Appendix A

Loudspeaker Dimensions

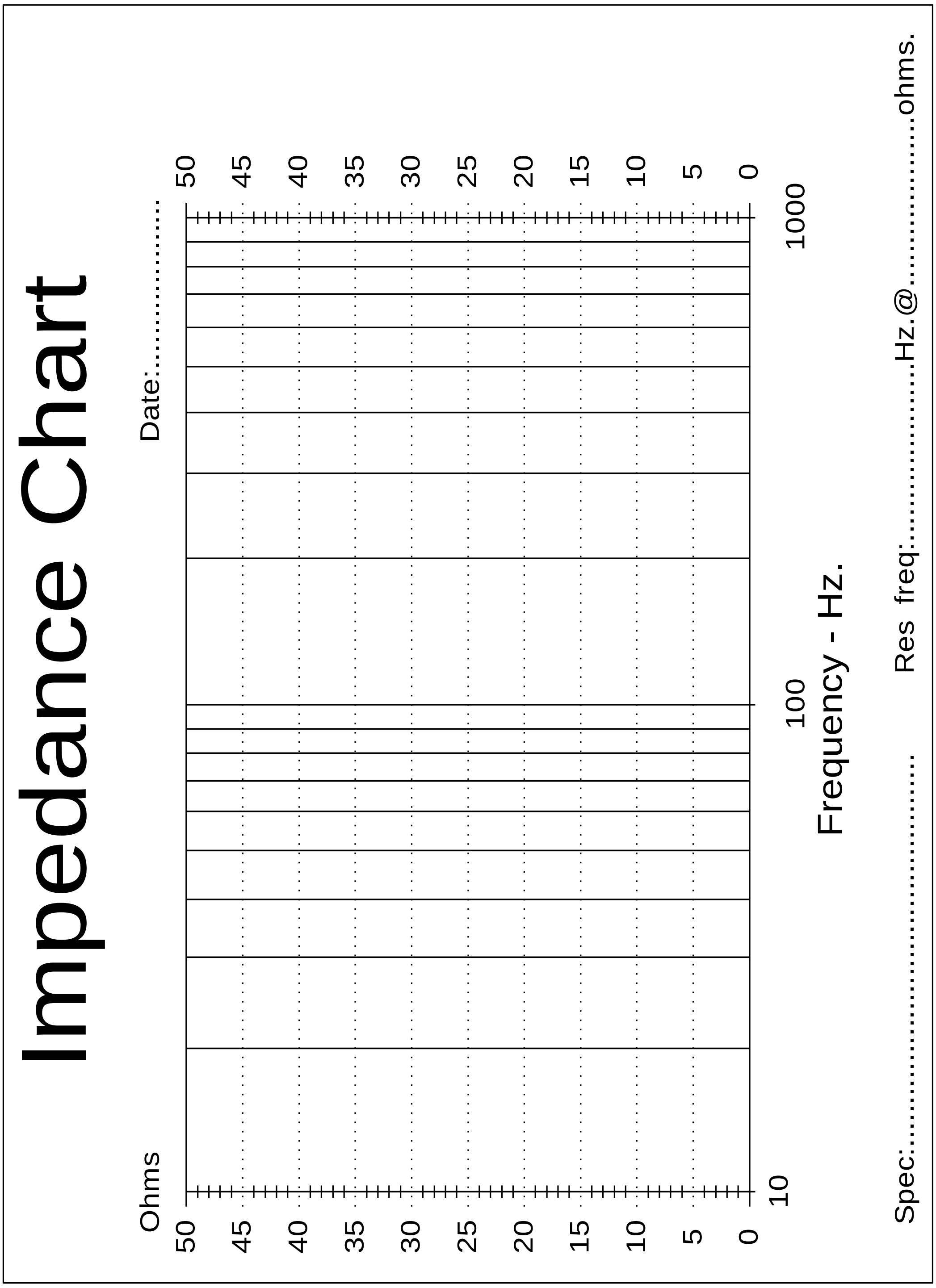
Woofer		
Outside diameter	W_{diam}	...........mm.
Woofer radius	R_w	...........mm.
Magnet radius	r_w	...........mm.
Woofer height	H_w	...........mm.
Cone depth	W_{cone}	...........mm.
Flange thickness	W_{flange}	...........mm.
Flange width	W_{rebate}	...........mm.
Cut-out diameter	W_{hole}	...........mm.
Mounting screws		M.....
Midrange		
Outside diameter	M_{diam}	...........mm.
Tube radius	R_m	...........mm.
Tube height	H_m	...........mm.
Cone depth	M_{cone}	...........mm.
Flange thickness	M_{flange}	...........mm.
Flange width	M_{rebate}	...........mm.
Cut-out diameter	M_{hole}	...........mm.
Mounting screws		M.....
Tweeter		
Outside diameter	T_{diam}	...........mm.
Magnet radius	R_t	...........mm.
Cone depth	T_{cone}	...........mm.
Flange thickness	T_{flange}	...........mm.
Flange width	T_{rebate}	...........mm.
Cut-out diameter	T_{hole}	...........mm.
Mounting screws		M.....

FREQUENCY Hz.	V_S mvolts.	V_R volts.	IMPEDANCE Ohms.
10			
15			
20			
25			
30			
35			
40			
50			
60			
70			
80			
90			
100			
200			
300			
400			
500			
600			
700			
800			
900			
1000			
Resonant Frequency - F_s			

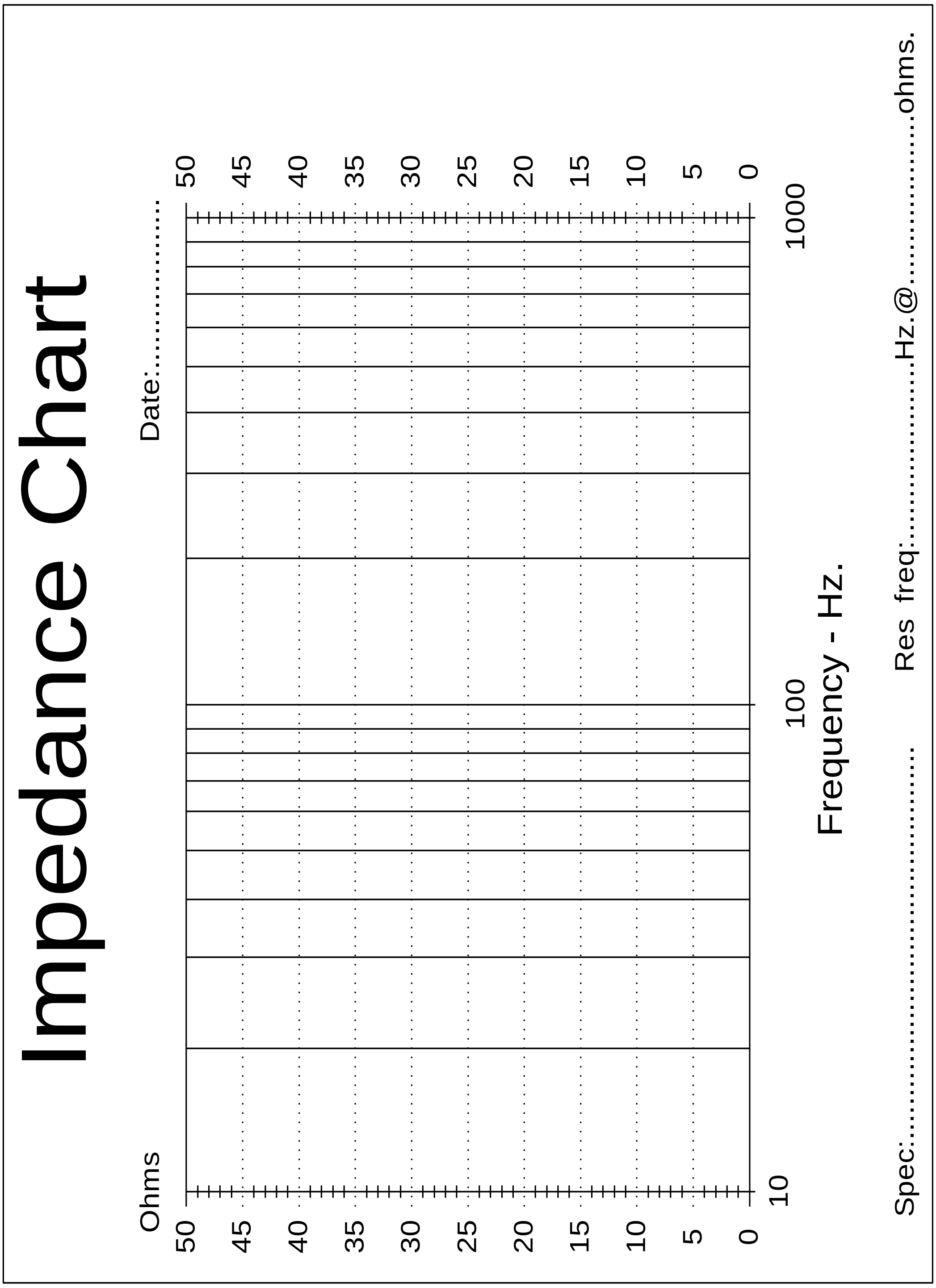
Woofer Impedance Data Chart. (Left hand)

FREQUENCY Hz.	V_S mvolts.	V_R volts.	IMPEDANCE Ohms.
10			
15			
20			
25			
30			
35			
40			
50			
60			
70			
80			
90			
100			
200			
300			
400			
500			
600			
700			
800			
900			
1000			
Resonant Frequency - F_s			

Woofer Impedance Data Chart. (Right hand)



Woofer Impedance Curve Chart. (Left hand)



Woofer Impedance Curve Chart. (Right hand)

TYPE : ……….....…....... **P/N** : ...…………......……….. **DATE** : …………………......

	LEFT HAND	**RIGHT HAND**
Woofer parameters : Crossover point: ……............Hz. R_e F_s Z_{fs} Z_{f3} F_1 F_2 **Z_{fs}** = $\frac{V_s}{V_r}$ $\frac{mV}{V}$	....…….......... Ohms. .....…........... Hz. ....………..... Ohms. ....………..... Ohms. ....…........... Hz. ....…........... Hz. ______ =	.... Ohms. .... Hz. .... Ohms. .... Ohms. .... Hz. .... Hz. _____ =
Impedance Z: L_o Z_{f3} = .707 x Zf_s F_1 & F_2 is the frequency of Z_{f3} above & below F_s.	**Z_{fs}** ...…..…...... Ω Z_{f3}=.707 x …… =…..……..Ω	**Z_{fs}** ....…......... Ω Z_{f3}=.707 x …… = ……..…Ω
Speaker Q: $r_0 = \frac{Z_{fs}}{R_e}$ **Q_{ts}** = $\frac{F_s}{F_1 - F_2}$ x $\frac{R_e}{Z_{fs}}$ x $\sqrt{ro}$	r_0 = ... = ...x .... x $\sqrt{..........}$ Q_{ts} = ...	r_0 = ... = ... x............ x $\sqrt{..........}$ Q_{ts} = ...
Check **F_s** : (±1 %) **F_s** = $\sqrt{F_1 \times F_2}$ Hz	$\sqrt{…......x…..... }$ = ……… Hz	$\sqrt{...........x......... }$ = ….…......Hz
Calculate **L_{ref}** = Re x √2 Find L_{ref} above F_s and record F_5.(>300Hz.)	= ……. x √2. = ……… Ω F_5 = …………….. Hz.	= ……. x √2. = ……… Ω F_5 = …………….. Hz.
Max Output. SPL =10LOG(P) + S P= rms watts. S=sensitivity- dB@1w/1 m	=10LOG............+............. =..........................dB SPL.	=10LOG............+............. =..........................dB SPL.

C7 = ……..…………..….µF.	R4 = ………………...….Ω.

F_5 = ……………....Hz. (see data chart)

Where $L_e = \frac{R_e}{2 \times \pi \times F_5} \times 10^3 = \underline{\qquad\qquad} \times 10^3$ = ………..………mH.

$C7 = \frac{L_e}{R_e^2} \times 10^3 = \frac{\qquad}{(\qquad)^2} \times 10^3$ = ……..…..……..…µF.

R4 (Use a standard 5watt value close to R_e. Check the impedance curve as a reference and aim to get a straight line) = ………….……..…Ω.

Note: Use R4 as Z_w in the woofer crossover calculation chart if using an impedance equalizer.

Woofer Impedance Equalizer Calculation Chart.

$\eta_{eff} = \frac{0.0953 \times (F_s^3 \times V_{as}) \times 10^{-6}}{Q_{es}} = \underline{0.0953 \times ((\quad)^3 \times \qquad) \times 10^{-6}}$ = …………..%

$Q_{es} = \frac{Q_{ms}}{(r_o - 1)} = \frac{\qquad}{(\qquad - 1)}$ = ……………

$r_o = \frac{Z_{fs}}{R_e} = \underline{\qquad}$ = ………….. (see data chart for R_e , Z_{fs} , F_h , F_l)

$Q_{ms} = \frac{F_s \times \sqrt{r_o}}{(F_1 - F_2)} = \underline{\qquad \times \sqrt{\qquad}}$ = ………………

$V_{as} = 1.15 \times \left(\left(\frac{F_{box}}{F_s}\right)^2 - 1\right) \times V_{box}$ = 1.15 x (……... - 1) x ….……

= ……………liters

Woofer Relative Efficiency calculation chart.

TYPE : .... P/N : .... DATE :		
	LEFT HAND	**RIGHT HAND**
Midrange parameters : R_e	.... Ohms.	.... Ohms.
F_s	.... Hz.	.... Hz.
Crossover point: Z_{fs}	.... Ohms.	.... Ohms.
Z_{ml}	……………. Ohms.	……………. Ohms.
L_o …............Hz & H_i …............Hz Z_{mh}	……………. Ohms.	……………. Ohms.
	____________ =	____________ =
$Z_{fs} = \frac{V_s}{V_r}$ mV / V	Z_{fs} = ……......Ohms.	Z_{fs} = ………..Ohms.
Impedance Z: M_{Lo}	= ________ =	= ________ =
	Z_{ml} = …..….....Ohms.	Z_{ml} = ……........Ohms.
M_{Hi}	= ________ =	= ________ =
	Z_{mh} = ……......Ohms.	Z_{ml} = ...….....Ohms.

Midrange Impedance Calculation Chart.

Parameters: F_n = ………….....Hz

R3 = …………..Ω	L6 = …..……....mH	C6 = …..……...μF

$C_{ideal} = \frac{1}{2 \times \pi \times R_e \times F_n} \times 10^6 = \frac{10^6}{\quad}$ = ...……….....uF

$L_6 = \frac{1}{C_n \times (2 \times \pi \times F_n)^2} \times 10^3 = \frac{10^3}{\quad}$ = ...……........mH

$R_3 = R_e$ = ...……....ohms.

F_n is the frequency of the notch you want to control and is usually equal to F_s. Calculate C_{ideal}, then choose the nearest standard value capacitor for C_n to enable a small enough coil to be wound (<6mH).

Midrange Notch Filter Calculation Chart.

TYPE : .... **P/N** : .... **DATE** :		
	LEFT HAND	**RIGHT HAND**
Tweeter parameters : R_e F_s Crossover point: Z_{fs} Z_t …............Hz	.... Ohms. .... Hz. .... Ohms. ……………. Ohms. ________ =	.... Ohms. .... Hz. .... Ohms. …………….. Ohms. ________ =
$\mathbf{Z_{fs}} = \frac{V_s \text{ mV}}{V_r \text{ V}}$	Z_{fs} = ……......Ohms.	Z_{fs} = ………..Ohms.
Impedance Z: H_i	= ________ = Z_t = …...….....Ohms.	= ________ = Z_t = ……........Ohms.

Tweeter Impedance Calculation Chart.

Parameters: F_n = …………...Hz

R2 = …...……..Ω	L5 = …..……...mH	C5 = ..………...µF

$$C_{ideal} = \frac{1}{2 \times \pi \times R_e \times F_n} \times 10^6 = \frac{10^6}{\quad\quad} = \text{....……….....uF}$$

$$L_5 = \frac{1}{C_n \times (2 \times \pi \times F_n)^2} \times 10^3 = \frac{10^3}{\quad\quad} = \text{....……........mH}$$

$R_2 = R_e$ = ...……......ohms.

F_n is the frequency of the notch you want to control and is usually equal to F_s. Calculate C_{ideal} , then choose the nearest standard value capacitor for C_n to enable a small enough coil to be wound (<6mH).

Tweeter Notch Filter Calculation Chart.

Crossover points : ....&...................   Date : ....

Z_w * = ... Z_{mh} = ... Z_{ml} = ... Z_t = ...

*Alignment: ……………. n = C x ………… & L x……………

Woofer :

$$L4 = \frac{Z_w}{2\pi \text{ x } F_L \text{ x } 10^{-3}} * n = \_\_\_\_\_\_\_\_ = \text{........................mH}$$

$$C4 = \frac{1}{2\pi \text{ x } Z_w \text{ x } F_L \text{ x } 10^{-6}} * n = \frac{1}{\_\_\_\_\_\_\_\_} = \text{..........................uF}$$

Midrange :

$$L2 = \frac{Z_{mh} \text{ x } \sqrt{2}}{4 \text{ x } \pi \text{ x } (F_h - F_L) \text{ x } 10^{-3}} * n = \_\_\_\_\_\_\_\_ = \text{........................mH}$$

$$L3 = \frac{Z_{ml} \text{ x } (F_h - F_L)}{2 \text{ x } \sqrt{2} \text{ x } \pi \text{ x } F_m \text{ x } 10^{-3}} * n = \frac{\text{x}}{\_\_\_\_\_\_\_\_} =$$

(Where $F_m = F_h \text{ x } F_L$ $\qquad = \frac{\text{x}}{\_\_\_\_\_\_\_\_} = \text{......……............mH}$

=...........x……..........

=.............................)

$$C2 = \frac{F_h - F_L}{\sqrt{2} \text{ x } \pi \text{ x } Z_{mL} \text{ x } f_m \text{ x } 10^{-6}} * n = \_\_\_\_\_\_\_\_ =$$

$$= \_\_\_\_\_\_\_\_ = \text{..........................uF}$$

$$C3 = \frac{1}{\sqrt{2} \text{ x } \pi \text{ x } Z_{mh} \text{ x } (f_h - F_L) \text{ x } 10^{-6}} * n = \frac{1}{\_\_\_\_\_\_\_\_} =$$

$$= \frac{1}{\_\_\_\_\_\_\_\_} = \text{..........................uF}$$

Tweeter :

$$L1 = \frac{Z_t}{2\pi \text{ x } F_h \text{ x } 10^{-3}} * n = \_\_\_\_\_\_\_\_ = \text{.......................mH}$$

$$C1 = \frac{1}{2 \text{ x } \pi \text{ x } Z_t \text{ x } F_h \text{ x } 10^{-6}} * n = \frac{1}{\_\_\_\_\_\_\_\_} = \text{........................uF}$$

* Notes: 1. Use R1 from impedance equalizer chart as Z_w if using an impedance equalizer on woofer.
2. '**n**' is the multiplier for the different alignments – see Table 1 page 16.

Crossover Network Calculation Chart.

Filter	1st order	2nd order		
	As calculated with the text book formulas. For higher orders multiply the standard values with the appropriate multiplier.	Butterworth	L/R	Bessel
C1		0.707	0.50	0.57
C4		0.707	0.50	0.57
L1		1.414	2.00	1.74
L4		1.414	2.00	1.74
		n^{th} multipliers		

Table 1

Crossover Parts List.

+ = series connection. * = parallel connection.

Tweeter: crossover point = …………….……….…Hz.

C1 = …..…..…µF = ……..…@……..…v …….……@….……v

C5 = …….…….µF = ……..…@……..…v …….……@.…..…...v

C6 = …………µF = ……..….@………..v ………….@…..……v

R1 = ……..…..Ω = ….…… …….…… or

R2 = ………….Ω = ….….… …………

L1 = …………mH

L5 = …………mH

Midrange: crossover point = …………….…...….&…….….……….…Hz.

C2 = …………µF = ………@………..v ..………@……..…v

C3 = …………µF = ………@………..v ……..….@…..……v

C6 = …………µF = ………@………..v ……..…@……..…v

R3 = ……….....Ω = ………. ……….

L2 = ……...…mH

L3 = ………...mH

L6 = ……...…mH

Woofer: crossover point = ………….…….………Hz.

C4 = ……...…µF = ……..…@……....v ………..@……..…v

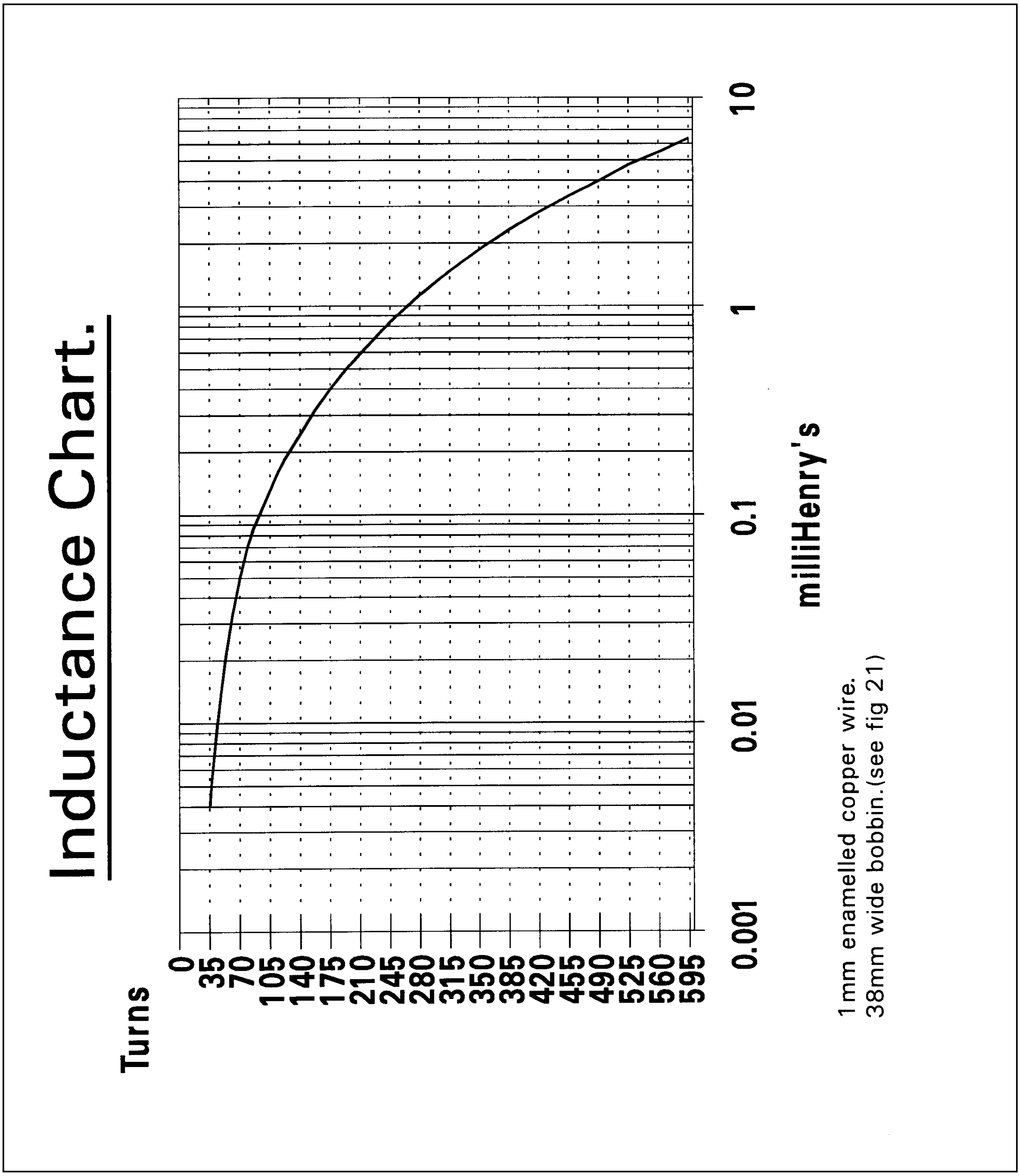
C7 = ……..….µF = ……..…@……..…v ……...…@.……....v

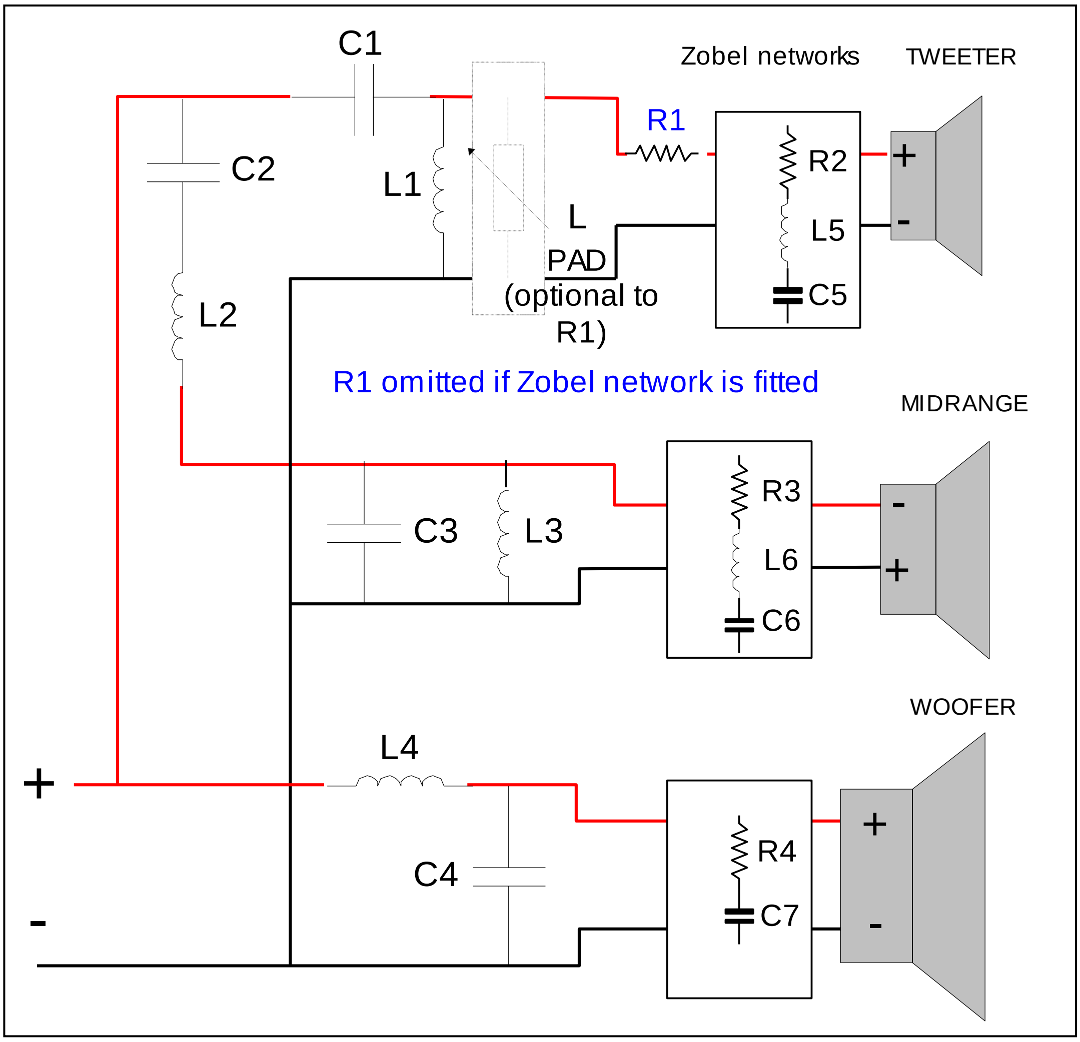
L4 = ……..…mH

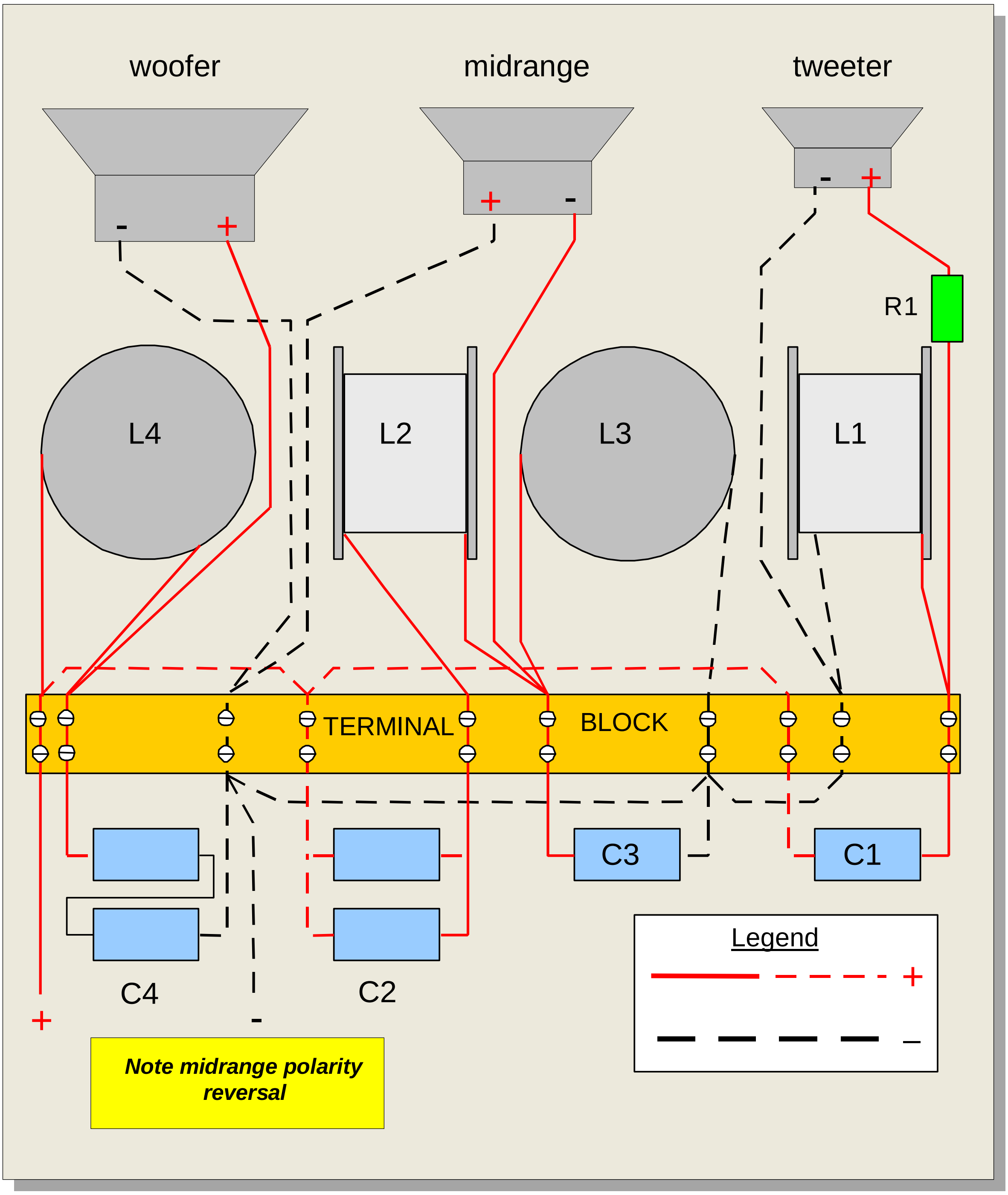
R4 = ……..…...Ω = ……..… ……..…

Note: Use higher voltage rated caps on parallel connection.

Crossover Parts List.


Inductance Chart.
Turns
0
35
70
105
140
175
210
245
280
315
350
385
420
455
490
525
560
595
0.001
0.01
0.1
1
10
milliHenry's
1mm enamelled copper wire.
38mm wide bobbin.(see fig 21)


C1
Zobel networks
TWEETER
R1
C2
L1
R2
+
L
L5
-
PAD
(optional to
R1)
C5
L2
R1 omitted if Zobel network is fitted
MIDRANGE
R3
-
C3
L3
L6
+
C6
WOOFER
L4
+
+
R4
C4
C7
-
-


woofer
midrange
tweeter
-
+
+
-
-
+
R1
L4
L2
L3
L1
TERMINAL
BLOCK
C3
C1
C4
C2
+
-
Legend
+
_
Note midrange polarity reversal