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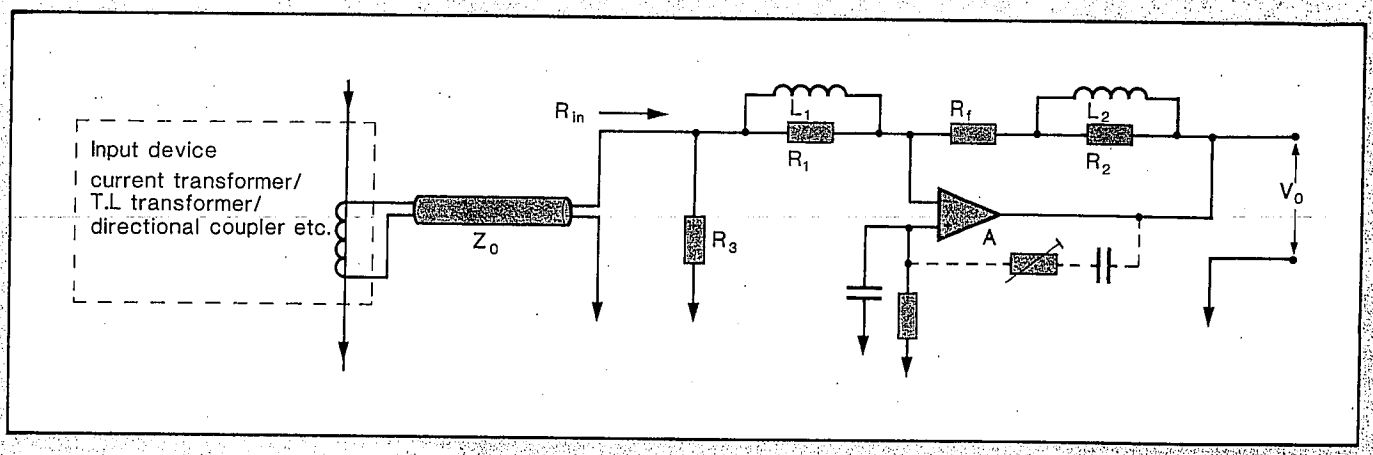

Extension of LF response of pulse transformers

Broad band transmission line inductive components are often used in small signal pulse processing circuits such as current transformers, pulse inverters, directional couplers, etc. The high frequency (HF) response is limited by line losses while the low frequency (LF) response is limited by the inductance of the device. Typically, a 1mH component when used in a circuit of 50 Ohm characteristic impedance would exhibit a L/R time constant of 30μsec, and could be used with pulses up to 1–5μsec. The circuit shown in the figure can be used to extend the low frequency response of such a device so that it is suitable for use well into the msec range.

The principle of operation is to feed the device output into an input which is correctly terminated only at HF and arrange the input impedance to fall to zero at LF thereby increasing the L/R time constant. Such a frequency sensitive termination is provided by R1, R3, L1 along with the virtual earth input of A. In this way the input step is correctly terminated for times slightly longer than the device and cable transit times. The resultant shelf type output frequency response is "straightened out" with a complementary feedback network (Rf, R2, L2). Two conditions must be satisfied:

$$\frac{Rf}{L2}=\frac{R3}{L1} \quad \text{and} \quad \frac{Rf+R2}{L2}=\frac{R3+R1}{L1}$$

The recent availability of very wide band, high slew rate operational amplifiers (e.g. Comlinear Corporation CLC220) has made this method practical, i.e. that the virtual earth is established quickly and the input match is preserved for the first 20–50nsec, depending on the transit time (L1 is typically a few μH). Using such an approach, a risetime of approximately 2nsec is readily obtained. The oscillograms on the lower part of the figure show the sort of improvement which can be achieved on a coaxial current probe (Tektronix CT3). Ultimately the LF response is limited by the finite open loop gain of A and the interconnection resistance. This resistance can also be cancelled by introducing a small negative resistance at LF through the use of positive feedback (shown dotted in Fig. 1). In this case a response down to a few Hz can be obtained.

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