

## [Emerging Device Technology](#) > Delay Line Filters

A delay line (transversal) filter is a delay line which carries out a filtering function at the same time as delaying a signal. The EDT group has pioneered it in a form of a long transmission line with series of impedance steps forming a line with non-uniform width. This delay line filter is very interesting because it can produce almost any phase and amplitude response and the bandwidth can exceeds 100%.

Figure 1 shows a block diagram of the delay line filter. A signal is input at the left, and proceeds through the delay line sections, the delayed replicas of the input signal are being tapped, which are multiplied by different constant  $w_n$  and then added to give the output.

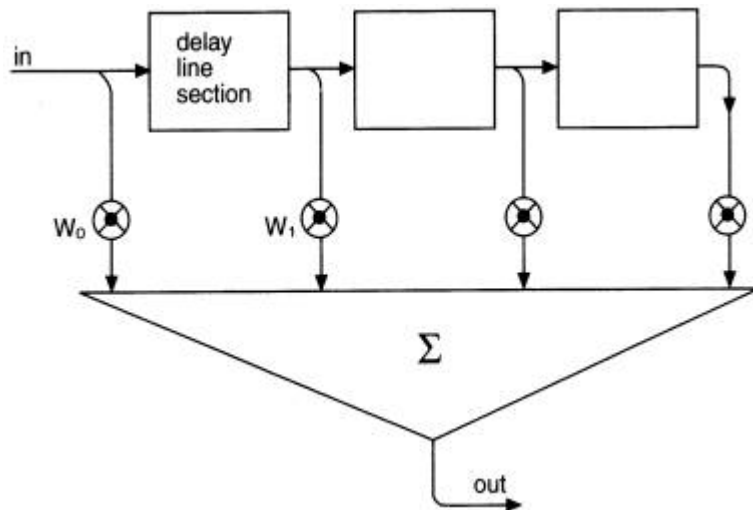


Figure 1 Block diagram of a delay line (transversal) filter

A new synthesis method of this delay line filter has been developed successfully within the group, which used an inverse scattering algorithm to compute the geometric configurations from the specified transmission coefficients, both in magnitude and phase. Consequently, two devices have been demonstrated. They are linear phase and quadratic phase (chirp) delay line filters, both were implemented using reflective method. Here the impedance step acts as a reflector or as a multiplier  $w_n$  in the transversal filter (Figure 1), by allowing a constant proportion of the input signal to reach the output.

Figure 2 shows the layout of a linear phase delay line filter. It is a spiral microstrip line; the non-uniform line sections, which actually consist of many small impedance steps are not visible. The structure was fabricated using a 1-inch square MgO substrate with YBCO deposited on both sides. The centre frequency is at 10GHz with a bandwidth of 4GHz and a group delay of 1ns. The measured response is shown in Figure 3. Note that it has almost a constant group delay over the passband width.

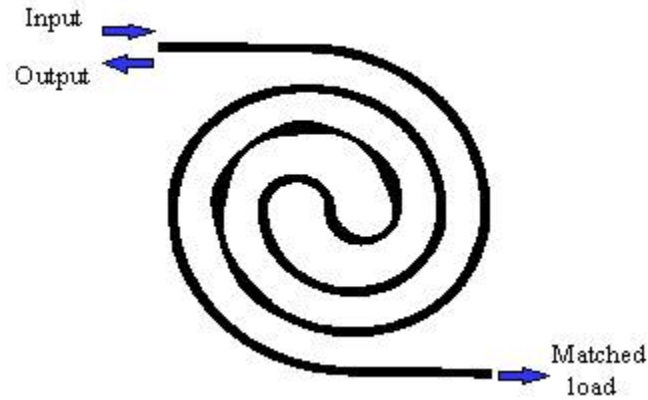


Figure 2 Layout of a linear phase delay line filter

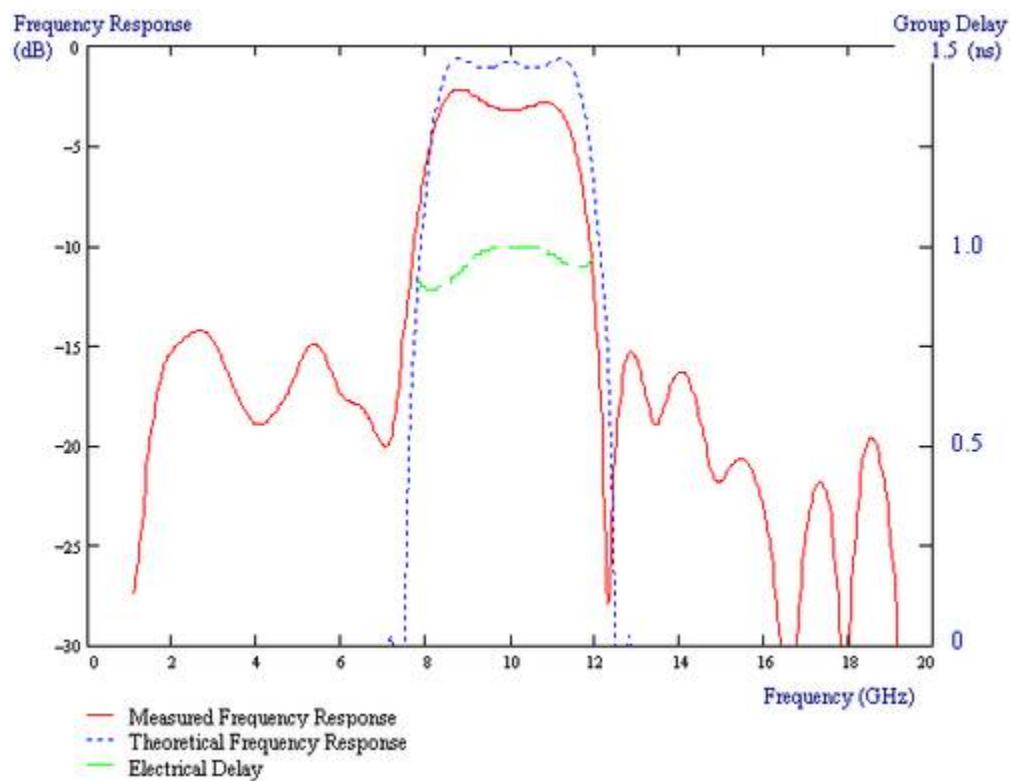


Figure 3 Measured performance of a linear phase delay line filter

For quadratic phase delay line filter, the structure is similar to that of a linear phase delay line filter except that the series of the impedance steps are now different. Figure 4 shows an example of a measured group delay of a quadratic phase delay line filter. The inset shows the layout of the microstrip delay line filter. Note that the group delay is a linear function over a wide frequency band and has been accurately produced. The filter has a centre frequency at 8GHz and a bandwidth of 10GHz (125%).

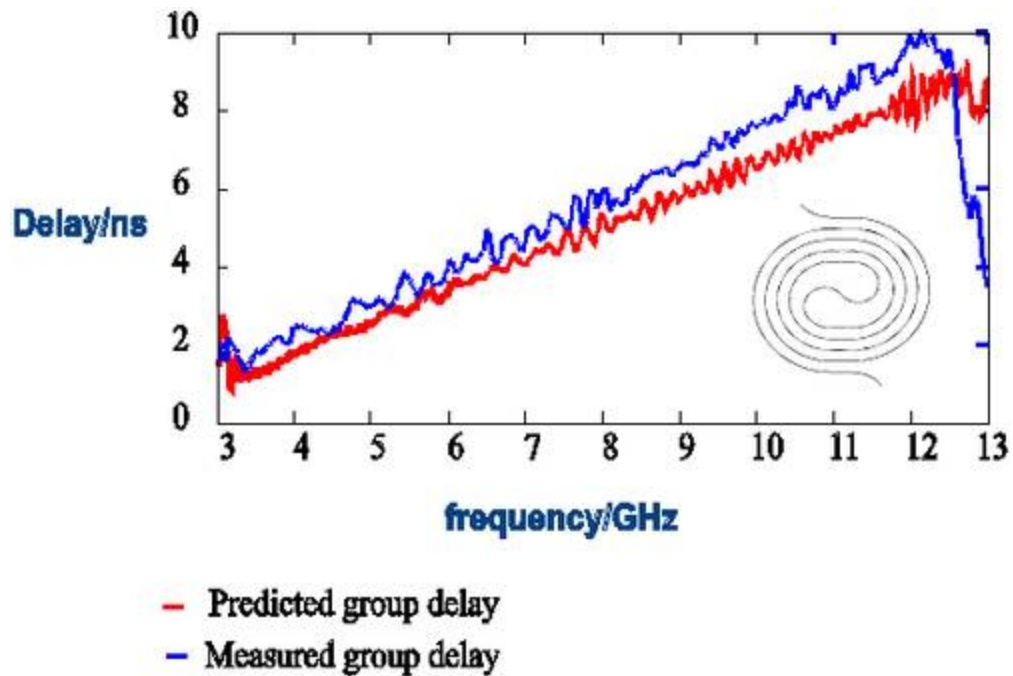


Figure 4 Measured group delay of a quadratic phase delay line filter

One important application of filters with specified phase characteristics is the chirp filter, implemented for example using high temperature superconductor (HTS) in a cueing receiver. Other useful applications include spectrum analyser and pulse compression receiver.