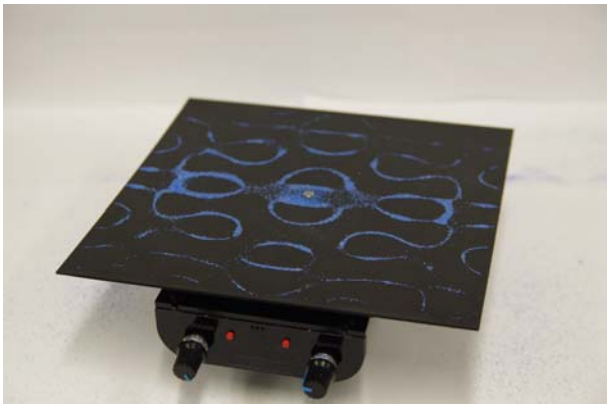
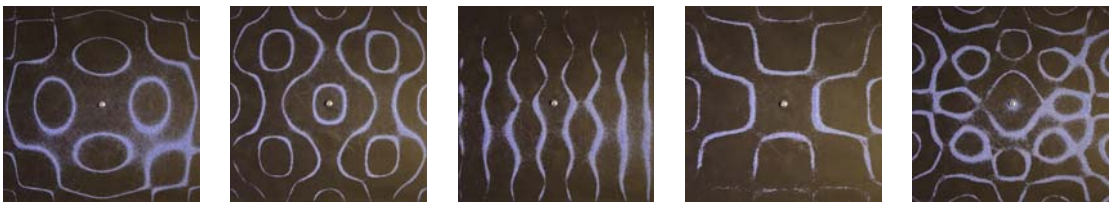
Cymatics Wave Resonator

Standing Wave Pattern Visualizer



Features and Specifications

- Adjustable Sine Wave Generator
- Interchangeable Vibration Plates
- 40W Power Amplifier Output
- Memory and Playback Function
- Over Current, & Temperature Protection
- Optional audio input & output
- Wide supply voltage range (10V – 26V)
- Size: L200 x W200 x H65 mm



The CMX-75 is a standing wave pattern generator that can be used to create visual representations of vibrational phenomenon. Commonly referred to as Cymatics, this process creates vibrations in a surface which reflect and interfere thus creating complex sanding wave patterns which are made visible with this device.

This is a fantastic educational tool for demonstrating in real time how standing waves form, and their significance in the formation of shapes in the world around us.

With a full range power audio sine wave generator, the CMX-75 can drive up to 40W of vibrational power into a range of surfaces.

By using different shaped vibrating surfaces and adjusting the frequencies used, all sorts of amazing patterns can be seen.

With a built in memory function, patterns can be recorded and played back in sequence for creating fantastic animated displays.

Built in 3.5mm audio sockets, allow the devices to be linked together or connected to external audio devices such as MP3 players or mobile phones.

Example Applications

- Education
- Research
- Visualisation of wave patterns
- Resonance and wave experiments
- And more…

ELECTRICAL CHARACTERISTICS

NB: Figures may vary under different loading conditions and environments.

Symbol	Parameter	Min	Max
V_{in}	Input Supply Voltage	10V	26 V
I_{sup}	Supply Current (no load)	50 mA	150 mA
I_{out}	Continuous Output Current	0 A	6.5 A [1]
P_{out}	Continuous Output Power	0 W	40 W
F_{out}	Output Frequency Range	10 Hz	25 kHz
F_{sig}	Input/Output Signal Voltage (3.5mm jacks)	0 V	5 V
M_{no}	Memory Storage	10 tones	10 tones

Table 1: Electrical Characteristics

[1] Max current may vary with operating conditions

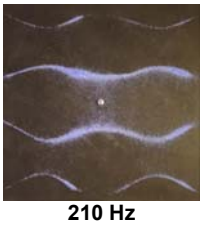
How it works

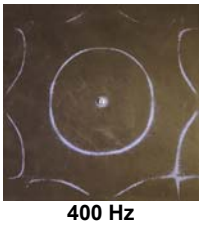
Virbations are applied to the flat surface through the screw in the centre. This causes waves to move through the flat surface out from the centre. When the waves reach the edge of the surface, they are reflected back again towards the centre. The reflected waves then interfere with the outgoing waves to produce standing wave patterns.

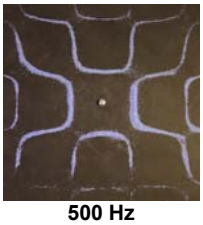
These standing waves will cause the sand to move away from the vibrating areas and to settle in the nodes where the waves are stationary. In other words; where you can see the black surface, the surface is vibrating up and down, while where you see the sand, there is virtually no movement.

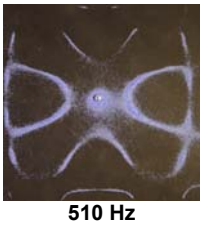
Patterns will form at many different frequencies. Some will be remain clear over a small range of adjustment, while others will only show at a very precise frequency. The patterns form when the frequency applied cause waves to fit within the surface multiple times.

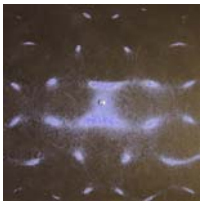

80 Hz

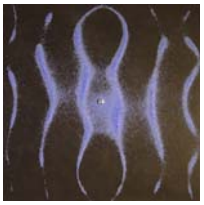

210 Hz

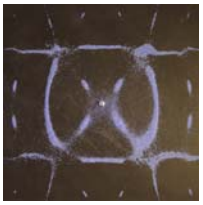

400 Hz

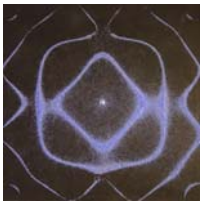

500 Hz

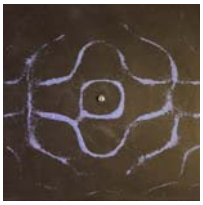

510 Hz

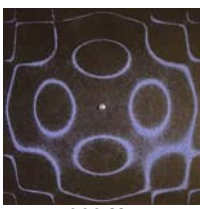

520 Hz

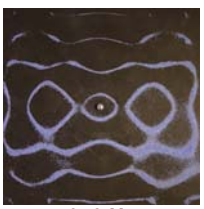

530 Hz

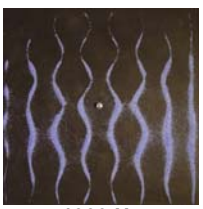

600 Hz

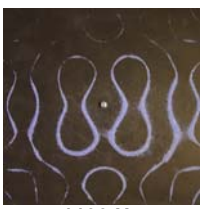

720 Hz

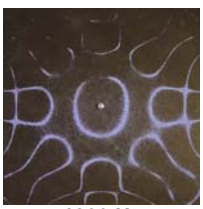

800 Hz


900 Hz


950 Hz


1000 Hz


1100 Hz


1200 Hz

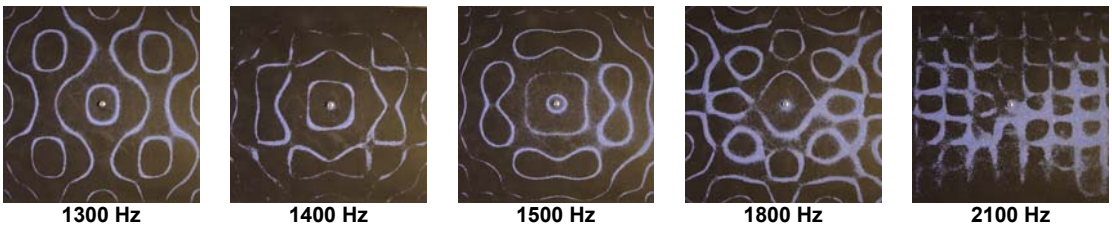


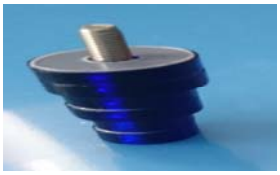
Figure 1: Example Patterns and Corresponding Frequencies

Assembly Instructions

This device will require basic assembly when shipped. You will need a Philips screwdriver to complete the process.

1. Gather the 6 spacers and the screw. They will be within the ziploc bag. These are used to separate the vibrating surface from the rest of the unit.

2. Pass the screw through the centre of the vibration plate (you can remove the protective film and stick on the paper cover beforehand if you like). Stack the spacers onto the screw.



3. Carefully turn the plate so to place the screw into the hole in the centre of the speaker grille. Screw it in using a screwdriver until the plate is held securely. Take care not to over tighten. The vibration plate needs to be held clear above the device so that it may oscillate freely without touching anything except the central support.

Connections

The CMX-70 is driven by a modified version of our DDS-40W controller which you can find fitted on the underside of the device. This circuit can be powered from a 12V to 26V DC supply. Power connection can be either via a standard 2.5mm DC socket, or using the terminal block connections marked V+ and GND. The speaker is connected to SPK- and SPK+.

Connections to external devices can be made using 3.5mm audio jacks to the sockets on either side of the circuit. To disable the on-board signal source and use an external one, the jumper link must be moved to the position marked EXT.

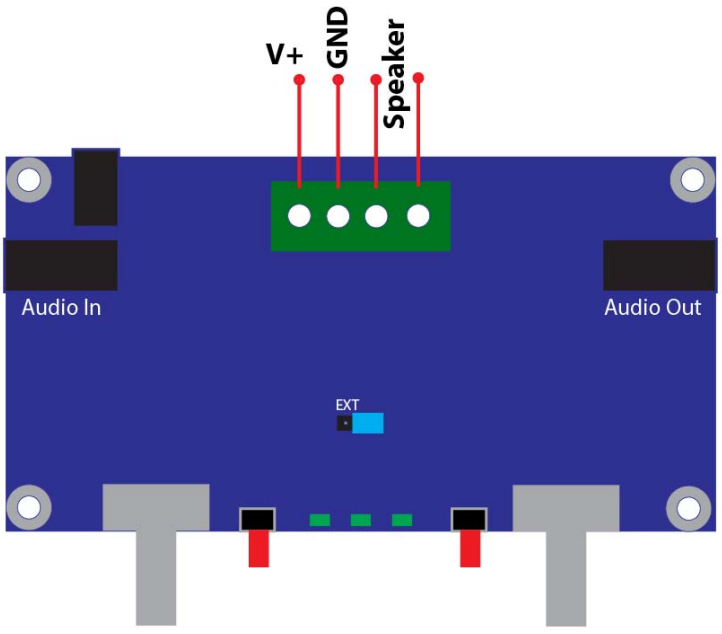


Figure 2: Connections (viewed from below)

Operating Instructions

- Place the device on a flat surface such as a table top. We suggest laying out some paper or using a tray to collect the sand as it falls off the device.
- Fix the vibrating plate to the speaker using the screw provided. You should also use some of the plastic spacers so that when fixed, the plate is held clear above the rest of the device. Ensure it is screwed in firmly but do not over tighten it.
- Make sure the volume is set to low and then plug in the power.
- Sprinkle some sand over the surface so there just enough to cover the surface while still showing the surface colour.
- Begin to turn up the volume slowly until the sand is moving and then slowly adjust the frequency. Some frequencies will need the volume to be higher or lower than others to work well so experiment with the controls until you are familiar with how it works.
- As you use the device, sand will fall from the edges, sprinkle more onto the surface to show a clear image.

Controls

The CMX-70 has four main controls. The two potentiometers are used for controlling amplitude (volume) and frequency. The two push buttons are used for special functions such as selecting the operating mode, storing tones, or adjusting the frequency range.

Mode Button
A short press of this button will cycle through the available operating modes which will also be indicated on the nearby LED indicators. In normal operation this will cycle between Sine and Playback modes.

Range Button
A short press of this button will toggle between high and low frequency ranges. Low frequency range will give an adjustable output from 10 Hz to 500 Hz, while high frequency mode will give 500 Hz to 25 kHz.

Frequency Potentiometer
This control will adjust the output frequency when using the on-board signal generator. The frequency range adjustable by this control is determined by the Rage button.

Amplitude Potentiometer
This control adjusts the output amplitude from either the on-board signal or an external one.

Record / Playback
To begin recording tones, hold the Mode button for about one second and then release it. You will hear a beep (if a speaker is connected to the output) and see the all the LED indicators illuminate together. You can now adjust the frequency control and press the Range button to reach the desired frequency. To save the tone, hold the Mode button again. You will hear a beep and observe an LED flash to confirm the tone was stored. You can store 10 tones in this way and once all ten are stored you will hear a double beep, then the LEDs will return to normal.

When in playback mode, both the left and right LEDs will be illuminated. The middle LED will flash each time the tone changes to the next one in sequence.

To replay the stored tones, cycle the mode to playback mode using the Mode button. Each tone will pay for the same amount of time and will loop endlessly through the 10 tones. In playback mode the length of time each tone plays is determined by the setting of the Freq control. You can turn this control to make the tones play faster or slower. Pressing the Range

button will cycle between longer or shorter tones allowing an adjustment of approximately 0.2s to 9s or 9s to 445s.

Important Usage Notes

- If the amplifier is overloaded it will interrupt the output. This may result in a distorted audio signal or intermittent shutdown of the output.
- Excessive weight or resistance on the vibrating plate could lead to overheating of the speaker coil. Only use for short periods if there is significant strain on the device.
- For best result, the vibrating surface should be as level as possible.

Vibration Surfaces

The shape and size of the plate used will have an effect on the shape of the patterns formed.

The surface supplied is a 0.5mm thick acrylic sheet cut as a 200x200mm square. The square shape can give a great range of patterns due to the creation of multiple interference zones as waves meet and reflect around the corners.

Circular surfaces will generally cerate simple concentric ring patters. This while less visually appealing is good for demonstrating the mathematical nature of the waves. By simply counting the number of rings formed and comparing this to the applied frequency, it is possible to calculate the speed of the waves propagating through the surface.

Figure 3: Circular Pattern Example

In the example above, the rings are spaced approximately 40mm apart. The frequency being applied was 1700 Hz. Therefore the wave velocity is calculated as follows;

$$V = f \lambda$$

1700 x 0.04 = **68 m/s**

Note that the waves that are causing this effect are not actually the longitudinal sound waves, but are a transverse wave much like ripples.

Complicated shaped surface will lead to more complex wave patterns; however, small details may not show through when the standing wave's wavelength becomes too small to cause any significant displacement on the surface.

The supplied surface is made from acrylic as it is lightweight and easy to cut. However, plastics do have a reasonable amount of attenuation to the vibrating and will damp out weaker vibrations, particularly at higher frequencies. Other materials such as sheet steel can work better for showing weaker vibrations, though its increased mass may be more difficult for the device to move.

External Audio

The CMX-70 has both input and output connections for external devices using a standard 3.5mm jack. The output is signal level only and should not be connected directly to headphones or speakers without an amplifier.

To use the audio input to drive the vibrating surface, you will need to move the small jumper link in the centre of the PCB on the underside of the device. In figure 2 above, you can see the default position for on-board audio. Move this jumper so that it links the two pins nearest the markings "EXT" this will disable the on-board audio and allow the device to be controlled by an external source.

A mobile phone makes an excellent controller as there are many audio generator apps available that can give you precise control over the frequencies you want to use.