THE ECONOMIC FUTURE OF SURFACE ACOUSTIC WAVE DEVICES

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Abstract

Surface Acoustic Wave (SAW) devices are now being manufactured for use in a number of electronic systems, both military and commercial. The advantages of these devices include size, reproducibility, and new function capability. Reliability has not yet really been established nor has cost proven to be low.

These devices are established, but the present and predicted market has been exaggerated. The eventual size of the SAW market will be due to a mix of one-of-a-kind high technology devices, moderate volume devices for the military market, and medium volume commercial devices.

We conclude that the SAW device supplier will have to be versatile enough to provide a variety of devices including delay lines, matched filters, and bandpass filters ar various production levels with very little high volume business.

Introduction

In 1967 there was a session on surface acoustic waves at the IEEE Ultrasonics Symposium.[1] The session created a great deal of interest and enthusiasm and by the following year there was an invited session[2] which contained papers describing important technical accomplishments and also papers predicting a prosperous future for surface wave devices in the VHF, UHF, and even microwave region. However, by 1970 people were questioning whether the large investment in this new technology would ever pay off, but by 1973 the pendulum had swung back with a prediction of a $120 million per year microwave acoustics market by 1980,[3] including about $100 million in SAW devices and modules. My purpose here is to show that 1) the current market seems to be overestimated, 2) there are potentially good markets, and 3) to achieve large markets will require a great deal of effort.

I currently estimate that the production of surface wave devices in the U.S., based on an estimation of the efforts I notice at various companies, accounts for less than $10 million per year of sales (rather than $20 million[3] as suggested for the SAW part of the microwave acoustic market). Further, the total number of competitive contracts in surface acoustic wave devices awarded in the U.S. in the past four years (for delay lines, matched filters, code devices, and bandpass filters) was only about $2.6 million. Even if that amount were tripled to account for directed awards and contracts in peripheral SAW subjects, we still get a total of less than $2 million per year in R&D. Thus, I feel $10 million per year is the order of the total current SAW market.

The potential market is large but not easily defined. SAW devices do not directly replace other classes of devices. For example, there is a $20 million per year delay line market but only $4 million per year in ultrasonic devices. The SAW delay lines will replace some but not all of the ultrasonic delay line devices but will also capture a share of the non-ultrasonic market. SAW devices will also create some new market in delay lines due to technical advantages.

The band-shape filter market has been estimated to be near $50 million/year, but this is certainly not all addressable with SAW devices since much is at low frequencies. Quartz crystal oscillators also have a $50 million/year market but less than $20 million is in the frequency range greater than 12 MHz.

Even though these established markets may grow, it does not appear that they will represent $100 million per year for SAW devices by 1980. New opportunities in the delay line field, in oscillators, in coded waveform generators and detectors, and in bandpass filters will help grow the market, but I feel that the SAW device will at best address a $50 million per year market in the next five years.

In the military business, the size of the component market is not always of prime importance. New systems which became feasible due to new components are of greater importance. Thus, I will consider high technology, one-of-a-kind devices separately because of their importance to systems companies. Volume markets are very different if the end use is military or commercial, and I will examine these separately as well.

Military Business

High Technology, One-of-a-Kind Devices

In the present U.S. economy we find many more military systems in the R&D phase than in production. In many of these cases, cost may be important, but other factors such as size, weight, reliability, or technical advantage will dominate the choice between various devices. Device design is expensive in SAW devices. They will seldom compete when small numbers of simple delay lines are needed. They are competitive in small lots only when they have a technological advantage. This advantage is currently found in delay lines operating above 60 MHz, in many pulse shaping devices, such as pulse expanders and their matched filters, and in many code generators.

This high technology market already exists. It accounts for several millions of dollars of business a year and will probably increase at a steady rate over the next five years. For example, reflective type pulse expanders and compressors, programmable code generators and convolvers may all find a place in military systems. Devices operating into the microwave frequency range will also become practical. On the other hand, digital techniques will erode the low frequency end of the market.

Production

We have identified very few high volume production opportunities for military hardware using

SAW devices. Production quantities of delay lines and matched filters for radar systems seldom exceed several hundred per year. Even bandpass filters, for use in radar IF systems, will not be large volume production. Missile applications and communications applications could lead to larger volumes. However, use of SAW devices in military communications is still in the advanced development stage, not yet in large scale production. It should be pointed out that no one has yet proven the reliability of these devices through long time testing and use.

Several examples of pulse compressors for use in radar systems which have moderate size production runs have been reported.[4,5] These have been successful because of their technical advantages rather than their cost advantage. However, it has been our experience that even for production orders of several hundred devices, the SAW device has proven to be less expensive than previously used devices. Packaging and testing to military specifications is often difficult and costly, no matter what type of device is procured; thus the main cost difference is in the material and in device fabrication. Fabrication techniques used for SAW devices are less costly than those for standard delay line type devices, and this seems to account for the lower cost even with small volume production and higher material costs.

Commercial Markets

The TV, IF filter is still the biggest hope for large voluem SAW device needs. However, it should be emphasized that work in this area started at Zenith before 1967,[6] at Mullard before 1969,[7] and there is still no sign of color TV's using SAW devices. Recent estimations[8] of $LiNbO_3$ substrate cost reductions ($4.50/sq. in. for quantities of 5000 to 7000 per month in 1976; $2.50/sq. in. in lots of 15,000 per month by 1978) will certainly help. However, yield and packaging costs still present a major problem. Once costs are at least comparable to standard filters, and reliability is insured, the advantages of size and reproducibility (non-adjustable replacements) should make the SAW device preferable.

Other potentially large volume commercial markets for SAW devices are in CATV band-shape filters, communications radio IF filters, and in code devices for identification. None of these markets is as large as the TV IF filter, but each could represent a need for ten's of thousands of devices per year. Markets like marine radar and mobile communications still appear to be very far away.

Minimum Size Market

The initial concept of the SAW device as an inexpensive device has been shown to be incorrect. Even though the devices have the advantage that they use semiconductor processing techniques, they seldom are made in production quantities, so that design costs become a significant portion of the per device costs.

For example, in bandpass filters in the UHF range, design, masks, and prototype costs could be $10,000 to $20,000. Standard lumped constant filters in this frequency range sell for from between $100 and $400. Thus, even if production costs for SAW devices are low, one must sell many hundreds of devices to become cost competitive. Of course, some of the nonrecurring costs are probably equally high for lumped constant filters. They have the advantage of already owning a share of the market and already having amortized the fixed costs. The SAW filter may have some technical advantages in bandwidth, size, and reproducibility, but faces the stigma of greater insertion loss.

Another important point is that to keep the per device costs low, many ten's of thousands of SAW devices per year must be produced. This spreads the capital expenses and fully utilizes the total minimum manpower needed to run the facility. With orders accounting for only hundreds or a few thousands of devices per type, the shop must be capable of designing and producing a large variety of SAW devices.

What this implies is that the surface wave device factory will be difficult to maintain on a self-supporting basis at first and will probably appear as an adjunct in a shop producing other photolithographic devices. This may prevent small SAW device businesses from springing up around the country.

Conclusions

The use of SAW devices as special, one-of-a-kind, high technology components for military systems is established. The volume of this market may approach $10 million per year at best, but probably no more. Low volume devices for radar, missiles, and military communications systems may be a few million dollars a year today and may increase to $10 million per year in five years. Finally, the commercial market is not here yet. There are potentially large volume sales but mostly in low priced devices with acute price competition. The conclusions to be drawn are that a SAW device operation (or company) will have to be involved in many fields, radar devices, missile devices, communications devices, and bandpass filters of all sorts, in order to win a share of the market. This market may at best reach $50 million dollars in the next five years.

References

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