



**Michigan Scientific**  
Corporation®

Precision Instrumentation and  
Measurement Solutions





Est. 1960 by Hugh Larsen, former director of development at General Motors.  
Today there are 100+ engineers, technicians, machinists, and supporting staff.



Slip Ring Assemblies



Transducers



Instrumentation  
Assemblies

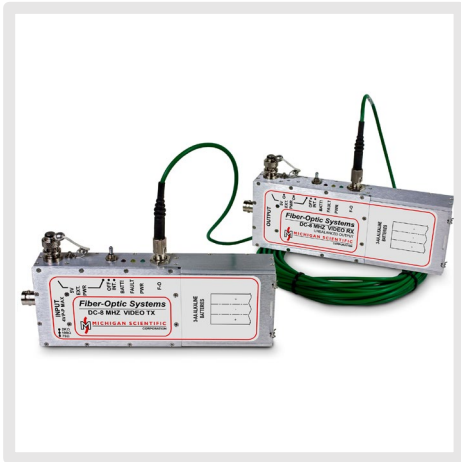
**60+** years of engineering  
excellence

**Made in America**

Instruments measure force,  
torque, strain, temperature,  
angular speed and position,  
and acceleration



Wireless Telemetry



Fiber Optic Systems



Signal-conditioning  
electronics

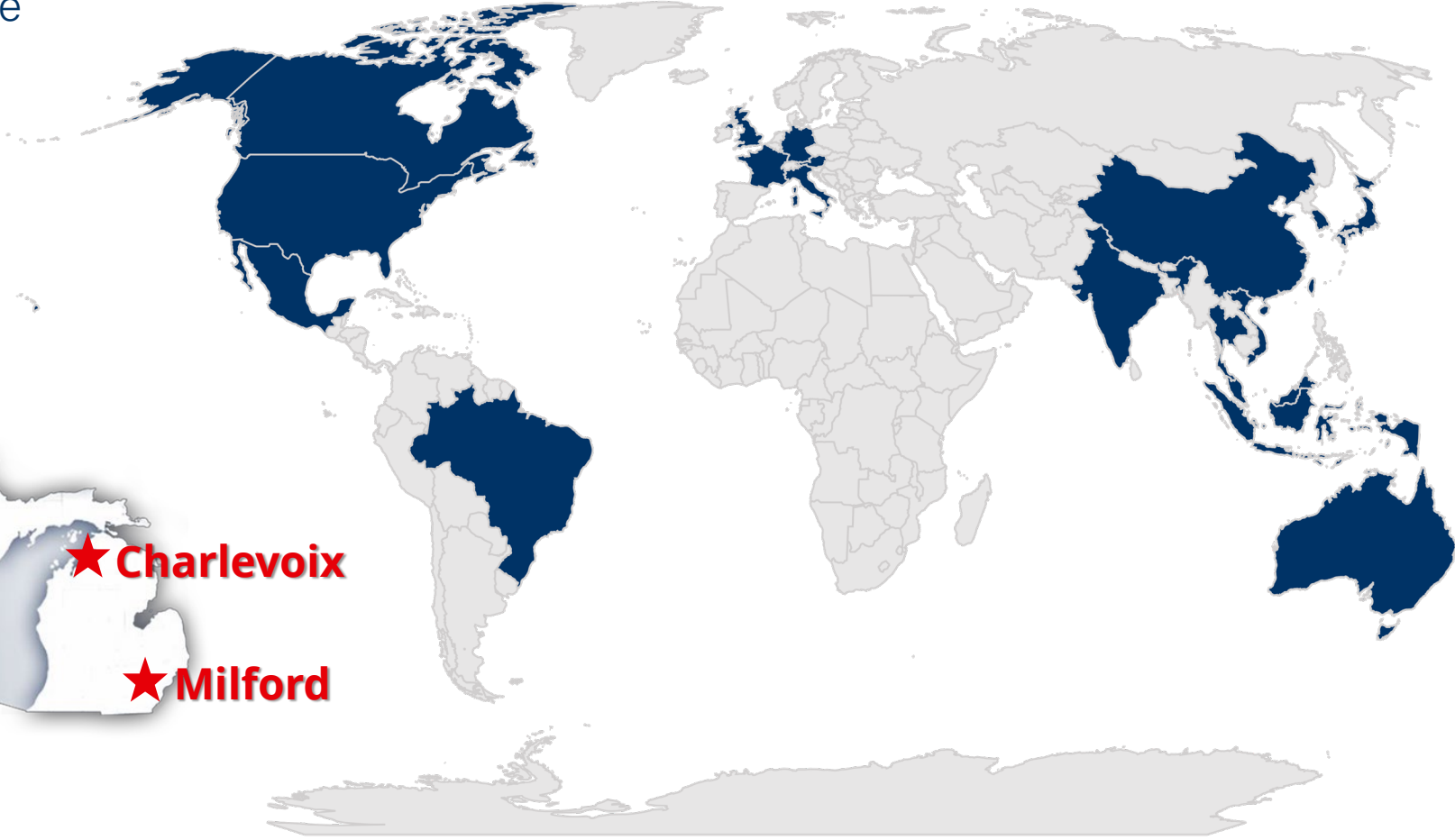
Countries with active Michigan Scientific representatives ■

Michigan Scientific facility locations ★



★ Charlevoix

★ Milford



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# Global Presence



# Wheel Force Transducer (WFT)

- Easy to install and use
- Highly accurate and reliable
- Waterproof (IP67) and temperature-compensated
- Lightweight

## Used in:

Durability testing • Vehicle dynamics testing

Brake development and testing • Traction studies

Suspension durability lab testing • Road-to-lab correlation

**Measures:**  
**THREE forces**  
**THREE moments**  
**TWO accelerations**





**MSC is a top supplier of WFTs for  
off-road and on-road  
applications**



Heavy equipment  
Military equipment

Fork trucks  
Tractor  
ATVs



# Off-road WFT Applications

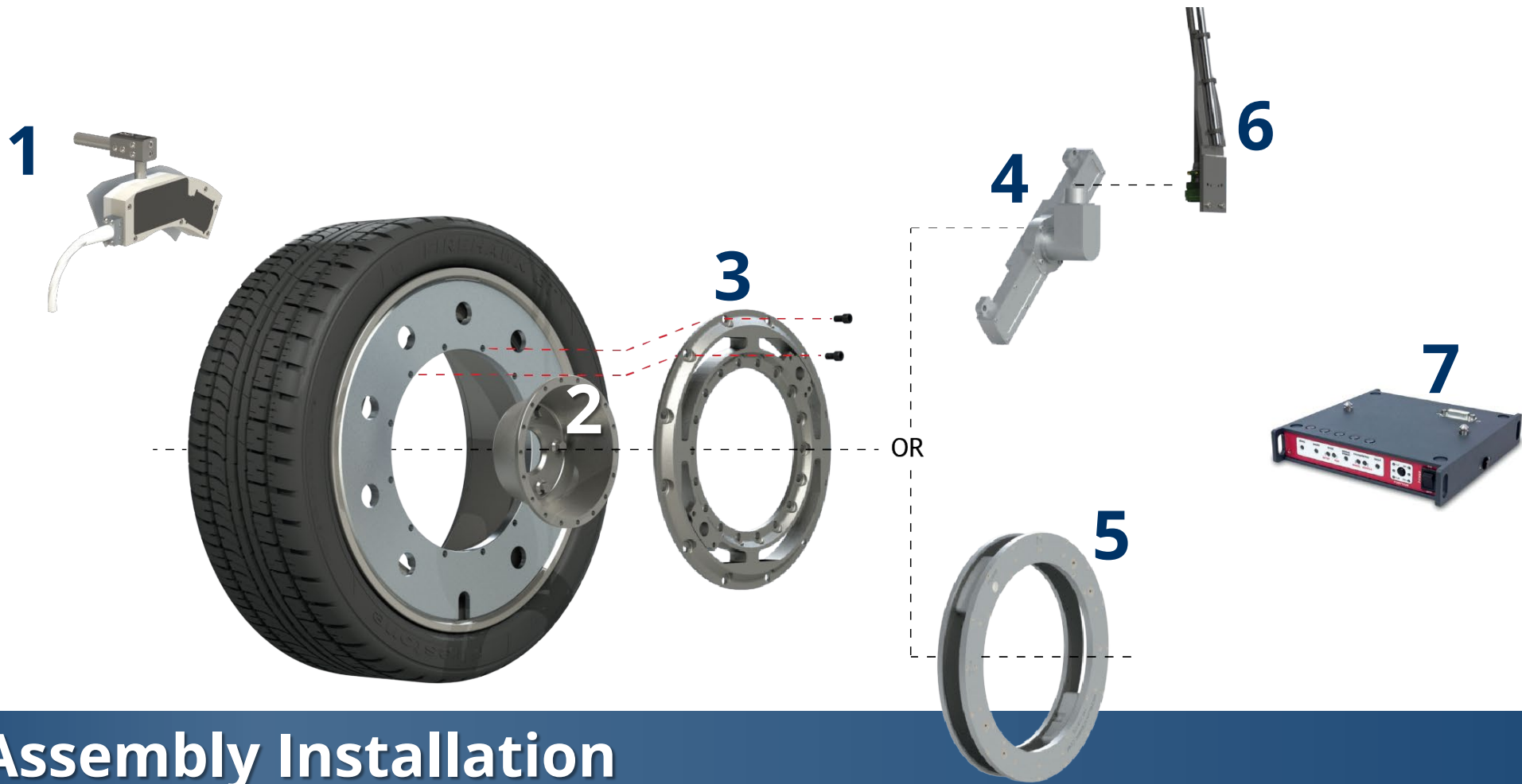






**Motorcycles**  
**Passenger cars**  
**Light trucks**  
**Heavy trucks**  
**Buses**  
**Electric Vehicles**

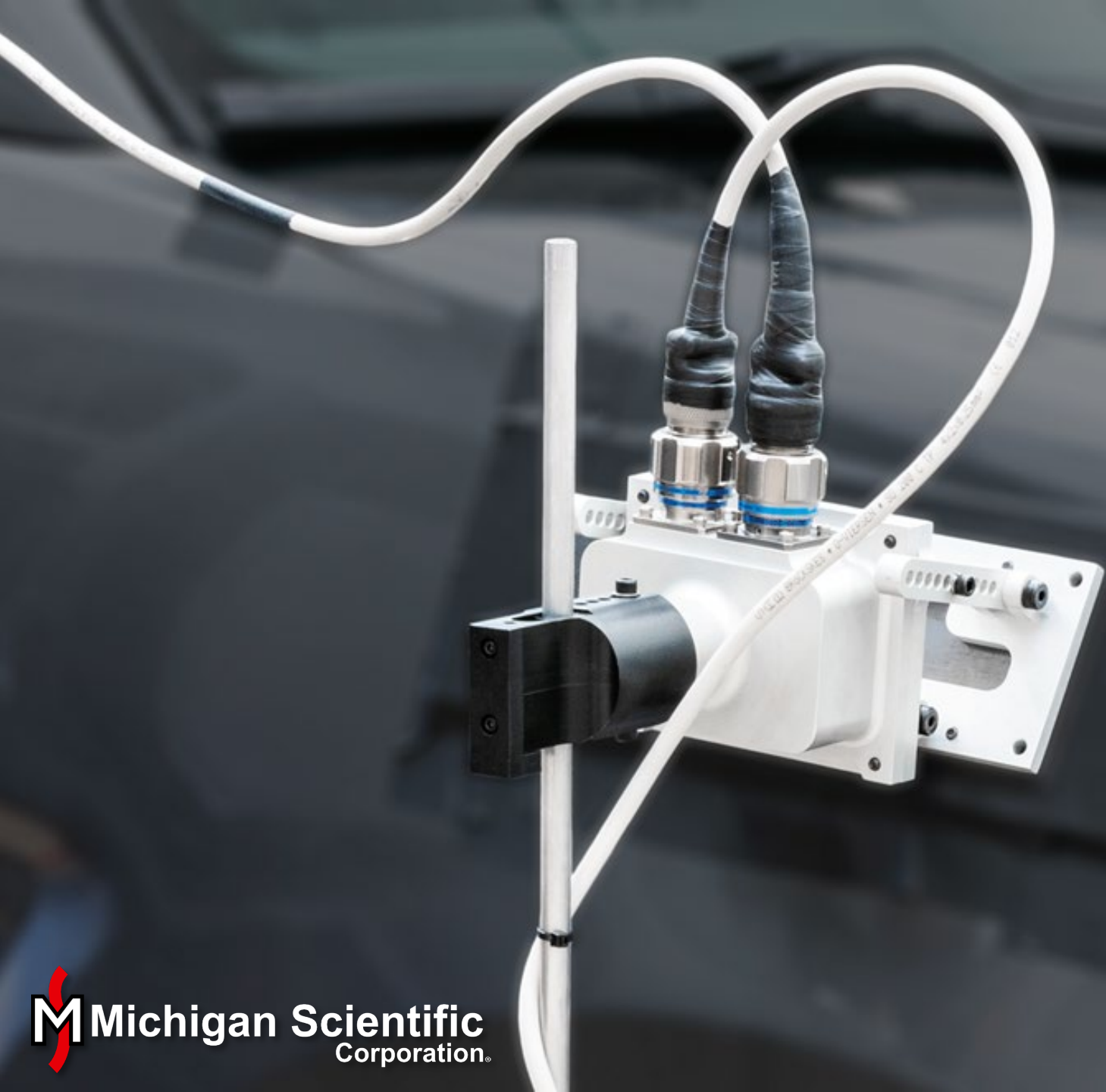
**On-road WFT Applications**



## WFT Assembly Installation

1. Telemetry stator restraint and bracket
2. Custom hub and rim adapters
3. WFT

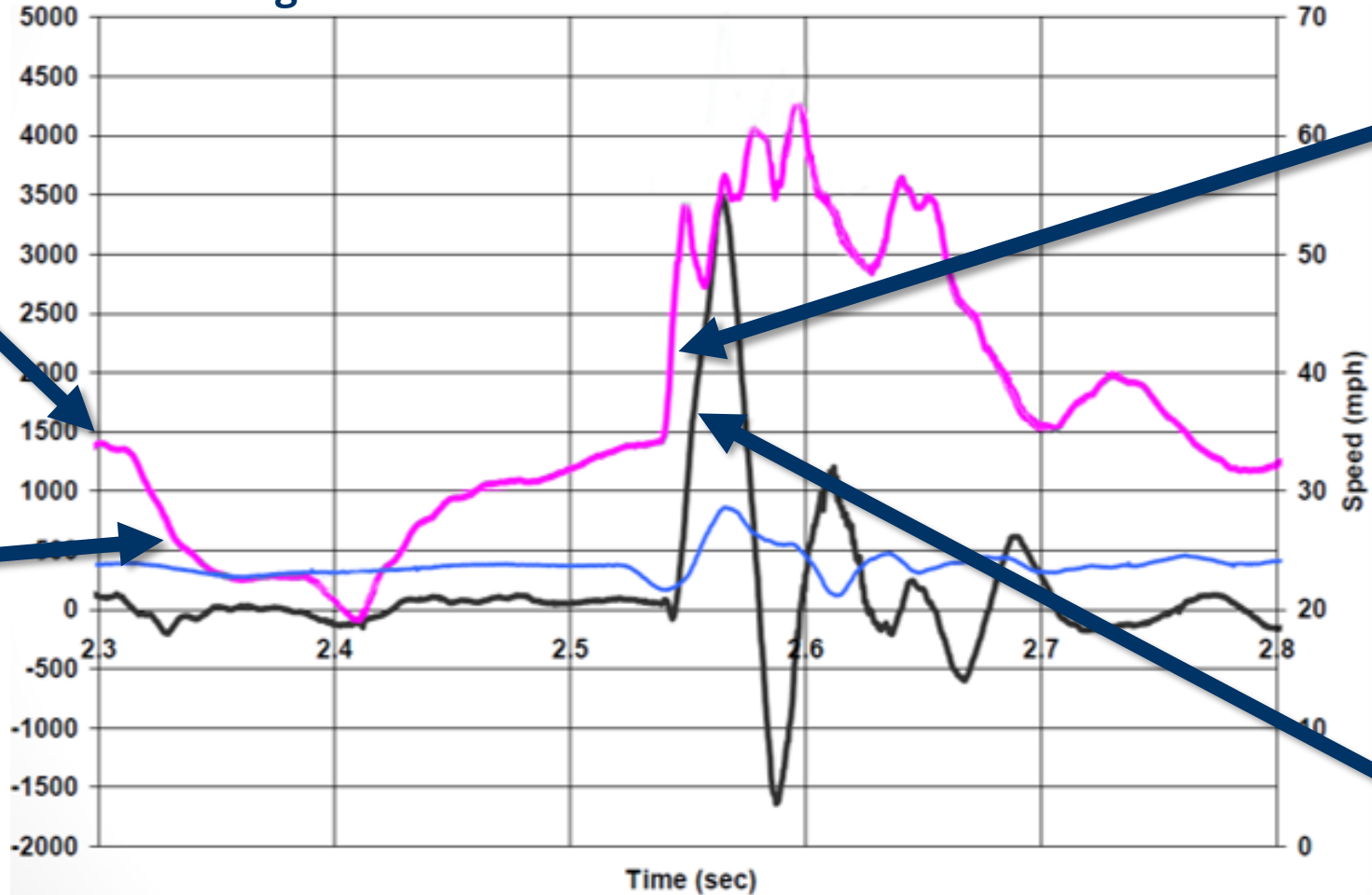
4. Integrated slip ring and amplifier subassembly
5. Wireless telemetry transmitter subassembly
6. Stator restraint rod
7. CT2 Transducer interface box



# Stator Angle Correction Device (SAC)

- Eliminates need for custom over-the-wheel bracket
- Prevents error when wheels are steered
- Automatic internal correction with no firmware upgrade
- Compatible with MSC WFTs sold since 2013

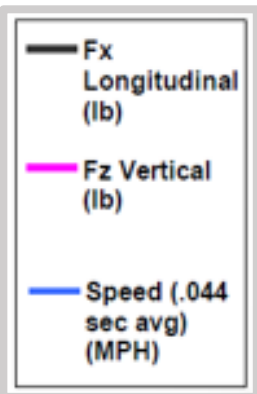
### SUV Right Front Wheel Loads: Pothole at 25 MPH



Weight of vehicle  
(while driving)

Pothole entrance  
(vertical force drops)

Vertical force spikes  
as the suspension  
compresses at the  
bottom of the pothole

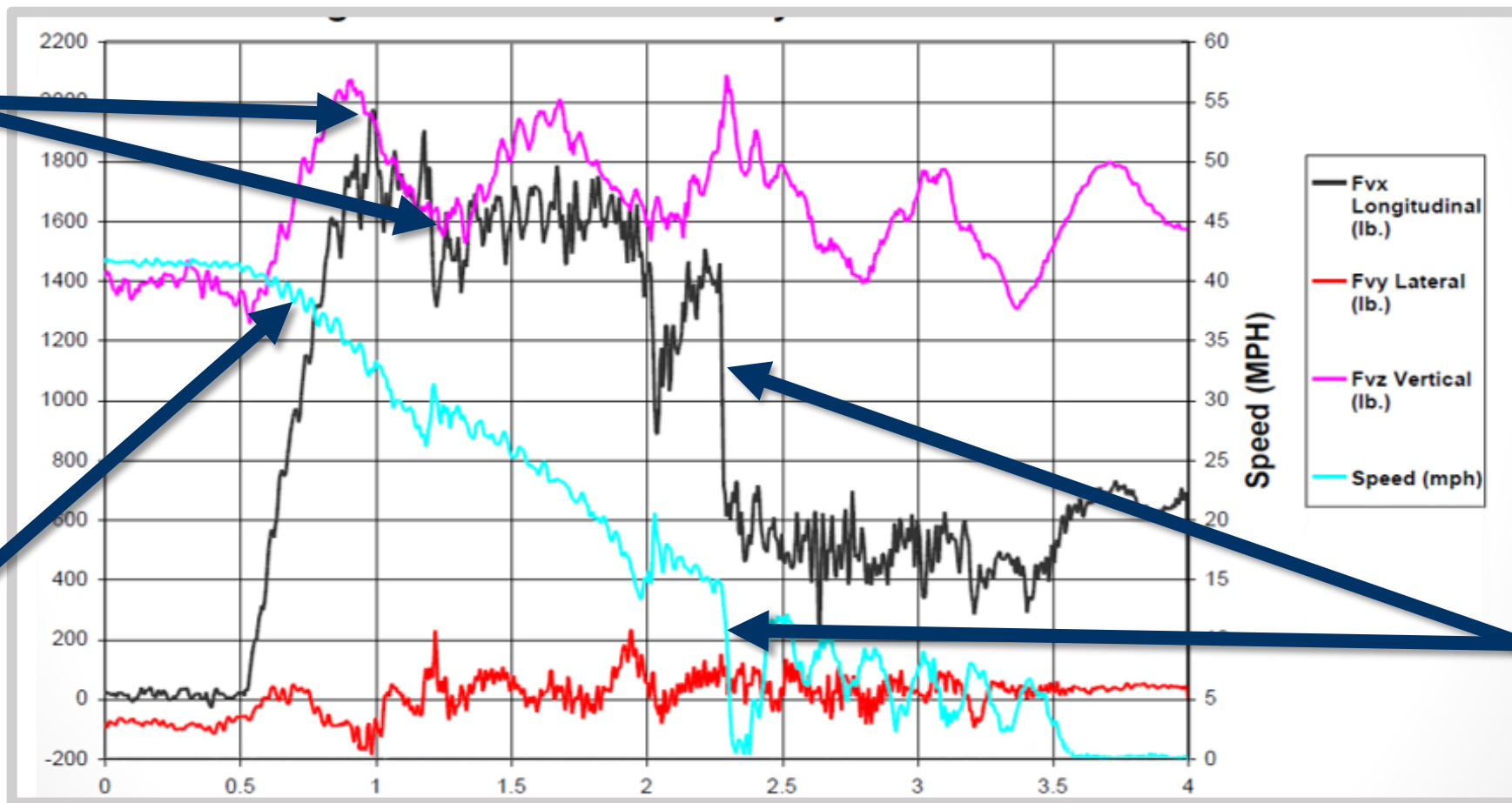


Longitudinal force  
spikes when wheel  
hits the edge of the  
pothole

## Right Front Wheel Loads Recorded on SUV Severe Braking with Transition from Dry Surface to Wet Tile Surface

Load transfer from front to rear of vehicle while braking

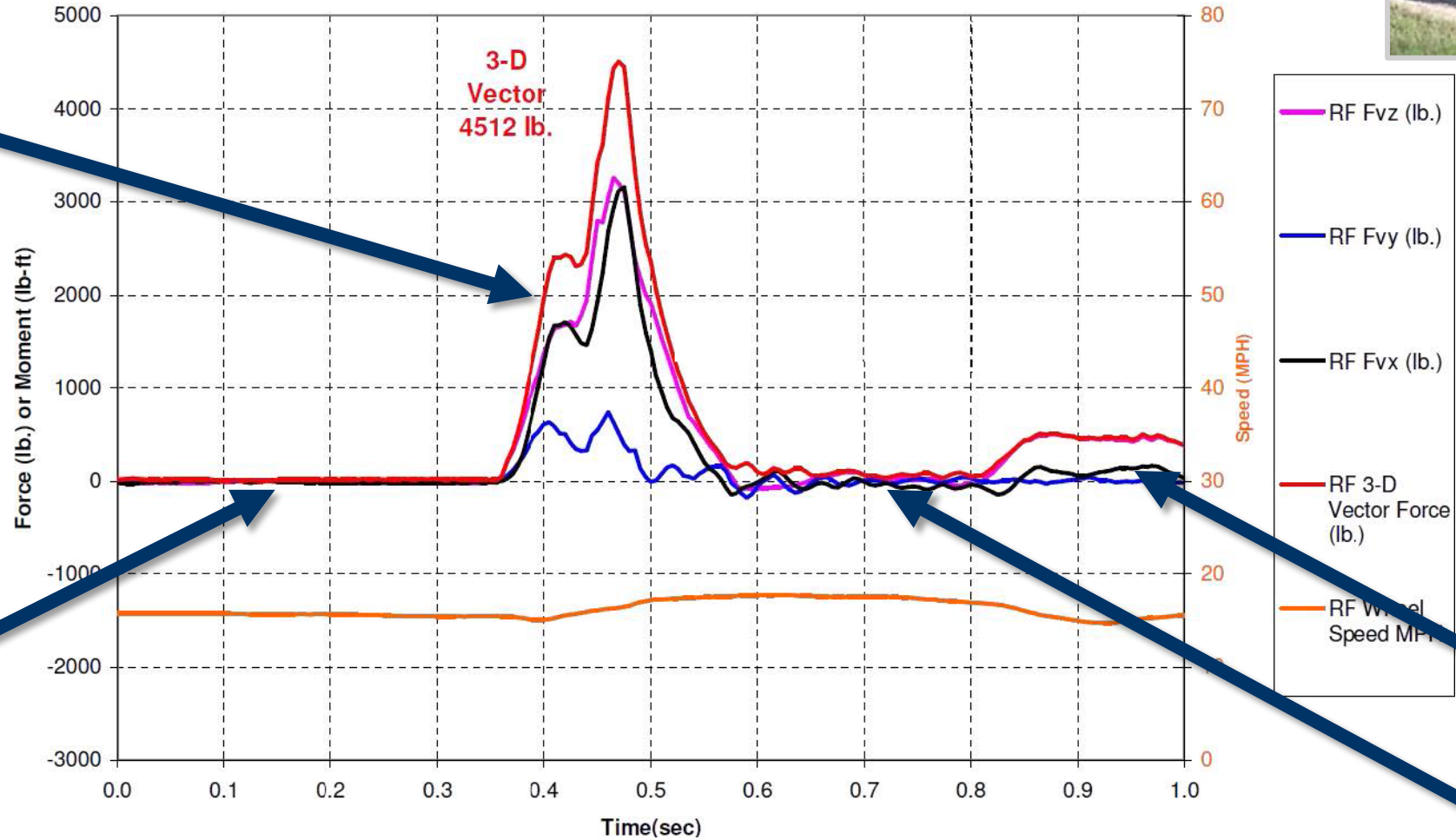
Speed starts to decrease



Wheel speed and longitudinal force drop each time ABS releases brakes



## LW9.5 Load Wheel Test



Force exerted on the wheel during landing

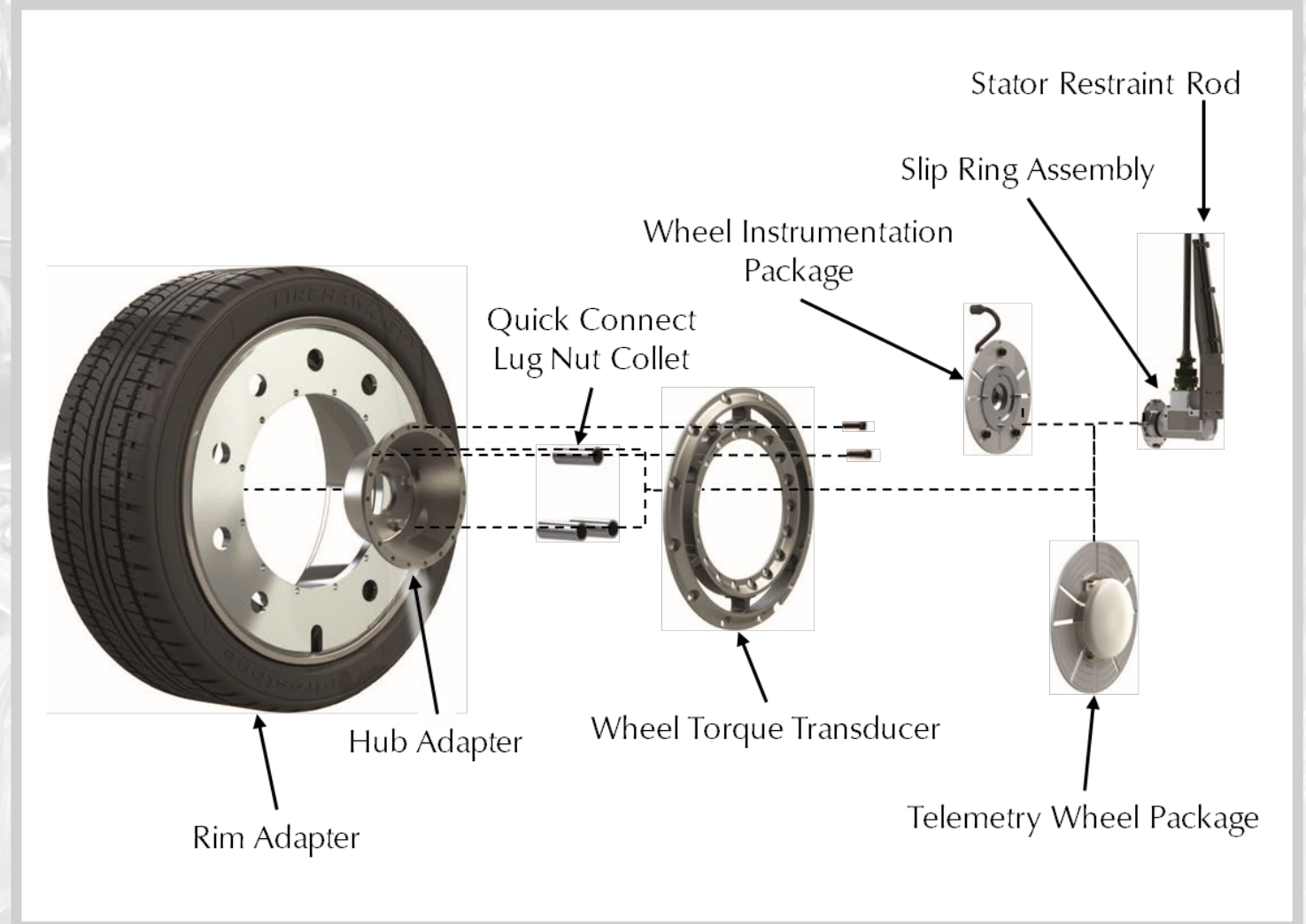
Zero force of WFT while vehicle is airborne after taking off from a ramp

Normal driving vertical force

Zero force again after wheel bounces

# Wheel Torque Transducers

- High Accuracy (0.1% full scale)
- Weatherproof and temperature compensated
- 3-year warranty on transducers
- Slip ring with high resolution encoder or wireless telemetry packages available
- Optional thermocouple amplifiers



# High Resolution Wheel Torque Transducers

- Used for efficiency and powertrain testing
- Used in EU 2017/2400 Regulatory CO<sub>2</sub> Emissions and Fuel Consumption Testing
- Can measure aerodynamic drag, brake drag, tire rolling resistance, and bearing seal drag
- Analog and CAN output available



Commercial trucks  
(TWHR2000)  
1.0 N·m resolution

Car, SUV, Light Truck  
(TW12.8HRMS175)  
0.1 N·m resolution





# Instrumentation Slip Ring Assemblies

- Solder terminals and/or connectors
- Optional built-in encoders, frequency-to-voltage electronics, or integrated strain gauge/thermocouple amplifiers
- Available in 4-100 connections



# MSC Slip Ring Assembly Types

End of Shaft Slip Ring Assembly

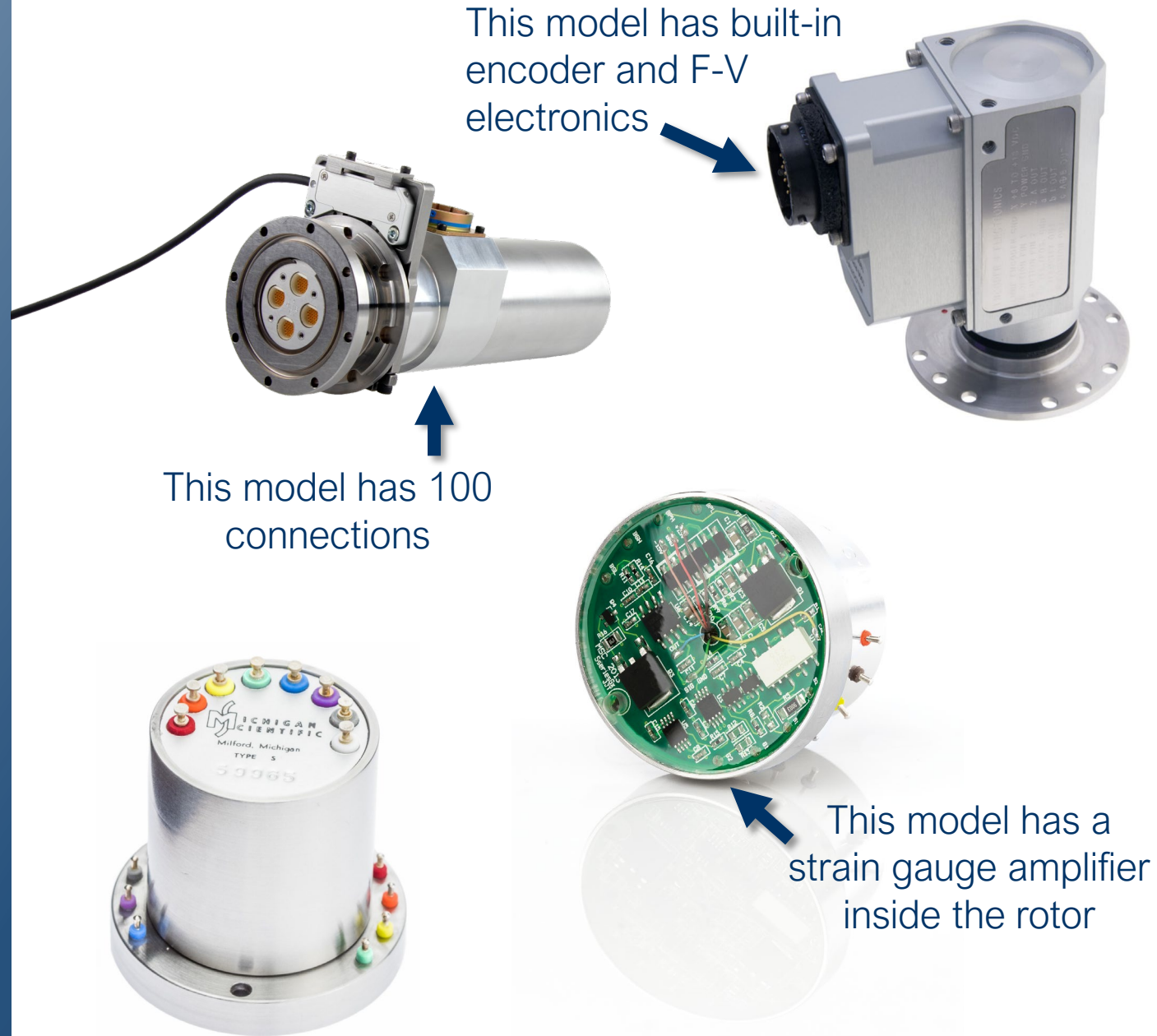


Tubular Slip Ring Assembly



# End of Shaft Slip Ring Assemblies

- Instrumentation quality rings and brushes
- Many optional accessories and features
- No bandwidth limits



# Tubular Slip Ring Assemblies

- Mounts directly onto shaft
- Easy installation
- Optional encoder or integrated amplifiers

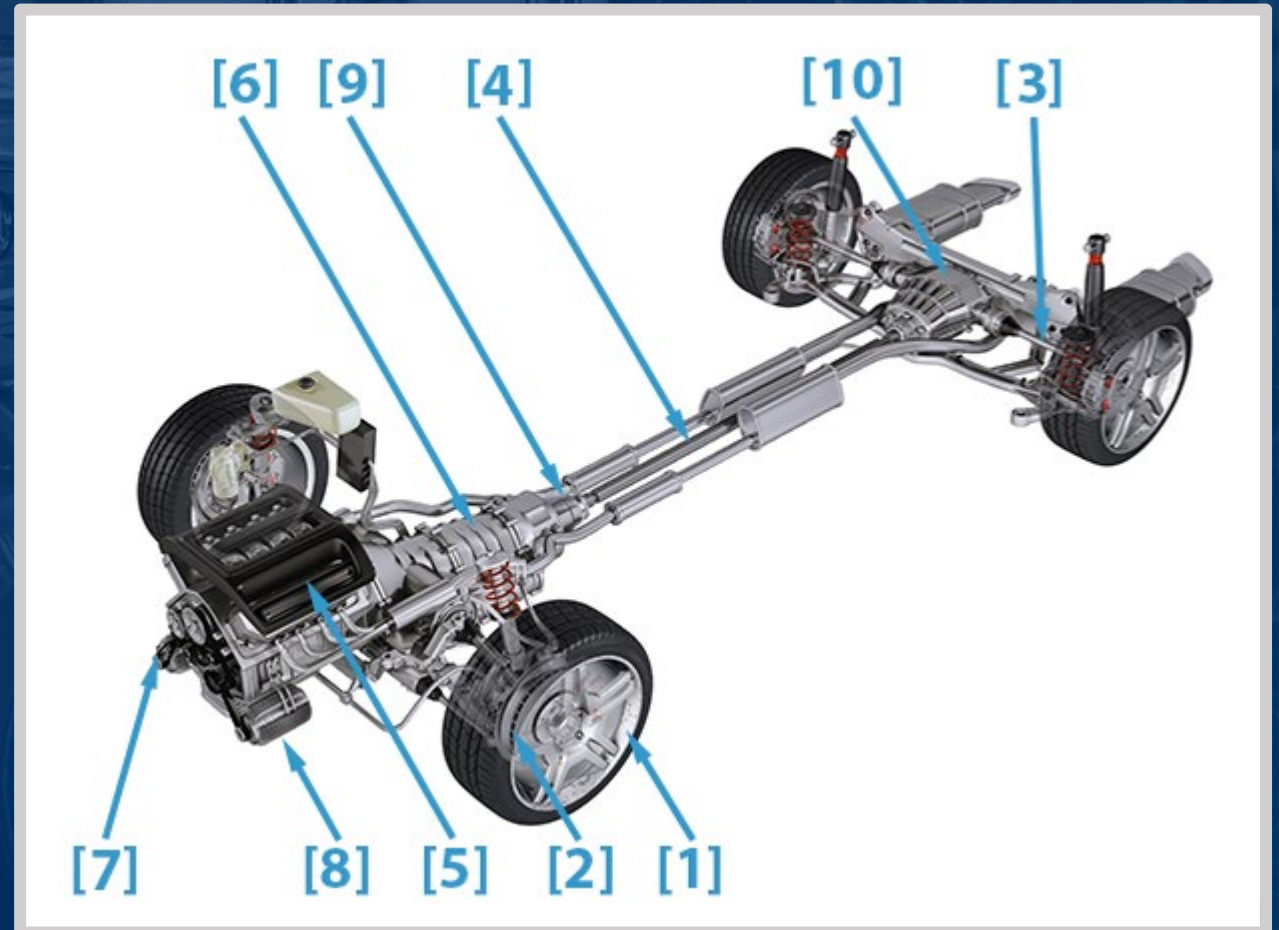


# Slip Ring Applications: Automotive

- [1] Wheels
- [2] Brakes
- [3] Half Shaft
- [4] Drive Shaft
- [5] Crank Shaft
- [6] Transmission
- [7] Alternator
- [8] AC compressor
- [9] Transfer case
- [10] Differential

## Used in:

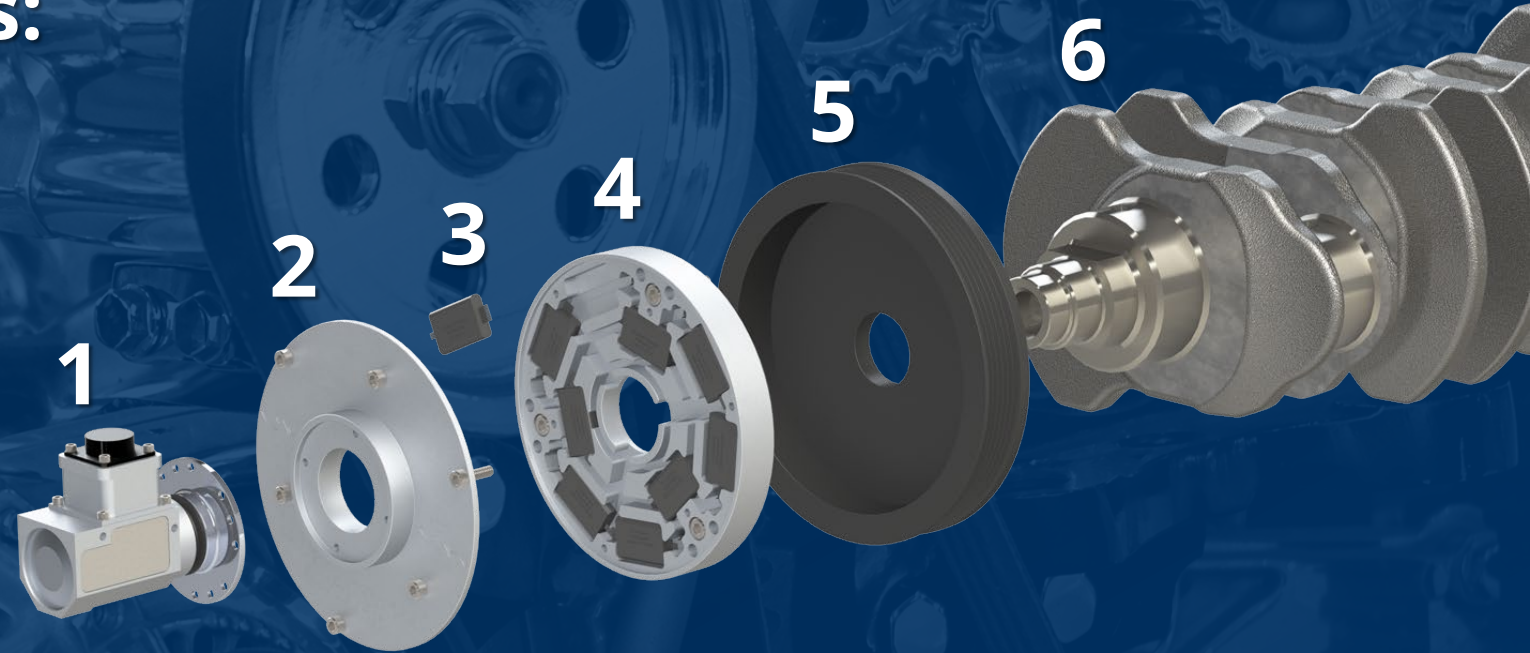
- Passenger cars • Heavy duty trucks
- Hybrid/electric vehicles • Autonomous vehicles



# Slip Ring Applications: Crankshaft

## Measures:

- Strain in fillets
- Torque
- Shaft bending
- Velocity
- Angular position



1. Slip ring assembly

2. Cover

3. Strain gauge amplifier

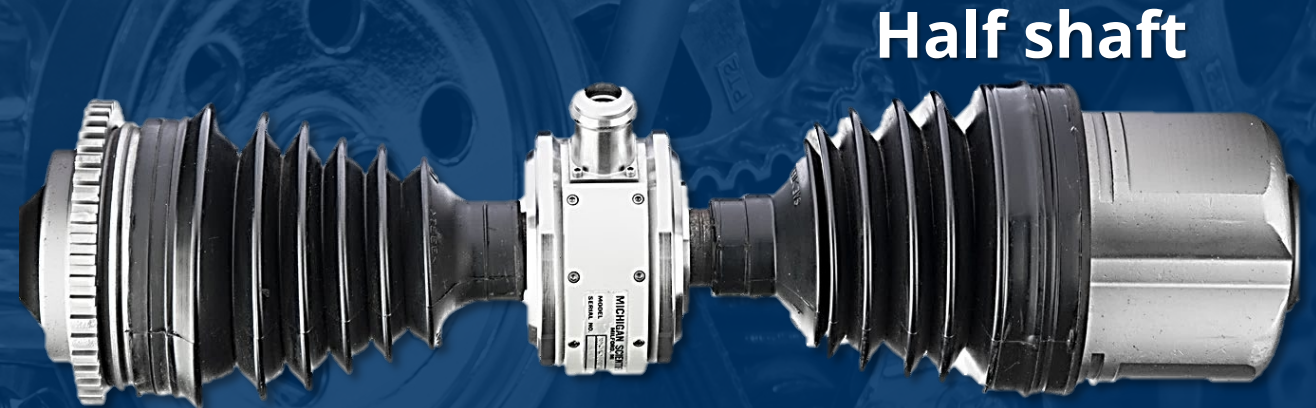
4. Amplifier housing

5. Harmonic balancer

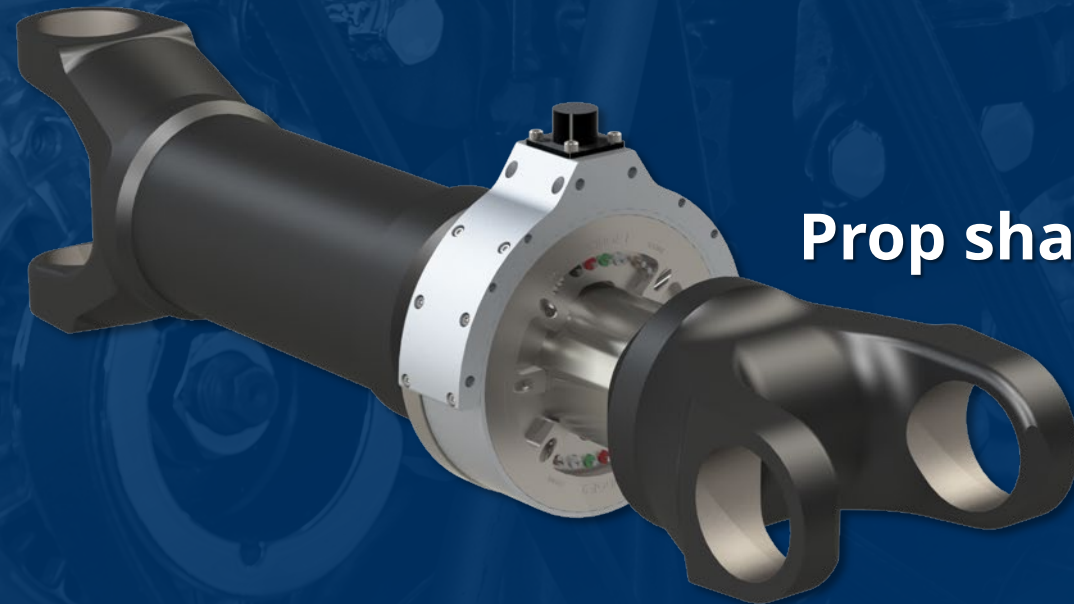
6. Crankshaft

# Slip Ring Applications: Shafts

- A tubular slip ring assembly can mount directly on a shaft
- Used to make electrical connections when measuring torque or temperature on the drivetrain



Half shaft



Prop shaft

# Slip Ring Applications: Half Shaft

The MSC Wheel Instrumentation Package (WIP) amplifies signals transmitted by an MSC ERT Slip Ring Assembly with an encoder





# Signal Conditioning Amplifiers

MSC manufactures a variety of precision, low-noise differential amplifiers

- Dependable in noisy environments
- Located close to the spinning sensor for improved signal quality



# MSC Amplifiers

## Strain Gage Amplifier

- Stable bridge excitation voltage
- Adjustable gain and shunt-cal resistor
- Remote shunt-cal and bridge-excitation-kill control



## Thermocouple Amplifier

- Thermocouple models available with 2 or 3 channels (all TC types available)
- Built-in cold junction compensation
- Eliminates potential error associated with inserting a slip ring within a TC circuit



# Amplifier Power and Control Box

- Use with any MSC Signal Conditioning Amplifier
- A box can power and control 20+ amplifiers
- Remote shunt-cal and bridge- excitation-kill control



12 Vdc-powered Control Box



120 Vac-powered Control Box

# Transducer Display Module (TDM)

- Precision, low-noise differential amplifier
- Adjustable gain and offset
- Display engineering units
- High level analog output
- 20 kHz at -3 dB
- Peak detect/hold feature



# Wireless Telemetry Systems

- Strain gauge or thermocouple-based measurements
- Up to 8 channels
- Non-contacting digital wireless link
- Transmitter powered by induction or battery



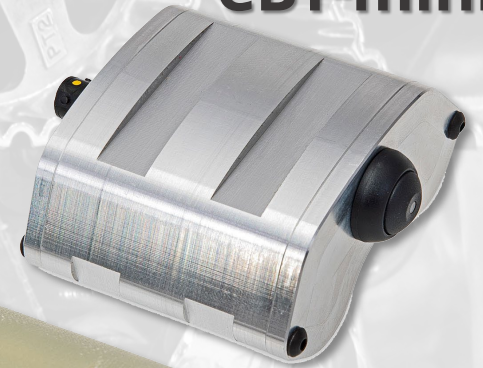
# Clamping Telemetry

- Clamping Induction Telemetry (CIT) or Clamping Battery Telemetry (CBT) options
- Mounts to various shafts
- Programmable transmitter available (dependent on transmitter selected)

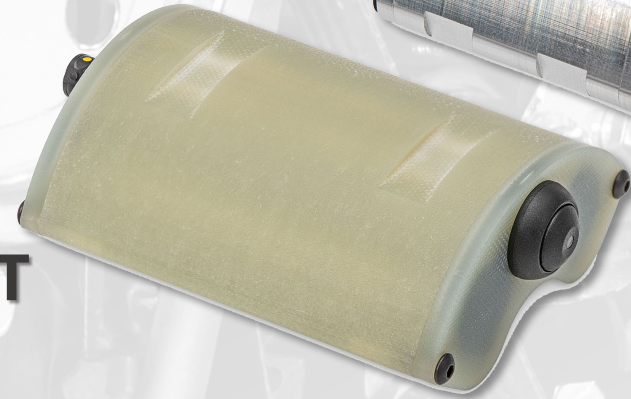
CIT



CBT-mini



CBT



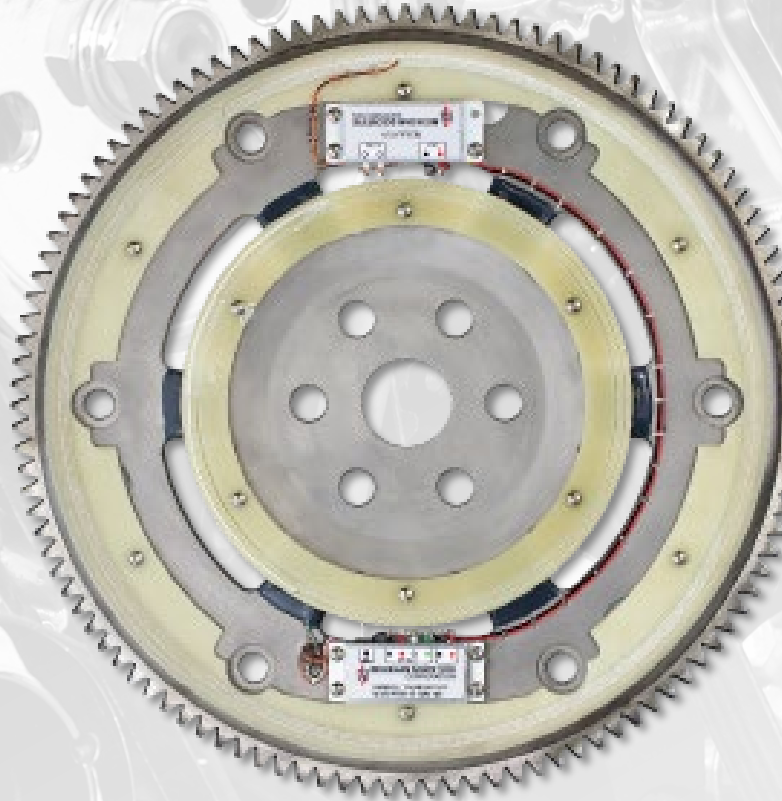
Mini CBT on shaft

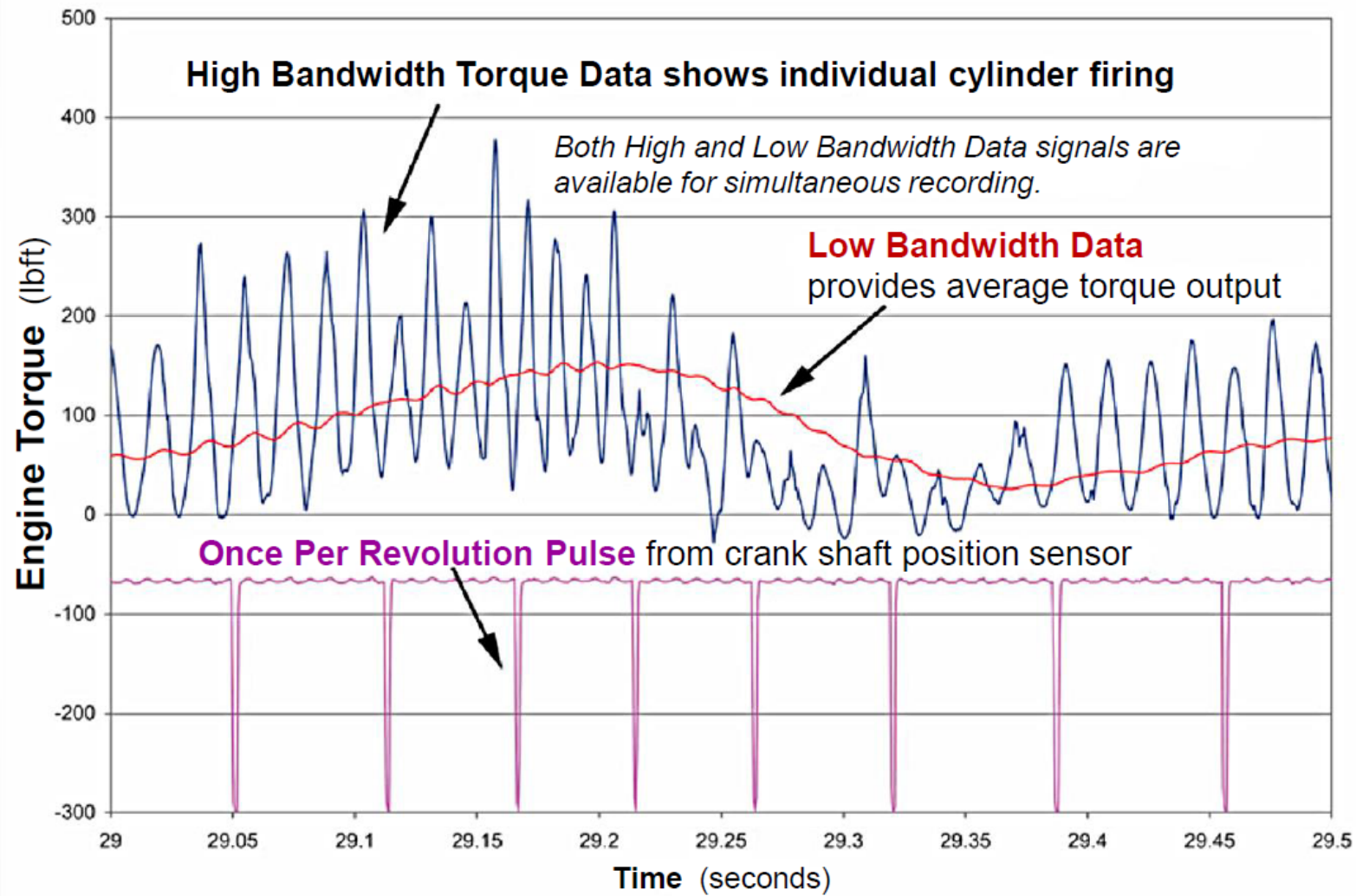


# Induction-powered Flexplate Telemetry System

Measures high-frequency dynamic engine torque input to transmission

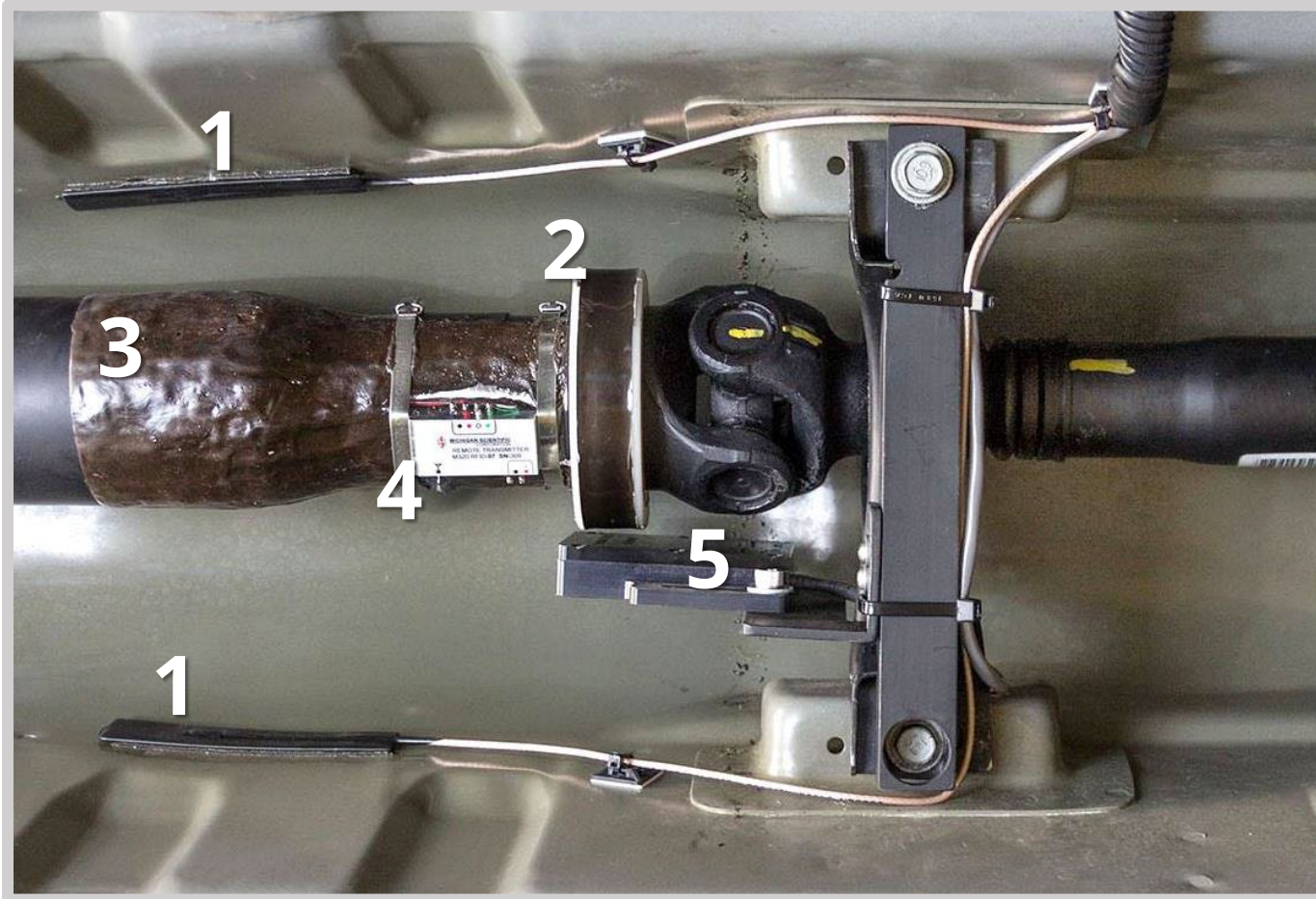
- Induction-powered with autotune feature
- Custom engineered, built, and balanced for accurate measurements





# Telemetry Data from Flexplate Transducer





## Custom Telemetry Application Example

1. Receiving antenna
2. Secondary induction coil
3. Strain gauge location
4. Transmitter (power regulator on far side)
5. Primary induction coil

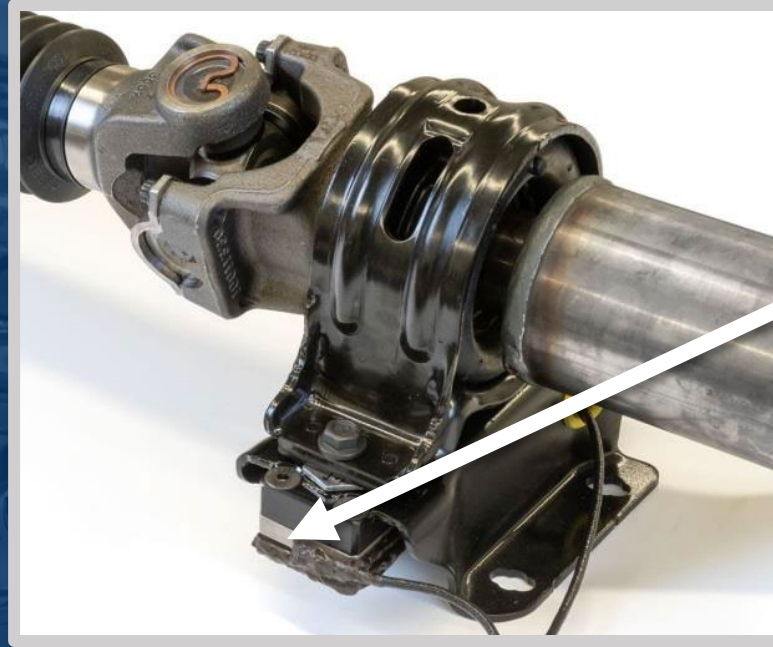
# Standard Multi-axis Load Cells

Strain gauge-based transducers

- For up to 6-directional force measurement at component surfaces
- Can be mounted in tandem to calculate roll, pitch, and yaw moments
- Available in capacities 250 lb (1,110 N) to 100,000 lb (444,000 N)

# TR3D Load Cell Applications

MSC TR3D Three Axis Load Cells measure forces in three perpendicular directions



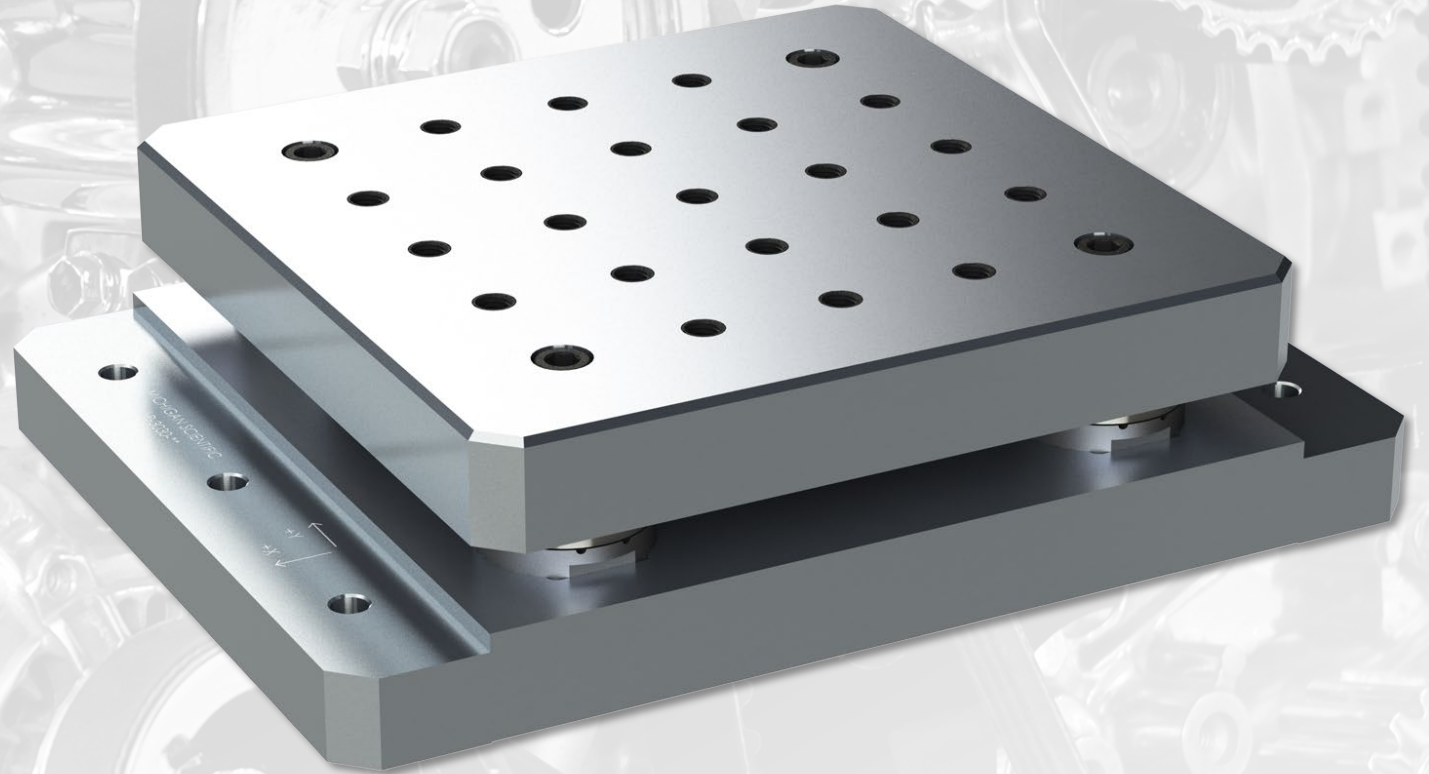
Bearing support mount loads



Engine mount loads

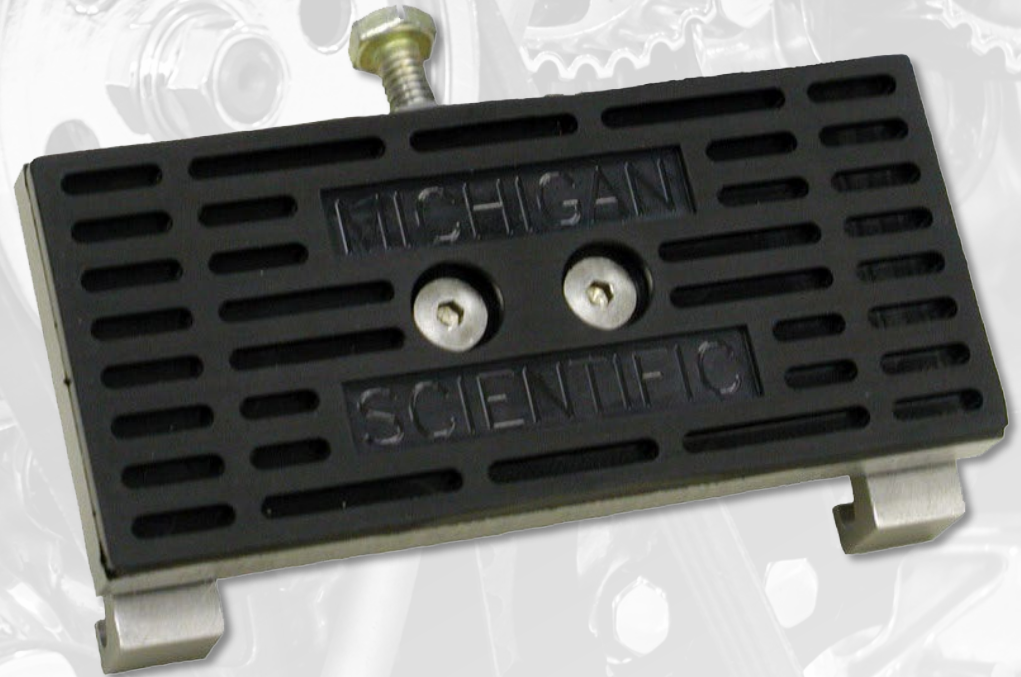
# Model LP-3030 Load Platform

- Three load ranges: 3,400 lb (15 kN), 10,000 lb (45 kN), and 17,000 lb (75 kN)
- Universal mounting pattern
- Temperature-compensated



# Brake Pedal Force Transducers

- 500 lb (2,200 N) capacity
- High accuracy for on- and off-center loading
- Fits standard brake pedals



# Wheel Pulse Transducer (WPT)

Uses a rotation sensor to measure velocity, angular position, and direction of rotation

- Encoder wheel speed sensor
- Up to 5,000 ppr
- Up to IP67 weatherproof protection
- NIST traceable calibration



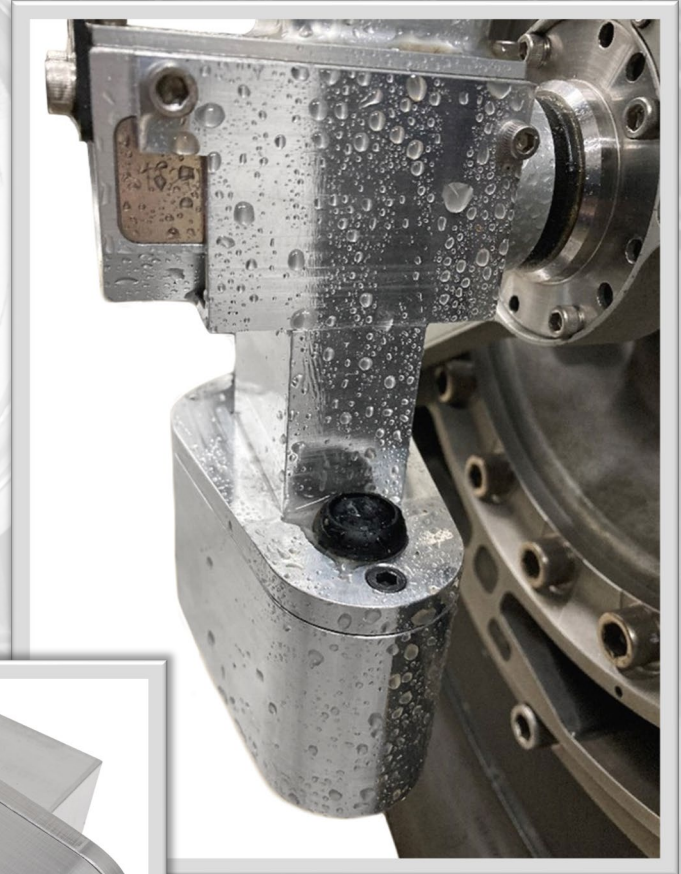


## WPT Applications

- Precision speed measurement
- Vehicle brake testing
- Distance measurement
- Map validation

# TrueSlip Side Slip Sensor

- Optically measures X and Y velocity
- Internally calculates side slip
- Mounts to wheel or vehicle body
- Works in variety of road conditions and all lighting conditions
- Designed to work with MSC WFTs





# EC-LV

## In-line signal conditioner

- Used in conjunction with a WPT
- Frequency to voltage converter
- Angular position 0-360°
- Angular velocity
- Externally adjustable full-scale RPM and direction

# Steering Wheel Torque and Angle Transducer

In-line signal conditioner

- Measures steering effort
- Uses an internal Slip Ring Assembly
- Internal high-resolution encoder
- Clamping arms or spline adapter available for mounting

# Power Take Off (PTO) Transducer

Measures torque and speed of a PTO shaft

Fits Type 1, 2, and 3 splines

Integrated telemetry and encoder system

Pre-calibrated

Convenient anti-rotation eye-hook



# Fiber-Optic Signal Links

Monitor, stimulate, or control a device under test

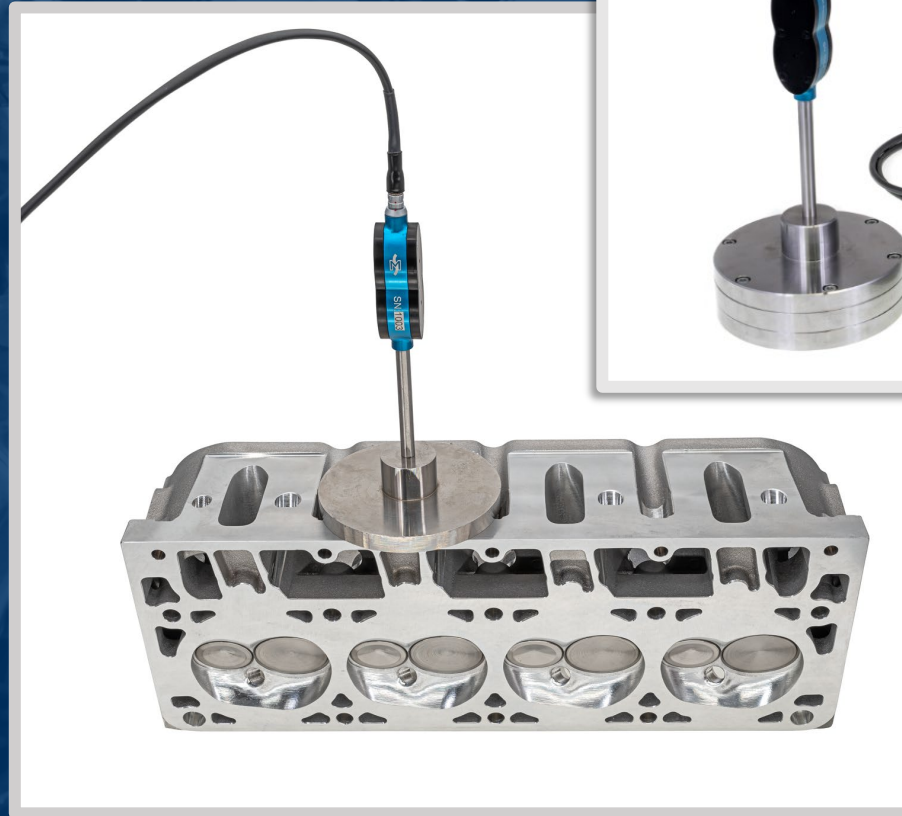
- Used for EMI/RFI engineering and electromagnetic compatibility (EMC) certification
- Used for EMC laboratory certification for the American Association for Laboratory Accreditation (A2LA) or the Automotive EMC Laboratory Recognition Program (AEMCLRP)



# Volumetrics

Used to:

- Measure cavity volume
- Measure compression volume
- Measure total volume
- Determine engine piston cylinder volume and compression ratios
- Locate top dead center

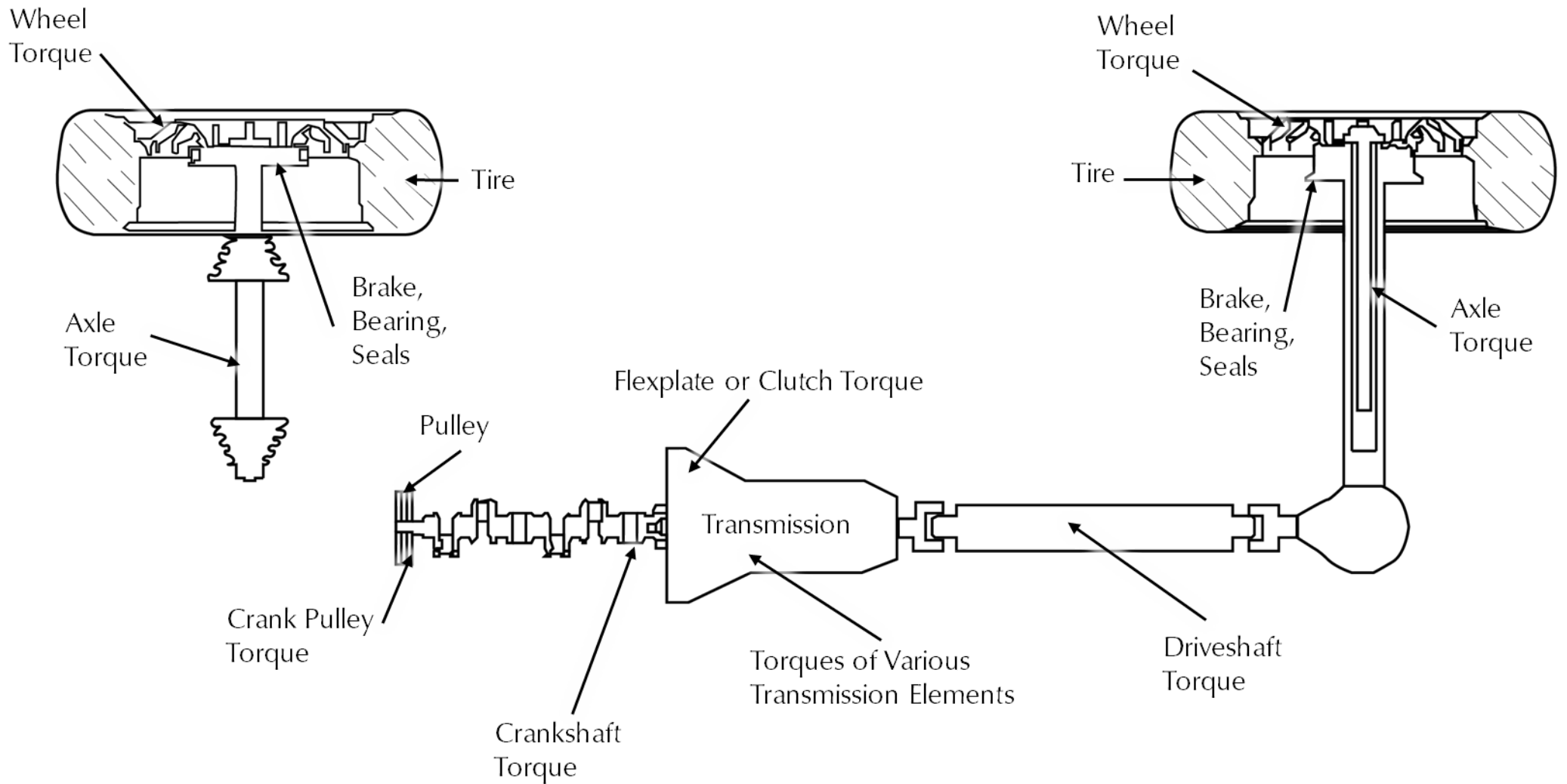


# Strain Gauge and Thermocouple Services

MSC can create custom strain gauge or thermocouple transducers from prototype and production components

- Strain in fillets
- Torque
- Shaft bending
- Velocity
- Angular position





# Powertrain Torque Measurements

# On-site Data Acquisition and Analysis

Instrumentation and data collection experience

- Full vehicle instrumentation
- Data validation
- WFT and adapter rental
- Data acquisition rental
- Accelerometer and load cell rental with custom mounting





# Thank You

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Corporation.

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