

## Video Camera Installation Guide

The intent of this guide is to provide the information needed to complete or modify a video camera installation to avoid lightning and induced power surge damage. This guide is not going to cover every possible situation and that is why there is a phone number at the end of this article for technical support. Do NOT assume, as we all know where that most often will lead.

First, a statement regarding the author's qualifications may put some at ease regarding the recommendations and guide. I have over 4 years of electrical systems and electronics technology study along with many years of experience in the technical repair of all types of electronic equipment. Over 18 years of experience in the design and installation of video and other security equipment with one of the largest security companies in the world. An additional 12 years of experience in the design of electrical systems, surge protection devices, grounding, isolation, power protection and surge protection devices, equipment and systems. Over 12 years experience teaching seminars regarding the protection of security and other sensitive equipment. Consulting and seminar clients that include government agencies such as the United States Secret Service Technical Division, US Postal Service, major utilities such as Progress Energy and OUC, commercial concerns such as Nestle, SunTrust Banks, L-3 and many of the largest security companies in the world including ADT, Diebold and Honeywell.

The basics required for a proper installation:

- ❑ Single point grounding.
- ❑ A clean and stable AC power.
- ❑ The proper selection of power and component protection devices.
- ❑ The proper selection of cable and wire for the system.
- ❑ The proper installation of the cable and wire.
- ❑ The proper installation of both the head end equipment & cameras.
- ❑ The proper bonding and/or isolation of all system components.

*(There are other fine points that will be covered in greater detail under each heading).*

### Single point grounding.

The only source of a ground reference must be the AC power ground. This is a requirement of the NEC (National Electric Code). Any attempt to install additional grounds will result in a ground loop (difference in ground potential). Improper grounding can also create a life safety hazard. This means the head end equipment as well as any cameras are grounded only to AC power ground at the head end. If it is impossible to power the entire system from a single point ground, please contact PSI for the options. DO NOT install equipment with multiple ground references. Doing so violates code and puts personnel in jeopardy of shock hazards.

The net resistance to the earth of any ground should be as low as possible, but in every case it should never exceed the intent of the NEC, <25 Ohms. The only manner in which the service entrance AC power ground can test a ground for earth resistance is by "fall-

of-potential testing”. A standard Ohmmeter will NOT provide accurate resistance readings of an earth grounding system. PSI recommends the grounding be <5 Ohms.

It is not proper to ground cameras, camera housings or point of use surge protectors since doing so will cause ground loops. The AC Surge protection installed to protect the head end equipment may be bonded to the common AC power supply ground. Coax cable surge protection should NOT be grounded at either the head end equipment or the camera. Again, the improper bonding and grounding will cause ground loops. The best installation is when the camera is “floated” or isolated from any possible ground source where it is installed.

#### A clean and stable AC power.

There are a few rules that will improve any installation. The first is ALL video equipment should be on the same phase. If the installation is made using multiple phases of an electrical service, the equipment’s power will be from phases that are out of sync. Hum bars and more serious issues can result in systems with out of sync phases.

Avoid using a phase that also powers inductive loads or outside circuits. Inductive loads (motors, air conditioners, etc.) very often cause significant power sags and surges. They are also a source of noise. Logic tells you not to use the same circuit for a fan and a TV, as you will get interference on the TV. The same holds true of other motor loads and video security camera systems. Avoid any panel with an outside circuit when possible because such circuits can be the source of a back door lightning event. In this case, an impulse or surge enters the electrical system, not from the utility power source, but from a circuit that goes out of the panel to the outside. Example: Site light poles powered by a panel often are exposed to both nearby lightning strikes (induced lightning surge into the wire from the panel to the light) and direct lightning strikes.

Install a commercial grade (high performance) surge protected power strip. These are NOT the ones you find at discount computer and office supply houses. The strip should be in a metal housing and have multiple surge protection elements. Low cost plastic surge protection power strips have been the source of fires and most often provide very poor surge protection.

Power the video security equipment with a battery UPS. A line interactive/standby UPS (not just a plain standby UPS) is the minimum protection level that should be considered. The best topology UPS is an on-line double conversion UPS. These are more costly, but also provide a much higher level of protection for the connected equipment. The on-line UPS should be considered for installations where the power requirements exceed 5 amps or more @ 120VAC.

When selecting a circuit to power the video security equipment, try to use a dedicated circuit. This will avoid any other connected equipment becoming a source of system damage. It will also reduce the possibility of EMI and RFI system noise.

### The proper selection of power and component protection devices.

Video security systems as well as all sensitive electronics are subject to power quality anomalies. These can be sags, surges, impulses, noise and numerous other events that are outside the input power requirements for normal stable operation. The four most common are listed above and will be the focus of this section.

Sags are long-term event that occur when voltage is lower than normal input voltage is supplied to the equipment. Long-term events for sensitive electronic devices range from milliseconds and longer. The tolerance of the power supply of each device is the determining factor of what is “long term”. Surges and swells are often long term over voltage events. They can result from a number of utility events as well as the operation of equipment connected to the same electrical panel or service at the site. An excellent example of local equipment is heating and air conditioning equipment. If you have ever seen lights dim when the air conditioning equipment starts you have seen the “sag”. What you rarely see is the surge that follows when the equipment turns off.

Impulses are short-term over-voltage events. The most common source is from grid switching or fault clearing by the utility and lightning events. No single device can “cure” all power quality issues, but a line interactive (good solution) or on-line UPS (best solution) that is used in conjunction with a good quality surge protector will protect equipment from all but the most severe power quality anomaly.

An added layer of surge protection in front of the UPS will protect both the equipment and the UPS. This is recommended, as UPS units are not high performance surge protectors as a stand-alone device. UPS are not UL listed as surge protectors and their primary function is not surge or impulse protection.

Any surge protector used with a UPS must be connected ahead of the UPS. NEVER plug a surge protector into the output of a UPS. The operation of the UPS while on inverter can damage both the surge protector and the UPS. All UPS manufacturers recommend and clearly state that surge protectors are not to be connected to their UPS output.

When the ideal AC power source is not available is not uncommon for electrical noise to be present. When these conditions dictate (electrical noise and other factors) it is necessary to provide noise filtration for the video security equipment. Standby and Line Interactive UPS do not provide adequate noise filtration. Their primary function is to provide power in event of short-term failure of the utility source. Most manufacturers will claim their products have noise filtration above 10khz. They do, but the most common noise issues with video equipment are far below that frequency.

Surge protection devices also make claims of noise filtration. Again, they are somewhat effective above 10khz, but almost no filtration is provided below 10khz. The most effective noise filter at frequencies below 10khz is a double-shielded isolation power

conditioner. If an effective (very low resistance) ground is in place and both the electrical panels and circuits to the video equipment is properly installed, it is still possible to have ground noise. When “ground noise” is still a problem, the only solution is a ground conditioning double-shielded isolation power conditioner.

#### The proper selection of cable and wire for the system.

The use of shielded wire is recommended for the AC power lines running to the cameras. The shield will reduce the possibility of induced (lightning) system damage. In the ideal 24-Volt AC power installation, the shield of the power conductor would be floated at the camera end (not connected to the camera or housing) and it would be grounded to the common AC power ground at the service entrance. Installation of the camera power wire in this manner will provide a “shield” that would drain to the AC power ground much of the energy induced by lightning. Such an installation would use a service entry ground bar and the point of entry at the electrical service entrance. Contact PSI for details of such an installation. The reduction in possible “induced” energy is dramatic and will often be enough to save equipment from damage when used in combination with high performance surge protection.

Double-shielded coax is the ideal coax installation for a video security system. While the installation is more expensive, the reduction in possible system and equipment damage will most often offset any addition cost associated with the coax. Used in combination with high performance coax series surge protection devices it is possible to achieve significant reductions induced lightning surge damage.

Very long runs of video coax that cannot be RF, fiber optic or optically isolated should be made with a product similar to Belden Triax. This coax has an isolated outer shield as well as an inner shield. The outer shield would be grounded at the service entrance of the facility on the head and floated on the camera end. It is often necessary to transition to a smaller cable, as this is a very large coax .475 inches in diameter.

See the link below for a path to Belden Triax. The part number is 8233A (<http://bwccat.belden.com/>)

It is always better to transmit video signals via some means that does not involve copper wires however the cost is often prohibitive. The cost of fiber optic video transmission as well as RF video transmission has become significantly lower in the past few years. These options should be considered. Transmission of video signals over twisted pair has now become popular and it is often competitive with coax installations. When coax runs are very long this can be a better option. The same principles of proper system installation should be followed, including the use of shielded wire.

#### The proper installation of both the head end equipment & cameras.

In keeping with a single point ground system the only ground reference for the video security equipment is the AC power ground. That means the cameras, camera housings,

and all associated equipment must only be grounded to the AC power ground. If multiple electrical systems are involved special equipment is required to isolate the additional ground reference(s).

As an example:

A DVR, with monitor and 4 cameras are to be installed. One camera will be installed on a metal light pole, the second camera on the side of a metal building, a third camera on a metal fence at a gate and the fourth camera on a concrete or wooden pole.

The DVR and other head end equipment will be powered as recommended above and will only have a single point ground (the AC power ground). The camera installed on the metal light pole must be isolated.

### Video Camera Isolation – Pole Mounted Cameras

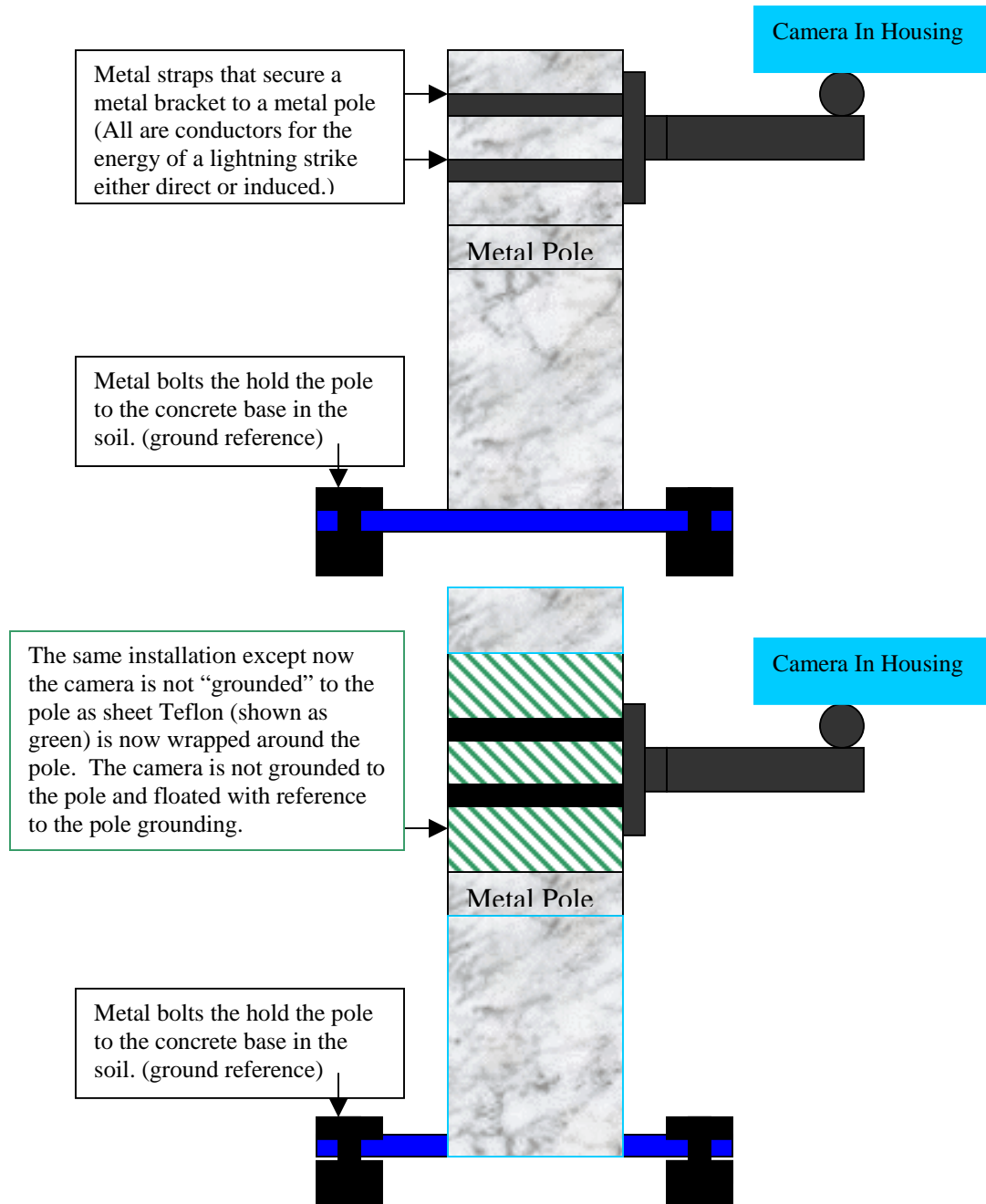
To avoid or reduce lightning damage from direct lightning strikes to pole mounted cameras and difference in ground potential (ground loop) issues with video security systems there are three common solutions. The first is to bond every component of the video security system together with a large stranded copper conductor and connect everything to a low resistance single point ground or bonded multi-point grounding system. In this case that would mean the poles where video cameras are installed should be grounded and bonded. Then install high performance surge protection devices that don't require a ground connection to operate properly. In most installations this is not practical or it is not economically reasonable to bond all the equipment with a large conductor. The second is to use fiber optic cables to replace coax. Then install isolation transformers for all camera power and use a high performance surge protection device for the camera power (at the camera). This is very expensive and systems are rarely installed in this manner. The third solution (most cost effective) is to isolate the video camera from any potential ground where it is installed. Then install the proper high performance surge protection devices on both ends of the coax cable and at the camera power input. These steps can be easily accomplished at a very low cost. In addition to being the most cost effective solution it also provides very good isolation from direct lightning damage.

The benefits to the user are significantly reduced issues with lightning damage and improved installation reliability. If you have trouble understanding the issue consider the below example.

#### Example of security cameras mounted to a light pole in a building parking lot.

Video security cameras are mounted to a metal parking lot light pole that has a ground reference either via the concrete support or a ground rod installed at the pole. The head end equipment is located inside the building some distance away from the light pole and the grounds are not common. The head end equipment is “electrically grounded” by the AC power system. The cameras are provided power by the head end equipment AC power. The camera is mounted directly (no isolation) to the metal pole by a metal

bracket or strap. Lightning strikes the light pole and seeks any and all paths to dissipate energy. The camera and the connected coax become a low resistance path directly back to the head end equipment AC power ground. ZAP! you just lost the equipment. If the camera is isolated the transfer of the energy is very difficult or impossible (ideal) and you don't have any "difference in ground potential" aka, Ground Loop. See the mounting outline below:



Does this installation technique help reduce damage from lightning? Yes, proven in hundreds of installations. Will this installation technique stop all the damage from a

direct lightning strike to the pole? No, but it has in a few cases our customers have reported. In every case the installations reliability is vastly improved and costly lighting damage repairs are reduced significantly.

A direct lightning strike on the pole may damage the camera and as a result cause some energy to follow the coax and camera power lines back to the head end equipment (mostly induced energy). That is the reason for the installation of high performance surge protection devices. The energy level entering the video security system will be reduced because the direct path that was available in the diagram on page #1 (the camera is no longer electrically connected to the pole) has been eliminated. The camera, camera coax, camera power lines and mounting are no longer part of a voltage divider as the mounting assembly is now isolated. Most of this electrical energy will follow the path of least resistance, the pole to ground. Most important this path now does not include the camera-mounting path to the head end equipment that was present in the diagram on page #1. In the case of a close proximity lightning strike the possibility of induced energy entering the camera system via the connection to the pole is reduced or eliminated. No one can predict what path lightning will take and no one can stop lightning. The best that can be done is to make the path you don't want the lightning to take the least attractive path.

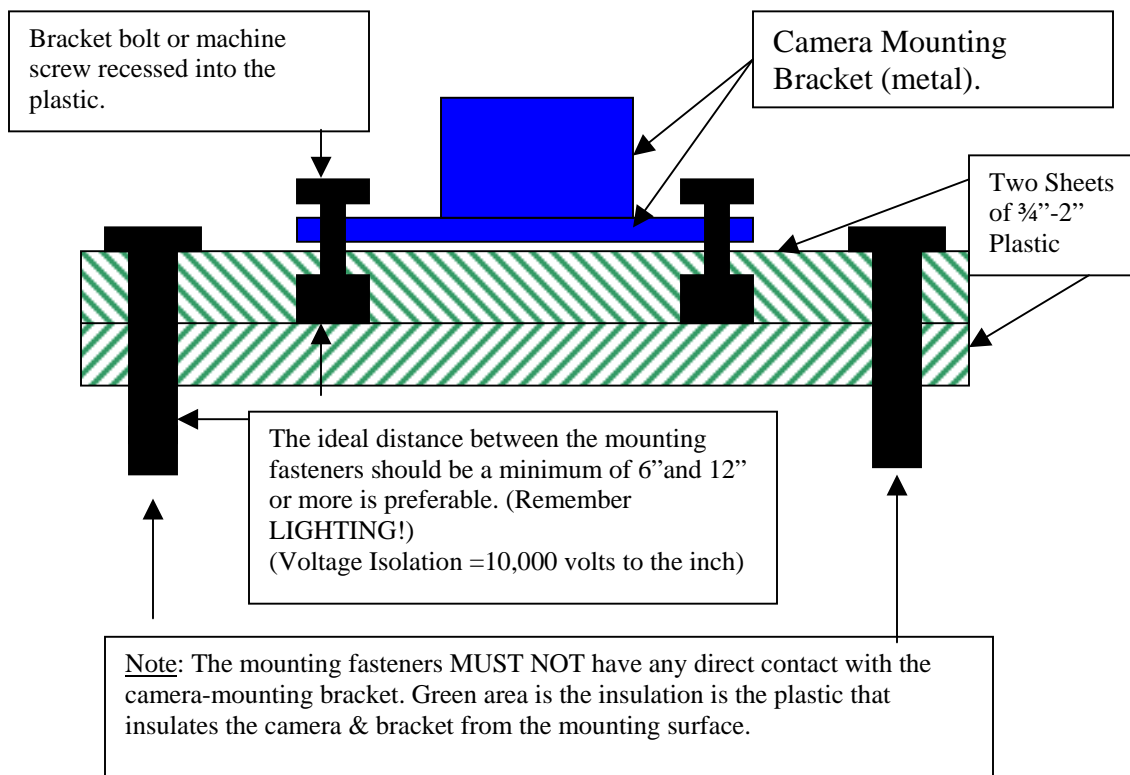
### Video Camera Isolation

To avoid lightning damage from direct building strikes and difference in ground potential (ground loop) issues with video security systems there are three common solutions. The first is to bond every component of the video security system together with a large stranded copper conductor and connect everything to a low resistance single point ground. Then install high performance surge protection devices that don't require a ground connection to operate properly. In most installations this is not practical or it is not economically reasonable to bond all the equipment with a large conductor. The second is to use fiber optic cables to replace coax. Then install isolation transformers for all camera power and use high performance surge suppressors for the camera power (at the camera). This is very expensive and systems are rarely installed in this manner. The third solution (most cost effective) is to isolate the video camera from any potential ground where it is installed. Then install the proper high performance surge protection devices on both ends of the coax cable and at the camera power input. These steps can be easily accomplished at a very low cost. This solution is the most cost effective.

The benefits to the user are significantly reduced issues with lightning damage and improved installation reliability, no difference in potential (ground loops). Remember when lightning strikes a building that energy is transmitted to every device connected to the building unless it is electrically isolated. Lightning will follow every conductive path possible. If you have trouble understanding the issue consider the below example.

### Example of security cameras mounted to a metal building

Video security cameras are mounted to a metal building. The head end equipment is located in another building some distance away from the metal building and the grounds are not common. The head end equipment is “electrically grounded” by the AC power system. The cameras are provided power by the head end equipment AC power. The camera is mounted directly (no isolation) to the metal building by a metal bracket. Lightning strikes the metal building and seeks any and all paths to dissipate energy. The camera and the connected coax become a low resistance path directly back to the head end equipment ground. ZAP! you just lost the equipment. If the camera is isolated the transfer of the energy is very difficult or impossible (ideal) and you don’t have any “difference in ground potential” aka, Ground Loop. See the mounting outline below:



The direct installation of cameras to metal poles, wooden poles (wet wood is a very good electrical conductor), fences or any other conductive surface that will create a ground reference between the camera and the attachment point should be considered as an improper installation. Lightning will follow any conductive path available and as experience has shown that includes video security equipment.