FL1 LOW PASS FILTERS

Broadband amplifiers, by definition, provide little, if any, suppression of harmonic energy. The output of the amplifier will contain harmonics of the input signal. Thus, if direct operation into an antenna is expected, filtering of the amplifier output is necessary to meet FCC regulations for spectral purity. A five element, low pass filter will provide more than sufficient harmonic attenuation. The low pass filter will attenuate signals above the desired output frequency.

Filter Design

The five element, low pass filter design is derived from information contained in the ARRL Handbook. The filter schematic is shown in Figure 1. The various filter parameters are shown in Table 1. The capacitance values derived for C1 and C2 are not standard values for some of the filters. In order to achieve the closest value for the filter, standard values are placed in parallel. Provision has been made on the PC board to accommodate the parallel values. When a capacitance value requires parallel values, the capacitors are identified as C1A and C1B for the parallel combination of C1. C2A and C2B are the parallel combination of C2. These combinations are shown in Table 2.

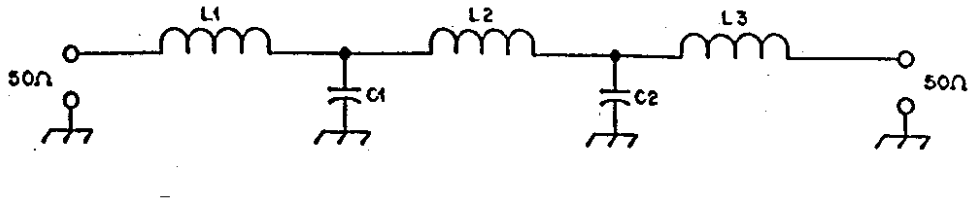

Figure 1 - FL1 Schematic Diagram

Table 1 – FL1 Filter Parameters

BAND	F_{cutoff}	L1,L3			L2			C1,C2
(meters)	(MHz)	(uH)	No. of Turns	Toroid	(uH)	No. of Turns	Toroid	(pf)
160	2.1	8.1	23	T-106-2	11.4	28	T-106-2	1653
80	4.1	4.1	16	T-106-2	5.8	20	T-106-2	847
40	7.4	2.3	12	T-106-2	3.2	14	T-106-2	470
20	14.450	1.18	9	T-106-6	1.65	11	T-106-6	240
15	21.550	0.79	7	T-106-6	1.11	8	T-106-6	161
10	29.8	0.57	6	T-106-6	0.80	7	T-106-6	117

Table 2 – Parallel Capacitance Values

	Desired Value	Parallel Values			
BAND	**C1, C2**	**C1A**	**C1B**	**C2A**	**C2B**
(meters)	**(pf)**	**(pf)**	**(pf)**	**(pf)**	**(pf)**
160	1653	1500	150	1500	150
80	847	820	27	820	27
40	470	470	--	470	--
20	240	240	--	240	--
15	161	110	51	110	51
10	117	100	18	100	18

Construction Hints

The effective inductance of a toroid coil depends in part on the distributed capacitance between the coil turns and between the ends of the winding. The distributed capacitance should be kept as low as possible. The pictorial illustration in Figure 2 show the inductor turns distributed uniformly around the toroid core, but a gap of approximately 30 degrees is maintained between the ends of the winding. This method is recommended to reduce the distributed capacitance of the winding. The closer the ends of the winding are to one another, the greater the unwanted capacitance. Also, in order to achieve the desired toroid inductance, the winding should be spread over the core as shown in Figure 2.

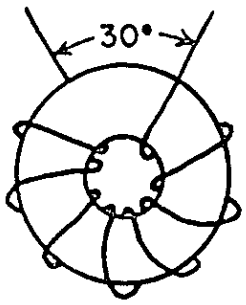

Figure 2 – Toroid Winding Pictorial

The proper method for counting the turns on a toroidal inductor is shown in Figure 3. The core is shown as it would appear when stood on its edge with the narrow dimension toward the viewer. In this example, a four-turn winding has been placed on the core.

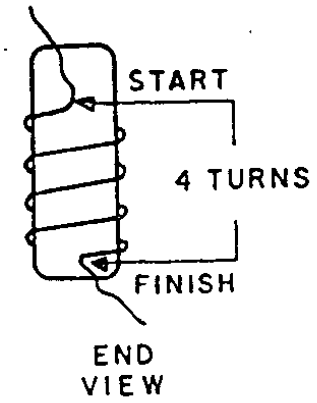

Figure 3 – Toroid Turns Counting Pictorial

Filter Construction

The construction of the filter is fairly simple but requires some care. A component layout pictorial is shown in Figure 4. For identification purposes, the foil side of the PC board is the bottom. The components are placed on the topside of the PC board and soldered on the bottom. The PC board is the same for all frequency bands. The toroid cores are identified by the color of the core. The T-106-2 is gray in color and the T-106-6 is yellow.

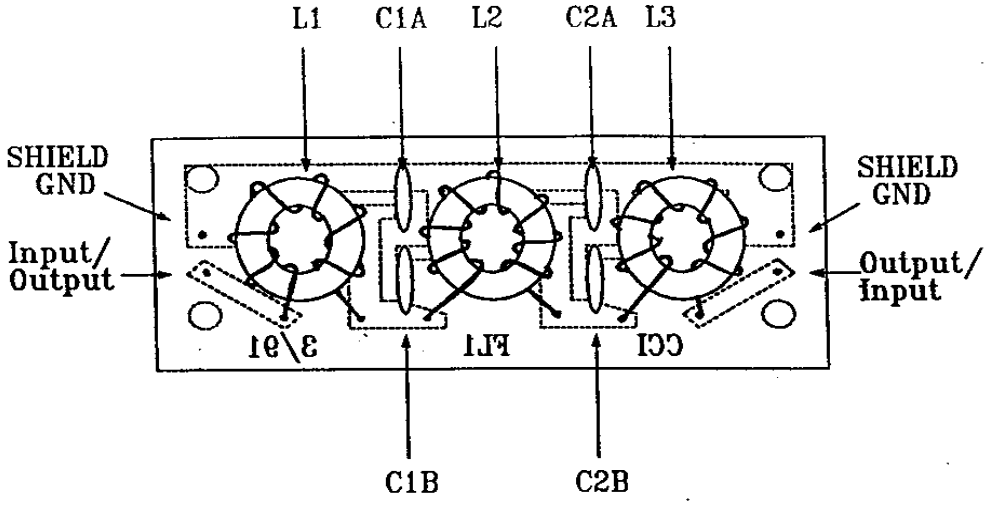

Figure 4 – Component Layout Pictorial

The capacitors C1 (or C1A and C1B) and C2 (or C2A and C2B) should be mounted on the PC board first. Refer to Table 2 for the proper values and the component layout pictorial in Figure 4 for proper placement. Next wind the toroid with the proper number of turns using the #18 AWG enameled wire included. The wire should follow the contour of the core and be snug. Refer to Figure 2 for the proper number of windings and the construction hints for the toroid winding procedures. After winding the toroids, scrape off enough of the enamel coating on the wire for soldering purposes. Then mount and solder the toroid to the PC board. The toroid is mounted to the PC board using a 4-40 x ¾ inch bolt and KEP nut with a large fiber washer. Refer to the toroid mounting pictorial in Figure 5.

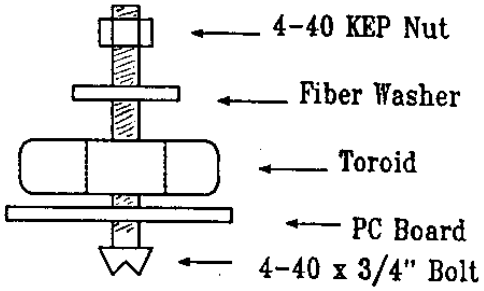

Figure 5 – Toroid Mounting Pictorial

Since the filter circuit is symmetrical, the input and output can be reversed. 50 ohm coax should be used for the connections as shown in the component layout pictorial in Figure 4. The shield of the coax should connect to the large ground foil on the PC board. The filter should be connected as close as possible to the output of the power amplifier. This distance should be 6 inches or less. Connect the filter between the output of the amplifier and the antenna as shown in Figure 6. No tuning of the filter is necessary if care is exercised in the construction.

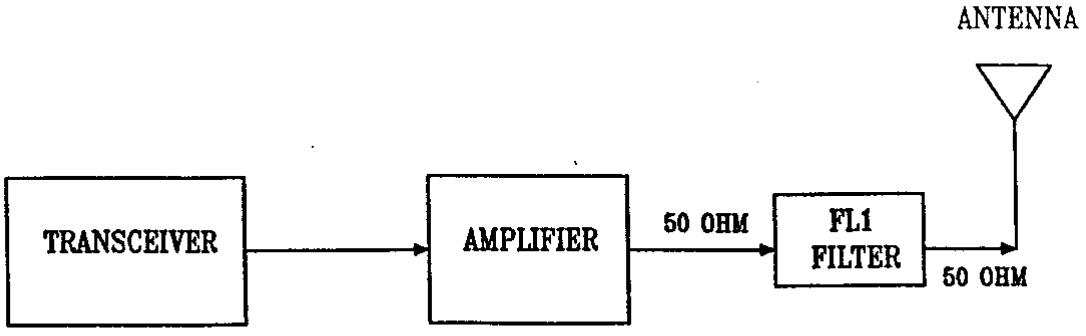

Figure 6 – Filter Installation

Filter Parts List

160 Meter Filter Board Part Number FL1-160	
3 each	T-106-2 Toroid Cores
2 each	1500 pf Silver Mica Capacitors 500 WVDC
2 each	150 pf Silver Mica Capacitors 500 WVDC
3 each	60 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)

80 Meter Filter Board Part Number FL1-80	
3 each	T-106-2 Toroid Cores
2 each	820 pf Silver Mica Capacitors 500 WVDC
2 each	27 pf Silver Mica Capacitors 500 WVDC
3 each	40 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)

40 Meter Filter Board Part Number FL1-40	
3 each	T-106-2 Toroid Cores
2 each	470 pf Silver Mica Capacitors 500 WVDC
3 each	28 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)

20 Meter Filter Board Part Number FL1-20	
3 each	T-106-6 Toroid Cores
2 each	240 pf Silver Mica Capacitors 500 WVDC
3 each	22 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)

15 Meter Filter Board Part Number FL1-15	
3 each	T-106-6 Toroid Cores
2 each	110 pf Silver Mica Capacitors 500 WVDC
2 each	51 pf Silver Mica Capacitors 500 WVDC
3 each	18 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)

10 Meter Filter Board Part Number FL1-10	
3 each	T-106-6 Toroid Cores
2 each	100 pf Silver Mica Capacitors 500 WVDC
2 each	18 pf Silver Mica Capacitors 500 WVDC
3 each	15 inches #18 AWB enameled wire
3 each	4-40 x ¾" bolt
3 each	4-40 Kep Nut
3 each	Fiber Washer
1 each	PC Board (FL1)