AUDIOWELL SENSOR TECHNOLOGY

ULC:

Automotive Vision System stays clear

Sensor technology shaping an intelligent life

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Automotive Vision System

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About Automotive Vision System

Automotive Vision System

The camera is an important sensor for self-driving cars, known as the ‘eye of self-driving’, and is mainly used to collect information and analyse images to achieve vehicle recognition, pedestrian recognition, lane line recognition and other functions.

Regulations

According to the U.S. Department of Transportation, as of 1 May 2018, all cars manufactured must be equipped with a rear-mounted reversing camera. This means higher requirements for camera cleaning technology.

Why are vehicle cameras difficult to clean?

1)Environmental factors:

the camera is easily polluted by the environment

2)Limited applicability of current technologies:

Traditional cleaning methods such as small windscreen wipers, compressed air and rotating lenses are not only complex and expensive, but also not applicable to all scenarios.

3)Automated cleaning technology requirements:

fixed position, can not be cleaned manually, need to develop special automated cleaning technology

4)Integration of washing systems:

Various design adjustments of the vehicle need to be taken into account.

5)Sensor protection:

avoiding damage to the sensor during the cleaning process requires a very delicate and accurate cleaning system design.

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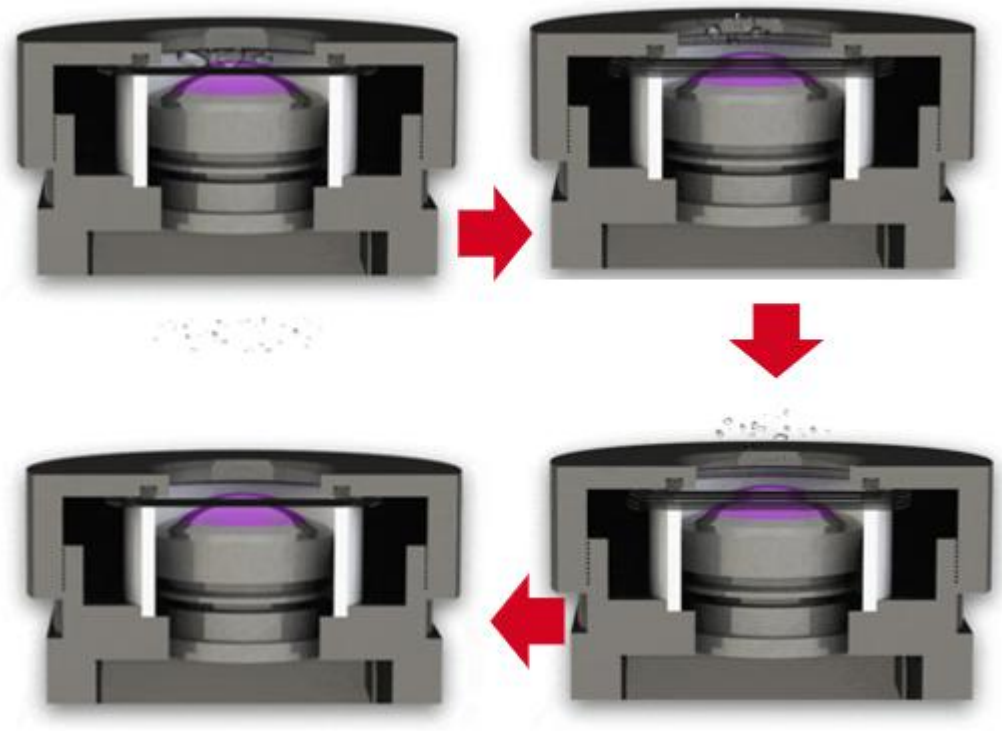
About ULC

About ULC

Adopting Ultrasonic Lens Cleaning (ULC) technology, it uses tiny vibrations generated by ultrasonic waves to remove water, dirt and other contaminants from the surface of the lens cap. The product is suitable for electronic mirrors, car surveillance, mobile phone cameras and other types of small lenses.

Ultrasonic lens cleaning solutions utilize Audiowell's proprietary materials and algorithms that enable camera systems to quickly detect and use tiny vibrations to remove contaminants such as dirt, water and ice. Ultrasonic cleaning has many advantages over traditional cleaning methods, including high cleaning quality, speed, less damage, and full automation.



About ULC

Auto-cleaning technology based on resonant frequency scanning

Since the resonant frequency changes slightly with the contaminant, the cleaning cycle may scan several kilohertz around the intrinsic frequency of the lens.

e.g:If the intrinsic frequency is 30 kHz, the ULC system can scan from 28 kHz to 32 kHz to ensure proper cleaning.

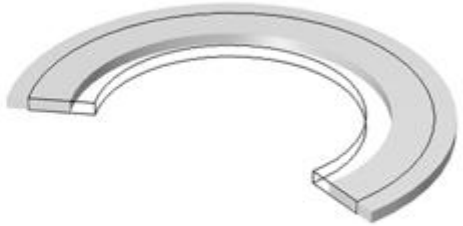
Direct vibration method:

The direct vibration method achieves the cleaning effect by driving the camera lens itself to generate vibrations. This method allows for direct ULC in the camera module, but may add complexity to the ultrasonic cleaning and manufacturing process.

About ULC

Vibration due to piezoelectric effect

When the electric field is applied to the piezoelectric transducer, it will produce mechanical deformation, and its strain is proportional to the electric field strength, which is called the inverse piezoelectric effect, the stronger the applied electric field strength, the greater the amplitude of vibration.

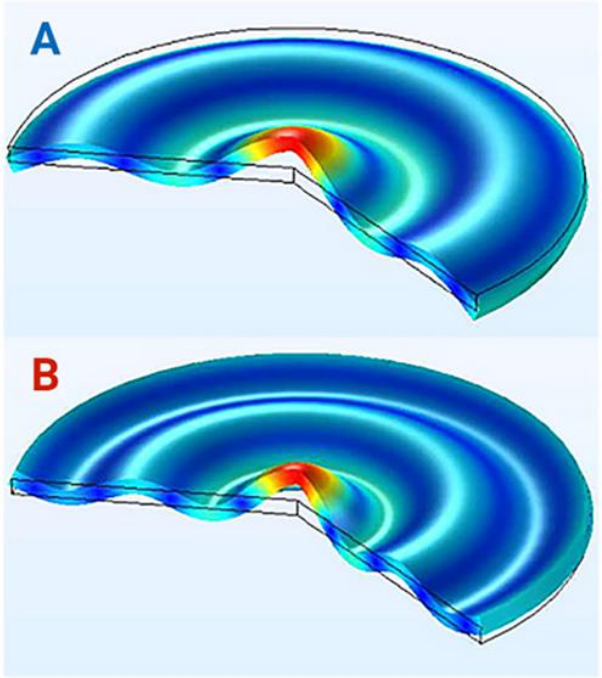


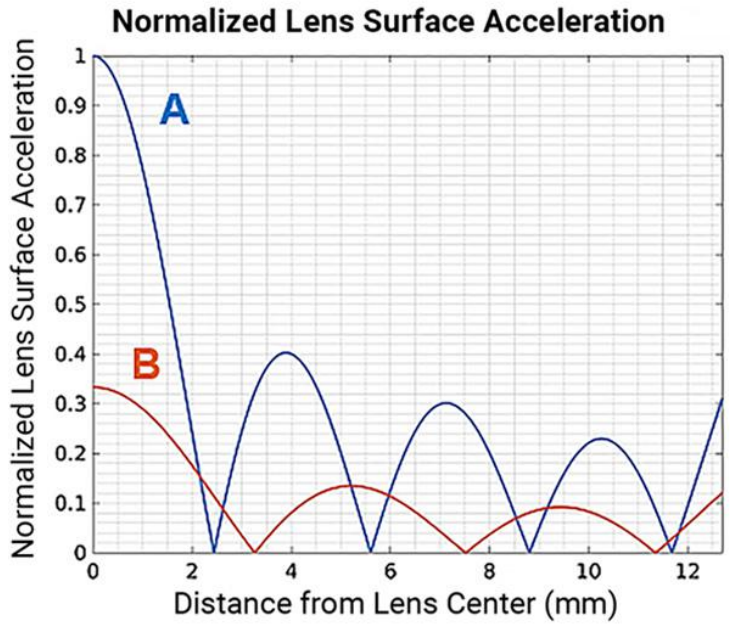
About ULC: **Bimodal cleaning**

Bimodal cleaning

Bimodal cleaning is a more advanced ULC method that employs two different standing waves in successive cleaning cycles. This method helps to eliminate cleaning blind spots that can occur in single-mode cleaning and ensures more comprehensive cleaning coverage.

Bimodal cleaning is cleaner than single mode cleaning and more cost-effective than SAW.

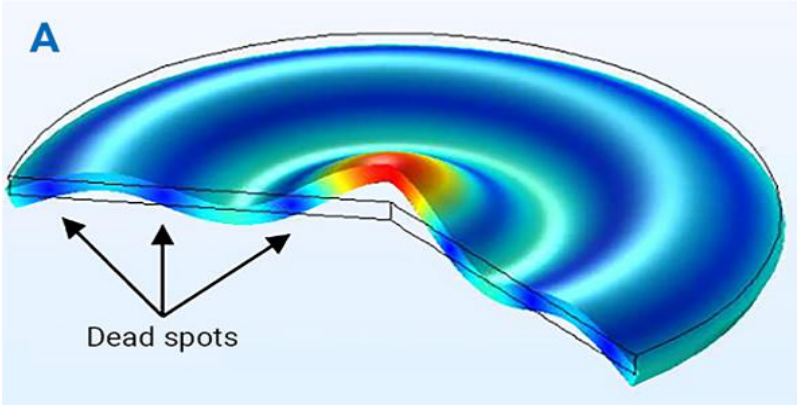


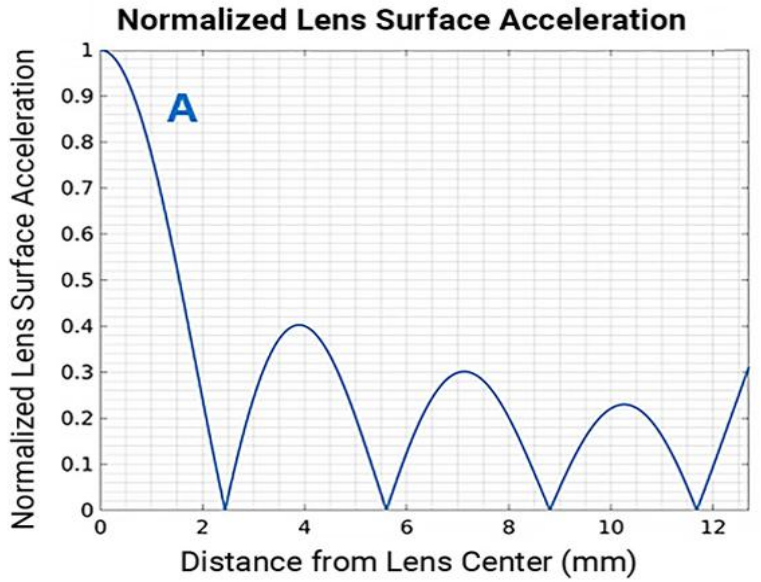


About ULC：Other Modes

Single mode cleaning

By applying energy at one of the intrinsic frequencies of the lens, a standing wave can be generated which creates areas of high acceleration on the lens surface which are sufficient to exclude water droplets. The limitation of single-mode cleaning is the acceleration gradient, i.e., cleaning may not be as effective at points of low acceleration and may leave residues.





Surface Acoustic Wave (SAW) Method

Unlike standing waves that directly vibrate the lens, the SAW method uses sound waves travelling along the surface to pop off contaminants by applying direct energy to them.The application of SAW technology can improve cleaning efficiency, especially when faced with large or specially shaped glass surfaces that are difficult to clean with traditional vibration methods.But is more complex and expensive as it requires higher frequencies and multiple actuators.

About ULC： Comparison of Cleaning Modes

Items	Bimodal cleaning	Single mode cleaning	Surface Acoustic Wave (SAW) Method
Cleaning range	Full	Fixed frequency area	Full
Structure	Simple	Simple	Simple
Number of transducers	Less	Less	More
Size	Small	Small	Small
Installation Space	Small	Small	Small
Installation degree	Low	Low	Low
Costs	Cheaper	Cheaper	Cheaper
Cleaning method	Direct cleaning	Direct cleaning	Non-direct cleaning

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About LCS

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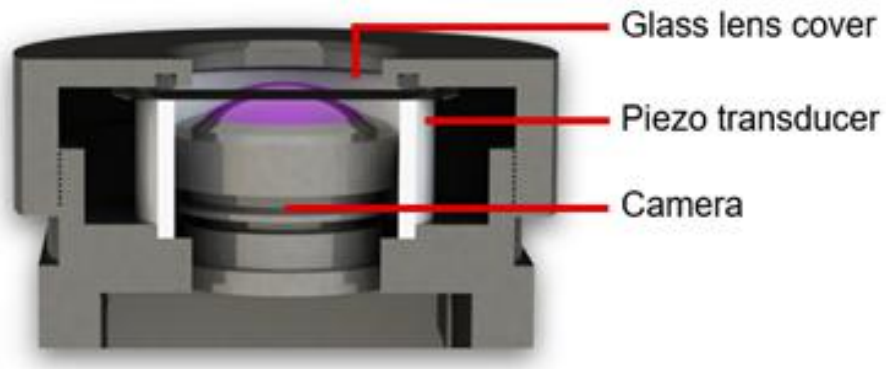
About LCS

LCS

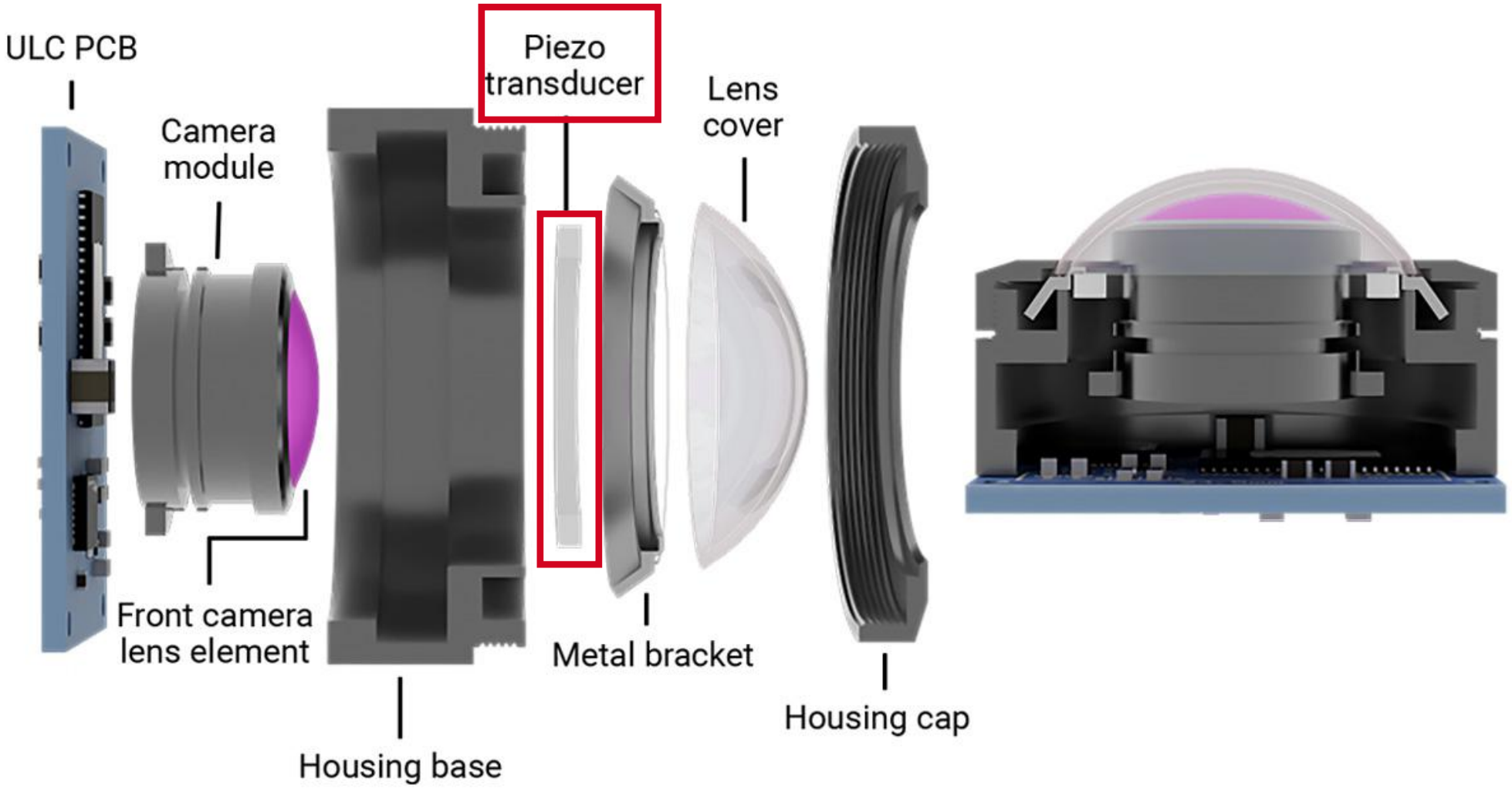
The LCS is a compact component that fits over the camera lens, similar to the flat cover glass on smartphone cameras, providing a large field of view with little optical distortion. The piezotransducer resonates with the glass lens cover to clean the lens.



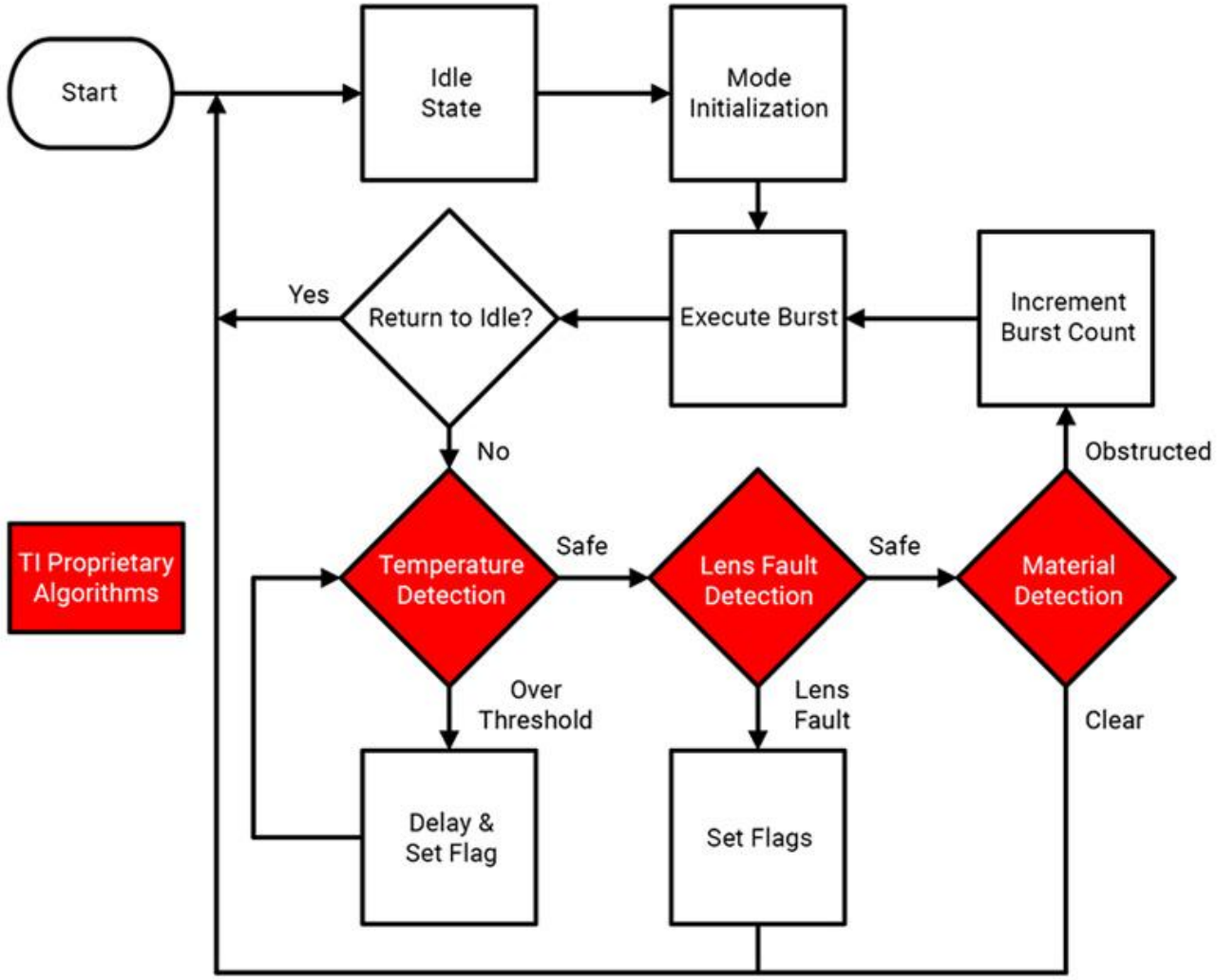
Consist

- A glass lens cover
- A piezo transducer
- A camera.

About LCS：Internal structure diagram



About LCS：Operating logic



About **Piezo Transducer**

Piezo Transducer in LCS

The piezo transducer is the core component in ULC technology and its operating principle is based on the piezoelectric effect.

When a voltage is applied to the piezo transducer, it will deform and produce mechanical vibration. This deformation is proportional to the strength of the electric field, so the amplitude and frequency of the vibration can be controlled by adjusting the magnitude and frequency of the voltage.

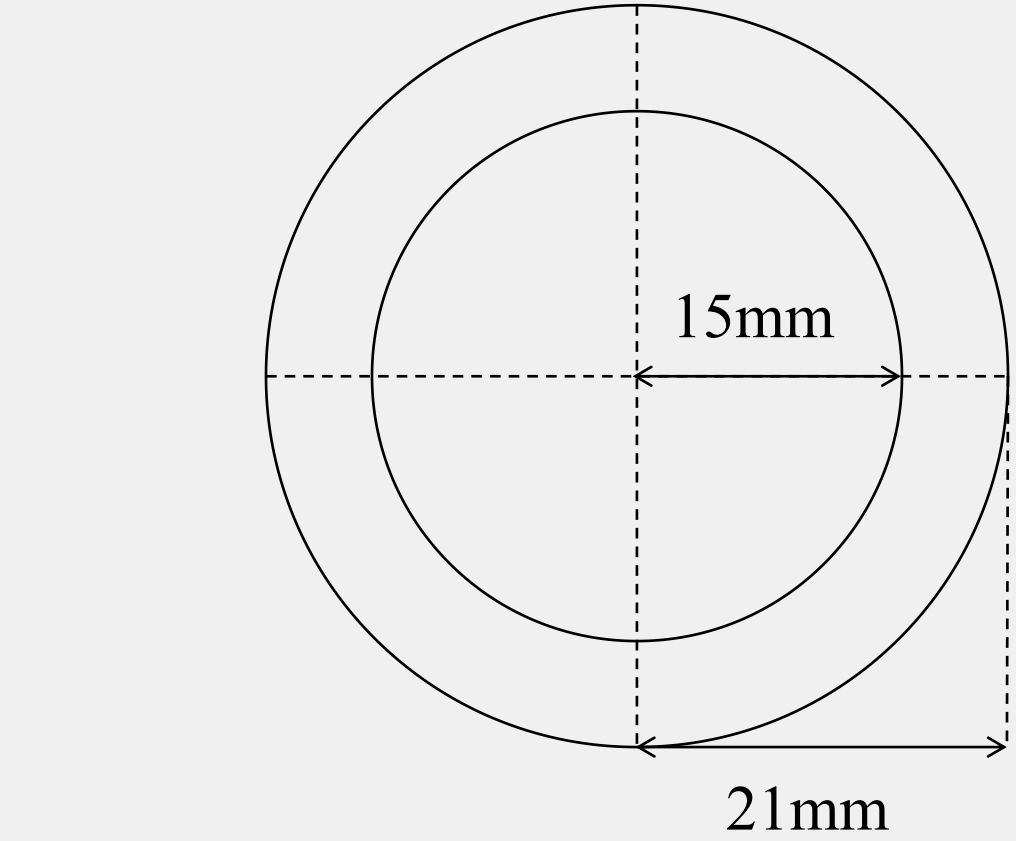
- High cleaning quality with low dirt residues
- Fast cleaning speed
- Less damage to parts
- Automatic

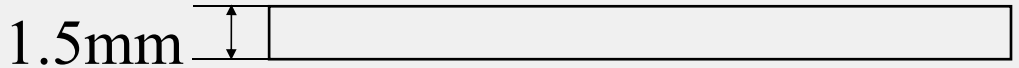
About **Piezo Transducer**

‘Ultra-thin’

without compromising optical imaging

The piezo transducer is available in various ultra-small sizes such as : **21mm(Outer diameter)X15mm(Inner diameter)X1.5mm(Thickness)**, etc., making it suitable for installation in very tight spaces. This reduces the design and adjustment time required to secure the installation space. Subsequent installation is also easy.





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Appliances

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Appliances: Automatic removal of various pollutants

Video:https://www.ti.com/video/6317728222112

Drop of water

Vapour

Snow

Dusty

Appliances: Industry Sectors

Medical Imaging

Traffic Monitoring

Automation & Robotics

Smart Agriculture

Smart Security

Sports Shooting

Automotive

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