

Decoding the Choice: Conventional Junction Boxes Vs. Smart Marshalling Systems in Industrial Applications for Informed Decision-Making

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ABSTRACT

This technical Paper explores the evolution of control systems driven by innovative technologies, including new Universal Input/Output (UI/O) module, Smart Marshalling Cabinet (SMC), and Smart Junction Box (SJB). These innovations enable automated instrument configuration and simplify operations by standardizing a range of I/O modules into universal I/O modules. This approach achieves several objectives, including an effective cost reduction of total plant, shortened construction time, hardware standardization and optimization of spare parts.

KEYWORDS: Smart marshalling, Junction Box, Universal I/O, Process Control system

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1. INTRODUCTION

This paper aims to shed light on the differences and key considerations between Conventional Junction Box, Smart Marshalling Cabinet and Smart Junction box. It explores the factors that influence technology selection and presents essential facts to aid in informed decision-making.

By assessing the strengths and limitations, this paper offers valuable insights into their respective roles in modern process control systems.

2. CONVENTIONAL JUNCTION BOX

In conventional Junction box, the signals are segregated based on type of signals, such as analog signal, discrete signal, resistance temperature detector (RTD) signal, Thermocouple (TC) signal. Additionally, Junction boxes are segregated to the type of system such as separate Junction Box for Process Control system, Emergency Shutdown system, and Fire & Gas System. These Junction Boxes are connected to the Control room marshalling cabinets through multi-cables. To complete the

connection, cross wiring is performed in the marshalling cabinet and the I/O card is subsequently linked to the controller. Refer Figure 1 below. This conventional approach necessitates additional engineering efforts, considerable time & labor cost during Construction, and subsequent maintenance requirements at the site.

2.1. CONVENTIONAL JUNCTION BOX PROBLEMS:

Increased Junction Box: The need of signal & system-wise segregation, results in higher number of junction boxes. This not only incurs additional material cost but also increased expenses related to engineering and as well labor for site installation.

Extensive Cabling: Increased number of junction boxes leads to increased costs for both procurement as installation of multicable, cable trays etc.,

Late I/O changes: Knowing I/O requirements is crucial before I/O cabinet design and the control

configuration Any changes after wiring are completed leads to design modifications, increased labor cost and in some cases put project schedule at risk.

Increase in Control room /Equipment room size: The segregation of signals requires more marshalling cabinets which, in turn, leading to increase in building size and subsequently increase in installation, testing, and commissioning cost.

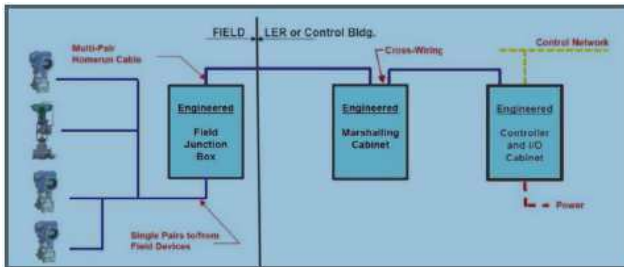


Figure1. Conventional Junction Box Wiring

3. SMART MARSHALLING

- A. Utilizing Smart marshalling cabinet or smart Junction boxes equipped with universal I/O modules offer an effective solution to overcome problems posed by conventional Junction boxes.
- B. With Universal I/O modules, there is no need to segregate signals based on their type. This simplifies the setup considerably, reducing the number of junction boxes required and, subsequently, related engineering and labor costs.
- C. Modules are connected to controller via control Layer network, this reduces load on controllers and enhances, communication speed.
- D. A single cabinet or enclosure design can accommodate wide variety of I/O signals directly from the field. This minimizes the need for custom marshalling wiring designs in the local equipment room (LER), effectively eliminating internal cross wiring and I/O rationalization processes.

3.1. SMART MARSHALLING CABINET:

The cabinets are available in a standardized format, saving time and effort that would require for building customized cabinet.

Due to the use of universal I/O's, signals can be configured at any time. This flexibility allows for late changes in I/O requirements thus eliminates the impact of design modifications.

3.2. SMART JUNCTION BOX:

Integrating UI/O's modules and communication modules into a conventional field junction box (JB), transforms it into a smart junction box (SJB). Smart Junction Box collect various types of field signals, convert it into digital signals, then connect them to the control system via fiber optic cables.

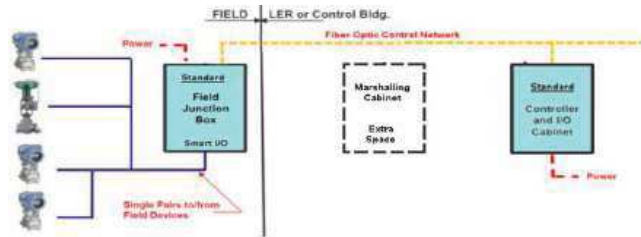


Figure 2. Smart marshalling wiring

Figure 2 shows architecture of smart Junction box.

Smart Junction Boxes provide ready to use solutions that expedite project execution and reduce installation costs. These field enclosures optimize system footprint, eliminating the need I/O home run cables and reducing the complexity of cabinet design engineering.

In addition, eliminating I/O and marshalling cabinets, reduces the size of building, including HVAC, and Electrical load/requirements.

3.2.1. MAJOR CONCERN -SMART JUCTION BOX:

There are significant concerns related to smart Marshalling Junction Boxes:

- A. The Smart junction box, being located in the field, shall be suitable for operating in extreme weather conditions of temperature, humidity, salt laden marine atmosphere and shall be capable of operating at the maximum shade temperature of 55°C which may cause failure (or reduce expected life) of electronics inside Smart marshalling because of heat dissipation of electronics.
- B. The maintainability of Smart junction box is difficult due to the following:
 - Smart junction box located at field particularly if in red zones (High H2S) will increase the exposure of humans in high-risk areas.
 - Maintenance activities at field will be hard on maintenance personnel due to the harsh environment and PPE for H2S environment.
 - Hazardous area (Zone 1) requires Ex" d" enclosures, which are heavy to handle, and no visual inspection is possible to the modules powered on condition.
 - Smart Marshalling's shall be powered off during maintenance activities, which will have high impact on the availability of the plant (partial shutdown).
 - Smart junction boxes require a composite style hybrid cable including both power and Fibre combined in one cable. A Failure of the Fibre Optic cable will impact all connected signals.

4. APPLICATION BROWNFIELD AND GREENFIELD

The choice of smart marshalling or Junction Box for industrial installations, whether brownfield or greenfield, should be made based on careful consideration of the specific requirements, constraints, and objectives of the project. Here's a summary of the recommendations for different scenarios:

4.1. BROWNFIELD INSTALLATIONS:

In brownfield installations, the existing philosophy should be followed for operational and maintenance consistency. For e.g., where the majority installation is based on Conventional Junction box then, the logical choice is to continue with conventional junction box philosophy. It allows for seamless integration with existing infrastructure and minimal disruption.

4.2. GREENFIELD INSTALLATION:

Smart marshalling cabinet or smart Junction box to be more cost-effective in greenfield applications due to advantages as mentioned above.

5. CONCLUSION

In the realm of greenfield projects, the preference clearly tilts towards Smart marshalling due to its

numerous advantages over conventional Junction Box. Further considering concerns associated with Smart Junction boxes, the preferred choice emerges as Smart Marshalling cabinet.

Study shows that smart marshalling cabinet can potentially reduce the number of marshalling cabinets by nearly 50 % leading to substantial cost savings.

Similarly, the adoption Smart junction box results in a significant reduction in the count of marshalling cabinets.

The selection between Smart marshalling cabinet or Smart Junction box should always be guided by a careful assessment of specific project requirements, safety considerations, budget constraints, and future scalability.

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