

A Software Based Audio Signal & Noise Generator

Diamond Cut Productions Software versions DCart10.75 and DCForensics10.75 have expanded signal generation capabilities. It adds a Preview Mode as well as the ability to directly create numerous random noise distributions (sometimes referred to as various ‘colors of noise’).

Make Waves Signal Generator

Make Waves

Frequency (1-fs/2) 440 HZ Stop Frequency (1-fs/2) 20000 HZ OK

Amplitude (0 to -96) -10 dB Peak Linear Sweep Close

Length 60 sec Preview

File Type Wave shape Noise Color

Mono Stereo Sample Rate 48000Hz

Sine Wave Square Wave Triangle Wave Noise

White
Blue
Brown
Green
Grey
Pink
Seismic
Violet

Resolution 16 Bits

Presets Save Delete

Musical Scale - A4 - 440.00 Hz

The Make Waves Signal Generator

The “Make Waves” signal generator function provides you with the comprehensive capabilities associated with a fully programmable audio signal generator (sometimes referred to as a function generator by engineers). It is also a “Make Noise” generator as well. It can produce Sine Waves, Square Waves, and Triangle Waves of adjustable frequency and amplitude. The frequency of those periodic waveforms can also be swept from one value of to another. The Make Waves generator is also capable of producing pseudo random noise signals having various spectral distributions as defined by their “color”. The basic random noise signal that the Make Waves generator produces is White noise, but you can also synthesize Blue, Brown, Green, Grey, Pink, Violet or Seismic noise by choosing the appropriate noise checkbox. These noise distributions can be produced directly in one step. (Various Noise distributions can also

be produced from a White noise signal source in conjunction with the appropriate Multifilter preset if desired.) When the Make Waves generator is in stereo mode, the random noise signals will be incoherent with respect to one another. (The noise signals are created by two independent noise sources and not just one, thus yielding random phase relationships between the two channels). Make Waves can produce a file containing the signal or noise of interest, or it can produce the chosen signal in real time by way of the Preview button (to stop a real time Preview, click on the Preview button again) or use the Cancel Button found on the progress bar dialog box. The Preview Button is essentially a toggle switch (on/off). The Make Waves generator is useful for calibrating and verifying the performance of the audio equipment used in your sound restoration laboratory, especially when used in conjunction with the onboard Spectrum analyzer, Spectrogram, VU meter or the X-Y plotter. These tools will also be useful to help you better understand the functionality of some of the filters provided in the Diamond Cut software program. The Sweep and Random generator are especially useful for characterizing the frequency response (and/or transfer function) of electrical and acoustical systems when used in conjunction with Diamond Cut measurement tools like the VU Meter, X-Y plotter, Spectrum Analyzer or Spectrogram. The Triangle Wave generator is useful for characterizing the time-domain linearity of an audio system or component. Included with the Make Waves Generator presets are all of the musical notes running from C0 to D9# (referenced to a 440 A4 of the equal-tempered scale) as well as a number of useful test signals from which to choose. The following controls with their adjustment range are provided with the Make Waves Generator:

1. Start Frequency: 0.01 Hz to 100,000 Hz. (100 kHz)*
2. Stop Frequency: 0.01 Hz to 100,000 Hz. (100 kHz)*
3. Length: (Duration of the tone burst) 10 Millisecond to 600 seconds. (Data entry is in seconds.)
4. Amplitude: 0 dB to -145 dB
5. Linear Sweep check box (on or off)
6. Sine, Square, Triangle Wave or Random (white noise)* selector
7. File Type (Stereo or Mono)
8. Sampling Rate {Factory Pre-Programmed} (8, 11.025, 22.05, 44.1, 48, 88.2, 96, 176.4 and 192 kHz)
9. Sampling Rate {User Programmable} (100 Hz to 210 kHz)**
10. Resolution (8, 16, 20, and 24 bits)
11. Presets: Includes common signals as well as the Musical Scale ranging from C0 (16.35 Hz) to D9# (9,956.06 Hz)
12. Noise Color: Chose between White, Blue, Brown, Green, Grey, Pink, Seismic or Violet.
13. Use the OK button to create a file having your selected signal or noise.
14. Use the Preview to hear the selected signal or noise in real time and use the Cancel button to stop it or click again on the Preview button (it will toggle back and forth).

Random Noise Characteristics and Usages

White Noise: White noise is often used to obtain the impulse response of an electrical circuit, in particular that of amplifiers and other audio equipment. It can also be used to evaluate audio computer DSP algorithms and their transfer characteristics. It is used extensively in audio synthesis, typically to recreate percussive instruments such as cymbals or snare drums which have higher noise content in the upper end of their frequency spectrum. It is also used as a sleep aid or as a masking element to help soundproof a room.

Blue Noise: Blue Noise is also known as azure noise and gets its name from the optical field since the color blue is on the higher end of the frequency spectrum of visible light. In audio applications, Blue Noise is used for dithering, a process where noise is added back into an audio signal in order to smooth out the sound and reduce the audibility of various distortion products. Some A-D converters use this type of noise to 'dither' the LSB of the digital signal produced.

Brown Noise: This comes from the physics principle of Brownian motion and diffusion. Its energy falls off with increasing frequency with a $1/f^2$ manner. Brown noise can sound like a very uneventful ocean surf since it has more bass content than white noise, making it more pleasant to listen to. It makes for a good sleep aid.

Green Noise: Green Noise is White Noise with emphasis in the mid-band region around 500 Hz. It is good for setting up PA system in which the spoken word needs the most energy to cover a large audience. Use this noise in

conjunction with a 1/3 octave equalizer to achieve good PA performance for speech oriented and optimized sound systems.

Grey Noise: This distribution of random noise varies with sound level based on how humans perceive “loudness”. The Fletcher-Munson contour curves of equal loudness are based on Grey Noise signals.

Pink Noise: Pink Noise contains equal energy per unit octave and is used extensively in acoustical measurements and Public Address system setup and calibration in conjunction with a 30 band graphic equalizer.

Seismic Noise: This is a random noise signal containing primarily sub-sonic frequencies. It is useful in sonar physics experiments as well as a special effect in very large theater sound installations having very large sub-woofers. It is not very audible, but can be physical felt under some circumstances. You need to be careful with using this noise signal since most sound system will not reproduce it, but the amplifier and speaker drivers may still be trying to respond potentially causing damage to the system.

Violet Noise: Violet Noise has a rising power density with increased frequency. The human ear has limited sensitivity to very high-frequency noise (or hiss) and the ease with which white noise can be electronically differentiated (high-pass filtered at 6 +dB/Oct) allowed some early realizations of a dithering process as applied to digital audio using violet noise.

Noise Traits by Color

Color (or type)	Characteristics	Slope	Density
White	Equal Energy per unit Hertz	Flat	Uniform
Pink	Equal Energy per unit Octave	-3 dB/Octave	1/F
Brown	Analogous to Brownian Motion	-6 dB/Octave	1/F ²
Red	Another name for Brown Noise	-6 dB/Octave	1/F ²
Blue	Azure Noise (proportional to F)	+3 dB/Octave	F
Green	Pink Noise with Emphasis at 500 Hz	Non-Linear	Subjective
Violet	Differentiated White Noise	+6 dB/Octave	F ²
Grey	Psychoacoustic equal loudness Curves	Proportional to SPL	Varies with loudness
Seismic	Random Noise below 100 Hz	-3 dB/Octave	Semi-audible
Black	Analogous to black body radiation	Silence	No Signal

Note 1: The frequency programming precision of the Make Waves Generator in the DC Forensics10 version is greater than the standard DCArt10 product. Keyboard entry of the desired frequency must be used to attain this higher level of resolution. The actual frequency resolution in the DC Forensics10 Make Waves Generator is 0.01 Hz (10 mHz or millihertz). Thus, values like 59.99 Hz or 60.01 Hz are permissible

****Note 2:** To create a Make Waves file having a custom sample rate value, simply highlight the sample rate field and use your keyboard to enter the desired sample rate value. Note that only very high-end soundcards are capable of handling sample rates above 192 kHz (such as 210 kHz). Less capable soundcards may hang your system when presented with sample rate signals greater than their maximum design capability.

The following chart summarizes the Harmonic Distortion components produced by the various waveforms provided by the “Make Waves” generator at a 44.1 kHz sample rate and 16 bit resolution:

Wave-form	THD %	3 rd Harm.	5 th Harm.	7 th Harm.	9 th Harm.
Sine	0	0	0	0	0
Square	44	33.3	20	13.8	10.8
Triangle	12	11	4.1	2.0	1.3

***Note:**

Using the Making Waves Signal Generator (Tutorial)

1. Click on the "Edit" Menu with the left mouse button.
2. Click on "Make Waves" with the left mouse button.
3. Choose between Sine Waves, Square Waves or Random by clicking on the appropriate box with the left mouse button.
4. Set the desired "Frequency" by clicking on the number(s) that you desire to change with the left mouse button. Use the keyboard to enter the new values with the "Start frequency" slider control. The allowable range is from 0.01 Hz to 100,000 Hz. (100 kHz)
5. Set the "Length" of the file, which you desire to create using the mouse, and direct keyboard entry. Data entry must be in terms of seconds. If you desire 2 minutes, enter 120. If you desire 10 Milliseconds, enter 0.01.
6. Set the "Amplitude" which you desire, anywhere from 0 dB to -145 dB. 0 dB is the largest signal value which you can produce, with the peak value of the waveform being + / - 32,767 LSB's referenced to a 16 bit file.
7. Click on "OK" and a Source file will be created for you containing the signal that you have just defined.

Important Note 1:

If the sweep generator function is desired, click on "linear sweep" and then adjust the "stop frequency" control to the desired value. The generator will then produce a linear sweep of frequencies ranging from the start frequency value to the stop frequency value over the interval of time defined by the "length" control.

Note: The Sweep and Random Generator is useful for characterizing the frequency response or Transfer Function of electrical and acoustical systems when used with other Diamond Cut Measurement tools (VU Meter, Spectrum Analyzer, Spectrogram, and/or the X-Y Plotter).

Important Note 2:

Pink noise can be created from the random white noise generator by applying the "White to Pink Noise Converter, 20 kHz" to the white noise file or simply by choosing Pink directly as your Noise Color. Alternatively, a white to pink noise converter is also found in the preset list under the Multifilter. First, create a sample of random (white) noise using the Make Waves Generator. Use a sampling rate of 48 kHz for this procedure. Next process the resulting file through the indicated Multifilter preset and the resulting file will be Pink Noise. White Noise can also be converted to various Noise colors by using the appropriate noise Converter in the Multifilter.

Important Note 3:

Brown (Red Noise or Brownian Noise), Violet Noise and/or Seismic Noise can be created in a similar manner as described in Important Note 2. However, the converters are found as presets under the appropriate names in the Multifilter.

Important Note 4:

When planning to convert White Noise to Pink, Violet, Red (Brownian) or Grey Noise, it is very desirable to start with a 48 kHz file in order to obtain the maximum accuracy following the conversion process.

Important Note 5:

A number of factory presets are provided for the Make Waves Generator consisting of commonly used audio signals. You can add to that list as desired.

