Environmental Potentials

Power Quality For The Digital Age

# ISOLATION AND NOISE FILTRATION IN THE MODERN FACILITY

AN ENVIRONMENTAL POTENTIALS WHITE PAPER

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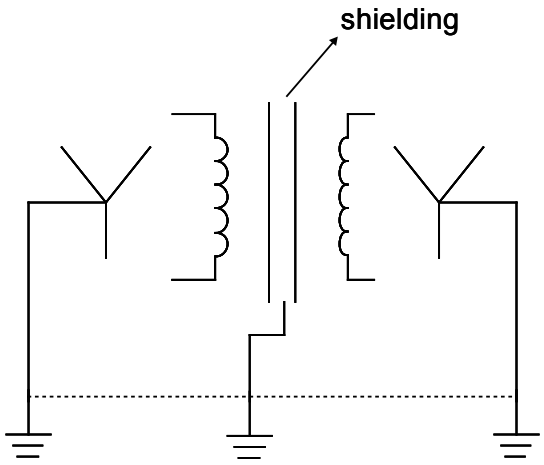
## Introduction

An average-sized facility can have upwards of ten electrical panels. Each panel is connected to the main panel. A typical industrial electrical panel can power several motors, VFD's (variable frequency drives), conveyor systems and computers, while a typical office panel can power several computers, phones, printers and copy machines. All electrical equipment is powered by wire fed from a panel. Likewise, the panels are fed wire from the main panel. Most importantly all panels are connected to the facility ground. This means the entire electrical distribution system is interconnected.

This interconnectivity poses serious risks to power quality. All electronic, computerized and digital equipment are constantly generating noise and power pollution. This pollution circulates within the facility through the phase, neutral and ground wires. Facilities employ many methods to protect sensitive equipment from this circulating noise and pollution. One of the most common strategies is to isolate equipment with an isolation transformer.

## Isolation Transformers 101

An isolation transformer is a power quality device used to isolate a load from the main supply. It is made up of two separate windings separated by a metallic shield. This metallic shield is an electro static shield, called a Faraday shield, and is connected to earth ground. Figure 1 shows the structure of an isolation transformer.




Capacitance (C) of the shielding = Inductance (L) of connecting ground wire

**Fig.1 Structural view of an isolation transformer**

Typically, isolation transformers are 1:1 transformers, meaning it does not step up or step down voltage or current. Figure 1 shows that an isolation transformer

Figure 2 shows the typical application of an isolation transformer connected between the supply and the load. The objective is to isolate the load that generates harmful noise or equipment that is sensitive to harmful noise from the rest of the electrical system. Noise generated on the supply side is diverted towards the ground.

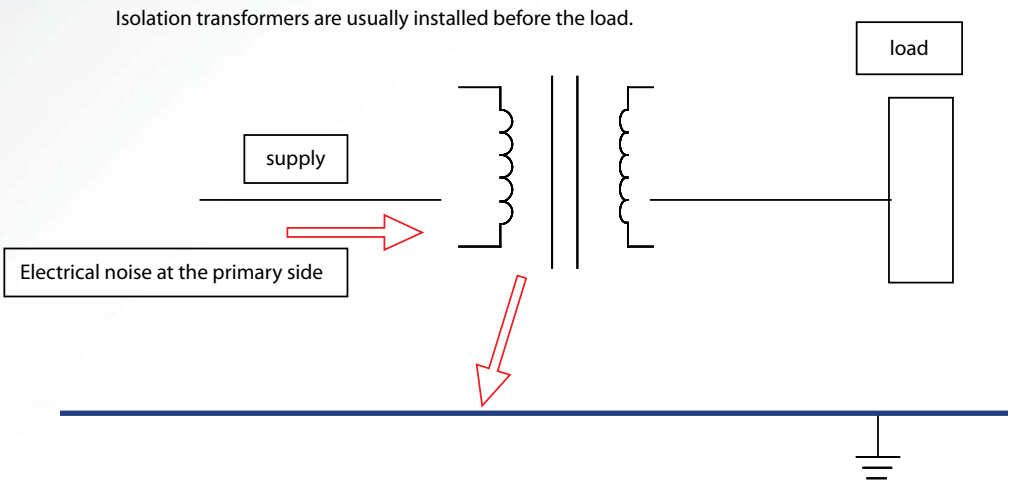



**Figure 2: Isolation transformer connected between supply and the load**

The transformer principle is to inductively couple the supply from the primary winding to the secondary windings. However, due to the leakage in the primary windings noise transfers to the secondary winding. This noise can only be removed when the shielding is connected to the ground. The noise is diverted to the ground and the secondary winding will only get inductive reactance. Theoretically, diverting noise to ground protects the load from harmful and destructive noise.

## Ground Noise and Ground Loops

Facilities connect all grounds together. According to IEC 950 and UL 1950 (standards for computerized electronics under 600v range), an isolation transformer is used to isolate only the phase and neutral, but not the ground. Isolation transformers rely on a Faraday shield, which is grounded to the facility ground. However, both sides of the isolation transformer are connected to the same ground. This indicates that while the load is isolated from the electrical noise generated on the phases and neutral, it is not isolated from noise on the ground.

This means an isolation transformer will NOT remove ground loops from the facility but instead will create ground loops. Ground loops can be defined as the loops generated in the facility between multiple ground rods that represent differing potentials and therefore, multiple circulating paths of impedance. Current circulating on the ground will lead to imbalance in the system and thus the electrical noise on the phases.

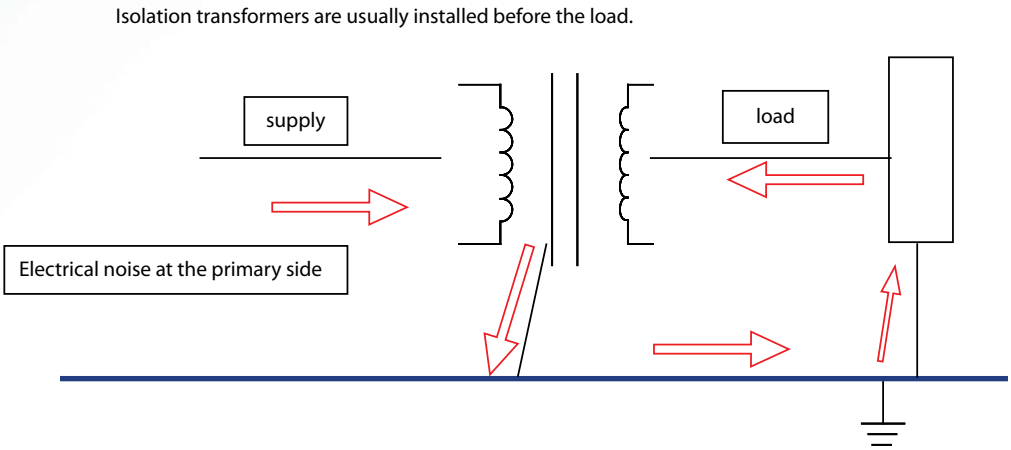



**Figure 3: Electrical noise diverting to all parts of the electrical system through the ground.**

Figure 3 demonstrates the behavior of electrical noise in the system when an isolation transformer is used. Since the electrical system relies on the same ground at both the primary and the secondary, ground noise will circulate at both the supply side and the load side. This means, isolation transformers increase ground noise.

The frequency at which the inductive reactance equals the capacitive reactance is called the resonating frequency and at this frequency the electrical noise will be amplified. This means that whenever the inductance of the grounding rod equals the capacitance at the Faraday shield, electrical noise will be amplified. This is extremely harmful for the electrical system since the amplified electrical noise is sufficient to damage the load.

Examine the following measurements taken at Wheeling Corrugating in Fallon, NV. Wheeling Corrugating used an isolation transformer to isolate three VFD's from the rest of the facility. The facility was experiencing constant downtime and constant maintenance. However, the isolation transformer only exacerbated the problem.

The voltage noise is at extremely high levels of -2dB at regular intervals.

The current noise is also at extreme levels of greater than -20 dB

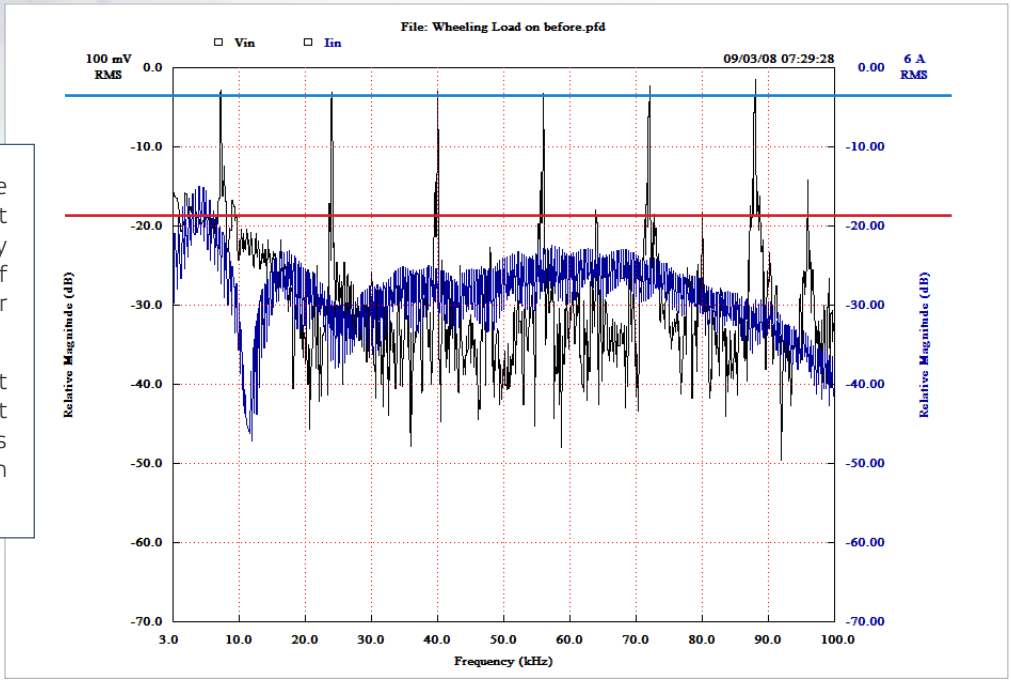



**Figure 4: Noise measured at VFD with the isolation transformer installed**

Figure 4 measurements are taken from 3kHz to 100kHz on phase A of a VFD. The isolation transformer is magnifying the noise to extreme levels. Noise at these levels will increase malfunctions, waste energy and cause premature failure of electrical components.

*Isolation transformer will not reduce ground loops but increase the ground currents and electrical noise on the ground.*

## The EP Solution

Isolating noisy equipment from the rest of the facility will significantly improve power quality. The problem is connected grounds combined with the increased use of improper electrical configurations make this isolation increasingly unattainable. Isolation transformers are not able to isolate equipment from noise in the modern facility.

Figure 5 measurements are taken from 3kHz to 100kHz on phase A of a VFD after installing the EP system and removing the isolation transformer.

Approximately 18dB reduction in current noise

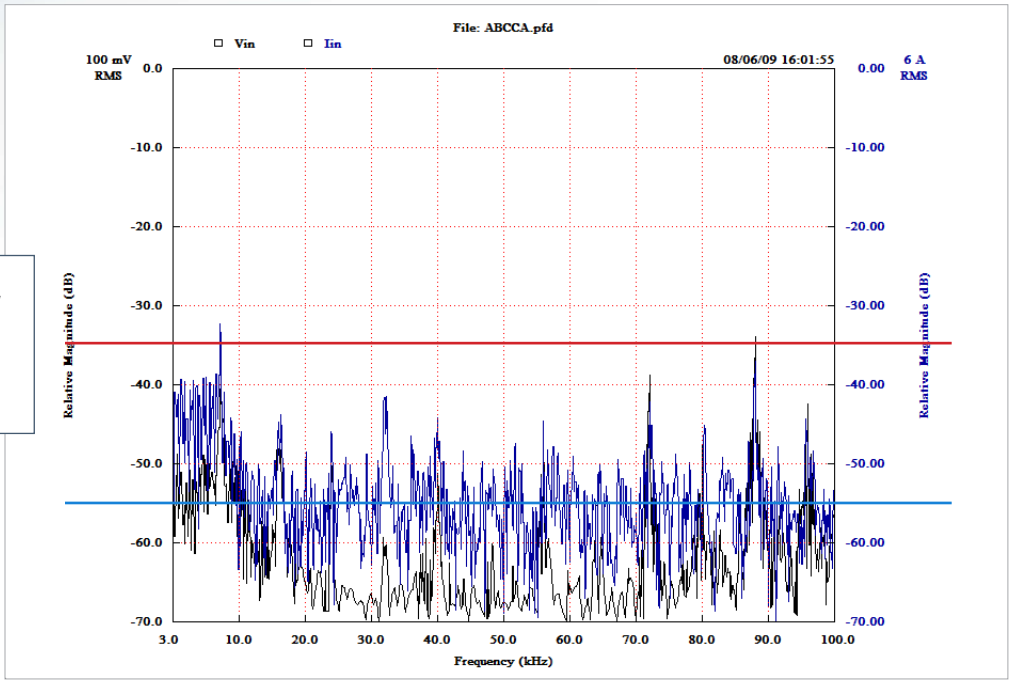



**Figure 5: High frequency noise measured at VFD after EP installed**

Approximately 48dB reduction in voltage noise

The voltage noise was attenuated by 48dB while the current noise was attenuated by 18dB. EP not only reduced the electrical noise in this facility, but also protected the sophisticated electrical drives by eliminating ground loops.

Environmental Potentials' patented waveform correction technology filters and removes noise between 1.5kHz-1MHz. Installing the EP system at the main panel, sub-panels and load centers isolates noisy equipment from the rest of the facility. Environmental Potentials does not shunt energy to ground and this helps eliminate ground loops. Installing EP ground filters will remove any remaining noise on the ground. This provides protection and isolation for equipment generating harmful noise and equipment sensitive to harmful noise.

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