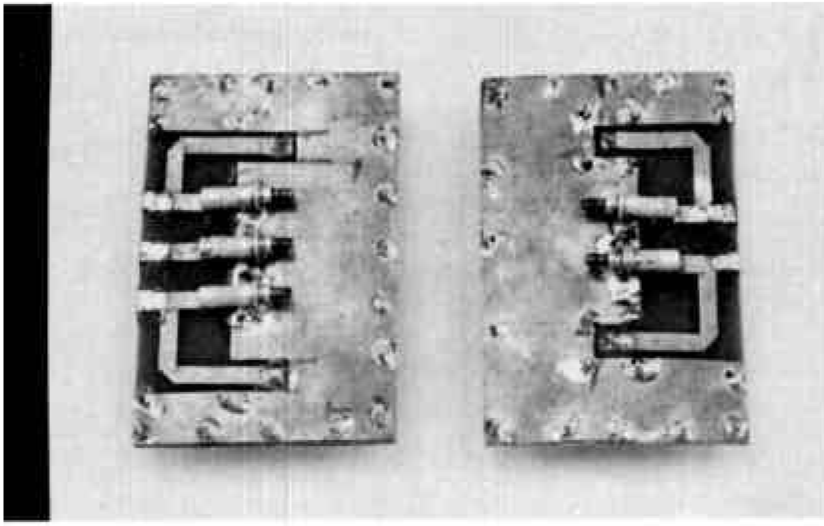

microstripline bandpass filters for 1296 MHz

Miniature bandpass filters for the amateur 1296-MHz band

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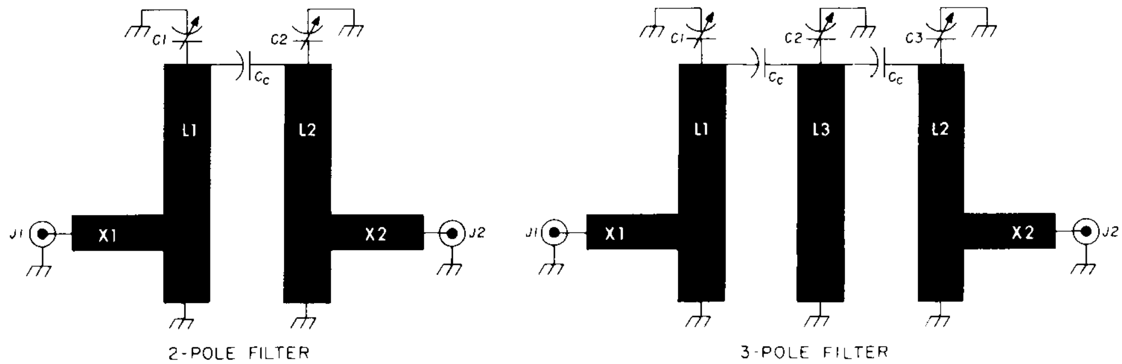
Uhf experimenters frequently need to filter out spurious or image responses, usually with coaxial or trough-line resonators.[1-5] Although properly designed coaxial and trough-line filters offer exceptional skirt selectivity and minimum insertion loss, they are large and bulky and require access to sheet-metal cutting and forming equipment. The 1296-MHz filters presented here are based on printed-circuit microstripline techniques and are easily duplicated in the home workshop.

Two- and three-pole bandpass filters for 1296 MHz are shown schematically in **fig. 1**. In each of the filters parallel-resonant sections, consisting of microstripline inductors and piston trimmer capacitors, are loosely top coupled. The input and output striplines are tapped down on the inductors to provide a match to 50 ohms. The two-pole bandpass filter is functionally equivalent to the filters used at the input of the RF and LO ports of my 1296-MHz double-balanced mixer.[6] In the design presented here, however, the coupling capacitor, C_c, formerly a 0.5 pF chip capacitor, has been replaced by the stray coupling capacitance between the stator ends of trimmers C1 and C2.

As can be seen from the swept frequency response curve in **fig. 2**, these microstripline filters are relatively low-Q devices. The steepness of the rejection skirts may be sacrificed somewhat to minimize passband insertion loss, which for this design averages around 1 dB.

construction

Full-size artwork for the printed-



C1-C3	1-5 pF ceramic piston trimmer
C_c	Stray coupling capacitance between stator ends of trimmer capacitors
J1, J2	SMA or equivalent microstripline launchers (E. F. Johnson 142-0248-001 or similar)
L1, L2, L3	Microstripline inductor, 0.5" (13mm) long, 0.1" (2.5mm) wide, spaced 0.3" (7.5mm) center to center. Bottom ends strapped to groundplane with thin copper strap
X1, X2	50 ohm microstripline, 0.1" (2.5mm) wide, any length. Centerline tapped to L1 and L2 0.2" (5mm) from grounded end

fig. 1. Two- and three-pole microstripline bandpass filters which tune the range from 1100 to 1500 MHz. Full-size printed-circuit layouts for these filters are shown in fig. 3.

circuit microstripline filters is shown in **fig. 3** and is designed for 1/16 inch (1.5mm) thick G-10 epoxy-glass printed-circuit board, double clad with 1 ounce copper.* The unetched side of the board serves as a groundplane. Board dimensions are such that the filters mount easily in a miniature die-cast aluminum box such as a Pomona 2417. The cutaway view of **fig. 4** shows the method of mounting the piston trimmer capacitors on the circuit board.

With the circuit values shown, these filters can be adjusted to resonate anywhere in the range between 1100 and 1500 MHz. The easiest method to adjust for resonance at 1296 MHz is to connect a weak-signal source through the filter into a receiver, and adjust the trimmer capacitors for maximum received signal. Since the output impedance of the signal source and the input impedance to the receiver may deviate substantially from 50 ohms, it's a good idea to temporarily install fixed attenuators at the input and output of the filter while tuning as shown in **fig. 5**. There is a certain amount of interaction between the trimmer capacitors so the adjust-

*Tuned and tested two- and three-pole bandpass filters for 1296 MHz are available from Microcomm. For complete specifications and prices, send a self-addressed, stamped envelope to Microcomm, 14908 Sandy Lane, San Jose, California 95124.

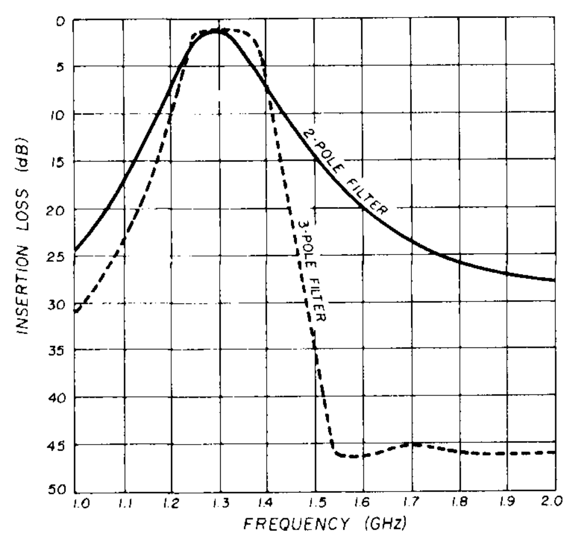


fig. 2. Swept frequency response of the two- and three-pole microstripline filters (measured with a Hewlett-Packard network analyzer and X-Y plotter). The 3 dB bandwidth is 150 MHz and passband insertion loss is about 1 dB. The 20-dB bandwidth is 320 MHz for the 3-pole filter, 570 MHz for the two-pole design.

ments should be repeated several times to insure that you have the filters tuned for minimum insertion loss.

If the filter is to be used to reduce the spurious output of a local-oscillator chain, alignment to the desired passband frequency is most easily accomplished by placing the filter in the line between the LO and the mixer and adjusting the filter for maximum indicated mixer current (**fig. 6**).

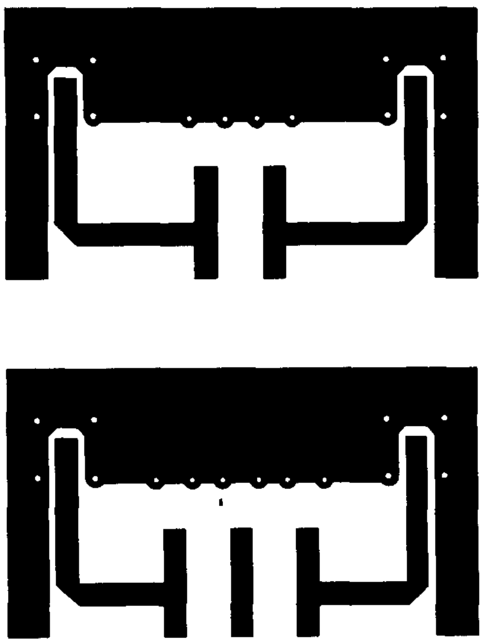


fig. 3. Full-size artwork for the two- and three-pole bandpass filters for 1296 MHz which are designed for 1/16" (1.5mm) double-clad G-10 epoxy-glass circuit board.

applications

Most amateurs who are active on 1296 MHz will probably want to have several of these bandpass filters available on their workbench. In general, accurate measurements on any two-port device are enhanced by the application of filtering at each port. Microstripline amplifiers, for example, tend to be extremely broadband; since transistors tend to have higher gain at lower frequencies, any low-frequency spurious which is applied to the amplifier will be amplified more than the desired in-band signals. It is not unlikely, in fact, for lower frequency, out-of-band signals to actually force an amplifier into gain compression. Bandpass filters at the input and output of an amplifier under test will thus aid considerably in making accurate gain and dynamic range measurements.

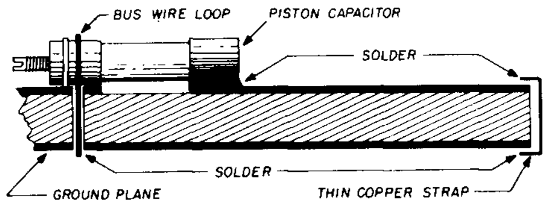


fig. 4. Method of mounting the piston trimmer capacitors on the microstriplines.

In operational equipment it's a good idea to place bandpass filters between each wideband stage as shown in **fig. 7**. The filter's 1 dB or so of insertion loss is more than offset by the elimination of image signals and spurious responses. For maximum image rejection it is recommended that the more selective three-pole filter be installed between all active stages. In the local-oscillator chain, where harmonically related spurious signals are separated from the passband by an octave or more, the simpler two-pole resonators are usually sufficient.

acknowledgements

I would like to thank Marvin Wahl, W6FUV, for critiquing the design of these filters, and Stu Rumley, WB6LOU, for assisting in the swept-frequency response measurements.

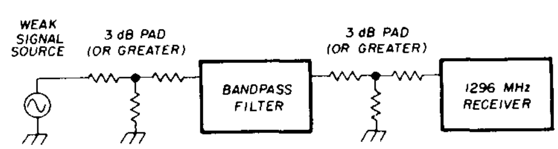


fig. 5. Using a weak-signal source to align a filter to 1296 MHz. The 3 dB attenuators swamp out any impedance mismatches.

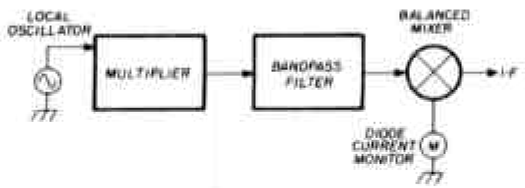


fig. 6. Bandpass filter can be adjusted to the local-oscillator output frequency by tuning the filter for maximum mixer current.

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ham radio

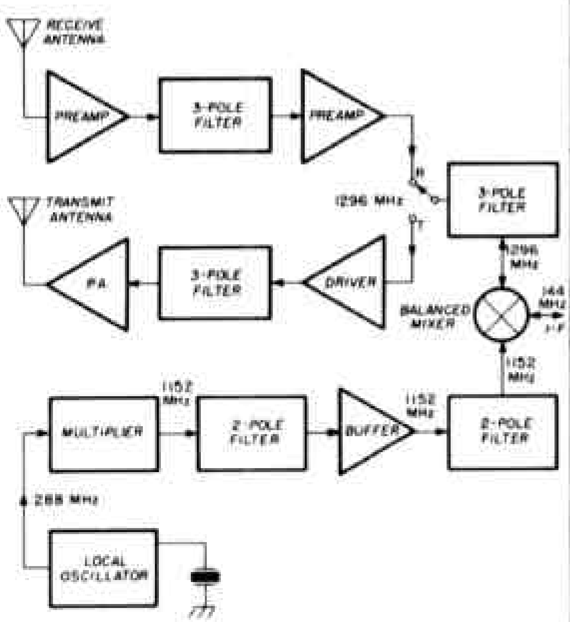

fig. 7. Installation of bandpass filters in a typical 1296-MHz transmitter and receiver. Three-pole filters are recommended between active stages, as discussed in the text.