

VFD Guide



Introduction

This guide provides a clear and practical explanation of industrial **VFDs**, from their basic operating principle and benefits to selection, operation, accessories, and common faults.

It is written in a direct, easy-to-read style to help engineers, buyers, and operating teams understand the essentials before making technical or purchasing decisions.

Important: Final values such as cable lengths, breaker ratings, and operating parameters should always be confirmed using the specific model manual and actual site conditions.



What is inside this guide?

- Simple and clear VFD basics.
- Key questions that support correct selection.
- Common faults and initial troubleshooting direction.
- Accessory guidance and when to use each item.
- Best practices for operation and protection.

Quick contents

Section	Content
1	VFD basics and general concept
2	How to select the right VFD
3	Common faults and solutions
4	Installation and accessories
5	Programming, operation, and control

Why use a VFD?

Benefit	Practical value
Speed control	Run the machine at the required speed instead of full speed all the time.
Energy saving	Reduce electricity consumption, especially in pump and fan applications.
Soft starting	Reduce electrical and mechanical stress during startup.
Better protection	Monitor abnormal current, voltage, temperature, and fault conditions earlier.
Flexible operation	Integrate easily with sensors, control panels, and PLC systems.

Common applications

- Pumps and constant-pressure systems.
- Fans, ventilation, and HVAC systems.
- Conveyors and mixers.
- Hoists, cranes, and motion applications.
- Compressors and various industrial machines.

Quick accessory map

The table below gives a simple view of common accessories and when they are recommended.

Accessory	When it is needed	Main benefit
Line Reactor	Unstable supply or electrical disturbances	Improves input power quality and adds drive protection
Output Reactor	Medium motor cable length	Reduces voltage stress on the motor
dV/dt Filter	Long motor cable runs	Provides better motor insulation protection
Sine Wave Filter	Very long cables or sensitive motors	Highest output quality and motor protection
Braking Resistor	Fast stopping or regenerative loads	Dissipates returned energy and reduces Over Voltage trips
EMI Filter	PLC, sensors, or communication systems nearby	Reduces electromagnetic interference

VFD Basics

Practical answers to the most common questions.

1. What is a VFD?

Answer: A VFD, or Variable Frequency Drive, is an electronic device that controls motor speed and torque by changing the output frequency and voltage supplied to the motor.

2. How does a VFD work in simple terms?

Answer: It converts the AC input into DC, then recreates an AC output with variable frequency and voltage to match the required motor speed.

3. What are the main benefits of using a VFD?

Answer: The main benefits are speed control, lower starting current, energy savings in pumps and fans, smoother operation, and better protection for the motor and driven equipment.

4. Does a VFD really save energy?

Answer: Yes, especially in pump and fan applications. Reducing speed can significantly reduce power consumption compared with running at full speed all the time.

5. What is the difference between a VFD and a Soft Starter?

Answer: A Soft Starter reduces starting current only during startup. A VFD controls motor speed and torque throughout operation, not only during startup.

6. Can any motor run on a VFD?

Answer: Most three-phase induction motors can run on a VFD, but the motor nameplate, insulation condition, cooling, and cable length should be checked first.

7. What is the difference between constant torque and variable torque loads?

Answer: Constant torque loads, such as conveyors and hoists, need strong torque even at low speed. Variable torque loads, such as pumps and fans, require less torque as speed decreases.

8. Can one VFD run more than one motor?

Answer: It can be done in some cases when all motors run together at the same speed and follow the same control logic, but each motor should have suitable individual protection.

9. What does carrier frequency mean?

Answer: Carrier frequency is the internal switching frequency used to create the PWM output. A higher value may reduce audible motor noise but can increase drive heating and affect allowed cable length.

10. What is the difference between single-phase input and three-phase input?

Answer: Some small VFDs accept single-phase input and provide three-phase output for the motor. Larger ratings usually require a three-phase input supply.

VFD Selection

Practical answers to the most common questions.

11. How do I select the correct VFD rating?

Answer: Start with the motor nameplate: power, voltage, current, frequency, and speed. The most important check is that the VFD output current is suitable for the motor current.

12. Should I select by kW or by current?

Answer: The final selection should be based on motor current and the VFD output current rating. Two drives with the same kW rating can have different current ratings and duty classifications.

13. What is the difference between Normal Duty and Heavy Duty?

Answer: Normal Duty is usually suitable for lighter applications such as pumps and fans. Heavy Duty is used for more demanding loads such as conveyors, mixers, crushers, and hoists.

14. How do I select a VFD for pumps?

Answer: Check the motor rating, pump type, operating pattern, and whether PID control or a pressure sensor is required to maintain constant pressure.

15. How do I select a VFD for fans?

Answer: Fans are one of the best VFD applications. Selection is usually based on voltage, motor current, airflow control requirements, and operating environment.

16. How do I select a VFD for conveyors?

Answer: Review the load weight, starting torque, acceleration time, and stopping requirements. Many conveyor applications benefit from vector control and sometimes Heavy Duty selection.

17. How do I select a VFD for cranes and hoists?

Answer: Hoists require strong torque, careful braking, and often a more detailed technical review. Encoder feedback or braking resistors may be needed depending on the application.

18. When should I oversize the VFD?

Answer: A larger rating may be used when the ambient temperature is high, the load is heavy, the duty cycle is demanding, or extra operating margin is needed.

19. How do I define the required speed range?

Answer: The speed range depends on the motor and the application. Very low speeds can affect motor cooling, while operation above rated speed requires careful review.

20. What information should be prepared before buying a VFD?

Answer: Prepare the motor power, voltage, current, load type, motor cable length, control method, operating environment, and any PLC or sensor requirements.

Common Faults and Solutions

Practical answers to the most common questions.

21. Why does an Over Voltage fault occur?

Answer: It often occurs during fast deceleration, when the load returns energy to the DC bus, or when the input voltage is too high. Increasing deceleration time or using a braking resistor may solve the issue.

22. Why does an Under Voltage fault occur?

Answer: Common causes include low supply voltage, weak power supply, voltage drop under load, or unsuitable wiring or protection design.

23. Why does an Over Current fault occur?

Answer: It can be caused by very short acceleration time, excessive mechanical load, motor cable problems, short circuit, or incorrect motor parameters.

24. Why does an Over Load fault occur?

Answer: It means the drive or motor has operated above its allowed load for too long. This can happen due to overload, wrong sizing, or unsuitable duty selection.

25. Why does the VFD temperature rise?

Answer: Common causes include high ambient temperature, poor cabinet ventilation, dirty filters, insufficient clearance, or operation close to the drive limit.

26. Why does the VFD trip at startup?

Answer: This usually happens when the load is heavy, acceleration time is too short, motor parameters are incorrect, or the control mode is not suitable for the application.

27. What does Earth Fault mean?

Answer: It usually indicates leakage or insulation problems in the motor or motor cable. Moisture, damaged insulation, or long cables can contribute to this fault.

28. Why does Phase Loss appear?

Answer: Possible causes include missing input or output phase, damaged fuse, faulty contactor, loose connection, or severe voltage imbalance.

29. Why does the motor heat up when running on a VFD?

Answer: Long operation at low speed, long motor cables without filtering, unsuitable carrier frequency, or poor motor cooling can increase motor temperature.

30. How should repeated faults be handled?

Answer: Record the fault code, operating condition, speed, current, voltage, load state, and time of occurrence. Repeated faults should be diagnosed from the root cause, not only reset.

Installation and Accessories

Practical answers to the most common questions.

31. When should I use a Line Reactor?

Answer: A Line Reactor is installed on the VFD input to improve supply quality, reduce the effect of disturbances, and add protection for the drive.

32. When should I use an Output Reactor?

Answer: An Output Reactor is installed on the VFD output when the motor cable length is moderate or when additional motor insulation protection is needed.

33. What is the difference between an Output Reactor and a dV/dt Filter?

Answer: An Output Reactor reduces part of the stress, while a dV/dt Filter is specifically designed to reduce voltage rise rate and better protect motors with long cable runs.

34. When should I use a Sine Wave Filter?

Answer: A Sine Wave Filter is used when the highest motor protection is required, especially with very long cables, older motors, sensitive motors, or noise-sensitive applications.

35. What should be used when the cable between the VFD and motor is long?

Answer: As a general guide: short cables may not need accessories, medium lengths may need an Output Reactor, long cables may need a dV/dt Filter, and very long or sensitive applications may need a Sine Wave Filter.

36. When should I use a Braking Resistor?

Answer: A Braking Resistor is used when fast stopping is required or when the load regenerates energy during deceleration, such as hoists, heavy conveyors, centrifuges, and some mixers.

37. How is a braking resistor selected?

Answer: Selection depends on the VFD rating, DC bus voltage, stopping time, duty cycle, and braking energy. It should follow the drive manufacturer recommendations.

38. Do I need an EMI/RFI Filter?

Answer: An EMI/RFI Filter may be required when PLCs, sensors, measurement devices, or communication systems are affected by electrical noise.

39. How do I select the correct MCCB?

Answer: MCCB selection depends on VFD input current, operating voltage, breaking capacity, protection requirements, and the drive manual recommendations.

40. Should a contactor be installed before or after the VFD?

Answer: Usually, the contactor is installed on the VFD input side. Switching a contactor between the VFD and the motor during operation should be avoided unless the system is specifically designed for it.

Programming, Operation, and Control

Practical answers to the most common questions.

41. What is the difference between Scalar and Vector Control?

Answer: Scalar or V/f control is suitable for simple applications such as pumps and fans. Vector control provides better torque and speed performance, especially at low speed.

42. What is Sensorless Vector Control?

Answer: Sensorless Vector Control improves motor torque and speed control without using an encoder. It estimates motor behavior internally and offers better performance than simple V/f control.

43. What is PID control in a VFD?

Answer: PID control allows the VFD to adjust motor speed automatically to maintain a process value such as pressure, flow, or level.

44. How should acceleration and deceleration times be set?

Answer: They should match the load. Very short acceleration can cause Over Current, while very short deceleration can cause Over Voltage.

45. How can motor direction be reversed?

Answer: Direction can be reversed from parameters or through a digital input, but the application must allow reverse operation safely.

46. How can a VFD be operated from an external control panel?

Answer: It can be controlled using Start/Stop buttons, a potentiometer, digital inputs, analog signals, or a remote keypad after setting the command and frequency sources correctly.

47. How is a potentiometer connected?

Answer: It is usually connected to reference voltage, analog input, and common terminals. The analog input type and scaling must be configured in the parameters.

48. How is a pressure or level sensor connected?

Answer: Sensors commonly use 4-20 mA or 0-10 V signals. The VFD must be configured for the correct analog input type and measurement range.

49. How can a VFD communicate with a PLC using Modbus?

Answer: The RS485 wiring must be connected and communication settings such as address, baud rate, parity, and register mapping must match between the PLC and VFD.

50. What are the best practices to extend VFD lifetime?

Answer: Correct sizing, good ventilation, proper protection, clean cabinets, reliable grounding, and solving repeated faults at the root cause all help extend VFD lifetime.

Best Practices

- Select the drive based on actual motor current, not only motor power.
- Provide proper ventilation and grounding inside the control panel.
- Enter motor data correctly in the VFD parameters.
- Do not ignore repeated faults; identify and solve the root cause.
- Add the correct accessories when the application requires them, especially for long cables or fast stopping.

Summary: A VFD is not only a speed control device. It is a key part of a more efficient and reliable operating system. Correct selection from the beginning saves time, cost, and future downtime.

This guide can be used as a concise reference for early technical discussions and faster solution selection.