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ADVANCED MOTION SOLUTIONS

Customization to Suppress Electromagnetic Interference in DC Motors

A variety of active and passive approaches can be adopted to reduce electromagnetic interference (EMI) in systems that rely on precision motion control. For applications ranging from medical diagnostic to office automation equipment, the need to suppress conducted and radiated noise is critical, especially in light of increasingly stringent electromagnetic compatibility (EMC) requirements. The challenges are to maintain system integrity and DC motor performance without adding significant cost or weight to a subassembly.

One active approach to reduce the effects of EMI is by customizing DC motor and encoder combinations with differential line drivers. Differential circuits improve noise immunity by processing a signal that is the algebraic difference of two complementary signals at the input. The differential line driver receives the signal from the encoder and inverts polarity on one output to form complementary signals. A 5V input signal would transmit as 5V on one output and 0V on the other. Because the transmission lines are balanced and positioned closely, any noise induced in the circuit equally affects the signal amplitude, polarity and phase in both wires.

The lines feed to a differential receiver, which re-inverts one input and adds the voltage in the lines, effectively canceling EMI. Therefore, if a +1V noise spike enters the 5V system, the lines would carry 6V and 1V for the duration of the spike, then the receiver would invert the 1V input and detect the original 5V.

To ensure that noise equally affects both transmission lines, differential circuits commonly employ twisted-pair wiring, especially as transmission distances become longer. For shorter transmissions, ribbon cable will suffice. With twisted-pair wiring, higher noise immunity can be achieved, because the inductively coupled noise currents are out-of-phase and effectively cancel one another in each loop. Wires should be terminated at the receiver-end only with a resistor equal to the differential line impedance.

While differential circuits and twisted-pair wiring cancel noise within the encoder circuit, EMI may still be encountered in other parts of the motion control system. Proper grounding, filtering and shielding can enhance these techniques and further suppress EMI.

In terms of specific EMI reduction options involving passive components, capacitors and inductors can be incorporated to filter noise. While filters can be incorporated externally, it is advantageous to add filtering inside the motor frame to place components as close to the noise source as possible for maximum effectiveness.

For low frequency EMI (typically below 30 MHz), capacitors can be installed from the terminal to the ground and/or terminal to terminal for optimum filtering. To reduce high frequency noise (generally above 30 MHz), ferrite beads can be installed on wire and cable harnesses by slipping them over the wires' insulation. For maximum electrical noise suppression, a combination of passive components can be specified to create a low-pass LC filter that will be inductive capacitive at low frequencies and dissipative at higher frequencies.