DIGITAL FUNCTION GENERATOR for NeXT
- revolutionary software for a revolutionary computer

By: Digital Recordings, Halifax, Nova Scotia, Canada, August , 1992.
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Overview

If you have not heard about the **NeXT** yet, then you should. It is the most user friendly and powerful personal computer / UNIX station on the market today. The **Digital Function Generator** (**DFG**) software, specifically designed for the NeXT, extends its power even further.

, Sound synthesis on the NeXT computer can be accomplished using DSP resources (Motorola 56001 processor). But, the Digital Function Generator does not use these resources, therefore releasing them to perform, simultaneously with sound synthesis, other tasks such as FFT, recording, running the Digital Oscilloscope and Spectrum Analyzer applications. This allows sophisticated tests and experiments in acoustics, audio, electronics, etc. to be performed on a single NeXT computer (doubling it's power).

, The quality of sound synthesis that is achieved with the Digital Function Generator is better than with the DSP, since there is no interpolation during synthesis and because a signal dithering technique is used. The Digital Function Generator, with a given set of D/A converters, allows the synthesis of pure tones with ultimate quality.

, This generator has the ability to synthesize any arbitrary sound with any arbitrary complexity --a task that can be too complex for a DSP chip to perform in real time.

, The Digital Signal Generator software not only outperforms, in terms of quality and functionality, sound synthesis on the Motorola 56001 processor, but it also outperforms (in that respect) any 16 bit digital generator currently available on the market. And for this type of generator you would have to pay anywhere between $8,000 to $60,000. This, we hope, shows the power and potential of the NeXT/DFG combination.

, The Digital Function Generator software is based on algorithms designed and developed at Digital Recordings. The code for the programs was written by scientists at Digital Recordings, Halifax, Nova Scotia, Canada. Feedback from various researchers and students is constantly incorporated in the improvement of the software. This software has been used for the last 10 months in various research projects and in the teaching of various courses related to acoustics, psychoacoustics, audiology and speech pathology. Since close attention was paid to code optimization, ergonomics of the user interface, software stability, flexibility and performance, user feedback has been very positive. This software is totally stable and fool-proof. The use of nonsense and out of range variables does not lead to a crash of the application.

, Future plans for the Digital Function Generator include further optimization of the software and addition of many
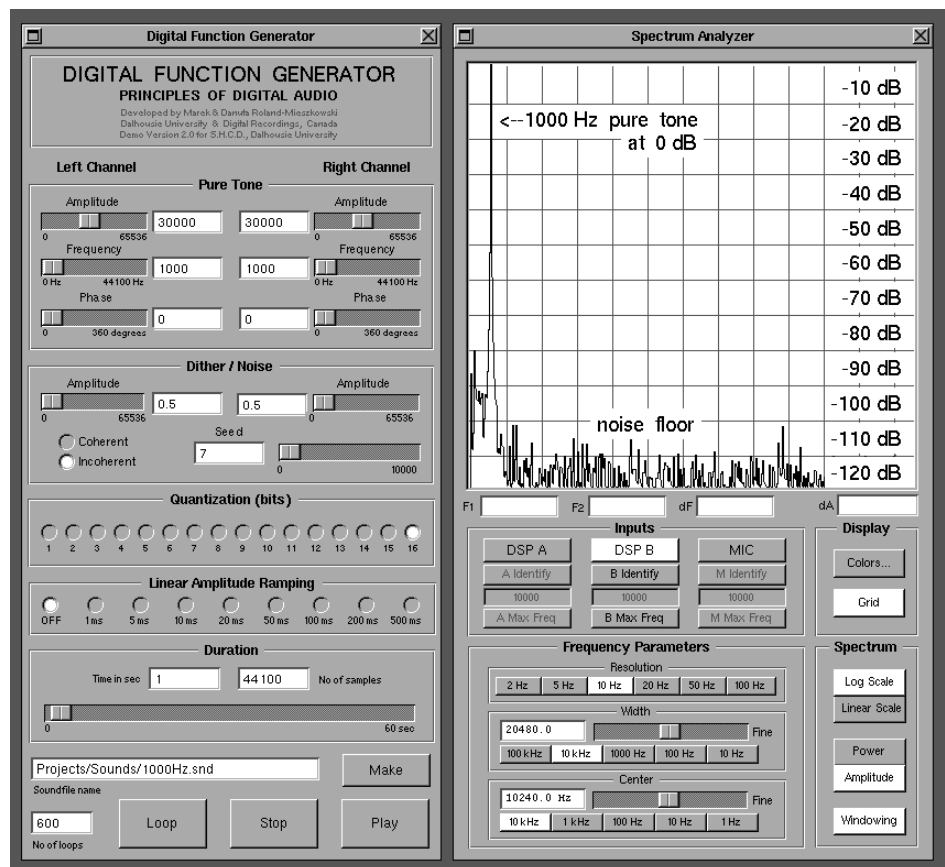

Figure 1. 1000 Hz pure tone generated with the Digital Function Generator (Principles of Digital Audio module) and displayed with the Spectrum Analyzer (output of the NeXT is connected to the A/D interface).

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exciting new features and synthesis panels to further increase its power and flexibility.

Parameters and features

Stereo output (two independent channels) - different waveforms can be synthesized in both channels.
Frequency range from 0 Hz to 20,000 Hz.
Frequency stability +/- 0.0001 Hz (accuracy of the quartz clock).
Amplitude adjustable continuously from -140 dB to 0 dB.
Phase adjustable continuously from 0 degrees to 360 degrees.
S/N ratio = 95 dB (with dither).
No harmonic and no intermodulation distortion due to the used algorithm.
No use of Motorola DSP 56001 processor - the DFG, Digital Oscilloscope & Spectrum Analyzer can run simultaneously.
Generated sounds are written to standard stereo, linear 16 bit sound files *.snd. These files can be used in other sound applications such as sound editors, etc. Complex sounds can be saved for fast retrieval and playback.

The simultaneous playback of sound by DFG and the recording of this sound via microphone input or the stereo A/D interface (from Singular Solutions, Ariel or MetaResearch) can be done, allowing very flexible testing and experimental procedures. If you have an A/D interface you can connect the RCA outputs of the NeXT computer to the RCA inputs of the interface. If you don't have an A/D interface you can use a microphone to input sound back to the NeXT. An even better way is to build an interface cable with a passive, resistor network-based 60 dB attenuator, to connect NeXT's RCA output (L or R channel) to the microphone input. In this case the quality will be limited by the A/D converter on the microphone input.
Signals: sine wave, square wave, triangular wave, sawtooth wave, pulse, white noise, AM, FM and AFM modulation, amplitude and frequency sweep, additive synthesis, etc.

Application

The Digital Function Generator software consists of 5 modules. Not only can they be run simultaneously, but one module can play one sound while another module (or the same module) is generating another sound.
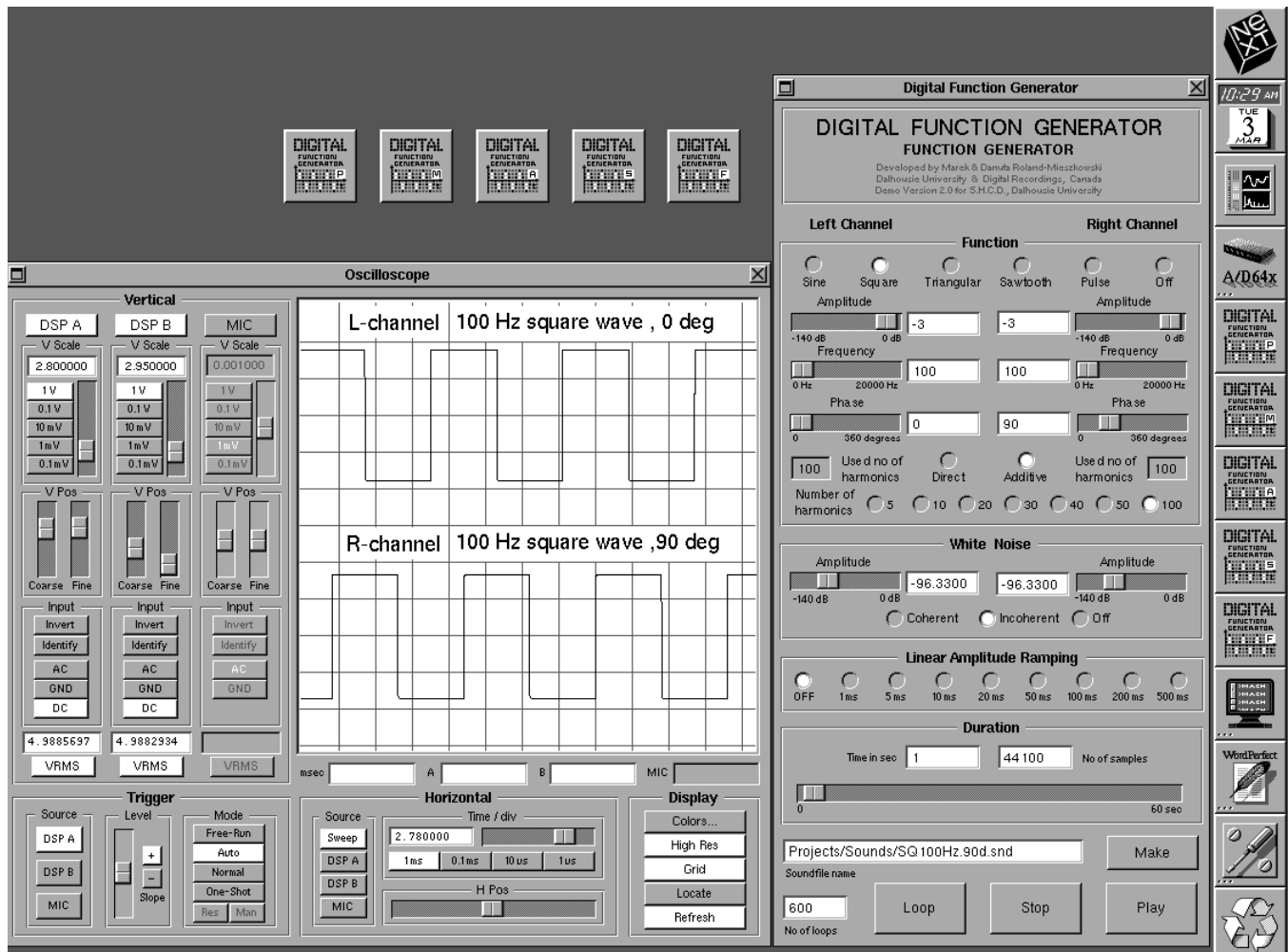

Figure 2. 100 Hz square wave generated with the Digital Function Generator (Function Generator module) and displayed with the Oscilloscope.
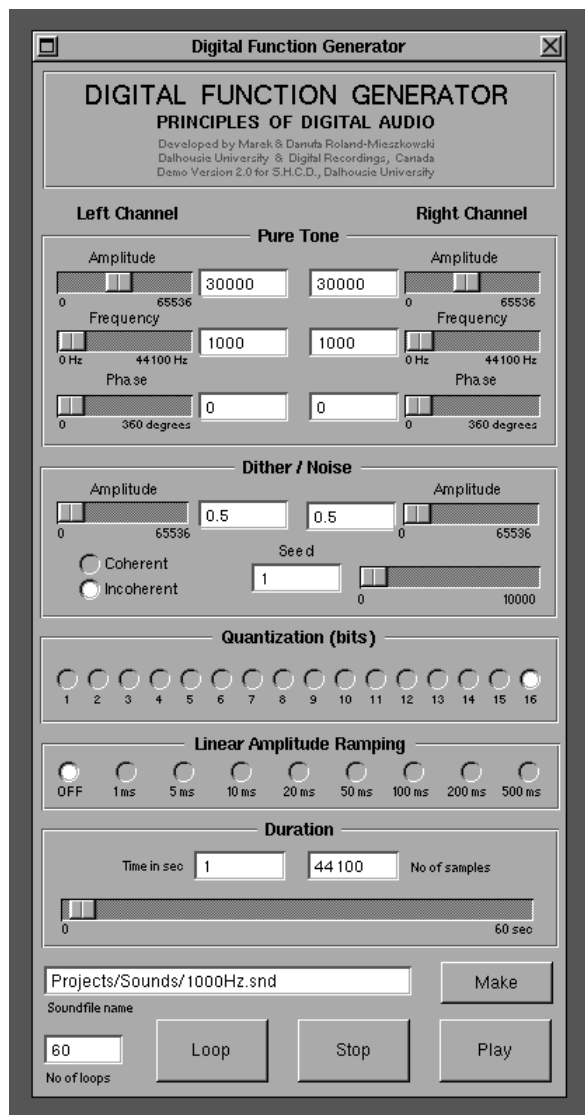
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Figure 3. The Principles of Digital Audio module.

The **Sweep Generator (AS, FS & AFS)** module (Figure 6) is a very flexible tool for generating arbitrary linear or logarithmic and up or down amplitude sweeps (AS), frequency sweeps (FS) and amplitude plus frequency sweeps (AFS) that can be used in the testing of equipment, rooms, and the auditory system.

The **Function Generator** module (Figure 2 & 7) can be used to synthesize sine, square, triangular, sawtooth, pulse, and white noise signals. These signals, in turn, can be used in various tests. White noise can be mixed with any other signal. This can be used in "masking" experiments in psychoacoustics and in the extraction of a signal from noise experiments.

These modules can be used for :

Various audio and acoustical tests.
Testing electronic components and devices (amplifiers, etc.).
Hearing and psychoacoustic tests.
Testing loudspeakers, headphones and other transducers.
Testing microphones and other transducers.
Testing recording equipment.
Testing and tuning musical instruments.
Testing NeXT's D/A as well as external D/A's and A/D's.
Teaching Acoustics, DSP, Physics, Psychoacoustics, Audiology, Speech Pathology, etc.
Public demonstrations in audio, acoustics and NeXT's computer capabilities.
Production of sound effects for radio ,TV, and film.
Production of test tapes and CD's.
Architectural testing.
Measurements of sound velocity in gases, liquids and solids.
Optical and other types of modulators.

The following is a short description of variables used in the software:

Amplitude is any real number from 0 to 32767 (or from -140 dB to 0 dB) and represents the amplitude of the signal.
Frequency is any real number from 0 to 20000 and represents the frequency of the signal in Hz.
Phase is any real number from 0 to 360 and represents the phase of the signal in degrees.
Dither is a small additive **noise** used to eliminate the harmonic and intermodulation distortion generated in typical generators.
Seed allows a choice of different noise sequences. When the same seed number is used, the same noise sequence is generated.
Linear Amplitude Ramping allows fade-in and fade-out of the sound within a chosen time, when using the Play button.
Duration of signal is expressed in the number of samples or seconds. Any number in the range of 0 to 60 seconds can be chosen. Total signal length = (duration) * (number of loops).
Make creates a sound file with chosen parameters. The name of the sound file and the path can be modified in the provided text window. If there is no need to save files, the same name can be used all the time. Each time the "Make" button is pressed, the file with the name appearing in the text window is overwritten. The *.snd extension should be used

The **Principles of Digital Audio** module (Figure 1 & 3) allows synthesis of pure tones and white noise. It can be used to demonstrate principles of digital audio, such as quantization, dithering, aliasing distortion, hard clipping distortion, harmonic and intermodulation distortion, digital deafness, etc.

The **Modulation (AM, FM & AFM)** module (Figure 4) allows synthesis of pure tones and of Amplitude Modulated (AM), Frequency Modulated (FM) and Amplitude plus Frequency Modulated (AFM) tones. This is a very powerful tool for psychoacoustic experiments investigating, for example, difference limen (DL) for frequency and intensity of the sound.

The **Additive Synthesis** module (Figure 5) allows very flexible synthesis of complex sounds from their Fourier components. This is a very powerful tool for the "construction" of many test signals. "Beats", "virtual pitch", and other effects can be easily investigated.

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when making sound files. Since they are standard format sound files, they can be used in other sound playback programs and sound editors. Also, if a name of an already existing *.snd file is entered, it can be played using either the "Play" or "Loop" button and a new sound file can be made while another sound file is being played.

Loop plays a *.snd file the number of times indicated in the text window. Total playback time = duration * number of loops. This button can be used to play "in loop" any sound file, as long as its name appears in the text window.

Stop stops looping or playback of a sound file at any time.

Play starts playback of a sound file. Sound files of any length can be played.

Availability

The Digital Function Generator 2.0 software is available now for an introductory price (till December 31, 1992) of $295 US for a licence for one NeXT computer and $145 US for each
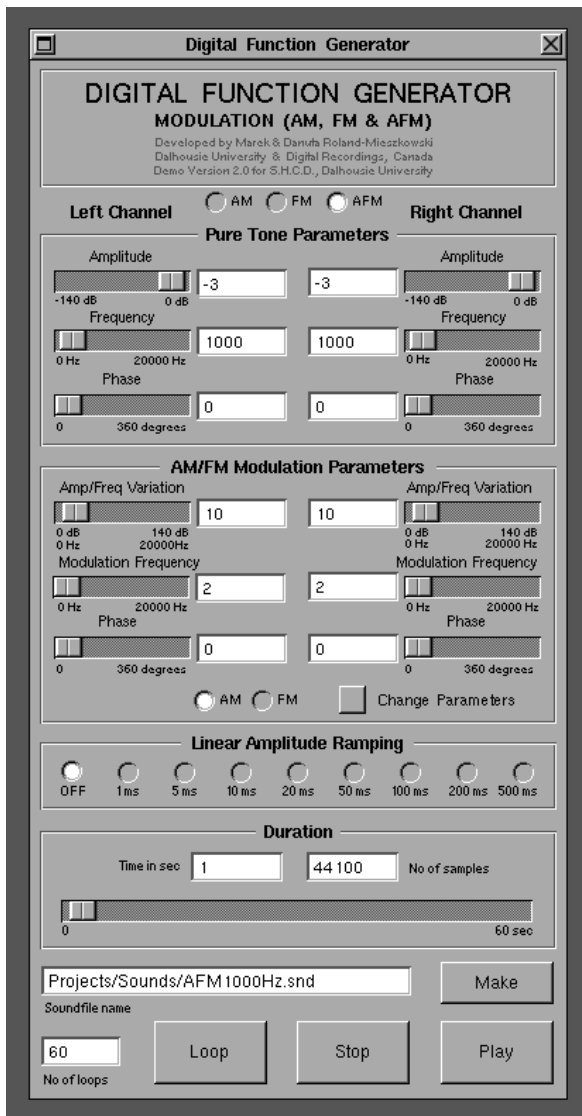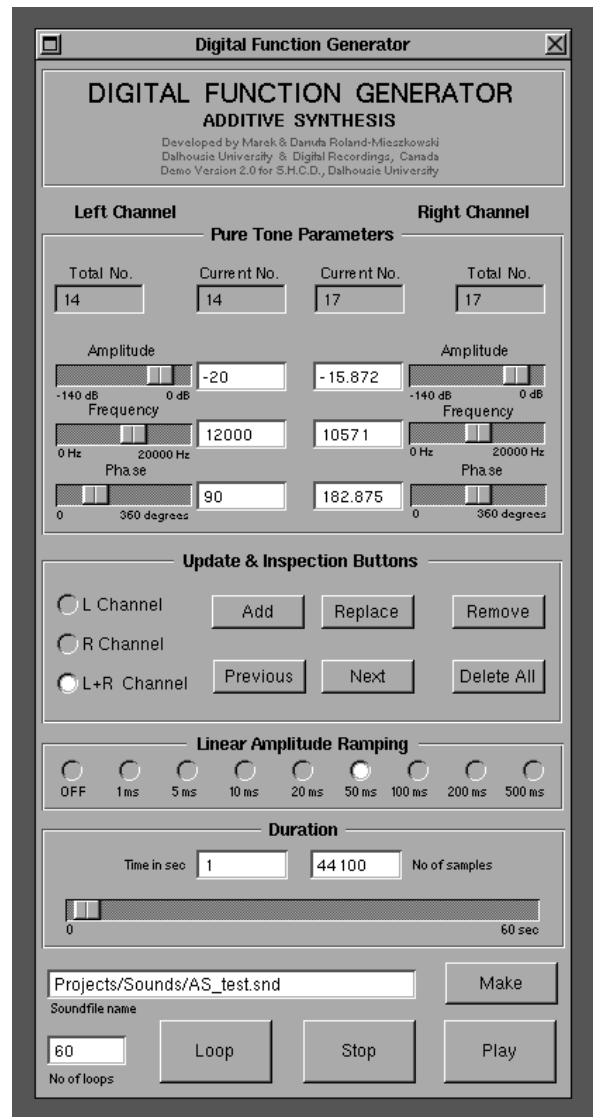

Figure 5. The Additive Synthesis module.

additional NeXT computer. An introductory educational discount price (till December 31, 1992) of $195 US is available for qualified educational institutions for a licence for one NeXT computer and $95 US for each additional NeXT computer. Shipping and handling: $20 US in Canada and the USA, $40 US for other countries.This includes shipping and handling of any software upgrade, up to a period of one year. An additional upgrade of the software for each subsequent year after the 1-year period can be obtained for 30% of the original purchase price.

Your satisfaction and your suggestions

Your satisfaction with the Digital Function Generator software is very important to us. We would appreciate your comments and suggestions regarding this software. They will help us with future versions, increase software flexibility and most important, increase your satisfaction with the product.

Figure 4. The Modulation (AM, FM & AFM) module.

Customization

The DFG software could be customized according to your specifications to best suit your needs. Cost of customization will depend on the complexity of the customization and time involved. Please contact us for details.

Tapes and disks with sound tests

For those who would like to make tapes (DAT, reel-to-reel, compact cassette, etc) or disks (floppies or erasable optical disks) with test signals, rather then to buy the software, this service is also available. Cost of the service depends on the complexity of the task and the time involved. Please contact us for details.
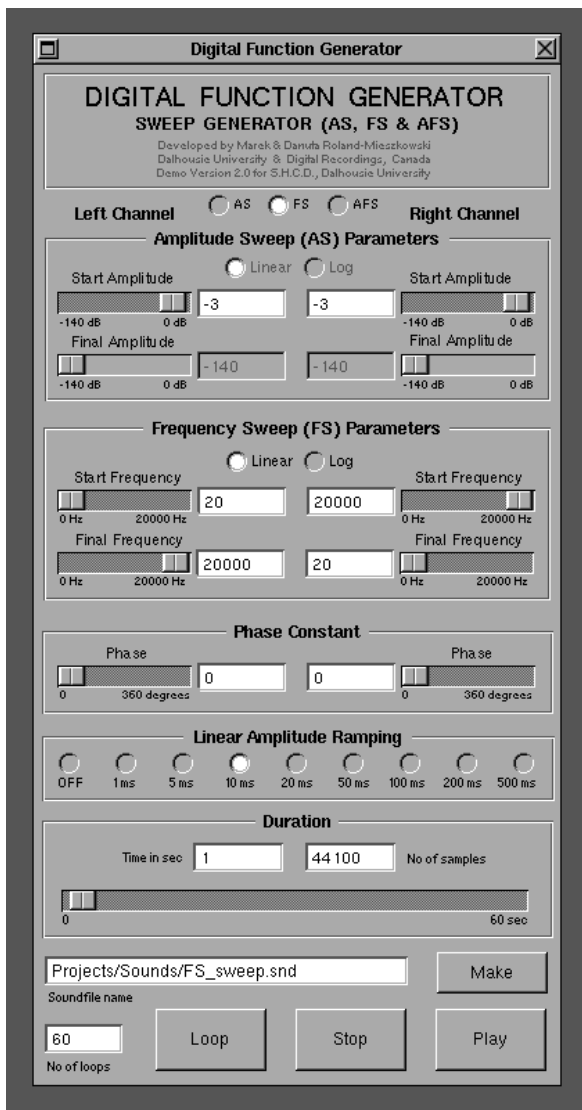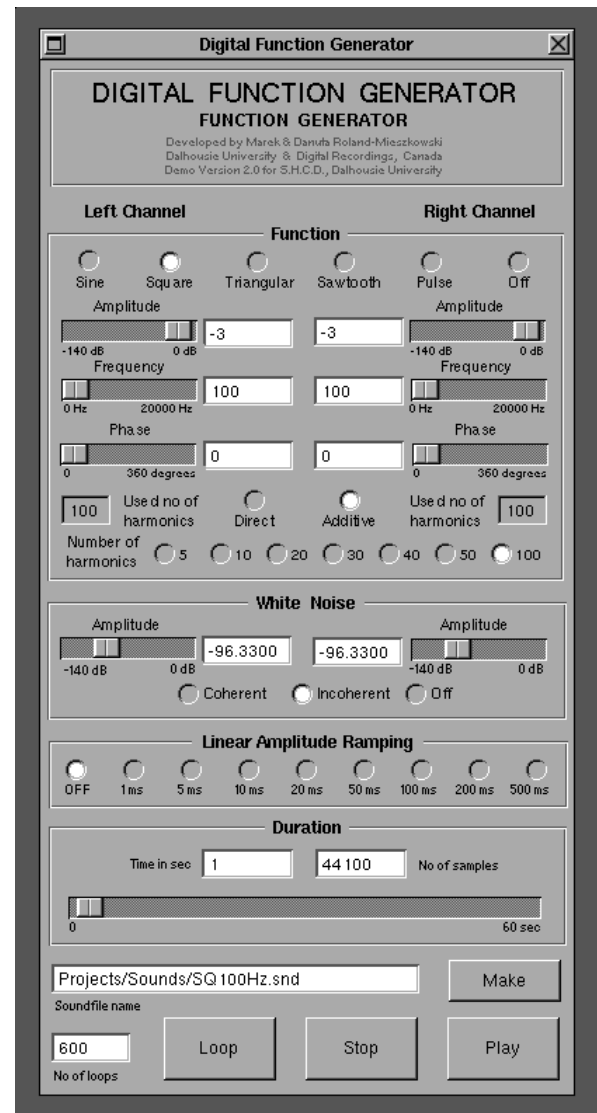

Figure 7. The Function Generator module.

More information

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Figure 6. The Sweep Generator (AS, FS & AFS) module.

NeXT computers are available from:

NeXT Computer, Inc.
900 Chesapeake Drive
Redwood City, California 94063
USA
Tel. 1-800-848-NeXT

A/D 64x Interface is available from:

Singular Solutions
959 East Colorado Boulevard
Pasadena, California 91106
USA
Tel. (818) 792-9567
Fax. (818) 792-0903