RealSimPLE:

Strings

Monochord Assembly Instruction

RealSimPLE lives on the web:

For high school: in Swedish and English http://www.speech.kth.se/realsimple

For college and university, in English: http://ccrma.stanford.edu/realsimple

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RealSimPLE - Reality and Simulations in a Pedagogical Learning Environment – is a collaborative research and development project involving KTH, Stanford University and the House of Science. It is supported through the Wallenberg Global Learning Network. www.wgln.org by the Knut and Alice Wallenberg Foundation.

Kungliga Tekniska Högskolan; School of Computer Science and Communication; Department of Speech, Music and Hearing. www.speech.kth.se

Stanford University, California, USA - Department of Music, Center for Computer Research in Music and Acoustics (CCRMA). http://ccrma.stanford.edu

House of Science, KTH Albanova, www.houseofscience.se

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Parts list

- One wooden plank 110 cm long, 93 mm wide and 20 mm thick.

- Two bolts M6 × 40 mm

- A tuning screw for guitar

- Two nuts for guitar

- Two simple screw clamps

Two rectangular magnets

- Violin steel G string (196Hz)

Optional optical sensors (typically less than $10 each):

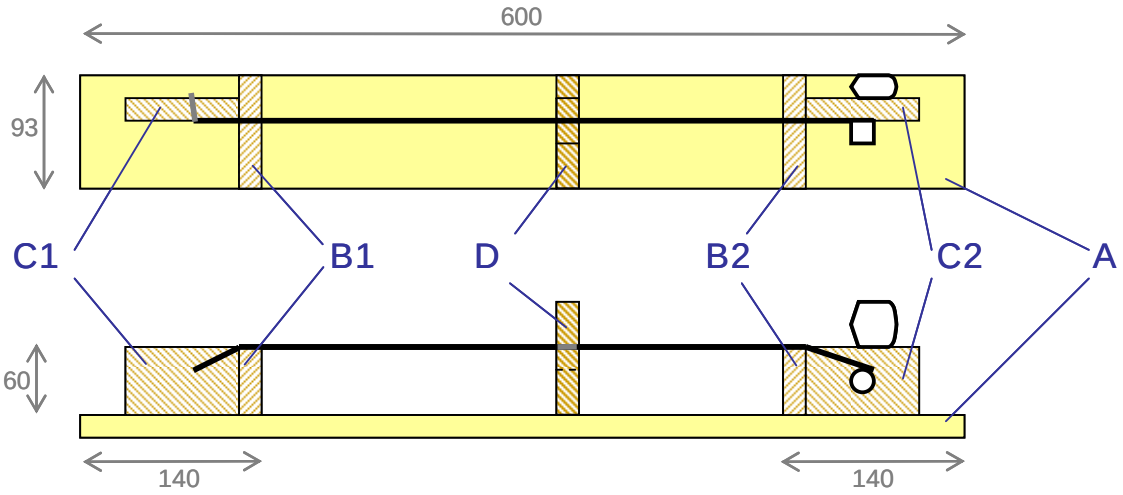
OPB815 W with 9.5 mm gap (Optek)
ELITR8102 with 3 mm gap (Everlight)
ELITR8402 with 6 mm gap (Everlight)

List of tools

- Folding rule or large ruler
- Saw
- Rasp
- File
- Clamps
- Hammer
- Chisel
- Screw gun or drill with the following accessories:
    - 5,5 mm (7/32")drill bit
    - Drill bit to pre-drill pilot holes for the screws – diameter depends on screw size.
    - Drill bit to countersink the sleeveof the nut
    - Screw bits that fit the screws and bolts

Assembly

Top view



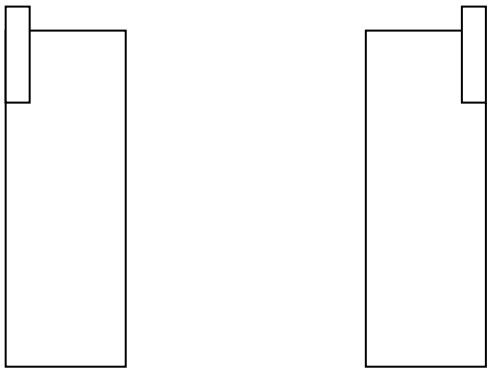
Side view

1. Cut out the six wooden parts from the plank. The parts can favourably be drawn on the plank using the folder rule beforehand.

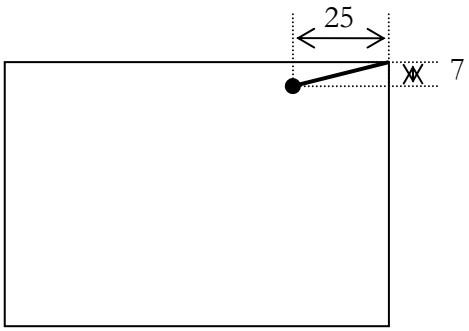
Part name	Measures (mm)
A	600 x 93 x 20
B1	60 x 93 x 20
B2	60 x 93 x 20
C1	100 x 60 x 20
C2	100 x 60 x 20
D	100 x 93 x 20

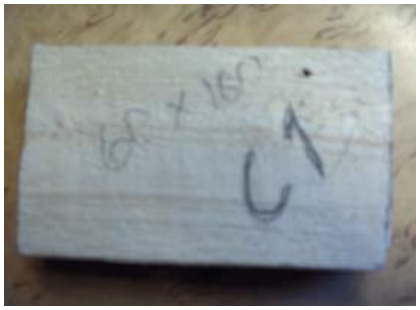
(mm)	A ←600→	(X) C1 ←100→	C2 ←100→	B2 ←60→	B2 ←60→	D ←100→

2. Make a recess 3 mm wide and 8 mm deep along one upper edge of the transverse supports B1 and B2 (the boundary condition of the string). Change the measures of the recess if necessary to fit the nuts.

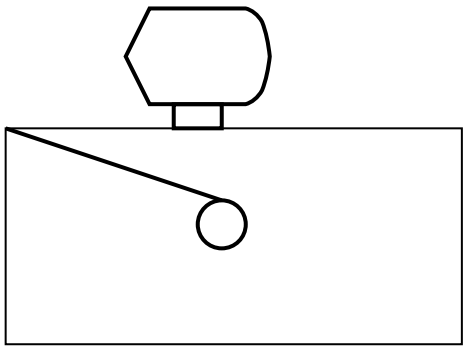


3. In the longitudinal support C1, drill a hole with the diameter 2 mm (5/64") through which to pass and fasten the string. Place the hole 7 mm from the upper edge and 25 mm from the end.

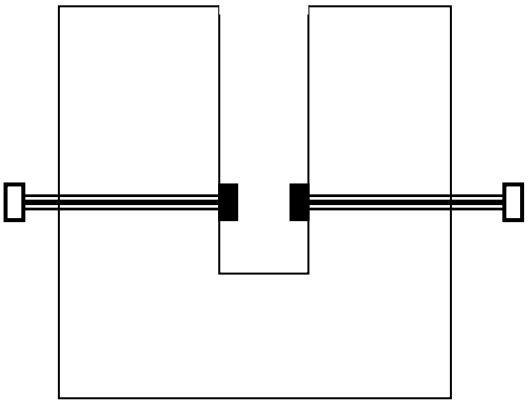




4. Drill a hole with the diameter 5.5 mm (7/32") in the longitudinal support C2 in which the tuning screw is mounted. Place the hole 20 mm from the upper edge and 40 mm from the end. Change the position of the hole if the tuning screw so requires. If necessary use the chisel to make a groove in which the tuning screw is going to be mounted if its cylindrical arm is too short. A snug fit of the tuning screw is very important.



5. Make a recess in the magnet holder D from the upper edge 55 mm tall and 14 mm wide. On both sides drill a 5.5 mm (7/32") hole, 45 mm from the upper edge, into which the 40 mm M6 bolts are screwed. The tip of each bolt needs to be filed flat.

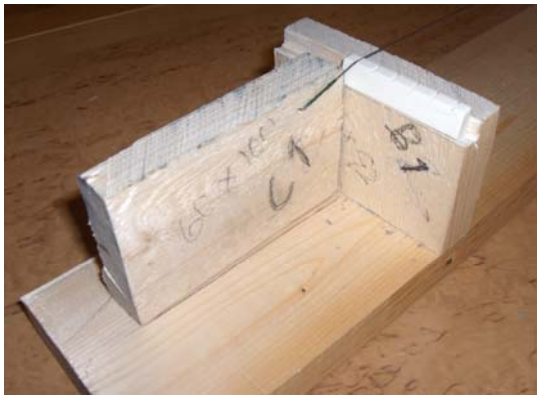


6. Place the two rectangular neodymium magnets on the bolt tips. The magnets are helt in place by their own magnetic force.

7. Glue and/or screw the transverse supports B1 and B2 to the bottom plate A with the recesses facing away from each other. The distance between the side facing outwards on the transverse supports to the respective ends on the bottom plate should be 140 mm.

NB! It is necessary to pre-drill pilot holes for all screws to avoid cracks in the wood.

8. Glue and/or screw the longitudinal supports C1 and C2 to both B1 and B2 and to the bottom plate.



9. For a horizontal magnetic field, attach the clamps (see photograph) so that the recess is vertical. The Magnet Holder can then be moved alongside the string and also be rotated 90 degrees for vertical magnetic field.

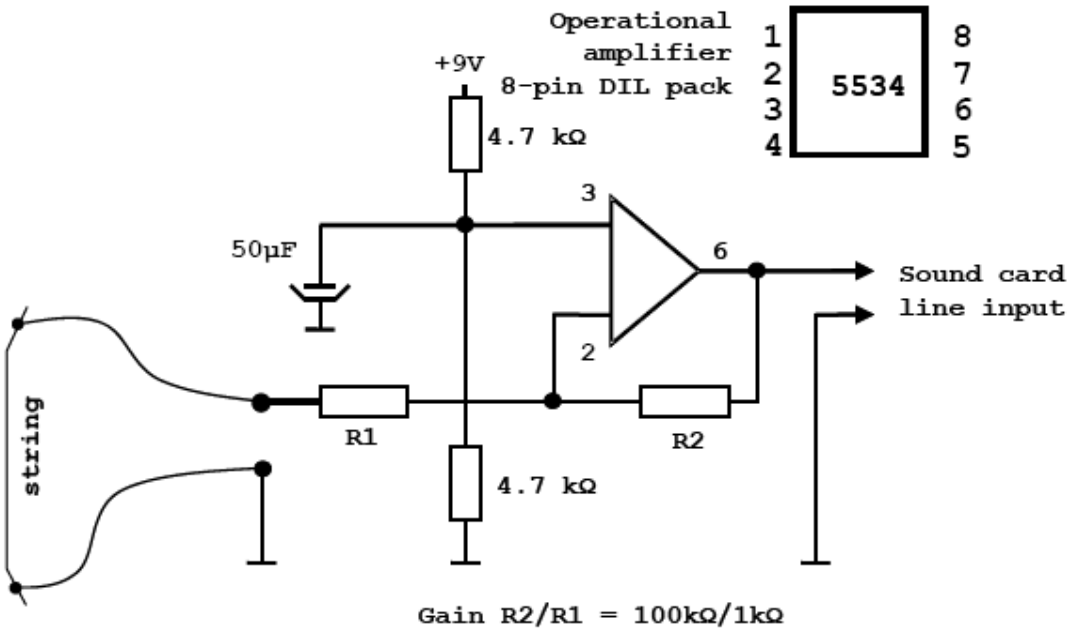
10. Mount the string by passing it through the 2 mm hole in C1, over the nut on B1, further on over the nut on B2 and finally to the tuning screw in C2.

11. Fasten the string to the tuning screw by winding it at least half a turn around the peghead before running it through the hole. Pull the string fairly tight and hold it in place while tightening the tuner clockwise until an appropriate string tension is achieved.

Magnetic pickup amplifier

An amplifier might be needed if the microphone input on the sound card proves to be too noisy.

The signal levels are faily low. Using a 9V battery supply reduces possible problems with hum and earth loops. The signal output is proportional to the velocity of the string.



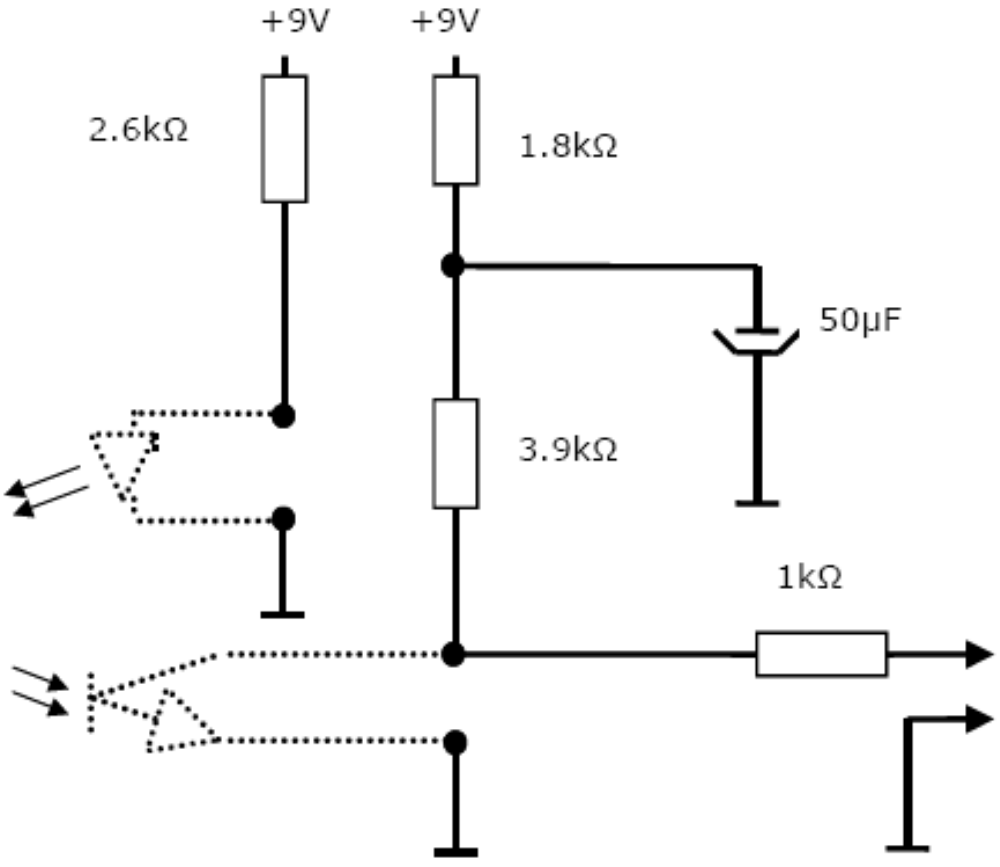
Optical transducers

Each transducer is a LED/phototransistor pair that are mounted facing each other, in what is henceforth called a "fork." The fork must be carefully positioned such that the string at rest partially obstructs the light passing from LED to the phototransistor. The string does not need to be an electrical conductor. Optical transducers measure the string's displacement. With two of them mounted at right angles, both horizontal and vertical deflection can be measured. Optical transducers are best mounted near one end of the string.

Mounting

1. Make a small wooden block that can be clamped onto support B1.
2. Mount the fork on the small block, such that the light from the LED is shadowed by the string before reaching the phototransistor, see http://www.speech.kth.se/music/acviguit4/ chapter 9 Figure 9.14

Drive circuit and pickup circuit for optical transducers, O1 and O2.



Positioning the optical sensor

The optical transducer can be correctly positioned using only a voltmeter, measuring the output voltage of the circuit shown above. Test the fork by measuring the output voltage both for unobstructed light and when the light is blocked by an opaque object. This will give the working range. An example is shown in the table.

Note that stray light in the room will significantly affect the result. These measurements should be done in a darkened room or under cover.

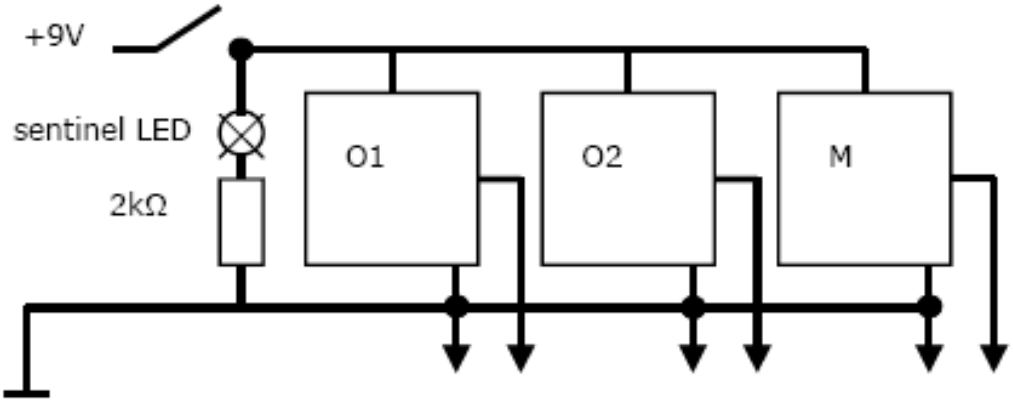
Fork gap	Unblocked [V]	Blocked [V]
9.5 mm	0.25	3.7
6 mm	1.1	3.6
3 mm	0.52	3.6

Select the resting point as the voltage midpoint between the two extremes. Adjust the position of the fork so that the midpoint voltage is reached. Start from the unobstructed position and move the fork slowly.

For example, with a violin G string of .75 mm diameter gives the voltage 0.38 V when unblocked and 3.0 V blocked, giving a midpoint voltage of 1.7 V.

The position must be accurate to a few tenths of a millimeter. When acquiring the string vibrations, the oscilloscope and/or sound card should be AC-coupled. Sound cards are almost always AC-coupled.

The optical method requires 10 times higher accuracy for positioning than does the magnetic method. The magnetic velocity signal can be time-integrated to give displacement, which is easier to understand.



Block diagram for the two optical transducers O1 and O2 and magnet preamplifier M.

FAQ