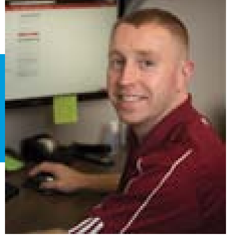


**ENGINEERING NOTES**

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# Panel Wiring: Re-Routing

**THINKING BACK** before the smartphone, many people used a GPS when traveling out of town. I had a Garmin and she did a great job, most of the time. I referred to the GPS as "she" because I always had it set to the female voice. I guess it felt more natural to be told what to do by a woman, more so than a man. Anyway, when I missed a turn, she would say "recalculating" and I swear she said it with an exasperated tone in her voice. Almost as if she was saying, "Hey idiot, you just missed your turn. Now hold on while I look for yet another route that you will probably ignore." Maybe it was imagined, but I'm still not completed convinced.

However, I get a similar feeling when I'm troubleshooting a MagnaValve at a customer's facility and I open the electrical panel. Most panels have very clean and neat wiring. All wires are neatly located in wire trays with the covers on, all wires are clearly labeled, and all the wires take the shortest route possible. These panels look great! But they all have the same problem—there was no thought put into the routing of the wires. And not just the wires inside the panel, but the conduit also.

The comical part of all this is that the designer/engineer chose all the correct parts and worked out all the logic, but the panel builder did not spend the extra 10 minutes to create a plan for wire routing. I prepared an example to illustrate this.

Let's say we're designing a small wheel blast system. The panel will be supplied with 480 Vac. The wheel is driven by a 25 Hp three-phase motor with variable frequency drive. It has a PLC with a HMI and controls shot flow using a 590-24 MagnaValve and FC-24 Controller. The panel will be mounted on the side of the machine so the HMI, FC-24, and any additional pushbuttons will be mounted on the side of the panel that faces the operator, see Figure 1. Remember, this is an example.

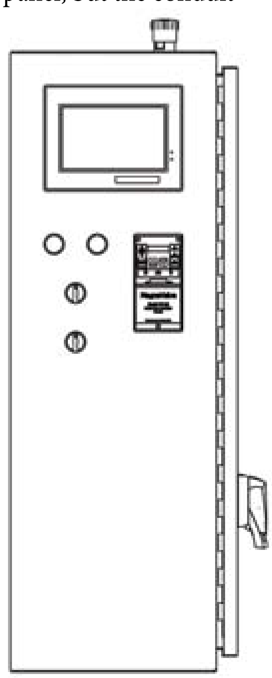

*Figure 1*

Figure 2 shows an example of a poorly planned panel layout and the conduits connected to it. In this example, the variable frequency drive (VFD), step-down transformer, fuses and disconnect are mounted at the bottom of the panel. The 24 Vdc power supply, PLC, ethernet controller and control relays are mounted at the top of the panel. In the middle are the terminal blocks that connect everything together.

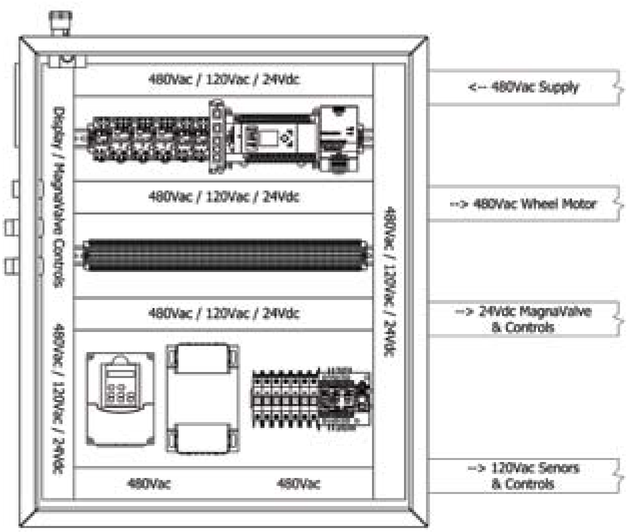


*Figure 2*

Looking at the conduits connected to the side of the panel, notice the 480 Vac supply enters the top of the panel while the lower voltage lines leave at the bottom of the panel. This might make the conduit on the outside of the machine look like a cascading waterfall. But is it the best way?

The question some of you are asking right now is, "What's the problem? I don't see anything wrong with that panel."

Well, the problem is the high-voltage AC and low-voltage DC lines are ran together. You can see in Figure 2 that the 480 Vac line enters the top of the cabinet and must travel towards the bottom of the panel to the disconnect. The VFD output then must travel upward and across the panel to exit through the conduit towards the top of the cabinet. The low-voltage sensor and control lines must travel down and across the panel to exit out their respective conduits. I have even seen some panels run one large conduit and all wiring types placed together. Fortunately, this is less common.

The problem with this layout is the high-voltage AC and low-voltage DC get placed in the same wire tray and are in very close proximity with one another. This allows coupling of the high-voltage into the low-voltage DC lines.

The VFD, typically the biggest source of noise in a system like this, will couple noise onto the low-voltage DC lines. This is why it is recommended and, in some cases, it is required to install line reactors, EMI filters, and/or RF filters on the input or output of the VFD.

All this high-voltage and noise coupling can create excessive noise in sensitive electronics and excessive jitter on the digital communication lines, such as ethernet. All is undesirable.

The good news is the solution doesn't cost a thing other than about 10 minutes of thought.

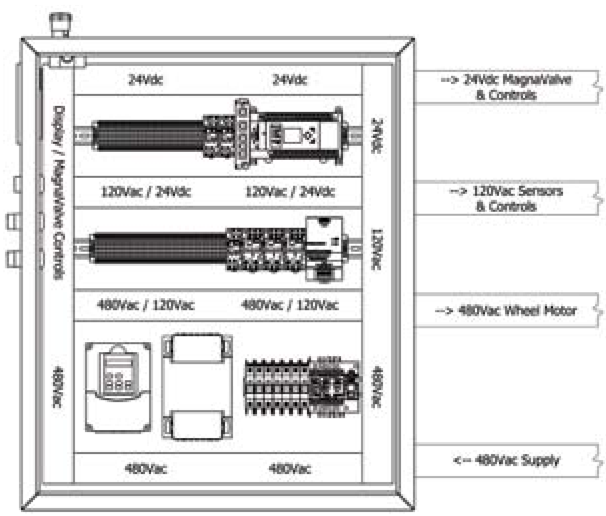


*Figure 3*

Figure 3 shows the same panel, same controls, same parts—the only difference is grouping of the parts and conduit. The VFD, step-down transformer, fuses and disconnect are in the same location; however, the 480 Vac supply enters near the bottom of the cabinet. The 480 Vac wheel motor conduit and 24 Vdc supply have been moved to the middle of the cabinet. This removes all the 480 Vac from the top of the panel, keeping all the high-voltage AC in the bottom of the cabinet.

The 120 Vac relays have been moved to the middle of the panel along with the terminal blocks that connect all the 120 Vac sensors and controls. This removes the 120 Vac from the top of the panel.

This leaves the top of the panel for the PLC, ethernet, low-voltage sensors, low-voltage controls, and low-voltage analog communication.

Notice that in the improved layout in Figure 3, the 24 Vdc/low voltage and the 480 Vac never cross and are kept enough distance from one another to prevent coupling.

You may have noticed that the 480 Vac and the 120 Vac overlap as well as the 120 Vac and the 24 Vdc/low voltage. This is acceptable in most applications and it may be unavoidable in a tight panel such as this example. But if the space allows, another wire tray could be added to separate the 120 Vac and the 24 Vdc/low-voltage DC.

So the next time you're laying out a panel, take 10 minutes and plan your route. Keep in mind that the less contact low-voltage electronics have with high-voltage lines, the better.