

Video setup

Many AV video setups are simple connections of a video source like a videotape player to some kind of display and are “no brainers” that should be very simple. It is surprising how many technical problems can arise with a very basic setup and leave you looking like a fool.

Connections

The first part of understanding a video setup is to go over the world of video connectors. There are several types of ways that video moves from one box to another but in our humble AV world the most common is by a shielded coaxial wire with a connection device on the end.

The most common connection device by far is the **RCA** style that simply inserts like a peg in a hole with an outside metal sleeve that slides over the outside of the hole.



Everyone and their uncle used these types of connection for their stereo or TV hookup at home. The bummer with these connections is that they tend to pop out with a little pull and then you are left with a high impedance air gap and no picture and I client or talent staring at you in anger. This style of connection is also commonly used for carrying consumer audio signals.

To make a more secure connection most professional video people use the **BNC connector** that has a locking outer shield that is much harder to remove. For some large installations you may need a BNC tool to reach into tight places to secure the connections. There is a long running debate over the source of BNC’s name. The source I believe, Extron electronics, said that it stands for it’s style and it’s inventor Bayonet, Niell Councelman.



There are adaptors that convert from BNC to RCA and visa versa to help you out when you need to convert a cable.

The BNC Female to Female is useful for joining two BNC video cables.



RCA Male
BNC Female



RCA Female
BNC Male



BNC Female
to BNC
Female

If you are using one Coaxial cable to pass RF Video with audio on one cable traditionally the connections are made via **F-connectors**. These are the kind of connectors that the cable company uses and are probably all over your apartment. If your client wants to



watch the superbowl or the sopranos from the hotel cable system you will probably start with a signal on one of these style of connectors. Remember this is a modulated video signal i.e. video and audio are encoded together as an Radio Frequency signal. To project this signal the RF video needs to be decoded with a TV tuner and the decoded (separated) video and audio will then be able to be sent to the projector and sound board.

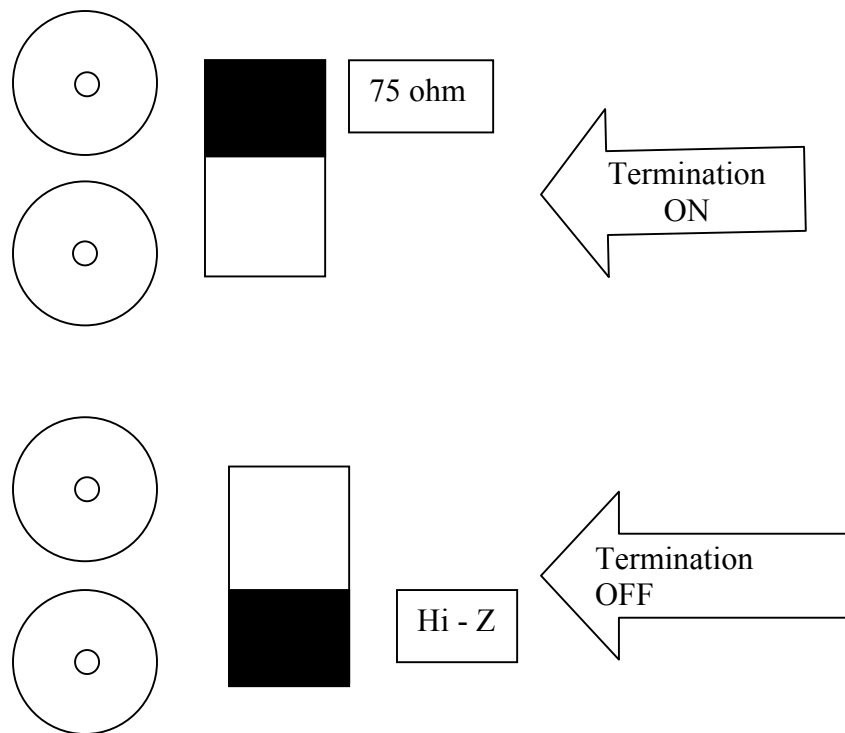
A less common type of connection is the **S-video or SVHS connection** that like the RCA end is not locked to the device. THW S-Video is a consumer component video cable that



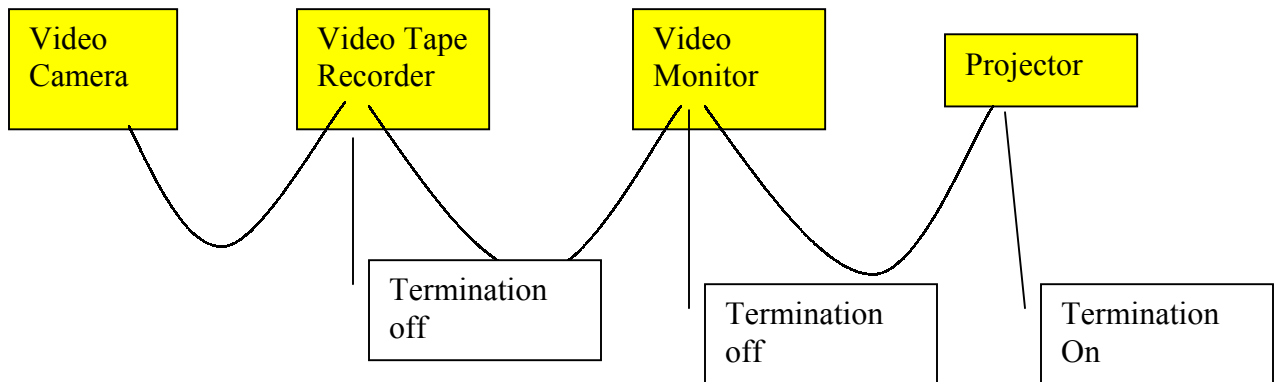
keeps the video's color and brightness or luminance information separated to maintain a higher signal bandwidth than coaxial cables. These separated signals are carried on 4 pins with an outer metal shield. The picture quality of S-video can be great but the cables are often less shielded from RF interference and the connections like the RCA type can come loose. Or as I have seen happen a waiter from the hotel kitchen cuts through backstage, hooks his foot on the cable you forgot to tape down and there goes your connection and you are back to the angry looks.

Termination: Off at the loop, on at the end of the line

Another very important part of understanding connections is the proper termination of the video signal at the connection points. The main rule is that all video paths need to end at a 75ohm resistor. This is referred to as Terminated video. Many professional video devices have an ability to pass the video signal on to another device in the video signal chain. This is very common with professional video monitors like the Sony 2030 or 2530 video monitors that many companies use. If you see a video in and a video out next to each other then normally the equipment can pass the signal to another device. This passive pass through or “loop through” requires that the device passing the video signal does not put a resistance on the signal indicating that the video path does not end at that point. We refer to this as un-terminated, or an un-terminated connection. There sometimes is a physical switch on the side of the loop through that turns the resistor in the circuit on and off. On, or 75 ohm turns the resistor on in the circuit and off, or Hi-Z un-terminates the video line for loop through.



A Typical video setup using loop through circuits might start with a video camera outputting to a video recorder, looping out to a monitor, then into a projector.



Remember un-terminate at the loop through and terminate at the end of the line.

Many new display and processing equipment will self terminate and un-terminate by sensing whether there is a cable attached to the end of the connection of the loop through. If there is no switch on the unit it is possible that the signal is self-terminating.



Beware that some old equipment is not self-terminating nor do they have the switches. These need to be terminated with BNC terminators that lock onto the loop through and terminate the line. These adaptors have a 75 ohm resistor built in to make the proper 75ohm termination that the video circuit needs.

The result of improper termination can be seen in the picture quality of all the display devices in the video signal chain. An overly bright or blown out look to the picture usually indicates that the signal is un-terminated. An overly dark picture can indicate that the signal is double terminated, terminated before the end on the video signal chain and then again at the display or device at the end. It is very important to check for these switches and make sure that when a monitor or device is removed from the end of the line that the cable is also removed at the loop through and the chain re-terminated at that point.

Cable Types:

There are dozens of coaxial video cables that are used for temporary and permanent installations with variations in core diameter and shielding. There are several guides

available from manufactures like Canare and Belden for the specifications and attributes of cables. You can get the latest information at <http://www.belden.com/> or at www.canare.com . Belden even has a “cable college” for those who aspire to a higher level of video geek education that teaches everything you could possibly want to know about video and audio cables. The most common type of video cables used by video companies are the RG-59 (Belden 8241) or RG 58 (Belden 8240) coaxial cables. These are flexible cables with copper braided shields to reduce electrical interference in the signal. For longer runs of video, less flexible, double shielded Belden 8281 or Canare lv-77s are preferred. For a fixed facility where the cables are not going to be wrapped, twisted, run over by lifts and carts an additional foil shield is added to the cable to add shielding from RF and electrical interference. This foil makes the cable rather stiff and hard to wrap. Another common coaxial cable is the RG-6 type of cable which is a lower cost option common in Cable TV or Broadband cable transmission.

There are also new types of cables designed for Digital video transmission that incorporate slightly different construction to minimize errors in digital video signal transmission. The Canare L-4CFB RG-59 size cables and several Belden cables are recommended for digital transmission. Regular coaxial cables may work fine for shorter distances. Concerning Digital video in cables there is a recommended limit to transmission distance that needs to be consulted for installations. Unlike analog video digital video signal errors are imperceivable on a standard display until they reach a critical level, a shelf so to speak, and then the signal disappears.

Video Hum

Video ground loops, otherwise known as video hum is a common problem for video systems in the temporary setups that are installed in hotels or convention centers. The problem for video hum is usually seen as a horizontal bar of distortion that moves



through a video picture from the bottom to the top. The level of hum can vary from almost imperceivable to so severe that the image is completely distorted. There are many potential causes for video hum in a signal but the usual cause is setting up a video system that has more than one path to ground. If you set up a video player in one ballroom and send the signal through a video distribution amplifier then into an overflow room down the hall it is likely that you will have a projector or monitor in that location

that will add a new path to ground to the video system. The result can be seen when you connect the video cable to the amplifier and look at the systems output. One common

solution is to use video transformers, also know as hum-buckers to break the circuit on the shield of the video cable stopping the voltage that is causing the hum to appear in the video picture.

This is a picture of a video signal with some video hum induced in the circuit.

The best description I have found to explain the source and solutions for video hum is from a publication from Video Accessory Corporation and their publication Sync Times.

Ground Loops: What They Really Are

Ground loops are a mystery to many people. Even college-trained electronic engineers may not know what ground loops actually are. Engineers have either concentrated on power distribution (for the electric company) or on equipment that happens to plug in to the power distribution system. Not much thought has been given to power distribution and equipment as a single entity where ground loops arise.

Myths. A couple of myths need to be dispelled before ground loops are examined. Here are the facts:

First, there is no absolute ground. There is a certain amount of resistance to electrical current between all grounding points. This resistance can change with humidity, temperature, connected equipment and many other variables. No matter how small, the resistance can always allow an electrical voltage to exist across it. The ground wires between wall sockets and power company transformers are not perfect conductors and neither is the shield of your coaxial video cable. If they were, ground loops would not be a problem.

Second, percent coverage, a coaxial cable specification, refers to how well the shield conductor protects the center conductor *from light, not electrical interference.*

An Ideal Electrical World. A simplified drawing of an electrical distribution system is shown in figure 1. The path that the 12,000 Volt AC power should follow is shown by the arrows, flowing from the power line through the transformer primary coils and back to the power line. The transformers transform the 12,000 Volts AC to the 115 Volts AC to which we're all accustomed. Everything works well when the power follows the path it's supposed to.

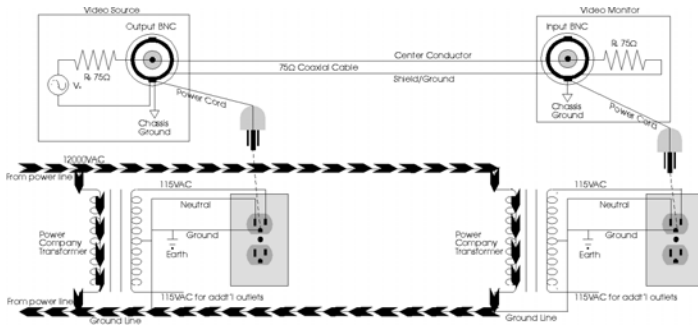


Figure 1. The power company's 12,000 Volt distribution is supposed to follow the arrowed path. The ground symbols indicate where a copper stake has been pounded into the earth. In many cases the earth is a poor electrical ground because of high resistance.

60 Hz Hum-Bars. Figure 2 shows an alternative path for the power flowing through the right-most transformer. Unfortunately, the alternative path is right through your coaxial cable shield. Because the shield conductor is carrying an extraneous current that the center conductor is not, there is a voltage difference between the two conductors at the monitor input that will be displayed as interference. The percentage of the power company's current that you're carrying for them is determined by the ratio of their ground line's resistance to your cable's shield resistance. The power company takes solace in the fact that if their ground line breaks and the earth ground is poor, your video cable and equipment will keep the neighborhood from suffering a black-out.

If both the video source and the monitor are connected to the same power company transformer, this type of interference won't occur unless something is defective. The defect could be excessive resistance in the power cord ground line to either the source or the monitor. Such resistance is usually caused by loose or oxidized connections in the equipment or the building wiring.

The defect could also be within some other electrical device that is producing excessive ground current. The device could be leaking current to its safety ground (that's why it's there) or the neutral and ground wires could be reversed. Such a device can work normally, but it can cause interference in video systems.

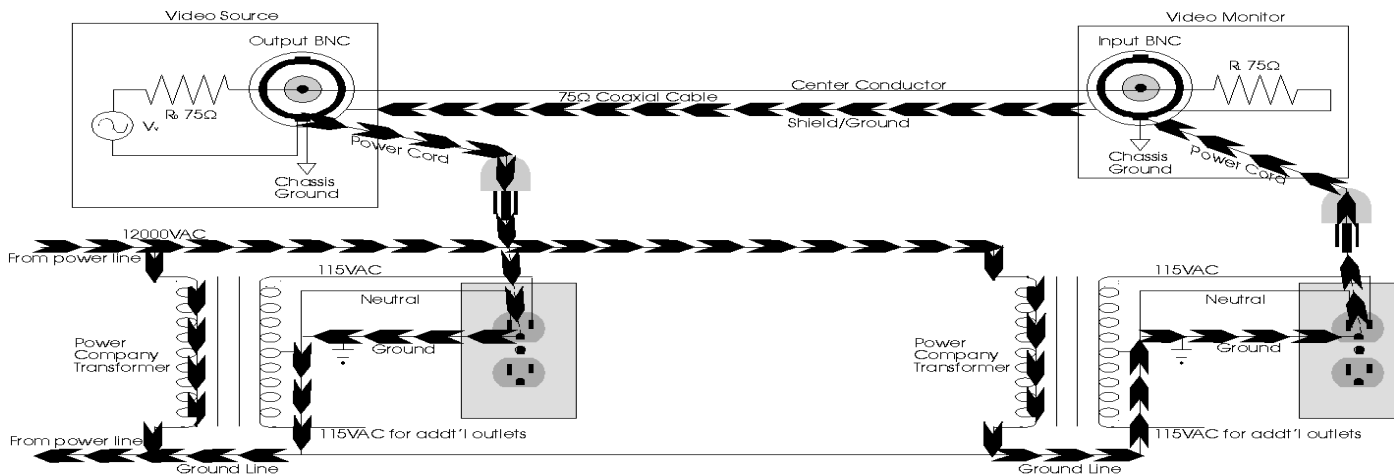


Figure 2. By running a coaxial cable a fair distance, you risk setting up an alternate path for the power company's use, right through your system! Hum and hum-bars, if not worse, result.

RF Interference. Sixty Hertz hum-bars are not the only symptom of ground loops. "Herring Bone" or RF interference is also a common problem in long cables carrying composite video. Herring bone interference is caused by a ground loop (that includes your coax shield) acting as an AM radio antenna (see figure 3). Any large loop of wire makes a good AM antenna. These antennas are especially adept at picking up AM broadcasts if most of the loop is vertical. A video installation in a tall building with cables running between floors makes a good antenna. As figure 3 shows, this loop does not involve the power company transformers. Therefore, whether one or more transformers is involved has no effect on the likelihood of encountering this or any other type of interference following this particular path.

A very common misconception is that the center conductor of the cable picks up the RF interference and that a cable with a high "percent coverage" of the center conductor by the shield will alleviate the problem. It's not true. The shield actually picks up the interference and introduces it to the video system. Any shield whose coverage gaps are much smaller than the wavelength of the potential interference provides the center conductor with adequate shielding. The wavelength of AM radio is about 180 meters at the shortest. Percent coverage in even the cheapest coaxial cable is adequate to protect the center conductor against this RF interference. The best shield is one that offers the lowest resistance per unit of length (Ohms/kM) in order to minimize the voltage potential that can develop across it.

RF induced currents *in the shield* are the problem. As with hum-bars, the shield conductor is carrying an extraneous current that the center conductor is not. Hence, there is an undesirable voltage difference between the two conductors at the monitor input and it will be displayed as interference.

Light Dimmers and other Obnoxious Devices. Interference caused by light dimmers and similar electrical equipment is also a symptom of ground loops. Light dimmers operate not by reducing voltage, but by actually turning it on and off fast enough that the light bulb can't keep up and operates at some point of compromised brightness. Each time the power is turned on or off, a large, fast-changing, 'spike' of current is created in the building's AC wiring.

Electricians, by running 115 VAC cables with parallel conductors (commonly called romex) over long distances, create capacitors. The power and ground conductors in the AC cable are capacitively coupled to each other. High frequency AC current flows through capacitive coupling, the higher the current's frequency, the better it flows.

The current spike, because it is fast changing, has a high frequency component that couples from the AC power conductors to the ground conductor. The ground conductor is part of a ground loop that also includes your coaxial shield conductor. The path of the capacitively induced extraneous current is the same as that shown for broadcast interference in figure 3. Again, the video cable shield conductor is carrying an extraneous current that the center conductor is not. Hence, there is an undesirable voltage difference between the two conductors at the monitor input and it will be displayed as interference.

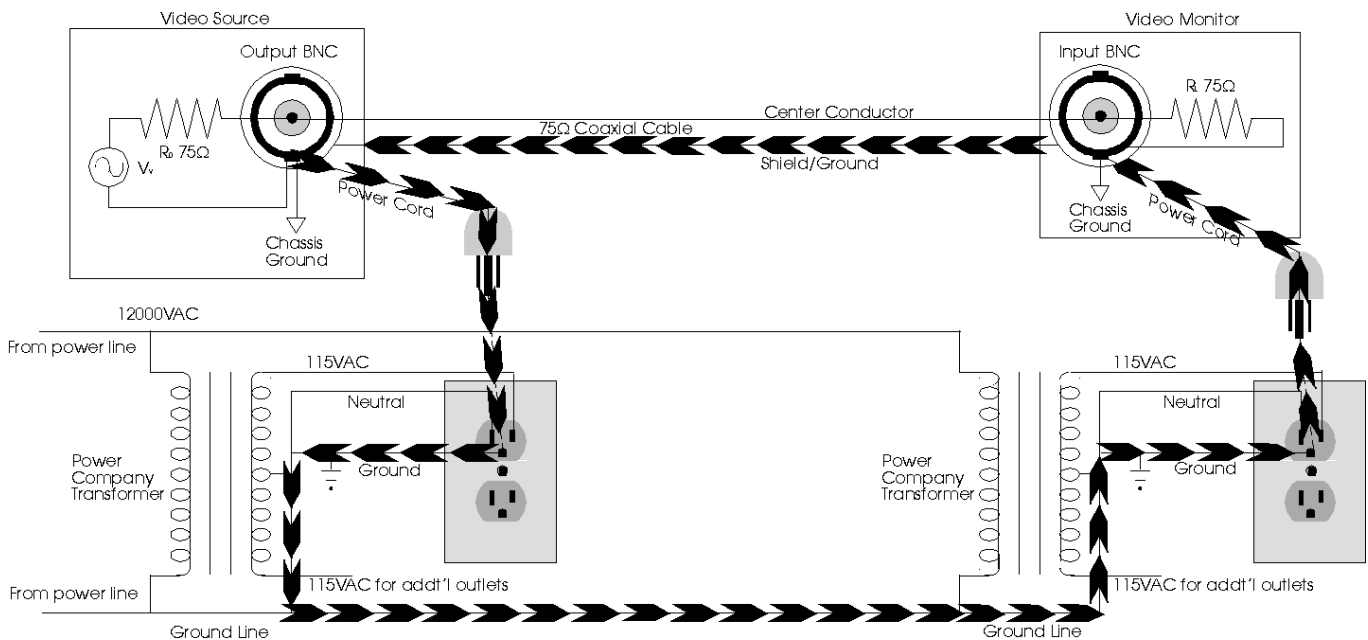
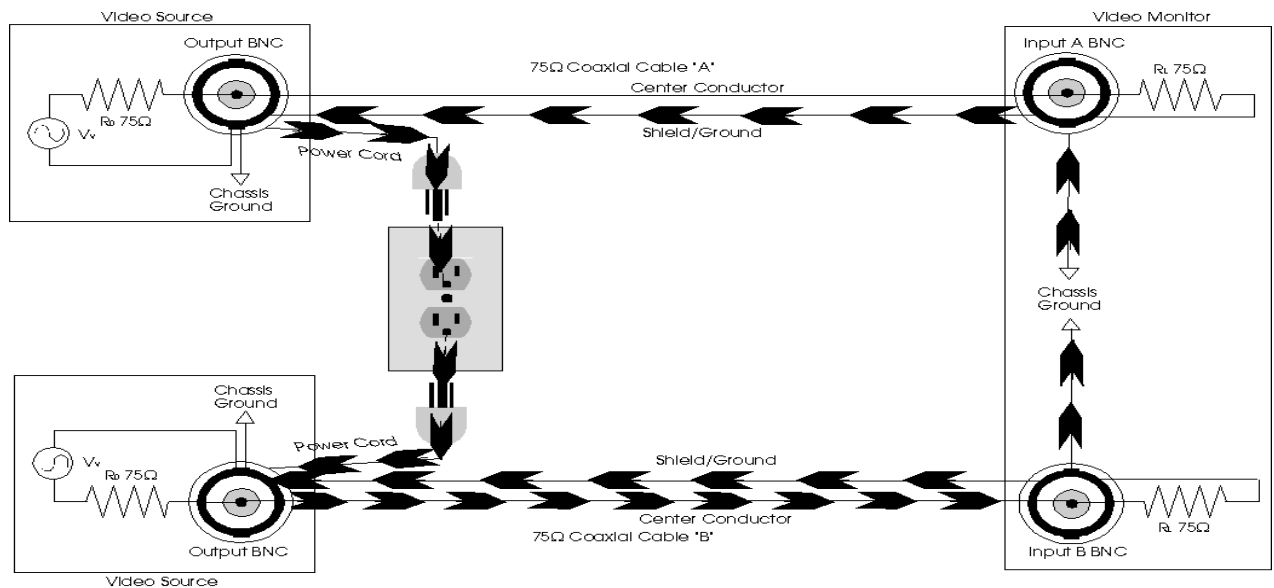


Figure 3. A ground loop serving as a loop antenna, introducing RF interference to your video.

Cross-Talk. Ground loops can cause one signal to interfere with another. Figure 4 shows two long coaxial cables whose shield grounds are connected together at each end (through one path or another). The signal shown traveling through the center conductor to the "Input B BNC" should ideally return through the corresponding shield conductor, but there's an alternative path through the other shield conductor. That causes the shield conductor connected to the "Input A BNC" to carry an extraneous current that the center conductor does not. Therefore, there is an undesirable voltage difference between the two conductors at the monitor input and it will be displayed as cross-talk interference.

The video and power industries have each designed their systems and equipment independently. As a result, there's a degree of incompatibility. Ground loop interference is a consequence.



Solutions for Ground Loop Interference

Video Accessory Corporation offers four ways to cope with Ground Loop Interference. You can use equipment that doesn't create them in the first place, eliminates them,

ignores them, or compensates for them. Here's how to pick your strategy and the equipment you'll need to implement it.

How to Avoid Creating Ground Loops. Figures 2 and 3, on pages 2 and 3 respectively, show ground loop paths through the power cord grounds of the involved equipment. The VAC Video Brick, VDA-640, HN/VDA, and YCDA-2 distribution amplifiers (DAs) all use wall-transformer type power supplies providing 12 to 24 Volts *ungrounded*. When a distribution amplifier is necessary at either end of a long cable, using one with an ungrounded power supply eliminates a possible ground loop path. However, if the distribution amplifier does not have differential inputs or outputs, a ground loop can still form if equipment connected to the DA is grounded.

Eliminating Ground Loops. The VAC Video Line Isolator Model VL-2 eliminates any significant electrical connection between its input and output grounds, thus breaking the loop. The video signal is optically coupled through the unit. To be effective the VL-2 must be installed at a point within the video system where the ground loop exists, most commonly at either end of a long cable run.

The VL-2 offers isolation up to 1,500 volts peak, the highest isolation voltage specification of VAC's ground loop solutions. A red Shock Hazard indicator glows when the voltage difference between grounds is 24 Volts or more. The VL-2 is the best solution when there is a potential between the two grounds of more than a few volts.

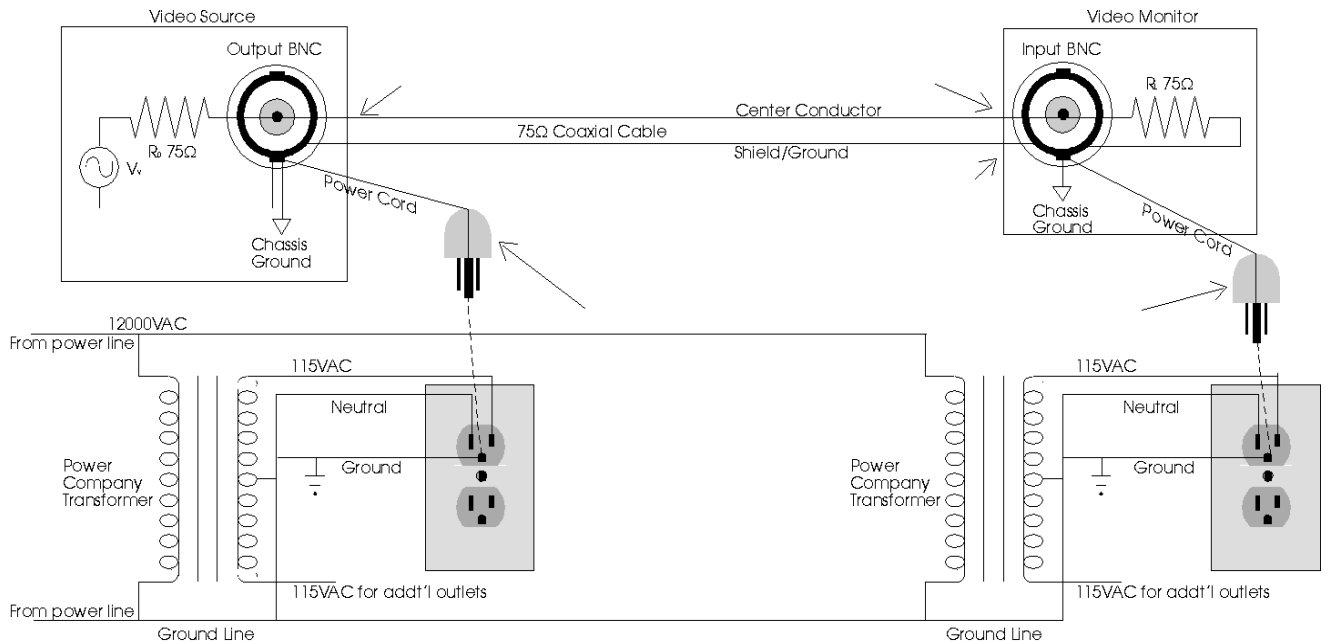
Ignoring Ground Loops. To ignore ground loops, VAC offers a number of distribution amplifiers with combinations of differential inputs and outputs. These DAs are Models VB/VDA Video Brick, XB/VDA Extended Bandwidth Video Distribution Amplifier, and HN/VDA Hum Nulling Video Distribution Amplifier.

A differential input has no ground, merely two conductors. The shield of the offending coax is connected to one of these conductors (instead of ground) and the coax center conductor to the other by means of a BNC insulated from the amplifier's chassis. With no connection to ground, there is no completed ground loop. DAs with differential inputs act on the voltage potential difference between the two input conductors, not between a conductor and ground. Voltage differences between ground and input are ignored up to a point determined by the amplifier's internal power supply. A good differential input video DA will typically exhibit a 40 db or better common mode rejection ratio. VAC's HN/VDA achieves 54 db CMRR.

Clamp Out Hum. If a video signal is suffering from 60 Hz "hum-bars" and a solution cannot be implemented at a point where the ground loop current exists, the CVDA-3 can be used to correct the corrupted video signal. The CVDA-3 Clamping Video Distribution Amplifier clamps the video signal to a proper DC level (-40 IRE sync = -0.286 VDC) during each horizontal sync pulse. The clamp will re-establish absolute DC signal levels, compensate for poor upstream low frequency response, and cure hum-bars by eliminating

low frequency interference present in the video signal at the input. A clamp can correct a signal with hum-bars even after it's been sent through satellite or microwave transmission (provided the signal hasn't been further degraded by equipment unable to cope with the added burden of interference).

Call VAC to discuss your particular situation and find the best solution.



Different models of ground-loop solving equipment can be installed as indicated by the arrows. The CVDA-3 can also be installed down-stream of the involved equipment, outside the loop.