

DURA
PULSE

Output Frequency
60.0 Hz

RUN STOP JOG FWD REV

PROGRAM

DISPLAY

JOG

RUN

▲

▼

STOP
RESET

ENTER

FWD/REV

AUTOMATION
DIRECT



WARNING

Do not connect AC power to output terminals T1, T2 and T3
before electrical check. Wait 10 minutes after
servicing.

10HP 230V

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Application Focus: Drives, Motors and Motion

Tips for Specifying Variable Frequency Drives



For well over 30 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.

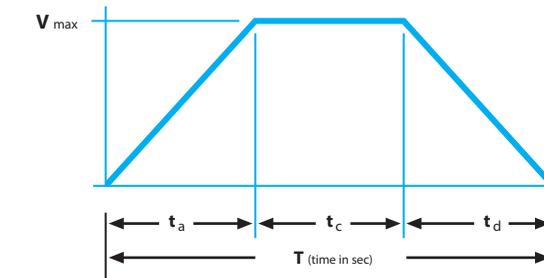
Understanding digital communication options

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, open-loop sensorless-vector 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.

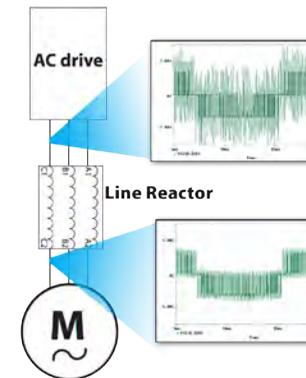
Outline installation requirements

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.

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Selecting Motors for Industrial Applications



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.



AC MOTOR

DC MOTOR

DC GEARBOX

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 the 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.

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.



CONTACTOR (W/OVERLOAD)

MOTOR STARTER

SOFT STARTER

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 DRIVE

AC DRIVE

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.



SERVO SYSTEM

STEPPER SYSTEM

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, stepper 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.



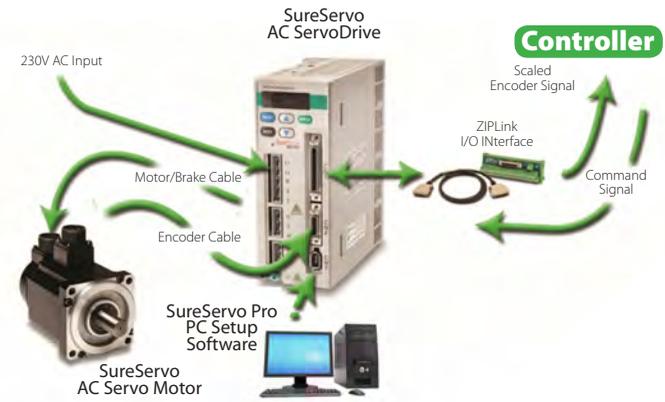
GEARBOXES



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Have questions about Motion Control?

Chances are, you're not alone.



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.

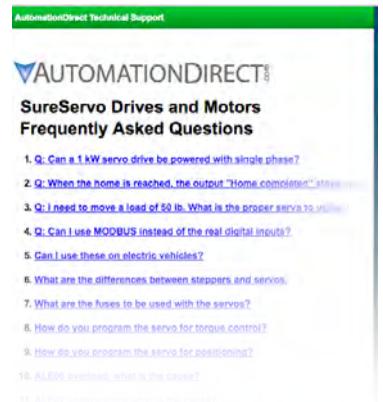
In a typical motion control system, there are three basic components: the controller, the drive (sometimes referred to as an amplifier), and the motor. The path planning or trajectory calculations are performed in the controller, which sends low-voltage command signals to the drive, which in turn applies 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.

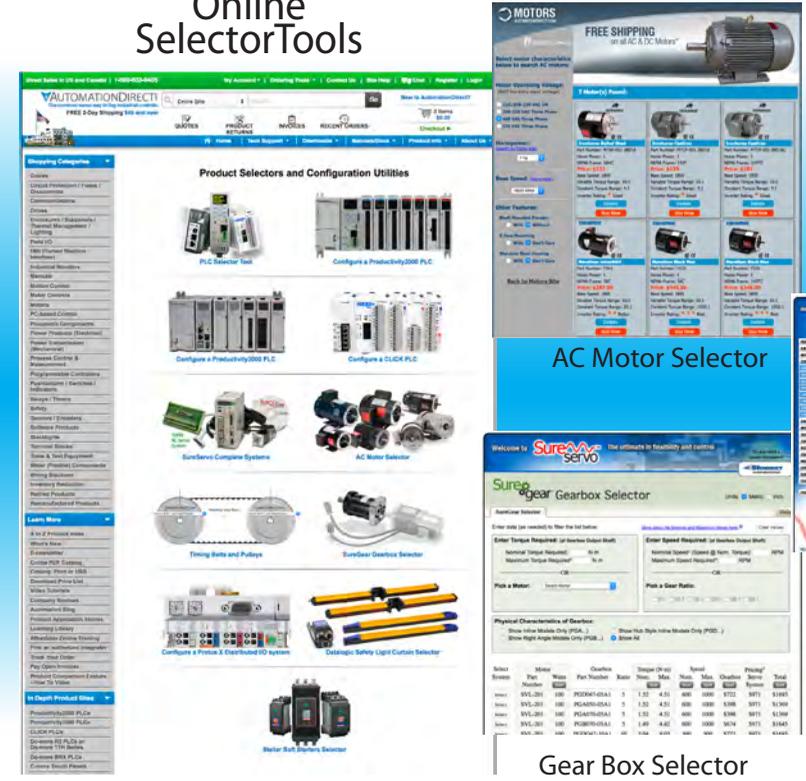


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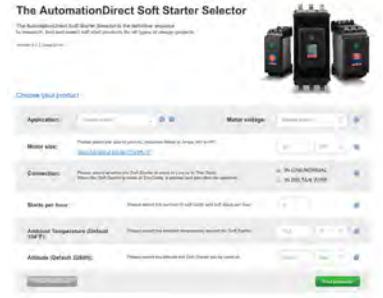
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tive number and a liberal number to see how it affects the product offering); “Ambient temperature”; “Altitude” etc., and the selector will provide suggestions for an appropriate soft starter. You’ll also find technical data and definitions to help 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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"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."

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"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."

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- DirectLOGIC DL05, DL06, DL105, DL205, DL305, and DL405 PLCs
- Think & Do PC control software

Programmable Controllers



Distributed I/O with Modbus TCP, Modbus RTU, DeviceNET and Profibus support

Universal Field I/O

| CPU and I/O Comparison | AutomationDirect CLICK | AutomationDirect Productivity2000 | AutomationDirect Do-more (H2) | AutomationDirect Productivity3000 | Allen-Bradley CompactLogix |
|------------------------------|--|-----------------------------------|-------------------------------------|-----------------------------------|----------------------------|
| Base (if required) | N/A | \$69.00 P2-04B | \$194.00 D2-06BDC1-1 | \$125.50 P3-05B | N/A |
| Power Supply | \$39.00 CO-01AC | \$69.00 P2-01AC | \$0.00 Included with Base | \$133.00 P3-01AC | \$495.00 1769-PA4 |
| CPU | \$79.00 CO-00AR-D | \$255.00 P2-550 | \$399.00 H2-DM1E (with Ethernet) | \$449.00 P3-550E (w/ Ethernet) | \$6,830.00 1768-L45 |
| 16 AC Inputs | \$40.00 CO-08NA (8-point AC Input)* | \$105.00 P2-16NA | \$135.00 D2-16NA | \$121.00 P3-16NA | \$309.00 1769-IA16 |
| 16 24VDC Inputs | \$45.00 CO-16ND3 | \$69.00 P2-16NE3 | \$91.00 D2-16ND3-2 | \$116.00 P3-16ND3 | \$263.00 1769-IO16 |
| 8 Relay Outputs | \$40.00 CO-08TR | \$51.00 P2-08TRS | \$69.00 D2-08TR | \$96.00 P3-08TRS | \$319.00 1769-IO8I |
| 8 Analog Input Channels (mA) | \$89.00 x 2 (2) CO-04AD-1 | \$199.00 P2-08AD-1 | \$255.00 D2-08AD-1 | \$232.50 P3-08AD | \$851.00 1769-IF8 |
| Total System Price | \$421.00 | \$817.00 | \$1,143.00 | \$1,273.00 | \$9067.00 |

*CO-08NA used in conjunction with eight AC inputs on CPU gives the 16 points needed
 All prices are U.S. published prices. AutomationDirect prices as of 7/15/2017. Allen-Bradley prices taken from www.ab.com 5/10/2017.



- C-more operator interface HMI touch panels
- C-more Micro-graphic text and touch panels
- ViewMarq LED message displays
- Point of View SCADA/HMI software
- ATLAS industrial monitors

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- AC stainless steel motors
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- Marathon inverter duty AC motors up to 100 hp
- Compressor duty AC motors up to 5 hp
- Motor controls and contactors up to 300 hp



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- Digital panel meters
- Temperature sensors and transmitters
- Pressure sensors and gauges
- Level and flow sensors and controllers
- Signal conditioners
- Pipeline valves

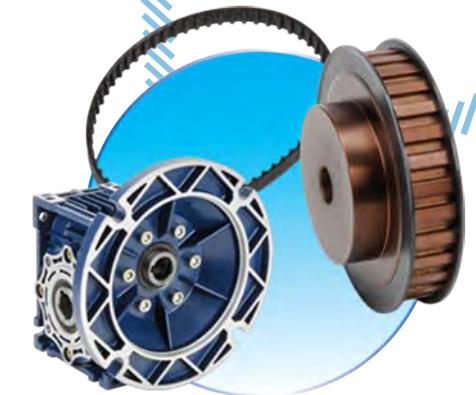
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- Tachometers
- Motor control relays



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- Wera wrenches, ratchets and sockets
- Knipex pliers, stripping and crimping tools
- Cable tie tools
- Hole cutting tools
- RUKO grinders and burrs
- SHIMPO handheld tachometers and stroboscopes

Servo Systems

| | AutomationDirect Price/Part Number | VS. | Allen-Bradley Price/Part Number |
|--|---------------------------------------|-----|------------------------------------|
| Digital Servo Drive | \$488.00 SVA-2040 | | \$1,790.00 2098-DSD-005 |
| 100W Servo Motor with connectorized Leads | \$325.00 SVL-201 | | \$584.00 TLY-A130T-HK62AA |
| Breakout Board Kit for CN1 Control Interface | \$79.00 ZL-SVC-CBL50 + ZL-RTB50 | | \$268.00 2090-U3BK-D4401 |
| 10' Motor Feedback Cable | \$49.50 SVC-EFL-010 | | \$91.80 2090-CFBM6DF-CBAA03 |
| 10' Motor Power Cable | \$29.50 SVC-PFL-010 | | \$103.00 2090-CPBM6DF-16AA03 |
| Configuration Software | FREE SV-PRO* | | \$75.00 2098-UWCPRG |

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

Complete 1-axis 100W System \$971.00 \$2,911.80

All prices are U.S. list prices. AutomationDirect prices as of 6/1/2017. The Allen-Bradley 100W system consists of part numbers shown in table above with prices from www.wernerelectric.com, www.todaycomponents.com 4/20/2017.

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- Flow sensors



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- Killark hazardous location control stations
- IDEM emergency stops
- Fuji, Schmersal and Eaton metal/plastic 22 and 30mm pilot devices
- WERMA and Fuji audible devices and visual signals
- WERMA stacklights
- Foot switches



Communications

- Industrial managed and unmanaged Ethernet switches
- Modbus gateways
- Network adapters/converters
- Ethernet cables



Power Products

- Acme, Hammond and Jefferson Electric transformers
- Rhino DC power supplies and converters
- Roxburgh and Eaton line filters and surge protectors
- Roxburgh power outlets



Circuit Protection

- 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



Terminal Blocks and Wiring

- Electrical hook-up wire/building wire
- Multi-conductor cable
- DIN rail
- Connect-It and DINnectors terminal block systems
- Edison power distribution blocks
- Bryant power wiring devices
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- Sensor cables



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|--|----------------------------|-----|-----------------------------|----------------------------|
| Non-repairable Air Cylinder 2 inch bore, 4 inch stroke, double acting, pivot/double end mount | \$64.00 A32040DD | | \$130.74 36697563 | \$93.36 6498K478 |
| Non-repairable Air Cylinder 3/4 inch bore, 1 inch stroke, single acting spring return, nose mount | \$13.00 A12010SN | | \$25.22 36696458 | \$18.50 6498K141 |
| Non-repairable Air Cylinder 1-1/16 inch bore, 6 inch stroke, double acting, pivot/double end mount | \$29.50 A17060DP | | \$63.43 36696847 | \$45.50 6498K658 |

All prices are U.S. published prices. Many other part numbers are available from all vendors. AutomationDirect prices as of 7/15/2017. Norgren prices are from www.msdirect.com 5/2/2017. McMaster-Carr prices are from www.mcmaster.com 5/2/2017. Prices subject to change without notice.

Paul in TWINSBURG, OH wrote:

"I have received many ecommerce products and this company is my favorite. Web site is quick and easy to navigate, on-time delivery and great schematic details and don't forget competitive prices. All around *Five Star**"

| Enclosures | AutomationDirect Hubbell/Wiegmann Price/Part Number | VS. | Hoffman Price/Part Number |
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| NEMA 1 wall mount 24 x 24 x 08" | \$188.00 N1C242408LP | | \$327.00 A-24N248LP |
| NEMA 12 wall mount 20 x 16 x 08" | \$253.00 N12201608 | | \$465.00 A-201608LP |
| NEMA 12 free-standing mount 60 x 60 x 12" | \$1,661.00 N12606012 | | \$2,582.51 A-606012LP |
| NEMA 4 wall mount 20 x 20 x 06" | \$328.00 N4202006 | | \$603.13 A-20H20ALP |
| NEMA 4X wall mount 20 x 20 x 06" | \$784.00 SSN4202006 | | \$1,374.70 A-20H2006SSLP |
| NEMA 4/12 wall mount 36 x 24 x 08" | \$327.00 N412362408C | | \$604.00 C-SD36248 |

*All prices are U.S. published prices. AutomationDirect prices as of 6/1/2017. Hoffman prices are taken from www.newark.com 5/2/2017. Prices may vary by dealer. Many other part numbers are available from all vendors.

- NEMA rated metallic and non-metallic enclosures from Hubbell-Wiegmann
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Enclosures



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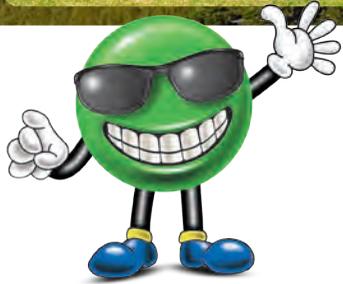
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