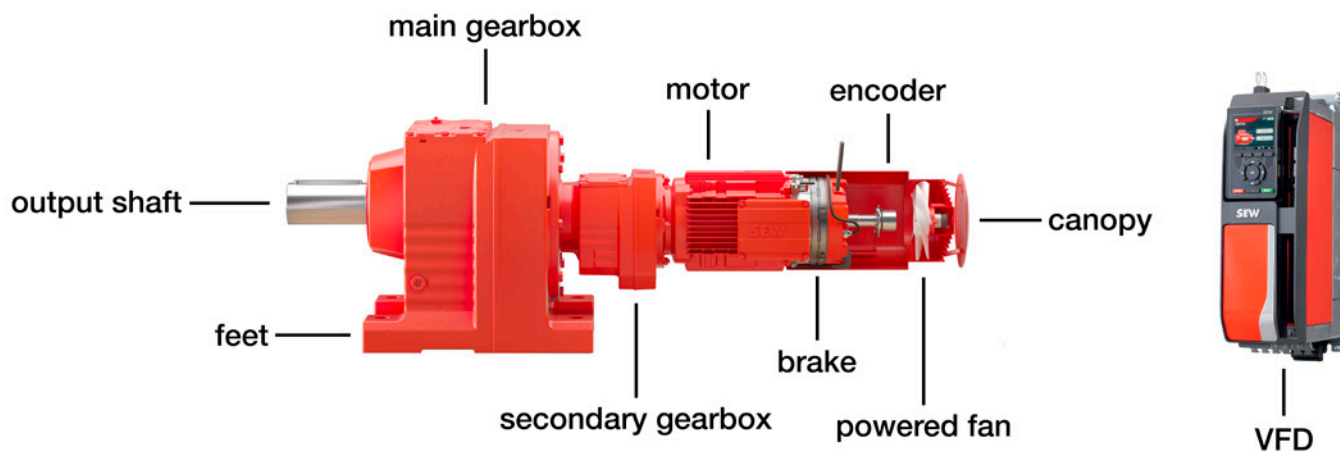


# To Pick the Right Drive, Ask the Right Questions

## SEW-Eurodrive addresses application requirements to select components

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*A drive and some of its optional accessories. All photos courtesy SEW-Eurodrive.*

Selecting a drive, whether for a new application or to replace an existing one, doesn't have to be a traumatic experience. The key to success lies in asking a logical sequence of thoughtful questions.

### Learning Objectives

1. Recognize the core components and optional accessories making up a drivetrain.
2. Identify an application's key electromechanical requirements.
3. Identify an application's key electronics requirements.

If an electrically powered industrial machine moves, chances are that a *drive*—an electronically controlled gearmotor—orchestrates that motion. While ordinary gearmotors have moved industry for over a century, inexpensive electronic drives have been mainstream technology for just a few decades. Consequently, plant engineers and maintenance personnel may feel uncomfortable about selecting a drive. Traditionally, drive manufacturers guided this process through their sales engineers, but many now offer online selection tools or smartphone apps as an alternative. While these certainly make the selection process more convenient, they can be daunting to use correctly.

Happily, there's a simple solution to this problem: ask the right questions before sitting down to the selection tool. Thoughtfully defining the problem and organizing the application's requirements paves the way to a smooth and successful selection experience. This article outlines the questions you should ask yourself as you prepare to use a drive manufacturer's selection tool.

### The Drivetrain

The drivetrain contains everything that powers the application, including the drive itself. The drive (pictured above) has three core components: a gearbox, an electric motor, and a variable frequency drive (VFD). It may connect directly to the application, or it may deliver power through additional transmission elements, such as a belt, chain, or spindle. In either case, the drive must have appropriate coupling and mounting devices. These include flexible couplings, flanges, feet, or torque arms.

The motor may require a brake, either to stop the load or hold it in place. If the application requires precise speed control or accurate positioning, a motor encoder will be necessary. When a PLC or other industrial controller manages the application, the VFD will probably need a suitable fieldbus interface or some extra inputs and outputs.

The questions you'll be asking will define the drive. They flesh out the main components and tease out the specialized accessories required. The questions broadly divide the drive into its electromechanical and electronic components.

## Core Electromechanical Questions

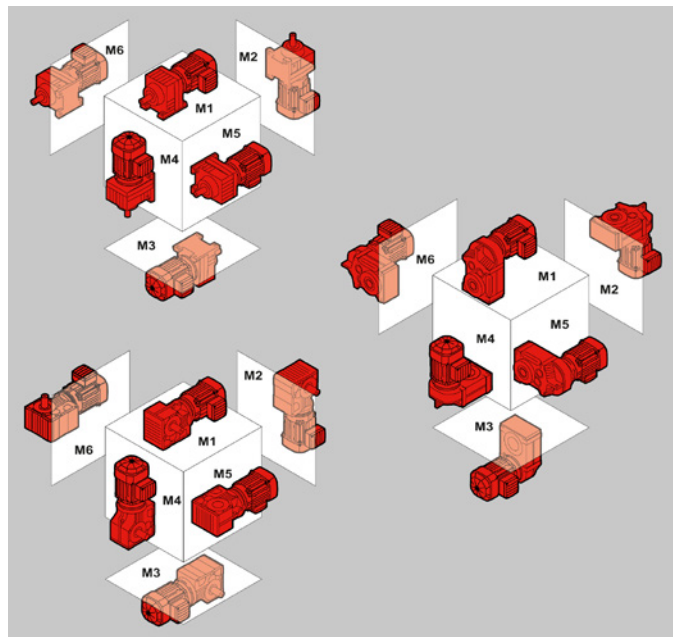
Begin by identifying the application's *motion*. Is it rotary or linear? With linear motion, is it horizontal, vertical, or angled? Vertical and angled applications usually require a brake, while horizontal ones may or may not. Be sure to identify the motion's *duty cycle* too. Continuous duty applications, like simple conveyors or a blower, can work well with an ordinary AC induction motor. Cyclic applications performing repetitive sequences, such as packaging machines, may benefit from a more dynamic permanent magnet synchronous motor.

While you're thinking about the application's motion, identify the expected *loads*. Besides their magnitude, also determine whether they're predominantly static or dynamic. Sizing a drive for an application with relatively static loads is simple. If the load varies widely or can change abruptly, the drive will need a larger service factor. Be sure to identify the application's acceleration requirements too. In cycling applications, the motor must deliver sufficient torque to accelerate the load within the time constraints. PM synchronous motors can handle aggressive acceleration better than ordinary induction motors.

Determine the application's *speed, torque, and horsepower* requirements. These help size the motor and gearbox. The speed and torque requirements also determine the appropriate gearbox ratio. Be sure to identify how the drive will connect to the application. List appropriate details like *shaft diameter, flange and feet requirements, and coupling type*. Finally, if the application needs a brake, identify the required braking torque.

Application efficiency has progressively become more important in recent years due to rising energy costs and legislation mandating efficient motors. Questions that you've already answered may steer the selection tool towards a particular motor efficiency rating. For example, a continuous duty application requires a premium efficiency (IE3) motor. You can improve efficiency even further by requesting a particular *gearbox style and mounting position*. Gearboxes based on helical or bevel gears tend to be much more efficient than those containing worm gears, so they're preferable when efficiency is paramount.

Similarly, the gearbox mounting position influences efficiency since position determines how much oil the housing must contain to keep the gear stages lubricated. Vertical mounting positions often require more lubricant, which leads to higher churning losses as the gears plow through the oil. Whenever possible, select a mounting position that requires the least lubricant. Every manufacturer has its own mounting position identification scheme (pictured above right). Be sure that you understand it, so you can correctly specify the gearbox mounting position.



Gearbox mounting position identifiers vary among manufacturers. This is SEW-Eurodrive's system.

## Environmental Electromechanical Questions

You're past the most difficult electromechanical questions. Those that remain help identify additional factors needed to ensure a good match between the drive and the application. Begin by describing the application's *operating environment*. Is it indoors or outdoors? Clean or dirty? Wet or dry? Are there harsh or corrosive chemicals involved? Will the drive require regular washdown?

The answers to these questions determine the drive's materials, protective coatings, seals, and cabling. A drive operating in a poultry processing plant, for example, requires multiple washdowns per day with hot water and caustic cleaning agents. Ordinary protective coatings won't survive these conditions for very long. A stainless-steel drive with potted motor windings and conduit box connections is a much better choice.

On the other hand, the environment can be dry but still very harsh. Drives powering ore or rock crushing machines must endure heavy dust and abrasive grit. These will probably require multiple shaft seals or ones specifically designed to keep abrasives out. The drive may also need bearing re-lubrication fittings to make regular grease changes simpler.

Identify the application's expected *temperature range*. Is it unusually hot or cold? Temperature affects lubricant choices. Mineral oils and greases perform well at everyday temperatures, whereas specialized synthetics are better choices for hot and cold extremes. The gearbox and motor may require auxiliary heat in a cold environment or more aggressive cooling in a hot one. While you're thinking about lubricants, remember that food processing and pharmaceutical machines often need food-grade lubricants.

## Core Electronics Questions

At this point, you've asked enough questions to specify the motor and gearbox. The remaining questions help select the VFD and its accessories. These may be unfamiliar territory if you've not worked with VFDs before. While all VFDs do much the same thing—control the motor—they vary widely in their features and intended applications. Again, asking the right questions will help you decide which one is right for you.

You've already answered an electromechanical question that is equally important for selecting the VFD—the application's *horsepower* requirement. Additionally, determine the available power supply *voltage* and *phase* (single- or three-phase). These answers size the VFD and identify possible models. In most cases, a drive manufacturer will offer several VFDs that will satisfy your application's basic electrical requirements. Listing additional application requirements will help you choose from among these.

Begin by identifying the application's *operating mode*—whether it's speed-, position-, or torque-based. Speed-based applications are the simplest, so almost any VFD can handle them capably. Do determine the *accuracy* required, however. Entry-level VFDs can handle applications with modest requirements—fans, pumps, and blowers, for example. Applications requiring higher accuracy must use a VFD that supports closed-loop control via a motor encoder. While many VFDs can operate in closed-loop mode, not all come with built-in encoder interfaces. Those that don't will require an add-on interface board. This must match the motor encoder's communications standard.

By their very nature, positioning applications require a more advanced VFD. It must run the motor at a specific speed while monitoring one or more encoders to determine the application's position. Upon reaching the specified position, it must stop the motor cleanly and accurately. If your application requires positioning, determine its *type* (linear or angular) and the required *accuracy*. These answers will also influence the encoder selection. Precise positioning will require an expensive, high-resolution encoder, while basic positioning can get by with a more economical choice.

Applications requiring torque-based control are the least common, so not all VFDs support this mode. They require the VFD to maintain a specific tension on the load by adjusting the driving torque. A wire winder is an example, as is the paper feed system in a web printing press. In each case, the VFD monitors the tension on the wire or paper with a sensor, such as a dancer potentiometer. The VFD uses this feedback to generate the torque required to maintain the target tension. If your application is torque-based, be sure the VFD supports this mode and can interface with the required sensors.

For the final core electronics question, determine how the VFD will integrate into the application. Many VFD manufacturers offer their products in two styles: *control cabinet* and *decentralized* (pictured above right). A control cabinet VFD, as its name implies, lives in an electronics cabinet. Wires enter and exit the cabinet, connecting power, the motor, and any sensors to the VFD. The cabinet protects the VFD from the environment, especially important when operating under harsh conditions.



**Control cabinet (left) and decentralized (right) VFDs perform the same task but in completely different ways.**

Decentralized VFDs approach control differently. They mount either on the motor itself or very close to it. Since they're exposed to the application's operating environment, decentralized VFDs usually have relatively high IP (ingress protection) ratings, such as IP66 or higher. A decentralized VFD integrates more seamlessly into the application and typically requires less wiring since it mounts very close to the motor. Decentralized VFDs are becoming increasingly popular in many industries. Some drive manufacturers even offer "electronic gearmotors"—an all-in-one gearbox, motor, and VFD (pictured below). These offer an especially elegant solution to many drive challenges. As a bonus, some are exceptionally efficient because they combine a super premium efficiency (IE4) motor with an efficient gearbox and VFD.



**A highly efficient electronic gearmotor integrating a motor, a helical-bevel gearbox, and a VFD.**



## Secondary Electronics Questions

Once you've identified the core electronics requirements, ask questions that will reveal *special features* affecting the VFD. For example, many applications include controls or sensors that the VFD must monitor. These may be digital devices like toggle switches, pushbuttons, limit switches or a referencing cam. Alternatively, they may be analog devices, like temperature sensors, a speed-control potentiometer, or a voltage that represents a process variable. Most VFDs include at least a few digital inputs and outputs, but not all support analog signals. In some cases, the VFD may require an expansion card to augment its built-in I/O.

Finally, consider the *control method* that the application will use to manage the VFD. Simple applications like fans and pumps may rely on the VFD's front panel for control and status display. More-sophisticated applications might operate the VFD in terminal control (binary) mode via switches, a potentiometer, and digital indicators.

The most sophisticated applications use a PLC or similar industrial controller to manage the VFD. These usually communicate with the VFD over a fieldbus—a robust industrial network. Fieldbus control provides maximum flexibility and sophistication but adds an extra layer of complexity. If the application requires fieldbus control, you'll need to identify the controller brand and model, as well as the fieldbus standard it uses. Newer controllers

use Ethernet-based fieldbuses such as EtherNet/IP, Modbus TCP, or PROFINET. Older controllers use legacy standards such as PROFIBUS or DeviceNet. Most VFD manufacturers support multiple fieldbus standards. The VFD may have a built-in fieldbus interface or may require an add-in card.

## Selecting the Drive

At this point, you've gathered everything necessary to use the drive manufacturer's selection tool. Fire it up and answer its questions, supplying the information that you've gathered. You'll discover that thinking things through in advance will give you confidence as you work your way through the selection process, as well as afterwards when the tool generates its recommendations. Far from being a worrisome experience, drive selection will become a routine task that gives plenty of satisfaction.

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