SOURCE

Source PSU Source AC/DC PSU & signal generator worksheets

CP7670

MATRIX

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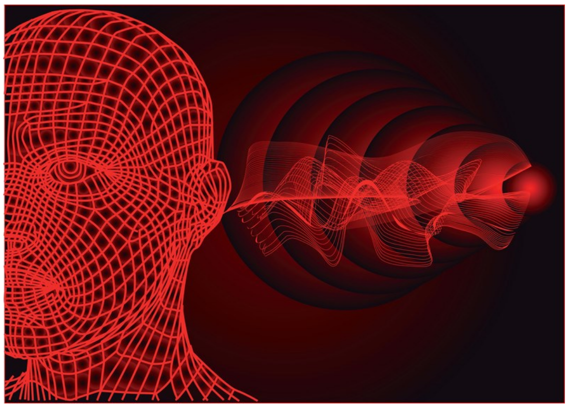
Contents

The Source

Just Listen!



We describe the sounds that we hear using ideas like 'pitch' and 'loudness'. However, sound waves are measured using terms such as 'frequency' and 'amplitude'.

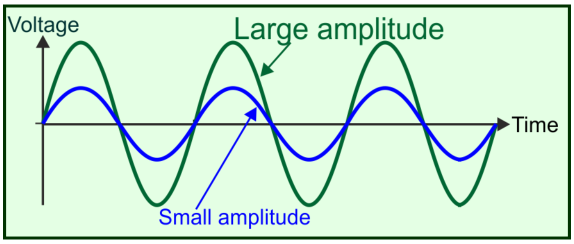
We can recognise different people from the tone of their voice and distinguish between different musical instruments even when they play the same note.

This demonstration shows how these terms are related.

Over to You

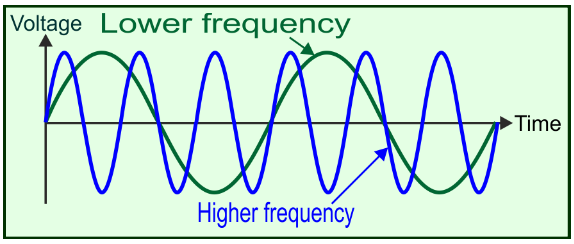
Connect the speaker to the loudspeaker terminals of **Source** and switch it on.

1. Loudness



- Use rotary knob to select the AC tab.
- Use 'Down' button to select 'Amplitude' and press rotary knob.
- You are now on the 'Edit value' screen.
- Rotate the knob to change the amplitude of the sound wave from 1.0V to 5.0V.
- Notice the effect on what you hear, as you do so.

2. Pitch



- If necessary, select the AC tab again.
- Use the 'Down' button to select 'Frequency' and press the rotary knob.
- On the 'Edit value' screen, rotate the knob to increase the frequency of the wave slowly from 300Hz up to 600Hz.
- Again, notice the effect on the sound that you hear.

3. Tone

- If necessary, select the AC tab again.
- Set the frequency of the sound to 300Hz and its amplitude to 1.0V.
- Use the 'Down' button to select 'Wave Type' and press the rotary knob.
- On the 'Edit value' screen, rotate the knob to change the wave type and notice the effect on the sound you hear.

Sine waves are the simplest. They contain only one frequency. Other 'shapes' of wave are built up from a large series of sine waves of higher and higher frequencies, called harmonics.

The Source

Piped music!

A church organ uses pipes of various lengths to produce different notes. A trombone player moves the slide in and out to change the note produced.

It's all a matter of **resonance** - making the column of air inside the pipe vibrate at its natural frequency.

These activities demonstrate the effect.

Over to You

- Connect the speaker to the loudspeaker terminals of **Source**.
- Place a one metre length of plastic pipe on the bench, so that the speaker sits close to one of the open ends.
- Switch on **Source**.
- Select the AC tab and set the amplitude to 1.0V.
- Use the 'Down' button to select 'Frequency' and press the rotary knob to enter the 'Edit value' screen.
- Rotate the knob slowly to change the frequency of the sound wave from 100Hz to 200Hz.
- Notice that the sound intensifies at one particular frequency and seems to come from the end
- of the pipe rather than from the speaker. This is one of the resonant frequencies of the pipe. If you are unsure, move the pipe away from the speaker to check if the loudness has intensified.

  Resonance is caused when two sound waves of exactly the right frequency and amplitude, travelling in opposite directions, combine together.

- Starting at this resonant frequency, increase the frequency until you hear resonance again. (It may not be quite as distinct this time.)

- Now do exactly the same again using a plastic pipe 0.5m long.
- This time, start from a frequency of 200Hz.

- Repeat the procedure but this time, close one end of the pipe with your hand. You should find a different set of resonant frequencies.

Weird wobbles

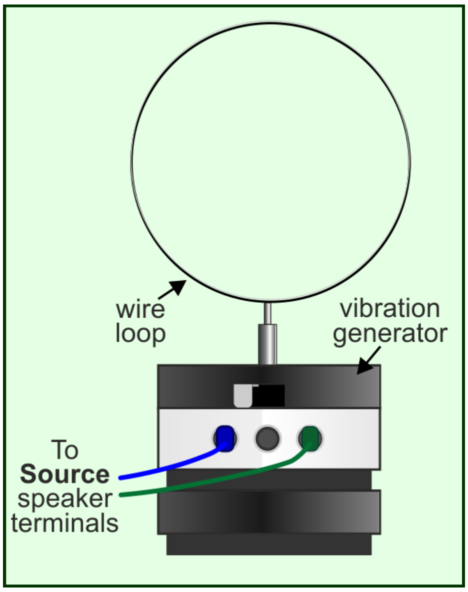
Resonance again, but not in air this time!

Most structures have particular frequencies which cause them to vibrate in some way.

When engineers design bridges and tall buildings, for example, they need to take steps to counteract this vibration, which can cause serious damage.

Over to You

The wobbly loop:



- Connect the vibration generator to **Source**'s loudspeaker terminals.
- Attach the wire loop to the vibration generator.
- Switch on **Source**.
- Use the rotary knob to select AC tab.
- Use the 'Down' button to select 'Amplitude' and press the rotary knob to enter edit mode.
- Set the amplitude of the vibration to 5.0V.
- Use the 'Down' button again and select 'Frequency'.
- In edit mode, rotate the knob slowly to increase the frequency of vibration from 1Hz to around 70Hz, watching the wire loop as you do so.
- At a number of frequencies, it develops 'lobes' of large movement with neighbouring points of virtually no movement.

The Source

Vibrating strings

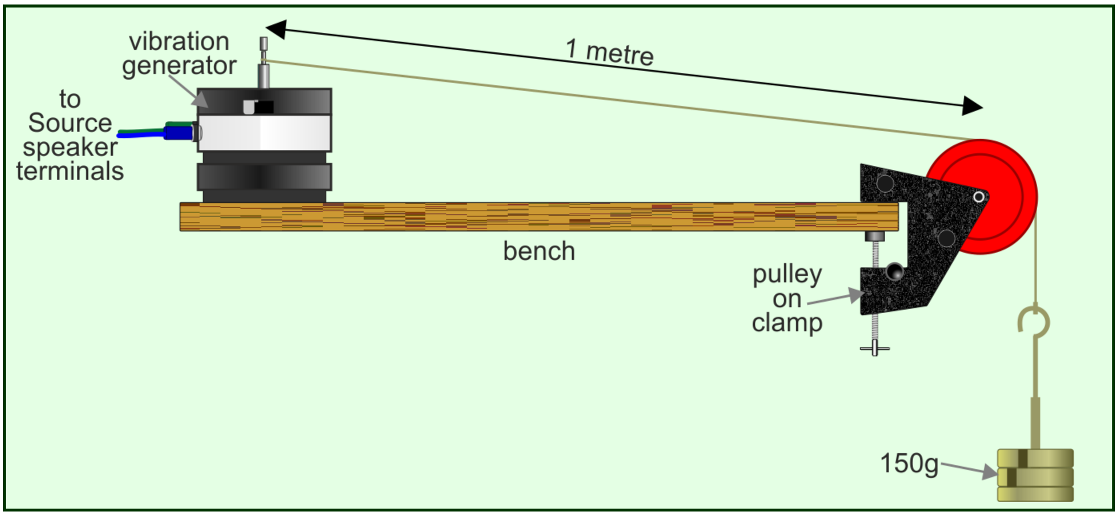
Resonance again!

Guitarists can produce a variety of notes from the guitar by changing the length of the string or by choosing a string under different tension.

This activity illustrates why this works.

Over to You

- Connect the vibration generator to **Source.**
- Attach a length of string to the shaft of the vibration generator and hang the other end over the pulley to give a length of 1 metre between pulley and vibration generator.
- Hang a slotted mass holder with a total mass of 150g from the end of the string.



- Switch on **Source**.
- Use the rotary knob to select the AC tab and set 'Amplitude' to 5.0V.
- Now use the 'Down' button to select 'Frequency'.
- In edit mode, rotate the knob slowly to increase the frequency of vibration from 10Hz to around 70Hz and watch the behaviour of the string as you do so.

  At a number of frequencies, it develops 'lobes' of large movement with neighbouring points of virtually no movement. This is caused by the wave generated by the vibration generator, travelling down the string towards the pulley, combining with a reflected wave, travelling back to the vibration generator.
- Lower the tension in the string by reducing the mass of the mass hanger to 100g.
  What effect does this have?
- Reduce the length of string to 75cm.
  What is the effect of this change?

The Source

Hear the beat

Guitarists again!

One way to ensure that the strings of a guitar are 'in tune' with each other is to use 'beats'.

The guitarist plays the same note on two strings. If the player hears a throbbing sound (beats) then the strings are not quite in tune.

The tension in one string is adjusted until the beats die away to a steady sound.

Over to You

- Connect the speaker to the AC speaker sockets on **Source**.
- Switch **Source** on.
- Use the rotary knob to select the AC tab.
- Set the amplitude of the wave to 1V and its frequency to 500Hz.
- Place your mobile phone next to the speaker and use the 'Sound Recorder' app. to record about 30s of the tone produced by the speaker.
- Stand your mobile phone next to the speaker and replay the recording.
  It is generating exactly the same tone as the speaker, but you may need to adjust the playback volume to match that of the speaker.
- Now, change the frequency of **Source**'s AC output by one or two hertz (i.e. from around 498 Hz to 502Hz.)
- Describe what you hear.

The Source

Flashy

On film and TV, helicopter blades, wagon wheels and cycle spokes often seem to do the impossible and rotate very slowly, or even rotate backwards.

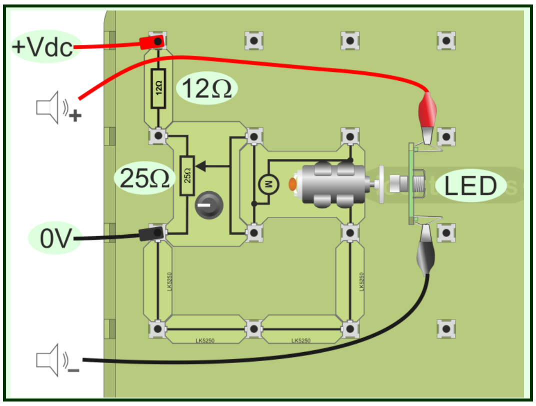
A trick of the light?

In a way, yes.

More precisely, a trick of ***stroboscopic*** light.

Over to You

- Set up **Source** so that:
  - the AC terminals output sine waves with an amplitude of 10V and a frequency of 100Hz;
  - the variable DC terminals output 5.0V .
- Build the Locktronics circuit shown opposite and connect it to **Source**'s '+Vdc' and '0V' terminals as shown. The 'pot' controls the speed of the motor.



- Connect the ultrabright LED to **Source**'s AC sockets, as shown.
- Switch on **Source**.
- Place the LED close to and pointing at the motor. Although our eyes are not aware of it, the LED is flashing on and off one hundred times a second.
- Slowly increase the speed of the motor by turning the knob on the 'pot'.
- Watch the appearance of the motor flywheel as the speed increases. What do you notice?

  The effect is caused by the flashing LED. We see the flywheel only during these flashes.
  If they occur when the flywheel is in the same position, it appears as if it is stopped.
  If the flashing is a little faster, then the flywheel doesn't quite get to the same position each time. It appears as if it is rotating slowly backwards!

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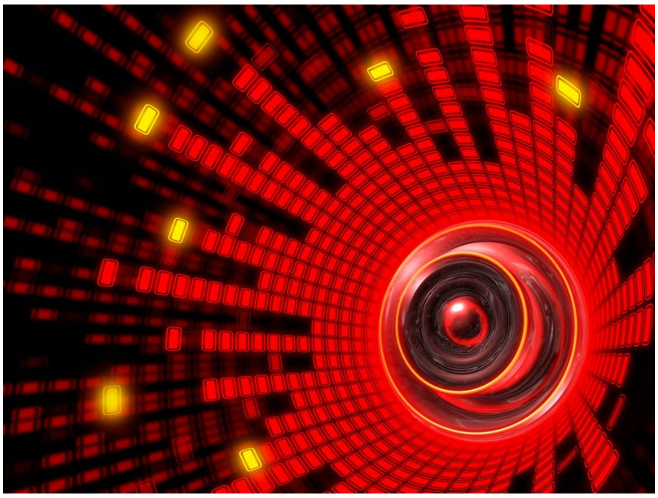
In sequence



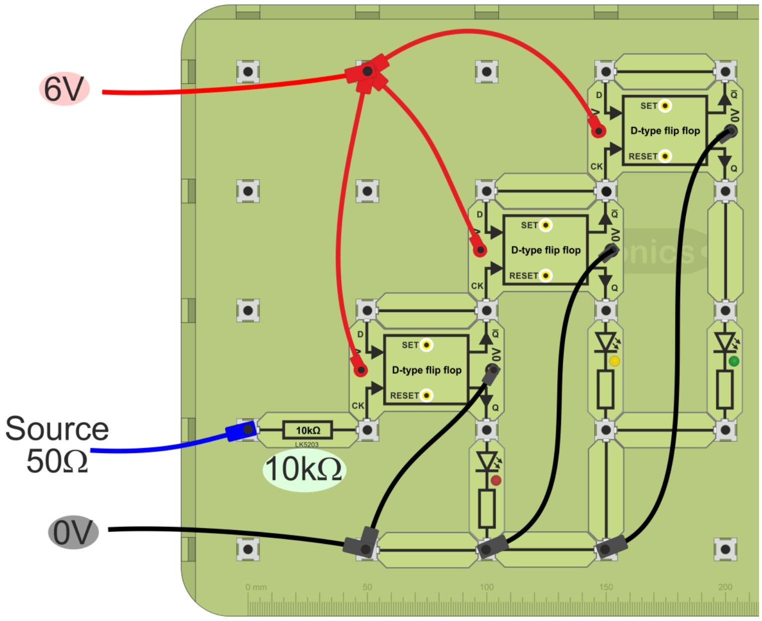
Many modern electronic systems create sequences:

- traffic lights;
- washing machines;
- vending machines;
- Christmas lights, etc.

Here is a simple example.
It is actually a three-bit counter, able to display a count of up to seven, (in binary notation.)

Over to You

- Build the Locktronics circuit shown opposite.
- Connect it to the **Source** terminals as shown. (Notice that we are using the 50Ω AC output.)
- Switch on **Source**.
- Set it up so that the AC terminals output square waves with an amplitude of 6V and a frequency of 5Hz.
- Observe the sequence produced on the LEDs.



Each D-type flip-flop generates the pulse that triggers the next. Hence they change in sequence.

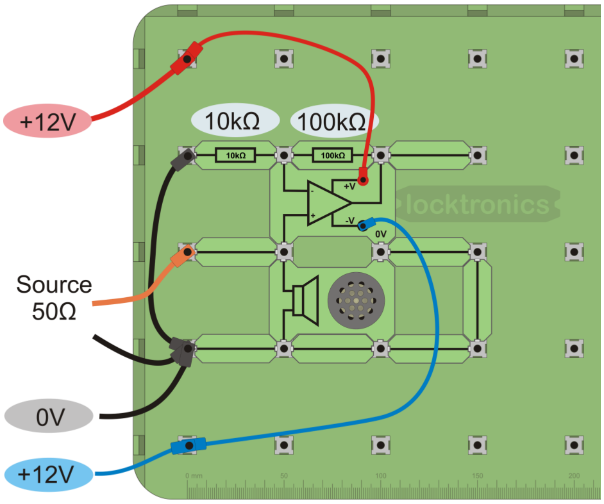
The Source

Booster

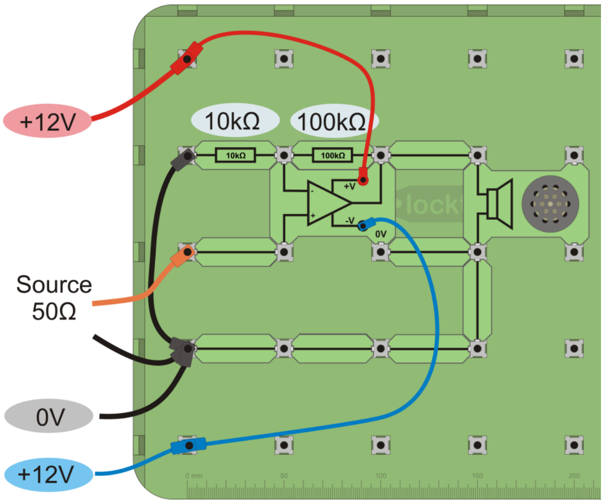
Amplifiers are everywhere!

They are built into hi-fi systems, mobile phones, instrumentation, televisions, heart monitors and a multitude of other electronic systems.

Over to You



- Build the Locktronics circuit shown opposite.
- Connect it to the **Source** terminals as shown. (Notice - we are using the 50Ω AC output)
- Switch on **Source**.
- Set it up so that the AC terminals output sine waves with an amplitude of 1V and a frequency of 1KHz.
- The speaker is connected to the input signal of the amplifier.
- Listen closely to the speaker - you should be able to hear a faint sound.



- Now move the speaker to the new position as shown opposite. The speaker is now playing the output of the amplifier.
- What do you notice?

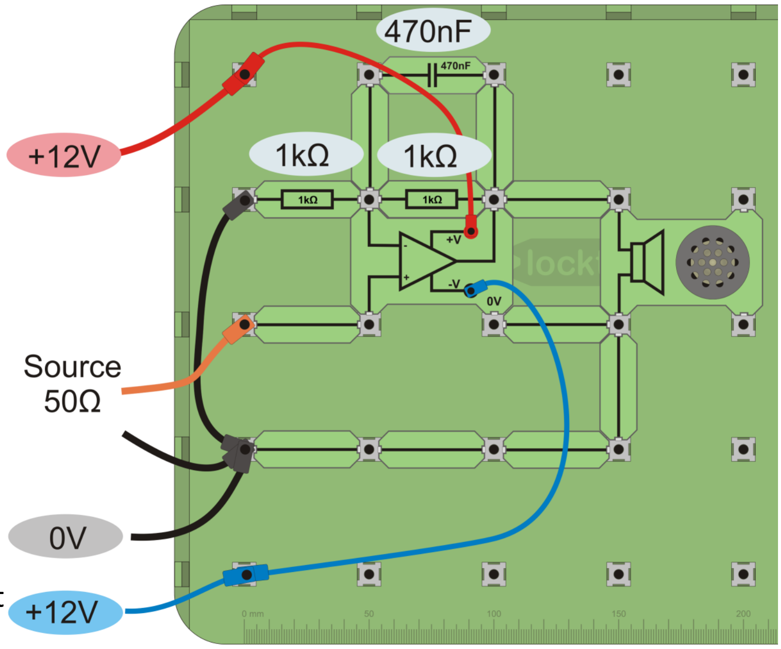
The Source

Filter the treble

In recording studios, it is important to be able to manipulate the sounds - boost some frequencies, reduce others, add effects etc.

This system illustrates the process. It cuts high frequencies but leaves low frequencies unaffected.

Over to You



- Build the Locktronics circuit shown opposite, but with the 470nF capacitor removed from the circuit.
- Connect it to the **Source** terminals as shown. (Using the 50Ω AC output.)
- Switch on **Source**.
- Set it up so that the AC terminals output square waves with an amplitude of 5V and frequency of 500Hz.
- Listen to the sound from the speaker.
- Now place the 470nF capacitor into the circuit as shown opposite.
- The speaker is now playing the output of the filtered audio signal.

What do you notice?

This system removes a portion of the higher (treble) frequencies from the signal. As a result, the output doesn't sound so harsh.