# CCTV VIDEO TRAINING MANUAL

Someone once said, "Knowledge is the key to success". This rule also applies to the installation and maintenance of CCTV camera equipment. Have you ever installed a CCTV camera system and then had to go back to solve a problem that was overlooked. A basic understanding of CCTV video signals, can save you hundreds of man hours, improve customer relations and increase job profitability all at the same time. This manual will discuss problems and solutions for CCTV camera installations.

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## VIDEO LEVELS.

To discuss video let's start with the unit of measure, the I.R.E. unit. I.R.E. stands for Institute of Radio Engineers, this regulating body set the standards of measure for the video industry. This standard has been adopted by all industries in the United States and other parts of the world. 140 I.R.E. units is equal to 1 Volt Peak to Peak. I.R.E. units are easier to use because they divide into a video signal evenly.

For example proper Sync on a camera is 40 I.R.E. units, the Voltage equivalent would be 0.2857143 Volts. Unfortunately this voltage cannot be measured on the Volt Ohm Milliamp Meter that you use for checking contacts. An oscilloscope has been used by some people for this purpose, but it is bulky and does not read in I.R.E. Most people would rather use the simple 40 I.R.E. units of measure. Fortunately some equipment manufacturers sell hand-held battery operated meters to measure the video signal in I.R.E. units. This equipment is compact, extremely accurate and simple to use. Some units like the "CAMERA MASTER" can even help to set the focus of a camera more accurately.

## HOW SYNC PULSE AMPLITUDE EFFECTS CCTV INSTALLATIONS.

A CCTV video camera creates synchronization pulses to lock the viewing monitor on the picture. These pulses occur at a rate of 15,750 times a second. There is one synchronization pulse or (sync pulse) for each line in the picture frame. The sync pulse tells the video monitor to start drawing a video line across the picture screen. When it gets to the end of the screen another sync pulse begins the next line, and so forth until the screen has been filled with lines. It takes 262 and a half lines to form a frame, and two frames to form the video picture we see on the monitor.

The proper level for sync is 40 I.R.E. units. If the sync signal from the camera is too small in amplitude the picture will break up or roll. If the sync pulse is too big, any black portion of the picture will be more gray and the dynamic range of the picture will be degraded. Peak white level will also be compressed causing a blooming effect (loss of picture definition).

## WHITE LEVEL IRIS SETTING, HOW MUCH IS ENOUGH?

There is a standard for Iris setting, or white level and it is 100 I.R.E. units. When setting a manual iris, or an automatic iris the level should be the same, 100 I.R.E. units. If you set the iris below 100 I.R.E. units, the picture will be dim with less than desired dynamic range and the white picture elements will not be pure white.

If you set the iris for more than 100 I.R.E. units, the picture can be washed out causing loss of picture definition. Some cameras can be set to 120 I.R.E. units, but it should be noted that the standard is 100 I.R.E. units and in any case all cameras in the system should be set to the same level of white. This will ensure that the white portion of the picture will be the same brightness when a monitor is switched between them.

## PEAK TO PEAK MEASUREMENT OF VIDEO.

A quick measurement of the peak to peak video signal will re-assure you that the CCTV camera is putting out the right level. The standard level is 140 I.R.E. units.

## COLOR CAMERAS AND COLOR BURST.

More color cameras are being used in CCTV installations. The color camera adds a chromanance component (color information) to the signal, also known as Chroma. This Chroma signal operates at 3.58 Mega-Hertz. The standard level for the Chroma is 40 I.R.E. units. When the chroma level is low, the colors will be dull. If this level is too low, the color monitor will turn its color receiver off causing a Black and White only picture. This condition also indicates a loss of picture detail. You can see this effect on long cable runs. The solution is to install a video equalizer in the line and adjust the color burst back to 40 I.R.E. units. If the Chroma signal is too high the picture will display color flaring and reduction of detail at the edge of the color flare.

## VERTICAL INTERVAL, ITS MANY USES.

The Vertical Interval (V.I.) is the part of the video signal that tells the monitor to start drawing a new screen. It is made up of special SYNC pulses with no picture elements. The standard level for these SYNC pulses are 40 I.R.E. units. All video SYNC pulses should be 40 I.R.E. units. The Vertical Interval is a very useful place to put alarm and control signals. Some manufacturers make equipment for pan and tilt camera control, alarm contact information, and data transmission that is inserted into the V.I. signal and sent up or down the cable.

## TERMINATION, THE END OF THE LINE.

A termination for video is a 75 Ohm resistor placed at the end of any video cable to prevent signal reflections that cause ghosting or multiple images on the monitor. Some CCTV equipment have built-in terminations some of which are switch able. If you are using this equipment in series, you must switch off all Terminations except the termination at the last piece of equipment in the cable run.

Proper termination can be checked by measuring the SYNC pulse amplitude anywhere in the video cable. It should read 40 I.R.E. with the termination ON, and 80 I.R.E. with the termination OFF. If the SYNC level does not change when you remove the termination, the camera or video source is not standard 75 Ohms and should be serviced or replaced. Problems with V.I. control systems can result if the level does not double when you remove the termination.

## THE BASIC THREE.

To check performance of any CCTV camera installation make sure the SYNC level is 40 I.R.E. units +/- 5 I.R.E. WHITE level should be 100 I.R.E. units +/- 5 I.R.E.. Remember if you want to run high white level say 120 I.R.E., be sure that all camera's in the system have the same level of I.R.E +/- 5 I.R.E. Color burst level should be 40 I.R.E. units +/- 5 I.R.E. SYNC, WHITE, and COLOR BURST are the three basic measurements to make to insure proper operation of your CCTV system.

## CCTV VIDEO GROUND LOOP PROBLEMS.

When Video Ground Loop problems or 60 cycle Bars occur, they are easy to see on a video monitor. They look like a horizontal band or bar across the video monitor that slowly moves up the video screen. These bars can be barely noticeable, or can be so bad that the video monitor loses lock and breaks up the picture. If the video camera is Line-Locked to the 60 cycle main power, the bars may stand still in the picture, but they still obscure picture definition and create customer complaints.

The source of the 60 cycle bar originates from the power industries use of local grounds to balance their power grid. Everywhere 60 cycle power is used, a local ground is attached to the power grid to return all unbalanced current flow to ground. As an example, you will notice that every main power breaker box will have a ground wire or conduit going to a ground rod or similar device connected to an earth ground. Every correctly installed power outlet will have a connection to this ground.

Not all grounds are created equal. In fact the earth ground in one building is most likely to have a different voltage potential relative to any other building, even grounds inside the same building will have different voltages between them, based on the uneven current flow of the power load.

Here is how the 60 cycle bar gets into your video picture. If you connect a coaxial cable to a monitor or other equipment that plugs into the 60 cycle main power and the other end of the coaxial cable becomes grounded locally for any reason a Ground Loop is created. Any difference in the 60 cycle voltage between these two ground points will create a current flow in the shield of the coax that induces the 60 cycle AC voltage into your video signal.

It is easy to measure these differential voltages, simply disconnect the video cables at the monitor point and using your voltmeter on AC volts, measure between any two shields of the incoming video cables, you will be amazed at the difference.

The solution is to never connect both ends of a video cable to local grounds. Any cable can be grounded at one end without inducing the ground loop current. When you run coax cable from one building to another, it is acceptable to install through connection points, but do not allow the shields to come into contact with one another or the local ground. A coaxial connector laying in a cable tray or conduit box can accidentally contact ground, don't let this happen. Use tape on the connector to prevent accidental grounding. Also try not to attach the camera to any structure that is likely to be grounded. Remember that the camera is already grounded at the opposite end of the coaxial cable by the monitor equipment.

At the monitor station you may have many pieces of equipment connected together, like a (Quad, Tape Recorder, Monitor) all of which plug into the main 60 cycle power. This will not present a problem if you plug all of the equipment into the same power line at the monitor point. Making sure that all the equipment share the same ground point at the monitor station. Also try to keep the video cables between equipment, (the service loops) as short as possible.

If you already have an installation that has 60 cycle bars, there are some steps you can take to solve the problem. If coaxial cable shields are connected together anywhere in the system, separate them if possible. Similarly remove all but one ground connection on each coaxial cable if possible. The ground is usually at the monitor end of the coaxial cable because the monitor equipment plugs into the 60 cycle main power supply which is grounded.

Sometimes a ground loop problem can be reduced by reversing the AC plug on the power transformer used to power the camera, or reverse the 24 VAC power connection to the camera. This technique will not work on DC powered cameras.

If the problem still persists, video isolation transformers can be installed at one end of the coaxial cable to block the shield current flow and eliminate the 60 cycle bars.

These transformers must be installed at the coaxial cable that is originating the 60 cycle bar problem. Isolation transformers only work when they can block the current flow in the shield. Once 60 cycle bars become part of the video signal, no economical down stream solution will remove the bars. Use a portable monitor to find the origin of the ground loop problem, start at the camera and move down the coaxial cable until you see the bars appear on the portable monitor. This then is the coaxial cable with the current in the shield. Clear the ground connection or install an isolation transformer at this point.

The type of AC power transformers you use to power your cameras can contribute to Ground Loop problems. A ground can be introduced to your camera "Capacitively" through the power transformer windings depending on the type and construction technique used to build the AC transformer. Some transformers are built by winding a primary (the 110 VAC side) on a metal core, then simply winding the secondary coil (24VAC) directly over the primary coil. This puts the primary and the secondary in direct capacitive contact. This type can cause Ground Loop problems.

Other manufacturers build their AC transformers with a split bobbin. That is each winding is separately mounted on the metal core. The separation of primary and secondary coils are greatly increased, reducing the capacitive coupling and removing the unwanted second ground in your system. This type of transformer usually does not cost any more, and may prevent the 60 cycle ground loop from occurring. It would help if you determine which transformers are built to minimize capacitive coupling between windings and purchase that type only.

With an understanding of Ground Loop problems and the use of good single ended grounding techniques, you should be able to keep the 60 cycle bars out of your CCTV installations.

## CCTV FOCUS PROBLEM SOLVING.

Have you ever wondered why Auto Iris cameras seem to go out of focus at night? Many installers have had to return to the job site at night and reset the focus of a camera to solve this problem. This can be costly to your company's pocket book and reputation. There is a solution to the problem that will enable you to set the cameras focus correctly every time, day or night.

Let's examine what causes the Auto Iris camera to go out of focus when the lighting level changes, as it does day to night. All lenses and Auto Iris cameras exhibit this effect to a greater or lesser degree.

## DEPTH OF FIELD, WHAT IS IT?

All lenses have a characteristic called Depth of Field. Depth of Field is a zone in front of the lens that is in focus. It is measured as the minimum distance and maximum distance from the lens where objects are in focus. All objects inside this minimum and maximum bracket zone will be in focus. The further away you go from this bracketed "in focus zone", either toward or away from the camera the more out of focus the objects become.

## THE PROBLEM WITH AUTO IRIS LENSES.

The Auto Iris lens has a movable aperture inside the lens that controls the amount of light allowed to pass through it. This aperture also directly controls the Depth of Field of the lens. So an Auto Iris lens will have a variable Depth of Field depending on the amount of light entering the lens. This causes the minimum and maximum bracket zone of focus to change when the lighting level changes.

During the day or in bright lighting conditions the Iris is closed down to a small opening, and the Depth of Field is quite large. So called Pin Hole cameras exhibit this effect where all objects in the scene are in focus. However with movable iris cameras at night or in low lighting conditions the Iris is open wide, this causes the Depth of Field to collapse down to a smaller minimum and maximum bracketed zone of focus. An object that was inside the zone of focus during the day can be outside the zone of focus at night.

## THE SOLUTION.

One way to set up the camera to minimize the Depth of Field problem, is to adjust cameras focus at a time when the light level is at its lowest. This may not be convenient for your installers.

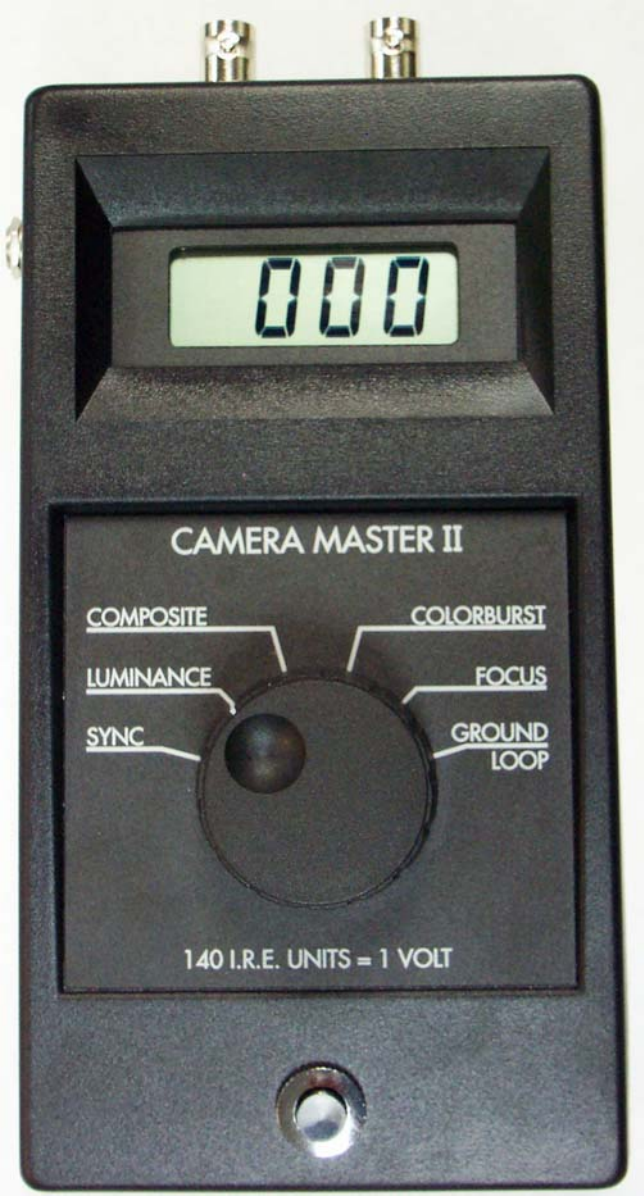
The best way is to use a SHADE 5 FILTER PLATE also called a #5 welders glass filter. It is the filter plate that welders look through to protect their eyes during welding operations. When you have full daylight or bright lighting conditions the filter plate is placed over the cameras lens to simulate half lighting conditions.

This filter plate costs only a few dollars and should be carried by installation personnel to every job site for use with Auto Iris lenses, especially those jobs using outdoor cameras. By using the filter plate to adjust the Auto Iris, you will be centering the control range of the Auto Iris system. This will give you optimum performance from your cameras Iris control system.

Hand held focus meters such as the CM-2 Camera Master are also useful in determining the maximum focus of any scene. They are more accurate than large screen monitors and much easier to take up a ladder. They display the maximum focus numerically on an LCD type display. By eliminating the subjective nature of focus setting, you will insure that all cameras will be set to their maximum focus by any installer.

An understanding of Depth of Field and the proper setting requirements for Auto Iris cameras will save you time and reduce the frustration of having to return to the job site to refocus cameras.

CM-2




THIS METER WILL MEASURE VIDEO I.R.E. UNITS AND ALOT MORE!

## HOW TO SHOOT A LICENSE PLATE WITH A CCTV CAMERA.

When your customer asks you to set up a camera to grab a shot of a license plate on a car, here are a few things you will want to know.

## WHERE TO LOOK.

When setting up a camera to view a license plate, the framing is very important. You must frame the camera so that the plate will be in the camera's view no matter where the plate is mounted on the car, or how the car is positioned in the roadway. The first trick is make sure you place the camera so that it can clearly see the numbers and letters on the license plate. Be sure to set the camera focus control for the sharpest focus. Make sure the plate is large enough in the scene to be identified. If you can do a good job of this, most installations will work very well during the daylight.

The camera works well during the day because the light from the sun is strong and defused, it comes from many sources by reflections off of all the objects in the immediate area.

## THE PROBLEM.

Unfortunately an unaided camera does not do as good a job of reading license plates at night. They need some assistance to work well under dark circumstances. Even if the scene were well lit for observation by eye, a car presents special problems for a video camera.

Often area illumination will be placed immediately over the entrance and exit gates, a narrowing point just where you would like to see the license plate. Just as the car enters the gate area, a reflection from the overhead light bounces off the windshield and blinds the camera. The most common sources of camera blinding light are the headlights on the car. Any direct light source pointing into the camera lens at night will cause a camera blinding effect.

The camera blinding effect at the least will result in a loss of detail around the direct light source, like a blooming effect or halo. At its worst it can darken the screen so that you will only see the two headlights and everything else on the monitor will be black and unreadable.

## THE CAUSE.

The blooming effect or halo type of loss is caused by the scattering of electrons on the CCD element inside the camera.

This darkening effect is caused by the auto iris in the camera. When it sees the bright hot refection or headlights, the iris in the camera will close down the opening in the lens. An auto-iris takes the light that it sees and tries to determine how to set the opening in the lens for the best picture illumination. It can use a peek measure of the light level entering the lens, or when you engage the “Back Light” feature it will take an average of the light ignoring the hot spots. Unfortunately the back light feature in most cameras will not handle headlights or windshield flashes and only reduce the problem somewhat.

A CLUE.

A clue to the answer comes from the relatively good observations made during daylight. During the day most of a cameras received light comes from defused light and even if a car has its headlights on the camera hardly notices it, because the energy from the headlights are just a small portion of the light entering the lens.

HOW TO MAKE IT WORK.

To reduce the blinding effect of reflected light sources you can install a light source pointing directly at the car from the direction of the camera to where you wish to read the license plate. The light source must be bright enough to overwhelm the headlights on the car and stop the cameras auto iris from closing down due to the increase in direct light. To avoid blinding the driver of the car, you must use an infra red light source. People cannot see light in the infra red spectrum, but cameras can. In fact most CCTV cameras are very sensitive to the infra red light spectrum and will work quite well. Infra red light sources are available from the same manufacturers that you buy your cameras from.

Try a test the next time you have a license plate reading camera. Arrange the camera in the normal way, and see what happens when the cars lights are turned on. Notice the darkening of the picture on your monitor. Then point a regular bright white spot light at the car from the direction of the camera. Notice that the scene gets brighter but also the headlights have less of an effect on the iris of the camera and you can see more of the details of the car, with much less blinding effect.

The main point here it to overwhelm the direct light coming from the car with a source of light coming from the camera. If you do this, license plates can be seen easily even under the worst conditions.

## HOW TO MEASURE CCTV CAMERA OUTPUT IMPEDANCE.

The vast majority of coaxial cables are either 50 Ohm or 75 Ohm Characteristic Impedance. This Characteristic Impedance is determined by the ratio of the diameters of the shield and core wire and the Dielectric Constant of the insulating material between the core wire and the shield. The CCTV Industry chose to use the 75 Ohm standard for coaxial cable.

Since a coaxial cable must be terminated at both ends of the cable with resistances equal to the cable Characteristic Impedance to prevent reflections from impairing the picture, cameras must have an internal source impedance of 75 Ohms, and Monitors must be provided with a 75 Ohm termination.

## THE PROBLEM.

In the past, CCTV cameras could be counted on to have proper 75 Ohm source impedances, but recently there have been a rash of cameras showing up on the market that do not have a 75 Ohm source impedance. In fact they exhibit almost zero output impedance even though the specification sheets that come with them specify 75 ohms! Clearly the cameras do not meet their own specifications and thus could be returned for not meeting their own published specifications.

## PROBLEMS CAUSED BY INCORRECT TERMINATIONS.

The worst of termination problems occur when the camera has a zero source impedance, or the 75 Ohm impedance is left off at the Monitor location. By far the worst effects occur when both zero Ohm source impedance exists and the 75 Ohm termination is removed at the Monitor.

Ghosts and Ringing become more evident as the length of the coaxial cable becomes greater. The ringing effect (where a white-to-black or black-to-white transition in the picture is repeated many times in close succession) occurs with short cable runs of 50 to 200 feet. Obvious Ghosts appear when the cable is 500-1000 feet long. The first of many successive Ghosts will be about 1/2 inch to the right of the original object on a TV monitor screen with about 1000 feet of cable.

Another problem caused by zero source impedance cameras is that signals placed on the coaxial cable to control Pan and Tilt of the camera will be shorted out by the zero Ohm output of the camera and may cause remote Pan and Tilt systems to be intermittent or fail.

The same intermittent or failed condition may be induced into other equipment that is using the same coaxial cable to transmit special signals.

The key idea here is that such intermittent or failed conditions are caused by a CCTV camera with a zero output impedance, not a failure in the Pan and Tilt or other equipment.

THE SOLUTION.

Buy only CCTV cameras that exhibit 75 Ohm output impedance! But how can you be sure a particular camera really has 75 Ohm output impedance when the spec sheets for that camera proclaim 75 Ohms? The answer of course is to test the output impedance before installing them in the field. Unfortunately this measurement cannot be made directly with your trusty Volt-Ohmmeter. The output impedance of a CCTV camera is not a static Resistance reading, but a dynamic AC Reactance measurement.

CORRECT MEASURING OF CAMERA OUTPUT IMPEDANCE.

Connect the camera to be tested through a short 75 Ohm coaxial cable to an Oscilloscope, Waveform Monitor or CM-1 Camera Master. Arrange to be able to place a precision Termination (75 Ohms +/- 1%) at the Oscilloscope or meter. Measure the amplitude of the sync pulse with the termination in place. The sync pulse should read about 40 I.R.E (0.286 Volts Peak-to-Peak). Now remove only the 75 Ohm Termination. The sync level will Double (80 I.R.E 0.571 Volts Peak-to-Peak) if the camera has the correct source impedance. A typical defective camera well read almost the same amplitude with or without the termination on it. An actual output impedance measurement may be made by using the formula in the following TABLE 1.

SYNC PULSE PASS / FAIL TEST TABLE 1.

| UNTERMINATED | | TERMINATED | | | SOURCE IMPEDANCE |
|---|---|---|---|---|---|
| Vp-p | IRE | Vp-p | IRE | | |
| 0.571 | 80 | 0.286 | 40 | PASS | 75 Ohms (=/- 5%) |
| 0.286 | 40 | 0.286 | 40 | FAIL | NEAR ZERO Ohms |

Even though exact readings will vary between various CCTV cameras, this test will suffice as a PASS/FAIL test. If a more exact measurement is desired, the following formula may be used.

CALCULATION OF PRECISE SOURCE IMPEDANCE.

$$S = \frac{U - T}{T} \times 75$$

U = Un-terminated Reading of Sync IRE or Voltage.
T = Terminated Reading of Sync IRE or Voltage.
S = Internal Source Termination in Ohms.

## DIGITAL VIDEO RECORDER PROBLEM SOLVING.

The new digital revolution has brought us many new and exciting products for the CCTV industry. The DIGITAL VIDEO RECORDER or (DVR) may be one of the most important upgrades that can be made to any CCTV system. The DVR takes a camera video signal and converts it to a digital bit stream and saves it on a computer hard drive. It can then be played back with remarkable fidelity. This new technology brings with it a new set of problems and solutions. This article will discuss some of the problems and solutions for DVR installations. To understand the problem we must look at the standards.

## STANDARDS.

A video standard was developed by the Institute of Radio Engineers so that all manufactured video equipment would be compatible. The unit of measure for this standard is the I.R.E. Unit. One I.R.E. unit is equal to .007142 Volts peak to peak. A Black and White (B/W) video signal is 140 I.R.E. units equal to 1 Volt peak to peak. A color video signal has three vital standard measurements the SYNC = 40 I.R.E. units, the WHITE = 100 I.R.E. units, and the COLORBURST = 40 I.R.E. units. Both the B/W and Color signal measure a total of 140 I.R.E. units, but unlike the B/W signal the Color signal measures 1.142857 Volts peak to peak. The additional 0.142857 Volts peak to peak is caused by the color information called "CHROMA" in the video picture. It is a common misunderstanding that all video is 1 Volt peak to peak. Only a B/W video signal is 1 Volt peak to peak, a Color signal is 1.142857 Volts peak to peak. Now how does all this relate to the DVR problem?

## THE PROBLEM.

When properly installed the DVR does not output a video picture, displays a "NO VIDEO" image or has a blank blue video screen. Yet if the video input signal is connected to a monitor it displays a video picture. At first you might think that the DVR is defective, that is very unlikely. It is more likely to be a video level standards problem.

## HEADROOM IN THE DVR.

Most DVR's are designed to accept a video signal of 1 Volt peak to peak with some extra range known as "headroom". This headroom allows the video signal to exceed the 1 Volt peak to peak by some percentage. Usually 20% over the 1 Volt peak to peak video level. That makes it possible for the equipment to accept a video signal of up to 1.2 Volts peak to peak. The standard Color signal measures 1.142857 Volts peak to peak so this amount of headroom should be adequate.

The amount of headroom varies from one manufacturer to another, so you may discover one brand works better than another under certain circumstances, but the problem does not necessarily lie with the DVR.

THE REAL PROBLEM.

One of the most over looked problems in CCTV installation is the output level adjustment of the camera. The standard for camera output is SYNC = 40 I.R.E. units, WHITE = 100 I.R.E. units, and the COLORBURST = 40 I.R.E. units. However some camera manufacturers have "fudged" the standards some what. We find that WHITE levels in auto iris and auto shutter control systems to be padded up to 120 I.R.E. units (1.285714 Volts peak to peak). That is 20% above the standard maximum level established by the Institute of Radio Engineers.

When a camera's WHITE level is set anywhere above 100 I.R.E. units the video signal can exceed the maximum headroom allowed by the DVR and the system will go into digital overload resulting in the failure of the DVR to record a video signal. When a monitor is attached to the video signal the video can be viewed because a video monitor is not sensitive to overload. This would lead you to believe that the DVR is non-functional, when actually the camera level is not set correctly.

SOLUTION.

To avoid DVR problems at installation and subsequent service calls the camera's in the system must be adjusted to the proper standard levels so that the video will not overload the DVR. It is recommended that a Camera Master or waveform monitor be obtained to set the camera's level accurately. If the type of camera you are using will not allow the WHITE level to be set to 100 I.R.E. and you have already purchased the camera's, then you can insert a video correction amplifier like the GB-60 and adjust the gain below unity (a loss of signal) to solve the problem. The Camera Master CM-2 and the Ground Loop Blocker Amplifier GB-60 can be purchased at FM SYSTEMS, INC.

Proper setting of the video levels will correct the problem and an understanding of what causes the problem will help you to solve other level related problems with digital equipment in the future. If you would like more information regarding this or other CCTV related problems call FM SYSTEMS, INC. CCTV HELP LINE at: 800-235-6960.

**GB-60**


**GROUND LOOP BLOCKER AMPLIFIER**

HOW TO PREVENT LIGHTNING DAMAGE IN CCTV.

Protecting a CCTV system and it components from lightning damage does not use the same methods used to protect human life from electrical shock. In fact many of the techniques used to protect humans from lightning also cause some other problems in the CCTV system.

First of all, nothing can prevent a direct lightning strike. The result is usually a smoking melted down blob of carbon and metal. However, if the lightning strike is somewhat off center or just nearby, then there is a chance for electronic equipment to survive, provided certain precautions have been taken to protect the electronic components from over-voltage and over-current. These two things cause electronic equipment to fail.

If you read up on the subject the first thing you learn from the various books on the subject of lightning protection is that you need to “GROUND EVERYTHING”. This process creates as many paths to ground as possible to bleed off current from the strike and keep the destructive voltage from rising to high.

From a human protection point of view this is good solid advice, but from the CCTV equipment point of view this is very hard on the equipment and can reduce the lifespan of the equipment to the first occurrence of a lighting storm.

The “Ground Everything” advice is designed to protect <u>people</u> from electric shock and should be followed wherever possible. But what you must do to protect equipment from damage is very different.

Lighting Protection in the form of diode and gas tube lighting suppressors need to be installed at one end and maybe both ends of any long cable run. The long cable runs are more prone to voltage build ups due to local lightning static discharges.

When lightning strikes from cloud to cloud or from the upper atmosphere to the ground, a differential charge appears on the ground. Since the charge is not equal at all points on the ground, this differential change will cause current the flow down any conductor connected to both grounds. This current flow can be thousands of amperes occurring for only milliseconds, but in that short amount of time the current causes a sharp rise in the voltage that can reach thousands of volts. Your CCTV equipment is not designed to withstand that kind of voltage at the video input and output terminals, so the equipment gets permanently damaged.

For safety sake you should install lightning protection on your video cables but be sure to BOND EVERY LIGHTNING PROTECTION DEVICE with the LEAST POSSIBLE **INDUCTANCE** TO MINIMISE THE AMOUNT OF VOLTAGE THAT WILL BE DEVELOPED BETWEEN THEM WHEN THE LIGHTNING DOES STRIKE. Even a few inches of #l6 wire is enough to generate up to 300 volts or more at the video input frying the video system when lightning strikes, (not because of the resistance of the wire but because of the inductance of the wire connecting the lightning protection unit to the ground).

A lightning strike is a very short duration event, and so the signal it creates has very high frequency content, this is why the inductance of the connecting wires, not the resistance determines the effectiveness of the lightning protection device.

Even a very small inductance on the order of one or more nano-Henrys is capable of generating very high voltages between the video equipment and the lightning protection devices during a lightning discharge. The ground wires on the lightning protection devices should be as short as possible. Do not add extra wire to the ground wire to extend the connection, instead route the video cable over to the lightning protection device mounted as close to the ground as you can so that the ground path for the current will be as short as possible.

There is one more thing to consider when using lightning protection. Lightning protection requires a good ground to function. That ground can induce ground loop artifacts into your video signal. Now that you have protected your video equipment with the lightning arrestors, you may discover that you now have a ground loop in your video image.

This ground loop is created by the normal ground at the DVR or Monitor and the new ground applied by the lightning arrestors. This will look like black or translucent bars on the video image. These bars can stand still or move slowly up the screen. When the bars reach the top of the screen others will appear at the bottom of the screen to take their place.

Since you cannot remove one of the grounds to eliminate the ground loop it may be necessary to install ground loop blockers to finish the system. The ground loop blockers will remove the interfering signals created by the lightning arrestors and the arrestors will protect the system from lightning strikes. The ground loop blockers are called GB-60, or GB464 and they are available from FM SYSTEMS, INC.

Remember, grounding is for electrical shock protection purposes.
Lightning arrestors reduce damage to electronics from lightning. You can't avoid equipment damage from a direct hit. Both bonding and grounding conditions must be met to protect both people and the equipment.

CCTV LINE-LOCK PROBLEMS.

Someone once said, "Timing is everything". The same thing can be said about Line-Lock CCTV camera installations. The Line-Lock feature is available on most CCTV cameras, and is used to prevent picture rolling on the monitor during switching from one camera to another. Picture Roll will cause the loss of vital picture information in the video recorder and is irritating to view. This article will discuss the problems encountered by installation and maintenance personnel along with solutions to save time and make your job more profitable.

The CCTV camera puts out a series of pulses called "Sync" pulses that allow a video monitor to synchronize the picture on the screen. Special sync pulses called "Vertical Interval Pulses" tell the monitor to begin a new picture. The Vertical Interval Pulses from multiple cameras must be synchronized if you wish to switch from one camera to another without the monitor producing a picture roll. When a roll in the monitor occurs, the Vertical Interval can be seen as a black horizontal bar that appears momentarily on the screen.

Lets look at how the Line-Lock system keeps CCTV cameras in synchronism. To synchronize multiple cameras you must first have a common reference that is all the cameras must share the same timing information. The term Line-Lock refers to the 60 cycle AC (alternating current) supplied by the power company.

This 60 cycle line frequency is the common reference used to lock the cameras together. For this reason only AC powered camera's have the Line-Lock feature. DC powered camera's are not capable of being Line-Locked.

When you select the Line-Lock feature in a camera there is internal circuitry that samples the 60 cycle AC frequency and uses it to time the Vertical Interval Pulses. All Line-Lock cameras have a Phase control that must be adjusted when the camera is installed. The Phase control is adjusted so that all the camera's Vertical Intervals occur at the same time.

One way to adjust this Phase control is to switch between cameras and adjust the control until you no longer see the roll. This trial and error method is time consuming, requires 2 installers (one at the camera and one at the monitor) and is frustrating to accomplish.

The preferred method is to use a VTM (Video Timing Meter) or an oscilloscope to adjust the Phase control. An oscilloscope is an instrument that displays the waveform of the Vertical Interval Pulse. It is hard to set up, requires interpretation of the waveform, and is bulky in size.

The VTM timing meter is specifically designed to quickly adjust the timing error to zero with a digital readout that does not require interpretation of the waveform.

To make the Phase adjustment, you must select one camera as the reference. At the monitor point connect the output of the reference camera directly into the output of the camera that you wish to adjust, use a BNC Barrel connector. This makes the reference signal available at the camera to be adjusted.

Next go to the camera you wish to adjust and insert the VTM or oscilloscope between the camera and the cable you previously connected to the reference camera. Now adjust the camera Phase control to zero on the meter display or zero coincidence of the Vertical Interval Pulses on the oscilloscope. Repeat this step for each camera in the system using the same reference camera. When all cameras in the system are adjusted, no roll of picture will occur when you switch from one camera to another. Once the Phase controls have been carefully set in the system no further timing adjustments will be needed.

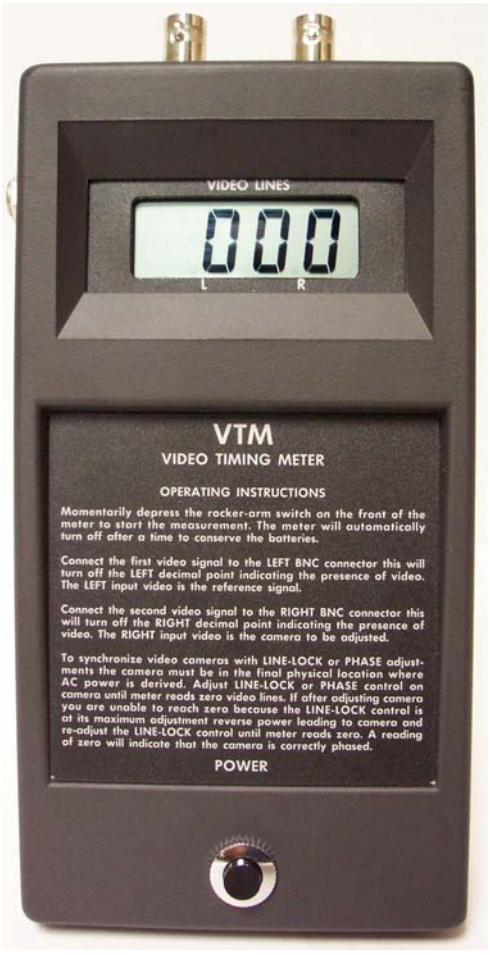
There is one exception. This carefully set Phase adjustment can be upset if the power circuits are re-balanced by an electrician at the power breaker box. When an electrician installs new power circuits into a commercial building, sometimes they will move the circuit breakers to a different Phase in the breaker box.

In commercial buildings the utility power is Three Phase, that is three separate 60 cycle lines whose phase is 120 degrees apart. Moving the power line that your camera is on to a different phase will throw off the timing and require a re-adjustment of the phase control on the camera.

If monitor personnel complain about picture roll, a fast check of timing can be made. Go to the monitor station and connect one camera as a reference to the VTM or oscilloscope and then connect each camera one at a time to make the measurement. The timing should be zero +/- 3 Video Lines or Sync Pulses. A roll can be noticed if the difference between cameras is more than a few lines. As the line difference between cameras increase so does the noticeable roll. If you measure a camera and the readings seem to change, that indicates the camera is not Line-Locked. The solution is to select the Line-Lock feature on the camera or replace it with one that has Line-Lock.

A clear understanding of how the Line-Lock system works combined with a way of measuring the Phase of each camera will let you set them quickly and correctly with confidence.

**VTM**




**VIDEO TIMING METER**

CCTV UPS TROUBLE SHOOTING TIPS.

Many CCTV Closed Circuit Television systems use a UPS Un-interruptible Power Supply to provide guaranteed continuous power to operate a surveillance system. The UPS also provides down stream voltage regulation that protects equipment in the event of under or over voltage swings that occur during “brown-outs” or brief power outages. The UPS will also protect equipment from voltage surges or spikes coming from the Main Power Line. Using a UPS to power your CCTV system is a good idea if you have a budget for it.

SYMPTOMS.

Have you ever had interference in your CCTV monitor that exhibited dozens of narrow vertical lines either black or white, and as thin as a pencil line. They may be staggered or jagged from the top of the screen to the bottom and may even dance side to side slightly while standing in one place or move across the screen slowly from side to side. If the lines stand still and dance around one spot your cameras are line locked, but if they slowly move across the screen then your cameras are not line locked. If you have this kind of interference on your monitor, there is a good chance that the system is being powered by a UPS and that the interference is coming directly from the UPS.

THE BAD NEWS.

Some models of UPS Un-interruptible Power Supplies will induce interference into your CCTV picture. This interference can enter your CCTV system through the ground in the case of shared grounds like a ground loop or directly through the power supply used to power the camera. Technically UPS power supplies come in two output types. The most common kind is the low cost square-wave output type, like the kind used for computers and sold in computer stores, the second less common kind is the sine-wave, semi-sine-wave or quasi-sine-wave type used to power analog equipment.

The word “sine-wave” refers to the output waveform being sinusoidal in the shape. A pure sine-wave has only one frequency, and in the case of line voltage that frequency is 60Hertz or (60 cycles per second). The output of this type is well filtered to remove all other frequencies that might interfere with the equipment it is powering.

The “square-wave” type of UPS will put out the same 60Hertz frequency but its output waveform is that of a square-wave. A 60Hertz square-wave signal contains the “fundamental” or lowest frequency of 60Hertz, however it also has every “harmonic” or multiple of that frequency all the way up to and beyond the video frequency range. Strong high level signals in the Kilo-Hertz region (1000Hz) and even in the Mega-Hertz region (1000,000Hertz) will interfere directly with video. These interfering signals are multiples of 60 Hertz and are locked to the line rate which makes the interference stand still on the screen if your cameras are line locked. If not line locked the interference will slowly move across the screen.

HOW IT GETS IN.

One way that the interfering signal can get into the CCTV system is from a power supply. If a square-wave type UPS is used to power the camera, the high frequency interfering signals can enter through the AC or DC power supply and become part of the video by cross-talking directly to the video amplifiers in the camera. The high frequency interference will get through the cameras power regulators because the camera was designed to filter out 60Hz AC, not hundreds of Kilohertz of AC. DC powered camera’s can have the same problem for the same reason, however the interfering signal will always be moving on the screen because DC cameras cannot be line locked.

GROUND LOOPS AND THE COMMON POWER SUPPLY.

Another way interfering signals can enter the video is through an induced ground loop. The UPS is grounded and if the camera is also grounded some of the UPS energy can flow down the coax cable to the cameras ground. This sharing of grounds will induce the interfering signal onto the video. A ground at the camera can be a tricky thing. If you are using a DC powered camera, the coax cable shield and the negative power supply wire are the same at the camera. This means that if the negative power supply is grounded anywhere, then your camera coax shield is also grounded at that point and it can induce a ground loop.

If you are using a common power supply to power multiple cameras and even one camera is grounded then the ground connection will back up to all of the cameras. Common power supplies for DC cameras are especially susceptible to this problem. The common power supply ground loop may not affect all the cameras depending on the distance of coax and the grounding conditions at each camera.

TROUBLE SHOOTING.

To begin trouble shooting you must first identify the source of the interference. First disconnect the suspected UPS and turn it off (power it down). This will guarantee that the UPS cannot create the interference in the first place. Then reconnect the equipment that was powered by the UPS to a normal non UPS power line. Check the monitor and see if the interference has been eliminated. This test will check for direct camera power supply and ground loop type interference at the same time.

If your interference did not go away and you suspect that another UPS somewhere else in the building is operating, you can check for ground loop interference by placing a battery operated monitor on the end of the coax cable at the DVR end of the system. Observe the monitor. If the interference is gone, that indicates ground loop interference. Confirm this by touching the original DVR ground to the connector shield on your battery operated monitor while you are watching the picture. Use a short wire or a coax jumper (shield only). If you touch the ground to the monitor the interfering signal will re-appear if it is ground loop induced interference.

HOW TO SOLVE THE PROBLEM.

If the interference is resolved by disconnecting the UPS then you should replace the UPS with a sine-wave, semi-sine-wave or quasi-sine-wave type of UPS. The best way is not to create the interfering signal in the first place. If the interfering signal is getting in through a ground loop then isolate the cameras from ground at the camera end. This may be more difficult when using common power supplies however first try an isolated wall mount power supply on one camera to test whether power supply isolation will resolve the problem.

VIDEO LINES OF DEFINITION.

Picture quality can be defined by many different parameters, but the most important from an observed picture detail point of view is the LINES OF DEFINITION as observed on a Monitor. The larger the "number of lines" that can be distinguished, the greater the detail in the picture. The number of Lines of Definition actually has nothing to do with the number of horizontal lines that comprise the picture. In fact, all CCTV cameras used in the United States create exactly the same number of horizontal lines in the picture regardless of the Lines of Definition that the camera can produce.

The term, Lines of Definition actually refers to the number of times the picture screen can be modulated (made lighter and darker) across the screen. Therefore a test pattern for this purpose would display vertical lines on the screen of the Monitor. Fifty white lines alternating with fifty black vertical lines across the screen would constitute a total of 100 Lines of Definition. The more lines that can be discerned, the greater the fine detail observable in the picture.

High picture definition would enable a viewer to clearly see as many as 500 or more "Lines" in each screen width. Medium definition would blur 500 "Lines" but would clearly show 400 or less "Lines". Low picture definition would blur 300 or more lines, but clearly identify 200 or fewer "Lines" per screen width. To clearly identify the picture definition capacity of any specific CCTV system, a test pattern generator needs to be connected at the Camera location and the resulting test pattern observed at the Monitor location.


The VLTG-800 is a Video Line Test Generator that creates a normal NTSC video picture with a test pattern consisting of 100, 200, 300, 400, 500, 600, 700, and 800 "Line" groups. Each of these groups of "Lines" is clearly identified so that you do not have to count the lines on the screen. Monitors may be tested "on the bench" by connecting the VLTG-800 directly to the Monitor under test.

The "Lines of Definition" for that Monitor will be clearly evident on the Monitor screen. This test should be performed prior to any field tests of the CCTV system to make sure that the Monitor does not constitute the limiting factor in overall picture definition.

The ability of a Video Recorder to reproduce a picture without degrading picture quality can also be tested with the VLTG-800 by connecting it to the Recorder and Monitor, recording the test pattern and playing it back into the Monitor. There should be no reduction in the "Lines" as played back into the Monitor.

If it is a Tape Recorder, old or worn tape will play back fewer "Lines" than new tape. Even new tape of different types may show variation in the number of "Lines" played back. Worn Tape Heads will also show fewer "Lines" than new Tape Heads. It is recommended that this test be performed at regular intervals to catch Tape Head wear before performance suffers.

After the Monitor and recorder have been proven to display at the desired quality level, a Camera is chosen that is capable of at least equal "Lines" capability. Now the entire CCTV system is assembled complete with the transmission system (whether coaxial cable, twisted pair wires, fiber-optic, or wireless) to see if the transmission system degrades the overall system performance.

To perform a picture quality test of the complete CCTV system, temporarily replace the Camera with the VLTG-800 test generator. Now the test signal must traverse the transmission system (coaxial cable, twisted wire, fiber-optic, or wireless) as well as the receiving terminal equipment. The video losses encountered in the transmission facilities will degrade the number of "Lines" observable in direct proportion to the length and type of facility.

Now compare the "Lines" observable through the entire system to that observed on the Monitor alone. If the "Lines" have been significantly reduced below the performance target because of the losses created by the transmission facilities, then it is time to consider applying amplifiers and equalizers to the system to bring it up to performance targets.

Loss of video level and the even much greater loss of high frequency resolution occurs on coaxial cable and twisted wire (UTP) facilities in direct proportion to the length and quality of those facilities. Serious loss of quality in terms of "Lines" can begin to occur in un-equalized transmission facilities as short as 400 feet or less.

Finally, after the Monitor and Recorder have been proven to display at the desired quality level, overall tests can be made, including the Transmission facilities. To do this, temporarily connect the VLTG-800 in the place of the Camera and observe the number of "Lines" that are clear on the Monitor. If the number of "Lines" now observable is lower that the desired quality performance level, that condition can be cured by adding amplifier/equalizers to the transmission facility.

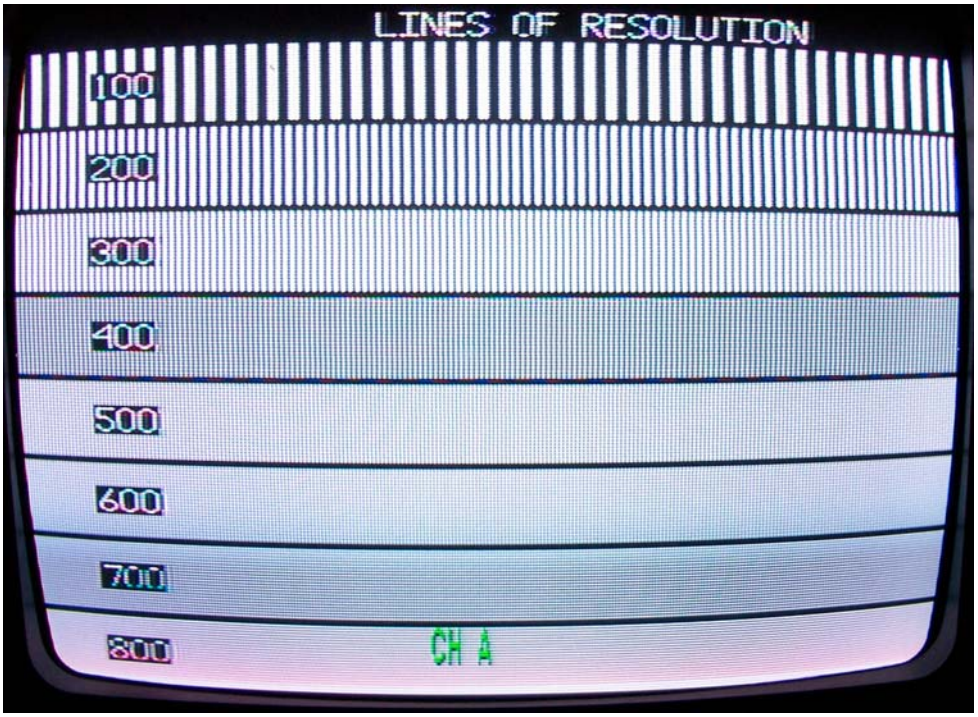
Twisted Pair (UTP) and coaxial cable equalizers can <u>fully compensate</u> for the loss of picture level and loss of "Lines of Definition" in cables up to about 4000 feet.

Even greater distances of 8000' or even 12000' can be equalized by adding intermediate "booster" amplifiers and equalizers. These cable equalizer/amplifiers are made by a variety of manufacturers, and when included in CCTV system designs can completely offset the cable or twisted pair loss so that the resultant "Lines" delivered are as good as the Camera, Recorder, and Monitor can produce "on the bench". In effect, when a transmission facility is properly equalized, the transmission facility becomes "transparent" and will not degrade the picture that a given Camera, Recorder, and Monitor can produce.


The VLTG-800 becomes instrumental in adjusting the equalizers and amplifiers for optimum performance. It is not enough just to add some gain and equalization to the transmission facility. It is just as important to add the right amount of compensation. More compensation than is required is just as bad as none, or too little compensation. The VLTG-800 in conjunction with the CM-1 Camera Master makes it possible to correctly equalize any cable so that it becomes transparent to the video signal.

To exactly compensate for cable loss, temporarily connect the VLTG-800 in place of the Camera and connect the CM-2 Camera Master in line with the input to the Monitor. With all of the equipment turned on and working correctly, observe the CM-2 (on the SYNC scale). Adjust the amplifier LEVEL control until the CM-1 reads 40 IRE Units. Next set the CM-2 to the COLOR BURST scale and adjust the DEFINITION control on the equalizer until the CM-1 reads 40 IRE Units on the color burst scale. When both SYNC and COLOR BURST read 40 IRE Units on the CM-2, then the transmission system is perfectly aligned to the optimal 40-40 condition and the transmission system is now transparent to the video signal. In this condition the transmission system will transmit the full capability that any Camera, Recorder, and Monitor can produce.

Using the VLTG-800 Video Line Test Generator as a test signal source and the CM-1 Camera Master as the picture quality measurement system enables a specific quality Proof of Performance to be performed on any new transmission. Component parts can be evaluated as to picture quality to isolate, identify, and replace non-conforming parts to upgrade CCTV system performance. In particular, the loss of “lines” caused by the coaxial cable or twisted pair transmission facilities may be completely compensated by using cable equalizer/amplifiers such as the GB-60, GB60-UTP, or GB-464 so that every CCTV system you install will have the best pictures possible.




For more information about cable equalizer/amplifiers contact FM SYSTEMS, INC. at: 800-235-6960 or 714-979-3355. FM SYSTEMS, INC. Santa Ana, CA.

FIBER TRANSMISSION PROBLEM SOLVING.

Have you ever installed a fiber optic video transmitter / receiver and discovered that you were not getting a good signal output and you knew you were putting in a good video signal but you were not getting the same good signal out. The video image would roll or appear darker than expected. Then when you used the AGC (Automatic Gain Control) or the Iris on the camera to make the picture brighter, the response was not what you expected. If you have you are not alone, many installers have experienced this problem and struggled to solve it without understanding the cause. Knowing what causes bad pictures in a fiber optic transmission system will save you many hours of trial and error repair time.

HOW FIBER SYSTEMS WORK:

To understand the problem it will help you to know how a video fiber optic transmitter and receiver work. When you connect your video signal onto the fiber transmitter that signal is first put through a buffer amplifier to control the input impedance and then the video signal is clamped to the tip of White, the most positive part of the video signal. After that the signal can be directly modulated onto the fiber using the AM (Amplitude Modulated) system or it can be introduced onto the fiber using the FM (Frequency Modulated) system.

Both systems will work quite well in most applications, but both systems use a "TIP OF WHITE CLAMP" which can create a problem. In most video equipment normal clamping is accomplished by using the "Back Porch" part of the video signal. This type of clamp holds the minimum luminance or black level in one place so that overall video level changes do not affect the relationship between the Sync Pulse and the Luminance level in the video signal. Next the signal goes through shaping circuitry and then on the light source. This is usually a Light Emitting Diode LED or LASER diode.

The receiver works in very much the same way but in the reverse order, with light from the fiber hitting a light sensitive receiver element or photo detector which converts the light signal into an electrical signal, then the signal goes into an AGC (Automatic Gain Control) to offset any light amplitude losses incurred in the fiber run. The AGC is a required part of the system but it combined with the Tip of White clamp creates a problem. Next the signal is demodulated using either the AM or FM process back into a video signal.

THE CAUSE OF THE PROBLEM:

Remember the "tip of white clamp" in the transmitter, it uses electronic circuitry to make the most positive part of the video waveform stay at a particular voltage no matter what size or shape of the waveform. This type of "clamp" is used to keep the maximum white level of the video at the maximum illumination point for the LED or LASER light source.

Then in the receiver there is an AGC to make up the loss of light in the fiber, this is necessary to improve the signal to noise ratio in the fiber optic system, but it also creates a problem. The AGC raises or lowers the video signal to keep it at 140 I.R.E. units peak to peak regardless of the input level. This type of clamp and AGC is quite effective at maintaining good operation of the fiber optic system, but it requires a correct input video signal to operate properly.

If the input video signal deviates from the established standards, the tip of white clamp will change the relationships within the video signal according to how much the video input level is off of the standard level.

The standard level expected by the fiber equipment is 140 I.R.E. units, specifically 100 I.R.E. units of White (Luminance) and 40 I.R.E. units of Sync Pulse (Synchronization Pulse). The manufactures of fiber equipment rely on this standard and expect the video source to be correct in order to deliver the video correctly.

The equipment manufactures will tell you that “what you put in is what you get out” and this is true, but only if you put in exactly a 100/40 video signal, any other signal will give you a "non-unity" altered signal output. The relationship between the input and output will vary depending on the relationship between the Luminance and the Sync signal input.

Example #1: If your input Luminance starts out as 130 I.R.E. units a 30% increase over a normal level, and the Sync level is a normal 40 I.R.E., this ads up to 170 I.R.E. units, the clamp will reduce the total signal to 140 I.R.E. units, this will change the Luminance signal to 107 I.R.E. and the Sync signal to 33 I.R.E. This condition reduces the Sync level and could produce picture rolling if the condition gets worse.

Example #2: If your input Luminance is 70 I.R.E. units a 30% decrease from normal video level and the Sync is 40 I.R.E. normal, equaling 110 I.R.E. The clamping system will convert these levels to 89 I.R.E. units of Luminance and 51 I.R.E. units of Sync. This condition will produce a darker than expected video image. The higher Sync level can cause synchronization problems as well.

As you can see both the Luminance and the Sync levels are altered by the fiber system if the Luminance level is not an exact 100/40 = 140 I.R.E. level. This is the reason that your video input level may vary from your output level when traversing a fiber optic system. You can test this process and see it for your self. In a fiber optic system, cap the camera so that the luminance level is zero. Then measure the Sync level, it can be as high as 140 I.R.E. units depending on the range of the AGC in the fiber receiver. The normal level of Sync is 40 I.R.E. units. This black out effect can cause Sync Pulse overdrive in the DVR or monitor. This effect can be seen as rolling or tearing of the picture at night when the picture is extremely dark.

There is another condition that can occur that will have devastating effects on a fiber systems output. This problem is one that affects older established systems, if the system was working and begins to cause problems, look at the levels at the output of the fiber system.

If the Sync signal is unusually high (over 50 I.R.E. units) it may be possible that the internal 75 Ohm termination has been damaged by a lightning storm or other high voltage ground-loop related occurrence. Lightning storms can cause a permanent increase in the termination resistance or a removal of the termination completely. This will cause the video level to go up radically and if the camera cannot deliver a total of 240 I.R.E. units or the clamp and AGC (automatic gain control) inside the fiber unit cannot handle the increased level then the output level of video will be corrupted.

THE SOLUTION:

Careful measurement and setting of the video levels originating from the camera is the best way to solve the problem caused by the clamp in the fiber optic equipment. You should have a way of measuring video levels of both the Sync and Luminance levels to properly determine the extent of the problem and to set the camera correctly.

TOOLS:

If you do not currently have a way of measuring video levels a meter that allows you to measure the Sync and Luminance is a must. One meter that meets this goal is called a CM-2 Camera Master. It will measure the Sync, Luminance, Composite, Color Burst, Focus, and Ground Loop on any video signal. It is battery operated and portable. It is also small enough to take up a ladder to set up any camera. It is manufactured by FM SYSTEMS, INC. Santa Ana, CA. 800-235-6960.

A HELPING HAND.

If you cannot isolate the problem and resolve the interference then please contact me at: 800-235-6960 my name is Don McClatchie and I would like to talk to you about your specific problem. Together we can find the solution to your problem.