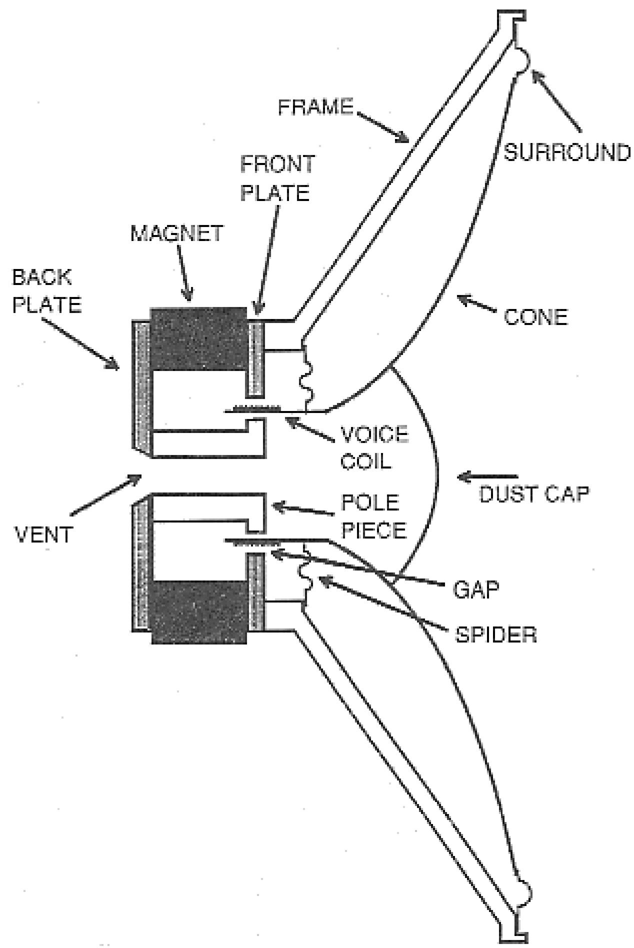
Loudspeaker Enclosures

What is Sound

- Pressure variations
- Frequency
- What can we hear?
- Frequency Response

How do we make sound?

- Move air
- Use a diaphragm
- There's a problem – cancellation
- Need an enclosure
- Mainly for low frequency characteristics



Types of Enclosures

- Sealed
- Ported (Bass reflex, vented, etc…)
- Passive Radiator
- Bandpass
- Tapered Quarter Wave Tube
- Transmission Line
- Aperiodically Damped
- Horn Loaded

Sealed Box

- Absorbs rear wave
- Cone motion controlled by trapped air
- Performance (Large Box – Small Box)
- Shallow Roll off – 12db/octave
- Good Transient Response

Ported Box

- Utilizes some work done by rear of cone
- Reinforces the lower bass
- Steep roll off – 24 db/octave
- Reduced distortion around port frequency
- "Unloading" below port frequency
- OK transient response

Design Procedure

- Define goals
- Conceive ways to reach them
- Decide on an enclosure type
- Determine enclosure parameters
- Design enclosure

Thiel - Small Parameters

- 1972 – Richard Small
- Characteristic driver parameters
- Greatly simplified the design process
- Used to predict performance
- Fs , Qts , Vas
- Qtc

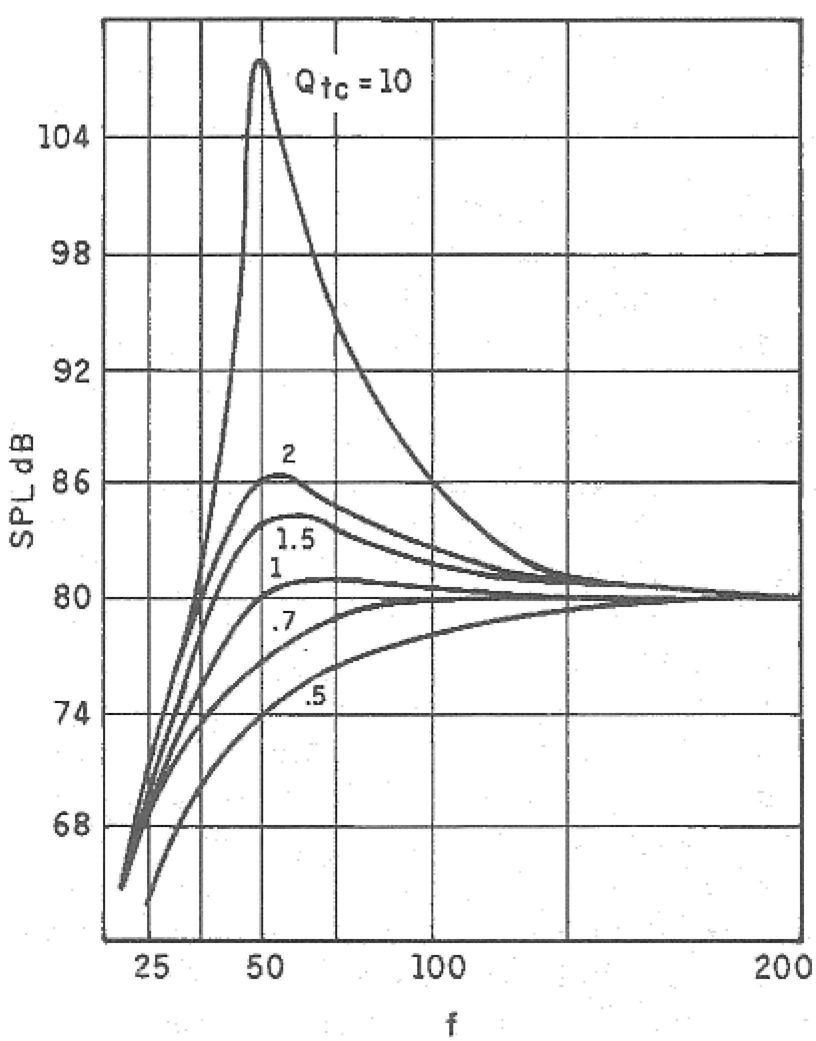
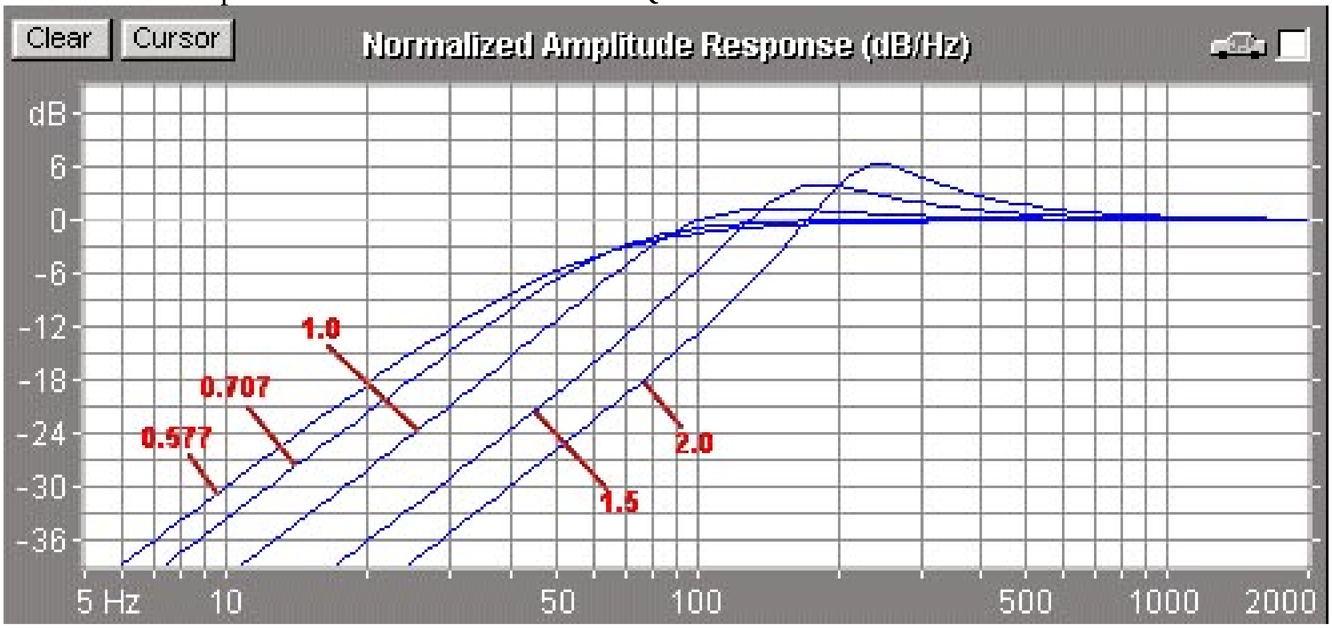


FIGURE 1.1: Frequency response of closed-box systems with different Qs.

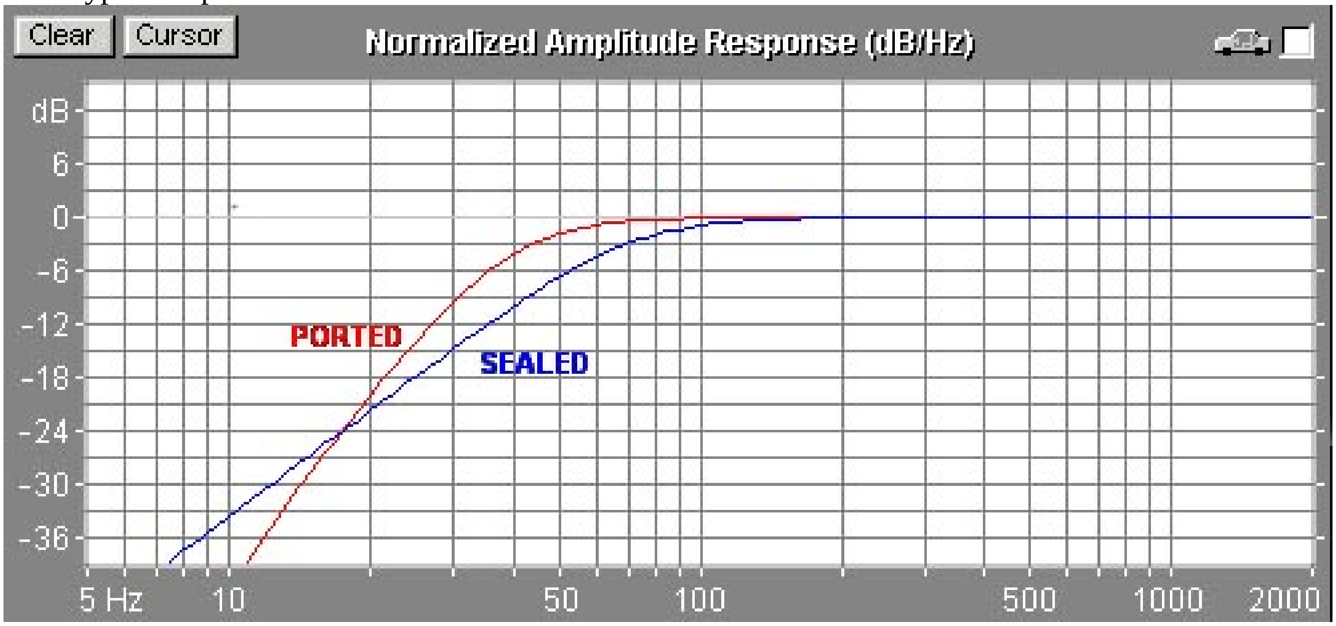
Same Fb – Different Qtc

Parameter	Description
F_s	driver resonance frequency
L_e	voice coil inductance
Q_{ms}	mechanical Q of the driver
Q_{es}	electrical Q of the driver
Q_{ts}	total Q of the driver = QmsQes / (Qms + Qes)
M_{ms}	mechanical mass of the diaphragm assembly including air load
C_{ms}	mechanical compliance of driver suspension (inverse of stiffness)
R_{ms}	mechanical resistance of driver suspension losses
S_d	diaphragm radiating surface area
V_{as}	volume of air having the same acoustic compliance as driver suspension
xmax	peak linear displacement of driver diaphragm
Z	nominal impedance of driver voice coil
R_e	DC resistance of driver voice coil
B	magnetic flux density in driver air gap
l	length of voice-coil wire in the magnetic field
Bl	product of B and l – rough estimation of driver motor strength
Sensitivity	standardized measure of acoustic output from a reference voltage input
Efficiency	standardized measure of acoustic output from a reference power input
F_3	frequency at which driver low-end rolloff is -3dB from the reference level
F_c	resonance frequency of a closed-box system
Q_{tc}	total Q of a speaker system at F_c
F_b	resonance frequency of a ported box system (box tuning frequency)

Sealed Box Comparison: Same Driver – Various Qtc



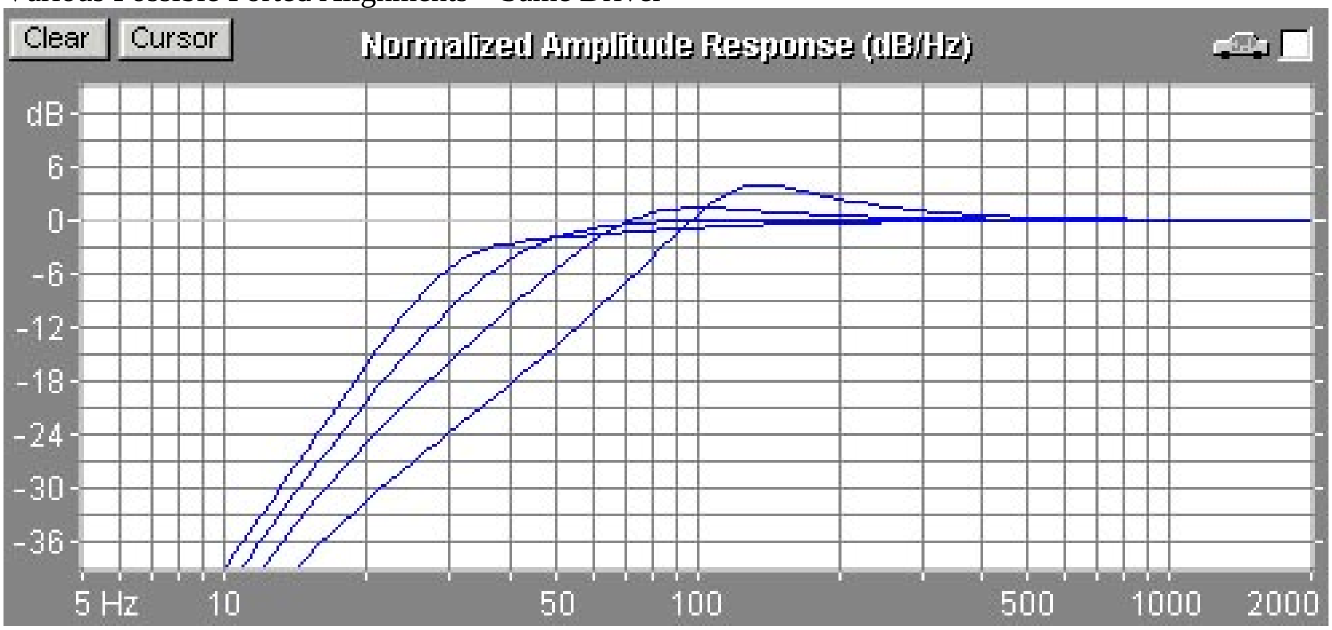
Box Type Comparison: Same Driver – Ported v. Sealed



Ported Design

- Software will calculate "optimal"
- R.O.T – Size it for SB Qtc of 0.57
- Tuning frequency – around Fs

Various Possible Ported Alignments – Same Driver



Box Shape

- Golden Ratio 1.618 / 1.0 / 0.618
- Generally, cubes are bad
- Angled baffle
- Non-parallel walls
- Curved panels

Diffraction

- Effects of baffle size, shape, and design
- Theoretical solutions
  - Flush mount the tweeter
  - Offset tweeter
  - Narrow baffle
  - Round-over/Chamfer edges
  - Crossover manipulation

Internal Damping (stuffing)

- Makes box act 15-25% larger
- Suppresses internal standing waves
- Too much can “deaden” midrange
- Not to be confused with Panel Dampening

Box Construction

- Usually ¾” MDF
- Butt joints common & easy
- Glue and screw
- Bracing
- Seal the inside edges (silicone)