= Variable @-@ frequency drive =

A variable @-@ frequency drive (VFD) (also termed adjustable @-@ frequency drive , variable speed drive , AC drive , micro drive or inverter drive) is a type of adjustable @-@ speed drive used in electro @-@ mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage .

VFDs are used in applications ranging from small appliances to the largest of mine mill drives and compressors . However , around 25 % of the world 's electrical energy is consumed by electric motors in industrial applications , which are especially conducive for energy savings using VFDs in centrifugal load service , and VFDs ' global market penetration for all applications is still relatively small . That lack of penetration highlights significant energy efficiency improvement opportunities for retrofitted and new VFD installations .

Over the last four decades , power electronics technology has reduced VFD cost and size and has improved performance through advances in semiconductor switching devices , drive topologies , simulation and control techniques , and control hardware and software .

VFDs are available in a number of different low- and medium @-@ voltage AC @-@ AC and DC @-@ AC topologies .

= = System description and operation = =

A variable @-@ frequency drive is a device used in a drive system consisting of the following three main sub @-@ systems : AC motor , main drive controller assembly , and drive / operator interface .

= = = AC Motor = = =

The AC electric motor used in a VFD system is usually three @-@ phase induction motor . Some types of single @-@ phase motors can be used , but three @-@ phase motors are usually preferred . Various types of synchronous motors offer advantages in some situations , but three @-@ phase induction motors are suitable for most purposes and are generally the most economical motor choice . Motors that are designed for fixed @-@ speed operation are often used . 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 .

= = = Controller = = =

The VFD controller is a solid @-@ state power electronics conversion system consisting of three distinct sub @-@ systems : a rectifier bridge converter , a direct current (DC) link , and an inverter . Voltage @-@ source inverter (VSI) drives (see ' Generic topologies ' sub @-@ section below) are by far the most common type of drives . Most drives are AC @-@ AC drives in that they convert AC line input to AC inverter output . However , in some applications such as common DC bus or solar applications , drives are configured as DC @-@ AC drives . The most basic rectifier converter for the VSI drive is configured as a three @-@ phase , six @-@ pulse , full @-@ wave diode bridge . In a VSI drive , the DC link consists of a capacitor which smooths out the converter 's DC output ripple and provides a stiff input to the inverter . This filtered DC voltage is converted to quasi @-@ sinusoidal AC voltage output using the inverter 's active switching elements . VSI drives provide higher power factor and lower harmonic distortion than phase @-@ controlled current @-@ source inverter (CSI) and load @-@ commutated inverter (LCI) drives (see ' Generic topologies ' sub @-@ section below) . The drive controller can also be configured as a phase converter having single @-@ phase converter input and three @-@ phase inverter output .

Controller advances have exploited dramatic increases in the voltage and current ratings and switching frequency of solid @-@ state power devices over the past six decades . Introduced in

1983 , the insulated @-@ gate bipolar transistor (IGBT) has in the past two decades come to dominate VFDs as an inverter switching device .