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# Based on the SAW Resonator Sensor in Weighing Applications Design

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## Abstract

In view of the traditional particulate air automatic monitoring technology and equipment in the study of automatic weighing device, design related acoustic surface wave pressure sensor based on SAW technology scheme of automatic weighing, optimize and innovative design. Research in the design of new type of surface acoustic wave pressure sensor is the key to the problem, including the selection of substrate material and the selection of cutting, surface acoustic wave device structure, input and output frequency of the sidelobe suppression and temperature compensation, etc., and puts forward the solution.

## Keywords

SAW; SAW pressure sensor; weighing module; passive wireless; fine particulate matte

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## 1. Introduction

Surface Acoustic Wave (SAW) is the propagation along the solid Surface, amplitude increase with depth in the rapid decline of an elastic Wave. Human understanding of SAW very early, early in 1885, the British physicist Riley (Lord) <sup>[1]</sup>.

Surface acoustic wave with low speed and a very short wavelength. Surface acoustic wave propagation along the solid surface and spread speed is very slow, which makes the time-varying signal at a given instant can be completely rendered on a crystal substrate surface. Surface acoustic wave devices of radiation resistance is strong, large dynamic range, up to 100 dB <sup>[2]</sup>. This is because it is using the elastic wave on the surface of the crystal and does not involve the use of electricity.

SAW technology after nearly 50 years of research and development, and now has become mature. For 50 years, has successfully developed and produced many SAW devices, widely used in radar, communication, electronic countermeasure and military system such as TV, radio and other civil system <sup>[3]</sup>.

Because the SAW sensor has not contact, fast, and no power supply, anti-interference, easy coding, the secrecy good, the low cost advantages, at present, has been widely used in many fields. Composed of its sensor array, the sensing unit can be a signal wire connection between array output also need not lead connection, distribution more easily, the application is not restricted, especially suitable for some complex application environment, the unfavorable contact engineering structure and environment of telemetry, sensor and target recognition <sup>[4-5-6-7]</sup>. Therefore, the study of SAW sensors, especially is to research the greater distances SAW sensor has a wider application prospect.

## 2. In the New Application of the Weighing Module

SAW sensors is electronic technology and the combination of the material science, it consists of the interfacial film of SAW oscillator, sensitive material and the oscillation circuit. The core component of

SAW sensors is SAW oscillator, the piezoelectric substrate and deposition on the substrate material of different function fork refers to the transducer, a delay line (DL) and resonance ware (R) two kinds. As shown in the figure below .

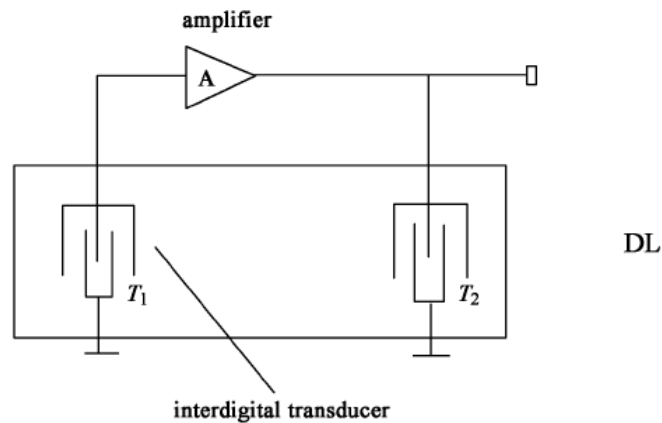


Figure 1. The delay line SAW sensor

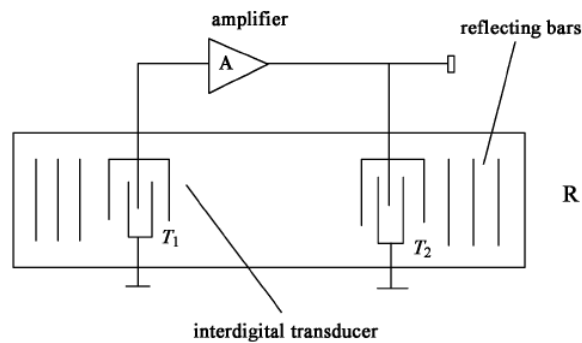


Figure 2. Resonance ware SAW sensors

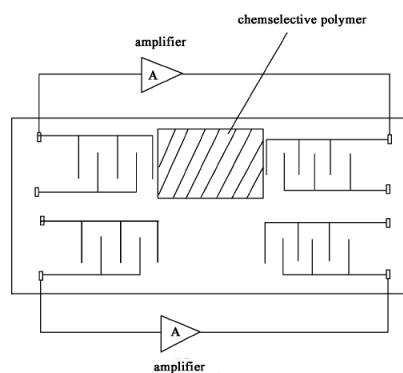


Figure 3. Dual channel delay line SAW oscillator

The delay line SAW oscillator is composed of surface acoustic wave delay line and amplifying circuit. Input transducer IDT1 arouse sound surface wave, spread to the transducer IDT2 converted into electrical signal, after amplification feedback to IDT1 in order to maintain the oscillation state. As long as the amplifier gain is high enough, enough to offset the delay line and the wastage of the peripheral circuit, and meet certain phase condition, the system can generate oscillation.

Resonance shape SAW oscillator, surface acoustic wave bounces back and forth many times between the reflecting grating array, when reflecting grating of the distance between two adjacent article refers to the integer times of the half wave, they form a standing wave, then in 2 reflex is formed between the grid array cavity. Put two IDT antinode of standing wave field, can constitute a cavity. Transmitting and receiving IDT used to complete the acoustoelectric conversion. When to launch the fork refers to the

alternating signal transducer, the equivalent of alternating electric field on piezoelectric substrate materials. Such material surface is proportional to the applied electric field intensity of mechanical deformation, produce SAW, as long as the amplifier gain compensation resonator and its connection wire loss, at the same time can meet certain phase condition, this oscillator can be composed of start up and maintain the oscillations<sup>[8-9]</sup>.

Resonant type SAW sensor with the characteristics of high quality factor, low insertion loss, in the study of passive wireless sensor detection system. Resonant type SAW sensor structure is mainly composed of piezoelectric substrate, fork electrode (IDT) and reflection grating, the reflecting grating acoustic resonator, fork refers to the electrode will be the energy of the excitation signal import and the export of energy, within the cavity structure is shown in figure 6 resonator frequency depends on the fork fork refers to transducer refers to the distance and speed of wave propagation, as shown in formula (1):

$$f_0 = \frac{v}{L} \quad (1)$$

Type:  $f_0$  is the resonance frequency of the resonator in room temperature,  $v$  is the velocity of surface acoustic wave,  $L$  for fork electrode spacing. When the temperature of the piezoelectric substrate of SAW resonator changes, can cause surface acoustic wave propagation velocity and the change of the reflection grating spacing, causing resonator resonance frequency  $f$  changes, namely<sup>[10-11]</sup>:

$$\frac{df}{f} = \frac{dv}{v} - \frac{dL}{L} \quad (2)$$

Changes caused by pressure change the size of the substrate is lesser, so:

$$\frac{df}{f} \approx \frac{dv}{v} = \frac{1}{v} \frac{\Delta v}{\Delta t} d\theta = C_{tf} \times d\theta \quad (3)$$

Type:  $\Delta v$ ,  $\Delta$  respectively for surface acoustic wave propagation velocity and pressure changes in the value, the  $C_{tf}$  for pressure coefficient, the pressure coefficient is the crystal of tangential and change<sup>[12]</sup>.

Implantable device consists of three modules: antenna module, AC/DC module, SAW sensor module, measurement and send it to complete the pressure signal. Made up of ANT1 and ANT2 antenna module<sup>[12-13]</sup>. Among them, the energy coupling antenna ANT1 responsible for wire winding inductance coil outside receive radiation energy, by an average of 14 mm diameter circle number is 30 circle of enameled wire; Rf antenna ANT2 for loop antenna is responsible for the temperature of the physical signal transmission, and the body by an average of 2 mm diameter circle of enameled wire number for 15 circle. AC/DC module consists of full-wave rectifier circuit and voltage regulation circuit, the former will receive antenna ANT1 coupling to the AC signal into DC signal, the latter the DC signal can be converted to a stable voltage.

### 3. Further Improve the Saw is Used for Weighing Technology

SAW technology although more into hot, but it is limited by a lot of performance, influence it into the new application domain, therefore, must make a further improvement of the technology<sup>[14-15]</sup>. Several main aspects of SAW technology to improve is:

Reduce the wastage of the filter.

To improve packaging.

Improve the frequency device.

Filter can be programmed.

To further improve the design precision of the filter.

To improve material performance and material processing technology.

The first item or reduce the loss of filter is as SAW technology is put forward as one of the oldest problems in. In order to adapt to the new development trend for SAW filter below 1 db, high power dissipation ((10 w), the phase matching, tunable<sup>[16]</sup>.

Improve packaging has special important meaning to the SAW civilian, because it is decided to product and price of the key factors. To make the SAW device compatible with other components and adapted to the automatic assembly technology, chip packaging requirements development[17]. We know that the parasitic capacitance and resistance, cleanliness is poor and bad sealing will worsen the performance of the device, with the development of SAW technology by ultra-high frequency to microwave frequencies, the deterioration of performance will become more serious, this makes packaging SAW technology further development of the key factors.

The demand for high frequency large bandwidth need microwave SAW devices directly. According to the existing technical level, frequency has been able to reach about 1000 MHZ, but by the propagation loss, the density of surface defects and adjust the tolerance limit of multilayer device. To this, a promising approach is to use xisha tile has high inherent velocity of surface transverse wave or shear wave and other surface wave mode[18].

Although the best program filter is SAW convolver, but it still has many deficiencies. In this respect, with SAW to implement low power and high speed clock pulse of GaAs charge transfer device can yet be regarded as a kind of ideal device.

Finally, to promote the quality of materials, components, manufacturing process, as well as the progress of design techniques, will help to comprehensive improvement of SAW devices, help to opening up the new application field of SAW technology, help to develop a broader market SAW technology.

#### 4. Conclusion

In this paper, this paper narrates the present situation and prospects of SAW. On the basis of SAW technology, based on surface acoustic wave pressure sensor automatic weighing module. Surface acoustic wave pressure sensor was applied to the weighing module, the comprehensive promotion in the field of weighing precision, from SAW either technology or development in the field of weighing module, the further improvement and optimization has certain reference significance

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