V-9. SUPPRESSION OF MULTIPLE PASS SIGNALS FROM MICROWAVE ACOUSTIC DELAY LINES

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Microwave acoustic delay lines normally exhibit an output that shows a series of delayed pulses corresponding to a succession of passes through the delay medium. Such a train of multiple pass pulses can be used to advantage in many test equipment applications. In some applications, however, they are highly undesirable. In cw applications they are, of course, prohibited. While complete suppression of multiple passes is practically impossible, effective suppression of multiple pass signals, 30 db suppression, can be achieved in a number of ways.

The simplest and most direct method of suppressing multiple pass signals is by selecting as the delay medium a crystal whose intrinsic attenuation is large enough to place the following signals 30 db below the first pass output. The first pass signal then would be attenuated by approximately 15 db by intrinsic acoustic losses in addition to coupling losses. This technique requires matching a particular crystal to a desired delay time and frequency. For example, quartz (BC-cut) operates satisfactorily in this mode when the desired delay is 4 microseconds at a frequency near 1.9 gigacycles, then intrinsic acoustic losses in quartz place the third pass signal 30 db below the first. Ruby can similarly be used for a 4 microsecond delay time above 4.2 gigacycles.

In the event that a suitable material is not available or known, artifically introduced attenuation can be used to increase the suppression of multiple pass signals. This is most easily accomplished by careful roughening of the optically polished end faces of the crystal rod. This degradation of surface polish increases scattering from the end and effectively increases loss in the rod much as would intrinsic loss. The roughening can be accomplished by abrasive action or preferably by a chemical etching technique. The etch used varies from one crystal to the next, but hydrofluoric acid is applicable to a wide range of crystals. By this technique the attenuation of ruby has been increased sufficiently to make it acceptable for cw applications at L-band.

The preceding two techniques both have the disadvantage of suppressing not only the multiple pass signals, but also the desired delayed signal. By using impedance matching techniques in end coatings, one can decrease the reflection from the end face and thus increase the attenuation of undesired signals while not necessarily increasing the attenuation of the desired signal. While this method has not achieved 30 db suppression by itself, it has been used with some degree of success in assisting suppression of undesired signals by other methods.

The final two techniques to be discussed are the most desirable, and the least well understood, both are capable of achieving considerable suppression of multiple pass outputs, while essentially not affecting the amplitude of the first delayed output. It is found that by careful orientation of the electromagnetic fields with respect to the crystallographic axes of the delay medium marked suppression can be achieved. In a c-axis ruby rod, for example, it is found that as the crystal is rotated the suppression of the third pass signal can be varied from approximately 3 to 30 db at L-band frequencies, while the amplitude of the first delayed signal is essentially unchanged. Similar results can be achieved through orientation of the transducer coupling structures used on either end of the crystal rod. While this effect is probably the result of interference effects, the exact mechanism or mode pattern necessary is not known at this writing. Details of the observation of such interference effects will be presented.

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