Finally – Digital IO Means Digital IO!

Introduction

Industry 4.0 is a new byword for the modern factory environment. It consists of dozens of networked controllers continuously monitoring inputs from hundreds or even thousands of sensors such as switches and level detectors. Simultaneously, signals are sent to a similar number of output devices such as valves, solenoids or motor drives. In this design solution, we discuss how electronic marshalling has simplified the process of connecting this expanding set of field wiring back to the controller. We then present an innovative solution which introduces a new degree of flexibility to the electronic marshalling approach.

Wired Marshalling

Until recently, the standard way of connecting field I/O devices to a programmable logic controller (PLC) has been through traditional wired marshalling as illustrated in Figure 1. Multi-core cables run wires from the field devices located on the factory floor to the terminal blocks of marshalling panels, usually located in an I/O room. Here, the wiring is cross-marshalled so that each field device is connected to the I/O card of the appropriate controller channel.

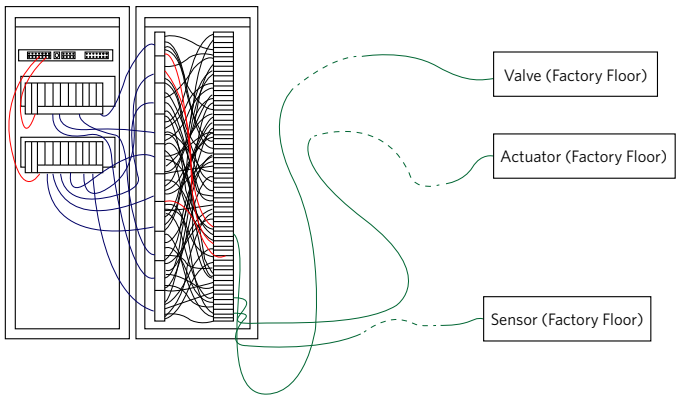

Figure 1. Wired Marshalling

This approach has the potential to cause problems. For example, during cross-marshalling, it is difficult to keep track of which wires are coming from and going to, leading to errors if wires are incorrectly connected or even left completely unconnected. Debugging and testing each connection can be time-consuming and laborious for technicians and engineers alike, potentially introducing costly delays to the commissioning of a new process.

In theory, once debug is complete, the system should run correctly but additional problems can emerge if unforeseen changes are required late in the project. Sometimes it may be necessary to add a new field device. For example, if a temperature switch is changed to a temperature transmitter, then a digital input will need to be changed to an analog input.

An even worse situation occurs if new field devices are added to the system but the marshalling panel does not have enough spare connections of the required type to accommodate them. In this case, the controller would need to be replaced, potentially adding additional cost and delay to the project.

Electronic Marshalling

Wired marshalling has begun to be replaced by electronic marshalling, a new approach to signal routing in process automation (Figure 2).

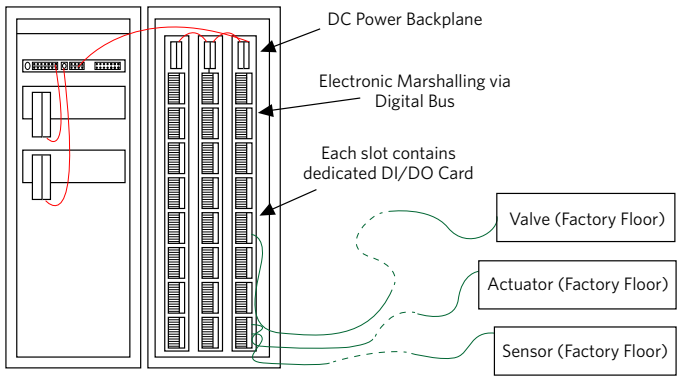

Figure 2. Electronic Marshalling

This technique was developed to prevent the human errors associated with the manual element of wired marshalling,

namely the cross-connection of the I/O devices on the marshalling panels. As with wired marshalling, the multi-core cables from the field are routed to the right side of the terminal blocks in the marshalling cabinet by technicians on the factory floor. However, in the I/O room, there's no longer any need to manually connect each terminal block to the appropriate controller I/O channel, as this is handled electronically within the system itself.

The clear advantage of electronic marshalling is that an I/O device can be connected to a specific controller whenever necessary without physical wiring changes. If at a later stage in the project, changes are made to I/O types, or additional devices are required, then no changes are needed to existing wiring or cabinets. In addition, extra I/O capacity can be added to the marshalling cabinets and then electronically marshalled to the controllers as required.

At the heart of the electronic marshalling approach is a rack of portable and replaceable modules or cards. An appropriate card type is inserted into the slot to which the wiring for an I/O field device is connected. For example, a digital input (DI) card would be placed in the slot for a temperature switch. The card would then connect to the appropriate channel of the controller. The function of each controller channel is defined by the type of card (for example, DI or DO) placed in each slot.

A New Type of Digital I/O

While the flexibility offered by electronic marshalling is obvious, there is a not-so-obvious inherent inflexibility. Traditionally, industrial and process control engineers have used the term "Digital IO" to refer to digital signals transmitted and received by PLCs. However, the term itself is something of a misnomer. There is no such thing as a "Digital IO" channel on a PLC. There exists either a "Digital input" channel or a "Digital output" channel. Thus, if it's necessary to change the functionality of a controller channel from a DI to a DO, or vice versa, the physical card for the channel must be changed. Also, the total number of DI and DO channels is defined by the number of each type of card in the rack. This places limitations on the flexibility of the electronically marshalled system by fixing the number of DI channels and DO channels in the rack.

Clearly, a more desirable scenario would be to configure each channel as either a DI or a DO, as needed. This is now possible with the MAX14914 high-side switch with digital input configuration. With the MAX14914, the PLC can configure each card to function as either a DI or a DO. A card does not need to be manually removed and reconfigured if the functionality of the channel changes. Control channels can truly be designated as "Digital IO" channels, without limiting the number of each type of channel. The only limitation will be the number of channels the PLC itself can handle.

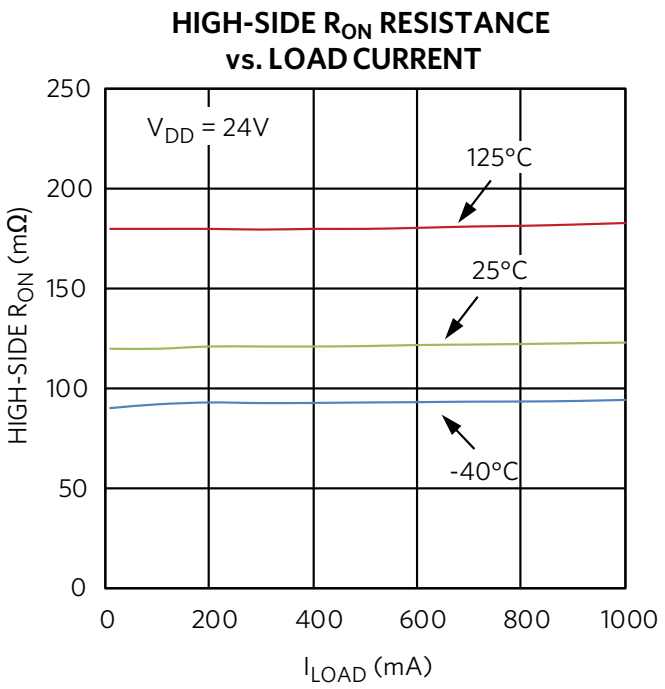

Figure 3. MAX14914 On-Resistance vs. Load

Other important features of the MAX14914 include low R_{ON} (Figure 3) and very low propagation delay of less than 2µs in DI mode (Figure 4).

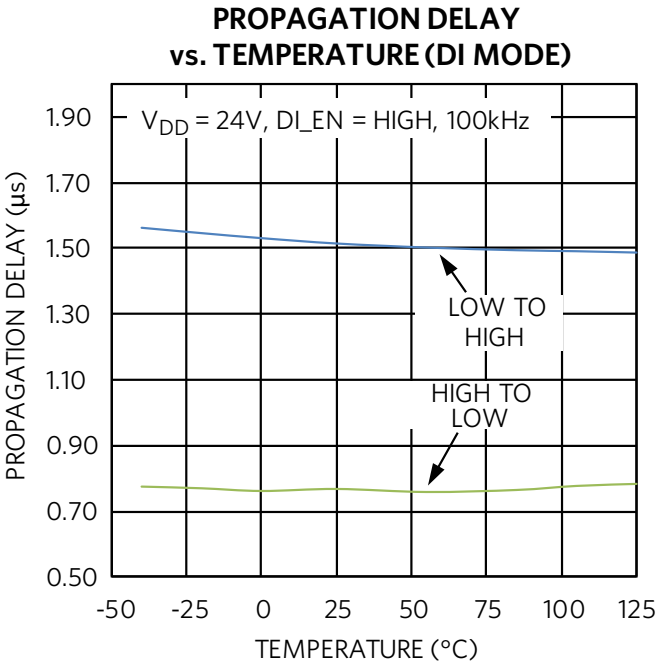

Figure 4. MAX14914 Propagation Delay in DI Mode

Conclusion

In this design solution, we reviewed the traditional approach to signal routing in process automation systems, namely wired marshalling. We showed how the problems associated with this approach have been largely addressed by the migration to electronic marshalling. While this has been a considerable improvement in its current guise, it's not without its limitations. A high-side switch with digital input configuration, like the MAX14914, offers a new degree of flexibility for electronic marshalling. The ability to electronically configure an individual controller channel as either a digital input or digital output, without the need to change hardware and without limitation on the available card types, allows greater design flexibility and reduces the costs associated with changes that can develop in the project commissioning process.

PLC: Programmable Logic Controller

I/O: Input/Output

DI: Digital Input

DO: Digital Output

Wired Marshalling: Where a PLC channel is manually wired to a landing block for a remote I/O

Electronic Marshalling: Where a PLC channel is electronically connected (multiplexed) to a landing block for a remote I/O

Learn more:

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