GZ SUBWOOFER TECHNICAL BASICS

BASICS

SUBWOOFER ENCLOSURES

GZ SUB BASICS: Most commonly used box types

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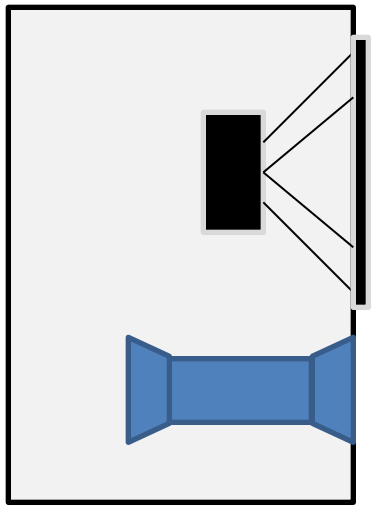
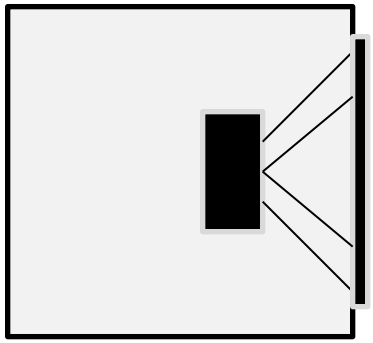


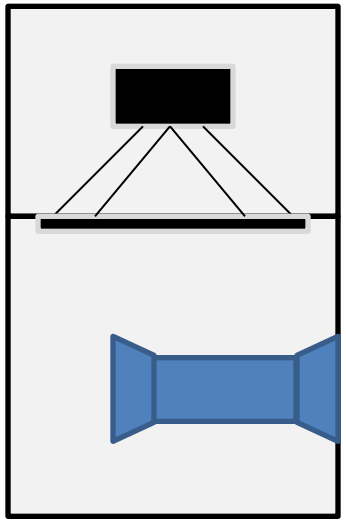
Vented

+ Powerful Low bass
+ Good efficiency
+ Wide freq. range
+ flexible tuning
+ High output SPL
+/- Medium box size
- Port noise
- Less precision



Sealed

+ Punchy
+ Highest precision
+ Wide freq. range
+ Small box size
- Low output SPL
- Low efficiency



4th order Bandpass

+ Powerful Low bass
+ Highest efficiency
+ flexible tuning
+ Highest output SPL
- Big box size
- Narrow freq. range
- Port noise
- Less precision

GZ SUB BASICS: Subwoofer Displacement

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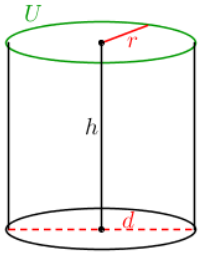
Basic rules for subwoofer displacement calculatíon

It is not necessary, and almost impossible to calculate the 100% correct displacement volume of a subwoofer. Because normally all areas behind spider, inside of t-yoke ventliation, behind the cone and all basket spokes must be included in the calculation. If you install the woofer with or without magnet-boot, if it is mounted on the top of the panel or from behind. All these facts are complicating the calculation.
In below list you can find a guideline for almost 90% of all woofers.

Motor calculation

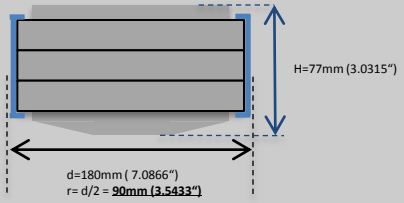


The formula to calculate a round motor:

r² (radius) x Pi (3.14159) x h (height) = Volume

Example:
GZHW 30X including magnet-boot

90 x 90 x 3.14159 x 77 = 1959409.6 (1.96 liter)
or
3.5433 x 3.5433 x 3.14159 x 3.0315 = 119.57in³ (0.069196 ft³)



Now you add the basket/cone displacement and finally get the displacementvolume of a GZHW 30X including magnet-boot:

1.96 liter (0.069196 ft³) + 1 liter (0.03531 ft³)

= ~**2.96 liter (0.104506 ft³)**

Cone/Basket Displacement

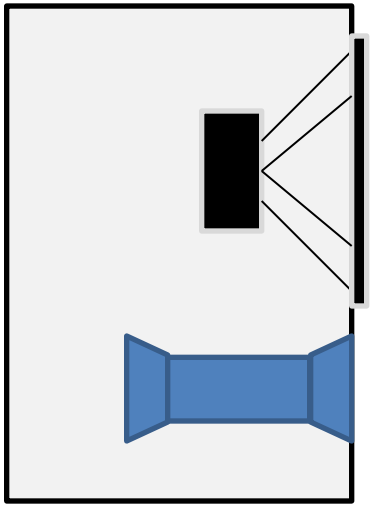
8“ Woofers ~ 0,3 liter (0.010593 ft³)
10“ Woofers ~ 0,5 liter (0.017655 ft³)
12“ Woofers ~ 1 liter (0.03531 ft³)
15“ Woofers ~ 1,8 liter (0.063558 ft³)
18“ Woofers ~ 3.5 liter (0.123585 ft³)

If you have no option to measure the motor and calculate the volume, you can also use below guideline

8“ Woofer	0.8 – 1.3 liter (0.028248 – 0.045903 ft³)	
10“ Woofer	1.3 – 2.5 liter (0.045903 – 0.088275 ft³)	Plutonium SPL: ~4 liter (0.14124 ft³)
12“ Woofer	2.5 – 3.5 liter (0.088275 – 0.123585 ft³)	Plutonium SPL: ~4.5 liter (0.158895 ft³)
15“ Woofer	4 – 6 liter (0.123585 – 0.158895 ft³)	Plutonium SPL: ~8.5 liter (0.300135 ft³)
18“ Woofer	5.5 – 8 liter (0.194205 – 0.28248 ft³)	Plutonium SPL: ~10 liter (0.3531 ft³)

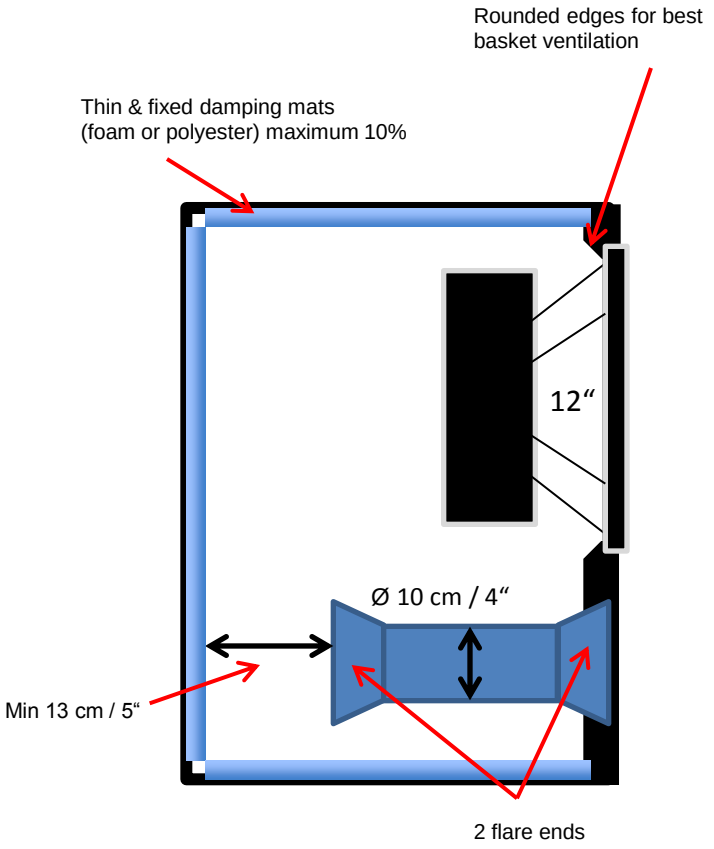
BASICS

VENTED ENCLOSURES



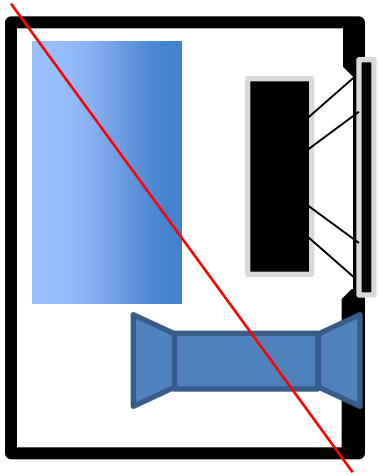
GZ SUB BASICS: Vented enclosure

Basic rules for vented boxes		
Damping	0 – 10% fixed thin damping mats behind woofer	
Wood thickness	8“	Min 16mm / 0.63” MDF / Multiplex
	10“	Min 19mm / 0.75” MDF /Multiplex
	12“	Min 19mm / 0.75” MDF /Multiplex
	15“	Min 25mm / 1” MDF / Multiplex
	18“	Min 30mm / 1.18” MDF / Multiplex
Box stabilisation	No stabilisation bars inside, which could affect the airflow and pressure	
Box design	Symmetrical design.	
Port	Port with 2 flare ends	
Port mounting	Distance from Port to opposite wall minimum Port diameter + 25%	
Woofer mounting	Good basket rear ventilation	



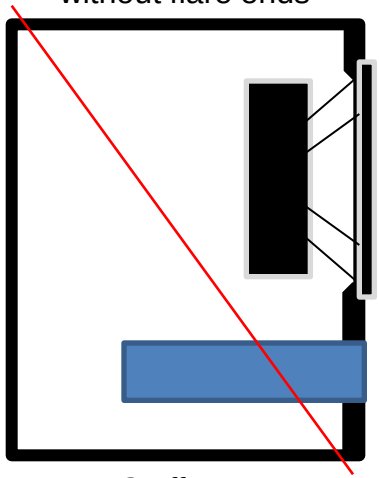
GZ SUB BASICS: Vented enclosure

Too much damping



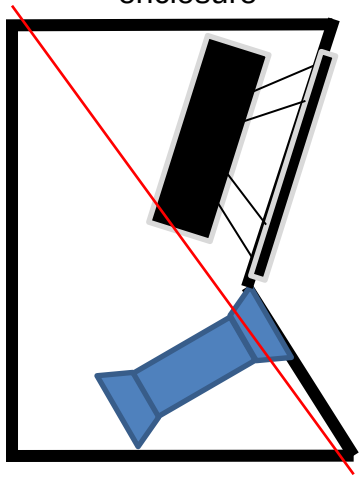
- Air noise
- Low SPL

Straight port
without flare ends



- DC offset
- Port noise
- High distortion

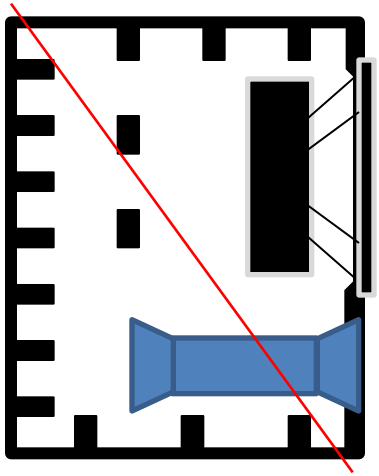
Unsymmetrical
enclosure



- DC offset
- High distortion

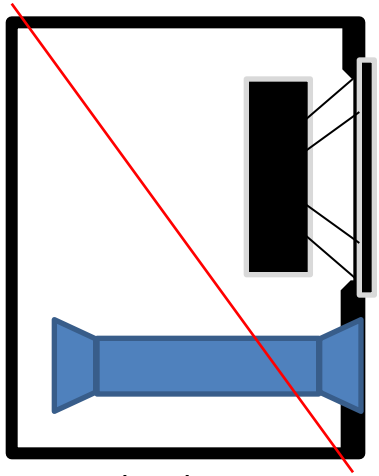
GZ SUB BASICS: Vented enclosure

Stabilisation
bars inside



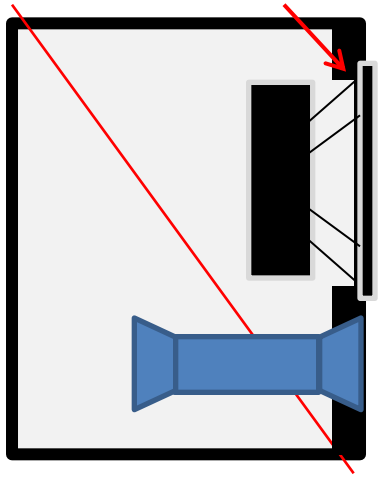
- Air noise
- Low SPL

Port distance
to opposite wall



- Air noise
- Low SPL
- High distortion

Bad basket
rear ventilation



- Low SPL
- High distortion

GZ SUB BASICS: Vented enclosure

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To avoid air flow noise and bad performance, follow below basics

Net volume range for vented boxes (except competition)

20 cm / 8”	15 – 25 liter	0.49 – 0.88 cu.ft
25 cm / 10”	25 – 40 liter	0.88 – 1.59 cu.ft
30 cm / 12”	40 – 80 liter	1.41 – 2.82 cu.ft
38 cm / 15”	80 – 120 liter	2.82 – 4.24 cu.ft
46 cm / 18”	120 – 200 liter	4.24 – 7.06 cu.ft

Volume too small
- Port too long for adequate tuning

Volume too big
- Reduced powerhandling and less punch

Port Ø diameter range for vented boxes (except competition)

20 cm / 8”	50 – 70 mm	2” – 2.76”
25 cm / 10”	70 – 100 mm	2.76” – 4”
30 cm / 12”	80 – 160 mm	3.15” – 6”
38 cm / 15”	100 – 200 mm	4” – 8”
46 cm / 18”	160 – 200 mm	6” – 8”

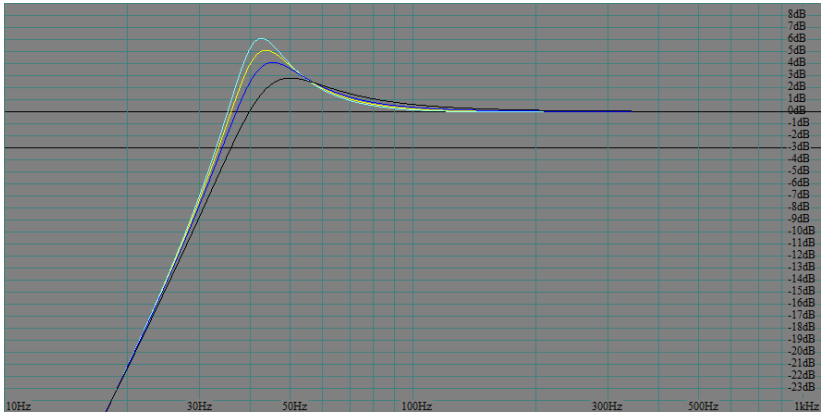
Port Ø diameter too small
- High distortion and port noise

Port Ø diameter too big
- Port too long for an adequate tuning

GZHW 30X

(FS 25 Hz - Qts 0.33 - VAS 55 liter / 1.94cu.ft)

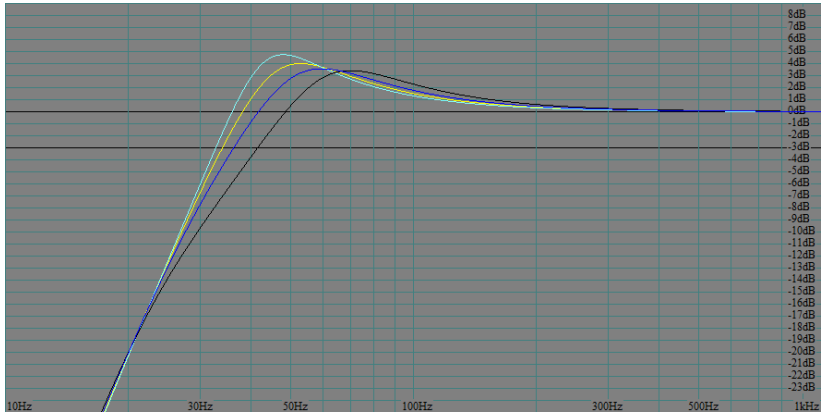
Curve	Volume	Tuning	Ø 10 cm / 4“ Port length
Black	30 l / 1.06 cu.ft	40Hz	40 cm / 15.7“
Blue	45 l / 1.59 cu.ft		24 cm / 9.4“
Yellow	60 l / 2.12 cu.ft		16 cm / 6.3“
Lightblue	80 l / 2.82 cu.ft		11 cm / 4.3“



GZTW 30TX

(FS 33 Hz - Qts 0.53 - VAS 55 liter / 1.94cu.ft)

Curve	Volume	Tuning	Ø 10 cm / 4“ Port length
Black	30 l / 1.06 cu.ft	40Hz	40 cm / 15.7“
Blue	45 l / 1.59 cu.ft		24 cm / 9.4“
Yellow	60 l / 2.12 cu.ft		16 cm / 6.3“
Lightblue	80 l / 2.82 cu.ft		11 cm / 4.3“



Important facts

Too small Box : Port too long. Port noise high and mechanically don´t fit.
Too big box: Peaky, but powerful and high efficient
Woofer with low Qts (<0.5): Perfect for vented boxes. Good sound quality in vented boxes
Woofer with high Qts (0.5>0.7): Peaky, but powerful performance in vented boxes
Woofer with Qts more than 0.7: Not recommended for vented boxes

GZ SUB BASICS: Vented enclosure

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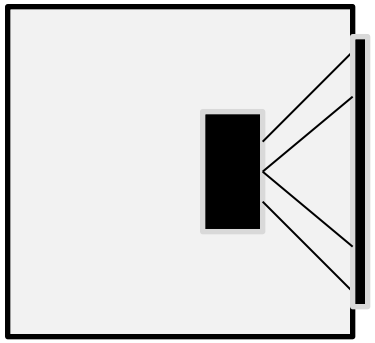
Average box tuning depending on car type (except competition)		
Small Car (Fiat Panda, Daihatsu Cuore,….)		50 – 55 Hz
Compact (VW Golf, Toyota Corolla,….)		45 – 50 Hz
Medium station wagon (Audi A4, Honda Accord,….)		40 – 45Hz
Big SUV and van (Mercedes ML, Toyota Landcruiser,….)		35 – 40 Hz
Transporter and big family van (VW Multivan, Toyota Hiace,….)		30 – 40 Hz
Coupes and sedan with sealed trunk		Vented box not recommended

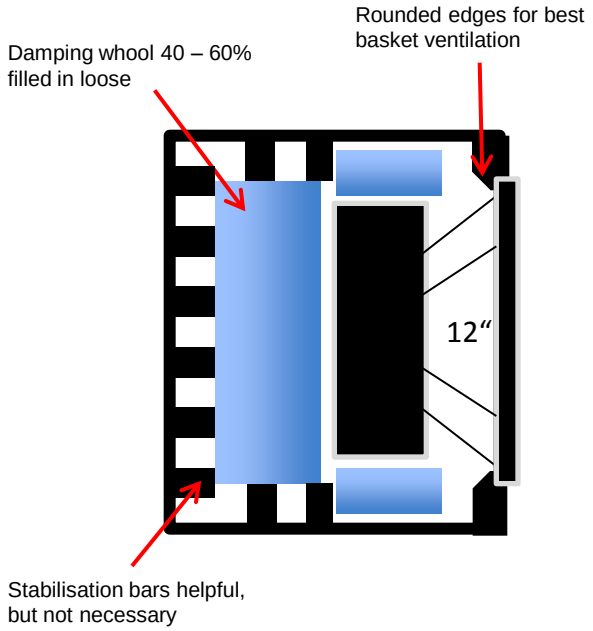
BASICS

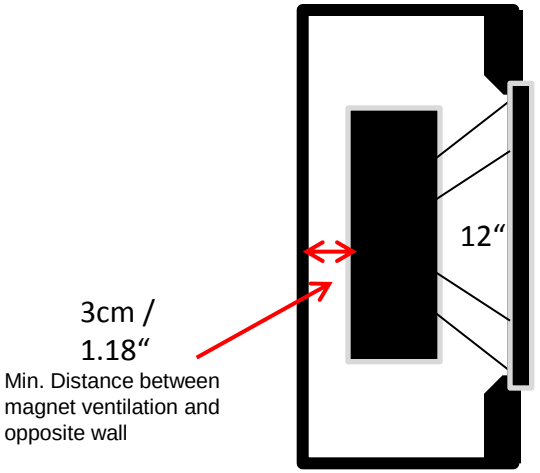
SEALED ENCLOSURES



GZ SUB BASICS: Sealed enclosure

Basic rules for sealed boxes		
Damping	40 – 60% filled in loose	
Wood thickness	8“	Min 16mm / 0.63” MDF / Multiplex
	10“	Min 19mm / 0.75” MDF /Multiplex
	12“	Min 19mm / 0.75” MDF /Multiplex
	15“	Min 25mm / 1” MDF / Multiplex
	18“	Min 30mm / 1.18” MDF / Multiplex
Box stabilisation	Stabilisation bars inside are workable	
Box sealing	Sealed boxes must be 100% seal!	
Woofer mounting	Good basket rear ventilation	
Woofer depth	Free magnet ventilation	





GZ SUB BASICS: Sealed enclosure

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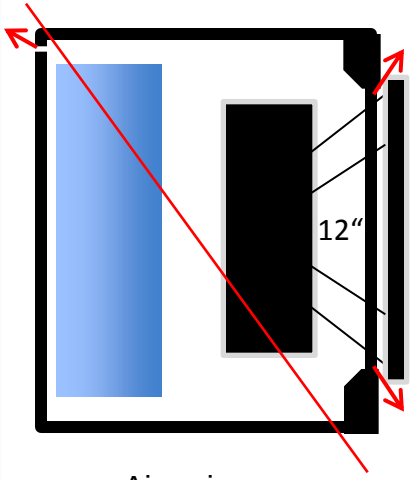
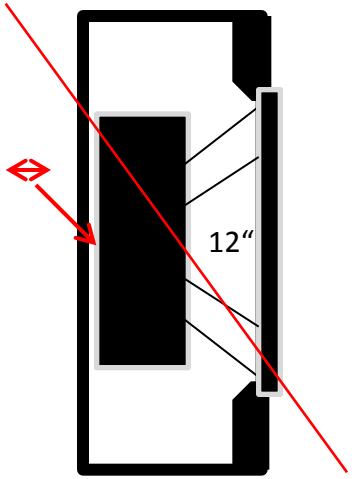
Airleak



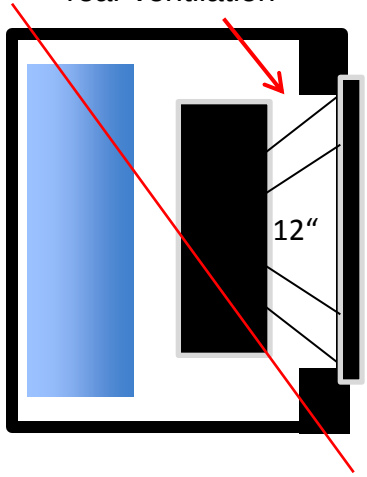
- Air noise
- High distortion

Distance too small



- Less powerhandling
- High distortion

Bad basket
rear ventilation



-High distortion

GZ SUB BASICS: Sealed enclosure

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To avoid peaky or punch less performance, follow below basics

Net volume range for sealed boxes

20 cm / 8”	5 – 15 liter	0.18 – 0.53 cu.ft
25 cm / 10”	8 – 30 liter	0.28 – 1.06 cu.ft
30 cm / 12”	10 – 40 liter	0.35 – 1.41 cu.ft
38 cm / 15”	40 – 80 liter	1.41 – 2.82 cu.ft
46 cm / 18”	60 – 100 liter	2.12 – 3.53 cu.ft

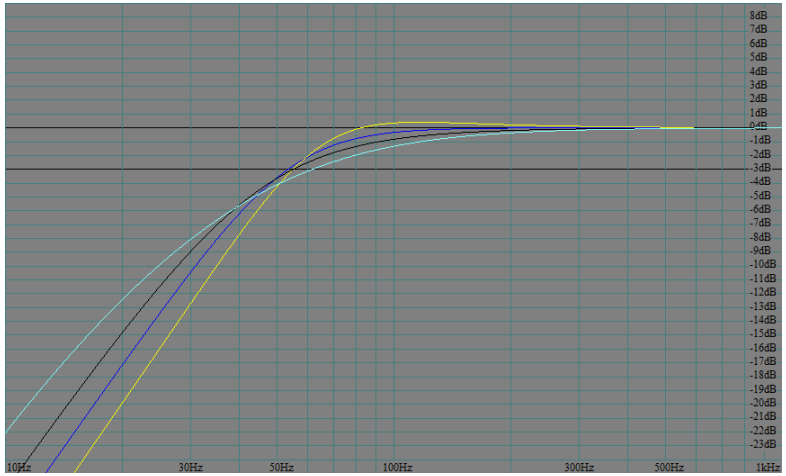
Volume too small
- Peaky performance, no lowbass, DC offset

Volume too big
- Less punch

GZHW 30X

(FS 25 Hz - Qts 0.33 - VAS 55 liter / 1.94cu.ft)

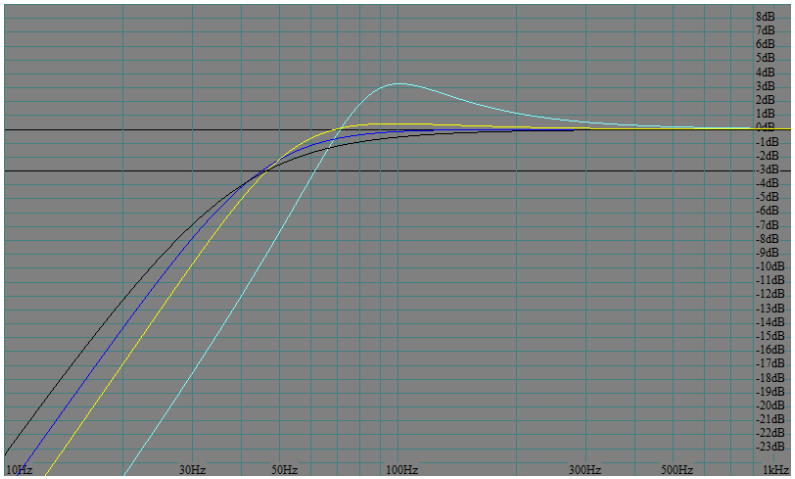
Black	25 liter / 0.88 cu.ft	Qtc 0.6 / F3: 53 Hz
Blue	15 liter / 0.53 cu.ft	Qtc 0.7 / F3: 54 Hz
Yellow	10 liter / 0.35 cu.ft	Qtc 0.84 / F3: 55 Hz
Lightblue	70 Liter / 2.47 cu.ft	Qtc 0.44 / F3: 62 Hz



GZTW 30TX

(FS 33 Hz - Qts 0.53 - VAS 55 liter / 1.94cu.ft)

Black	200 liter / 7 cu.ft	Qtc 0.6 / F3: 46 Hz
Blue	71 liter / 2.5 cu.ft	Qtc 0.6 / F3: 46 Hz
Yellow	36 liter / 1.27 cu.ft	Qtc 0.84 / F3: 46 Hz
Lightblue	10 liter / 0.35 cu.ft	Qtc 1.36 / F3: 61 Hz



Important facts

Workable **Qtc** Range of 0.5 (SQ) – 1.0 (punchy)
Too low Qtc (<0.5) : No punch, but precise, low and smooth performance
Too high Qtc (>1.0) : Peaky performance without lowbass

GZ SUB BASICS: Sealed enclosure

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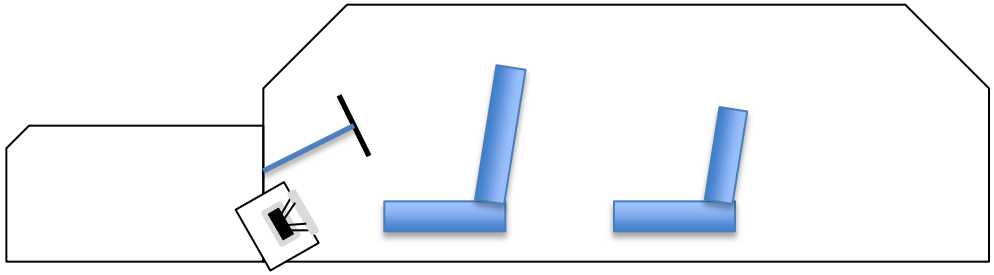
Perfect applications for sealed boxes

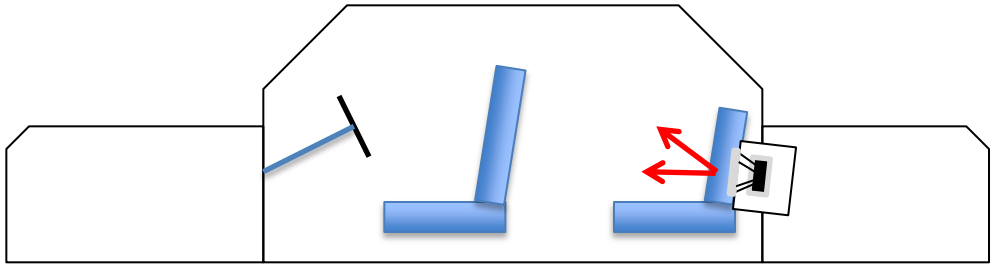
Frontwoofer

+ Powerful performance with small drivers
+ No phase problems
- No subbass
- Complex construction



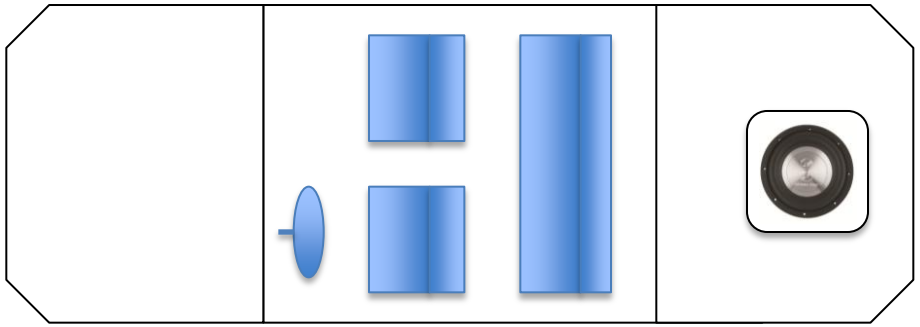
Woofer in loadthrough provision

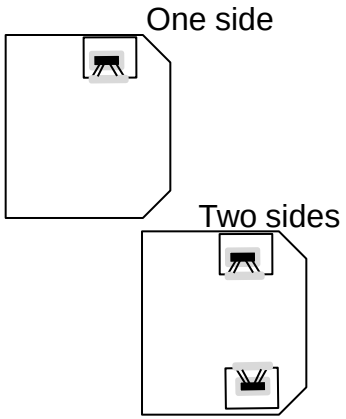
+ Perfect for sedan, coupe and cabrio with sealed trunk
+ Precise performance
- Low maximum SPL



Woofer in trunk side panels or tire mould

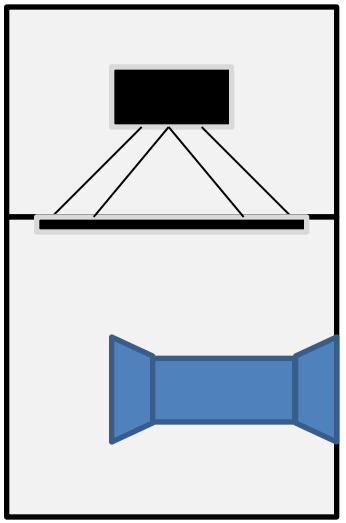
+ Powerful low and subbass with small enclosures
+ Precise performance
- Phase problems





BASICS

4th ORDER BANDPASS ENCLOSURES



GZ SUB BASICS: 4th order Bandpass enclosure

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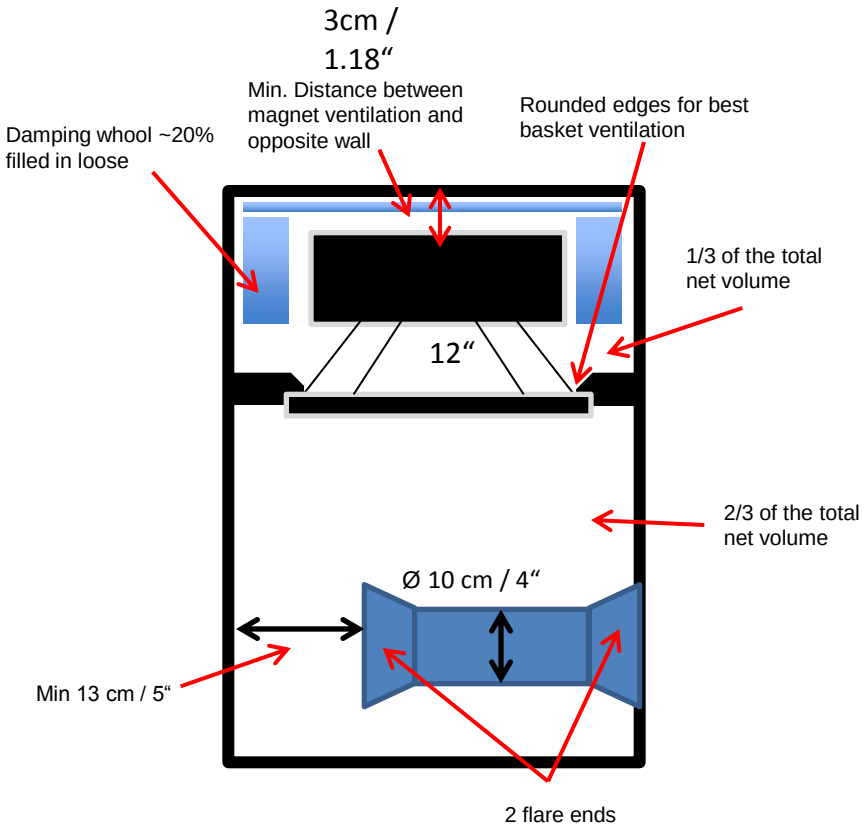
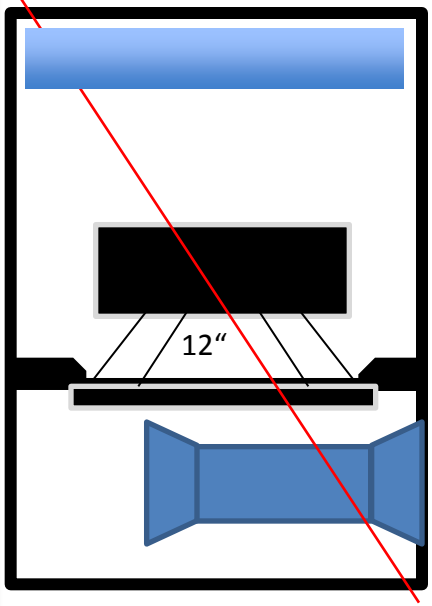
Basic rules for 4th order Bandpass boxes		
Damping	~20% loose damping in sealed cabin	
Wood thickness	8“	Min 16mm / 0.63” MDF / Multiplex
	10“	Min 19mm / 0.75” MDF /Multiplex
	12“	Min 19mm / 0.75” MDF /Multiplex
	15“	Min 25mm / 1” MDF / Multiplex
	18“	Min 30mm / 1.18” MDF / Multiplex
Box stabilisation	NO stabilisation bars inside of the vented cabin, which could affect the airflow and pressure	
Box design	Symmetrical design with ~ 1/3 sealed and 2/3 vented	
Port	Port with 2 flare ends	
Port mounting	Distance from Port to opposite wall minimum Port diameter + 25%	
Woofer mounting	Good basket rear ventilation	
Tuning	For Car Audio a Centerfrequency between **55-65Hz** always works well	



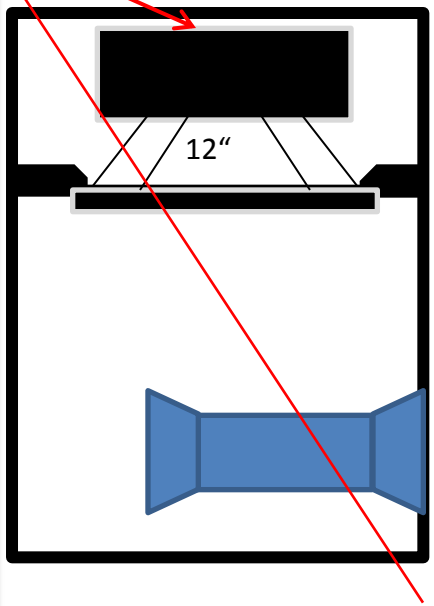
GZ SUB BASICS: 4th order Bandpass enclosure

Sealed chamber
bigger than vented



-Theoretically it works,
but for an adequate tuning,
the port will be way too long

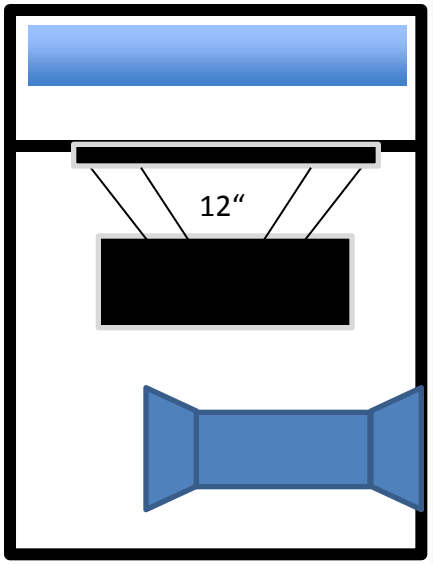
Distance too small



- Less powerhandling
- High distortion

Solution

Reverse mounting



+ Good solution for small sealed chambers
+ Higher powerhandling because of better cooling

GZ SUB BASICS: 4th order Bandpass enclosure

GROUND ZERO
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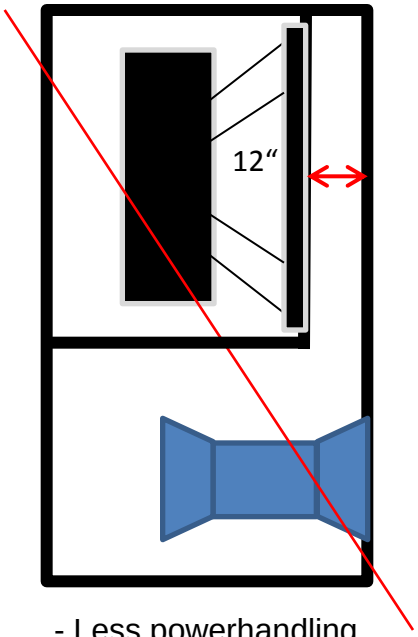
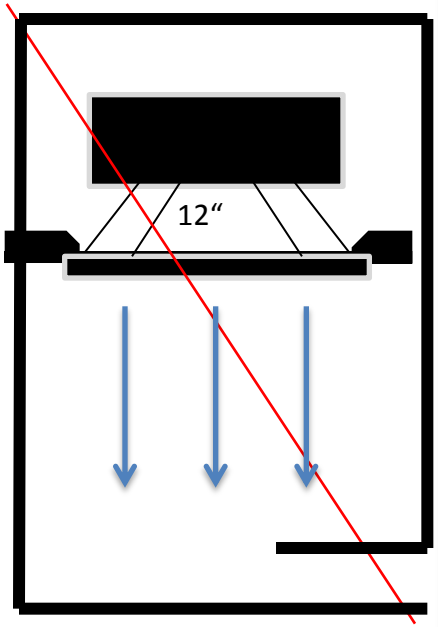
Distance between woofer and opposite wall



- Less powerhandling
- High distortion
- Terrible performance

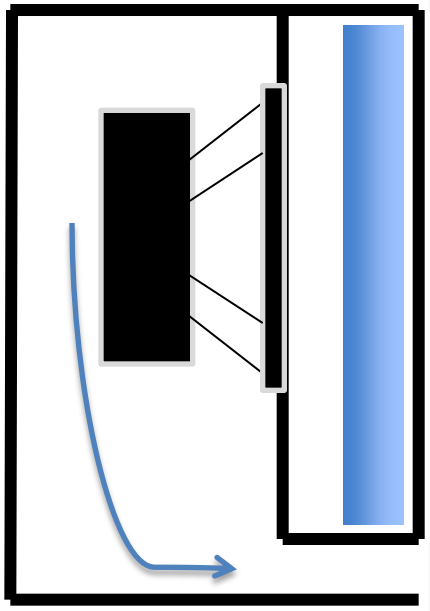
Woofer firing to port



- Air noise
- High distortion
- not perfect performance

Solution

Symmetrical design



+ Less air noise
+ Low distortion
+ Most efficient

GZ SUB BASICS: 4th order Bandpass enclosure

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GERMAN ENGINEERING

To avoid peaky or punch less performance, follow below basics

Net volume range for Bandpass boxes
(1/3 sealed and 2/3 vented)

20 cm / 8”	15 – 30 liter total	0.53 – 1.06 cu.ft
25 cm / 10”	25 – 60 liter total	0.88 – 2.12 cu.ft
30 cm / 12”	40 – 100 liter total	1.41 – 3.53 cu.ft
38 cm / 15”	80 – 150 liter total	2.82 – 5.3 cu.ft
46 cm / 18”	120 – 250 liter total	4.24 – 8.8 cu.ft

Volume too small
- No lowbass, port noise

Volume too big
- peaky and small band width

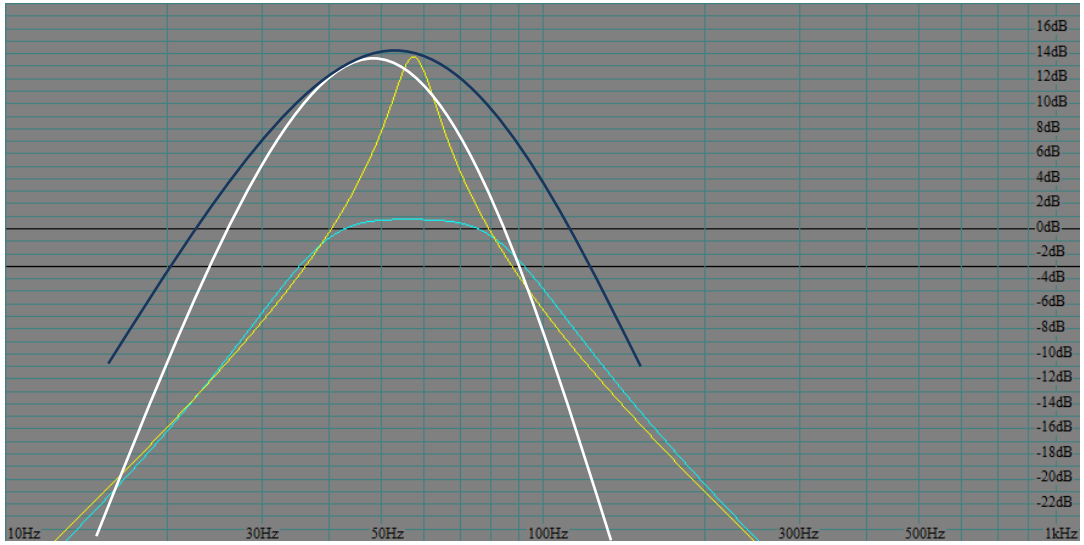
GZ SUB BASICS: 4th order Bandpass enclosure

GROUND ZERO
GERMAN ENGINEERING

GZNW 12X

(FS 35 Hz - Qts 0.43 - VAS 22 liter / 0.77 cu.ft)

Curve	Volume	Tuning	Center frequency	Ø 10 cm / 4“ Port length
Lightblue	9 l / 0.32 cu.ft vented	15 l / 0.53 cu.ft sealed	57 Hz	70 cm / 27.56”
Yellow	40 l / 1.41 cu.ft vented	20 l / 0.71 cu.ft sealed		11 cm / 4.3”
White	Transferfunction of the car			
Blue	Final frequency curve with bandpass and transferfunction added together			



Important facts

Theoratically the lightblue curve looks perfect, but with 70 cm / 27.56” Port it is not possible to realise

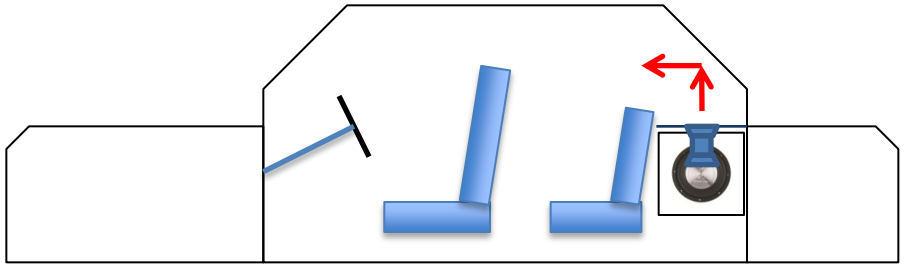
The yellow curve looks peaky, but in combination with the transferfunction of the car, the final curve looks totally different to the calculated one.

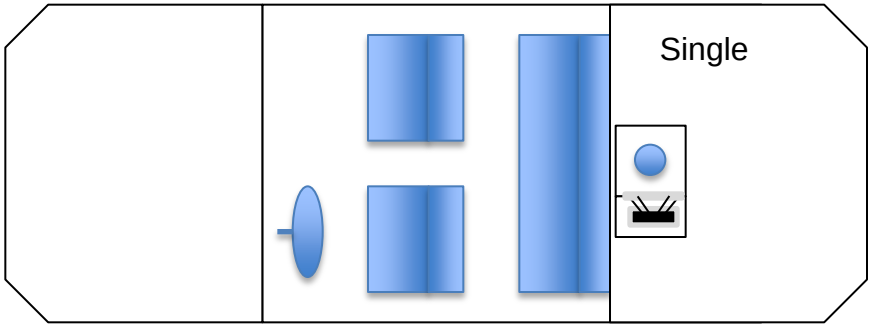
GZ SUB BASICS: 4th order Bandpass enclosure

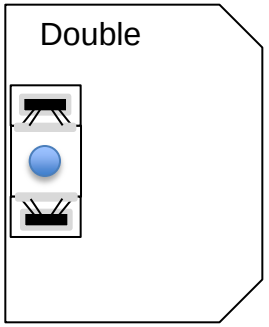
Perfect applications for Bandpass boxes

Sedan, Cabrio & Coupe with sealed trunk and without loadtrough provision

+ Extremely Powerful performance
+ No vibrating trunk
- Possible to hear port noise
- Less sub bass







Sedan, Cabrio & Coupe with sealed trunk and with loadtrough provision

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