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Pros & Cons of Electronic Marshalling for a Safety System

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Abstract

Electronic Marshalling represents a new technology for connecting hard wired inputs and outputs to a control system. In lieu of using a twisted pair of shielded wires

There are specific and obvious advantages to using electronic marshalling in a safety system, but are there specific disadvantages? This would include the risk incurred in moving from a system that brings specific field inputs to the safety system processor, and instead multiplexes a number of inputs/outputs in a set of fiber optic strands. Electronic marshalling also depends on redundant power being supplied from a local equipment room. The loss of power from the redundant source would mean that a whole junction box worth of safety system inputs/outputs would be lost.

This paper will review the advantages and potential disadvantages to the use of electronic marshalling in safety system applications.

Introduction

Over the last five years I have been involved in two major expansion projects for the same client at the same facility. The facility is located at Sakhalin Island Russia. One interesting observation is that unlike earlier in my career when the use of any new technology was decidedly frowned upon this client has pushed the envelope in terms of moving from established methods and technology to new ways of performing work and using new processes and equipment. There was a time when clients would not approve the use of something new unless it could be demonstrated that the new technology had been in successful operation for a period of at least one year. That has not been the case with our client in the recent time frame. In my first project with this client we used the established system of conventional input/output modules with wiring techniques employed in the facility previously. The point was not to 'reinvent the wheel' but rather to go with what had been successful before. We did that in terms of our process control system and two safety systems. As we began our second expansion project we took a look at electronic marshalling. [See Attachment A, "Electronic Marshalling Review"]

Future Innovation

Our client has informed us that in the next development project there is a very good chance that electronic marshalling will be used for the safety systems in addition to the process control system. Almost certainly the project automation team will be asked to provide some kind of written evaluation of pros & cons, advantages, & risks of making such a change from the conventional wiring to the electronic marshalling for the plant safety system. It is in anticipation of this that this paper has been developed for the International Safety Conference.

Attachment "A" provides a discussion of the electronic marshalling technology and lists the advantages of making the change to the electronic Marshalling. In general, the same advantages will apply to the safety systems, but good engineering practice requires that the potential disadvantage for using this technology for a safety system be more thoroughly reviewed.

Having the field wiring end at a field junction box is clearly an advantage to the process control system, but the question is, is it also an advantage to the safety systems? Is it better for a safety system to bring inputs & outputs in separate sets of wired pairs to the safety system I/O processors, rather than converting those signals at a field junction box to a communication link. Is a set of redundant fiber optic cables at least as safe & reliable as a hard wired multi-pair cable?

A. One advantage of the dual fiber optic cable option is that the fiber optic cables can be run in 'separate & divergent paths'. This kind of routing is a standard method at the facility for redundant communications links. [Note that there is also redundant power feeds to the electronic field junction boxes, and these are also run in 'separate & divergent paths'.]

B. Although, due to grounding and shielding and separation practices, home run cables do not generally experience induced & stray voltages, fiber optic cables are immune to such stray voltage interference, an advantage for the use of fiber optic cables.

C. The use of hard wired multi-pair cables wired in a conventional method to a marshalling cabinet means that there are multiple screwed connections to be made. In the above example there are at least 13 connections that have to be made to connect a field device to an input/output module. Use of electronic marshalling means that the connection from the device to the electronic field junction box is the only connection that needs to be made, reducing the chances for a loose connection or for a connection to come loose.

Regarding the use of a hard wired multi-pair cable versus the sure of redundant fiber optic cable links, the use of the fiber optic cables is at least as secure as that of the multi-pair cables.

Another aspect to consider in this change to electronic marshalling concerns the architecture of the safety systems, the one currently used in the plant and the one proposed for future work. The existing system is a triple modular redundant (TMR) system that as the name implies is a triplicated system that employs two out of three voting to achieve it safety rating and reliability. The new system employs redundant type architecture. Moreover at the heart of the existing system are triplicated main processors that evaluate all the inputs to the systems, resolve the programming of those inputs and then set outputs at their appropriate status based on the inputs and programming. The TMR system can have up to 118 I/O modules connected to it (a mix of 16, 32 and 64 points each). The proposed system employs a distributed architecture where processors are installed in the electronic field junction boxes I/O with a predetermined amount of electronic inputs and outputs, to a maximum of 48 points.

The evaluation to be made is whether there is advantage one architecture over the other and would that evaluation impact the ultimate decision to use one system or the other. In one sense the architecture may not be relevant since both systems will meet the same required Safety Integrity Level (SIL). It is more likely that the actual consideration that has to be made here is in the programming of the systems. In the one case there is one large integrated program running in the set of triplicated main processors. In the other case there will be multiple processors running much smaller programs. The issue then is the coordination in the case of the distributed system where consistency in design and operation has be much more closely managed and maintained.

Project Requirements

In order to integrate the design of the SIS electronic marshalling the project team will have to develop the documentation necessary to make the transition successful. One important the document to be developed will be a design guide like the one the project developed for the PCS electronic marshalling. That the current project made the transition to electronic marshalling for the PCS system will give a head start to adapting the SIS system too. The existing PCS design guide can be upgraded to include sections for the SIS as required. Training for the design group who develops the detailed wiring for field instruments will also be facilitated by their previous experience with the PCS devices.

Conclusion

Making a transition to a new technology invariably presents challenges to all the parties involved in making the change. In an industrial environment this only begins with the engineering team assigned with incorporating the new equipment into the overall scheme of the control systems design, to ensuring that the correct equipment is purchased, and making sure that control systems designers become educated into new wiring techniques, etc. However, the advantages presented with new technology outweigh concern about its incorporation and implementation so those challenges have to be overcome with attention to all the details necessary to install, test, commission and start-up the new process in a secure and safe manner.

References

1. *Technical Product Guide for Tricon V10 Systems* - Invensys

2. *DeltaV SIS with Electronic Marshalling* – Emerson Process Management, Jul 2, 2016

Attachment "A"
Electronic Marshalling Review

The concept of electronic marshalling is that a field device, a transmitter for example, is connected to a set of terminals in a junctions box and then, instead of wiring brining the signal to a main processor for display to the operator, a communication link is used to bring the signal from the field to the main processor for display to the operator. The advantage is that a substantial amount of wiring and hardware can be eliminated.

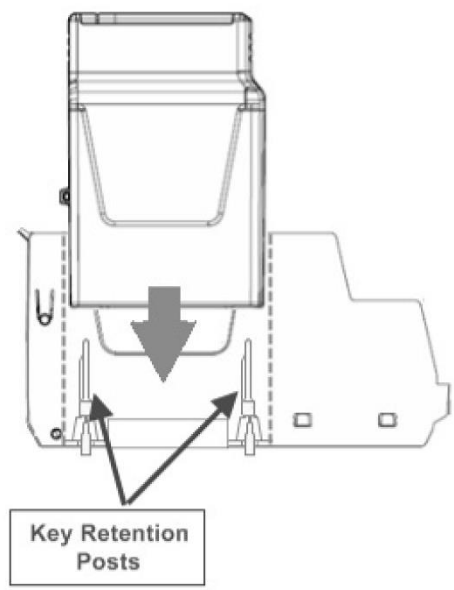
Conventional Wiring

In a conventional wiring scheme, a field device, such as a transmitter, is connected to a terminal strip in a field junction box. The junction box will contain some number of terminals, perhaps 72 terminals. Three terminals are allocated per field device, one for a plus signal, one for a minus signal and for a shield signal. In a 72 terminal junction box this means that 24 instruments can be connected to that box [required spares will limit that to some degree, not all the terminal will be used per client specs]. In any case a 24 pair (nominal 24 pairs but each pair includes a shield wire) cable will be connected to the field junction box to a marshalling cabinet in an I/O room. Located near the marshalling panel will be another cabinet with one or more chassis into which main processors, power supplies and I/O modules are installed. The chassis will have backplane connectors that allow for communication between all the processor and I/O modules. Each I/O modules is a dedicated type, such as an analog input modules, a digital input modules, digital outputs modules, etc. From each module there is a cable that connects the I/O module to a field termination assembly mounted (FTA) in the marshalling cabinet. The FTA provides a place to land field signals. However since the FTA are a dedicated I/O type and the field cables brought in from a field junction box can have a mixture of different I/O types, it's necessary to run cross wiring from the field terminals to the FTA's, completing the loop from the field device to the I/O processor to the main processor for display to the operator. In this scheme, including wiring of shields, there can be 13 connection points to bring the field signal to the FTA board.

Electronic Marshalling Wiring

Using electronic marshalling a field device is wired to an electronic field junction box module and the conventional wiring is complete. However, unlike a conventional junction box, the electronic field junction box requires redundant power and fiber optic cable connections. Redundant power supplies in the EFJB supplies power to the field devices [this power is supplied at the FTA in a conventional wiring scheme]. The fiber optic cables connect redundant processors (communication processors for the PCS, and main processors for the SIS) in the EFJB to communication switches in the local control rooms. Having power supplies in the EFJB can create a challenge if the EFJBs are located in a classified area in the unit. This can require the appropriate certification of the EFJBs that can make them exponentially more expensive that a traditional junction box. This is one factor to consider in making the decision to use the electronic marshalling technology.

The photo below illustrates a safety system electronic marshalling carrier. The two SIS [yellow] processors are installed at the top of the assembly. Below the assembly reside the electronic I/O modules. The electronic modules are inserted into a terminal base that includes terminals for wiring field devices. One feature of this technology is that the installation of a particular module characterizes the I/O point into its specified function. In theory then, the field devices can be connect to any of the terminals and at commissioning when the proper module is installed the I/O point assumes the identity of the module, be it a digital input, digital input, analog input, analog output, etc.



Attachment B
Facility Description

The facility that is described in this plant expansion is located on Sakhalin Island in the Russian Republic. Sakhalin Island is located on the east coast of Russia just north of Japan. The climate is subarctic. Weather conditions are such that 'stick' building on the island is difficult and problematic, so much of new construction for the industrial facilities are construct off site at a module yard, and then the modules are barged to the Island in the relatively calm summer months. As much as possible the controls for the module are 'commissioned' at the module yard before the modules are shipped. Then, the modules are constructed such that once they are set in place, final piping and electrical connections can be made relatively quickly without the need for a large assembly of construction craft people.

The facilities on Sakhalin have been developed in stages and the current projects have provided for expansion of the plant.

The Control Systems at the plant include a process control system, a process shutdown system, and an Emergency Shutdown/Fire & Gas system. The process control system controls the normal operation of the plant and the Safety Systems provide for shutting down the plant in the case of failures or out of normal process conditions or fire in the facility.

Both the PCS and SIS system have used traditional methods of wiring for bringing field signals to local instrument buildings and then transmission of those signals to a central control room.

The traditional methods of wiring are described in Attachment "A"