Celera MOTION
A Novanta Company

Grounding and Shielding Recommendations

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INTRODUCTION

Proper shielding and grounding are essential to good servo design. Selecting the appropriate cable and devoting effort to the grounding of the encoder in the planning stage will save considerable time and expense in troubleshooting and correcting signal noise problems once the design is complete.

SHIELDING

A cable can transfer noise by acting as an antenna or it can pick up noise that is radiated from other equipment. Proper wiring and shielding can mitigate the effects of signal interference by reflecting it from the signal carrying wires and by conducting the interference to ground.

MicroE encoders feature double-shielded cables with twisted differential pairs. The inner shield is connected to circuit ground and the outer shield is connected to both the sensor and the connector housing. When the encoder is connected to ground, either at the sensor or at the connector, a path to ground for electrical noise is provided.

Cross-section of double-shielded cable

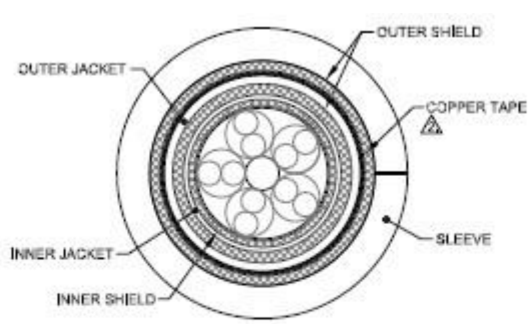

Figure 1

The use of twisted pairs takes advantage of differential signaling where one line carries one signal and the other its complement. The signal measured is the difference between the two lines. The differential signal propagated in twisted pairs is more robust to cross talk and will be less susceptible to noise.

GROUNDING

An effective grounding system will help reduce electromagnetic interference effects from disturbing the encoder signal outputs. A single-point grounding scheme operates better at low frequencies, and a multipoint ground behaves best at high frequencies. In designing a ground system for MicroE sensors, the ground connection would ideally be made at the sensor head; however the bracket that the sensor is mounted to is often attached to moving parts. There is no guarantee that there will be a good ground contact on parts that are moving, so in such cases the ground connection may be best made at the connector.

Figure 2 shows the connections of the inner and outer shields of a MicroE encoder. The first drawing shows the encoder properly grounded, which will offer the best protection against signal noise interference.

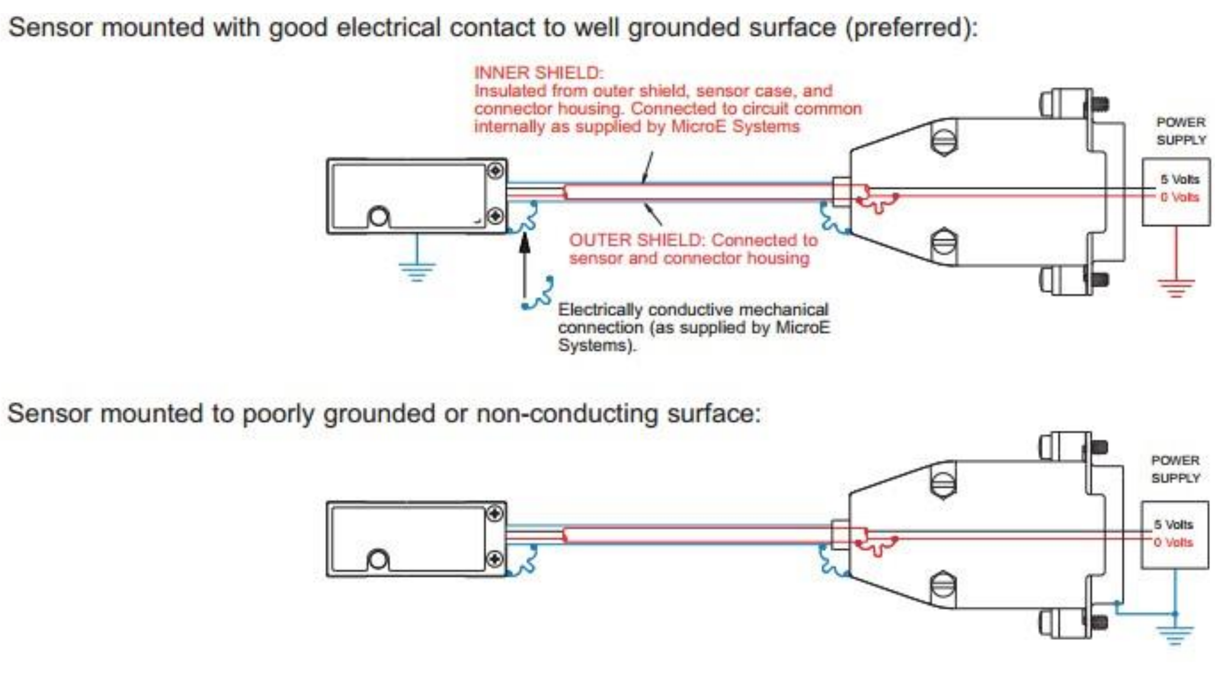

Figure 2

For units with 2x5 micro-connectors, the outer shield is terminated at the hex sleeve.

Ground loops can occur when more than one point is used for ground connections causing these points to be at different ground potentials. This difference of potentials can cause noise due to induced AC

voltage and electromagnetic interference. Ground loops can occur if the sensor and the connector shell are each grounded separately.
It is unlikely that the sensor mounting bracket and the electrical chassis ground at the receiving end will be at exactly the same electrical potential. For most applications, a single ground connection is recommended.

To stress this point, two different ground symbols have been used in the following illustrations. For systems where the expected noise sources will be relatively low in frequency, grounding at only one point is best – either the sensor or the connector shell, but not both.

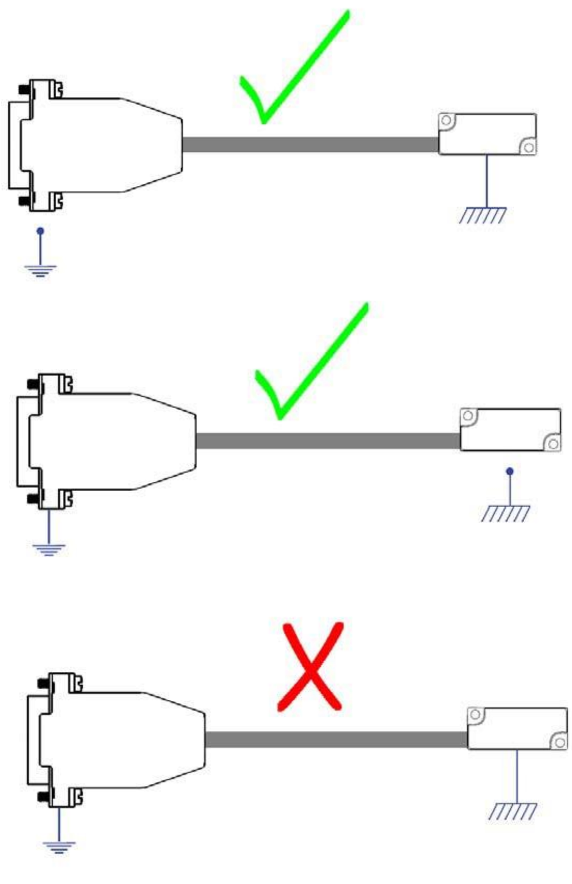

Figure 2

In cases where high frequency noise sources exist, such as some medical equipment applications, multiple ground points are desirable. In such cases, using a 0.1µF capacitor between the connector shell and the ground can be very effective:

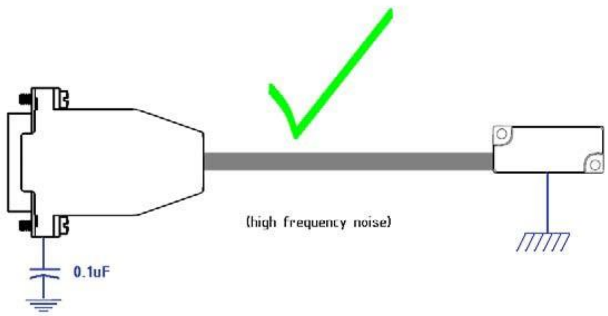

Figure 2

In this example, the capacitor will act as an open circuit for low frequency noise (or a DC potential between grounds) and a short circuit for higher frequencies. This technique is highly recommended for applications where high frequency interference is common.

Sources: Henry W. Ott, "Noise Reduction Techniques In Electronic Systems," 1988
Howard Johnson, "High-Speed Signal Propagation: Advanced Black Magic," 2003