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A Simple Active Equivalent to a Lattice Pulse-Slimming Filter

In a recent article by Sierra,[1] a symmetrical constant-resistance lattice (Fig. 1) was proposed as the realization of a passive pulse-slimming filter. A fourth-order realization contains four reactive elements in each of four lattice arms. The component values of the filter must be accurately bridged to obtain optimum results.

An active filter can be derived (Fig. 2) which has the same transfer function but uses only one leg of the original lattice together with a phase-splitter circuit. The nominal element values of the impedance leg Z_a are determined from the theory given by Sierra; the individual elements may then be "tuned" experimentally for optimum performance while the filter output is observed on an oscilloscope. In many cases the desired result can be achieved merely by adjusting R_0. Source and termination impedances are not a problem, since isolation is provided by the two transistors.

In the following calculation, the transfer function of the filter in Fig. 2 is shown to be equivalent to that of the symmetrical lattice:

$$V_2/V_1 = \frac{[1/(R_{s1} + Z_a)] - (1/R_0)}{[1/(R_{s1} + Z_a)] + (1/R_0) + (1/R_L)}.$$

For $R_L \gg R_0 \gg R_{s1}$ this expression reduces to $V_2/V_1 = (R_0 - Z_a)/(R_0 + Z_a)$, which is the transfer function of the constant-resistance lattice. The approximations involved are not difficult to achieve in practice.

Figure 1 **Lattice filter.**
$e_2/e_1 = (R_0 - Z_a)/(R_0 + Z_a)$;
$Z_a Z_b = R^2_0$.

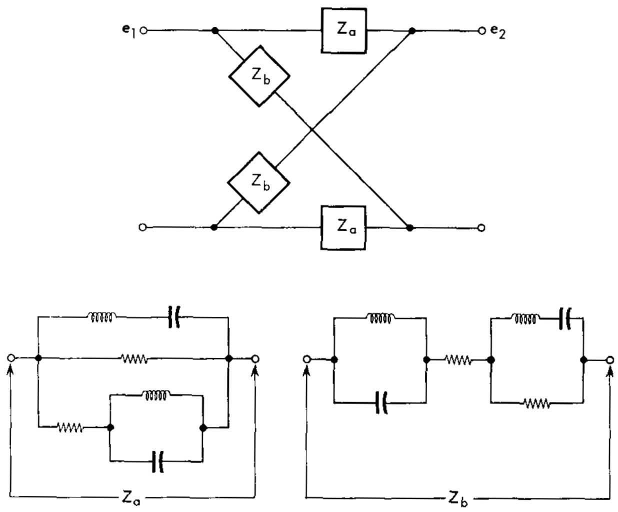
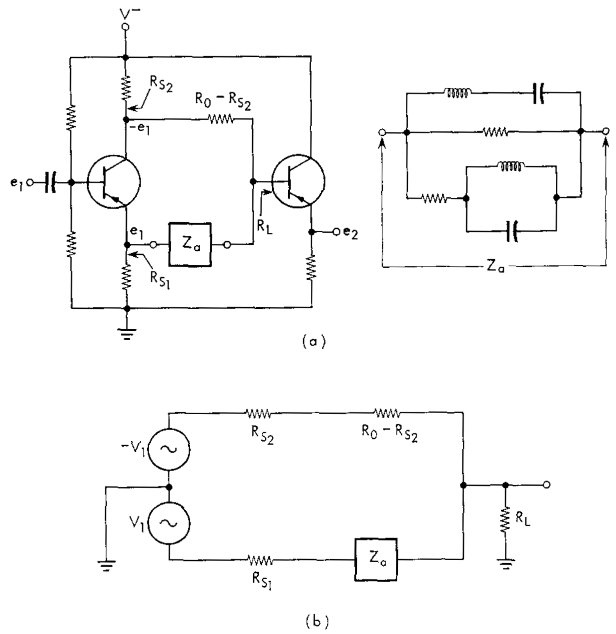


Figure 2 **a) Modified lattice filter.**
$e_2/e_1 \simeq (R_0 - Z_a)/(R_0 + Z_a)$
b) Equivalent circuit for modified filter.



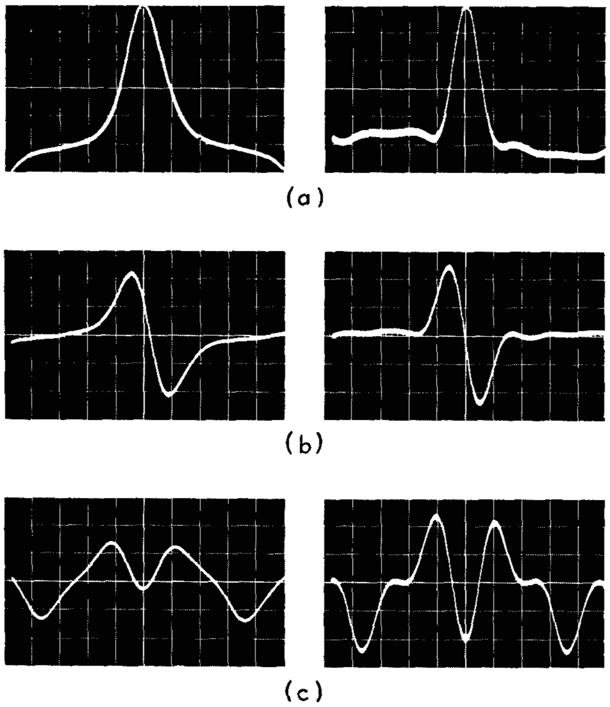


Figure 3 **Effect of pulse slimming combined with termination compensation and phase correction on inside-track pulses of terminated IBM 1301 head.** *Filters at fixed setting for best over-all results from inside and outside tracks. Photos on left: After phase correction and termination compensation. Photos on right: After pulse slimming. a) 1 μsec/div. b) 1100 kbps, 00011000, 1 μsec/div. c) 1100 kbps, 00111001, 1 μsec/div.*

The results obtained using this type of filter on an IBM 1301 head-disk assembly designed for 625 kbps operation (8 percent peak shift on the inside track) are shown in Fig. 3. Since the filter requires a symmetrical pulse with no overshoots for best results, the actual readback waveform is preprocessed by a phase correction and termination compensation network[2] to achieve the symmetrical filter input waveform shown in the Figure.

Acknowledgments

The phase-splitter technique, as applied to this problem, is an extension of earlier work in the design of constant-delay filters by Schlaepfer and Melas[3] and Calfee.[4]

References

1. H. M. Sierra, "Increased Magnetic Recording Readback Resolution by Means of a Linear Passive Network," *IBM Journal* **7**, 22-33 (1963).
2. R. M. Bennett, P. D. Dodd and C. E. Schlaepfer, "Electronic Compensation of Ringing Caused by Magnetic Readback Head Load," *IBM Technical Disclosure Bulletin*, December 1962, p. 44.
3. Unpublished work.
4. R. W. Calfee, unpublished report.

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