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Paper On Mitigation Of Electro Magnetic, Radio Interference Frequencies On AC Drives

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Abstract:

This paper possesses the brief altercations to be made to the ac drives which we use in many industries,the main part is to place a filter to eliminate the radio interference and radio interference frequencies in the ac drives which are due to high and low frequency signals of electronic chords in the control panel of drives,this paper shows the few ways of placing those filters for efficient elimination of noise,harmonics and thus improve the drive efficiency and life.

A variable frequency drive will generate radio frequency interference(RFI) in the range of 0.5 MHZ to 1.7 MHZ,and electro magnetic interference(EMI) frequencies in the range of 1.7MHZ to 30 MHZ.the high frequency generation is caused by high carrier frequencies of the pulse width modulation,the associated short rise times of the igbt output devices,and the refelected waves from the motor terminals.EMI is also produced by the harmonics which are generated by the carrier frequencies,rise times and reflected waves.these are caused by capacitive effects of long motor leads and the resulting impedance mis match between the motor cables and the motor windings.EMI/RFI is also referred to as electrical noise.

The EMI/RFI will travel to the motor along the motor leads and will be transmitted to ground via the capacitive effect between the motor windings and motor fame,the capacitive effect between the line conductors and bond wire,and the capacitive effect between line conductors and conduit.the EMI/RFI will then seek a return path to the source,that iss,to the input of vfd.

The return path to the input power terminals of vfd will be of the form the ground grid neutral of the wye secondary of the upstream power distribution transformer and through that transformer's load lines as shown in figure.

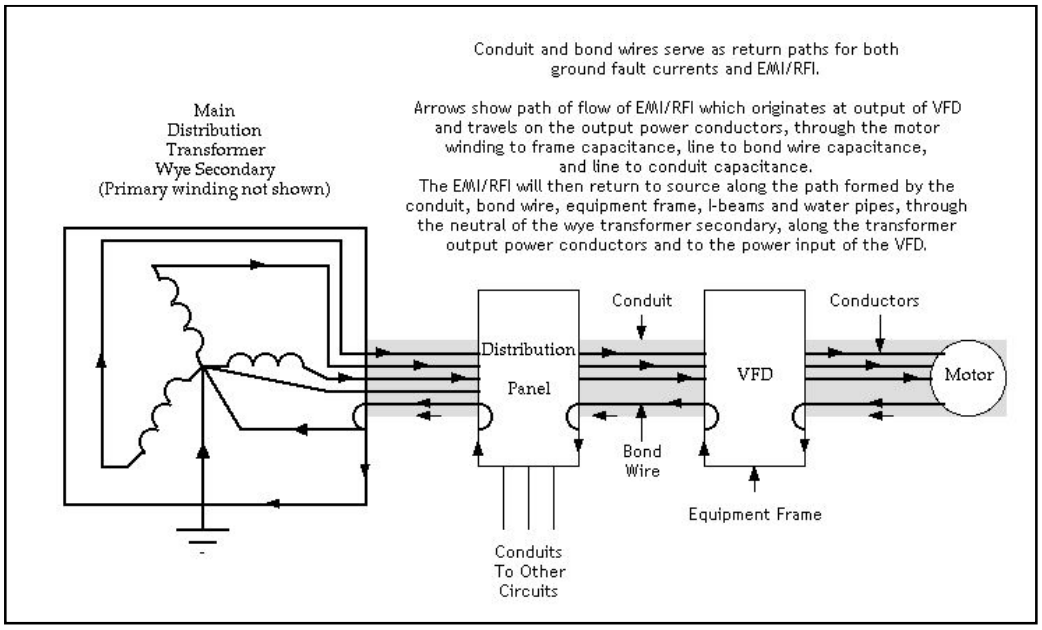

Figure 1

The return path to source of EMI/RFI along a conduit or other portions of the facility ground will cause a voltage gradient on both the conduit and grid that may effect the proper operation of other equipment.

The grounding grid normally consists of motor and electrical enclosure frames,cable conduit,conduit straps,grounding rods.thus EMI/RFI and the associated voltage gradients may be spread around the facility,allowing problems to be created along the path of return.

Solutions To Power Cable Problems

In older installations which utilize a conduit for a ground return, and in all new installations, introduce a bond wire that will pass through the conduit. A bond wire will appear as low impedance to low frequency EMI/RFI, causing the low frequencies to pass on the bond wire and not on the conduit. Thus those frequencies will be kept off the facility ground grid and will create a lower voltage gradient than would otherwise be created if they traveled along the conduit.

However, due to "skin effect" of high frequencies passing on a wire, the bond wire will appear as a high impedance path to those frequencies. The higher frequencies will therefore continue to pass along the conduit rather than the bond wire.

Cable with both a metallic shield and an outer insulating jacket is preferred over conduit. The aluminum or copper braid of a shielded cable or the clad of a metal clad cable will present a lower path of impedance for the higher frequencies than does conduit, allowing a minimal voltage gradient to develop along the braid or clad on the return path. The outer insulating jacket will eliminate the problem created by conduit and conduit straps which pass the EMI/RFI to the structural I-beams and water pipes with which they come in contact.

A continuous corrugated aluminum sheath is preferred over inter locked aluminum or interlocked steel.the effectiveness of interlocked shielding will be lost over time due to oxidation increasing the turn to turn contact resistance

A cable with a "bond wire" consisting of three symmetrically placed grounding conductors is preferred over a cable with a single grounding conductor.

A ferrite core (also referred to as a choke) may be used to attenuate common mode noise (noise that is passed from line to neutral and line to ground) on AC and DC circuits by passing all output power lines through the core. The properties of the core are such that it provides an inductance to the fields created by the noise.

If the bond wire is passed through a ferrite core along with the output power conductors, then the bond wire will present a higher impedance to the EMI/RFI, thus encouraging the lower frequencies to remain on the conduit.

Differential noise (noise that is passed from line to line) may be attenuated by passing a single wire through a ferrite core. However, for an application with DC or with with a low fundamental frequency AC power, the permeability of the core will be reduced by the saturation effects of the DC component of the line current. In those applications, the effective attenuation will be reduced and the impedance offered to the EMI/RFI by the core must be de-rated. A typical cylindrical ferrite core may have an internal diameter of 1.0 inch, an outside diameter of 2.0 inches and a length of 2.0 inches. The following figure shows the line diagram.

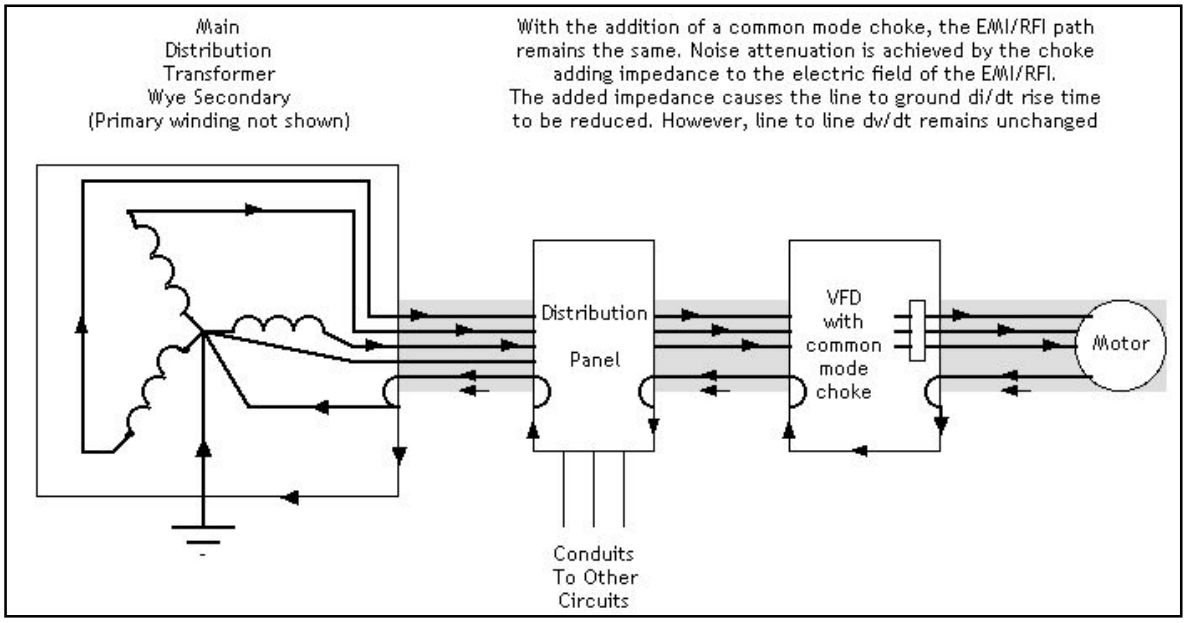

Figure 2

An EMI/RFI filter at the drive input terminals will provide a return path for noise that will effectively reduce the distance of noise travel along the ground grid and keep the noise away from the upstream transformer and incoming power lines. Like shown in the figure

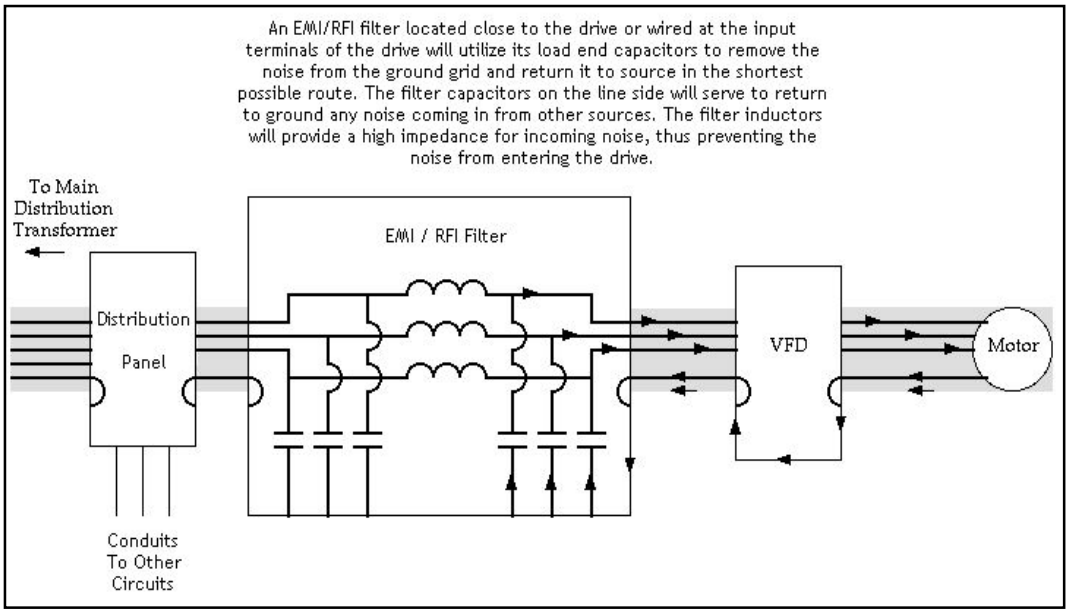

Figure 3

A drive isolation transformer with a solidly grounded neutral will also provide a return path that will keep the noise away from the upstream transformer and incoming power lines.

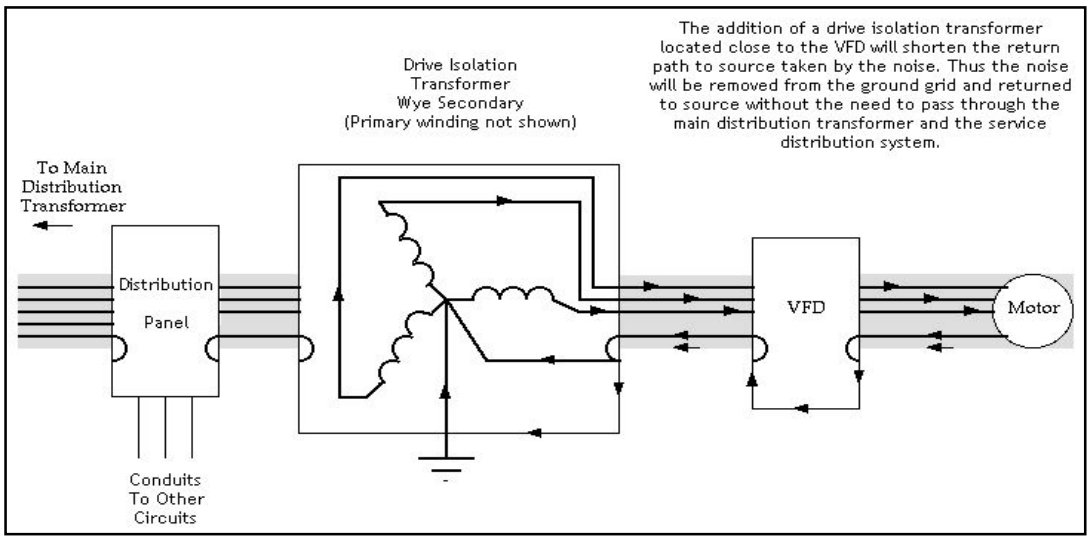

Figure 4

Both a load reactor or a dv/dt filter will reduce the high rate of change of output voltage which is caused by the rapid switching of the IGBT devices. The dv/dt filter derives its name from the high rate of change (d) of voltage (v) with respect to a small change in

time(t).

The reduction of the rate of change of voltage will reduce the capacitive effects which cause EMI/RFI. Thus, a load reactor or dv/dt filter wired directly to the output terminals of a VFD will reduce both common mode noise and differential noise. In addition to reducing the rate of change of output voltage, the filtering of the high carrier frequencies via a dv/dt filter will also yield a reduction of the impedance mis-match at the motor terminals and, consequently, a reduction in the reflected wave. A dv/dt filter consists of a load reactor with a parallel capacitor Keep in mind that a load reactor or dv/dt filter with 1 1/2% impedance will cause a reduction in output voltage to the motor of 1 1/2%. A 5% impedance will cause a corresponding 5%reduction in voltage to the motor.

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