4. What is a Variable Frequency Drive and how does it generate harmonics?

A Variable Frequency Drive (VFD) is a solid state device that converts utility power to a variable voltage and frequency in order to control the speed of a 3-phase induction motor. By controlling the motor's speed, both energy savings and better motor control can be achieved.

Figure 4.1 shows a typical VFD schematic diagram. The front-end rectifier and its DC bus smoothing capacitors make the VFD a non-linear load since it will draw current in a non-sinusoidal manner.

The characteristic harmonics generated by a diode bridge rectifier will follow the relationship below:

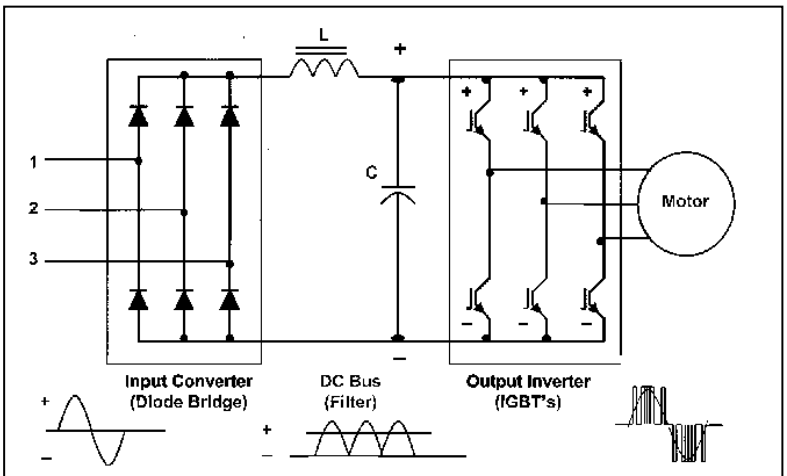

Figure 4-1: Typical Schematic of a PWM Variable Frequency Drive

h = np +/- 1, where: h = the harmonic number
n = any integer
p = the pulse number of the rectifier

Most VFD's use a 3-phase, 6-pulse (p = 6) rectifier which results in currents of harmonic number 5, 7, 11, 13, 17, 19, etc. being generated. When dual rectifiers are used and phase shifted by 30° a 12-pulse scheme is created. 12-pulse VFD's will only have residual amounts of 5^{th} and 7^{th} harmonics since substituting p = 12 in the above equation results in harmonics 11, 13, 23, 25, etc. Other multipulse schemes such as 18 and 24 can be used to reduce harmonics further.

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