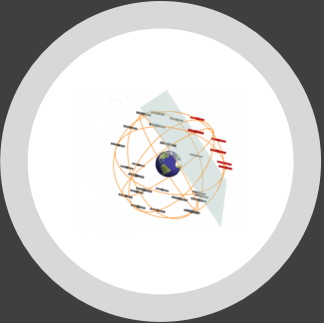# Distance Sensors

Jared Allain and Devin Crowley

ENGR 325

Distance Measurement

- Transmitter-Receiver types
  - IR, **LIDAR**, Ultrasonic, RADAR, GPS
- Other types
  - LVDTs, Draw Wire, Capacitive displacement

GPS

GPS Overview

- Driving directions
- Airplane navigation
- Hiking navigation
- Device tracking
- Construction layout
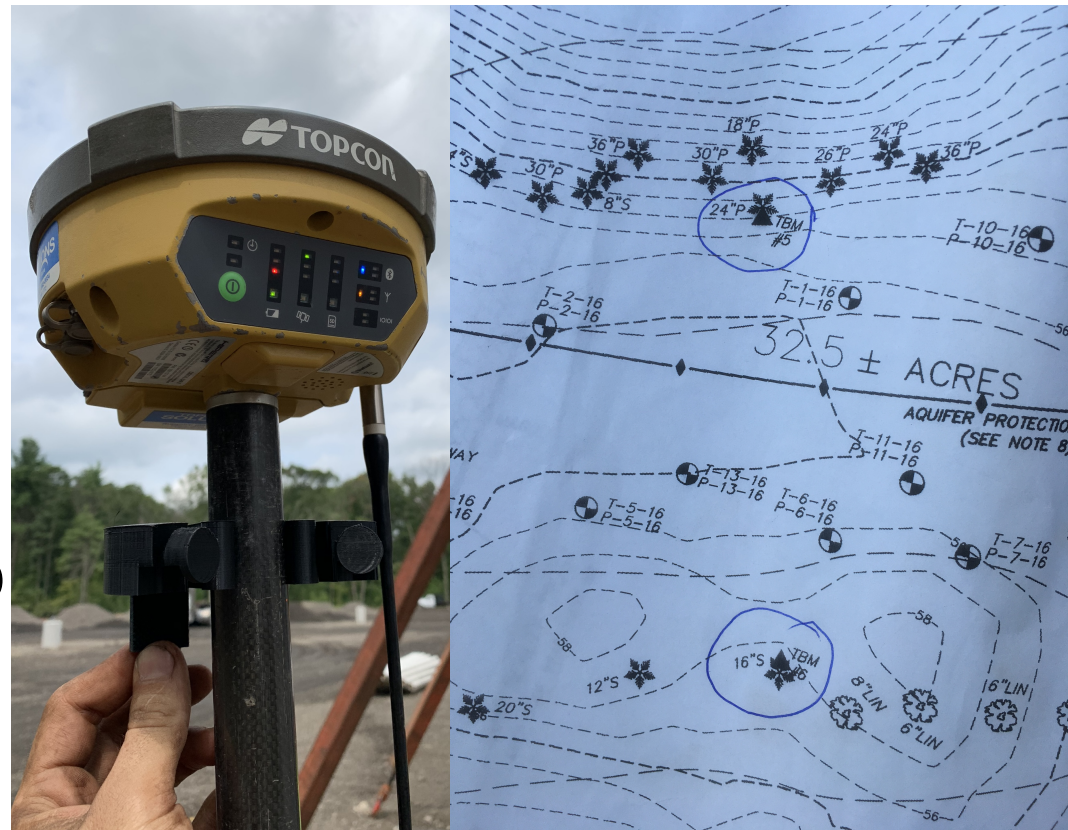- Construction automation

Topcon GPS System

- Rover

- Base

- Data Collector

- Cat D6 Automation

The Base

- Receives the same GPS signal that your cell phone uses. This gets the accuracy down to +- 30 ft.

- Must be localized with surveyed control points to get accuracy down to +- .01 ft

- Sends out real time kinematic (RTK) corrections over a radio signal to other rovers

The Rover

- Receives GPS Signal and RTK corrections via radio signal

- Only capable of xyz sensing

- Excellent for layout

- Excellent for making as-builts

The Data Collector

- A computer that is designed to operate in harsh environments

- Runs Topcon's proprietary software

- Capable of making distance measurement, volume measurements, and many other useful subprograms allow for more extensive data collection

Cat D6 Automation

- This GPS technology can be implemented to automate various machines

GPS System pros and cons

Pros

- Excellent precision and accuracy for most construction applications
- Orders of magnitudes faster than the old-fashioned pulling multiple tapes method
- Only need to call surveyors once
- Speeds up overall site production

Cons

- Steep learning curve for the older guys in the industry
- Very expensive
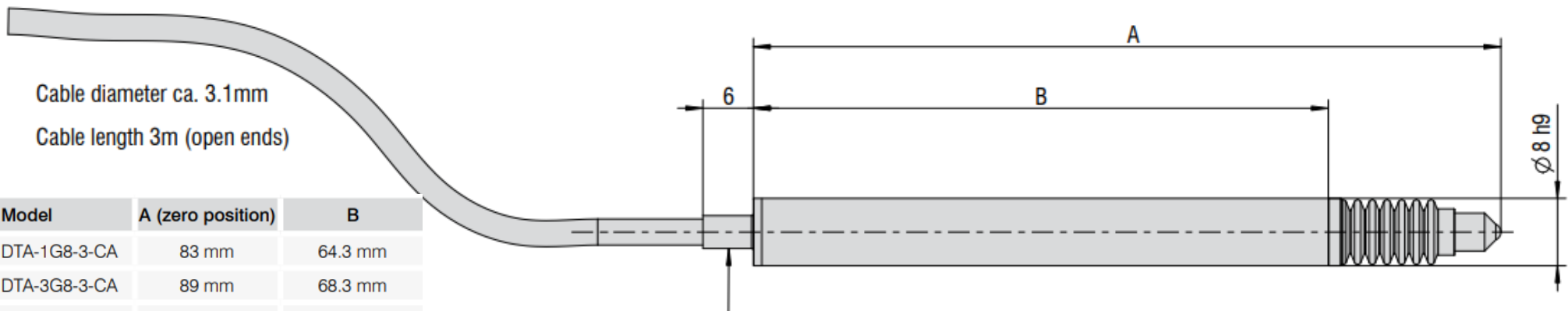- Doesn't work in areas of radio or GPS interreference.

LVDT-Overview

- Linear Variable Differential Transformer

- Inductive Distance Sensor

- High Resolution, Fast Response, Widely Used, Cheap, Robust.

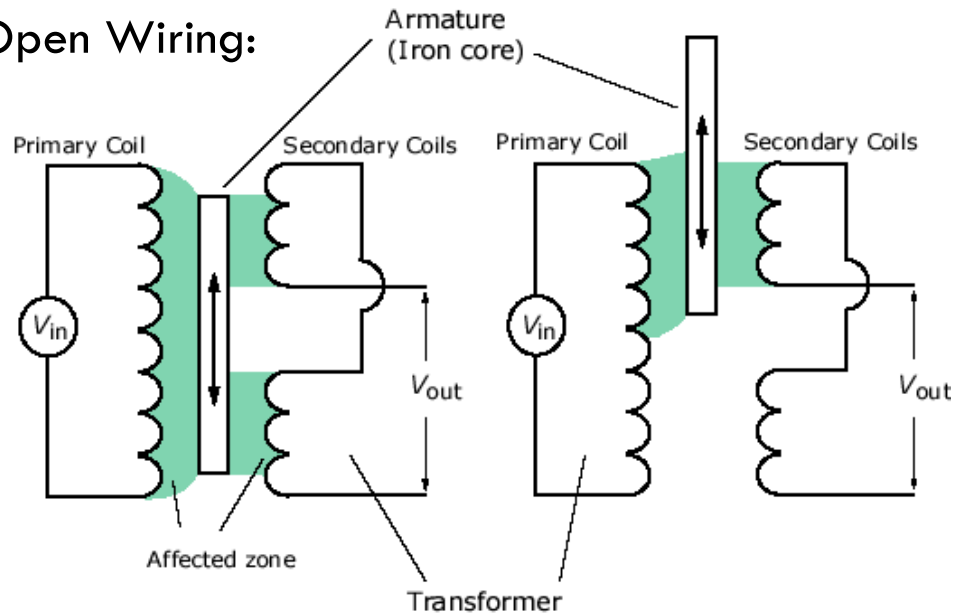**DTA-xG8-3-CA**

Cable diameter ca. 3.1mm

Cable length 3m (open ends)

A

6

B

⌀ 8 h9

Model	A (zero position)	B
DTA-1G8-3-CA	83 mm	64.3 mm
DTA-3G8-3-CA	89 mm	68.3 mm

LVDT-Theory

Open Wiring:

Armature
(Iron core)

Primary Coil   Secondary Coils   Primary Coil   Secondary Coils

V_{in}

V_{out}

Affected zone

Transformer

V_{in}

V_{out}

$$D = MV_{Out}$$

Ratiometric Wiring:

V_{in}

V_A

V_B
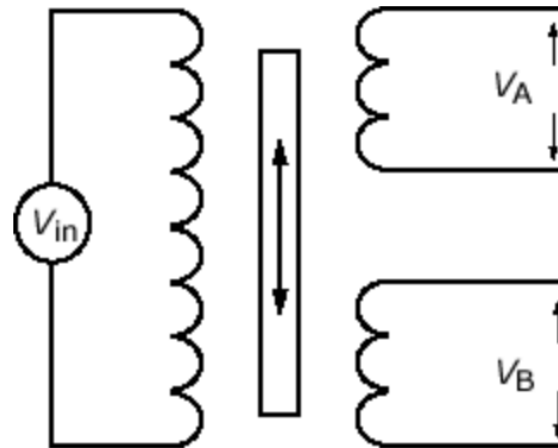
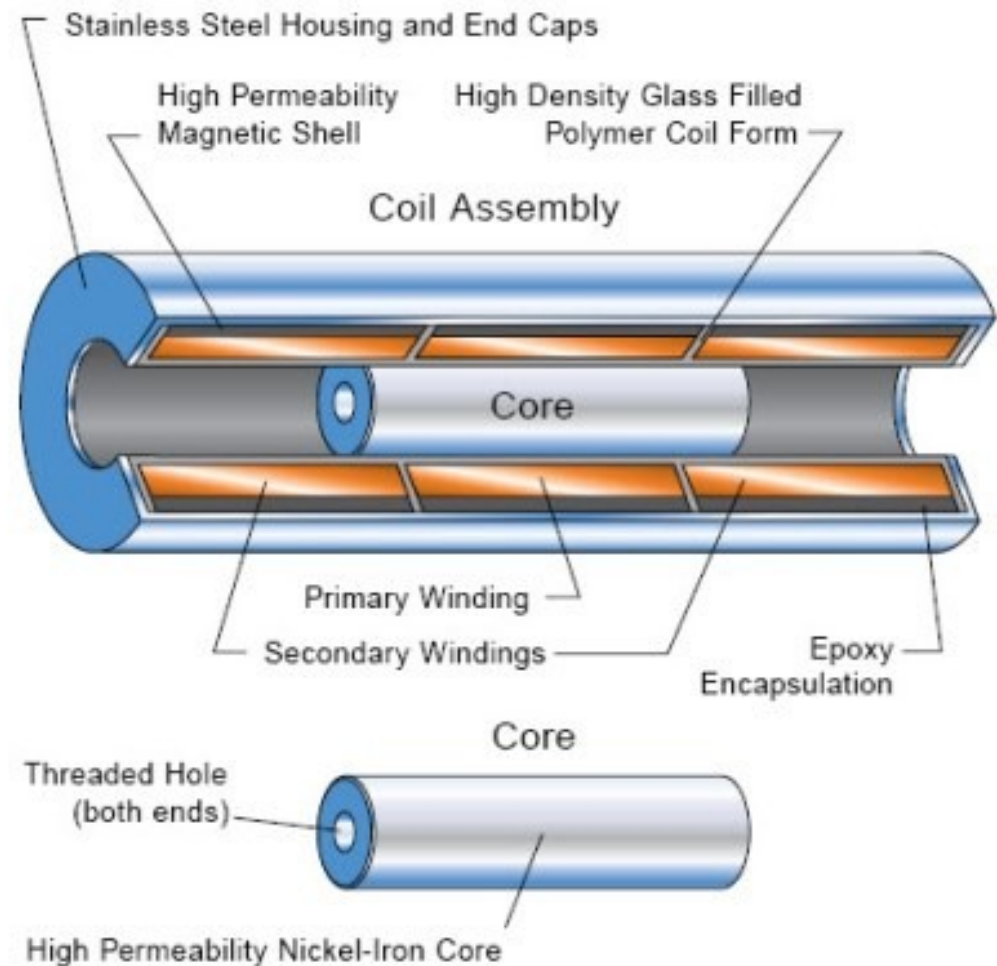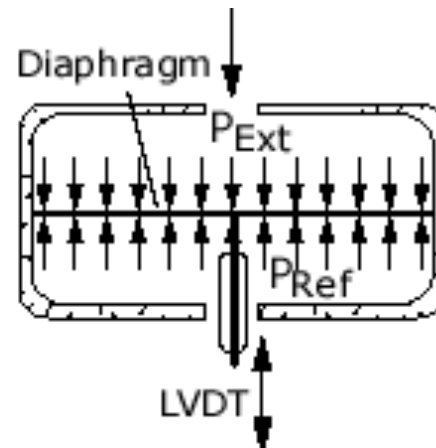$$D = M \frac{V_A - V_B}{V_A + V_B}$$
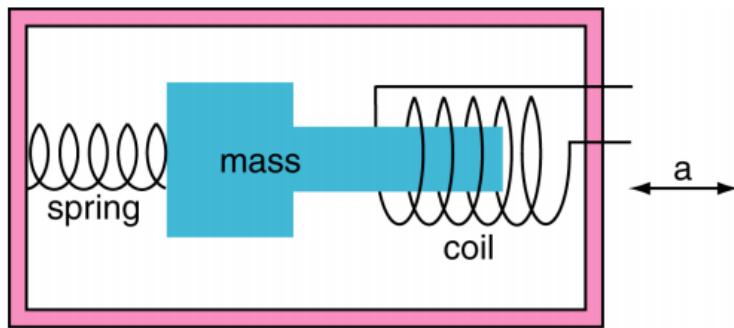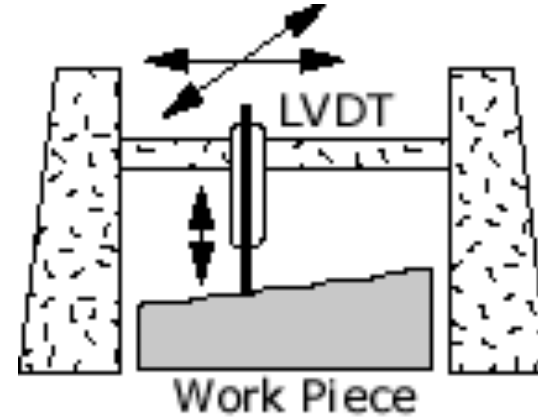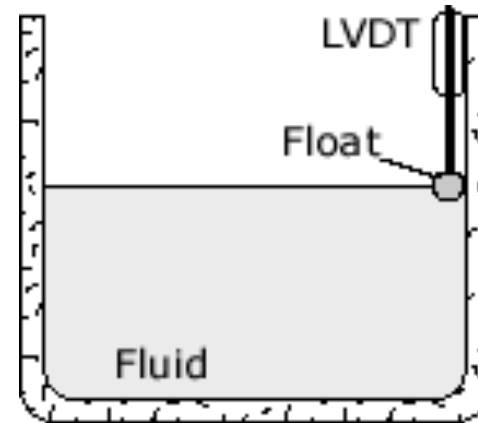
Ratiometric Wiring

LVDT-Construction

- Nickel-Iron Core with a threaded hole

- Primary and Secondary Windings are usually copper

- Stainless Steel outer casing

Stainless Steel Housing and End Caps

High Permeability Magnetic Shell

High Density Glass Filled Polymer Coil Form

Coil Assembly

Core

Primary Winding

Secondary Windings

Epoxy Encapsulation

Core

Threaded Hole (both ends)
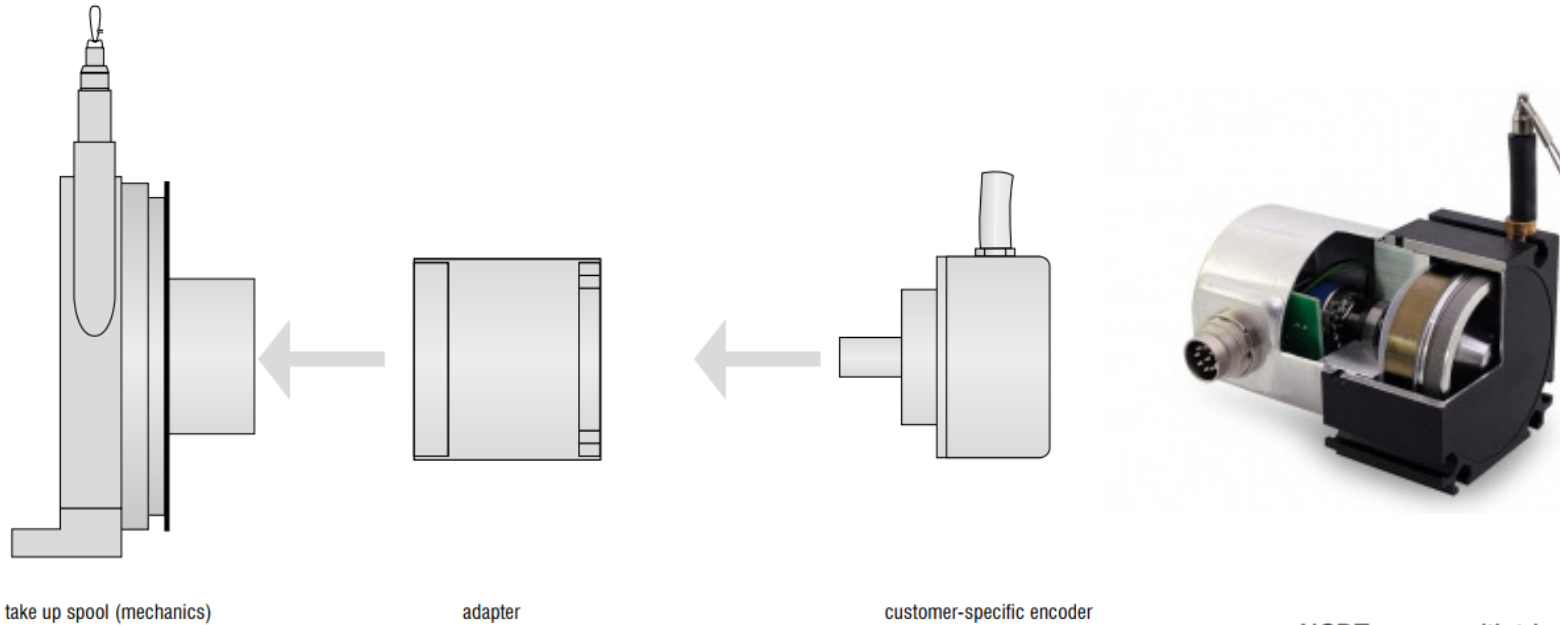
High Permeability Nickel-Iron Core

LVDT Applications

- Fluid Level
- Workpiece thickness
- Diaphragm deflection/pressure
- Velocity and Acceleration
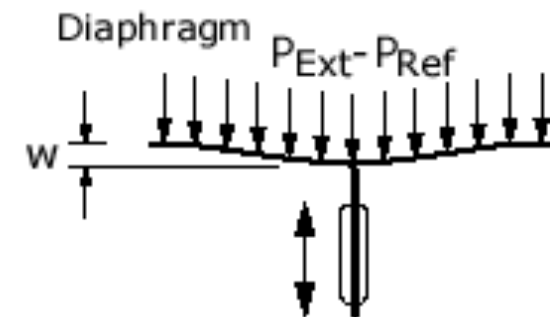
Honorable Mentions

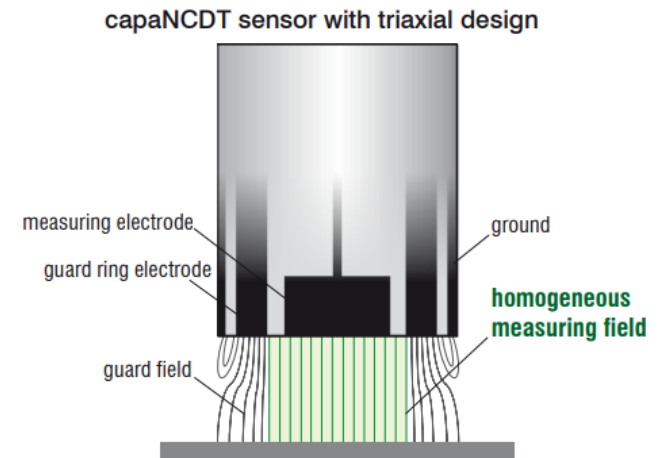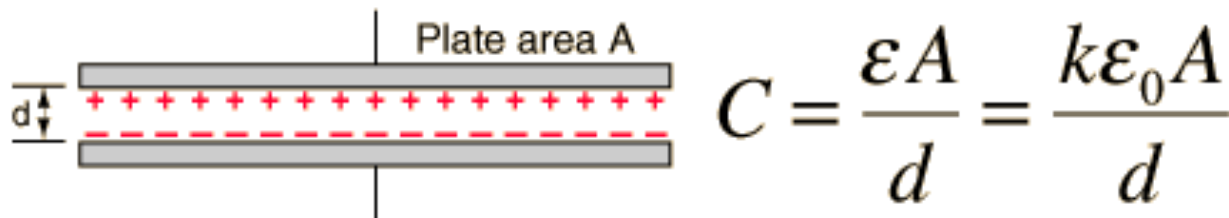- Draw Wire Displacement Sensors

take up spool (mechanics)   adapter   customer-specific encoder

- Capacitive Displacement Sensors

Plate area A

$$C = \frac{\varepsilon A}{d} = \frac{k\varepsilon_0 A}{d}$$

capaNCDT sensor with triaxial design

measuring electrode

guard ring electrode

ground

homogeneous measuring field

guard field

References

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- https://www.micro-epsilon.com/displacement-position-sensors/

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- https://www.machinedesign.com/archive/article/21815003/the-hot-and-cold-of-lvdts

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