[Emerging Device Technology](#) > **Superconducting Delay Lines**

A delay line consists of a long transmission line, which delays a microwave signal over a wide bandwidth. Ideally, the output should be a replica of the input signal but delayed by a certain time. It is a useful device for signal storage and processing. More advanced delay lines can perform a filtering or signal processing function and are so called delay line transversal filters.

Delay lines are important components both in electronic warfare and communication systems. Specific applications are Cueing Receiver, Digital Instantaneous Frequency Measurement (DIFM) subsystem and Beam-Steering Antenna Arrays. For instance, Figure 1 illustrates a Cueing Receiver. The incoming signal is temporarily stored in a superconducting delay line while the spectrum analyser determines its frequency content. Before the signal emerges from the delay line, the main signal analyser can be pre-tuned to process specific frequency bands of interest.

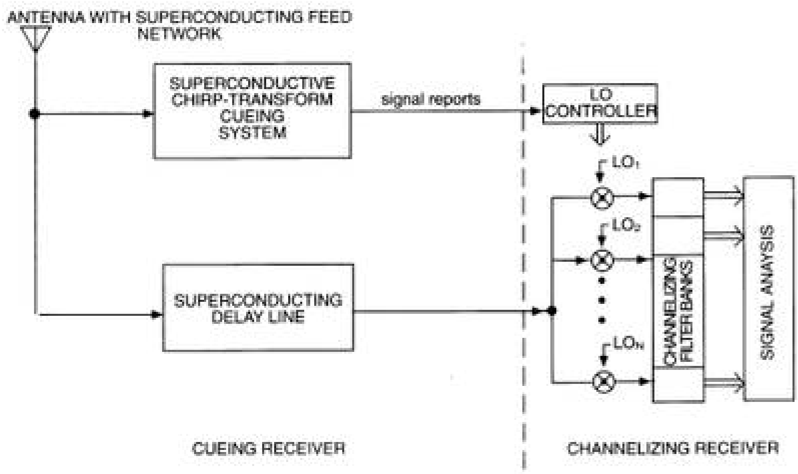


Figure 1 A Cueing Receiver

The delay line work, which started in collaboration with QinetiQ and BAE SYSTEMS, has produced good experimental results. This was after a considerable time spent on the detailed design of the components. Both microstrip and coplanar transmission lines have been used in a meandered double spiral configuration to produce wideband delay lines up to about 18GHz. The delay lines have been tested by a resonant method as well as conventionally, and showed the best results ever produced worldwide.

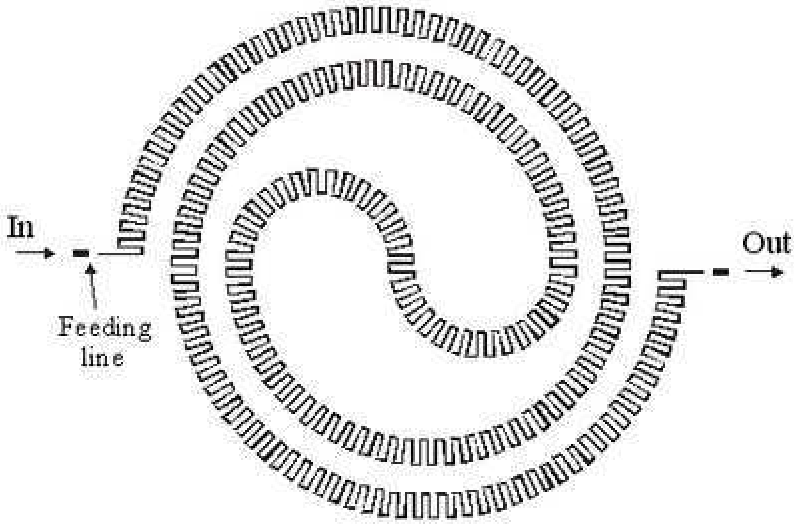

Figure 2 Double-spiralled meander delay line structure

Figure 2 shows the structure of a double-spiralled meander delay line, the actual delay lines have more turns. The double spiral configuration enables compact delay line design on a 2-inch diameter circular substrate. This is a new delay line structure and was first reported by the group. The delay lines were patterned using a 600nm superconducting, YBaCuO thin film on a 2-inch diameter LaAlO3 single crystal substrate. For microstrip, a thin substrate was used in order to improve isolation between adjacent lines as well as to reduce radiation loss. The delay lines were fabricated in-house using a standard photolithography process, followed by dry etching using argon ion beam milling. Shown in Figure 3 is a packaged device. The wound pattern is the superconducting microstrip delay line. The delay line was mounted directly to the base of the housing using a silver-loaded conductive film to ensure a good grounding.

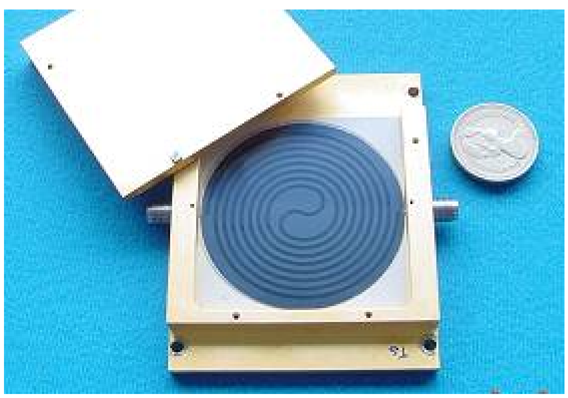
Figure 3 A packaged superconducting delay line

Figure 4 shows the measured group delay for the superconducting coplanar delay line at 77K. The inset shows the actual delay line. The delay is approximately 25ns at 2GHz and 27ns at 18GHz. This is the best superconducting delay line ever reported.

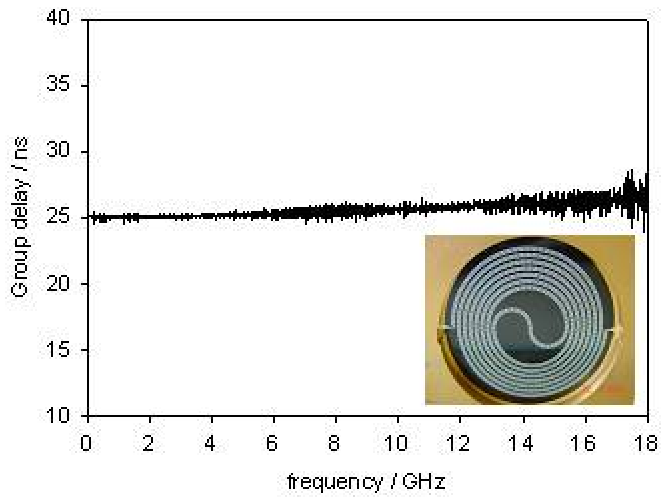

Figure 4 Measured group delay for the superconducting coplanar delay line

The advantage of using superconductors is not only to give an improved performance over conventional delay methods such as using a coaxial cable but also to shrink the size of the device. This is more significant for a system, which requires a large number of delay lines. Figure 5 shows size comparison between a coaxial cable and a superconducting delay line, both having approximately 28ns delay. The attenuation per nanosecond of these delay lines are compared and are shown in Figure 6. At 30K and 60K, the improvement over a bandwidth up to 18GHz is significant.

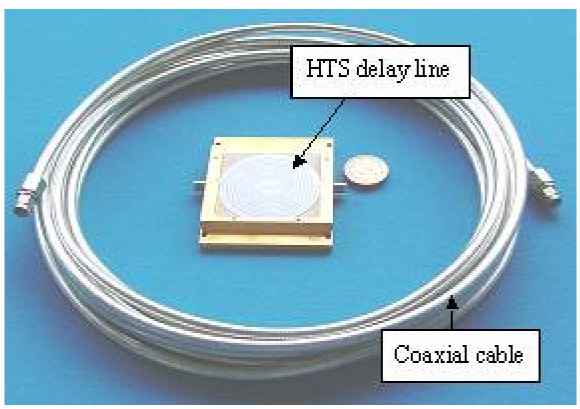

Figure 5 Comparison of physical size between a coaxial cable and a superconducting delay line

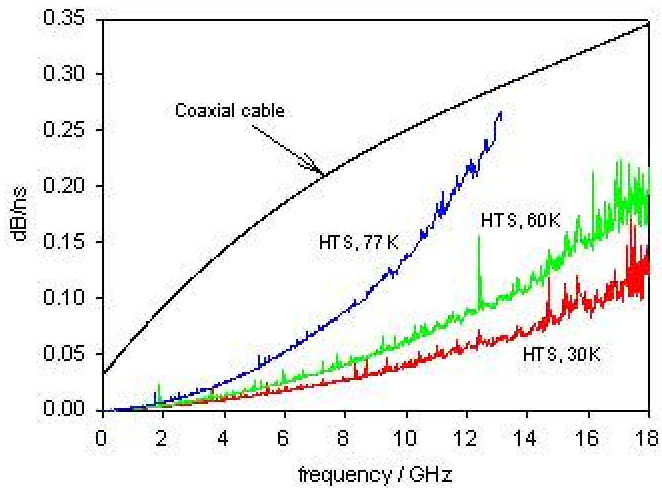

Figure 6 Comparison of measured attenuation per nanosecond between a coaxial cable and a superconducting delay line