



Environmental Potentials

Power Quality For The Digital Age

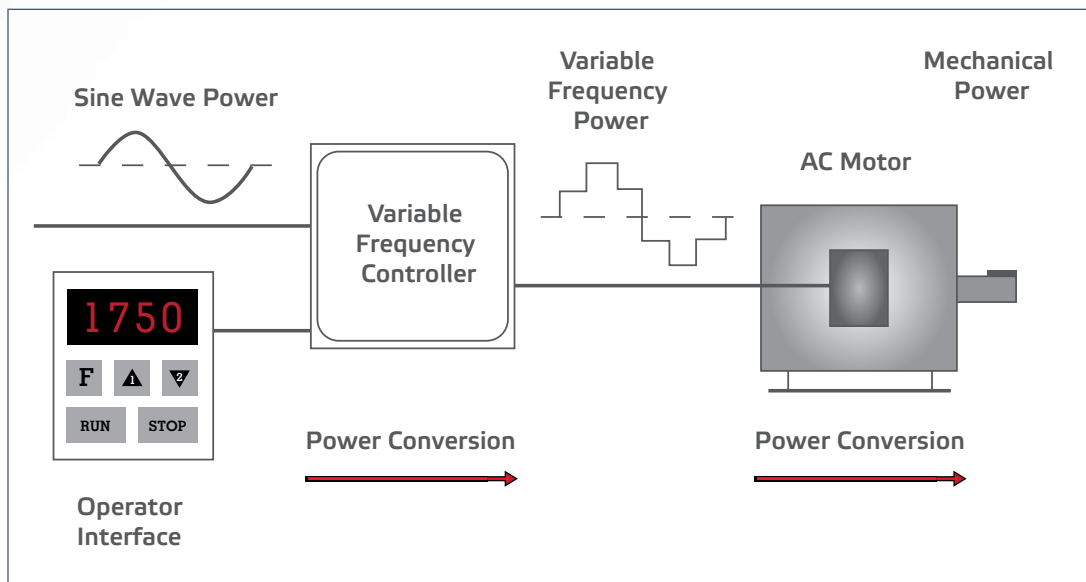
THE EP VFD NOISE SOLUTION

Report by EP Research & Development

Optimizing Production

Variable frequency drives (VFD), have revolutionized the production process of nearly every industry. It is one of the most significant advancements to the modern facility. VFD's control motor outputs, change speeds as needed, control torque, reduce energy consumption and even report operating information. These benefits have led to the widespread use of VFD's.

A VFD is a system for controlling the rotational speed of an alternating current (AC) electric motor by manipulating the frequency of the electrical power supplied to the motor. The equation for motor speed is $120 \cdot f / P$ where 'f' is the frequency of operation and 'P' is the number of poles on motor. To vary the speed of the motor either number of poles should be decreased or the frequency of operation should be increased. Changing the frequency is the most efficient option. While the benefits of VFD's are undeniable, these benefits also come with a significant price. Varying frequency generates noise and severely degrades power quality.



← Figure 1: Schematic diagram of VFD with Motor in a facility

Isolating the Problem

It is a common misconception that electrical noise generated by a VFD flows only towards AC motor, this is not true. Variable frequency power is a pulse width modulated signal, or a sine wave with squared notches. A waveform with notches is also called as non-sinusoidal electric signal. While motors used in industrial applications are tough enough to handle the non-sinusoidal signal, these waves will also cause electrical noise in the supply

side of the VFD. Return path of currents, bearing currents, and ground loops at the AC motor are responsible for causing electrical noise to flow towards supply side of the VFD. To demonstrate this theory, Environmental Potentials' research and development department setup a motor with a VFD and recorded the following readings. Measurements are taken at the supply side of the VFD.

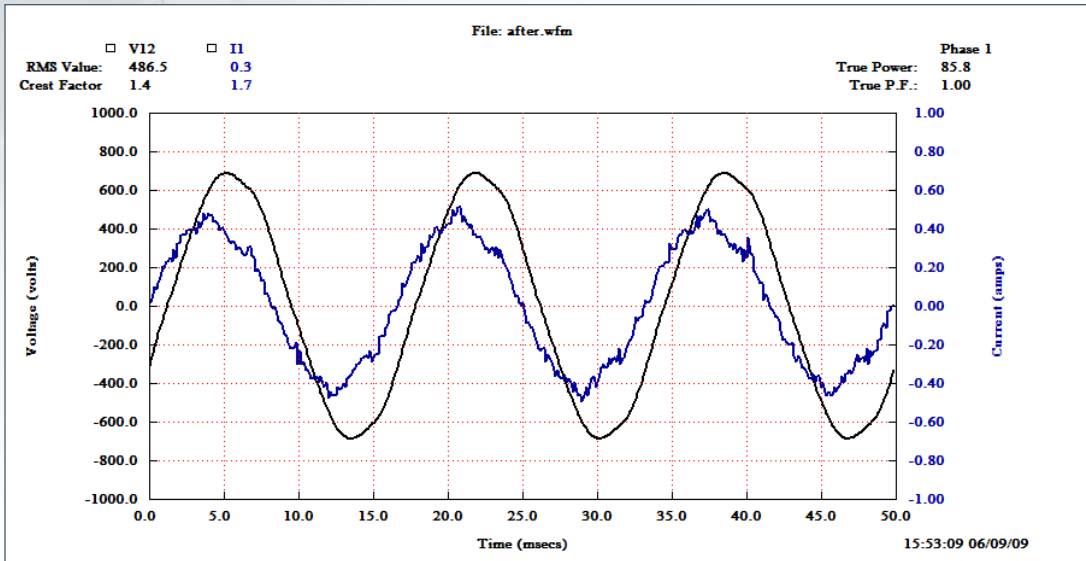


Figure 2: Voltage and current waveforms on the supply side of phase 1 when the VFD is not connected

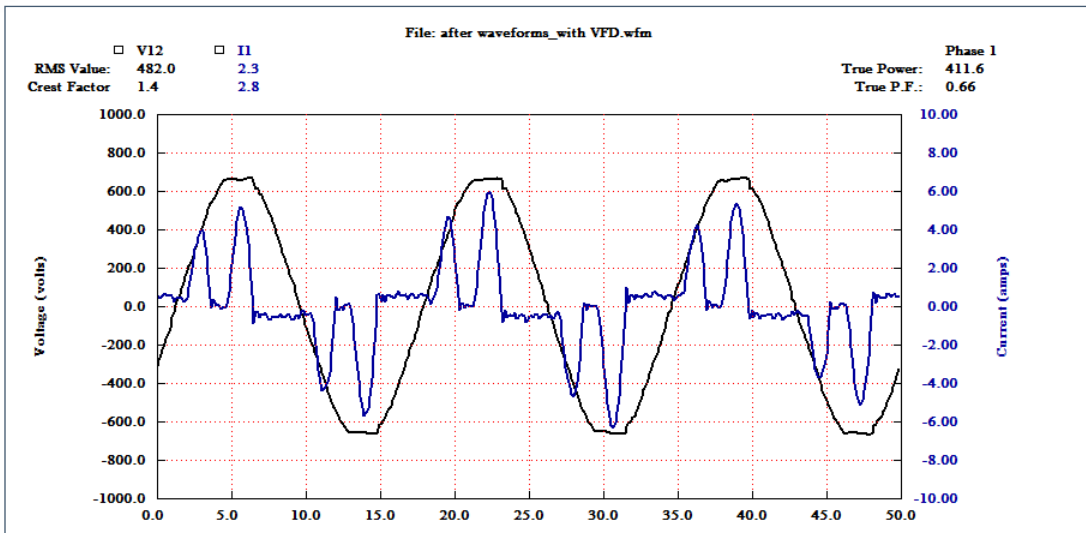


Figure 3: Voltage and current waveforms on the supply side of phase 1 when the VFD is connected

Figures 2 and 3 clearly demonstrate the nonlinearity of the current wave is increased when the VFD is turned on. Figure 2 clearly shows notches on both peaks of the waveform. Both measurements were recorded on the supply side of the VFD. This means nonlinear current signal travels to the other loads connected in the facility significantly deteriorating the power quality. This affects the VFD as well as the other equipment in the building.

VFD's are designed with sensitive electronic components. These components are extremely sensitive to the nonsinusoidal nature of the electrical signal and the infinite frequency rise times that result in the way the sinusoidal waveform is manipulated. This non-sinusoidal signal causes board level components to become non-sequential, switching noise generators resulting in erratic behavior and/or failure of the VFD.

Nonlinear nature of the electrical signal will cause losses in the magnetic cores of conductors, motor windings, and transformers such as eddy currents and hysteresis losses. These losses will cause failure, increase inefficiency and shorten the duty lifecycle of the transformers and motors.ⁱ

Gap in Technology

Traditional power quality equipment is not the solution for noise. This equipment allows high frequency currents and common mode currents to circulate within earth ground. These circulating currents degrade the insulation of motors windings, bearings and also interfere with other systems (sensors, PLC's/PAC's, industrial computers, etc).ⁱ VFD's are inter-harmonics source generators causing amplification of electrical noise in the rest of the facility. This causes voltage fluctuations, flicker, and line losses in the facility. Studies have shown that the inter-harmonics caused by VFD's can even cause voltage flicker in neighboring facilities.ⁱⁱ

In order to protect VFD's from the damaging effects caused by nonlinear nature of the electrical signal, facility engineers will add additional impedance. Sources of additional impedances include AC line reactors and isolation transformers. However, due to the common practice of powering a Delta VFD from a Wye end of the distribution transformer without running a neutral to the VFD, the additional impedance sources will create ground loops and amplify resonance the electrical noise.

EP's Solution for Noise

With all of the benefits offered by VFD's, their use will continue to rise. Facility managers must remain diligent with efforts to combat harmful noise generated by the normal operation of VFD's. The solution to destructive noise is to install a sine wave tracking filter on the supply side of the VFD.ⁱⁱⁱ EP's patented waveform correction technology is a powerful low pass filter, which not only removes the electrical noise and ground loops from the system, but also maintains the sinusoidal nature of the electrical signal throughout the facility.

Figure 4: Frequency noise from 3-100kHz on the neutral wire at the supply side of VFD before EP installation

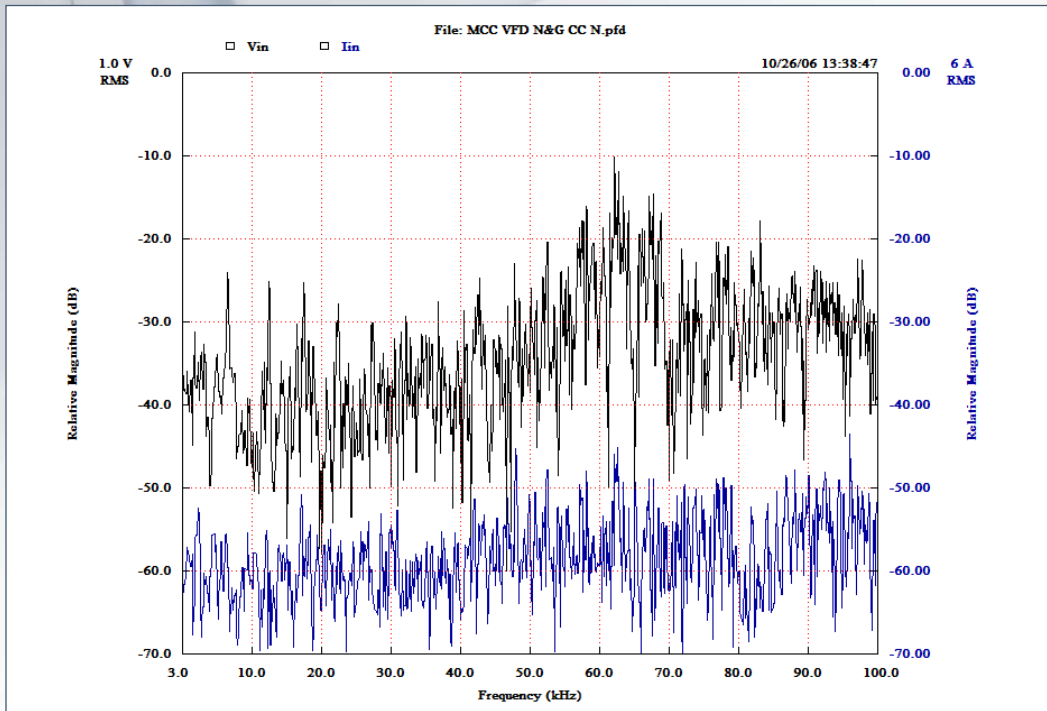
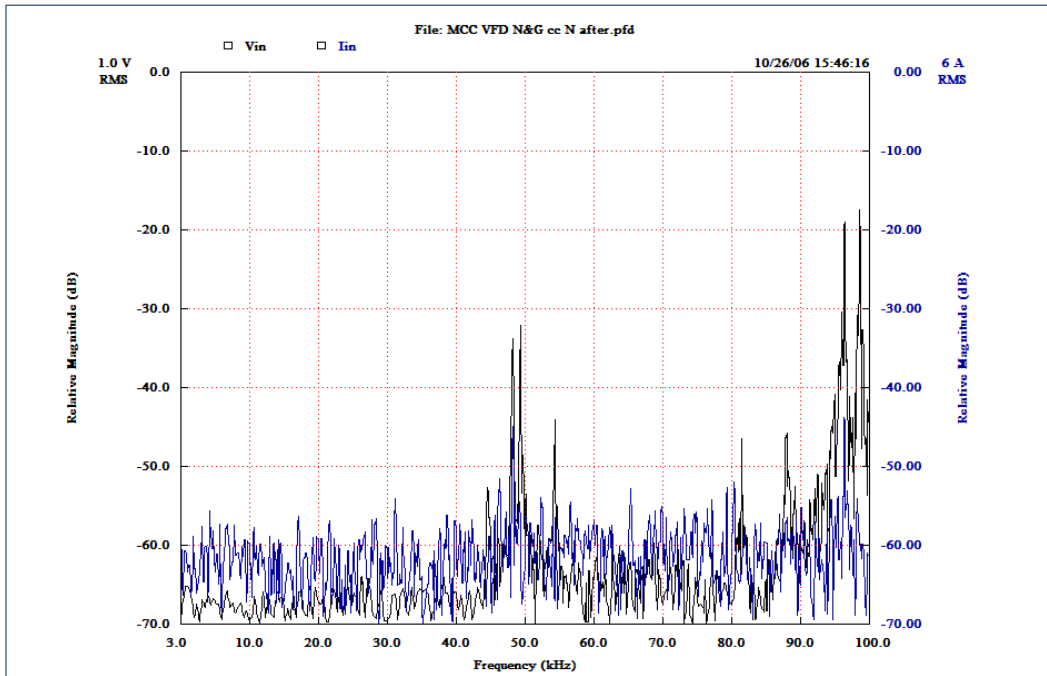


Figure 5: Frequency noise from 3-100kHz on the neutral wire at the supply side of VFD immediately after EP installation



Figures 4 and 5 demonstrate the immediate noise reduction after installing EP's waveform correction technology. The advantage of EP's patented technology is that it converts noise into heat inside of the unit.

Environmental Potentials is the solution to noisy drives.

