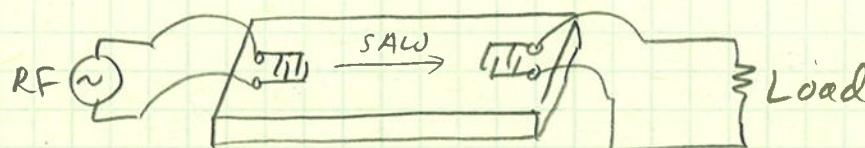


Instrumentation For SAW Devices

1. SAW Delay Line Effects



If wave velocity is 3490 m/s, and $m = 1\text{mm}$

Then the time delay, τ_d , is

$$\tau_d = \frac{1 \times 10^{-3}}{3490} = 2.9 \times 10^{-7}\text{s/mm}$$

$$f_{360^\circ} = \frac{1}{\tau_d} = 3.49\text{MHz} \quad \text{for } M = 1\text{mm}$$

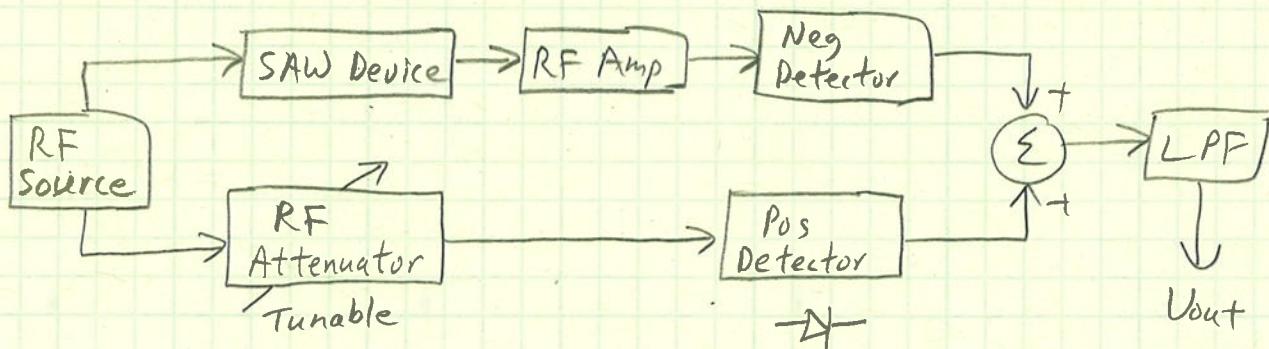
($M \equiv \text{IDTs center-to-center separation}$)

So an $m = 1\text{mm}$ substrate will delay a 3.49 MHz RF signal by 360° with $V = 3490\text{ m/s}$

a. Possible Measurand Effects on SAW wave

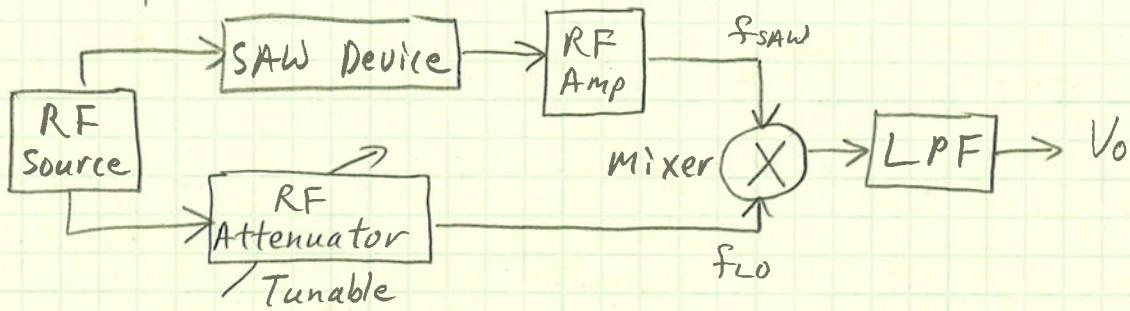
- ① change in propagation delay
- ② change in acoustic wave amplitude
- ③ change in acoustic wave frequency

2. Amplitude Measuring System



V_{out} is a DC voltage proportional to the amplitude variation through the SAW delay line

3. Delay (Phase) Measurement System



V_o is a DC voltage proportional to the phase delay between f_{LO} and f_{SAW}

4. Frequency Measurement System

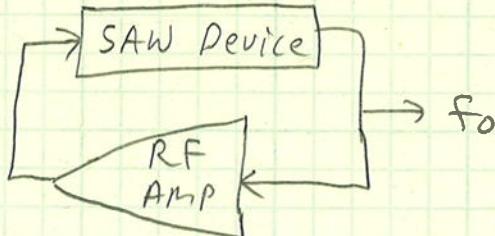
same block diagram as used for the delay measurement system, except $V_o(t)$ is a sinusoid of f_o

$$\text{where } f_o = |f_{LO} - f_{SAW}|$$

Typically, f_{LO} and $f_{SAW} \geq 10 \text{ MHz}$ while $f_o \sim < 20 \text{ kHz}$

5. Oscillator System

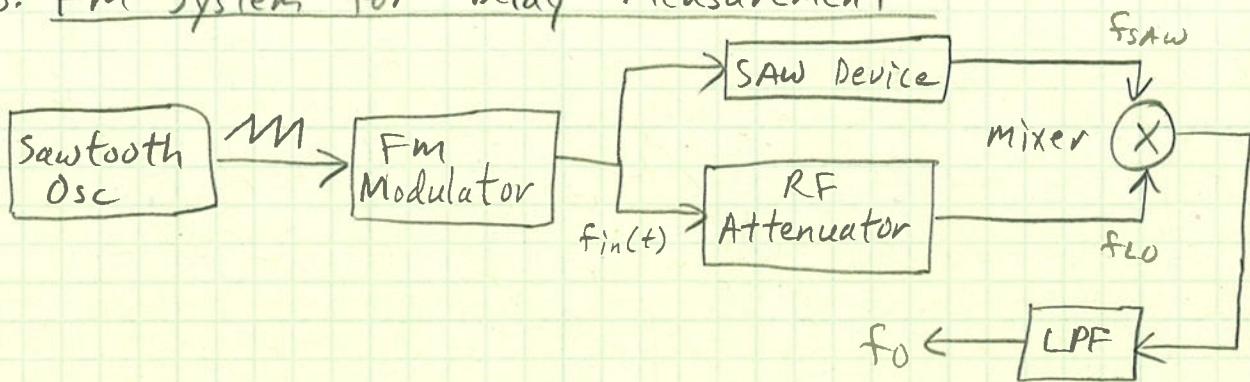
For variable propagation delay measurement



f_o inversely proportional to SAW delay

Use a digital frequency counter to measure f_o

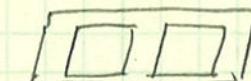
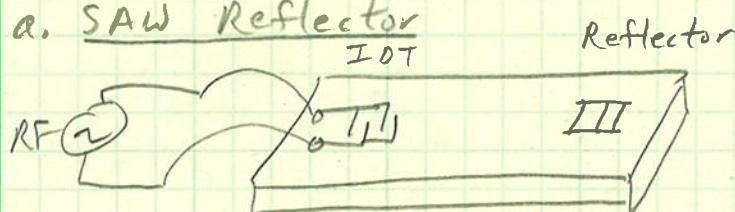
6. FM System for Delay Measurement



Over the measurement period, f_0 will vary in proportion to the delay through the SAW device

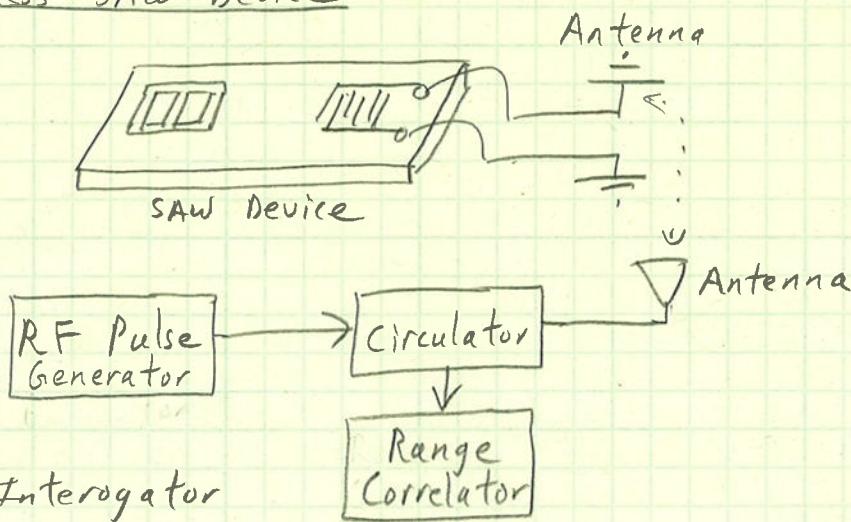
7. Wireless SAW Based Sensors

a. SAW Reflector



↑
acoustic wave reflecting
structure

b. Wireless SAW Device



The interrogator sends an RF pulse to the SAW device and measures the time until the return pulse is received
→ similar to a distance measurement radar system