Whitepaper

Voltage Vector Control Plus

The unique Voltage Vector Control, introduced with the VLT 3500, has been further developed into Voltage Vector Control Plus (VVC+). VVC+ provides a nearly sinusoidal output current waveform. This provides optimum motor magnetization. There is never a need to derate the motor for full speed, full load applications. For variable torque applications, there is never a need to derate the motor for any operational speed. The maximum output voltage of the VLT HVAC Drive drive at full speed and load can be equal to the input voltage. Its exact value is not dependent on the line or the DC bus voltage. Instead, it will precisely equal the user defined output voltage established during setup. Even if the input line is up to 10% below the desired output voltage, the desired output voltage will be maintained.

In addition to monitoring and controlling the frequency and the voltage, VVC+ continuously measures the magnitude and phase angle of the current in all three motor phases. The actual voltage requirement of the motor and the slip at the present load are calculated from a motor model. Automatic Motor Adaptation helps create an accurate motor model. The VVC+ control then adjusts the output frequency and voltage to exactly meet the motor's needs. This optimizes the motor operation over a broad range of speeds and loads.

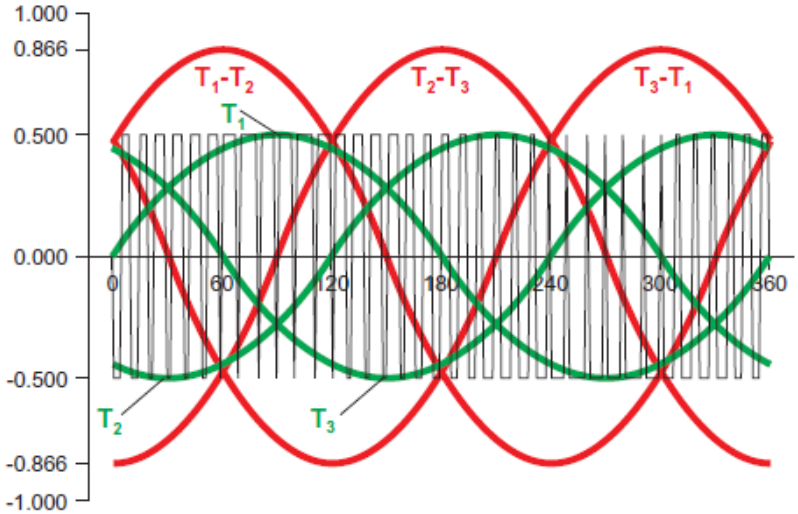
There is no need to choose a V/Hz curve to approximate the load demands on the motor. VVC+ does this automatically and continuously. VVC+ determines both the current required for torque generation and the current required for magnetizing the motor. This allows an accurate representation of the motor and its load.

The control scheme of the VLT HVAC Drive uses the VVC+ algorithm. VVC+ is superior to traditional PWM control schemes in the following ways:

- Full rated motor voltage is provided at rated frequency.
- Full rated motor load can be produced at full speed.
- The actual voltage and current requirements of the motor are continuously modeled.
- Working in conjunction with AMA, the ideal voltage level is always provided, maximizing performance and efficiency while minimizing heating.
- The output current wave shape is an almost perfect sine wave.
- Automatically chooses the ideal inverter switching pattern for the operating conditions.
    - The low speed switching pattern ensures reliable starts and smooth low speed operation.
    - The high speed switching pattern minimizes switching losses and maximizes drive efficiency.

Stator Flux Asynchronous Vector Modulation (SFAVM) for Low Speed Performance

Continuously pulsing all six inverter IGBTs to simulate the required output sine wave is ideal for low speed operation. It ensures smooth motor operation and allows the drive to meet the demanding requirements of starting high friction or high inertia loads. However, this switching pattern is not suited for high speed operation. Continuously pulsing all six inverter IGTBs causes extra inverter switching losses, increased heat generation, and reduced drive efficiency. In addition, if a pure sine wave template is followed for each line-to-neutral voltage, the maximum output voltage is limited to 87% of the input voltage. This makes it impossible to produce rated motor power without exceeding rated motor current. To obtain higher full speed voltages, some conventional PWM drives add third and ninth harmonics to their reference AC wave. Without full voltage on the motor, conventional PWM waveforms use the motor's service factor in order to produce rated output from the motor. This reduces motor life.



60 Degree Asynchronous Vector Modulation (60° AVM) for High Speed Efficiency and Full Motor Output

As a result of the high speed limitations of SFAVM, the VLT HVAC Drive automatically changes its switching pattern above a predefined output frequency. Above this speed, the 32-bit microprocessor control holds each IGBT on for 60° of the full cycle and off for another 60° of the full cycle. By doing no switching in each inverter IGBT during 120° of each output cycle, the VLT HVAC Drive minimizes switching losses. In addition, this unique switching pattern allows the drive to provide the motor with full rated voltage. This allows the motor to produce full rated torque at full speed without creating excessive motor heating.