

HINTS FOR CAR SOUND BUILDERS USING DLS SUBWOOFERS HINTS FOR CAR SOUND BUILDERS USING DLS SUBWOOFERS

SPEAKER ENCLOSURES, GENERAL

Build your enclosures in a stable and air-tight material. The best is MDF-board, 19 mm, or particle board, 22 mm. Larger enclosures must have braces inside to avoid resonance. The enclosure must be completely air-tight. Use sealing compound in all joints, also in the hole for the cable. The size of the enclosure are decided by the speaker data, but also the car type and music have an influence on the size. Deep bass demands larger enclosures than disco music.

SEALED ENCLOSURES

Sealed enclosures are easy to build. The size is not critical, but it can't be too small. The speaker data such as F_s , Q_{ts} , V_{as} and X_{max} decides the size of the enclosure.

Large speakers need larger enclosures. Two speakers need an enclosure of the double size etc. The enclosure must be completely air-tight. Sealed enclosures are normally used for door-panels or kick-panels. Most 4", 5,25" and 6,5" speakers can be used in sealed enclosures. They should be filled with acoustic wool up to 75 - 100%.

A sealed enclosure has a lower efficiency than vented one but they can handle high power and are easy to build.

A subwoofer in a sealed enclosure creates a tight bass suitable for the audiophiles listening to classical music, jazz and soft rock.

If you use a 30-40 Hz subsonic high pass filter on the line input of your amplifier you will achieve a tight and well-defined bass in your enclosure. (All DLS amplifiers have a built-in subsonic filter.)

VENTED ENCLOSURES

A speaker in a vented enclosure has higher efficiency (3 dB) and higher power handling capacity than in the sealed one. In a vented enclosure the sound from the speaker and the port work together creating a higher sound level. The sound from the port must come out in the same phase as from the speaker otherwise the sound result is bad.

The size of the enclosure is decided by the speaker data just as in the sealed enclosure. Also the car type and music type have an influence on the enclosure size.

A smaller enclosure has a higher resonant frequency than the larger one. The size of the enclosure should not be so large that the speaker plays below it's own free air resonance (F_s), then it loses in power handling capacity. The enclosure volumes given on our WEB-site and in the manuals can be used in most type of vehicles.

The port in a vented enclosure should be installed on the same side as the speaker, but sometimes this is impossible. The port opening inside the enclosure must have a free space behind the port, to the wall behind, of at least the port diameter. There must also be a free area in front of the port. A large sub needs a larger port to avoid whistling sounds. Use ports with conical openings to avoid this. The port must also be fastened properly to avoid rattle.

As port material, 3" or 4" PVC tubes are normally used. In a correct tuned enclosure you should be able to feel the air pumping out from the port. At high volumes the air can blow out a burning match, if not the enclosure and port are mismatched.

The port does not have to be fully inside the enclosure as long as the area and length are correct. for example you can mount the port through a hat rack. In a small enclosure this can have an effect on the tuning since the volume changes. Sometimes you need two or more ports in an enclosure. You can convert from one to two or more ports as long as the total port area is the same.

If the port is to long for the enclosure you can angle the tube. If this is not possible you can compromise. If you let the port end 25 mm (1") from the enclosures back wall the result is rather good, not the best result, but it works. You fool the subwoofer to think that the port is longer because the small gap to the back wall reduces the air speed through the port.

BAND PASS ENCLOSURES

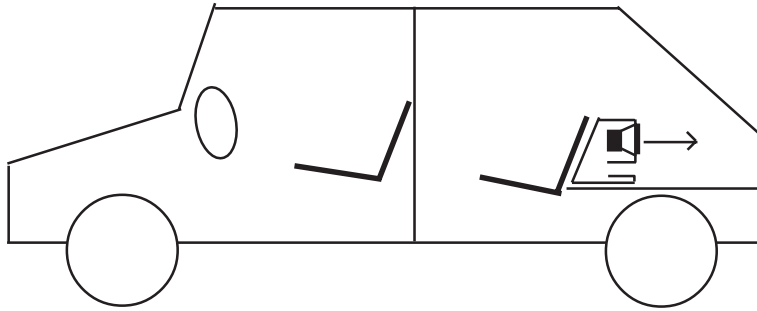
In all band pass enclosures the speakers are hidden inside the enclosure, all sound is coming out through the ports. There are different types of band pass enclosures and they have in common that they are a bit more difficult to build. In the band pass examples given on our WEB-site, and in the manuals, the port is fully inside the enclosure. If you prefer to have some part, or all of the port outside the enclosure, you must reduce the volume of the vented chamber with volume of the port on the outside of the enclosure.

INSTALLATION IN THE VEHICLE

On the next page you find examples of how to install the enclosure in different types of vehicles.

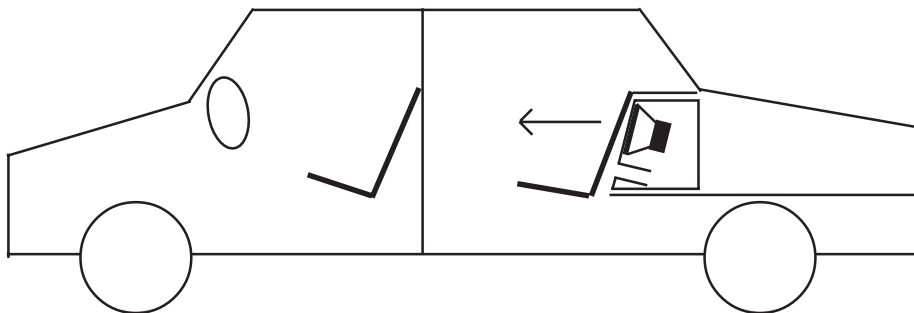
INSTALLATION OF SUBWOOFER ENCLOSURE IN DIFFERENT VEHICLES

1. SMALL CARS LIKE VW GOLF, PEUGOT 206 AND SIMILAR



In this type of vehicles the enclosure should be installed with both speaker and port directed backwards. Alternatively both speaker and port can be directed upwards. This way of installation is good for all type of vehicles except for sedan.

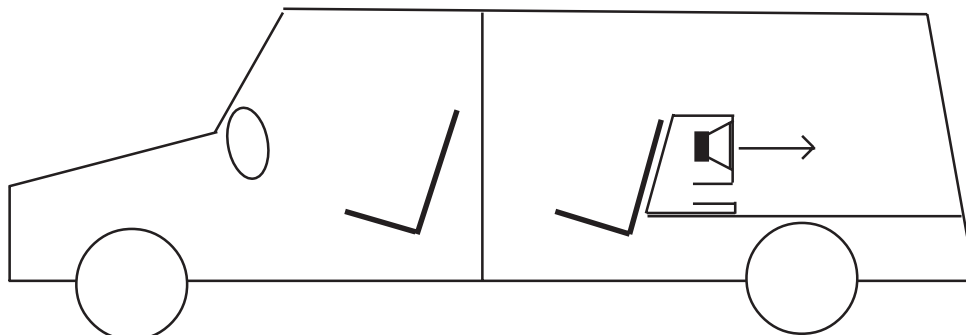
2. SEDAN CARS



In sedan vehicles, where the passenger room is separated from the boot, the enclosure should be installed with both speaker and port directed towards the rear seat. In some vehicles there are an opening in the middle of the rear seat for loading skis etc. You can install the enclosure behind this opening and direct speaker or port through there. There must be some free space in front of the port, (between the rear seat and the port opening)

Don't put the port through the hat rack if the speaker is directed towards the rear seat, this will give a poor sound. Alternatively you can install both speakers and port in the hat rack with a box under it, but this requires more changes of the car original interior.

3. LARGE VEHICLES, STATION WAGONS LIKE VOLVO V70 AND SIMILAR.



In this type of vehicles the best sound is achieved with the bass box mounted behind the rear seat with both speaker and port directed backwards. Alternatively you can install the enclosure on one side of the boot.

SOME HINTS FROM DR. "BACKE"

When building a bass box the following are very important: The box must be very steady and completely air-tight. Use 22 mm particle board or 19 mm MDF-board. The particle board has a self resonant frequency of 14 Hz while the MDF has a resonant frequency of approx. 400 Hz. Its important to stabilize the box inside with some braces, especially the boxes made of MDF could cause "PLONK"-sounds if it's not sufficiently braced.

If you are using a milling machine its better to use MDF-board since particle board wears the cutter edge. After cutting all pieces to the box you attach glue in all joints and screws every 10 cm. Use more screws if the edge cutting isn't perfect.

The length of the screws should be a little more than double the board thickness. Tighten all joints with extra silicon sealing compound.

If you build a band pass box let one side be removable to make it easier to change speaker.

Use sealing strips in the joint. The length of the screws should be 3 times the board thickness. Mount them 6 cm apart. Use conical bass ports for best result. (DLS BP-75 or BP-110).

If the ports are too long for the box you can add a bend to it. Either cut the tube and glue it together in angle, or use factory made tube bends.

It's easier to use the factory made ones. The total length must be the same as for a straight tube. Make the measure in the centre of the tube.

The port opening inside the box must not be closer to a box wall than the ports own diameter. Otherwise it will have negative effects on the airflow.

Most boxes should be damped inside with synthetic (acoustic) wool (do not use any rock wool types). Attach the damping material on the wall opposite from the speaker and port. A sealed box should be filled up to 70-100% with acoustic wool.

In a vented box the speaker and port should be mounted on the same side, otherwise a fade-out of some frequencies can occur. In most car-types, except for SEDAN cars, the speaker and port should be directed backwards for best result.

If you build an isobaric-box use screws with nuts and washers to fasten the speakers. Also tighten the screw holes with sealing compound. Be sure to connect the isobaric speaker pair in the correct way.

You can't use felt cloth or similar in front of the ports, especially in band-pass boxes.

MEASURE CONVERSION

The following relation between some units are useful to know of.

1 yard (yd) = 3 ft = 36 in = 0,9144 m
1 foot (ft) = 0,3048 m
1 inch (in) = 2,54 cm
1 square yard (yd²) = 9 ft² = 1296 in² = 0,8361 m²
1 square foot (ft²) = 144 in² = 9,290 dm²
1 square inch (in²) = 6,452 cm²
1 cubic yard (yd³) = 27 ft³ = 0,7646 m³
1 cubic foot (ft³) = 1728 in³ = 28,32 dm³
1 cubic inch (in³) = 16,39 cm³
1 pound (lb) = 16 oz = 0,4536 kg
1 ounce (oz) = 28,35 gram

Enclosure / box volumes (V):

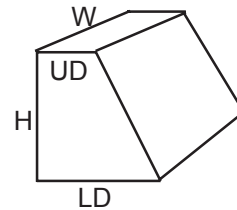
When calculating the volume of a box you simply multiply the width (W) x height (H) x depth (D).

Use measures in dm and you will get the answer in liters.

A trapezoid box is calculated as below:

$$V = \text{width (W)} \times \text{height (H)} \times \frac{\text{upper depth} + \text{lower depth}}{2}$$

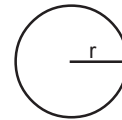
To get the net volume use the inner measures of the box.



Volume (V) of a pipe:

D = depth (length) r = radius

$$V = r^2 \times 3,14 \times D$$



Use measures in dm and you will get the answer in liters.

SPEAKER TERMS

It's useful to know what the most common speaker data terms stands for.

Fs = speaker resonant frequency in Hz

Fc = box resonant frequency in Hz

F3 = approximate lower frequency for vented boxes in Hz. Often called F-3 dB point = the point where the power is half.

Qes = the speakers electrical Q-value

Qms = the speakers mechanical Q-value

Qts = the speakers total Q-value

Vas = Equivalent air volume. The air volume having the same acoustic compliance as the speaker suspension.

X-max = voice coil length - 2 x thickness of the inner pole plate.

Sd = the speakers effective cone area

Vb = net volume of the box

SPL = sound pressure level in dB

Sens. = speaker sensitivity in dB at 1Watt / 1 mtr

Re = speaker DC resistance in ohms

Mms (Mmd) = moving mass

Le (Lbm) = Voice coil inductance

RMS = AC average power value

BL = The flux density factor in the magnetic gap in the speaker * the wire length of the voice coil

Gauge (ga) is an American measure for cable areas, also called AWG (American Wire Gauge).

1 AWG = 42 mm ²	9 AWG = 6,8 mm ²
2 AWG = 33 mm ²	10 AWG = 5,3 mm ²
3 AWG = 27 mm ²	11 AWG = 4,2 mm ²
4 AWG = 21 mm ²	12 AWG = 3 mm ²
5 AWG = 16 mm ²	13 AWG = 2,7 mm ²
6 AWG = 13 mm ²	14 AWG = 2 mm ²
7 AWG = 10 mm ²	15 AWG = 1,65 mm ²
8 AWG = 8 mm ²	16 AWG = 1,3 mm ²

SPEAKER LOADS

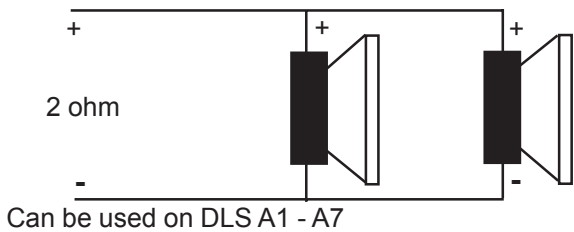
Most car audio speakers have a 4 ohm impedance.

DLS Classic amplifiers can be loaded down to 2 ohm on each stereo channel but DLS ULTIMATE amplifiers can be loaded down to 1 ohm.

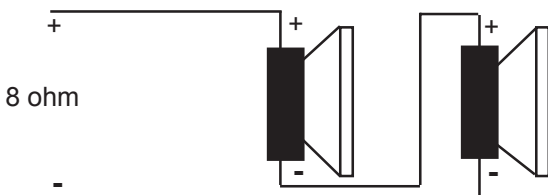
In mono bridge mode operation the speaker load must never be less than 4 ohm. If you are using more than one driver they must be connected in a way so the impedance still is 4 ohm when connected to a Reference amplifier. To an ULTIMATE amplifier you can connect speakers in bridge mode operation that has an impedance of only 2 ohms. When you run the amplifier in mono bridge mode it sees a 4 ohm load as 2 ohm, and a 2 ohm load as 1 ohm.

Below you find different speaker wiring examples.

Two speakers in parallel

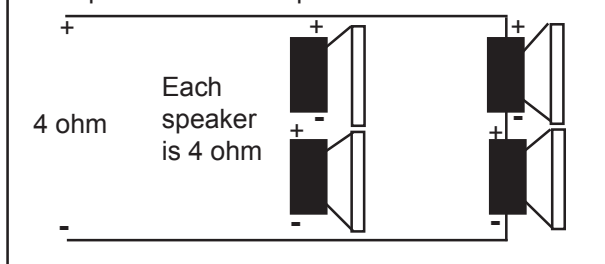


Two speakers in series.

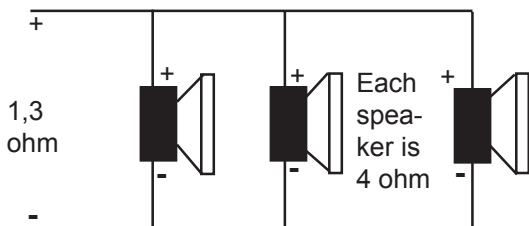


We don't recommend this connection.

Four speakers in series/parallel to 4 ohm.



Three speakers in parallel to 1,33 ohm



SPEAKER CONNECTION

Always use high quality speaker cables such as **DLS SC 2x1,5**, **SC 2x2,5** or **SC 2x4**. Subwoofer connection requires 2 x 4 mm² cable.

Connect the speaker + (marked with + or a red dot) to the amplifier + terminal, and the speaker - to the amplifier -.

When fitting the cables to the amplifier terminals, remove only 10 mm of the insulation. Twist the wire strand together and insert the wire after loosening the terminal screw. Do not over tighten as this can cut the cable strands.

If you want an extra high class speaker cable choose any of the DLS SCP, SCK, SCKS, SC 4x1 or SC 4x1,5 cables.

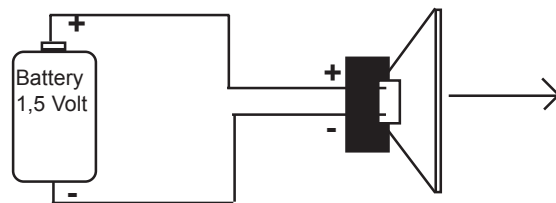
SPEAKER POLARITY CHECK.

All speakers in a car audio system should be connected in phase (the same polarity). All speaker cones must move in the same direction. Out of phase speakers will cause a lack of bass, and a poor stereo soundstage.

Checking polarity:

Hold the - connection of the speaker wire to the - terminal of a 1,5 Volt flashlight battery. Tap the + wire on to the + terminal of the battery, and observe the movement of the cone. The cone should move outwards when the wire touches the battery, and inwards when the battery is removed. If it is the other way around, the speaker has been connected backwards and it must be removed and connected correctly.

If your system also has a subwoofer connected through a passive 6 or 12 dB crossover, try to connect this with various polarity and judge what sounds best. The phase shift in passive crossovers sometimes makes it necessary to change polarity.



Tweeters can't be tested in this way

Installing car sound can sometimes cause problems. If you are not satisfied with the sound you could have made something wrong. Some typical problems are described below with hints for solving them.

1. Problem: Poor bass reproduction despite of a correctly designed bass box.

- Start with phase reversing the subwoofer to see if this helps.
- If you are using more than one subwoofer make sure they are connected in the same phase (polarity), if not most bass sound disappears. (The speaker cones are moving but will not create bass sound).
- If the bass reproduction is improved when opening the doors of your car the box is too large, The F-3dB point is too low. Make the box smaller.
- Standing waves can "kill" some frequencies. Try to change place for the box. You can also try to make the bass port shorter, this will increase the box resonant frequency.
In some cases the area under the dashboard can work as a wave trap killing some low frequencies. Try to fill this area and tighten it.
- Also check the signal cable. If your subwoofer is connected in mono bridge mode and one of the leads are broken in a signal cable the sound becomes real bad.
- You must also have enough power, especially if you have a small sealed enclosure the power output should be at least 200 Watts RMS.

2. Problem: The real "kick" lacks in the bass sound.

- The box is not correctly build, or the box is not air tight.
- The sub amplifier does not get enough power, the power cables are too small, the ground connection bad, or some other things that is causing voltage drop at high power outputs. A cheap amplifier with insufficient capacity in the DC-converter can give the same result. A good car battery with low inner resistance or a Power Cap of 0,5 Farad or more connected to the power lead will also improve the bass reproduction.

3. Problem: "Rumble" bass sound.

- The box tuning is too low, make the F-3dB higher with a smaller box.
- Connect a subsonic high-pass filter, 30 - 50 Hz, in series with the amplifier input.
- Use vented or sealed boxes. Avoid band-pass boxes, they are more difficult to build, and if they are incorrectly designed they create a rumble bass sound.

4. Problem: Poor bass reproduction in a system without separate subwoofer.

- Is normally caused by incorrect speaker phasing. Make sure all woofer elements in the system are connected with the same polarity (phasing). Both front and rear speakers.
This is easiest made with the use of a 1,5 Volt battery. Connect the battery + to the speaker + cable, and the - to the speaker - cable. All speaker cones must move outwards when the battery is connected.

5. Problem: Interference sound from the alternator in systems with a separate amplifier.

- Is normally caused by incorrect grounding. Try to connect all units to the same ground point. It should be a place close to the amplifier where the paint is removed from the metal surface.
- Poor shielding on the signal cables, or a defective cable.
- The signal cable is placed close to the cars own cable wiring inducing interference into the signal cable.