

TECHNOTE!

Protecting your RS-232 connections from Power Surges

(Much of the technical information in this Technote was gleaned from the literature published by the companies mentioned at the end, as well as from our own experiences)

As many of us have found out the hard way, lightning induced or other power surges can damage or destroy the chips and/or printed circuit boards in the CNC and the DNC computer that are involved in data communication. Lightning causes trouble three ways:

1. **Direct Strike.** Not much can be done to protect against a direct lightning strike. The energy induced into the equipment overwhelms most lightning protection equipment.
2. **Induced Voltage Surges.** A lightning strike one mile away can induce over 300 volts/m in a communications cable inside a factory. So, if your RS-232 circuit is 100 m, 30,000 volts can be induced on that cable.
3. **Ground wave.** When a lightning bolt strikes the earth a short circuit is made between the cloud and the earth. A massive flow of current that measures on average 100 to 1000 amps with possible peak values from 1000 to 100,000 amps rushes from all directions on the ground to the point of lightning impact. The current surge will run in from power lines, telephone lines, ground stakes, water lines, etc. on the side of the building away from the lightning strike, through those lines out the other side of the building.

Surge Protectors

A surge protector works by clamping the transient surge voltage to a safe level and directing the excess energy to ground. They are composed of two parts: a switching device or circuit and a good ground connection. Design and choice of a power surge protection device is a challenge because the nature of the event responsible for the surge is unpredictable. A strike might be close or far. The surge can arrive with a wide variation in energy magnitude and temporal behavior. There are three types of devices typically used as the protective switch: Gas tubes, metal oxide varistors (MOV's) and silicon avalanche diodes (SAD's or tranzorbs.) Each has its pros and cons.

1. **Gas Tubes** can withstand many kilovolts and hundreds of amps. They have been used to suppress high energy lightning surges resulting from direct strikes on telecommunications lines. However, gas tubes have a relatively slow response time. They can knock down big pulses but their slowness can let enough energy by to destroy the typical solid state circuits found in RS-232 equipment.
2. **Metal oxide varistors (MOV's)** respond much quicker than the gas tubes (< 5 nanoseconds). However, operational life is a drawback. A MOV's protection deteriorates and eventually fails when subjected to repeated overvoltages.
3. **Silicon avalanche diodes** have proven to be a very effective means of protecting data equipment against power surges. They are able to withstand thousands of high voltage, high current, and transient surges without failure. While they cannot deal with the surge peaks that gas tubes can, SAD's do provide the fastest response time (< 1 nanosecond.)

Surge protectors installed at each end of each RS-232 cable connected to a good earth ground provides excellent defense against damage due to power surges.

There are many manufacturers that sell surge protectors using one or more of the above components. The type you need depends upon several factors including not the least, what your willing to spend for this protection. General purpose devices using SAD's are very effective against most power surges as long as you have a good earth ground and your cable length is relatively short. If you are in a high thunder storm area where close strikes are common, then there are hybrid devices available that have combinations of SAD's, gas tubes and even MOV's that protect against almost anything short of a direct hit.

Optical-Isolators

There is a misconception that optical isolators and surge protectors are the same thing. That is no so. Whereas surge protectors re-direct excess energy to ground, optical isolators block unwanted currents originating on one side from reaching the other side. Optical isolators are designed to eliminate ground loops. A ground loop is a current across the cable created by a difference in potential between two grounded points. This happens if you have a long cable run of several hundred feet, or cables run between two buildings. When two devices are connected and their ground potentials are different, current flows from high to low by traveling through the data cable even the ground wire. If the voltage difference is large enough one of the RS-232 ports can be damaged. Even a small potential difference can cause trouble even though it does not cause circuit failure. Small ground loop voltages cause transmission errors with data signals riding on top the ground loop current. Optical isolators block this damaging or interfering current.

So, if optical isolators provide a barrier against ground loops, won't it provide a barrier against surges as well? This belief fails to account for the fundamental difference between ground loops and surge transients. Ground loops tend to be of long duration and relatively low voltage. Surges, on the other hand, tend to be of short duration and very high voltage. Consequently, the amount of current instantly presented by a surge must be directed safely to ground. A high voltage exceeding its rating will destroy an opto-isolator. It is true that transients less than about 2500 volts will not get past the barrier and components on the other side of the opto-isolator will be spared, however, components on the side receiving the "hit" can be damaged. In any case the opto-isolator will no longer pass data after the "hit."

Optical isolators will also block power surges caused by a catastrophic failure in the equipment on one side of the cable from getting to the other side. It will not protect the communication circuits on the side where the failure occurred. A surge protector is need to do that; that is direct the catastrophic currents to ground.

For long cable runs, the best protection is to use a pair of surge protectors at the ends of the cable with one optical isolator in between.

DNCwin Installation Tips

Lines that need to be protected at the CNC end of the cable.

The typical wiring for DNCwin RS-232 to CNC connections use signals TXD, RXD, RTS, CTS and Signal Ground. On a 25 pin D-Sub connector these correspond to pins 2,3,4,5 and 7. There are many models of surge protectors that protect just those pins or those plus 6, 8 and 20 are typical. You can also get models that protect all pins 2 through 25. Pin 1 is the ground connection.

Note! Do not use models that protect pin 25 with Fanuc CNC's since that pin has the 24 volt power supply attached to it.

In order for the surge protector to work it must be connected to a good earth ground. The surge protector depends upon the CNC chassis to be connected to earth ground. A licensed electrician should confirm this.

Suggested general purpose models: Cylix #825-RS232; MCG #DLP-3.1; Patton #501

Lines that need to be protected at the Computer end of the cable.

1. Connection at the computer is to a standard COM port or RocketPort quad or octo cable or non-surge type interface.

The typical wiring for DNCwin RS-232 to CNC connections use signals TXD, RXD, RTS, CTS and Signal Ground. On a 25 pin D-Sub connector these correspond to pins 2,3,4,5 and 7. On a 9 pin D-Sub these correspond to pins 3, 2, 7, 8 and 5. As described above, there are many models of surge protectors with 25 pin D-sub connectors that protect just those pins or those plus 6, 8 and 20 are typical. You can also get models that protect all pins 2 through 25. Pin 1 is the ground connection. Surge protectors with 9 pin D-Sub connectors are also readily available.

In order for the surge protector to work it must be connected to a good earth ground. In general surge protectors depend upon the earth ground being connected to the RS-232 connector shell and the computer chassis. Adding

ground straps using wire size AWG 10 or larger from the connector shells and/or the computer chassis to a true earth ground is good added protection.

Suggested general purpose 25 pin models: Cylix #825-RS232; MCG #DLP-3.1; Patton #501

Suggested general purpose 9 pin models: Cylix #DB9-RS232; MCG #DLP-3.9; Patton #509/25

2. Connection from CNC to the computer is via a Comtrol Rockport card with a Surge Interface. (CAD/CAM Integration supplies only this type of interface for new installations using RocketPort cards in the computer.)

No extra surge protector device is required. However, it is important the computer chassis be connected to earth ground. A licensed electrician should confirm this. Adding a ground strap using wire size AWG 10 or larger from the surge interface and/or the computer chassis to a true earth ground is good added protection.

3. Connection from CNC to the computer is via a Comtrol Serial Hub.

Some Comtrol Serial Hub's RS-232 connections are via an RJ-45 modular jack. There are several surge protectors available with RJ-45/RJ-45 connections or RJ-45 to DB25 connections. If you are using the Comtrol RJ45 to DB25 adapter cables you can use the DB25 type of surge protector as described in item 1, above as long as you connect the connector shell to the hub chassis.

In order for the surge protector to work it must be connected to a good earth ground. The RJ45/RJ45 types have ground straps that must be attached to the hub chassis. The RJ-45/DB25 adapter type depends upon the DB25 connector shell connected to the hub chassis. A licensed electrician should verify that the hub chassis is connected to a good earth ground. Adding ground straps using wire size AWG 10 or larger from the hub chassis to a true earth ground is good added protection.

Suggested general purpose RJ45/RJ45 models: Cylix # MTJ-08(18)/RJ45; MCG #DLP-4.8; Patton #512.

Suggested general purpose RJ45/DB25 model: Cylix #DB25M/RJ45-E (Must specify pin configuration)

Companies that manufacture surge protectors

The following list of companies provides various types of data line protectors. The list is presented here as a convenience to our customers and is by no means exhaustive. CAD/CAM Integration, Inc. does not endorse nor warrant any of the products of the following companies. We will, however, recommend some models for your application based on your needs and the technical specifications supplied by these companies.

- The Cylix Corporation, Westlake Village, CA, 805-379-3155, www.cylix.com
See their SIP series for data line general-purpose protection using SAD's.
Note! Cylix offers a 5-year warranty and \$25,000 Connected Equipment Guarantee.
- MCG Electronics, Deer Park, NY, 800-851-1508, www.mcgsurge.com
See their DLP-3 series for general-purpose data line protection using SAD's.
See their DLP-30 for heavy-duty protection using both SAD's and gas tubes.
See their new 3-stage data line surge protection devices.
- Patton Electronics, Gaithersburg, MD, 301-975-1000, www.patton.com
See their model 501 for general-purpose data line protection using SAD's.
See their model 509 optical isolator.
- Telebyte, Greenlawn, NY, 800-835-3298, www.telebyteusa.com
See their model 22 for 3-stage protection using gas tube, SAD's and MOV's (4 lines only)
See their model 268 optical isolator.

CAD/CAM Integration, Inc. can help you select, supply and install surge protection devices.