Non-Contact Measurement

IBS Precision Engineering

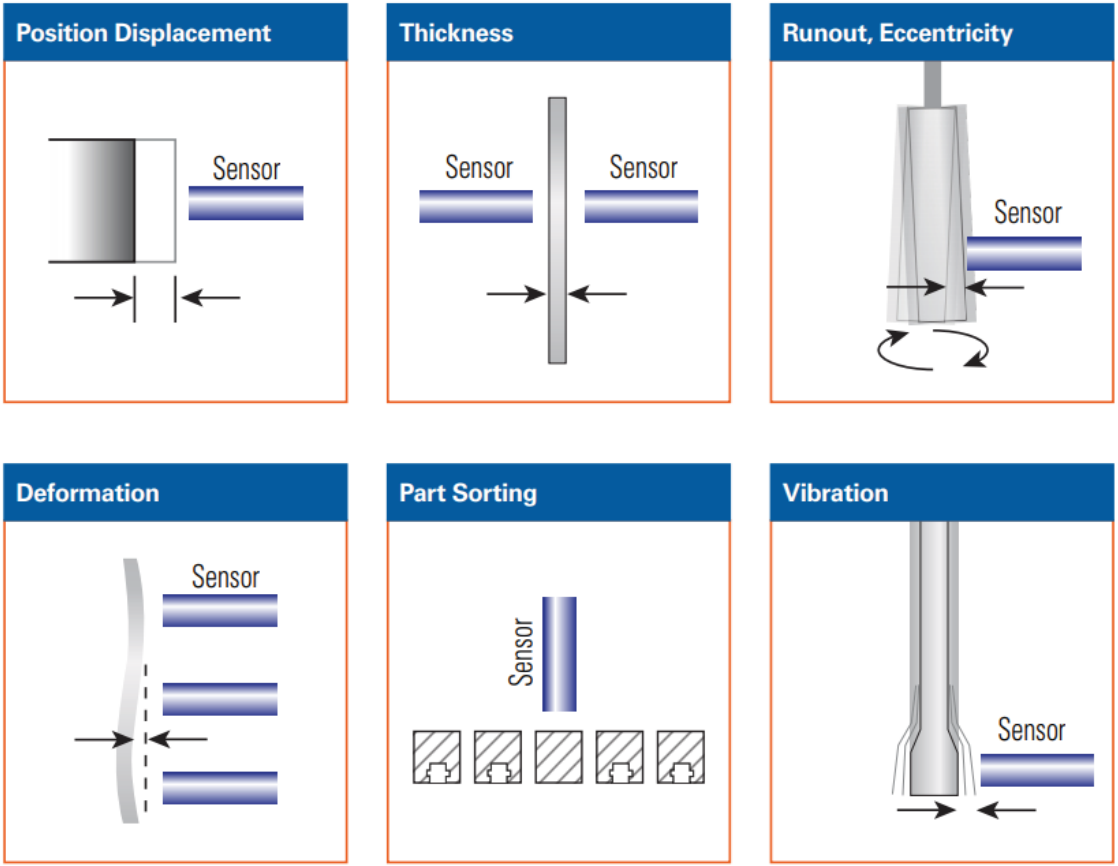
Comparing Capacitive and Inductive Sensors

Non-contact sensors using **capacitive and inductive measuring technologies** each represent a unique blend of advantages and disadvantages for a variety of applications.

www.ibspe.com info@ibspe.com +31 (0)40 290 12 70

Comparing Non-Contact Sensors

Typical applications



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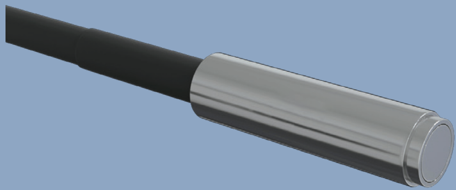
Our **inductive and capacitive** measuring systems

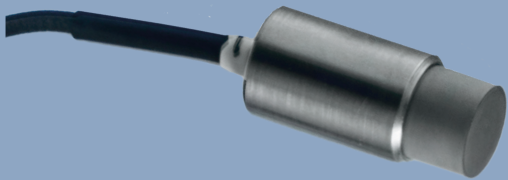
Comparing Non-Contact Sensors

A **comparison** will help you to select the best technology for your application.

Understanding the **difference between capacitive and inductive (or eddy-current) sensors** begins by looking at how the probes are constructed.



Capacitive sensor



Inductive sensor

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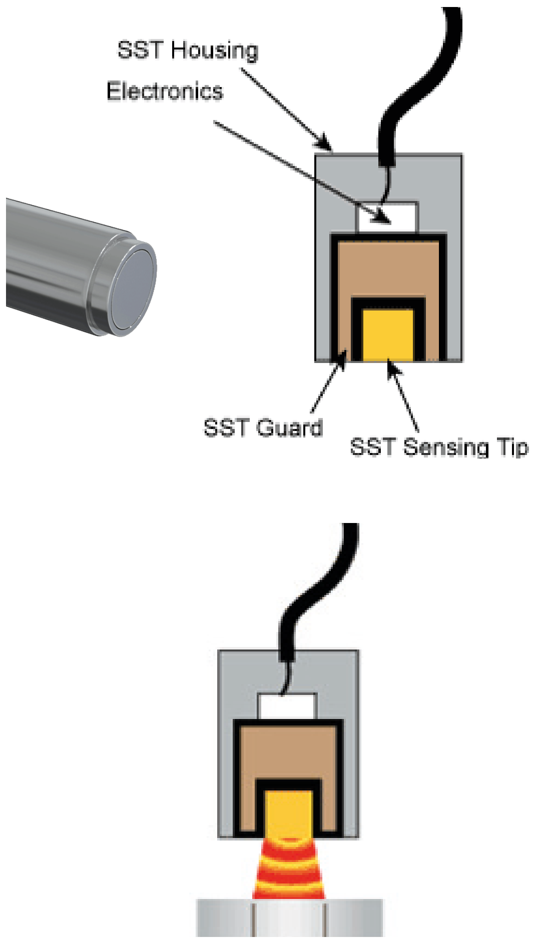
Capacitive probe construction

At the center of a capacitive probe is the sensing tip generating the electric field used to sense the distance to the target. The guard ring, separated by an insulating layer, surrounds the sensing tip and focuses the electric field toward the target.



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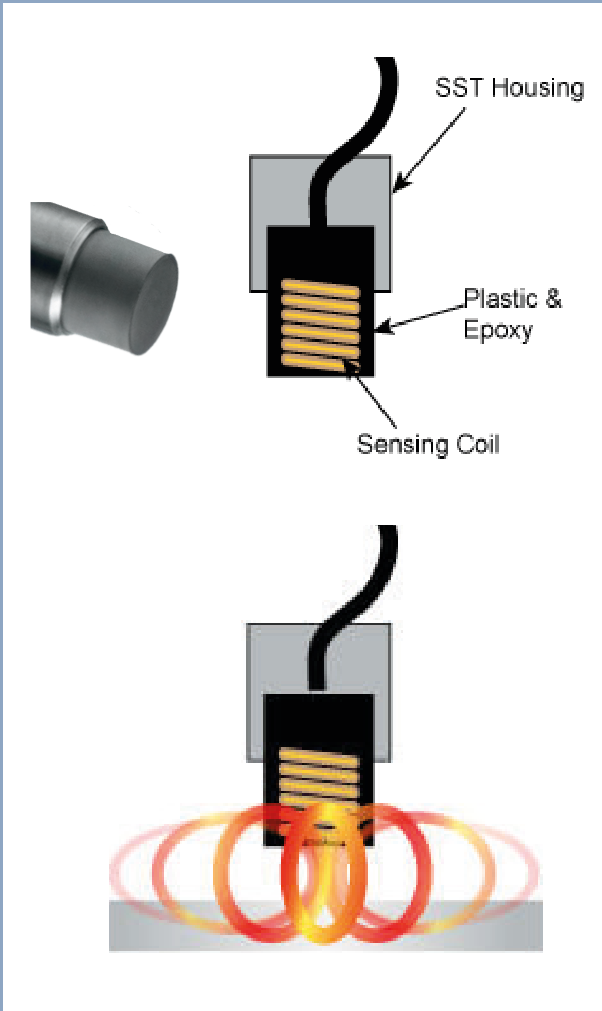
Inductive probe construction

In the sensing coil of wire alternating current is passed through, creating an magnetic field, used to sense the distance to the target. The epoxy and plastic covered coil extends from the steel housing to allow the full sensing field to engage the target.



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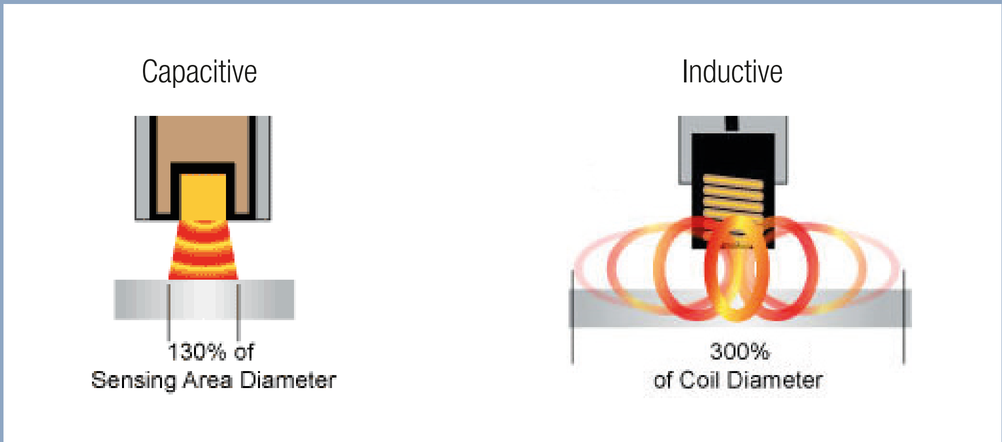
Sensing area

Capacitive

Sensing area diameter: 130% of sensing tip diameter.

Inductive

Sensing area diameter: 300% of sensing tip diameter.



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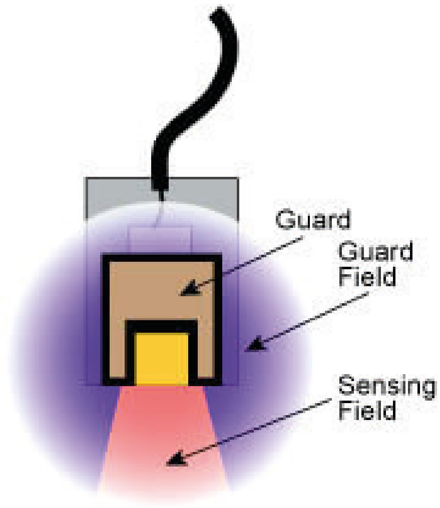
Capacitive sensing technique

Capacitive sensors use a high-frequency electric field to determine the capacitance. Changes in the distance between the probe and the target change the capacitance, which changes the current flow in the sensing element.



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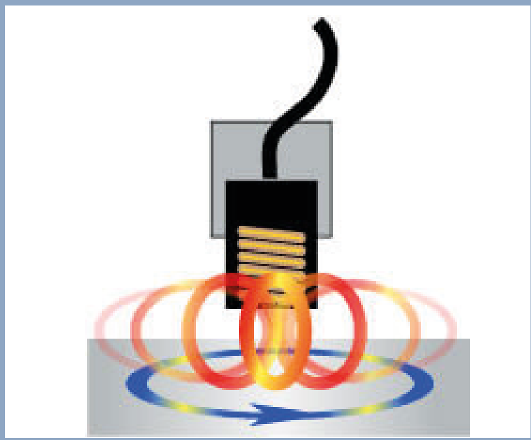
Inductive sensing technique

Inductive sensors use magnetic fields. Alternating current is passed through the sensing coil, creating an alternating magnetic field. This induces an eddy current in the target that opposes the magnetic field of the coil. The impedance of the sensing coil will change. The amount of impedance change is dependent on the distance between the target and the sensing coil in the probe.



Magnetic field induces eddy current (blue) in conductive target

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Gap contamination

Capacitive: Contamination (dust, oil, and water) also increases the capacitance. Therefore capacitive sensors must be used in a clean environment.

Inductive: Magnetic fields are not affected by non-conductive contaminants such as dust, water, and oil. So these sensors are the best choice when the application involves a dirty or hostile environment.

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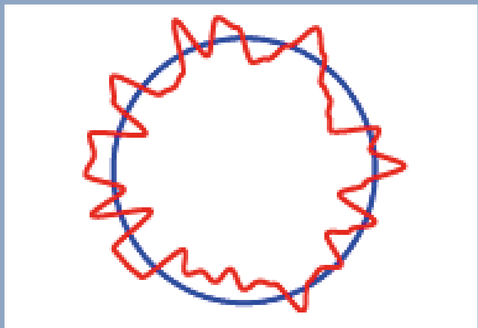
Target materials and rotating targets

In **capacitive sensors** the electric field uses the target as a conductive path to ground and does not penetrate the material. Once calibrated, they can be used with any conductive material with no material related errors, and they work well with rotating targets.

Inductive sensors need to be calibrated to the same material as the target and should not be used with rotating magnetic material targets unless the electrical runout errors are acceptable in the application.



Actual runout (blue), and electrical runout from ind. sensor (red).

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Temperature and Vacuum

Capacitive probes (affected by condensation) have an standard operating range of +4 to +50°C. On request available: 150°C or cryogenic options.

Inductive probes aren't affected and have an operating range from -25 to +125°C. On request available: 200°C or cryogenic options.

Both sensors types can work well in **vacuum** environments. In temperature sensitive vacuums, inductive sensors may cause too much heat for the application, due to the larger power consumption. In these applications, capacitive sensors will be a better choice.

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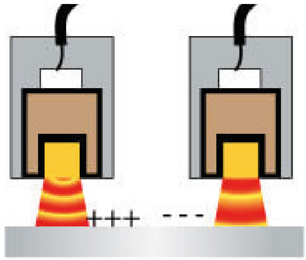
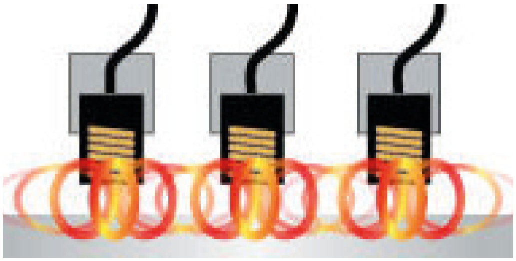
Probe Mounting

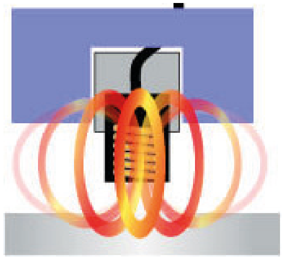
When your application requires the use of multiple probes with a common target, synchronized sensors are easy to use. If the application requires inductive (or eddy-current) technology, special care must be taken in the mounting plan (mounting block may interfere) and special calibration may be required.



Synchronized capacitive sensors will not interfere when used on the same target.



Synchronisation can eliminate interference occurring when inductive probes are mounted near each other.



Mounting hardware can interfere with inductive probe magnetic field.

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Comparison table

●● Best Choice ● Good Choice – Not an option

Factor	Capacitive	Inductive
Dirty environments	–	●●
Small Targets	●●	●
Large Range	●	●●
Thin Materials	●●	●
Material Versatility	●●	●
Multiple Probes	●●	●●
Resolution	●●	●●
Bandwidth	●●	●●

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Further reading

Visit our website for more educational and technical information about our non-contact sensors.

https://www.ibspe.com/measuring-systems/capacitive-measuring-systems

https://www.ibspe.com/measuring-systems/inductive-measuring-systems

https://www.ibspe.com/expertise/technical-resources