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ENABLING ADVANCED DRIVETRAIN CONTROL WITH CUSTOM SPEED AND DIRECTION SENSORS

For Heavy Off-Road Vehicles

Standex Electronics

Long-Term Partnership Leads to Custom Solution

A world leader in drivetrain and e-propulsion systems, faced a challenge in their heavy off-road vehicle chassis designs. They needed a reliable way to sense speed and direction from non-standard gears deep within their drivetrain assemblies. These gears had unique pressure angles and spline features that standard sensors struggled to detect accurately.

Standex Electronics, supplying 25 to 30 percent of a major automotive manufacturer's speed sensor volume, was called upon to develop a custom solution. This partnership showcases Standex Electronics' ability to tackle challenging sensor applications, leveraging its expertise in magnetic sensing technology and custom design.

The collaboration between a major automotive manufacturer and Standex Electronics highlights the importance of long-term relationships in developing innovative solutions for complex engineering challenges. By understanding the manufacturer's evolving needs, Standex Electronics has provided increasingly sophisticated sensor technologies tailored to specific applications.

Check out the full list of testing and certifications:

- AS9100 Certified
- ISO9001 Certified
- IATF16949 Certified
- ITAR & NIST Compliant
- AEC-Q200 Qualified
- UL-Recognized

Meeting Unique Mechanical and Electrical Requirements

The custom sensor solution developed for the customer showcases the ability of Standex Electronics to meet complex design requirements:

1. **Extended Sensor Housings:** Custom stainless-steel housings with barrels up to 4 to 5 times longer than standard sensors were designed to reach deeply positioned gears while maintaining precise gap control. This extended reach allows for accurate sensing without compromising the drivetrain's structural integrity.
2. **Electrical Compatibility:** A new circuit was developed to match the customer's specific control system voltage and protection needs, ensuring seamless integration with existing vehicle electronics. This custom design includes protection against load dump events up to 200V, critical for maintaining reliability in harsh environments.
3. **Output and Connectivity:** The sensors feature PNP outputs and Deutsch DT04-4P connectors, meeting the customer's compatibility requirements for their heavy-duty applications. The robust Deutsch connectors ensure a secure, weatherproof electrical connection, crucial for off-road reliability.

These custom features allowed the customer to implement advanced speed and direction sensing in their drivetrains without compromising vehicle design or performance. The ability to sense gear movement deep within the drivetrain opens up new possibilities for advanced traction control and power management systems.

Providing Quadrature Encoder Outputs for Speed and Direction

The heart of the solution lies in the sophisticated quadrature encoder technology implemented in the CS1253, CS1258, and CS1296 sensors. These sensors provide dual-channel quadrature (A/B) outputs that enable precise determination of both speed and direction:

1. **Speed Measurement:** The sensors track pulse frequency on either channel, directly corresponding to the target gear's rotational speed. This allows for near-zero speed detection, essential for applications requiring precise low-speed control.
2. **Direction Detection:** By analyzing the phase relationship between A and B pulses, the system determines rotation direction. A leading A pulse indicates one direction, while a leading B pulse signals the opposite. This real-time direction data is indispensable for implementing advanced traction control algorithms.
3. **Accuracy in Challenging Conditions:** Despite non-standard gear geometries, these sensors maintain accurate outputs through self-calibrating capabilities and robust design. The self-calibration feature adapts to varying air gap distances and gear tooth profiles, ensuring consistent performance across different drivetrain configurations.

This quadrature output provides the control systems with real-time data about drivetrain performance. It allows for more complex traction control, power management, and diagnostic capabilities in heavy off-road vehicles. The precision in sensing both speed and direction can help foster and support advanced features such as hill-hold assist, improved regenerative braking, and more precise torque vectoring in all-wheel-drive systems.

Collaborative Design Process Ensures Performance

Developing a custom sensor solution for the unique requirements involved a highly collaborative process:

1. **In-House Validation:** Standex Electronics conducted comprehensive electrical design validation through in-house testing, subjecting the sensors to temperatures from -40°C to +130°C and various voltages to ensure reliable performance in harsh off-road environments. This rigorous testing included thermal cycling, vibration analysis, and electromagnetic compatibility assessments.

2. **Target-Specific Testing:** Standex Electronics technicians correlated functional testing between Standex Electronics and the customer using actual target gears from the drivetrains. This crucial step fine-tuned the sensors' performance for the specific application, ensuring accurate readings across various gear sizes and tooth profiles.

3. **Iterative Optimization:** Through multiple iterations, Standex Electronics optimized calibration and achieved the required sensor gap tolerances, ensuring consistent performance across various drivetrain configurations. This process involved adjusting sensor positioning, calibration, and refining signal processing algorithms.

4. **Production Readiness**: The process culminated in a successful Production Part Approval Process (PPAP) submission, leading to full production implementation of the initial two sensor designs. This comprehensive documentation and validation process ensured that the sensors met all the quality and performance requirements.

This rigorous development process demonstrates Standex Electronics's commitment to delivering solutions that exceed expectations. The close collaboration between Standex Electronics engineers and the customer's team throughout the process ensured that the final product was perfectly tailored to the specific needs.

Adapting the Design for Additional Applications

The success of the initial sensor designs led to further collaboration between Standex Electronics and the customer:

1. **Third Variant Development:** Standex Electronics created a third sensor variant, the CS1296, for use in another assembly that is calibrated and oriented differently to provide speed and direction feedback in that product.
2. **Form Factor Consistency:** The new variant maintained the same custom form factor and performance characteristics of the initial design, ensuring compatibility with the existing integration processes. This consistency allows for easier implementation of the new sensor across different vehicle platforms without significant redesign.
3. **Flexible Solution:** This adaptation showcases our ability to quickly respond to evolving needs, providing flexible solutions that grow with product lines. Our modular approach to sensor design allows for rapid customization to meet new requirements as they arise.

The development of this third variant demonstrates the long-term value of partnering with a sensor supplier capable of adapting and expanding custom solutions as new requirements emerge. It also underscores our commitment to supporting product evolution over time.

Standex Electronics Custom Design Capabilities

The expertise of Standex Electronics in custom sensor design was instrumental in developing the ideal speed and direction sensing solution for the customer's complex drivetrain applications. By leveraging Standex Electronics' advanced quadrature encoder technology and adapting it to meet the customer's specific requirements, they delivered a robust, reliable system that enhances drivetrain control and performance in challenging off-road environments.

This project showcases Standex Electronics' ability to collaborate closely with customers, rapidly prototype custom solutions, and bring innovative sensing technologies to market in demanding heavy-duty vehicle applications In-house design, testing, and manufacturing capabilities enable Standex Electronics to provide end-to-end support, from initial concept through to high-volume production.

Whether you need a modified version of an existing sensor or a completely custom design, Standex Electronics has the capabilities to meet the most challenging requirements. Experienced Standex Electronics engineers combine their deep expertise in magnetic field sensing with a collaborative approach to problem-solving, ensuring solutions tailored to specific needs.

To learn more about how Standex Electronics can support innovative drivetrain projects with custom magnetics and sensor solutions, and to see Standex Electronics' full engineering and design capabilities, visit standexelectronics.com.

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