

Soft Switching Technology (dv/dt reduction)

Introduction

Technology to control the speed of AC motor continues to develop at a fast pace. Adjustable frequency drives (AFDs) are a significant part of this development. Energy savings, less wear on the mechanical components, and better process control are the primary factors, which push the rapid advancement of this technology.

Today's AFD technology with a pulse width modulation (PWM) microprocessor based algorithm, uses insulated gate bipolar transistor (IGBT) to generate the variable voltage and frequency required to control the speed of AC motor. Since IGBT devices can switch at high carrier frequencies (up to 15Khz), there are several advantages:

- More lowly speed torque for applications where nominal motor torque is required close to zero speed.
- Quieter motor operation, which reduces audible noise
- Improved low speed stability, which minimizes low speed oscillations.

Unfortunately, fast switching IGBT technology also generates a very fast voltage rise (dv/dt) in the output waveform that induces additional stress on the motor insulation.

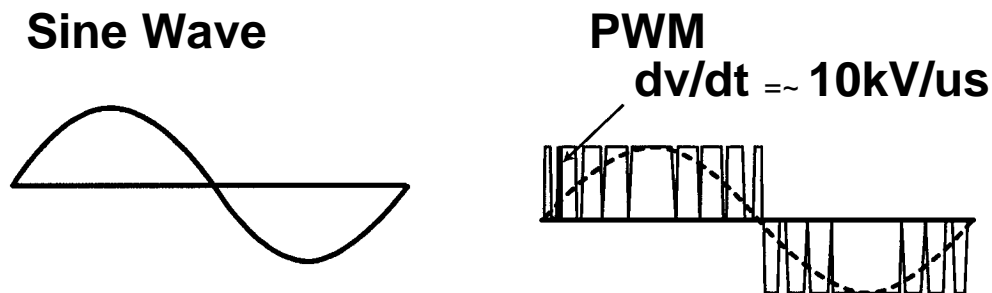
Pulse Width Modulation

Sine Wave Generated by Utility

AC is represented by a sine wave where the period of the wave is the inverse of its frequency and the height is equal to its magnitude. When AC motors are connected directly to the utility line (across the line), they operate at a fixed speed. The input voltage could be 230 or 460 volts at 60 hertz in the USA and 380 volts at 50 hertz in other parts of the world. With sinewave at this low of a frequency, the motor and the cable see a peak voltage that is the RMS voltage times 1.414, or about 650V for a nominal 460V line. Allowing for high line transients, a 1000v insulation dielectric rating on the motor is usually adequate.

Pulse Width Modulation

Pulse width modulation, usually referred to a "PWM," is a type of AFD technology that achieves frequency and voltage control with a drive section called the inverter. By using PWM technology, a constant dc bus voltage is chopped into voltage pulses of fixed amplitude and variable width to approximate a sine wave output to the AC motor (as represented by the sine wave on the PWM graph).



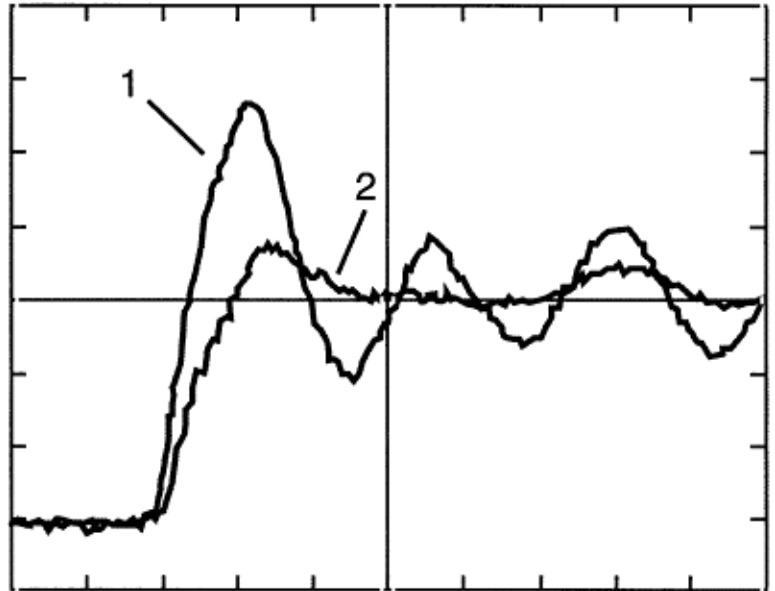
Voltage Rate of Rise (dv/dt) Issue

The rapid rise of voltage associated with PWM chopping combined with impedance differences between the cables and the motor, acts like a transmission line causing voltage reflection. As the pulse reflect, they reinforce each other causing peak voltage on the cable and at the motor terminals which can be several times the nominal drive output voltage.

The graph compares peak voltages between a HMS-FLUX drive with soft-switching technology and a traditional drive that does not have this technology.

1 = Traditional Drive
(no soft-switching)

2 = HMS-FLUX
(soft-switching)



Benefits of Soft Switching Technology

Feature	Benefit
Reduced motor insulation stress	Increased motor life
Use of 1000V insulation motors (old) where application conditions permit.	Reduced AC motor cost
Increase drive/motor cable run distance before consideration of output filters.	Reduced installation time
	Reduced panel/wall space
	Reduced installation cost

In addition to the above benefits, the HMS-FLUX series AC drives provide the following:

- 1300 foot motor cable lengths with a HMS-FLUX motor drive package.
- Dynamic torque vector control smooth, precise, and efficient motor operation.
- Keypad that functions as a copy unit.
- Built-in RS-485/Modbus RTU for easy connection to process controllers.