NAME

**sox_gen** − a graphics front end to SoX (Sound eXchange) synthesizer commands

SYNTAX

source sox_gen.sh

DESCRIPTION

The **sox_gen** script uses widgets provided by **gtkdialog** to implement a graphics front-end for **SoX** synthesizer functions. This version supports 4x waveform inputs, 2x channel outputs, AM/FM modulation, frequency sweep function, output signal attenuation and a generated waveform display, making it suitable for demonstration and training applications.

Specific features are discussed in the following sections.
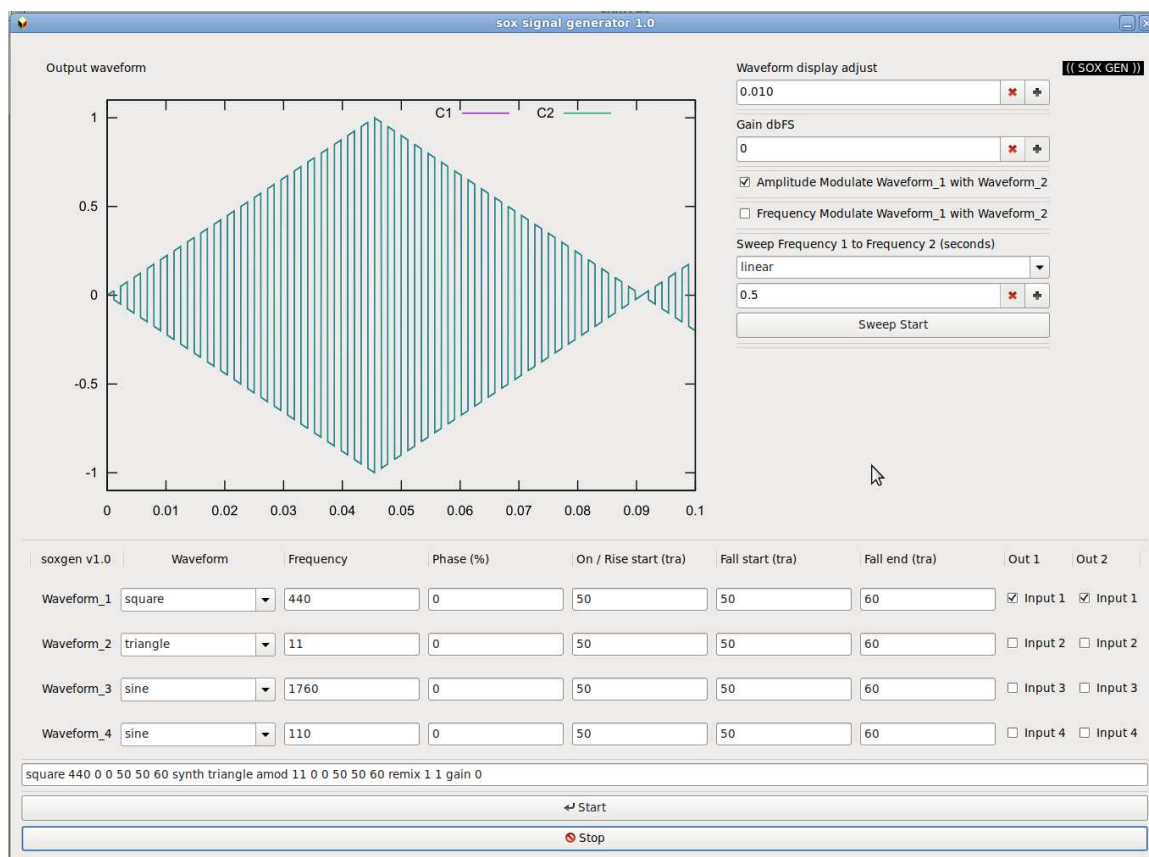
AUDIO GENERATOR OUTPUT AND HARDWARE CONSIDERATIONS

gen_output(), stop_output() − signals are generated via the available computer hardware using the SoX **play** command. The command is run in the background and its process id (PID) is stored to allow stopping the generator output without disrupting other sound sources using the same **play** command.

```
play −q −r 192k −n −r 192k synth $DURATION $TONES &
```

The maximum sampling rate supported by the output circuit is specified for both input and output, along with the sample resolution. This application uses a 'null input file' (−n option)

Signal output starts by activating the **Start** button or by selecting / deselecting individual inputs.

Individual input waveforms can be routed to either or both output channels (**Out 1**, **Out 2**).

The output duration is set to 0, meaning continuous output. For the frequency sweep function the output duration is selectable from 0.5 to 90 seconds.

sox generates signals at maximum volume (0 dBFS - Full Scale). The provided **Gain dbFS** control, common to both output channels, allows attenuation down to -99 dBFS. Actual output level depends on the hardware and software controls and filters further down the audio chain.

It is advisable to check the hardware performance in order to understand the limits of this generator implementation. For example, the audio circuit in a certain computer uses the CMI8788 audio processor, supporting 32-bit, 192k samples. However, output measurements for signals 0 to 25 kHz show that the output level rolls off steeply above 17kHz being almost constant from 3.5Hz to 17kHz.
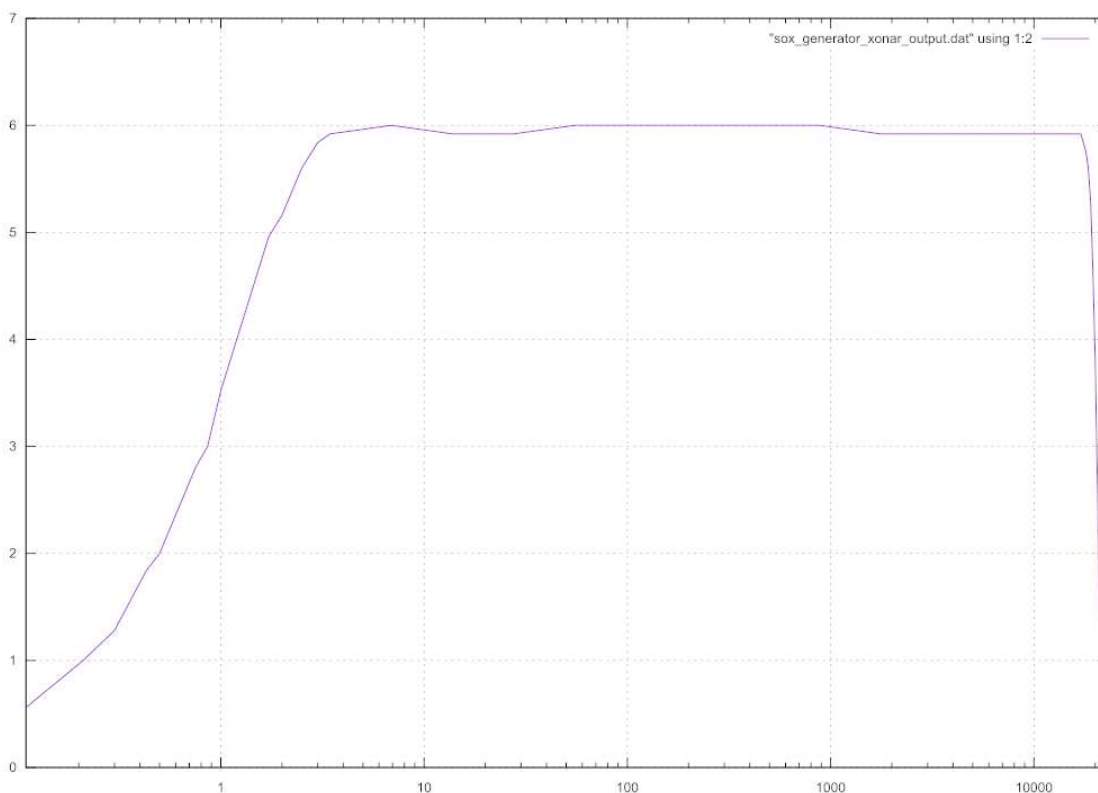
AUDIO GENERATOR WAVEFORM INPUTS

gen_prep(), wave_create() − the purpose of the **gen_prep** function is to form the sox synthesizer parameters. Up to 4x input waveforms can be specified and routed to either or both output channels (**Out 1**, **Out 2**). If more than one waveform is output on one channel, it will be scaled down by a factor of 1/n where n is the number of the input channels combined for the particular output.

For each waveform, the following can be specified:

Waveform - can be sine, square, triangle, sawtooth, trapezium, exp, whitenoise, tpdfnoise, pinknoise or brownnoise.

Frequency - frequency in Hz, up to 6 characters, including the decimal point (specified in **wave_create**)

Phase - phase shift in percentage of one cycle (0-99); default is 0. Not used for noise waveforms

On / Rise start - percentage of one cycle (0-99); 'On' time for the square waveform, start of the rising part for the triangle, exp(onential) and trapezium waveforms; default is 50. Not used for sine, sawtooth and noise waveforms

Fall start - percentage of one cycle (0-99); start of the falling part for the trapezium waveform; default is 50. Not used for other waveforms.

Fall end - percentage of one cycle (0-99); point where falling ends for the trapezium waveform; default is 90. Not used for other waveforms.

Parameters not applicable for the specific waveform may be specified in the **sox (play)** output stanza but will be ignored.

Changing the above parameters will not have an immediate effect. Generator output is started or restarted by pressing the **Start** button or by selecting / deselecting individual inputs. The output can be stopped by the **Stop** button or by pressing the **space bar** or the **Enter** key (the **Stop** button is automatically selected when the output is enabled).

When the **sox_gen** script is started, the waveform, frequency and enabled outputs are set by **MAIN** calling the **wave_create** function. These can be customized for the work at hand.

WAVEFORM DISPLAY
gen_prep() > gen_period.bc > bc > sox > gen.dat > gnuplot > gen.svg

Within the **gen_prep** function, the **sox** program is called to generate a data file in the background depicting the compound waveform(s) for the output channel(s). An approximation of a full compound waveform period is attempted using **bc** with the included **gen_period.bc** script.

```
sox −n $TEMPDIR/gen.dat synth $DISPLAY_PERIOD $TONES
```

The display period can be adjusted without affecting the output using the **Waveform display adjust** entry, the minimum 'adjust' period set to 0.005 seconds (MAIN, Waveform display adjust).

The data file generated by the **sox** command (**gen.dat**) is converted to a Scalable Vector Graphics image (**gen.svg**) by **gnuplot** and displayed by the **gtkdialog pixmap** widget.

```
gnuplot −e "set datafile commentschars \";\"; \
            set yrange [−1.1:1.1]; \
            set terminal svg size 600,400; \
            set output \"$TEMPDIR/gen.svg\"; \
            plot \"$TEMPDIRgen.dat\" \
            using 1:2 title \"C1\" at 0.6,0.926 with lines, \
            \"$TEMPDIRgen.dat\" \
            using 1:3 title \"C2\" at 0.75,0.926 with lines \
            "
```

MODULATED OUTPUT
gen_prep() – MODULATION

Waveform 1 can be modulated by Waveform 2 by selecting **Amplitude Modulate Waveform_1 with Waveform_2** or **Frequency Modulate Waveform_1 with Waveform_2**.

When modulation is selected, only **Input 1** is considered for output on either channel.

SWEEP OUTPUT
gen_prep() – SWEEP

The frequency of Waveform_1 will be swept from the Frequency specified for Waveform_1 (Frequency 1) to the frequency specified for Waveform_2 (Frequency 2).

The sweep type (linear, square function, exponential, stepped exponential) and duration (seconds) determine the form of the sweep output.

When sweep is selected, only **Input 1** is considered for output on either channel. The waveform display is representative of the selected waveform and the starting frequency.

FILES
/dev/shm/gen_BASHPID

While the **sox_gen** script is running, some information is stored in shared memory and specifically in **/dev/shm/gen_BASHPID** where BASHPID is the process identification of the shell where from the script is run.

This directory is deleted on script exit but while the script is running generated files are accessible and can be copied to permanent storage:

gen.dat - sox-generated data for the selected display period

gen.svg - gnuplot graph of gen.dat (gen_prep)

gen_period.bc - display period calculation (included in sox_gen.sh)

spectrogram.png - spectrogram of the sweep function

tones - waveform part of the **SoX play** command stanza

play_pid - process id of the play instance, used by **stop_output**

REFERENCES
SoX - Sound eXchange by Lance Norskog, Chris Bagwell et al. (https://sourceforge.net/projects/sox/ or **man sox**)

bash - the GNU Bourne-Again SHell by Brian Fox, Chet Ramey (https://www.gnu.org/software/bash/ or **man bash**)

gtkdialog - by Laszlo Pere (https://fossies.org/linux/privat/old/gtkdialog-0.8.3.tar.gz/ - Basic docs)

gnuplot is a command-line driven graphing utility for sever platforms by Thomas Williams, Colin Kelley and contributors (http://gnuplot.info/ or **man gnuplot**).

bc is an arbitrary precision calculator (language) by Philip A. Nelson (https://www.gnu.org/software/bc/ or **man bc**).

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