Appendix A

Loudspeaker Dimensions

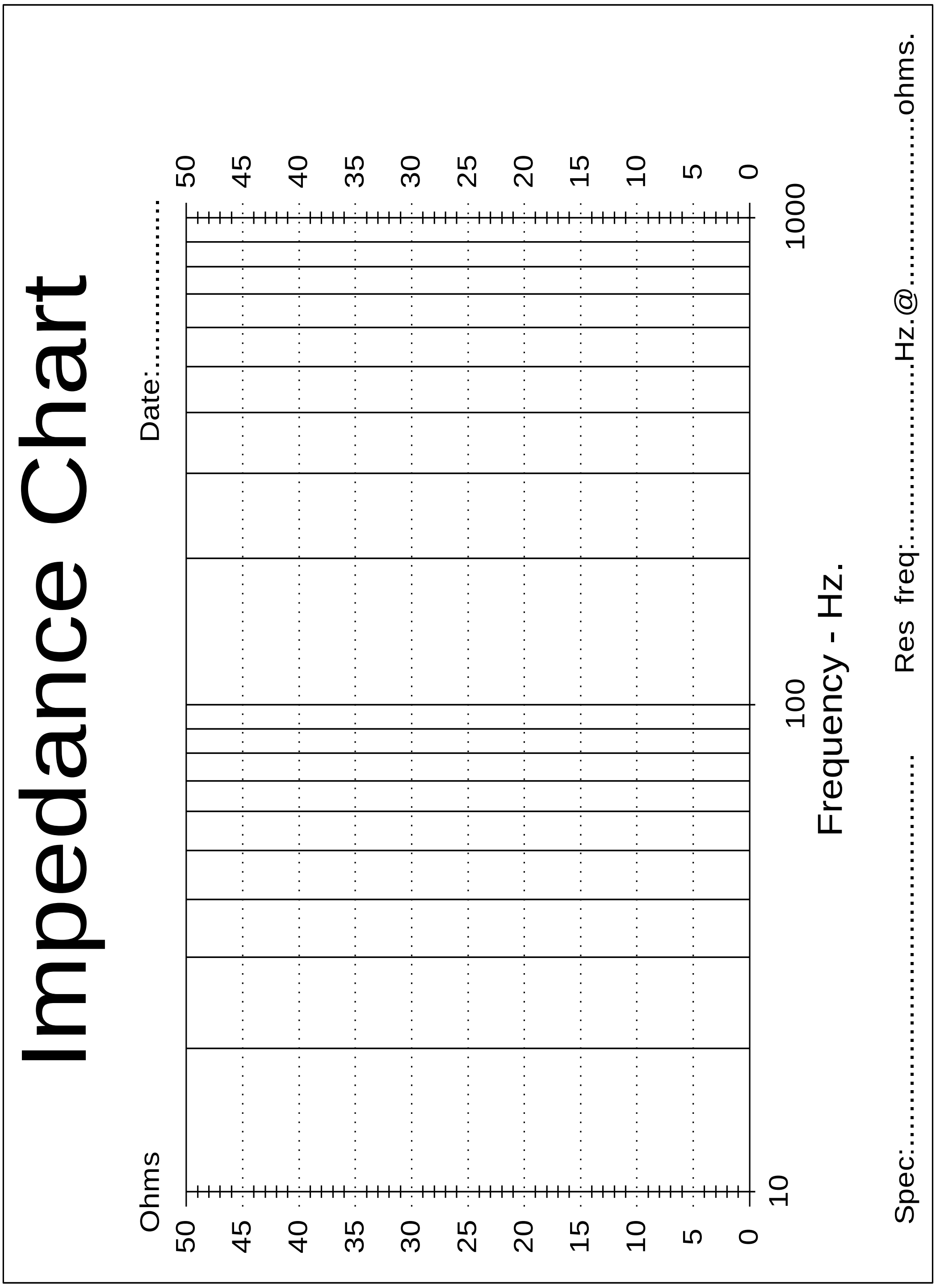
Woofer		
Outside diameter	W_{diam}	………..mm.
Woofer radius	R_w	………..mm.
Magnet radius	r_w	………..mm.
Woofer height	H_w	………..mm.
Cone depth	W_{cone}	………..mm.
Flange thickness	W_{flange}	………..mm.
Flange width	W_{rebate}	………..mm.
Cut-out diameter	W_{hole}	………..mm.
Mounting screws		M…..
Midrange		
Outside diameter	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			

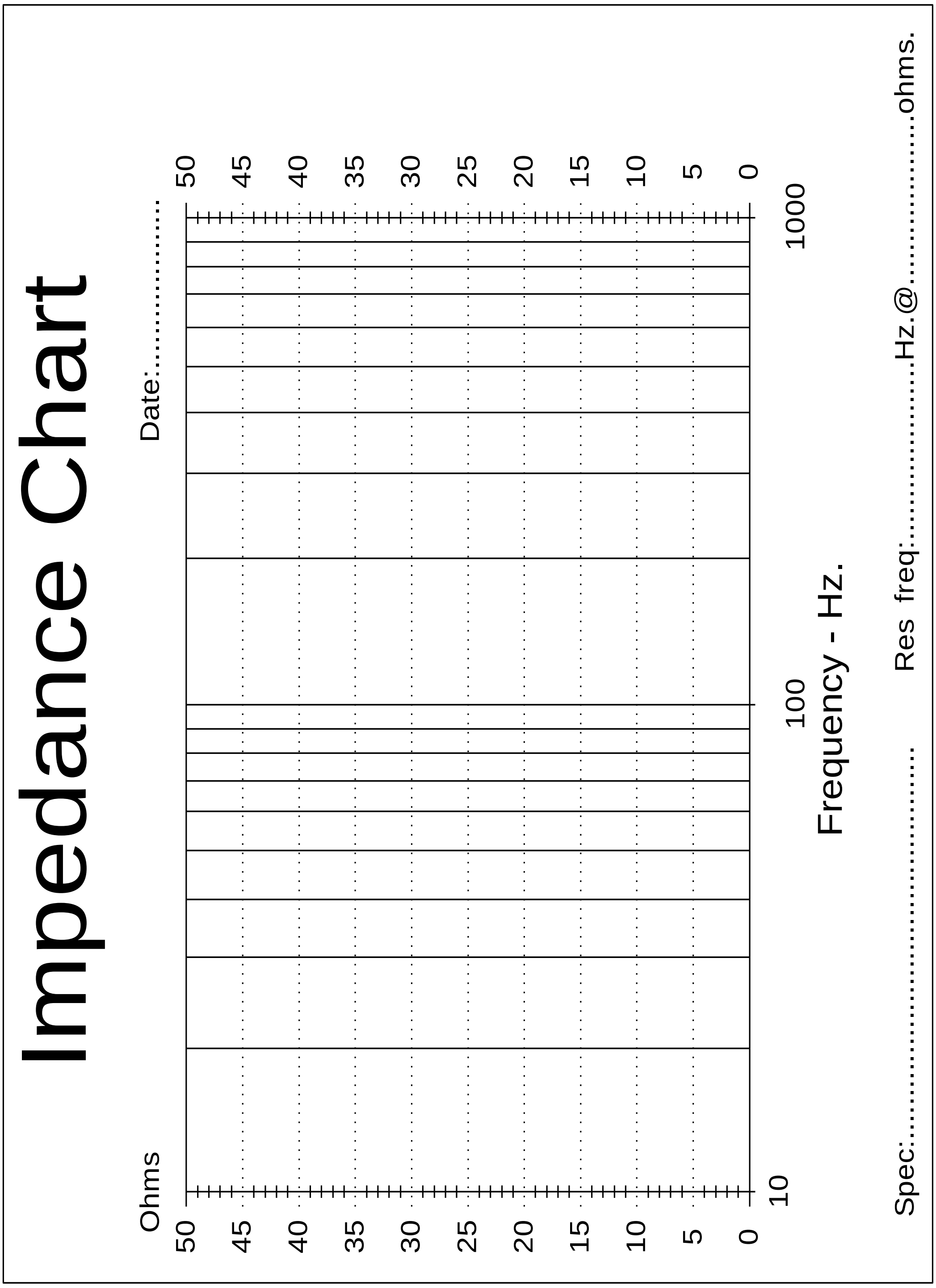
Woofer Impedance Data Chart. (Left hand)

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 : R_e F_s Z_{fs} Z_{f3} F_1 F_2 Q_{ts}	.... Ohms. .... Hz. .... Ohms. .... Ohms. .... Hz. .... Hz.	.... Ohms. .... HZ. .... Ohms. .... Ohms. .... Hz. .... Hz. ....
$\mathbf{Z}_{fs} = \dfrac{V_s}{V_r} \dfrac{mV}{V}$ Crossover points: F_h = ...Hz. F_h= F_l = ...Hz. X = w-woofer m-midrange t-tweeter F_l= $Z_{f3} = Z_{fs}$ x 0.707	___________ = Z_{fs} = ...Ohms. Z__ = _________= Z__= ....Ohms. Z__ = ________ = Z__ = ...Ohms. Z_{f3}=.707 x ...... =..........Ω	___________ = Z_{fs} = ...Ohms. Z__ = ________ = Z__ = ...Ohms. Z__= __________ = Z__ = ...Ohms. Z_{f3}=.707 x ...... =..........Ω
Speaker Q: $ro = \dfrac{Z_{fs}}{R_e}$ $\mathbf{Q_{ts}} = \dfrac{F_s}{F_1 - F_2} \times \dfrac{R_e}{Z_{fs}} \times \sqrt{ro}$	ro = $\dfrac{.......}{}$ = ... Q_{ts} =....... x .... x$\sqrt{.........}$ Q_{ts} = ...	ro = $\dfrac{.......}{}$ = ... Q_{ts} =....... x .... x$\sqrt{.........}$ Q_{ts} = ...
Check $\mathbf{F_s}$: (±1 %) $\mathbf{F_s} = \sqrt{F_1 * F_2}$ Hz	$\sqrt{........x..........}$ = ...Hz	$\sqrt{...........x.........}$ = ...Hz
Max Output. SPL =10LOG(P) + S P= rms watts. s=sensitivity.dB@1m/1w	=10LOG............+............... =.......................... dB SPL.	=10LOG.............+.............. =...........................dB SPL.
Calculate $\mathbf{F_5}$: L_{ref} = Re x √2 Find L_{ref} above F_s and record F_5.(300-1000 Hz.)	= .... x √2. = ... Ω F_5 = ... Hz.	= .... x √2. = ... Ω F_5 = ... Hz.

C7 = ……..…………..…μF.

R4 = ……….……….…...…Ω.

F_5 = ……………....Hz. (see data chart)

Where $L_e = \dfrac{R_e}{2 \times \pi \times F_5} \times 10^3 = \dfrac{\quad}{\quad} \times 10^3$ = ………..………mH.

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

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

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

Woofer Impedance Equalizer Calculation Chart.

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

$Q_{es} = \dfrac{Q_{ms}}{(r_o - 1)} = \dfrac{\quad}{(\quad - 1)}$ = ……………

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

$Q_{ms} = \dfrac{F_s \times \sqrt{r_o}}{(F_1 - F_2)} = \dfrac{\quad \times \sqrt{\quad}}{\quad}$ = ………………

$V_{as} = 1.15 \times \left(\left(\dfrac{F_{box}}{F_s}\right)^2 - 1\right) \times V_{box}$ = 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 Z_{mh}	……………. Ohms.	……………. Ohms.
&		
H_i …............Hz	______ =	______ =
$Z_{fs} = \frac{V_s}{V_r}\ \frac{mV}{V}$	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

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

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

$$R_3 = R_e \qquad = \text{.....……......ohms.}$$

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	.... Ohms.	.... Ohms.
F_s	.... Hz.	.... Hz.
Crossover point: Z_{fs}	.... Ohms.	.... Ohms.
Z_t	……………… Ohms.	…………….. Ohms.
…...........Hz	____________ =	__________ =
Z_{fs} = $\frac{V_s}{V_r}$ $\frac{mV}{V}$	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 :

$$L4 = \frac{Z_w}{2\pi \times F_L \times 10^{-3}} * \mathbf{n} = \underline{\qquad\qquad} = \text{........................mH}$$

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

Midrange :

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

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

(Where $F_m = F_h \times F_L$ $= \frac{x}{\qquad}$ = ...mH

=...........x................

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

$$C2 = \frac{F_h - F_L}{\sqrt{2} \times \pi \times Z_{mL} \times f_m \times 10^{-6}} * \mathbf{n} = \underline{\qquad\qquad} =$$

= ________________ = ...uF

$$C3 = \frac{1}{\sqrt{2} \times \pi \times Z_{mh} \times (f_h - F_L) \times 10^{-6}} * \mathbf{n} = \frac{1}{\qquad} =$$

$= \frac{1}{\qquad}$ = ...uF

Tweeter :

$$L1 = \frac{Z_t}{2\pi \times F_h \times 10^{-3}} * \mathbf{n} = \underline{\qquad\qquad} = \text{.......................mH}$$

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

* 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	1^{st} order	2^{nd} 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

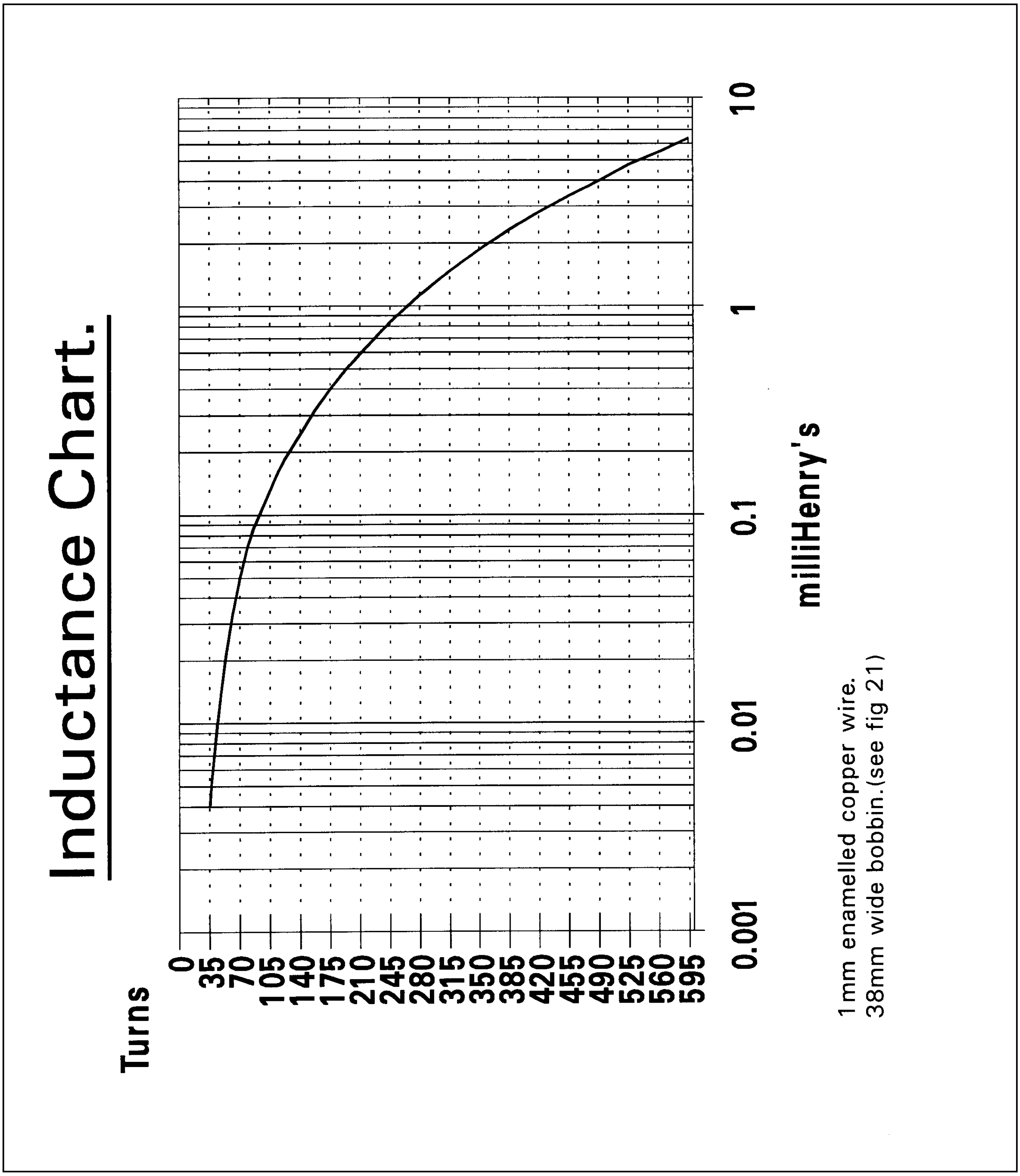
C7 = ……….…μF = …….…@…….…v ……...…@.……....v

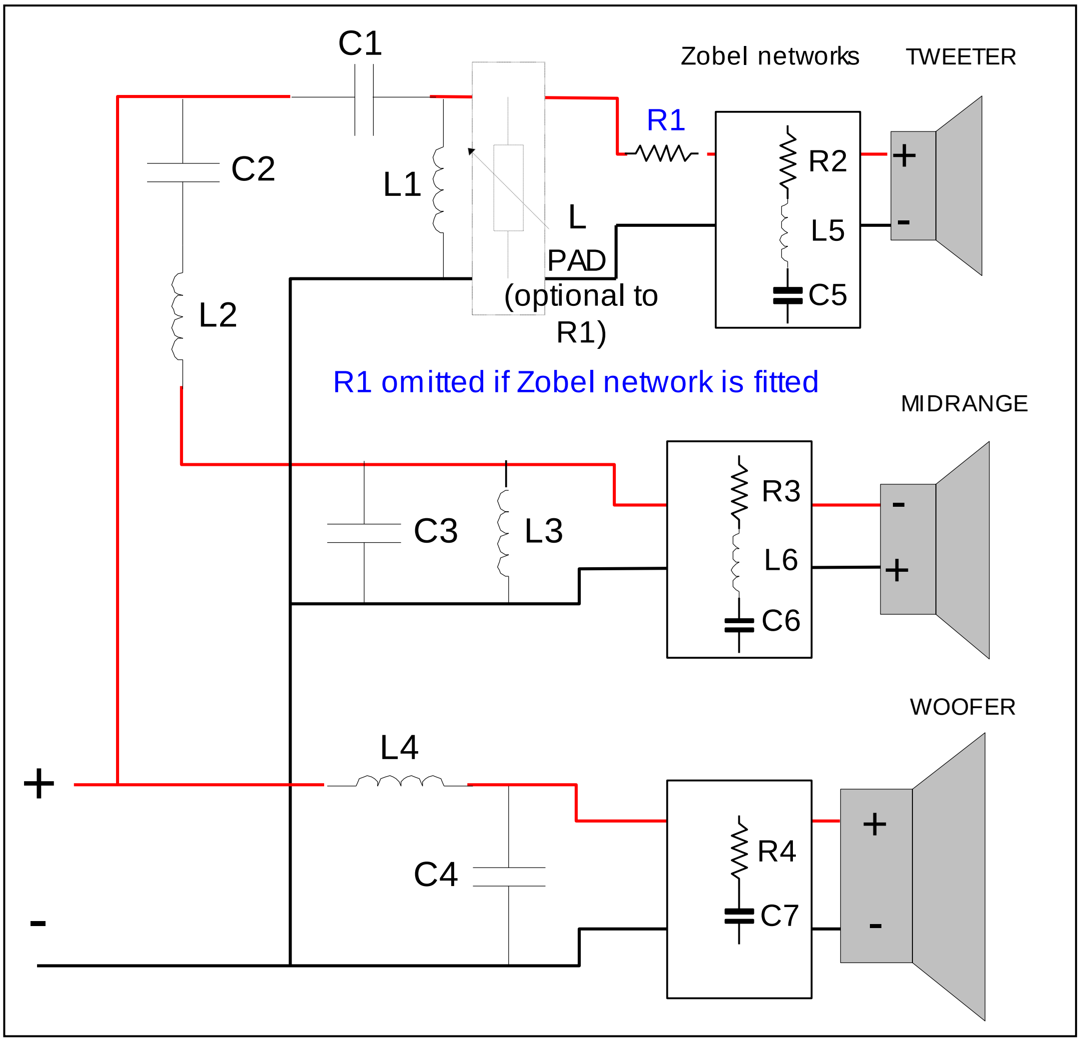
L4 = ……..…mH

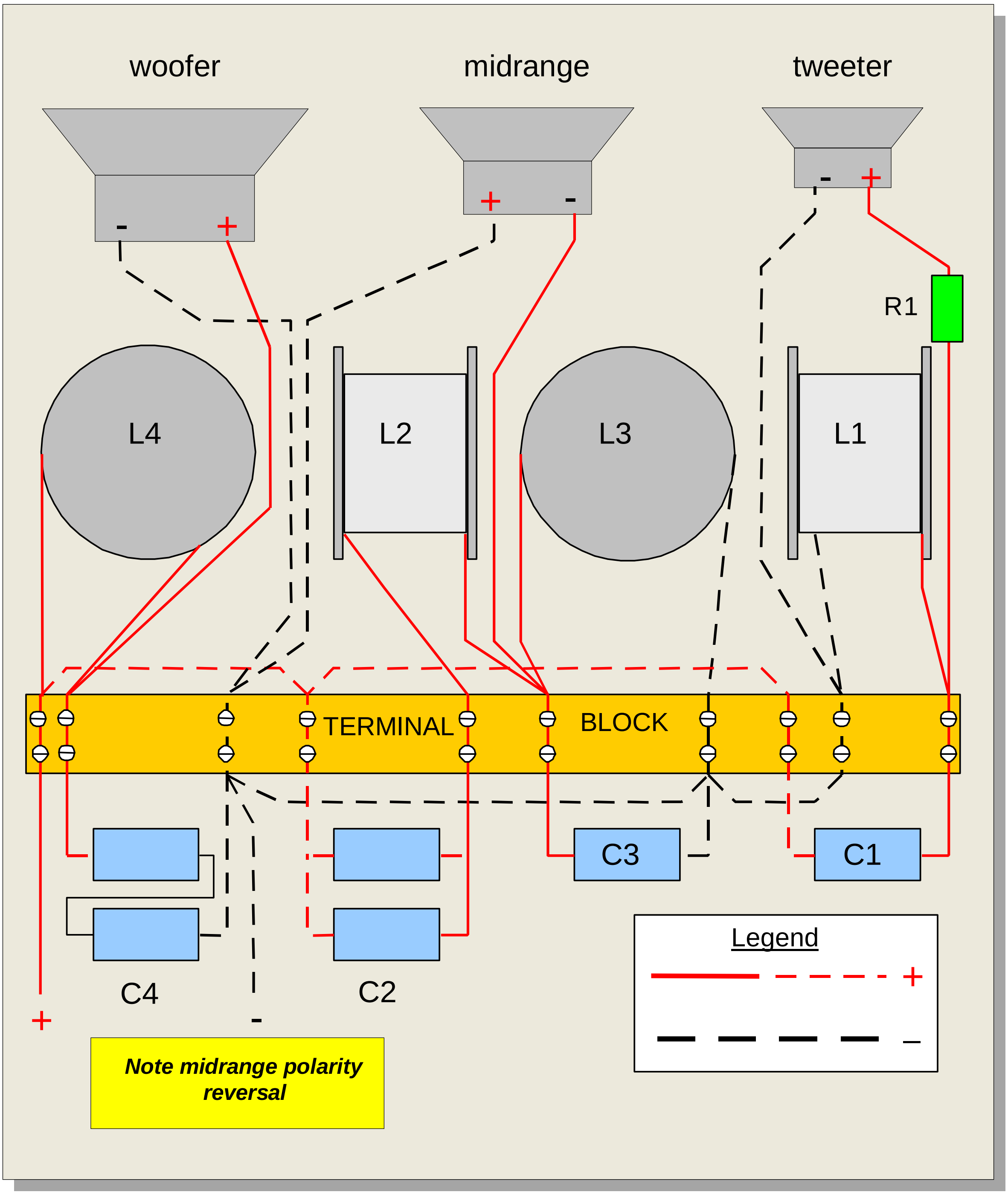
R4 = ……….…..Ω = ……..… ……..…

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
C2
L1
R1
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
+
-
Note midrange polarity reversal
Legend
+
–