Application Brief

Encoder Signal Chain

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Position Encoder Signal Chain Designs

Applications such as robotics, semiconductor manufacturing, computer numerical control (CNC) machines and medical imaging use high-precision, high-speed machinery so the applications require optimized, low-noise signal chains to offer maximum output. Texas Instruments offers a portfolio of high-performing position encoder designs which includes high-speed, high-precision analog-to-digital converters (ADCs) for control loop performance, specialized sensors for inductive, magnetic, and optical encoders, and high-performance transceivers.

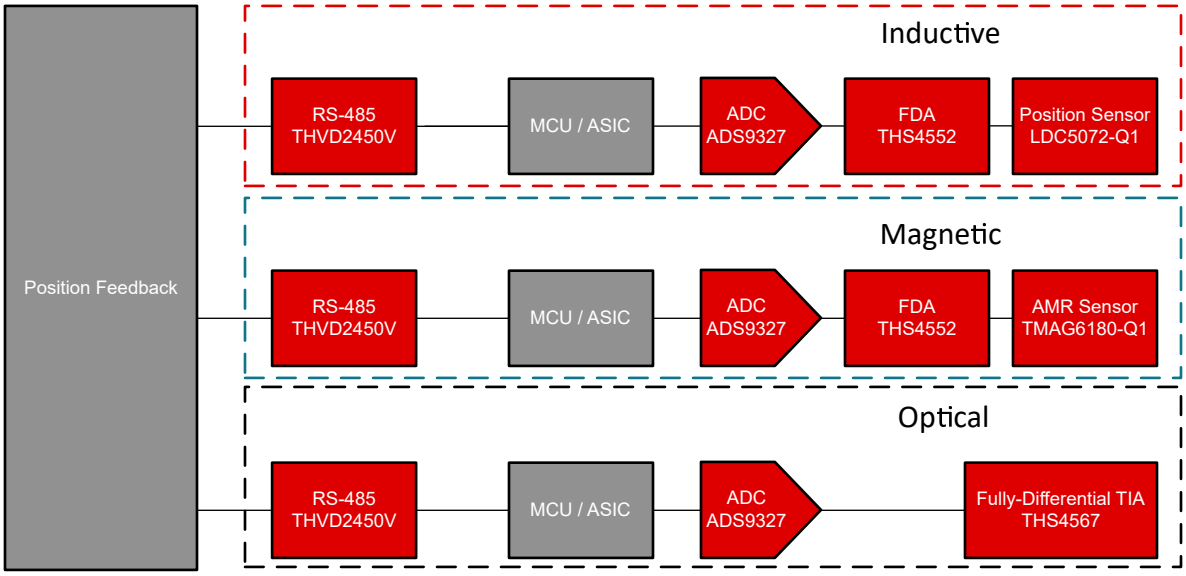

Figure 1. Encoder Signal Chain

Inductive, Magnetic, and Optical Encoders

The high-speed, high-precision ADCs include the ADS9219, ADS9224R and ADS9327 family of devices. With the devices high throughput rate and simultaneous sampling abilities, the devices facilitate on-chip oversampling, resulting in improved angular position accuracy. The ADS9219 family also includes integrated drivers for the ADC inputs, simplifying the signal chain, reducing power consumption, and supporting high-frequency signals beyond 1MHz. Table 1 presents alternate ADC options for different resolution, sample rate, and package size requirements. This *product overview* on encoders gives a larger list of ADCs for encoder applications. For applications without high resolution requirements, the C2000 real-time microcontrollers feature multiple high-speed, 12-bit ADCs. Single and multi-rail low noise LDOs, such as the TPS7A20 and TPS7A87 power all components in optical, magnetic, and inductive encoder signal chains. The THVD2450V is a±70V fault-protected, half-duplex RS-485 transceiver with flexible I/O supply that is designed for transmitting a clock.

Table 1. ADC Recommendations

2-Ch Simultaneous Sampling ADCs	Resolution (bits)	Sample Rate (MSPS)	Size (mm x mm)
ADS9219	18	20	6 x 6
ADS9218	18	10	6 x 6
ADS9227	16	5	6 x 6
ADS9327	16	5	3.5 x 3.5
ADS9224R	16	3	5 x 5
ADS9324R	14	3	5 x 5
ADS7254	12	1	

For inductive encoders, the LDC5072-Q1 IC is an analog front-end for contact-less, inductive position sensors targeted for absolute rotary position in automotive and industrial applications. The LDC5072-Q1 excites sensing coils that are typically printed on a printed circuit board (PCB). The excitation is coupled back into two sets of receiver coils on the same PCB using a conductive target that is placed in close proximity to the receiving sensing coils. The sensing coils remain stationary on the PCB while the metal target moves with the motor, actuator, or valve. An excitation coil generates a high-frequency secondary voltage on the receiver coils depending on the position of the target. A signal representation of the position is obtained by reading in the voltages from the receiver coils, processing, and outputting analog Sine and Cosine signals. Error levels <<1 degree can be achievable with proper sensor coil design.

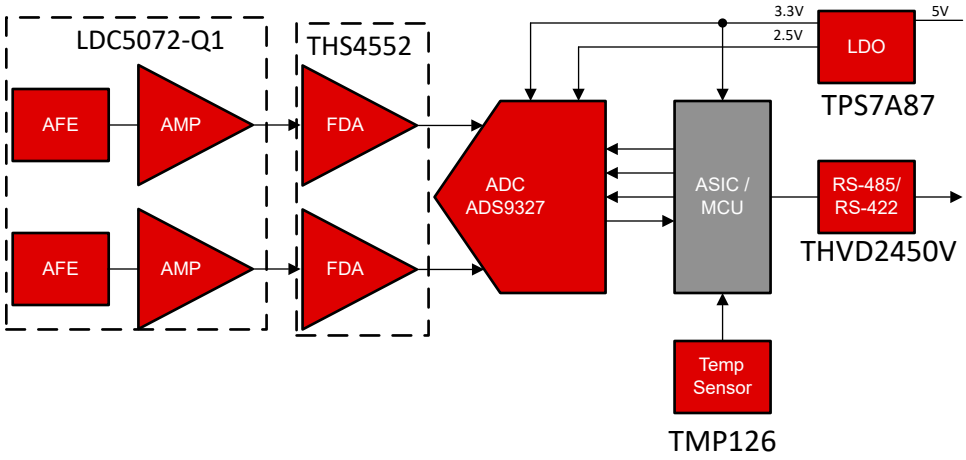

Figure 2. Inductive Encoder Signal Chain

For magnetic encoders, the TMAG6180-Q1 is a high-precision anisotropic magneto resistive (AMR) sensor with a 360° angle range. The device integrates signal conditioning amplifiers and provides differential sine and cosine analog outputs related to the direction of the applied in-plane magnetic field. The device also features a wide operating magnetic field and ultra-low latency on the sine and cosine outputs to enable flexible mechanical placements and minimize latency related angle errors respectively.

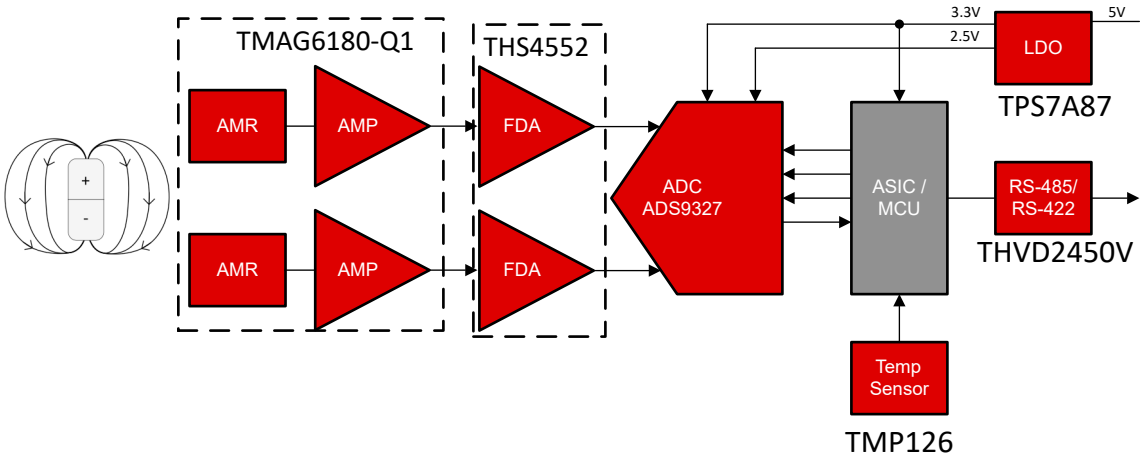

Figure 3. Magnetic Encoder Signal Chain

The THS4567 is a 220MHz, high input impedance, fully differential amplifier that includes independent input common-mode and output common-mode control that is designed for optical encoders. The device operates as a fully differential trans-impedance amplifier (TIA) and as a direct ADC driver to the ADS9327 in a single integrated stage.

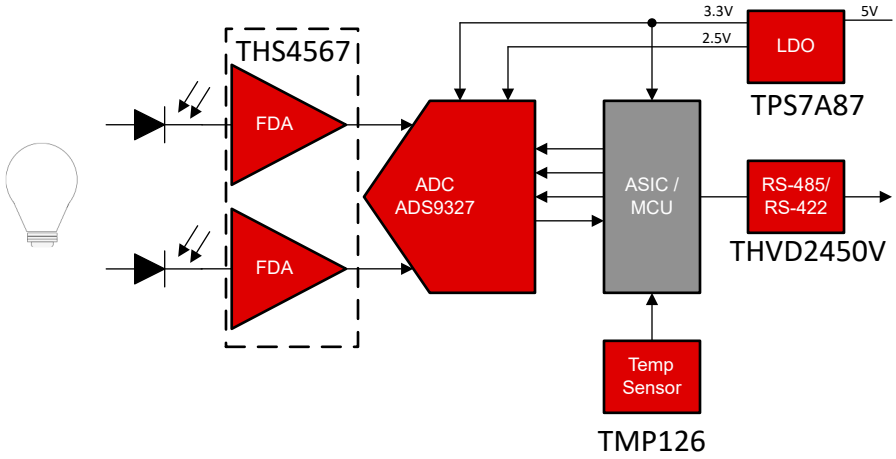

Figure 4. Optical Encoder Signal Chain

Transceivers

Transceivers within motor encoder applications need to be robust enough to survive harsh environments. THVD2450V was designed with that in mind with ±70V fault tolerance, ±25V operational common mode range, and rated to survive up to ±4kV EFT. These design specifications make the THVD2450V designed for motor encoder applications. THVD2450V can be used with protocols like SSI, BiSS, EnDat 2.2, and Hiperface DSL because of the low transmitter and receiver skew.

Power Management

As advanced manufacturing capabilities increasingly deploy more motors with encoders, reducing the encoder form factor becomes essential. Low noise, multi-rail and power density LDOs mitigate the thermal and board space challenges within the encoder.

Table 2. LDO Recommendations

Device	Specs
TPS7A20	Single 300mA
TPS7A87	Dual 500mA
TPS7A88	Dual 1A

Related Articles

- Texas Instruments, *Precision ADCs for Motor Encoders and Position Sensing*, product overview
- Texas Instruments, *Precision ADCs in Servo Drives*, application brief
- Texas Instruments, *Low Latency Signal-Chains for Digital Control Loops with ADS9219*, application brief
- Texas Instruments, *How to monitor automated testers and encoders*, technical article
- Texas Instruments, *Simplify Antialiasing Filters With ADS9218*, application note

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