
POWER	2.1mm dc power socket

PCB