Michigan Scientific Corporation®

Suspension Testing with Force and Torque Transducers

Component-level measurements for modern vehicle suspensions

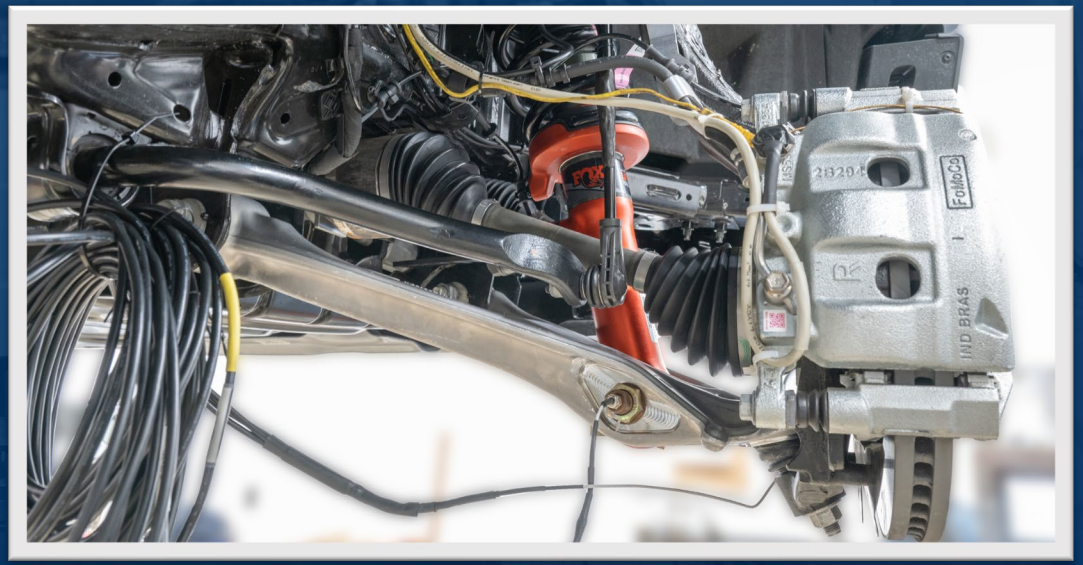
Importance of Suspension Instrumentation

Why Suspension Force Measurement Matters

- Critical to design and validation of suspension systems
- RLDA, durability studies, and chassis optimization

Why Component-level Measurement Matters

- Understand how loads distribute through suspension to chassis
- Insight into load paths
- Better correlation between simulation and real-world systems



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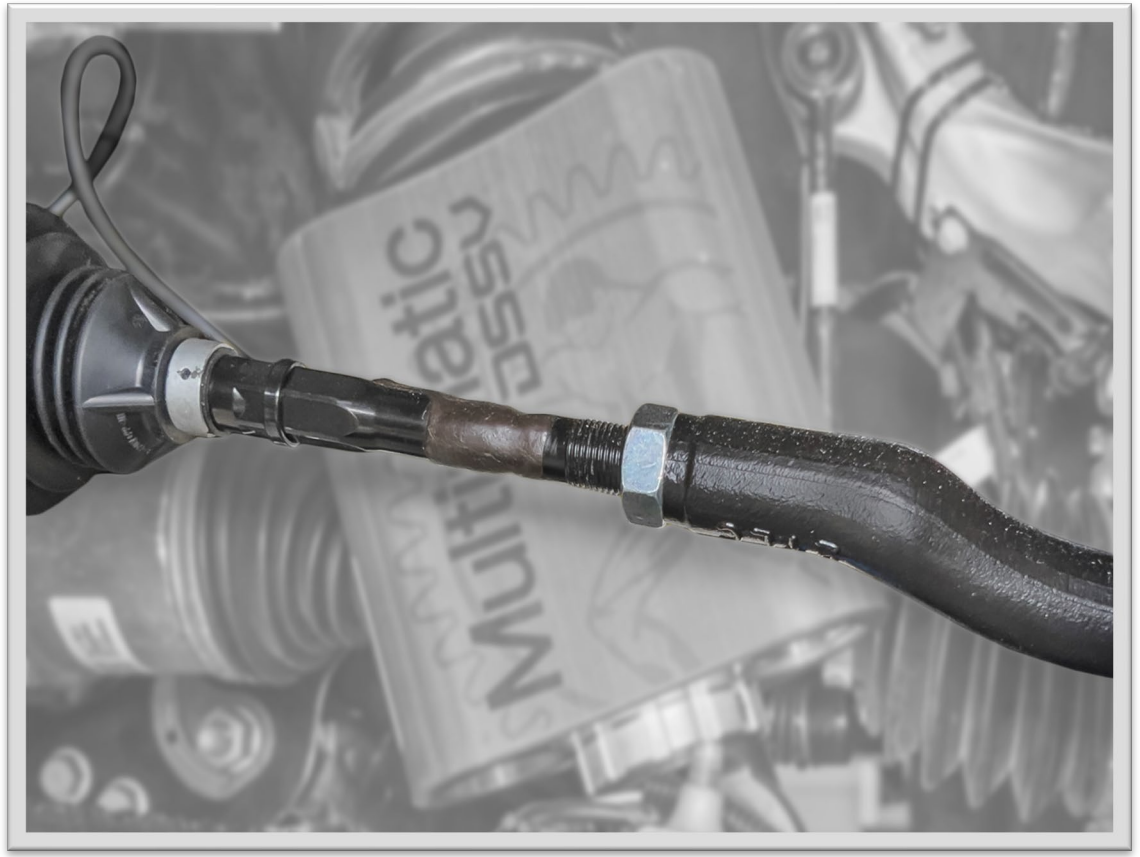
Tie Rod Force Transducers

- Tie rods are commonly instrumented to measure steering forces
- Inner or outer tie rod can be instrumented
  - Michigan Scientific prefers instrumenting inner tie rods due to their more linear characteristics
- No vehicle modification required



Ball Joint Force Transducers

- Lower control arm ball joints typically see higher loads than upper ball joints, but both can be strain gauged
- Capable of measuring two- or three-axis forces
- If the ball joint cannot be removed due to design constraints, strain gauging and calibration can be performed with the joint still installed in the control arm

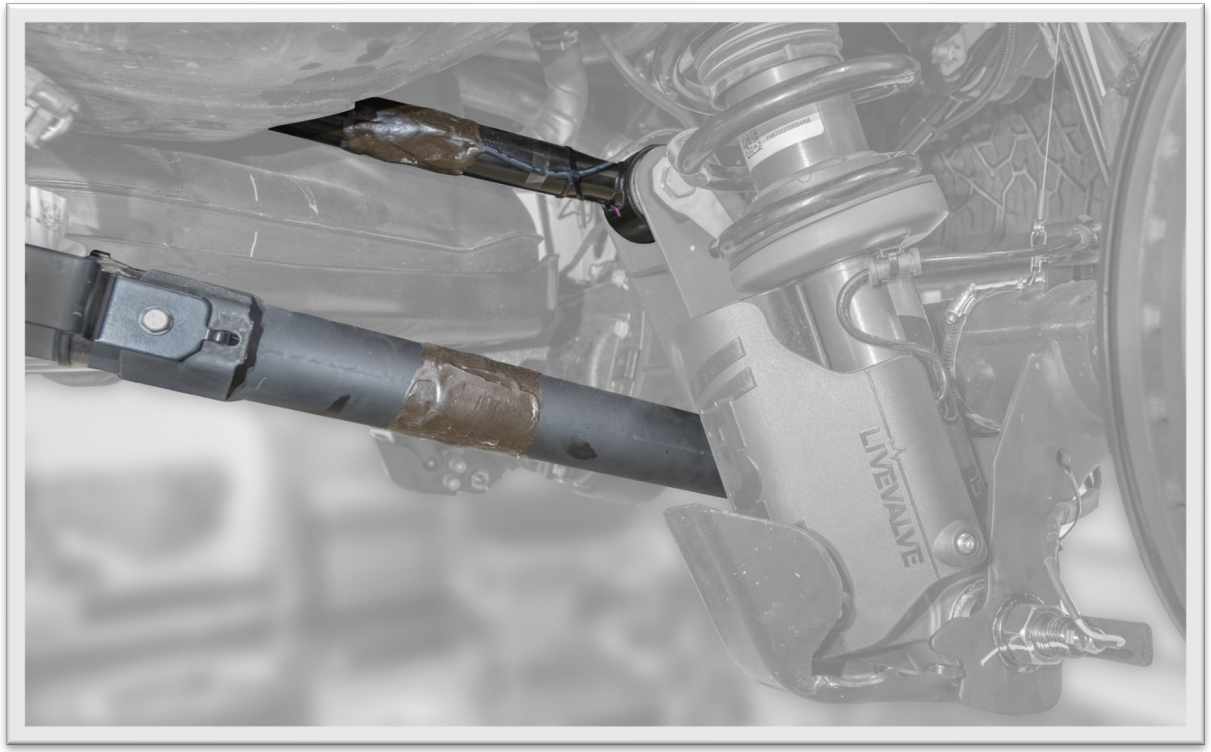
Sway Bar Force and Torque Transducers

- Sway Bar Link Force Transducer
  - Boundary conditions during calibration match boundary conditions in the vehicle
- Sway Bar Torsion Transducer
  - Strain gauged and calibrated to measure torque

Suspension Link Force Transducer

- Measure axial force
- Michigan Scientific uses FEA to determine the ideal gauge location, ensuring accurate measurement even on curved or complex geometry

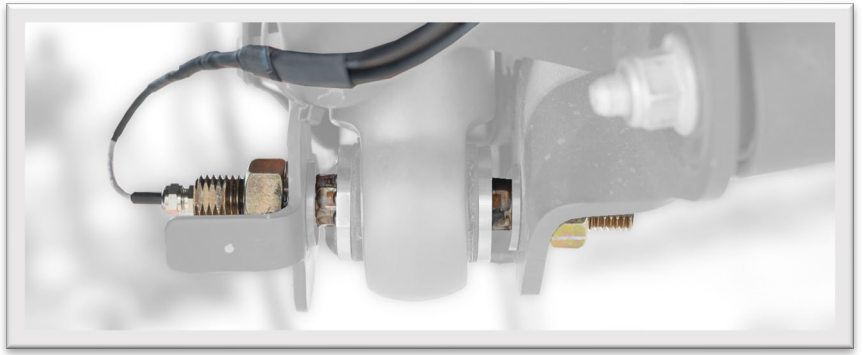
Note: Accuracy cannot be guaranteed for irregularly shaped links



Strut Force Transducers

- Shear Pin for Dampers and Struts
  - Michigan Scientific can replace the bolted joint at the bottom of the damper or strut
  - Measures one or two axes perpendicular to the pin
  - Requires modification to the damper bushing and mating parts
  - Designed to measure load directly through the joint

  - For a MacPherson strut two shear pins can replace the two strut to knuckle bolts
  - Requires minor modifications to the knuckle and strut bracket



Strut Force Transducers, Continued

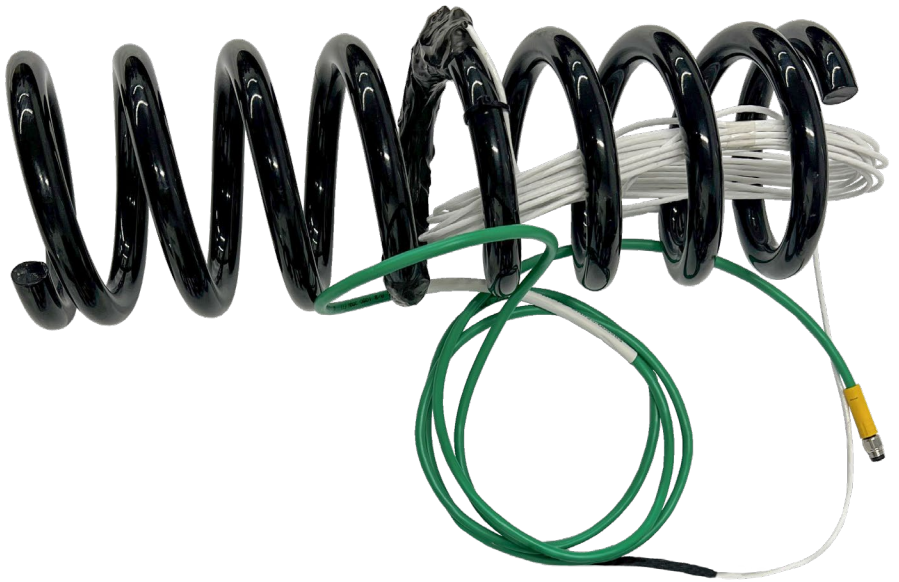
- Strut Bracket Transducer
  - Replaces the bottom bracket portion of the MacPherson strut and clamps onto the strut tube
  - Does not require modification to the knuckle
  - Four-beam transducer is made from high strength stainless steel and makes a very accurate transducer
- Crossbar Transducer for Strut
  - In cases of a strut with a lower bolting crossbar, Michigan Scientific can replace that crossbar with a one- or two-axis custom transducer (occasionally, factory crossbars must be gauged)
  - Requires no modification to the lower control arm

Damper Force Transducers

- Strut or Damper Fork/Clevis Transducer
  - If the geometry allows, this is the quickest and most cost-effective option and requires minimal modification
  - Bolt clamping load during calibration is representative of OEM installation for best accuracy
- Damper Rod Transducer
  - Gauging is done so normal travel is maintained.
  - For this transducer, welded damper shrouds are removed or modified to allow for gauging
  - Some dampers allow for the wire to simply exit through the remaining shroud. Some dampers require the drilling of the end of the damper rod to allow the wire to exit through the end of the rod
- Damper Top Mount Transducer
  - We can modify and strain gauge the top of the damper mount or replace it with a custom transducer to measure force
  - Measure the total force from the damper to the chassis

Rear Suspension Force Transducers

- Shackle Force Transducer
  - Instrument the shackle to measure axial force from the leaf spring into the chassis at one end of the leaf spring
  - Maintaining representative boundary conditions is critical for this transducer
- Coil Spring Force Transducer
  - Provides valuable insight into how vertical loads are transmitted through the suspension system
  - Michigan Scientific can instrument coil springs to capture this data accurately, even under dynamic conditions
  - In addition to force, coil springs can be calibrated to measure displacement, which is useful for correlating spring compression with ride height and suspension travel



Key Takeaways

Michigan Scientific engineers will work with you to identify the most effective instrumentation strategy based on your specific suspension layout and testing goals.

We offer complete instrumentation services.

Thank You

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