# To Enhance Efficiency in Automated Palletization Systems with Wireless Communication

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***Abstract:*** *This review paper examines the enhancement of automated palletizing systems by integrating wireless communication modules, focusing on a detailed functional analysis of an automatic palletizing and wrapping line for Tetra pack carton conveying. Initially using wired Murr Electronic modules, the system is assessed for operational scope, specifications, and sequence of operation, aiming to transition to a wireless setup for benefits like improved flexibility, reduced maintenance, and enhanced scalability. The study compares the existing wired Murr modules with proposed SMC wireless modules, analyzing control architecture, line description, and module functions. It details system specifications, including case and pallet details, utility requirements, and operational sequences. The transition methodology covers conceptualization, design, engineering, testing, and commissioning, emphasizing cycle time analysis and bill of materials preparation. Additionally, the research evaluates safety aspects, power requirements, and operational modes in the context of wireless communication, aiming to provide insights into the advantages of wireless communication modules in enhancing system efficiency, flexibility, and performance in industrial automation.*

*Keywords:* **We would like to encourage you to list your keywords in this section**

# 1. INTRODUCTION

Automated palletizing systems have revolutionized logistics operations by streamlining processes, increasing efficiency, and improving overall productivity in industrial settings. These systems have become indispensable in modern warehouses and distribution centers, where the demand for speed, accuracy, and flexibility is paramount. The integration of cutting-edge technologies, such as wireless communication modules, offers a promising avenue for enhancing the capabilities of automated palletizing systems even further. By transitioning from traditional wired communication setups to wireless solutions, organizations can unlock a new level of operational agility, enabling real-time monitoring, remote control, and seamless coordination between robotic components. This research delves into the transformative potential of wireless communication in optimizing automatic palletizing systems, aiming to not only improve system efficiency but also pave the way for future advancements in industrial automation.

# 2. WIRELESS COMMUNICATION IN ROBOTIC SYSTEMS: OPPORTUNITIES AND CHALLENGES

Automated palletizing systems play a crucial role in modern logistics operations, enhancing efficiency and productivity. The integration of advanced technologies, such as wireless communication modules, presents an opportunity to further optimize these systems. This research paper explores the feasibility and benefits of replacing wired communication modules with wireless solutions in an automatic palletizing system. The existing literature on wireless control of robotic arms and grippers highlights the growing trend of integrating wireless technologies into industrial automation systems.

Research studies have explored the potential benefits of wireless control, including enhanced flexibility, reduced wiring complexity, and improved system responsiveness. For instance, a study published in the Journal of Intelligent Manufacturing discusses the implementation of a wireless control system for a robotic arm in a manufacturing environment, demonstrating improved productivity and reduced downtime. Another study published in the International

Journal of Advanced Manufacturing Technology presents a case study on the integration of wireless sensors and actuators in a robotic gripper, showcasing enhanced precision and control. These studies demonstrate the potential of wireless control in enhancing the performance and efficiency of robotic systems.

SMC wireless modules are designed to provide reliable and secure wireless communication in industrial automation applications. These modules offer advanced features such as high data transmission rates, robust signal strength, and compatibility with industry-standard communication protocols. SMC wireless modules are suitable for a wide range of applications, including the control of robotic arms and grippers. Their potential applications in industrial automation include enabling real-time monitoring and control of robotic systems, facilitating remote maintenance and troubleshooting, and enhancing system flexibility and scalability.

The use of wireless communication in robotic systems offers several advantages, including enhanced flexibility, reduced wiring complexity, and improved system responsiveness. However, it also presents several challenges, including reliability, latency, and security considerations. Reliability is a critical concern in wireless communication, as it directly impacts the performance and efficiency of the robotic system. Latency is another important consideration, as it can affect the responsiveness of the system. Security is also a significant concern, as wireless communication can be vulnerable to cyber threats and unauthorized access. To address these challenges, it is essential to implement robust wireless communication protocols and ensure the integrity of the system through proper security measures.

# 3. METHODOLOGY

## 3.1 Existing Methodology of Palletization using wired systems

The existing methodology of palletization using wired systems typically involves the use of a robot gripper to pick up and place boxes onto a pallet. The robot gripper plays a crucial role in this process, as it is responsible for accurately grasping and manipulating the boxes.

### 3.1.1 Robot Gripper

The robot gripper is equipped with various sensors and components to ensure precise control and monitoring of the palletization process. In the given scenario, the robot gripper utilizes:

1. 4 proximity sensors to detect the gripper position
2. 4 diffuser sensors to detect the presence of boxes to be palletized
3. Reed switches for gripper movement control
4. Festo valves for pneumatic actuation of the gripper

All the communication between the sensors, reed switches, valves and the control system is facilitated through the Murr Impact67 pro, which serves as the interface for data exchange and control commands. The proximity sensors are strategically placed on the gripper to provide feedback on its position relative to the boxes and the pallet. This information is crucial for ensuring accurate placement of the boxes on the pallet, minimizing errors and maximizing efficiency.

The sensors used to detect the presence of boxes are responsible for identifying the boxes that need to be palletized. This information is relayed to the control system through the Murr Impact67 pro, allowing the robot gripper to pick up the appropriate boxes and place them on the pallet in the desired arrangement. The reed switches are used to detect the position of the gripper fingers, ensuring that they open and close at the right times for secure box grasping. The Festo valves provide the pneumatic power to actuate the gripper fingers, allowing for smooth and precise movement.

However, the use of wired systems for communication between the sensors, switches, valves and the control system can lead to limitations and challenges. For instance, the wired

connections can be prone to damage or disconnection, which can result in downtime and reduced productivity. Additionally, the physical constraints of wired systems can limit the flexibility and mobility of the robot gripper, making it less adaptable to changing production requirements.

These issues with wired communication highlight the need for a more reliable and flexible solution, such as wireless communication, to optimize the palletization process and improve overall efficiency.
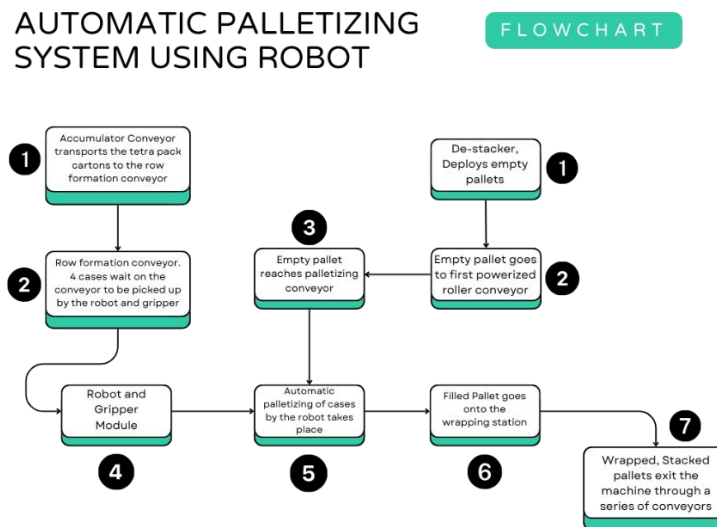


**Figure 1. Flowchart Showing the Overall Process of the System**
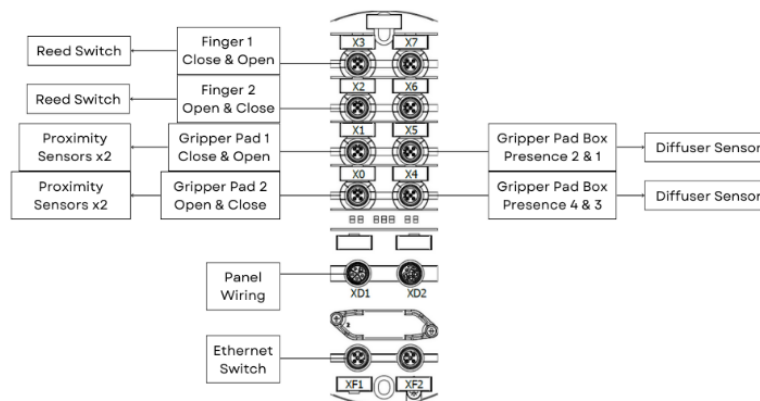


**Figure 2. Connections through Wired Murr Module**

### 3.2 Proposed Methodology of Palletization using wireless systems

### 3.2.1 Wireless System Configuration

To set up the system, use the EX600-WPN wireless base module as the main communication unit. Connect the EX600-WPN base to the PLC or control system via the PROFINET protocol. Pair the EX600-WPN base with multiple EX600-W wireless remote modules, assigning one to each robot and gripper. Mount the EX600-W remotes on the robots and grippers to enable

wireless communication.

### 3.2.2 Wireless Communication

The communication between the EX600-WPN base and EX600-W remotes will utilize SMC's proprietary wireless protocol, employing frequency hopping spread spectrum (FHSS) within the 2.4 GHz ISM band. Data transmission will occur at a rate of 250 kbps, maintaining connectivity within a range of up to 10 meters between the base and remotes. Frequency channel selection features will be employed to mitigate potential interference from other wireless devices in the vicinity. Additionally, encryption measures will be implemented to safeguard against unauthorized access and data manipulation.

### 3.2.3 Palletization Process

In the system operation:

1. Commands are initially dispatched from the PLC to the EX600-WPN base module via the PROFINET protocol.
2. Subsequently, the base wirelessly relays these commands to the designated EX600-W remote situated on the relevant robot or gripper.
3. Upon reception, the robot and gripper devices interpret and execute the assigned palletization tasks as instructed.
4. Concurrently, sensor inputs originating from the robot and gripper are wirelessly transmitted back to the respective EX600-W remote units.
5. The EX600-WPN base then receives this sensor data and forwards it to the PLC using the PROFINET communication protocol.
6. Finally, the PLC processes the received sensor data, refining its understanding of the system's status, and subsequently generates updated commands as necessary, thereby perpetuating the cycle of communication and control within the wireless system.

### 3.2.4 Diagnostics and Monitoring

The EX600-WPN base is equipped with a web server function, enabling users to monitor communication status and customize settings as needed. Diagnostic signals can be dispatched from the base to the PLC, serving as alerts for any wireless system errors or communication hitches that may arise. Additionally, for troubleshooting purposes, LED indicators on the EX600-W remotes provide visual feedback by displaying the received signal strength, facilitating swift identification and resolution of potential issues within the wireless communication network.

By using the EX600-WPN wireless system, the palletization process can be optimized with reduced wiring, increased flexibility, and reliable communication between the PLC, robots, and grippers. The compact size and long communication distance of the EX600 series make it well-suited for palletization applications.
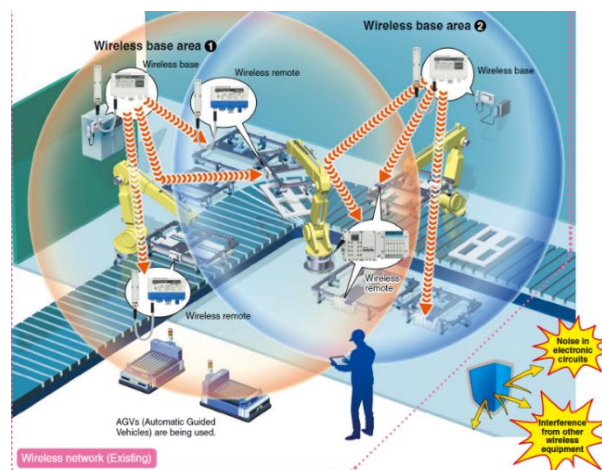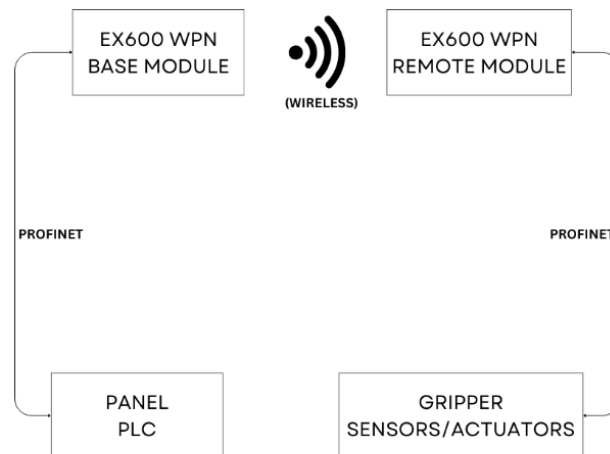


**Figure 3. Communication shown through wireless module**

**Figure 4.  Flowchart showing the basic communication**

# 4. TECHNOLOGY USED

The EX600 WPN Model, as described in the document, incorporates advanced technologies to enhance efficiency in automated palletization systems through wireless communication. The model utilizes the 2.4 GHz ISM frequency band, which is allocated for industrial, scientific, and medical applications. This frequency band is chosen for its ability to support high-speed data transmission and reliable communication in industrial environments.

**4.1 Frequency Hopping Technology**

The EX600 WPN Model employs frequency hopping technology, which involves rapidly switching the carrier frequency among many different frequency channels using a pseudorandom sequence known as a hopset. This technology is used to minimize interference from other wireless devices and to ensure stable communication. The frequency hopping cycle is set at 2 ms or 5 ms, depending on the operating environment.

**4.2 Compact and Modular Design**

The EX600 WPN Model is designed to be compact and modular, allowing for easy integration into existing systems. The compact type EXW1 series and modular type EX600-W series offer flexibility in terms of installation and configuration. The compact design reduces wiring work, space, and cost, while minimizing the risk of disconnection.

**4.3 Communication Distance and Speed**

The communication distance of the EX600 WPN Model varies depending on the type. The compact type EXW1 series has a communication distance of up to 100 m, while the modular type EX600-W series has a communication distance of up to 10 m. The communication speed is 1 Mbps for the compact type EXW1 series and 250 kbps for the modular type EX600-W series.

**4.4 Security Features**

The EX600 WPN Model incorporates security features to prevent unauthorized access and data falsification. Data encryption is used to ensure the integrity and confidentiality of transmitted data.

**4.5 Diagnostic and Logging Functions**

The EX600 WPN Model includes diagnostic and logging functions to facilitate troubleshooting and maintenance. The model features LED displays on the base and remote units to indicate the installation location and communication status. Web functions and setting software are also available for product diagnostics and configuration.
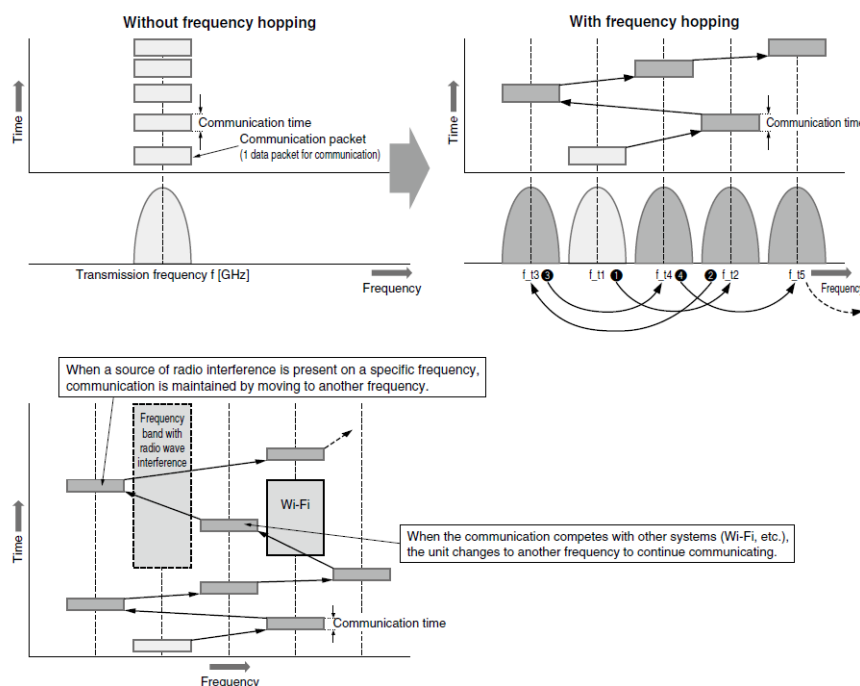
**Figure 5. Graphs showing the process of Frequency Hopping**

# 5. RESULTS AND DISCUSSIONS

The integration of wireless communication technologies, as exemplified by the EX600 WPN Model, has demonstrated significant advantages over traditional wired systems in automated palletization applications. The compact type EXW1 series and modular type EX600-W series offer flexible and efficient solutions that address the challenges faced in industrial environments. One of the key benefits of the wireless system is the reduced wiring work, space, and cost compared to wired systems. By eliminating the need for communication cables, the wireless system simplifies installation and minimizes the risk of disconnection. This is particularly advantageous for moving parts, such as in tool changing applications, where wired systems are prone to disconnection.

The wireless system also provides communication stability in FA environments by employing frequency hopping technology. This technology rapidly switches the carrier frequency among multiple channels, reducing interference from other wireless devices and ensuring stable communication. The frequency hopping cycle can be set at 2 ms or 5 ms, depending on the operating environment, further enhancing the system's responsiveness. Moreover, the wireless system offers a shorter time for establishing communication, reducing startup time compared to wired systems. This feature is particularly beneficial in applications where quick response times are crucial, such as in rotary tables or AGVs (Automatic Guided Vehicles).

The EX600 WPN Model also incorporates security features to prevent unauthorized access and data falsification, ensuring the integrity and confidentiality of transmitted data. This is achieved through data encryption, providing an additional layer of protection for the wireless system.
In terms of diagnostic and logging functions, the EX600 WPN Model offers LED displays on the base and remote units to indicate installation location and communication status. Web functions and setting software are also available for product diagnostics and configuration, facilitating troubleshooting and maintenance.

**Table 1. Comparison of basic parameters of both modules**

| Specifications | MURR Elektronik | SMC |
|---|---|---|
| Model Name | IMPACT67 Pro PN DIO8 IOL8 M12L 5P | EXW1, EX600W |
| Wiring | Wired | Wireless |
| Communication Protocol | PROFINET | PROFINET |
| Data Transmission Rate | 2 × M12 D-coded, 100 Mbps | 100 Mbps |
| Power Supply | 24 VDC +- 10% | 24 VDC +- 10% |
| Voltage Monitoring | Available | Available |
| Current Monitoring | Available | Available |
| Diagnostics | Signal and Communication | Signals and Software |
| Device Protection | IP67 | IP67 with Manifold Assemble |
| Mounting Method | 2-Hole Screw Mounting | Direct Mounting/ DIN Rail Mounting |
| No. of Inputs | 32 bits | 128 bits |
| No. of Outputs | 32 bits | 128 bits |
| Communication Distance | Wire Length | 10-100 m (Depending on type) |
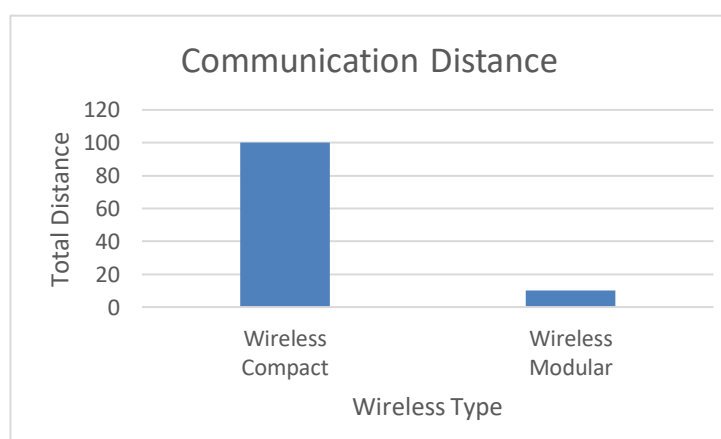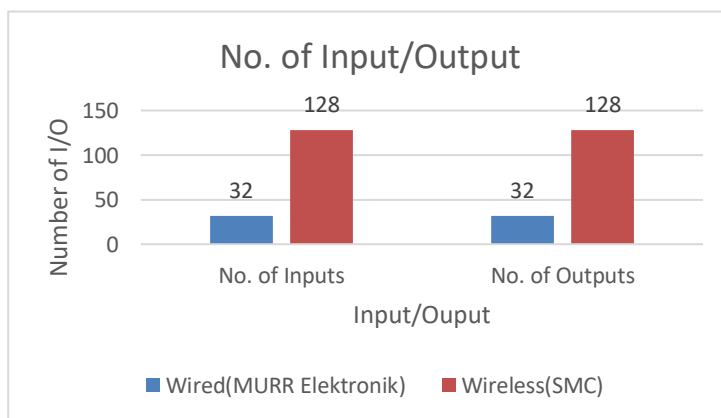




**Figure 6. Graphs showing some comparisons between different modules**

# 6. CONCLUSION

The integration of wireless communication technologies, as demonstrated by the EX600 WPN Model, has proven to be a superior solution for automated palletization systems compared to traditional wired systems. The wireless system offers reduced wiring work, space, and cost, while providing communication stability, shorter startup times, and enhanced security features. The diagnostic and logging functions further contribute to the reliability and maintainability of the system.

The successful implementation of the EX600 WPN Model in automated palletization applications highlights the potential of wireless communication technologies to revolutionize industrial processes. By leveraging the advantages of wireless systems, manufacturers can achieve greater efficiency, flexibility, and cost savings in their operations.

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