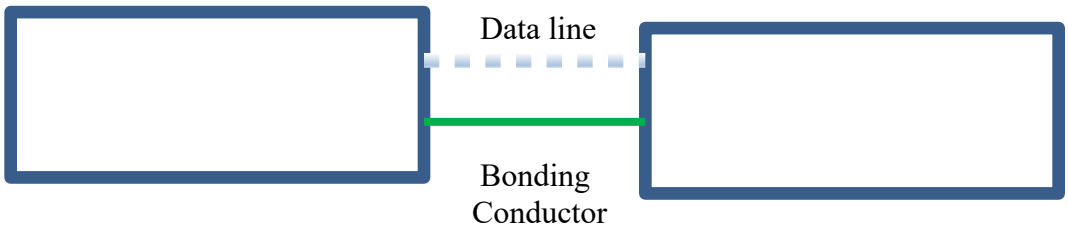
BONDING AND GROUNDING

The first step in securing effective lightning protection is bonding and grounding.

Bonding is simply a matter of taking all of the electrical and metallic masses in a facility and connecting (bonding) them with conductors, bringing them to the same electrical potential. The primary reason for bonding is personnel safety, so someone touching two pieces of equipment at the same time does not receive a shock by becoming the path of equalization. For the same reason bonding protects people, it protects equipment, reducing unwanted current flow on power and data conductors and controlling arcing between pieces of equipment at different potentials.

Particularly in oil production facilities, arcing is the major cause of ignitions. Therefore, bonding is critical. EMP and secondary effect can cause differences in potential between masses. That difference in potential can equalize through arcing. If the arc takes place in a flammable mixture, ignition is likely. Therefore, bonding is critical.

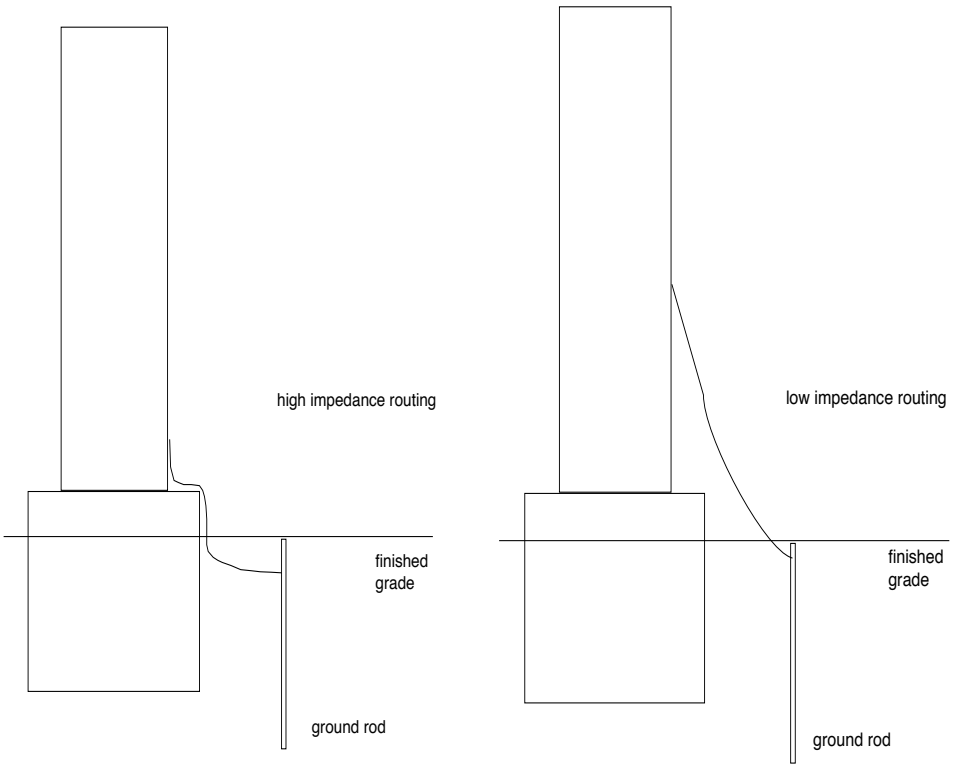
BONDING



Grounding is a matter of bringing the bonded equipment mass to the potential of the surface of the earth which it occupies. Again, the primary reason is personnel safety, and the secondary reason is equipment protection.

When it comes to grounding, we need to consider two types of grounding: low-impedance grounding of structures, and single-point ground potential referencing for services and equipment.

Structure grounding. A structure is anything which is likely to be struck by lightning, and requires multiple, low-impedance paths to the grounding system to transfer lightning energy off of the structure and into ground as quickly as possible. Since lightning is very high frequency, low impedance, not just low-resistance, paths are the key. The higher the impedance the lightning energy "sees", the greater the voltage increase. The higher the voltages, the more likely the energy will arc or take unwanted paths to ground. Therefore, it is important to provide multiple paths with good geometry directly to grounding electrodes within the grounding system.

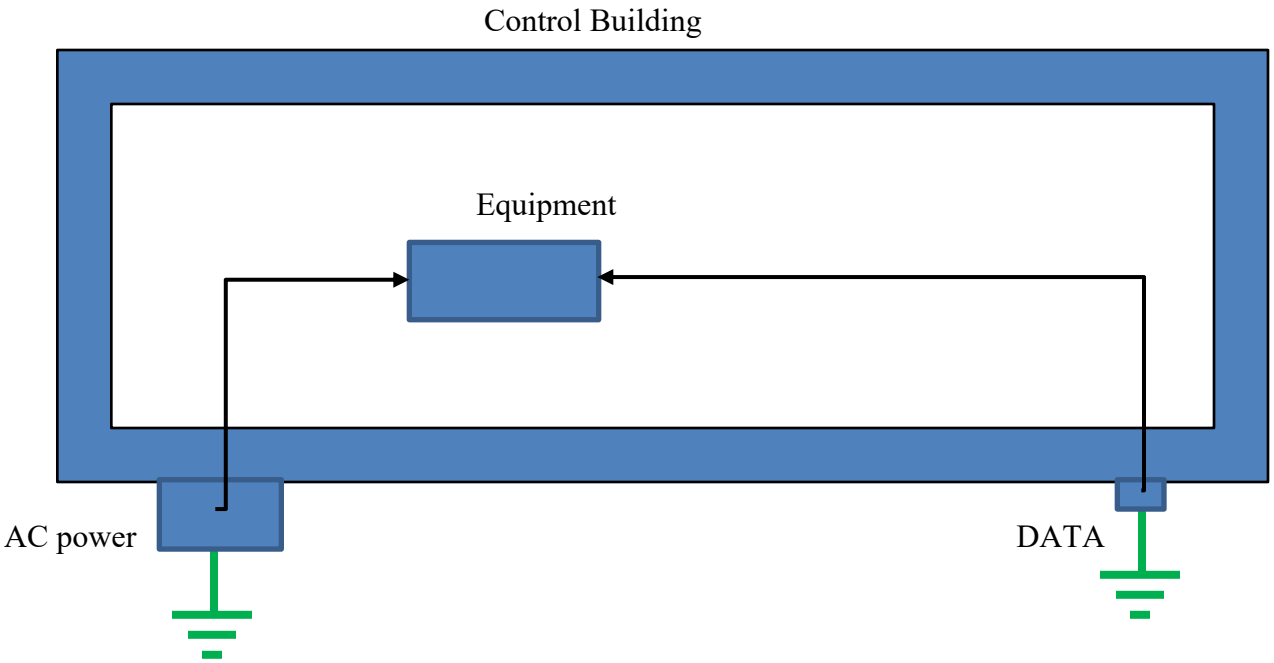


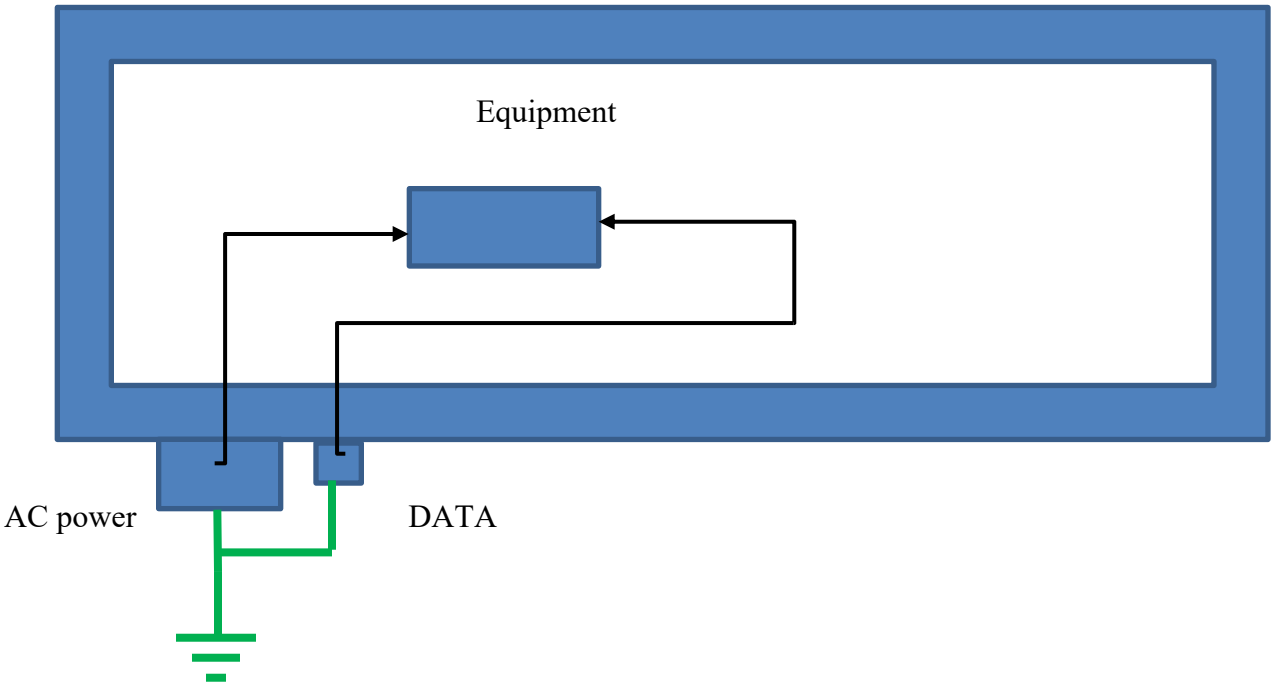
Services and equipment grounding. Among all the variables involved in system design, we have found the single most important factor in effective lightning protection to be not simply bonding and grounding of equipment and services, but proper connection of the services and equipment bonding sub-system to the grounding system. A change in potential per se does not damage equipment. It is a difference in potential across your equipment causing current flow through the equipment which causes damage. If the potential of the entire system changes at the same time and rate, and the equipment does not have any other source of ground potential reference, there is no current flow and no damage occurs. The equipment does not even realize it changed potential without a second reference.

Current divides and takes all paths. The amount of the current flowing on any one path is proportional to the surge impedance of that path relative to the total surge impedance of all paths. Even if heavy duty bonding straps are provided between grounds as the primary intended path of equalization, some of the current flow will be through unintended paths; through other conductors and equipment. Therefore, it is critical to bring all services and equipment grounds within a facility to the same potential before they connect to the grounding system, eliminating the possibility of current flow.

In a typical facility, we must be concerned with several different ground potentials. The first set of ground potentials is associated with the services to the site, i.e., AC power, TELCO, data and RF transmission lines from antennae. If a piece of equipment is connected to both a data line and to a power supply, and there is a difference in ground potentials between those two service grounds, that difference in potential can equalize within the equipment, causing damage or accelerated wear. That grounding condition is shown in the top illustration.

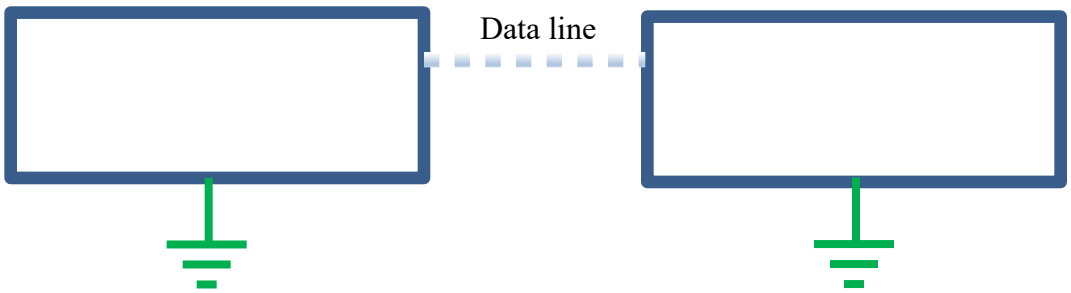
The correct grounding configuration is shown in the lower illustration. With only one point of ground potential referencing, there can be no current flow.


Control Building
Equipment
AC power
DATA


Equipment
AC power
DATA

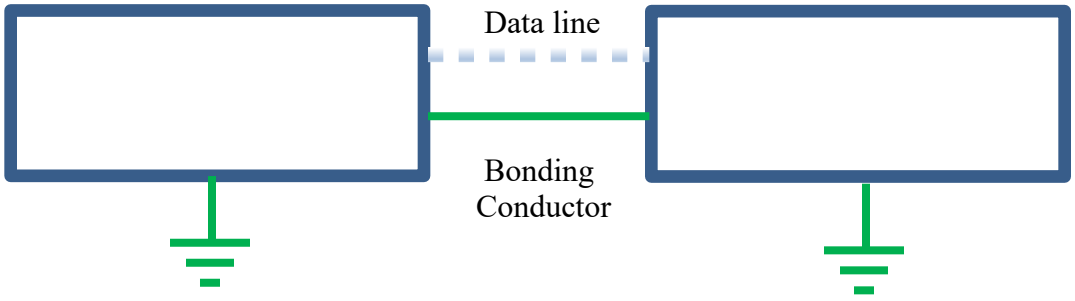
The second set of potentials is associated with the various electrical and electronic equipment chassis grounds. If two pieces of equipment are communicating with one another through a data line, and if there is a difference in potential between the two pieces of equipment, that potential can equalize through the data lines within one or both of the pieces of equipment (see illustration below). When we refer to the facility equipment, it is important to note that we are referring only to electrical or electronic equipment, not door frames, air conditioning ducting, miscellaneous masses of inductance, etc.

GROUNDING



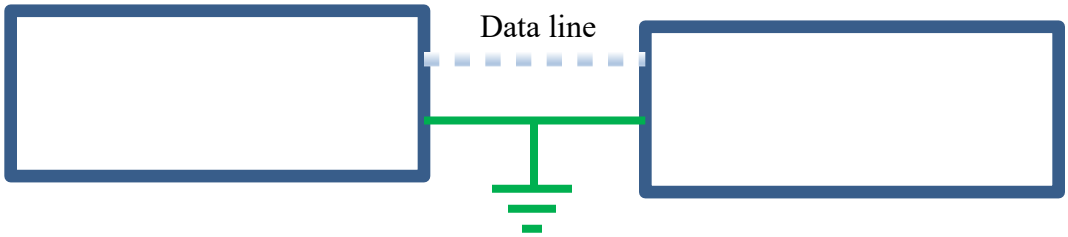
If equipment is grounded as shown above, any difference in ground potential between the equipment will be equalized through the data line, causing unwanted current flow and equipment damage.

BONDING AND MULTIPLE-POINT GROUNDING



Bonding and grounding, as shown above, is an improvement, in that some of the current will flow through the bonding conductor, again in proportion to the surge impedance of the data line versus the bonding conductor. However, even with a large bonding conductor, some current will flow over the data line causing equipment damage.

BONDING AND SINGLE-POINT GROUNDING



Bonding and grounding as shown above will offer the best chance for eliminating current flow through data lines. As both pieces of equipment are sampling ground potential at one, and only one, location, if the ground potential changes both will rise and fall at the same time and rate. As there is no other source of reference, the equipment will not know that it changed potential, so there will be no current flow.

To perhaps oversimplify the concept, envision an imaginary plane at or just below the floor level of the facility. All of the site equipment and services should be appropriately bonded together above this plane, and bonded to an appropriate grounding system through a single hole through that imaginary plane.

Using this technique will assure that all equipment within the site will be at the ground potential of that single-point. This concept is commonly referred to as “single-point grounding”, or, more accurately, “single-point ground potential referencing”.