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Déjà Vu All Over Again

SHOW OF HANDS: Who has learned a lesson the hard way, only to forget and relearn it again at a later date? I have joined that club many times and I recently renewed my membership. A customer contacted the EI engineering staff a short time ago with a very unique problem with one of our AC-24 Controllers.

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This customer is a US-based auto part manufacture that has two different wheel blast machines. One of these wheel machines was outfitted with four MagnaValves controlling the flow of media to four blast wheels. The customer complained, "The servo function on any one of the AC-24 Controllers would mysteriously turn OFF randomly." Now we have seen strange things, but this was new.

A colleague and I started by asking the customer the usual stuff: What is on the power supply with the MagnaValves and AC-24s, are the wires going to the MagnaValves in their own conduit or bundled with high voltage AC lines, are the control wires shielded? We were hoping it was something simple. In this case, the customer had the MagnaValves and AC-24 Controllers on their own power supply, all the low voltage controls and PLC were in their own cabinet, and only in a couple of locations were the high voltage AC and the low voltage DC in close proximity. It appeared the customer did a nice job of installing the MagnaValves and AC-24 Controllers on their machine. Deeper investigation was required.

Before arriving at the customer's location, we asked if the event could be caught on video. The customer set up a camera and captured the event on two different controllers at different times. This was a huge help because in both instances, we noticed that a conveyor turned ON at the same time the servo function turned OFF. This small bit of information indicated that noise from a motor could be the culprit to their mysterious function change. Once in front of the troubled machine, my colleague also noticed that all the LEDs on the AC-24 Controller that should be OFF were very dimly lit. This confirmed noise as the culprit.

When we determined it was a noise issue, we thought finding the source would be simple. Boy, were we wrong. We started by connecting an oscilloscope to the supply lines and looking at the noise level with the conveyor motor running and the conveyor motor stopped. The noise level did increase when the conveyor motor turned ON. We then probed all other control lines coming into and out of the AC-24 Controller. Every input and output line had noise and that noise increased when the conveyor motor turned ON. The head scratching starts. Which wire contains the source of the noise? Out of desperation, we started to remove one wire at a time and continued to measure the noise on the supply and monitor the dimly lit LEDs on the front of the controller. One-by-one we removed the wires from the controller and none of them proved to be the source of the noise. What the heck? Is there a leak in the matrix? How is this possible?

Then someone said, "That's all the wires, except the ground." My reply, "Remove the ground." Just then, the sea parted and the clouds of electrostatic noise cleared. The noise levels on the supply line dropped significantly and the dimly lit LEDs turned OFF completely. That's when it dawned on me—I spent two days troubleshooting a similar problem in Japan a couple years earlier. As soon as I was back in the office, I dug out my notes from my Japan trip and confirmed that it was in fact the exact same problem.

You might be asking yourself, "How could the chassis ground be the source of noise?" The system used variable frequency motor drives (VFD) to drive all motors on the machine, including the conveyor motor. The VFD generates an EMI (Electro-Magnetic Interference) in the form of leakage currents on the AC power supply lines (not an issue for the DC supply lines) and ground lines. The manual of the VFD stated, "Noise from earthing cable due to leakage current may cause peripheral device to malfunction. Disconnecting the earthing cable from the peripheral device may stop the malfunction of the device."

The wiring diagrams from the customer indicated that the earth/safety ground and 24 V supply common were tied together. Tying the ground and 24 V supply common together is NOT recommended. Tying the ground and common together creates a path for the noise generated by the VFD to enter the low voltage system. This noise will wreak havoc on your system and cause you to question your career choice.

There are three lessons here. One: RTFM. Two: Earth/safety ground has a different purpose than DC supply common and they should not be tied together. Three: Just because you write something down, it doesn't mean you will remember it and you may have to discover the information all over again.