Development of a Torque Measurement System for Use in Flex Plate Applications

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Strain gages from Micro-Measurements are used by TECAT Performance Systems to measure flex plate torque for an automotive manufacturer. Utilized in conjunction with TECAT's WISER torque telemetry system, the strain gages provide the high accuracy and compact size required for this high-temperature, space-constrained application.

Company/Institute: TECAT Performance Systems

Industry/Application Area: Automotive

Products Used:

- 8x EA-06-062TH-120 strain gages, configured in a full bridge
- M-Prep surface preparation
- M-Bond 610 gage adhesive
- M-Bond GA-61 leadwire adhesive and protective coating

The Challenge

An automotive manufacturer wanted to measure flex plate torque in the real world, in order to determine loss distribution throughout the drivetrain system. Other torque measuring devices were too large to be packaged within the tight space constraints, and could not handle the harsh environment. In addition, when other systems were used in a test environment, the high temperatures of this application led to false readings.

The Solution

The TECAT team developed a solution that incorporated their WISER instrument system, an effective temperature compensation strategy, eight Micro-Measurements strain gages configured in a full bridge, and high-temperature-resistant batteries. This solution was then packaged onto the existing flex plate, without the need to alter the flex plate. The torque sensing flex plate system was installed on a vehicle, which then collected real-world measurements of the flex plate torque.

The User Explains

Flex plates connect the engine output crankshaft to the torque converter on automatic transmissions. The plate bends along the main axis to take up motion in the torque converter as rotational speeds change. As a flexible drivetrain component, the flex plate is a source of loss in the system.

Measuring the amount of loss in situ has always been extremely challenging, as this is inherently a very tight space within any vehicle. In addition, each flex plate is unique in terms of packaging, stiffness, calibration, test conditions, and protocol. A plug-and-play sensor solution won't work, since every flex plate and every flex plate application is different from vehicle to vehicle. Taking advantage of the small size, light weight, and low power consumption of the WISER system, TECAT was able to overcome these challenges.

In order to properly quantify the influence of temperature changes during loading, TECAT application engineers developed a test rig where torque and a temperature profile could be applied to the flex plate simultaneously while measuring the torque and temperature response using the WISER system. The final test rig configuration is shown in Figure 1. The team then performed the following development activities:

1) Torque Load Calibration: Known torque loads were applied to the flex plate which had been installed with Micro-Measurements strain gages and TECAT WISER telemetry in order to determine the output slope calibration values over the measurement range.
2) Temperature Offset Calibration: While unloaded, the instrumented flex plate was run through a temperature sweep from -40 °C to +125 °C, which covered the operating temperatures that would be present in the real-world testing.
3) Temperature and Torque Load Span Calibration: With the previous two calibration tests complete and the ability to track flex plate strain and temperature simultaneously with the TECAT WISER system, a temperature offset compensation equation could be used to counteract the temperature offset affects and the span and changes to span due to temperature could also be quantified.

These development activities resulted in a flex plate measurement system that produces accurate real-world torque data despite the extreme temperature variances involved. With its small size and industry-leading battery life, the TECAT flex plate torque measurement system can be installed entirely on a production flex plate and provide 1000+ hours of data before the batteries need replacement. As a result of this set-up, the automotive manufacturer was able to obtain accurate measurements of flex plate torque and thus gain valuable information about drivetrain losses in real world conditions.

An example of a complete torque sensing flex plate is shown in Figure 2.

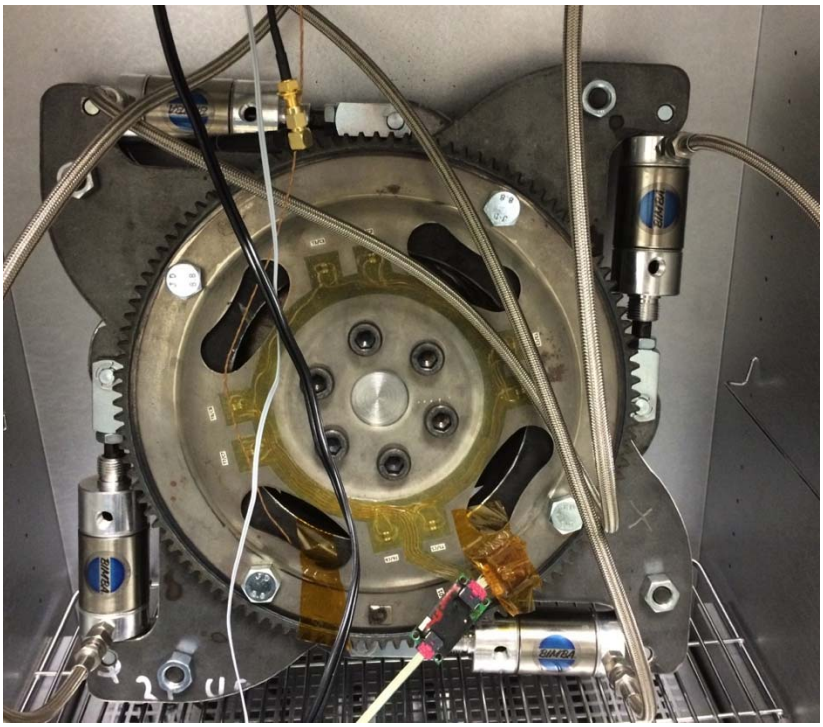

Figure 1: Flex Plate Test Rig

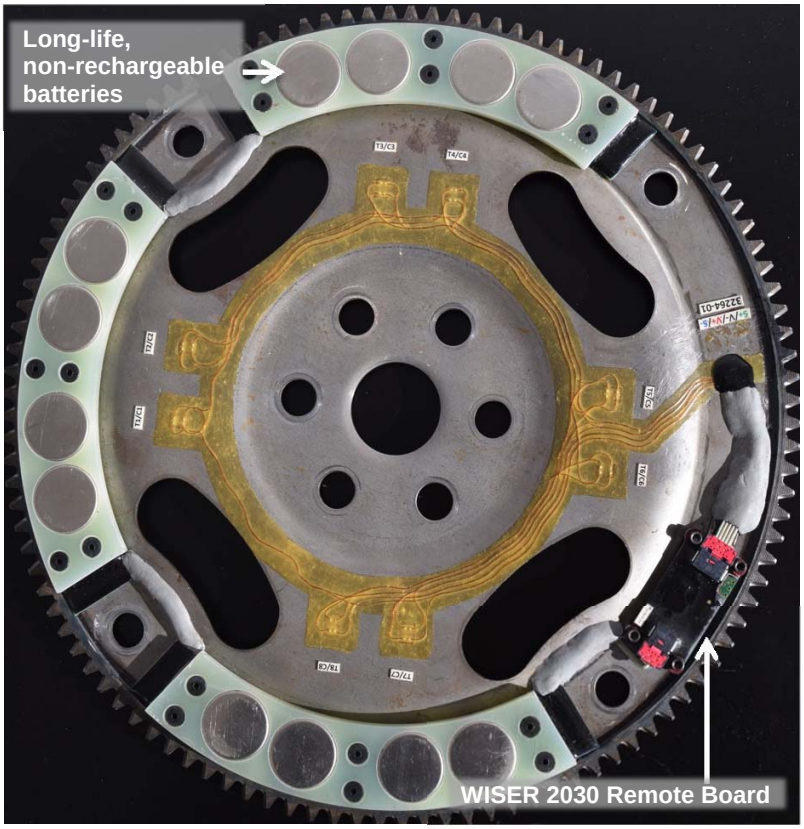

Figure 2: Sample Torque Sensing Flex Plate

"For our WISER system, the high-temperature performance of Micro-Measurements' strain gages was essential in providing our customer with accurate flex plate torque measurements."

Acknowledgement:

TECAT Performance Systems designs and manufactures the world's smallest, lightest, and most power-efficient wireless sensors. These features allow our customers to measure torque, acceleration, and atmospheric data in places and applications that were previously inaccessible. Delivering wireless sensor solutions that are unmatched in accuracy, price, size, efficiency, and simplicity, TECAT Performance Systems maintains headquarters in Ann Arbor, Michigan and production facilities in Madison Heights, Michigan.

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