

Drive & Control profile

Integrated Drive and Motor Units: Doing More with Less



With integrated servo drive/motor technology the drive electronics are mounted directly on the motor.

In the world of factory automation, “doing more with less” is a fundamental, ongoing goal that’s led a major development in drive technology: the introduction and growing use of integrated drive/motor combinations.

With integrated servo drive/motor technology, the drive electronics are relocated from the control

cabinet and mounted directly on the motor at the machine. It conserves space, reduces equipment components and cabling, and offers a modular, more efficient drive solution.

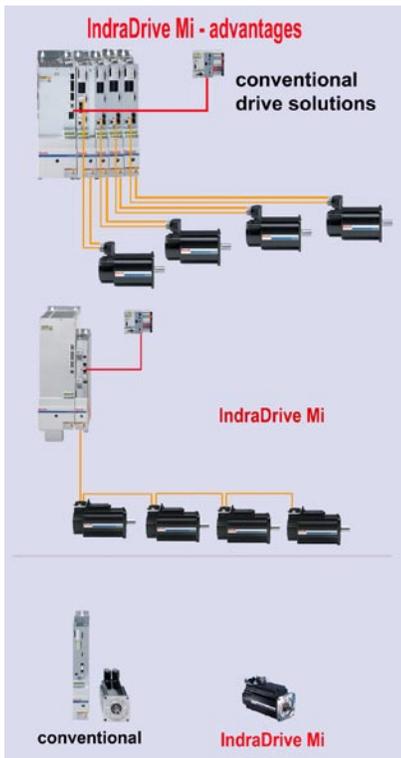
For example, the Bosch Rexroth IndraDrive Mi is an extremely compact drive and motor combo that uses 50 percent less space than

Factors for Choosing a Combined Drive and Motor Unit

- Adequate power range for your application
- Compact size
- Superior heat dissipation
- Easy connectivity
- Robust electronics
- Intelligent drive performance and functionality

IndraDrive Mi Benefits

- Servo motor and drive amplifier combined into one compact unit
- 50 percent smaller than traditional system using separate servo drive and motor
- 30 percent smaller than other drive/motor combinations
- Reduces control cabinet space requirement by up to 70 percent
- Single cable provides both power supply and communication
- Potential reduction in cabling needs by more than 80 percent
- Add drives as needed without changing the control cabinet



The IndraDrive Mi uses 50 percent less space than conventional servo solutions.

comparable conventional servo solutions, and up to 30 percent less space compared to other integrated solutions. It demonstrates the value of leveraging advanced materials and electronics to combine more functionality into smaller, simpler units.

Conventional Servos and Integrated Drive/Motor Units

Conventional servo drives place the power units and drive control in a separate cabinet outside the machine enclosure. Cabling runs from the cabinet and connects the control unit to the motor, with one power unit cable and one control unit cable per motor. The control cabinet is used to protect sensitive electronic elements from harsh factory floor conditions such as

heat, vibration, static discharge and other factors.

Advances in current-day drive electronics, which are smaller and more rugged, have helped make integrated drive/motor units practical for locating outside of the control cabinet. This helps reduce cabinet size and leads to a reduction in components such as cabling, distribution boxes, and cabinet cooling devices.

Plus, integrating the drive control and motor into one package creates a more flexible “plug and play” capability. This can help OEMs speed system development and installation, and ease changes for maintenance or machine upgrade requirements. Additional machine axes can be added with minimal set up at the main controller, since the drive control functionality is resident in the combination unit.

Multiple Factors Drive Move to Integration

Several factors have contributed to the development of integrated drive/motor technology. The first has been the widespread transition from mechanically-driven production lines to electronic line shafting.

Complicated, maintenance-heavy gears, pulleys, and other mechanical components have been replaced in many applications with electronically synchronized servo motors for systems like wrappers, pouchers, cartoners, and so forth. Electronic line shafting helps deliver more accurate and flexible machine control, less

downtime, lower maintenance costs, and the opportunity to reduce machine footprint.

Machine builders, however, continue to face pressure for cost and space savings. The control cabinet required to house power and drive units is an additional factor that can eat up limited floorspace and cost, particularly in applications where an existing machine is being retrofitted with servos.

Many OEMs and factory operators have also embraced the application of distributed intelligence in factory automation. This approach to motion control moves the burden of controlling an individual axis of movement from a centralized control (PLC or industrial PC) out to the drive, allowing the OEM to add scalable processing power as needed for more complex machinery.

Thanks to advances in microelectronics, intelligence can be distributed throughout a machine—to the sensors, motors, drives and other components. Integrated drive/motor technology leverages the processing power that can be built into the drive with today’s low cost processors and memory, enabling combo servo drives to be quite intelligent.

Correcting Common Misconceptions

In the past there have been several attempts by servo manufacturers to commercialize the combination drive/motor concept for factory automation. The first products

on the market simply attached conventional drive control to the motor frame, without truly engineering integration into a single package.

This led to performance issues that established some misconceptions about the value and reliability of the drive/motor architecture. The most prevalent concern has been heat dissipation: some machine designers fear placing drive electronics on the motor will adversely impact drive electronics performance.

Thermal management is a legitimate concern. In a combined drive/motor configuration, the heat sources are the motor, the drive electronics and overall machine/factory floor conditions (which can top 100° F in some settings).

However, most component suppliers have resolved this issue in various ways: improving heat dissipation through design features such as ventilator fans or with more reliable solutions such as efficient heat sinks, and also with the use of more robust drive electronics proven to operate efficiently and produce less heat. This helps ensure that the drive doesn't compound heat production from the motor it's attached to and therefore the integrated motor/drive solution is able to work well at higher output levels.

These improved drive electronics also resolve other misconceptions about combined drive/motor units: that they are too sensitive to withstand high-temperature, high-

vibration operating environments, and that they will wear out too fast and lead to frequent interruptions and maintenance issues.

Leading manufacturers have engineered solutions to address these issues. For example, Bosch Rexroth tapped into the electronics expertise of its cross-company Bosch automotive division to help design the extremely durable and



Some drive/motor models mount the electronics on the back end of the motor, which is an obvious disadvantage in component size compared to the IndraDrive Mi (bottom).

heat-resistant components for the IndraDrive Mi. Current generation combined drive/motor units are designed to operate on the machine itself. Rather than taking standard components and mounting them in a drive, the drive electronics have been specifically chosen, tested and proven to withstand these environmental considerations and operate reliably.

One final misconception is that combined drive/motor units are underpowered as a way to control heat production, thus limiting their range of application. However, current designs with improved heat dissipation and electronics

make it possible for motors of a given size and geometry to deliver the full measure of torque. For example, the Rexroth IndraDrive Mi is available with power/torque curve ranges from 8 to 30 Nm, making it suitable for a wide range of applications and industries.

Combined Drive/Motor Design Configurations

Two basic design considerations distinguish how different suppliers have implemented integrated drive/motor packages:

- 1) How the drive is mounted
- 2) Cabling architectures

There are advantages and limitations to these approaches that are important for OEMs to consider.

Some combined motor/drive units mount the control electronics on the back end of the motor. Typically, this configuration is cooled with an axial fan. While this mounting approach can work, there are limitations that must be taken into account:

- The entire drive/motor package is longer, potentially reducing the motor's effective length, and thus its power rating; its size may also make it more difficult to fit cleanly into machine designs with limited space, or as a retrofit option for existing installed equipment.
- Mounting the drive this way limits the heat dissipation efficiency of the drive casing, which is why an axial fan is typically added to ensure sufficient cooling. However, the fan itself represents an additional moving part subject to wear, breakdown and replacement.

An alternative approach demonstrated by the IndraDrive Mi is to mount the drive horizontally, on the long axis of the motor. This innovative design uses the motor casing as a heat sink; the casing itself is textured to increase its surface area, improving its thermal dissipation characteristics, while the horizontal mounting provides a longer, better radiating surface than vertical mounting on the end of the drive



Mounting the electronics horizontally on the long axis of the motor helps with heat dissipation. The IndraDrive Mi uses the motor casing as the heat sink.



The casing itself is textured to increase the heat-dissipating surface area.

This design eliminates parts such as fans, electrolytic capacitors or relays that can wear out over time. The IndraDrive Mi's design provides a slim form factor and tight sizing without sacrificing motor torque or power. Available in four sizes, it provides the same performance as conventional motors of comparable size with separate drives.

of combining drive and control in one package—is a key assessment criterion for machine builders.

Since the drive is no longer located in the cabinet, there is no need to run separate power and control cables from each motor back to the cabinet. Suppliers have adopted several cabling approaches—some are more efficient than others.

but does not reduce the number of cables needed, therefore offering no cost advantage.

Cabling Configurations

Combined drive/motor units offer OEMs the opportunity to implement new cabling architectures between the control cabinet and the drives. The efficiency of these architectures—how well they leverage the inherent advantages

One approach still uses separate power and control cables; however, instead of connecting each motor individually to a control system, each motor on a machine is connected to the next in sequence; this approach cuts down on the cable lengths,

A second approach combines drive power and communications into a single cable. This combination cable connects to a distribution box, which can link up to five drive/motor units (one cable per drive.) While this option does reduce the aggregate number of cables, it adds a distribution box to the cabling architecture—adding components, when the strategy underlying combined drive/motor technology is to reduce components. This box must be mounted in a convenient location for the drive operation; plus, if an application requires more than five axes, an additional box must be purchased and installed, which can add substantial cost to the automation project.



Current combined drive/motor designs offer the same performance as conventional servo motors of comparable size with separate drives (shown at right).

A third approach shown in Rexroth's IndraDrive Mi provides a separate, extremely efficient cabling solution: A single cable



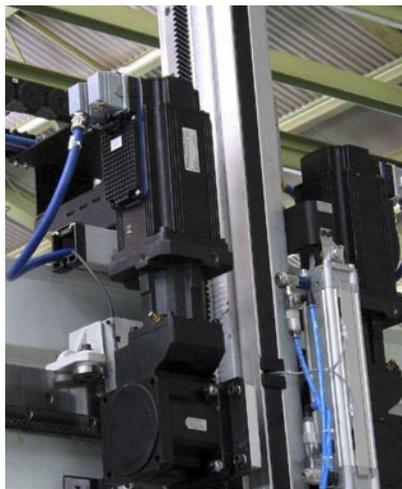
Units can be daisy-chained off a single power supply, dramatically reducing the cabling and associated installation costs.

carries both power and SERCOS communications. Up to 20 units can be “daisy-chained” off a single power supply, dramatically reducing cabling and the associated installation and maintenance costs—a simpler solution that maximizes the design advantages of distributed architecture. Optimally, the cable connections are easy to install and terminate, use pre-fabricated components, and are rated to protection class IP65 for longer usage life and reliable operation.

Suited for Broad Applications

The operational characteristics of many integrated drive/motor units make them well-suited for most machines calling for high-performance servos. Across industries from food and packaging to metal cutting to woodworking, integrated drive/motors provide an efficient, proven motion solution for two general types of scenarios.

The first is constant synchronized motion, or electronic line shafting—when all the motors stop and start simultaneously and turn at a constant, synchronized speed. This is typical of machines processing a web of material—coated paper for magazines, carton stock for packaging, etc.



Integrated drive/motor systems are ideal for gantry robots in pick and place operations.

These applications call for continuous current, with very little variation in the peak currents on the drives. The primary role for drive control is to keep all axes spinning in synchronization, and make small, pre-defined adjustments to the phase angle of a given axis for smooth, stable handling of the material being processed.

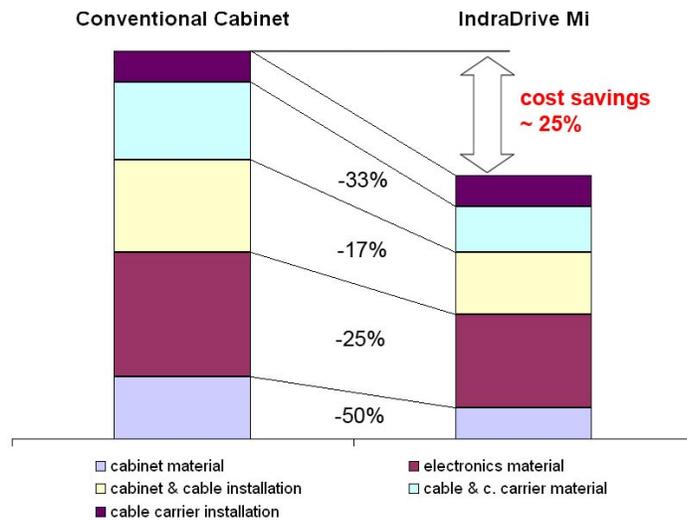
The other types of applications in which combined drive/motor units are suited are step-by-step applications, such as a gantry robot in a pick-and-place operation. The motion profile in this example calls for lifting and moving a mass in space, which means greater acceleration and decelerating, moving varying loads with intermittent motion.

Reducing Machine Costs

Integrated drive/motor units deliver much more than improved design and more efficient, better engineered automation systems. Ultimately, they offer OEMs substantial opportunities to reduce costs—component cost, development costs, and Total Cost of Ownership (TCO).

The more efficient the cabling architecture, the greater the potential savings—which is generated in two ways: reduction in the numbers of cables used, and reduction in cable lengths.

Consider a typical eight-axis cartoner, with motors mounted in line with the axes of the



Integrated drive/motor systems reduce Total Cost of Ownership.

cartoning machine. The first motor is mounted three meters from the control box, with each subsequent motor mounted three meters apart thereafter.

Using a conventional servo solution, with the drives sitting in the control cabinet, each motor has two cables running back to the cabinet. For the first motor, six meters of cable (2 cables x 3 meters) must be run; to the second motor, 12 meters of cable (2 cables x 6 meters); to the third motor, 18 meters of cabling (2 cables x 9 meters) etc. The final cable run, from the cabinet to the eighth motor, is 48 meters of cabling (2 cables x 24 meters). The total cable need is 216 meters!

Compare the potential reduction, for the same application, using the Rexroth IndraDrive Mi, with a single cable daisy-chained from the control cabinet to all eight drive/

motor units. Eight cables at three meters per cable equals 24 meters total—a potential 89 percent reduction in cabling alone.

The most significant advantage integrated drive/motor technology offers the machine designer is modularity. Combining drive and motor into a single module gives OEMs the flexibility to design machines with tighter footprints. You can deliver more functionality, implement complex multi-axis systems faster and have room to modify and scale up automation applications with much greater ease.

Modularity can help reduce the time and resources needed to design, build and install a machine—a shrink packer, a printing press, or a filling machine, for example. Instead of specifying, purchasing and integrating separate motors, drives and cabling components, combined

drive/motor units offer a complete package ready to plug and play.

Units like the IndraDrive Mi enhance this modularity with included features such as integrated Motion Logic compliant with IEC 61131-3 (which adds drive-level motion control), technical function blocks on-board (to simplify and speed drive commissioning) and configurable I/O (to support machine features such as integrated vision and programmable limit switches.)

More Performance, Less Space

Integrating drives and motors into a single, compact package is part of a continuing and growing trend in factory automation: using fewer components with greater functionality can reduce machine footprint and achieve substantial savings in machine components, design time, and delivery to the factory floor.

While some may argue that the initial cost of combo drive/motor solutions can be higher than conventional servos, the overall system costs are lower when you consider how the savings of reduced cabling, installation, testing and maintenance are factored in. These systems are quite cost-competitive, both initially and on a TCO basis.

Rexroth
Bosch Group