WHITE PAPER

WP-2008: Noise and Signal Distortion Considerations

When the electrical signals leave the encoder, they are "clean" in the sense of being noise free. However, by the time these signals reach their intended destination, they can be degraded by radiated and induced electrical noise, as well as signal distortion mechanisms such as cable capacitance and impedance mismatches. Inadequate shielding, poor cable termination, poor cable quality, and long cable lengths all contribute to undesirable signals.

Cable Length Considerations

All cables have small amounts of capacitance between adjacent conductors. This capacitance is a direct function of the cable's length, and tends to round off the leading edge of the square wave signal, increasing rise times. It can also distort the signal to the extent of causing errors in the system.

Signal distortion is not usually significant for lengths less than 30 feet (or 1000 picofarads). To minimize the distortion, use low capacitance cable (less than 30 picofarads per foot), in the shortest length possible for the application. To minimize distortion for cable lengths in excess of 30 feet, use differential line driver outputs, along with differential type receiver circuitry.

Also, a low capacitance twisted-shielded pair cable should be used whenever using differential signals. For high frequency applications (> 200kHz), this type of cable may be needed for all lengths.

Model 25T encoder with cable and 10-pin connector

Cable Termination

Proper cable termination is extremely important with differential signals. With an un-terminated configuration, signal reflections can occur, resulting in severely distorted waveforms. If signal distortion occurs, try parallel termination, which involves placing a resistor across the differential lines at the far (receiver) end of the line. The parallel termination resistor value should be:

Approximately equivalent to – or up to 10% greater than – the characteristic impedance of the cable (Zo) (usually between 70 - 150 ohms).

This permits higher frequencies to be transmitted without significant distortion.

Encoder with cable

Unfortunately, low valued resistors can increase the power dissipated by the line driver, and reduce the output signal swing. In this case, a capacitor should be placed in series with the resistor. The capacitor value should be equal to the round trip delay of the cable divided by the cables Zo. Round trip delay is equal to the cable length multiplied by 1.7ns/ft. Note that the RC time constant of this type of termination can reduce the system frequency response.

Model 25H encoder mounted on a motor

A parallel termination resistor value larger than listed on Page 1 can often provide adequate reduction of signal reflections, and still maintain adequate frequency response, and low power dissipation. Experimentation is often required for each application consisting of long cable runs and high frequencies.

Cable Connection

It is extremely important to connect cable shields to ground on the instrument end (counter, PLC, etc.). Always properly ground the motor/machine for which the encoder is mounted. Also, ground the encoder case under the following conditions:

(1) DO NOT ground the encoder case through both the motor/machine and the cable wiring, and

(2) DO NOT allow the encoder cable wiring to ground the motor/machine exclusively. High motor/machine ground currents could flow through encoder wiring, potentially damaging the encoder and associated equipment.

Conclusion

If you follow the recommendations given here, you will see a reduction in noise and signal distortion in your encoder. If you still have questions about installation, signal clarity, or anything else encoder-related, give us a call. When you **contact EPC**, you talk to real engineers and encoder experts who can answer your toughest encoder questions. You'll get the right answers that make sense for your application.

Contact EPC today to get the information you need.