SOUND HANDBOOK 1998

Hints and advices for car sound builders using GENESIS amplifiers and DLS speakers

CONTENTS:

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INTRODUCTION

We have made this handbook as a small help for thoose who want to do a first class car sound installation.
This book advices the reader in matters concerning amplifier and speaker installation and wiring, passive crossovers, cable choice and different bass box constructions.

DLS SOUND PHILOSOPHY

DLS sound philosophy is based upon providing equipment that will accurately and faithfully reproduce all kinds of music without distortion and colouration. The sound reproduction must be natural, the soundstage well imaged and stable even when the tweeters are mounted apart from the bass/midrange elements.
If you close your eyes the sound should be as close as possible to the real. You should be able to experience the sound as it is in the concert hall or on a rock concert. Every instrument and singer should be on it´s correct place on the stage. To achieve this you need a good front stage image and to do such an installation is not easy. GENESIS amplifiers and DLS speaker systems will help you to achive a sound as good as possible, but you also have to do a correct installation if you want a perfect result. This book will give you hints about doing a good installation.

DLS lay a great job in developing and refining the different products in order to give the market the best Car-Hi-Fi products possible to the worlds most demanding listeners.

DLS AMPLIFIER PHILOSOPHY

A wellknown french sound philosopher, Jean Hiraga, said regarding home Hi-Fi: A good sound starts in the mains plug and then through the AC/DC-converter, which must be oversized.
The same is valid for Car Hi-Fi, the amplifier must at all occasions have enough power to make a good job. Remember to use well oversized cables from the battery to the amplifier. It is also essential that the DC/DC-converter is well oversized to make it distribute enough power to the amplifiers final stage when it´s needed, otherwise both the dynamics and the good sound will be lost. The amplifier will sound "tired" and the sound will be strained. The bass will lack the real "bass-kick" and the treble becomes sharp instead of soft and airy.
The built-in amplifers in most CD:s and stereo casette players can´t stand up to these demands. To achieve a good sound it´s necessary to install. an external high quality amplifier.

AMPLIFIER CLASSES

Depending upon the construction, amplifiers are divided into different classes, there are class A, AB, B or C. The characteristic mark for a class A amplifier is the lack of switching noise distortion, which the other types have. The class A amplifier also has a higher idle current, but instead it creates a much better resoulution and dynamics. For home use the class A amplifiers are not very common, many people think they are only for sound connoisseurs and Hi-Fi entusiasts.Powers from 2x15 up to 2x50 Watts are common on these types, no high power, but instead real good AC/DC-converters with reliable power resources.
The most common amplifier type is class AB.

CLASS A - IN A NEW WAY

To make a pure class A amplifier for in-car use would be relatively easy, but would cause many problems. the main problem is the efficiency of true class A operation. To provide 50 watts per channel would require a power consumption of about 250 watts continuous. This is around 21 A from a 12 V system. A second battery and maybee alternator would be required for most installations. This would also require fan cooling to get rid of the heat.

In a class "A" amplifier, the improvement in sound quality is thanks to absence of switching noise from the output transistors. The penalty for this is that the amplifier is not efficient and wastes energy. By using a special biasing circuit to ensure the output transistors do not switch off, the GENESIS amplifiers achieve all the advantages of a class "A" operation with only a small reduction in efficiency.
All amplifiers can be used in bridgemode and multi-mode applications.

The new GENESIS series 3 amplifiers can not be defined either as class A or AB. They are a unique GENESIS construction. All amplifiers are 2 Ω stable except for Monoblock and the subwoofer channel on Five Channel which are 1 Ω stable.

GENESIS AMPLIFIERS TO 97-10.

SA-30	class "A"	B-40	class "AB"
SA-50	"	SM-60	"
DA-100	"	SM-100	"
Q-100X	"	DM-200	"
P-300X	" + AB	Q-200X	"
MONO-250	"		

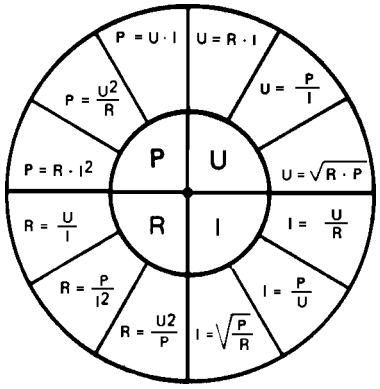
GENESIS AMPLIFIERS FROM 97-11.

Stereo 60	Stereo 100
Dual Mono	Four Channel
Five Channel	Monoblock

FORMULAS

It´s easier to understand some parts in this book if you know some of the formulas on this page. They are also useful at many other occasions.

OHMS LAW:
R = resistance in ohm, U = voltage in Volt
I = current in Ampere, P = power in Watt



GEOMETHRY:

Circel:
r = radius O = periphery
d= diameter A = area

Radius (r) = $\frac{O}{2\pi}$ Diameter (d) = $\frac{O}{\pi}$

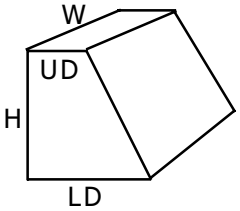
Periphery (O) = $2\pi \times r$ Area (A) = $\pi \times r^2$

Box volumes (V):
When caculating the volume of a box you simply multiply the width (W) x heigth (H) x depth (D). Use measures in dm and you will get the answer in liters.

A trapezoid box is calulated as below:

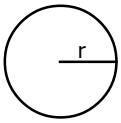
$$V = \text{width (W)} \times \text{heigth (H)} \times \frac{\text{upper depth} + \text{lower depth}}{2}$$

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.

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 (yd^2) = 9 ft^2 = 1296 in^2 = 0,8361 m^2
1 square foot (ft^2) = 144 in^2 = 9,290 dm^2
1 square inch (in^2) = 6,452 cm^2
1 cubic yard (yd^3) = 27 ft^3 = 0,7646 m^3
1 cubic foot (ft^3) = 1728 in^3 = 28,32 dm^3
1 cubic inch (in^3) = 16,39 cm^3
1 pound (lb) = 16 oz = 0,4536 kg
1 ounce (oz) = 28,35 gram

CONVERSION GAUGE - mm^2

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 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 = approximative 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 = Eqvivalent air volume. The air volume having the same aqoustic 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 volyme 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 = moving mass
Lbm = Voice coil inductance
RMS = AC mean power
BL = The factor of theflux density in the magnetic gap in the speaker x the wire length of the voice coil

DECIBEL - dB

dB is a unit used to describe a realation. It´s used to describe an amplification as well as an attentuation. At an attentuation a minus sign is put before the figure.
An amplification is the relation between the input and the output signal. In can be valid for voltage, current or power.
When used for power amplification you must remember that current x voltage = power. This means that the relation becomes larger, see the table below.

Examples of fixed dB relations:
For voltage and current:

dB	Amplification
0 dB	1 time
1 dB	1,1 times
3 db	1,4 times
6 dB	2 times (double)
10 dB	3,16 times
20 dB	10 times

The amplification increases logarithmic.

For power:

dB	Amplification
0 dB	1 time
3 dB	2 times
6 dB	4 times
10 dB	10 times
20 dB	100 times

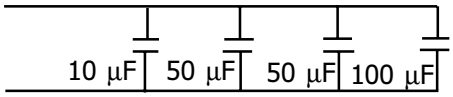
An attentuation of -6 dB is a half for voltage and current and a quarter when talking about power.

CONNECTION OF CAPACITORS

Capacitors acts in the opposite way as resistors when connected in series or parallel.

IN PARALLEL:
The total capacitance when connecting capacitors in parallel is the sum of each capacitor.

C tot = C1 + C2 + C3 + C4 etc.



C tot = 10 + 50 + 50 + 100 = 210 µF

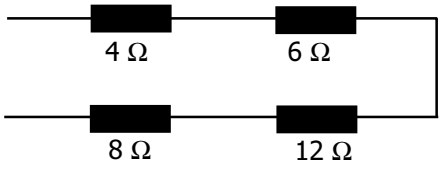
1 µF = 0,000001 Farad (10^{-6})
1 nF = 0,000000001 Farad (10^{-9})
1 pF = 0,000000000001 Farad (10^{-12})

CONNECTING RESISTORS

The formualas below is valid when connecting resistors and inductances in series or in parallel. It can also be used for speakers.

IN SERIES:
The total resistance is equal to the sum of all resistors in the connection.

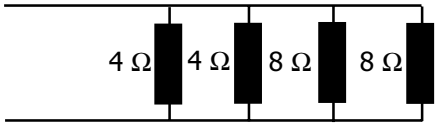
R tot = R1 + R2 + R3 + R4 etc.



R tot = 4 + 6 + 8 + 12 = 30 Ω

IN PARALLEL:
When connecting in parallel the total resistance always becomes lower, it is always lower than the lowest resistor value in the connection.

Formula: $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}$



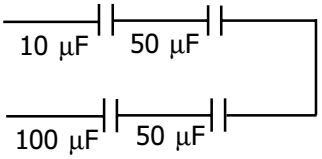
$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} + \frac{1}{8} + \frac{1}{8}$ R = 1,33 Ω

When connecting only two resistors in parallel you can use the formula below.

$R = \frac{R1 \times R2}{R1 + R2}$ Ex. $\frac{4 \times 8}{4 + 8} = \frac{32}{12} = 2{,}66\Omega$

IN SERIES:
When connecting capacitors in series you calculate in the same way as for resistors connected in parallel.

Formula: $\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4}$



$\frac{1}{C} = \frac{1}{10} + \frac{1}{50} + \frac{1}{50} + \frac{1}{100}$ C= 6,66 µF

When connecting only two capacitors you can use the same formula as in the example with two resistors connected in parallel above.

PARAMETERS DLS SPEAKERS

Data 1/4-1998

Typ /Type	Fs	Re	Res	Qms	Qes	Qts	Vas	Mms	Cms	Le	BL	Sd	SPL	X max
	Hz	ohm	ohm				liter	gram	µM/Newton	mH	Tesla-M	cm^2	dB	mm
DLS C4/P4	89	2,98	7,32	3,51	1,43	0.67	1,79	6,15	222	0,25	3,31	44,13	82,1	
DLS C5/P5	62	3,09	20,91	4,93	0,73	0,64	6,02	6,94	694	0,29	3,95	78,54	84,8	
DLS C6/P6	63	3,02	14,27	4,62	0,98	0,81	13,49	10,02	645	0,25	3,49	122,0	87,1	
DLS PS4	113	4,23	16,36	4,07	1,05	0,84	1,10	4,89	403	0,18	3,74	44,13	83,7	
DLS PS5	87	4,15	13,65	3,20	0,97	0,75	5,78	6,06	550	0,18	3,76	86,5	87,8	
DLS PS6	65,8	4,15	10,89	3,23	1,23	0,89	14,34	8,65	677	0,20	3,47	122,8	87,0	
DLS 424														
DLS 425	81	3,37	40,89	10,62	0,87	0,81	11,98	13,92	398	0,29	5,23	176,0	90,5	
DLS 425 slimline	87	4,15	13,65	3,20	0,97	0,75	5,78	6,06	550	0,18	3,76	86,5	87,8	
DLS 426	77,8	2,92	14,94	4,99	0,98	0,82	9,29	9,55	406	0,30	3,74	122,8	88,3	
DLS 426 slimline	65,8	4,15	10,89	3,23	1,23	0,89	14,34	8,65	677	0,20	3,47	122,8	87,0	
DLS 428	56	3,35	34,08	8,29	0,82	0,74	20,34	18,17	442	0,36	5,14	181,0	88,3	
DLS 962	81	3,37	40,89	10,62	0,87	0,81	11,98	13,92	275	0,28	5,23	176,0	90,5	
DLS 960	50					0,59	47,50							
DLS R4/RC4	89	2,87	16,69	5,78	1,00	0,85	1,28	6,79	468	0,26	3,32	44,13	81,4	
DLS R4 Al-cone	96,4	3,43	28,78	7,61	0,91	0,81	1,03	7,23	377	0,26	4,07	44,13	81,9	
DLS R5/RC5	68	2,87	23,39	5,48	0,67	0,60	6,52	8,87	620	0,24	4,02	86,50	86,6	
DLS R5 Al-cone	61	3,00	7,63	7,21	0,72	0,66	8,11	10,77	633	0,27	4,13	86,50	86,0	
DLS R6 /RC6	63	3,17	19,20	4,58	0,76	0,65	11,68	11,72	551	0,31	4,40	122,8	87,6	
DLS R6 Al-cone	52	3,48	45,00	8,18	0,63	0,59	15,59	12,73	736	0,27	4,78	122,8	87,2	
R8/RC8	37					0,34	43							
R36 4" element	150	3,22	17,79	7,51	1,36	1,15	0,55	5,59			3,53	44,18	83,2	
R36 6" element	54					0,40	11							
R38 5" element														
R38 8" element	44					0,32	32							
CS 1 tweeter	1500	-	-	-	-	-	-	-			-	-	92	
PR 1 tweeter	1500	-	-	-	-	-	-	-			-	-	93	
RC 1 tweeter	950	5,2	-	-	-	-	-	-		0,04	-	-	93	
U 2,5 mid	350	3,5	-	-	-	-	-	-			-	28	92,5	0,5
U5 bass	61	3,65	26,52	3,55	0,49	0,43	7,77	9,91	683	0,41	5,33	90	87,4	3
U6 bass	48	3,57	18,79	2,90	0,55	0,46	18,37	11,69	850	0,47	4,80	119,0	87,6	3
U6 bas from 7-96	68	3,30	20,06	3,91	0,64	0,55	7,65	14,08	385	0,42	5,57	119,0	87,6	3
UC5 bass	78	3,30		3,49	0,93	0,86	6,5	5,8	571	0,21	2,88	90	89	3
UC6 bass	68	3,3		3,93	1,51	0,97	11	8,13	561	0,16	2,83	119	90	3
UX5	90	3,3		4,90	1,21	0,95	7,80	3,25	674	0,31	2,50	90	89	3
UX6	75	3,3		4,20	1,09	0,86	20	4,40	1017	0,31	2,52	119	90	3
DLS W108/108C	41,7	3,40	20,56	3,77	0,62	0,54	29,55	22,91	635	0,67	5,72	182,0	87,2	4
DLS W110/110C	39,9	3,37	18,23	3,77	0,70	0,59	49,11	45,14	353	0,65	7,39	314,6	88,3	4
DLS W112/112C	34,5	3,33	21,13	4,32	0,68	0,59	97,77	62,72	339	0,82	8,15	453,0	89,5	4
DLS W108B	40,3	3,34	10,6	1,81	0,57	0,43	27,10	26,65	586	0,45	6,28	181,5	86,7	5
DLS W110B	34,5	3,44	11,26	1,50	0,46	0,35	69,86	42,45	503	0,72	8,31	314,6	89,8	5
DLS W112B	30,7	3,50	12,85	2,03	0,55	0,43	134,93	57,39	470	0,74	8,36	452,3	90,3	5
DLS W310	36,0	3,43		2,49	0,32	0,28	48,6	55,15	349	1,1	11,50	314,6	92	5
DLS W312	30,0	3,43		3,26	0,36	0,34	115,0	79,65	317	1,1	12,22	453,0	93	5
DLS W510C	28,6	3,38	25,36	3,46	0,30	0,28	68,1	78,7	392	1,60	11,89	314,6	89	9
DLS W512C	30,4	3,31	23,60	3,63	0,31	0,28	109	88,8	308	1,68	13,07	452,3	92	9
OLDER DLS SUBWOOFERS														
DLS 5508	36					0,40	36							
DLS 5508A	44					0,32	22,9							
DLS 5310/5510	33					0,65	76							
DLS 5310A	49	3,0		2,58	0,52	0,45	46,8	40,8			8,51		92	3
DLS 5310B	35					0,33	81,6							
DLS 5512	28					0,35	280							
DLS 5512A	43	1,9		2,58	0,43	0,37	134	39,1			6,81		98	2
DLS 5612	27					0,39	204							
DLS 5612A	47	2,7		1,65	0,45	0,35	81,0	59,1			11,1		96	3,8
DLS 5615	49	3,2		1,73	0,20	0,18	125	94,1			21,4		100	3,5

Data can be changed without prior notice. On some models some data are missing.

TECHNICAL SPECIFICATIONS GENESIS AMPLIFIERS, series 3.

GENESIS	**Stereo 60**	**Stereo 100**	**Dual Mono**	**Four Channel**
Continuous power output watts RMS, 20 Hz - 20 kHz, 0,1% distortion				
Nom. power in 4Ω	2 x 30 Watt	2 x 50 Watt	2 x 100 Watt	4 x 50 Watt
Typ. power in 4 Ω	2 x 55 Watt	2 x 95 Watt	2 x 150 Watt	4 x 95 Watt
Nom. power in 2 Ω	2 x 60 Watt	2 x 100 Watt	2 x 200 Watt	4 x 100 Watt
Typ. power in 2 Ω	2 x 85 Watt	2 x 145 Watt	2 x 250 Watt	4 x 145 Watt
Nom. power, 4 Ω bridge	1 x 120 Watt	1 x 200 watt	1 x 400 watt	2 x 200 Watt
Typ. power 4Ω bridge	1 x 170 Watt	1 x 290 Watt	1 x 500 Watt	2 x 290 Watt
S / N ratio, A-weighted	>100 dB	>100 db	>100 dB	>100 dB
Damping factor	>200	>200	>200	>200
Input impedance	>10 k	>10k	>10k	>10k
Input sensitivity	0,3 - 5V	0,3 - 5V	0,3 - 5V	0,3 - 5 V
Filter high-pass	20-200 Hz	20-200 Hz	20-200 Hz	20-200 Hz (K1 - 4)*
Filter low-pass	Fixed 80 Hz*	50-200 Hz*	50-200 Hz*	50-200 Hz (K1 - 4)*
Fan output terminal	No	Yes	Yes	Yes
* Switchable in/out				
Current draw:				
Idle	1,0 A	1,6 A	2,5 A	2,0 A
Typical	5 A	7 A	12 A	10 A
Maximum	23 A	37 A	58 A	75 A
Dimensions (mm)	150x210x62	200x210x62	300x210x62	360x210x62
Weight	1,6 kg	2,1 kg	3,2 kg	3,75 kg

GENESIS	**Monoblock**	**Five Channel**	
RMS output power per channel at 14,4 volt, 20 Hz - 20 kHz, < 0,1% distortion, (Monoblock at 0.01%)			
Nom. power in 4Ω	250 Watt	4 x 40 Watt	Sub channel: 140 Watt
Typ. power in 4 Ω	400 Watt	4 x 55 Watt	Sub channel: 155 Watt
Nom. power in 2 Ω	500 Watt	4 x 60 Watt	Sub channel: 200 watt
Typ. power in 2 Ω	750 Watt	4 x 80 Watt	Sub channel: 260 Watt
Nom. power in 1 Ω	1000 Watt	-	Sub channel: 300 Watt
Typ. power in 1 Ω	1200 Watt	-	Sub channel: 360 Watt
Bridge mode 4Ω nom.	-	2 x 150 Watt	
Bridge mode 4Ω typical	-	2 x 160 Watt	
Damping factor	>500	>200	
S / N ratio, A-weighted	>100 dB	>100 dB	
Input sensitivity	0,3 - 5V	0,3 - 5V	
Input impedance	>10 k	>10 k	
Filter high-pass	Nej	80-400Hz + 15-40 Hz*	* Switchable in/out
Filter low-pass	50-125 Hz	400Hz-40k + 50-125 Hz*	
Fan output terminal	Yes	Yes	
Current draw:			
Idle	3,0 A	3,0 A	
Typical	30 A	12 A	
Maximum	170 A	80 A	
Dimensions (mm)	450x210x62	450x210x62	
Weight	5,0 kg	4,75 kg	

Recommended cable size for the DC-feed:

Cable length:	**<1,5 m**	**1,5 - 5 m**	**> 5 m**
Stereo 60	6 mm²	10 mm²	16 mm²
Stereo 100	10 mm²	16 mm²	21 mm²
Dual Mono	16 mm²	21 mm²	33 mm²
Four Channel	16 mm²	21 mm²	33 mm²
Five Channel	16 mm²	21 mm²	33 mm²
Monoblock	33 mm²	33 mm²	42 mm²

Max fuse value for different cable sizes:

6 mm²	= 9AWG	25A
10 mm²	= 7AWG	40 A
16 mm²	= 5AWG	60 A
21 mm²	= 4AWG	100 A
33 mm²	= 2AWG	140 A
42 mm²	= 1 AWG	200 A

Recommended main fuse for amplifiers:

Amplifier	**Fuse**	**Fuse holder**
Stereo 60	25 A	FH1
Stereo 100	40 A	FH1
Dual Mono	50 A	FH1
Four Channel	60 A	FH1
Five Channel	60 A	FH1
Monoblock	125 - 150 A	FH2

TECHNICAL SPECIFICATIONS GENESIS AMPLIFIERS, series 2

AMPLIFIERS IN CLASS AB:

GENESIS	**B-40**	**SM-60**	**SM-100**	**DM-200**	**Q-200X**
Continuous power output watts RMS, 20 Hz - 20 kHz, 0,1% distortion					
Nom. power in 4Ω	2 x 20 W	2 x 30 W	2 x 50 W	2 x 100 W	4 x 50 W
Typical power in 4 Ω	2 x 30 W	2 x 45 W	2 x 75 W	2 x 130 W	4 x 70 W
Nom. power in 2 Ω	2 x 40 W	2 x 60 W	2 x 80 W	2 x 150 W	4 x 90 W
Typical power in 2 Ω	2 x 50 W	2 x 80 W	2 x 110 W	2 x 200 W	4 x 120 W
Bridge mode 4Ω nom.	60 Watt	120 Watt	160 Watt	300 Watt	2 x 180 W
Bridge mode 4Ω typical	90 Watt	150 Watt	240 Watt	425 Watt	2 x 240 W
S / N ratio, better than	100 dB	100 dB	100 db	100 dB	100 dB (A-weigthed)
Channel separation	60 dB	70 dB	70 dB	70 dB	60 dB
Input variable	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V
Power consumption:					
idle	0,4 A	0,5A	0,8A	1,2A	1,3A
4Ω nom. power	8A	13A	19A	45A	45A
2Ω nom. power	16A	24A	35A	65A	65A
Dimensions (mm)	100x190x62	125x177x62	165x192x62	260x192x62	320x192x62

AMPLIFIERS IN CLASS "A":

GENESIS	**SA-30**	**SA-50**	**DA-100**	**Q-100X**	**P-300X***
Continuous power output watts RMS, 20 Hz - 20 kH, 0,1% distortion					
Nom. power in 4Ω	2 x 15 W	2 x 25 W	2 x 50 W	4 x 25 W	4x40 W + 1 x 100 W
Typical power in 4 Ω	2 x 25 W	2 x 45 W	2 x 85 W	4 x 45 W	4 x 53 W + 1 x 130 W
Nom. power in 2 Ω	2 x 30 W	2 x 50 W	2 x 100 W	4 x 50 W	4 x 60 W + 1 x 200 W
Typical power in 2 Ω	2 x 45 W	2 x 75 W	2 x 140 W	4 x 75 W	4 x 78 W + 1 x 220 W
Typical power in 1 W					1 x 300 W
Bridge mode 4Ω nom.	60 Watt	100 Watt	200 Watt	2 x 100 Watt	2 x 100 W
Bridge mode 4Ω typical	100 Watt	160 Watt	300 Watt	2 x 160 Watt	2 x 130 W
S / N ratio, better than	100 dB	100 dB	100 db	100 dB	105 dB
Channel separation	70 dB	70 dB	70 dB	70 dB	70 dB
Input variable	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 2V
* P300X subchannel works in class AB					
Power consumption:					
idle	1,3 A	1,7A	3,3A	3,4A	3,8A
4Ω nom. power	8A	12A	22A	24A	
2Ω nom. power	16A	23A	33A	46A	87A
Dimensions (mm)	125x177x62	165x192x62	260x192x62	320x192x62	450x192x62

BUILT-IN FILTERS

Q-100x, Q-200x and P-300X are equipped with built-in 12 dB variable electronic crossovers.
Low-pass variable 60 - 150 Hz
High-pass variable 80 - 200 Hz
P-300X: K1-2: HP 80-200 Hz / 2,4 kHz - 6 kHz
K3-4: HP 80 - 200 Hz + LP 3 kHz - 40 kHz
K5: HP 15 - 40 Hz + LP 50 - 125 Hz
The high-pass filters on channel 1-2 and 3-4 can be switched in-out.

REC. CABLE SIZES FOR THE DC-FEED

Cable length:	**<1,5 m**	**1,5 - 5 m**	**> 5 m**
B-40/SA-30/50	6 mm^2	10 mm^2	16 mm^2
SM-60/SM-100	6 mm^2	10 mm^2	16 mm^2
DA-100/DM-200	10 mm^2	16 mm^2	21 mm^2
Q-100X	10 mm^2	16 mm^2	21 mm^2
Q-200X	16 mm^2	21 mm^2	33 mm^2
Mono-250/P-300X	16 mm^2	21 mm^2	33 mm^2

CROSSOVER FILTERS

The ideal speaker element that can reproduce all frequencies from lowest bass to highest treble is not yet invented. Instead we have to use two or more speakers where each speaker is adapted to a part of the frequency range.
To make this work the input signal to each speaker element must contain only the frequencies it´s designed for. For this purpose we need crossover filters.

ACTIVE CROSSOVERS

Crossovers can be ACTIVE or PASSIVE. An active filter is connected before the amplifier line input. You need one amplifier for each speaker pair which will become rather expensive.
But the advantages are that it´s possible to mix speakers with different impedance or sensitivity and still be able to balance the system.
Most 4, 5 and 6-channel amplifiers are equipped with built-in active crossovers that can be adjusted in frequency and switched in-out.
GENESIS Q-100X, Q-200X and P-300X are equipped with these features. All GENESIS series 3 amplifiers are equipped with built-in active crossovers

PASSIVE CROSSOVERS

Passive crossover consists of coils and capacitors, and sometimes resistors for impedance adaption. A passive filter is connected between the amplifier and the speaker and is of LC-type, (coil and capacitor).

A coil stops the higher frequencies while the low passes through, a capacitor works in the opposite way. By changing the component values, different crossover frequencies are obtained. The coils must be of high quality with a large wire area to avoid losses and distortion. Air coils without iron core are the best but they can be rather big for high values. For high values we often use coils with an iron core. The best capacitors are of polyester type. For large capacitance values bipolar electrolytic capacitors are used.
Resistors are used in a filter for impedance adaption. Read the part about conjugate compensation.
A passive filter steals more power than an active.

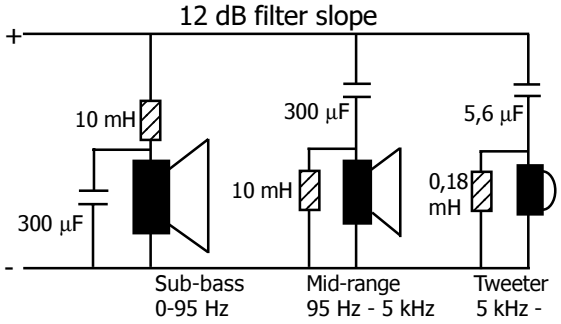
CROSSOVER FREQUENCIES:

In a two-way system with separate tweeter a crossover frequency from 3 - 8 kHz is normal.
In a three-way system it´s normal to split the sub at 200-400 Hz and the tweeter at 3 - 8 kHz.
In a four-way system the x-over frequencies can be as follows. To the subwoofer 80-130 Hz, mid-bass 400-600 Hz and the tweeter 3 - 8 kHz.
This is a just a recommendation. Depending upon the speaker data and where the different elements are mounted in the car, other x-over frequencies could be better.

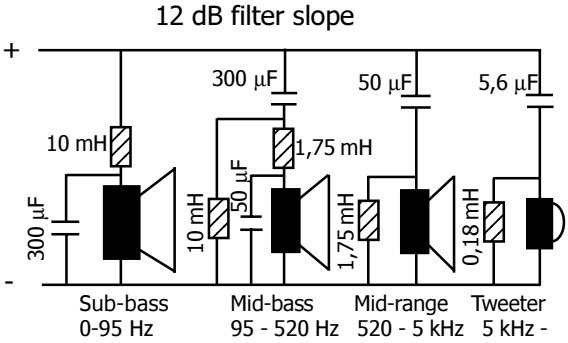
CROSSOVER EXAMPLES:

(without conjugate compensation)

3-WAY SYSTEM:



4-WAY SYSTEM:



The systems above are shown without impedance compensation. Read below about conjugate links.

PHASE SHIFT IN CROSSOVER FILTERS

All passive crossovers will phase shift the signal.
A 6 dB filter shifts 90 degrees and a 12 dB 180 degrees. Because of this you should always try to phase reverse the tweeter in a system to see what phase is creating the best sound. In a 3-way system it´s normal to phase reverse the tweeter. All tweeters used in a system must have the same polarity (phase). Also subwoofers with a 12 dB crossover should you try to phase reverse. If the subwoofer cone is moving but you don´t achieve any good bass you can try to phase reverse. If two subwoofers are connected with different polarity (phase), the sound from each speaker will kill the sound from the other, resulting in a poor bass reproduction.

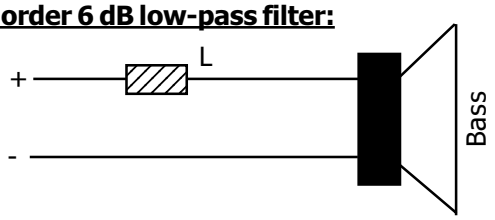
CONJUGATE COMPENSATION:

Conjugate compensation is a way to equal the speaker load over the whole frequency range. A 4 ohm speaker can have an impedance peak up to 25 times the normal at the resonant frequency (Fs). To make the calculated crossover filter to match, you can connect a conjugate link in parallel with the speaker. It´s normally made of a capacitor and a resistor. If you cant calculate the exact component values for the conjugate link you can use a 33 µF capacitor in series with a 3,9 ohm resistor to most 4", 5,25" and 6,5" speakers.

PASSIVE 6 dB LOW-PASS

A 6 dB x-over filter has a 6 dB slope / octave. The output from an amplifier is only a quarter after falling with 6 dB. A 6dB filter is also called 1:st order filter.
A common use for a 6 dB low-pass filter is for a subwoofer to stop frequencies over, as for example, 100 Hz.
A 6 dB low-pass filter consists of a coil. The x-over frequency is decided by the inductance value measured in the unit Henry (H) and parts of a Henry. For speakers we normally use coils with the unit mH.
1 H = 1000 mH.

1:st order 6 dB low-pass filter:



CALCULATION FORMULA:

$$L\ (mH) = \frac{160 \times Z}{Fc}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L= Coil inductance in mH

When connecting coils in series the values are added.
Use this formula when connecting in parallel:

$$\frac{1}{L} = \frac{1}{L} + \frac{1}{L} + \frac{1}{L}$$

Inductance values for different x-over frequencies:

	Speaker impedance		
X-over fq. Hz	2Ω L (mH)	4Ω L (mH)	8Ω L (mH)
65	5	10	20
80	4	8	16
100	3,2	6,4	12,8
130	2,5	5	10
200	1,6	3,2	6,4
360	0,9	1,75	3,5
500	0,65	1,3	2,6
800	0,4	0,8	1,6
1000	0,32	0,64	1,28

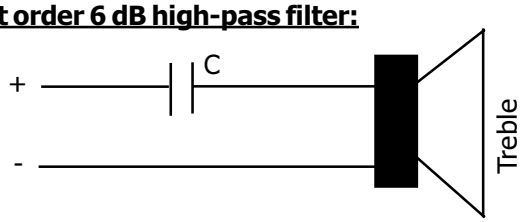
X-over frequencies at given values:

	10 mH	6,3 mH	1,75 mH
2Ω	32 Hz	50 Hz	183 Hz
4Ω	64 Hz	101 Hz	365 Hz
8Ω	128 Hz	203 Hz	730 Hz

PASSIVE 6 dB HIGH-PASS

A 6 dB high-pass x-over filter consists of a capacitor. The crossover frequency varies with the capacitor value that is measured in the unit Farad and parts of Farad. Normally we use μF values for speakers.,
1 F = 1000 000 μF
Capacitor values from approx. 10 μF and up are normally of bipolar electrolytic type. For lower values we often use polyester capacitors. A capacitor as in the drawing below let the high frequencies pass and stops the lower.

1:st order 6 dB high-pass filter:



CALCULATION FORMULA:

$$C\ (\mu F) = \frac{160000}{Fc \times Z}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
C = Capacitor value in μF

When connecting capacitors in parallel the values are added. Use this formula when connecting in series.

$$\frac{1}{C} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

Capacitor values for different x-over frequencies:

	Speaker impedance		
X-over fq. Hz	2Ω C (μF)	4Ω C (μF)	8Ω C (μF)
80	1000	500	250
100	800	400	200
130	600	300	150
200	400	200	100
500	160	80	40
800	100	50	25
1000	80	40	20
2000	40	20	10
5000	16	8	4

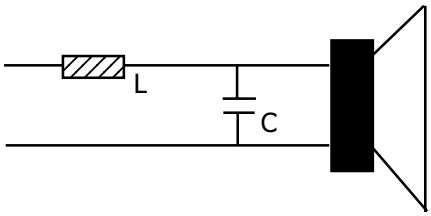
X-over frequencies at given values:

	300 μF	200 μF	150 μF	50 μF	6,8 μF
2Ω	266 Hz	400 Hz	533 Hz	1,6 kHz	11,7 kHz
4Ω	133 Hz	200 Hz	266 Hz	800 Hz	5,85 kHz
8Ω	67 Hz	100 Hz	133 Hz	400 Hz	2,92 kHz

PASSIVE 12 dB LOW-PASS

A 12 dB x-over filter has a 12 dB slope / octave.
A 12 dB filter is a combination of a coil and a capacitor. It is also called 2:nd order filter. 12 dB low-pass filters are often used for subwoofers in order to stop frequencies over the x-over frequency, for example 100 Hz. A combination of a low- and high-pass filter is called a band-pass filter.

2:nd order 12 dB low-pass filter:



CALCULATION FORMULA:

$$L\ (mH) = \frac{225 \times Z}{Fc} \qquad C\ (\mu F) = \frac{112500}{Fc \times Z}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L = coil inductance in mH
C = capacitor capacitance in μF

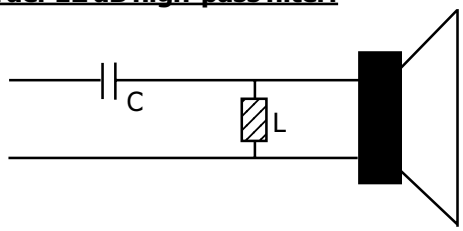
When connecting coils in series the values are added. Use this formula when connecting in parallel:

$$\frac{1}{L} = \frac{1}{L} + \frac{1}{L} + \frac{1}{L}$$

PASSIVE 12 dB HIGH-PASS

The difference between the passive 12 dB high-pass x-over filter and the low-pass filter is that the coil and capacitor change place. For a certain x-over frequency the component values are the same for both high- and low-pass filters. A high-pass filter let high frequencies pass, and stops the lower.

2:nd order 12 dB high-pass filter:



CALCULATION FORMULA:

$$L\ (mH) = \frac{225 \times Z}{Fc} \qquad C\ (\mu F) = \frac{112500}{Fc \times Z}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L = coil inductance in mH
C = capacitor capacitance in μF

When connecting capacitors in parallel the values are added. Use this formula when connecting in series.

$$\frac{1}{C} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

COMPONENT VALUES FOR 12 dB PASSIVE CROSSOVERS

X-over freq. in Hz	2 Ω		4 Ω		8Ω	
	C (μF)	L (mH)	C (μF)	L (mH)	C (μF)	L (mH)
62,5	900	7,2	450	14,4	225	28,8
95	600	5	300	10	150	20
140	400	3,2	200	6,4	100	12,8
190	300	2,35	150	4,7	75	9,5
375	150	1,2	75	2,4	38	4,8
520	108	0,87	54	1,75	27	3,5
800	70	0,56	35	1,12	18	2,25
3500	16	0,12	8	0,25	4	0,5
5000	11	0,09	5,6	0,18	2,8	0,36

The same component values are used for both high- and low-pass filters, but they change place.

Use coils with low resistance, air coils are the best. Coils with iron core must be able to handle high current or the iron core magnetic saturation becomes to high causing distortion.
Capacitors must be of bipolar type, 50 - 100 Volt.

IMPORTANT WHEN CONNECTING FILTER !
When connecting a 12 dB low-pass x-over to a subwoofer it´s suitable to solder the capacitor directly on the sub terminals between + and -.
If the sub is disconnected without disconnecting the capacitor at the same time the amplifier can be damaged.
A 12 dB filter connected without a speaker will overload the amplier (if it´s turned on) and damage the output circuits.

THE CABLES - AN IMPORTANT LINK

No chain is stronger than it´s weakest link !
It´s not unusual that people buy expensive amplifiers and speakers but forget the wiring. DLS have high quality cables for both amateurs and professional users.

Cables made of oxygen free copper (OFC).
Cables made of oxygen free copper will not oxidize as normal copper do. The oxidation increases the DC-resistance and as a result of this the voltage drop in the cable. All DLS cables use oxygen free copper.

DLS POWER CABLES.
As we have said before the DC-feed to the amplifier is of great importance. The amplifier must in all occasions have enough current, otherwise both the dynamics and good sound will be lost.
DLS power cables of oxygen free copper are made of a lot of small cores to make it soft and flexible with lowest DC-resistance. Use the table below to choose the correct DC-feed.

Cable length:	<1,5 m	1,5 - 5 m	> 5 m
Stereo 60	6 mm^2	10 mm^2	16 mm^2
Stereo 100	10 mm^2	16 mm^2	21 mm^2
Dual Mono	16 mm^2	21 mm^2	33 mm^2
Four Channel	16 mm^2	21 mm^2	33 mm^2
Five Channel	16 mm^2	21 mm^2	33 mm^2
Monoblock	33 mm^2	33 mm^2	42 mm^2

In many installations the current capacity is improved with extra batteries (OPTIMA) with low inner resistance or large 1 Farad capacitors, DLS Power Caps. If you don´t want to spend money on extra batteries at least you shouldn´t save money on the DC-feed.

DLS SPEAKER CABLES.

Also the speaker feed must be of high quality. Use cables with an area of at least 1,5 mm^2.DLS speaker cables are soft and flexible with a construction that minimizes the loss over the whole frequency range.

DLS SC 4x1 and SC 4x1,5 are special speaker cables with four leads. They are twisted and has a powerful insulation protecting them from mechanical agitation.
The four leads are connected in pairs as they have different strand sizes using the skin effect to minimize the resistance on all frequencies.
The capacitance, inductance and EMF are reduced by the twisted cores in the cable.
Two of the four leads have a strand size of 0,1 mm^2, and the two others have 0,2 mm^2.

DLS SC 2x1,5, SC 2x2,5 and SC 2x4 are the standard two-lead speaker cables made of oxygen free copper. They have twisted strands and are soft and flexible for easy installations.

SKIN-EFFECT AND INDUCTANCE

In a conductor the higher frequencies moves on the surface, while lower frequencies moves in the center of the cable. To make the active resistance (impedance and inductance) as low as possible for each frequency some cables use different strand sizes for different frequencies. Higher frequencies prefer a cable with very thin strands while the lower frequencies will find the lowest active resistance in a thicker strand. To minimize the cable resistance further the cable can be designed with a combination of copper and silver plated strands.
One of the advantages with DLS speaker- and signal cables are the low inductance. Opposite an ordinary DC-resistance the inductance is linear. It means that higher frequencies will be more supressed than the lower which can create a distored and false sound reproduction. Inductance will occour when an AC-current flows in an electromagnetic field. These fields are causing eddy currents superposed the normal current leading to an increase of resistance. They also make the current flow to decrease towards the center of the conductor (skin-effect). A low inductance is to prefer. This is achieved by using raw materials with high purity. A low inductance will also be achieved by twisting the strands in the conductor. When the current to the speaker passes through the speaker coil, which is an inductance, it creates eddy currents that goes back to the amplifier called counter- Electro Motive Force (EMF). The EMF is also reduced by a correct cable construction with twisted strands.

DLS speaker cable design gives the following advantages:

- Maximum reduction of the EMF which causes phase shift resulting in bad sound quality.
- Lowest possible damping resistance on all frequencies by using the skin effect.
- Lowest possible power loss.

SIGNAL CABLES:
The signal cables must be of good quality as well as the speaker cables.
The construction of the cable must have the best possible reduction of inductance and capacitance together with a low damping over the whole frequency range.
The shielding is also important to avoid interference noise from the electric system of the car.
DLS **SL2PRO** and **SL5PRO** are triple shielded but without a remote wire. A remote wire included with the signal cable may induce interference.
Also use RCA phono connectors of highest quality with good shielding and gold plated for minimum contact resistance.

INSTALLATION

THE HEAD UNIT

The heart in a car stereo installation is the car stereo, often called head unit. Today it´s normally a tuner with an external CD-changer or built-in CD-player. The well-known brands are the best choice if you want a high quality product.
One important detail is to buy a head unit with RCA pre-outs which makes it easier when you want to do a more sophisticated installation than standard. The head unit is normally installed in the dash-boards original fitting, just make sure it´s fastened properly. If possible use heavier DC-feeds than the originals used in the car. If you use the internal amplifier to feed any speaker pair this is important. The ground wire must have the same area as the +-feed.
If you have interference noise from the alternator or ignition its´often the ground connection that is wrong. Try different places for the ground connection, the best is close to a unit (the amplifier).

THE AMPLIFIER

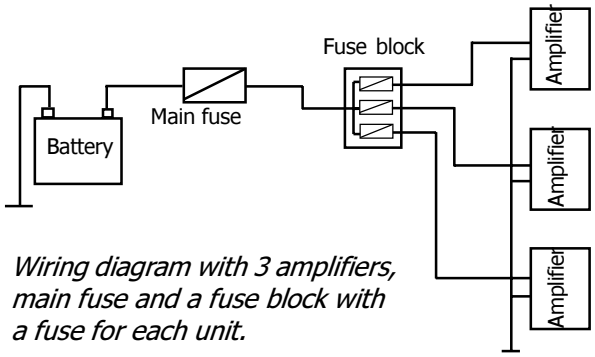
An extra amplifier should be installed in a place where it can be satisfactory cooled. Many amplifiers get very hot and need a good cooling.
In some installations you might need one or two external cooling fans.
First check if there are any cable mats or fuel pipes behind the place where you plan to mount the amplifier. Alternatively use an extra particle board or the bass box when you mount the amplifier and you will have a better ground insulation. To avoid interference noise this can be to prefer.
Install the amplifier far away from your radio aerial. Sometimes the amplifiers DC/DC-converter generates high frequency interference.

THE CABLES

As we have said before the cables are very important. In the table on page 5 you find recommended areas for the DC-feed for different amplifiers. The ground wire must have the same area as the +-wire. Connect the ground wire as close as possible to the amplifier. Connect all units in the system to the same ground point to avoid interference.
Use high quality speaker cables with an area of at least 1,5 mm^2 to the side systems and 2,5 mm^2 to the subwoofers, (or more).
Signal cables must have good shielding, otherwise they can pick up interference noise.
Avoid to place the power cables on the same side of the car as the signal cables. Also try to avoid the cars own cable mats to come close to the signal cables.
Any extra cable must be laid out in zig-zag style and definitely not coiled.
Don´t let the cables pass sharp edges that can hurt the cable insulation causing short circuits or other problems.

THE DC-FEED

To avoid damage to the amplifier or the electric system of the car the DC-feed installation must be made with care. A main fuse should be installed close to the battery. The fuse value depends on what kind of amplifier / amplifiers you use, but a fuse value of 40 - 60 A is normal.
Use either glass fuses or automatic circuit breakers. If the amplifiers are installed in the back of the car it´s normal to install a separate fuse block from which you distribute the power to the separate units. Each unit will then be separately fuse protected. See the drawing below.



Wiring diagram with 3 amplifiers, main fuse and a fuse block with a fuse for each unit.

The main fuse holders use either a glass fuse of AGU-type (max 80A), or ANL-fuses with values up to 250 Amps. There are fuse blocks for 2, 3 or 4 AGU fuses.
Automatic circuit breakers is another good alternative as main fuse. They also have a test button with which you easily can switch off the power to all units.
The ground wires from all units can easily be connected together with a power block type PB1.

For best function with lowest possible DC-resistance in all connection points, all the above products are gold plated with 24 K gold. Besides of a good function it´s also gives a good impression.

EXTRA BATTERY

In many exclusive installations, and most competition cars, extra batteries are installed. Sometimes also extra alternators for improved charging, or extra capacitors of 0,5 or 1 Farad value.
The purpose of this is to make sure that the amplifiers always gets enough current even at very high volumes, otherwise the sound will be destroyed at high volumes.
For a normal listener the ordinary car battery is sufficient. Just make sure you have DC-feeds that´s big enough. But if you plan to compete or just want to get the most out of your equipment it´s always right to install an extra battery or extra capacitors that works as a current reservoir.
These extra batterys are of a special type with low internal resistance that can handle large current flows.

SPEAKER INSTALLATION

An important part of the installation is of course the speakers.
How they are installed varies from car to car and depends upon the possibilities in each type.
The factory pre-made installation holes are not always ideal for other types of speakers than original. We will give you some hints of what to think of when installing speakers.

ORIGINAL INSTALLATION
The easiest way to install a speaker in a car is to use the factory pre-made holes. If you use car specific speakers, the installation job becomes very easy. But the problem is that these type of speakers are usually not of the highest quality and will not satisfy a demanding listener.
The high quality speakers often have large magnets making it necessary to first measure the space and sometimes make changes in the door or dash-board to make them fit. Especially the depth is important to check so that the side windows goes clear from the magnet.
Some car models requires special adaptors or distances to make the speaker fit when you use other speakers than the original.
If possible use some kind of baffle on the back of the door panel. Make sure the baffle is fastened properly and fasten the speaker in the baffle. This is easy to make and will normally result in a better sound than without baffle.
A speaker installation high up on the door-side is to recommend, but if the pre-made hole is at the bottom part of the door it´s difficult to change.
A 2/3-way system should be installed with the elements close to each other to achieve the best sound image. An alternative is to install the bass element in the door and the tweeter on the dash-board.
A door or dashboard installation is actually an "open-air" installation since there is no limiting box.

ORIGINAL MOUNTING:

ADVANTAGES:
- Fast, easy and simple

DISADVANTAGES:
- The speakers have no baffle = rattle.
- Bad power handling capacity.
- Bad sound image.
- No box to the speaker element.

Exemple of a door installation with new baffles.

NEW DOOR BAFFLES
If you want to improve your door installation you should build a new door-side. This must be adapted to the door side and is normally made of MDF or particle board. The baffle is covered with cloth or vinyl matching the car interior. Some car sound builders changes the whole door-side to a new one. The speaker element is directed to obtain the best sound image. They are also fastened properly to avoid rattle.
They are normally mounted with a sealed speaker box behind the elements. The volumes needed for a 4" or 5,25" element are only a few liters.

BAFFLE MOUNTING:

ADVANTAGES:
- The speakers are mounted in real baffles.
- A box construction that improves the sound quality with less rattling.
- Higher power handling capacity.
- Better sound image (front stage).

DISADVANTAGES:
- More work and more expensive mounting.
- The cars original door sides are affected.
- The installation requires a lot of knowledge to make the installation to look professional.

KICK-PANELS
Another installation alternative giving a good sound image is the kick-panel. It´s placed down on the floor in front of the door on both sides. It can contain the whole system with bass, midrange and tweeter or a bass and midrange with the tweeter installed on the dashboard. The best places for the speakers must be tested out in the respective car.
Kick-panels are normally made of MDF or particle board and are build as sealed boxes or as membrane boxes where the element is allowed to breath through a membrane of foam rubber or similar.
Kick-panels are very popular in competition cars.

MOUNTING IN KICK-PANELS:

ADVANTAGES:
- Stable mounting without rattling.
- Superb sound image.
- Higher power handling capacity.
- Less affection on the cars interior.

DISADVANTAGES:
- More mounting work.
- Possibilites to damage the speaker if kicking on them with the feets.

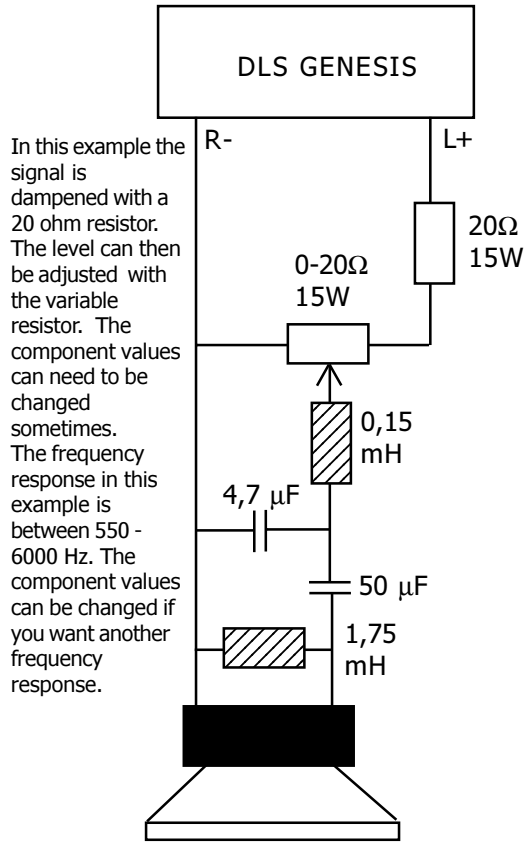
HIGH MOUNTED KICK-PANELS:
In some cars the kick-panel can be mounted invisible up under the dashboard. Can create a good sound image despite the strange mounting.

DASHBOARD MOUNTING
A mounting of the midrange and tweeter up on the dashboard will result in an improved sound image. It will be moved up on the dashboard. Some cars that have suitable original dashboard mounting holes can be used.
The tweeters should be mounted on the dashboard or on the door poles. The woofer elements should be mounted in a door-side or in a kick-panel. Suitable for DLS U-35/U-36 or R36/RC36.

REAR FILL
A well mounted front system is the most important in a sound system. In some cases we also use rear mounted speakers used as "rear fill". Rear fill speakers will improve the front stage image by adding a weak sound from the rear filling up the sound stage and giving it a deep. As Rear fill speakers we can use midrange elements in combination with a passive or active bandpass filter, mounted in the rear. A suitable frequency response can be from 500 - 6000 Hz. The level must be dampened easiest made with a series resistor of 10 - 20 ohms in series with the + lead. The rear fill speaker can also be connected in multimode. In this case you use only one element working as a center channel speaker.

Kick-panel

CENTER CHANNEL SPEAKER
A center channel speaker can be used to improve the sound image in installations where the speaker mounting makes it difficult to achieve a correct sound image.
On a GENESIS amplifier you connect the center channel speaker in bridge mode between left and right channel and then you obtain the sum signal of both channels.
It can be mounted on the middle of the dashboard.



In this example the signal is dampened with a 20 ohm resistor. The level can then be adjusted with the variable resistor. The component values can need to be changed sometimes. The frequency response in this example is between 550 - 6000 Hz. The component values can be changed if you want another frequency response.

Center channel speaker 4 ohm

HAT-RACK MOUNTING

The best sound stage for front seat listeners is achieved with door- or kick-panel mounting. In competition cars the front system combined with rear subwoofers are often the only speakers. Sometimes they are combined with a pair of small 4" or 5,25" speakers in the back used as "rear fill". These rear fill speakers are connected with x-overs giving a reproduction from 1-2 kHz and up. Tweeters are normally not used in combination with rear fill.

The traditional hat-rack mounting with a system or 6x9" speakers requires some installation work to create a good sound.
A new hat-rack made of particle board (22 mm) or MDF-board (19 mm) must be produced. The original hat-racks are normally not sufficient to use.
If you furthermore want the speakers to have a high power handling capacity you need to make some kind of speaker box (normally of sealed type) on the back of the hat-rack, limiting the cone movement.
If you have a bass box in your trunk it´s necessary to have a box for the hat-rack speakers. If not, the low bass from the sub will have an influence on the speaker cones and destroy the sound.

In many installations you must use passive filters to the different speakers in your system. Later in this book there are some wiring examples where passive filters are used.

SUBWOOFER INSTALLATION

An "open air" subwoofer installation in the hat-rack or towards the back seat calls for the same baffles of particle board or MDF-board as described above. But the best result is normally achieved using a separate bass box of some type. Later in this book we will describe different types of boxes and give advices of how to build a box.
You will also find suitable box sizes for all DLS subwoofers.

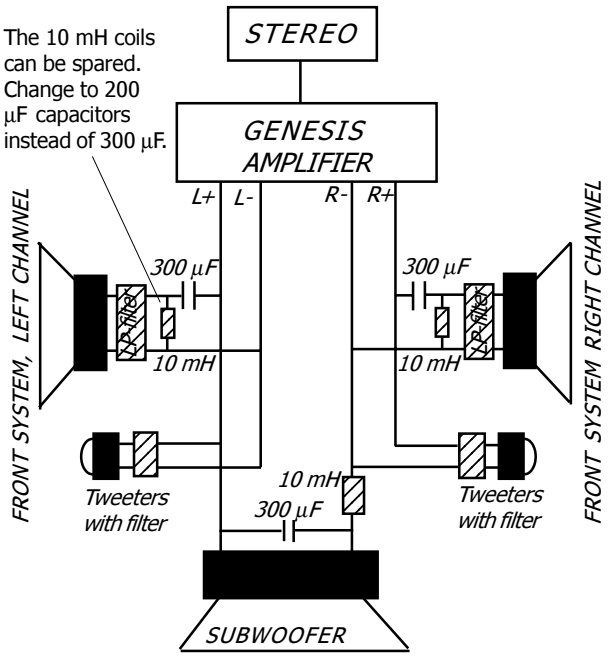
GENESIS IN MULTIMODE

All GENESIS (except for MONO 250) can be used in multimode operation. Multimode means that you from one amplifier can take three different signals, left channel, right channel and the sum of right and left channel.
To the sum signal you can connect one or more subwoofers through a passive low-pass crossover. You can also connect a center-channel speaker in multimode. (See example on page 18).
The stereo connected speakers can be either a 2/3-way system or coaxial speakers. To this speakers you must use passive high-pass filters that limits the frequency response.
The advantages of multimode operation is that a single amplifier can be used for all speakers in the car. It´s easy to install, it needs less space and it´s cheaper. The disadvantages is that you need passive crossovers and it´s difficult to adjust the sound balance between the front system and the subwoofer. The load capacity of the amplifier limits the number of speakers that you can use in the system.

GENESIS series 3 amplifiers are 2 Ω stable, the minimum amplifier load is 2 ohms.

MULTIMODE CONNECTION

This is an example of a typical multimode connetion with a front system and a subwoofer. 12 dB passive high- and low-pass filters are used in combination with the original filters used for the front system.
All speakers have an impedance of 4 ohms.

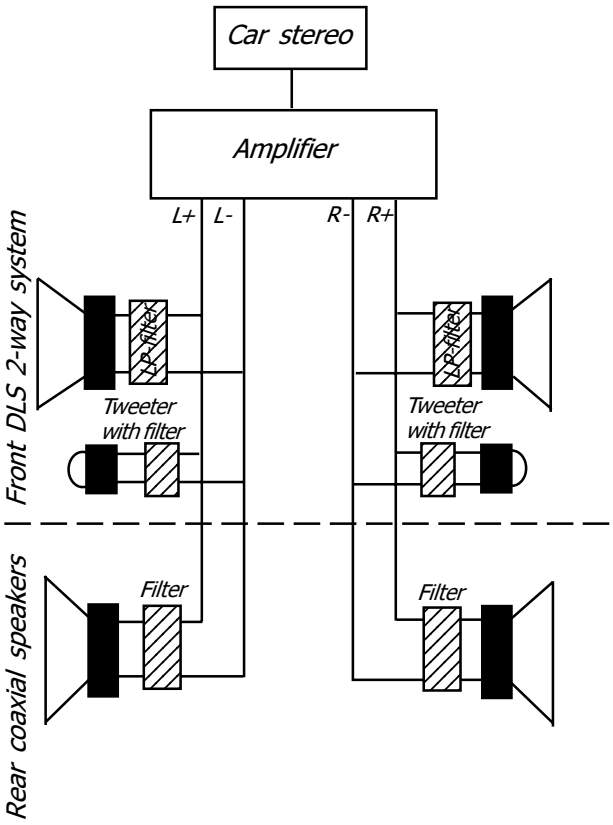


You can also use DLS Multimode filter with all passive components built in a nice box. This will make the installation much easier.

GENESIS WIRING EXAMPLES

Example 1.
Basic wiring with one or two speaker pairs.

This example with one or two 4 ohm systems can be used with all GENESIS amplifier models.
The amplifier load is 2 ohms when connected in parallel. Use 2/3-way systems or coaxial speakers. All speakers must have an impedance of 4 ohms.

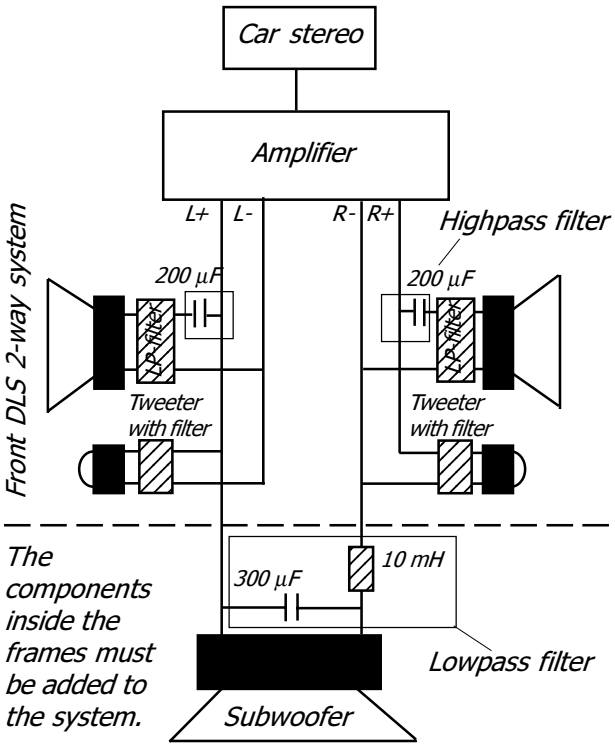


Suitable for: All GENESIS models.
Speaker impedance: 4 ohm

Passive filters: Not needed except for the filters coming with the speaker kits.
Advantages: One amplifier can run both front and rear speaker systems.
Disadvantages: You can´t balance the sound levels between front/rear speakers. (It´s possible to use fixed resisors in series with the speakers to adjust the levels.)
Amplifier load: 2 ohms

Example 2.
System with a front system and a multimode connected subwoofer.

This system is similar to that on page 12. But here we use a 6 dB filter (200 μF capacitor) to the front system. With only one system and a subwoofer it´s sufficient with a 6 dB filter. All speakers must have an impedance of 4 ohms.

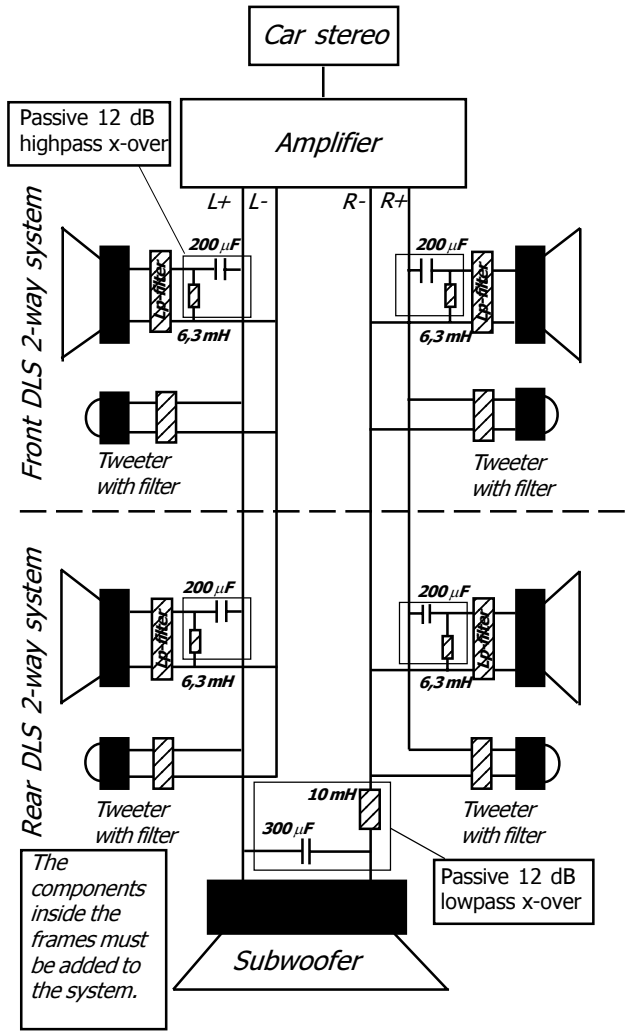


Suitable for: All GENESIS models.
Passive filters: To the sub: 12 dB low-pass filter with 300 μF capacitor + 10 mH coil giving 95 Hz x-over.
To the front system: 6 dB high-pass filter with 150 - 200 μF capacitor giving 180 Hz x-over. The original filters in the systems must also be used.
Capacitors must be of bipolar type.
The coil must have low resistance, 0,5 - 0,7 Ω.
Advantages: One amplifier can be used for the whole system.
Disadvantages: You can´t vary the sound level to the subwoofer.
Alternatives: If you use two subs they must be of 8 ohms impedance connected in parallel to obtain a 4 ohm amplifier load.
Amplifier load: 2 ohms

NOTE! In multimode operation the connected subwoofers must never form an impedance lower than 4 ohms.

Example 3.
System with a front and a rear system, and a multimode connected sub.

This system can be used together with most GENESIS 2-channel amplifiers if 12 dB highpass cross-overs are used to both front and rear systems and subwoofer. Both front and rear speakers are 2-way systems. The impedance of the subwoofer is 4 ohms.

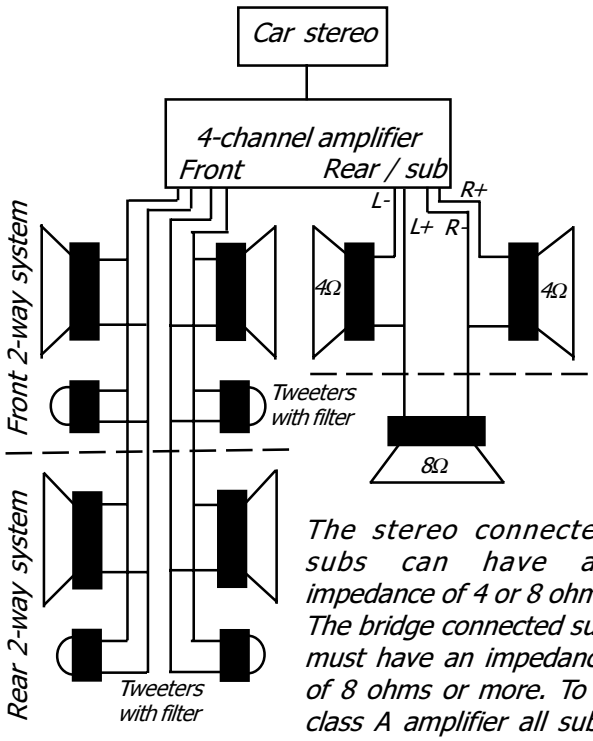


Suitable for: GENSIS SA-30, SA-50, DA-100 Stereo 60, Stereo 100, Dual Mono.
Speaker impedance: 4 ohms for all.
Passive filters:
To the sub: 12 dB lowpassfilter with 300 µF capacitor + 10 mH coil giving 95 Hz x-over freq.
To front/rear systems: 12 dB highpass filter with capacitor 200 µF and 6,3 mH coil giving 140 Hz x-over frequency. The systems original filters must also be used.
Alternatives: If you use 2 subs they must be of 8 ohm impedance connected in parallel to 4 ohm.
Advantages: One amplifier for the whole system.
Disadvantages: You can´t vary the sound front/rear or the level to the subwoofer.
Amplifier load: 2 ohm

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 4.
System with a 4-channel amplifier, front and rear system and subwoofer.

In this example a front and a rear system are connected in parallel on FRONT. Two or three subwoofers are connected to REAR. The amplifiers built-in filters are used. Suitable for Q-100X, Q-200X and Four Channel.



The passive filters are not shown, but must naturally be used.

The stereo connected subs can have an impedance of 4 or 8 ohms The bridge connected sub must have an impedance of 8 ohms or more. To a class A amplifier all subs can have an impedance of 4 ohms.
In the example above the amplifier load is 2 ohms.
As an alternative you can connect two subs in stereo or one sub in bridge mode.

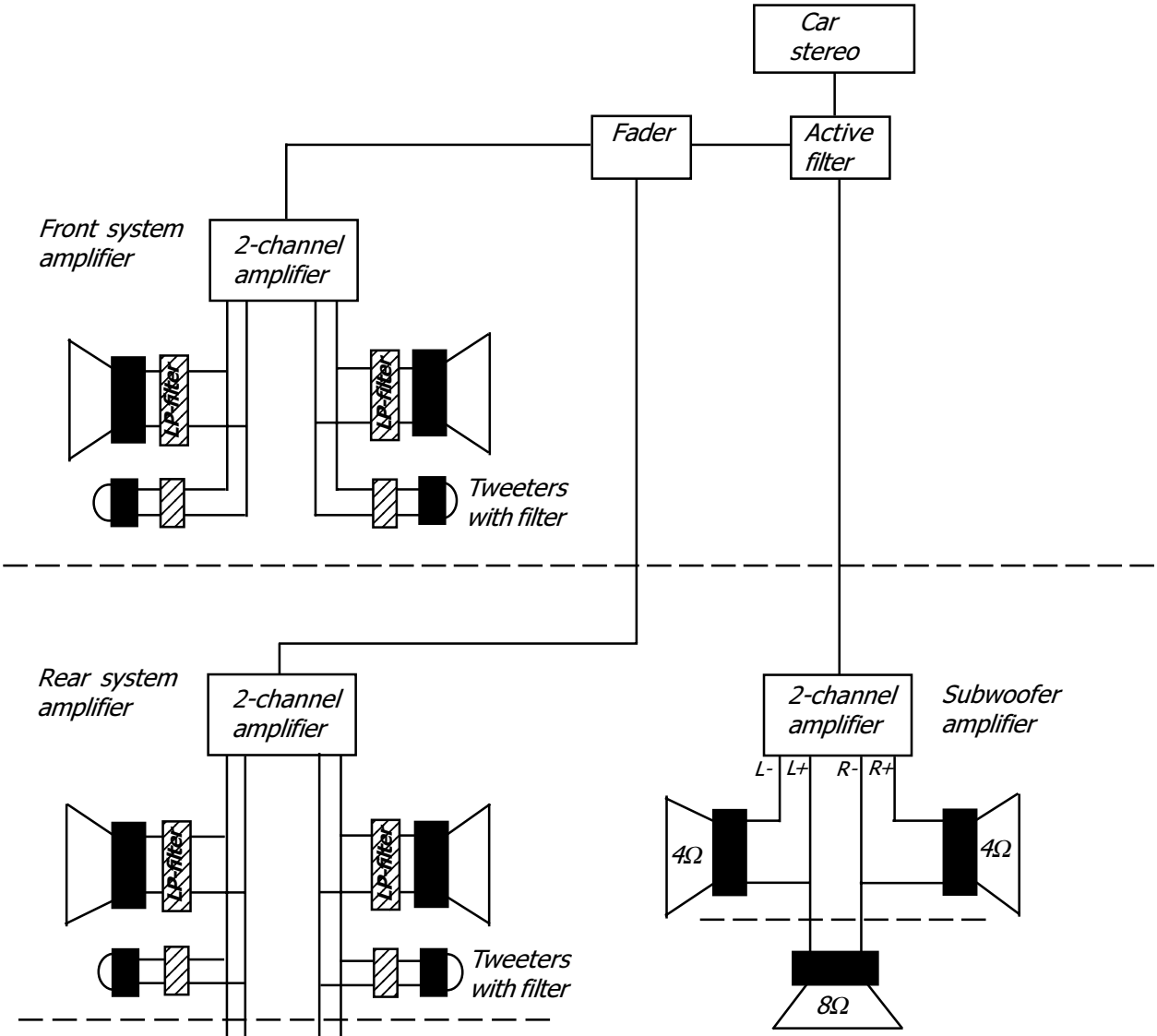
Suitable for: GENESIS Q-100X, Q-200X.
Filter: No passive filters needed. The amplifiers built-in filters are used.
Built-in filters: Adjust the built-in filters of the amplifiers according to the owners manual.
The speaker systems own filters are also used.
Alternatives: One or two systems can be connected in parallel to the FRONT output.
Mid-basses can be connected to the speaker output of the car stereo through a 12 dB low-pass filter with 550 Hz crossover. C = 50 µF, L = 1,75 mH.

Amplifier load in the example above: FRONT: 2 ohms
REAR: 2 ohms

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 5:
System with separate amplifiers for front and rear system with fader. Separate amplifier for the subwoofers.

This system with three amplifiers and a filter box gives you many possibilities to adjust and balance the sound in your car so that every speaker plays at the wanted level. This is an advantage compared to multimode connected systems. It´s also possible to use mid-bass speakers with a passive crossover.



Mid bass speakers with 12 dB low-pass filter. X-over freq. 550 Hz

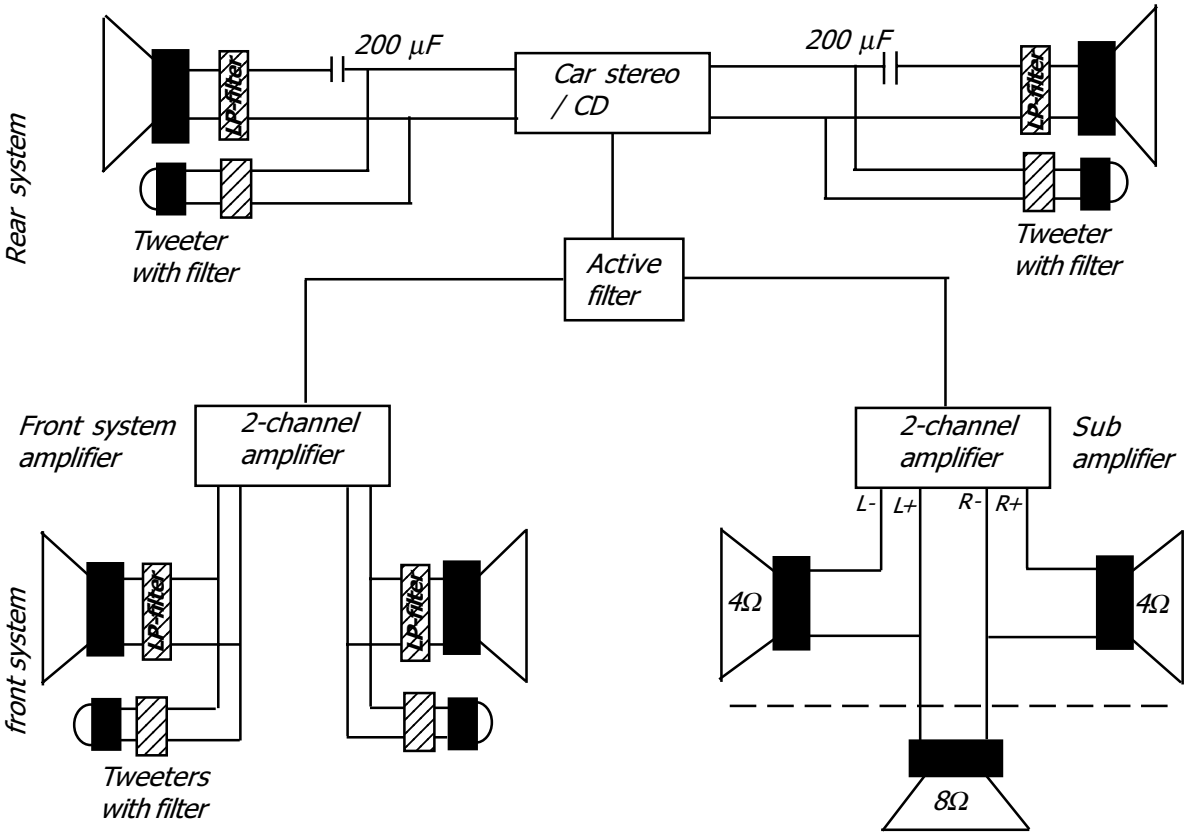
The stereo connected subs can have an impedance of 4 or 8 ohms .The bridge connected sub must have an impedance of 8 ohms or more. To a class A amplifier all subs can have an impedance of 4 ohms. In the example above the amplifier load is 2 ohms. As an alternative you can connect two subs in stereo or one sub in bridge mode.

Suitable for: All GENESIS 2-channel amplifiers can be used in this example.
To GENESIS series 3 you can use the internal crossovers instead of the separate active filter.
The mid-bass speakers can be connected to either the front or the rear system.
Active filter: You can use DLS 2W1 to split the signal.
Amplifier load: front system 4 ohm
rear system with mid-subs: 2 ohm

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 6:
System with separate amplifiers, one for the front system and one for the subwoofers. The rear system is fed directly from the car stereo.

In this system the built-in amplifier of the car stereo is used for the front system through a 6 dB highpass-filter with 200 Hz x-over. An active filter splits the signal between the rear and the sub amplifiers.



The stereo connected subs can have an impedance of 4 or 8 ohms .The bridge connected sub must have an impedance of 8 ohms or more.
To a class A amplifier all subs can have an impedance of 4 ohms.
In the example above the amplifier load is 2 ohms.
As an alternative you can connect two subs in stereo or one sub in bridge mode.

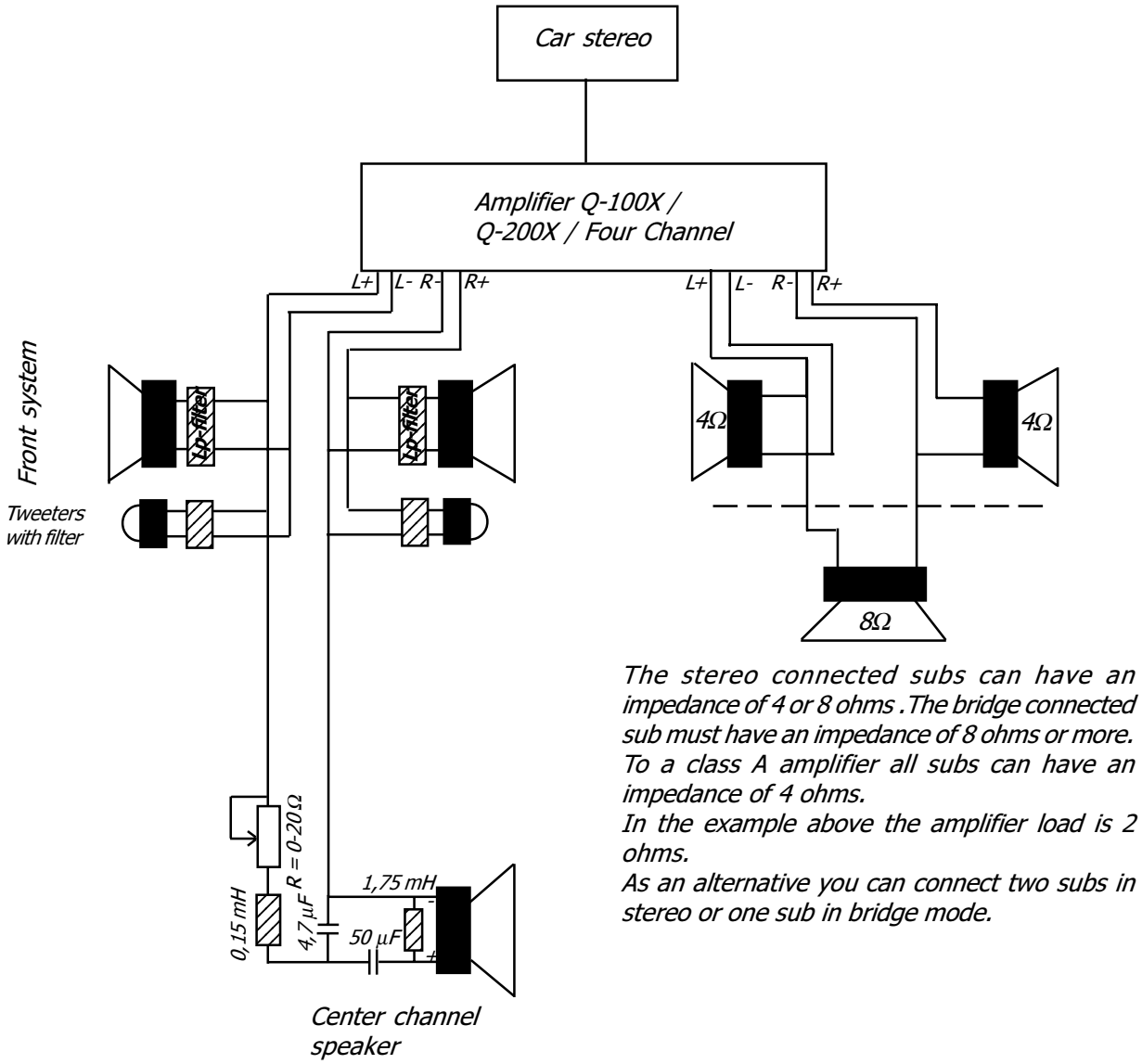
Suitable for: All GENESIS 2-channel amplifiers can be used in this example.
To GENESIS series 3 amplifiers you can use the internal filters instead of the 2W1.
Passive filters: To the rear system a 6 dB x-over (200 µF capacitor) with 200 Hz x-over frequency, 300 µF gives a x-over of 130 Hz, 150 µF gives 266 Hz.
Active filter: Use a DLS 2W1 2-way filter box to split the signal between front and sub system. It has selectable x-over frequencies from 50 to 150 Hz.
Disadvantages: There will be a great difference in sound quality between the rear system without external amplifier, and the front system using a separate amplifier.
Amplifier load: Rear system: 4 ohms.

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 7:
System with a 4-channel amplifier, front and rear system, subwoofers and a center channel speaker.

In this system you can use GENESIS Q-100X, Q-200X or Four Channel, 4-channel amplifiers with built-in electronic crossovers.

A center-channel speaker is connected i multimode. The center-channel level can be adjusted with a variable resistor.

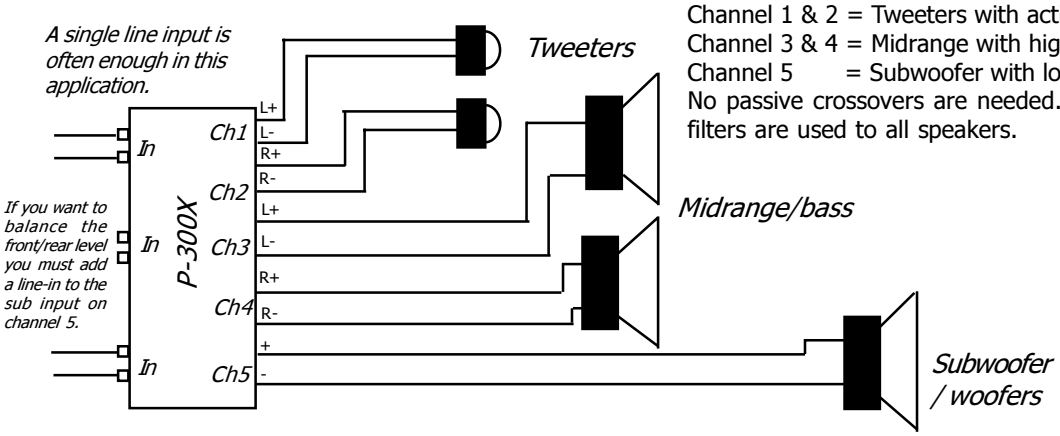


The stereo connected subs can have an impedance of 4 or 8 ohms .The bridge connected sub must have an impedance of 8 ohms or more.
To a class A amplifier all subs can have an impedance of 4 ohms.
In the example above the amplifier load is 2 ohms.
As an alternative you can connect two subs in stereo or one sub in bridge mode.

Suitable for: GENSIS Q-100X, Q-200X or Four Channel
Passive x-overs: A center channel speaker is connected in bridge mode. To adjust the level you need a variable resistor with 15 watts power handing capacity. A band-pass filter allows the speaker to reproduce frequencies between 550 to 6000 Hz.
Active filters: The built-in filters are used.
Amplifier load: FRONT: 1,3 ohms
REAR: 2 ohms in the example above.

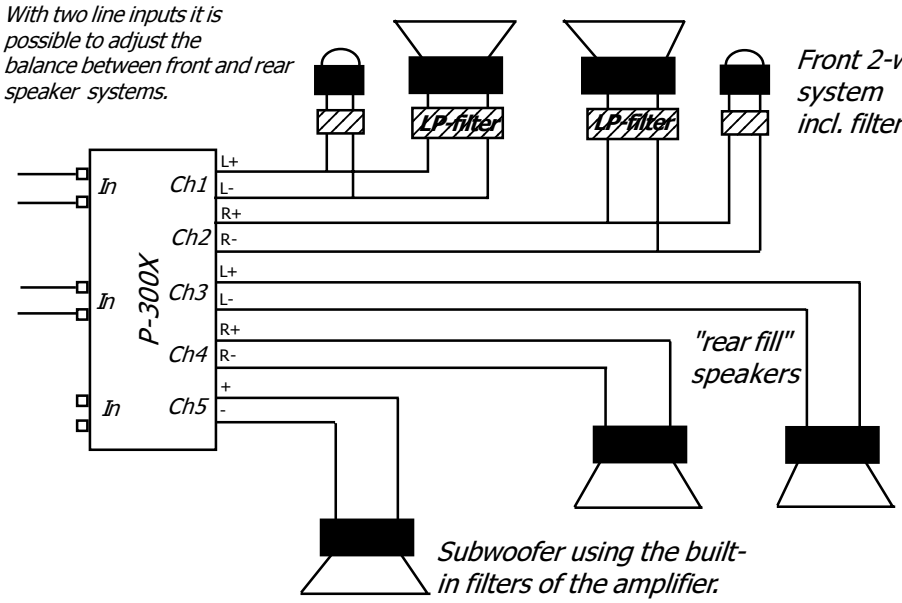
NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 9:
System with P-300X, 5-channel amplifier with a front 2-way system with active crossover and a subwoofer.



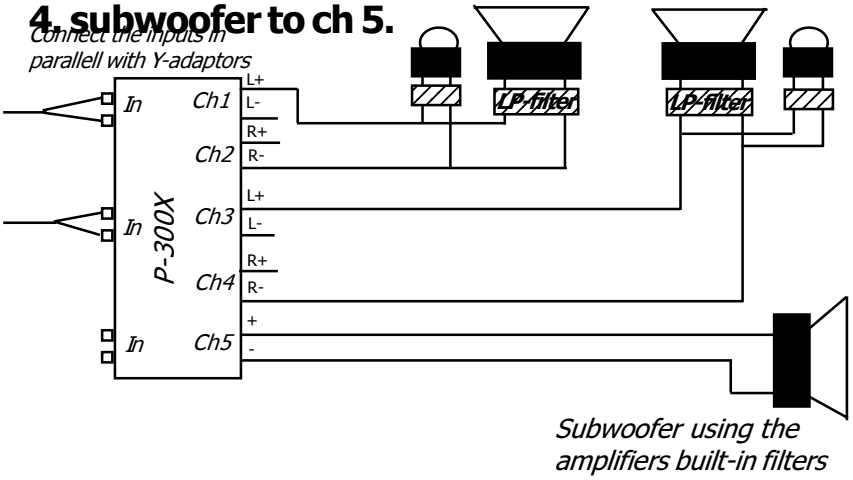
Channel 1 & 2 = Tweeters with active high-pass filter
Channel 3 & 4 = Midrange with high- and low-pass filter
Channel 5 = Subwoofer with low-pass filter
No passive crossovers are needed. The built-in active filters are used to all speakers.

Example 10:
System with P-300X, front system, "rear fill", and a subwoofer.



In this example the speakers own passive filters are used to the front system in combination with the built-in highpass filters on channel 1-2.
On channel 3-4 är "rear fill" speakers are connected. the amplifiers built-in filters are used.
The sub also uses the built-in filters.

Example 11:
System with P-300X. Front system connected in bridge mode to ch. 1 - 4, subwoofer to ch 5.

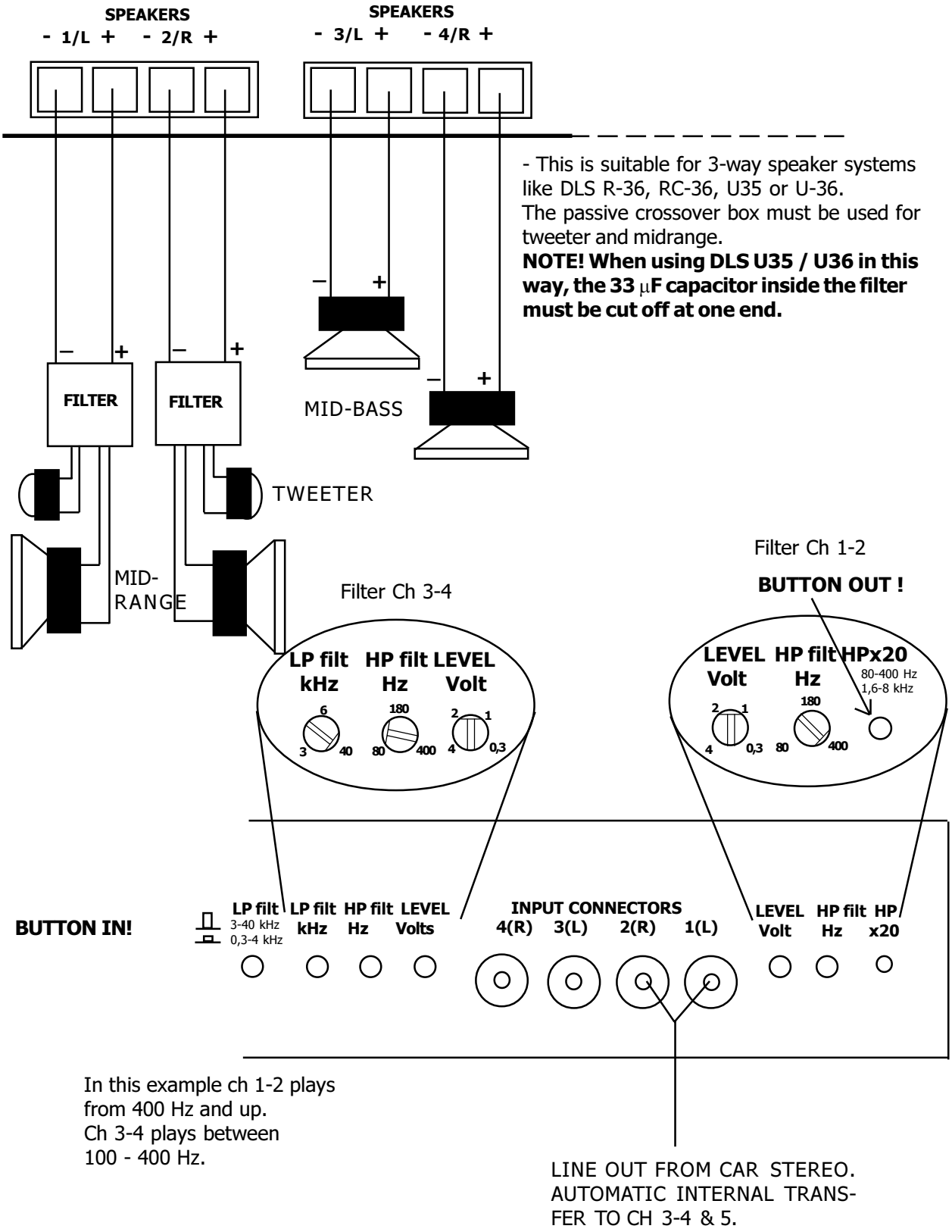


Front system connected in bridge mode to channel 1 - 4. The speakers own filters are used in combination with the built-in filters in the amplifier. (Adjust the ch 3-4 lowpass filter to 40 kHz x-over freq.) Subwoofer is using the ch 5 built-in filters.

Example 9:
System with GENESIS Five Channel, 5 channel amplifier with a front 3-way system with active x-over. (Not for P-300X).

All other wiring examples can be found in the owners manual for Five Channel.

The diagram shows the connection of a 3-way system, DLS U36 or similar, where tweeter and midrange speakers are connected to ch 1-2, midbasses to ch 3-4, and subwoofers to ch 5 (not shown). Passive crossover is used between tweeter and midrange.



WHY DO WE NEED SPEAKER BOXES?

A Hi-Fi speaker for home use is always mounted in a box to reproduce the best possible sound.
Traditional mounting in cars are in a door side or in the hat rack, this is a simple baffle mounting. You can of course achieve a better sound in your car by using suitable speaker boxes.
In a correct adapted box the sound is improved and the power handling capacity increases.
If you have a subwoofer in your trunk and a pair of "open air"- mounted speakers in the hat-rack the air pumping from the sub will effect the hat-rack speakers and make the cones move a little ruining the sound from them. This is one of many good reasons to use boxes also in your car.
Normally we use boxes for the subwoofer but also the rest of the speakers sounds better mounted in a suitable box.
We will now describe the different types of boxes normally used in a car.

SPEAKER BOXES, GENERAL

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

SEALED BOXES

Sealed boxes are easy to build. The size is not critical, but it can´t be too small. The speaker data such as Fs, Qts, Vas and X-max decides the size of the box. Large speakers need larger boxes. Two speakers need a box of the double size etc. The box must be completely air-tight. Sealed boxes are normally used for door-panels or kick-panels. Most 4", 5,25" and 6,5" speakers can be used in sealed boxes.
A sealed box should be filled with acoustic wool up to 75 - 100%.
A sealed box has a lower efficiency than vented boxes but they can handle high power and are easy to build. A subwoofer in a small sealed box creates a tight bass suitable for disco and hardrock.
DLS subwoofers are best in vented boxes but works well also in sealed boxes.

If you use a 30-40 Hz subsonic highpass filter on the line input of your amplifier you will achieve a tight and well-defined bass in your bass-box. (All GENESIS series 3 amplifiers have a built-in subsonic filter.)

VENTED BOXES

A speaker in a vented box has higher efficiency (3 dB) and higher power handling capacity than in a sealed box. In a vented box 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 real bad.
The size of the box are decided by the speaker data just as in the sealed box. Also the car type and music type have an influence on the box size.
Often the size of the car decides the practical size of the box. A smaller box has a higher resonant frequency than the larger one. The size of the box should not be so large that the speaker plays below it´s own free air resonance (Fs), then it looses in power handling capacity.
The port in a vented box should be mounted on the same side of the box as the speaker. But sometimes this is impossible. The port opening inside the box must have a free area 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 box 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 box and port are mismatched.

The port does not have to be fully inside the box as long as the area and length are correct. for example you can mount the port through a hat-rack. In a small box this can have an effect on the box tuning since the volume changes, avoid such small boxes.
Suitable port diameters for different speaker sizes:

8"	4 - 8 cm
10"	6 - 10 cm
12"	8 - 15 cm
15"	10 - 15 cm

Sometimes you need two or more ports in a box. You can convert from one to two or more ports as long as the total port area is the same.

All DLS subwoofers works well in vented boxes.

PORT LENGTH CALCULATION

The following formula can be used:

$$L(cm) = 17914 \times \frac{d^2}{Fc^2 \times Vb}$$

L = port length in cm
d = inner diameter of port in cm
Vb = net volume of the box in liter
Fc = Box resonant frequency in Hz

BANDPASS BOXES

In all bandpass boxes the speakers are hidden inside the box, all sound is coming out through the ports. There are different types of bandpass boxes and they have in common that they are a bit more difficult to build.

BOX DESCRIPTION

Mechanical orders for speaker boxes:

1:th order

Speaker in free air. Not in practical use, the speaker is acoustically shortened.

2:nd order

Speaker mounted on a baffle, normally called "open air".

This is not a box, just a way of mounting the speaker. For example in a hat-rack or behind the rear seat. Can create a good sound with the correct speaker parameters. The speaker should have a low resonant frequency.

3:rd order

Speaker mounted in a sealed box.

A sealed box is easy to build and calculate. It also has a high power handling capacity. On the other hand it has low efficiency and the box must be rather big to create a deep bass. With a rather small box and a 20-40 Hz subsonic filter you will get a box suitable for hard rock with a fast attack in the bass.

4:th order

Speaker mounted in a vented box, often called bass reflex box.

A vented box has a higher efficiency and a higher power handling capacity than the sealed box - but only if it´s correctly calculated with a suitable speaker element. Suitable for all kinds of music. The power handling capacity below the F-3db point is rather weak. It is important that the ports are correctly tuned, they must not be too small, then whistling sounds can occcour. With a wrong port the sound from the ports comes out phase reversed and causes a blurred sound.

5:th order

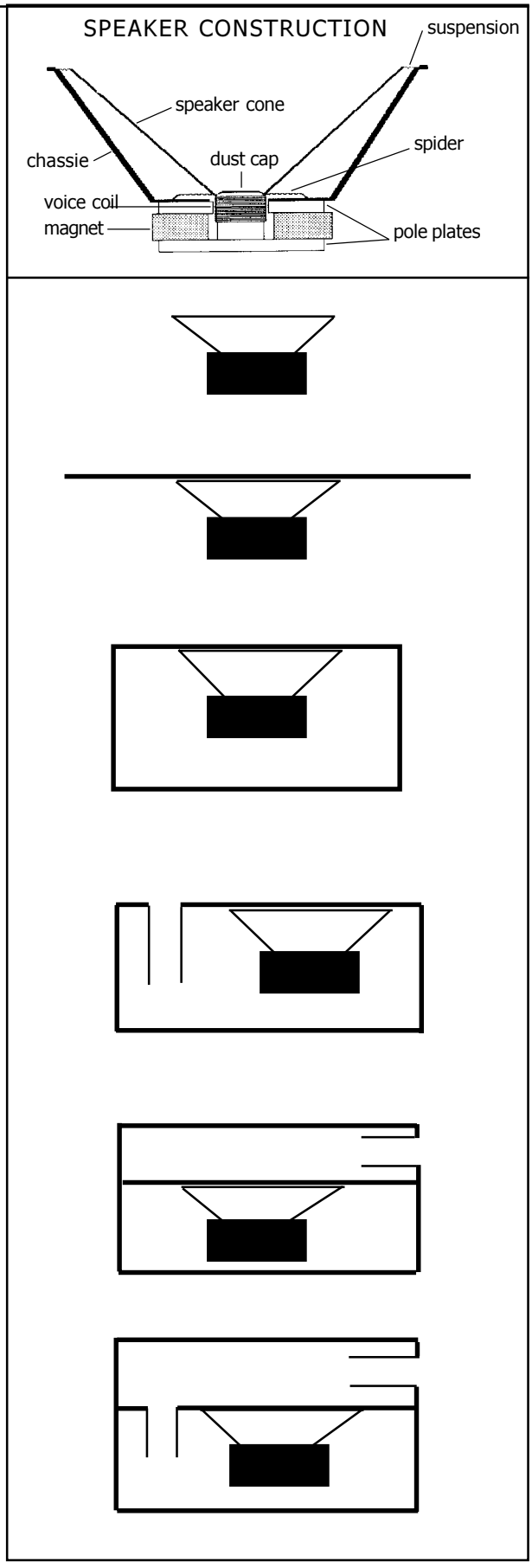
Speaker mounted in a sealed box, playing into a vented box.

This type of box can play one octave only, but it has a high power capacity and gives a 3-5 dB raise at it´s tuned frequency. Suitable for disco and hard-rock music. Difficult to build and calculate and you can´t have speaker cloth in front of the ports.

6:th order

Speaker mounted in a vented box where both the speaker and the port is playing into another ported box.

This box is also difficult to calculate and build. Plays 2 octaves and gives a natural cut-off for higher frequencis with 12 dB/oct. which reduces the audible distortion. It has a high efficiency and power handling capacity. Low F-3dB and a top at the tuned frquencies. Small ports gives a whistling sound and you can´t have speaker cloth in front of the port. Build as isobaric it creates a powerful and distinct deep bass.



7:th order bandpass box

Speaker mounted in a vented box playing into another vented box. All ports going out.

What is valid for 6:th order boxes is also valid for 7:th order boxes. The difference is that this box gives a 6 - 10 dB peak at the tuned frequencies.

8:th order bandpass box

Speaker mounted in a vented box playing into another vented box with all ports playing into a third vented box.

This type of box becomes rather large but the port openings can be covered with cloth. It has like the 6:th and 7:th order boxes high efficiency and power handling capacity. It also gives a 6 - 10 dB peak at the tuned frequencies.

3-chamber bandpass boxes

Both 5:th order boxes and 7:th order boxes can be built as 3-chamber boxes with two speakers playing into a ported chamber. The picture shows a 5:th order 3-chamber box. In a 7:th order 3-chamber box all chambers have ports.

ISOBARIC BOXES

Two speakers mounted on the same axis and operating in the same phase and direction (push and pull).

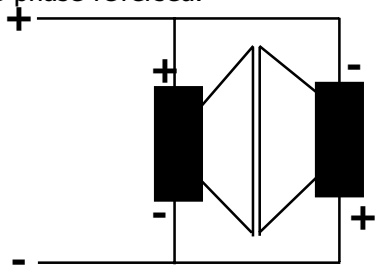
All box types can be built isobaric giving the following advantages and disadvantages.

Advantages: *Reduced box volume with the same F-3 dB*
Higher efficiency
Lower distortion

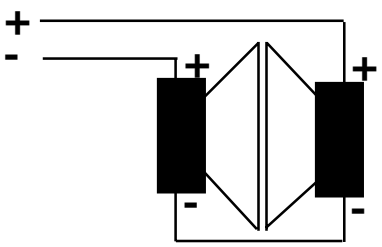
Disadvantages: *Difficult to build and calculate*
The speaker specifications changes (Qts and Vas)

Isobaric-connection:

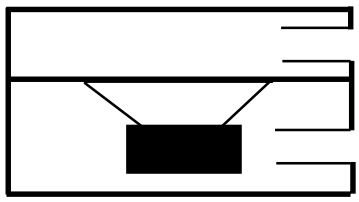
Isobaric speakers are connected with the inner sub in phase with the outer, but phase reversed as in the drawing below.
If both are in boxes the one in the smallest box should be phase reversed.

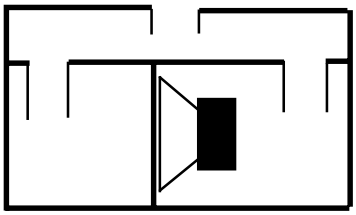


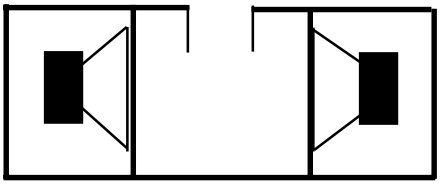
Speakers in parallel

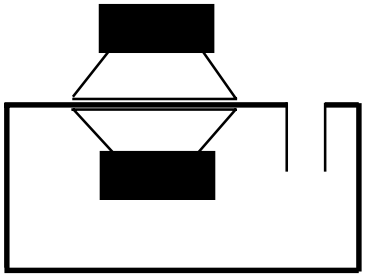


Speakers in series

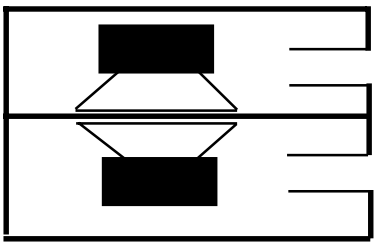








4:th order isobaric box



7:th order isobaric bandpass box

Use DLS BP-75 and BP-110 conical ports to avoid whistling sounds.

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 a correct 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.

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 unsufficient capacity in the DC-converter can give the same result.
  A good car battery with low inner resistance (OPTIMA) 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.

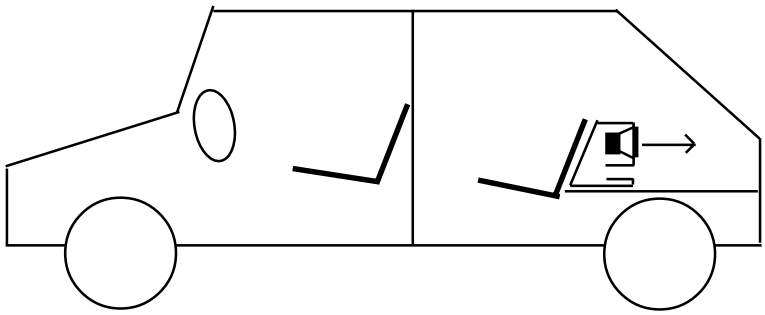
- Is normally caused by incorrect speaker phasing. Make sure all woofer elements in the system are connected with the same polarity (phasing). Both front and rear speakers.
  This is easiest made with the use of a 1,5 Volt battery. Connect the battery + to the speaker + cable, and the - to the speaker - 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.
- Any extra cable must not be laid in a ring, shorten the cable or lay it in zig-zag instead.

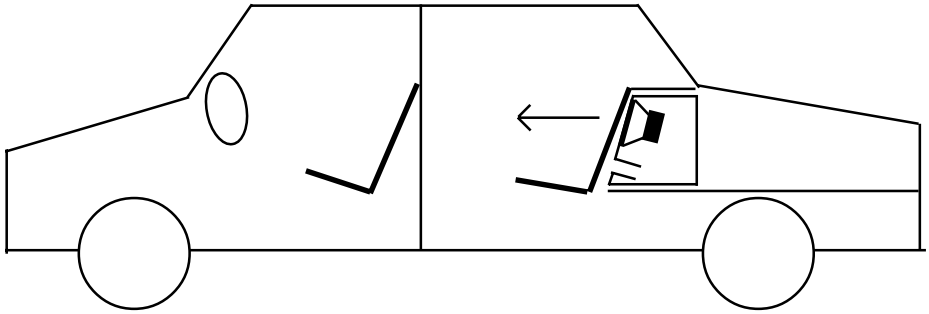
BASS BOXES IN DIFFERENT TYPES OF CARS

1. SMALL CARS LIKE VW GOLF, OPEL KADETT, PEUGOT 205 AND SIMILAR



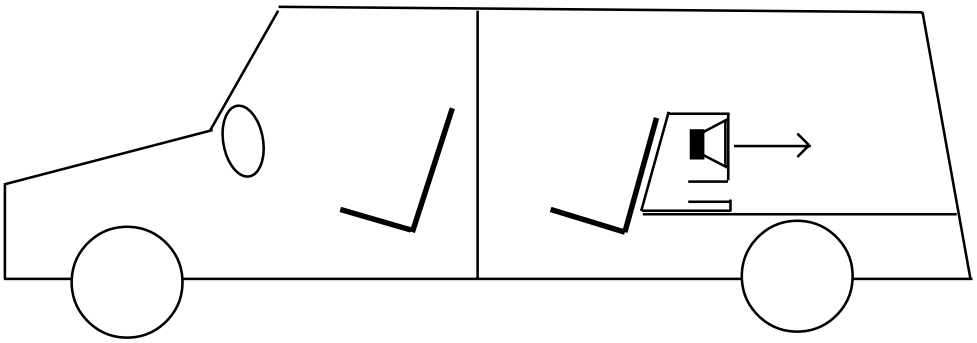
In this car type the bass box should be mounted with both speaker and port directed backwards. Alternatively booth speaker and port can be directed upwards. This way of mounting is valid also for half-combi car types.

2. SEDAN CARS LIKE VOLVO 240/740/940/850, SAAB 9000 AND SIMILAR



In this car type with the passanger compartment separated from the luggage room the bass box should be mounted with booth speaker and port directed towards the rear seat. In some cars there is an opening in the middle of the rear seat for loading skis etc. You can place the box behind this opening and direct speaker or port through this opening. 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 mount 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 CARS, STATION WAGONS LIKE VOLVO 245 / 745 AND SIMILAR.



In this type of cars the best sound is achieved with the bass box mounted behind the rear seat with booth speaker and port directed backwards.

DLS-BOX COMPUTER PROGRAM

A speaker box can be calculated either by hand or with the help of a computer program. DLS-BOX is a program that easily helps you design your own box to your DLS speakers.
You choose speaker, box type, car-type and music type and the program calculates the correct box volume. The program is developed in cooperation with Backes ljudbyggeri in Ekerö. "Dr. Backe" has many years of box building experince and assures you that if only the parameters are correct the program will give you the best speaker box.
Read his box building advices below.

SOME ADVICES 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 bandpass 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 center 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 syntetic (acoustic) wool (do not use any rockwool 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 occour. In most car-types, except for SEDAN cars, the speaker and port should be directed backwards for best result.
If you plan **not** to cover your box with felth cloth or imitation leather you should also tighten behind the speaker element before mounting it in the box. It must be absolutely air-tigth.
If you build an isobaric-box use through 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.
Good luck with your box project!

BOX EXAMPLES

On the following pages you will find examples on suitable boxes for DLS speakers and subwoofers.
If you follow the advices in this handbook we are sure you achieve a good car sound.

Good luck !

If you have any questions you are always welcome to call us on DLS in Sweden. We will do our best to assist you.

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Fax: +46 31 84 40 21
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BOXES FOR DLS SPEAKER SYSTEMS

Also a small 4", 5,25" or 6,5" speaker sounds better in a box than mounted directly to the door-side or in the hat-rack. Here you find tables with speaker some data and suitable box volumes. Normally sealed boxes are used for these types of speakers.

BUILDING BOXES

Sealed boxes are the most suitable type for small speaker elements. The box size varies depending on the speaker size and data. If you want the speaker to reproduce the full frequency range you need a larger box than if you cut the reproduction at higher frequencies. For F-3dB at 100 Hz you can use half the recommended volumes.

FACTS ABOUT DLS CLASSIC/PRO SERIES

	DLS C4/P4	DLS C5/P5	DLS C6/P6
Size	4" (10 cm)	5,25" (13 cm)	6,5" (16 cm)
Nom. power (RMS)	50 Watt	50 Watt	60 Watt
Freq. range	55 Hz - 20 kHz	45 Hz - 20 kHz	35 Hz - 20 kHz
Sensitivity	94 dB	93 dB	93 dB
Crossover freq.	3500 Hz	3500 Hz	3500 Hz
Magnet, diameter	70 mm	80 mm	82 mm
Mounting depth, bass	58 mm	64 mm	62 mm
Mounting hole, bass	102 mm	120 mm	140 mm
Fs / Qts / Vas	89Hz / 0,67 / 1,8 l	62 Hz / 0,64 / 6 l	67 Hz / 0,92 / 10 l
Rec. box volume	3-4 liter	5-6 liter	8-10 liter

FACTS ABOUT DLS PRO slimline SERIES

	DLS PS4	DLS PS5	DLS PS6
Size	4" (10 cm)	5,25" (13 cm)	6,5" (16 cm)
Nom. power (RMS)	50 Watt	50 Watt	50 Watt
Freq. range	55 Hz - 20 kHz	40 Hz - 20 kHz	35 Hz - 20 kHz
Sensitivity	90 dB	92 dB	92 dB
Crossover freq.	3500 Hz	3500 Hz	3500 Hz
Magnet, diameter	90 mm	91 mm	92 mm
Mounting depth, bass	50 mm	45 mm	53 mm
Mounting hole, bass	102 mm	120 mm	140 mm
Fs / Qts / Vas	113Hz / 0,84 / 1,1 l	87 Hz / 0,75 / 5,8 l	66 Hz / 0,89 / 14,3 l
Rec. box volume	2-3 liter	5-6 liter	10-12 liter

FACTS ABOUT DLS COAXIAL SERIES (98 year models)

	DLS 424	DLS 425	DLS 426	DLS 428	DLS 962
Size	4" (10 cm)	5,25" (13 cm)	6,5" (16 cm)	8" (20 cm)	6 x 9"
Nom. power (RMS)	50 Watt	50 Watt	60 Watt	80 Watt	80 Watt
Freq. range	60 Hz- 20 kHz	45 Hz-20 kHz	35 Hz-20 kHz	35 Hz-20 kHz	30 Hz-20 kHz
Sensitivity	92 dB	92 db	92 dB	93 dB	93 dB
Crossover freq.	4000 Hz	4000 Hz	4000 Hz	3500 Hz	3500 Hz
Magnet diameter	80 mm	91 mm	92 mm	105 mm	100 mm
Mounting depth	55 mm	45 mm	53 mm	87 mm	78 mm
Mounting hole	102 mm	118 mm	140 mm	185 mm	222x154 mm
Rec. box volume	3-4 liter	4-5 liter	10-15 liter	15-20 liter	15-20 liter

FACTS ABOUT DLS REFERENCE SERIES (98 year models)

	DLS R4	DLS R5	DLS R6	DLS R8	R36
Size	4" (10 cm)	5,25" (13 cm)	6,5" (16 cm)	8" (20 cm)	4" / 6,5"
Nom. power (RMS)	50 Watt	80 Watt	80 Watt	80 Watt	80 Watt
Freq. range	50 Hz-20 kHz	40 Hz-20 kHz	35 Hz-20 kHz	35 Hz-20 kHz	35 Hz-20 kHz
Sensitivity	94 dB	94 dB	94 db	93 dB	90 dB
Crossover freq.	4 kHz	4 kHz	4 kHz	3 kHz	250 Hz / 3,5 kHz
Magnet diameter	80 mm	86 mm	105 mm	120 mm	80/110 mm
Mounting depth, bass	60 mm	58 mm	72 mm	86 mm	46/80 mm
Mounting hole, bass	102 mm	117 mm	140 mm	185 mm	92/146 mm
Fs / Qts / Vas	96Hz/0,81/1 l	61Hz/0,66/8,1 l	52Hz/0,59/15,6 l	37Hz/0,34/43 l	
Rec. box volume	3-4 liter	5-6 liter	8-10 l	20-25 liter	4" 2 liter 6,5" 8-10 liter

FACTS ABOUT DLS ULTIMATE SERIES

Data element:	U2,5-mid	U5-bass	U6-bass	UC5-bas	UC6-bas	UX5	UX6
Size	2,5" (6,3 cm)	5,25" (13 cm)	6,5" (16 cm)	5,25" (13 cm)	6,5" (16 cm)	5,25" (13 cm)	6,5" (16 cm)
Nom. power (RMS)	100 Watt	120 Watt	120 Watt	120 Watt	120 Watt	120 Watt	120 Watt
Freq. range	250 - 7000 Hz	50 Hz-6 kHz	35 Hz-5 kHz	50 Hz-6 kHz	35 Hz-6 kHz	50 Hz-25 kHz	35 Hz-25 kHz
Freq. range system		50 Hz-25 kHz	35 Hz-25 kHz	50 Hz-25 kHz	35 Hz-25 kHz		
Sensitivity	91 dB	91 dB	91 dB	91 dB	91 dB	92 dB	92 dB
Outer diameter	99 mm	135 mm	165 mm	135 mm	165 mm	135 mm	165 mm
Magnet diameter	67 mm	70 mm	70 mm	63 mm	63 mm	63 mm	63 mm
Mounting depth	29 mm	58 mm	54 mm	58 mm	58 mm	58 mm	58 mm
Mounting hole	82 mm	118 mm	145 mm	120 mm	145 mm	120 mm	145 mm
Fs	350 Hz	61Hz	68,4 Hz				
Qts		0,43	0,55				
Vas	-	7,77	7,65				
Rec. box volume	-	6-8 liter	8-10 liter				

BASS BOXES FOR OLDER SUBS

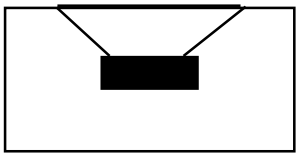
Some bass box examples for older DLS subwoofers

HÖGTALARE & LÅDTYP:	BILTYP: SEDAN/GOLF	KOMBI
DLS 5508:		
Music: Normal		
Vented box	23 liter	26 liter
Port	3" x 22 cm	3" x 21 cm
DLS 5508A:		
Music: Normal		
Vented box	20 liter	23 liter
Port	3" x 22 cm	3" x 21 cm
DLS 5310 / 5510:		
Music: Normal		
Sealed box	35 liter	41 liter
Vented box	35 liter	39 liter
Port, vented box	3" x 14 cm	3" x 14 cm
DLS 5310A:		
Music: Normal		
Vented box	37 liter	43 liter
Port	3" x 9 cm	3" x 8 cm
DLS 5310B:		
Music: Normal		
Vented box	39 liter	45 liter
Port	3" x 12 cm	3" x 11 cm
DLS 5512A:		
Music: Normal		
Vented box	68 liter	78 liter
Port	4" x 10 cm	4" x 9 cm
DLS 5612:		
Music: Normal		
Vented box	54 liter	63 liter
Port	4" x 13 cm	4" x 12 cm
DLS 5615:		
Music: Normal		
Vented box	81 liter	93 liter
Port	4" x 16 cm	4" x 15 cm

If you have any older type of DLS subwoofer, please contact us and we will help you calculate a suitable box.

SEALED BOXES FOR DLS SUB-WOOFERS W108 / W108C, W110 / W110C, W112 / W112C

Box with one driver



Volume in liters for different car types and music.

W108 / W108C:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	17	17	18	19
Disco	20	19	21	22
Normal	23	22	24	26
Deep bass	26	25	27	29

W110 / W110C:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	25	25	26	28
Disco	28	28	30	32
Normal	32	32	35	37
Deep bass	36	36	39	41

W112 / W112C:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	36	35	38	40
Disco	40	40	43	45
Normal	46	45	49	52
Deep bass	51	51	55	59

All box volumes are calculated with DLS-BOX 96 computer program. The boxes should have the above volumes inside the box. You get the volume by multipliing the inner height x depth x width.

VENTED BOX

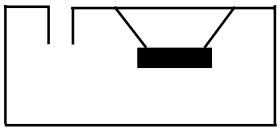


Table showing volume in liters and port length for one subwoofer in different cars.

W 108 / W108C:

Port diameter 3" (75mm) O.D. One (1) port used.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	18	17	19	19
Port length	23 cm	23 cm	22 cm	22 cm
Disco	20	20	21	22
Port length	21 cm	21 cm	21 cm	20 cm
Normal	23	23	25	26
Port length	20 cm	20 cm	20 cm	20 cm
Deep bass	26	26	28	30
Port length	20 cm	19 cm	19 cm	18 cm

W110 / W110C:

Port diameter 3" (75 mm) O.D. 1 port used.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	25	24	26	28
Port length	16 cm	16cm	15 cm	15 cm
Disco	28	28	30	32
Port length	15 cm	15 cm	14 cm	14 cm
Normal	32	32	35	37
Port length	14 cm	14 cm	13 cm	13 cm
Deep bass	36	36	39	42
Port length	13 cm	14 cm	13 cm	13 cm

W112 / W112C:

Port diameter 4" (110 mm) O.D. 1 port used.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	37	36	39	40
Port length	25 cm	25 cm	24 cm	24 cm
Disco	41	41	44	46
Port length	24 cm	24 cm	24 cm	23 cm
Normal	47	46	50	53
Port length	23 cm	22 cm	22 cm	22 cm
Deep bass	52	52	56	60
Port length	21 cm	22 cm	21 cm	20 cm

5:TH ORDER SPL-BOX

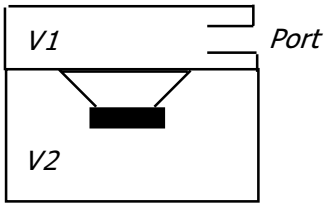


Table showing volume in liters for each chamber and port length for different cars and music.

W 108 / W108C:

Port diameter 3" (75mm) O.D.
One (1) port with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Hard rock	5/11	5/11	5/12	6/13
Port length	11 cm	11 cm	12 cm	11 cm
Disco	6/13	6/13	6/14	7/15
Port length	9 cm	9 cm	10 cm	9 cm
Normal	7/15	7/15	8/16	8/17
Port length	8 cm	8 cm	8 cm	8 cm
Deep bass	8/17	8/17	9/19	9/20
Port length	7 cm	7 cm	7 cm	7 cm

W110 / W110C:

Port diameter 4" (110 mm) O.D.
One (1) port with the length below in this example.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Hard rock	8/17	8/17	9/18	9/19
Port length	16 cm	16 cm	15 cm	16 cm
Disco	9/19	9/19	10/20	11/21
Port length	14 cm	14 cm	14 cm	13 cm
Normal	11/22	11/22	12/24	12/25
Port length	11 cm	11 cm	11 cm	12 cm
Deep bass	12/25	12/24	13/27	14/28
Port length	10 cm	10 cm	10 cm	10 cm

W112 / W112C:

Port diameter 4" (110 mm) O.D.
Two (2) ports with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Hard rock	14/24	13/24	14/26	15/27
Port length	20 cm	21 cm	21 cm	20 cm
Disco	15/28	15/27	16/29	17/31
Port length	18 cm	17 cm	18 cm	17 cm
Normal	16/31	16/31	17/34	18/36
Port length	15 cm	15 cm	16 cm	15 cm
Deep bass	18/35	18/35	19/38	20/40
Port length	14 cm	13 cm	14 cm	14 cm

Note, It must be two 4" ports to DLS W112 / W112C

3-CHAMBER BANDPASS BOX

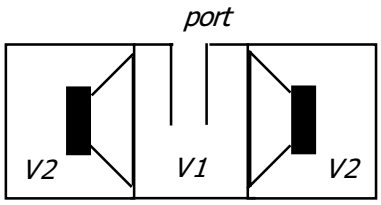


Table showing volume in liters for each chamber and port length for different cars and music characters.

W 108 / W108C:

Port diameter 4" (110mm) O.D.
Two (2) ports with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	V1/V2	V1/V2	V1/V2	V1/V2
Hard rock	11/14	11/13	12/14	12/15
Port length	23 cm	22 cm	22 cm	24 cm
Disco	12/14	12/14	13/15	14/16
Port length	21 cm	20 cm	20 cm	20 cm
Normal	14/16	14/16	15/17	16/18
Port length	18 cm	17 cm	17 cm	18 cm
Deep bass	16/17	16/17	17/18	18/19
Port length	16 cm	15 cm	15 cm	16 cm

W110 / W110C:

Port diameter 4" (110 mm) O.D.
Two (2) ports with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Hard rock	16/16	16/16	17/17	18/18
Port length	15 cm	15 cm	15 cm	15 cm
Disco	18/18	18/18	19/19	20/20
Port length	13 cm	13 cm	13 cm	14 cm
Normal	21/21	20/20	22/22	23/23
Port length	11 cm	12 cm	11 cm	12 cm
Deep bass	23/22	23/22	25/24	26/25
Port length	10 cm	10 cm	10 cm	10 cm

W112 / W112C:

Port diameter 4" (110 mm) O.D.
Two (2) ports with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Hard rock	23/21	23/21	24/22	26/24
Port length	10 cm	10 cm	10 cm	10 cm
Disco	26/24	26/24	28/26	29/27
Port length	9 cm	9 cm	9 cm	9 cm
Normal	30/28	29/27	32/30	34/32
Port length	7 cm	7 cm	7 cm	8 cm
Deep bass	33/31	32/30	35/33	38/36
Port length	7 cm	7 cm	7 cm	7 cm

5:TH ORDER 2-CHAMBER ISO-BARIC

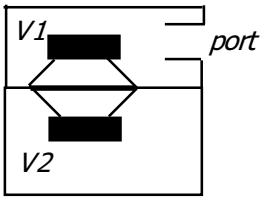


Table showing volume in liters for each chamber and port length for different cars and music characters.

W 108 / W108C:

Port diameter 3" (75 mm) O.D.
One (1) port with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Disco	10/11	9/11	10/12	11/13
Port length	15 cm	14 cm	14 cm	15 cm
Normal	11/13	11/13	12/14	12/15
Port length	12 cm	11 cm	11 cm	12 cm
Deep bass	12/15	12/14	13/16	14/17
Port length	11 cm	10 cm	10 cm	10 cm

W110 / W110C:

Port diameter 4" (110 mm) O.D.
One (1) port with the length below in this example

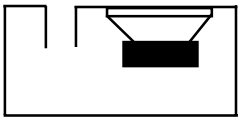
Car type: / **Music:**	Small type	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Disco	16/16	15/16	16/17	17/18
Port length	20 cm	19 cm	19 cm	20 cm
Normal	17/19	16/18	18/20	19/21
Port length	17 cm	17 cm	16 cm	17 cm
Deep bass	19/21	18/21	20/23	21/24
Port length	15 cm	15 cm	14 cm	15 cm

W112 / W112C:

Port diameter 4" (110 mm) O.D.
Two (2) ports with the length below in this example

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Chamber:	*V1/V2*	*V1/V2*	*V1/V2*	*V1/V2*
Disco	24/23	23/23	25/25	26/26
Port length	25 cm	27 cm	26 cm	27 cm
Normal	26/27	26/26	27/29	29/30
Port length	23 cm	23 cm	22 cm	23 cm
Deep bass	28/30	28/29	30/32	32/34
Port length	20 cm	20 cm	20 cm	20 cm

VENTED BOX



Volume in liters and port size for different car- and music types, one speaker element.

W108B:

Port diameter 3" (75 mm) outer diameter. One port.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	16	16	17	18
Port length	25 cm	26 cm	25 cm	25 cm
Disco	19	18	20	21
Port length	24 cm	24 cm	23 cm	23 cm
Normal	21	21	23	24
Port length	23 cm	23 cm	22 cm	22 cm
Deepbass	24	24	26	28
Port length	22 cm	21 cm	21 cm	21 cm

W110B:

Port diameter 3" (75 mm) outer diameter. One port.

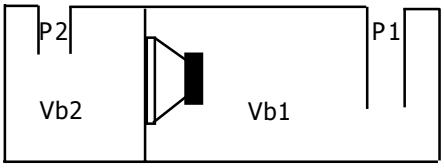
Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	26	26	28	29
Port length	16 cm	16 cm	15 cm	15 cm
Disco	30	30	32	34
Port length	16 cm	15 cm	15 cm	14 cm
Normal	35	34	37	40
Port length	15 cm	15 cm	14 cm	14 cm
Deep bass	39	38	42	45
Port length	13 cm	14 cm	14 cm	13 cm

W112B:

Port diameter 4" (110 mm) outer diameter. One port.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	39	39	42	44
Port length	26 cm	25 cm	25 cm	24 cm
Disco	45	44	47	50
Port length	25 cm	25 cm	24 cm	23 cm
Normal	51	50	54	57
Port length	23 cm	24 cm	23 cm	22 cm
Deep bass	57	56	61	65
Port length	22 cm	22 cm	21 cm	21 cm

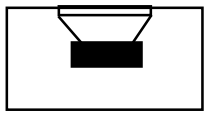
2-CHAMBER BAND PASS BOX WITH TWO W110B



NOTE! The number of speakers and ports are not correct in the drawing.

Speakers: 2 pcs of DLS W110B
Vb1 = 45 liters (Fb1 = 48 Hz)
Vb 2 = 21 liters (Fb2 = 96 Hz)
Port P1 = 2 pcs 3" (75 mm), length 23 cm
Port P2 = 4 pcs 3" (75 mm), length 11 cm
F-3dB = 51,5 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

SEALED BOX



Volume in liters for different car- and music types for one speaker element in a sealed box. Most suitable for hard rock and disco type music.

W108B:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	16	15	17	17
Disco	18	18	19	20

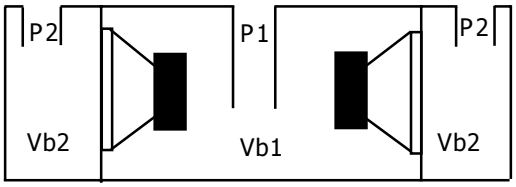
W110B:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	27	26	28	30
Disco	30	30	32	34

W112B:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	38	38	41	43
Disco	44	43	46	49

3-CHAMBER BANDPASS BOX WITH TWO W110B



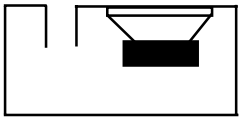
Speakers: 2 pcs of DLS W110B
Vb1 = 44 liters (Fb1 = 49 Hz)
Vb 2 = 14 liters (Fb2 = 98 Hz)
Port P1 = 1 pc 4" (110 mm), length 24 cm
Port P2 = 1 pc 4" (110 mm), length 9 cm
F-3dB = 51,5 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

3-CHAMBER BANDPASS BOX WITH TWO W112B

The box is identical with the box in the example above. (The number of ports is different)

Speakers: 2 pcs of DLS W112B
Vb1 = 62 liters (Fb1 = 50 Hz)
Vb 2 = 21 liters (Fb2 = 100 Hz)
Port P1 = 1 pc 4" (110 mm), length 16 cm
Port P2 = 2 pcs 4" (110 mm) in each chamber, length 12 cm
F-3dB = 52,9 Hz
Car type: SMALL, music type: NORMAL, SPL: 134 dB

VENTED BOX



Volume in liters and port size for different car- and music types, one speaker element.

W310:

Port diameter 3" (75 mm) outer diameter. One port.

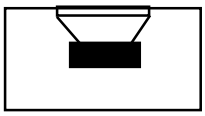
Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	23	22	24	25
Port length	19 cm	19 cm	19 cm	18 cm
Disco	26	25	27	29
Port length	19 cm	18 cm	18 cm	17 cm
Normal	30	29	32	34
Port length	17 cm	18 cm	17 cm	17 cm
Deepbass	34	33	36	38
Port length	17 cm	16 cm	16 cm	16 cm

W312:

Port diameter 4" (110 mm) outer diameter. One port.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	36	36	38	40
Port length	29 cm	29 cm	28 cm	28 cm
Disco	41	40	43	45
Port length	27 cm	28 cm	27 cm	26 cm
Normal	47	46	50	53
Port length	27 cm	26 cm	26 cm	25 cm
Deep bass	52	51	56	59
Port length	25 cm	25 cm	24 cm	24 cm

SEALED BOX



Volume in liters for different car- and music types for one speaker element in a sealed box. Most suitable for hard rock and disco music.

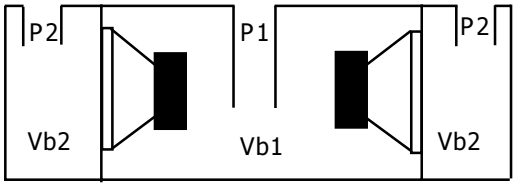
W310:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	22	22	24	25
Disco	26	25	27	29

W312:

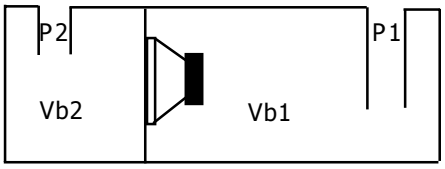
Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	35	34	37	39
Disco	39	39	42	44

3-CHAMBER BANDPASS BOX WITH TWO W310



Speakers: 2 pcs of DLS W310
Vb1 = 36 liters (Fb1 = 46 Hz)
Vb 2 = 12 liters (Fb2 = 92 Hz)
Port P1 = 1 pc 3" (75 mm), length 15 cm
Port P2 = 1 pc 4" (110 mm), length 12 cm
F-3dB = 49,3 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

2-CHAMBER BAND PASS BOX WITH TWO W310



NOTE! The number of speakers and ports are not correct in the drawing.

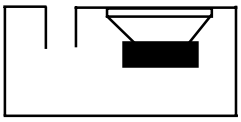
Speakers: 2 pcs of DLS W310
Vb1 = 40 liters (Fb1 = 47 Hz)
Vb 2 = 18 liters (Fb2 = 94 Hz)
Port P1 = 2 pcs 3" (75 mm), length 29 cm
Port P2 = 3 pcs 3" (75 mm), length 10 cm
F-3dB = 51,5 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

3-CHAMBER BANDPASS BOX WITH TWO W312

The box is identical with the box in the example above. (The number of ports is different)

Speakers: 2 pcs of DLS W312
Vb1 = 57 liters (Fb1 = 48 Hz)
Vb 2 = 19 liters (Fb2 = 96 Hz)
Port P1 = 1 pc 4" (110 mm), length 19 cm
Port P2 = 2 pcs 4" (110 mm) in each chamber, length 14 cm
F-3dB = 51,3 Hz
Car type: SMALL, music type: NORMAL, SPL: 134 dB

VENTED BOX



Volume in **liters** and port size for different car- and music types, one speaker element.

W510C:

Port diameter 3" (75 mm) outer diameter. One port.

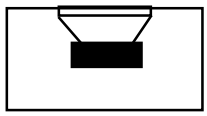
Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	23 liter	22 liter	24 liter	25 liter
Port length	25 cm	24 cm	24 cm	23 cm
Disco	26 liter	26 liter	27 liter	29 liter
Port length	24 cm	23 cm	22 cm	22 cm
Normal	30 liter	30 liter	32 liter	34 liter
Port length	22 cm	23 cm	22 cm	20 cm
Deepbass	34 liter	34 liter	37 liter	39 liter
Port length	20 cm	21 cm	20 cm	20 cm

W512C:

Port diameter 4" (110 mm) outer diameter. One port.

Car type: / **Music:**	Small car	Sedan type	Combi type	Station wagon
Hard rock	35 liter	34 liter	37 liter	39 liter
Port length	21 cm	21 cm	21 cm	22 cm
Disco	39 liter	39 liter	42 liter	44 liter
Port length	22 cm	22 cm	23 cm	22 cm
Normal	45 liter	45 liter	48 liter	51 liter
Port length	21 cm	22 cm	21 cm	20 cm
Deep bass	51 liter	50 liter	55 liter	58 liter
Port length	22 cm	21 cm	20 cm	21 cm

SEALED BOX



Volume in **liters** for different car- and music types for one speaker element in a sealed box. Most suitable for hard rock and disco music.

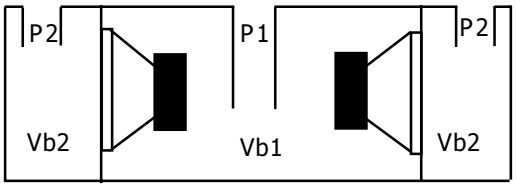
W510C:

Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	22 liter	22 liter	23 liter	25 liter
Disco	25 liter	25 liter	27 liter	28 liter

W512C:

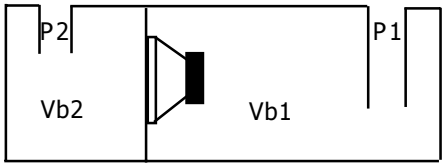
Car type: / Music:	Small car	Sedan type	Combi type	Station wagon
Hard rock	34 liter	34 liter	36 liter	38 liter
Disco	39 liter	38 liter	41 liter	43 liter

3-CHAMBER BANDPASS BOX WITH TWO DLS W510C



Speakers: 2 pcs of DLS W510C
Vb1 = 38 liters (Fb1 = 44 Hz)
Vb 2 = 13 liters (Fb2 = 88 Hz)
Port P1 = 1 pc 3" (75 mm), length 16 cm
Port P2 = 1 pc 4" (110 mm), length 12 cm
F-3dB = 46,5 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

2-CHAMBER BAND PASS BOX WITH TWO DLS W510C



NOTE! The number of speakers and ports are not correct in the drawing.

Speakers: 2 pcs of DLS W510C
Vb1 = 39 liters (Fb1 = 44 Hz)
Vb 2 = 18 liters (Fb2 = 88 Hz)
Port P1 = 1 pc 3" (75 mm), length 16 cm
Port P2 = 3 pcs 3" (75 mm), length 12 cm
F-3dB = 46,9 Hz
Car type: SEDAN, music type: NORMAL, SPL: 131 dB

3-CHAMBER BANDPASS BOX WITH TWO DLS W512C

The box is identical with the box in the example above. (The ports is different)

Speakers: 2 pcs of DLS W512C
Vb1 = 56 liters (Fb1 = 48 Hz)
Vb 2 = 19 liters (Fb2 = 96 Hz)
Port P1 = 1 pc 4" (110 mm), length 20 cm
Port P2 = 1 pc 4" (110 mm) in each chamber, length 7 cm
F-3dB = 51,2 Hz
Car type: SMALL, music type: NORMAL, SPL: 134 dB

TABLE 1:

Shows the relation between power increase and SPL measured 1 mtr in front of the speaker at three different speaker sensitivities.

Input power (W)	1	2	3	4	5	10	15	20	50	100	200	500	1k	2k	5k
Speaker sens-itivity in dB	88	91 dB			95 dB		100 dB		105 dB		110 dB	115 dB		120 db	125 dB
	95	98 dB			102 dB		107 dB		112 dB		117 dB	122 dB		127 dB	
	98	101 dB			105 dB		110 dB		115 dB		120 dB	125 dB		130 dB	

SPL in dB

A speaker with a sensitivity of 88 dB gives a SPL of 88 dB with an input of 1 Watt. If the input power is increased to 2 Watts the SPL will be 91 dB etc. Duoble power will increase the SPL with 3 dB.

TABLE 2:

Shows how the inner resistance (impedance) of a coil changes in relation to the frequency.

	Frequency in Hz														
mH	25	50	75	100	120	200	400	800	1k	1,2k	2k	4k	8k	10k	12k
0,05												1,3	2,5	3,1	3,8
0,1		**Resistance in ohm**									1,3	2,5	5,0	6,3	7,5
0,2									1,3	1,5	2,5	5,0	10,0	12,6	15,1
0,3								1,5	1,9	2,3	3,8	7,5	15,1	18,8	22,6
0,5							1,3	2,5	3,1	3,8	6,3	12,6	25,1	31,4	37,7
1						1,3	2,5	5,0	6,3	7,5	12,6	25,1	50,2	62,8	75,4
2				1,2	1,5	2,5	5,0	10,0	12,6	15,1	25,1	50,2	100,0		
3			1,4	1,9	2,3	3,8	7,5	15,1	18,8	22,6	37,7	62,8			
5		1,6	2,4	3,1	3,8	6,3	12,6	25,1	31,4	37,7	62,8				
10	1,6	3,1	4,7	6,3	7,5	12,6	25,1	50,2	62,8	75,4					
20	3,1	6,3	9,4	12,6	15,1	25,1	50,2								

For example a coil with 10 mH inductance, often used as lowpass filter for subwoofers, has an inner resistance (impedance) of 1,6 ohms at 25 Hz increasing to 6,3 ohms at 100 Hz, and 62,8 ohms at 1 kHz.

TABLE 3:

Shows how the inner resistance (impedance) of a capacitor changes in relation to the frequency.

µF	12 kHz	10 kHz	8 kHz	6 kHz	4 kHz	3 kHz	2 kHz	1 kHz	800 Hz	700 Hz	600 Hz	500 Hz	400 Hz	300 Hz	200 Hz	120 Hz	80 Hz	60 Hz
0,22	60	72	90	120														
0,33	40	48	60	80	120													
0,47	28	34	42	56	85	113							**Resistance in ohm**					
0,68	19	23	29	39	58	78	117											
1	13	16	20	27	40	53	80											
2,2	6	7	9	12	18	24	36	72	90	100	120							
3,3	4	5	6	8	12	16	24	48	60	69	80	96						
4,7	3	4	6	8	11	17	34	42	48	56	68	85						
6,8		2	3	4	6	8	12	23	29	33	39	47	58	78				
10			2	3	4	5	8	16	20	23	27	32	40	53	80			
22						2	4	7	9	10	12	15	18	24	36	60		
33							2	5	6	7	8	10	12	16	24	40	60	80
47								3	4	5	6	7	8	11	16	28	42	56
68										3	4	5	6	8	12	20	39	39
100												3	4	5	8	13	19	27
150													3	3	5	9	13	18
220														2	4	6	9	12
330															2	4	6	8