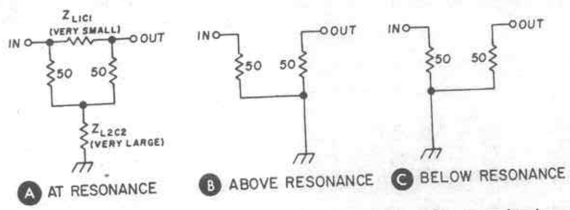

fig. 2. Equivalent circuit of the 50-ohm vhf terminator at resonance (A), above resonance (B), and below resonance (C).

resistors, as shown in **fig. 2A**. Thus the insertion loss of the network at resonance is minimal (due primarily to component losses in the resonant circuits).

At frequencies far above resonance, capacitors C1 and C2 appear as short circuits, and inductors L1 and L2 appear open. Thus the circuit is equivalent to that shown in **fig. 2B**, with input and output isolated from one another, and each port terminated in a 50-ohm load.

Well below the resonant frequency, both capacitors appear open, the two inductors may be thought of as short circuits, and the equivalent circuit of **fig. 2C** applies. Again, maximum isolation exists between the two ports, and each is terminated in 50 ohms.

A less clearly defined condition exists at frequencies slightly removed from resonance. Isolation is incomplete and the transfer coefficient is a function of circuit Q. Thus the selectivity characteristics of a single-pole band-pass filter are achieved. However, non-propagated signal components are not reflected, as would be the case with a simple resonant circuit. Rather, they are absorbed by the 50-ohm loads, giving the interstage network its wide-band terminating properties. Since reflected waves are not evident from either port, bilateral out-of-band isolation has been achieved.

determining circuit Q

Assuming minimum dissipative losses in the reactive components, circuit Q is primarily a function of the ratio of the reactances at resonance to the terminating impedance (50-ohms in this case). Selecting a desired circuit Q, component reactances at resonance are found from:

$$X_{L1} = X_{C1} = 50Q$$

$$X_{L2} = X_{C2} = 50/Q$$

Ideally, any desired circuit Q could be selected, and component values derived. Practical considerations, however, restrict practical values of Q to 10 or less. Higher Q is possible if passband insertion loss is not a significant consideration, but this usually requires that variable capacitors be used to set the network to resonance at the desired frequency. With lower values of Q, fixed components of standard values may be used with minimum circuit degradation.

The required Q is a function of the amount of out-of-band isolation which is desired, as well as the frequency separation between the signal and spurious components. It is useful to relate isolation requirements to ripple bandwidth, which is defined as center frequency divided by Q. As a rule of thumb, isolation is 10 dB for frequency components separated from resonance by ±3BW and 20 dB of isolation is achieved at the center frequency ±10BW.

In receiving converters, when terminating the i-f port of a balanced mixer, the rf feedthrough, LO feedthrough, and image frequency components may be separated from the i-f signal frequency by an order of magnitude or more. In such cases a Q of one may be entirely adequate to effectively isolate all spurious components. (Incidentally, a Q of unity is the only case for which C1 = C2 and L1 = L2).

Improperly terminated uhf preamplifiers, on the other hand, often tend to oscillate in the vhf spectrum (a common occurrence with Microcomm's RA-70, 432-MHz preamplifier, for example). Therefore, the terminator following a preamplifier should exhibit relatively high Q so it will provide adequate isolation at the frequency of potential instability, thus suppressing oscillation. An acceptable compromise seems to favor a Q of about 5. Insertion loss thus remains low (fractions of a dB), selectivity is moderate, and components have practical values and are non-critical.

Table 1 lists actual component values for terminators operating at various i-f and rf frequencies of interest to radio amateurs, assuming a circuit Q of 5. At the lower frequencies the circuits may be built successfully by using disc capacitors and either miniature molded rf chokes or hand-wound toroidal inductors. In the uhf region, the use of chip capacitors and microstripline inductors seems more appropriate. Of course, as frequency is increased, lead lengths must be kept to a minimum.

table 1. Interstage 50-ohm terminator component values (Q = 5) for various vhf and uhf amateur bands.

	frequency (MHz)						
	10.7	28	50	144	222	432	1296
L1 (nH)	3720	1420	796	276	179	92	30.7
C1 (pF)	59.5	22.7	12.7	4.4	2.9	1.5	0.5
L2 (nH)	149	56.8	31.8	11.1	7.2	3.7	1.2
C2 (pF)	1490	568	318	111	71.7	36.8	12.3

acknowledgements

I wish to thank Gary Frey, W6KJD, for bringing this terminator circuit to my attention, explaining its operation to me, and calculating the component values presented in **table 1**. And I owe a special thanks to Stan Savage, W6ABN; his frustration in fighting oscillations in not one, but two Microcomm preamplifiers, convinced me of the importance of providing an effective, broad-band impedance match.

references

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