High Speed Motor Test Stand

Virtual Design Review II

Danfoss

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Emily Simmons

PROJECT RECAP

Recap

- Project Scope
  - Design a system that can measure motor efficiency at standard operating speeds for various Danfoss Turbocor compressors

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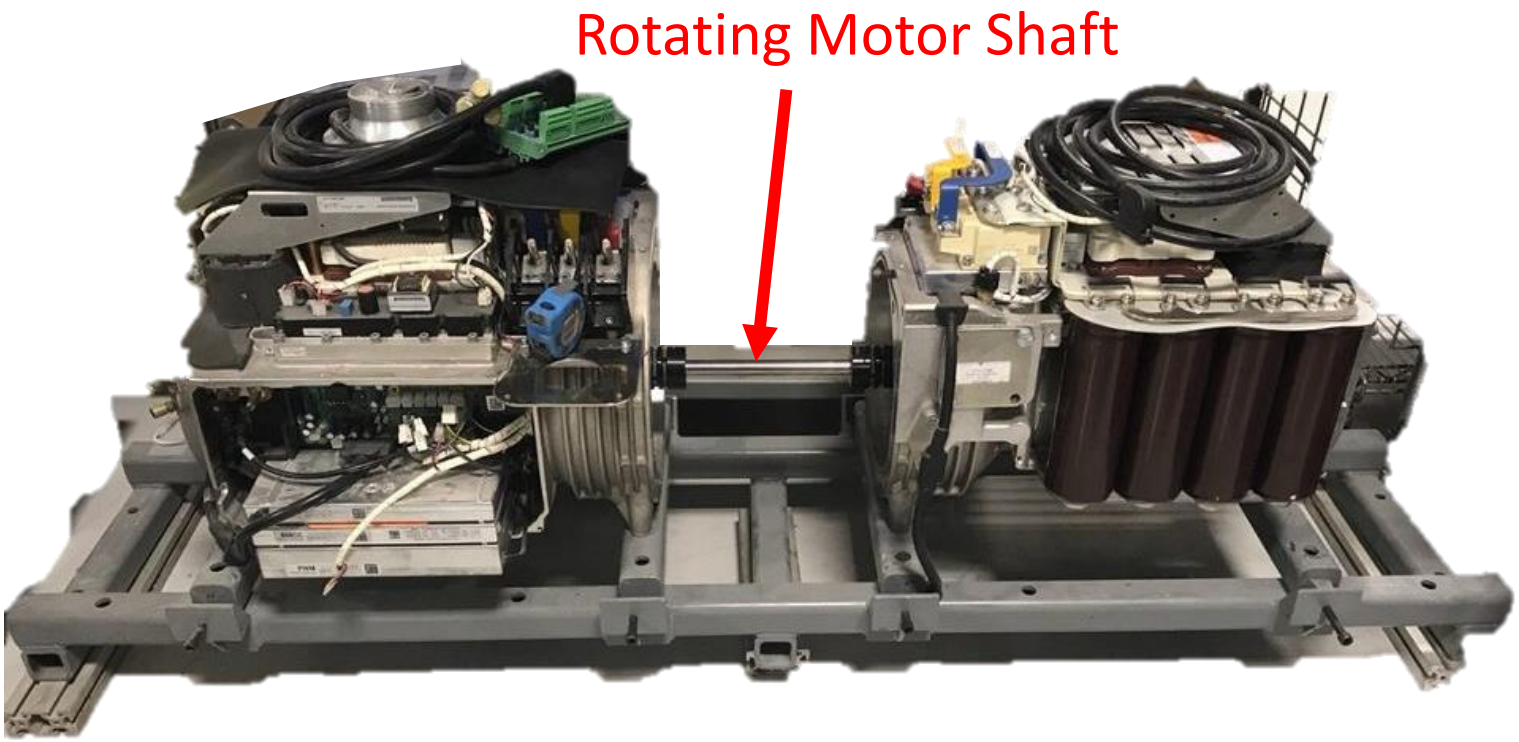
Recap

Emily Simmons

Recap



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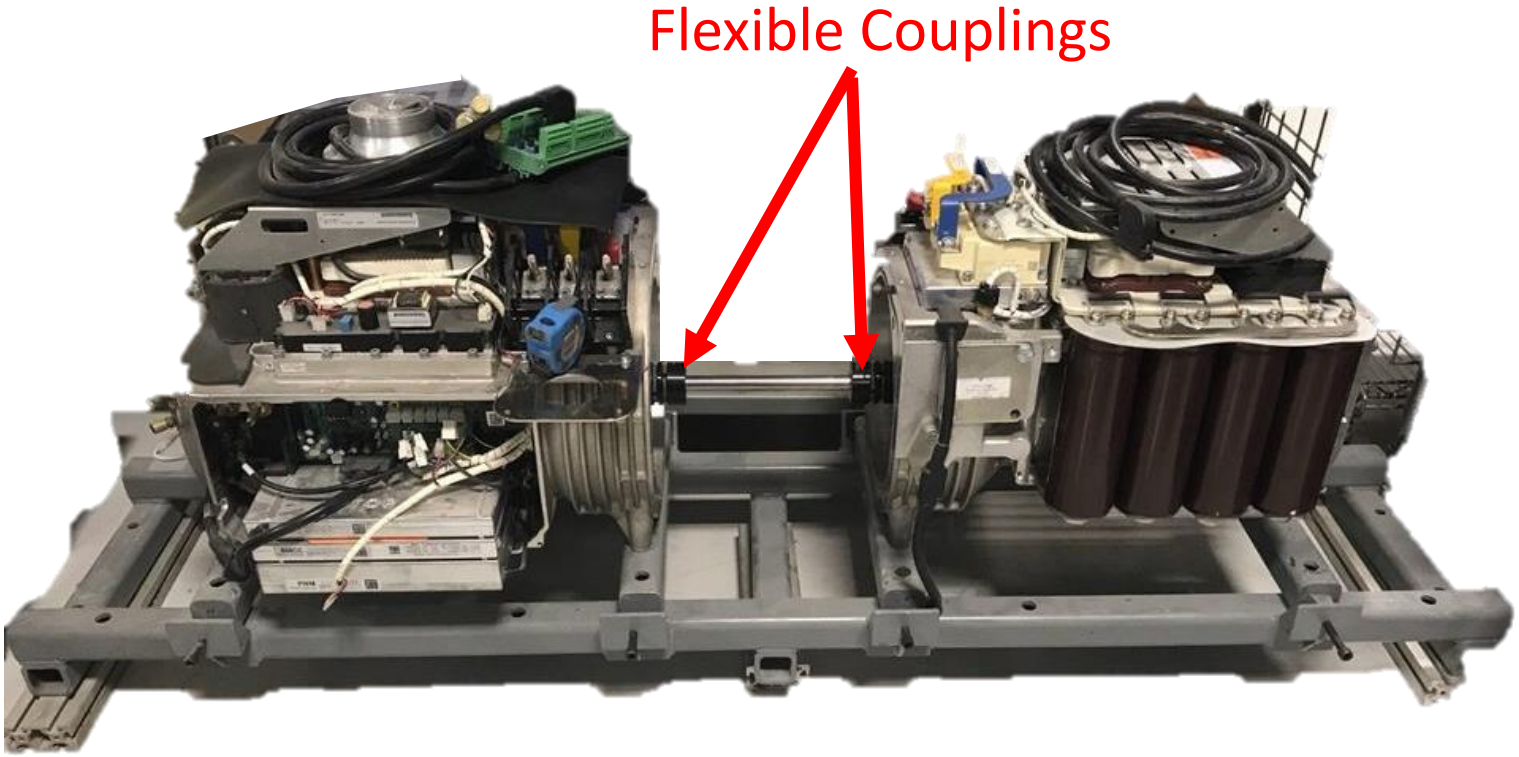
Recap



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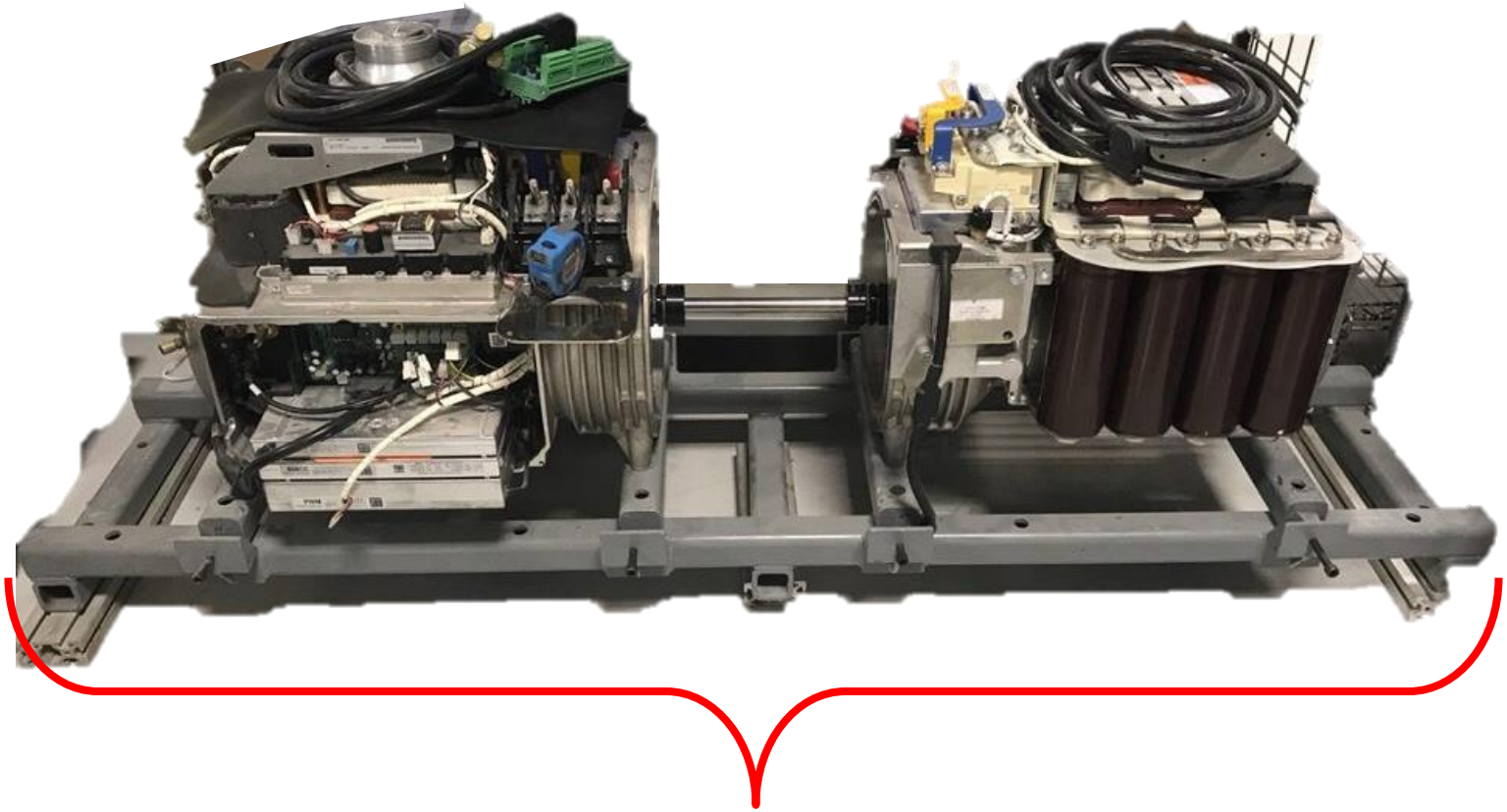
Recap



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Recap

- Functional Decomposition

		Main Functions		
		Measure Motor Efficiency	Hold the Weight of Motor Testing System	Protect Operator while Testing
Sub-Functions	Operate at standard motor speeds	●		
	Attach a safety shield			●
	Measures torque with a torque transducer	●		
	Build with appropriate material		●	●
	Add accessible E-stops			●
	Maintain stability		●	
	Prevents operator from handling tester while testing			●

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TARGET CATALOG

Target Catalog

Measure Motor Efficiency:

Main Function	Sub-Functions	Type of Target	Target
Measure motor efficiency	Operate at standard motor speeds	Speed	7,000 - 40,000 rpm
	Measures torque with a torque transducer	Speed, Torque	40,000 rpm, 100 Nm

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Target Catalog

Hold the Weight of the System:

Main Function	Sub-Functions	Type of Target	Target
Hold the weight of motor testing system	Build with appropriate material	Mass	272 kg
	Maintain stability	Radial Force	890 N

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Target Catalog

Protect the Operator:

Main Function	Sub-Functions	Type of Target	Target
Protect operator while testing	Attach a safety shield	Length	0.61 m x 0.61 m x 0.5 m
	Build with appropriate material	Impact Energy	13 kJ
	Add accessible E-stops	Number of E-stops	1 E-Stop
	Prevents operator from handling tester while testing	Length	0.172 m

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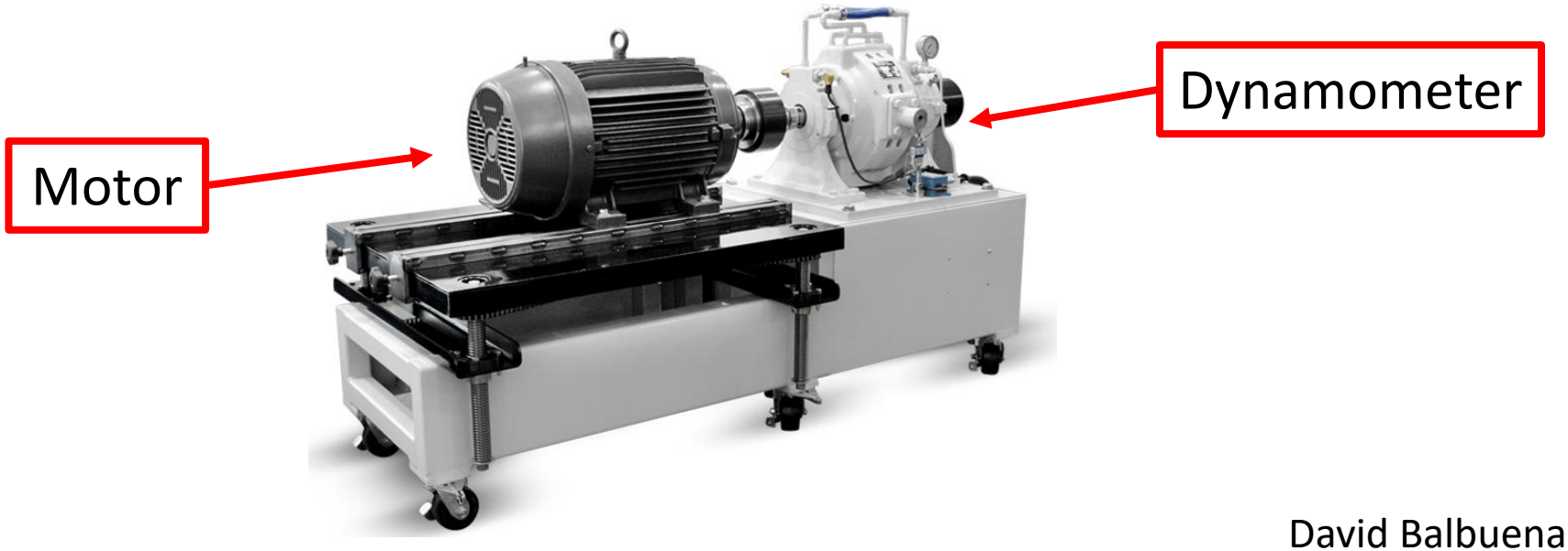
CONCEPT GENERATION: MOTOR TORQUE MEASUREMENT

Motor Torque Measurement

- Dynamometer
- Torque transducer between coupled motor/generator system
- Torque transducer with some fixed inertia



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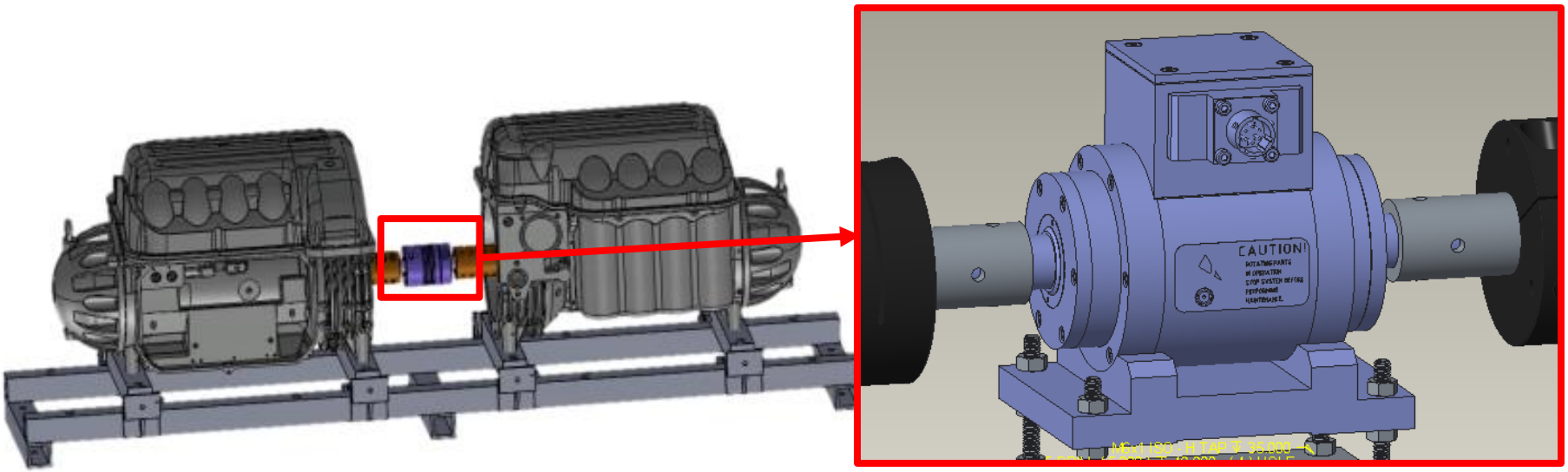

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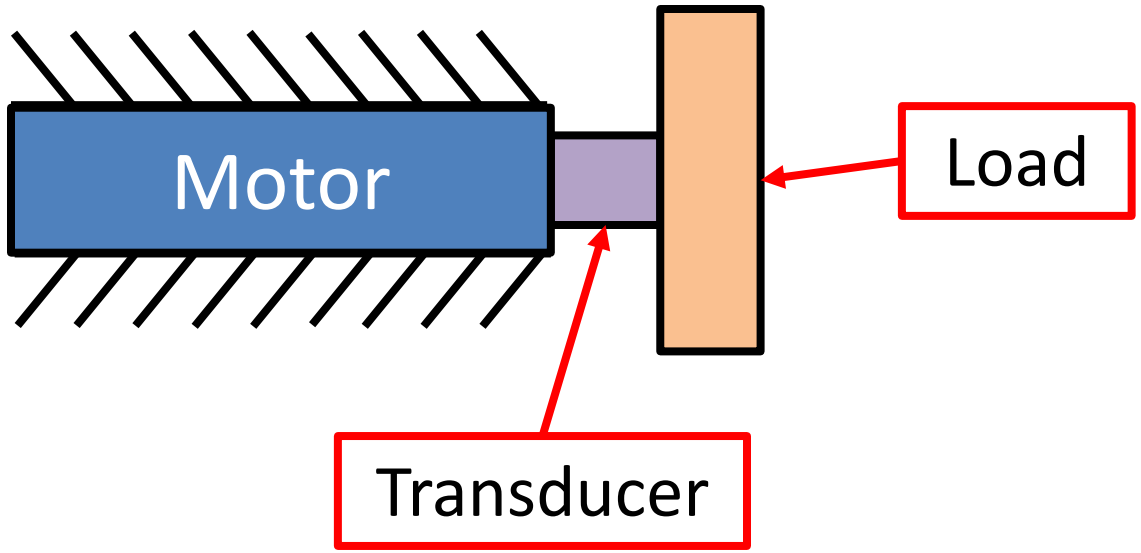

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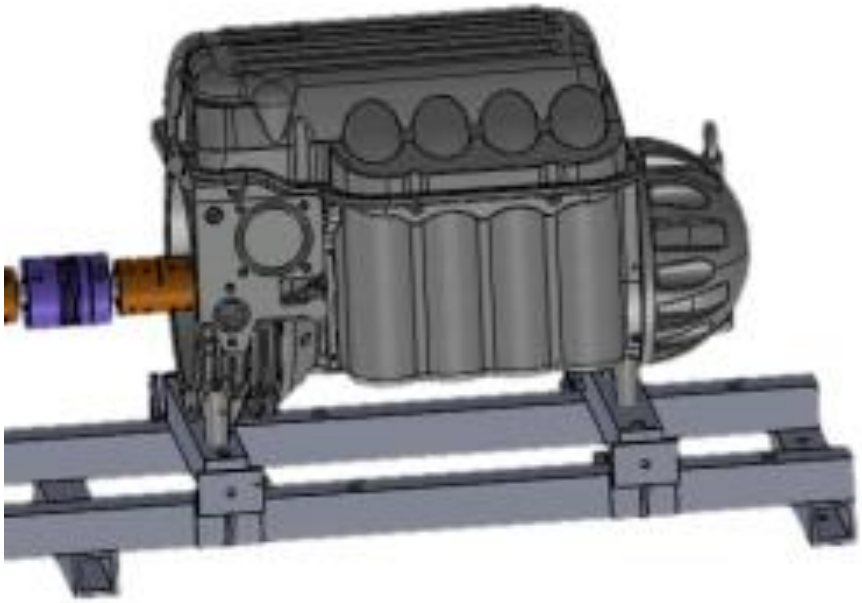
CONCEPT GENERATION: SHAFT ALIGNMENT

Axis Alignment



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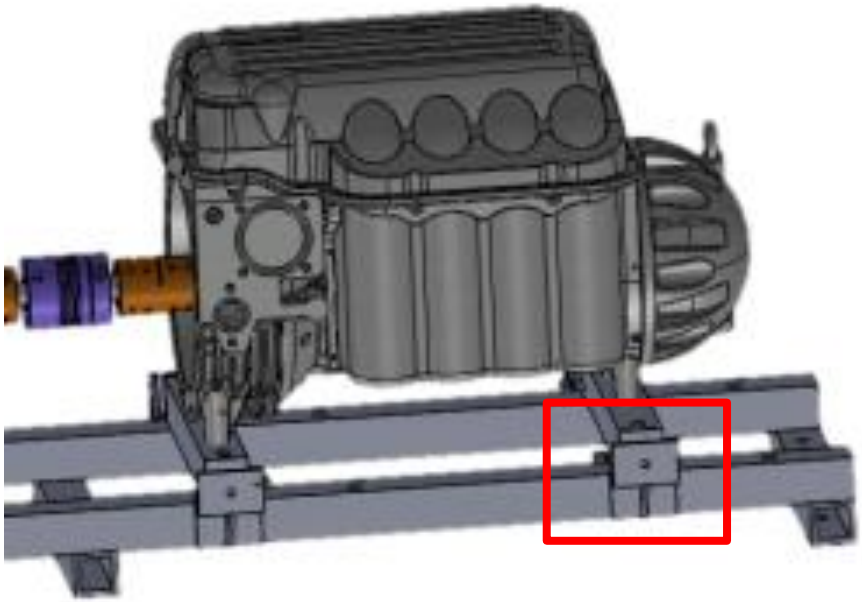
Axis Alignment



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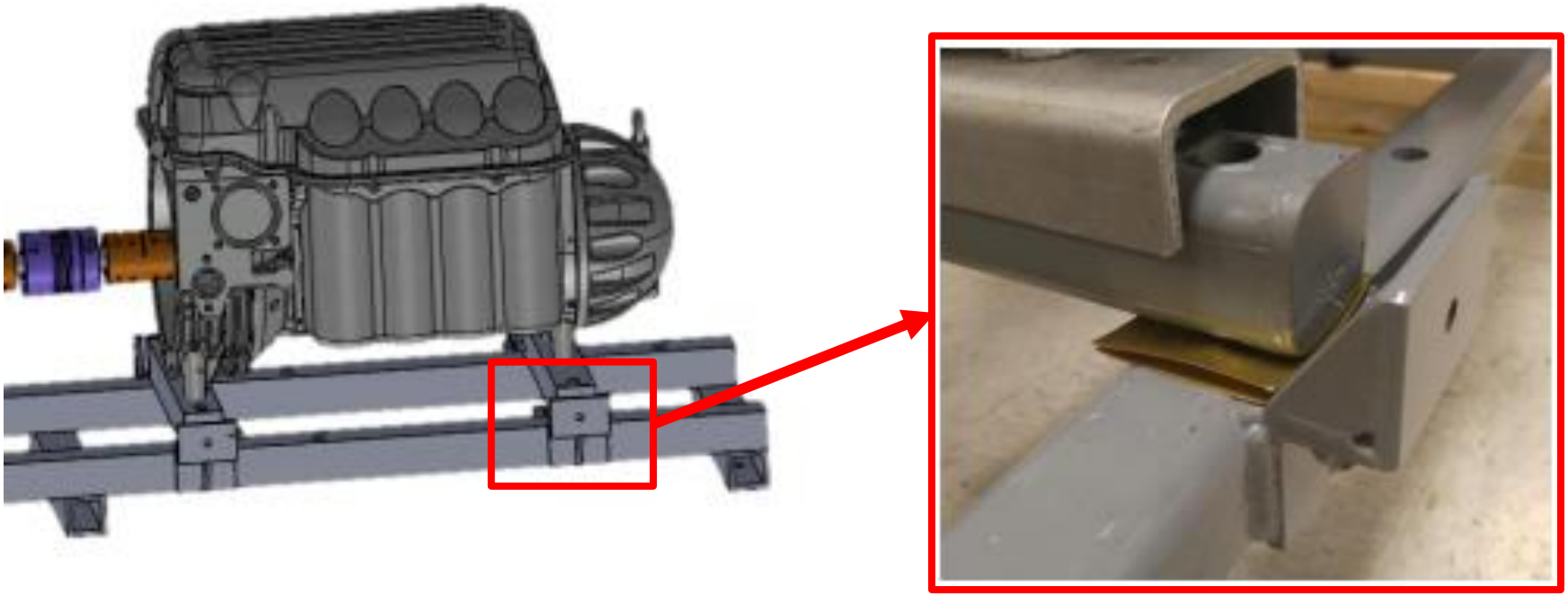
Axis Alignment



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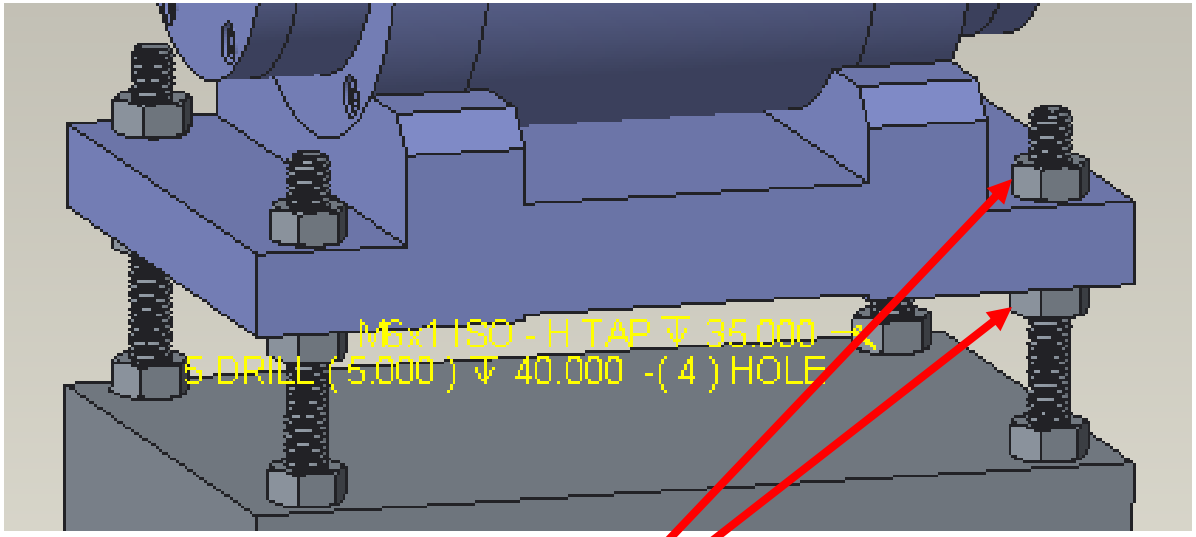
Axis Alignment



Adjust nut to change axially alignment

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CONCEPT GENERATION: COUPLING

Coupling System

- Zero Max Double Clamp A1C Coupling
- Custom Made Carbon Fiber Coupling
- Lovejoy 90-6 SU Coupling

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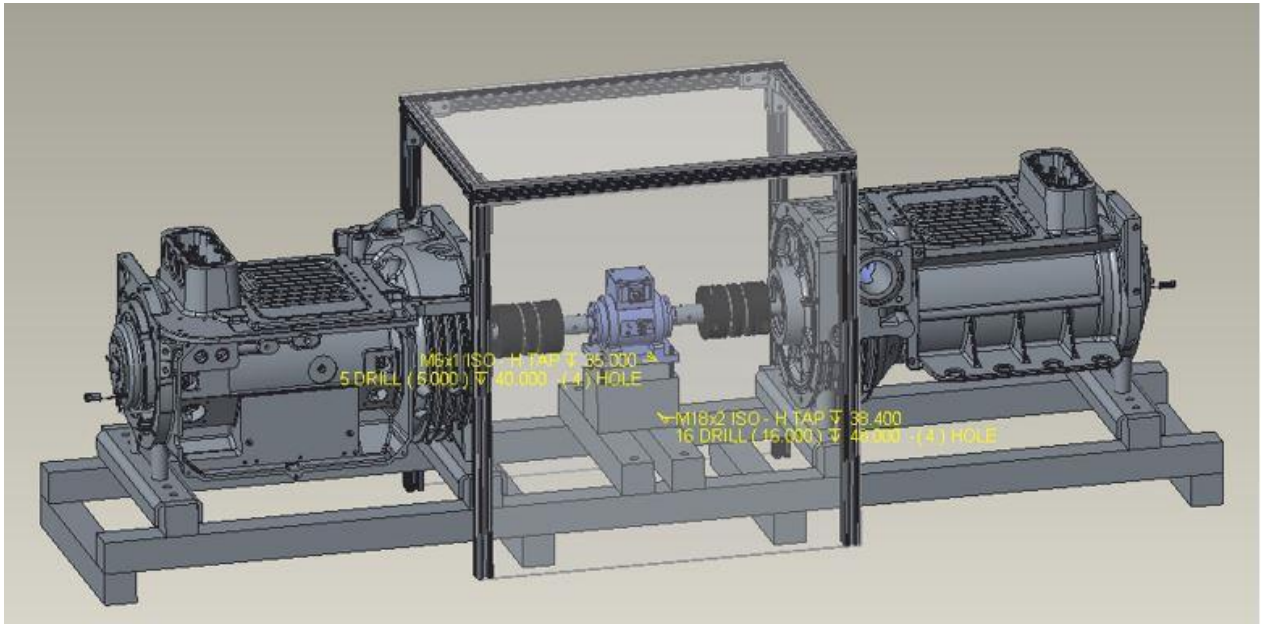
CONCEPT GENERATION: SAFETY

Safety System

- Partially Enclosed System
- Fully Enclosed System



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Safety System

- Partially Enclosed System
- Fully Enclosed System

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NEXT STEPS

Next Steps

- Concept Selection
  - Compare concept ideas to targets and choose best option
- Project Plan
  - Mapping out tasks for the design project for the spring semester

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References

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Questions?

ADDITIONAL INFORMATION

Impact Energy Calculation

$m = 0.907\ kg$

$\mathrm{d} = 0.08128\ meters$

$r = \frac{d}{2} = \frac{0.08128}{2} = 0.04064\ meters$

$\omega = 40{,}000\ rpm = 4{,}188\ \mathrm{rad/s}$

$$v = \omega * r = 4{,}188 * 0.04064 = 170\ m/s$$

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(0.907)(170)^2 = 13{,}000\ J = 13\ kJ$$

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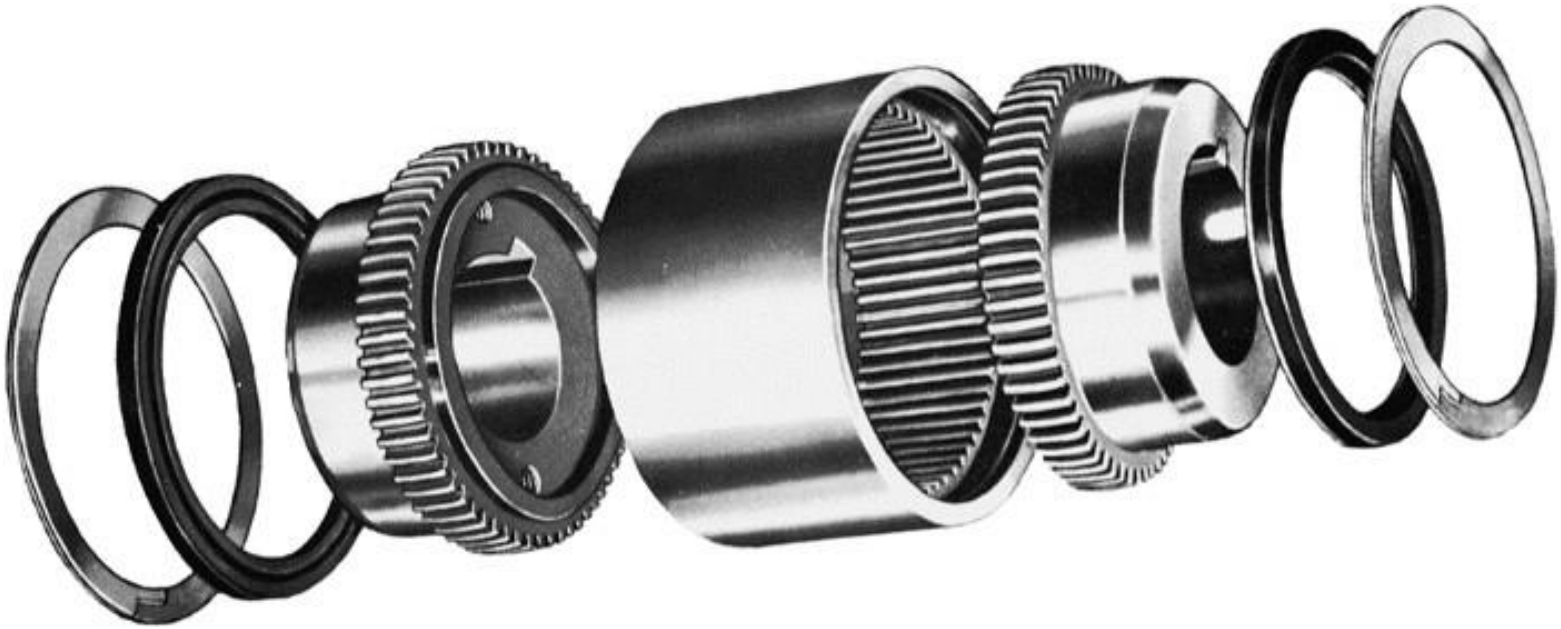
TYPES OF COUPLINGS

Gear Coupling



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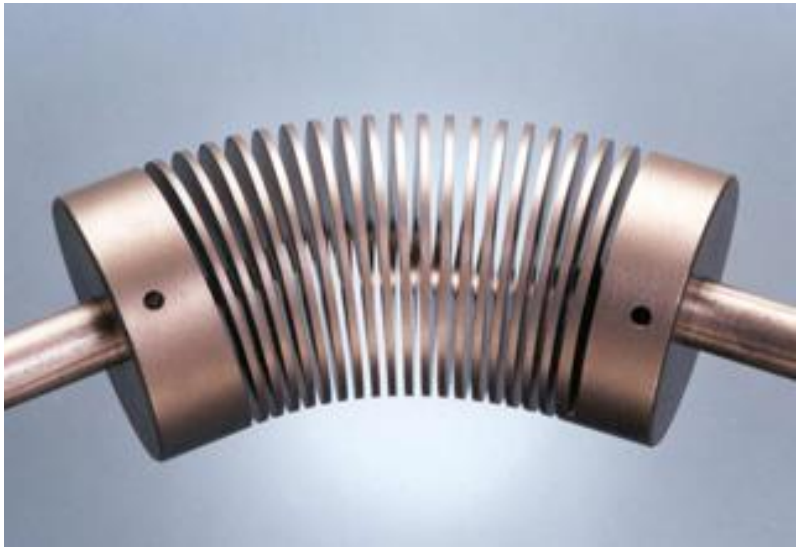
Beam Coupling



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Disk Coupling

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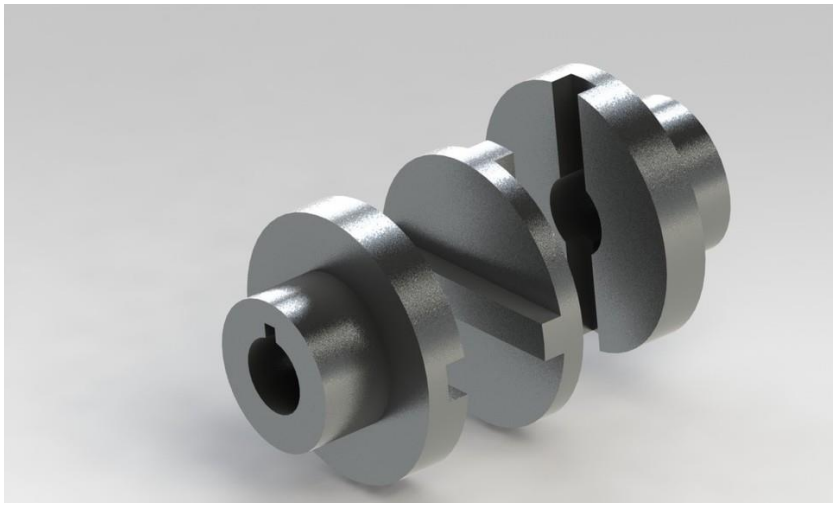
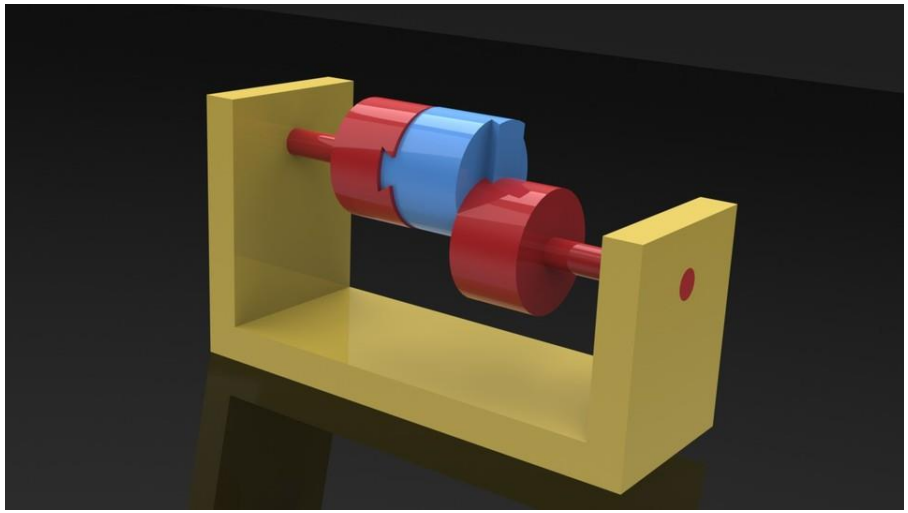
Oldham Coupling





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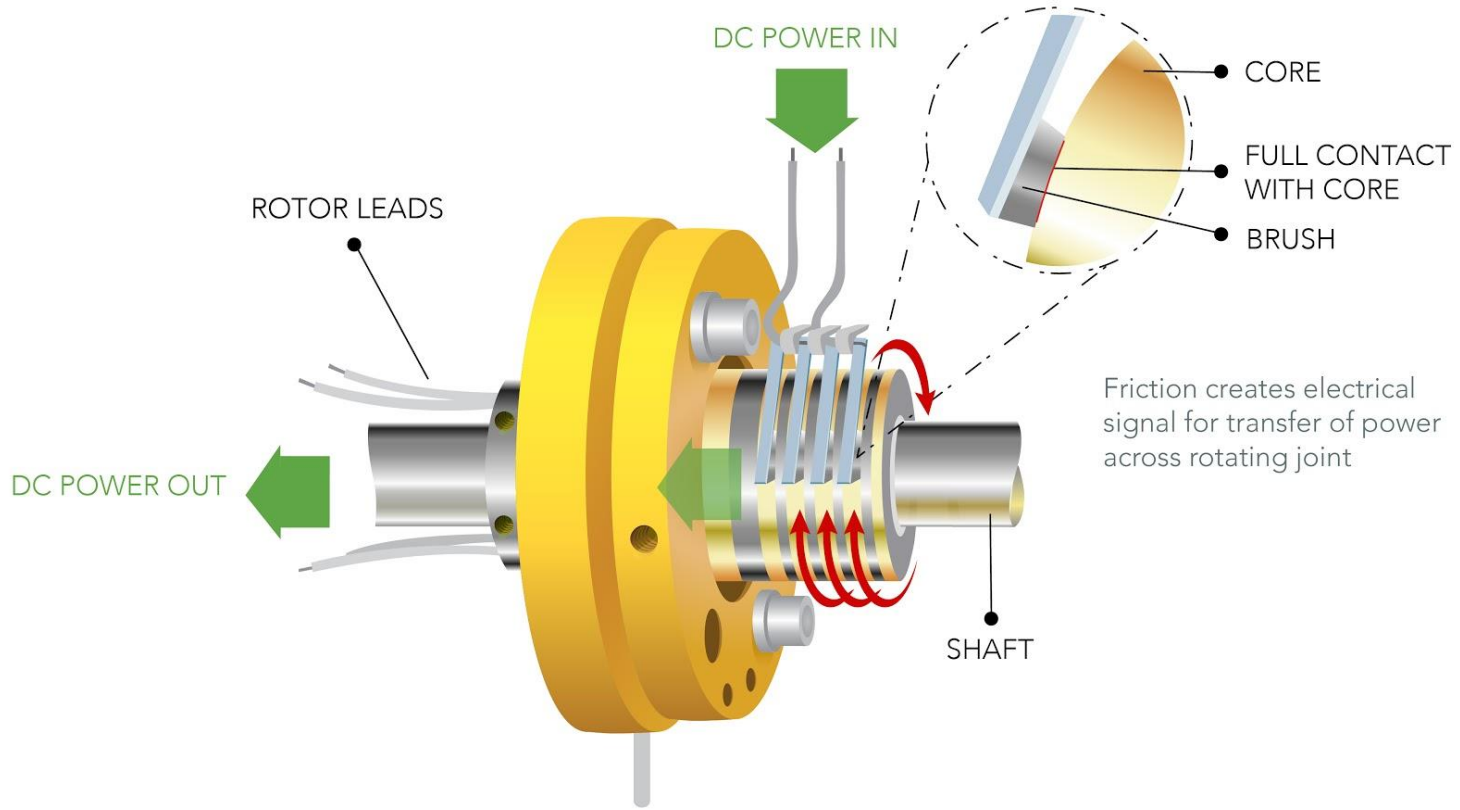
TORQUE TRANSDUCER SELECTION

Mechanical Design

- Contact bearings
  - low speed only
  - wear over time
- Non-contact bearings
  - can handle high speed

Signal Transmission

- Slip Ring



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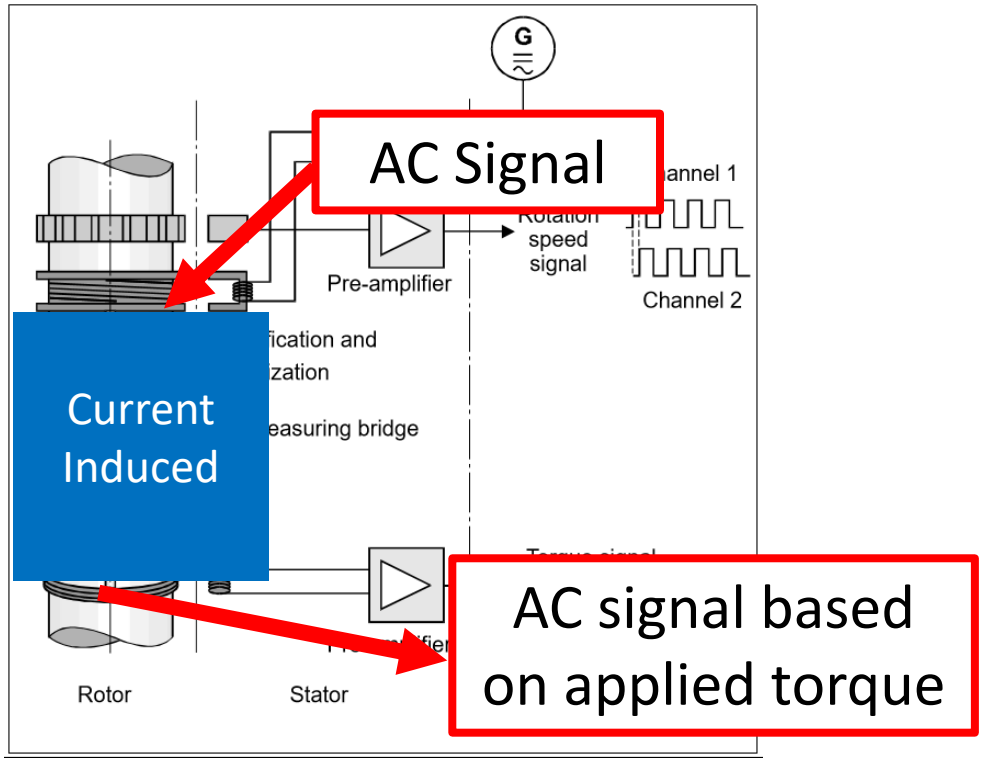
Signal Transmission

- Non contact transmission
  - Uses electromagnetic induction to transmit signal frequency



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