

Technical Article

Thinking outside the cabinet:

What does motor-integrated automation technology have to do with your business ROI?

Key Insights & Considerations

- **Cabinet-free technology enables more flexible and faster machine design**
- **Cabinet-free technology reduces the machine build cycle**
- **Cabinet-free technology reduces shipping costs and machine footprint**
- **Cabinet-free technology allows for simpler and faster machine installation**
- **Cabinet-free technology improves production efficiencies**

Introduction

Thinking cabinet-free is nothing new. We have always been able to eliminate some parts from the cabinet and integrate them into the machine. Some examples of devices include sensors, switches, vision, safety and identification systems. More powerful technologies with better IP protection ratings make components smaller, more intelligent and more mobile. Ethernet or wireless connectivity, along with standard protocols and safety functions, allows for all of these devices to be located directly on the machine. The benefits of these new advancements can range from simply reducing wiring to providing significant cost savings across the complete manufacturing value chain. Identifying these benefits may reduce the total cost of ownership and could eliminate the need for a cabinet at all. By thinking

outside the box or, in this case, outside the cabinet, the benefits improve the status quo.

If you are thinking of redesigning your machine or designing a new machine, this article is a must-read. We will look at motor-integrated automation technology and cabinet-free technology holistically. Additionally, we explain how you can significantly reduce costs and time in all project phases – from machine design to building and testing of equipment, from shipping to installation and throughout the life of the production equipment.

“Manufacturers want maximum productivity and flexibility at minimum operating costs.”

-Karl Rapp, Applications Engineering Manager | Bosch Rexroth

Motor-Integrated Automation Technology unlocks equipment efficiencies in the manufacturing value chain



Unlocking efficiencies across the manufacturing value chain with motor-integrated automation technology.

Consumer behavior drives manufacturing

Increasing consumer demand for a customized product requires an increase in flexible production, more product variations, smaller lot sizes, and even the ability to create a unique customer-specific product. Product manufacturers demand production equipment with flexibility, higher availability, lower inventory, minimal setup/change over time, and easy support.

Manufacturers want maximum productivity and flexibility at minimum operating costs. To remain competitive remain competitive, machine builders (OEMs) must provide innovative production solutions and integrate end-user demands for higher flexibility and complexity. Shorter engineering time, the ability to provide design verification, faster build and startup, reduced machine floor time and open connectivity are important aspects. More prevalent use of electrical equipment in machinery more than ever requires new, innovative approaches to reduce the size of electrical enclosures. The result is smaller machine footprints, less engineering, and a reduced need for cooling and cabling.

Automation control, drive, I/O, and sensor component suppliers strive to provide innovative products with reliable communication based on open standards and increasingly higher integration for cabinet-free installation. The components that do not require electrical enclosures can enable new, innovative production equipment solutions.

Evolution of cabinet-free products

Cabinet-free technology has a proven usage in many areas of automation component equipment:

- Hydraulic and pneumatic valves and manifolds, pressure sensors and related components have proven to be reliable over the years, all installed in various areas within machinery.
- Many sensor types available for direct installation into the machine work reliably for many years in a wide range of environmental conditions. Latest advances in open communication, such as IO-link, enable more intelligent sensor design with minimal wiring efforts.
- Machine safety has improved greatly with the use of safety products installed into the machinery environment and conveniently connected with networks (beyond discrete wiring). Safety curtains, scanners and switches provide the highest reliability and safe operation in production equipment.
- Panel and mobile human machine interfaces (HMIs) with better protection ratings are increasingly available for installation into the machine without requiring electrical enclosures. They are enabled by innovative HMI software and multi-touch interfaces. The increasing use of mobile devices as machine HMI will further reduce enclosure needs.
- Frequency converter drives mounted on AC induction motors used for conveyors, sorting systems and other applications have proven to reduce cabinet space.
- As servo drive use in machines continues to increase, removing the servo drive units from the enclosure often represents the greatest possible reduction in enclosure size and cabling efforts. This is especially true, not only for low-voltage drives, but also for higher voltage/power servo drives.

An example of successful cabinet-free integration is Rexroth's IndraDrive Mi, which reduces the machine footprint of packaging and processing machines thanks to fewer components, generating significant savings with up to 90 % less wiring, reduced cabinet size, and lower energy consumption.



Rexroth cabinet-free drive technology IndraDrive Mi application

Justification to go cabinet-free

Instead of just selecting the lowest cost components, it is smarter to look at the equipment more holistically. Let's take a look at the advantages cabinet-free technology offers in each phase of the value chain.



1. More flexible and faster machine design

Engineering savings?

Machine builders already commonly integrate some components directly into the machine, reducing the need for them in the cabinet. Sensors and switches are used for monitoring, I/O banks and I/O bus technology to reduce wiring, and load encoders measure length/distance as well as synchronize with packaging. Light curtains, laser scanners, sensors, and door locks provide safety, with safe and non-safe I/O data sharing a channel on one Ethernet cable.

The challenge is building a machine that is completely cabinet-free, taking advantage of the benefits a machine redesign can provide to the machine builder and end-user, and ultimately providing a better product for the consumer. How do you design a machine like this? The traditional way would be for each module to have its own cabinet for the axes it uses. The cutting-edge, cabinet-free way would allow axes or modules to be added without the need to adapt the cabinet. This would allow the machine builder to design an entire machine based on modules, offer the complete machine or only individual modules. Then as the customer's need changes, the machine builder has the flexibility to add additional modules.

Intelligent and efficient?

Many cabinet-free products are intelligent with built-in functions for diagnostics, energy savings, and configuration. In some cases, hybrid modules combine multiple technologies into one cabinet-free component. Products are Internet of Things (IoT)-ready, providing access to machine data and converting it to useful information to help improve

OEE (Overall Equipment Effectiveness). To share this information, today's products have standards and open communication, including Ethernet communication protocols. In addition, many cabinet-free components meet the necessary IP ratings for industrial environments.

Less electrical engineering?

Fewer components and connection points directly save cost for creating electrical and cabling schematics. Successful fieldbus technology eliminates many discrete wire connections (terminals) and possible points of failure. One in-machine component is often comprised of multiple conventional components that employ modern plug-and-play cabling and connections, reducing the overall cabling effort in the machine. Reduction of the number of cables and cable length directly results in savings of the number of components inside the enclosure, volume of electrical schematics and installation instructions. Additionally, indirect savings in smaller conduits and cable tracks, and the elimination of connection boxes can further help justify cabinet-free product use.

Noise reduction?

The removal of electric noise-generating and noise-sensitive components (electric drives and supplies) from the electrical enclosure reduces the engineering efforts for shielding, as well as component and wire placement. With motor-integrated drive technology noise is further reduced by partially or even completely eliminating cabling with noisy PWM through the electrical enclosure walls, which dramatically lowers shielding and routing efforts to achieve electrical noise compliance (such as for CE). Pre-manufactured and tested cabling ensures minimal noise issues and speeds up installation and startup time.

Heat reduction inside the enclosure?

Removing components with high-heat generation, such as drives and power supplies, from the enclosure provides the largest benefit. It vastly reduces or even eliminates up-front engineering needed to assess total power converted to heat, natural heat dissipation of the enclosure, cooling methods, condensation concerns, and documentation. Cooling unit installation and subsequent maintenance costs are saved. Finally,

there is no longer any need to plan for the additional power consumption of cooling unit(s). Overall, removing heat sources from the electrical enclosures by converting to cabinet-free technology results in savings during the machine operation and life, reducing manufactured product costs. This helps to achieve reduction goals for power consumption (CO₂) of the manufactured product.

Innovation effects?

As is increasingly evident in many industry sectors, cabinet-free products, especially larger power drives and supplies, allow new innovative machine designs. Fewer enclosures allow better access to the machine process and maintenance areas, reduce the machine footprint, and enable modular designs.



2. Quicker build and test

Shorter machine build-cycle?

Cabinet-free components typically reduce the machine build cycle because the components are accessible on the machine and require a minimum of connection points. Fewer components, cabling and connections save assembly and troubleshooting time. The results are shorter delivery times, reduced machine build time, and a shorter time for testing as well.

Available products combine many electrical components into one cabinet-free device, making them easier to mount on the machine. The combination of products, such as motor-integrated drive technology, are becoming smaller and more powerful. These products have many built-in functions that go beyond just a frequency drive and motor or stepper motor. Now, the combination can be a servo drive on a servo motor with the space required almost equal to only the motor itself, and no need for drive space in the cabinet.

Reduced cost of changes?

Without a cabinet, the electrical designer no longer needs to define the many components and connection methods within the enclosure, which eliminates costly changes during the build or installation.

Better logistics?

The machine builder can reduce logistics efforts by scheduling motor-integrated drive technology and other cabinet-free products directly for machine assembly, and not for the enclosure builder. This reduces the risk of not receiving a complex enclosure in time for wiring, and possibly delaying startup.



3. Reduced shipping cost

Smaller machine footprint and less shipping efforts?

Traditional machines require increased space in the enclosure due to more commonly used electric drives. Choosing cabinet-free technology still includes the essential electrical components but instead incorporates stand-alone drives or motors with integrated drives. This reduces the size of the electric enclosure or the number of enclosures required. The smaller/fewer the enclosures, the easier they are to attach to the machine body, reducing shipment size and volume. Additionally, cabinet-free products no longer need to be connected to the cabinet, but can be linked from one component to another, resulting in up to a 90 percent reduction in cables. All of these factors result in a machine with a much smaller footprint and substantially lower weight, significantly reducing shipping costs.



4. Simplified and faster machine installation

Quicker machine installation time?

Machine installation times in a production plant have traditionally been long and costly. Using new, cabinet-free products contributes to more modular machine design, requiring reduced wiring and fewer connection points. Fewer components and connections mean faster assembly, less wiring, easier testing and validation, and fewer errors. These benefits can result in significant material and labor savings and a competitive advantage to achieve the start of production (SoP) goal.

What are the installation savings for the end-user?

Usually, products designed for direct installation into the machine consist of one or very few components, which saves engineering time and installation effort. Placement of cabinet-free components within the machine still requires the assessment of product ratings versus environment and access for possible replacement, but reduces overall assembly time. Cabinet-free products have frequently triggered new innovative machine designs, resulting in an additional competitive advantage for the customer.



5. Improved production efficiencies

Smaller footprint?

With the development of cabinet-free technology, machines can be producing products effectively and production lines can be expanded with the smallest possible footprints. Thanks to the ease of modular integration, end-users can now operate more machines within the same factory space and have more flexibility with adjustments to existing production equipment. At the production facility, a significant savings can be achieved with material handling equipment and conveyors, where shorter distances result from more compact machinery footprints.

Back into production faster?

Fewer components and connection points of cabinet-free solutions mean less complexity to troubleshoot. Network connectivity offers more diagnostics to identify the problem. The limited number of connections and components result in less machine downtime, primarily because there is less to troubleshoot while the machine is out of production. This speeds up decision time to replace a component and consequently reduces machine downtime.

Cabinet-free technology provides diagnostics that hone in on the nature and location of the problem. Thanks to closed-loop redundant communication, pinpointing a problem with an axis is extremely quick. Because cabinet-free machine design makes the axis easily accessible, replacing it is as simple as removing two connectors and mounting screws, replacing the axis, and getting it back into production as quickly as possible.

What about availability?

Using Ethernet or wireless communication with standard protocols offers more diagnostics and functionality, which can prepare for IoT connectivity and increase machine availability. Additional savings result from stocking fewer components, reduced maintenance and parts replacement time, simplified procurement of machine parts, and reduced shipping and tracking costs.

Is the equipment functionally safe?

Integration of machine safety is also available with cabinet-free products. Drive-integrated safety brings more flexible operation/setup to the manufacturing floor by allowing safe machine operation while reducing the electromechanical footprint and components of machines. Furthermore, it simplifies troubleshooting and wiring as safety-relevant signals can be transferred via automation buses. Many integrated products are available with Safe Torque Off (STO). Safe motion functions, such as Safe Operational Stop under power, Safe Limited Speed or

Safe Direction can reduce setup and recovery times and increase productivity. Safety-state information can be accessed via the network to monitor the safety devices in the plant. Using components outside of the cabinet does not limit the safety functionalities on the machine.

How about data integration?

To integrate cabinet-free products into a company's IT system, the system must have direct access to power supply, drive, and motor parameter values. This is possible using interface technology that allows direct access to products using high-level languages. Information can be accessed via smart phones and tablets to parametrize or to view the product diagnostics and status, enabling the user to monitor production from anywhere. Using data analysis, processes can be adjusted to improve production and identify quality issues in the end-product. The information collected can provide accurate data about the OEE of the plant floor, improving the company's output.

Summary

When creating a new machine design or redesign, it is worthwhile to take a holistic approach from the start, implement cabinet-free technology, take full advantage of connected products, and maximize the areas of savings while exploring innovative solutions. An example of successful cabinet-free integration is Rexroth's IndraDrive Mi, which reduces the machine footprint of packaging and processing machines thanks to few components, generating significant savings with up to 90% less wiring, reduced cabinet size and lower energy consumption.

If you are looking for a different way to design your machine and add benefits to your design, consider

cabinet-free products. Introduce a machine with a minimal footprint, which is energy efficient and intelligent. Offer a machine that is flexible and modular with the option to add modules or axes. Launch a machine that has state-of-the-art safety features and saves time and money, with quicker installation at the customer's site. Provide a machine that can be integrated to the IoT with data available for improved production and continuous uptime. Design a machine that is easy to troubleshoot and maintain, so production is not disturbed. All of this and more can be accomplished with cabinet-free products.

Main areas of possible savings checklist

- **Flexible and faster machine design**
- **Saves floor space, eliminating the cabinet**
- **More cost-effective and sustainable, eliminating cooling units**
- **Up to 90% cabling reduction**
- **Smaller footprint**
- **Shorter machine build cycle**
- **Reduced shipping cost**
- **Faster machine installation**

[Link: Download full estimated savings checklist here](#)

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