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Design Tables for Low- and High-Pass Filters for the Reduction of TVI

By Mack Seybold,* W2RYI

Many a ham who likes to "build his own" gear will admit, without any hesitation, that he doesn't get much pleasure out of building a five-section, low-pass filter for his transmitter. And for some unknown reason, the very thought of constructing a multi-section, high-pass filter for the XYL's TV set always seems to help him muster up sufficient "negative enthusiasm" to postpone such a project!

W2RYI comes to the rescue with the following set of useful filter-design tables. As in his two previous HAM TIPS articles on filters, Mack Seybold has again made the difficult seem easy. To design a filter with the aid of the tables in this issue of HAM TIPS, all you need do is look in the tables for the type of filter you want. There you will find a schematic diagram and the actual values of L and C. No formulas are given, and no calculations are required. Armed with this data and the given sample mechanical-layout drawings, you'll surely agree that the difficult part of the job is behind you—only the bench work remains!

Novices and those hams who find this article to be their first encounter with high- and low-pass filters for TVI reduction should compare the curves in *Fig. 1* with those in *Fig. 2* to determine the basic difference in the performance of these two types of filters. A low-pass filter is placed in the transmission line between the amateur transmitter and the antenna system. It is designed to pass all signals in the amateur bands below 30 Mc, and to prevent the trans-

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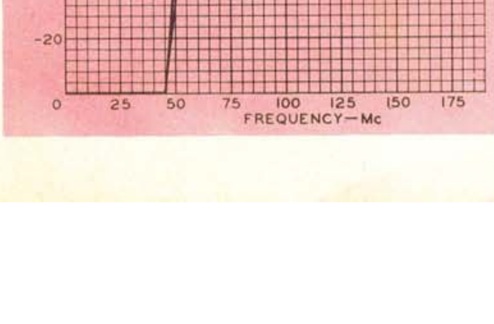


Fig. 1. Theoretical response curves for all of the low-pass filters in the tables. Attenuation below 45 Mc is negligible, and harmonic radiation above 54 Mc is attenuated 60 db or better, depending upon the number of sections in the filter. Complete shielding of the transmitter and filter is required to approach the response shown in these curves.

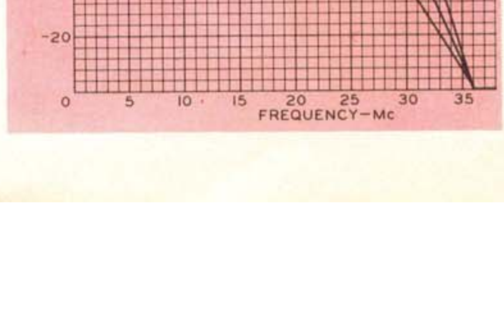


Fig. 2. Theoretical response curves for the high-pass filters in the tables. Attenuation above 36 Mc is negligible, permitting full-signal reception of television programs. Below 30 Mc, the two-, three-, and four-section filters have various attenuation peaks, and the choice for a particular installation is determined by the distance of the TV receiver from the amateur transmitter, the frequency and power of the transmitter, and the amount of filtering already present in the TV receiver.

mission of harmonics (that may be generated in the transmitter) above 45 Mc. A high-pass filter, placed in the transmission line at the "front end" of the TV receiver, does just the opposite; it passes the TV signals and attenuates all signals below 30 Mc. *Figures 1* and *2* also show the attenuation that is theoretically possible with various low- and high-pass filter structures.

Note that both series-derived filter designs and shunt-derived filters are shown in the tables. The shunt-derived, low-pass filter requires more capacitors and fewer coils than the series-derived structure.

Practical experience indicates that shunt-derived, high-pass filters have performed better than the series-derived types, probably because the signal to be attenuated comes down the feeder as a parallel standing wave and not a "transmission-line" signal; however, series-derived filters do work successfully in many installations. The latter are also easier to build and are, therefore, included in these tables.

To choose a filter design from the tables, select the configuration that matches the transmission line and produces the desired attenuation. After it has been decided what filter is best suited for the job, the values of components listed for that particular filter should be obtained from the appropriate table. The values of the components required to construct these filters are tabulated as completely-designed filters. The voltage rating for the capacitors is determined by the amount of rf to be handled. Above 200 watts input to the final amplifier of the transmitter, variable air-padder types are safest. Ceramic and mica capacitors are satisfactory for lower-powered rigs and for high-pass filters for TV receivers. Where fixed capacitors are used, select the nearest values that are commercially available and adjust the common-circuit coil inductance for the resonant frequency given in the table.

The coils for the low-pass filters can be wound with No. 12 copper wire. Directions for winding specific inductances are given in the February, 1953 issue of HAM TIPS. Coil dimensions for high-pass filters are given in the article entitled, "Design and Application of High-Pass Filters," in the Fall, 1950 issue of HAM TIPS.

Isolation of the various components (inductively and capacitively) is necessary to achieve maximum attenuation from both low-pass and high-pass filters. This isolation is accomplished by shielding as shown in *Figures 3* and *4*. If the number of sections in the desired filter is less

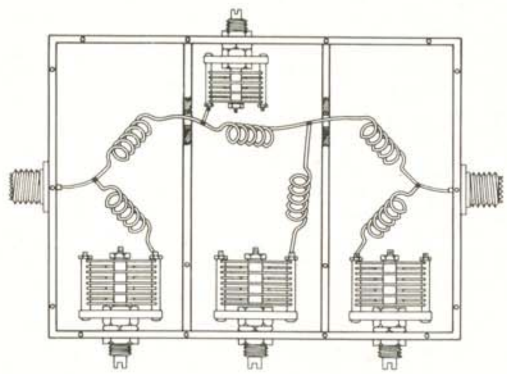


Fig. 3. Top view showing the arrangement of the parts in a three-section, series-derived, low-pass filter. The top and bottom plates of the shield box are not shown. When these plates are bolted into position, the shield box completely encloses the components. The shield box should be bolted to the transmitter cabinet where the transmission line emerges.

than five for a low-pass filter or four for a high-pass filter (the maximum number in the tables) and you feel that you may later wish to increase the number of sections, choose a shield box large enough to provide an extra compartment.

Other filter configurations and further details on construction are given in the articles mentioned above and in, "The Design of Low-Pass Filters," *QST*, Dec., 1949.

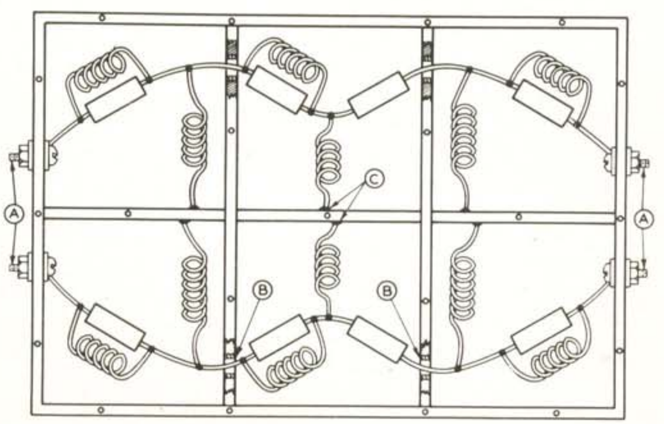
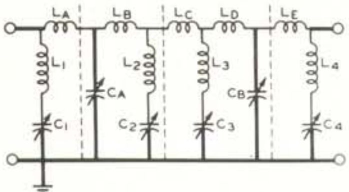
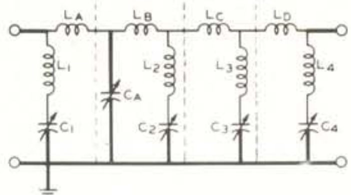


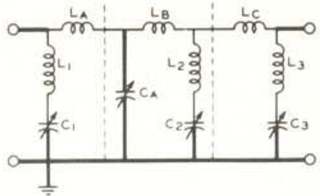
Fig. 4. Top view of a three-section, shunt-derived, balanced-line, high-pass filter. Insulated screws (A) can be used for connection to the transmission line, and insulated bushings (B) carry the connections between shielded sections. Grounded components are connected directly to the shield walls (C). The shield box should be bolted (or connected with a short copper strap) to the TV receiver chassis. Similar shielding is recommended for balanced-line, low-pass filters. High-pass filters will work without shielding, but additional sections are required to make up for the signal passed on from section to section by stray coupling.

Table I

Low-Pass Filters, Series Derived, for Coax Line (45-Mc Cut-off)







5 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	41	29	56
L_1	0.196	0.275	
C_2	87	62	58
L_2	0.087	0.122	
C_3	106	76	71
L_3	0.048	0.067	
C_4	41	29	57
L_4	0.196	0.275	
C_A	136	97	
C_B	136	97	
L_A	0.294	0.412	
L_B	0.301	0.422	
L_C	0.261	0.365	
L_D	0.328	0.460	
L_E	0.294	0.412	

4 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	41	29	56
L_1	0.196	0.275	
C_2	87	62	58
L_2	0.087	0.122	
C_3	106	76	71
L_3	0.048	0.067	
C_4	41	29	57
L_4	0.196	0.275	
C_A	136	97	
—	—	—	
L_A	0.294	0.412	
L_B	0.301	0.422	
L_C	0.261	0.365	
L_D	0.254	0.356	
—	—	—	

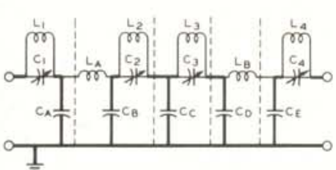
3 Sections

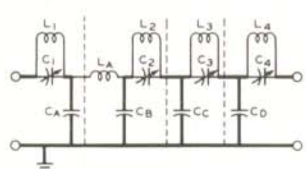
	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	41	29	56
L_1	0.196	0.275	
C_2	106	76	71
L_2	0.048	0.067	
C_3	41	29	57
L_3	0.196	0.275	
—	—	—	
—	—	—	
C_A	136	97	
—	—	—	
L_A	0.294	0.412	
L_B	0.328	0.460	
L_C	0.254	0.356	
—	—	—	
—	—	—	

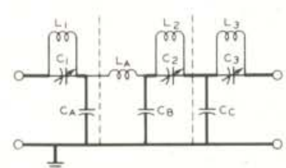
NOTE. In tables I through VII, C is in $\mu\mu f$ and L is in μh. The heavy lines represent short, low-inductance paths connecting the components. The dashed lines are shield compartment walls. (An unshielded low-pass filter is undesirable because harmonics may be radiated from the first or second section.)

Table II

Low-Pass Filters, Shunt Derived, for Coax Lines (45-Mc Cut-off)







5 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	73	53	56
L_1	0.11	0.154	
C_2	17	12	71
L_2	0.288	0.40	
C_3	33	24	58
L_3	0.231	0.32	
C_4	73	53	57
L_4	0.11	0.154	
C_A	109	79	
C_B	124	90	
C_C	100	72	
C_D	112	81	
C_E	109	79	
L_A	0.368	0.510	
L_B	0.368	0.510	

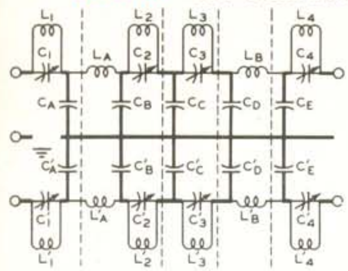
4 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	73	53	56
L_1	0.11	0.154	
C_2	17	12	71
L_2	0.288	0.40	
C_3	33	24	58
L_3	0.231	0.32	
C_4	73	53	57
L_4	0.11	0.154	
C_A	109	79	
C_B	124	90	
C_C	100	72	
C_D	85	61	
—	—	—	
L_A	0.368	0.510	
—	—	—	

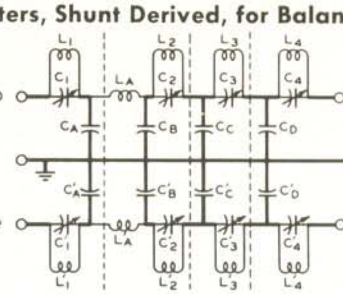
3 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	73	53	56
L_1	0.11	0.154	
C_2	17	12	71
L_2	0.288	0.40	
C_3	73	53	57
L_3	0.11	0.154	
—	—	—	
—	—	—	
C_A	109	79	
C_B	124	90	
C_C	97	70	
—	—	—	
—	—	—	
L_A	0.368	0.510	
—	—	—	

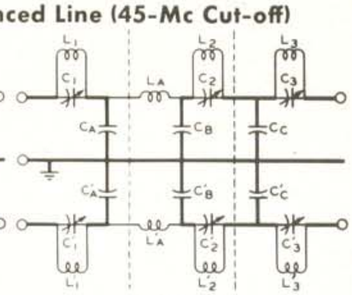
Table III Low-Pass Filters, Shunt Derived, for Balanced Line (45-Mc Cut-off)



5 Sections



4 Sections



3 Sections

5 Sections

	Trans. Line 100 (Ohms)	150	300	600*	Resonant Freq. (Mc)
C_1, C'_1	75	50	25	12.5	56
L_1, L'_1	0.107	0.16	0.32	0.635	
C_2, C'_2	18	12	6	3	71
L_2, L'_2	0.275	0.415	0.83	1.66	
C_3, C'_3	33	22	11	5.5	58
L_3, L'_3	0.225	0.34	0.66	1.33	
C_4, C'_4	75	50	25	12.5	57
L_4, L'_4	0.107	0.16	0.32	0.635	
C_A, C'_A	114	76	38	19	
C_B, C'_B	129	86	43	22	
C_C, C'_C	105	70	35	18	
C_D, C'_D	117	78	39	19	
C_E, C'_E	114	76	38	19	
—	—	—	—	—	
L_A, L'_A	0.35	0.53	1.06	2.12	
L_B, L'_B	0.35	0.53	1.06	2.12	

4 Sections

	Trans. Line 100 (Ohms)	150	300	600*	Resonant Freq. (Mc)
C_1, C'_1	75	50	25	12.5	56
L_1, L'_1	0.107	0.16	0.32	0.635	
C_2, C'_2	18	12	6	3	71
L_2, L'_2	0.275	0.415	0.83	1.66	
C_3, C'_3	33	22	11	5.5	58
L_3, L'_3	0.225	0.34	0.66	1.33	
C_4, C'_4	75	50	25	12.5	57
L_4, L'_4	0.107	0.16	0.32	0.635	
C_A, C'_A	114	76	38	19	
C_B, C'_B	129	86	43	22	
C_C, C'_C	105	70	35	18	
C_D, C'_D	87	58	29	15	
—	—	—	—	—	
L_A, L'_A	0.35	0.53	1.06	2.12	
—	—	—	—	—	

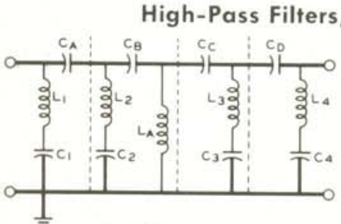
3 Sections

	Trans. Line 100 (Ohms)	150	300	600*	Resonant Freq. (Mc)
C_1, C'_1	75	50	25	12.5	56
L_1, L'_1	0.107	0.16	0.32	0.635	
C_2, C'_2	18	12	6	3	71
L_2, L'_2	0.275	0.415	0.83	1.66	
C_3, C'_3	75	50	25	12.5	57
L_3, L'_3	0.107	0.16	0.32	0.635	
—	—	—	—	—	
—	—	—	—	—	
C_A, C'_A	114	76	38	19	
C_B, C'_B	129	86	43	22	
C_C, C'_C	102	68	34	17	
—	—	—	—	—	
—	—	—	—	—	
L_A, L'_A	0.35	0.53	1.06	2.12	
—	—	—	—	—	

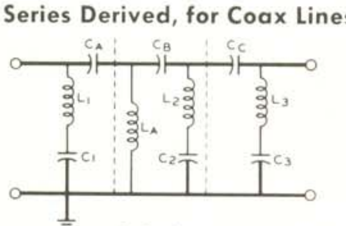
*600-ohm filters designed to cut off at 45 Mc are difficult to construct because of the low capacitance and high inductance of the components. Coils with low distributed capacitance must be employed, and care must be taken to mount the resonant sections away from shield walls.

Table IV

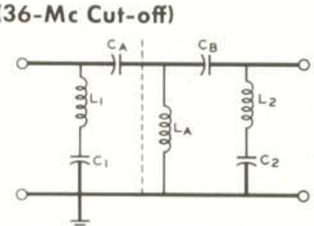
High-Pass Filters, Series Derived, for Coax Lines (36-Mc Cut-off)



4 Sections



3 Sections



2 Sections

4 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	79	57	29
L_1	0.38	0.53	
C_2	200	145	27
L_2	0.17	0.24	
C_3	400	290	21
L_3	0.14	0.20	
C_4	79	57	28.5
L_4	0.38	0.53	
C_A	66	48	
C_B	51	37	
C_C	47	34	
C_D	60	43	
L_A	0.11	0.16	

3 Sections

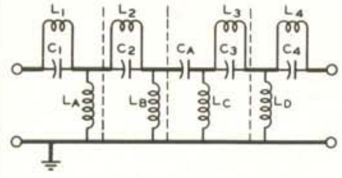
	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	79	57	29
L_1	0.38	0.53	
C_2	400	290	21
L_2	0.14	0.20	
C_3	79	57	28.5
L_3	0.38	0.53	
—	—	—	
—	—	—	
C_A	53	38	
C_B	47	34	
C_C	60	43	
—	—	—	
L_A	0.11	0.16	

2 Sections

	Trans. Line 52 (Ohms)	72	Resonant Freq. (Mc)
C_1	79	57	29
L_1	0.38	0.53	
C_2	79	57	28.5
L_2	0.38	0.53	
—	—	—	
—	—	—	
—	—	—	
—	—	—	
C_A	53	38	
C_B	53	38	
—	—	—	
—	—	—	
L_A	0.11	0.16	

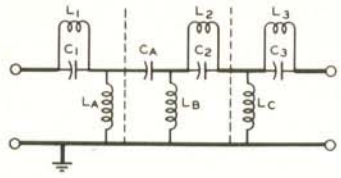
Table V

High-Pass Filters, Shunt Derived, for Coax Lines (36-Mc Cut-off)



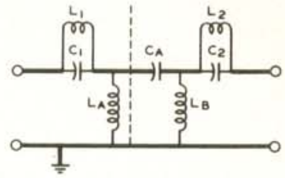
4 Sections

	Trans. Line 52 (Ohms)	Trans. Line 72 (Ohms)	Resonant Freq. (Mc)
C_1	141	102	29
L_1	0.21	0.30	
C_2	63	46	27
L_2	0.55	0.77	
C_3	52	38	21
L_3	1.09	1.51	
C_4	141	102	28.5
L_4	0.21	0.30	
L_A	0.18	0.25	
L_B	0.14	0.19	
L_C	0.12	0.17	
L_D	0.16	0.23	
C_A	42	30	



3 Sections

	Trans. Line 52 (Ohms)	Trans. Line 72 (Ohms)	Resonant Freq. (Mc)
C_1	141	102	29
L_1	0.21	0.30	
C_2	52	38	21
L_2	1.09	1.51	
C_3	141	102	28.5
L_3	0.21	0.30	
—	—	—	
—	—	—	
L_A	0.14	0.20	
L_B	0.12	0.17	
L_C	0.16	0.23	
—	—	—	
C_A	42	30	

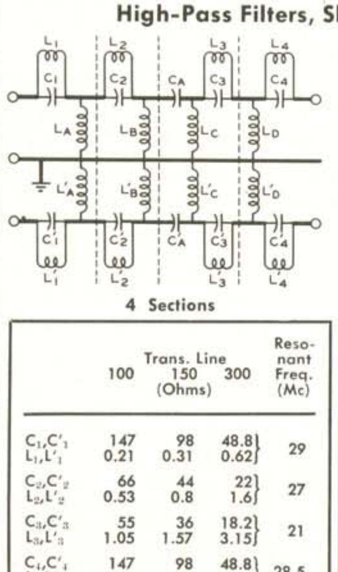


2 Sections

	Trans. Line 52 (Ohms)	Trans. Line 72 (Ohms)	Resonant Freq. (Mc)
C_1	141	102	29
L_1	0.21	0.30	
C_2	141	102	28.5
L_2	0.21	0.30	
—	—	—	
—	—	—	
—	—	—	
L_A	0.14	0.20	
L_B	0.14	0.20	
—	—	—	
—	—	—	
C_A	42	30	

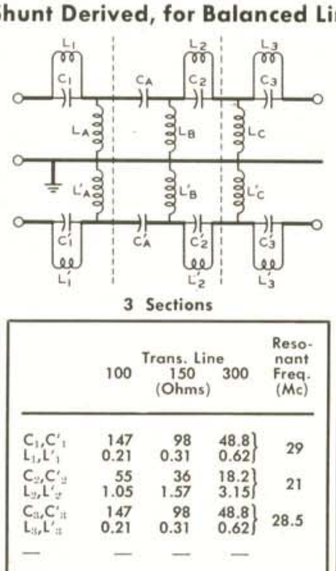
Table VI

High-Pass Filters, Shunt Derived, for Balanced Lines (36-Mc Cut-off)



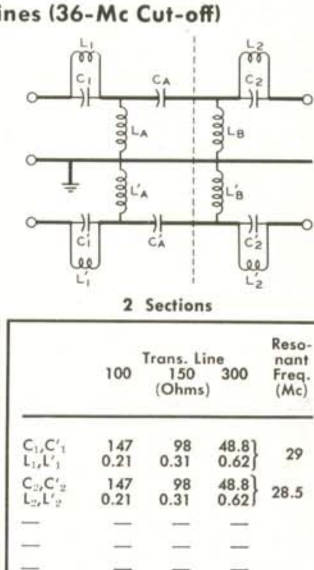
4 Sections

	Trans. Line 100 (Ohms)	Trans. Line 150 (Ohms)	Trans. Line 300 (Ohms)	Resonant Freq. (Mc)
C_1, C'_1	147	98	48.8	29
L_1, L'_1	0.21	0.31	0.62	
C_2, C'_2	66	44	22	27
L_2, L'_2	0.53	0.8	1.6	
C_3, C'_3	55	36	18.2	21
L_3, L'_3	1.05	1.57	3.15	
C_4, C'_4	147	98	48.8	28.5
L_4, L'_4	0.21	0.31	0.62	
L_A, L'_A	0.17	0.26	0.52	
L_B, L'_B	0.13	0.20	0.39	
L_C, L'_C	0.12	0.18	0.36	
L_D, L'_D	0.16	0.24	0.47	
C_A, C'_A	44	29	14.7	



3 Sections

	Trans. Line 100 (Ohms)	Trans. Line 150 (Ohms)	Trans. Line 300 (Ohms)	Resonant Freq. (Mc)
C_1, C'_1	147	98	48.8	29
L_1, L'_1	0.21	0.31	0.62	
C_2, C'_2	55	36	18.2	21
L_2, L'_2	1.05	1.57	3.15	
C_3, C'_3	147	98	48.8	28.5
L_3, L'_3	0.21	0.31	0.62	
—	—	—	—	
—	—	—	—	
L_A, L'_A	0.14	0.20	0.41	
L_B, L'_B	0.12	0.18	0.36	
L_C, L'_C	0.16	0.24	0.47	
—	—	—	—	
C_A, C'_A	44	29	14.7	

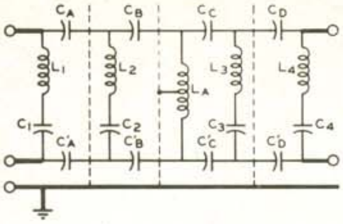


2 Sections

	Trans. Line 100 (Ohms)	Trans. Line 150 (Ohms)	Trans. Line 300 (Ohms)	Resonant Freq. (Mc)
C_1, C'_1	147	98	48.8	29
L_1, L'_1	0.21	0.31	0.62	
C_2, C'_2	147	98	48.8	28.5
L_2, L'_2	0.21	0.31	0.62	
—	—	—	—	
—	—	—	—	
—	—	—	—	
L_A, L'_A	0.14	0.20	0.41	
L_B, L'_B	0.14	0.20	0.41	
—	—	—	—	
—	—	—	—	
C_A, C'_A	44	29	14.7	

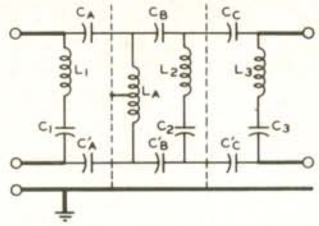
Table VII

High-Pass Filters, Series Derived, for Balanced Line (36-Mc Cut-off)



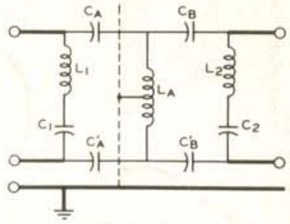
4 Sections

	Trans. Line 100 (Ohms)	150	300	Resonant Freq. (Mc)
C_1	41	27.4	13.7	29
L_1	0.73	1.1	2.2	
C_2	104	69.6	34.8	27
L_2	0.33	0.5	1.0	
C_3	210	140	70	21
L_3	0.27	0.41	0.818	
C_4	41	27.4	13.7	28.5
L_4	0.73	1.1	2.2	
C_A, C'_A	69	46	23	
C_B, C'_B	53	35.2	17.6	
C_C, C'_C	49	32.4	16.2	
C_D, C'_D	62	41.6	20.8	
L_A	0.22	0.33	0.66	



3 Sections

	Trans. Line 100 (Ohms)	150	300	Resonant Freq. (Mc)
C_1	41	27.4	13.7	29
L_1	0.73	1.1	2.2	
C_2	210	140	70	21
L_2	0.27	0.41	0.818	
C_3	41	27.4	13.7	28.5
L_3	0.73	1.1	2.2	
—	—	—	—	
—	—	—	—	
C_A, C'_A	55	37	18.4	
C_B, C'_B	49	32.4	16.2	
C_C, C'_C	62	41.6	20.8	
—	—	—	—	
L_A	0.22	0.33	0.66	



2 Sections

	Trans. Line 100 (Ohms)	150	300	Resonant Freq. (Mc)
C_1	41	27.4	13.7	29
L_1	0.73	1.1	2.2	
C_2	41	27.4	13.7	28.5
L_2	0.73	1.1	2.2	
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
C_A, C'_A	55	37	18.4	
C_B, C'_B	55	37	18.4	
—	—	—	—	
—	—	—	—	
L_A	0.22	0.33	0.66	

TMK(S)

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Joseph Pastor, Jr., W2KCN
Editor

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