Delay line eases comb-filter design

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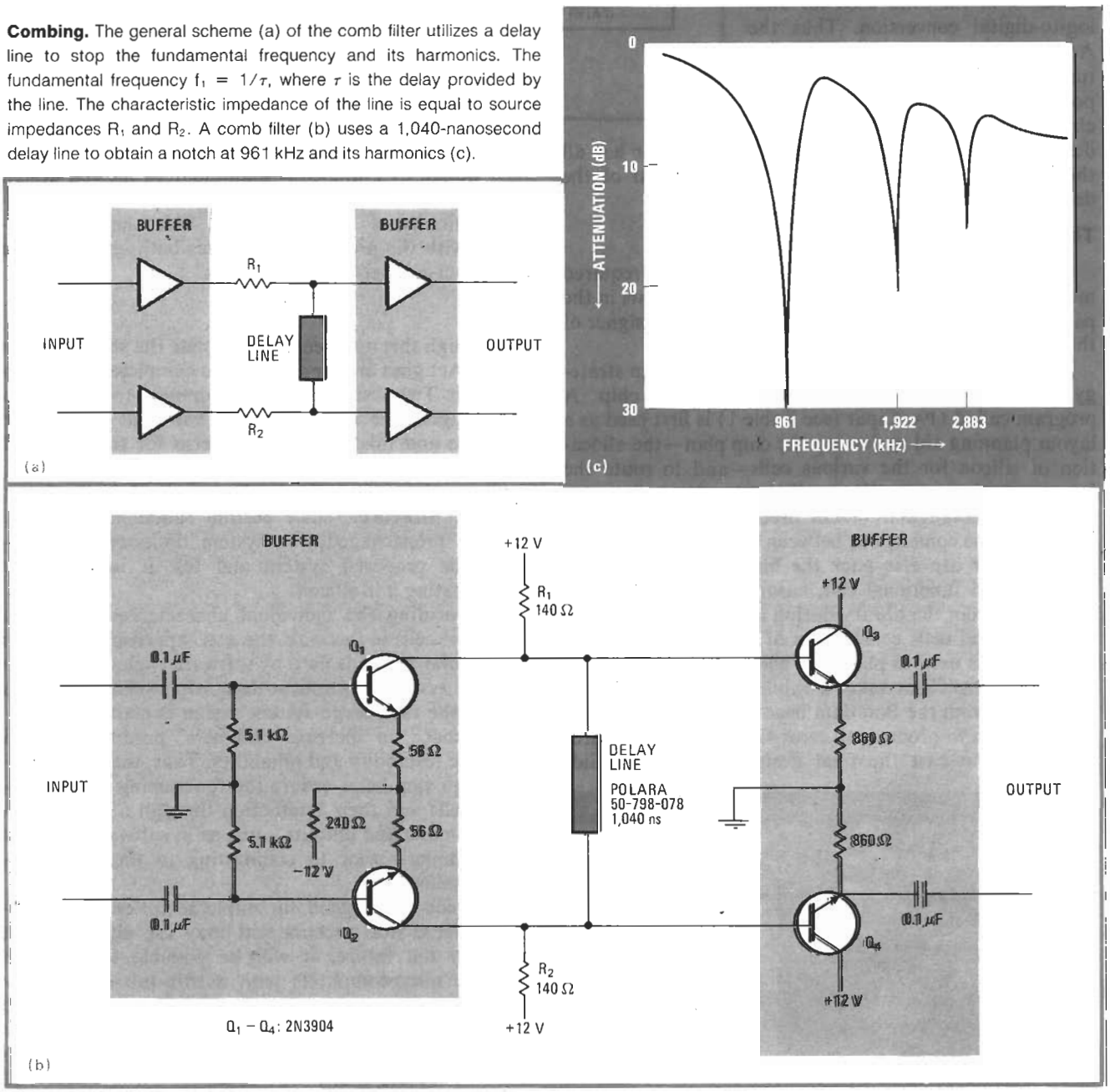
Designing a multiple-frequency notch filter with standard band-stop transfer functions is complicated and tedious because the process needs repeating. In addition, filter matching is difficult for sections with different band-stop frequencies. Through exploiting the characteristics of a delay line, this comb filter is easily realized and provides a band-stop response for a fundamental frequency and its harmonics. The fundamental frequency corresponds to the delay time of the delay line.

The general scheme of the filter (a) shows that the delay line with a delay τ and characteristic impedance R is driven by and equals matched impedance sources R_1 and R_2. Use of input and output buffers in the circuit is optional. The fundamental frequency where the first notch occurs is $f_1 = 1/\tau$. Other band stops occur at $f_2 = 2/\tau$, $f_3 = 3/\tau$, and so on. Related to the rise time of the delay line, the filter's bandwidth determines how many

Combing. The general scheme (a) of the comb filter utilizes a delay line to stop the fundamental frequency and its harmonics. The fundamental frequency $f_1 = 1/\tau$, where τ is the delay provided by the line. The characteristic impedance of the line is equal to source impedances R_1 and R_2. A comb filter (b) uses a 1,040-nanosecond delay line to obtain a notch at 961 kHz and its harmonics (c).



harmonic frequencies will be attenuated. If the rise time of the line is faster, the bandwidth is wider, and therefore the stop-band range is higher.

This comb filter (b) is designed for a fundamental notch frequency of 961 kilohertz. The delay time of the delay line is 1,040 nanoseconds. Transistors Q_1 and Q_2 serve as input buffers, with Q_3 and Q_4 serving as output buffers. A degradation occurs in the attenuation of higher harmonics (c) and can be attributed to the rise time of the delay line. The magnitude of stop-band attenuation at higher frequencies can be improved by using a delay line with a faster rise time. □