Capacitive sensing

Inherently noncontacting capacitive sensors hold a charge differential and register when passing objects alter it. Either one metal plate generates and detects the capacitance between it and an electrically conductive target, or a pair of metal plates maintain a capacitance that changes when objects draw nearer or recede. These capacitive sensors are particularly useful over shorter distances, and for measuring displacement of components made of anything from plastic or metal to wood and glass.

Q&A

How do capacitive sensors detect nonconductive objects?

Materials like plastic have a dielectric constant different than that of air (which is about 1) so even though they're not metal, they still change the capacitance between (air-separated) conductors and induce readings. For example, silicon's dielectric constant is about 12, and water's at 80°C is 80.4.

Where are they used?

Nanopositioning and closed-loop multi-axis applications are two examples.

For components that have constant stiffness, capacitive sensors can also be used to measure force, even down to a few μN. The main benefit here is that noncontacting capacitive sensors don't affect system dynamics — particularly important on delicate applications.

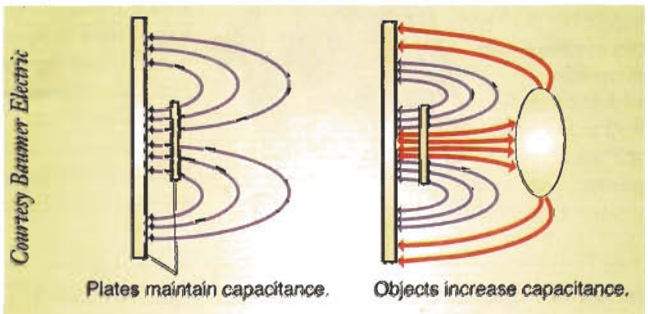
If false triggers may pose a problem, sometimes *inductive sensors* are recommended instead of capacitive when detecting metal objects — as these sensors aren't tripped by nonconductive materials.

How accurate are capacitive sensors?

Target size, shape, and environment affect accuracy, but on the sensors themselves, sometimes special shields keep plate potential consistent over the entire face. Too, some plate faces are diamond polished for smoothness and resolution to the sub-micron level, for accuracy of the same. Closed-loop control eliminates hysteresis and drift inaccuracy.

Electrical noise (always present in electronics) does degrade resolution. It's related to bandwidth (the frequency at which output voltage drops about 70%) so it's important to select a sensor capable of operation at a given system's bandwidth. Sometimes noise is reduced with high-frequency filtering before output.

Capacitance to the max



As objects enter a capacitive sensor's detection zone, capacitance increases; circuit natural frequency shifts towards an oscillation frequency, causing amplitude gain.