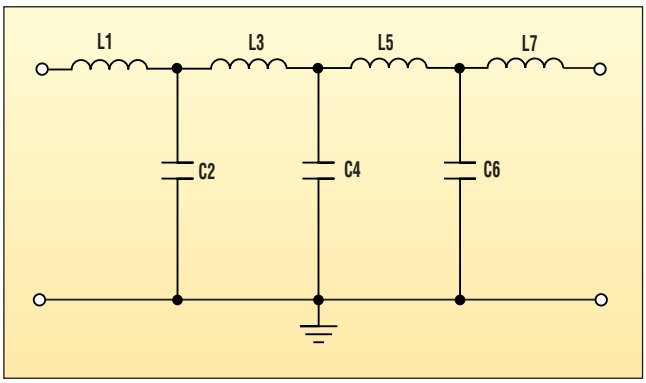
Circle 520

Low-Cost Prototyping For VHF Circuits

RICHARD M. KURZROK
RMK Consultants, 82-34 210th St., Queens Village, NY 11427;
(718) 776-6343; fax (718) 776-6087

Below 10 MHz, the realization of engineering models is fairly straightforward and not critically dependent on pc-board layout. At VHF, parasitic circuit elements and spurious coupling can wreak havoc with attempts to achieve performance at low cost without design iterations. In this article, a passive VHF low-pass filter is presented that can be quickly designed, constructed, and tested. The techniques discussed also apply to active circuits.



1. This seven-pole low-pass filter is designed for a passband ripple of 0.003 dB at a nominal 3-dB cutoff frequency of 74 MHz.

The seven-pole low-pass filter has been designed for a passband ripple of 0.003 dB at a nominal 3-dB cutoff frequency of 74 MHz *(Fig. 1)*. The source and load impedances are 50 Ω. The circuit elements are shown in Table 1.

The low-pass filter was constructed on a microstrip transmission line on a single-clad vector board. The vector board is mounted on male/female spacers in a Bud CU-123 die-cast aluminum box. The input and output connectors are Pomona 2451 BNC panel jacks.

The vector board uses a 0.062-in. thick epoxy-glass substrate with a hole grid of 0.1 in. The microstrip conductor pattern is obtained using copper-foil shielding tape *(Fig. 2)*, which can be cut using scissors and an "X-acto" knife. The microstrip ground pattern uses the copper-clad side of the vector board *(Fig. 3)*.

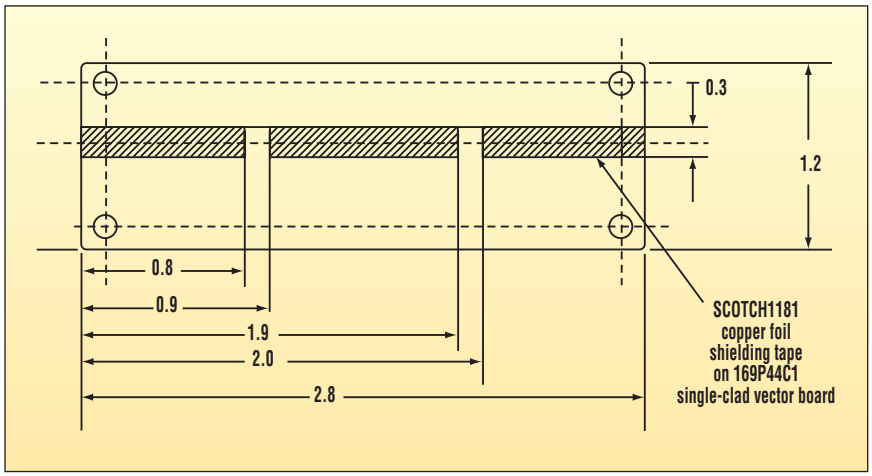
Filter components are soldered to the conductor and ground patterns in different ways. The interior inductors L3 and L5 are soldered to the conductor pattern via surface mounting. The exterior inductors L1 and L7 have one lead surface-mounted to the conductor pattern, while the other lead is soldered to the BNC connectors. To effectively absorb stray lead inductance, the number of turns for L1 and L7 has been reduced from six to five (all toroids are from Micro Metals).

The shunt capacitors C2, C4, and C6 each have one lead surface-mounted to the conductor pattern. The other lead of each capacitor passes through the substrate and is soldered to the ground pattern.

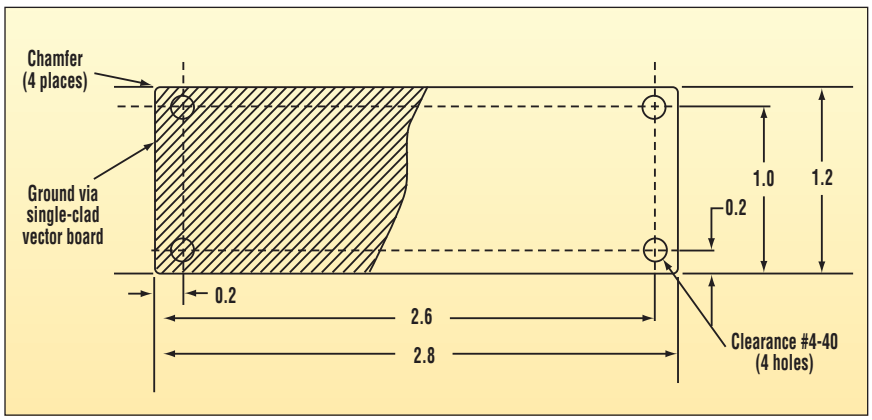
When soldering to the copper foil of the conductor pattern, use of excessive heat must be avoided. A 25-W soldering iron should be used.

When comparing the computed and measured amplitude responses *(Table 2)* for the low-pass filter, it can be observed that a reasonable correlation was obtained. The unloaded Qs of the inductors are approximately 100. The dissipation in the capacitors has been neglected.

For production units, the low-pass filter would probably employ surface-mounted



2. The microstrip conductor pattern is created using copper foil tape on single-clad vectorboard.



3. The microstrip ground is provided by the single-clad copper side of the vector board.

chip components with etched conductor patterns. The low-pass filter also can be realized as a tubular filter.

As the filter frequency approaches the UHF range, different connectors, different substrates, and etched components need to be employed. These connectors would provide microstrip launchers and all microstrip discontinuities will need to be addressed. ❐

TABLE 1: CIRCUIT ELEMENTS FOR LOW-PASS FILTER

Circuit Element	Value	Realization
L1, L7	0.087 µH	6 Turns #26 AWG on T25-17 Toroid
L3, L5	0.210 µH	9 Turns #26 AWG on T25-17 Toroid
C2, C6	68 pF	50-V CA10 axial ceramic unit
C4	82 pF	50-V CA10 axial ceramic unit

TABLE 2: LOW-PASS FILTER AMPLITUDE RESPONSES

Frequency (MHz)	L-dB for Q_{UL}=50	L-dB for Q_{UL}=100	L-dB (Measured)
0	0.46	0.23	----
7.4	0.46	0.23	----
14.8	0.47	0.24	0.2
22.2	0.48	0.24	0.2
29.6	0.49	0.25	0.25
37.0	0.52	0.26	0.25
44.4	0.55	0.27	0.25
51.8	0.60	0.30	0.3
59.2	0.69	0.34	0.5
66.6	1.08	0.63	0.6
74.0	3.99	3.50	3.2
81.4	10.7	10.37	11.8
88.8	17.8	17.6	20.5
111.0	34.9	34.8	32.1
125.8	43.8	43.7	41.8