GET MORE THAN YOU PAY FOR...

Application Focus: Drives, Motors and Motion
For nearly 40 years, variable frequency drives (VFD) have been controlling the speed of three-phase alternating-current (AC) induction motors. In addition to saving energy, there are many things to consider for maximum efficiency, control, operation and motor life when using VFDs.

A VFD’s speed control is necessary for applications where variable torque and horsepower are needed such as centrifugal pumps, blowers, fans, mixers and agitators.

Benefits of using VFDs
Reducing motor speed saves energy in a variety of fan, blower and pump applications. Reduced inrush current when starting the motor along with controlled acceleration and deceleration are big benefits. Other key advantages include non-emergency motor start-stop control and motor overload protection. Features on the VFD, such as a keypad or potentiometer, allow manual adjustment of parameters, including speed and torque. Automatic or dynamic adjustment of these parameters is also possible using a PLC or other controller.

Size based on loads
When it comes to sizing the VFD, don’t just match the horsepower of the motor. Review of the operating profile is also important. Changing loads, continuous running vs frequent starts and stops, changes in torque, and peak current demands can all affect the size of the VFD required for the application.

Peak current demands may create temporary overload conditions, yet the VFD must provide adequate current for proper motor performance. In an application such as a conveyor with a heavy load, high breakaway torque may demand power and torque, requiring an oversized VFD. The additional headroom provided by a larger drive is worth the small increase in price and extra panel space.
Braking
When decelerating a motor, a VFD can provide approximately 20% of the available torque for braking (it’s a matter of shedding the extra current that is generated during braking). For heavy, high-inertia loads and frequent start-stop applications, adding a braking resistor can significantly increase braking torque.

Interface to the VFD
While simple pushbuttons are sometimes used, an automated approach might include the use of discrete and analog output signals from a PLC (or other controller) for the run, jog and speed control functions of the VFD. Often a combination of discrete, analog and preset control is used. For example, a controller may send an analog speed signal to a drive, and discrete signals to control run and jog functions, with acceleration and deceleration parameters preprogrammed.

Understanding digital communication options
To reduce or eliminate hardwiring, digital communication such as Modbus RS-232/RS-485, EtherNet/IP or other protocols can be used to control the drive and set parameters. This type of communication also enables monitoring of drive status, such as speed and current, and may also enable remote configuration capability.

Apply the right control mode
Some drive control modes require specific types of AC drives. Volts-per-Hertz (V/Hz) drives are most common and work well for pump and fan applications. As speed accuracy requirements increase, sensorless vector (SVC) drives, field-oriented control (FOC) drives and closed-loop VFDs with encoder feedback provide accurate speed regulation for web handling, paper mills, printing presses and converting applications.

Define the motion profile
Before setting a drive’s parameters, be sure to understand the motion profile required. What speed is needed; and can the motor accelerate slowly or must it start quickly, are just some of the questions to be answered. VFD parameters must also be understood for optimum drive setup and control.

Outline installation requirements
VFDs create heat during operation that may need to be vented out of the control cabinet, particularly if there are frequent starts and stops. Running a motor at low speeds for extended periods also generates heat and can require an inverter-duty rated motor, which includes a built-in fan.

Specify operation parameters
The AC drive manual covers many installation requirements. An important installation note is to not use a contactor or disconnect switch at the AC drive input for run-stop control, but only to remove power from the drive input under an emergency stop condition. Use discrete signals or digital communication for non-emergency start and stop functions during normal operation.

Handle noise and harmonics
Noise and harmonics generated by a VFD can damage connected motors and nearby equipment. Passive harmonic filters such as AC line reactors and chokes are often installed to reduce these problems. Check the drive installation manual and use these filters to reduce harmonics and protect the VFDs from transient overvoltage. Active harmonic filters can also be used to reduce noise generated by the VFD.
Efficient use of motors is always important, but there are many other things to consider when specifying an electric motor. Mechanical and environmental considerations are on the list, as is the application and operation. All of these factors are important, but the application is where the selection process should start.

The application defines the motor load, speed, acceleration, deceleration and duty cycle of the motor. This all feeds into the horsepower and torque requirements. Specific shaft speed and position requirements help determine the type motor used, and defines whether the motor load is constant or variable horsepower/torque.

Load Types
Applications drive the type of motor load, and there are four main types in industrial automation:

**Type 1 - Variable horsepower and constant torque**
Gear pumps, cranes and conveyors are examples of variable horsepower and constant torque applications. Constant speed AC and DC motors work well in these applications where the horsepower requirements may vary, but the load remains constant.

**Type 2 - Variable torque and constant horsepower**
A web unwind or rewind machine is an example of a variable torque and constant horsepower application because the load increases with the diameter of the roll and vice versa. DC motors and servo motors work well here, and AC motors with closed loop drives are another option. Consider regenerative power in this case to increase efficiency.

**Type 3 - Variable horsepower and variable torque**
Centrifugal pumps, fans and mixers/agitators require variable horsepower and variable torque. When speed increases, so does the motor load. Variable frequency drives (VFDs) are often used in these situations.

**Type 4 - Positional control or torque control**
Motion control applications with linear motion slides and actuators often require accurate positional control, and some presses and tension control systems use torque control. Feedback is usually required, and servo and stepper motors are often a good choice.

You only need to choose between two classifications of motors, AC and DC, but there are over three dozen motor types used in industrial applications. Fortunately, looking through AutomationDirect’s website, you’ll find solutions for motor applications using servo systems, stepper systems, general purpose and inverter duty AC motors, or general purpose DC motors and gearmotors. The selection of motors and drives should cover most industrial automation motor applications.

For more insightful articles like this one, visit our library: http://go2adc.com/go-library
Three common motor speed/torque control applications include constant speed, variable speed and position (or torque) control.

**Constant Speed**

Many applications only require the motor to run at constant speed with no need for acceleration and deceleration ramps. Simple on-off control using branch circuit protection fusing, contactor and overloads are all that is needed to turn the motor on and off. Motor starters, manual motor control or soft starters are also often used. Common AC and DC motors are suitable in these applications. Both are simple and efficient designs and require minimal maintenance.

**Variable Speed**

Precisely controlling the speed of fans, centrifugal pumps, mixers/agitators, conveyors and other loads can greatly increase energy efficiency. The ability to control acceleration and deceleration may also help handle product better, such as on a conveyor, and reduce mechanical issues by being gentler on the motor and drivetrain of the system. Coarse positioning of product can also be accomplished with variable speed control using slowdown and stop photoeyes.

DC and AC motors work well in most variable speed applications. DC drives have been around for over 100 years, and variable speed drives for AC motors have been in use for about 30 years.

DC motors are commonly used on conveyors and other fractional horsepower applications because they provide full torque at low speeds, with torque remaining constant throughout much of the speed range. Many DC motors use brushes which require maintenance, so keep that in mind or spend a little more money for brushless DC motors, or switch to AC motors and drives. An AC induction motor with a VFD is the popular choice today. If it is a fan or pump application, this is often the best option, especially if motor loads are over 1 HP.

**Position (or torque) Control**

Beyond simple constant speed and variable speed applications is motion control. Executing precise position control, and implementing motion profiles with closed loop control, often requires a servo or stepper system. Dispensing applications and moving a linear slide or actuator are examples.

At the low speed end of the precision scale, a stepper system, open or closed loop, is a good choice, especially since the stepper has full torque at zero speed. As speeds and accuracy requirements increase, a servo system is a good choice because it handles dynamic loads and complex motion profiles better than a stepper.

**Gearing**

Depending on the speed required, a gearbox may be considered regardless of the motor type. Gearboxes increase the available torque while reducing the top speed available. A gearbox can allow the motor to run in a more efficient speed range, to operate in a range where more power is available, to run more coolly, or all of the above.

To help with motor, drive and gearbox sizing, AutomationDirect has online product selectors and configuration utilities for Sure-Servo Complete Systems, AC Motors, SureGear Gearboxes and more. With application and environmental information in hand, it’s possible to calculate load inertia, torque and speed, along with mass and size of the load.

There is a wide choice of AC, DC, step-per and servo motors available for your applications. Identify whether it is a constant speed, variable speed or position control application—and then size and select appropriately using online guidance from AutomationDirect.
Motion control is generally understood to mean the use of servo and/or stepper systems as the “muscle” to move a given load. These motion control systems are capable of extremely precise speed, position, and torque control. Applications which require positioning of product, synchronization of separate elements, or rapid start/stop motion are all perfect candidates for the use of motion control. PLCs are very capable of providing the signals required to command these servo and stepper systems in a cost-effective and digital (noise-free) manner.

In a typical motion control system, there are three basic components: the controller, the drive (sometimes referred to as an amplifier), and the motor. The path planning or trajectory calculations are performed in the controller, which sends low-voltage command signals to the drive, which in turn applies the necessary voltage and current to the motor, resulting in the desired motion. Sometimes feedback devices on the motor or the load are used to notify the drive or the controller with specific details about the actual movement of the motor shaft or the load (thus “closing the loop”). This feedback data is used to increase the accuracy of the motion, and can be used to compensate for dynamic changes that may occur at the load, such as changes in mass, friction or other disturbances. Servo systems operate in a closed-loop fashion and vary output torque to move into/stay at the commanded position, while most stepper systems typically provide open-loop position control (a stepper will drive at full force to get to the commanded position or will fail trying).

The choice of open-loop versus closed-loop control depends on many factors and both are useful methods for controlling motion. PLC-based controllers can be used for either type of system. Applications that can be accomplished with a low-cost PLC and servo/stepper components include cut-to-length, indexing tables or conveyors, and x/y tables (plotter/cutter/router/placer).

The classic pulse and direction’ signals that are widely used with PLCs provide an inexpensive, noise-free (digital) method for precision motion control. Extensions or function blocks within the PLC ladder logic are typically used for programming and are easy for factory personnel to understand and maintain. While typically limited to a few axes of control and where coordination between axes is limited, PLC controllers with pulse and direction capability are an excellent fit for many motion applications. Often, low-cost PLCs are already being used for logic control on the machinery and can also handle the motion tasks with the addition of a pulse output card and some additional programming. This can eliminate the need to integrate the logic controller with a separate motion controller. Machine builders can also save considerable time when implementing PLC-based systems, especially if they are already familiar with the PLC and its programming software.
Need help choosing the correct part for your next project?
We can help: we have online product selectors for drives and motion

Like our other selectors, this selector has a simple drop-down style menu. You can choose from a comprehensive list of over 40 soft starter applications that most closely match your requirements (or simply choose an application class), select your motor voltage and size, then answer a few simple questions such as "Anticipated starts per hour" (you can try a conservative number and a liberal number to see how it affects the product offering); "Ambient temperature"; "Altitude" etc., and the selector will provide suggestions for an appropriate soft starter.

You'll also find technical data and definitions to help you gain more soft starter application knowledge, increasing your confidence as you make your selection. Once you've decided on the criteria that best matches your application needs, you can simply choose from the list of models offered and add one to your shopping cart. The end result is the purchase of a correctly sized (and economically priced) soft starter that will meet your needs and requirements: quickly, easily and confidently.

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- Required or recommended items
- Plus a lot more . . .

PedroM in EL PASO, TX wrote:
“Items have a high quality/value rate, technical documentation and software are 100% available in the WEB page, because of this, most of the times, direct technical support is not required.”

Robert in QUALITY, KY wrote:
“I have never had a problem with any of ADC’s products. The price and availability of their product line is not matched anywhere that I have found. Their PLC line as well as other automation products are on a par with anything I have found on the market in the same price range and provide a cost effective alternative to the old industry standards that are much more expensive. The only reason I go anywhere else is if they don’t have the specific item I am looking for, and that is a very rare occurrence.”
Many FREE resources are available 24/7

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Looking for FREE online PLC training? We have that too!

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- Productivity3000 modular PLCs
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**HMI/Operator Interface**
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- C-more and C-more Micro HMI design software free to download
- ViewMarq® LED message displays
- ATLAS® industrial monitors

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**PLC CPU and I/O Comparison**

<table>
<thead>
<tr>
<th></th>
<th>AutomationDirect Productivity2000</th>
<th>Allen-Bradley CompactLogix</th>
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<tr>
<td>Base (if required)</td>
<td>$81.00  (P2-04B)</td>
<td>N/A (N/A)</td>
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<tr>
<td>Power Supply</td>
<td>$79.00  (P2-00A)</td>
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<td>CPU</td>
<td>$273.00  (P2-16B)</td>
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<tr>
<td>16 AC Inputs</td>
<td>$113.00  (P2-16M)</td>
<td>$325.00  (1769-AI8E)</td>
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<td>16 24VDC Inputs</td>
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<td>$283.00  (1769-16I2)</td>
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<td>8 Relay Outputs</td>
<td>$54.00  (P2-08R)</td>
<td>$327.00  (1769-DR8)</td>
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<tr>
<td>8 Analog Input Channels (mA)</td>
<td>$222.00  (P2-08AD-1)</td>
<td>$913.00  (1769-IA16)</td>
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<tr>
<td>ASCII Comm Module</td>
<td>$0.00  (Built in to CPU)</td>
<td>$824.00  (1769-ASCI)</td>
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<td>Modbus RTU Comm Module</td>
<td>$0.00  (Built in to CPU)</td>
<td>$910.00  (1769-OW8I)</td>
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<tr>
<td>Total System Price with USB, Ethernet and Serial</td>
<td>$896.00</td>
<td>$7,299.02  (1769-IF8)</td>
</tr>
</tbody>
</table>


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Go!

Motors and Motor Controls

- IronHorse general purpose AC motors up to 300 hp
- Stainless steel AC motors
- IronHorse Farm Duty up to 10 hp
- IronHorse three-phase ODP motors up to 50 hp
- Marathon inverter duty AC motors up to 100 hp
- Marathon single-phase ODP motors up to 5 hp
- Compressor duty AC motors up to 5 hp
- DC motors up to 2 hp
- Motor controls and contactors up to 300 hp

AC and DC Drives

- DURAPULSE variable frequency AC drives up to 300hp, featuring GS20, GS20X, GS3 and GS4 series
- WEG CFW100 and CFW300 AC drives up to 5hp
- IronHorse DC drives up to 3hp
- Cost-effective GS1 series VFDs up to 2hp
- Drive accessories
- Soft starters up to 480A

Software

- Free PLC programming software (download)
- FREE Process control configuration software (download)
- Free motion control software (download)
- Free C-more and C-more Micro HMI programming software (download)
- Free AC drive configuration and programming (built-in PLC) software (download)

Process

- Temperature controllers
- Digital panel meters
- PID, Batch PID, and Loop Control
- Temperature sensors and transmitters
- Pressure sensors and gauges
- Level sensors and controllers
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Kelsey in WYOMISSING, PA wrote:
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“I have built several pieces of equipment using products from Automation Direct. I have always been satisfied with the product selection, delivery times, and the customer support. Automation Direct is the first place I look when I am looking for components.”
## Servo Systems

<table>
<thead>
<tr>
<th>Description</th>
<th>AutomationDirect Price/Part Number</th>
<th>Allen-Bradley Price/Part Number</th>
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<tbody>
<tr>
<td>Digital Servo Drive</td>
<td>$483.00  SVD-2040</td>
<td>$1,410.00  2099-S02-005</td>
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<tr>
<td>100W Servo Motor with connectorized Leads</td>
<td>$322.00  SVL-201</td>
<td>$660.00  1LY-A13B1-04ZFAA</td>
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<td>Breakout Board Kit for CN1 Control Interface</td>
<td>$84.00  ZL-SVC-OBL50 + ZL-RTB50</td>
<td>$316.05  2098-U28K-C4041</td>
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<tr>
<td>10’ Motor Feedback Cable</td>
<td>$56.00  SVC-EFL-010</td>
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<td>10’ Motor Power Cable</td>
<td>$33.50  SVC-PFL-010</td>
<td>$112.00  2098-CFBMDT-16A03</td>
</tr>
<tr>
<td>Configuration Software</td>
<td>FREE SV-PRO*</td>
<td>$85.02  2093-UWOPRS</td>
</tr>
</tbody>
</table>

*SureServo Pro software is FREE when downloaded and is also available for $9.00 on a CD.

**Complete 1-axis 100W System $978.50 $2,682.17**

All prices are U.S. list prices, AutomationDirect prices as of 4/17/2020.


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**Motion Control**

- SureServo® drives and motors, up to 3kW
- Stepper and servo gearboxes
- SureStep® drives and NEMA motors
- Leadshine® stepper drives
- Linear slides
- Koyo® encoders
- CUI Devices’ Kit Encoders

**Sensors**

- Proximity sensors
- Photoelectric sensors
- Limit switches
- Precision limit switches
- NEMA limit switches
- Laser sensors
- Color and contrast sensors
- Area sensors
- Encoders
- Current and voltage sensors
- Pressure sensors and gauges
- Temperature sensors, switches, transmitters and thermometers
- Liquid level sensors
- Flow sensors
- Ultrasonic sensors
- Fork sensors
- Linear position sensors

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**Jason in PARAGOULD, AR wrote:**

“Automation Direct is my #1 source for all of my companies automation needs. You just simply can’t beat their cost and quality! Pair that with excellent customer service and it makes an unbeatable combination. Way to go Automation Direct!”

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- WERMA and Patlite stacklights
- IP69K-rated Patlite stacklights
- Patlite signal towers and LED lighting
- Foot switches
- Enclosure and work area LED lighting
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- StrideLinx VPN routers and cloud services for secure remote access
- Pocket Portal IIoT remote I/O
- MQTT gateways
- Modbus gateways
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- Ethernet cables
- Power over Ethernet (PoE) switches
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- Rodless air cylinders
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- Air preparation and air relief valves
- Pushbutton valves
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- Pneumatic pushbuttons and limit switches

### Pneumatics
- Acme Electric®, Hammond and Jefferson Electric® transformers
- Rhino® DC power supplies and converters
- Mersen surge protectors
- Roxburgh and Eaton line filters and surge protectors
- Roxburgh power outlets
- ACME Electric encapsulated transformers
- Edison® power distribution blocks
- Bryant® electrical plugs, connectors and receptacles, and other wiring devices
- AcuAMP® AC current transformers
- Socomec multifunction power meters
- Trumeter graphical panel meters
- Regulators
- Solenoid valves in lead-free brass, nylon or stainless steel bodies
- Hand valves
- Check valves
- Push-to-connect water fittings
- Lead-free brass fittings
- Tubing
- Hose
- Hose clamps

### Water (Potable) Components
- Acme Electric® transformers
- Rhone® DC power supplies and converters
- Mersen surge protectors
- Roxburgh and Eaton line filters and surge protectors
- Roxburgh power outlets
- ACME Electric encapsulated transformers
- Edison® power distribution blocks
- Bryant® electrical plugs, connectors and receptacles, and other wiring devices
- AcuAMP® AC current transformers
- Socomec multifunction power meters
- Trumeter graphical panel meters
- Regulators
- Solenoid valves in lead-free brass, nylon or stainless steel bodies
- Hand valves
- Check valves
- Push-to-connect water fittings
- Lead-free brass fittings
- Tubing
- Hose
- Hose clamps
### Terminal Blocks and Wiring

- Eaton UL 489 miniature circuit breakers
- Fuji UL 489 molded case circuit breakers
- Eaton UL1077 supplementary protectors
- Edison fuses, fuse holders and fuse blocks
- Socomec, Gladiator® and Bryant® disconnect switches
- Bryant UL 508 manual motor controllers
- Socomec Manual Transfer Switches

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- Flexible portable cord
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- Flexible control cable
- Variable frequency drive (VFD) Cable
- Instrumentation cable
- Continuous flexing control cable
- Continuous flexing motor supply cable
- Continuous flexing industrial Ethernet cable
- Control and signaling cable
- DLO, RH, RHV-2 Heavy Duty Flexible Power Cable
- Power Machine Tray Cable
- VFD / Servo Cable with single pair
- Tray rated continuous flexing control cable
- Continuous flexing prohnet cable
- Prohbus cable
- Sensor / actuator cable
- Cat5e Industrial Ethernet Cable
- VN5C Tray Cable
- Thermocouple Extension Cable

### Enclosures

<table>
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<tr>
<th>Enclosures</th>
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<td>NEMA 1 wall mount 24 x 24 x 08&quot;</td>
<td>$222.00</td>
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<td>NEMA 12 wall mount 20 x 16 x 08&quot;</td>
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AutomationDirect.com has been a leader in providing affordable, quality industrial control products to the U.S. and Canada for more than two and a half decades.

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