Boom Box Project (Teacher's Guide)

This document is intended as a Teachers Resource Guide . The objective of this document is to assist with showing how to construct the Electronics components of a "Boom Box" project. We anticipate that most teachers will arrange their own housing as a different part of the syllabus. *(If you need help with a plastic box to provide a quick solution for housing, we can offer some choices for you).* These notes are written with the expectation that most students have little or no previous experience with constructing electronics systems.

A demonstration of a completed system can be seen at http://youtu.be/b6itB7rU2Kw

Resources you will need:

- Kitstop Stereo Audio Amp kit with Speakers (P/N FK675)
- Kitstop "Boom Box Kit Components" (P/N KSBOOMBOX)
- Locally written Teacher's Guide for FK675
- A copy of the locally written "Student Instruction Sheet for FK675" (provided as a soft copy with class sets).
- Locally written Teacher's Guide to "Wiring a 3.5mm Stereo Audio Plug".
- A copy of the locally written guide "Towards Better Soldering" (provided as a soft copy with class sets).
- 9V DC power source. *(We recommend using a 9V DC Plug pack if your students want a long operational life, OR please consider a 6 X AA Battery holder.)*
- Soldering Iron
- Soldering Iron Stand with a damp cloth or sponge
- Diagonal Pliers ("Side-cutters")
- Solder sucker or Solder wick (for removing unwanted solder)
- Any extra equipment you choose for building the housing for this project.

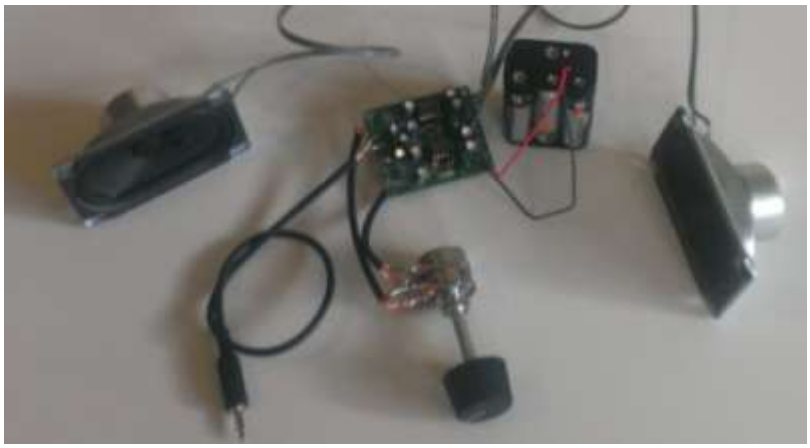


Fig. 1 : Key Electronic components of the Project.

Boom Box Project (Teacher's Guide)

What we are building:

This instruction guide will show you how to assemble the Electronics module and components into a working audio amplifier system which can be used to plug into an IPod or similar source of audio signal.

This guide does not include directions on building a protective housing for the completed system.

Introducing the 6 key parts of the system:

For this system to work well and reliably, there are 6 key sub-systems which need to be considered and assembled correctly. *(Refer to Fig 2).* These 6 sub-systems are:

1) The Audio Amplifier module
2) The Speakers and the wiring to them.
3) The 3.5 mm audio plug and the correct wiring to it.
4) The volume control ("Gang Potentiometer") and the correct wiring to it.
5) The electrical power source.
6) The mechanical housing (not included in these notes, but we will offer some considerations).

Boom Box Project (Teacher's Guide)

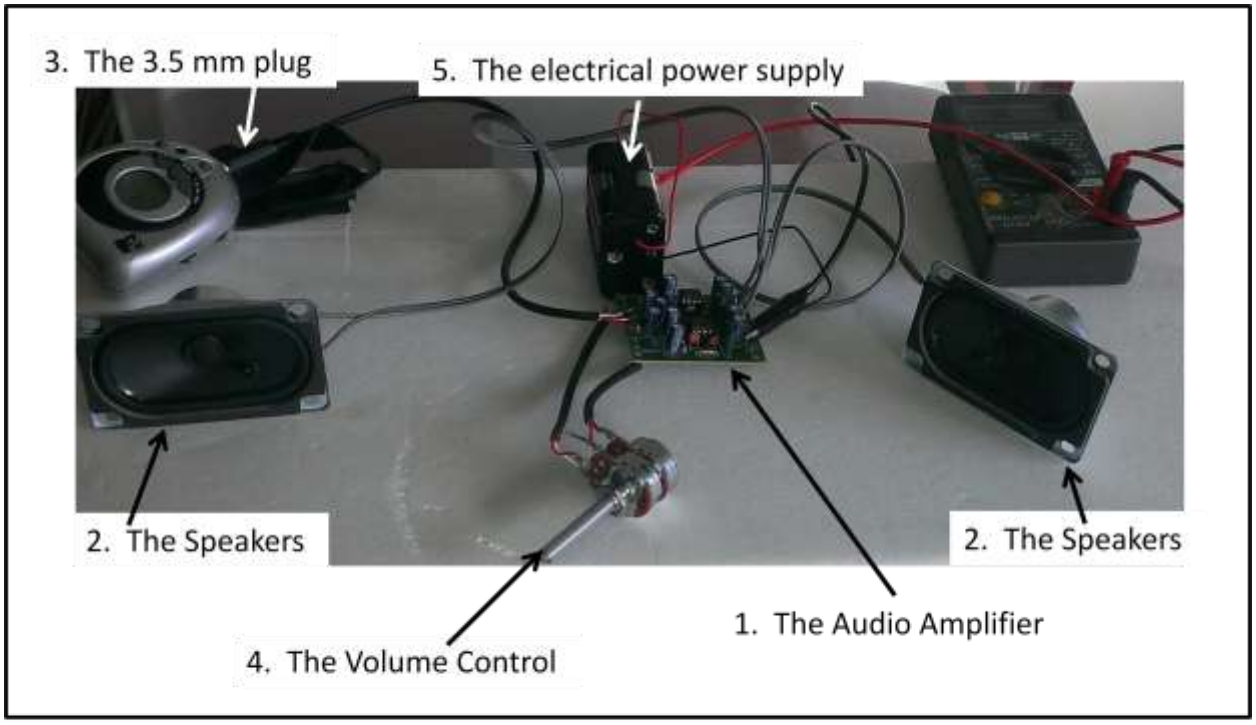


Fig 2: Identifying the main sub-systems of a completed project

Note the following items are NOT included in the kit:

1) *Audio source is the small radio on the top left of the picture.*
2) *The meter on the top right is an ammeter used during the design and testing of this project.*

Constructing the Audio Amplifier Module:

Please refer to our FK675 Instruction guide for detailed information on assembling the audio Amplifier. *(Kitstop also offers Student Instructions for this stage).* The following change needs to be considered:

- Do NOT install the small "trimpots" supplied in the FK675 kit. Instead follow the instructions later in this guide for the Volume Potentiometer.

Boom Box Project (Teacher's Guide)

The Speakers and the wiring to them:

The speakers and the Amplifier output have a definite "+" and "-" .

Refer to figure 3 for a close up of the speaker , to identify the orientation of the mounting tabs.

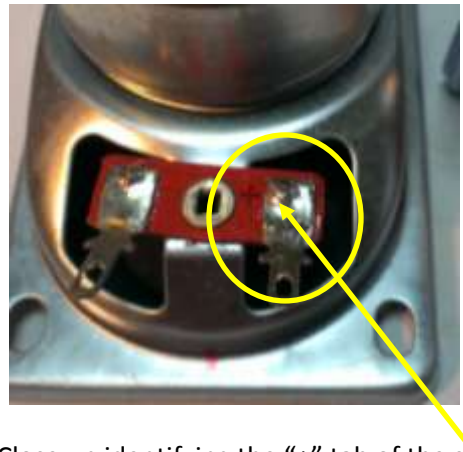


Fig. 3 : Close up identifying the "+" tab of the speaker.

The supplied speaker wires have one conductor marked with a black stripe. We recommend that students be encouraged to set their own protocol for wiring to the speakers. Usual international wiring protocols adopt the marked conductor as the "+", which we have also copied for this guide. Refer to Figure 4.

Boom Box Project (Teacher's Guide)

Fig. 4 : Identifying the marked conductor in the speaker cable PLUS showing leads stripped and tinned prior to connection to the speakers.

The final process for the speakers is to connect them to the Amplifier.

i) Ensure the "+" wire on the left speaker is attached to the pin marked "SP L".

ii) Ensure the "+" wire on the right speaker is attached to the pin marked "SP R".

iii) Ensure the two ground wires from both speakers are joined together and then attached to the Amplifier output pin which located between the "SP L" and "SP R" pins.

Refer to figure 5.

Boom Box Project (Teacher's Guide)

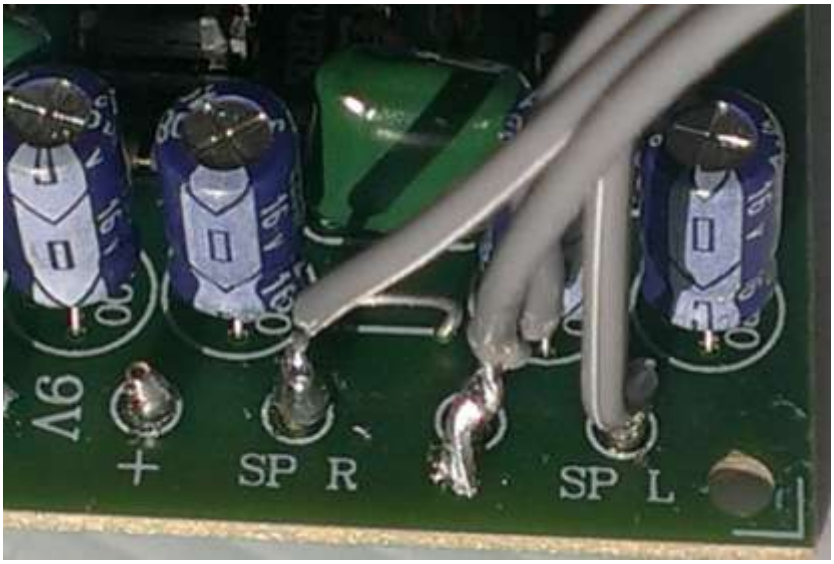


Fig. 5 : Showing the speaker wires attached to the Amplifier output pins.

The 3.5 mm audio plug and the correct wiring to it:

Step 1: Wire up the 3.5mm audio plug.

For technical support and guidance on wiring up the 3.5 mm audio plug, please refer to our separate Teacher Guide titled "Wiring a 3.5 mm Stereo Audio Plug" . This document offers a pictorial step-by-step guide along with some background information and common industry protocols so that this plug can be wired up with high reliability that it will work correctly in most applications.

Step 2: Connect the Audio Input lead to the Amplifier input.

Identify the three input pins of the Amplifier. They are marked "IN L', "G" and "IN R".
Ensure these are connected to the appropriate wires from the 3.5 mm Plug.

Boom Box Project (Teacher's Guide)

If you have followed the protocol we recommended in the Teacher Guide "Wiring a 3.5 mm Stereo Audio Plug" these connections are:

IN L = White wire.

G = Shield.

IN R = Red wire.

Please refer to figure 6 to see our example.

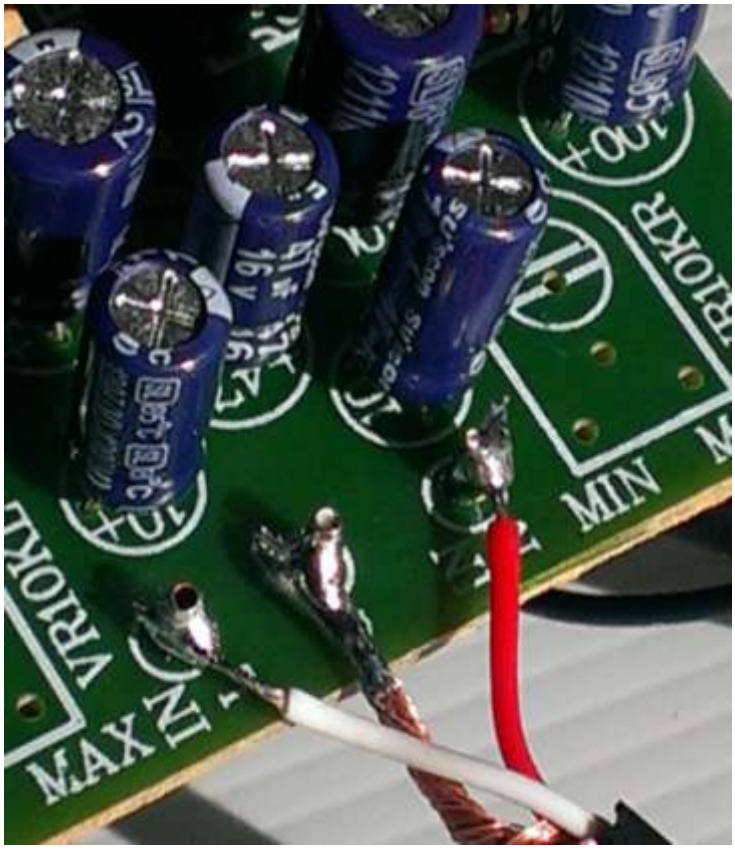


Fig. 6 : Showing the Audio Input connections (from the 3.5mm plug) of the Amplifier

Boom Box Project (Teacher's Guide)

The volume control ("Gang Potentiometer") and the correct wiring to it:

Step 1: Cut two short lengths of the supplied Audio cable .
We have used approx 10 cms for each. (Refer Fig 7)

Step 2: Prepare each end of the shielded audio cable by stripping and tinning them. (Refer fig 8).

Step 3: Take care as you attach the prepared wires to the Gang Potentiometer.
Please identify the orientation from Fig 9 .
Warning: While the orientation of the connections is not mandatory, the operation of the Volume Control may be unpredictable unless the connections follow our recommendations.

Step 4: Connect the wires to the underneath side of Amplifier module.
Refer to Figures 10 to 15 for details.

The good news: It does not really matter which potentiometer you connect to the Left Control or the Right control on the PCB. Often this choice is dictated by the length of the wires attached to the Gang Potentiometer.

Boom Box Project (Teacher's Guide)

Fig. 7 : The shielded Audio cable as supplied with the kit.

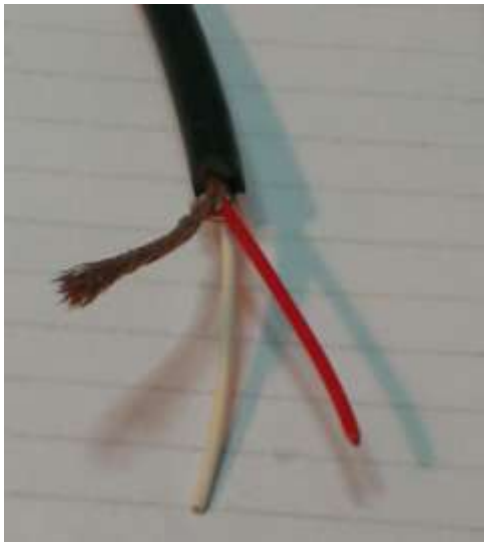


Fig. 8 : The Audio cable with leads being prepared for tinning.

Boom Box Project (Teacher's Guide)

Fig. 9 : Showing the recommended orientation for connecting the Audio Cable to the Gang Potentiometer.

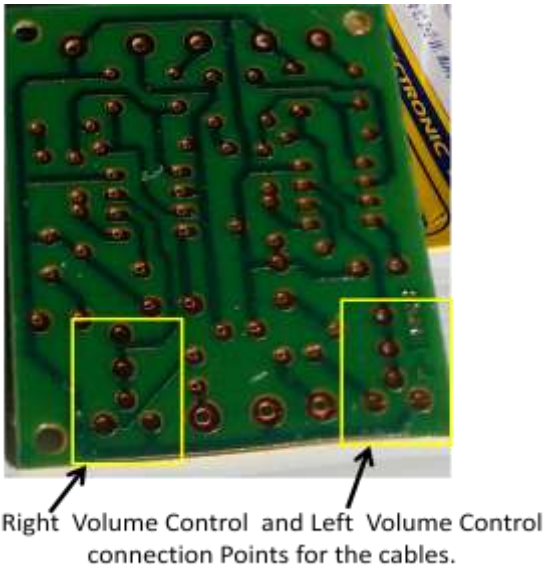


Fig. 10 : Identifying where the Potentiometer wires will connect onto.

Boom Box Project (Teacher's Guide)

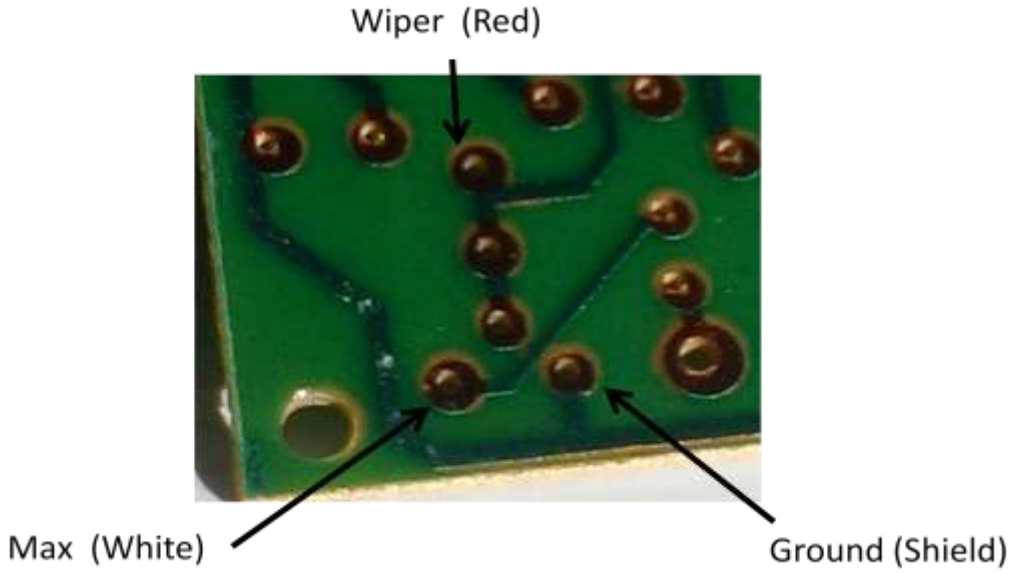


Fig. 11 : Identifying the connection points for the wires from the Right Volume Control Gang Potentiometer. (See fig 13 showing the wires attached).

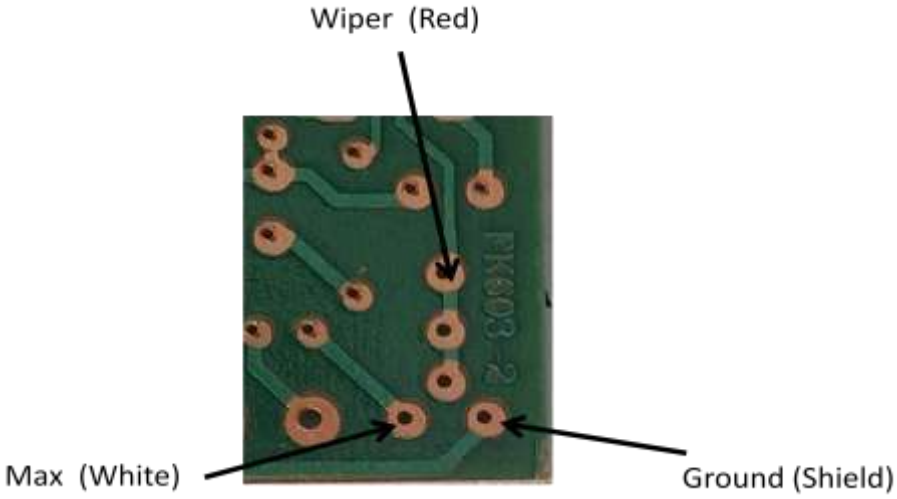


Fig 12: Identifying the connection points for the wires from the Left Volume Control Gang Potentiometer (See fig 14 showing the wires attached)

Boom Box Project (Teacher's Guide)

Fig 13: Showing wires soldered to the Right volume control points on the PCB. Note the white wire has been soldered to a point connected directly to the intended solder "pad", but easier for us to access.

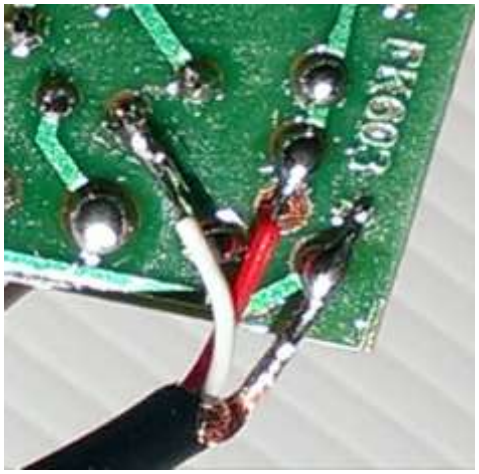


Fig 14: Showing wires soldered to the Left volume control points on the PCB.

Boom Box Project (Teacher's Guide)

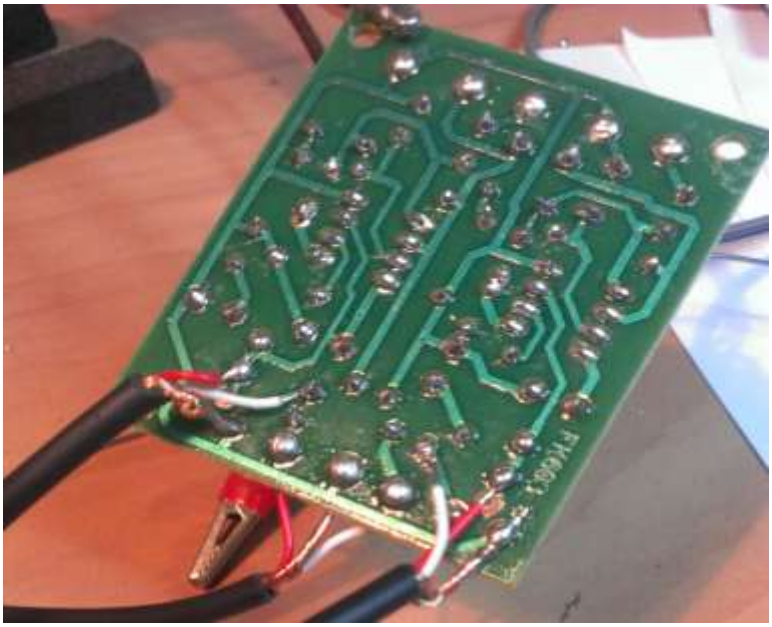


Fig 15: Showing the Volume control wires soldered to the underneath of the PCB.
(Note: In this photo you can also see the Audio input wires attached to the pins on the top of the PCB)

The electrical power source:

The Amplifier will operate safely from 6V DC to 12 V DC.

In this demonstration we have used a 9 V DC supply which consists of 6 X AA batteries. We made this decision as it offers a low entry cost (for class sets) while providing a reasonable life time of the batteries during class exercises.

For a project which is expected to be used often after it leaves the class room, you may prefer to use a "Plug Pack" style of adapter. If doing this, we recommend a 12V DC , regulated output power pack, with minimum of 500mA capability.

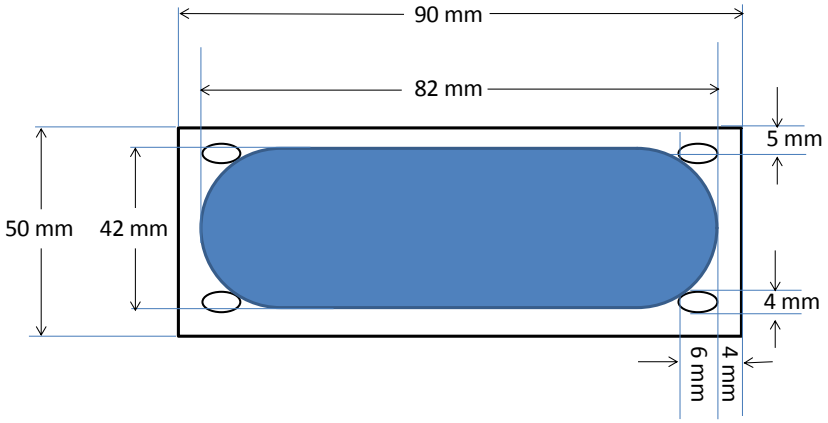
Refer to Fig 1 or 2 which show the Battery pack connected to the finished system.

Boom Box Project (Teacher's Guide)

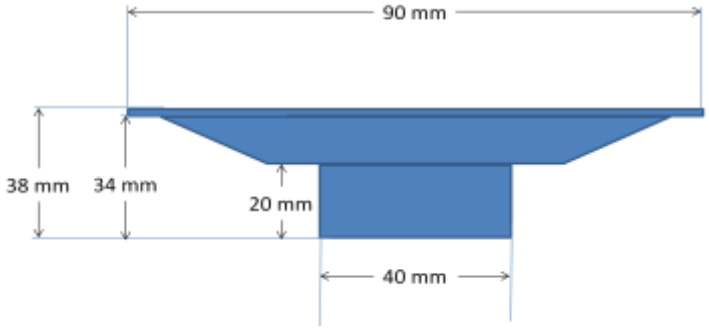
The mechanical housing:

While we expect most teachers will wish to develop their own housings as a separate part of the curriculum outcomes, here are some suggestions and background information for Teaching considerations:

a) Mechanical dimensions of the Speakers: (Not to scale)



Top View of Speaker



Side View of Speaker.

Fig 16: Mechanical outer dimensions of the speakers (not to scale)

Boom Box Project (Teacher's Guide)

b) A demonstration of a finished housing (with a clear cover so that the key components can be seen) is available on You Tube at http://youtu.be/b6itB7rU2Kw .

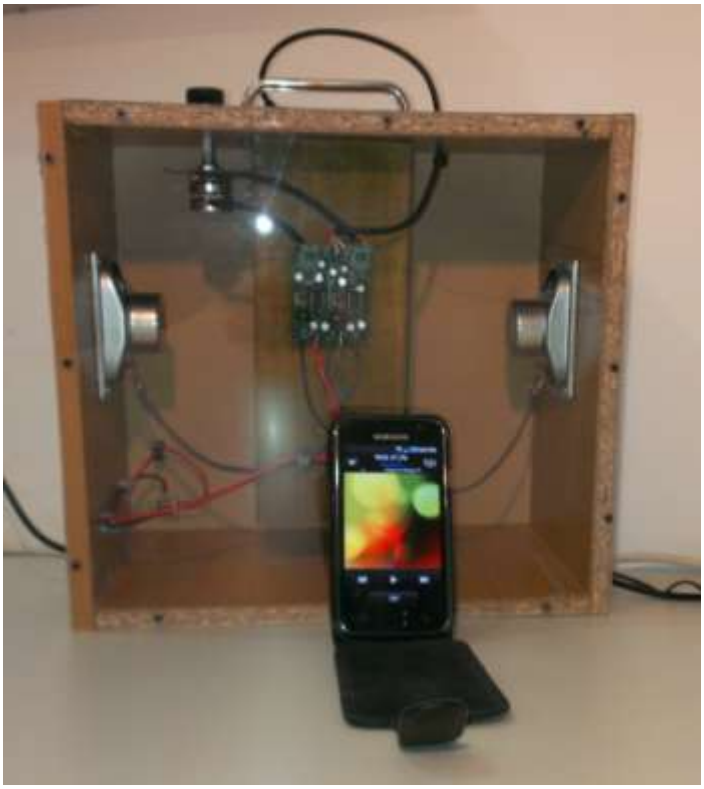


Fig 17: A demonstration housing made from scrap materials but which still gives a dramatic effect. (The clear front cover is to show the key system components).

c) Acoustic Coupling for the speakers.
The speakers included with this kit are designed to offer a reasonable response at "mid-range" audio frequencies.
However in the free air, you will notice that the bass frequencies seem to be very low in power. This is in fact due to the longer wavelength signals

Boom Box Project (Teacher's Guide)

(Bass notes) mostly cancelling each other out between the front and rear of the speaker.

If possible, mount the speaker onto a baffle which reduces the reflected waves generated by the rear of the speaker from interfering with the front of the speaker.

The affect is dramatic and may be the subject of a separate class room exercise.

Some simple ways to achieve this are:

a. Hold the speaker in your hands (with the rear open)
   See fig 18
b. Use a "baffle" to mount speaker onto. (See Fig 19.)

(For a simple demonstration of the affects of a baffle, you may like to visit our YouTube demo which is at the following URL … http://youtu.be/QAzdqE89c9o)

Fig 18: Quick demo of baffling the speaker by hands.
NOTE the fingers behind the speaker are leaving a large open space.
An effective demonstration can be made by closing the "Cupped hands" behind the speaker!

Boom Box Project (Teacher's Guide)

Fig 19: Another demo of baffling the speaker by using a sheet of cardboard
See also Youtube demo with sound track for further understanding at
http://youtu.be/QAzdqE89c9o.

A summary of our advice considering the affects of "Acoustic Coupling" is: "Do not make the internal space of your housing too small! If you do, you may be disappointed by the loss of the bass tones." *(The system will sound "tinny") .*

d) Wiring inside the box:

I. Please keep wiring inside the box as short as practical, WITHOUT being tightly stretched. *(Refer to Figs. 20 & 21 for examples we have used.)*

II. Be constantly aware that vibration will weaken solder joints over time, so do not rely on the solder to carry a mechanical load.

III. Please also ensure that the audio input cable has some form of mechanical "Strain relief" . *(Something which will take the worst of any accidental mechanical strain, and so protect the cable from having to do all the work on its own).* We have used a tightly bound "zip-tie" around the cable, and inside the housing, as a simple but effective method. (Refer figure 22).

Boom Box Project (Teacher's Guide)

Fig 20: The power supply cabling, showing the Back of the 2.1 mm plug. The positive supply goes via a switch and then to the Amplifier.

Fig 21a: The wires to the speakers.

Boom Box Project (Teacher's Guide)

Fig. 21b: A close up of the supply wires as well as the speaker wires

Fig. 22: Using a "zip-tie" for strain relief on the audio input cable.

Boom Box Project (Teacher's Guide)

e) Power supply options:

a. Our standard Boom Box kit comes with a battery holder for 6 X AA batteries. This will work fine for most class room activities if fresh, good quality batteries are used. (Cost advantage)

b. However you may wish to consider a "Plug Pack" for longer operational life.

c. We recommend using a supply Socket which allows you to change from either power source easily.
Refer to figures 23 & 24 for examples.

Fig. 23: Alternative power sources. We attached an old plug onto the battery pack.
(If you do not have one available, we suggest simply wire the battery pack onto the back of the 2.1 mm socket.)

Boom Box Project (Teacher's Guide)

Fig. 24: Showing the ON/OFF switch and the battery pack plugged into the system.

f) Other mechanical considerations:
   a. The volume control knob should be housed as close as possible to the surface of the case, without restricting movement. This is intended to offer some measure of "Mechanical Strain relief" to the potentiometer, in the event that the knob is accidentally subjected to a high impulse load.
   b. We recommend adding a carry handle , so that there is reduced risk of mishandling the system and subjecting the speaker cones to accidental puncture.
   c. As far as is practical, we recommend the entire housing should be mechanically sealed to a very high standard. This includes the use of adhesives and sealants to minimise air leaks which become paths for stray acoustic coupling paths. *(It is amazing the detrimental effects a poor speaker housing will have on the sound quality).*
   d. A simple pocket for holding the Ipod (or other device which is the audio source) is suggested.

Boom Box Project (Teacher's Guide)

.

Fig. 25: Showing the volume knob seated close to the housing surface, along with a low cost carry handle.

e. Housing material considerations:
    i. "Chip board" or "MDF" make good acoustic absorbers, which are low cost, flexible and easy to work with. (Avoid getting them wet, as they will both suffer and start to disintegrate alarmingly!)
    ii. Thin ply is good to work with, but can have strange and unexpected effects if it is not framed and braced well! We recommend avoiding ply if possible. Encourage the use of plenty of PVA glue (wood glue) if your students are working with ply!