



Setup

Input Power

Connect the included power supply to the power input of the Sine Wave Generator. Slide the ON/OFF switch to the right to turn it on.

Output Power

Connect a device such as a speaker or string vibrator to the output jacks of the Sine Wave Generator with a pair of 4 mm banana patch cords. Both jacks produce AC signals with opposite phases, so polarity is not important. (Note that the outputs do not float with respect to ground.)

If the Sine Wave Generator is connected to a short-circuit, the unit's short-circuit protection will shut off the output. Remove the short and cycle the input power to restore it.

Mounting and Storage

You can use the built-in clamp on the back of the unit to mount the Sine Wave Generator on a vertical rod, as shown. Rod mounting makes the display more visible for demonstrations and allows you to position the controls conveniently when you set up an experiment.

For storage, recessed dimples in the top of the case align with the feet on the bottom, allowing several units to be stacked as shown.



Operation

In addition to the description given here, there is a complete operational flow chart on page 10.

Manual Control

Amplitude

Adjust the amplitude of the output signal with the Amplitude knob. The amplitude range is approximately 0 V to 10 V.

Frequency

Set the output frequency with the Coarse and Fine Frequency knobs (labeled “1.0” and “0.1”). The LED display indicates the frequency to 0.1 Hz resolution. When the Sine Wave Generator is first turned on, it outputs the default frequency of 100 Hz. You can adjust the output signal from 1 Hz to 800 Hz.

The Frequency knobs are mechanical encoders with 24 discrete detents, or clicks, per revolution. One click of the Fine knob changes the frequency by 0.1 Hz. One click of the Coarse knob changes the frequency by 1.0 Hz if the knob is turned slowly, or 4.0 Hz if the knob is turned quickly. This allows you to change the frequency more quickly over a large range.

You can also use the Up and Down Increment keys to change the frequency. Each quick press of the Up or Down key changes the frequency by the stored increment. By default the increment is 100 Hz. To change the stored increment, see the Increment Keys section below. (If you press and hold the Increment keys, a different function will occur, so only use *quick* presses to change the frequency.)

This following sections describe how to change the stored frequency increment and program the Sine Wave Generator to play automatic sequences of notes. If you would like to skip to some practical demonstrations, see the Applications section on page 11.

Increment Keys

The Up and Down arrow keys have multiple functions. The Increment function is activated by a single quick press and release of either key. Other functions are activated when you press and *hold* the keys. For example, to implement the Play function you would press and *hold* the Up arrow key for about 1 second. The instructions may read, “press and *hold* the Play key,” or, “press the Up Increment key.” Both refer to the same key, but different functions. The labels below the keys (Store/Exit and Play) indicate the press-and-hold functions of the keys.

Changing the Output Frequency by the Stored Increment

Each *quick* press of the Up or Down Increment key changes the output frequency by the amount stored as the increment. The default increment (when unit is initially turned on) is 100 Hz. Thus, a single press of the Up Increment key will add 100 Hz to the output frequency. Try this:

1. Turn the Sine Wave Generator on (if it is already on, turn it off for a second, then back on). The initial output frequency is 100 Hz.
2. Press the Up Increment key. The frequency changes to 200 Hz. Press it again and it changes to 300 Hz. Press the Down Increment key and the frequency changes back to 200 Hz.
3. Use the Frequency knobs to change the frequency to 220 Hz.
4. Press the Up Increment key; the frequency changes to 320 Hz.
5. Press the Up Increment key several more times so that the output is 720 Hz. Additional presses of the Up Increment key will do nothing because the output will not exceed 800 Hz.

Setting the Stored Increment

The harmonics of a resonating device (such as a vibrating string or tube) are usually spaced at equal frequency increments. It is useful to set the Sine Wave Generator's stored increment to match your device.

The label below the Up arrow key reads Store/Exit. When you press and hold this key, it will function as a Store key; the stored increment will change to the value on the display (which is the output frequency). Try this:

1. Use the Increment keys and the Frequency knobs to set the output to 120 Hz.
2. Press and *hold* the Store key. After 1 second the display will blink and you can release the key. The stored increment is now 120 Hz.
3. Press the Up Increment key a few times; the frequency changes by 120 Hz with every press.

This value will remain stored until a new value replaces it or the unit is turned off.

Auto Play

In Auto Play mode you can program the Sine Wave Generator to scan automatically through the harmonics of a device.

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The label below the Up arrow key reads Play. When you press and *hold* it, this key will start automatic play. Try this:

1. Set the stored increment to 120 Hz (as described above).
2. Use the Amplitude knobs to change the output frequency to 60 Hz.
3. Press and *hold* the Play key. The display will blink to show you that Auto Play has started, and you can release the key.
4. The Sine Wave Generator will play the starting note (60 Hz), then increment to the next notes (180 Hz, 300 Hz, 420 Hz, etc.), playing each note for 1.5 seconds. You can use the Amplitude knob to adjust the output.

Duration of Each Note

While in Auto Play mode, you can use the Frequency knobs to change the duration of each note. By default, each note is played for 1.5 seconds. If you turn the Course (1.0) knob one click clockwise, it will increase the duration by 1 second. The display will switch over to show the duration (in seconds), and then switch back to showing the frequencies. One click of the Fine (0.1) knob will change the duration by 0.1 second. The duration can be set from 0.1 to 99.9 seconds.

Wrap Around

Auto Play will continue to increment the frequency until it reaches the maximum (up to, but not over 800 Hz); then it will wrap around and start the sequence again. To make Auto Play wrap around at a lower frequency, press and *hold* the Play key when the sequence is at the highest note that you want. (The display will blink after 1 second to indicate that you can release the key.)

Exit Auto Play

To stop Auto Play, press and *hold* the Store/Exit key. (The display will blink after 1 second to indicate that you can release the key.) The Sine Wave Generator will return to normal mode, and the output frequency will return to the original starting frequency.

Advanced Mode: Record and Playback

In Advanced Mode you can set, store and play back a sequence of up to 80 notes. The Sine Wave Generator will record the frequency and *amplitude* of each note. Advanced Mode is especially useful when demonstrating resonance in vibrating strings because it allows you to set the optimal amplitude and frequency for each harmonic.

This mode is a hidden sub-layer so as to not confuse the student with extra complexity in normal lab use. It is intended for the teacher's use in demonstrations. Although it is "hidden", it is easily accessible and straightforward to use.

Entering Advanced Mode

Press and hold *both* arrow keys simultaneously (as shown) until the display changes to indicate the number of recorded notes. If no sequence is stored it will display "0."

After entering Advanced Mode there are 3 options:

Exit: Press and *hold* the Store/Exit key to leave Advanced Mode and return to normal mode.

Play the Stored Sequence: Press and *hold* the Play key. The Sine Wave Generator will enter Playback Mode and play the sequence of recorded notes. (If there is no recorded sequence, this action will exit Advanced Mode.)

Enter Record Mode: Press and hold *both* keys simultaneously again to enter Record Mode. The display will show "0" (to denote that it has cleared out the previously stored sequence) and begin to flicker to indicate that the unit is in Record Mode.



Record a Sequence of Notes

In Record Mode the display will always flicker. When you enter Record Mode, the display shows the output frequency. Connect the apparatus (such as a string vibrator with a string) to the Sine Wave Generator so that you can tune the frequency and amplitude for each harmonic.

1. Enter Record Mode (see above).
2. Set the frequency *and amplitude* of the first note in the sequence (usually the fundamental resonance frequency of the apparatus).

The Frequency knobs and the Increment keys function as normal. Use only a *quick* press and release to implement the up and down increment. The increment value is what it was set to before you entered Advanced Mode.

3. Press and *hold* the Store key until the display changes; for a moment the display will show the total number of stored notes, then return to showing the frequency.
4. Adjust the frequency and amplitude for the next note in the sequence and return to step 3.
5. After you have stored the entire sequence of notes, press and *hold* the Play key until the display stops flickering. The Sine Wave Generator will switch to Playback Mode and begin to play the sequence that you have recorded.

While you are recording a sequence, be careful not to make a mistake. There is no way to edit a note in the sequence after it has been stored. When you enter Record Mode, all previous notes are erased and you start over. Once you have stored a note, you can not change or erase it.

Playback of Stored Notes

With the Sine Wave Generator in Playback Mode and playing the stored sequence, you have several options:

Amplitude: If you turn the Amplitude knob all the way up, the unit will play back the stored notes exactly as you recorded them. If you turn the knob down, it decreases all of the stored notes by the same proportion.

Duration: You can use the Frequency knobs to change the duration of every note. The default duration is 1.5 seconds. The Course (1.0) knob changes the duration by 1 second per click, the Fine (0.1) changes the duration by 0.1 second per click. If you exit Advanced Mode and return later, the Sine Wave Generator will remember the previous duration setting.

Pause: A *quick* press of the Down arrow key pauses the playback of the stored sequence. To resume playback, press and *hold* Play until the display blinks.

While paused, a quick press of the Up or Down arrow key will cause the next or previous note in the sequence to play.

While paused, you can use the Frequency knobs to vary the output frequency. This is useful to show what happens when the driving frequency is slightly off resonance. Changing the frequency with the knobs while playback is paused does *not* change the stored notes.