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Your Premium Provider for Supply and Service of Electric Motors, Industrial Controls, and Power Distribution Solutions

Information Sheet # 07

Your Reliable Guide for Power Solutions

VARIABLE FREQUENCY DRIVE
Applications & Explanations

1.0 Introduction:

Variable Frequency Drive, usually using the acronym VFD, refers to the technology for fine control of motors with an electro-mechanical drive system. VFD has two principal benefits, first a more efficient way to start and ramp up an electric motor, and secondly a method for finely controlling motor speed and/or movement with a wide range of systems, including but not limited to, continuous manufacturing process, industrial and commercial machinery and water-treatment plants. While the technology is not new, the advancements in digital switching technology has greatly accelerated the use of the VFD.

This information sheet discusses the principles behind VFD, the benefits of using VFD technology, and typical applications employing VFD systems.

Figure 1 Flow Diagram AC -DC -AC VFD Connection to AC Motor

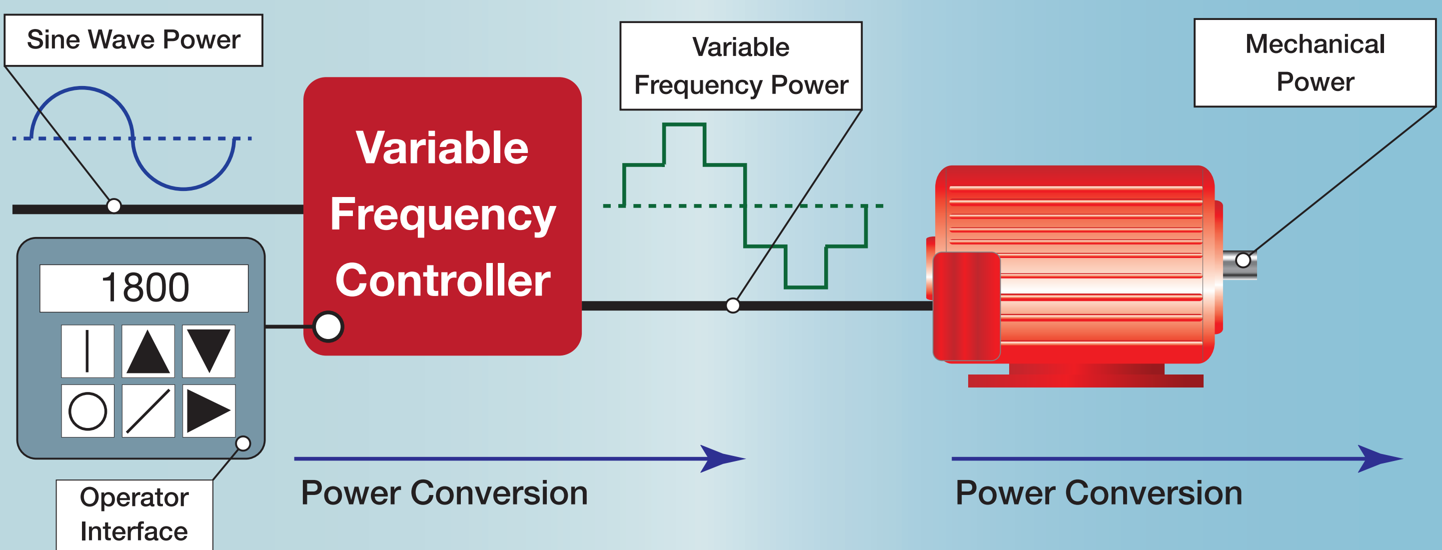
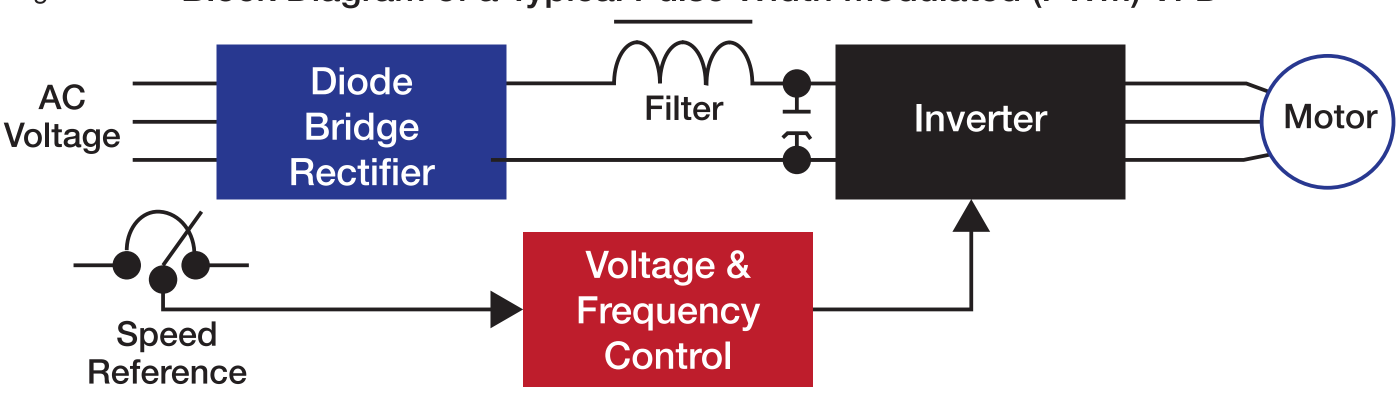


Figure 2 Block Diagram of a Typical Pulse Width Modulated (PWM) VFD



To fulfill our commitment to be the leading supplier, the Layco Electric Innovations team ensures they are always up-to-date with the current industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power and motor control industry.

2.0 Explanation of VFD Technology:

The primary purpose of a VFD is precise control of electric motor speed. With a VFD, a system designer can precisely control ramp up and ramp down speed to ensure all the components within a process are coordinated and operate efficiently in sync. Without a VFD an AC electrical mechanical device, such as a constant electric motor, just runs up to constant speed as current is applied and while doing so consumes up to 7-times the running amps required, to overcome starting torque. Prior to the application of VFD, motors would have to be connected to various mechanical components such as gears.

VFDs control the speed of an AC motor by varying the frequency supplied to the motor. The drive also regulates the output voltage in proportion to the output frequency to provide a relatively constant ratio of voltage to frequency (V/Hz), as required by the characteristics of the AC motor to produce adequate torque. To enable VFD three components are employed (see figure 1).

2.1 AC Motor:

The AC electric motor used in a VFD system is usually a three-phase induction motor. Some types of single-phase motors or synchronous motors can be advantageous in some situations, but generally three-phase induction motors are preferred as the most economical. Elevated-voltage stresses imposed on induction motors that are supplied by VFDs require that such motors be designed for definite-purpose inverter-fed duty in accordance with such requirements as Part 31 of NEMA Standard MG-1.

2.2 VFD Controller:

The electronics for VFD operate on direct current (DC) as the majority of applications connected to the utility use alternating current (AC). The first step in this process is to convert the AC supply voltage into DC by the use of a rectifier. DC power contains voltage ripples which are smoothed using filter capacitors. When converted to DC this part of the VFD is referred to as the DC link.

The resultant DC voltage is then converted back to AC voltage using an inverter. The inverter output AC voltage is turned on and off at a high frequency, with the duration of on-time, or width of the pulse, controlled to approximate a sinusoidal waveform. Finely ramping up and ramping down the AC input frequency and voltage enables precise control of the AC motor's speed.

The entire process, (see block diagram figure 2), is controlled by a microprocessor which monitors:

- Incoming voltage supply
- Speed set-point
- DC link voltage
- Output voltage and current to ensure operation of the motor within established parameters

2.3 Operator/PLC Interface:

The inverter output voltage to the AC motor can be controlled by a manual interface to start and stop the motor and adjust operating speed. However, in most automated industrial and commercial applications using VFD technology, a Programmable Logic Controller (PLC) through Modbus or other similar interface.

3.0 VFD Remote Speed Control:

There are two main ways to control the speed of a VFD; networked or hard wired. Networked involves transmitting the intended speed over a communication protocol such as Modbus, Modbus/TCP, Ethernet/IP, or via a keypad using Display Serial Interface while hard wired involves a pure electrical means of communication.

4.0 Applications Using VFD:

As VFD enables very accurate control of an AC motor's speed as varying and/or ramping up input voltage is applied, operators and system designers have a tool to finely control electric motor starting and speed. Applications for VFD are numerous and include:

4.1 Continuous Process Industries:

Steel plate and paper production are manufacturing processed where the raw material enters the start of the process slow and exits much faster. Electric motors driving the stages of the manufacturing processes can have their speeds accurately synced together and controlled by VFD technology.

4.2 More Efficient Motor Starting:

By applying VFD starting to electric motors, an operator/user can significantly reduce the current draw on direct motor starting with the subsequent cost reductions in power consumed and greater efficiency of the starting process

4.3 Water Treatment Plants:

Water treatment plants incorporate many electric motor powered pumps for moving waste water from one segment and level to another. The whole plant requires fine control of the water pumped to ensure that all treatment processes are coordinated. Using a VFD connects all the various pumps and level switched and controls the rate of flow.