

DEVELOPMENT OF A CLEAN GROUND

Electrical Ground Faults

In the United States, the electrical distribution grid system is designed such that fault currents are routed through earth or a bonded ground. The fault can rise as high as 25 times the quiescent current and remain that high until

the protection interrupt device clears the fault. The rise time of a fault is made up of high frequency components that interact with the distributed inductance of the line. They create instantaneous voltage surges that typically reach

magnitudes in excess of 5000 volts on low voltage power systems (Figure 1). These can be minimized by practicing good grounding techniques. Short, direct and dedicated grounds are the best approach to minimizing fault generated transients.

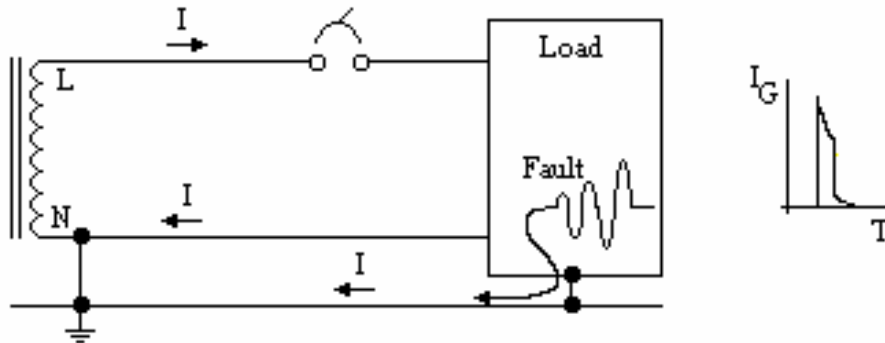


Figure 1

Ground Current

Other anomalies exist within our ground system; such as unwanted ground current, especially currents that include high harmonic content and successive commutation events. These

unwanted ground currents exist because of two major reasons:
(1) Improperly wired buildings. Many cases show us that the neutral and ground are bonded in

secondary distribution panels when they shouldn't be (Figure 2). This produces a secondary path for return current.

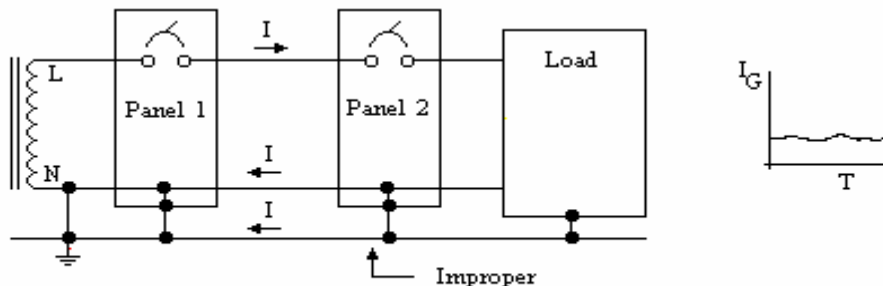


Figure 2

2) Failed filter components (Figure 3). Typically, shorted capacitors placed neutral to ground within electronic equipment produce

situations that cause a portion of the neutral current to follow the ground path. In both cases a portion of the intended neutral

current flows through the ground system; producing what is referred to as a "noisy ground".

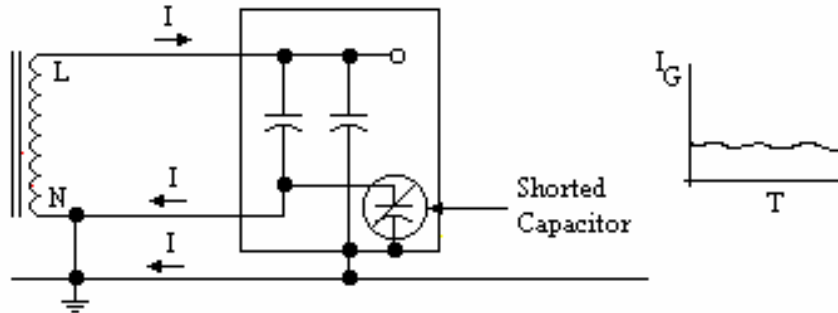


Figure 3

Coexistence

All of this noise on the ground is not too important when it comes to the hair dryer or electric motor. But, electronic devices reference their signal processing to ground, making it susceptible to the noise

on the utility ground (one in the same ground). Electronic equipment typically operates on voltages from 5 to 15 volts for the control circuitry. With a noisy ground it is easy to disturb signals

within digital control circuits. The National Electric Code (NEC) offers no reprieve, we are forced to address this problem with some form of power treatment.

Solutions

Transients generated on ground (Common Mode Noise) follow the fundamental laws of electricity; there must be a path to complete the circuit. The path is from the source of the transient to the load and returned via ground to source. In our case, the source is part of the ground. If we were to open this path, the transients cannot flow to the load .

This path is broken with the use of specialty transformers that exhibit extremely high isolation. It is the value of inner winding capacitance that differentiates transformers designed for this purpose. Typical panel transformers exhibit 2 to 20 pico farads of capacitance between the primary and secondary winding of an isolation transformer.

Transformers designed to remove transients exhibit .001 to .001 pico farads; 1,000 to 10,000 times smaller. Some manufactures

express this as an attenuation characteristic as common noise rejection in decibels (dB).

10pf	60dB	
2pf	74dB	
.01pf	120dB	1000 x better, not 2 times
.001pf	140dB	

As the value of the inner winding capacitance decreases, the ability of the transformer to attenuate noise and transients increases.

Voltage excursions in the output of the transformer also effect electronic equipment. These excursions are caused by changing loads (hard start currents). The effects can be minimized by using low output impedance (Z) transformers; transformers that recover quickly and limit the voltage dips to 4% for 100% load change. 50 to 100 micro seconds recovery is recommended for this application.

Typical transformer output impedance varies from 2% to 8%; the lower the better for transformers that are feeding electronic equipment.

Another concern in transformer application is the ability to handle the higher frequency components that are produced by the electronic non-linear loads. These higher frequencies do not fully penetrate the conductors nor do they cancel correctly in three phase circuits. The result is current in the neutral close to two times the anticipated magnitude. By double sizing the neutral wire and using K-factor rated transformers, the heating effect will be minimized and the dangers of a fire hazard will be removed. Typically, transformers are rated K-1 unless otherwise stated. K-4 through K-13 is a respectable rating for commercial buildings.

Summary

The *Ultra-K* manufactured by Controlled Power Company is a K-rated shielded low impedance isolation transformer that provides galvanic isolation, electrical noise attenuation and transient attenuation. The *Ultra-K* derives it's own ground to neutral bond so that the load won't see any unwanted noise or ground current.



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