Technical Bulletin 116
Noise and Signal Distortion Considerations

BRITISH ENCODER PRODUCTS COMPANY

When the electrical signals leave the Accu-Coder™, 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.

If cable lengths are in excess of 30-50 ft, we recommend using our differential line driver outputs (output code HV or H5) along with differential type receiver circuitry.

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.

To minimize the distortion, we recommend that low capacitance cable be used (less than 30 picofarads per foot), and that cable lengths should be as short as possible. Signal distortion is not usually significant for lengths less than 30 ft (or 1000 picofarads).

A low capacitance twisted-shielded pair cable should be used whenever using differential signals, with cable lengths in excess of 30-50 ft. For high frequency applications (>200kHz), this type of cable may be needed for all lengths. Our standard cable has a braided and foil shield, however, it is not a twisted shielded pair cable. Therefore, we recommended for high frequency applications that the user terminate our standard cable just outside the encoder, and then run a low capacitance twisted-shielded pair cable the remaining distance.

Proper cable termination is extremely important with differential signals. First, we recommend trying an un-terminated configuration. However, signal reflections can occur, resulting in severely distorted waveforms. If signal distortion occurs, parallel termination is recommended, which involves placing a resistor across the differential lines at the far (receiver) end of the line. This resistor 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. 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.

In our experience, a parallel termination resistor of a larger value than given above 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.

It is extremely important that cable shields be connected to ground on the instrument end (counter, PLC, etc…). Always make sure the motor/machine for which the encoder is mounted is properly grounded. The encoder case should also be grounded 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.

If you have any extra questions
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