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A Twisted/Shielded Tale
Putting a Lid on Electromagnetic Interference
1,000 words

At a manufacturing plant outside Philadelphia one hot day last summer, HVAC installers were preparing to measure the cool fruits of their labor. They inserted a thermocouple probe into a gleaming new air conditioning duct, part of a totally redesigned cooling system that promised to make sweaty brows on the plant floor (heat rather than stress induced) a thing of the past.

The HVAC crew expected a meter reading much lower than the ambient temperature of about 90 degrees F. Instead they got one that went off the charts. The temperature meter's LED flashed 999.9.

"That can't be right," said the crew's newest hire, staring at the meter. A more experienced coworker wasn't so mystified. He quickly saw that the path of the thermocouple wire went close to the air conditioner's compressor motor. The meter wasn't merely reading the heat picked up by the probe. It had literally gone haywire as electromagnetic interference from the compressor bombarded the unshielded thermocouple wire.

Most motors generate such electromagnetic interference (EMI), or noise—also known as radio frequency interference (RFI). To a greater or lesser degree, so do many other electrical devices. In homes, sources of EMI include dimmer switches (which produce a telltale buzz), attic fans, exercise equipment such as motorized treadmills, and microwave ovens. (EMI leakage from early microwave ovens posed a danger to people with cardiac pacemakers, but today's stricter government limits on leakage and the shielded leads that have become standard on pacemakers have greatly reduced concern.)

On the factory floor, spark-producing machinery such as spot, arc, and induction welders generate significant EMI, as do computerized numerically controlled (CNC) lathes and milling machines, other equipment powered by large motors, high-intensity lights, relays, and walkie-talkies. As for the omnipresent cell phone, the low-level energy it sends probably wouldn't affect the type of thermal monitoring system that was used in the Philadelphia plant.

What would have prevented the spurious meter readings at that plant is twisted/shielded thermocouple wire or cable—the first and most cost-effective line of defense against EMI.

“Twisted/shielded cable is a good start because the leads in a temperature meter can act like an antenna if they’re not protected,” said Frank Welsh, Omega Engineering’s resident EMI troubleshooter. “Thermocouple probes are designed to sense temperature, not electromagnetic radiation. The problem arises because the thermocouple circuit can pick up extraneous information, or noise, and pass it along to the meter.”

At Omega’s Bridgeport, New Jersey manufacturing facility, Welsh oversees the anechoic chamber, a thick-walled, eerily quiet lab with walls covered in thousands of pointed foam baffles. The baffles absorb electromagnetic waves, allowing technicians to strictly control the testing of temperature meters, pressure transducers, and other devices that Omega manufactures.

Bridgeport is also where Omega produces twisted/shielded thermocouple wire—more of it than just about anyone. With shielding, the antenna that is the thermocouple wire shrinks to a small point, which is the probe. Even the probe may need shielding in extreme cases, though there will probably be a tradeoff in reading time, which might increase from milliseconds to seconds. According to the experts at Omega, using twisted/shielded thermocouple wire on a sensing device can cut EMI by 500 to 1000 times, virtually eliminating the problem in most applications.

“Whether used as a preventive measure or to solve a known noise issue, twisted/shielded wire represents a low-cost, field-installable solution,” said Jim Ferguson, vice president and plant manager at Bridgeport. Omega recommends the wire wherever leads to a sensor will run more than a couple of feet, and wherever a large electric motor threatens to disrupt a sensor’s readings. “All the wire used in our in-house probe assemblies we make ourselves, so you can be sure we adhere to the highest standards of quality,” Ferguson added.

Omega’s standard twisted/shielded thermocouple wire consists of PVC-insulated, ANSI or IEC color-coded conductors twisted with tinned-copper drain wire, then wrapped with aluminized polyester tape. Another PVC layer covers the wrapping. The aluminized polyester and the drain wire protect against EMI; the PVC resists moisture, chemicals, abrasion, and ultraviolet light. While some manufacturers insulate only with polyvinyl, Omega also offers Teflon for higher-end applications. For ultimate durability and flexibility, stainless steel and tinned-copper overbraidings are available; with the tinned-copper providing added electrical shielding. Lengths range from 25-foot convenience spools to 10,000 feet.

“In making the cable, we pay attention to detail,” said Robert Lesutis, who handles OEM sales for Omega’s component manufacturing division. “When we twist, we lay the ground wire in the space between the conductors. Our cabling machine is unique because it wraps the ground wire into the conductors, not merely on top of them.”

Omega builds, stocks, and supplies complementary products that shield against electrical noise at the probe and at the instrument connection, including the

HGKMQSS Series of low-noise thermocouple probes and a high-temperature standard connector, the HFSTW-K-M, which has an EMI-suppressing zinc ferrite core. The company also makes standard GST and miniature GMP low-noise connectors, which provide easy connection of ground wires to probes and extension wires.

Perhaps the biggest demand for twisted/shielded wire is from high-tech manufacturers using large automation equipment, such as a computer chip maker or a producer of medical devices. These operations require steady feedback in the form of real-time data, yet they also tend to produce very high EMI levels. Manufacturing data used to be collected mainly in the lab, a relatively quiet environment, electromagnetically speaking. Today, however, the factory floor itself can be a lab brimming with information for those savvy enough to cut through the noise.

Sensors protected with twisted/shielded wiring are also common in aerospace applications, where constant exposure to EMI is the norm. In space exploration and satellite communications, for example, cosmic rays—electromagnetic waves of extremely high frequency—would wreak havoc if the sophisticated, sensitive electronics demanded by these applications lacked EMI barriers.

The current-signal domain is relatively immune to EMI, and, compared to voltage signals, current signals can run for very long distances. An option, therefore, for the noisiest applications would be to shift from voltage to current in the offending environment—using, for example, twisted/shielded wire in conjunction with a signal conditioner such as one of Omega's iDRN/iDRX Series transmitters, which mount on a 35 mm DIN rail. All models in the series are designed to work directly with a wide range of sensors, and, ordinarily, they require no extra components.

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