Diploma of Audio Production **Name_________________**

Analogue Fundamentals (Audio Knowledge)

Module 10

Topic 1: Specifications and testing of Loudspeakers
Topic 2: Testing Amplifier power output using OHMS law

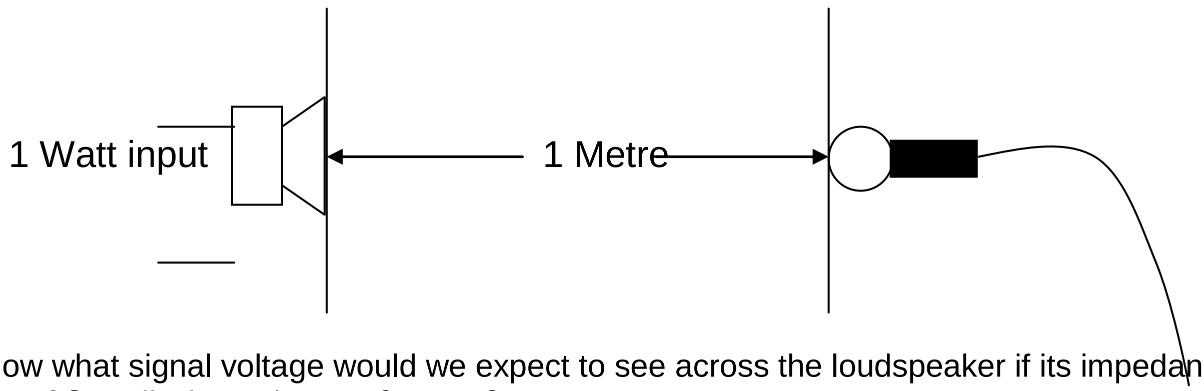
Reference Chapter 13, Yamaha Sound Reinforcement Handbook

Topic 1: Specifications and testing of Loudspeakers

Now we have already mentioned that is not the power rating of the speaker that determines how "loud" the speaker will sound for a given input so what is the determining factor?
Answer. **Efficiency or Sensitivity** and this is measured in dBspl @ 1metre @ 1 watt @400Hz on Axis. That is the **S**ound **P**ressure **L**evel produced at 1metre by inputting a power of 1 Watt using a frequency of 400Hz. looking straight at the speaker.

Here we are not just talking about ratios expressed in dBs, but also the A**bsolute Sound Pressure** level expressed in decibels, where 1 dB is the reference level (for air), and is usually chosen as 20 micropascals (20 μPa), or 0.02 mPa. (This is very low: it is 2 ten billionths of an atmosphere. Nevertheless, this is about the limit of sensitivity of the human ear, in its most sensitive range of frequency. Usually this sensitivity is only found in rather young people or in people who have not been exposed to loud music or other loud noises, such as disgusting sounding i-Pods.
(There is a good reference for this at: http://www.phys.unsw.edu.au/jw/dB.html)

This should be tested in a room that absorbs all sound. Such a room is called an **Anechoic Chamber.** The word Anechoic means "No Echo" or an Acoustically Flat Room.



Now what signal voltage would we expect to see across the loudspeaker if its impedance was 8Ω to dissipate 1 watt of power?
Well to find out we'll probably use ohm's law won't we? Which one of the power formula's will we use? As we have the resistance and the power we will use the

$$P = \frac{V^2}{R} \qquad V = \sqrt{PR}$$

arrangement and transpose to find

You work it out……….

This will of course be the RMS voltage which is what we are after but what will the P-P voltage be as we would view it on the oscilloscope
Typical efficiencies of loudspeakers can range from 80dBspl to as high as 102 (or greater) dBspl:

If we check some specs in one of the electronic components catalog we can get an idea what we are talking about.

What difference does this really make in the real world of sound reproduction?
Well for every 3dB increase in efficiency we can halve the Amplifier's power rating and still have the same sound output.

Proving this by use of a formula we use:

$$dB = 10 \log {}^{\mathbf{power\,1}}\!/_{\mathbf{Power\,2}}$$

$$dB = 10 \log {}^{\mathbf{2}}\!/_{\mathbf{1}} \quad \text{(ie Double the power)}$$

$$dB = 10 \log 2$$

$$= 3 \text{ dB}$$

Now it wouldn't matter if the power changed from 50 Watts to 100 Watts or from 2 Watts to 4 Watts providing we have a doubling of the power output.

Determining the power requirements to provide a specified sound pressure level at a required distance from the sound source.

Lets say you required 95dBspl at a distance of 8 metres from the source and the speaker was rated at 92dBspl @1metre@1 watt. (on axis)

$$\text{formula} = \text{dBchange} = 20 \log \frac{\mathbf{ReferenceDistance}}{\mathbf{NewDistance}} = 20 \log \frac{\mathbf{1}}{\mathbf{8}}$$

$$= 20 \log 0.125$$

$$= 20 \times -0.9$$

$$\mathbf{= -18dB}$$

But then we need another 3dB. ∴ total = 21dB.

This means that we will need **antilog** $\mathbf{\frac{21}{10}}$ **= 125 x 1 watt** to produce this level.

The confusing part of this is that when we refer to distance, the dB is called by 20 x the log of the difference. When we then calculate how much *power* difference there is, we then revert to 10 x the log of the difference. That's because power in watts is calibrated to 10 x the log of

the difference. Distance is a bit like voltage difference in that it functions with 20 x the log of the difference.

Note: These figures do not take into account the reflections from walls etc which will add to the sound so in reality the actual Amplifier can be quite a lot less that what we have calculated::
This is how the system would behave in an anechoic chamber or in an outside environment where there are no echoes or reflections.

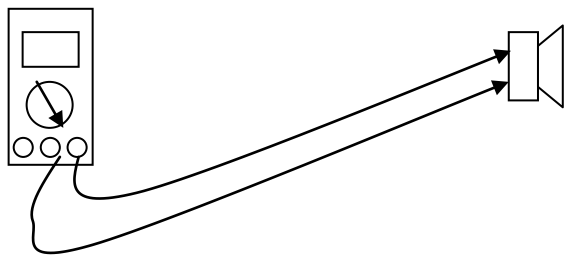
Other Loudspeaker specifications:

- **Frequency response**
- **Impedance**
- **Power Handling**
- **Size**
- **Directional Characteristics**

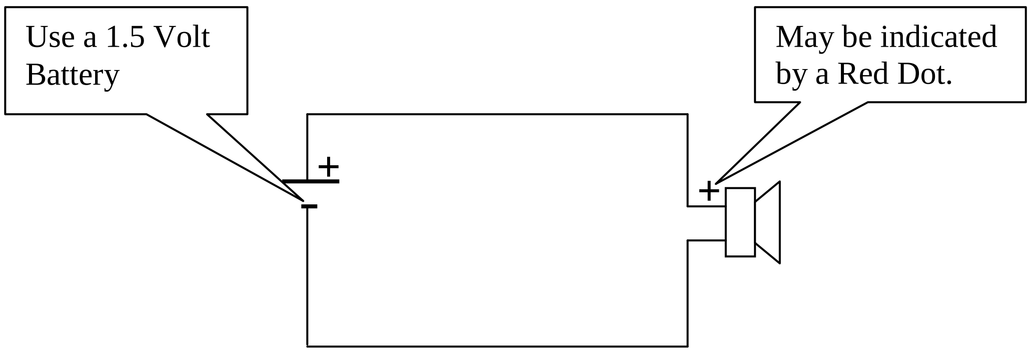
Practical exercise.

Aims:

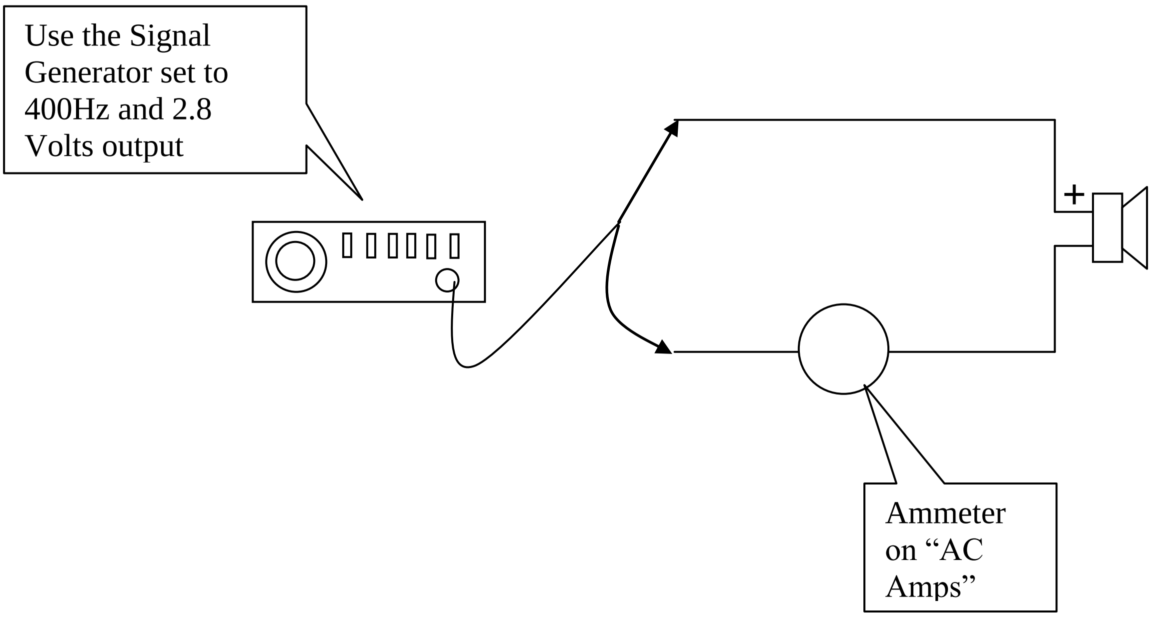
1. To Measure the resistance of the voice coil using a DMM.



2. To prove that the cone moves forward with the application of a positive voltage to the positive terminal of the speaker. We will use a small battery or a power supply to carry out this test.

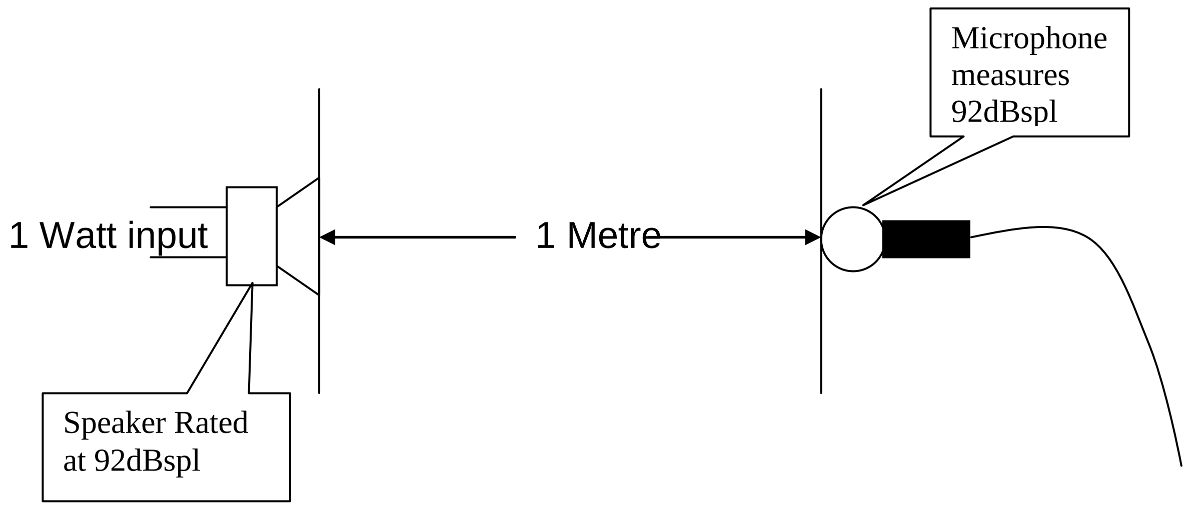


3. To measure the current in the voice coil when applying 2.8 Volts RMS to the speaker.



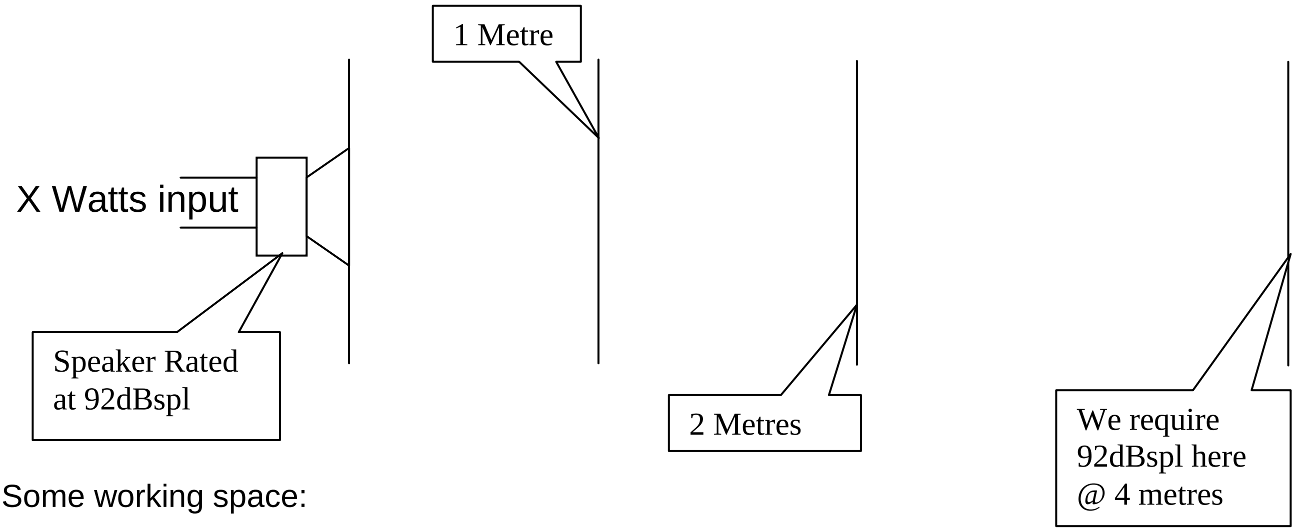
Some more problems for you to ponder over::

1/. If the speaker in the set up below is replaced with a unit that is 86dBspl, what must the input power to the speaker change to provide the same dBspl reading?



The base formula we will use is dB = 10 log $\mathbf{AmpPower}/\mathbf{1Watt}$ and we will need to transpose to find Amplifier power.
Write your solution in here.

2/. What power must we deliver to the loudspeaker to provide 92 dBspl @ 4 Metres?
See diagram below.



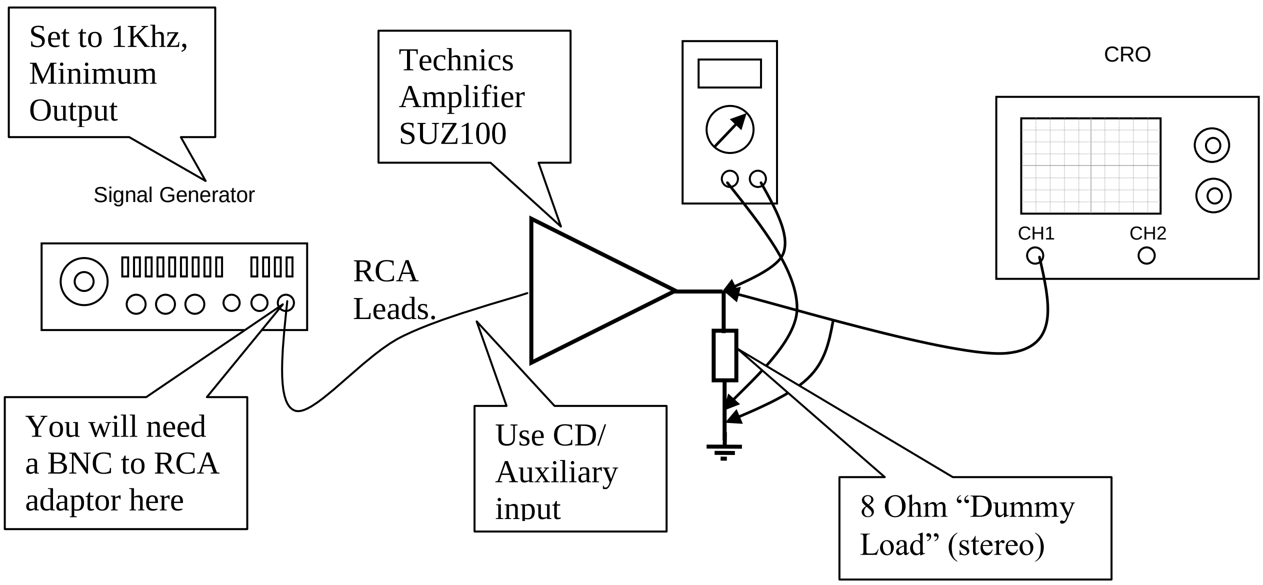
Some working space:

3/. In the diagram in problem 2, what would be the dBspl at 0.5 metres and 0.25 Metres?

Topic 2: Practical Exercise:

Using Ohms law to test the maximum power output of an audio amplifier

This is how we are going to connect up the test equipment to the amplifier.



Procedure:

1. Ensure the Volume control is at minimum on the amplifier.
2. Turn Amplifier on and slowly increase the volume setting and check there is no signal on the Oscilloscope.
3. Now with the volume control at or close to maximum setting slowly increase the signal output from the generator. If all is OK we should see a sine wave appear on the CRO. You may have to make adjustments on the CRO for optimum viewing of the signal.
4. Increase the output from the generator until clipping of the output of the Amplifier just occurs. **This represents the maximum power output of the amplifier::**
5. Now as this power is being dissipated by the "Dummy Load" it will start to get warm and this is due to current being forced into the load resistance.
6. The RMS Voltage applied to the loudspeaker can now be measured on the DMM or the Peak-to-Peak voltage on the CRO.
7. Using OHMS law Calculate the Maximum RMS power output from the amplifier.

Calculations:

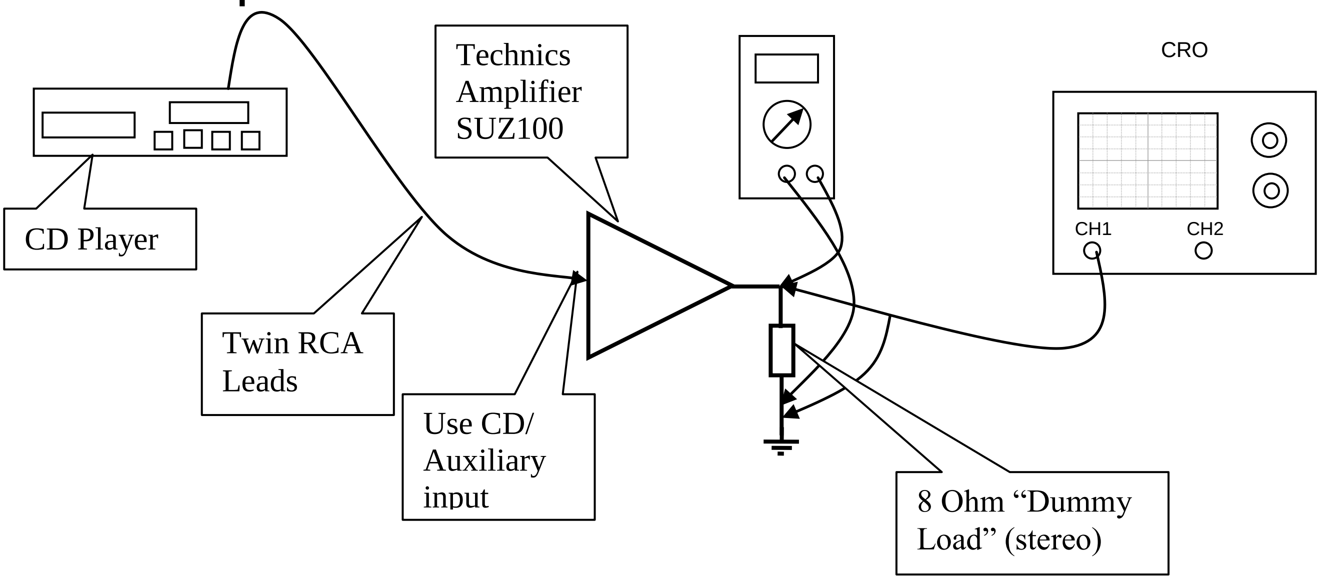
8. Now replace the signal generator with a CD player connected to the CD/Auxiliary input and turn the volume control to minimum. **Note leave the dummy load connected, do not connect a loudspeaker:: See Below**
9. Play a CD and turn the volume control up until clipping of the output signal is evident on the oscilloscope.
10. Measure this Peak-to-Peak "Clipping Voltage" and convert to RMS.

P-P voltage = _______________ RMS = __________________

Question:: Is it possible to calculate the approximate output power of the Amplifier using this "Music" signal?

The answer is yes and the reason is that once we have reached the clipping point of the amplifier it doesn't matter how much more we turn the volume control up we cannot increase the voltage level.
We would not normally drive an amplifier to clipping as we will have run out of "Head Room" i.e. nothing in reserve::

The "Hook-up"



Calculation of Amplifier Output power using a "Music" CD.

Incidentally, Can we use the DMM to obtain our output voltage from a music source? If not, Why not?

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