

Ultrasonic Component Measurement

Summary

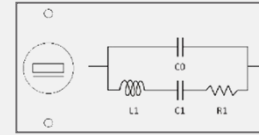
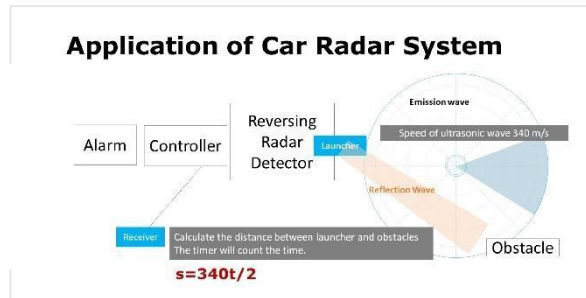
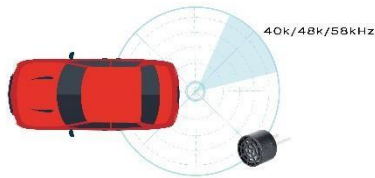


- Ultrasonic is a mechanical wave, a special sound wave with a frequency above 20kHz.
- This sound wave has physical properties, such as refraction, reflection, and interference.
- Applied to ultrasonic ranging sensors, the transmitter can be used to send out sound wave, and the time difference between sender and receiver can be used to calculate the distance.
- Divided into destructive and non-destructive.

Application of Car Radar System

Use an ultrasonic transmitter to emit sound wave in a certain direction. (Launch and start timing)

Sound signal transmit through air, and when obstacles are encountered on the way, they are reflected and send back to the receiver. (Stop timing as soon as the response is received)



Most piezoelectric component connect to a circuit.

We could use the equivalent circuit model to simulate the vibration characteristic. The characteristic of impedance change by the frequency.

C0 Static Capacitor

R1 dynamic impedance- Resistor

L1 dynamic impedance- Inductor

C1 dynamic impedance- Capacitor

We can use the complex symbol of AC circuit to evaluate the resonance impedance characteristic of piezoelectric component.

Impedance in the circuit: $Z = U / I$

Admittance in the circuit: $Y = I / U$

Measuring admittance of component = Measuring Impedance

Evaluate the matching impedance between the component and the circuit.

When the piezoelectric component is static.

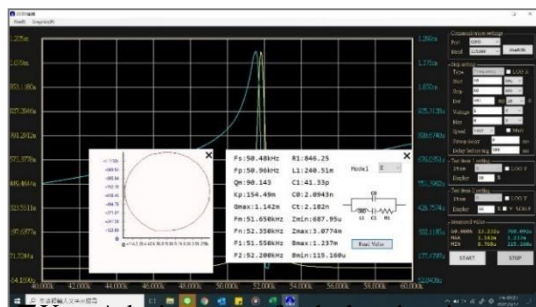
We ignore the loss and consider it as a static capacitor C0.

When the component is vibrating and radiating energy.

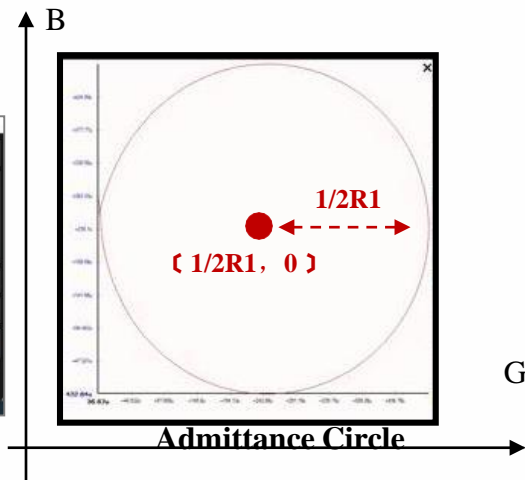
The dynamic impedance and static capacitor will have reflection.

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It's more intuitive to analyze impedance of piezoelectric component by using admittance circle drawing



▼ Y – Admittance of whole circuit



Admittance Circle

Static admittance Y_0 Dynamic admittance Y_1

▼ Y_0 parallel branch

(Compose by material insulation resistance R_0 and static capacitor C_0)

▼ Y_1 Series branch

(Compose by dynamic impedance R_1 , capacitor C_1 , and inductor L_1)

Calculated by following formula,

$$Y = Y_0 + Y_1$$

$$Y_0 = 1/R_0 + 1/(j2\pi f C_0)$$

$$Y_1 = 1/(R_1 + j2\pi f L_1 + 1/(j2\pi f C_1))$$

Conclusion: Y and dynamic Y_1 will change by the frequency.

GMGA MEASURING

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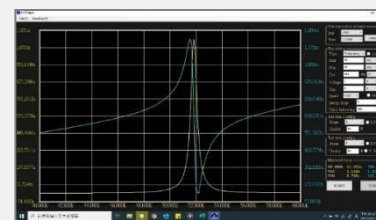
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In the past, Agilent 4294A was used to analyze piezoelectric component. Now 6632 Impedance Analyzer is a better option.



LIST RUNS	FREQ (Hz)	LEVEL	MEAS. VAL	RESULT
1	SWEEP		Fs	50.320kHz
2	SWEEP		Fp	51.040kHz
3	1.00000k	1.000 V	Cs	2.1939nF
4	1.00000k	1.000 V	D	0.01530

- F_s/F_p Resonance Frequency Curve
- Key parameters (F_s / F_p / C_s / D)
- Admittance circle graphical analysis
- Important parameters on admittance circle coordinate

