High Definition Video and Audio Quality

Common Issues and Resolutions
As Related to Large Scale Retail Environments

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1. Coaxial Cabling

Coaxial Cables are the highways that carry the signal traffic in a video distribution system. The quality of the cabling can have a definite impact on the signal by the time it reaches the end of the display. Just as pot-holes, narrow roads, and congested neighborhoods can impede traffic, video in particular is sensitive to corollary issues in cabling. High Definition video in particular, due to its much higher bandwidth requirements, demands a quality delivery system. Cabling should be chosen based on several criteria and price is not necessarily the best indicator of quality.

a. Reliability

The outer coating should be rugged but flexible to minimize breakage due to tight bends.
There should be a molded strain relief between the connector and the cable.
The connector should be a solid ring for better retention in the socket.

b. Bandwidth

High Definition video signals extend as much as ten times higher in frequency than Standard Definition. It is essential that the cabling be as low loss as possible especially at the higher frequencies. This means the cable needs good return loss for 75 ohms and extremely low capacitance. One way to identify a low loss cable is diameter. A miniature coax cable (< than 0.10 inches diameter), usually has much more loss than a larger (> 0.20 inches diameter) cable. This is due to the smaller cable having much higher capacitance that causes the high frequencies to be attenuated.

c. Connectors

Each connector should be clearly labeled as to its function.
Color coding is desirable for easy identification.
The connector should fit firmly in the jack to prevent accidental disconnects.

d. Routing

The cable should be located behind shelving or in a cable trough out of public view whenever possible.
Try to avoid running the audio and video cabling parallel with any power cables.
Do not use cables that are too short. They will eventually come unplugged.
Do not use a 25 foot cable when all you need is a 6 foot cable. The excess length is detrimental to the bandwidth of the overall system.

e. Connections

This is one of those things that is very obvious, but needs to be said. Follow the color code and look at the labels. Reversing the colors in the video cabling can lead to some interesting pictures on the television. Also, watch out for swapped right audio and Pr video. They are both red and when swapped, will cause wavy distortion in the picture.

2. Distribution Equipment (Video / Audio Amplifiers)

a. Bandwidth

In order to resolve the fine details in high definition signals, the bandwidth required for 1080i is more than 25MHz. 1080p requires roughly 40 MHz for unimpaired transport through the system. Using an amplifier with insufficient bandwidth will cause a softening of the finer details in the picture.

b. Construction

Retail displays can be harsh environment for electronics infrastructure. Elevated temperatures due to close proximity to hot televisions, poor ventilation, high dust concentrations, etc. are factors that can shorten the life of electronics. Locating amplifiers near power lines can cause hum to be induced into the audio and or video.

There are several factors to look for in a distribution amplifier:

Rugged metal chassis to stand up to the sometimes harsh retail display environment.
Cool operating design to increase unit life-span.
Clearly labeled and color coded connectors to ease installation.

c. Video Coupling

There are two types of video amplifiers, related to how they pass the signal, AC and DC. This is not to be confused with the type of power supply used, as that is a separate issue. Amplifiers using AC video coupling can use less expensive internal power supplies, but cause a negative impact on video by removing its DC component. Some televisions are not receptive to video that has been modified in this manner. DC coupling requires a more complex internal power supply, but produces a truer representation at the amplifier output.

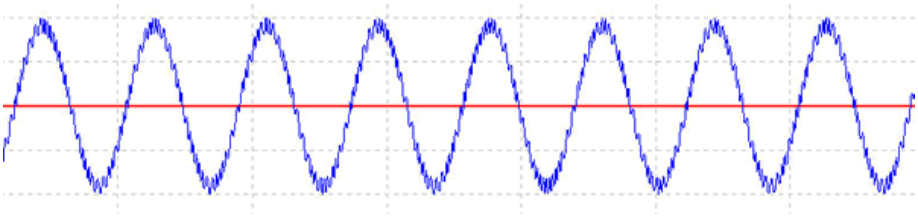
3. Power Quality

a. Line Voltage

A low line voltage (less than 105 VAC) is indicative of problems in the AC wiring. This could be a loose connection, excessive cable run length, overloading of the circuit, etc. Have a certified electrician check the AC wiring.

b. Noise

AC lines can carry noise as well as the intended power. Sources such as lamp ballasts, defective motors, and dirty contacts on switches can introduce noise onto the AC power line. If there appears to be noise on some or all the television screens, it may be time to add a power conditioner or at least a common mode choke power filter. A qualified electrician can recommend and install a permanent filter.



c. Power Cycling

Some retail establishments that are not open twenty four hours a day turn off power to the electronics department in order to save on energy bills. This is harmful to some equipment as surges may be created when a large number of televisions are powered on or off. When ever possible, turn off a video display wall in sections in order to minimize power surges.

d. Chassis grounds

Modern electronics equipment should be grounded in most cases to prevent the possibility of electrical shock. However, the greater the number of ground points in a system, the more likely an AC ground loop imbalance will occur. See AC ground loops later in this paper.

4. Video Hum Bars Induced by AC Ground Loops

a. What is a ground loop and why does it cause a slowing scrolling horizontal bar to appear on my TV?

Multiple paths to ground formed when electronic devices using three wire power cords are powered by line voltage and connected together by signal cables. In a properly functioning system, the only signal carried on the coax is the independent audio and video. If an imbalance in the AC power ground system occurs, a small AC current may flow through the video (or audio) cabling and manifest itself as audible hum or a scrolling horizontal bar on the television screen.

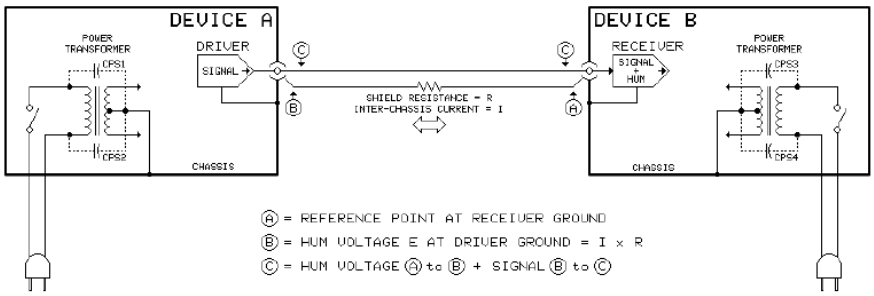


Figure 1 - THE HUM GENERATING MECHANISM
The basic problem is that the shield is a common path for both inter-chassis "ground" and signal currents.

Jensen AN-004

AC power is regulated at the power generation station to 60 cycles. Video uses a refresh rate of 59.94 cycles. This is harmonically related to the video color burst frequency and horizontal sync rate. This slight difference in frequency means that any AC induced hum bar will never stay in one place but will scroll from the bottom to the top of the screen.

Both the signal source chassis and the display chassis will be grounded (we are presuming these are modern sets). When the coaxial signal cable is connected between the two devices, essentially, the two chassis are electrically bonded. If both devices are plugged into the same outlet, there is very little chance of a ground loop problem occurring. The problem usually arises when the source and display are not plugged into the same outlet. If everything is connected properly and there is a low impedance ground at all the outlets, there should be no problem. If the hum bar appears or is heard in the audio, this means that there is a difference in ground potential between two or more AC outlets. In addition to the electrical outlets, the source or display device itself may improperly cause current to be drawn through the ground connection. When this happens, it causes a voltage to appear on the ground relative to a properly functioning outlet. This elevated voltage potential can cause ground loop current to flow and it will show up on screen as a scrolling hum bar.

All of this becomes even more complicated in the typical store display. The use of distribution amplifiers allows a single source to feed dozens of televisions and the odds of one of these being plugged into an outlet with a problem goes up. The amplifier itself is usually floating relative to ground, but it passes through the ground from source to display.

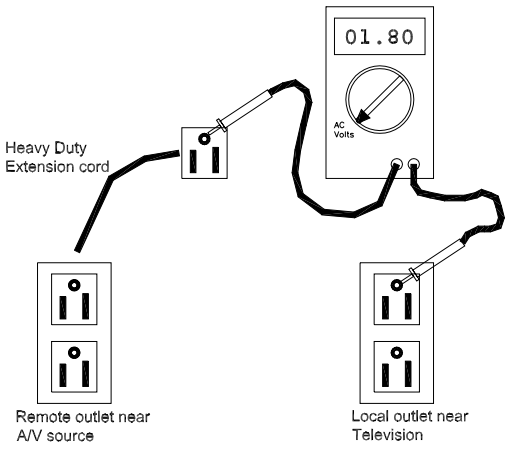
The hum in the system might also be induced into the video cabling by being routed too closely to an AC power cable. The signal and AC power cables should never be bundled together.

b. How do we find the source of AC induced hum bars?

The best way to eliminate a hum bar is to simplify the system as much as possible and start from a known good condition. This means if a system has a multiple signal sources and several displays fed through a distribution amplifier, start by disconnecting devices from the AC outlet one at a time while monitoring the video quality. It may be advisable to disconnect all the displays from the AC outlets and connect one at a time until the hum bar appears. In larger display systems, it may actually be a combination of several outlets or several pieces of equipment.

One tool useful for diagnostics is a simple LED outlet tester that can be obtained at most major retailers. Plug the tester into the outlets and verify that the LEDs indicate that the outlet is wired properly. Do not assume anything; test both outlets of duplex receptacles. Disconnect sets from the outlet while testing as they may give a false indication.
Once an AC outlet is suspected of being the source of ground current flow, it should be tested further with an AC voltmeter. Of particular interest is the measurement of the voltage on the ground pin relative to the ground pin of a near by AC outlet. An extension cord may be needed if the voltmeter probes do not reach the next outlet. Set the meter to measure AC voltage. Connect one probe to the ground of the first outlet and the second probe to the second outlets ground socket. Verify that the meter is reading 0 volts. It there is a reading of more than a few hundred milli-volts, the potential for ground loop current exists.

Method for discovering the source of AC ground current.



Caution:
AC Electrical Outlets are potentially deadly. Use caution.

Run an extension cord from the first outlet in the display system to one near the end of the display system. Set the multimeter to read AC voltage. Place one probe on the round ground socket of the extension cord and the other probe in the round ground socket of the local outlet. The meter should register less than 100 mV. If the meter reads 1 volt or more, there could be a serious problem with the AC electrical grounds. A qualified electrician should repair the ground fault.

How do we get rid of AC induced hum bars?

c. Use equipment that compensates for them.

Distribution amplifiers are manufactured that incorporate a balanced input circuit on every signal input. This creates a virtual signal ground that is much higher in impedance and tremendously reduces the current induced by the AC ground imbalance. Unfortunately, these amplifiers have historically been astronomical in cost relative to a traditional amplifier as the circuitry is quite involved. In the third quarter of 2007, we will be introducing CE Labs version of the isolated ground distribution amplifier. The cost will be only a marginal increase above our industry leading reasonable pricing.

d. Install equipment that eliminates them.

There are video signal isolation transformers which break the ground connection between the source and display. While this is an effective solution, there are several drawbacks.

- The system bandwidth is reduced on both ends. There is a high frequency roll-off and the response no longer extends to DC.
- A good quality transformer is very expensive. A quick search on the Web reveals a five channel isolation amplifier costs in excess of one thousand dollars.
- A transformer is required on every line; this means three for the video and two for the audio.

Fix the source of the problem.

This is by far the best solution. The other solutions above are merely applying a patch to the problem. If the source of the problem cannot be found, it may be necessary to use one of the patches, but only as a last resort.

Make certain that the audio and video cables are not bundled up together with or routed parallel to the AC power cords. The magnetic fields produced by the power cords may couple into the signal cables if they are in close proximity to one another.

Make certain there are no high current devices located within close proximity to the video system. Induction motors and heating elements are just an example of devices that generate huge AC magnetic fields.

It is imperative to find the outlet or outlets or possibly the television that is causing the AC ground current to induce the hum bar. Refer to the section above finding the source. An electrician may be needed to correct any problems with the electrical outlets. A two prong to three prong AC cord adapter may be used to troubleshoot and identify the problem outlet, but must not be left in place as it removes the ground that is there for the consumer's protection.

It might also be possible that the outlet or power strip has a defective receptacle due to a broken wire or a corroded contact.

Once a problem outlet has been identified, try powering the units normally plugged into this outlet by extension cord that is plugged into the outlet powering the video source device. If the hum bar is not present, this proves that this outlet needs repair by a qualified electrician.