AI UniBox

2x Dayton Audio RSS210HF-4 (series) Subwoofer

Loudspeaker enclosure design report

Recommended: **Vented 100L Fb24 D12.5cm**

F3 22 Hz · ripple 1.1 dB · 184 W excursion-limited · 108 dB max clean SPL

2026-09-13

1. Design brief

Two Dayton Audio RSS210HF-4 8-inch subwoofers, wired in series and sharing one enclosure, driven by an amplifier rated under 150 W. The brief was to compare sealed, vented, and passive-radiator alignments side by side rather than commit to one topology up front, with no fixed box-size ceiling -- size was given the lightest scoring weight of the criteria below, not zero weight.

All hardware was sourced from real, currently-stocked catalog items at Parts Express and Madisound. The RSS210HF-4 and its cosmetically-matched Reference-series passive radiator (RSS210-PR) are Dayton Audio products carried by Parts Express; Madisound's catalog does not currently list either, so those two parts come from Parts Express specifically, while generic enclosure hardware (terminal cup, damping fill, port tubing, fasteners) is available from either retailer.

Requirement	Value
Evaluation power	100 W
Max port length	0.5 m
Port air-velocity limit	17 m/s (5.0% of c)
Topologies considered	sealed, vented, passive radiator

2. Driver parameters

RSS210HF-4 Thiele/Small parameters were checked across three independent listings: Dayton Audio's own current product page and datasheet, the Parts Express listing, and the loudspeakerdatabase.com aggregator (which additionally reports Rms directly rather than only Qms). All three agree to 0% spread on every parameter -- Fs 29.6 Hz, Qms 3.25, Qes 0.69, Qts 0.57, Vas 23.7 L, Sd 219 cm2, Bl 8.12 T-m, Xmax 9.0 mm (peak, one-way), Le 0.7 mH -- so there was no disagreement to arbitrate and no per-parameter choice was needed. The self-consistency check flags a 5.2% gap between the stated Vas and the value implied back out of Cms and Sd; that's inside the rounding band (below the 15% fail threshold) and traceable to Cms being published to only two significant figures. It doesn't change any design decision here.

The two drivers were modeled as one equivalent driver via the standard two-driver-in-series array relations: Sd, Vas, Re and Le all double (Re: 3.1 to 6.2 ohm; Vas: 23.7 to 47.4 L; Sd: 219 to 438 cm2); Fs, Qts and per-unit Xmax are unchanged, since mass and stiffness scale together. A 0.2 ohm series resistance was added for amplifier output impedance and speaker cable.

Parameter	Value
Fs	29.6 Hz
Re	6.20 Ω
Qms / Qes / Qts	3.25 / 0.719 / 0.588
Qts effective (Rs = 0.20 Ω)	0.604
Vas	47.4 L
Sd	438 cm2
Xmax (peak)	9.0 mm
Bl	16.24 T·m
Mms / Cms	164.3 g / 0.18 mm/N
Sensitivity	84.1 dB/1W · 85.1 dB/2.83V

Parameter	Value
EBP	41

Source comparison

Parameter	Dayton Audio (mfr datasheet)	Parts Express listing	loudspeakerdatabase.com (aggregator)	Spread	Flag
Fs	29.6	29.6	29.6	0.0%	ok
Re	3.1	3.1	3.1	0.0%	ok
Qms	3.25	3.25	3.25	0.0%	ok
Qes	0.69	0.69	0.69	0.0%	ok
Qts	0.57	0.57	0.57	0.0%	ok
Vas_L	23.7	23.7	23.7	0.0%	ok
Sd_cm2	219.0	219.0	219.0	0.0%	ok
Xmax_mm	9.0	9.0	9.0	0.0%	ok
Bl	8.12	8.12	8.12	0.0%	ok
Le_mH	0.7	0.7	0.7	0.0%	ok
Mms_g	78.4	78.4	78.4	0.0%	ok
Cms_mm_N	0.37	0.37	0.37	0.0%	ok
Pn_W	280	280	280	0.0%	ok
Rms	—	—	4.49	0.0%	ok

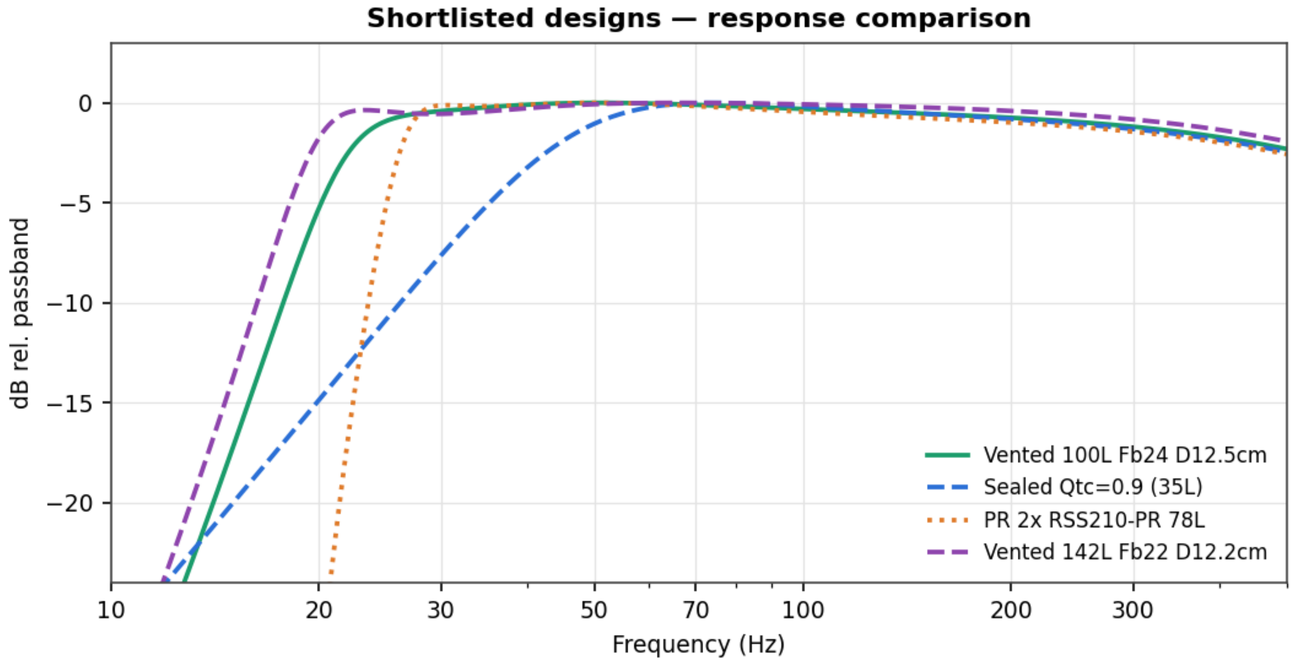
Spread = (max/min – 1) across sources. ok < 5%, warn < 15%, FAIL ≥ 15%.

3. Designs evaluated

The survey enumerated sealed boxes across Qtc 0.5-1.3, vented boxes across box volume x tuning frequency x port diameter (each at several fill and leak levels), and passive-radiator boxes against four real, currently-stocked Parts Express radiators sized for a two-driver 8-inch pair: the Reference-series RSS210-PR (Dayton's own cosmetic and mechanical match for this exact driver family, with a 20 mm Xmax and cast-aluminum frame), the 10-inch Designer-series DSA270-PR, and the smaller 8-inch DS215-PR / DSA215-PR (paper and aluminum cone). 947 candidates were generated and evaluated at a 100 W reference power (representative of the stated sub-150 W amplifier) against a conservative port-air-velocity limit; nothing was rejected outright, since no hard F3 or box-size ceiling was set for this comparison. Flatness, extension and headroom were weighted equally; box size was given a light weight (0.2) rather than zero, since "no hard limit" was read as "no fixed ceiling," not "size is irrelevant"; cost and topological simplicity got a secondary weight.

The central trade-off the shortlist exposes: vented alignments buy the deepest, flattest bass, and the score keeps climbing with box volume all the way to the edge of the search range (142 L / 5 ft3) -- but the climb flattens out past about 100 L, so a ~3.5 ft3 box already captures nearly all of the benefit of the biggest box surveyed. Sealed buys a genuinely compact footprint (1.25 ft3) and the most excursion headroom of the four, at the cost of roughly 20 Hz of low-end extension. The cosmetically-matched passive-radiator design splits the size difference but drives its own radiators to 96% of their excursion limit at the evaluation power, leaving little spare margin if the amplifier is ever pushed toward its full 150 W.

Design	Vb (L)	Fb/Fc	F3	Ripple	Clean pwr	Z min	Score
Vented 121L Fb23 D12.4cm	120.9	22.9 Hz	20.0 Hz	0.74 dB	157 W	6.5 Ω	0.93
Vented 142L Fb22 D12.2cm	142.2	21.8 Hz	19.0 Hz	0.56 dB	138 W	6.5 Ω	0.93
Vented 100L Fb24 D12.5cm	99.5	24.3 Hz	21.5 Hz	1.07 dB	184 W	6.5 Ω	0.93
Vented 142L Fb24 D12.5cm	142.2	24.2 Hz	21.3 Hz	0.59 dB	157 W	6.5 Ω	0.92
Vented 121L Fb23 D12.4cm	120.9	22.9 Hz	20.4 Hz	1.29 dB	158 W	6.5 Ω	0.92
Vented 121L Fb26 D12.7cm	120.9	25.5 Hz	22.5 Hz	0.90 dB	180 W	6.5 Ω	0.92
Vented 100L Fb24 D12.5cm	99.5	24.3 Hz	21.9 Hz	1.54 dB	185 W	6.5 Ω	0.92
Vented 121L Fb26 D12.7cm	120.9	25.5 Hz	22.3 Hz	1.01 dB	180 W	6.5 Ω	0.92
Vented 142L Fb22 D12.2cm	142.2	21.8 Hz	19.5 Hz	1.11 dB	139 W	6.5 Ω	0.92
Vented 142L Fb24 D12.5cm	142.2	24.2 Hz	21.1 Hz	0.83 dB	157 W	6.5 Ω	0.92
Sealed Qtc=0.9 (35L)	35.4	45.3 Hz	40.5 Hz	1.80 dB	212 W	6.4 Ω	0.89
PR 2x RSS210-PR 78L	78.2	27.4 Hz	25.8 Hz	0.85 dB	108 W	6.5 Ω	0.81



Shortlisted designs — response comparison
dB rel. passband
0
−5
−10
−15
−20
10
20
30
50
70
100
200
300
Frequency (Hz)
Vented 100L Fb24 D12.5cm
Sealed Qtc=0.9 (35L)
PR 2x RSS210-PR 78L
Vented 142L Fb22 D12.2cm

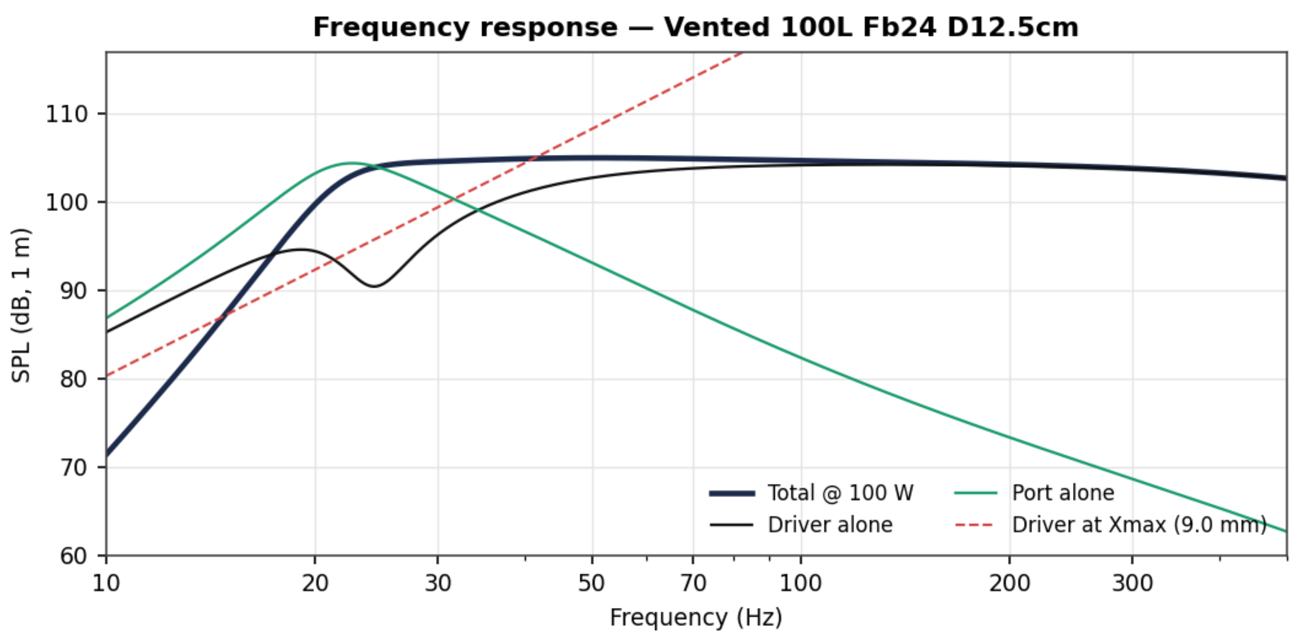
4. Recommended design: Vented 100L Fb24 D12.5cm

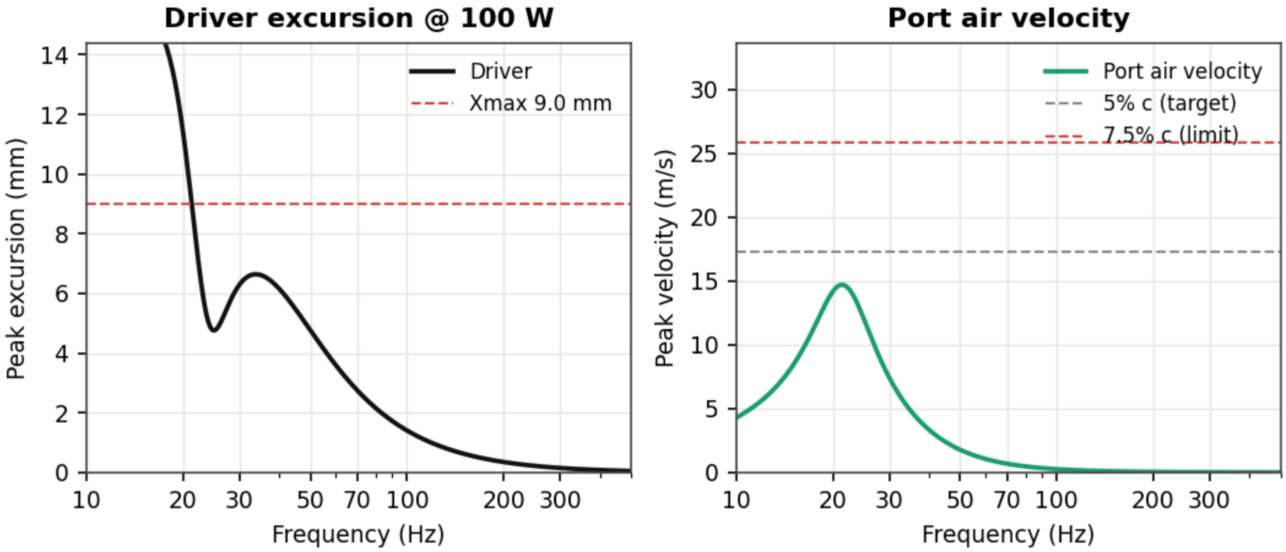
The recommended box is a 99.5 L (3.5 ft3) vented enclosure, filled heavily enough (Qa=5) that it behaves acoustically like 120.5 L, tuned to Fb = 24.3 Hz via a single 12.5 cm (4.9 in) diameter x 42.8 cm port. It scores 0.93 -- tied with the largest vented candidates the survey considered (up to 142 L) -- at nearly 30% less internal volume, which is essentially all of the benefit of the biggest box surveyed in a meaningfully smaller cabinet. F3 lands at 21.5 Hz with only 1.1 dB of passband ripple: flat, genuinely deep bass from two 8-inch drivers.

At the 100 W evaluation level the driver pair uses 6.6 mm of its 9.0 mm peak Xmax (74%), and the excursion-limited clean power is 183.6 W -- comfortably above the stated sub-150 W amplifier, so the amplifier is the practical ceiling here, not the drivers or the box. Port air velocity peaks at 14.7 m/s, under the 17.3 m/s conservative target, so chuffing shouldn't be audible at normal listening levels. The port's own pipe resonance sits at 358 Hz, well clear of any sensible subwoofer crossover point.

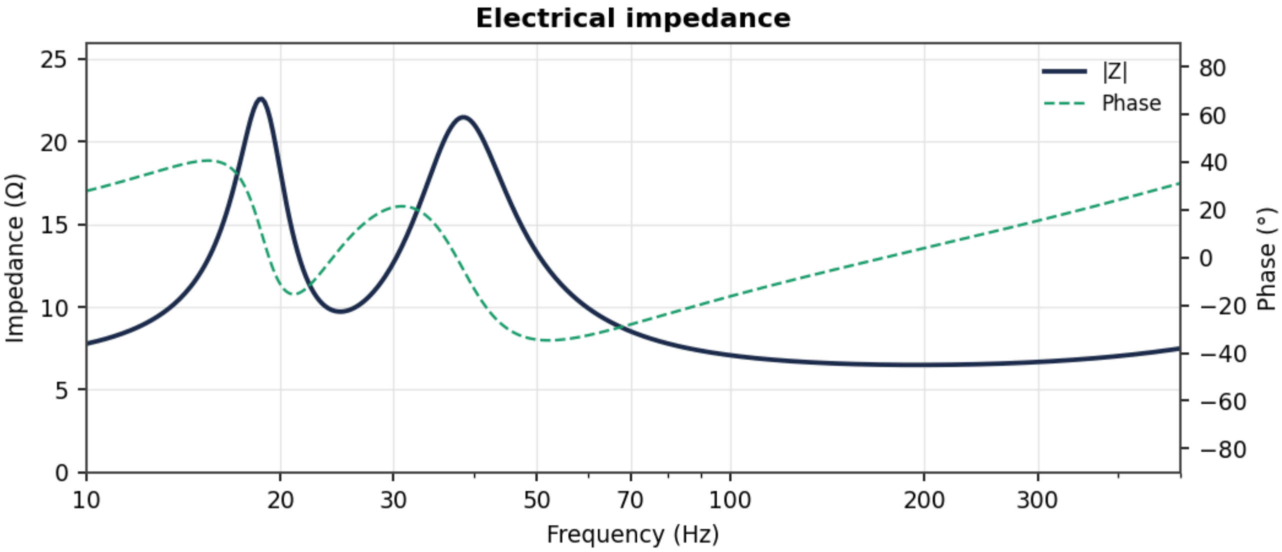
Trade-offs accepted

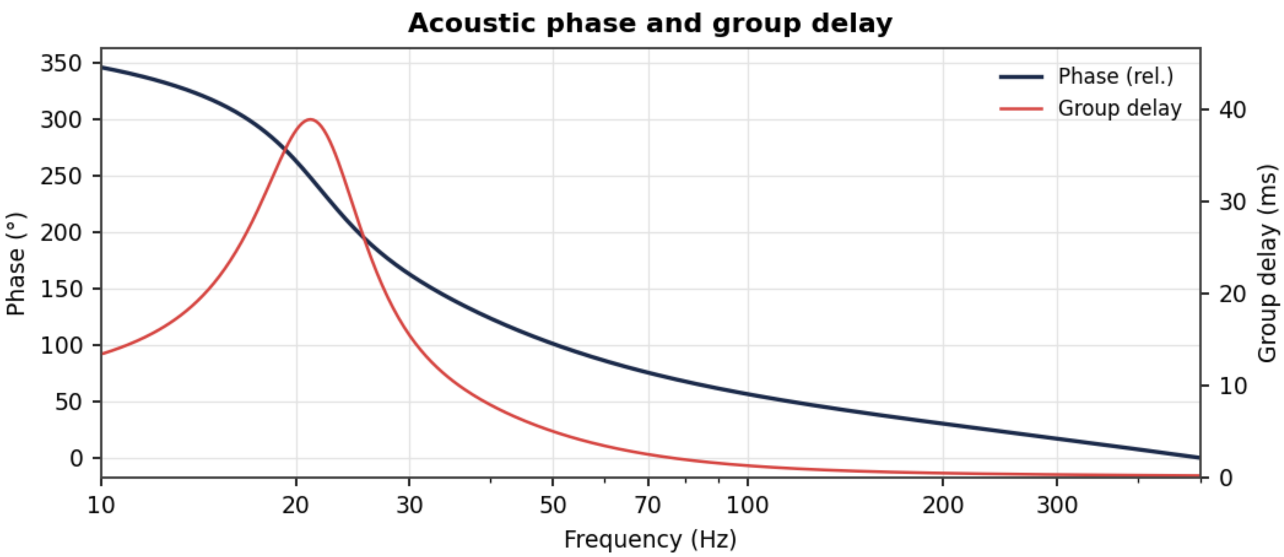
Against the largest vented candidate the survey considered (142 L, F3 19.0 Hz), this box gives up about 2.5 Hz of extension and 0.5 dB of ripple flatness for roughly 30% less internal volume -- worth it unless the last couple of Hz matters more than the footprint. Against the sealed alternative, it gives up about 30 W of excursion-limited headroom (183.6 W vs 212.3 W) and requires a port to build and tune correctly, in exchange for nearly 19 Hz of extra low-frequency extension (F3 21.5 Hz vs 40.5 Hz) at a comparable ripple figure. Against the passive-radiator alternative, it's mechanically simpler (no radiators to source or excursion-match) and carries substantially more clean headroom (183.6 W vs 107.7 W) in a similar-sized cabinet.

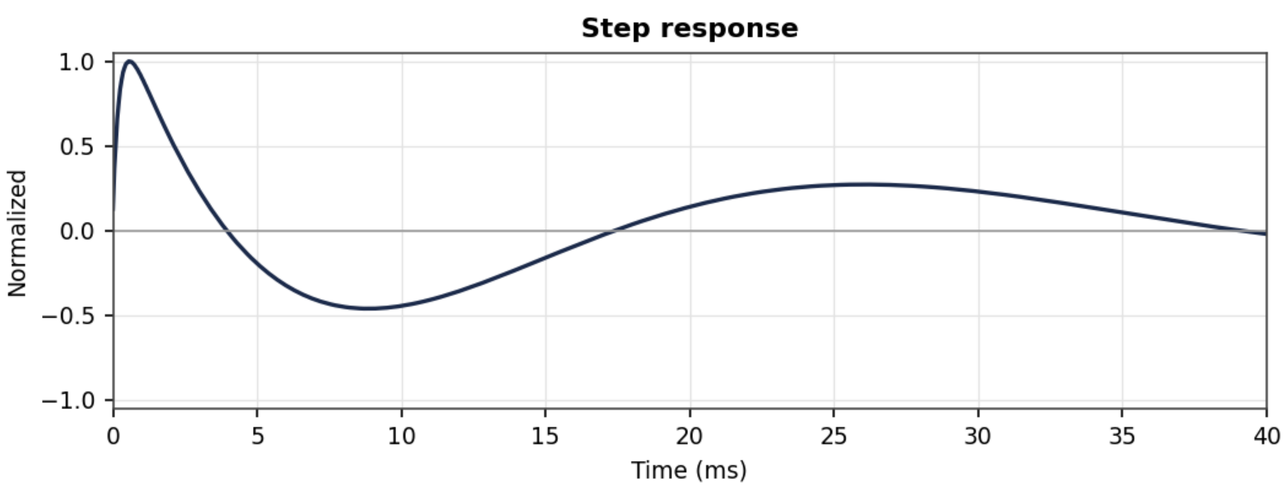




Driver excursion @ 100 W
Driver
Xmax 9.0 mm
Peak excursion (mm)
Frequency (Hz)
Port air velocity
Port air velocity
5% c (target)
7.5% c (limit)
Peak velocity (m/s)
Frequency (Hz)


Electrical impedance
|Z|
Phase
Impedance (Ω)
Phase (°)
Frequency (Hz)
25
20
15
10
5
0
80
60
40
20
0
−20
−40
−60
−80
10
20
30
50
70
100
200
300


Acoustic phase and group delay
Phase (rel.)
Group delay
Phase (°)
Group delay (ms)
Frequency (Hz)
350
300
250
200
150
100
50
0
40
30
20
10
0
10
20
30
50
70
100
200
300


Step response
Normalized
Time (ms)
1.0
0.5
0.0
−0.5
−1.0
0
5
10
15
20
25
30
35
40

5. Build sheet

Item	Specification
Topology	Vented (ported)
Net internal volume	99.5 L physical (acts as 120.5 L with fill)
Tuning frequency Fb	24.3 Hz
Port	Ø 12.5 cm, length 42.8 cm (pipe resonance ≈ 358 Hz)
Port air velocity	14.7 m/s peak @ 100 W (target < 17, limit 26)
Damping material	heavy (fully stuffed)
Sealing	airtight (no leaks)
Driver excursion	6.6 mm peak @ 100 W (Xmax 9.0 mm)
Excursion-limited power	184 W (above Fb; use a high-pass below)
Max clean SPL	107.6 dB @ 1 m
Sensitivity	85.1 dB @ 2.83 V / 1 m
Minimum impedance	6.5 Ω

Cut all panels from 3/4 in (19 mm) MDF and brace the two largest unsupported panels. The 99.5 L figure is the box's NET internal volume as the driver and port need to see it -- add roughly 5% for internal bracing and driver/port displacement when sizing the outer panels, i.e. build for about 105 L of gross internal space before those subtractions.

The model assumes heavy fill (Qa = 5), which is a full loose fill throughout the box, not just wall lining -- for a 3.5 ft3 net volume this is on the order of three to four 1-lb bags of Acousta-Stuf polyester fill (Parts Express #260-317, $15.98/lb, or the 5-lb bag #260-330). It also assumes an airtight box (Ql = None): glue every seam and gasket the terminal cup and driver cutouts.

The modeled 12.5 cm-diameter port isn't a standard Parts Express Precision Port size (their round tubes are stocked in 2, 3, 4, and 6 in). The closest drop-in options are two 4 in Precision Port tubes (PSP-4TB, chained with PSP-4RG connecting rings to reach length) sized to roughly 76 cm each for the same tuning and lower port velocity, or a shop-built rectangular slot port from the enclosure's own MDF sized to the same 122.7 cm2 minimum cross-section and about 42 cm deep. Either way, don't undersize the port cross-section below 122.7 cm2 -- that's what causes audible port noise.

Driver and hardware, all currently listed at Parts Express: 2x Dayton Audio RSS210HF-4 8" subwoofer (#295-456, ~$109 each); 1x speaker terminal cup, 5-way gold binding post (#260-242, ~$8); Acousta-Stuf polyfill as above; port tubing/flares as above; plus standard mounting screws and wood glue.

Filtering and protection

Use a subsonic (high-pass) filter around 15-18 Hz, below the 24.3 Hz tuning frequency, to keep the driver loaded and protected from unloading on high-level infrasonic content (rumble, warped records, HVAC noise) that a vented box otherwise passes through un-damped. Keep any crossover to the rest of the system well below the port's own 358 Hz pipe resonance -- a subwoofer crossover point anywhere under about 150 Hz leaves a wide, safe margin.

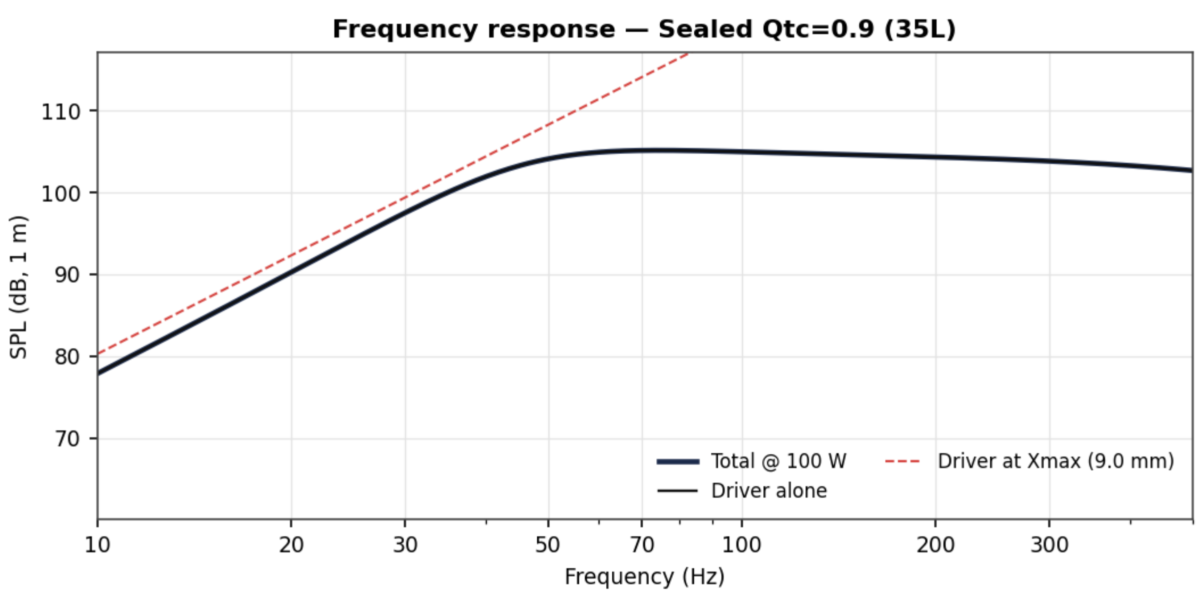
6. Alternatives considered

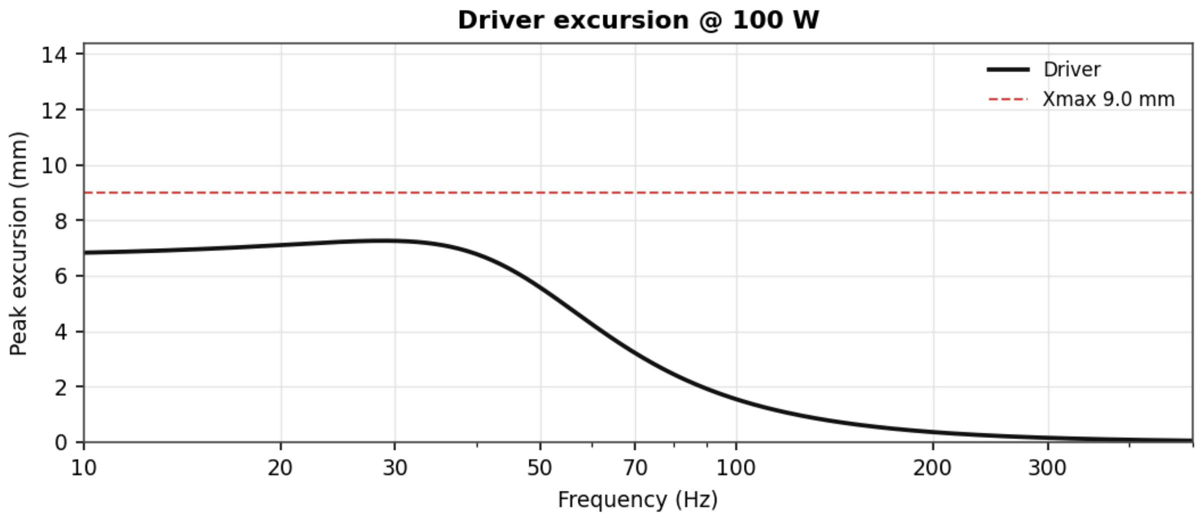
Compact sealed, Qtc 0.9 (35.4 L / 1.25 ft3): choose this if a small footprint matters more than reach, or if the extra 28.7 W of clean headroom (212.3 W vs 183.6 W) is worth more than low-end extension -- F3 rises to about 40.5 Hz, which is a noticeably smaller, tighter, less "full-range" bottom end than the recommended box.

Passive-radiator, 2x RSS210-PR (78.2 L / 2.8 ft3, $84.98 each at Parts Express, #295-499): Dayton's own Reference-series radiator, built with the same cast-aluminum frame and cosmetics as the RSS210HF-4 driver pair, so it's a genuine factory-matched look as well as a mechanical match. It's the flattest of the four shortlisted designs (0.85 dB ripple) and needs no port to tune, drill, or maintain -- but at the 100 W evaluation level the radiators themselves reach 96% of their 20 mm Xmax, leaving very little spare excursion margin, and it has the least clean headroom of the four (107.7 W). This is the pick for a sealed-quiet, no-port build only if the amplifier genuinely stays well under 100 W continuous.

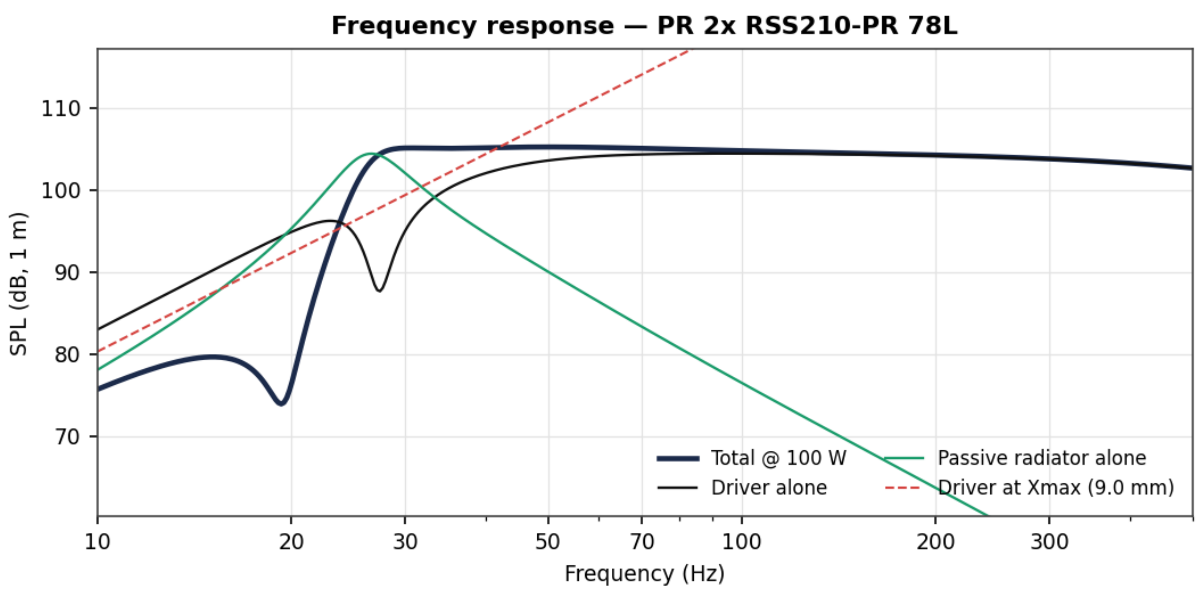
Maximum-extension vented (142.2 L / 5.0 ft3): the largest box the survey considered, trading roughly 43% more internal volume for about 2.5 Hz more extension (F3 19.0 Hz) and a flatter response (0.56 dB ripple) than the recommendation. Worth it only if the extra cabinet size is genuinely free.

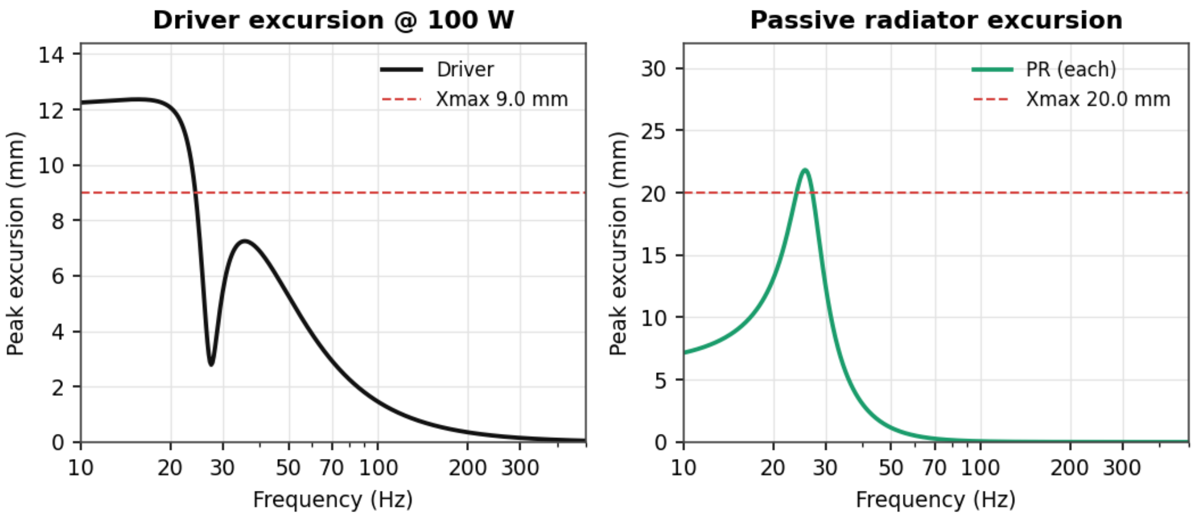
Sealed Qtc=0.9 (35L)



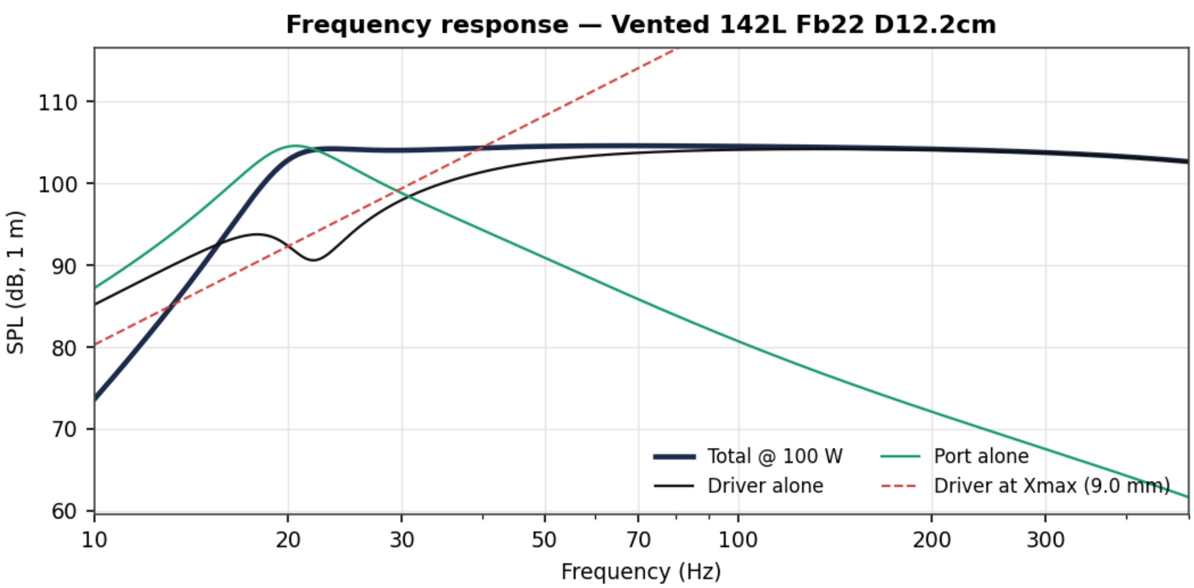


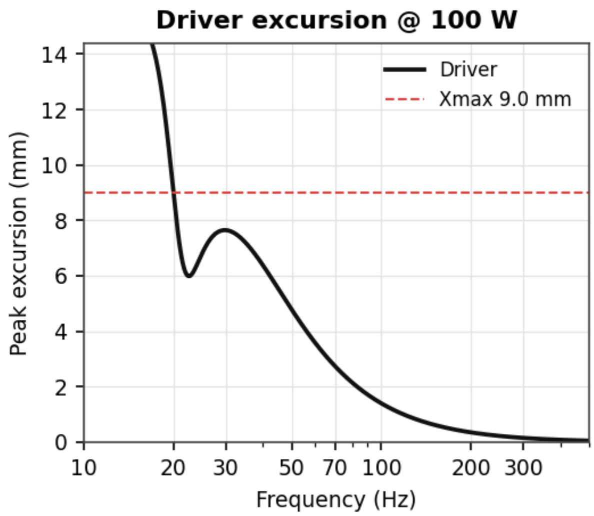
PR 2x RSS210-PR 78L

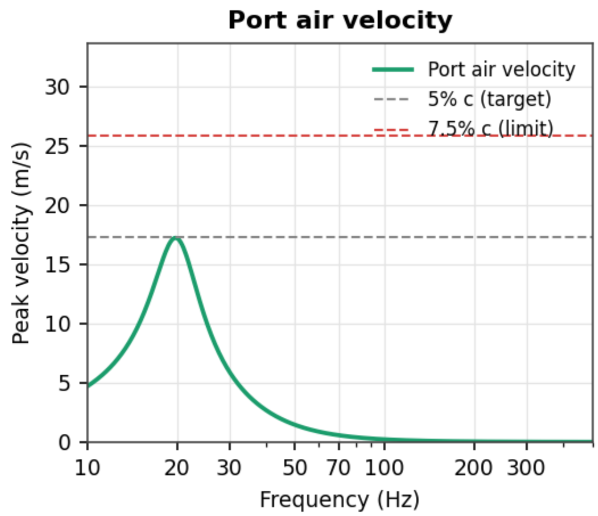




Vented 142L Fb22 D12.2cm




Driver excursion @ 100 W
Driver
Xmax 9.0 mm
Peak excursion (mm)
Frequency (Hz)
0
2
4
6
8
10
12
14
10
20
30
50
70
100
200
300


Port air velocity
Port air velocity
5% c (target)
7.5% c (limit)
Peak velocity (m/s)
Frequency (Hz)
0
5
10
15
20
25
30
10
20
30
50
70
100
200
300

Appendix — method and limitations

Every design was evaluated with a lumped-parameter acoustic model in which the driver, the port or passive radiator, and the box are three acoustic-impedance branches (radiator/port in parallel with the box, that pair in series with the driver). Box losses follow the standard Small treatment: absorption in series with the box compliance, leakage as a shunt path, and stuffing also expanding the effective box volume. Every formula was checked against the corresponding cell in a UniBox 4.08 workbook.

Drive voltage is RMS; excursion figures are peak and are compared directly against peak Xmax. "Excursion-limited power" is the highest input at which both driver and radiator remain within their linear limits from the tuning frequency upward — it assumes a high-pass filter handles content below tuning, and it is usually the real power limit rather than the thermal rating.

The model is small-signal and linear: no power compression, thermal effects, or distortion, and it is valid only up to a few hundred hertz, above which cone breakup and baffle diffraction (not modeled) take over. Ripple and F3 with box losses should be read as roughly ±0.2 dB and ±1–2 Hz; tuning frequency is exact. Parameters were taken from published data and validated for internal consistency, but a measured T/S set for the specific units in hand will always be better.