POWER LINE CONSIDERATIONS

AC POWER SOURCE REQUIREMENTS

The AC power source should be examined during the selection and installation of any power conversion unit. All Control Techniques controls are designed to to operate from typical AC power sources found in industrial plants and commercial installations. Some of the possible abnormal conditions that can exist are listed below.

HIGH OR LOW LINE VOLTAGE

Each control is designed to operate at some nominal voltage (i.e. 240 VAC or 480 VAC) with an allowable voltage variation around that nominal voltage (i.e. +10%).

While most AC power sources will never exhibit a full +10% voltage variation, many AC power sources may have a nominal voltage which is higher or lower than the nominal voltage of the control. This high or low line voltage condition combined with the normal variations that occur in line voltage can result in a fine voltage condition higher or lower than allowed. If high or low voltage conditions are suspected, it is a good idea to take a chart recording of the line voltage to determine the extent of the problem. An isolation transformer with taps will usually correct a high or low line voltage condition by matching the nominal plant voltage to the nominal voltage rating of the drive.

Line voltages that are too high can cause regulated power supplies to heat up excessively, thus causing improper drive operation or premature failure. Line voltages that are too high can also cause motor field windings to heat up excessively in DC applications which can reduce motor life.

Line voltages that are too low can cause power supplies to fall below regulation ranges and thus cause erratic operation.

LINE FREQUENCY VARIATIONS

For almost all applications served by an electric utility, line frequency variation will never be a problem. Care should be taken however if drive equipment is operated off an engine generator set.

HARD LINES

Figure 2 illustrates a scenario which comes up occasionally. A drive system is installed very close to the main power bus or a capacitor power factor correction bank.

Because of the proximity of the drive control equipment to the main power distribution center, drives could experience power bridge failures due to being tied to a hard line which is too stiff or being of too low an impedance. The power semiconductors could fail due to excessive di/dt current (rate of current change with time).

This characteristic is not unique to CT drives and is true of virtually all manufactured brands of drives since it is a limitation of the available power semiconductors. Drives are designed to operate under typical industrial conditions and normally the power wiring length or distance from the main bus provides sufficient impedance for proper operation.

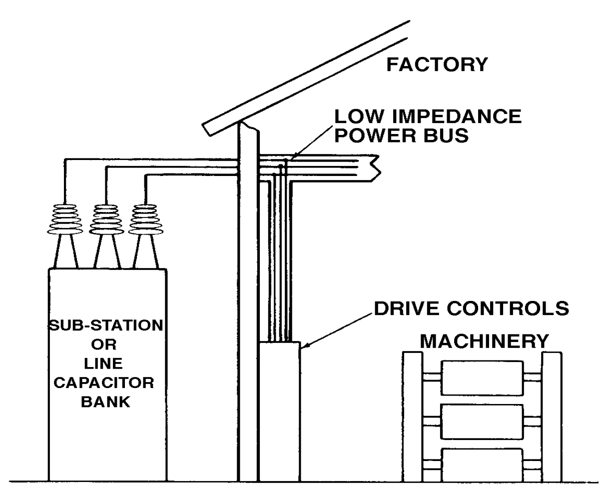

Figure 2

POWER LINE CONSIDERATIONS

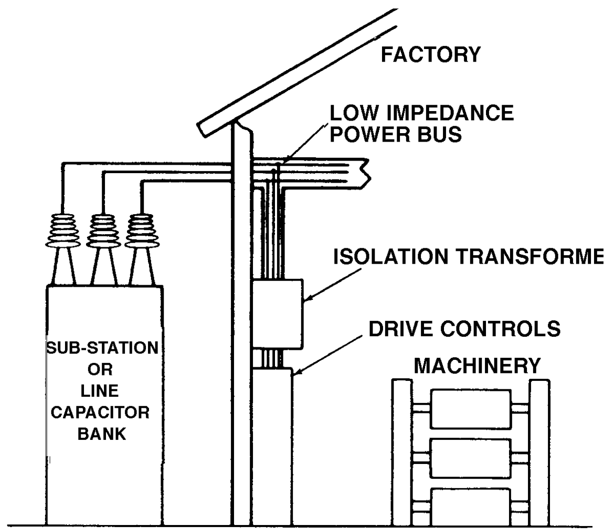

Figure 3

Figure 3 illustrates the installation of an isolation transformer for each drive to raise the impedance and provide a buffer between each drive and the stiff power bus.

Individual line chokes or air core reactors could also be instrumental in raising the line impedance to an acceptable level.

LINE CHOKE INDUCTOR CALCULATIONS

Below are some general rule of thumb formulas to approximate the required inductance to achieve 1 % (per unit) inductance in series with the AC line supplying a typical drive.

On 460 VAC lines with 500 VDC armatures:

Per Unit Line Inductance
in microhenries - $\mu H \cong \frac{5200}{HP}$

Current Rating ≅ 2 times the horsepower
Amperes (RMS) ≅ 2 (HP)

On 230 VAC line with 240 VDC armatures:

Per Unit Line Inductance
in microhenries - $\mu H \cong \frac{1248}{HP}$

Current Rating ≅ 4 times the horsepower
Amperes (RMS) ≅ 4 (HP)

Example

If you were supplying a drive system from a stiff line, such as that in Figure A, you might elect to insert line inductors in series with the lines that feed each drive to achieve an acceptable impedance of 2%-3%. What size of inductors would we specify?

Given:
- Line Voltage: 460 VAC
- Drive Voltage: 460 VAC
- Current Line Impedance: less than 1% (stiff)
- Drive Size: 25 HP
- Motor Voltage: 500 VDC

$$\frac{5200}{HP} \cong \frac{5200}{25} \cong 200\ \mu H \text{ for 1\% impedance}$$

therefore, 400 - 600 µH would provide about 2-3% impedance. Choke ratings should be 2 (HP) or 2 x 25 or 50A.

A suitable choice would be 500 µH, 50A chokes for this example.

Our application group and engineering staff can advise you further should the need arise. We also can provide ready-to-wire panels with mounted line reactors should your application require it.

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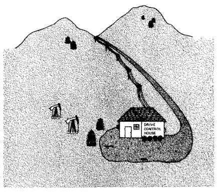

Figure 4

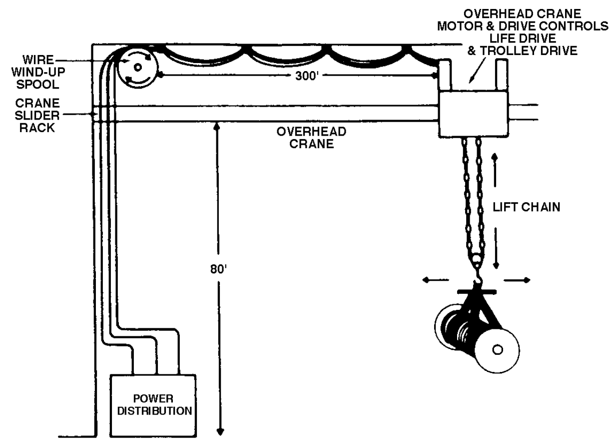

Figure 5

SOFT LINES

The alternate case where the power lines supplying drives is too soft, can also cause drive application problems. In Figures 4 and 5 shown above, the current carrying wires are quite lengthy and represent a relatively high impedance seen by the drive system. The problem is most prominent in multiple drive systems as illustrated above. One drive turns on its power bridge and the voltage applied to the drives dips or notches suddenly. This sudden notch, as illustrated in Figure 6, can sometimes be so severe as to cause the power semiconductors of an adjacent drive to falsely turn on due to exceeding the SCR dv/dt rating—(dv/dt is the rate of voltage change with respect to time that the SCR experiences).

Although our drives include snubber networks (resistor/capacitor bypass networks) and transient voltage suppressors (MOV - metal oxide varistors), which protect the power devices and ensures reliable operation in typical industrial situations, some atypical situations such as those shown in Figure 4 and Figure 5 may require additional consideration for reliable operation.

This notching effect is sometimes described by users as, “The drives talk to one another,” or “One drive influences another especially during higher current draws, quick motor accelerations or heavy load demands.”

The effect is analogous to a situation where someone is using the bathroom faucet and suddenly a toilet is flushed. If the pipes carrying the water supply to the faucet are incorrectly sized (too high an impedance) and/or distributed improperly, output would be noticeably reduced temporarily due to the sudden drop in pressure in the immediate line.

As would be true in fluid systems, power lines carrying drive current must be oversized to allow for transient voltage drops over long distance wiring. If a step-down isolation transformer is being used, it too should be oversized to minimize flow restriction or keep impedance low during transient current demands. This oversizing may require that wire sizes and/or transformers sizing be as high as five times the full load current in order to minimize transient impedances and subsequent line notching.

Line notching due to high impedance power lines may not be severe enough to disturb drive operation but it may cause nearby electrical instrumentation or computer equipment to be affected. In these cases, line conditioners such as line filter, ferroresonant transformers etc., may be necessary to provide clean power to such equipment to ensure reliable equipment operation.

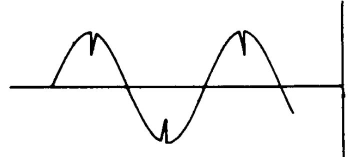

Figure 6
Line Notching