Protecting your Motor from Harmful Distortions

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Advancing Power Quality

Understanding the Basics



A sinusoidal waveform is a continuous wave free of any distortions.

Most US Utilities deliver power at a frequency of 60hz which is known as the fundamental frequency. Motors are designed to run off of this clean sine wave.



Variable Frequency Drives (VFDs)

A Variable Frequency Drive (VFD) is a drive that can accurately control the speed of an AC motor speed and torque by varying motor input frequency and voltage. VFDs are also known as: variable speed drive, adjustable speed drive, and adjustable frequency drive.

A VFD can be found on many different applications including small appliances, oil pumps, elevators, HVAC units, conveyor systems, manufacturing equipment, fans, and compressors.





Applying a VFD





Benefits to Using a VFD

Frequency (hertz) is directly related to the motor's speed (RPMs). In other words, the faster the frequency, the faster the RPMs.

If an application does not require an electric motor to run at full speed, the VFD can be used to ramp down the frequency and voltage to meet the requirements of the electric motor load. As the application's motor speed requirements change, the VFD can vary the motor frequency to meet the necessary speed requirement. (vfd.com blog by: Craig Hartman)





Benefits to Using a VFD

- 1. Controlled Starting Current
- 2. Reduced Power Line Disturbances
- 3. Lower Power Demand on Start
- 4. Controlled Acceleration
- 5. Adjustable Operating Speed
- 6. Adjustable Torque Limit
- 7. Energy Savings
- 8. Reverse Operations
- 9. Controlled Stopping
- 10. Elimination of Mechanical Drive Componentsex: Gearboxes

Information provided by ABB Automation Technologies





Drawbacks to VFDs



easa.com- Winding shorted turn-to-turn



- 1. Overheating of equipment
- 2. Crosstalk
- 3. Increased Cooling Costs
- 4. Harmonic Distortions
- 5. Large Voltage Spikes-causing insulation deterioration

High peak voltages of short duration (dv/dt) create stresses that can cause motor insulation to deteriorate and fail. The rise time is of concern because short rise time and high magnitudes of voltage cause voltage peaks to be unevenly distributed across the motor windings.



Variable Frequency Drives (VFDs)





What Happens to the Sine Wave?

- Pulse Width Modulation (PWM) the output voltage wave form represented by a series of square wave pulses that produces a reasonable approximation of sine wave currents.
- Switching/Carrier Frequency One (1) cycle of the output waveform at a given output voltage can be made from many narrow pulses or fewer wider pulses. To generate a waveform containing more pulses, the switching devices in the inverter must switch more often. The rate at which the switches operate is called the switching frequency or carrier frequency.







What Happens to the Sine Wave?

- The output voltage and current waveforms produced by PWM drives place stresses on motor insulation systems.
 PWM waveforms contribute to increased thermal, vibration and dielectric stresses.
- If the insulation continually exceeds rated temperature from excessive heat, its lifetime will be shortened in proportion to the level and duration of the excess temperature.



easa.com-Winding grounded in the slot





Protecting Your Motor





Motor Protection

Motor Protection

1. Output Load Reactors

- 2. dv/dt Filters
- 3. Sine Wave Filters





Output Load Reactors

Reactors act as interface buffers between solid state power circuits and the line or the motor. (Similar to a surge protector for your desk-top PC). Reactors are recommended when the motor lead lengths are less than 100 feet.

Benefits

- Dampen Overshoot Peak Voltage
- Reduce Motor Heating
- Reduce Audible Noise







dv/dt Filters

dv/dt filters are mounted at the VFD output terminals for applications with long leads to the motor.

Benefits

- · Protects cables and connections
- Recommended on VFDs with lead lengths greater than 100 feet
- Reduces voltage spikes <1,000 volts to motors
- Protects motors from shorted windings, & insulation breakdown
- Protects old motors on IGBT drive retrofits.
- Motors run cooler
- Can apply VFDs to non-inverter rated motors
- Reduces common mode noise by 30 to 40%
- Uses Impedance, Capacitance and Resistance to slow down the steep edges of the PWM voltage waveform



Prevents voltage spikes from exceeding 1,000 V





Sine Wave Filter

Sine wave filters are low pass filters, used in combination with variable frequency drives, that convert the PWM wave form to a near sinusoidal wave form to protect motors from excessive voltage spikes and overheating.

Benefits

- Eliminates PWM Voltage Spikes
- Reduces Motor Heating
- Reduces Audible Noise
- Prevents Motor Insulation Failure
- Reduces Common Mode
- Prevents Motor Bearing Damage
- Reduces Voltage Distortion
- Extends Life of Motor & Cable









Sine wave Results

VFD Output Wave





Conclusion

VFDs provide many advantages for AC motors, but motors left unprotected are at risk from harmful voltage distortions and spikes produced from a VFD output.

Unprotected motors lead to shorter lifespans of your motor and cabling resulting in costly repairs or replacements.

Depending on the lead length and the amount of distortions, there are different products to fit your needs.





Thank you!



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