OPTIMIZE CONTROL PANEL LAYOUT FOR NOISE MITIGATION

Electrical noise is a real threat to reliable manufacturing. Learn how a cost-effective, multilayered approach to panel layout helps boost performance, security and sustainability.

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Editor's Note: This article is adapted from a white paper about using a Unified Physical Infrastructure to reduce electrical noise, optimize control panel layout and improve cable management. Download the free, comprehensive white paper at http://bit.ly/tjpanduitwp.

>> One of the core issues affecting the performance and reliability of industrial control systems is electrical noise. It can cause field device misreads; devices to fail, reset, or enter a fault state; equipment damage; or signal retransmission that inflicts communication delays.

The topic of mitigating performance issues caused by electrical noise is wide ranging. This article focuses on ways to implement a multilayered approach to noise mitigation within your physical infrastructure. For a deeper dive into all the factors that affect electrical noise mitigation, including considerations for implementing the Ethernet layer, download the complete white paper at http://bit.ly/tjpanduitwp.

Types of Electrical Noise

Electrical noise is a very real threat to reliable manufacturing operations. Several types of electrical noise can occur:

- Low-frequency 50 to 60 Hz interference.
- High-frequency noise from 100 KHz to 30 MHz.
- Radiated frequency interference (RFI) (100 MHz and higher).
- Electrostatic discharge (ESD).

Types of problems resulting from electrical noise include:

- Erratic operation of sensing systems where measurements might be disrupted or have false variability.
- Unstable production measurements, such as miscounts or corruption of output sensors.
- Controller lockups or memory corruption, as with programmable controller system lockups.
- Component failure over time, such as when input circuits or protective devices are hit too many times with spikes.
- Communication failures with transmit and receive causing dropouts, retries and missed packets.

Both electromagnetic interference (EMI) and RFI electrical noise take the form of an external electromagnetic signal interfering with the normal, desired signal or control action that is expected to occur.

Multilayered Approach to Noise Mitigation

A key factor in mitigating electrical noise is to follow a multilayered electrical noise prevention and mitigation strategy that optimizes control panel space use. Different layers should include grounding and bonding, separation, shielding and filtering practices to provide optimal protection (see illustration on **page 43**).

The layers involved in defending against the threat of EMI are inner layers focused on preventing noise problems through proper grounding/bonding and segregation/separation practices, and outer layers to mitigate existing noise sources through shielding and filtering/suppression.

Grounding and Bonding. The grounding and bonding layer is the foundation for controlling EMI in control systems (see illustration). Because grounding is an NEC requirement for electrical safety, the sight of green and yellow ground straps, ground bars and PE conductors are common and relatively well understood.

However, a grounding system can be fully compliant but have equipment that encounters serious disruptions, stoppages and even damage caused by an inadequately installed and engineered low-impedance ground/bonding system for high-frequency noise.

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Separation and Segregation. One of the easiest and least expensive ways to prevent noise problems is to lay out the control panel using segregation and separation techniques. This is the practice of physically separating noisy circuits and devices from potential victim circuits (see illustration).

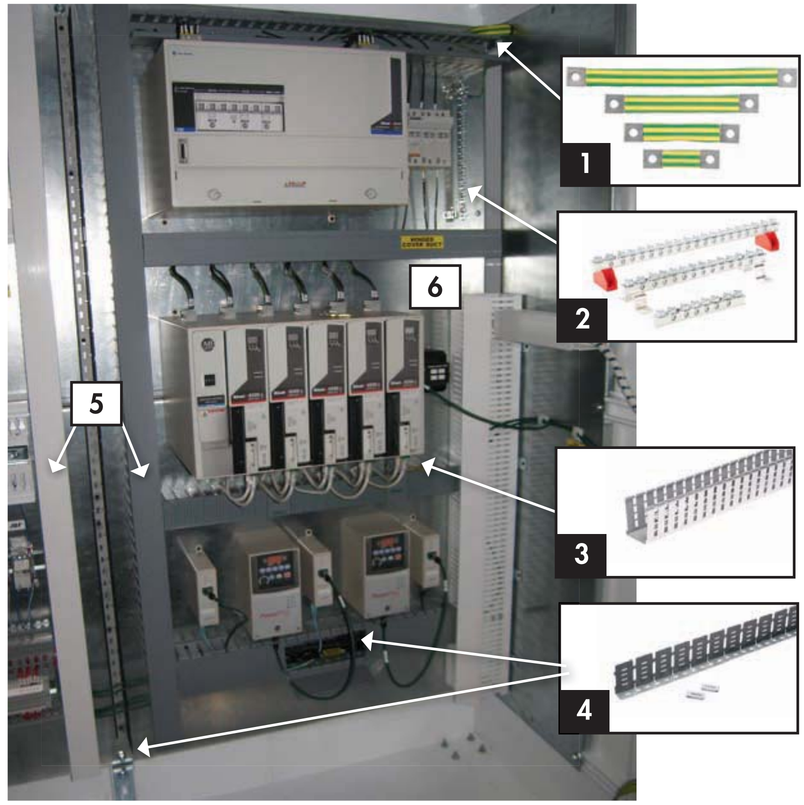
Creating distance between sources and victims reduces the noise's field strength and can eliminate or reduce the risk of costly noise issues later on. However, this conflicts with the desire to conserve panel space, so various shielding solutions have been developed to address this conflict.

When creating a panel layout, it is best to create physical, color-coded zones in the panel to separate clean and noisy circuits. This zoned approach allows technicians to identify clean and dirty circuit areas easily within a panel.

In addition, it's good practice to follow applicable codes for separating various voltage classes by providing separate wiring ducts to avoid mixing high- and low-voltage cabling. Higher-voltage devices should be mounted in the upper right-hand corner of the panel, keeping as much distance as possible from other electronic devices (such as programmable controllers, DC power supplies and timers) that are positioned on the opposite left side of the panel. Also, maintain distance between motor power and encoder, I/O and analog cables.

Separation Distances. Past standard IEEE 518 (withdrawn in 2002) provided some guidance on the minimum distances between certain types of conductors in parallel runs based on noise susceptibility and generation.

However, the evolution of power and signal wiring requires an update to this approach. ISO/IEC 24702, Generic Cabling for Industrial Premises, recommends the MICE (mechanical, ingress, chemical and EMI) classification to help designers select proper cabling.



This example of a panel layout uses 1) braided ground straps between subpanel sections, 2) a ground bar system, 3) a shielding wiring duct, 4) a noise shield, 5) color-coded duct and 6) galvanized back panels.

Rather than defining separation distances, MICE defines the environmental conditions, including noise, where cabling will be installed. Proper cabling type is selected based on environmental class (see illustration).

Because noise coupling will drop off with the square of the distance of separation, moderate separation distances between wiring classes provide effective noise mitigation. A separation distance of 3 to 6 in. (75 to 150 mm) is recommended between high-noise and low-noise circuits.

A minimum of a 12-in. (300-mm) separation should be maintained between encoder or resolver feedback cables and the motor cables or any AC power cables.

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Barriers and Partitions. When physical separation can't be maintained fully, a conductive physical barrier or partition can be used effectively to provide wire segregation and shielding while reducing physical separation distance between wires. A metal barrier provides the greatest shielding protection from magnetic and capacitive coupled noise (see illustration).

A metal barrier can provide 20dB of noise reduction, which is equivalent up to 6 in. of air spacing. The value in reducing or eliminating the air spacing between cables is to optimize space usage within the enclosure. A noise barrier also can be used to enhance other noise mitigation efforts, including air spacing, for a defense-in-depth approach and a more robust control system design.

> The grounding and bonding layer is the foundation for controlling EMI in control systems.

Shielded Wire Ways (Trunking). Another method to provide wire segregation and shielding while reducing physical separation distance between wires is to use a shielded wire way or shielded trunking. This method is similar to a metal barrier, but also provides a channel for routing larger wire counts and is fully enclosed for greater protection (see illustration).

A shielded wire way also can provide a 20dB reduction in noise that's equivalent to up to 6 in. of air spacing. As with metal barriers, the value in reducing or eliminating air spacing between the cables is to optimize space use in the enclosure. A shielded wire way also can be used to enhance other noise mitigation efforts.

Cut Downtime, Boost Quality

Electrical noise emitted from sources such as pulse-wide modulation (PWM) drives, power supplies and inductive load switching can affect system efficiency and uptime adversely by interfering with analog signals, industrial network transmissions and controller programs. A multilayered approach for grounding and bonding, segregation, shielding and filtering is a key strategy for mitigating electrical noise in your control panel.

Mitigating electrical noise helps minimize downtime, quality problems and erroneous communication without a significant cost increase to the panel designer and builder. □

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