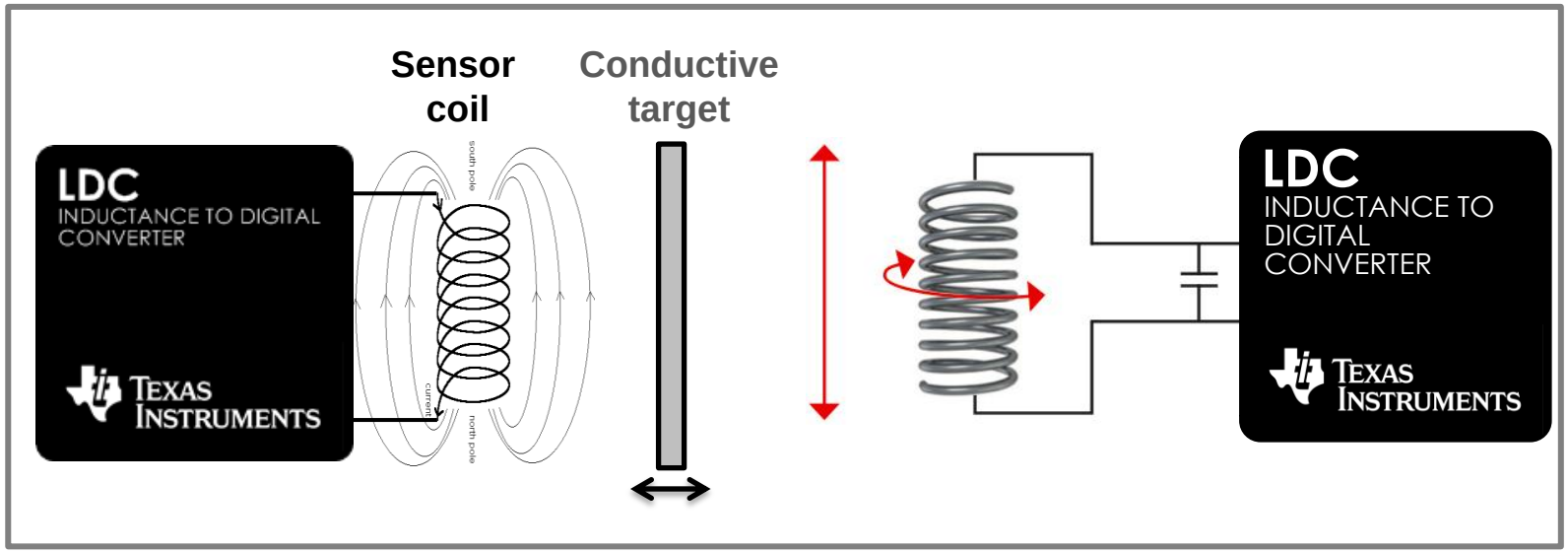
Inductance-to-Digital Converters (LDCs) for Inductive Sensing

LDC Enables Inductive Sensing

Inductive Sensing

Inductive sensing



Benefits

Advantages of Inductive Sensing:

- Does not require magnets
- Reliable by virtue of being contactless
- Insensitive to environmental contaminants (dust, dirt, etc.)
- Sub-micron resolution
- Sensor is low-cost
- Electronics can be located remotely from the sensor

Target markets and applications

Industrial

Automotive

Consumer

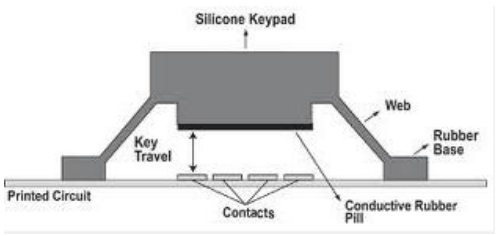
Medical

Computing & Mobile Devices

Communications

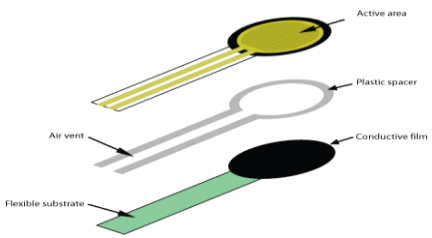
Existing sensing technologies

OHMIC (ON/OFF)



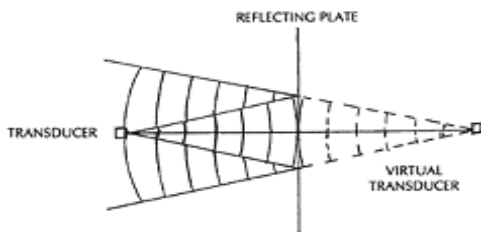
Unreliable in dirty environments

FSR (PRESSURE)



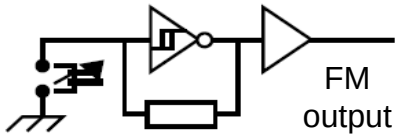
Limited resolution, not for distance sensing

ULTRASONIC



Not suited for short-range sensing

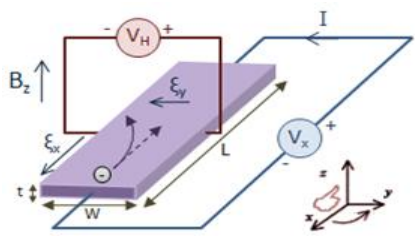
CAPACITIVE



Variable capacitance

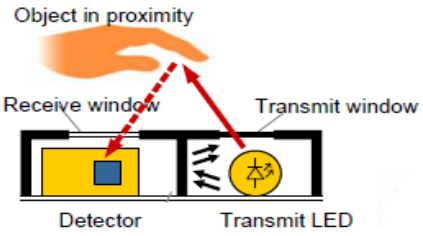
High sensitivity, poor selectivity

HALL



Requires magnets and calibration

OPTICAL

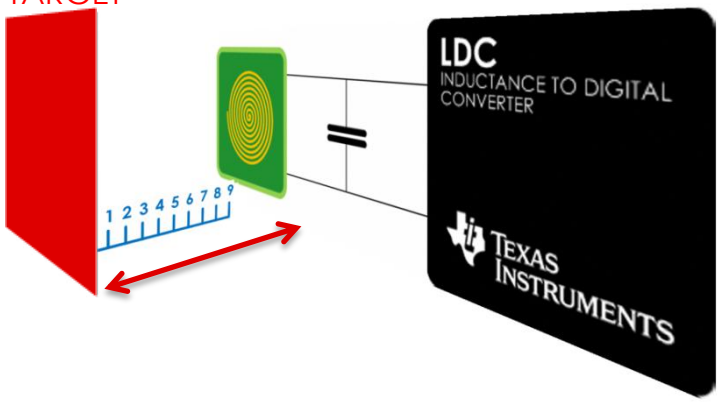


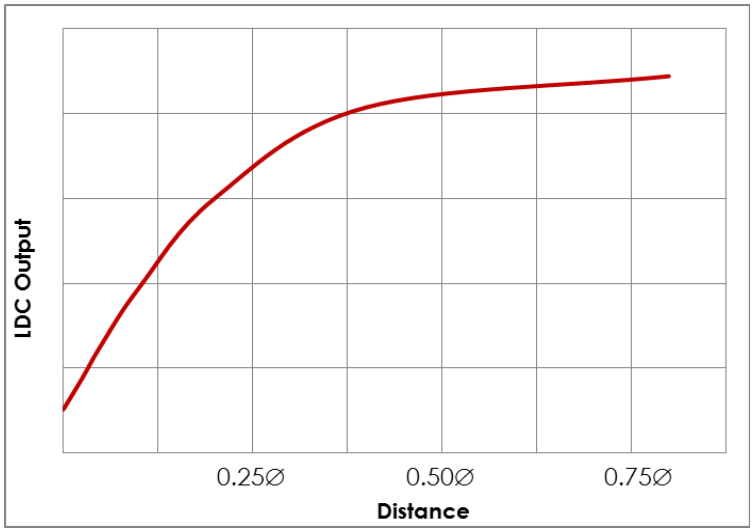
Unreliable in dirty environments

Basic Modes of Operation

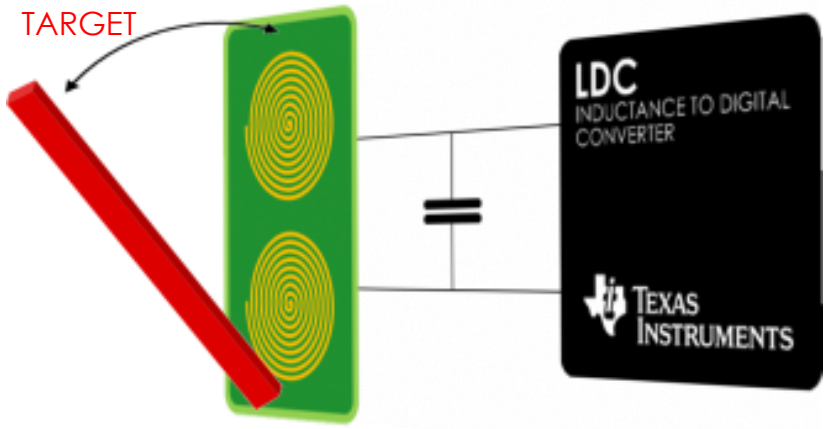
Axial Sensing

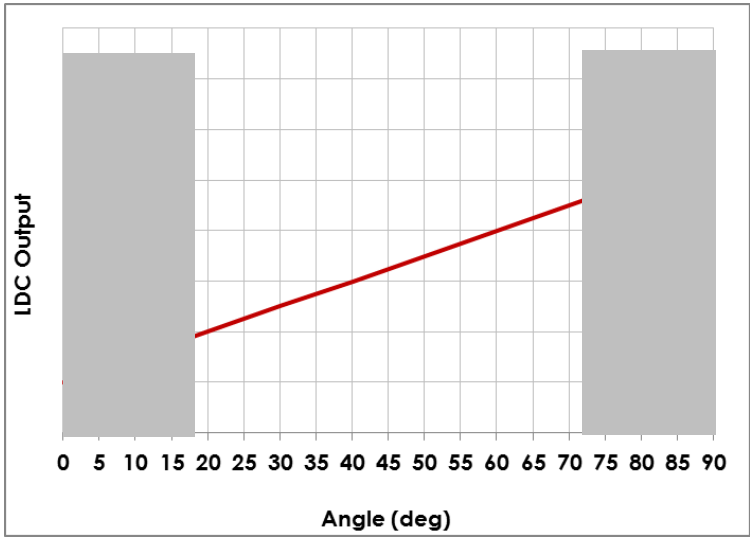
CONDUCTIVE TARGET



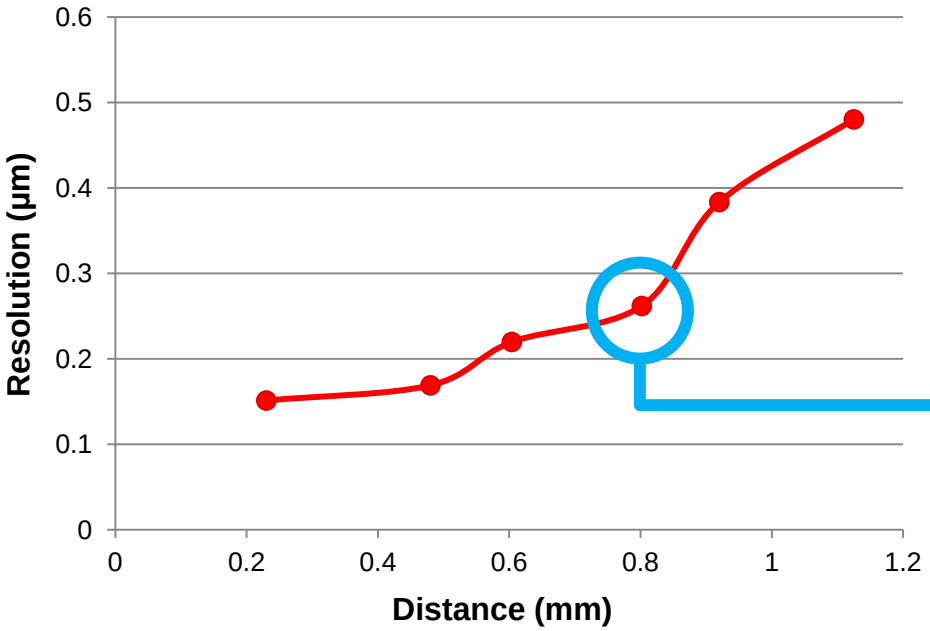


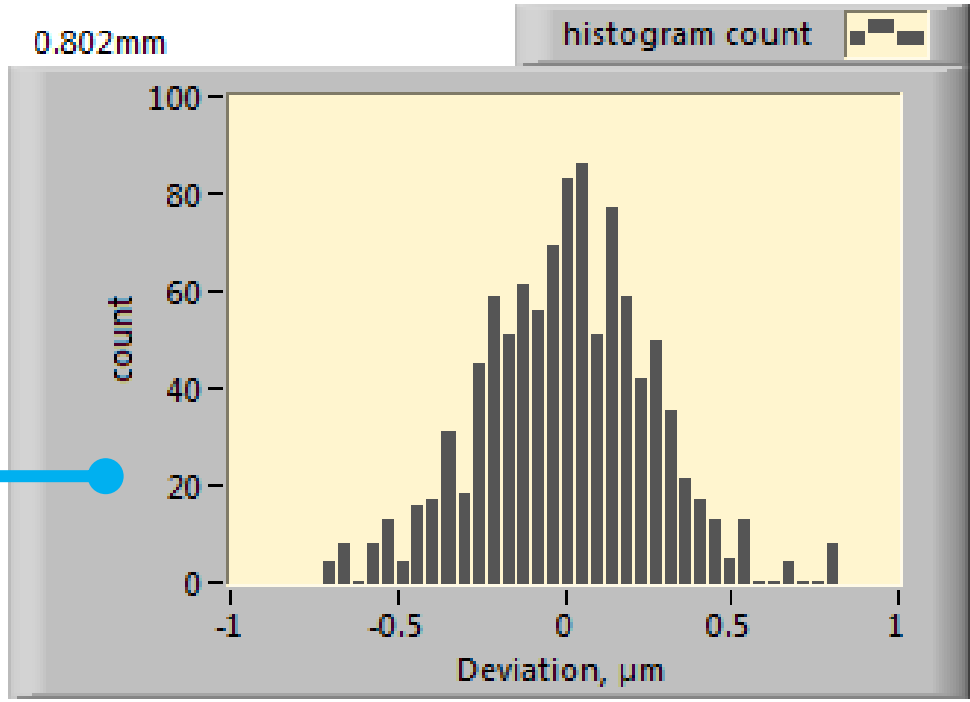
CONDUCTIVE TARGET

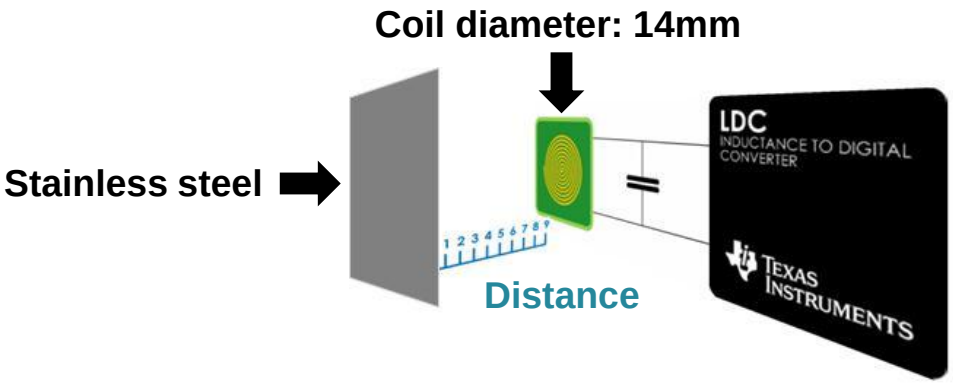




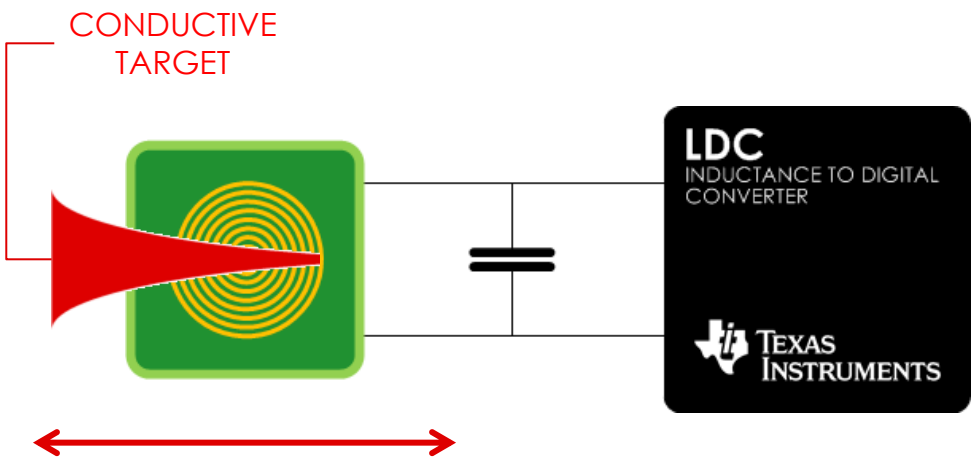
LDC1000 achieves sub-micron resolution

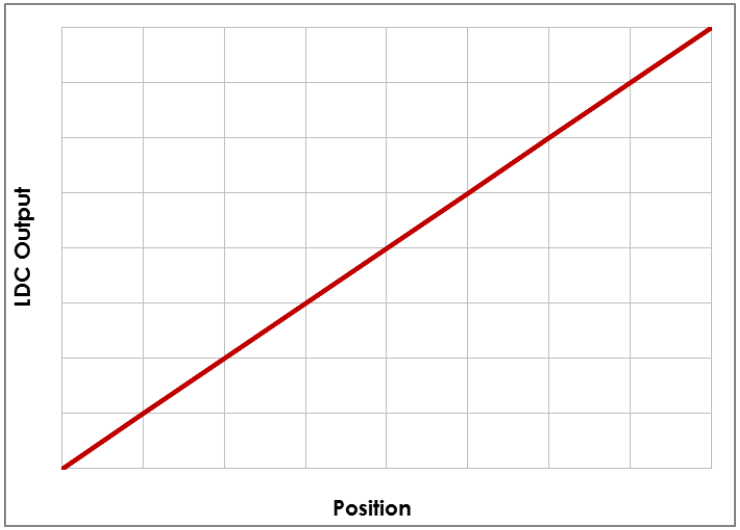


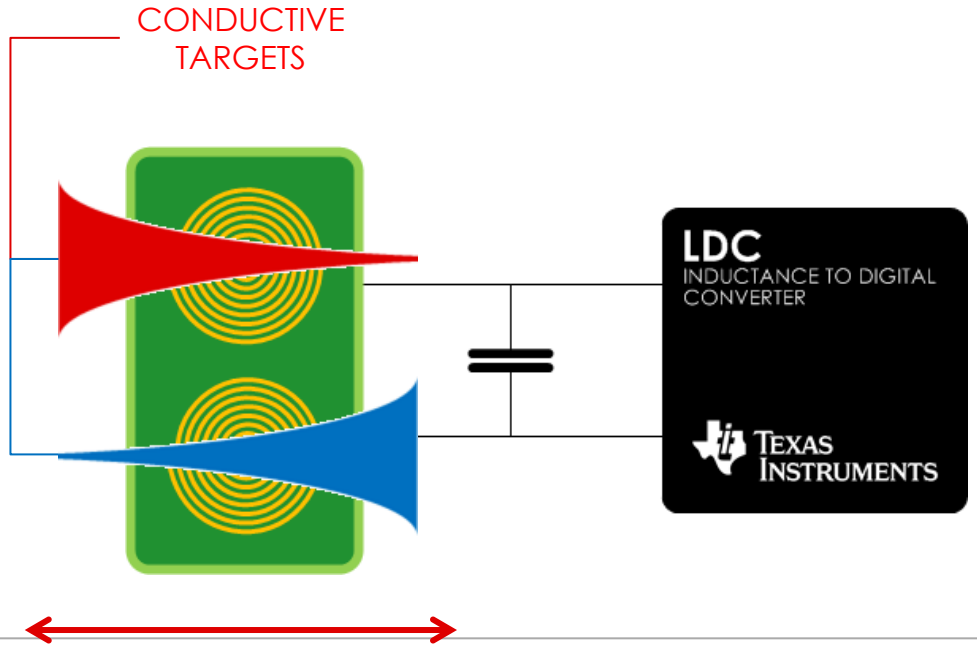


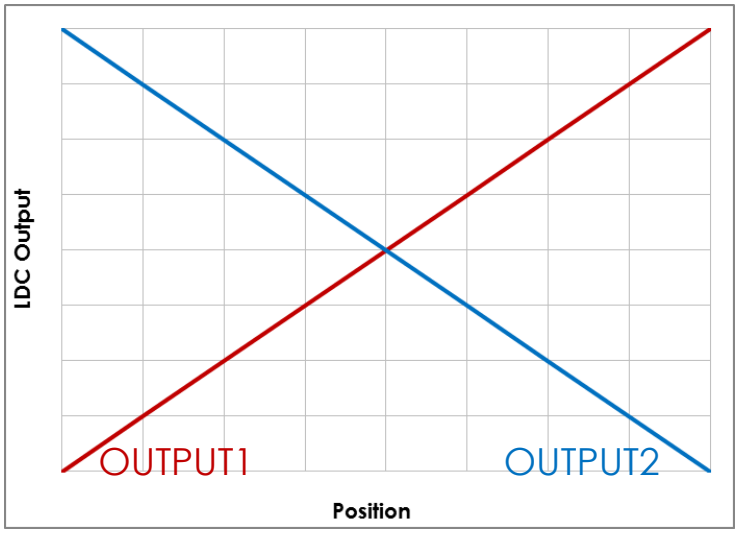


Lateral Sensing



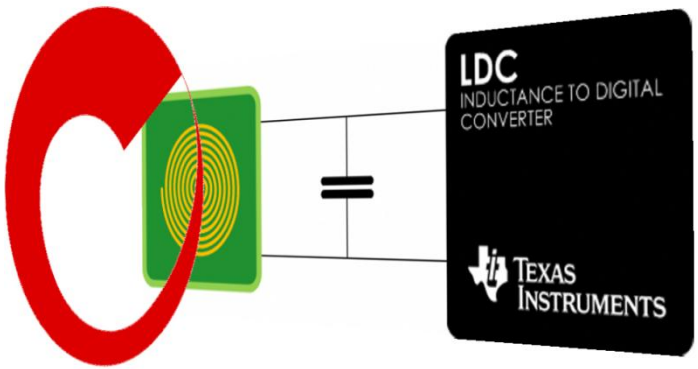


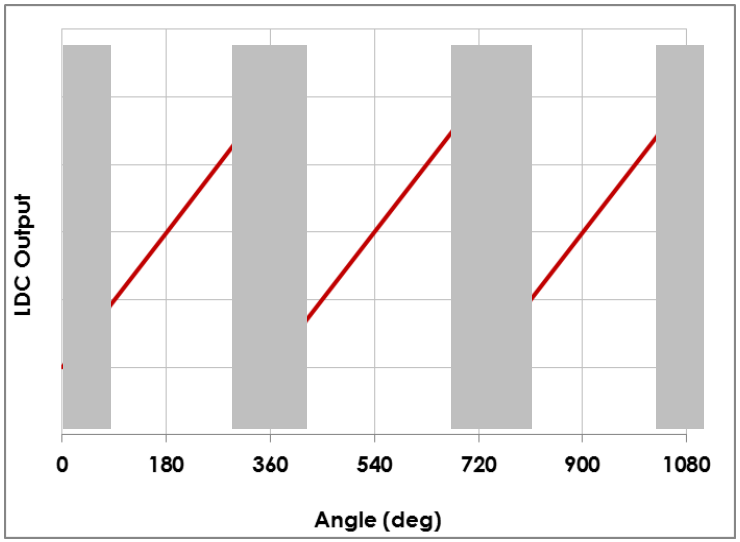




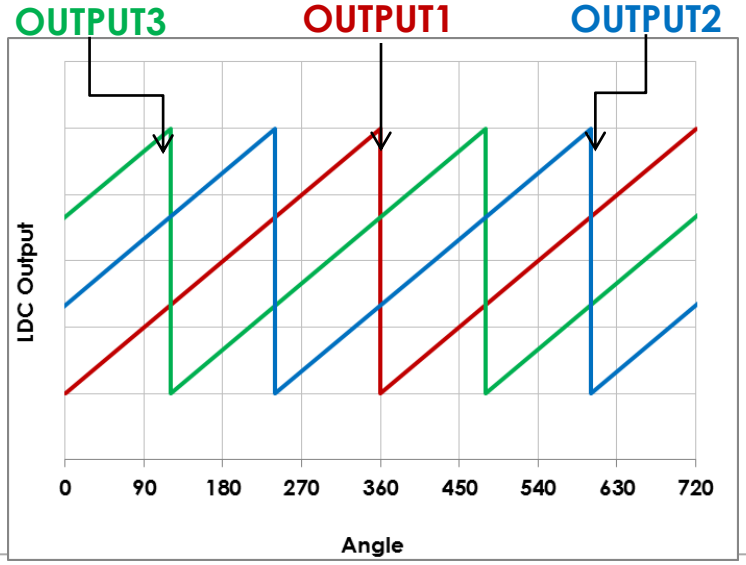
Rotational Sensing

CONDUCTIVE TARGET



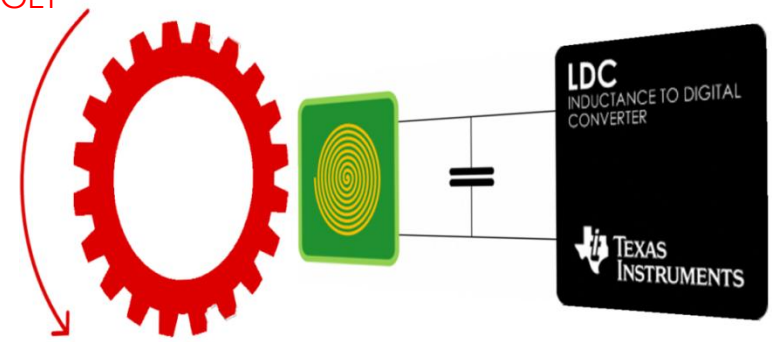


CONDUCTIVE TARGET

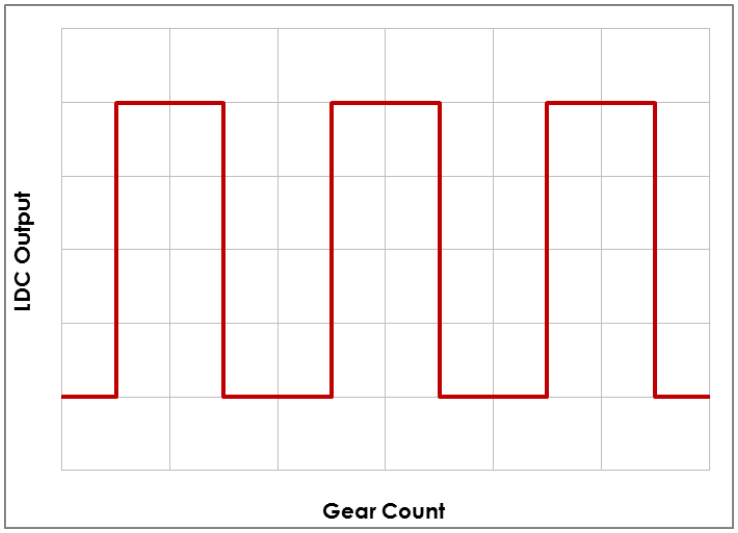


Event Counting

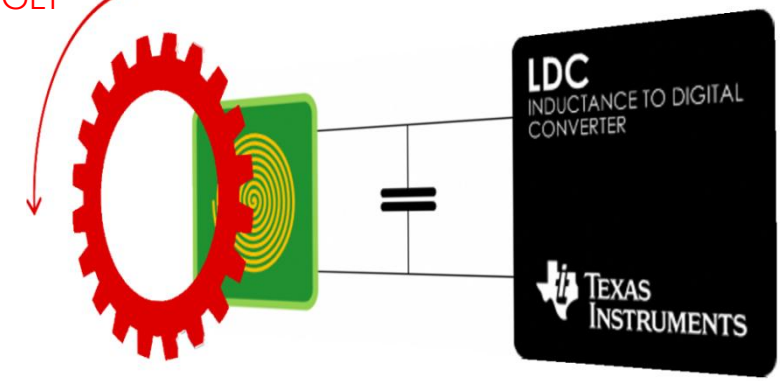
CONDUCTIVE TARGET



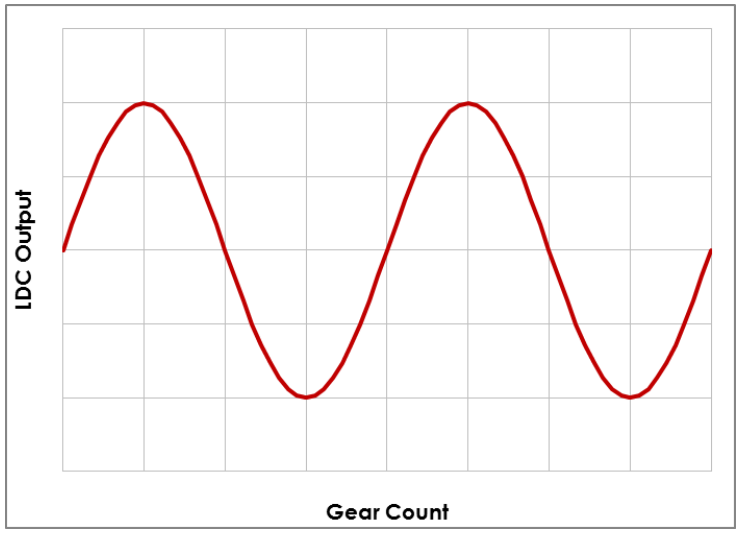
Axial: Target perpendicular to coil



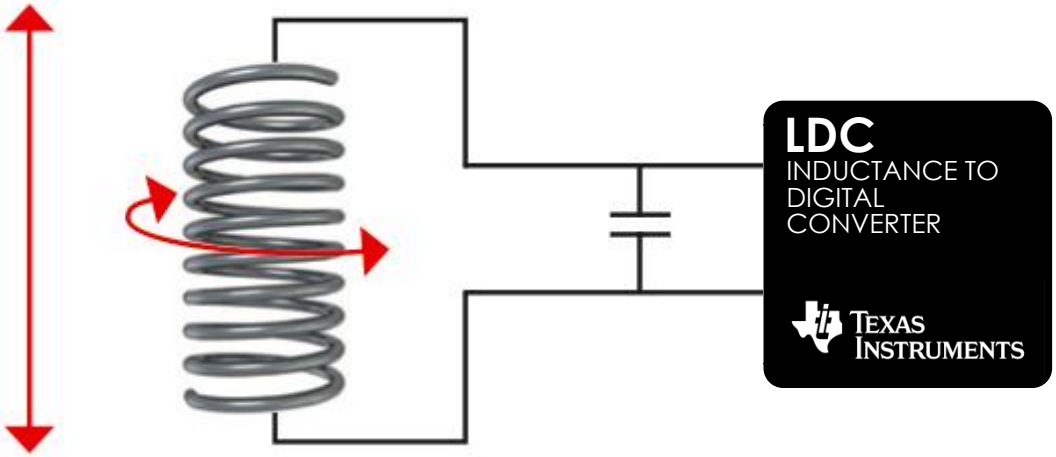
CONDUCTIVE TARGET



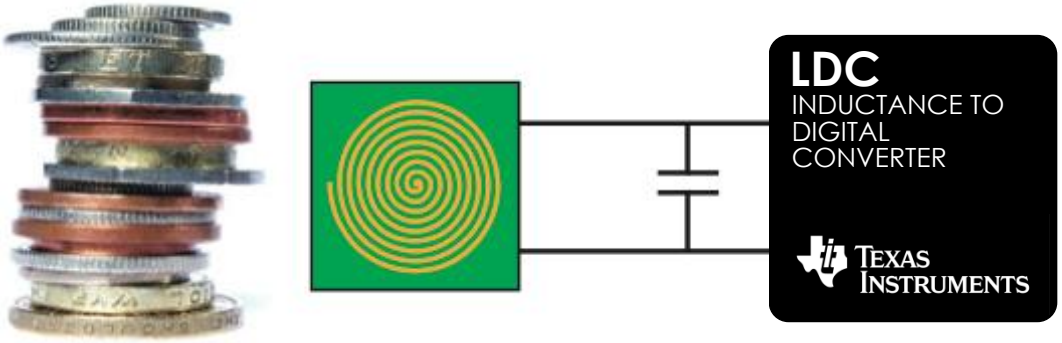
Lateral: Target parallel to coil



Spring and metal sensing



Compression, extension and twist using a spring as a sensor



Metal composition identification

LDC1000
5.0V LDC, High-Res, 1-Channel

Specs

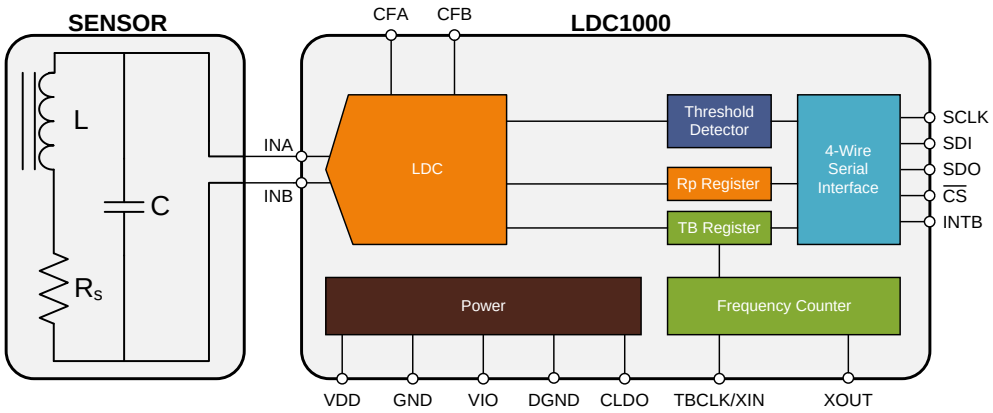
- Supply Voltage = 5.0V
- Current Consumption (Active) = 1.7mA
- Current Consumption (Sleep) = 250uA
- Channels = 1
- Oscillation Frequency = 5kHz-5MHz
- Resolution = 16-bit (Rp) / 24-bit (L)
- Output = 4-Wire SPI
- Temperature Range = -40C/+150C
- Package = SON16

Benefits

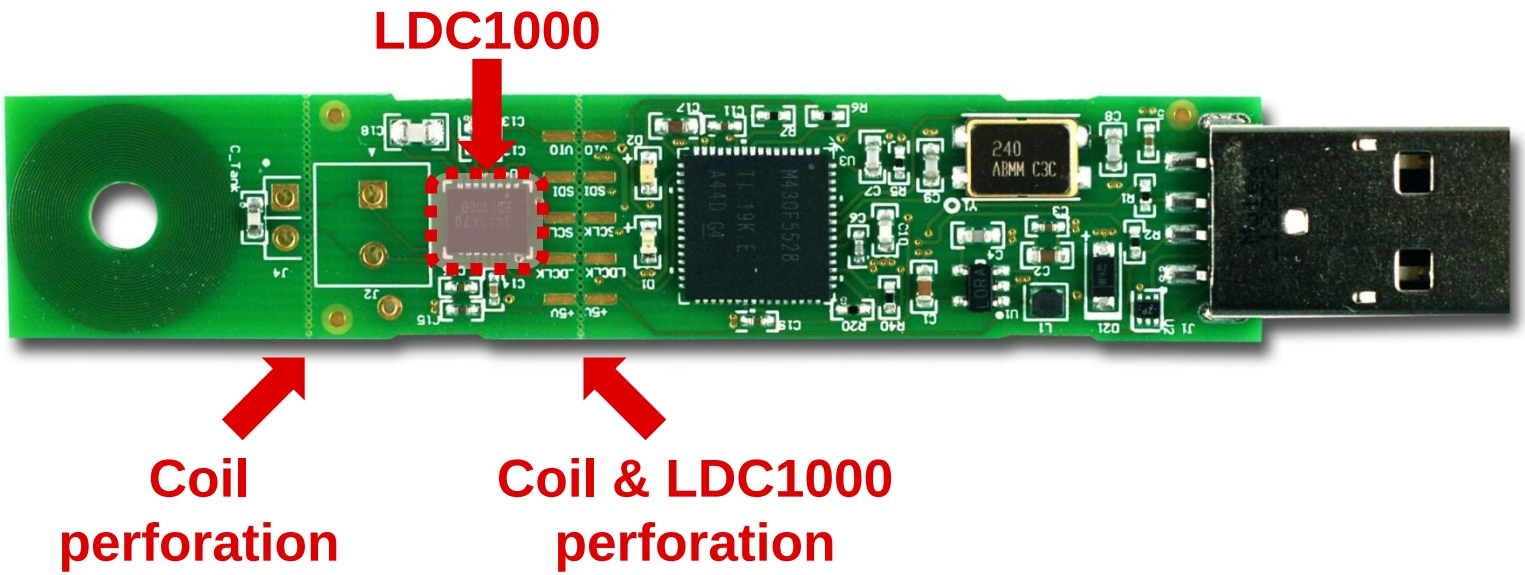
- Magnet-free operation
- Adjustable sensing range via coil design
- Lower system cost using PCB sense elements
- Remote sensor placement
- High durability/contactless technology
- Insensitivity to environmental interference (dirt, dust, water)
- High Resolution

Applications

- Paper Stack Height measurement
- High-Precision Position measurement
- High-Precision Angle measurement



Explore with LDC1000EVM



- EVM and GUI provide complete prototyping and evaluation platform
- USB interface allows control and evaluation of LDC1000 with GUI
- Includes 14-mm, 2-layer PCB coil sensor
  - Coil can be removed to allow prototyping with other coils, springs or inductors
- Coil and LDC1000 board section can be removed
  - Interface with other MCUs
  - Implement multi-channel prototyping

Inductive Sensing Demo Kit

Inductive Sensing Demo

WEBENCH®
Inductive Sensing Coil Designer

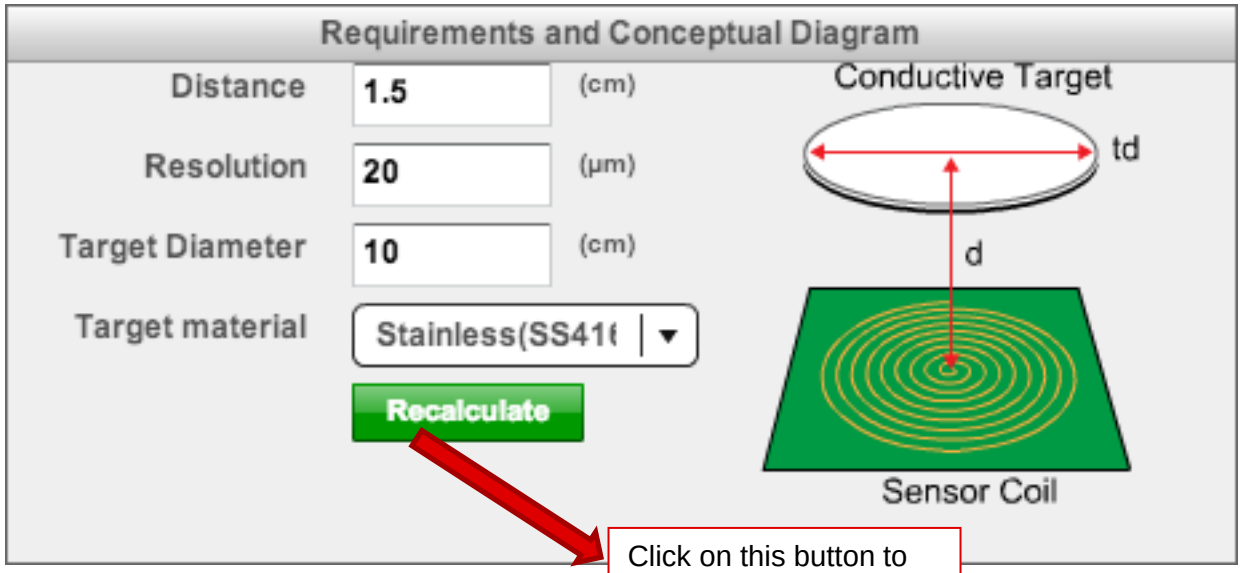
Webench® Inductive Sensing Designer

Key functionalities:

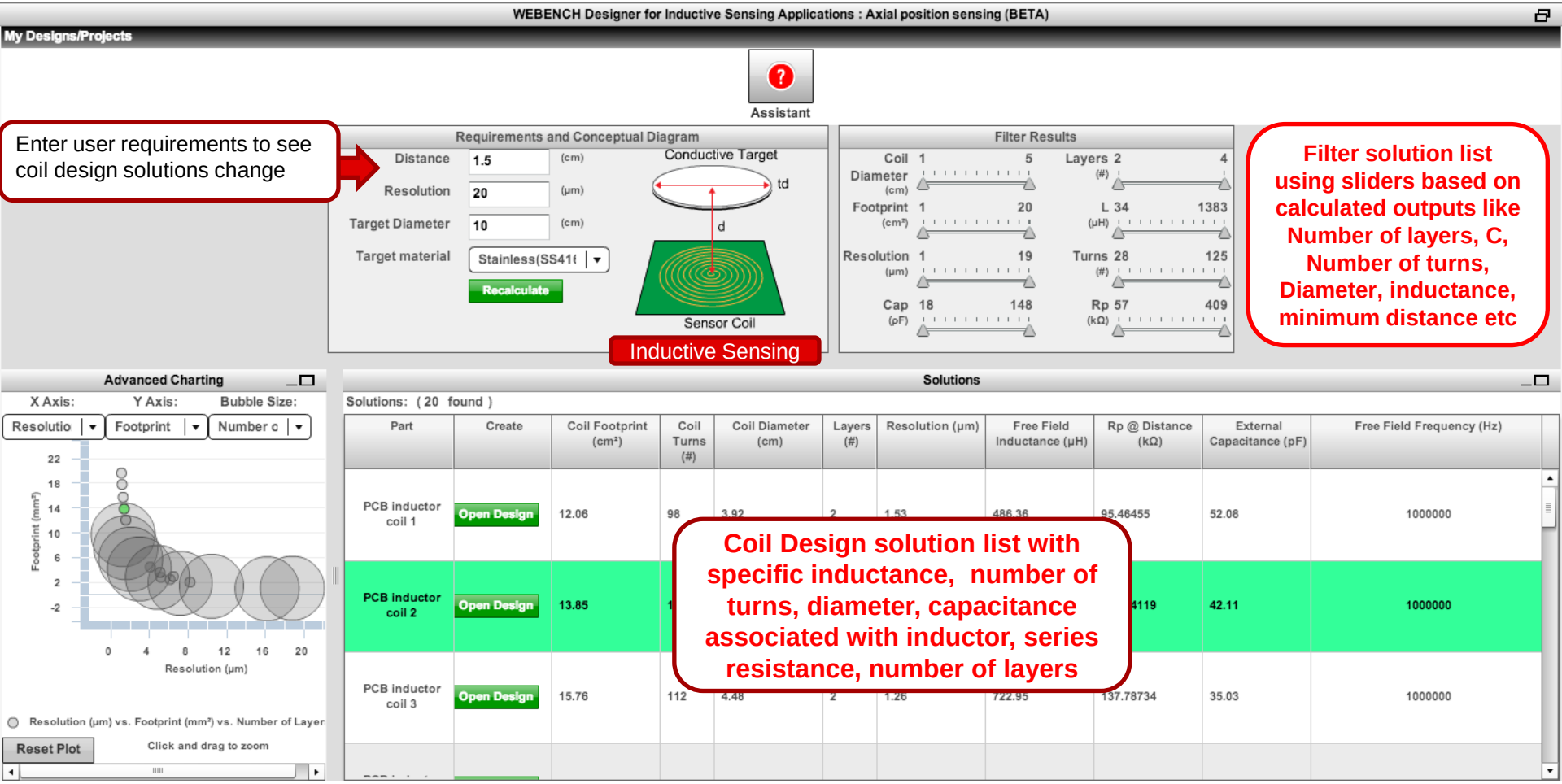
- Online tool to design sensor coils
- Provides analysis of the coil and related system characteristics
- Generates PCB layout of the selected coil
- Exports PCB layout to user’s preferred CAD software

Webench® Tool – Requirements gathering

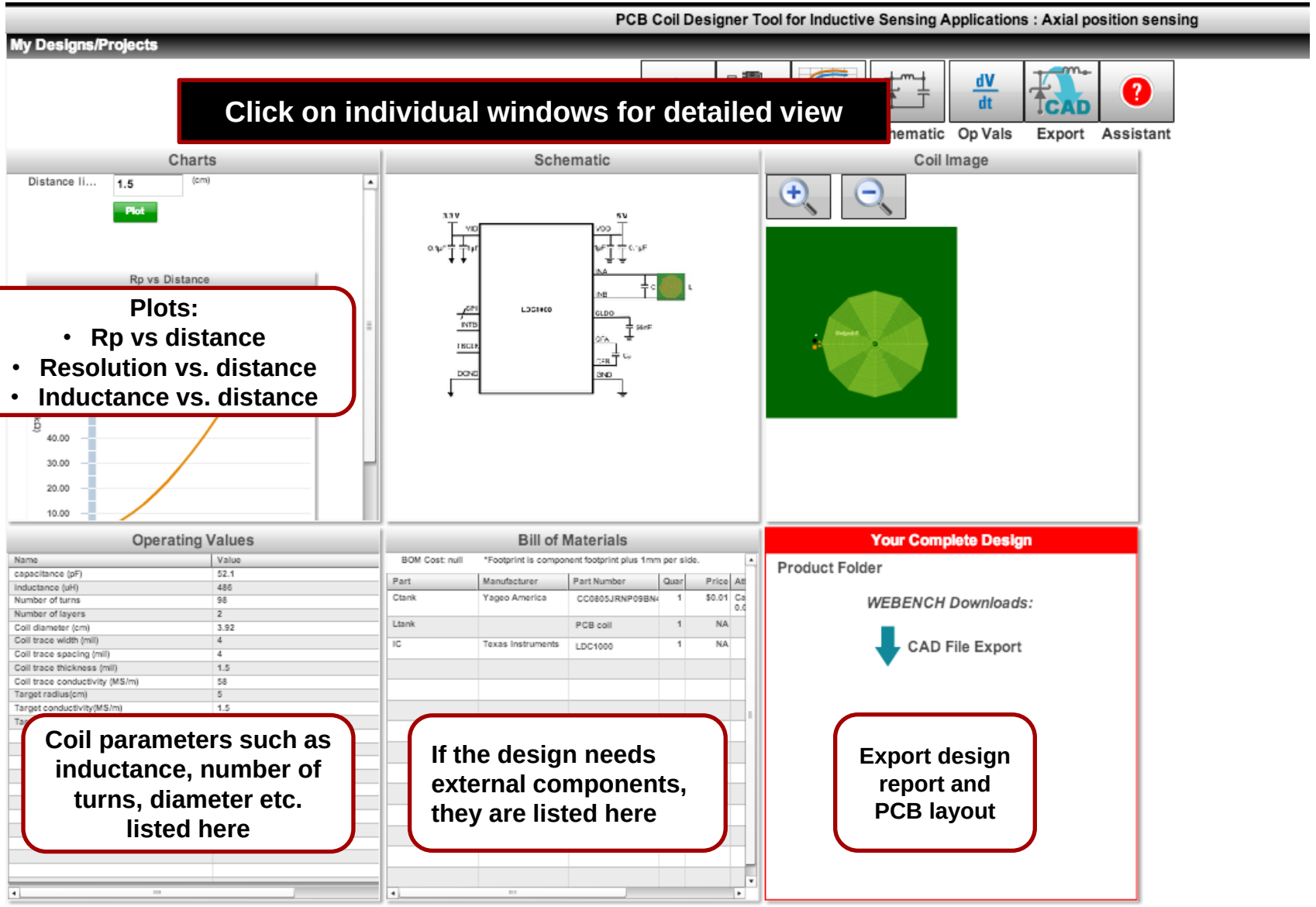
- User fills in basic requirements
  - Maximum distance to be measured.
  - Precision.
  - Metal target type (radius and material).
  - Size limitations, if any (example – max area/diameter of coil).



Webench® Tool – Coil Design Solution look

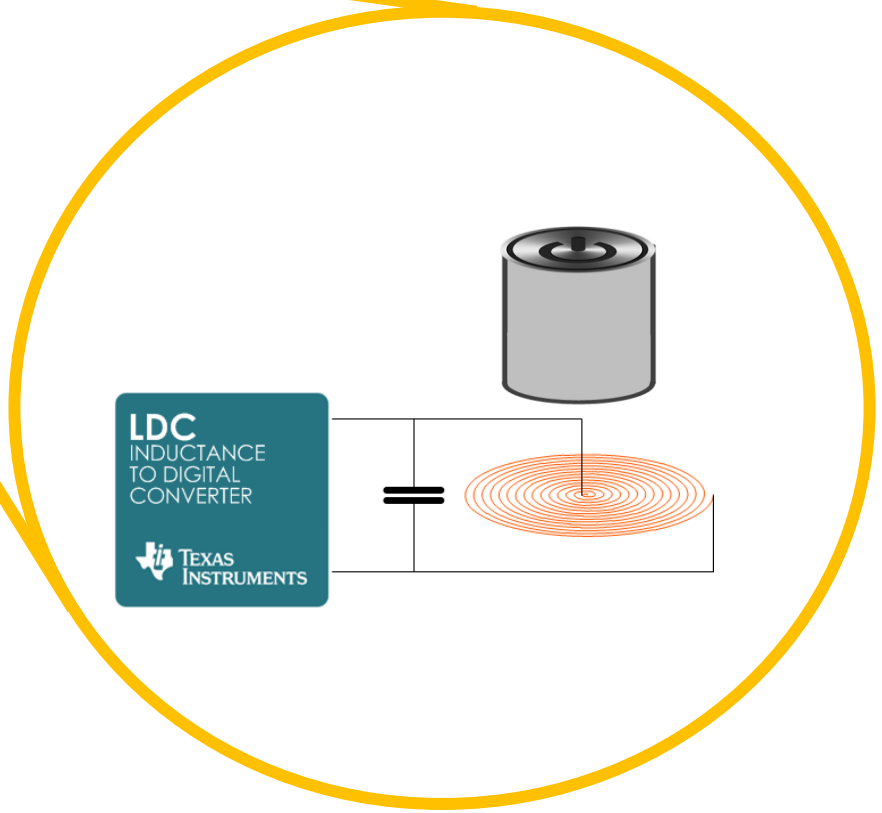


Webench tool – Design Summary



Applications

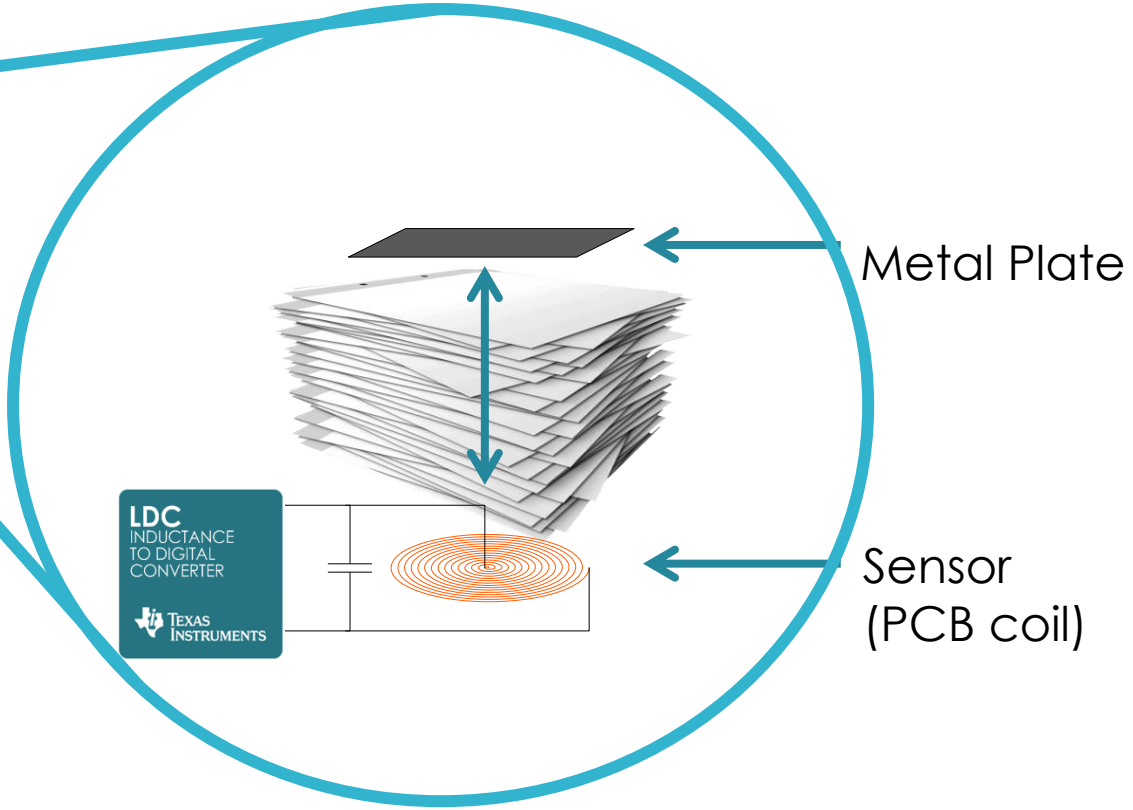
Buttons



Buttons on game controllers can be made more reliable with contactless implementation. When a button crosses set threshold, it is detected by the coil

Paper Stack Height

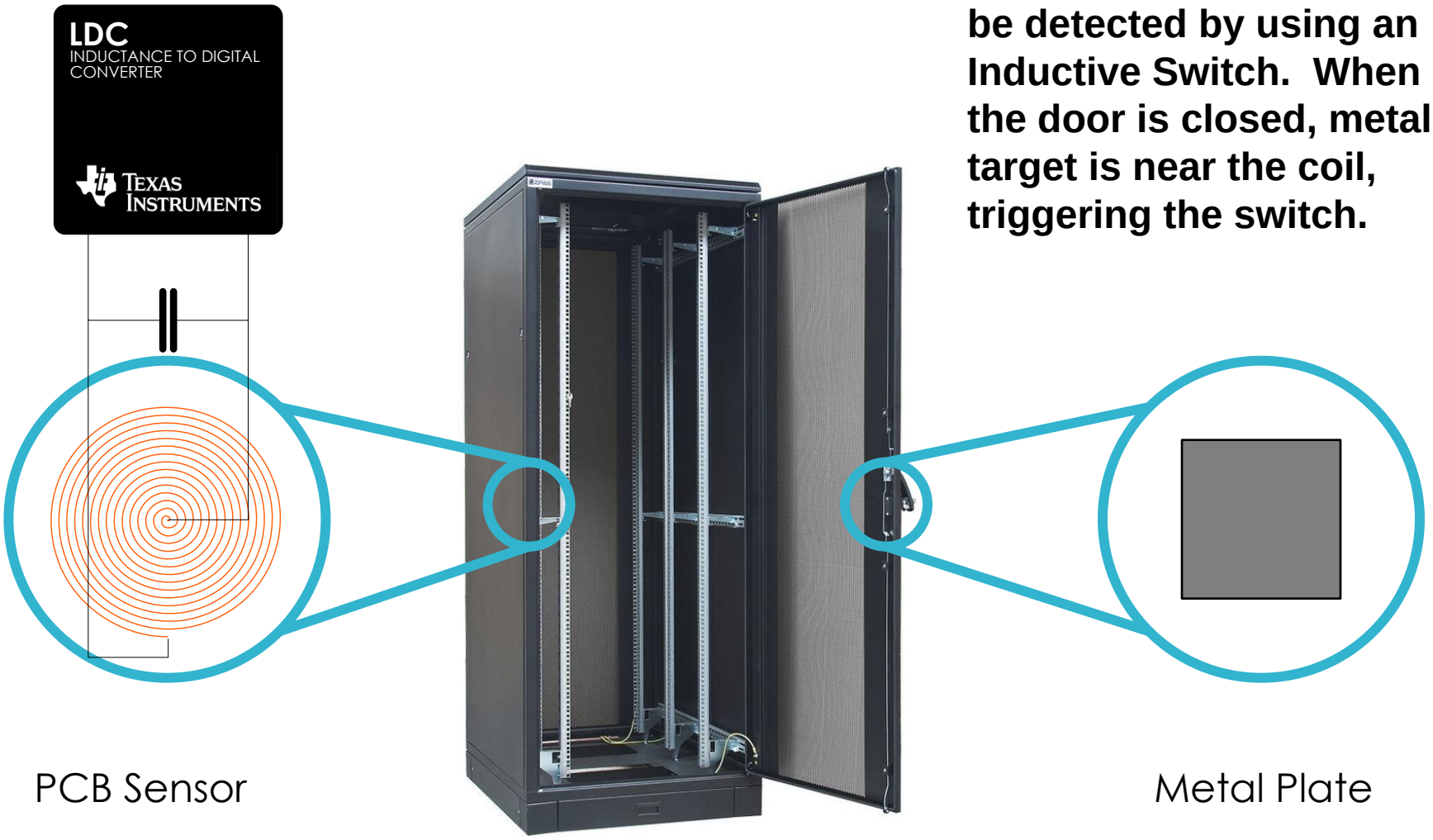
Paper stack height measurement can be done by placing a coil under the stack, and a metal target on top.



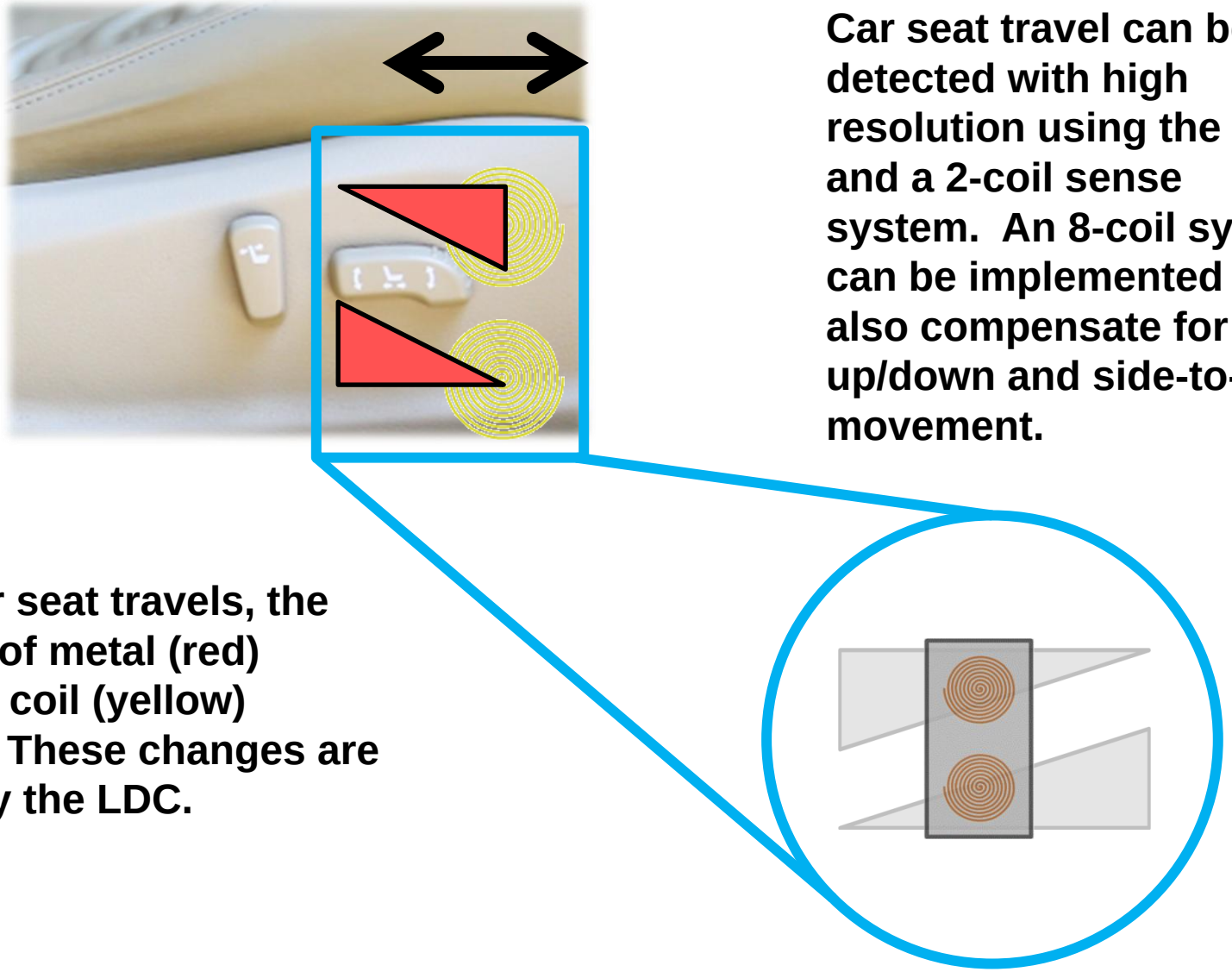
Number of sheets can be calculated by dividing the measured distance by sheet thickness.

Door Open/Closed

Open/Closed doors can be detected by using an Inductive Switch. When the door is closed, metal target is near the coil, triggering the switch.



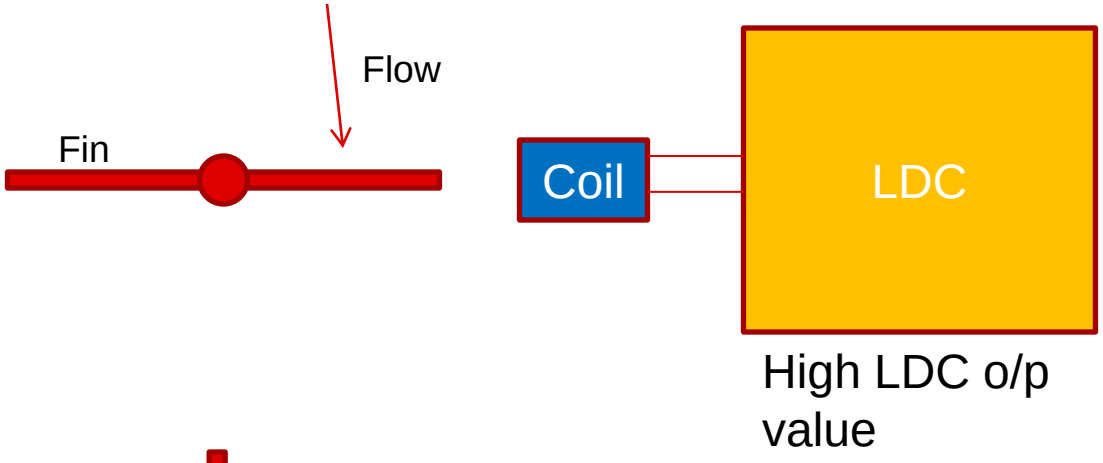
Car Seat Travel



Car seat travel can be detected with high resolution using the LDC and a 2-coil sense system. An 8-coil system can be implemented to also compensate for up/down and side-to-side movement.

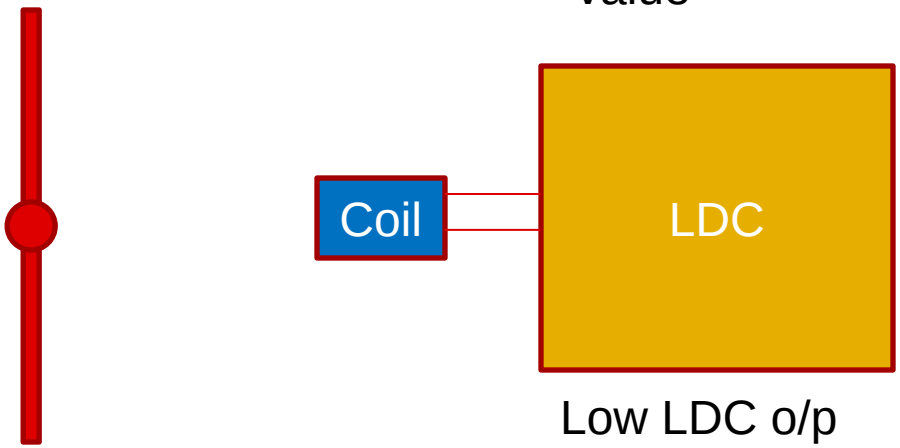
As the car seat travels, the coverage of metal (red) above the coil (yellow) changes. These changes are tracked by the LDC.

Turbine Flow Meter



High LDC o/p value

Metal Fin of the flow meter inside the sensing range.

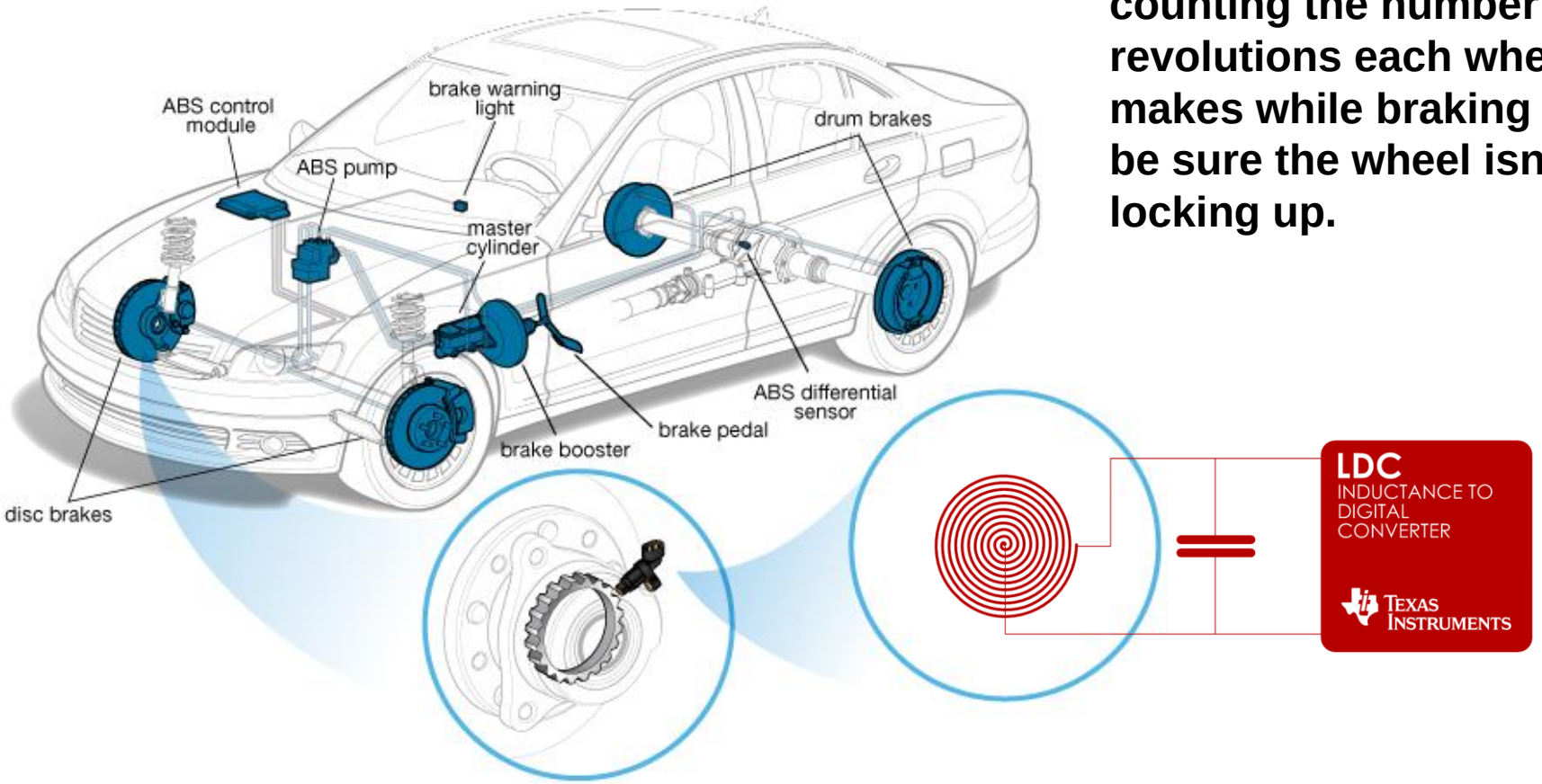


Low LDC o/p value

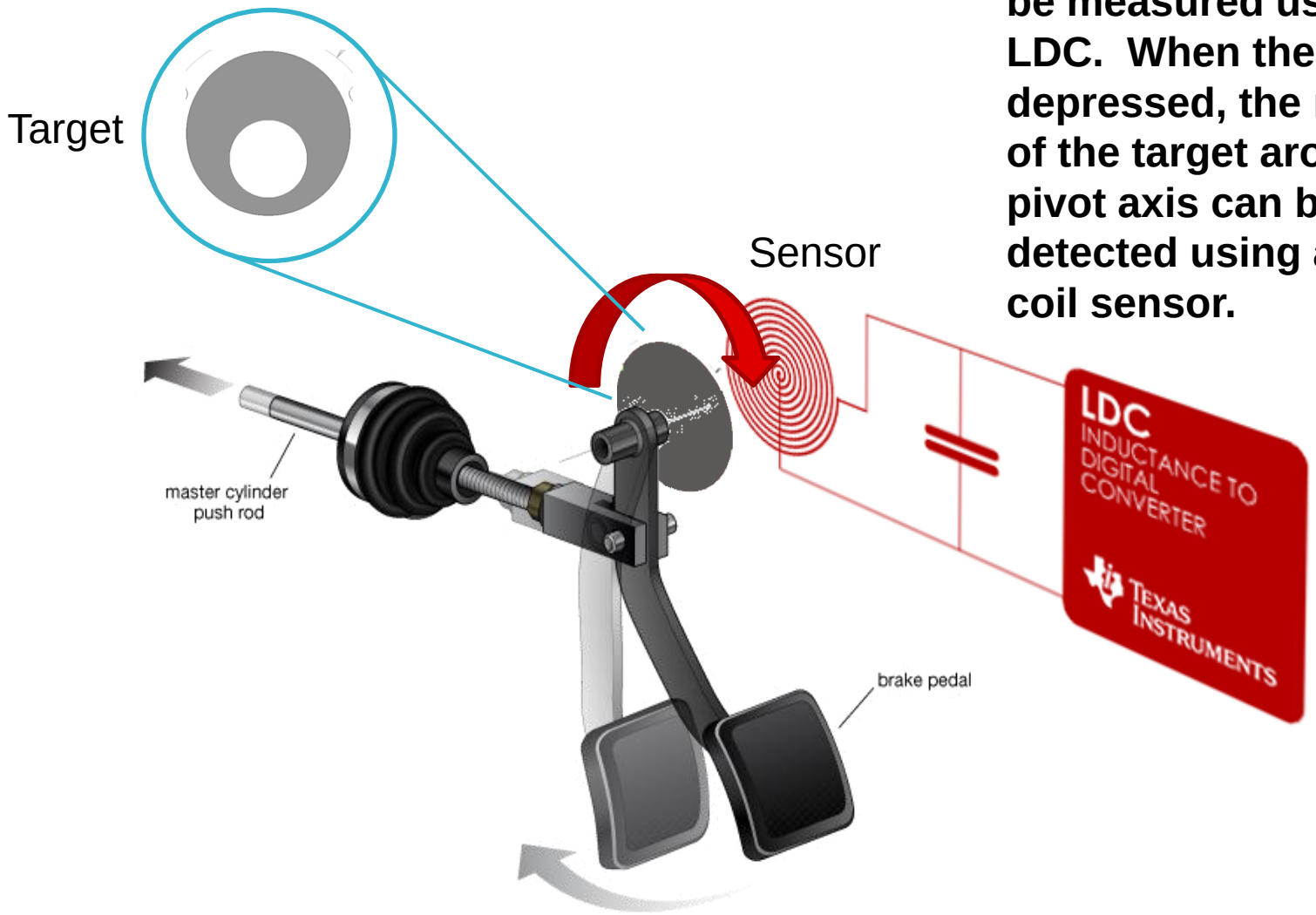
Metal Fin of the flow meter outside the sensing range.

ABS Wheel Speed Sensor

LDC with an LC tank can be used as an ABS wheel speed sensor. Such sensor measures the speed of each wheel by counting the number of revolutions each wheel makes while braking to be sure the wheel isn't locking up.



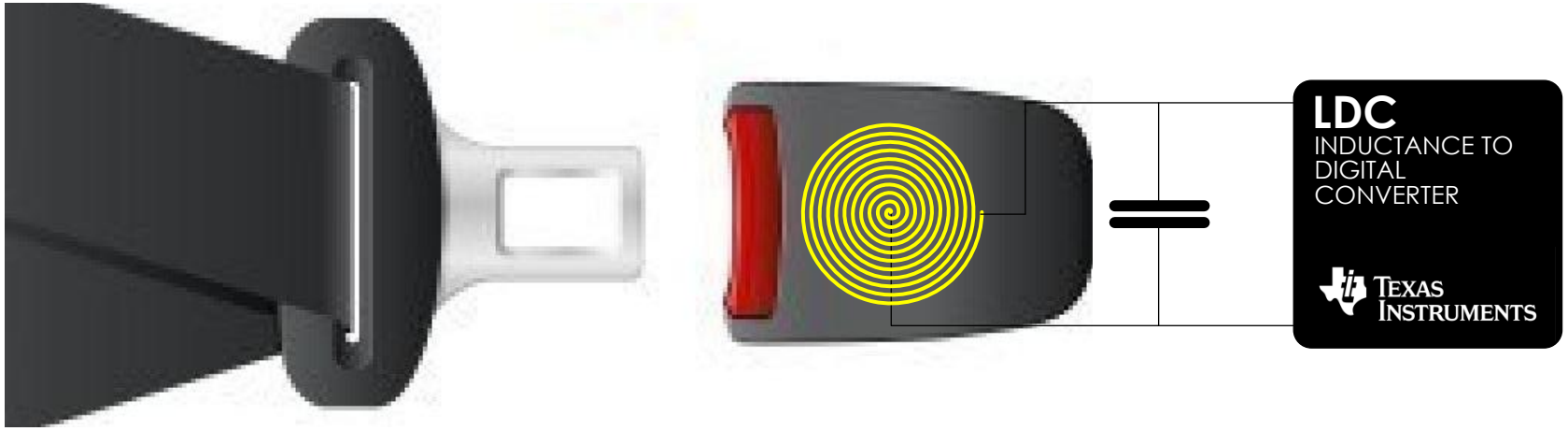
Brake Pedal Position Sensor



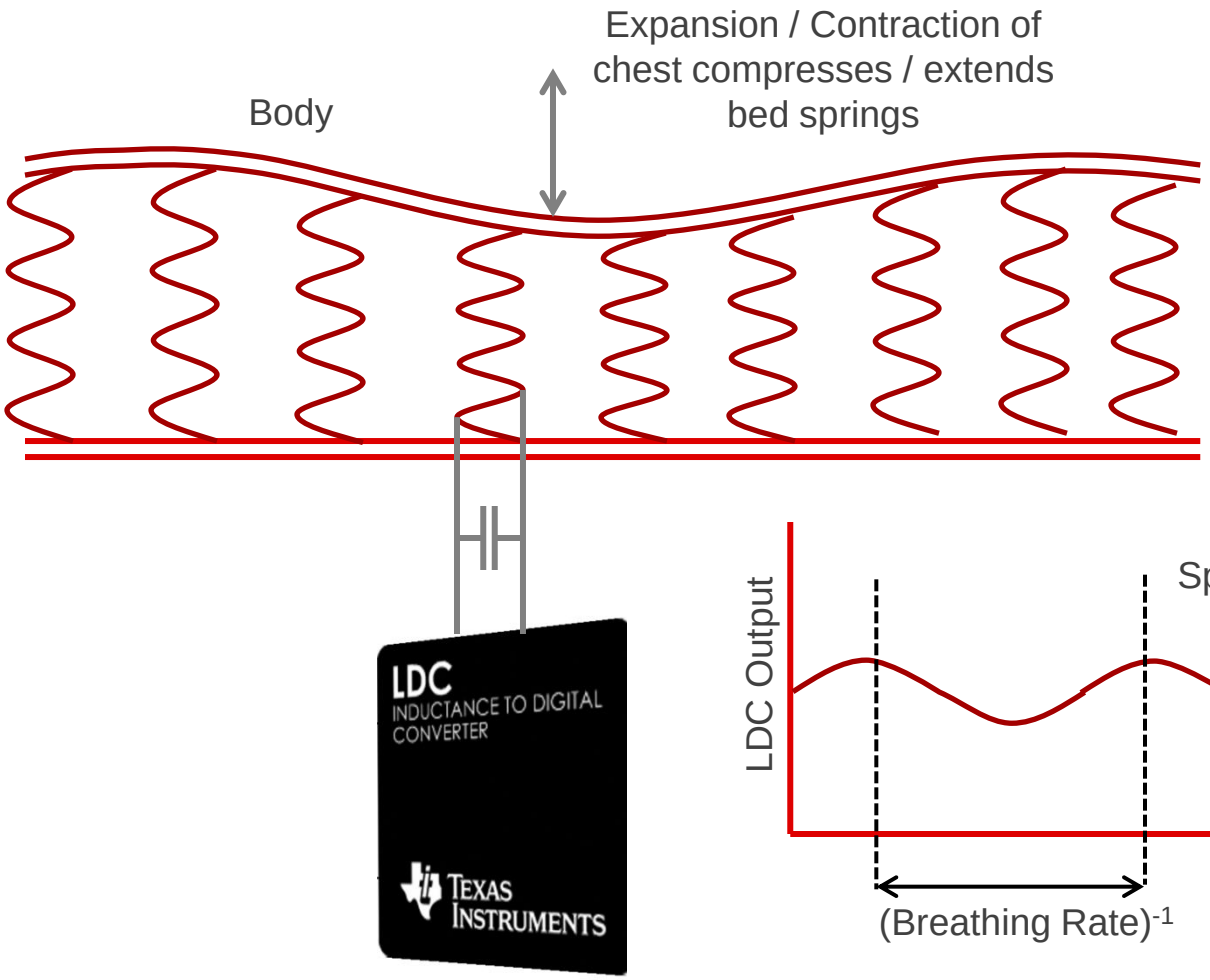
Brake pedal travel can be measured using the LDC. When the pedal is depressed, the rotation of the target around the pivot axis can be detected using a PCB coil sensor.

Seatbelt Buckle Detection

PCB coil inside the buckle can be used as a sensor (LC tank). The insertion of the seatbelt buckle generates losses in the LC tank which can be detected by the LDC.



Spring Motion Monitoring
Non-Contact Breathing Monitor



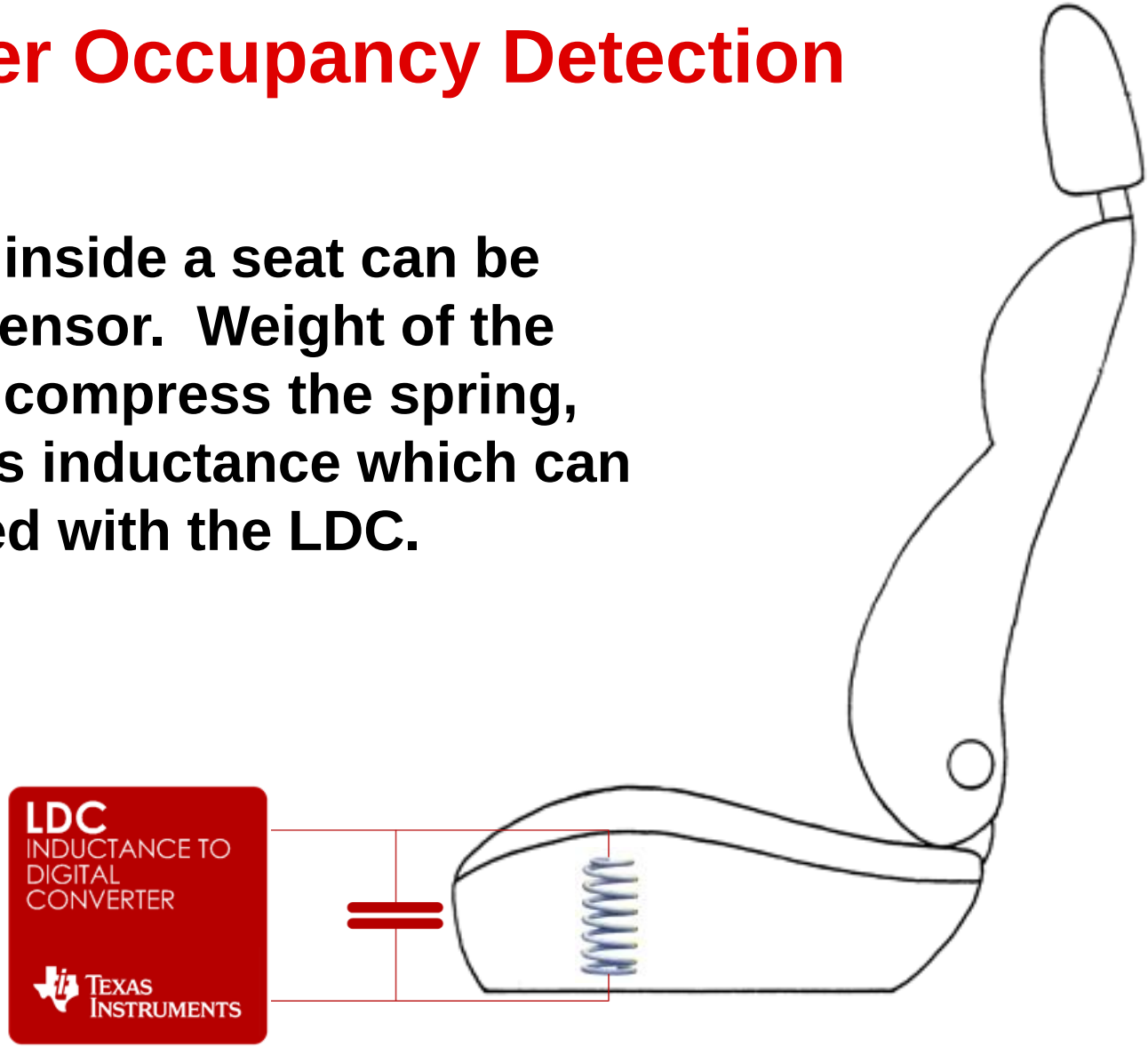
Example use cases:

- Baby crib monitoring
- Infant bed monitoring
- Elderly care
- Hospital care
- Patient transport monitoring

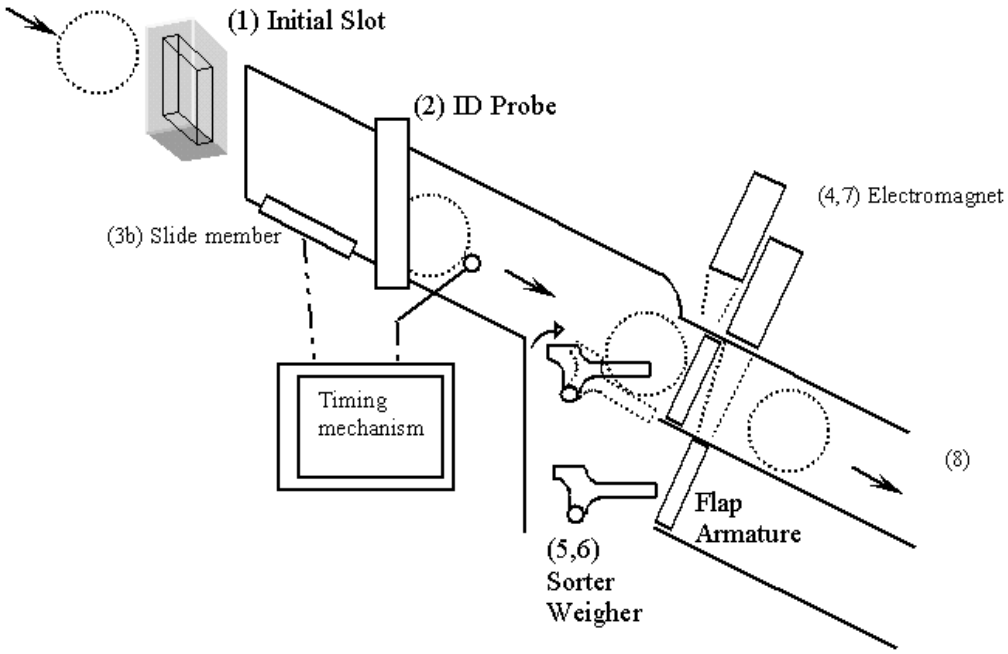
Periodicity of LDC response is reciprocal of breathing rate

Passenger Occupancy Detection

Coil spring inside a seat can be used as a sensor. Weight of the person will compress the spring, changing its inductance which can be measured with the LDC.



Metal Identification



can detect metal composition/type by eddy current loss signatures