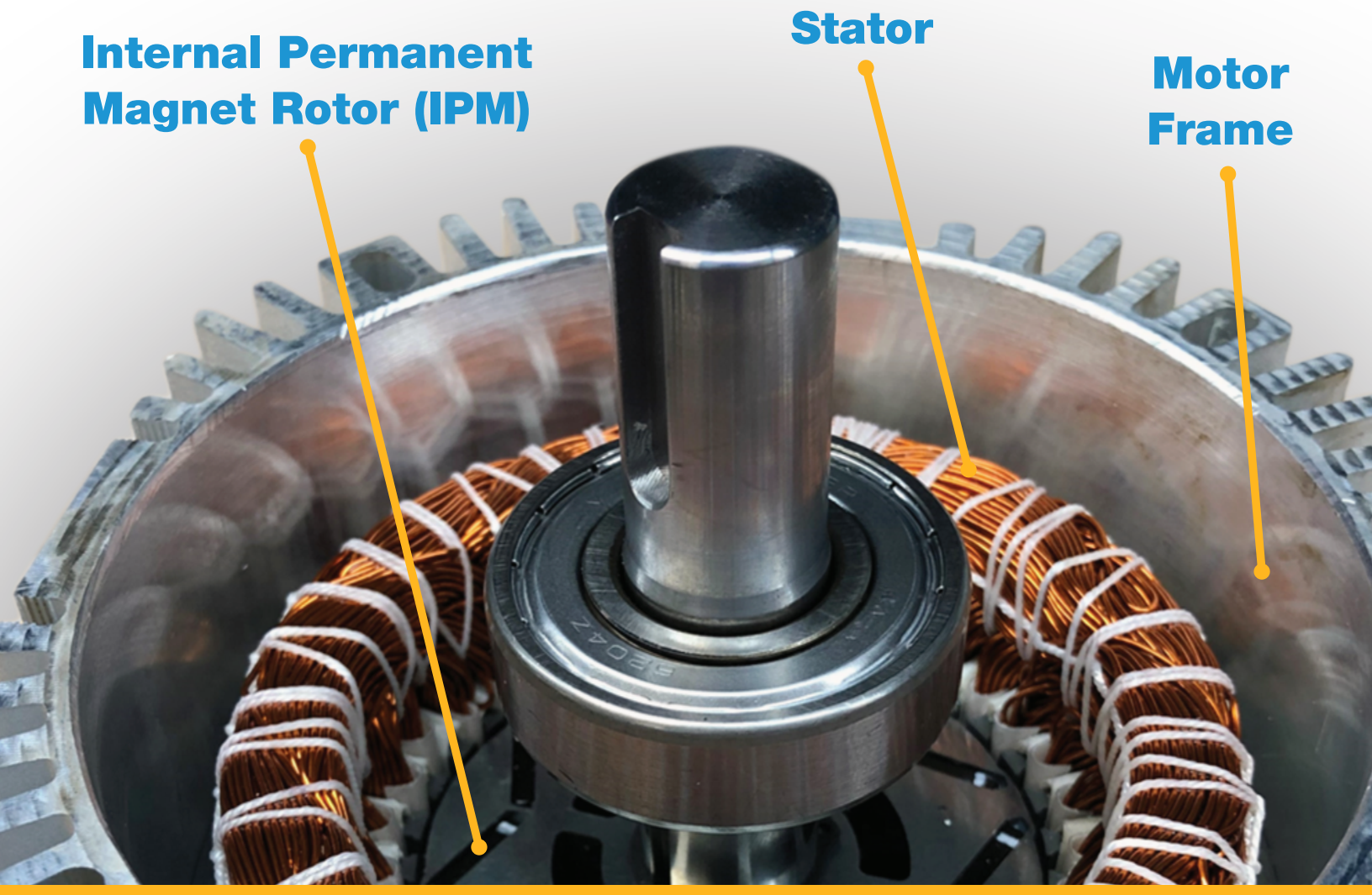
BISON
Gear & Engineering Corp.

Permanent Magnet AC Motors
The Perfect Fit

Variable Frequency Synchronous Motors

This motor type is growing in popularity and is marketed with several different names including Permanent Magnet AC (PMAC) and AC Synchronous. These motors are desired as they consume less power, fit in a smaller space, and operate precisely where they were set to operate. Many variable frequency drives can now operate PMAC motors, and these drives are considerably less expensive than servo drives. This new motor type provides machine builders an option that can solve one or more problems at an affordable price.



Motor Characteristics

Stator

PMAC stators are very similar to three phase induction stators. There are three sets of coils that create three phases. Inverter duty wire is used to minimize corona induced stator failures. 230V and 460V three phase are the common voltages which match with today's VFDs. Stators are wound on the same automated winding equipment that manufacture induction motors, the lowest cost manufacturing method for wound stators.

Rotor

PMAC rotors are normally designed using finite element analysis software. The leading motor manufacturers use rotor laminations with interior permanent magnets (IPM). These magnets are commonly made from neodymium-iron-boron, selected for their robust performance and reliability. Failure modes of earlier designs where magnets are glued onto the surface of a steel shaft have been eliminated since the magnets are embedded within the rotor.

PMAC motors act like a generator when they are driven mechanically either by hand or by the machine they are in and the output voltage is sinusoidal. The magnitude of the voltage delivered while the motor is back-driven is considerably higher than an induction motor, which can be negligible for most machine designers. Applications that are routinely back driven need special precaution for generated voltages.

Rotor Cogging

Since magnets are embedded within the rotor, cogging forces are present. These forces are caused by the attraction of the magnets to the steel stator pole faces. There are several ways to mitigate or minimize these forces in the rotor construction. The most common method is to slice the rotor into individual disks, and then position the disks on the rotor shaft in a skewed orientation. This tends to minimize the cogging, as not all magnets would align with a given pole face at one time. Cogging forces, if not minimized by the motor designer, can lead to audible noise at low velocity. These forces are not present in induction motors.

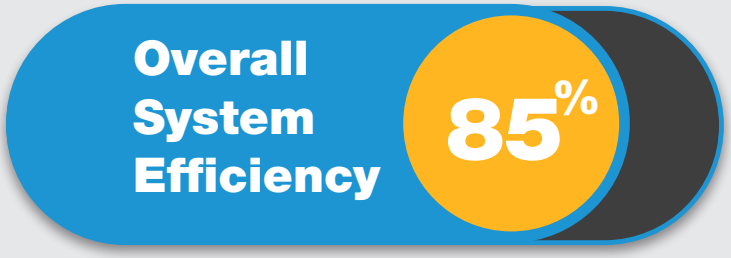
Motor Performance

This new class of motors easily outperforms induction motors in several categories including:

- **Starting torque**
- **Operating current**
- **Variability in speed**
- **Envelope size**
- **Efficiency**

PMAC motors operate at the specified velocity while delivering the nameplate torque. This allows machine builders to reliably operate the machine within predetermined boundaries compared to induction motors, which have a sloping speed versus torque curve.

The PMAC class of motors, when coupled with a good VFD, can deliver overall system efficiency levels above 85%. This is clearly better than any induction motor solution whether it is single or three phase, with or without inverters.



PMAC motors are smaller in size compared to their induction motor counterpart providing an advantage to machine builders. The motors can easily fit into spaces where induction motors were originally specified, deliver more power and do so at less current.

In addition, the ability to maintain full torque at low speeds improves performance over induction three phase motors with VFD's.

To improve efficiency on induction motors, additional lamination steel and more copper wire need to be added. This reduces losses but adds to size and weight.

PMAC motors are considerably smaller in diameter and lighter than their induction motor counterparts as the rotor uses permanent magnets.

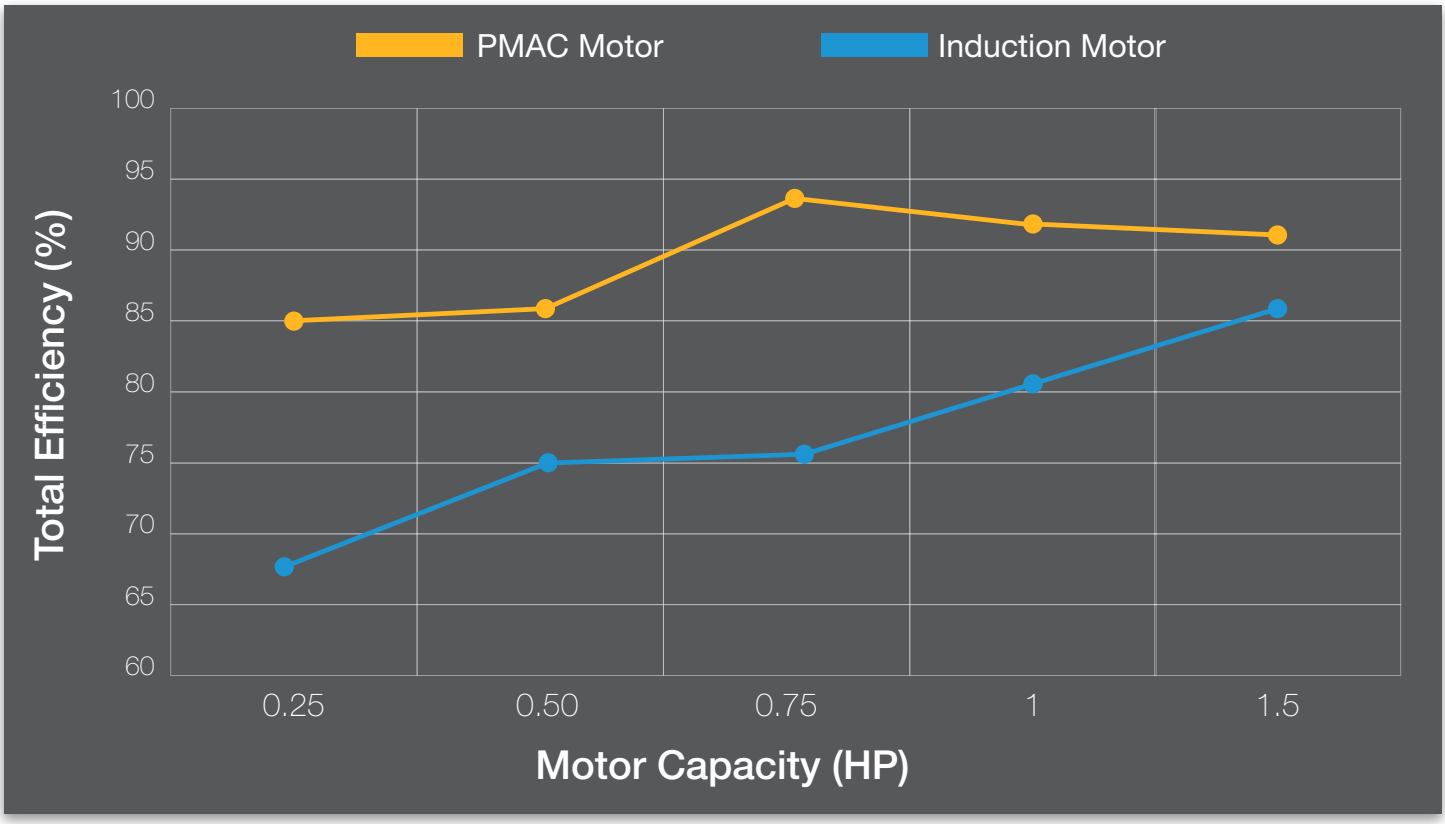
Variable Frequency Drive Technology

Permanent magnet AC motors are designed to rotate in harmony with a supplied waveform from an inverter that generates sinusoidal waveforms within a specified frequency range. This synchronous operation allows the motor to run “in tune” with a given frequency from a VFD.

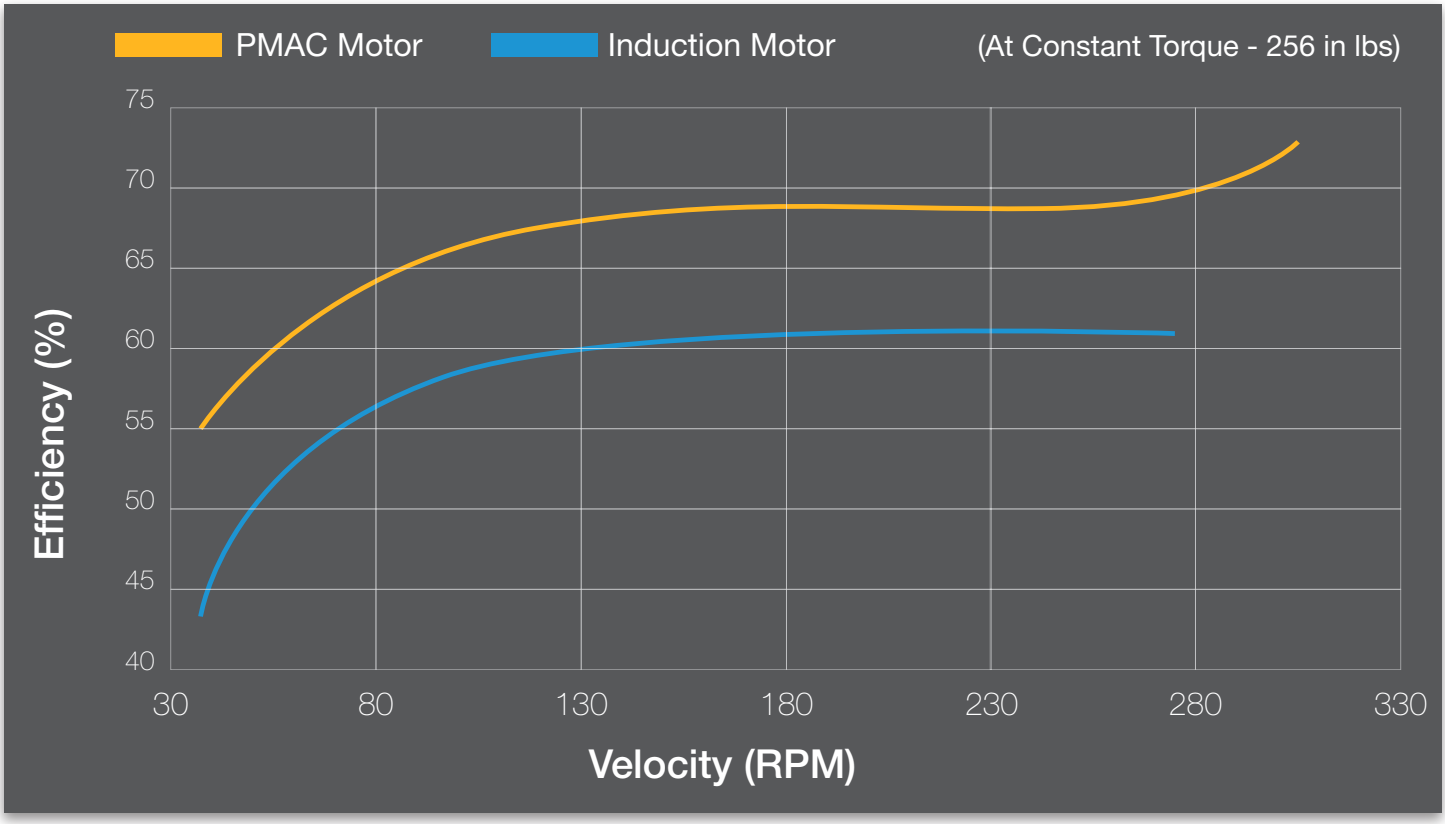
Most variable frequency drive manufacturers offer a drive that can run the newer PMAC motors. Most servo drive manufacturers also have specific drives that can run this new motor type. The major difference is in the platform the drives are intended to operate within, and if they are controlled by a network or as a stand-alone solution. Many drives include multiple digital and analog programmable inputs and outputs that can be programmed for various machine functions, another positive when it comes to optimizing machine performance.

Motion Control Capabilities

Drive & Motor Efficiency



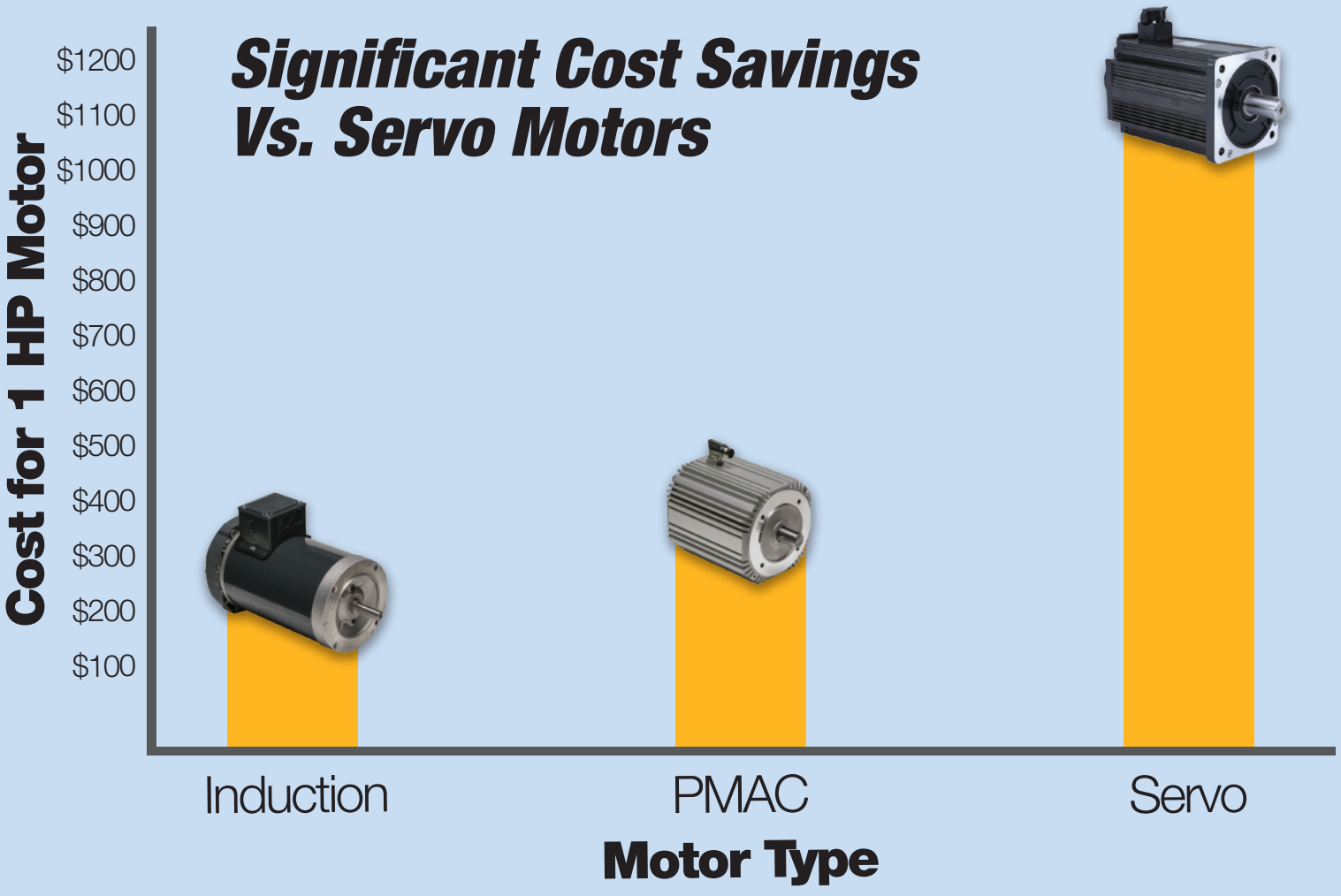
Gearmotor System Efficiency vs. Velocity



Market Factors Influencing the Development of Permanent Magnet AC Motors

- High Efficiency
- High Torque to Inertia Ratio
- Compact Size
- More Affordable Options
- Power Density
- Precise Speed Control

Significant Cost Savings Vs. Servo Motors



Applications That Could Benefit From Permanent Magnet AC Motors

Greenhouse Equipment

Equipment used to fill flats with soil have multiple motors that need to run synchronized in order to optimize throughput and minimize the amount of soil that doesn't get placed in the flat. Two PMAC gearmotors could be used in place of two servo driven units.

Conveyor Systems

Many machine builders use gearmotors to power multiple conveyor sections that are connected and need to run at the same speed. A Modbus network cable connects the inverters and the main PLC, allowing all PMAC gearmotors to run at the same speed.

Bottling Equipment

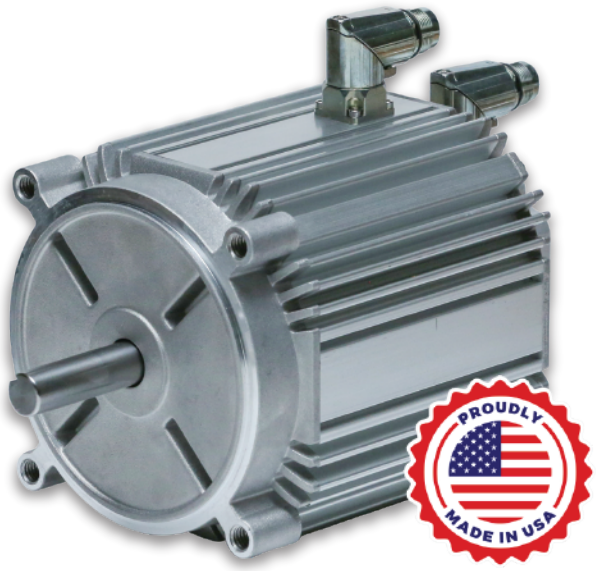
Bottles that are about to be labeled need to be spaced out prior to the labeling process. The variable speed machine needs to operate in sync with the feed rate and the mechanism applying the label. Two PMAC motors (with encoders) could be used instead of servos for a substantial cost savings.

Bagging Equipment

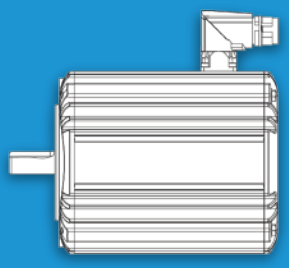
A packaging equipment manufacturer uses two belts in a bag sealing application. The lower belt supports the bag as it goes through the top bag closing/sealing mechanism. All of the belts need to go the same speed so that the bag remains in proper orientation as it goes through the sealer. Two PMAC gearmotors could run synchronously and meet the requirement.

PERMANENT MAGNET AC MOTOR VFsync

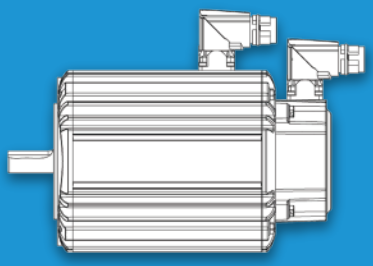
Designed with high-tech automated machines in mind, Bison Gear & Engineering's VFsync motors deliver the velocity control that engineers have previously only found in much more expensive servo motors.



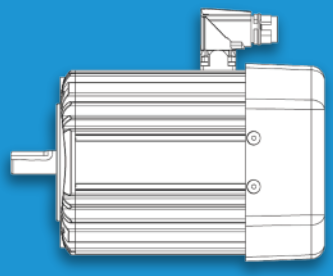
Three Motor Styles Available



Totally Enclosed Non-Vented



Totally Enclosed With Encoder



Totally Enclosed Fan Cooled

Contact Bison Gear & Engineering today and speak with one of our automation experts to find out if our new VFsync Permanent Magnet AC Motor technology is **The Perfect Fit** for you.

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