

Electrical Noise . . . Sources, Symptoms and Solutions

Noise related difficulties can range in severity from minor positioning errors to damaged equipment from runaway motors crashing blindly through limit switches. In microprocessor controlled equipment, the processor is constantly retrieving instructions from memory in a controlled sequence. If an electrical disturbance occurs, it could cause the processor to misinterpret an instruction, or access the wrong data. This is likely to be catastrophic to the program, requiring a processor reset. Most Compumotor indexers are designed with a watchdog timer that shuts down the system if the program is interrupted. This prevents the more catastrophic failures.

Sources of Noise

Being invisible, electrical noise can be very mysterious, but it invariably comes from the following sources:

- Power line disturbances
- Externally conducted noise
- Transmitted noise
- Ground loops

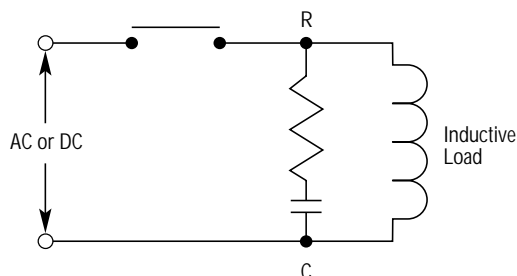
Some common electrical devices generate electrical noise.

- Coil driven devices: conducted and power line noise
- SCR-fired heaters: transmitted and power line noise
- Motors and motor drives: transmitted and power line noise
- Welders (electric): transmitted and power line noise

Power line disturbances are usually easy to solve due to the wide availability of line filtering equipment for the industry. Only the most severe situations call for an isolation transformer. Line filtering equipment is required when other devices connected to the local power line are switching large amounts of current, especially if the switching takes place at high frequency. Corcom and Teal are two manufacturers of suitable power line filters.

Also, any device having coils is likely to upset the line when it is switched off. Surge suppressors such as MOVs (General Electric) can limit this kind of noise. A series RC network across the coil is also effective, (resistance; 500 to 1,000 Ω , capacitance; 0.1 to 0.2 μ F). Coil-driven devices (inductive loads) include relays, solenoids, contactors, clutches, brakes and motor starters.

Fig. 5.10 Typical RC Network

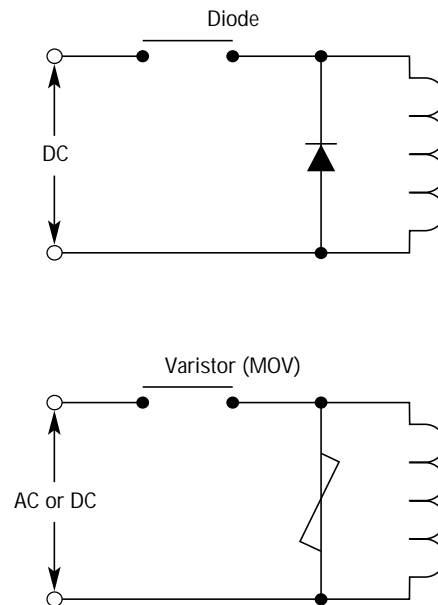


Externally Conducted Noise

Externally conducted noise is similar to power line noise, but the disturbances are created on signal and ground wires connected to the indexer. This kind of noise can get onto logic circuit ground or into the processor power supply and scramble the program. The problem here is that control equipment often shares a common DC ground that may run to several devices, such as a DC power supply, programmable controller, remote switches and the like. When some noisy device, particularly a relay or solenoid, is on the DC ground, it may cause disturbances within the indexer.

The solution for DC mechanical relays and solenoids involves connecting a diode backwards across the coil to clamp the induced voltage "kick" that the coil will produce. The diode should be rated at 4 times the coil voltage and 10 times the coil current. Using *solid-state relays* eliminates this effect altogether.

Fig. 5.11 Coil Suppression Methods



Multiple devices on the same circuit should be grounded together at a single point.

Furthermore, power supplies and programmable controllers often have DC common tied to Earth (AC power ground). As a rule, it is preferable to have indexer signal ground or DC common floating with respect to Earth. This prevents noisy equipment that is grounded to Earth from sending noise into the indexer. The Earth ground connection should be made at one point only as discussed in "Ground Loops" on p. A53.

In many cases, optical isolation may be required to completely eliminate electrical contact between the indexer and a noisy environment. Solid-state relays provide this isolation.

Transmitted Noise

Transmitted noise is picked up by external connections to the indexer, and in severe cases, can attack an indexer with no external connections. The indexer enclosure will typically shield the electronics from this, but openings in the enclosure for connection and front panel controls may "leak". As with all electrical equipment, the indexer chassis should be scrupulously connected to Earth to minimize this effect.

When high current contacts open, they draw an arc, producing a burst of broad spectrum radio frequency noise that can be picked up on an indexer limit switch or other wiring. High current and high voltage wires have an electrical field around them, and may induce noise on signal wiring (especially when they are tied in the same wiring bundle or conduit).

When this kind of problem occurs, consider shielding signal cables or isolating the signals. A proper shield surrounds the signal wires to intercept electrical fields, but this shield must be tied to Earth to drain the induced voltages. At the very least, wires should be run in twisted pairs to limit straight line antenna effects.

Most Compumotor cables have shields tied to Earth, but in some cases the shields must be grounded at installation time. Installing the indexer in a NEMA electrical enclosure ensures protection from this kind of noise, unless noise-producing equipment is also mounted inside the enclosure. Connections external to the enclosure must be shielded.

Even the worst noise problems, in environments near 600 amp welders and 25kW transmitters, have been solved using enclosures, conduit, optical isolation, and single-point ground techniques.

Ground Loops

Ground Loops create the most mysterious noise problems. They seem to occur most often in systems where a control computer is using RS-232C communication. Garbled transmission and intermittent operation symptoms are typical.

The problem occurs in systems where multiple Earth ground connections exist, particularly when these connections are far apart.

Example

Suppose a Model 500 is controlling an axis, and the limit switches use an external power supply. The Model 500 is controlled by a computer in another room. If the power supply Common is connected to Earth, ground loop problems may occur (most computers have their RS-232C signal common tied to Earth). The loop starts at the Model 500's limit switch ground, goes to Earth through the power supply to Earth at the computer. From there, the loop returns to the Model 500 through RS-232C signal ground. If a voltage potential exists between power supply Earth and remote computer Earth, ground, current will flow through the RS-232C ground creating unpredictable results.

The way to test for and ultimately eliminate a ground loop is to lift or "cheat" Earth ground connections in the system until the symptoms disappear.

Defeating Noise

The best time to handle electrical noise problems is before they occur. When a motion system is in the design process, the designer should consider the following system wiring guidelines (listed by order of importance).

1. Put surge suppression components on all electrical coils: resistor/capacitor filters, MOVs, Zener and clamping diodes.
2. Shield all remote connections and use twisted pairs. Shields should be tied to Earth at one end.
3. Put all microelectronic components in an enclosure. Keep noisy devices outside. Monitor internal temperature.
4. Ground signal common wiring at one point. Float this ground from Earth if possible.
5. Tie all mechanical grounds to Earth at one point. Run chassis and motor grounds to the frame, frame to Earth.
6. Isolate remote signals. Solid-state relays or opto isolators are recommended.
7. Filter the power line. Use common RF filters (isolation transformer for worst-case situations).

A noise problem must be identified before it can be solved. The obvious way to approach a problem situation is to eliminate potential noise sources until the symptoms disappear, as in the case of ground loops. When this is not practical, use the above guidelines to troubleshoot the installation.

References

Information about the equipment referred to may be obtained by calling the numbers listed below.

- Corcom line filters (312) 680-7400
- Opto-22 optically isolated relays (714) 891-5861
- Crydom optically isolated relays (213) 322-4987
- Potter Brumfield optically isolated relays (812) 386-1000
- General Electric MOVs (315) 456-3266
- Teal power line isolation filters (800) 888-8325