A Machine Builder’s Guide to Improved Motor Control Performance
New methodologies for designing motor controls are enabling OEMs to drive end user plant productivity. As industrial end users focus on speed, reliability, efficiency, flexibility and lifetime costs, OEMs are addressing these requirements through a more modern logic of design that is more focused on safety and operation efficiency.

Despite more challenging end user demands, OEMs have access to motor control automation technologies (e.g., motor circuit breakers, contactors, all-in-one starters, soft starters, variable speed drives) which provide their teams of machine builders with the tools they need. This e-guide reviews some of those technologies and describes how OEMs can gain competitive advantage using tools and components that improve efficiency by up to 30% thereby achieving faster time-to-market.

Executives responsible for driving OEM business growth take great care in choosing the right component manufacturers to partner with. Over the years, many have selected Schneider Electric for a number of important reasons:

- **Stability and a global presence** – As a €25 Billion company that operates in over 140 countries, Schneider Electric provides resources that are
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physically close to OEM end users and can ensure rapid parts delivery and support. Certified products are designed in accordance with all major international standards.

- **Technology innovation** – Schneider Electric’s broad range of globally available machine control products drive efficiency in both machine design and performance. Smart hardware and interpretive software help integrate and optimize performance of motor starters, circuit breakers, contactors and variable speed drives (VSDs).

- **Process simplification** – Schneider Electric tools shorten machine design, assembly, installation and commissioning by up to 30% thereby reducing OEM project implementation costs.

- **A reputation for high quality, safe products** – Robust Schneider Electric products are recognized worldwide. Safety features are built in thereby ensuring peace of mind and protection of people and assets.

- **Motor control expertise** – Schneider Electric is staffed with the top motor control experts – PHDs who work full time on motor control.

Attractive prices, robust products and a strong product support team has helped Schneider Electric to develop deep relationships with OEMs. Schneider Electric solutions are designed to help OEM executives boost both employee and end user efficiency.
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Such ease of use makes for rapid integration of motor starters into machines resulting in a 5 to 15% faster time-to-market.

- **Higher product reliability** – By designing and delivering higher quality motor control products, machine performance is optimized through higher availability (5-10% fewer instances of downtime).

- **More efficient remote support** – Schneider Electric remote monitoring tools allow for reduced maintenance costs through fewer on-site visits (2 to 8% in support cost savings).

- **Faster machine installations** – Open, and interoperable software tools and machine components simplify work at end user site. Field tests have resulted in 10 to 15% faster installation and commissioning times.

Those OEM design teams that have worked with Schneider Electric TeSys, PowerPact Multistandard, Compact, Acti 9, Multi 9 and Altivar motor control products, have discovered new ways to optimize machine design efficiency. These tested and validated products are certified to conform to regulatory environments across all parts of the globe. The protection value (kA) is highest in relation to component size (e.g. 80A in 55mm instead of 84mm of space – a 35% space reduction), the products lend themselves well to general use (including harsh environments), and the units are all designed to be extremely easy to wire and mount.

**Improvements in engineering efficiency**

Machine and motor control technologies that embrace open communications and exploit advanced diagnostic capabilities help design engineers to tie together breakers, contactors and drives through open standard programming and development software.

Working with Schneider Electric helps OEM technical design staffs make their jobs easier in the following ways:

- **Reduced design time** – New standard and open software tools help design engineers to more easily link disparate components such as breakers and drives.
Machine design efficiency gains

What makes Schneider Electric motor control products easy to fit into an OEM machine design? The TeSys GV circuit breaker and switch disconnectors, among the smallest on the market, integrate earth leakage protection (ELCB), build-in DIN rail and plane mount capability, and fit perfectly into standard modular enclosures, improving safety, and providing externally visible auxiliaries.

When working with Schneider Electric motor control technologies, design efficiency means easy selection of devices, fewer references to choose from, a broad range of possible applications. Innovative motor starter size-to-performance ratios enable 30-40% space savings within panels, driving more efficient machine design. Material and transport costs are lower and machine design time is reduced. The smaller footprint machine components make machine assembly faster and easier.

Below are several examples of the practical ways design and assembly time is saved:

- **Less wiring and cabling required within motor control** – Up to 30% of time is saved when mounting and installing.
Machine design efficiency gains

• **Innovative EverLink™ power connectors** – This creep-compensating technology speeds up installation because installers don’t have to spend time building lugs onto cables (to securely connect or terminate within the power panel). EverLink™ is a creep-compensating technology that speeds up installation and enhances safety. TeSys units equipped with EverLink terminals eliminate the need to build lugs and secure and terminate power connections. The small footprint of the TeSys unit combined with EverLink design generate an installation time and space savings of up to 25%.

• **Clear safety indicators** – Contactors are equipped with visible indicators that show that they are part of the safety circuit.

• **Main interrupt switches** – When padlocked in the “off” position, these products guarantee safe maintenance. In some cases, rubber control handles extend from the enclosure door as a 90-degree handle on the side of the enclosure. This can serve as a primary tool for technicians to lock their system and work in a safe testing or commissioning environment.

• **Software macros** – Macros for motor starters are imbedded in Schneider Electric PLC software. This results in faster software development.

TeSys motor controls come with the isolation, protection and emergency handling needed to comply with international codes. High-contrast covers identify safety-critical devices to prevent inadvertent manual operation. Every TeSys contactor is both mechanically linked and equipped with mirror contacts for safety applications – and wherever auxiliary contact state reliability is critical.

TeSys motor controls are easy to choose and easy to use. A single configurable control unit can provide a wide range of current settings and control voltages. TeSys motor controls offer the plug-and-play convenience and flexibility needed to optimize panel designs.
Enhanced worker efficiency

Schneider Electric motor starter units, because of the way their internal electronics are designed, have fewer parts. That means that OEMs have less parts to order and stock and overall worker efficiency improves as a result.

Engaging Schneider Electric as a partner boosts worker efficiency through the simplification of installation, commissioning and safety-related regulatory compliance. Machinery directives surrounding safety can be very complex. A multitude of rules need to be complied with across geographies. If OEMs are using non-compliant products, their work is increased as they will be required to perform extra tests and perhaps need to install additional equipment.

The safety functions built within Schneider Electric Altivar ATV320 VSDs, for example, are unique and offered as standard. The drive is already compliant with global machinery directives. In the case of many non-Schneider Electric VSD products, safety features are optional, so the OEM needs to buy more componentry to assure a high level of safety. In many cases, the cost of the safety-related equipment could end up equaling the cost of the drive.

Programming of the built-in Altivar ATV320 safety functions is very easy because of an intuitive commissioning tool that illustrates functions with images and graphics. Once configured, the drive is delivered with a machine signature that
Enhanced worker efficiency

records which of the safety functions can be used and that data can be directly submitted to certification bodies for rapid approval.

Some regulations are in place to ensure that the power of a given motor can be shut off in situations where human safety is at risk. A controlled stop function, also called a safe stop, can halt the motor based on pre-defined parameters. Consider the control of a motor that drives the blade of a saw. When a particular button is pushed, the motor stops in less than two seconds, for instance.

The Altivar ATV320 drive also has a built-in safe maximum speed function. This comes in handy with tooling machines that are spinning. The drive ensures that the pre-set maximum speed will never be exceeded. There is also a safe limited speed function. In this case, consider an assembly line with a light curtain (a sensor that detects if an object, like a human arm, enters into a particular area). When the light curtain detects such an object, the speed of the motor slows down to a safe limited speed so that the person near the machine avoids injury. Think of a worker who is responsible for checking samples on a fast-moving assembly belt. As the belt slows down in response to a human presence, that worker can pick up the samples without risking injury.

Another example of a built-in Altivar ATV320 drive safety feature is a guard door locking function. In this case, a machine door is allowed to open within a pre-defined time. In order to perform this function, under most circumstances, the OEM would have to add a safety module. Such an option would cost almost as much as the drive itself or even more.

TeSys D Green: new motor control with electronically controlled coil for increased efficiency and performance of your machines.
Enhanced worker efficiency

Within motor starters and protection components (like TeSys T, TeSys GV4, Compact NSXm and PowerPact B Multistandard product ranges) Schneider Electric patented connection technologies like EverLink prevent potential electrical hazard and fire risks. In the case of EverLink, an integrated spring is designed into the power connector. The spring compensates for loss of connection pressure due to vibrations or copper creep. Thus, a loose connection that leads to overheating of a terminal (and a potential fire) can be avoided. EverLink terminals are also finger proof. Anyone installing the equipment cannot touch the metal parts carrying current.

These families of motor control devices are equipped with all the isolation, protection, and emergency handling needed to comply with international standards. Roto active technology within these devices reduces the effects of short circuit by a factor of eight increasing the life duration of all components downstream of the electrical network. The newest models, like the TeSys GV4, support Android smart phone connections, providing access to pre-alarms, alarms, device settings and diagnostics so that technicians can quickly understand why a trip was experienced.

Safe employees are more productive employees. By working with motor starter components that guarantee peace of mind, integration of machine functions during commissioning is easier and faster. Reliable components that offer near field and/or remote setting and monitoring drive more efficient use of engineering resources and require fewer costly on-site visits to support end users.
Energy efficient and sustainable solutions

Designing a more energy-efficient motor starter creates cost savings over the lifetime of the equipment. This lower cost can then be passed directly to end users, making OEMs more competitive. Industrial infrastructures consume more than 31% of the available energy in the world and electrical motors alone represent more than 60% of that energy consumption. The purchase price of a motor also only accounts for 2 to 3% of the overall costs, the remainder of the expense primarily being energy consumption.

Traditional oversizing leads to machines that consume more energy than necessary, something that can easily be avoided through proper design. For applications with variable loads, the use of variable speed drives can bring immediate benefits and up to 50% in energy savings (pumps, ventilation fans, and compressors are obvious applications). At the same time, for any application that requires repetitive starting, the choice of speed drives over conventional contactors limits starting current and therefore reduces losses and load peaks. The instant benefits for end users, such as cost savings in their electrical bill, can be highlighted by a payback of less than one or two years.

When using contactors, some simple choices can significantly reduce power consumption. Today the use of low-consumption contactors or special function contactors (like latching relays), in combination with motor starter contactors (such as the TeSys U motor starter) can reduce...
Energy efficient and sustainable solutions

power consumption by a factor of four thanks to the lower energy loss attributed to the lower number of power contacts and fewer connections.

All of the TeSys circuit breakers and thermal relays, including the latest GV4 model, have undergone magnetic, electrical, and thermal endurance testing in laboratory conditions to ensure their compatibility with new high efficiency IE3/IE4 motors. Motor control energy efficiency generates savings of up to 30%, with thermal dissipation improvements of up to 50%.

**Pumping applications also benefit**

Pumping applications also represent an opportunity area for introducing solutions that drive energy efficiency. When it comes to the Total Cost of Ownership of a pump, 60% of the cost is represented by purchase and maintenance, and 40% by energy consumption.

The choice of the pump motor control system depends on the application. If a constant flow of water is required, a fixed motor starter-based solution (like a TeSys GV4) is sufficient and the most efficient. If flow variation is required, however, two options present themselves: either use of a throttling valve or a variable speed drive. If the flow variation is limited around the Best Operation Point (BOP) of the pump, the association of a direct-on-line motor control and a throttling valve is an efficient and low-cost solution to control the pumping system. If flow is highly variable or requires precision accuracy, a VSD (like the Altivar ATV320) provides an efficient, active solution as it adapts the speed of the motor to the desired flow.

OEMs should avoid situations where a component oversizing strategy is used in order to operate near the best efficiency point. An oversized pumping system combined with permanent flow reduction via throttle is not energy efficient.

Energy efficiency has traditionally been viewed by OEMs as an end user benefit and not so much as an OEM benefit. Yet, end user benefits are important to incorporate into OEM solutions because they become the criteria that define competitive advantage.
Boosting operational efficiency and reliability of machines

Machine efficiency is all about uptime of production. The machine earns money when it is operational. Therefore, reliability, quality, robustness and effective protection are critical success factors. Top-level machine starter reliability improves machine uptime by 5-10%, with certified circuit protection contributing to the highest production efficiency.

Recent Innovation in the area of motor start technology can help OEMs to improve the operational efficiency and reliability of their solutions in several ways:

- **Simplification** – For OEMs simplicity plays a huge role when it comes to the commissioning process. A device such as a variable speed drive is considered a complex product. But, as opposed to most VSDs available in the marketplace today, the Schneider Electric Altivar ATV320 is simple to configure and commission. The management interface software is intuitive and easy to understand. The staff engineer simply scrolls through and quickly identifies which parameters are key, and which must be active. This results in significant commissioning time reduction. These devices are easy to access and integrate through all standard communication protocols like Modbus TCP & Ethernet/IP, EtherCAT, DeviceNet, Profibus, Profinet, and Powerlink.

- **Dependability** – Tools such as QR (quick response) code technology (for non-connected drives), and remote monitoring (for connected drives) can help to link the Altivar VSD to diagnostic experts. These trained and certified staff members can then address
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**Boosting operational efficiency and reliability of machines**

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Issues that surround commissioning, diagnostics, spare parts selections, troubleshooting, and preventive/predictive maintenance operations.

Altivar VSDs (when operated in “service-oriented drive” mode) can act as “smart” sensors and collect data on all of the key parameters affecting the driveline lifetime (such as operating time, temperatures, torque, main voltage, currents). Through such monitoring, the VSD can compute future outcomes for those chain elements that are predictable, and to perform statistical analysis on those components in the driveline that are not predictable.

- **Flexibility** – Product flexibility is important when it comes to integrating drives into the existing system architecture. Schneider Electric’s Altivar ATV320 VSD is available in a number of formats for OEM contractors. These include a compact format, a book format, and a high IP format (IP 65) for wall mounting applications. The drive can integrate within the body of the machine, within the electrical cabinet, or even can be operated without a cabinet.

The drives are also suitable for use in harsh environments. IEC 60721-3-3 compliant circuit boards are rugged enough to run in environments where corrosive chemicals are present. They can be used in the woodworking and packaging industries, or owing to the option of controlled positioning, in lifting and transportation applications.

A function called “Altivar logic” helps OEMs to modify and customize functions without having to modify the PLC program. No extra equipment needs to be ordered to make it all work. The programming ability provides the design flexibility needed to optimize machine efficiency performance.

Customers who have tested both Schneider Electric and competitors’ products find, on average, that Schneider Electric VSDs save between 3 to 10 percent more energy than a typical VSD. The efficient way the drives control and regulate the motor is what makes the difference.
Product selection and productivity tool guidance

Schneider Electric provides Machine builders and other OEMs with online tools that can be accessed to facilitate fast selection, configuration and ordering of Schneider Electric products. Following is a list of resources that help support machine builder project initiatives:

**Motor Starter Components Finder** – This tool supports the quick selection of components to start, control and protect an electrical motor. The appropriate contactor, soft starter or variable speed drive is selected based upon electrical motor size requirements. The tool allows the user to choose between five different methods of motor control: Direct on Line, Reverse, Star-Delta, Soft Starter and Variable Speed Drive. The upper limit of choice in this tool is 315kW.

**Motor Controller Smart Selector** – This cloud-based tool makes it faster and easier to build a complete TeSys solution. Key electrical characteristics (voltage, prospective short circuit current, motor rated power) are identified by the user and the software generates a combination of components designed to protect and control the target asynchronous motor. Using this tool, the user can build a complete motor starter solution in minutes. The tool can be accessed from a PC, smart phone, or tablet.

**Motor Control Configurator tool** – This tool is to be released in September of 2018, as a replacement for the Motor Starter Components Finder and Motor Controller Smart Selector tools. The functionality will include scoping and localization, configuration management, proposal generation, analytics and accessories information.

**Additional configuration software** – This collection of tools provides low voltage switchboard design, power launcher, digital management of electrical distribution, quick quotation, power factor correction calculation, LV device definition and coordination, tripping curve displays, electrical installation sizing, busbar design and quoting, lighting lines configuration, and AutoCAD plug ins.

**Consolidated product catalog** – A license-free tool that provides machine builders with instant access to quick and easy detailed information that converges over 7,000 pages of automation and industrial control product catalog data.

**Spare parts distributor locator** – With a vast distribution network of more than 15,000 outlets across the globe, machine builders can quickly and easily identify the nearest distributor for needed spare parts. A “Distributor Locator” is available to find your closest distributors. These stock not only factory automation devices but also electrical, final distribution, and wiring devices.

**CAD System integration** – Machine builders can integrate Schneider Electric products in a few clicks into their own CAD system. The 2D or 3D files are downloadable from the Schneider Electric website in any mechanical CAD standards.

Selection of these products should be based on the needed performance price ratio.

The table below describes the principal product families that support motor start applications.
Quick guide to Schneider Electric industrial circuit breaker and motor starter control products

<table>
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<tr>
<th>Product Family</th>
<th>Function / description</th>
<th>Range</th>
<th>Certification</th>
<th>Recommended application</th>
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<tbody>
<tr>
<td>TeSys</td>
<td>Motor circuit breaker / motor starter, switches and protects electric motors</td>
<td>Up to 115 A and 55 kW</td>
<td>IEC, UL, CSA</td>
<td>For OEMs selling machines into Europe</td>
</tr>
<tr>
<td>Compact NSX</td>
<td>Molded case circuit breakers well adapted to motor-starting solutions providing protection against short circuits, overloads, phase unbalance, and phase loss</td>
<td>From 16 to 630 A</td>
<td>IEC, CCC, EAC and other local certifications</td>
<td>For OEMs looking to sell energy distribution solutions in Europe</td>
</tr>
<tr>
<td>PowerPact</td>
<td>Molded case circuit breakers well adapted to motor-starting solutions providing protection against short circuits, overloads, phase unbalance, and phase loss</td>
<td>From 15 to 600 A</td>
<td>IEC, UL, CSA, CCC, CE, NOM, KC</td>
<td>For OEMs looking to sell standard machines across the globe</td>
</tr>
<tr>
<td>Multi 9 OEM</td>
<td>Smaller range of circuit breakers (further downstream to Compact NSX &amp; NSXm or PowerPact)</td>
<td>Up to 125 A</td>
<td>IEC, UL, CSA</td>
<td>For OEMs looking to sell standard machines across the globe</td>
</tr>
<tr>
<td>Altivar Machine</td>
<td>Variable speed drive</td>
<td>For 3 Phase synchronous and asynchronous motors from 0.18 to 15 kW (0.25 to 20 Hp)</td>
<td>Compliance with Machinery Directive 2006/42/EC</td>
<td>For OEMs looking to sell standard machines across the globe</td>
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For many OEMs, selection of the right products can determine the profitability and success of end user projects. The Schneider Electric solution portfolio addresses the need for switching, protecting, and controlling motors with the marketplace’s most comprehensive suite of robust, quality products.
Product selection and productivity tool guidance

Expand your knowledge base
Below is a list of key assets that will serve as a quick orientation for learning more about how motor starter solutions can be easily designed, configured and integrated:

Article: How OEMs can generate efficiency gains

White paper: On the road to smart machines—How OEMs can improve the energy efficiency of machines

White Paper: Energy efficiency of machines: The smart choice of motorization

White Paper: How to ensure a secure, long-lasting power connection for your electrical installation

Blog: Variable speed drives: An IIoT tool that benefits both OEMs and manufacturers

Case study: Building better industrial laundry systems with Altivar Machine drives

Technical Guide: How to facilitate the UL-compliant approval to your control panel

ebook: TeSys D Green: new contactor series with electronically controlled coil