



AC POWERED MOTORS IN AUTOMATION

GENERAL PURPOSE, INVERTER/VECTOR DUTY AND STEPPER MOTORS

Every day throughout the industrial, scientific and commercial world electric motors supply the power of movement through rotation and/or torque to a multitude of automation applications.

The application of these motors can be very diverse as such there are a wide variety of options to consider during your electric motor selection process. Some of the basic options include the weight, size, power sources, torque, horsepower and cost. Beyond these basic criteria the type of motor itself is a critical factor in your selection and this technical presentation is intended to provide the end user an introduction to some of the most popular AC power motors (general purpose, inverter/vector duty and stepper) utilized in automation.

In many industrial and basic automation applications a General Purpose motor can meet the everyday requirements of the processes. These motors typically are readily available in off the shelf configurations from a fractional $\frac{1}{8}$ horsepower (HP) to over 100 plus HP models. One of the most popular general purpose motor designs and frames is the TEFC (totally enclosed fan cooled) NEMA 56C rolled steel version. Commonly these motor designs are utilized for the smaller HP motors in single or 3 phase electrical configurations. Larger horsepower designs tend to be made from Cast iron in T-frame mounting configuration. Some of the advantages of the cast iron include improved cooling through a ribbed design in casting along with other design considerations.

The drive and control mechanisms utilized with general purpose motors can be as simple as a direct shaft, or a more complex pulley belt and gear box system to achieve the speed, torque and other output desired. In carefully designed applications a general purpose motor can be utilized with a Variable Frequency Drive (VFD) to achieve multiple speeds, although this option is most commonly applied to inverter duty/vector duty motors.



General purpose motors application examples (above and below). Both motors are general purpose with totally enclosed fan cooled enclosure designs and running at a constant RPM. These motors are servicing the exhaust system and pumps in water heating/cooling system while automation components such as valves, temperature sensors and controllers provide the appropriate automated control.



Applications of general purpose motors include turning the blades of a ventilation fan, a water pump or other applications where the torque and speed requirements are within the minimum RPM and load requirement of the original motor design. Otherwise these motors are supplemented by other mechanical drive systems and automation components to achieve the desired result of the process.



General purpose motor used in transfer pump for water treatment system.

Inverter duty motors differ from general purpose models in that they feature higher grade insulation and better cooling at lower speeds; their windings can withstand higher voltages and harmonics, and they can run at lower speeds without overheating. Vector duty motors have all the advantages of inverter duty models, plus they can generally achieve full-load torque at zero speed. Vector duty motors in combination with sensorless vector drives are frequently used in applications requiring precise motor speed control.

The design strengths and capabilities of an Inverter or Vector Duty motor in tandem with a VFD (variable frequency drive) come into consideration with variable and constant torque, along with constant horsepower applications.

Variable torque motor applications can be a fan, blower, rotary pump or centrifugal pump in the air/water flow and temperature controls of a clean room, process or commercial space where variable motor speeds and loads are commonplace.

Constant torque is a very important factor in applications such as extruders, hoists or conveyors where despite the speed of the motor the torque will remain consistent. Other constant torque applications include reciprocating pumps/compressors and traction drives. Inverter/vector motors are good choices in many machining applications such as lathe turning, milling, grinding and drilling operations. These motors provide the constant horsepower required despite the individual feed and speed specifications of metals or other materials being machined.



The Variable Frequency Drive (VFD) used to control the inverter duty motor in the air handling system.



Inverter duty motor application example. The motor shown (above) is enclosed in the large air handling system (below). The motor and VFD control in this system is one of several motors driving and automatically adjusting multiple large forced air system with 14,000 CFM through hundreds of the HEPA filters, providing the appropriate amount of air changes, positive pressure and other environment controls to ensure the operational space contain no more than 10 particles of 0.5 microns in size.





In addition to the torque and horsepower considerations concerning inverter/vector duty motors, the selection process should also include the start, stop and speed changes required in the application along with the desired acceleration and deceleration rates. These motor control factors are typically accomplished through an AC variable frequency drive (VFD) such as the MVX9000 and NFX9000 series shown below and offered through Omegamation™.

MVXF25A0-1, \$360



Both shown smaller than actual size.



NFXF50A0-1, \$192

Stepper motors are different from other electric motors we have outlined at this point, as they do not simply rotate smoothly when power is applied. Every revolution of the motor is divided into a number of steps, in many cases 200 steps, and the motor must be sent a separate pulse for each step. The motor can only take one step at a time and each step is the same size. As the digital pulses increase in frequency, the step movement changes into continuous rotation. The speed of rotation is directly related to the frequency of the input pulses, and the length of rotation is directly related to the number of pulses applied.

Stepper motors require a drive for operation. Basic drives have inputs for step, direction and enable, and they depend on a host (PC or PLC) to provide the pulse train. Indexer drives are programmable by a host PC and develop their own pulses internally, thus are capable of stand-alone operation. Stepper drives are further divided into open-frame and packaged types. An open-frame drive requires an external DC power supply, while a packaged drive has an internal supply typically powered by 110 Vac. Omegamation™ offers a selection of various stepper drives to suit your application, including the 3540i indexer (open-frame) and the high-performance STAC6 series (packaged).

Stepper motors are in use every day without our realization. For example these motors are used in commercial applications such as computer disc drives, printers/plotters and in CD players. In the industrial and scientific world these motors are integrated with robots and machine tools, along with high speed pick and place machines, automated wire cutting machines or even precise fluid control devices.

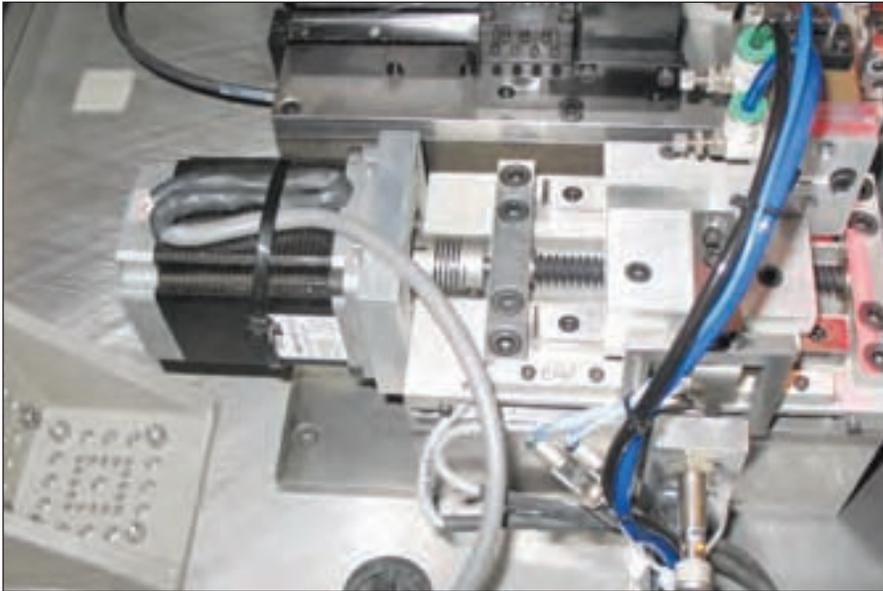
These motors are a good choice in applications requiring very precise movement of mechanisms, along with applications requiring continuous duty, high torque and low speed where the torque is lower than 500 oz-in and the speed less than 2000 rpm, with low to medium acceleration rates.

As you have learned from this introduction the utilization of these different motor types can be very diverse, although it is interesting to note it is commonplace to find all of these motor designs in the same general manufacturing, scientific or industrial spaces, as is the case in examples we shared from the Omega Engineering, Inc. operations.

The Omegamation Handbook and Encyclopedia along with our website **omegamation.com™** has taken both the diversity and common area factors into consideration and is designed to provide the end-user a comprehensive one-stop shop and technical resource for these motors and other products for your automation, scientific or general industry applications.

When working with the Omegamation™ sales engineering team not only will you find the excellent technical resources, customer service and quality you have come to expect from Omega, you will also have access to experienced individuals who live with the application of these products every day.

For stepper motor ordering information see page D-7



The stepper motor shown is an application where the positioning of a 0.5 mm welding pad for wire lead bonding to thin film sensors is critical. These stepper motors are an integral part of a fully automated machine designed and fabricated by the in-house Omegamation™ team and is a perfect example of the extensive product offering of the Omegamation™ products. Beyond the stepper motors and drive control this machine includes pneumatic linear slides and part gripper mechanisms, PLC and HMI, along with enclosures, electrical controls, terminal blocks, interface buttons and stack lights.

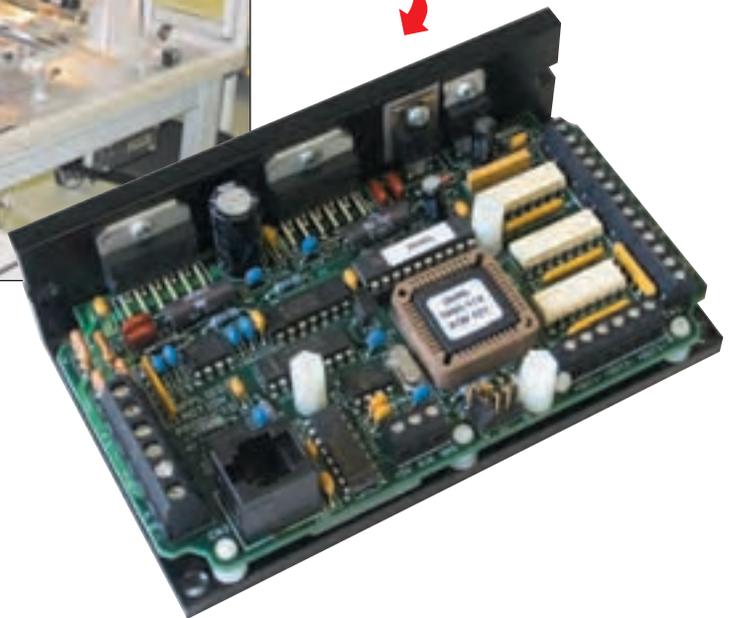


For stepper motor ordering information see page D-7



STAC6-Si high performance stepper drive/indexer with integral power supply, \$995, shown smaller than actual size.

3540i programmable stepper drive/indexer, \$385, shown smaller than actual size.





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