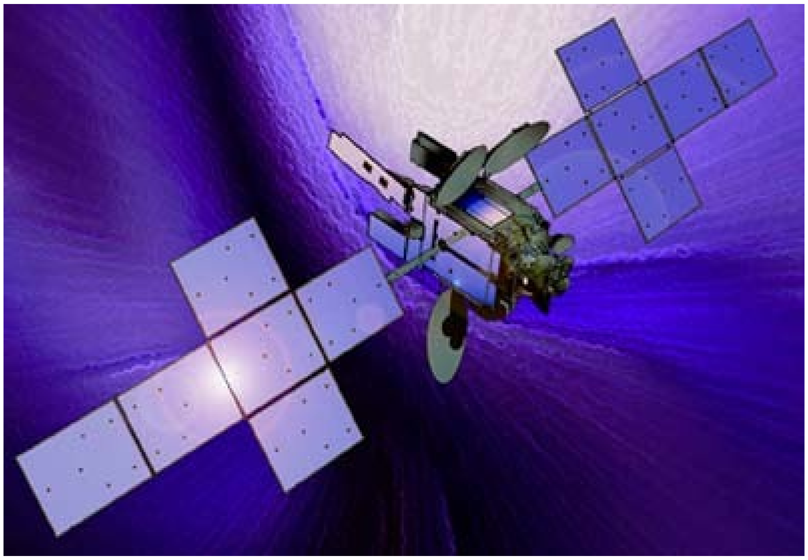

Satellite Uplink Training

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Dedication

I mention a lot of people in this book. They are real people, each one of them has taught me a great deal about satellites, television, and video production. My thanks go to them.

Today, I dedicate this book to "my imaginary friend" Michele Weigold, who reminds me to be myself and accepts me for who I am.

Introduction

Who makes a good satellite truck operator or engineer?

It's pretty difficult to find someone who will make a good satellite truck operator. Look at the lot of us. We've got poets, philosophers, inventors, real estate agents, war veterans, truck drivers, janitors, photographers and news directors. And we even have some real engineers, with actual engineering degrees here and there.

The good ones pull cable.
The bad ones won't.

The good ones know how to find the bird. And if they don't, they try to get there early enough, just in case they have trouble.
The bad ones show up late and can't find anything.

The good ones pull double, triple, and quadruple duty, and often overlook a little overtime here or there.
The bad ones gripe about every lunch break lost, and threaten overtime when they get close to their 10-hour day rate.

The good ones know a lot of people in the business. And if they forget a name, it's because you are one of tens of thousands they are trying to remember.
The bad ones don't remember anybody's name... ever.

The good ones will teach younger, newer people something once in a while.
The bad ones don't understand enough about what they're doing to be able to teach.

The good ones make friends with their competition.
The bad ones don't realize or care that they may be working with that person in the future.

The good ones tend to have a lot of books and manuals around.
The bad ones don't read.

The good ones are often a little more expensive, but are worth every extra penny.
The bad ones are always willing to do it for a lot less, usually because they aren't even worth the price you're paying them.

And in the end, remember what our friend William Shatner said: "It's just a TV show! I mean, come on! Look at you! Have you ever even kissed a girl!?"

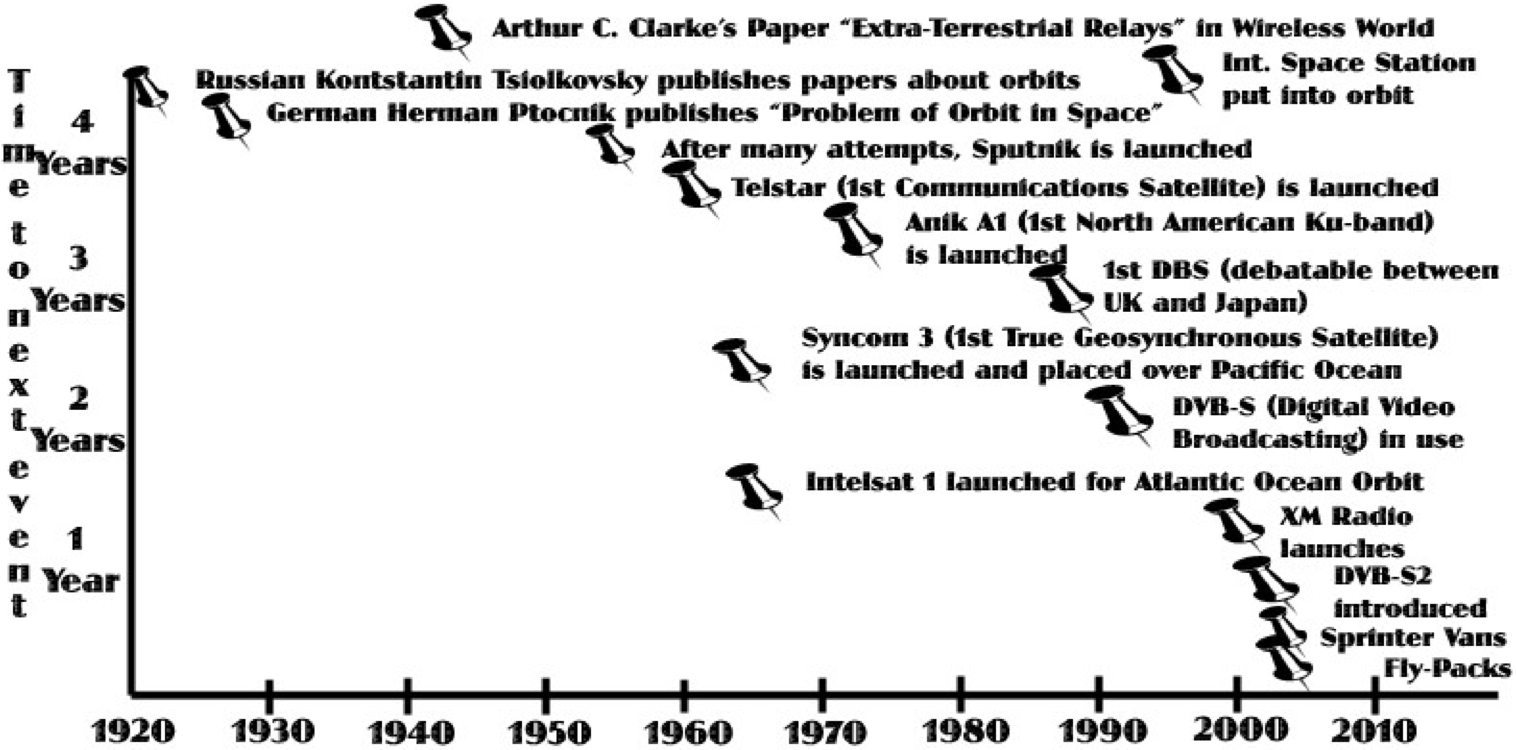
In this career, you will often hear, “This isn't rocket science!” and “This isn't brain surgery!” It is a harbinger of things to come.

With that, let's move on.

History of Live Transmission in Network News and Sports

In the United States, C-Band transportable uplinks (Satellite Trucks or Mobile Earth Stations) were first used to transmit longer-format live television such as sporting events and entertainment programming.

C-Band uplinking requires an RF Interference study, which is basically a computer-generated report detailing any FCC protected microwave stations in the 6 GHz C-Band spectrum in the immediate area,



Time line showing major events in the history of Communications Satellites

including the frequencies and bandwidth they are using.

This "frequency coordination" process has to be completed before an uplink transmission can commence. This is due to Terrestrial point-to-point or tower-to-tower signals sharing C-Band transmit frequencies (5.700-6.500 GHz). What you always need to remember is this: Full time terrestrial signals always take priority over occasional C-Band uplink transmissions.

C-Band transportable satellite service has remained a prevalent source of long haul transmission because of its near-immunity to rain fade that Ku Band experiences in significant rainstorms and snowstorms. C-Band doesn't share frequencies with police radar or police radar detectors like Ku-Band, therefore does not experience police radar downlink interference like Ku-Band downlink receive chains. In addition to all of this, networks and C-Band users tend to stick with what they know works, and haven't changed because they haven't had to change. C-Band space is usually readily available.

And in some ways, C-Band and RF Interference studies have become easier because a few terrestrial signals have moved to fiber or to Internet lines. Frequency coordination has become easier with the better use of computers, impressive mapping programs like "Google Earth," and the use of GPS technology which can tell a person the latitude and longitude of an uplink, within a few feet.

Because of the cost of surveys, larger size of C-Band trucks, and difficulty of use, C-Band transportable service tends to cost more than similar Ku services. With the advent of Ku-band trucks (that don't require frequency coordination in North America) and long-haul fiber optics providing similar signal qualities, C-Band transportable service experienced a slowdown in service volume in the 1990s.

It's still used in situations where rain fade (a problem affecting Ku-Band) is unacceptable and where fiber-optic links are not practical. C-Band uplinks are still commonly used for golf, auto racing, horse racing, and major college sports events in cities or more rural areas where local fiber interconnects to long-haul networks are either not available or where the low number of events at the venue per year make installation of fiber cost prohibitive.

Even with less use, C-Band transportable satellite services are used with fiber optics as an 'alternate' transmission path that most broadcast networks use to protect their remote broadcasts that cost them millions in rights holder feeds from remote transmission failure. After and during transmission, the backup paths often become “dual paths” where highlights of the day's events are sent using every available path in order to finish feeding to a network or “head end” faster. These “video highlight” feeds (once done on tape, but now done on hard drives) is called a “melt.”

At present, High Definition remote broadcasts have caused a resurgence in C-Band transportable uplink service. The major factor in the resurgence was the limited amount of available bandwidth in local and long haul fiber optics while uplink systems merely required installation of high definition encoders and decoders at either end. In other words, many fiber lines just don't have the bandwidth, or they aren't set up for new HD standards.

Fiber comes with other advantages. VYVX, for example, offers low (or NO) cost phone lines along with their fiber bandwidth rental. Fiber, in many places, also offers faster access and routing (when everything works right). But in its early days, it could be argued that Fiber had the most routing failures. Fiber companies were fast to fix these problems, for the most part.

Cost can be another factor. In a service requiring long hours of transmitting to a satellite, C-Band space is often less than half the cost of Ku-Band space and bandwidth. It is often cheaper than Fiber, but that cost can wash out in cell phone or land-line bills, since Fiber “drops” often come with free or reduced-cost phone lines along with the cost of the fiber. Add to that, it is often difficult to find a full transponder open on some satellites, especially to find a transponder that will be open for a half or full day. This is rarely the case with C-Band satellites.

The most important thing to remember is that both C-Band and Ku-Band, as well as other frequencies like Ka-Band will always be around. Transmission standards and signal processing may change, but there will always be a need for competent professionals who know how to find and identify communications satellites.

History of Live Transmission in Local News

In the mid 1970s, stations began to extend their live news coverage beyond the station itself. They did this with 'live' microwave trucks, the same trucks that have now come to be known as *Electronic News* Gathering or ENG trucks and vans. ENG trucks allowed stations and networks to provide coverage of local events with an “on the spot” look, a mixture of credibility building and immediacy.

The advantages of going live from a scene were balanced every day with the disadvantages of cost, crewing, and technical limitations. And there were a lot of limitations.

The 1980s became highly competitive, not unlike the Will Ferrel movie “Anchorman.” Most markets who once only competed against one or two other network affiliate stations in the VHF band were now competing against UHF stations. Independent stations started popping up, and in the middle of the decade cable networks like CNN and ESPN were taking more and more of the public ad revenue away from networks and affiliates as more and more coax cable became installed in homes across the country.

Station owners and news directors started getting desperate, coming up with ways to relay microwave signals to extend past the barely 30-mile range of a station or it's tower.

Add to that, live television started to become more than just a simple “live shot” and entire live events, speeches, conventions and corporate announcements started to add to the sporting events, Olympics, and other live events networks covered since the 1970s.

Think about what this meant for our country, and the world. Now, a CEO didn't need to rack up huge travel expenses going from place-to-place. From one location, a CEO could make a company announcement to all of the nationwide (or worldwide) locations for a few thousand dollars.

It also created distance learning, where teachers, engineers, and other educators could create multimedia presentations and provide college, company and student savings in education.

SNG, or Satellite News Gathering also meant local news now traveled beyond a 150-mile radius.

And when a multiple-murder, or a plane crash, or a cult compound becomes surrounded by police, it has now become more than just a local story. Now the world watches. While much of what you do will only be noticed by a few thousand or a few million people, there will also be times when you will literally become the eyes and ears of the people of the world. It is your practice in the "slow" times that makes you bulletproof in the highly stressful times when the world is watching.

Early C-Band SNG Experiments

The 1980s eventually saw large 4- and 5-meter dishes, being placed on flat-bed semi trucks. The control rooms for these early trucks required Klystron High Powered Amplifiers (HPAs) that took up an entire rack! And some of these trucks are still on the road today! Think about that: Now it is possible to fit two amplifiers and eight paths-worth of equipment, in addition to monitors, antenna controllers, patch bays and routers in that same space! Portable uplinks can now fit all of this, plus an antenna, into a couple of briefcases!

Before these large dishes became mobile, dishes were fixed and it usually wasn't possible to go live from the actual news scene.

A mix of an ENG truck, a microwave receive and a *turn* to C-Band at a fixed uplink site was often the only way to go live from a remote location. This required multiple engineers, and many calls to more than one company to set up each uplink.

The station usually had to deal with common carriers, now called uplink vendors. These carriers, or vendors, were not always very responsive to the needs of breaking news, and sometimes broadcasters themselves. Government and other private contracts often took precedence to the new and often "experimental" news organizations. And news providers, until they truly became a revenue source were often considered a "thorn in the side" of these uplink vendors. This attitude is now mostly gone, but so are most of those old common carriers and vendors. They have been replaced by a new breed of "can do anything" vendor. Many of the preferred vendors are always-connected, always-available, and work with news and sports clients as well as corporations requesting satellite and video production service.

Even receiving the C-Band transmissions was difficult in the early days. Equipment in these days was expensive, and required a long time to receive a return on investment (or ROI in economic terms). The dishes became known as "BUDs" or Big Ugly Dishes. And receiving a video feed usually meant a station or network needed several dishes (in some cases, these areas have become known as dish farms). The areas often have special material used to eliminate ground noise (rocks or bricks to drain away water) or use large walls around and behind the dishes to avoid other terrestrial interference.

Many broadcasters hoped the new transportable C-Band uplinks would open up new areas of live coverage. These transportables did make live coverage faster and easier, but they came with a lot of problems.

C-Band then, and largely today, is used most commonly during sporting events, political conventions, and any other live event where the truck will basically be at a 1-mile radius of a given location and won't be moving. C-Band trucks, once parked, usually stay where they are located until a large event is over.

Logistics are trickier than fixed sites because each location has to be frequency coordinated and essentially 'licensed.' This was called an STA and is now known as an RFI (Radiation Frequency Interference Study). There are one or two companies in this country who provide this service to the public. (England must do it for Ku-Band, too!)

Even though now a frequency coordination or RFI can often be done in a day's time, and as short as a few hours, or an uplink can often be completed on a previous RFI if you are in very close proximity to the original site, this severely limits C-Band's usefulness in covering spot and hard news. And it becomes difficult to impossible if a producer should decide to break down and move the live location to somewhere else, even on the other side of town.

Many of the issues, working with common carriers or vendor uplinks, downlink siting problems, the cost of equipment, and even problems with dish movement and flexibility have been solved in the past three decades. But C-Band transmission became quickly dismissed once engineers developed systems for Ku-Band portables.

Dishes could be lighter, smaller, and packed away easier than the larger dishes required for C-Band transmission (although even that is now changing and C-Band can be uplinked *in some rare cases to only a couple satellites,* on dishes as small as 1.8 meters... and 2.4 meter offset dishes have become common)

Ma Bell

History books in high school and college often tell the story about the telecom industry, and monopolies in the oil, gas and coal industry. And many pages are also dedicated to the breakup of the phone industry monopoly. It has become known as “Ma Bell” being forced to break up into the “Baby Bells.”

When AT&T broke up after the antitrust lawsuit in 1984, this lead to a huge problem in getting phone lines installed at your live location. Installers and sales people didn't want to deal with “one-time” use phone lines. And they wanted long, long lead times of a week or more (and they often still didn't want to install the lines even after several begging phone calls from engineers in a panic).

Conus Communications

- ***On November 9, 1972, North America's first geostationary satellite serving the continent, Anik A1, was launched by Telesat Canada, with the United States following suit with the launch of Westar 1 by Western Union on April 13, 1974.***

Taking notes from Canadian broadcasters who used Ku-Band satellites, and by developing their own satellite communications system, involving special transmit and receive boxes at each truck and an entire control room for satellite access, IFB, PL, and phone-via-satellite capabilities (along with seldom used data capabilities), Ray Conover, along with other Conus and Hubcom engineers created a service where member stations, some networks, and other clients made *satellite news gathering* (SNG) affordable.

Entire live shots, tape feeds, and other live broadcasts were completed with little to no use of phone lines or even cell phones when they became cheaper.

Add to this simplification in communication devices, using the Ku-Band meant there was little to no terrestrial interference (however, no technology comes with out problems, and there is now some interference being found in some downlinks which is created by today's police radar guns and cheap radar detectors at close range).

Stations and networks no longer relied on companies to downlink the satellite signal once Ku-Band dishes became smaller and cheaper and could be placed on or near television studios. This meant stations and networks now owned the uplink and the downlink.

Conus completed their service by adding a news service, a 24-hour news channel making use of the 24-hour incoming feeds from its member stations. They purchased one, then two, then several transponders, and resold that space to members and non-members.

They rolled out the first SNG truck in 1983 and closed their doors in 2002, with the exception of a a couple employees who sell archive video tape. Their masters are all on MII (M-2) tape. (A now defunct tape format.)

While they served a pivotal role in the period where it became difficult to get a day-of-air telephone line to a location, and where cell phones became common and finally had good service, Conus failed to keep up with the times by coming up with the next must-have service.

That being said, Conus Communications was the "yellow brick road" for many broadcast professionals. You will find a lot of good people in this industry who started working for Conus.

You will also find a lot of older truck operators and engineers who still miss the Conus Comms system. Once Conus went away, a lot of operators had to dial phone numbers themselves, deal with a lot of dropped cell phone calls, and move the truck to locations with decent cell phone reception.

Skyswitch, CNN, and ESPN

Other satellite communications devices were introduced in the years following the Conus Comms system. One such system was called Skyswitch, offering phone lines, program lines, and data. Some engineers loved it, many did not.

In the years since then, cell phone companies have developed new technologies and filled in the cell phone "dead zones" across the country.

And another contender to what broadcast professors and broadcast writers now call *new media,* came an unheard-of idea: 24-hour breaking news (CNN, launched on June 1, 1980) and 24-hour sports programming (ESPN, launched September 7, 1979).

100-years ago, in many states, *blue laws* made it illegal to sell things or pay for a service on a Sunday. In the 1980s, everything changed. The new revolution in the world became *always-on,* and later in the 1990s the world became *always connected* thanks to the fuel CNN and ESPN put on the fire in this new social revolution.

The growing technologies in this new revolution now include the Internet, computer-mediated communication such as Internet Relay Chat, and wireless devices like mobile phones and personal digital assistants.

New media uses have also emerged and remain ever-changing, like peer to peer (P2P) networks, wikis and pervasive computing. Each one of them helps change the ways in which people organize and share information.

Ethics professors can argue forever whether all this has been good or bad for our global society, and users continue to be amazed by things as simple as the ability to buy something from a man living in a hut in Africa on socially networked websites like Ebay.

But it's most important for you to understand what companies like CNN and ESPN have done to change the way news and sports are gathered. To study and understand these global companies is a big part of being an SNG engineer.

CNN and ESPN are only two examples. But they take different approaches to gathering news and sports programming. CNN bought their own satellite trucks, but ESPN chose to never buy their own trucks and depend solely on common carriers or vendors. CNN, on many occasions, will depend on vendors and freelancers too. But the vendor truck is rarely the first call when CNN has their own truck in the area. CNN also depends on their affiliates, where ESPN doesn't have affiliates (even though, one could argue that ESPN and ABC are both owned by Disney and they have affiliates through ABC... but ESPN doesn't see it that way).

CNN also chose to resell satellite services to their growing affiliates, which meant they required multiple path capabilities in each of their trucks. When 2-path, then 4-path, and now 8- to 16-paths became available from one truck, CNN continually finds ways to resell each path, the satellite space they own to transmit on those paths, and resells the video and archives of their stories to members and non-members around the world.

ESPN has taken a much different approach. When multiple paths became available in satellite trucks, they chose to cover many events with multiple cameras often looking at the same thing. They could send one crew to the home locker room, another to the visitor's locker room, another to the field, and another to the buses or tailgating areas outside the stadium. They use multiple paths to feed from all of these locations. Only recently have they started to feed for more than one station or network, but they haven't set up a system to charge such stations. Rather, they consider such actions a "favor" and will sometimes ask the stations for favors later when they have a piece of video someone at the ESPN complex wants. ESPN has done well with these favors, and they are very successful considering how much they "give away" every day.

Both cable networks have amazing, intricate systems involving thousands of people in locations around the world. And both networks have survived despite many people saying their model wouldn't work. Not only that, they are both leading all others by introducing products and services on the Internet and in mobile devices. And they will be forces to be watched for some time.

The latest step in Satellite Technology

No one thing advanced satellite technology more than the war in Iraq. 24-7 reports from "embedded journalists" brought the world a battle from the sands of the middle east right into their living rooms.

We will leave it up to the opinion writers and historians to fight about whether the "ego-pumping" of reporters or the "war stories for ratings" was worth it. But what we can look at is how much the budgets for new technology advanced the current technology and changed our industry.

R-BGAN and BGAN satellite service offered IP streaming over satellite, and although jittery and questionable in video quality, was everything networks wished for with audio quality. Reporters were now live from the tops of tanks, by using a small BGAN unit about the size of a laptop.

Never before in the history of satellite uplinks were so many uplink flyaway systems purchased. And now companies boast satellite uplinks, that are fully deployable in minutes rather than hours, all able to fit into two small suitcases.

This last year, small uplinks and flyaway units started to show up where large C-Band and Ku-Trucks used to park. The world had changed.

Another change that came to us around this time (XM launched first on September 25, 2001, only 14 days after September 11) was XM and Sirius radio. Satellites carried to cars, rooftops, and even hand held radios over 150 channels of audio. All this new technology required was a small receiver, about the size of a wallet, and an external antenna about the size of a quarter. Even though XM and Sirius both experience large amounts of delay, they are still an example of an amazing product that is only a very recent development in satellite technology and usage.

Notes on your first Satellite Truck

There's an old saying, "How do you get to Carnegie Hall?" The answer is practice, practice, practice. When you get the keys to your first truck, give yourself a week or so of practice. Spend as much time as possible in the truck, testing each system and following the path of every piece of gear.

Satellite training and this manual are only the first step. We won't spend a lot of time on how to do preventative and periodic maintenance and you need to develop your own methods that make the best use of your time and your company's time. Give yourself time to get used to everything and become comfortable in your surroundings. Give yourself even more time if you need to ask colleagues a question. Sometimes it takes time for them to get back to you. Some questions require looking up the answer, or calling other colleagues.

Some satellite space vendors will allow some free test time. Don't be afraid to ask for it, but don't waste it. There are enough problems you can find using a test loop system, if you are lucky enough to have one installed. Use the test loop first, then, when you are sure, ask for some test time.

Once you are on the road and are doing some jobs, be aware that the cost of being on the road is very expensive. Diesel and gas are worth the price of gold, hotels rarely come in under $100 a night in most of the United States. And there are so many nickel-and-dime costs from cleaning supplies, oil changes, cable connectors, adapters, and extra gear you can run up a big road bill very fast.

It is a good idea to keep lists of frequencies of transponders (such as those included at the back of this manual) and available frequencies you use frequently. Also keep lists of digital parameters being used. Even if you work for a place that never changes these parameters, if you have to do a *hard reboot* and equipment resets to a default setting, you have to know where your everyday frequencies are set.

You may also find that sometimes encoders or IRDs will "get stuck" because you haven't been changing the settings. Sometimes changing to a different data rate, FEC, or L-Band frequency and then changing back to your original settings will fix the problem. I have never gotten a straight answer from encoder designers about this problem or solution. But I gather I will get that as soon as Bill Gates answers why his Windows operating systems freeze up and have to be rebooted, constantly have to be debugged and can't seem to run more than 24-hours without "heaping" data inside the RAM.

We will discuss the meanings of these settings later in Chapter 7. And don't be afraid to take notes. Just don't write something down so you can forget it later. It's more important at this point to take mental notes on what you are learning and write down questions!

A note about pressure

Dennis Sweet, an early SNG trainer once wrote this passage about pressure:

"The exact amount of pressure that you can work under is less important (to us) than your ability to know when the pressure is affecting your performance.

It is important, when you reach that point, to stop and deal with the pressure.

Letting it build to a point that causes you to 'screw up' doesn't help anybody and is a major cause of accidental interference to other uplinks."

I would add to what Dennis said by saying that letting stress build on you is also bad for your health. When your nerves get "frayed" your body literally can't pass Seratonin from nerve receptor to nerve receptor. You will eventually experience what has become known as an "anxiety attack," or in worse cases a "nervous breakdown." Then, you will be no good to anybody.

Get there early, work quickly but not stressfully, and then go get a cup of coffee or read a book or magazine. This will often keep your stress levels down much more than if you "run and gun" like a small-market over-worked photographer.

The process of running a truck, from making sure all the signals coming in and out of an uplink are perfect is just part of the daily pressure you will endure.

Finding the satellite quickly, optimizing transmission performance, and making sure crew members get along well enough to work together are ultimately your biggest challenges.

Just as a captain is not always on the bridge, the captain is on the bridge or near the helm when docking, undocking, or during the worst storms. You will do this at the beginning and end of every broadcast, communicating as best you can what you need and when you need it from your coworkers.

You are the captain. You are the Uplink EIC (Engineer in Charge). Be there as much as you can, take a rest when you have been working hard, but don't ever miss a chance to be there and be prepared to make the biggest and most important decisions. In many cases, you will be the only one who can.

<u>CHAPTER 1</u>
Satellites and Satellite Identification

<u>What is a satellite?</u>

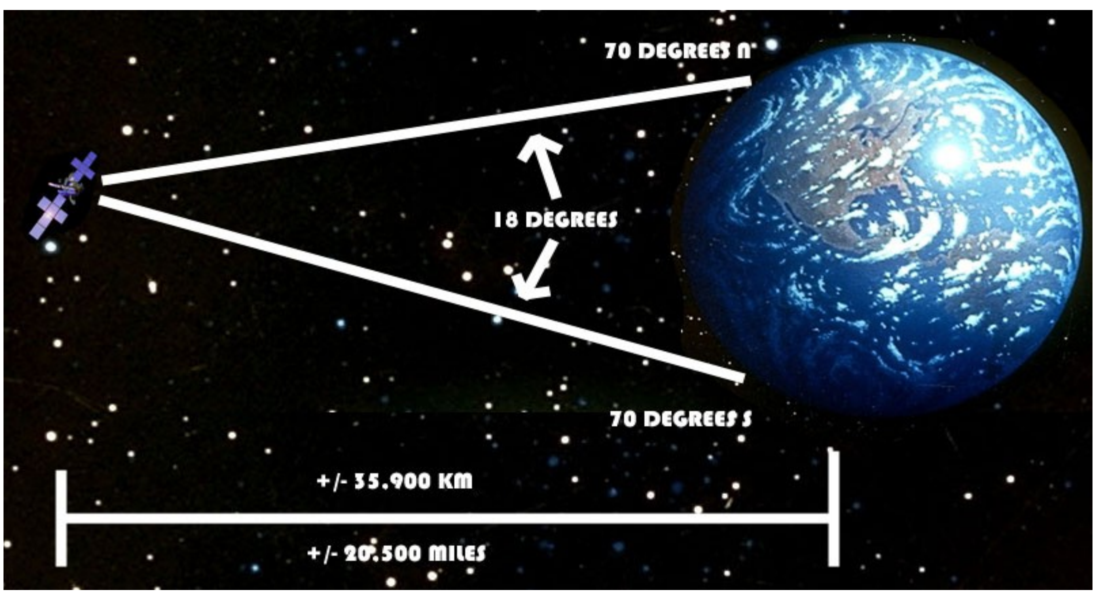
A satellite, simply, is an object in space orbiting another object. But the satellite you'll be learning about, transmitting to and receiving from is a geostationary communications satellite.

Geostationary satellites (known as birds), orbit the earth over the equator at the same speed as the earth is turning. So at any time of the day or night, any given geostationary satellite will be located in the same spot in the sky. That means once you find that satellite, you don't have to keep moving the dish.

- The only exceptions to this rule is a geostationary satellite that has been put into an *inclined* orbit. Satellites also travel in a Molniya orbit, other elliptical orbits and (polar and non-polar) Low Earth Orbits or LEO orbits.

- The only orbit other than geostationary you will need to worry about at this point is inclined orbit. An inclined satellite will basically move up and down up to about 10 degrees from the other satellites in the satellite *arc* and is typically done with older birds low in fuel or aging birds having trouble holding their position in a geostationary orbit. Use of these birds is rare, and you typically will not be asked to transmit on an inclined bird without plenty of experience. So – don't worry about it!

- "Graveyard Orbits" of the Eastern Pacific (105º W) and India (75º E) are positions where little to no satellite correction is needed from the ground. Satellites reaching the end of their life (quickly running out of fuel) are sent to these positions where gravity's pull is more stable (a more circular orbit rather than elliptical like most positions). They are used as long as possible here, then moved further out, and then often sent into the ocean.



The general relationship of a geostationary satellite to earth

<u>Finding the Satellite</u>

The process of finding the satellite is generally the most feared part of running a satellite truck when you first start out. Have faith that you will eventually get to the point where, without a compass, you will be able to point into the sky and say with confidence that is where a certain satellite is located. Once you get closer to this point, and gather experience, the fear will go away. And it will only resurface when you are operating in unfamiliar parts of the country or where you aren't sure if you are facing south.

Until then, there will be many times when you just can't find the satellite. It's how you deal with the time you have that is important. If you panic, and you allow pressure to control your next actions, you will *never* find the satellite.

But if you remain calm, and manage the pressures that you are working under, you will probably remember to use the procedures in this part of the manual.

Relax! Don't worry! Remember the procedures, and you *will* find the satellite.

The communications satellites used in our industry are in a band directly over the earth's equator at a distance of 39,500 km or about 20,500 miles. This distance, is about 3.7 times the earth's diameter of about 9,675 km.

The satellites travel at about 11,000 km/h, and the satellite completes one full orbit of the earth in 23 hours, 56 minutes and 4.9 seconds. At this speed, a satellite is geographically stationary (geostationary) to a point on the earth's surface.

At 39,500 km or 20,500 miles, the earth angle “subtends” at about 18 degrees, giving the satellite a coverage of about 40% of the earth's surface. This is roughly from the Arctic Circle to the Antarctic circle.

Satellite Footprints

Even though 40% coverage of the earth's surface is possible, it is not usually the case. Satellites are actually made up of several “beams” that are arranged to make a “footprint” of the U.S. (or Japan, Europe, Asia, Africa, or Australia).

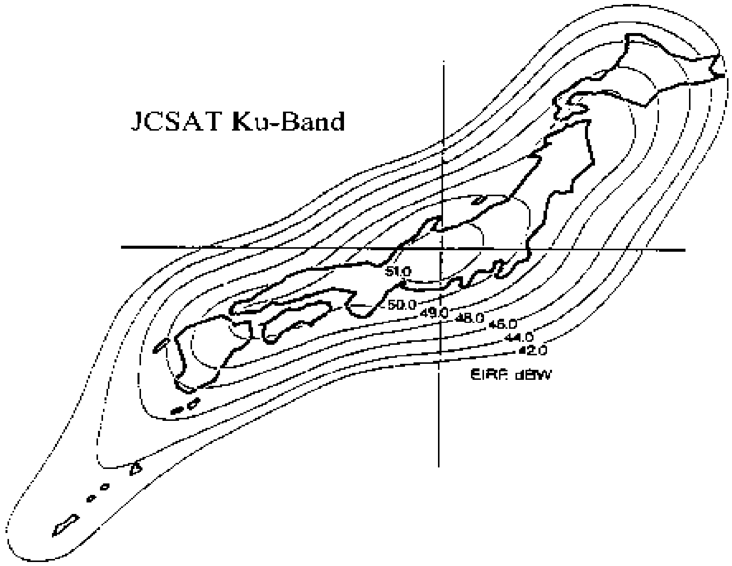
The antennas on board the satellite are set up for these footprints, and they are typically of three types: hemisphere, zone and spots.

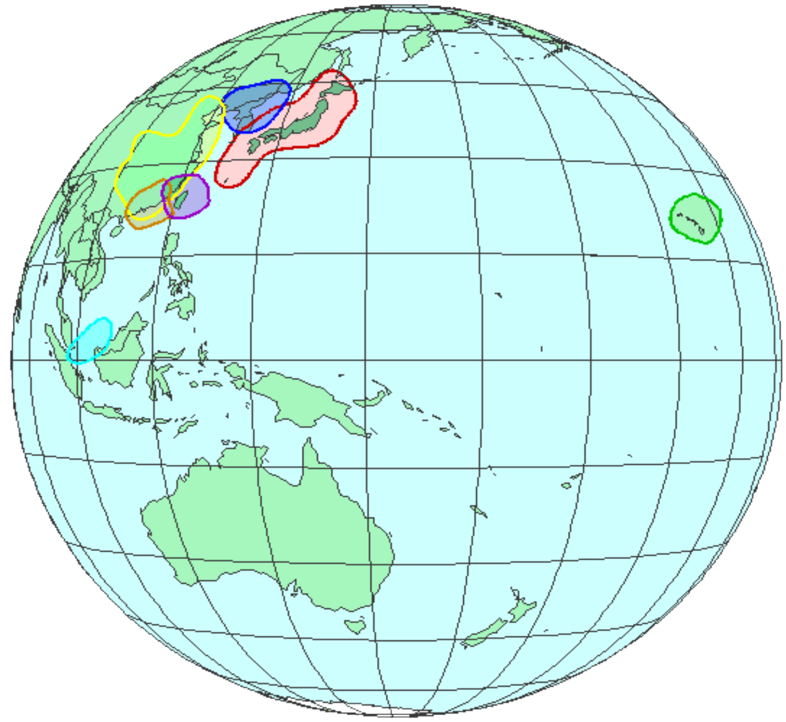
A hemispherical beam is designed to cover the 40% of the earth, for example, the western hemisphere. BGAN and RBGAN service often use hemispherical beams.

AMC 4 at 101° W, C-Band Footprint

AMC 4 at 101° W, Ku-Band Footprint

A zonal beam is set up for a specific area, in examples like I mentioned before as the U.S., Japan, or Africa. And a spot beam can be set up on the same satellite as the other beams mentioned before, or can be set up as a series of spot beams. Spot beams were often used to fill a spot in, say, Florida. They were set up for islands like Hawaii, Japan, or geographical areas like the western states of California, Oregon and Washington on the west coast of the United States.

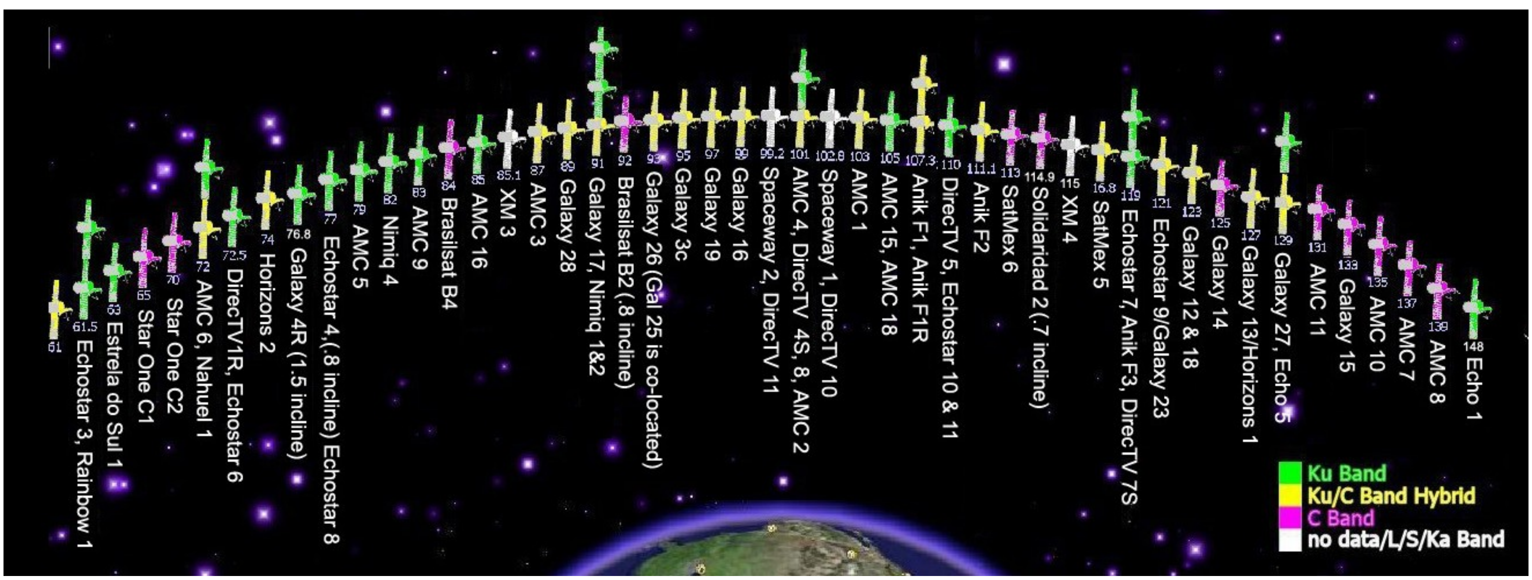




JCSAT was set up with Spot Beams for each country: Japan Beam=Pink, Hawaii Beam=Green, Korea Beam=Blue, China Beam=Yellow, Hong Kong Beam = Orange, Taiwan Beam=Purple, and Singapore Beam=Green/Blue

Sometimes satellites, for instance, were sent into space for *only* for the country of Japan. Using only spot beams, this gave Japan incredibly strong, intense satellite signals and early on they were able to give people set-top boxes with very small antennas with crystal-clear pictures. This is the trend here in the U.S. But so far we have only been able to shrink our dish size to 18 inches for DirecTV and DishNetwork. XM has managed to create a network in this way, using an antenna about the size of a quarter, but they are only providing audio and a small amount of data at this time. Full-motion video and certainly HDTV requires a lot more than this technology can provide for such a large area as the continental United States.

<u>You mentioned an arc? What is that?</u>



A Full Page chart of this arc is available at the end of this book

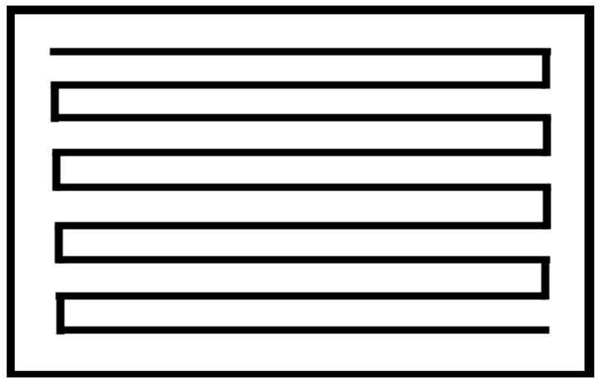
We know most geostationary communications satellites orbit the earth at about 39,500 km or about

20-Thousand, 5-Hundred miles over the equator.

When we look south (or north from the southern hemisphere), satellites sit directly south of us at at a determined angle. And as the orbit angle goes left or right (east or west), the satellites form what is commonly known as the arc.

Once you have found any satellite in the arc, it is very easy to find the next satellite to the left or right. However, finding your first satellite is not as easy as it looks.

Most satellite *operators* depend on their auto-find software installed in practically every dish and antenna system these days. But satellite *engineers* rely on the tried-and-trusted method of using a *search box*.



A search box is simply an area of the sky where you start from a point higher than where you believe the satellite is located. You will send the dish west about 10 degrees, stop, then send the dish down a half a degree, and go back east that same 10 degrees.

Where do you start? If you are in the middle of the continental U.S., then try to start your search at about 45 degrees. If you are as far south as Miami, 59 degrees. And if you are up north near the Canadian Border, try 36 degrees.

In the middle of the sky, you can move from one satellite to the next with little or no change in elevation. However, if you are searching the “edges of the arc,” you may have to move up or down (depending on the direction) until the previous satellite disappears. The steps up and down from each satellite become that dramatic at the eastern and western ends of the arc.

Over time, you will learn where the satellite you most commonly use is located. And if you take good notes, you will likely find your satellite within the first 15 minutes of deploying the dish. So relax! And any chance you get, practice, practice, practice. You will get better at finding the satellite arc every day you practice.

My dish automatically finds the satellite

I have two words: *Who cares.*

Auto features on today's equipment are great, when they work. But I wish I had five bucks every time I've been asked to step into a truck where some operator never bothered to look for the satellite the old fashioned way, or worse, *forgot how to do it manually.*

If you want to walk into any situation, use any uplink, help out any engineer, and feel completely comfortable, knowing you will find the satellite whether or not the auto features work, then learn to do it manually and never stop doing it manually. Don't use the auto features, even if you think it will save you five minutes. Once you lose the ability to find the satellites on your own, you risk losing it forever.

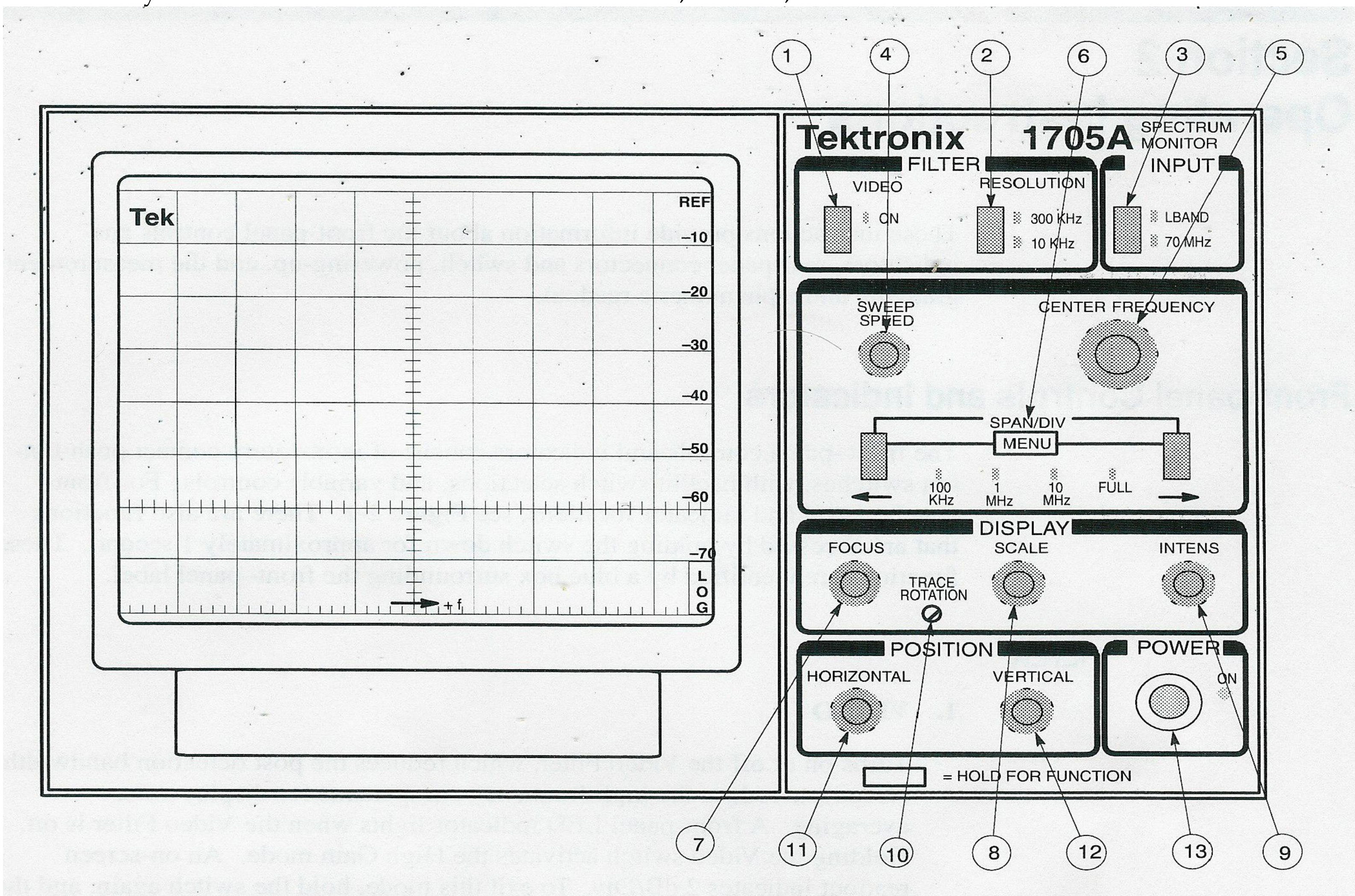
When you invent a machine to do the job of a human, you take something away from the human.

And you will be thankful that you are probably the only one who can find the satellite when the GPS stops working because the nearby airport radar is creating too much interference.

How do I see the satellite's signal?

The satellite signal is located by watching a small device called either a spectrum monitor or spectrum analyzer while moving the antenna. The monitor or analyzer typically takes in an L-Band signal, and allows you to see that small section of radio frequency, from about 950 to 1450 MHz.

- L-Band is used in trucks and teleports for two reasons: First, L-Band is a lower frequency (MHz) than Ku- and C-Band (GHz) and will travel farther down a cable and with less loss. Second, using L-Band allows you to use the same satellite receiver for Ku-, C-Band, and future bands like Ka-Band.



A popular Spectrum Display, the 1705a Spectrum Monitor by Tektronix

1. **Video –** Turns the video filter on or off. This displays noise averaging. Most truck operators turn the filter on, but it is not as accurate a picture. Engineers keep it off. Holding the video switch activates High Gain mode, holding it down turns off High Gain mode.
2. **Resolution –** Selects bandwidth of 10 kHz or 300 kHz.
3. **Input –** Selects L-Band (950-2000 MHz) or 70 MHz (45 to 100 MHz).
4. **Sweep Speed –** Sets sweep repetition rate, usually 20 to 200 ms. The slower you set this speed, the more accurate a reading you will receive.
5. **Center Frequency –** A ten-turn variable control that determines the center frequency. On the 1705a, this frequency jumps by 10 MHz, and is usually off by at least this much.
6. **Span/Div –** Two buttons, left and right, which determine how much bandwidth you want to look at. The LEDs between the buttons tell of your span.
   FULL- 50 MHz (all of the L-Band) and 5 MHz per division for the 70 Mhz.

10 MHz – Typically allows a view of one, two, or three transponders. Each division accounts for about 10 Mhz.
You typically will not use anything but these two settings.

7. **Focus –** This makes the screen "not blurry."
8. **Scale –** Controls the illumination of the division lines.
9. **Intens –** Controls the illumination of the spectrum display.
10. **Trace Rotation –** A screwdriver adjustment to align the trace and division lines.
11. **Horizontal –** Adjusts the position of the spectrum up or down.
12. **Vertical –** Adjust the display left or right. Do not use this to adjust your center frequency. Use this to line up the Center Frequency pointer at the top of the display.

Stabilize the Truck

Trucks and vans come equipped with stabilizing jacks. Use them. And if they don't work, fix them. And always remember to drop the jacks, then raise the dish.

Dropping the jacks does two things: First, it helps to give you the maximum stability for your transportable earth station. Second, it forces you to get out, put the jacks down, then LOOK UP AND LIVE.

If you get out and look up, you are less likely to put the antenna into a power line. If you screwed up and did put your dish into a power line, and you aren't dead, Tell everyone outside the truck to get as far away from the truck as possible. Then tell everyone inside to jump from the truck as far as you can without touching both the truck and the ground.

If you touch both the truck and the ground, if there is enough power in the lines to kill you, and leave a large crater where you used to stand. We will cover this more in Chapter 5.

Deploying the Dish (Antenna)

Only after you have stabilized the truck with jacks, jack stands, weight, ropes, ratchet straps, or whatever it takes to keep the antenna stable, then you can deploy the dish after you LOOK UP.

You may have an auto-deploy. Go ahead and use it. It will save you time if you have to do other things. Just never, never, never hit the auto deploy until you have gone outside to look up for ANYTHING the dish might come in contact with. This means power lines, but it also means overpasses, trees, or anything else that could damage your antenna or that your antenna could damage as it comes in contact. You may have to deploy manually. You may have an auto deploy that doesn't work. Then you have to do it manually anyway.

Some of the new trucks, especially trucks sold to California companies, must now come with antenna deploy buttons that can only be operated from outside the vehicle. This is because of the mounting accidents and deaths caused by operators putting masts and satellite dishes into power lines. I can't say it enough, LOOK UP.

The process of finding a satellite

Finding a satellite involves:

- 1 – Determining the look angle
- 2 – Establishing a search box
- 3 – Searching the box in a pattern
- 4 – If unsuccessful with 1-3, establishing a new search box and repeating the process

If guessing didn't work, then start from the beginning. You need to know where you are. Use a compass and determine south. Know your latitude and longitude. It is available on the Internet, via GPS, and if you lack that technology, they wrote it down on maps! How old school!

Wipe the dust off your brain and do some math. You can calculate your look angle using math!

Once you know your latitude and longitude, you need to know where the satellite is located. You need to know its longitude (it's latitude, by the way, is zero degrees).

Know which way south is. That's not always as easy as it may seem. Compasses are great, but some will give you two or three different souths.

Your easiest way to guess is to look for other satellite dishes! This is not foolproof, but if you can determine if a satellite dish is actually being used at that moment and hasn't been tossed in a different direction by the wind, then you can actually take an educated guess it is pointing in a somewhat southerly direction.

Only the great pyramids at Giza are actually lined up. Don't trust buildings or roads as a way of guessing your southerly direction.

Once you have found south, you need to calculate the look angle.

There are several ways to calculate the look angle. Carry with you Leland Kessler's SNG Look Angle Calculator. You will need a computer running windows to use this program.

Buy a Rand Sync-Sat Calculator. If you can still find one, or if they are still available, they can be ordered as #RM-5228-NASA from The Rand Corporation, 1700 Main Street, Santa Monica, CA 90406.

You can use a chart or slide-rule-type calculator. They are sometimes given away at Satellite conferences or by Satellite vendors.

Or you can calculate the look angle yourself with the following formulas. Determining the exact angle requires a little knowledge of trigonometry, but you really only need to be close. Double check with a calculator or computer. Use the calculator on your cell phone.

If the orbit of a geostationary satellite were roughly equal to the distance of the earth to the sun, then we would use ordinary latitude to figure out where to point the antenna. But since satellites are much closer, we will find that at about 45 degrees of latitude, we might find our satellite directly to the south of us at approximately 40 degrees.

Here are the equations, should you ever find yourself bored and like to do things like calculate pi, or have a bumper sticker on your car reading, I Love Pythagoras:

For Elevation:

$$EL = 90° - T - R \text{ where:}$$

$$T = \tan^{-1}\left(\frac{\sin R}{6.6166 - \cos R}\right)$$

and

$$R = \cos^{-1}(\cos q + \cos a)$$

where:

a = truck's latitude

and

q = relative longitude (equal to the satellite longitude minus the truck's longitude)

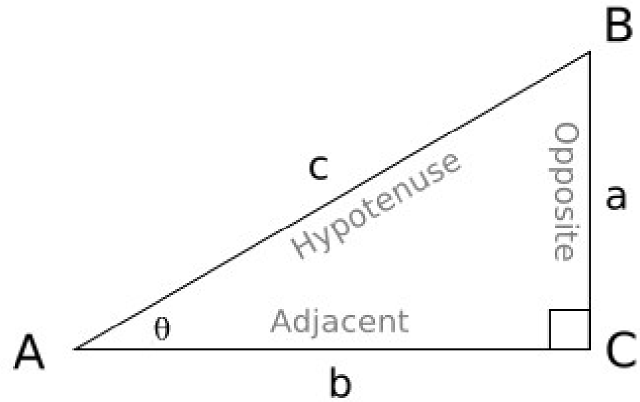
For Azimuth:

$$AZ = 180° + \tan^{-1}\left(\frac{\tan q}{\sin a}\right)$$

$$\sin\theta = \frac{\textbf{opposite}}{\textbf{hypotenuse}}$$

$$\cos\theta = \frac{\textbf{adjacent}}{\textbf{hypotenuse}}$$

$$\tan\theta = \frac{\textbf{opposite}}{\textbf{adjacent}}$$



Each degree of latitude equals approximately 69 miles, so you can figure out the opposite by taking an estimate of this number by rounding down. In Des Moines, Iowa, the latitude is 41° 35' 15" W (41.57°), so that is about 2,829 miles. Since we know the distance to the satellite is 20,500 miles, that makes our distance (range) from Des Moines to the satellite about 20,694 miles because the Pythagorean theorem tells us $a^2+b^2=c^2$.

The sin=.1367, the cos=.99, and the tan=.138.

Not accounting for the -1 (I believe the original equation reminds us the sin, cos or tan must be -1) on the cos and tan equations for T and R, you should get about 40.142 degrees for Elevation.

Another Proof for figuring your Declination Angle

$$\text{Declination} = \tan^{-1}\frac{3964 \text{ SIN } L}{22300 + 3964\,(1-\cos L)}$$

*Where 3964 = Radius of the Earth, in Miles
22,300 = Distance to the Satellite Arc, in Miles
L = Site Latitude

Yet ANOTHER set of Proofs for figuring satellite look angles

Azimuth Angle = $\cos^{-1}[-\tan\Phi/\tan Y]$

Elevation Angle = $\tan^{-1}[(\cos Y - 0.15116)/\sin Y]$

$Y = \cos^{-1}[\cos\Phi \cos\Delta]$

*Where: Δ is the absolute value of the difference between the satellite and your location. Φ is your latitude.

A quick note about using a compass

Magnetic fields vary in different places on earth. And over time, magnetic variation changes. Here is how the degree of magnetic variation in Washington, D.C. Has changed over the last 250 years, according to the National Geophysical Data Center:

1750 = -3.3 degrees
1800 = -1.0 degrees
1850 = 2.5 degrees
1900 = -5.5 degrees
1950 = -7.5 degrees
2000 = -10.6 degrees

The National Geophysical Data Center updates their worldwide observations on the magnetic fields of the earth every five years. If you are interested, there are typically new charts given away at satellite conferences held in Washington, D.C., Amsterdam, and the NAB meeting in Las Vegas every year.

Establishing the search box

Once you know the calculated angle of the satellite, you can then establish a search box like the one we pictured and mentioned earlier.

Establishing a search box acknowledges the inaccuracies of the truck, van or flypack compass and antenna positioner.

The height of the search box should be based on the accuracy of the elevation reading of your antenna positioning system (if you are lucky enough to have a working display of the antenna positioner). You may have to do this by visual inspection of the antenna itself.

Sometimes, especially in older units, the antenna positioner bases its elevation on the truck (and assumes the truck, van, or flypack is level). It is likely the position is not 100 percent accurate, and therefore the search box needs to be higher and larger than it would be if it was reading in true elevation.

The width of the search box depends on how much you trust your estimate of true north and south. A magnetic compass, if not influenced by magnetic fields, points to the magnetic north pole, not true north.

If you draw a diagonal line roughly from Chicago, Illinois, southeast to Tallahassee, Florida, along that line are all the points in the United States where magnetic north and true north are the same.

As you go farther west from this line, a compass will show north as being farther east than true north.

As you go farther east from this line, a compass will show north as being farther west than true north. The correction required from true north as being farther west than true north. The correction required from true north to magnetic north is listed on most sailing charts, if you really want to “nerd out” on the subject.

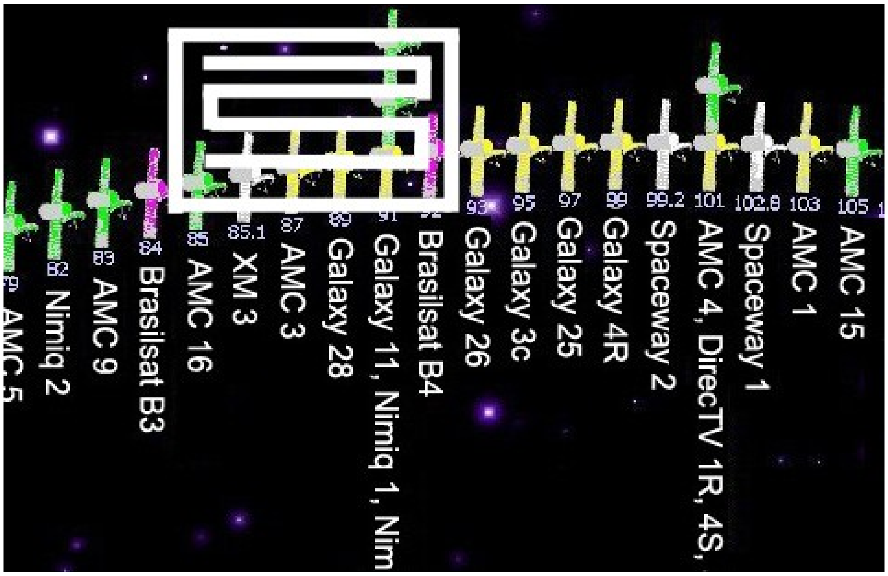
But if you don't wish to figure the magnetic correction factor (and most people don't), then just make your search box a little larger in width. Instead of 10 degrees, go 15 degrees.

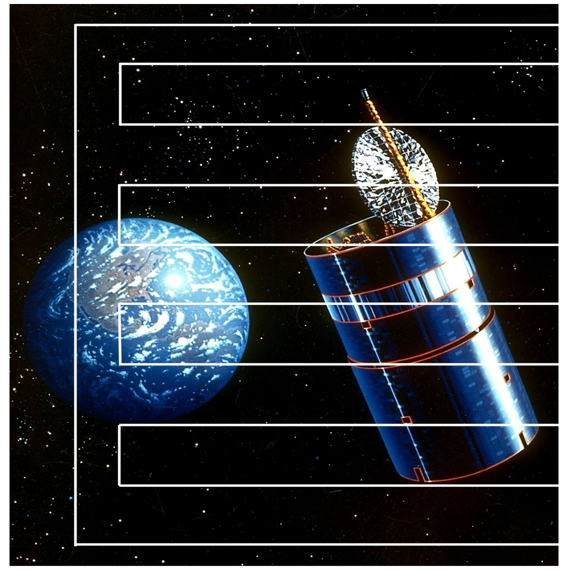
Once you have established your search box, write down the limits of the box and some idea of how you got your numbers (you may need this info later). Take good notes, and find a way to keep those notes.

Searching the Search Box

If we look at the geostationary arc, we can see the effect of establishing a search box. The figures may be different from the printing of this manual, but the procedures are the same.

10-degree search box superimposed over some satellites.





If we superimpose the search box over the diagram of the geostationary arc, we can see that it will encompass more than one satellite. And that is the intent of the search box.

The first thing to search for is the arc itself, and then look for the specific satellite.

The next step is to decide on a search pattern with which to search the box. For instance, try starting in one corner and scanning the box from left to right (then right to left), changing your elevation slightly each time.

This puts less stress on your antenna than searching up and down. Changing elevation only slightly each time puts the least amount of stress on *most* antenna designs.

Searching for a satellite is NOT a Play Station or X-Box Game!

As you make one move at a time, left, right, up, down, CW or CCW (Clockwise or Counter-Clockwise in your crosspol movements) you *must* stop for a second before going in the opposite direction! Hitting a button to go in the reverse direction too soon puts twice the amount of pressure on the components as they were built to handle!

At the end of each movement, let the dish settle. Then go in the other direction, and do not hurry any of your movements! If something breaks, you will not speed up the process if you have to fix a problem. And they don't sell parts for your antenna system at the local Home Depot or Lowe's.

A dish and antenna control system that is well maintained and not over-exerted can last 30 years, maybe much more.

Be sure you are watching a properly set-up spectrum display

Set up your spectrum monitor or analyzer so you can view the entire satellite spectrum (all 500 MHz of the L-Band of 950-1450 MHz).

Some spectrum monitors have two separate inputs. One is the L-Band, and is specifically designed to work with LNB down converters with an output range of 950-1800 GHz. And even though your readings may be in the Ku-Band, it will be capable of providing power to and reading a C-Band LNB.

The second input on many spectrum monitors is a 70 MHz and will accept signals from 45 to 100

MHz. This second input is usually used to monitor the IF output frequencies from analog and digital modulators (we will discuss this more in Chapters 2, 7, and 9). You can also use this input to look at signals in the low VHF television band and the FM broadcast band up to 100 MHz.

As you move the dish, watch the spectrum display. If you want to check your elevation and azimuth meter, *stop the antenna,* look at the meters, then look back to the spectrum display, then continue to move the antenna. You can miss a satellite signal in just a fraction of a second.

Searching for satellites, like I mentioned earlier, takes a lot of practice. Go out on days where you don't have a lot of pressure, and practice in an area where you have to find south on your own.

Move the truck so you are oriented in a different direction each time. In most cases, you have no control over the way you park the truck, van or flyaway, and will be asked to park against traffic, the wrong way on a one-way street, on sidewalks, and where situations aren't perfect.

Practice with different orientations to the arc, practice in places where you can't get the truck level. Park on hills, and with half of your wheels on top of a curb so the truck or van is tilted.

What if you don't find the arc within the Search Box?

The first thing you will do is panic. Sorry, you may think nobody and nothing in this world can rattle you. But the first time you think you know where the satellite is located, and you can't find it, *you will panic.*

Don't panic! Let me tell you a funny story:

- I spent half an hour searching for the satellite. And I *knew* the dish was pointed in *exactly* the right area. I was working on less then six hours of sleep in 3 days. I hadn't eaten in more than 12 hours, I was cranky, producers were yelling at me, and I was growing more and more frustrated with each second. I stopped for a moment, stepped out of the truck to get some fresh (very cold) air and discovered the boom arm holding the LNB was frozen to the dish and didn't come down when the dish was deployed. I did panic initially, and I honestly felt like an idiot. I had to make a cold, humiliating climb up onto the roof to pull the LNB boom off of the dish. Luckily I didn't say anything stupid. Now, I look up to live, *and* I look up to keep from wasting time.

If you know your LNB boom dropped properly, the setup looks right, and you haven't overlooked any broken parts or issues in the RF chain, the next step is to look back at your calculations and check to see if you've made any mistakes.

How much did you trust your elevation read out? Did you trust it too much? Did you make your search box too small vertically?

How much did you trust your azimuth read out? Is it based on a magnetic compass that could be getting magnetic interference from something nearby, like a power transformer or other large magnetic force? Or did you fail to consider the correction factor between true north and magnetic north and make the box too small horizontally?

Make your best guess in which direction you were most likely off. Then reposition your search box in that direction. Position it above, below, left, right, or at a diagonal line from the original box. Write down the position of your new box and draw it out to compare the position from the original box.

Now search the new box. Continue this procedure until you find the arc (any satellite) If you use this procedure, you will eventually always find the satellite.

The most important part in this procedure is that unless you move the truck in any way, *NEVER* search the same area of the sky more than once. If you start to search the same area of the sky over and over again, you will *NEVER* find the satellite.

- There is the distinct possibility that in rare cases your LNB has stopped working. We cover *How to Test for a Dead LNB* in Chapter 4. But at this point, if you suspect you have a dead LNB, and you have a switch for a Horizontal Polarity LNB and a Vertical Polarity LNB, simply switch to the other polarity for now. There is about a one in a million chance you have two dead LNBs.

Once you find the arc

When you find a satellite on the arc, write down its position with respect to your antenna position meter(s) or readout on your antenna controller.

Then attempt to determine which satellite you are viewing. We will go over this in a moment.

Uplinking across the country and around the world

On of the most exciting things about a career in the satellite industry is that this job can take you around the world. The knowledge you will gain through this training and reading, and the knowledge you will pick up every day allows you to jump on a plane and operate an uplink anywhere in the world.

But one of the problems operators face is that they don't tend to travel much further than a few hundred miles during a large part of their career. They forget their initial training, and forget about how difficult it can be to find a satellite after traveling to a different area of the country or the world.

If this is the case, and you are in a different place, then you need to allow yourself a longer setup time to become familiar with the orientation of the arc.

Not only that, but you need to realize that the arc doesn't always resemble an arc in some areas of the world.

Because satellites' ranges are close, but still different, when you are near the equator you often find some satellites are quite a few degrees higher than others. It will take some guessing if you find yourself in this situation. Go to where you think the satellite is located, and take the dish up and down up to 15 degrees from the last satellite's elevation location.

Before leaving for an unknown location, think about doing some look angle calculations, and bring with you a look angle calculator if at all possible.

- Leland Kesler wrote a computer program using Visual Basic back in 1999 and gave it away for free to satellite truck operators. He labeled it with an ABC News/ABSAT label, because it was initially distributed to truck operators in that affiliate news service.
- Kesler also took over control of sngforum.com when ABSAT gave it up in 2007. He, and the forum remain one of the best locations to get your satellite and uplink chain questions answered. *The original forum was the work of Michael Huitt of ABC News. He started the forum in 2002, and it has been steadily gathering knowledge from uplink operators around the globe for nearly a decade. Chris Meyers took over the forum for a short time, and asked Leland to take over in hopes the forum could reach out to more uplink engineers outside of the ABC family.
- Leland Kesler remains today as one of the top 5 satellite truck operators in the world, and quite possibly has done more to advance satellite truck and uplink knowledge in the past 10 years than any other person. He is an example of the good things anyone can do by working hard and doing good work.

What are you looking for? What does a satellite look like?

When looking for the satellite, you are actually looking for any satellite in the geostationary arc. Once you have found a satellite in the arc, you can work your way along the arc to the satellite that you wish to use.

The geostationary arc is the orbit, as viewed from the ground, of all the Ku-Band, C-Band, Ka-Band

and L-Band satellites you could use as an uplink engineer. Some orbital positions have more than one satellite parked there. This is sometimes because one satellite is Ku-Band only, and it shares a spot with a satellite that is C-Band only. They may be a mile away from each other, but to you an I from any position on the earth, they appear together.

The orbit is called geostationary because the satellites revolve around the earth at the same rate that the earth rotates.

That means that the satellites in orbit appear to be stationary as viewed by someone on earth. The fact that the satellites appear stationary from the earth makes operating the uplink much easier.

Accessing a satellite, especially from a transportable earth station, requires the use of a spectrum analyzer or spectrum monitor.

Each satellite has a characteristic look on the spectrum display. Just like you learn the voices of your friends and loved ones when they call you on the phone, you will over time learn the look and designated signature of each satellite.

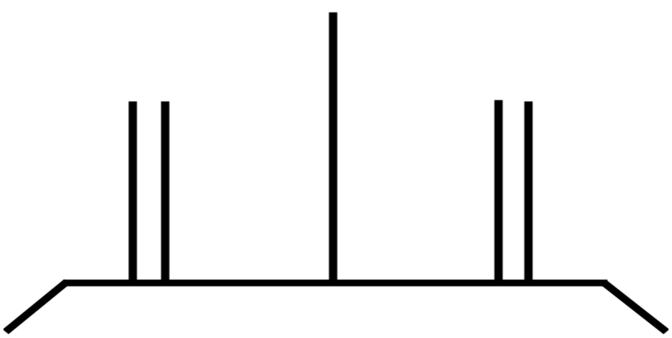
This look on the display is made up of two parts. The first is the mix of services on the satellite. There are a few rare analog video carriers. There are digital SCPC and MCPC signals, transponder pads, ATM data, and location signals sent by satellite controllers and access centers known a *beacons.*

The second part of the display is the characteristic response of the satellite itself. The mix of services on the satellite is the easiest method of determining the identity of a satellite. Response recognition takes a lot of practice and is not as reliable as identifying the satellite by the carriers and signals being transmitted through the satellite.

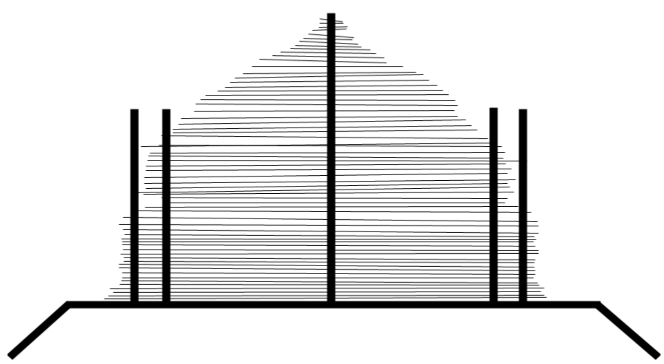
Both methods require an operator to spend time in the truck to become familiar with the look of the various satellites.

Types of satellite transmissions

Each type of service on a satellite has a characteristic look on the spectrum display. There are analog video, data (TDMA, CDMA, GSM and ATM), FM squared (rare), SCPC and MCPC.



An Unmodulated or Black Analog Video Signal



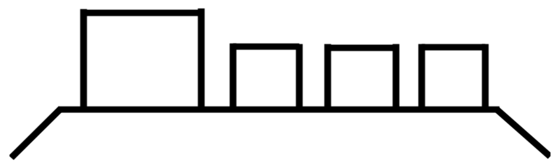
A Modulated Video Signal

Analog video has a triangular look to it on a spectrum display. When looking at the entire spectrum (the best way to initially find the satellite), an analog video signal looks like a tall spike that is wider at the bottom coming out of the noise floor.

The width of the triangular image on the spectrum display varies with deviation. For a time, many users used half-transponder deviation (between 17 and 18 Mhz wide). This mostly went away when Conus Communications dissolved. But CNN continued half transponder deviation for analog transmission, and along with rare occasions at the other networks, they appear to be the only ones continuing this practice in the United States for the time being.

Most full-transponder deviation ranges from 27 to 36 Mhz because the signals are transmitted on transponders that are between 27 and 36 Mhz wide. Transponder width is basically a static thing. You can not ask to change transponder width no more than you can ask a satellite provider to move the satellite.

Since it has been found that most analog satellite receivers work best between 27 and 30 Mhz, it is not recommended to send an analog signal beyond those limits. Contrary to what some engineers will tell you, while you will lose chroma (or color information), you will not lose any noticeable amounts by narrowing your deviation a few Mhz. Anything you lose, you will gain with better return on your power. A more narrow signal tends to have a better signal-to-noise ratio and gives you more dB on your satellite return.



One Digital MCPC and three SCPCs

Digital video, as well as Data (TDMA, CDMA and other MUXed signals) have a squared look when viewed on a spectrum display.

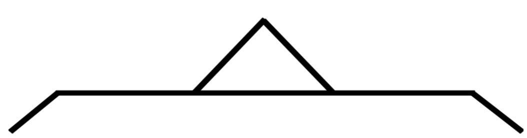
When viewing the entire spectrum, data looks like a hollow hump in the noise.

The users of large data carriers are often long-term, more permanent users of satellites. They move massive amounts of data every day, and often do not move their data carriers frequently or use them occasionally.

This is in part why our use, especially from transportable earth stations, is always called *occasional use.* You will always be, and should always consider yourself, a *guest* and not an *owner* in this industry.

Long time users generally appear on the satellite just after launch and leave shortly before the satellite is shut down. These users are usually the best 'sign posts' for determining the satellite's identification than any video signal, analog or digital.

You may find television networks going up and down on many transponders. If they own the space, the users are occasional, but the networks would be considered Long Time users. Most of them not only lease transponders and bandwidth, they have also insured their leases. That means if the satellite fails, the networks (or other long-time users) will be guaranteed and have “first dibs” on other satellite space available on other satellite transponders.

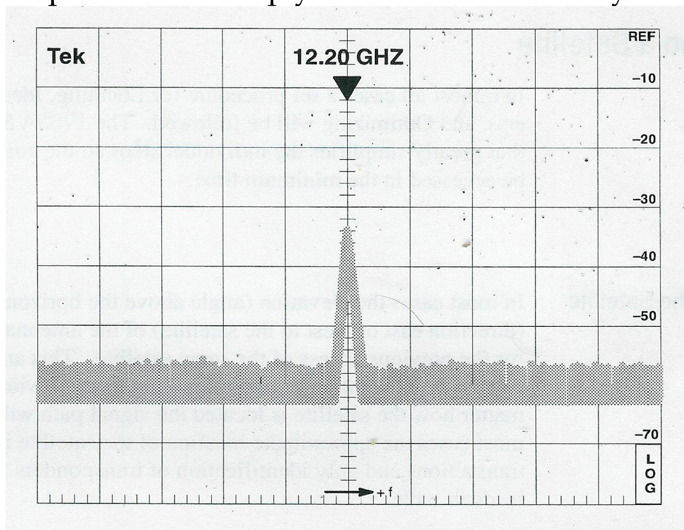


Picture of an FM Squared Signal

FM squared is one more example of a unique looking signal, but it is becoming rare because of the nature of digital video, audio and data transmissions. The signal is made up of a video-like carrier that contains a large number of audio subcarriers but no video modulation. The main carrier is only modulated by audio subcarriers (FM subcarriers on an FM carrier, hence FM squared).

Its shape can be thought of as a combination of a video carrier and a data carrier. It tends to be triangular in shape like video, but it is hollow, like data. It looks like a teepee.

The only reason I mention this signal is because it is unique. It is a good example of something on a satellite that is different and unique and will help you locate and identify satellites.



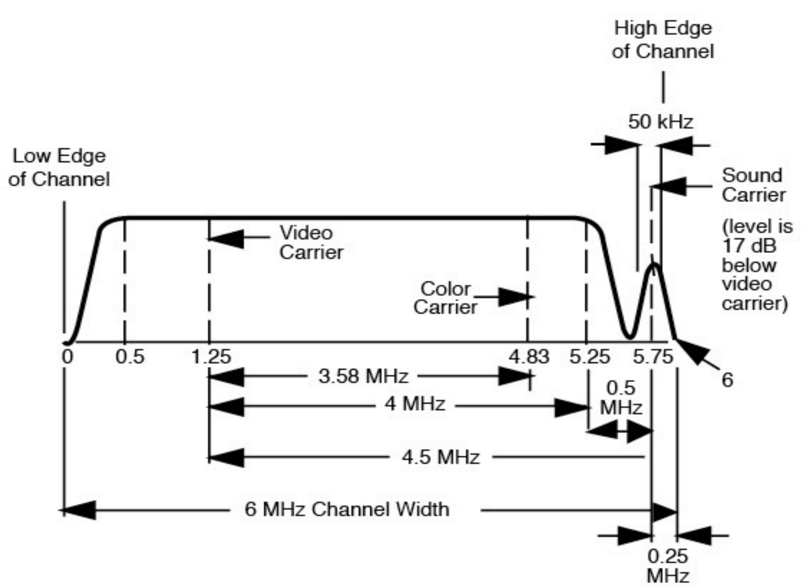
Example of a Telemetry beacon

Telemetry beacons are special tracking beacons used by the satellite controller that are often very easily recognizable on the spectrum display. They are often a good way to identify the satellite, because they won't move on that particular satellite. They *may,* however increase and decrease in power. So they may not move up or down in frequency, but they could go up or down in power.

Examples of Terrestrial Television Broadcast Standards

Should you find yourself in the realm of working as an engineer in the satellite world as well as the terrestrial world, some of the signals above may look familiar to you. The next signals will look extremely familiar, even though you may use a simpler piece of equipment that only measures video and audio levels of a broadcast signal.

I found myself asking the question of several engineers when I was put in charge of setting up an MATV system (with combination SMATV) system, of where to place the carrier levels, and more importantly where to place the audio carrier level from the top of the video carrier.



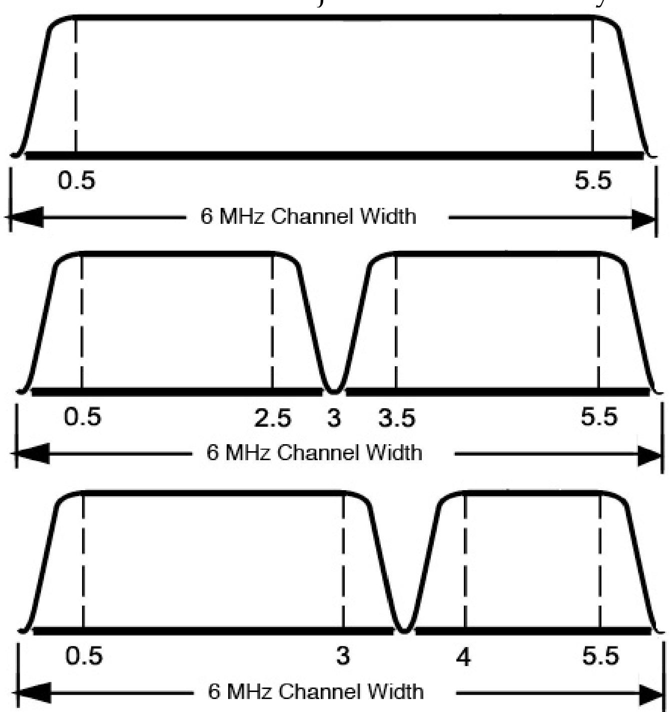
A diagram showing proper video and audio setup for an Analog NTSC Television “terrestrial” signal

As you can see, the answer to my question is to the right, and the audio carrier level should be set at -17db (below the video carrier).

The next question might be, “How high can my video signal go?” And that answer would be, “How much power are you licensed to run?” Or, if you are setting up a CATV, MATV, or SMATV (Cable Antenna TV, Mobile Antenna TV, or Satellite Mobile Antenna TV), then that would largely depend on what your equipment calls for, what your end televisions like to see, and often the distance of copper you must run to the final television receiver sets.

I found, in using fiber transmitters and receivers, the manuals asked for +18db. Regular televisions often accept signals from everywhere in the -10db to +10db range, but will usually accept higher power. It will always vary from equipment to equipment. I actually had *too much* signal being sent to the fiber transmitters and had to put attenuation on the fiber connector. This is done, by the way, by twisting the connector as if you are going to unplug it, and placing a small *air gap* between the fiber connections. That's right, ***you read right,*** I had to put an air gap between the fiber connections.

There is an old engineer's joke that whenever somebody forgets to plug in a video or audio cable, it is said there was an “air gap.” Who'd have known the joke would someday become useful?



Diagrams showing several different ways to set up
Digital ATSC “terrestrial” signals using the same bandwidth

As “over-the-air” traditional television stations get closer to “the big switch,” many have decided to set up channel spacing according to their own needs. Since the newer digital standard never demanded any station had to be “high definition,” many stations have decided to send two, three, or even more signals in the same allotted bandwidth. In the top example, a station may decide to use all of their allotted bandwidth for a high definition signal (where it would show up as, say, 11.1). Or, they may decide to add a channel, and split the bandwidth between them (where you would now have channels 11.1 and 11.2). The station may decide to have one higher-definition channel, as you see in the third example (where they would still show up in a consumer TV as 11.1 and 11.2).

The F.C.C., it appears, seems to have taken a “use it or lose it” approach to this nationwide use of bandwidth. There are so many companies making bids for this bandwidth, much of the space once used for analog television channels has already been sold off (where all analog television, with exception of low power analog TV signals must cease after February of 2009). It's as if the F.C.C went and threw a 62nd birthday party for grandma, then sold her house and yard. But she's not dead yet. In fact, with television sales for old analog sets happening in 2007 (and some sets still take in both analog and digital), it appears she still had a good twenty or more years of life left. Instead, a lot of old televisions will fill up the landfills.

I will talk more about the future of television and satellites in Chapter 10.

Now that you have found the arc

When you have found a satellite in the arc, and made notes about its position, you now have to determine which satellite you are viewing.

And since there are between 30 and 40 satellites visible from most of the inhabitable areas of the earth, this is quite a daunting task. However, *don't panic!*

There are many, many resources, and many, many people where you can find help.

First, use the mixture of services being transmitted on the satellite to assist you. If you carry a list of current analog and digital parameters of services on that satellite, you can simply use your analog satellite receiver or digital *IRD* to confirm it. This can be done simply by downloading the latest page showing parameters from the website: www.lyngsat.com

If you are not on the right satellite, and have trouble confirming what you are looking at, then move along the arc to another nearby satellite to see if you can confirm its identity.

Over time, you will come to remember and recognize the satellite by the way they are set up, by the services on them, and sometimes even by the way they line up from one to the next.

Satellites used by television networks like ABC, CBS, NBC, CNN, ESPN and FOX are ones you will first learn to identify. All of these networks have lists of commonly used transponders and the symbol rates, FEC rates, and channel MUXing inherent in the signals.

Be aware that these networks change transponder locations from time-to-time. And they often buy space on several different satellites, especially during large events such as the Super Bowl, the World Series, and during election or political convention coverage. This can throw you off. But sometimes a simple call to transponder operators (or the uplinks themselves) can help you to identify a bird.

Identifying satellites only by “occasional use” traffic is a bad, bad idea. If you can, search for more permanent 'sign posts,' rather than carriers that are probably only going to be there between 15 minutes and 3 hours.

And one more note: Someday, you might have to find a satellite with nothing on it! Get used to what satellites look like nearly empty, and know what it looks like when transponder pads sit above the noise floor without services on them. This is a rare thing, but it does happen. And it can sometimes happen on Sunday mornings, slow news days, or when you have been booked on a brand new satellite that just finished initial testing.

This is an example of why it is important to be able to identify more than one satellite in the arc. If you can identify at least one satellite next to your empty bird, then you've probably found your bird.

Fine antenna alignment procedure and polarization adjustment

Once you've found the satellite, your antenna must be precisely aligned before you may transmit.

Proper fine alignment maximizes your efficiency, giving you the best transmission for the lowest amount of power and gives you the most headroom in case of inclement weather.

Aligning the antenna for maximum efficiency also minimizes the adverse effects and potential interference issues created by wind, ground settling, or issues created by crews placing abnormal weight on one side of the transportable earth station. You are less likely to be pulled or blown off the satellite.

If you operate an older truck or uplink, and the wind is strong enough to affect antenna alignment, you need to install wind struts or use something to tie down or tie up the antenna so you stay in your proper position of perfect alignment and polarization on the satellite.

What a perfect time for another story:

- While covering Hurricane Georges, I had painstakingly tied down the dish on Conus One (the world's first SNG truck) with rope, ratchet straps, and wind struts. And no matter what I did (since winds reached gusts of over 170 miles per hour according to the nearby military base), I could not keep the truck steady. When I stepped out of the truck to take a look at everything, I realized it was not the dish but rather the *whole truck* that was rocking off the satellite. I took out another package of ratchet straps and strapped *the whole truck* to a big tree on one side and the parking structure on the other side. The truck never moved again. It was said of all the trucks operating from that hurricane that I had the best, most solid signal and I never completely lost the transmission except once when rain became too heavy. The ratchet straps, by the way, made a humming noise like a Honda off-road racing motorcycle.

It is your responsibility as the Uplink EIC to *not* transmit to the satellite if the wind is affecting antenna alignment and you cannot correct the problem.

Eliminating any antenna movement while transmitting greatly reduces the chances of interference. Sure, you can technically do it. But don't.

Most satellite access centers do not allow movement of the antenna while transmitting for any reason. You can properly align your antenna before you transmit. Only crosspol movement should be made once you have turned on the transmitter.

Fine antenna alignment using beacons or satellite carriers

Using telemetry beacons on the satellite to fine tune your antenna can be done, but it is not advisable. And if you are peaking using a carrier on a satellite, make sure the carrier is not being affected by its own power or the power levels of other carriers on that transponder.

Satellite beacons are a good signal to use for alignment because they originate in the satellite itself. They are not retransmitted signals like all of the other transmissions going to and coming from the satellite. As a result, beacons do not suffer from uplink fade, making alignment of the antenna easier.

The beacons tend to stay at a fixed power, and relay satellite telemetry. And they are always there whether or not there is other traffic on the satellite.

The beacons are a low level signal which can provide a quick indicator of the performance of the downlink. The low level of the signal also minimizes signal compression effects.

The beacons are located on either the upper end or the lower end of the downlink spectrum, just above the highest or below the lowest transponder. Many satellites, called hybrid satellites, operate both C-Band and Ku-Band (and sometimes Ka, L, S or other bands too) have beacons *only in C-Band, Ku-Band, Ka, L, or S-Bands*.

While fine tuning your antenna, set the center frequency adjustment on your spectrum monitor or analyzer to center the beacons on the screen of the spectrum display.

Use the dispersal control (sometimes labeled frequency span control) to expand the display to make the beacons easier to spot (zoom in to make them 'fatter').

Turn the scan rate or sweep speed down as much as you can yet still be able to read the spectrum. This will minimize display distortion that appears to attenuate (minimize the height of) the beacons. Yet you still need to keep the display viewable.

Switch the vertical display on the spectrum display to 2 db/division or 10 db/division and adjust the input attenuation to place the top of the beacons well into the upper half of the display using the horizontal and vertical positioner knobs.

Many spectrum displays have a filter (gain) switch. And you may find it easier to peak on the beacons if you filter out the noise of the signal.

Place the antenna positioning control speed to slow or turn down the dish speed. Drive the antenna off the satellite in one direction (horizontally), going through the peak of the beacons watching for the value or point on the display that the beacons become the strongest. Once you have definitely passed the peak, return to the point where the beacons peaked. If you do not go past the peak, you won't know where the peak is truly located.

Now drive the antenna up or down vertically until you lose the beacons. Then return, going in the opposite direction vertically until you go through the peak of the beacons watching for the value or point on the display that the beacons peak. Once you have definitely passed the peak. Return to the point where the beacons peaked.

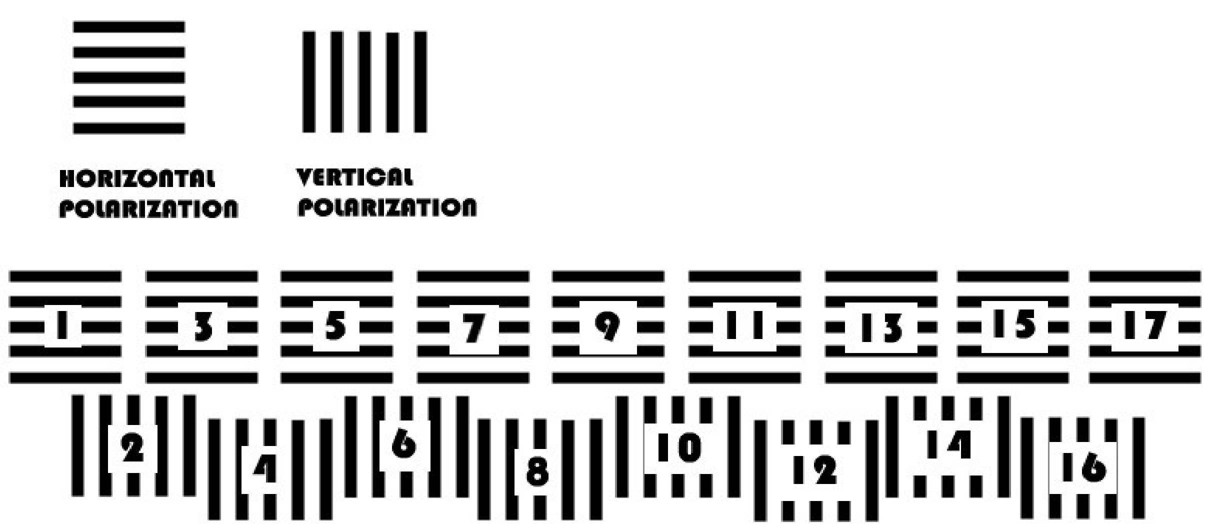
Repeat this process a minimum of three times. Get used to the normal signal-to-noise ratio.

You must perform fine antenna alignment before each transmission to the satellite.

Polarization adjustment

Polarization is most easily understood if we look at simple whip antennas. Principles that apply to whip antennas can be applied to satellite antenna feedhorns. If we have two whip antennas, such as two handheld “walkie-talkies” we can duplicate a similar situation. Imagine one is a transmitter and one is a receiver.

The optimum transfer between the two takes place if the two antennas are parallel to each other. If one antenna is at a right angle to the other, minimum signal transfer takes place. The level of the received signal with the antenna at a right angle to the transmitting antenna can be more than one thousand 1000 times less than the signal when the antennas are perfectly parallel. As a result, it should be obvious why correct antenna polarization is a necessity. In addition to this idea of optimum transmission, satellites require correct polarization due to 'frequency reuse.'



Polarization design

Satellite system designers initially only placed transmission pads on one antenna, essentially a horizontal path. This meant users had between 8 to 12 transponders on each satellite.

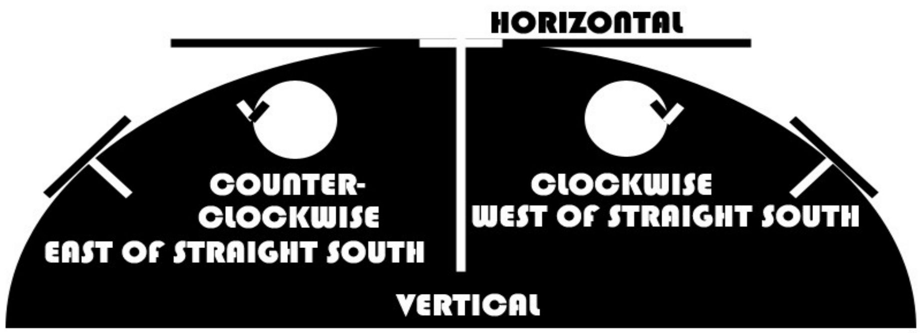
When designers later established two polarizations, and placed the transponders so the center carrier came up in between the opposite polarity, it allowed uplinkers to us the same frequency twice.

One set of transmissions would be transmitted with the antenna oriented in one direction (vertical) and the other antenna would be oriented in another direction (horizontal). To improve further on the isolation of the two sets of transmissions using the same frequency band, different channel plans were adopted for the two polarizations (i.e. Two sets of transmissions.). The two channel plans were chosen to interlace with each other. The frequencies used for the transponder centers on one 'pol' fit between those used for the other 'pol.'

Fine Polarization Adjustment

Fine polarization adjustment must be performed each time you make a fine antenna alignment and before you transmit to the satellite. Fine antenna alignment has a significant effect on polarization alignment, and being off left or right horizontally will throw off your fine polarization alignment.

Polarization adjustment is not the same from satellite to satellite, and moving across the arc, you will always have to adjust your cross-pol.



Polarization changes as you move the antenna east or west of straight south.

There are some signals that make polarization adjustment easier than others. If you take some time to select the best signal that you use for polarization adjustment, it will pay off in an easier to find null and more precise cross-pol isolation. The thing to look for is a strong signal that has the most visible center carrier. It may be an analog signal in black or a clean carrier. It may be an FM squared carrier or a large SCPC or MCPC. Adjusting the scan rate on your spectrum display may make the center carrier more visible. And it also helps to select a more powerful signal, because the null will be more visible.

Polarization is always done by nulling out (minimizing) the signal that is always on the opposite pol. Cross-pol using your spectrum display. Start with a signal you have determined to be on the opposite pol than that which you wish to operate on. And expand the spectrum analyzer or monitor display so that you can observe very low level signals easily. Rotate the feedhorn slowly, watching for the point where that signal is minimized (nulled). Go beyond that point until you see the signal start to rise again. Then return to that point until you see the signal start to rise again then return to the point where the null occurred.

If the signal goes away completely at the null point, observe the point where it goes away and the point where it becomes visible again, and center the feedhorn adjustment between those two points.

The normal procedure for checking cross-pol at any access center requires a go/no-go test. The access center will measure your cross-pol and if it is good, you will be allowed to continue transmitting. If your cross-pol is bad, you will be given a chance to correct it, but that time comes out of your satellite window, or the 5-15 minutes the satellite access center allows you to come up early.

Broken Cross-pol adjusters or working 'sans' a remote actuator

You may have to modify your feedhorn waveguide to get the entire adjustment range you require for a certain satellite. Be careful and don't add additional waveguide in the RF path (in front of the dish). Check with your truck and/or antenna manufacturer to see what they recommend. Any modification should me met with a determination of whether or not the change allows you to continue to maintain compliance and avoids interference.

Mechanical adjustments and manual adjustments of polarity are extremely clumsy. It usually requires two operators, unless you want to climb up on top of the truck one hundred times each day. One operator stands on a stepladder, or on top of the truck near the front of the reflector (with the transmitter disabled). The other operator watches the spectrum display inside the truck. The procedure is the same as working with a functional crosspol actuator, except that the mechanical lock on the polarization must be loosened for the adjustment and retightened once the adjustment is made (be careful during this adjustment that you don't inadvertently loosen the focus adjustment or make any other changes to the feedhorn placement).

With older Dalsat or similar C-Band designs, a crosspol adjustment often requires the operator to turn the entire dish.

In any case, once you have set polarization, you *must* recheck your fine antenna alignment. Don't ever forget you are hitting a target more than 20-Thousand miles over the earth.

Communication with an Access Center

Always, always, always identify yourself first. Find out who you are speaking to, and write down their name. If you didn't get their name, or didn't understand their name, ask again. Ask them to spell it. Get to know the operators you access with every day. It's a part of the communications process.

After you've identified yourself, and stated who you are working for, you need to identify the satellite space you will be accessing. There are a lot of parameters you will need to know:

- 1 – The name of the satellite
- 2 – The number of the transponder
- 3 – The transponder slot, number, letter whether it is upper or lower, or the entire transponder and its uplink frequency
- 4 – How much bandwidth you will be using
- 5 – The satellite time you or your client (station, or network) has booked for you
- 6 – Whether or not you have an approx out
- 7 – If there is anybody booked directly behind you
- 8 – Your phone number (know your own cell, and the number of a hardline if available)

When you and the access operator have identified the correct spot of satellite segment, the access operator will tell you to show them a low power, clean carrier. Before you do this, you need to verify you will be transmitting to the correct frequency *and* the correct polarity.

Do not continue until you have verified the correct uplink frequency and polarity.

When you have done this, look at the frequency they gave you. And if it is correct, then proceed:

- Change the power going from the load and put it into the antenna

- or unmute the IF carrier by turning the IF ON through the modulator
- or unmute the signal coming from the upconverter
- or you can plug and unplug the last two from the back of the unit or through a patch field

During transmission, be sure you keep the same level of power to the transponder. This may need to be adjusted due to drift in the HPA electronics, due to weather, or due to a transmission going into long hours (a transmission often does not require as much power in the middle of the night as it does in the afternoon).

An example of a good satellite access call

Access Center: Hello Intelsat, this is Tanya.
Me: Hi Tanya, this is Sam with Relay House. I'm working for C-Span today. And I am looking to access Galaxy 11, Ku, transponder 13 upper. It is an 18 MHz wide signal.
Access Center: Hi Sam, I see that window. Let me set up. (after a moment) O.K., I am ready for you to access on 13 upper. I show that frequency is 14-269 and that is a Vertical up.
Me: I have 14-269 and a Vertical up. (I switch from load to antenna at 4 watts of output from the HPA, and a clean carrier - no modulation on the signal) You should see a low-power, clean carrier.
Access Center: I see you there, and you are looking good. I don't see any cross-pol. Go ahead and bring it up to nominal power.
Me: Alright, coming up. (Turning up the power, I go to 40 watts where I normally run power on this transponder.) That's where I normally run, about 40 watts. I see I have some cross-pol. Would you like me to clean it up?
Access Center: Yes, I see you have some there. Let's see if we can clean that up. Pick a direction and go.
Me: I am bumping it in one direction (while watching the cross-pol null on the other side). It looks like I went through it.
Access Center: Yes, let's go back the other way.
Me: Going back (bumping it to where it nulled out). And how does that look?
Access Center: Yes, that looks good. Sam, let me get your callback number.
Me: Sure, I am at 612-770-1313. Let me also give you a hardline number. It is 402-555-1212.
Access Center: You are all set. I show your goodnight at 2200 EMT.
Me: That's what I show in my paperwork. Do you also show a half hour approx?
Access Center: Yes I do, you have a 30 minute approx.
Me: Great, I have that, too. Thanks Tanya.
Access Center: Call us with a goodnight.

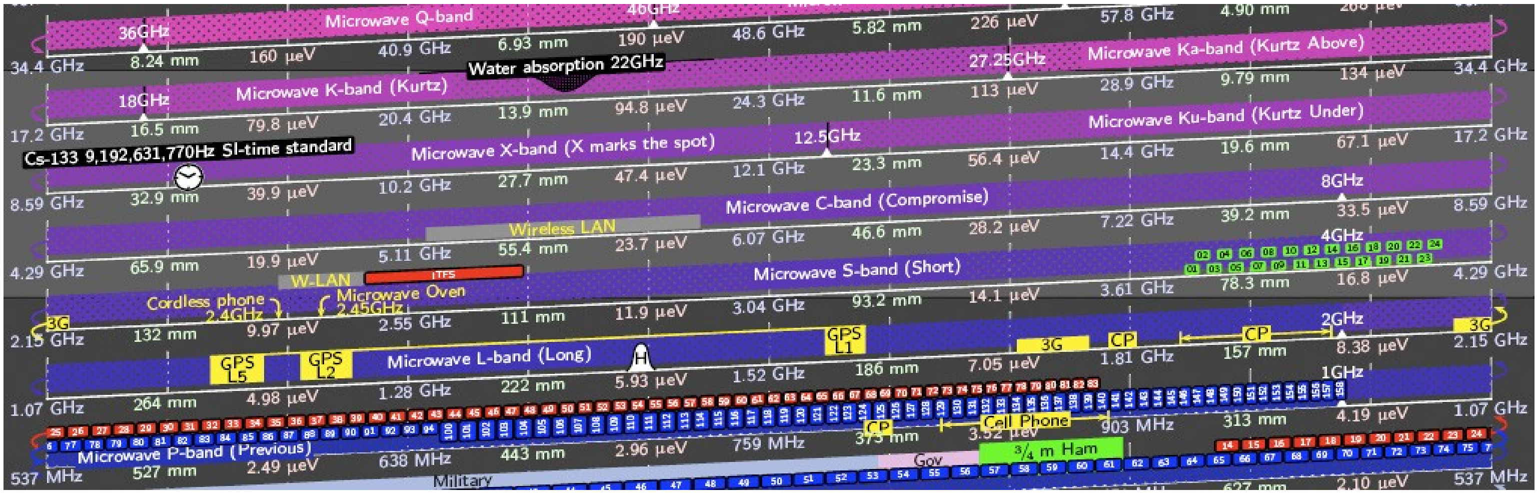
Be aware of the length of your window, and be sure that if somebody tells you they have extended the window, verify that they are telling you the truth. Do not trust your own mother. Call the access center and see if they can verify if the window has been extended. Often it has not. See if you can extend the window yourself.

At the end of the window, you need to "goodnight the bird" by calling the access center back when you have turned off your power to the satellite (by going into load, putting your HPAs into standby to cool off, or doing both and putting the dish away). During the goodnight call, you must give the above parameters again and note the exact time you dropped the carrier.

Depending on who you are working for, and where the space was purchased, goodnighting satellite space may require you to goodnight with the satellite space vendor. Be sure you ask for this before you access the window. Space vendors will charge you or your client if you ordered an approx and didn't use it, but forgot to call in the goodnight.

Ku- and C-Band

While C-Band transmission still requires an RFI (a holdover from the days the FCC required an STA or Special Temporary Authority), as of November 1, 1987, the FCC no longer required STAs for Ku-Band Uplinks. This is still the case in the U.K. However, they have made the STAs much easier and even possible from a 3G-enabled phone.



Full Spectrum Chart Showing Ku-, C-, and Ka Bands available at: unihedron.com

But you need an FCC license for any uplink chain you operate. Licensing should be the first thing you think about before acquiring a truck. Just like you would not drive a car or truck without a license plate, don't even think about uplinking without an FCC license. If you buy a used truck, don't assume you can do even one job without transferring the license to your name or getting a new one.

If you are operating an unknown uplink, make sure you know where the license is located. Most truck owners frame the license or place it in a protective plastic sheet and Velcro it to the wall.

Does the Government (F.C.C.) buy and sell every frequency?

The Federal Communications Commission does control frequencies used in the United States, but they do not buy and sell it all. Many of the frequency bands have been set aside for "government" or " military" use. There are a few bands that were set aside for free use:

- Citizen Band Radio (CB Radio) contains 40 stations between 26.965 and 27.405 MHz. A good case study for CB radio is the movie, "Smokey and the Bandit"or the TV show "Dukes of Hazard." Somehow these fantastic radios worked 10 miles or more past their intended range, no matter the line-of-site obstructions. Fantastic! And using an over-the-air service monitored by everyone to practice bootlegging, speeding, and other illegal acts!? "Honey, GET THE KIDS, this is gonna be great!
- Microwaves, Portable Home Phones, WiFi, and many other commercial products use a band at 2.4 GHz
- Portable Home Phones and some commercial products also use 5.8 GHz (an "octave" higher than 2.4)
- Ham radio bands have been set aside for free use. Ham operators continue to provide free public services, including but not limited to marathons and large event communications help, and disaster relief
- The atomic clock and other time and date standards run at frequencies set aside by the F.C.C.

Government and Educational Uplink Licensing

Many non-profit agencies such as government agencies and schools operate an uplink or uplink truck, and can receive their license for free or a diminished cost from the FCC.

However, they may not operate these uplinks for commercial services, and must provide any uplink services for free. They may not operate the uplink and sell this uplink as a service like a vendor or affiliate who has paid for their license, unless they have paid for a commercial license from the FCC.

Several large universities across the country have been operating illegally for years, but have not been caught because they have not reported or logged their uplinks. The FCC, in the meantime, has not bothered to track this use. Networks who use these uplinks have been tight-lipped about their use, too. Often these colleges and universities are the only way they can get video sent from some areas of the country, or networks can get reduced rates from these entities (Why not? Some of them have little overhead because their buildings, land, equipment, and even staff is already paid for.).

It is wrong for you to receive a large payment and not report it or be taxed for the payment. So therefore it is wrong to charge services under a free governmental or free educational license. Any of these entities can fix this problem by simply paying for a commercial license. End of sermon.

You are responsible

Only one person is ultimately responsible for the operation of your satellite truck. You. You are the operator, the engineer, and usually the sole controller of the transmitter. You are totally responsible. Your station, your network, your company, or anyone else does not have the ability to remove liability from you personally.

The major form of risk is not slipping on the ice, or tripping somebody with your cables, or even irradiating somebody. It's interference.

There are five major parameters you can fail to meet and cause interference:

- **1 - Antenna aiming**
- **2 - Antenna polarization**
- **3 - Frequency selection**
- **4 - Deviation**
- **5 - Power levels**

Antenna aiming – Are you on the right satellite? Are you on the right satellite, but not properly peaked up on it? Is your dish sitting still or are wind, weather or crew problems causing your antenna to come off peak? Is your dish damaged in any way that could create poor performance?

Antenna polarization – If you haven't properly crosspoled, you are leaking onto the opposite polarity of a satellite. Full transponder digital transmission has made it very difficult to adjust crosspol, and satellite access centers may ask you to change to another frequency to properly test your crosspol.

Add to that, if you are operating with more than one carrier, interference from a poor crosspol can be worse than ever before in the history of satellite service.

Frequency selection – It is of utmost importance to always verify you are on the right frequency before you transmit. If for any reason you don't believe the access center has given you the right frequency or polarity, *make sure you ask.* Don't ever forget you are in the communication business, and communication is only two-way, not one.

If you set your upconverter to the wrong transponder, you could come up on top of someone else.

Even if your frequency is off a little, it can affect users of adjacent transponders of that satellite. That is why you will always show low power first. A very low power, clean carrier will not cause irreparable harm to a fellow operator.

Deviation – In the days of analog, this wasn't always an issue. However, text books like this had to be rewritten. Now, you could be uplinking a signal with a deviation (signal width) of anywhere from 1.5 MHz wide to 44 MHz wide.

If you are not set right, you risk interfering with everyone else on the transponder. This could be one other person. This could be ten or more other people. You could, if you are running multiple paths, interfere with *your own* signals!

Power levels – If you are sharing a transponder (there's a 50-100% chance *you are*), then you always need to be aware of your power levels and how they are affecting the performance and *saturation* of that transponder.

Even if you are not sharing a transponder, oversaturating a satellite can increase the power in the side-lobes of your antenna, and has shown to often cause low-level interference in adjacent satellites, or if you are off-center (which is highly likely) you will cause what access centers call *intermod.* Intermod is essentially a "ghost" of your signal that appears on the other end of the transponder at the equal length from off-center where you are transmitting. And any signal that isn't where it's supposed to be, even if it's intermod, is called a *bandit.* You don't ever want to have a bandit in your history.

Of these five parameters, three of them are prone to change or deviate in a given day. Before we get to them, it is important to remember that it is very unlikely that frequency or deviation will change. If you are operating old analog equipment this may not be the case, but as analog is slowly being fazed out, you won't need to worry about frequency drift or deviation drift in new digital gear. This may change, but for now they are a minor worry.

That being said, let's go back at the previous five and go over the three parameters that can drift:

Antenna aiming – Wind can move your dish. The truck might "settle" over time if you are in one spot for a long, long time, especially on soft ground. Smaller vans and flypacks on unstable platforms are much more prone to moving around and need to be monitored for signal loss.

Antenna polarization – This is less likely to happen than having the whole dish move. But polarization motors, gears and cables can break loose. If one side of the truck starts to sink, you may have an aiming problem as well as a polarization problem.

Power levels – While power levels coming from your amplifier can change if you are using a TWT (Traveling Wave Tube) HPA (High Power Amplifier), you need to realize that the output power does not directly reflect on the satellite, because the satellite transponder output power is properly read by *saturation*.

Your power levels to the satellite can change with rain, snow, fog or waveguide issues. And your power levels from the satellite can change due to these things and more. Police radar and radar detectors, airport radar, military and other airport antennas, and general terrestrial interference can affect your downlink and the downlinks taking in your signal across the country.

While downlink power is certainly part of your concern, don't ever forget that your bigger concern is interference. You and the company you work for only purchased a portion of bandwidth and a portion of that satellite transponder's power. You cannot take more than you paid for, in the same way that others cannot take what you paid for. Cooperate with satellite access centers. They may be wrong, but usually they are not.

If the person who hired you can't receive you because they aren't getting a good enough signal, then they should have bought a bigger dish. They should have done a better job aiming and crosspoling their dish. And they should have purchased the proper equipment to receive a satellite signal.

I have personally witnessed Ku-Band signals downlinked from a 5-meter dish that looked perfect and were only being uplinked with 1 watt of power!

And sadly, I have witnessed many more (on perfect, clear days) who couldn't see a strong enough signal with over 500 watts of power, past full saturation of the satellite transponder (and, quite frankly, just a few hundred watts below setting off alarms and shutting off a multi-million dollar transponder).

It is of utmost importance that you realize and know that the former is an example of what we can do when we use our resources properly.

The latter is completely unacceptable. If you need more than 150 watts of power with a 2.4 meter dish on any satellite (or over 400 watts with a 1.8 meter dish), and you can't explain why, there is a good chance there is something wrong with the downlink site or the person tuning in the signal.

Know your signal

If the levels coming back from the satellite are not correct, find out why. This is, and will always be, your first indicator that there is a problem.

Maintain the truck. The antenna pan, tilt, and crosspol adjustment mechanisms must work perfectly.

Damage and interference with a third party uplink is unacceptable. Your live shot is not worth it.

And if you are not transmitting where you are *supposed* to be transmitting, then nobody is going to find you anyway.

If you are ever in doubt, do not transmit. Your ownership, your colleagues in the satellite industry, and I will back you up. Producers, reporters, and sometimes camera people will not.

Balancing the transponder

In one approach to trying to understand a transponder and your role as one of the transponder's caretakers, imaging your signal on the transponder is like standing on a large trampoline.

If you jump on or off the transponder, you disrupt everyone else. If you step on carefully, you do not.

If you put too much power on a transponder, or weight on a trampoline, you are stealing power or resources from others. Having an area pressed down too far creates other areas (and noise on a transponder) to raise up, create a *shoulders* and *intermod.*

If you are at too much deviation on a transponder, or fatter than the others on a trampoline, you are taking up more than your fair share of room on the trampoline.

What happens when you are in violation

If you work for an affiliate, or for the owner of a particular transponder, more than likely a violation of the things mentioned here will be handled “in house.”

Interfering with a fellow affiliate or someone else on a network transponder are typically an “in-the-family” issue and the spacecraft owners or FCC will never get involved. The issue might not even be recorded in any official sense.

However, interference spraying across other spacecraft or onto other satellite space will be brought to the attention of many people and perhaps even the FCC.

No excuse will ever get you out of this mess. And in some rare circumstances, uplink operators and uplink companies have been barred or blacklisted from being allowed access to a satellite. You don't ever want to be in that boat. Because nobody will come to your aid. You will lose a lot of shots if half of the access centers know you are an incapable operator. And in this business, word gets around.

There is also a new global effort to reduce satellite interference. The group is called SUIRG, the Satellite Users Interference Reduction Group, and they are made up mostly of satellite operators Intelsat, Inmarsat and New Skies). And they aim to reduce RFI, or Radio Frequency Interference.

The first step SUIRG has made is to share information and remedies. They help to define equipment standards and proficiency training.

Not surprising, SNG and occasional use satellite trucks are high on their target of violators: In other words, they are on the trail of untrained operators who illuminate the wrong satellite or the wrong transponder.

But keep in mind untrained operators are not their only targets. More so, SUIRG hopes to help eliminate malicious interference.

SUIRG acknowledges that everybody makes mistakes, so they have set an attainable goal: Focus more on the 10% of malicious interference and less on the 90% of cases that are accidents.

A recent theft of an amplifier and high definition encoders from a New Jersey hotel parking lot are a good example of that 10%. SUIRG and other groups worry thefts like this could lead to improper usage and third party thugs causing interference with malicious intent. Very few have been caught here in the U.S.

What other factors could keep me from making a live shot?

If you have experience operating ENG vans, you are already aware of the many video and audio problems that could keep a live remote from going on the air. We will discuss them briefly, and

- 1 – Poor communications
- 2 – Cable or connector problems (Chapter 2)
- 3 – Power failure (Chapter 6)
- 4 – Equipment failure (Chapters 2, 3, and 6)
- 5 – Operator error

Poor communications - People love to blame "the media" when they are looking for a scapegoat. And I rarely, if ever use the term "the media" except in this statement: For a group of people who have spent their lives studying it, making a living from it, and taught it, *the media* suffers from it the most. The media suffers from poor communications.

The solution for this problem starts with you. Always identify yourself. Communicate clearly and repeat yourself if necessary. And don't ever assume. There's an old saying in journalism that you need to always remember: "If your mother tells you she loves you, then you'd better check double-check with another source."

If somebody tells you you are going to the public library, and gives you a street address in Ottumwa, Iowa. You ought to think about making sure you are supposed to go there. Did they give the photographer and reporter a different address? Does Ottumwa even have a library (I've been there, so I can tell you it does)? Did you get the correct address for that library? Did somebody tell you Ottumwa, but they meant Osceola?

Cable or connector problems – Cables and connectors wear out. Rain and salt used to melt ice create corrosion in the connections. Corrosion is known to travel up the ends of the cable, or travel through cuts or other openings in the cable jacket. Some cable or fiber mults get crimped or dinged when they get slammed in a door, run over, or improperly put away.

Learn to care for cable properly. Learn and use the standard "over-and-under" method of rolling up and stacking cable. Many times you will loan out your cable or borrow cable from other operators and other engineers. Learn over-and-under and always wrap your cables and others' cables that way and ONLY that way.

Power failure – We will discuss power issues more in Chapter 6, but many live shots have failed because shore power was cut, generators shut down, equipment became unplugged, or somebody hit the power switch. Batteries die, fuses blow, and equipment fails from a general failure or because of a power surge.

Do everything you can to keep these things from happening. Sometimes no matter what you do you cannot prevent a power failure. But there are many cases where you can.

Equipment failure – Unless you have years of experience on *the bench* as a maintenance engineer, you probably haven't been privy to why equipment fails.

But think about this. Everything fails. Just as every human, animal or plant dies, every piece of equipment will die.

Luckily, equipment gets to live many lives, since so many components can be replaced. Do what you can to not only learn maintenance skills, but do what you can to learn *preventative maintenance* skills. Preventative maintenance is an ounce of prevention and often leads to pounds of cure. You will thank yourself in the future for the extra time you take caring for your equipment now.

It never hurts to give yourself time, and let the equipment warm up first. Making equipment work directly after powering up doesn't let the equipment dry up the condensation that often collects on equipment overnight.

Operator error – There are technically no laws saying you can't be drunk, high (at least not in Amsterdam), or even tired. But there is an unwritten law: *Don't operate stupid.*

Think about everything you do, how it affects you and how it affects others. Be the responsible one.

When the day is done

Always, always, always allow your amplifiers to cool off for 15 minutes. No excuses. It will take you this long to stow the dish, bring the jacks up, wind up your cable, and collect your things.

When your dish is down, then you can bring your jacks up. Remember: Jacks down, antenna up. Antenna Down, Jacks up. Do that every time and you won't forget. Don't assume your dash-board alarms will tell you the antenna is up.

Before you drive away, always do a pre-trip "walkaround" of your uplink vehicle. The vehicle D.O.T. (Department of Transportation) requirements include this anyway. Check your tires, look for oil or antifreeze from your vehicle on the ground.

Look for vehicle problems that could interfere with your ability to safely drive the vehicle. And also look to make sure your antennas are down and your jacks are up.

CHAPTER 2
Video and Audio

Most of the problems you'll have will be with video and audio.

If you have a background with troubleshooting video and audio problems, then this chapter will be a breeze. However, don't skip this chapter, for it offers a good refresher course on video and audio standards. And we will also discuss digital standards you will see as SDI, HD-SDI, AES, Dolby-E and Dolby AC3.

The original NTSC standards established in the late 1940s filled 4,100 pages and included over a million words. Now, the new digital standards aren't finished. In fact, they won't be finished. Algorithms and new modulation schemes can now vary *during the broadcast.*

Present and future broadcasts will allow machines or operators to make constant adjustments in order to get the best picture from the allocated bandwidth. But before we get to all of this in Chapter 10, let's start from the beginning:

In the analog world, and parts of the digital world, video travels down a shielded cable at 1 volt, peak-to-peak. Analog audio travels down a twisted pair, or three-conductor cable at 1.3 volts. And digital audio can travel by either voltage, but tends to travel better down shielded cable in the same way analog video travels. These voltage levels are what you will be trained to monitor and if possible, adjust.

It is your job, and only your job, to be responsible for knowing video and audio standards, and make sure you and your crew adhere to these standards.

With these standards, you will keep your video from turning orange or blue. You will keep audio from buzzing, hissing, sounding overmodulated, “clipping,” or simply being too quiet to understand.

Understanding television at a deeper level requires understanding the eyes and ears, and how human vision and hearing work. The human eye takes in a 3-dimensional image and puts it on a flat surface. Both of the eyes work together to give humans what they perceive as those 3-dimensions again. Close one eye or lose an eye in a fishing accident, and you see in 2-dimensions.

The same type of things happen with the ears. Using stereo settings rather than two monotone channels, for example, is a way of tricking the ears into believing it is hearing a deeper, richer sound. Dolby audio can do the same thing, and if done right can make one believe an object is moving from one side of the screen to the other or moving behind the observer.

In television, we are trying to mimic this with electronic devices. So being a television engineer is essentially being an image scientist. You will constantly analyze the continuous distribution of optical power and color on an image plane. You will constantly analyze audio levels and quality at the same time.

Several instruments in a satellite truck, uplink, or teleport are capable of monitoring these video and audio levels. And it is your job to make sure everything is *perfect.* And I don't say that lightly. If you don't make sure you look and sound good, no one else on your crew will do it.

Many volumes, many websites, and many people are dedicated to this effort and you will never be alone. You have the potential of accessing over 50 years of knowledge, by simply looking, reading, and asking. Image scientists, or television and satellite engineers range from photographers at a Sunday church service to engineers at NASA. Make sure you are never afraid to ask when you need help or don't understand something.

But always remember this: Understanding television standards often means understanding the limits of human vision and hearing.

For example, humans can only hear sound between about 20 Hz and about 20 kHz. Humans can only see the "visible light spectrum" ranging from 398 THz to 796 THz (strangely, one "octave" or doubling of the frequency). Most of us can't see "flicker" when pictures move at 24 frames per second. The first film standard was moved at 19 frames per second, and it stayed that way for a long, long time. And while many of us can hear when a note is flat or sharp, most cannot see that small a difference in luminance or color.

Analog Vu Meter

The first piece of monitoring equipment you need to learn is the *VU Meter.* Vu, or Volume Units are essentially a measurement, averaging out peaks and troughs of short duration to reflect the perceived loudness of the material. In other words, using a VU Meter is not an exact science.

The meter was originally developed in 1939 by the combined effort of Bell Labs and broadcasters CBS and NBC, for measuring and standardizing the levels of telephone lines. The instrument used to measure VU is called the volume indicator (VI) instrument. Most users ignore this and call it a VU meter. Many VU meters not only measure in dB, but also measure dBm. Some only measure dB. Either way, it is a measurement of the perceived differences in loudness of the materials.

The meter doesn't do much, but it is the most important piece of audio monitoring equipment in any video and audio chain.

You would think that being the most important piece of monitoring equipment would mean that everybody in the video and audio industry would know how to use one. However, that is not always true.

Testing the VU Meter and setting levels

*** The reading of the volume indicator or VU shall be 0 VU when it is connected to a 600-ohm resistance in which is flowing one milliwatt of sine-wave power at 1000 cycles per second.**

The most common test used on a VU meter today is to send a *tone* from a *tone generator.* Many pieces of equipment these days generate their own tone. And tone can be sent at different frequencies, different voltages, and can fluctuate if you call for them to do so. Tone generators, such as the one described above, generate a 1k tone, meaning 1,000 cycles per second. A 1k tone sounds like a slightly-flat "soprano's C" (two octaves above middle C on a piano, a soprano's C is a 1,046.5 cycles per second frequency).

Another popular tone is a 400 cycle tone. This one sounds like a slightly sharp G (above middle C, this piano G is a 391.995 cycles per second frequency).

A basic tone generator is a good start, because it will give you what should be the standard level coming out of a piece of equipment. Just as the description, this tone generator should be a 1k tone.

You will adjust your incoming power level using a volume knob or a distribution amplifier. Adjust your level until your VU Meter is at 100% (or, on many VU meters this level will be Zero).

The typical VU scale is from −20 to +3, which is a reading in dB. The rise and fall times of the meter are typically both 300 milliseconds, meaning that if a constant sine wave of amplitude 0 VU is applied suddenly, the meter will take 300 milliseconds to reach the 0 on the scale. It behaves as a full-wave averaging instrument, and is not optimal for measuring peak levels.

This is where many people go wrong in adjusting their levels. While every piece of equipment responds to levels in a different way, and every piece of equipment has a different sensitivity to audio peaks, this is where you need to know that you will never be exactly right. But there is a way to always be extremely close to perfect.

If your audio levels are too low, people will have trouble editing or reusing the piece on a later date.

If your audio levels are too high, your audio will bleed into your analog video or clip off and go silent in your digital video and audio mix.

Setting and *riding* a VU Meter at levels between 80-100% will always be the closest to perfect you will ever achieve. And don't worry about it! People down the line will always be glad to tell you, or shout at you, if your audio is too low or too high. You will know when you get better at this job. It's the day when people stop shouting at you!

Wait! What is dB?

The dB measurement, like the VU meter, was invented to help manage large power ratios. Rather than using multiplication and division to understand a power difference, the dB allows gains and losses to be measured using addition and subtraction.

That's the easy explanation. However, the formulas are a little tougher than that:

Ratio of power P_1 to P_2 in dB:

$$dB = 10 \bullet \log \left(\frac{P_1}{P_2}\right)$$

Ratio of power between two voltage measurements, calculated as follows:

$$dB = 20 \bullet \log \left(\frac{V_1}{V_2}\right)$$

Basically, in the world of audio, we will find adding 3 dB will make the output (speakers) twice as loud. By decreasing 3 dB, the audible output will be half.

Knowing what you now know, you can calibrate your VU meters. You can also read equipment manuals to find out what audio thresholds are acceptable. They might be 11dB, or 20dB. You might be able to adjust those levels inside that piece of gear.

Wait, you told me what dB is, but what is dBm?

A measurement in dBm is the ratio of power, referenced to one milliwatt (mW). Why bother? In many electronics, this shortens the amount of room it takes to describe a measurement. It also makes this measurement absolute, because the Watt is absolute.

If your next question is, why don't we make everything absolute, then you need to be reminded that much of what you work for in this business is measurements above the noise floor. Since you are constantly working with signal-to-noise ratios, therefore, the dB is an incredibly important measurement.

Audio Compression

There are many companies who build compression units or use compression software and components so you can have widely varying audio and avoid dropouts or overmodulated audio. However, adding *any* of this equipment will also add delay. If adding to the satellite delay isn't a problem, you should consider that the delay will place the audio at least one millisecond behind the video and will affect lip synchronization in your broadcast. You will need to adjust this lip sync at the encoder.

Should you ever use compression on one channel, you also need to compress all of the other channels in your feed. If you don't, you will introduce a channel that is “out of phase” by placing it one millisecond or more behind any other channels. You can see what an “out of phase” signal looks like by using an audio X-Y measuring device, such as the many made by Tektronix. (Many waveform monitors include this feature.)

Straight Delay

While many engineers and sound engineers make a compensation for equipment delay, most never even think about a thing called straight delay.

If you are managing talent, reporters, or anyone who is standing a long distance from the camera lens, you need to compensate for the passage of sound through the air!

This straight delay is approximately 1 millisecond per foot of air, or 3 milliseconds per meter. This changes, believe it or not, on the air temperature's effect on the speed of sound. The amount of liquid in the air also has an effect on the speed of sound. Since we never need to take an extremely scientific measurement, the speed of sound in dry air at 68 °F (20 °C) is 1,125.79 feet per second (343.14 meters per second).

Reinforced Audio

When audio needs to be sent to an audience or room in addition to the uplink, we call the audio going to the room “reinforced audio.”

Reinforced audio is a totally different beast than regular audio monitoring. The reinforced audio engineer (usually a separate person, but not always), works to deliver sufficient sound volume to the back of the venue as well as the front of the venue, without resorting to excessive sound volumes at the front. They must deal with the straight delay I mentioned earlier. They have to avoid feedback, flanging, reverberation, hiss, buzz, and other things, such as the Haas Effect. The Haas Effect happens when sounds differ by up to 30 to 40 milliseconds. When the same sounds reach speakers at this audible difference, the mind starts to hear two distinct sounds and often becomes too confused to listen with any real ability. Above 40 milliseconds, most audio engineers call this audible difference an echo.

AES Audio

The Audio Engineering Society, or AES created the standards for digital audio. Their first standard was built to use the existing analog audio XLR connectors, but this time using 110Ω impedance. It is officially called AES3-1995.

They later expanded this standard to include an unbalanced BNC connector, 1 V peak-to-peak signal level, and 75Ω impedance to basically use existing analog and digital video BNC connectors. This standard is officially called AES3-ID-1995 and SMPTE-276M.

Each of these standards are capable of carrying two channels of audio.

If you use AES audio, you will likely find that each company uses either one or the other of these standards. Therefore, if you use AES audio, you will need to carry impedance matching plugs that change from BNC to XLR or vice-versa. They are available through most broadcast equipment sellers, such as Markertek or Full Compass. More of these companies are listed in the dealers and parts list at the end of this manual.

Dolby AC-3 and Dolby-E

While I would be hard-pressed to call either of these a *standard,* I can say these two Dolby audio encoding methods are standard for Dolby.

AC-3 has become known as “surround sound” in many cases, and is often further defined by a “x.1” designation or a x/0, x/1, or x/2 designation in regards to the number of channels being carried.

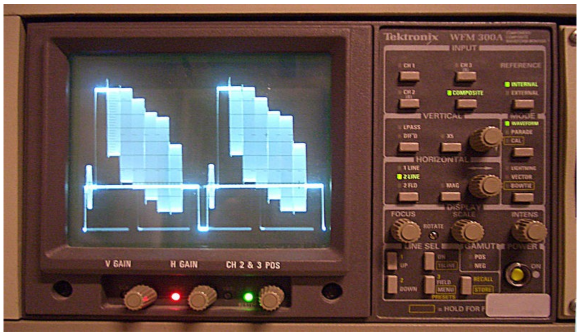
For example, if you are an extreme audiofile, and love to spend tons of money on music, you might own a stereo capable of 5.1, 8.1, or even 10.1 Dolby.

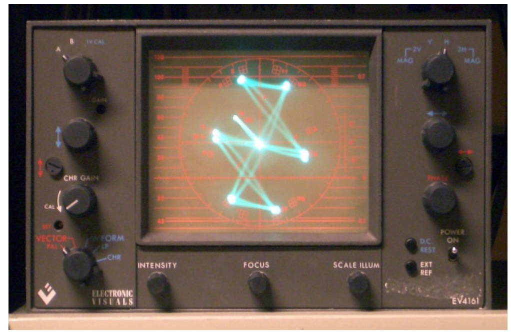
We still use these terms in the broadcast field, but we also might say we are sending 1+1 (dual mono), 1/0 Mono (regular mono), 2/0 Stereo, 3/0, 2/1, 3/1, 2/2, 3/2, or even higher numbers than that.

Once we are in the range of 3/2, we are must assign channel input numbers or letters, such as Left Front, Center, Right Front, Left Rear, Right Rear, and if there are more channels available, audio technicians may choose to run an “effects” channel. The “.1” stands for the subwoofer channel.

Tektronix Model AMM768 used for monitoring Dolby 5.1 (3/2) Levels

As demand for better audio, and higher standards like Dolby has introduced, so has audio monitoring. Tektronix is one company making Dolby audio analyzers and monitors used in production and uplink trucks today. It provides a 2-dimensional room model that helps users understand correct audio levels being projected to each area of the room.





Waveform and Vectorscope

On the video side, the first two pieces of equipment you will need to learn to use are the *waveform monitor* and *vectorscope.* Technology now mixes these two pieces of equipment into one, and often also gives you a place to monitor audio in a more 3-dimensional view called an X-Y display. Not only is this now all available in one piece of equipment, it is even now possible to have all three things input into a monitor, essentially putting four pieces of monitoring equipment into one. This looks good on paper, and saves money and real estate in a satellite truck or other equipment rack. However, it makes for a confusing first day. So let's take it one piece of equipment at a time.

The Waveform Monitor

A waveform monitor is a special type of oscilloscope. It is typically used to measure and display the level, or voltage, of a video signal with respect to time.

In addition to voltage, waveform monitors are capable of monitoring several other parameters.

The level of a video signal usually corresponds to the brightness, or luminance, of the part of the image being drawn onto a regular video screen at the same point in time. A waveform monitor can be used to display the overall brightness of a television picture, or it can zoom in to show one or two individual lines of the video signal. It can also be used to visualize and observe special signals in the vertical blanking interval of a video signal, as well as the colorburst between each line of video.

Using the waveform monitor, you will learn to monitor sync, black levels, and white levels. You will eventually learn to look for and see facial tones, and though there is less of a need for it in the digital age, you will also figure out how to set up horizontal sync.

Think of the waveform monitor as a way to view the 2-dimensional screen in 3-dimensions. It allows you to view not only power levels, but percentages of modulation.

Take a look at the right side of the waveform monitor, and you may notice small % markers. If they aren't there, then they are as follows:

-40 on the left is 100% on the right
+7.5 on the left is 75% on the right
+93 on the left is 12.5% on the right

Set your levels in this order, from the bottom of the waveform. Sync on every piece of video needs to be at -40. You can raise this by going through a distribution amplifier. Think of this -40 as 100% of modulation, and 100% important. You cannot continue until you get this step right.

Black level is the next step, and equals 75% of modulation and is 75% important. Absolute black is zero, but you aren't concerned with absolute black if you are working with analog video. You are concerned with visible black. Visible black levels on a waveform monitor need to read 7.5. You can adjust this at the camera, deck, or video processing unit sending the video. This can also be adjusted using a frame sync, or by simply doing several black balances with the originating camera.

The last level you will need to adjust is the white level. It may not seem as important, at only 12.5% of modulation, however it is the most misunderstood level of the three.

A camera shooting a white piece of paper needs to read about 93. Just like the difference between absolute black and visible black, there is also a difference between absolute white and visible white.

Visible white on a color bar test pattern just might be at 100. But this is not so for a white sheet of paper. Lights will peak at or above 100 on a waveform monitor. But a white sheet of paper does not reflect back 100 percent of that light.

When you have time to watch a waveform monitor, pay attention to what lights do and how facial tones appear on the screen. In proper lighting or good outdoor lighting conditions, you will see facial tones measuring in the 62 to 68 mark. And facial tones will fool you. For cameras often pick up as much reflection from the moisture on a person's face as much as the reflection from the skin itself.

The Vectorscope

The vectorscope was introduced in part to help engineers time cameras, but still serves in a somewhat more important role as a way of measuring chroma.

Chroma is the one parameter that is hard to measure with a waveform monitor. In the analog video signal chroma is defined as the amount of color saturation visible in the video signal. Without chroma, colors are faded or even nonexistent. Chroma can be adjusted using a video distribution amplifier with equalizing capabilities, or can also be adjusted using a frame sync. It can often be adjusted at the camera or the originating equipment. The main culprits of chroma loss are an excessively long cable run or an aging piece of equipment.

- When timing an analog switcher, a vectorscope is often used to adjust the camera chroma and hue. It is also the first chance to see if the camera or originating equipment is accepting a *black burst* or *genlock* signal. If the camera does not see this signal, the vectorscope will simply spin. Once the camera accepts the signal, the vectorscope will be still. Only then can you adjust between black and each camera or video source.

If you are lucky enough to have X-Y capabilities in your waveform/vector combo, or have another way of monitoring audio, be sure you use this feature. X-Y monitoring allows you to not only keep an eye on audio levels, it also allows you to monitor *audio phase*.

Audio phase happens when one channel of audio is timed a fraction of a second behind the other channel(s) of audio. This tends to affect music more than spoken word audio, but it introduces problems in the final product, including lower than normal audio levels, and improper record levels at the final receive point.

One you understand how to turn on the X-Y feature, you simply monitor a straight line (when you feed two channels of tone into the unit). The line will travel from a target in the lower left part of the screen to target in the upper right part of the screen. If you have an audio phase problem, the straight line will now be a *loop or oval*. You will know it when you see it, because it definitely doesn't look right.

- Audio phase usually happens when you are being fed from a mixer where you can turn an equalizer on or off for each outgoing channel. This delays the one channel being sent through the *E.Q.* Hence your audio phase problem. This also happens if one channel makes a longer cable run, if the channels come from different mixers, or if there is a problem with the originating audio mixer.

A deeper understanding of NTSC and PAL

In *component* video, the three color components are kept separate. Video can use RGB components directly, but you will rarely see this in the field and usually only in the studio. Three video signals are bulky. Instead of using one coax from a camera or piece of gear, you have to run three coax cables. YRB signals can also be sent from a piece of gear, but still need a multi-pin cable or three separate coax cables.

To fix this problem, engineers created *composite* video modulation. NTSC and PAL color coding both use quadrature modulation to combine two color components into a modulated chroma signal.

The next step involves frequency interleaving, which combines luma (Y) and modulated chroma (R and B) into a composite signal.

This signal transmits at 1/3 the data rate in a digital signal or 1/3 the bandwidth in analog than using RGB or YRB.

Composite video modulation stuck for many reasons, not just because it made our lives easier in the field. Engineers in the 1950s also had to begin transmitting in black and white and composite video modulation made this transition easier, while it also allowed for backwards-compatibility so viewers with new color TVs could still see black and white shows.

NTSC and PAL composite video has been used in billions of broadcast and consumer electronic devices. And the difference between them has come closer and closer. You will often see consumer quality video in a professional quality broadcast. And if it is well done, it is sometimes hard to see the difference.

Composite problems

Composite video suffers from three problems:

- 1 – Encoding introduces some mutual interference between luma and chroma
- 2 – It is very hard to process the image (reposition or resize the image) once it is encoded
- 3 – Artifacts, leftover overmodulated or undermodulated information are destructive to JPEG and MPEG image capture. Anything lost will not be regained later.

If you find any way to avoid NTSC or PAL, do it. If your camera or video output device has an SDI output, and you have an SDI input, use them. Otherwise, I can guarantee you are losing more information than if you used SDI.

SDI and HD-SDI

While we will explore encoding and modulation in Chapter 7, we will now touch on digital video encoding in this chapter.

Just like NTSC (National Television System Committee) before it, engineers developed another standards committee. Yet this time they joined with Motion Picture (movie) engineers, and created SMPTE (Society of Motion Picture and Television Engineers). The society is responsible for writing the standards you and I will live by in this industry.

In the standard-definition field, when researching SMPTE standards, you will be looking for SDI (Serial Digital Interface) standards. In the United States, this standard basically involves data rates between 143 Mbps and 360 Mbps. On-screen ratios may be 4:3 or 16:9.

In the high-definition field, these same SMPTE standards will be called HD-SDI (High Definition Serial Digital Interface) standards. And in the U.S. This standard has a data rate of about 1.485 Gbps (mistakenly called 1.5 Gbps) for *uncompressed,* studio-quality HDTV. On-screen ratios are usually 16:9.

All of the *standards* for digital broadcast systems in the United States today are based on MPEG-2 compression.

Many stations, online companies, consumer products, and even broadcast-quality gear sold today uses MPEG-4 compression. But I can say, without apprehension, that there is still *no standard* for MPEG-4. Buying any product that records or transmits in MPEG-4 means needing a device or software to play back or receive that MPEG-4.

You need to be aware of this issue. For if you buy an MPEG-4 device from a company like JVC, for instance, and the playback device breaks or becomes corrupted, you probably won't be able to get it out with a SONY player. You may not be able to playback the video with a new JVC device if that company no longer supports the old MPEG-4 standard.

The same issue occurs when companies buy MPEG-4 encoding equipment and discover they can no longer buy receiving equipment that recognizes the encoded feed. New equipment may not be backwards compatible, and after a few years a company may no longer support its old equipment if chipsets inside are no longer available. You now own an expensive boat anchor.

There are other problems being ironed out with MPEG-4. There is more “latency” or delay in the encoding. There have been up to ten-second delays in test-loop mode in some practical tests done by engineers at the networks. The quality over 12 Mbps starts to deteriorate over MPEG-2. At 20 Mbps, MPEG-2 looks better. But MPEG-4 will likely show up in broadcasts requiring very little bandwidth at very little power.

When researching new equipment, don't be pulled in by smoke and mirrors. Find out what you can about the playback of certain equipment. If you should be in the field and a playback unit breaks, will you be able to borrow from a neighbor and send your video with their device?

Most of the equipment made for terrestrial and satellite transmission today adheres to MPEG-2 standards.

On the ground, from local TV stations to your new HDTV set, HDTV systems in the United States were designed to deliver images at nearly twice the vertical and twice the horizontal resolution of SDTV (standard definition TV). The original bandwidth, 6 MHz of analog video, will go away in a big switch on February 2009.

Stations soon discovered they had choices. They have 6 MHz to use for HDTV transmission, *or* as some discovered they could continue to send one SDTV signal *and* up to four more SDTV signals in that same amount of bandwidth.

The reason I go over this is because you will see this in satellite transmissions. If you take the time to figure out what each empty hump really is on each satellite transponder, you would discover computer data from banks and financial institutions, MUXes each transmit an MCPC signal and each is capable of carrying a dozen television stations and radio stations. You might also find a whole transponder carrying only one HDTV signal, perhaps a football, basketball or baseball game.

This is the same way terrestrial television transmission works, and quite frankly the way most of the broadcast world works. There are many standards out there, and yet there are *no standards* anymore. You will find this frustrating, and yet comforting at the same time. If it is important for people to find your signal, be sure to update your transmission “descriptor” in your encoder's setup menu. This basically describes what you are transmitting, where, the downlink frequency, and other information. It might even include your phone number (in place of what used to be called an analog “ATIS.” We will discuss this later.

The ATSC (Advanced Television Systems Committee) was another off-shoot of the former NTSC. They basically are a U.S.-based committee advocating MPEG-2 video and Dolby Digital AC-3 audio.

And it was the ATSC that did part of the footwork, giving the FCC what they believed should or would be the 18 formats or standards for television in the U.S.

However, the FCC rejected some of their work and sent them back to the drawing board. Their work hadn't included 25 or 50 Hz frame rates, which left out and didn't take into account movie and computer industry standards.

There isn't enough paper in the world to write up everything NTSC, SMPTE, ATSC or the FCC have to say. And it's just too much to include here. But use what information I have given you to look for *more* information about these committees and the incredible work they have done for all of us. Consider this book the gateway to the knowledge available to you. Don't let your learning stop with this book!

The basics of television

Once an illuminated image enters the lens of a camera, it hits a CCD or Chip which encodes the signal.

Encoding happens in both the analog and the digital world. (Although analog used to be captured using tubes.) With analog, the 3CCD camera captures each of the primary colors, then encodes them, essentially combining them into a single NTSC *composite* signal.

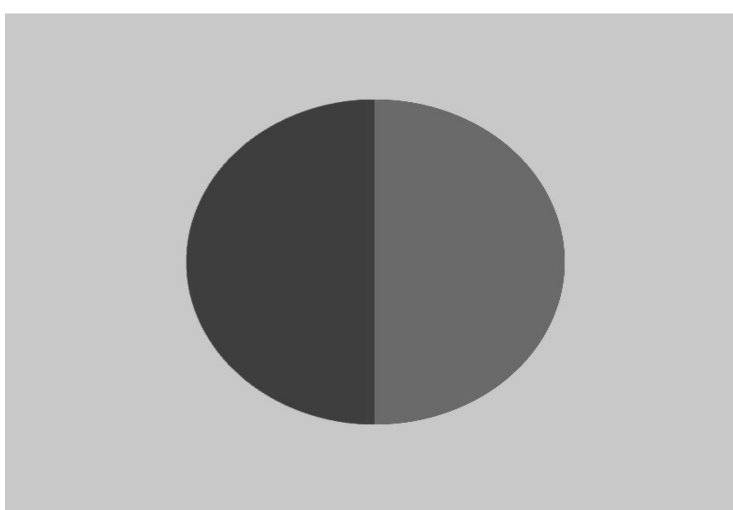
In digital encoding, these three images are encoded into ones and zeros. And there's something at this point I will stress: There are 10 kinds of people in this world. There are those who understand binary and those who do not.

If you can't wrap your head around binary, I have a children's book you can read. It's quite enlightening. If I have time, I will even read it with you and do what I can to help you understand it! It's really, really easy.

Binary can basically be described as a light switch. 1 is on, and 0 is off. Since the invention of data communications (the fax machine, for example, goes back to a patent written out in 1843!), the zero has been known as space, and the one has represented a mark. In printing, this mark deposits ink on the page. In television and computer imaging, a mark would be the placement of light.

However, it is quite a deep thought that it takes a 1 to mark black on a video monitor.

Understanding Luminance



Example of a Contrast Sensitivity Test

Truly understanding parameters often means needing to understand how engineers came to the decision to set parameters at certain levels. In luminance, designers knew they had to create a limit for ultimate white. White, by definition is all color, in full. Black, by definition is the absence of color (think about that when you see a New Yorker dressed in all black... you will giggle to yourself).

White and black luminance limits were established, setting up a definition for visible black, ultimate black, and full illumination of the three primary colors (which is white). However, one factor remains in the luminance scale that will not change for HDTV. And that is that the human eye and brain cannot distinguish two luminance levels if the ratio is less than 1.01. So when a digital, or even high definition capture device goes to transmit it's findings, it needs to set up less than 100 levels of lightness, because the human eye's contrast difference sensitivity is only 1%. Designers often do allow for more sensitivity, because they can. And in the analog world, there is no way to "step" the signal. When digital transmission came about, the signal "quantized" because the 1s and 0s carry specific luminance, chroma, and other information about the picture. And these levels look like very tiny "steps" when they are mapped out.

Understanding Chroma, or rather "Raster Images"

Color information in computing and digital video can be described in many ways. But to help them all make sense at once, perhaps it is best to use more universal, more standard terms. So when we talk about color information we will start by talking about raster images.

Raster images are made up of five parts: Bilevel, Pseudocolor, Hicolor and Truecolor regarding what we know as color, and Grayscale for luminance without color (but don't confuse luminance and Grayscale because they are not the same thing).

All of this information in the digital world (remember, it's all 1s and 0s) can be converted to Plain ASCII text, or to 1s and 0s from Plain ASCII text.

It is software and hardware designers who understand these relationships the best who are making the most money right now. Understanding how to convert this information back-and-forth and building hardware or software converters allowing, say, a JPEG to be converted to an MPEG file, has taken a very complex problem and simplified it for the masses.

Luckily, for television, the only two types of a raster images we need to really concern ourselves with are truecolor and grayscale. They are the only two that are capable of representing a continuous tone.

- Allowing a continuous tone means that color (or gray) information does not have to be repeated during the broadcast until or unless it changes. Not repeating information means you will transmit less information and essentially use less bandwidth. Are you starting to see the genius behind the system?

Truecolor - A truecolor system has separate red, green and blue components (RGB) for each pixel. In most truecolor systems, each component is represented by a byte of 8 bits. Each pixel has 24 bits of color information, and is called 24-bit color (or "millions of colors").

RGB values of each pixel can represent 2^{24} or about 16.7 million, distinct codes.

Grayscale - A grayscale image represents a continual range of tones, from black, to gray, to white. And a grayscale system with a sufficient number of bits per pixel, 8 bits or more, can represent a black and white photograph.

The monitor screen is not a matrix of independent pixels. While you could record each pixel and transmit each of them to everyone's TV at home, this is certainly not how it is done. That would be a complete waste of bandwidth.

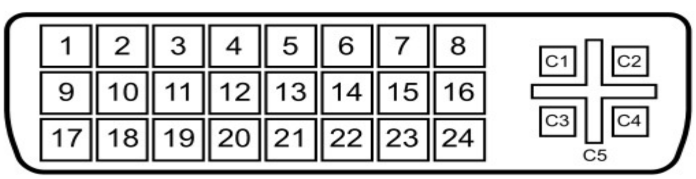
Lines are scanned, horizontally. And in these lines, similar luminance and chroma is repeated, or told to step up or step down, or change completely. The software algorithms in the early systems were made to imitate older NTSC standards, where a Cathode Ray Tube (CRT) electron gun scanned a line using the curving analog voltage information to determine luminance and chroma for each spot on the CRT's phosphor screen.

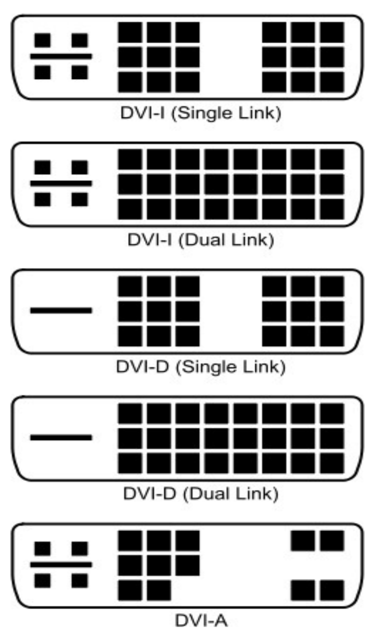
Common Types of Cable

- Coax Cable
  - RG-6
  - RG-59
- Twisted Pair Cable
- Telephone Line
  - Cat 3
- Ethernet Cable
  - Cat5
  - Cat5e
  - Cat6
- Fiber Optics Cable
  - Single Mode
  - Multi Mode

Common Types of video connectors

- BNC
- RCA (or Phono)
- S-Video (or 7-Pin)
- Triax (basically a very well shielded coax with an extra braid and big, expensive connectors)
- HDMI or High-Definition Multimedia Interface





Pinouts for DVI:

- Pin 1 TMDS Data 2- Digital red - (Link 1)
- Pin 2 TMDS Data 2+ Digital red + (Link 1)
- Pin 3 TMDS Data 2/4 shield

- Pin 4 TMDS Data 4- Digital green - (Link 2)
- Pin 5 TMDS Data 4+ Digital green + (Link 2)
- Pin 6 DDC clock
- Pin 7 DDC data
- Pin 8 Analog vertical sync
- Pin 9 TMDS Data 1- Digital green - (Link 1)
- Pin 10 TMDS Data 1+ Digital green + (Link 1)
- Pin 11 TMDS Data 1/3 shield
- Pin 12 TMDS Data 3- Digital blue - (Link 2)
- Pin 13 TMDS Data 3+ Digital blue + (Link 2)
- Pin 14 +5 V Power for monitor when in standby
- Pin 15 Ground Return for pin 14 and analog sync
- Pin 16 Hot plug detect
- Pin 17 TMDS data 0- Digital blue - (Link 1) and digital sync
- Pin 18 TMDS data 0+ Digital blue + (Link 1) and digital sync
- Pin 19 TMDS data 0/5 shield
- Pin 20 TMDS data 5- Digital red - (Link 2)
- Pin 21 TMDS data 5+ Digital red + (Link 2)
- Pin 22 TMDS clock shield
- Pin 23 TMDS clock+ Digital clock + (Links 1 and 2)
- Pin 24 TMDS clock- Digital clock - (Links 1 and 2)
- C1 Analog red
- C2 Analog green
- C3 Analog blue
- C4 Analog horizontal sync
- C5 Analog ground Return for R, G and B signals

- HDCP or High Bandwidth Digital Content Protection
- DisplayPort
- 36-pin
- 34-pin
- 32-pin
- 28-pin
- 26-pin
- 14-pin
- 10-pin
- 8-pin
- Cat-5 (This can be done with a Converter)
- Firewire (IEEE 1394)
- VGA

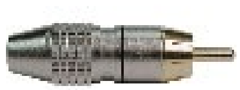
Common Types of Audio connectors

The XLR audio connector, made by the Neutrik Company

The XLR audio connector is the most common professional audio connector in the world. It was developed by the Canon company, and was first called the X-Series. In the industry it became known by engineers as a "Canon Plug." It finally became the XLR to describe it as the X-Series, with a Latch, and a Rubber gasket.

There are several brand names, Neutrik, Switchcraft, Amphinol, and Canon, to name a few. And there are two different kinds of XLRs, solder-less and regular. If you should choose the solder-less kind, it is highly suggested you buy the "smasher" that goes with that XLR type so the wires lock properly into place.

When soldering an XLR, be sure to use heat sparingly. Getting the XLR leads too hot could melt the plastic holding them in place.



The RCA audio connector is the most common consumer-grade audio connector in the world. It was developed by the RCA (Radio Corporation of America) company, and is commonly known as a phono jack, composite jack, or Cinch/AV connector.

The connector is made up of a central male plug surrounded by a ring which acts as a ground for the connection. Often, video and audio is paired up in a 3-color married cable with yellow, white and red connector jackets. In this way, Video usually runs down yellow, Left channel audio runs down white, and Right channel audio runs down red.

When RCA is split out for component video, you may also see the colors Red, Green, and Blue. This is often used either for Red, Green, and Blue video (sent separate and put together later), or Y' U' V' video (Y'=Luminance, U'=Blue minus luma, V'=Red minus luma). Another similar use to Y'U'V' breakouts includes $Y'C_B$, C_R video and $Y'P_B$, P_R video. BNC may also be broken out in this way.

The RCA connector was widely used for video and audio, but it's incredible popularity is largely because of the popularity of tape recording. Early headphones, before the 1/8 inch jack was popular, often used RCA connections, too.

In any connection, there is a direct relationship between the quality of the cable plus cable connection, and the purity of the video or audio signal that passes through it. Because so many RCA connections are cheap and cheaply built, this is even more apparent.

Basically, cheap cables with no insulation, ruin your video and audio signals.

Knowing this, there is a big business in selling Fear, Uncertainty and Doubt (known is business circles as selling FUD). Many people get suckered into buying very expensive cables that use very exotic and rare materials. Most of the time, down short lengths of cable, buying something "middle of the road" using a good connector and good cable is the best you can do with RCA connections.

- 5-pin XLR (XLR-5)
- 15-pin D-Style
- BNC
- DT-12
- MT-12
- 37-pin
- 54-pin Calrec (16 channels each connector)
- 96-pin Elco connectors
- 3.5 mm (also known as mini or 1/8 inch)
- ¼ inch
- Fiber Optic "Toslink" Cables
- S/PDIF
- Cat-5 (This can be done with a Converter)
- Firewire (IEEE 1394)
- Unbalanced down a "twisted pair" (This is not recommended, but you can use phone lines to send audio.)

Common Types of Fiber Connectors

- ST
- SC
- LC
- Unicam
- Telecast Fiber "Military-Style" (proprietary, unisex connectors)

Non-Cable, Non-Fiber Video and Audio Transmission Methods

- Microwave
- Infrared
- 802.11
- Bluetooth
- VHF or UHF Omni-directional
- Canobeam

Some of the adapters you might use

Video	**Audio**	**Other**
BNC to RCA	XLR to RCA	XLR to RJ-11 (for phones)
BNC to F-Connector	XLR to ¼"	XLR to "punch block"
RCA to S-Video	XLR to 1/8"	XLR to bare wires
BNC to Triax	XLR(s) to 5-pin	4-Pin XLR to 4-Pin (or 5-Pin) XLR*
BNC to BNC (barrels)	XLR to XLR (turnarounds)	*for adapting Clear-Com to RTS headsets

BNC to S-Video		
RCA to S-Video		
1/8" Video/Audio to BNC		

Try to put together a list of every possible video and audio cable you might need, the lengths of each cable, and any possible adapters you might need with your uplink and production gear. This list will grow through the years as you compare notes with other engineers and build your uplink kits from daily necessities.

If you have a set of gear you use the most, think about putting it in an easy-to-carry bag you can find at sporting goods stores. You may also want to put it in a rubber, plastic, or waterproof container. Most of the equipment and tools you use will see a lot of rain and snow in a given year. Think about Pelican-brand cases, KATA bags, Porta-Brace, or an equivalent quality product to take care of your gear.

Proper Termination

Termination refers to two different things. When BNC, XLR, or any other type of connector is placed on a cable, it is said the engineer is "terminating the cable." The vernacular, while confusing, has become a widely used and accepted term. Chapter 11 was added to assist you in understanding proper video and audio cable termination techniques.

The other type of termination involves placing a 75Ω (or in some cases a 50Ω) BNC video connector on the end of a piece of gear that allows pass-through video or data. Most gear has this termination built in, and in gear such as monitors this switch must have the termination turned on in order to work. Rather than turn this on or off, many engineers place BNC terminators on the output of the gear to either remind themselves or remind others that the gear must be terminated.

Without this termination, video will be out of control, far past the actual output. Video and data signals must hit this termination and essentially stop or resist the voltage and keep it at the last piece of gear. A BNC terminator is basically a housing for a resistor.

Understanding a patch bay

The basic unwritten (and often disobeyed) rule about a patch bay is that every patch bay has two rows. The top row includes the output of each device, and the bottom row includes the inputs.

Patch bays can be set to *Normal*, which is a verb in this case, and it means it will pass whatever is on the top row and send it to the bottom row, until or unless it is interrupted by a cable patch being inserted to either the top or the bottom.

Patch bays used to require a *horseshoe clip* which essentially did the same thing as normalling, except that when you were done using the patch, you had to replace the horseshoe-shaped device back into that part of the patch bay.

Patch bays can be used to send analog video, digital video (SDI), HD-SDI, ASI, AES/EBU audio, regular analog audio, L-Band, or any other signal that meets their specifications. Chances are an old patch bay will not pass an HD-SDI (uncompressed 1.487 GBps) signal, but you could try it. If it works, I don't know that I would trust it.

Patch bays get corroded, and this causes signals to break up. You need to carry a deoxidizing solution that can be sprayed into the patch bay holes. DeoxIT D5 is one such solution. You can use pressured air to spray the dust out. Do not use WD-40. WD-40 is flammable, it leaves a residue, but does not leave the proper "treatment" on the copper, silver, gold, bronze or aluminum conducting surfaces, and is only an extremely temporary solution. Besides, it makes a mess. Save WD-40 for the farm. It doesn't belong in a satellite truck. Use white lithium grease for lubrication, and use DeoxIT D5 or an equivalent (if you can find one at an electronics store) for cleaning out your electronics connections.

An Almost Complete List of all Tape, Disc, Flash, and Computer Formats

2″	Windows Media	DV HD (form of DV50)
1″	D-1	DVC
1″ Type-B	D-2	DVCAM
1″ Type-C	D-2-MAC	DVCPRO
¾ ″ U-Matic	D-3	DVCPRO50
¾ “ U-Matic SP	D-4	HDV
Beta	D-5	DVCPRO P
Betamax	D-6	DVCPRO 50 P
Betacam	Digital-S (D-9)	Quantel's D-16
Betacam SP	D-10 (MPEG IMX)	XD CAM
Betacam SX	D-11 (HDCAM)	P2
Digital Betacam (Digi-Beta)	D-12 (DVCPRO HD)	Flash
(also called Digital-B)	D-16	MXF
VHS	DVD	MPEG
VHS-C	Blu-Ray	MPEG-2
SVHS	HD-DVD	MPEG-4
SVHS-C	HD-VMD	Quicktime
Digital VHS (D-VHS)	CH-DVD	RealMedia
8 mm	Laserdisc	
Video8	DV	
Hi8	DV25	
Digital8	DV50	
M	DV100	
M-II (M-2)	MiniDV	

Cleaning Heads on Any Tape Format

Most of the formats mentioned above are cassette tape formats. Each one of the tape formats require that you clean the heads where the tape passes over each day. Each tape pass leaves residues, oxides, dust, or other particles on the tape head and need to be cleaned off on occasion.

Back before it became illegal, engineers used Freon to clean tape deck heads. It was a good cleaner, it left no residue, and it practically evaporated before you finished cleaning the head.

You can use many, many different solutions to clean tape heads. Some people use rubbing alcohol, others say it leaves a residue. Some people use the grain alcohol sold as Everclear (190 proof), others use some commercial brand of denatured or undenatured alcohol. There are also several other head cleaning solutions that break apart the foreign material left over on the record, playback, and erase heads.

You may decide to purchase a head cleaning tape specific to your format. However, this only passes the portion of the head where the tape tends to travel, and does not clean the entire head. It also means you will not open the top of the deck, and will unlikely see any other issues like dustbunnies or somebody's pen cap they accidentally dropped inside the machine.

If the machine appears to have a lot of sparkles even after you've cleaned the head, it could be a series of problems, or the head might need replacement. It might also mean somebody put a contaminated tape inside your machine, and will take a lot of cleaning to get it unglued. When most people were still using the BetaCam or BetaSP formats, it was common to replace the record or playback head when it became worn down to 9 microns thick. This, of course, required an instrument to properly measure the wear on the head. Engineers also measure this wear by keeping track of the amount of hours on the heads.

One more note on head cleaning: The newer formats, such as DV, DVC-PRO and DVCAM all have very, very tiny heads in them. Be more than extremely careful when handling these heads. Imagine they are the finest porcelain when you go inside to clean them.

The most common way to clean a head is to first open up the machine, then clean your hands. Using the alcohol or cleaning solution, place it on a clean, dust-free rag. Turn off the machine, then carefully hold the rag with cleaning solution to the head while you carefully spin the head with your other finger by spinning the head from the top (never the side). It may take several clean cloths and several tries before you can spin the head through the cloth and have it come out clean. Be sure to let the head dry before you place a tape back in the machine. There are several places where the tape can pass. Machines often have a separate record and playback head. They often have a small erase head which erases prior recorded material from the tape which lies just before the record head.

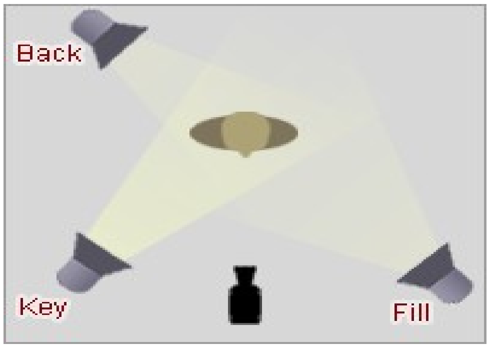
If you have any doubt about whether or not you can handle the delicate work of cleaning these extremely fragile parts inside a tape machine, do not even attempt to clean the heads in this way. Replacement costs for heads are much, much more than simply hiring somebody else to do the work.

A tape that has become contaminated from coffee, soda pop, or something else has the potential of contaminating a deck and every tape that passes through the deck. No matter how much you think that tape is worth saving, you would be wrong. Throw the tape away or even smash it to prevent somebody from placing it in a machine. As an engineer, always keep your tapes in cases when they are not being used to keep them from becoming contaminated. Be sure to police all tapes in your site, or risk somebody contaminating all of your equipment. If they lost the case, find one for them, even if the tape fits loosely inside the case.

A note on lighting

Lighting, like a lot of things in this book, is one of those things that I could write an entire set of books about. And, in fact, there are a series of great books and manuals that can help guide you in understanding lighting. One early book, Painting with Light by John Alton was originally published back in 1949 and even though a lot of the equipment has changed, the ideas have not. He coined the phrase that "black and white are colors" and called variations in light "virtual music." (Technically he is wrong. Black is the absence of color. White is all colors, but typically has more blue, red, or yellow, which is why you can never match two shades of white perfectly.)

Lighting is an art. And you should always pay particular attention to anybody who knows how to light a scene. Trust your eyes. If you are impressed by what somebody has done, ask them how they did it. Use their ideas, but invent your own style.



A proper 3-Point Lighting technique

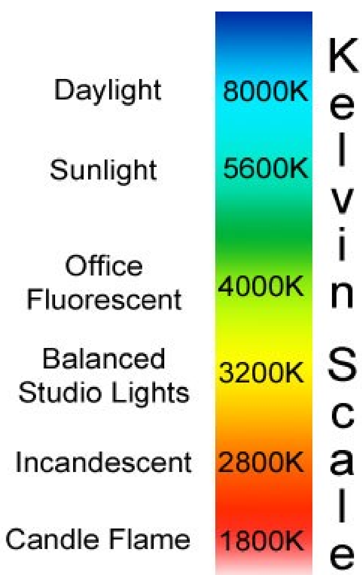
Example of good 3-Point Lighting

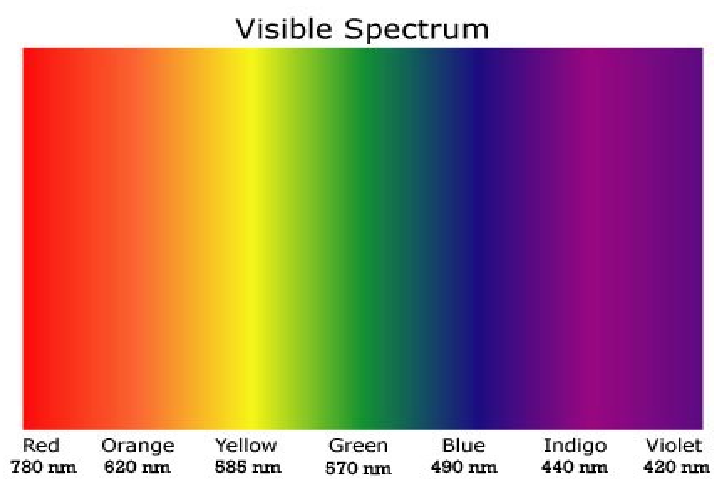
The simplest form of lighting for an interview or a subject who will stay still is called a standard 3-point lighting setup. The key light comes from the camera's left. The fill comes from the camera's right, and the backlight (sometimes called a rim light) comes from either directly behind the talent, behind the talent and typically elevated above their height.

Using 3-point lighting (or more than 3 lights) is the best way to create a flattering video, and keeps the subject and your video looking professional.

When you add your first light, if at all possible, there should be no light in the scene. After that, using angles, diffusion, dimmer switches, filters, and by tricking the camera with warm cards (available at warmcards.com) or gels placed in front of the lens during a white and balance setup can change the effect of the subject on the camera CCD or capture device. Using warmcards tricks the camera into a different color temperature setting by making it believe white is a color other than white, which is something to do during a white balance setup before your shoot.

In addition to doing a white balance before each shoot, do a black balance. This keeps black levels at the correct levels, and also balances the Red, Green, and Blue chips. Camera crews who do not black balance for long, long periods of time often show drifting black levels on their cameras anywhere from -10 to 20 units on a scope, nowhere near the 0 for SDI and 7.5 for analog NTSC.





Understanding lighting often means you need to learn lighting temperature. This is universally accepted in degrees Kelvin, or absolute temperature. Incandescent light is about 2800 K, Sunlight is about 5600 K.

Most cameras come with two or three filters and one non-filter setting. The filtered settings basically have a simple filter called a “neutral density” filter. This orange-looking filter knocks down 5600 K sunlight (which is blue) and turns it to a more natural or neutral color, where blue becomes white.

New frame syncs and post-production software made by AVID, Apple, and others are often capable of fixing video and JPEGs that were not white-balanced properly or were recorded using the wrong filter. They turn down or remove the blue, or add the orange filter over the top of the photo. The entire movie “Oh Brother, Where Art Thou” was filmed normal, then turned black and white, and then an orange filter was added. However, in many cases, this extra processing can do immeasurable harm to picture quality. And let's face it, the camera should have been white balanced (or warm-card balanced) in the first place.

Call for a white balance before any live transmission, if you think you need it. Your photographer should not fight you on this decision.

Every camera needs to be white-balanced. And what this means is you will basically tell the camera what white is by holding up a white card, or white piece of paper (a white shirt works, too). The camera will adjust to that white reference by adjusting what it knows as a set temperature in degrees Kelvin. Most cameras will tell you this Kelvin color temperature in the viewscreen or monitor. And like I mentioned already, before you white balance, each day, always, always, always, black balance, too.

If you are white balancing a camera, *do not ever white balance on ice or snow.* Ice and snow will often turn pictures blue, green or even red (I've seen purple, too). Ice and snow are never completely white. They do not reflect light in the same way a white card or white sheet of paper does.

There are typically two or three darkness levels of neutral density on any given camera. One setting, typically 3 on the filter wheel, is for shade. Setting number 2 is for direct sunlight. Setting number 1 has no filter and is used for indoor lighting only (and no direct sun coming in a window). If there is a filter 4, this is often an extra-strong neutral density filter used when you have extra reflected light coming into the lens from a lot of glass, snow, ice, and water (shooting, say, on a lake).

The other thing you should remember, is that a CCD or other image capturing device is actually able to pick up a much broader range than the human eye. Silicon chips are capable of picking up 200-1200 nm. And, as you can see on the previous page, the human eye can pick up about 420-780 nm. The study of CCD and image capture devices shows how most of this image is either thrown away or “dumbed down” for transmission and recording. But even that is changing, with many consumer models available for some time now with “night vision.” Others lately boast they have “low lux” capabilities.

CCDs and image capture devices also have longer exposure than the human eye, and are capable of taking in more data. For this reason, it is always a good idea to use a monitor when setting up your lighting. What you see will never be exactly what the camera sees.

Using a lighting Scrim

ESPN crew using a sunlight scrim and a background screen
Note the monitor underneath the tripod

Sometimes the best way to fight sunlight, especially when you have to shoot into the sun's direction, is to use a scrim, which knocks down the sunlight and diffuses it over the talent. Scrims are available in sizes of up to 50-feet or more, and take a while to set up.

There are a lot of other devices used to knock down sunlight, including screens placed behind the talent.

Camera and lighting people have also taken to carrying tents, or requiring that satellite trucks carry tents to use as scrims or to get the talent or equipment out of the sunlight or even rain. Tents often provide more than one purpose. They mark your spot, they diffuse sunlight, they reflect lights used on the ceiling inside them, and they provide cover from rain for reporters and equipment. Tent makers such as EZ-UP provide parts online.

An ABC ABSAT crew uses an EZ-UP tent at Johnson Space Center

There are obvious downsides to using tents. They blow away, they break easily, they get holes in them, and it's hard to find room for them in a truck or with equipment. But they are worth their weight in gold if you find yourself going live outside for hours or days.

HMIs or Hydrargyrum Medium-Arc Iodide Lamps

One popular option for lighting lately has been to require camera crews or satellite trucks to carry HMIs. The HMI is made up of a light, stand, two sets of power cable, and a lighting ballast. This ballast takes the available 110v outlet power and creates a high wattage output of 500 to 1200 Watts per light.

Unlike traditional tungsten or halogen lights, HMIs use their ballast to regulate and supply electricity without flicker to the lamp head via a high voltage header cable.

Rather than lighting up a filament, the ballast creates an electrical arc between two electrodes within the bulb that excites the pressurized mercury vapor (Hydrargyrum is an archaic term for Mercury). This provides an intense light output with greater efficiency than tungsten, halogen, fluorescent, and LED lights.

In addition to providing high power light (at a surprisingly low amperage draw on newer HMI lights), the light is also daylight, meaning it is closer to 5600 K and is blue, unlike other Tungsten lights which lights at 2800 K and has a more orange look.

Other new types of lighting is showing up, including fluorescent and LED technology which use a lot less power and supposedly much longer-lasting bulbs.

Warnings about HMIs

Older HMIs draw a lot of power, and are not rated for tiny extension cords. Placing multiple HMIs in addition to other large amperage items all on one extension cord is also dangerous. Be careful crews do not melt your extension cord. And more importantly, make sure they do not cause damage to your generator.

The other thing to be weary of is that HMIs shoot out a ton of UV light. No HMI should ever be used without the glass UV filter. Several reporters now suffer from burned retinas because camera crews were careless. HMIs used without UV lenses in the movie industry have also been known to have cause severe skin burns. Normally, all of the glass filters included with today's HMIs have a UV filter. But double check before you strike the ballast.

HMIs and their parts are very expensive. Bulbs run into the hundreds of dollars. Ballasts and the other components run into the thousands. Be careful when "striking" or turning the bulbs on, or off. And always strike at the ballast. If your light even allows you to strike at the light, do not strike there in case there is a short circuit.

Once a ballast is on and has warmed up, it will use a lot less wattage. Be aware that striking a ballast takes the most power, and if you can, try to strike only one ballast at a time if you are using more than one HMI.

Don't use a dimmer on an HMI. Some HMIs have dimmers built into their ballasts, and they can be used. But don't use a Tungsten dimmer on an HMI ballast.

In addition to all of these concerns, let everybody in your area know you are striking the ballast. HMIs have been known to blow their bulbs violently. Along with hot quartz glass, and sometimes hot gold coating, the exploding bulb also sends out mercury vapor and other metal halides used to give it spectral peaks in the visible spectrum.

HMIs are the biggest creators of video and audio "Hum"

If you are getting hum in your analog video, audio, or interference in your digital video or audio, check first to see that somebody didn't inadvertently cross a video or audio line over the top of an HMI ballast.

HMI ballasts throw off a lot of RF, a lot of magnetic power, and draw a lot of current in the higher wattage models.

If you do not see a problem when you power down the HMIs, then they are probably not the culprit. At this point, try unplugging the field monitor, running the camera or the audio mixer off of battery. And look for any other interference, such as fluorescent lighting that might be creating the hum.

Character Generation

Character Generation, or CG, is the act of placing words on a screen. And the main companies making most of this equipment for the television industry are Chyron, Deco, Sports Box, Aston, Avid Technology, Compix Media, Inc., Dayang, Inscriber, Pesa, Orad Hi Tec Systems, PixelPower, Texscan MSI, VertigoXmedia, and Visual Research, or VisRT. Apple also makes an application called "Live Type" in which you can produce CG with any Apple computer with a video card. Without a video card, you will need to use a converter to convert from a firewire (IEEE 1394) to an SDI or Analog out. You can also find character generation in new equipment such as Sony's High Def model of "Anycast" system. Much of today's character generation is also done in post-production, so if you are asked to place CG into a broadcast, many producers will ask for a "Clean Feed," meaning they wish to have a recording of the broadcast without any graphics or character generation on the screen.

There are two things needed to accomplish most character generation on a screen: First, the video card must have a fill element. A fill element or signal is the only signal needed if you are producing a full-screen element with no video underneath the characters. However, a broadcast switcher will need both a fill signal and a key signal in order to properly place the graphics over video and produce a clean edge on the graphics.

The only other way to produce this effect without a key signal is to match the luminance on the switcher. However, this is more difficult than it sounds, and the luminance is likely to change throughout the broadcast.

Safety regarding video and audio cable runs

As if there aren't enough safety issues to worry about in the manual and with this job, you should always be concerned about safety when running video and audio.

Audio and video run from the camera position and audio source, all the way back to the truck should be properly taped down, run through Yellow Jackets or other brands of cable trays, and traffic safety cones should be placed to warn people of the cable running across their lane of traffic or the sidewalk.

There are always a few other options. You can place large industrial carpet or rubber mats over the cable. Or you might choose to fly cable over a doorway to help prevent people tripping over your cable.

This isn't just a safety issue, it may save you from wrecking your equipment. If somebody drives a golf cart, or other vehicle over the cable and snags it without knowing, they may drag your equipment down the sidewalk or road. They may pull out and destroy the cable ends, or slice the cable in half. They might take you off the air.

The one thing that always gets the most use in any satellite truck or van are the yellow jacket cable trays. If you have them, take the few extra minutes each day to use them. If you are worried, see if a local rental house will rent them to you, or if another satellite truck will loan them to you.

CHAPTER 3
Communications Systems

The Art of Communications

Most communications problems, I've found, start and end with poor communication between the studio and the field. I could write a book simply about how people don't know how to communicate. But instead, I thought I'd write a chapter on the use of IFB and PL systems.

Let's start with two definitions to get us on the same page:

IFB - (Interruptable Foldback) A program audio channel fed from a station, network, phone or cell phone and fed into a talent's earphone or receiver and earpiece.

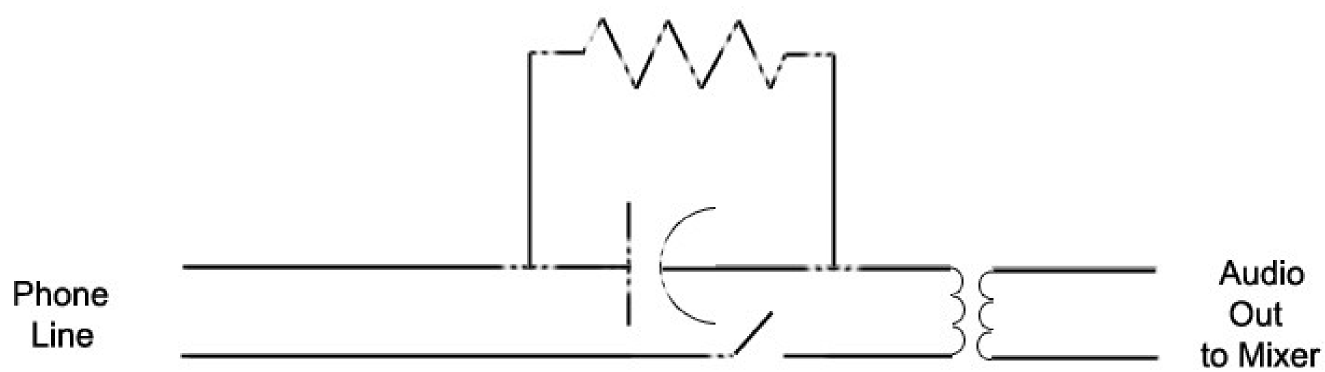
PL - (Producer Line) A two-way audio channel fed from a station, network, phone or cell phone into headsets used by photographers, producers, and other non-talent television professionals.

Several volumes have been written about how to establish and use IFB and PL. And despite popular opinion, there are many choices, and quite a few different ways to provide IFBs to talent and PLs to camera people and producers. The only wrong way is the way where it doesn't work. The only right way is the way that makes the most people happy. That leaves you with a lot of options.

Breaking IFB and PL systems down to their simplest forms, they basically do two things. First, a phone coupler is used, where resistance is placed across the two lines from the phone line. This captures and places the phone on "hold." Second, those two lines both send out and receive audio.

Phone company wires consist of two wires, a ring and a tip. The names “ring” and “tip” carry over from the manual switchboard days when operators manually connected callers with patch cords. Tip and ring terminals of the plug on the patch provided connections to the caller's telephone. Tip is positive, ring is negative, and these can be found using a simple volt meter. Phone lines carry 48 volts.

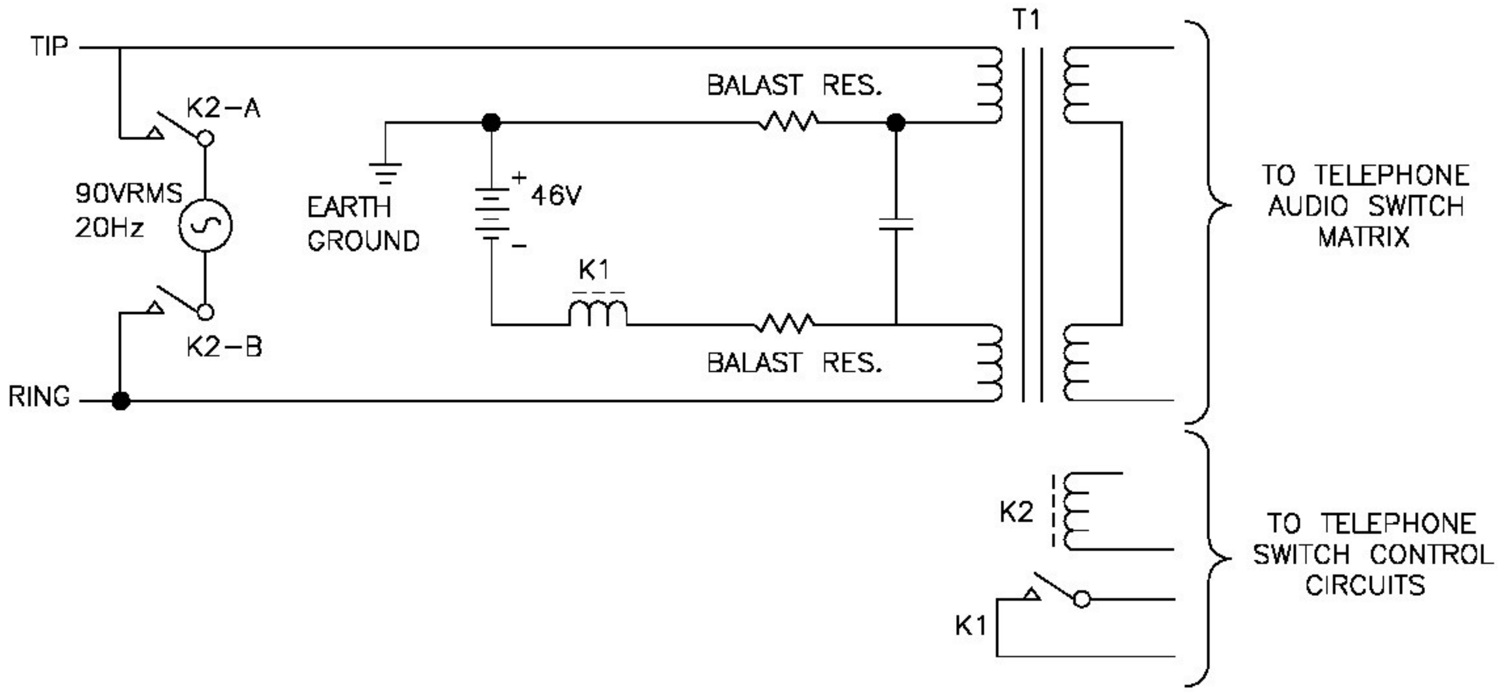
This pair of wires is commonly called “twisted pair.” The twisting helps to reject hum and noise on the telephone transmission of both send and receive audio. The wires provide DC current to power the telephone, send and receive audio, and send ringing voltage to ring the phone.



Resistor = 220 ohm, .5 Watt
Capacitor = 10 micro-farad, 50 volt
Audio Transformer = 600 ohm, 1:1
Switch = SPST

The diagram above is a very simple phone coupler, one that comes from Bill Hutchinson. It's similar to another drawing I've seen from Ray Conover, the engineer who started Conus Communications. More than likely this has been passed around for a long time.

- When the telephone line is not in use (on the hook) the voltage across the two wires (called tip and ring almost universally) is about 48 volts DC.
- When the telephone is in use (off the hook) the voltage across the tip and ring wires drops to about 6 volts D.C.
- When a ringing signal is sent there is an AC voltage "superimposed" on top of the normal DC voltage. This "ringing voltage" is nominally about 90 volts at 20 Hertz (cycles) but could be as high as 130 volts and at different frequencies around the United States and the world.
- Due to phone line lengths, deficiencies in the systems, and the addition of VOIP and digital lines, typical frequency response over phone lines is commonly limited to frequencies from 300 Hz to 3.4kHz.



This slightly more complex version of the phone coupler was built by the Gentner company (now Comrex).

You can build your own device, and change the recipe to suit your needs. All these devices will do is place a call on hold, just like any other commercial telephone coupler. So you will need a telephone to dial the call, connected to the same phone line. Think of it like you would calling somebody who picks up the phone in the kitchen, and another person picks up in the living room. Using a coupler, or an IFB or PL with a phone latch does the same thing as picking up a second phone device. Only one device is needed to keep the call latched, so you may hang up the phone after the coupler is engaged.

Once the call is made, throwing the switch will put the call on hold and you can hang up the telephone handset. The audio output can be amplified by placing it into a mixer, or sending it to an IFB amplification device, such as the common Studio Technologies, RTS, or Clear-Com 3-wire systems. There are many 4-wire systems available, but they are uncommon in smaller mobile uplinks.

If you choose to use a simple mixer, you will need to amplify the IFB channel from line level to a level that will “drive” the talent earpiece. GKC boxes are common, and are available from the company Audio Implements.

Now you have all of the knowledge needed to build a phone coupler. So why, you ask, do phone couplers cost so much? Perhaps the reason is that you get what you pay for. Do you want your incoming level to cancel while you are sending? Do you want your outgoing signal to come back into the talent's ear? Do you want to be able to adjust your incoming or outgoing levels? Do you have issues with soldering?

Other Phone Couplers

One British company I have always been impressed with since early on was the Prospect Electronics company. They build heavy, military-quality boxes that even today are the clearest I've ever heard. But many require a minimum of 4-wires, and ran best down two XLR cables if you are planning to use them as a 2-way system. I hope to someday see more of their products and get a better judgement on their quality, but you will need to ask around to other live truck and studio engineers what they think about them. I bow to much more experience with Prospect Electronics.

The story (perhaps an urban myth) is that the first guy who invented the headset system we know today started building them with a few guys in his garage (and/or a warehouse... no need to make this another Apple Computer Silicon Valley story). Two of those guys, knowing he hadn't patented his devices, broke off and created Clear-com and Telex (RTS).

If this is truly the story, it explains a lot about how these devices have seen very little improvement over the past few decades. Clear-com has gone down the Cat5 cable road in some of their devices. RTS has maintained the easiest devices to adapt to practically any other PL system, IFB system, or “dry audio” systems. But even the highest rated equipment is susceptible to buzz, hiss, and power failures.

What you will find in the field today

Since U.S. companies have desperately grabbed on to systems only requiring one 3-wire audio cable, 4-wire systems have an uphill battle for breaking news in the United States. Production trucks and studios have room for the extra cable, but in the field it's hard to justify giving up even one extra audio line, much less two audio lines for a 4-wire system (one line for send, one line for receive).

Every company and every engineer has different approaches to quality, cost, and ease of use, so you have a lot of choices. And in an era where you are likely to open up a box with a brand new item and find it broken, or use an item until it stops working the day after the warranty expires, I will share with you my experiences with some of the gear available for IFB and PL.

One popular phone coupler here in the United States is made by Telos, called "The Link." It is a simple phone capture device, and yet it offers a few nice options. It has an auto answer, which is great if you are using the device at a place where people are calling in, but completely useless if you are the one making the call. It has one VU Meter to monitor incoming or outgoing audio. And it has a switch which will let you place the audio onto "channel 1" or "channel 2" or will let you send powered audio to send to an IFB receive box or PL transmit/receive box (also known as a camera headset box). And the last feature is one that fails in the field more than it works. Audio levels are allegedly adjusted automatically, and you can override them by opening up the box to adjust the level. You then turn this adjusted level on by hitting a switch labeled "variable/fixed." It's a horrible design should you need to adjust that level in a hurry, such as a breaking news situation.

When car makers stopped putting in gages and put in lights warning you of your engine's impending doom, drivers and mechanics labeled such warning devices "idiot lights." And much in the same way, satellite truck engineers and control room engineers have labeled such boxes "idiot boxes." If all of your levels going in and out are perfect, then this device is perfect for you. However, if you live in the real world, you may want to step up to a device offering a few more adjustments. I'm not just picking on the Telos box. There's a lot of equipment designed like this, and you need to think seriously about if you want control taken out of your hands. Consider if you wish to be an engineer or an operator.

For more money, Telos does make couplers which offer adjustments. But for less money, you can also look to companies like Comrex and JK Audio. JK Audio, for example, offers a couple different couplers which offer level adjustments on the front at a fraction of the price of other companies. However, the boxes available at that price aren't placed in a rack, so you will likely have to build the rack panels for them yourself. I have heard of operators having trouble with cross-talk, but I have not been able to duplicate these problems.

Comrex builds a coupler based on the old Gentner design. Radio and television stations consider it the gold standard here in the United States. However, we have experienced cross-talk (interference between one line and the other) in their two-channel phone couplers. The problems only happened in very hard to understand circumstances. But if you have the space available in your racks and choose this brand, I would highly suggest buying two separate one-channel couplers rather than try to save real estate in your racks with one two-channel unit. It will be easier to explain than trying to explain why the people on channel one started to interview the people on channel two. I've been told the coupler was not made to work that way. Well, it did, and it does. I wouldn't make up something like that.

IFB

If you are only looking for an IFB system, or if you want to have an IFB system on a different line than your camera PL lines (which I fully suggest and endorse), consider looking to the company Studio Technologies, Inc. The Skokie, Illinois company introduced a one-rack, two channel IFB system with a built-in phone coupler.

My first experience with Studio Technologies' support and customer service staff happened when there was nothing wrong with the equipment! We had three trucks, all of them had a minimum of four pieces of Studio Tech gear, and the company had called because they believed six of our audio mixers MIGHT have a tiny glitch. They offered a loaner mixer, and one-by-one we sent in each mixer until all of the units had been repaired. When they arrived back, in addition to the repair, the engineers replaced the VU meters and put in some different colored and brighter LEDs.

Their IFB systems are crystal clear, and do as much in one rack space as the original control room IFB systems did in a dozen rack spaces. Add to that they are interchangeable with the Telex company's RTS systems and belt packs, so thankfully I can continue to buy gear from both companies and not worry about something not working when I have to put a live shot up in less than 15 minutes.

A friend and former coworker of mine drove up to the company one day and asked if they could chain the two "remote" one-rack units used for each of our IFB systems into a single one-rack unit with four buttons and an "all call" button. And they did. They cranked it out immediately. They dropped what they were doing and did it immediately.

These days, if you told me to look through my racks and tell me about every problem I had with every piece of gear, I would have a lengthy list of everything in every one of those 7 racks, except the Studio Technologies gear. I've had belt packs get dropped in a pool of water. After they were dried out, they worked fine and continue to work today. Their customer service should be the envy of the broadcast industry, in this always-on, always-connected, broken-in-the-new-box era.

IFB Earpieces

Just as there are numerous companies building couplers and IFB/PL systems, there are also many companies making talent IFB ear pieces and headsets for PL boxes. Again, while there are no right or wrong systems, I do have favorites.

Audio Implements and Telex are two companies making the majority of IFB earpieces in the United States. The parts between the two companies are interchangeable, and are typically made up of 3 or 4 pieces. There is a cord (my personal belief is that Telex makes a better cord, but Audio Implements are fine), a driver, and then a tube carrying sound from the driver into the ear. Audio Implements (and other companies) offer a kit which allows you to make an earpiece custom-molded to your own ear and allowing you to keep the entire kit to only three pieces. And they offer, just like every earpiece maker offers, a tube and set of tips made to fit almost any sized ear. And sometimes this fails, too. Some ears belong in a circus sideshow.

Beyer Dynamic and "Enhanced Listening" are two such companies in Europe I found looking for international sources for broadcast earpieces. I have purchased a lot of Beyer Dynamic gear over the years and can say I'm happy with their products. However, my preference of Audio Implements is due in part to the fact that while I'm driving through the Milwaukee, Wisconsin area, I can actually stop by the company and place the order in person. It's just so nice to drive up to the factory and place an order.

If you plan to send an IFB signal at line or mic level from a regular audio mixer, I would highly suggest purchasing a piece of equipment similar to the Audio Implements monitor amplifier, known commonly as the "GKC box." However, these boxes run on 9 volt batteries, and are a bad idea if your needs require you will be going live for long, long periods of time. Having a battery go dead at the last moment before you are about to go live, or while you are live is the worst feeling in the world. For this reason, I highly suggest you use a system that sends voltage down the 3-wire audio line and is made to power the box attached to the talent's belt or pocket. Most of these systems were made to power up to sixteen headsets or IFBs, which is more than adequate. If a producer wants to convince you they need to talk to more than 16 people, then you should consider bringing in a speaker and setting up "reinforced audio" with two talented audio professionals and good audio gear.

If you are desperate to stay on budget, or you work with irresponsible talent who constantly lose or steal your earpieces, then consider buying a few earpieces made for IPODs or other portable music players. These "earbuds" are easily replaced, and perhaps are a good way to teach talent the important lesson of taking care of your gear.

Understanding Mix-Minus

Most of the time you will transmit, it will include two places; your live location, and a television studio. When you ask for, or rather demand mix-minus, you are asking the studio for a full program mix, MINUS YOU!

The studio takes your audio from the satellite into the board, and mixes it with other audio. However, your audio is delayed by a 41,000+ mile trip. Since you can't move the satellite closer, the studio must give you an auxiliary (aux) feed from an audio mixer that is capable of sending all the other studio audio, yet completely muting your satellite feed.

If they cannot do this, the producer will need to hold a phone up to a speaker, and pull it back and *completely* cover and mute the mouthpiece as the talent speaks. This is not an easy task, and is usually screwed up in an awful way. If the producer screws it up, talent will hear themselves come back two or three seconds later into their own ear. Most talent are incapable of dealing with non-Mix-Minus audio in their ear.

Often studios set up a good IFB system with proper Mix-Minus, only to find the producer or director has left their mic open to the talent and a nearby speaker sends the talent's voice back to them. (Satellite uplinkers are usually blamed for this gross negligence of the producer hundreds or thousands of miles away.)

Staying on top of things and listening close to IFB and PL is a good way to fix these problems quickly. However, you need to always remind people working at the studio that it is not possible for you to send non-Mix-Minus audio into the Talent's ear, (it would require several patches from an IRD into a mixing IFB system and would be too obscure a task to ever do on purpose) so if anyone “throws you under the bus” and accuses you of creating a Mix-Minus problem at the remote site, copy and paste this last group of paragraphs in your next scathing email to your boss!

If this happens to a talent, tell them to pull out their IFB in such a way to make it obvious. The IFB should be attached to the back of the shirt and be flung over the front of the shirt for the remainder of the live shot. Not providing a Mix-Minus feed to a talent during a satellite feed is inexcusable. Blaming the problem on the satellite uplink people in the field is proof of complete and total ignorance, and it needs to stop immediately. Anybody who does such a thing just might be too dumb to work in Television, yet will somehow probably rise to a managerial position.

Headsets for Camera Positions, Producers and others

Headset companies are everywhere, thanks to the worldwide use of headsets by pilots, computer gamers, telemarketers, and other people forced to spend long hours on a communication system. My personal favorite happens to be the David Clark company from Worcester, Massachusetts. Pilots made them famous, and now our industry reaps the benefits of the demanding pilots. If a camera person can't hear, the worst that could happen is a director or producer might throw a fit. If a pilot can't hear, people could die. If you want a good headset, wherever you are in the world, find out what your local pilots are using.

Other than what I've mentioned today, get out to some live events or breaking news in your area and ask other engineers what works for them and what doesn't work for them. If you live and work in a remote area like me, consider joining an online forum for field or studio engineers. You will find a lot of people willing to help and offer their opinions. Just be sure you ask when they aren't busy.

Cellphones, Cellphone Docks, and Tellular

Ask who has the best cell phone coverage, and you will get many different answers. In the United States, there are basically three major players in the cell phone industry. If you choose to use any others, be sure you have the best nationwide plan.

Analog and TDMA cell phone service has gone away, or is going away in all states. The first to go was Iowa. If you have not updated these phones with new ones, you should do this immediately.

Verizon – Offers the best rural coverage. The only downfall of Verizon seems to be that they are the only company in the world not using SIM card technology. They only offer one phone that accepts a SIM card. They also use an older phone modulation standard of CDMA. This means you can't use the phone overseas, and you can't swap the card into another phone if you damage the one you have. Oh, and you will lose your phone numbers if you really damage your phone.

T-Mobile – Offers the best city coverage with the least dropped calls in the city limits. They use GSM, and use SIM cards, so you can swap them with any other phone (including base stations). They have the best cooperation in countries overseas, and are a perfect phone as long as you never need rural coverage.

AT&T – Offers a mixture of the two. They have good city service, and have good city rural service, but just aren't the best at both. They use GSM and use SIM cards, so you can use your phone overseas, but you will have to buy whatever service is available in each country. You will not find an AT&T office like you will find a T-Mobile office overseas.

Using SIM cards mean you will be able to swap your card, and essentially your service with any other phone. This includes phone base-stations made by the Tellular company. When you need to talk for a long, long time, or leave your phone connected for a long, long time, you should look into getting a base station such as a Tellular station.

The Tellular uses common phone connections, as in an RJ-11, and you can plug this into any phone. Inside the Tellular is basically a phone on an electronic card, and all of the inputs and outputs needed to connect it to AC or DC power and a regular phone.

There are other options, such as the Phone Labs “dock and talk” in which you can use a regular cell phone. But the problem is that the Tellular will give you a dial tone if the call is lost, or if somebody hangs up on you. The dock and talk only goes silent.

Also, the dock and talk does not always get along with the cell phone, and sometimes the cell phone will go dead after four or five hours and drop your call. You will not be able to make another call with this phone until at least 15 minutes later when the phone has a chance to charge up from being completely dead. Engineers have fixed this problem by drilling through the batteries and attaching dc leads directly to the cell phone.

In addition to installing a Tellular cellphone, or a dock-and-talk, you will need to install an external antenna if you are using the unit inside a satellite truck or van. If you are using the unit on its own, the Tellular unit comes with a 6-8 inch antenna.

Satellite Phones

There are a few options for satellite phones, the oldest was the Westinghouse system. The system works, but is full of flaws and is not consumer friendly. Half of the phones put into service are broken-in-the-box when they arrive, so they are not tested before they are sent to the customer.

Add to that, when you dial the Westinghouse satellite phones using a common phone plugged into the satellite phone by its RJ-11 jack, you usually have to follow your numbers with ** or the call will not go through. Most operators forget the ** (star key twice) and can't figure out why the phone won't dial out.

The quality of the Westinghouse phone is pretty much the worst of any phone. Add to that, their service is the most expensive, and they aren't any good in most cities.

Immeon phones work off of LEO (Low Earth Orbit) satellites, and seem to have better dependability, and lower cost. The phones cost less, and there usually is no breakup in service as they constantly jump you from LEO satellite to LEO satellite, which they must often do to keep your phone call active. These phones are harder to come by, and you must specifically look for a phone that will stay active even if the battery goes dead, and offers the option of an RJ-11 output, which severely limits your options.

Another option for satellite IFB and PL is to have your "head-end" (network, station, or production studio) uplink another signal to the satellite with which to feed you IFB, PL, data, or even video. This option is costly, and adds to the delay of your IFB return. But as an option it is the most bulletproof and offers you the best sounding IFB and PL return. The sound will be CD-quality, because it is broadcast quality.

However, it eats up satellite space, uses an expensive encoder, and requires a minimum 5 watt uplink transmitter from a registered 1.8 meter dish at the head-end. While this can be done at a low cost using spare or used parts, only a few networks have chosen this option for their satellite broadcasts. But as parts get cheaper, more users will develop their own systems.

IFB and Satellite Delay

Whenever you are transmitting to a satellite, and whenever you are using a satellite signal as a means of getting your IFB, you will experience delay.

Satellite path delay is approximately 270 milliseconds (the time required for the signal to travel to the satellite and return). However, there is more than just this delay. There is compression, processing time, and the time it takes to run down the copper at the uplink site and the downlink site.

VoIP or Voice over Internet Protocol

Voice over IP has been around for quite some time. However, only recently have broadband and fiber lines started to catch up to offer solid enough service to allow the high demands of video, audio, and voice services to be used for the broadcast industry. If you can't keep a simple IFB open for 24-hours-a-day, then you can't trust VoIP and have to order a phone line.

There are many web sites out there that will allow you to do a "speed test." This works by sending 5MB or more to a server, and bouncing it back, and counting the milliseconds it takes to make the trip. This will tell you speed, but it will not guarantee that speed will be there for the next 24 hours. You should consider several speed tests throughout a 24-hour period. You also may want to consider setting up your VoIP system and measuring what speed is left when the VoIP is connected and sending audio.

VoIP has the potential of bringing your phone bills down to close to nothing. By setting up a VoIP system at the receive end of your satellite feed, you can potentially connect a 24-7 feed for the cost of two VoIP phones, plus the cost of the broadband service.

VoIP standards

Just like there are many file extensions for documents (.txt, .pdf, .doc, .xls, etc...) and pictures (.jpg, .gif, .tiff, etc...) there are also many different file extensions used for VoIP. If you have programming skills, you could even write your own! Skype, for example, uses its own proprietary code for sending packets of audio information sent from computer-to-computer or VoIP device-to-device.

When IT people at many companies (I'd like to call them "Information 'Tards" because when it comes to information, they all seem awful slow or behind the curve. I'm probably going to hell for that, but who cares.) started to "crack down" on VoIP use at large companies, seeing VoIP as a "potential security breach," hackers created VoIP code disguised in the .html format. Genius! IT people never figured it out, seeing a little bit more www surfing but never understanding that people were making calls right under their nose.

While many VoIP phone devices and computer programs were specifically written for just one VoIP standard, there is at least one available that will work with many different standards. "Jon's Phone Tool" was written specifically for the Mac line of computers and can be purchased cheap, available for free on a trial basis.

Chapter 4
RF and RF Safety

Hazards of Microwave Radiation

Ku-Band and C-Band satellite uplinks have very high power amplifiers that produce large amounts of microwave radiation.

It takes a lot of power to send a high frequency, and it takes a lot of power to send that signal more than 20-Thousand miles.

With antenna gain, truck and fixed uplink dishes can have an EIRP of 75 dBw. What this means is 75 db above one watt, or about 20-Million watts.

In point-to-point vans capable of microwaving signals to local antennas, also known as ENG vans, the signal power of an SNG van is up to fifty times that power.

Scientists and doctors have mixed feelings about the effects of microwave radiation on the body, but standards vary based on frequency and exposure.

While safe levels for cell phone usage continue to be debated, we won't focus on them. But we will look at levels for Ku-Band radiation.

Your body can “safely” handle 5 milliwatts of Ku-Band radiation per square centimeter. Further, studies have shown there are no harmful effects from receiving 10 milliwatts of radiation per square centimeter.

The good news

Now that you're properly “freaked out,” try to remember one thing. Microwave energy and radiation has been in common, everyday use for over 50 years. There is no extensive evidence you will suffer any longterm effects should you be exposed to safe levels.

BUT, like global warming, it is hard or almost impossible to prove a negative. No one can ever prove to you that there are no dangers.

However, if you pay attention to your training, and remember how to read for warning signs, you too can live to a ripe old age like so many people in this industry I have come to know, and many are now enjoying their retirement.

It has been said you will be exposed to more radiation on a trans-Atlantic flight than you will from cell phones, microwaves, and other sources of radiation.

Whether you hold this job for any length of time or not, you will be exposed to Electromagnetic Radiation (EMR). It comes from anything and everything that vibrates or puts out heat. The only thing in the universe believed to *not* send EMR is dark matter. And there's no way to truly measure how much EMR any frequency will affect you. When a photon hits an atom, it can be absorbed if the energy is just right. The energy level of the electron is is raised and essentially holds the radiation. A new photon of specific wavelength is created when the energy is released. Many possible levels of radiation can exist in an atom. So if you and another person are exposed to the same radiation, you will probably experience different levels of absorption. You will also experience different speeds of expelling that radiation.

And think about this, the man who discovered microwaves and famously melted a candy bar in his front pocket, lived to be an old man. And who knows what he was exposed to over the course of a lifetime.

I'm sure he doesn't even know.

A history lesson half a world away

Most of the world's studies about what massive doses of radiation does to the human body come from Ukraine, a country once part of the U.S.S.R. It is a beautiful country, and if you ever get a chance to go, don't pass it up.

On April 26, 1986 reactor number four was supposed to be shut down for routine maintenance. Two men on a late shift decided to test the backup cooling system and see if it continued to perform during a power failure. They also somehow shut off the backup cooling system.

The cascade failure created a steam explosion, killing the two men and blowing the roof off of the nuclear reactor building. Moments later, without even a roof to slow it down, 9 Metric Tonnes of radiation, and every piece of everything in the immediate area (which dematerialized into small pieces of toxic dust), blew and rose up at least a mile into the air. The blast created and carried with it all that dematerialized waste as well as xenon and krypton gases. And much of that skyward cloud was carried by winds, mostly north, into Belarus and into the Dnepr River, which washed back downstream to the south and through the heart of Ukraine.

The Chernobyl disaster remains today the worst Nuclear accident in history.

Over 120-Thousand people were eventually evacuated, but not before Ukraine allowed their people living in the immediate area to be exposed to massive doses of radiation high enough to cause mutations, massive and even hideous birth defects, sterility, many types of cancer and even the quick and nasty unseen risks of eating contaminated fish from the Dnepr River.

The numbers at this point get sketchy. One report from the IAEA, or International Atomic Energy Area, says 56 people died of direct exposure from the blast, radiation, or fallout. They go on to say that 4,000 (*which sounds to me like too round a number) died from cancer, typically thyroid cancer. And here's where they don't pull any punches: The IAEA says 6.6 million people received large doses of radiation.

Once the area cooled off, and outside information got into the country in some places up to a couple of weeks later, the Ukrainian government and military finally sent in men to evacuate the people and clean up the site. This undertaking brought a death toll up to at least 25-Thousand people from either an immediate lethal dose or a slow, progressive one.

Firefighters and soldiers were the first on the scene.

They were completely unprepared. Going into the area with what equaled to what we might call a jogging suit, the soldiers and firemen wore gas masks built to keep out mustard gas but not dust from dematerialized waste.

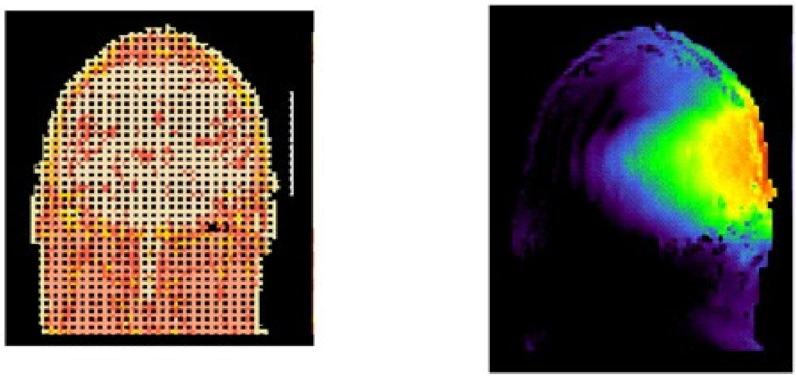
And in the early days, with a complete lack of understanding, men were literally cooking like hot dogs in a microwave. To make things worse, radiation like this cooks a person from the inside-out. So you may not see blemishes under the skin until you're already cooked inside.

If RF, radiation frequency, doesn't scare the hell out of you, it should. Always, always, always be careful and use your head.

More specific

I wish I could tell you scientists and doctors are studying Ku-Band, C-Band and Ka-Band radiation and its effects on the human body. But the truth is, they aren't on any intense, comprehensive level. The use of cellular phones is under the closest scrutiny at this point, where boards such as the F.C.C., the American Cancer Society, and for some reason the F.D.A. look at SAR (Specific Absorption Rate) of radio frequency (RF) used for exposure to fields between 100 kHz and 10 GHz. The FCC requires that phones sold have a SAR level at or below 1.6 watts per kilogram (W/kg) taken over a volume of 1 gram of tissue. In the U.K., the SAR limit is 2 W/kg, averaged over ten grams of tissue. For whole body exposure there is a limit of .08

Watt/kg averaged over the whole body.



Model human head, at left, replicates muscle and high water content (red), fat and bone (dark yellow), blood (dark red), brain and skin (light yellow).

Model human head, at right, shows a capture of typical exposure from a 1900 Mhz cell phone antenna with the power output of 125 mW.

0dB = 9.50 Watts/kg 0 -9 -18 -27 -36

Tests show most exposure appears to barely break the skin. However, fractions of power appear to penetrate a large part of the head, even at 1/8 of a Watt.

We do know that at these high frequencies, Ku-Band radiation cannot penetrate the skin more than .1" barely breaking the skin's surface. However, the same can be said about cell phones, that they barely break the skin yet somehow still expose large parts of the head to small, consistent levels of radiation.

Lower frequencies, even C-Band it is suspected, could pose a threat to vital organs. So much more care and concern should be taken with those frequencies.

But with all of these frequencies, there is one exception when it comes to exposure. Ku-Band especially, can penetrate the eye. Wearing glasses or sunglasses won't help. They will only filter UV light.

Take care of your eyes, and stay out of the dish when it's transmitting. Stay away from damaged waveguide, and stay away from any place where you suspect microwave leakage.

Keep an eye out for warning signs in your equipment, and don't forget to keep an eye on other satellite trucks and other operators. Your setup might be perfect. But your neighbor could be leaking and spraying radiation everywhere.

Older Trucks

Most older trucks on the road today have long waveguide runs. Unless the truck has a hub-mounted amplifier sitting on or near the dish, you can bet there is a minimum of eight feet of waveguide between the High Power Amplifier (HPA) and the antenna feed horn.

There are often several connections, and several places where you might experience problems.

If you experience low power on your receive, or have trouble making enough power in a place you haven't had trouble before, and you can't explain it by a line-of-sight problem or inclement weather, you need to check all of your waveguide.

Pin-hole-sized cracks can appear in the flexible waveguide (or "Flex"), and I've seen hair-line fractures appear in rigid waveguide. When in doubt, check them both.

Newer truck designs have amplifiers or "BUCs" living on or near the dish. Some new designs have the amplifiers built into the feed horn. However, these new designs have also failed. Engineers have discovered fractures, bent units, and water-filled LNBs (Low Noise Block) and LNAs (Low Noise Amplifier).

You should always have a rough guess as to how much power you will need for each satellite, and even transponder.

Transponder pads can differ from transponder to transponder. Upconverters and certain frequencies require more power from frequency to frequency. But you will know when a power level is out of the ordinary.

Don't shoot through obstructions

Don't shoot through buildings, trees, wires thicker than coax, or highway bridges and overpasses.

The focused beam is not within the safe standard until it has traveled the distance of 640 feet (194 meters). If it hasn't traveled the width of two football fields, then don't even try it. You can't stop everything. Trees and branches blow down. Over the years, I've had a blimp or two travel between my truck and the satellite.

Not only is the practice of shooting through trees and around buildings a bad idea because of signal loss, you will likely have to boost your power beyond normal levels, and these elevated levels may now be scattered by the obstructions you are shooting through or around. They are scattered to unknown places, causing not only a health risk, but the possibility you are interfering with the transmissions on other spacecraft in your visible arc.

Safe area from radiation in and around the truck

Most trucks and vans on the road today are safe from the ground to the roof level of the vehicle. Flypacks and C-Band antennas often sit closer to the ground, or require an area in front of them be “cordoned” off to prevent interference and provide a safe area to prevent radiation exposure to unknowing passers-by.

Most of the microwave energy is traveling in a rectangle tube, called *waveguide* or *traveling waveguide* of approximately one square centimeter in Ku-Band and two or more centimeters in C-Band.

That means the level coming out of the High Power Amplifier (HPA), and traveling all the way to the feedhorn is measured at that level per square centimeter (remember the 5 milliwatts I mentioned as “safe” just a moment ago?). A small SCPC (single channel per carrier – we will cover this more in depth in Chapter 7) might be transmitting at just a few watts. However, a full-power, full-transponder signal might be blasting out at anywhere from 75 watts to up to 1,000 watts per square centimeter.

At the reflector, the density varies from 14 milliwatts per square centimeter to no less than 2 milliwatts at the edge. The feedhorn concentrates more energy towards the center of the dish than at the edges.

On the ground, beneath the height of the roof, and beyond the safety zone set out by the flypack or C-Band operator, the highest density in these zones if everything is working properly is less than 1 milliwatt per square centimeter.

Use common sense

“Use the common sense God gave ya!” my grandma always says. And she's right. Do not, under any circumstances, let anyone climb up on the roof of your truck while you are transmitting. Do not, under any circumstances, let people set up a lawn chair in front of your flypack or in front of your C-Band dish. You may laugh, but it has happened...

When it comes to *content*, let your producers call the shots. However, and I can't say this enough, when it comes to *safety*, only you can call the shots. Nobody studied RF safety but you. You are, if I haven't mentioned it many times before, the Engineer in Charge. And if there is another EIC on that days shoot, then you are still the Engineer in Charge of the Uplink. Nobody else is flipping that switch but you.

Keep the path clear, and LOOK UP AND LIVE

Make sure you always look up before deploying the dish. Don't put the dish up into a power line. I've lost some friends this way, and I don't ever want to lose a student.

Make sure you have a clear path between your antenna and the satellite.

Before and after you deploy the dish, get out of the truck or van and get behind the antenna and visually inspect the path. Give yourself 10 degrees on each side to be completely safe.

If you should have to move the truck, PUT THE DISH DOWN. Even if you can afford to replace the 40-Thousand dollar reflector on top (and I doubt it), you can't afford to lose jobs for the next two weeks it will take to repair the damage. Oh, and you will likely have to drive the truck to North Carolina, or Florida, or somewhere on the other side of the continent.

Oh, we're not done... Let's talk about waveguide again

Like arteries and veins are important to your heart, the waveguide is the one thing that makes your truck an uplink truck and not just another box van.

Ignoring waveguide is the worst thing you can do as an uplink engineer. You might have waveguide damage and not even be aware of it.

Flexible waveguide wears out. Rigid waveguide does crack or fracture. And it only takes a tiny, pin-sized leak to create a big problem and possible health hazard.

Check waveguide once a week. When you are around other satellite trucks, make a visual inspection of their waveguide. It has been said you can use over-the-counter products made to help rubber last longer, but this will not extend the life of a flexible waveguide indefinitely.

For this reason, I would not suggest keeping a lot of flexible waveguide around. If you buy an extra piece at the same time you bought the other pieces, it stands to reason that this piece will wear out or deteriorate at the same time your original pieces start to fall apart. If you buy an extra piece of “flex,” just to have it as backup, buy it about seven years after your original piece. Use the old stuff until it breaks. It might last 20 years or more.

Flexible waveguide is difficult to check, especially if you have only a pinhole-sized leak. But if you find a deep crack, replace it. In fact, any cracks, abnormal abrasions, or anything making it look different than the other flexible waveguides you see on your truck or on other trucks or uplinks, think about replacing it if it looks bad.

Rigid waveguide issues sometimes show up in paint cracks. Cracks have been known to develop at junctions, and are most common at junctions with flexible waveguides.

The junction may have even come undone. Seal up the joint, re-tighten the bolts and use locktite.

If you are still worried that you might have a crack in the waveguide, take all of the rigid waveguide out and visually inspect it after it has been removed from the truck. After weeks of head-scratching, we found a waveguide fracture on the side of the rigid waveguide facing the satellite dish. It would have never been found with a quick visual inspection. But we knew something was wrong when it was requiring four times the amount of power in order to saturate the satellite transponder.

Always look for those early warning signs. Think, ask questions of fellow engineers, and LOOK UP AND LIVE. Do all those things, and you'll be just fine.

In addition to power levels as a warning sign, there are several other places we will talk about where you might catch a problem.

If you are operating a TWT (Traveling Wave Tube) amplifier, located in the truck, you should be monitoring your reflected power and your helix current. These levels vary a little, based on the type of the amplifier, the age of the amplifier, and the distance of waveguide in the truck or van.

You may still have the reflected power reading on a solid state amplifier, but you are less likely to see power fluctuations with solid state.

Hub mounted amplifiers at or near the dish show little to no reflected power, but a Hub mounted will still show helix currents. Anything out of the ordinary needs to be taken as an early warning sign.

We will discuss Helix current, reflected power, and cathode ray voltage later in this chapter.

If you see something out of the ordinary on your spectrum monitor or analyzer, this could also be a problem. However, this should never be a reason to be alarmed. For in both Ku-Band and C-Band frequencies there are many things that cause local interference, varying from a Police radar gun to a local ground-to-ground transmission or government radar facility. You might also receive interference from your own generator as it is warming up. Don't panic, think things through, and don't be afraid to ask another operator or engineer for their opinion.

Handle broken TWTs with extreme care

If you open a non-working HPA, be sure to be extremely careful if you find the traveling wave tube (TWT) broken. There are Beryllium oxides contained within the ceramics of the tube. Beryllium oxides are extremely toxic and can be toxic with simple skin exposure. Do not attempt to open a TWT. And if there is a chance the vacuum inside the tube has been compromised, be extremely careful.

TWTs need to be replaced by an experienced professional.

Replacing a TWT (Traveling Wave Tube)

The following comes from Bob Green's website: www.greensatellite.com

- Tube manufacturers have a set of parameters that they send out with each tube. In addition, the basic operating parameters are listed on a label that is affixed to each tube. When replacing a Tube (either Klystron or TWT) it is necessary to supply the correct parameters as well as verify that the trip circuits and parameter metering circuits are indeed functioning before powering up a Tube.
- Tube Manufacturers spend a lot of time and money to create a Tube that will work for your application. Do not undermine them by trying to get a Tube to work using a different set of operating parameters. Some engineers believe that reducing Filament Heater Voltage will increase the life of the tube. The Tube manufacturers know of this trick and have implemented the use of Electron Guns that will last longer and give better performance using the Manufacturer's Specified Operating Parameters. Making changes on your own when changing out a Tube may convert a Tube to a very expensive "Blown Fuse."
- Klystrons: The klystron uses a magnetic field to focus the beam and is less subject to Beam Voltage Potentials that are specified. As a matter of fact, Tube Manufacturers claim that you can extend the life of a klystron by decreasing the Beam Voltage. Of course, you will also change the output capability and the gain of the device. Klystrons should be operated at the nominal voltage for several months prior to backing off the beam voltage. This may help to cure gassing problems during the Tube's useful life.
- TWTs: The Traveling Wave Tube uses the voltages that are applied as part of the focusing apparatus of the tube. The Magnets that surround the tube are very small and rely on these specified voltages to correctly focus the beam through the slow wave structure or the Helix. The Helix is a relatively "fragile" device and excessive energy applied to it in the form of an electron beam will rapidly do damage. Some Amplifier Manufacturers claim that their system needs no resistive load for checking out your HPA

when replacing a TWT. This may be true if you can guarantee that the metering in the HPA will never get out of calibration and that trip settings will never drift and the power supply components will never fail. This is why we always use a Resistive Load when we change out a TWT for a customer. It's a proven fact that you can't damage a TWT with a power supply if it's not hooked up! (Unless you drop the power supply on the TWT.) It's better to catch a problem on a bank of relatively cheap resistors than on a $10,000.00 Plus Tube!

- Note: If you damage a tube by applying the incorrect voltages or by not protecting it sufficiently, the tube manufacturer will know! If there is a warranty issue, the tube manufacturer will most likely NOT cover the warranty in the event of a failure due to such damage!
- It is also necessary to verify the Tube's environment. Make sure that the cooling system is working and is not blocked. If you are at a higher altitude, be sure your blowers are moving enough air for cooling. Make sure that the waveguide flanges are concentrically aligned and parallel to each other BEFORE bolting them together.

Behind the racks

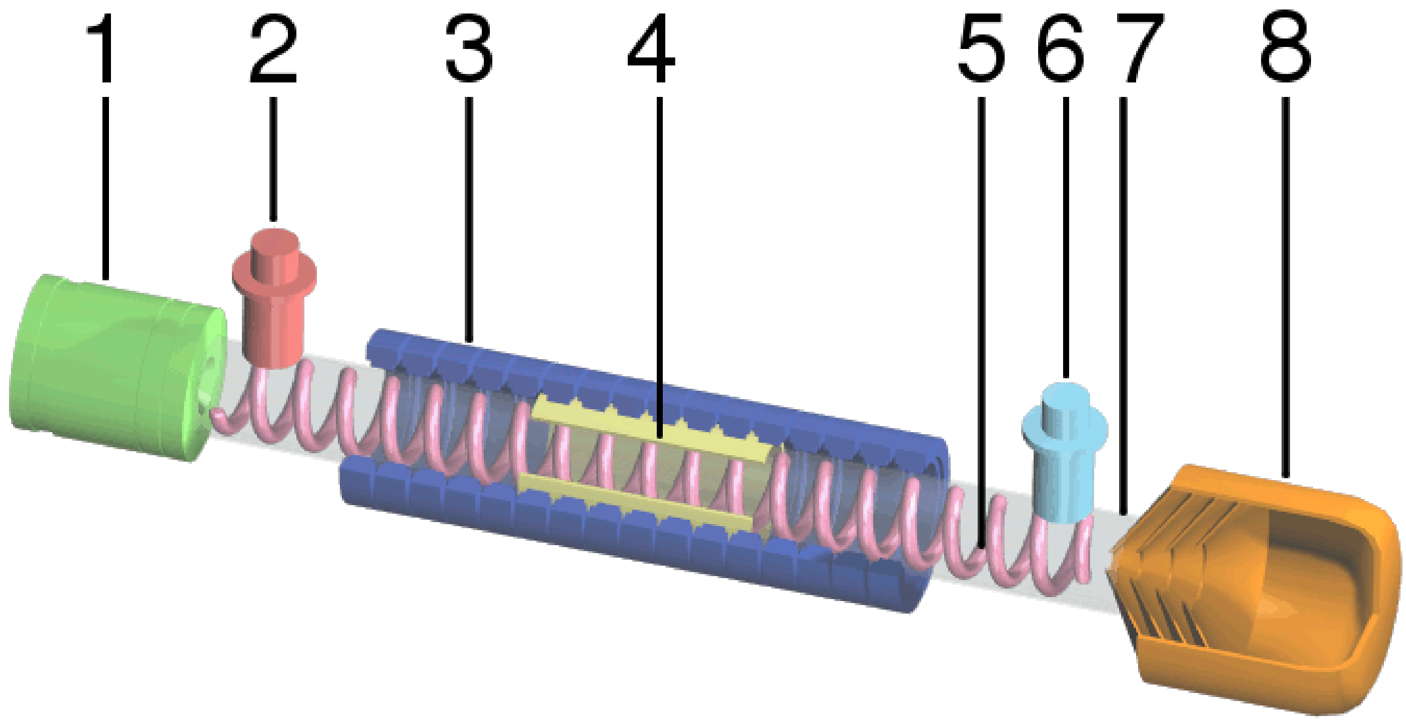
Always be careful behind the racks, especially racks containing HPAs and power supplies. The wiring there, in some cases, carries high voltage DC power at levels up to 10-Thousand Volts. Be careful storing anything near waveguide.

On the roof

Even when the truck is not transmitting, the roof of the truck or van can be a dangerous place. Ice, rain, and moisture from rooftop air conditioners make the roof slippery during inclement weather and on beautiful, sunny days. Don't forget that your air conditioners are running on nice days, too!

HPAs or High Powered Amplifiers

High powered amplifiers come in two forms: TWT (Traveling Wave Tube) and SSPA (Solid State Power Amplifiers).



Cutaway Drawing of a TWT

1. Electron gun, 2. RF input, 3. Magnets, 4. Attenuator, 5. Helix coil, 6. RF output, 7. Vacuum tube, 8. Collector.

After the modulator modulates the analog or digital signal, it travels to the upconverter which changes the signal from the MHz range to the GHz range.

After the upconverter, the output signal is in the milliwatt range. The signal must then be amplified to make the journey to the satellite. This amplification takes place in a High Powered Amplifier or HPA.

Despite their large, boxy, often military-style look and loud noises emanating from them, HPAs are a delicate device.

HPAs like to stay on and run for long periods of time. Their original design was typically for teleports and studio racks, not satellite trucks. They don't like heat, humidity, or fluctuations in AC power. They don't like to be overdriven by the upconverter. And the TWT amplifiers definitely do not like to be in standby for extended periods of time. We call this, “letting the tubes get gassy.” Gases build up inside the TWT and if allowed to build up usually prevent the TWT from igniting (going from “Standby” into “Transmit” Mode) In fact, you should never run a TWT amplifier in standby for more than 15 minutes.

If you should run your TWT HPA for longer than an hour or so in standby (power on, but with the voltage off), and you let the tube get too gassy, try several times to start the tube. This gassy effect is reversible once the tube is operated with high voltage. However, you risk shortening the life of the tube.

If several tries are unsuccessful, turn off the tube for the amount of time you left it in standby (usually an hour is enough to reverse the gassy effect).

The best way to take care of your gear, and practice preventative maintenance with your amps, is to turn your beams on, and turn your transmit to enable and send power into a load, as soon as the amplifier goes through its warmup cycle. And always make this your “standby” position. When you are done, let the amplifier cool off for 15 minutes, and cut the power completely. Each amplifier should have its own breaker. Take care of your amplifiers, and they will take care of you for a long, long time.

TWT Amplifiers

A TWT Amplifier (pictured previously) is basically a large box with a Traveling Wave Tube inside, a very long, thin vacuum tube. At one end of the tube there is an electron gun, and at the other there is a collector.

The tube travels through a protective field which in part creates a magnetic field that keeps the voltage inside. Also traveling along the tube is the attenuator, allowing you to turn power to the tube up or down.

And there is an input and an output for RF on the tube. This takes RF in, sends it through the Helix coil, and sends it out. The TWT also has a very large “brick” made of a rubbery material. This brick is part of the SSA (Solid State Amplifier), or IPA.

The whole idea behind an SSA/IPA is to make a small signal large enough to saturate the power amplifier stage...in this case a Klystron or Traveling Wave Tube. So essentially you have an amplifier in addition to another amplifier for much higher power than could be attained by only using an SSA.

Inside is housed the voltage amplifier method being used by that particular brand of amplifier. On rare occasion, this “brick” or other parts of the SSA may also need to be replaced. But out of the dozens of trucks, I have only seen this twice in 15 years. SSAs, as we will discuss later, have a very long life, and their failure rate is often very low.

Understanding Helix Current

One of the readings you can monitor on the TWT amplifier is the Helix Current. The Helix Current reading is exactly what it sounds like, an approximate reading of the current traveling down the TWT's Helix.

This will vary from amplifier-to-amplifier, but you will likely find them around 8.39 mW.

Understanding Cathode Ray Voltage

Another reading you should be familiar with is the Cathode Ray Voltage. This voltage typically stays the same, but low readings or high readings could mean there is a problem with circuitry voltage, or your truck voltage has risen or lowered because of generator problems or an electricity “brown-out.”

Uncommon voltage readings could mean there is a problem with the tube, in that it has come loose from its housing or connections. But again, this is a rare problem and keeping track of weird problems like this will help lead you or an amplifier person to solving the problem much faster than not keeping track of these readings.

Typical errors might read “Filament Under Volt” or “Filament Over Volt” and here are their definitions:

Filament Under Volt: Typically, if the filament voltage goes more than a volt or a volt and a half low, you will get a fault. The fault could be indicated either during the delay period or when the unit is in standby or transmit. It cause may be the result of a shorted Filament, a failed Filament Power Supply, no power to the Filament Supply, or a Control & Monitoring circuitry failure. Often the first place to check is your power source. Did your generator or shore power voltage dip?

Filament Over Volt : The filament Over Volt fault will usually occur when the filament voltage goes more than one half of a volt high. The fault could be indicated either during the delay period or when the unit is in standby or transmit. This failure may occur due to the Voltage having been set too high, a failure of the Filament Supply, a failure of the control & monitoring circuitry or possibly an open Filament. But again, I would look to the generator. Did somebody shut off a lot of lights and cause your generator to race? Was there a large truck or several trucks that were powered up using your same shore power and now they have all shut down? Any of these things can cause an over volt problem too.

Understanding Reflected Power

As the power leaves the amplifier, it is sent down a waveguide to the satellite dish feedhorn. The waveguide does exactly what its name describes: It guides the wave to a destination. It does this using special alloy metals, down a rectangular tube, and special rubberized waveguide often with “reflectors” in the rubber. Waveguide also tends to include filters made to help the wave along or focus it to one polarity and not the other, and rejection filters to step down unneeded frequencies at the LNB where you will be receiving signals from the satellite (including your own).

At the end, a residual wave (usually at only a fraction of the power) always travels back towards the amplifier. The amplifier is made to take a certain amount of this reflected power, but all of them are set up with alarms should the reflected power become too much for the equipment to handle, or too much for the uplink operator to handle.

What I mean by this is that high reflected power readings are a good sign that there is something seriously wrong with your waveguide. And there is a good chance that you are spraying RF all over the area and the people in that area. The alarms go off, and eventually shut down your amplifiers to keep the uplink from causing too much harm.

Keep an eye on your reflected power levels, and look for leaks in your waveguide if there is a problem with your levels. A good way to know if you have a leak is to look for pressure in your waveguide dehydrator. Depending on what you're using as a dehydrator, (old trucks used fish aquarium bubblers that offered 5 to 15 psi) you will often see levels at 30 to 50. There really isn't a correct level. There is only an incorrect level, and that is Zero! If you have zero level, you have no air pressure in your system, which means you have a leak in your waveguide!

The Accuracy of Meters

Kim Nocker once told me, word-for-word, “The only thing a meter usually tells you, is that there is probably power there. But as to it's accuracy?”

His words reminded me of my grandpa's lesson of the “stuck fuel gauge.” A gas tank can go empty even when it reads full. If I ran out of gas with my snowmobile, he would ask if there was any gas in it. And if I replied, “The gauge says it's ¼ full.” He would quip back, “I didn't ask you what the damn gauge says!”

The same can go for power meters. You could spend a large part of your career taking careful measurements of power readings, reflected power, helix currents, cathode ray voltage, or heat. And the truth is that every one of your readings could be wrong.

This lesson was recently learned while studying global warming. Researchers in 2008 discovered a 60-year-old bias in global surface temperatures recorded by British and American ships. There was a drop in temperature in 1945, but only in the data collected at sea. On British ships, they collected seawater in a bucket, noting its temperature. On American ships, they drew water through an intake pipe in the engine room making the American measurements higher. During the war, most measurements came from American ships. After the war, half the readings came from British ships.

Wow, that story was boring. But the truth is all of the readings will be taken into account and will not affect the proof that global warming is happening. It's been going on for 70,000 years (that scientists can prove).

Heed these words: Taking readings and keeping an eye on things can often be a harbinger of things to come.

SSPA or Solid State Power Amplifiers

There's no other way to put it, SSPAs are probably the biggest advance we've experienced in the satellite industry in the past 10 years. They produce power without requiring a lot of power. And they have a theoretical "Mean Time between Failures" of 100-Thousand Hours. (Yeah, RIGHT! If conditions are PERFECT!)

However, they are just now reaching the power output of a TWT in the same size and space. They still need to prove themselves on the road for a few years. Some of them step up and down in a more harsh manner (TWTs have a more analog slope), so it is best to adjust some of them during the less important times during your broadcast, if you have to adjust them at all. If you take hits in your truck's voltage, the SSPA will likely step up and down, too. At least that was still happening in 2008 with all of the SSPAs I've worked with as of this edition's writing.

As I will mention in the last chapter, amplification methods are changing, and SSPA designers are just now making SSPAs "stackable" to "cascade" them so if you need to double the output power, you will be able to chain two SSPAs together. (So you will be able to add more power by adding more units.)

One such company, Paradise Datacom, has made some impressive (and currently loud) amplifiers for indoor and outdoor use. Some of their systems use three power supplies for each amplifier for double-redundancy. They appear to be another company truly interested in what their clients want and in having foresight into our industry. Stackable systems work very well. Now, hopefully they can iron out the little things, such as the need for warning lights for each SSPA so an engineer can quickly determine which one has failed... But I digress...

Dummy Load

Attached to every amplifier chain (or at least most of them) is at least one switch that looks like a baseball switch. This baseball switch allows you to run the amplifier at a typical operating power into a load *rather* than transmitting to the satellite. More than likely your HPA or SSPA will transmit to this load as much or more than it will transmit into the sky. They are made to do this. Be aware of what your loads are rated for, and run your power levels according to this and never at the maximum output of your HPA. Run you HPA no more than 80% of it's declared total output power. Never run phase combined power into a dummy load, or push it past it's rating. If you have a 300 Watt rated load, don't run 750 Watts of combined power into the load. I've never done it, and I don't even want to know what happens when you do something this dumb.

TWT HPA warmup and cool down

TWT HPAs require a 5- to 10-minute warm-up before they will let you run them with the power on and the voltage on.

The cool down cycle is usually 8 to 10 minutes, depending on the amplifier, its power, the heat or coolness of the day, or even humidity.

Do not try to defeat this cool-down cycle. In fact, whether you have a 20-year old amplifier or a brand new one off the shelf, like I said before, give your TWT a minimum of 15-minutes. No excuses.

I can attest to over a decade of satellite transmissions where I have *never* (on purpose) shut off a TWT before 15 minutes were up. And, knock on wood, I have *never* lost a tube. I have operated with tubes made when many of you were probably in grade school.

If you shut off an HPA before the cool down cycle is complete, you risk greatly reducing the life of the tube. And that's expensive, at 10- to 20-Thousand dollars per tube. It must be special ordered, probably from France, and will probably be shipped to you on a slow boat.

If you lose power temporarily, many TWTs will allow you to “re-light” the tube automatically if you can get the power back up within about one minute.

If you lose power for longer than a few minutes, let the tube cool down for 10 minutes or so in standby before shutting it off and trying again. (you will not defeat 15 minutes because it is 10 minutes of shutdown, and usually 5 or 6 minutes of warmup)

If you shut it off for good at the end of a shoot, be sure you still allow 15-minutes before you shut everything off and move the truck or the uplink.

If you have an SSPA, even though you do not have to worry about a tube, it is still important to let the amplifier cool off for about 5 minutes. You probably have something you could do for that amount of time:

- Clean the floor
- Stow the dish
- Wrap up some cable
- Use the restroom
- Do a “dummy check” to see if you, your camera person, or reporter forgot something

Using handheld radios or “walkie talkies” in the truck

Gadgets are great. But anybody who's known me for any length of time will tell you I have much more than a mild dislike of wireless devices that don't use a focused dish.

2-ways, bluetooth, cell phones, microwave ovens, 802.11... all of these devices have made for an always-on, always-connected society. Crews, producers, reporters, and fellow colleagues love to use these devices. And most of them don't care that they are spraying RF everywhere, causing massive issues inside your truck, van, or video production gear.

High-powered UHF radios are infamous for causing “glitches” in video and audio equipment.

And the latest to cause massive interference issues are Blackberry devices (commonly known as “Crackberries” because they are allegedly as addictive as Crack cocaine). Blackberries send massive amounts of RF (usually heard as a beep, beep, bebebebeep) and will cause an almost complete loss in audio if you do not keep them away from all equipment and wires.

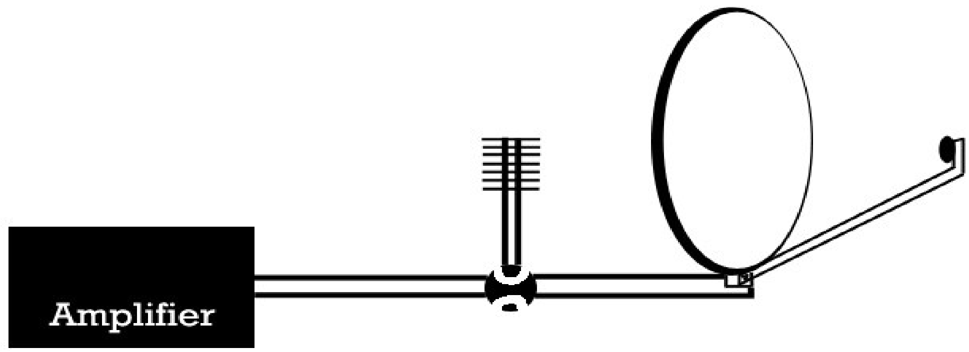
None of these devices should even be allowed into a truck or van unless it is kept away from ALL other equipment. Operating them inside an aluminum box just doesn't make any sense. There are other ways to communicate with your crew. Figure out how to use them.

UHF hand-helds should be set up with an external antenna. People can check their email in other ways, or step outside the truck.

Types of HPA chains used in today's trucks

There are several types of systems used in today's uplinks, including Single-thread HPA, Redundant HPAs, and Phase-Combined HPAs, and Magic T systems.

Single-Thread HPA



A Single-Thread HPA

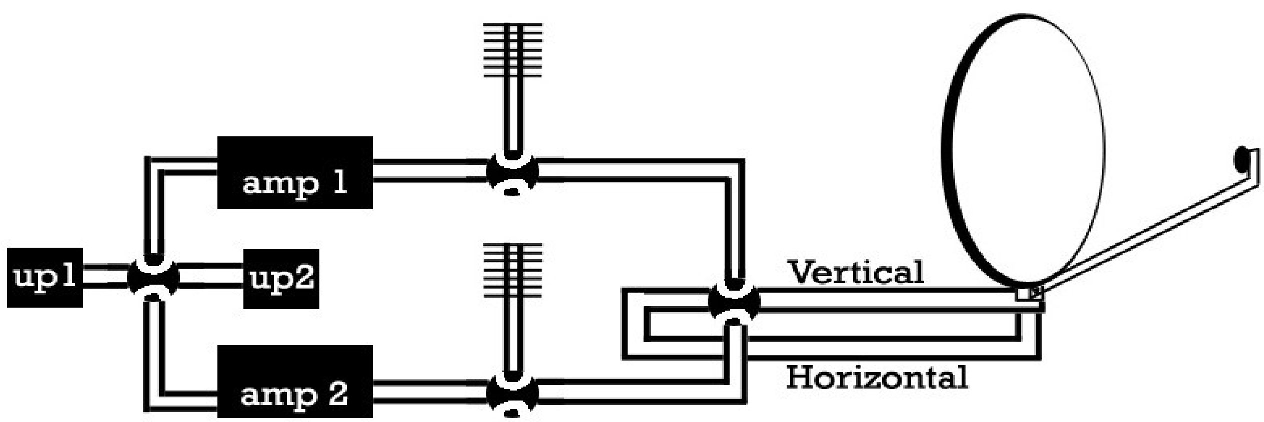
Cost or lack of real estate are the two biggest reasons people use single-thread HPA trucks today. Generally, but not always, these trucks have 500, 600, or even 1,000 watt amplifiers inside the truck. If they have an antenna-mounted HPA they may have a 125 to 400 watt amplifier on or near the dish.

The upconverter feeds the HPA, and unless it is mounted directly to the feedhorn, there is only one break in the waveguide where a baseball switch allows the operator to put the amplifier into antenna or into a dummy load.

There are other advantages to using this type of system, other than being cheap or not having room. For one, there is less loss because there are less pieces of equipment and switches for the signal to travel through.

And another huge advantage is that there are a lot less parts to break. Sometimes keeping systems simple is the best way. You can usually get an amplifier, or any portion of the uplink chain overnighted to you for the next day. If you are confident enough in your components, this may be an option for you.

Redundant HPAs



Redundant HPAs (with Redundant Upconverters)

Typically redundant HPA RF chains use 350-500 watt amplifiers, but can have anywhere from 5- to 1,000 watt amplifiers inside the truck or on or near the dish.

There are two or more HPAs, and the outputs to them from the upconverter can come from one, two, or more sources.

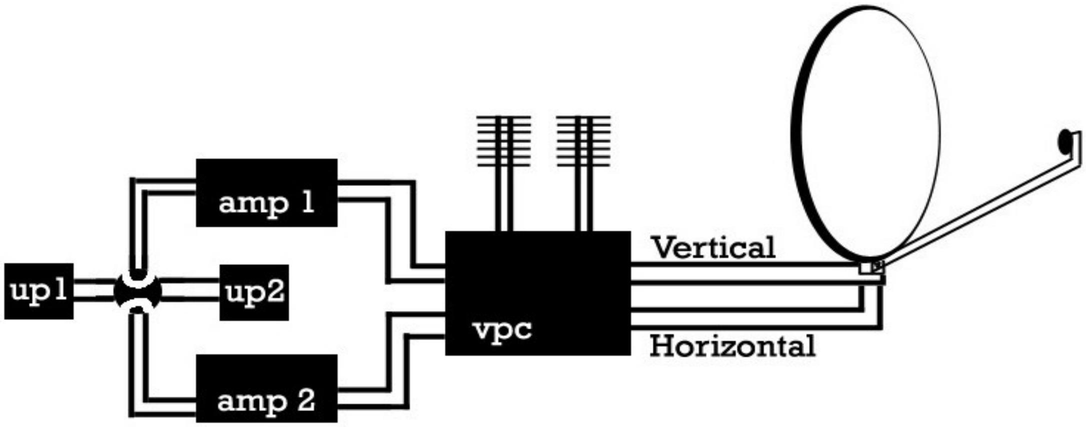
Older upconverter designs allow only one signal to be sent to the HPA.

But newer encoder/modulator/upconverter designs offer the option of adding an undetermined number of signals. However, each signal will require a fraction of the HPAs power and this alone can determine how many signals you are capable of transmitting.

A waveguide baseball switch allows the operator to uplink from HPA 1, or HPA 2 (or others if there are more), but not both.

Redundant HPAs are often also set up so you can send one signal to the Horizontal polarity and send a second to the Vertical polarity.

Phase-Combined HPAs



Phase combined HPAs using a VPC (Variable Power Controller)

Phase-Combined HPA chains allow the ultimate control for satellite engineers. You can use two HPAs to give you more power (almost double, but not quite).

You can also use only one amp when you don't need as much power.

You can also send two signals to the Horizontal, or two to the Vertical, or one signal to each polarity just like some Redundant HPA chains.

Some engineers have also found they wanted TWT HPAs for higher power broadcasts and wanted SSPA HPAs for lower power, single path and small deviation broadcasts. They have installed Phase-Combined systems allowing for either HPA, or even both HPAs.

If an HPA fails using redundant, and it's set up to automatically switch, you will lose the transmission in the second it takes to switch to the backup amp, or the seconds it takes for you to flip the switch.

If you run power phase combined, the belief is that you will lose half of your power and will not lose the broadcast. However, unless the downlink site has done a perfect job of tuning in the feed, you will likely still lose the broadcast until you turn up the power on the remaining amplifier.

In a phase combined system, both amplifiers need to have a way of *attenuating* each signal. This can be done at each amplifier, at the upconverter if they are equipped with attenuation adjustments, or at each modulator.

In addition, many phase combiners also have a *variable phase element*, allowing you to shift the phase of one HPA to match the other.

The variable power combiner allows the switching of either HPA 1 or HPA 2 to the antenna, the other going into a reject load (also called a dummy load or simply a load). Or it allows the switching of either the sum of HPA 1 and HPA 2, or the difference of HPA 1 and HPA 2 to the antenna with the other going to a reject load.

As I mentioned before, adding the two HPAs together does not give you twice the power, because no two HPAs, the RF chain, or the weather gives you 100% efficiency.

In fact, running one amp alone is the most efficient way to go!

There is always power in the *difference* signal. As a result, do not ever select HPA 1 + HPA 2 and send it into the dummy load! The reject power just might be going to the antenna *and* the satellite. You could be on the bird!

The “magic tee” or VPC controller

The simplest form of phase combining can be accomplished with a magic tee. The way it works is two inputs come in each side “arm.” They output out of a horizontal (H) arm, and the *difference signal* comes out of the “E” arm which comes out at a 90-degree angle from the “tee.”

The VPC, or Variable Power Combiner does the same job as a magic tee and provides switching with rotary components in a way that never deprives the antenna of power.

If a magic tee is used, instead of a VPC, and one of the HPAs were to fail, the power of the antenna would drop one-quarter (not less than half, as with the VPC).

This is because the magic tee combining of an HPA with nothing (a failed HPA) is an equal split of power between the antenna and the reject load. Once power drops, the extra power that was going into the reject load is now going into the antenna.

Magic tees are used extensively as splitters to take advantage of this mode, and I hope to have a good drawing in the next update of this manual. The Magic T is showing up in more and more trucks these days.

The advantage of a phase combiner, if used in redundant mode and not phase-combined mode is that it senses the failure of an HPA and switches the good HPA directly to the antenna, maximizing the output.

Antennas

Antennas for transportable earth stations vary in size from 1.2 to 5.5 meters. Big or small, the antennas must meet FCC sidelobe envelope requirements.

Antennas smaller than 2.2 meters are the most likely of all sizes to not meet FCC requirements. But uplink antennas, depending on your bandwidth, may meet requirements down to 1.8 or even 1.2 meters.

Some antennas are transported in more than one piece. They can fold out, or need to be pieced together. They may have a removable feed support.

If you are involved in the purchase, or it is your first time out with an antenna that folds out or pieces together, be sure the seller shows you the best deploy and stow techniques. And be sure they can prove the reliability of the unit as well as troubleshooting tips if you have to deploy or stow in freezing or extremely hot conditions.

Antennas must have pointing mechanisms capable of moving slow enough so that fine pointing the antenna is reasonable and efficient. Remember, you are trying to hit a target more than 20-Thousand miles in the air!

The antenna and feed support must be capable of maintaining the radiating beam within +/- of .4 degrees of its intended *boresight* during any environmental condition it can be reasonably expected to occur during operation.

The integral part of every antenna system is the truck, van, or antenna stabilizers. You should be able to stabilize your van or truck with good, working jacks. And you should be able to tie down, or ratchet-strap down your portable uplink. Make a trip to Home Depot or Lowe's if you must.

Antenna Damage

Reflector damage – The surface of a Ku-band antenna is often about +/- 20 one-Thousandths of an inch.

It can usually not be repaired. And even if it is repaired, it must be retested for compliance after the repair. Leave this up to a professional.

Considering its size and how hard it is to replace a reflector, this means it is very expensive. Some antenna systems cost as much money as you will make in six to nine months. Don't ever forget that.

On my first day on the job in television, photographer David Coleman looked at me and pointed at a piece of umbilical cable, "Do you see that? It's easier to replace *you* than it is to replace *that* cable." I often wonder what he would say about a 40-Thousand dollar dish.

Feedhorn support damage – Generally, feedhorn supports can be repaired, reformed, or rebuilt. This will be difficult if the feedhorn is part of the folding or deploying mechanisms.

These days, getting proper replacement parts from the manufacturer or having a complete retrofit done to the antenna is often the only way to make a repair that will maintain compliance in a damaged or old dish.

The FCC has declared a few dishes are no longer compliant, now that satellites are living closer together (3 degrees has now become 2 or less degrees between some satellites). If this is the case, it would be sad to see the dish destroyed or thrown away. Even a small DirecTV or Dish Network dish is useful for something and could be used as a downlink dish. See what you can do to donate the dish to a small TV station or sports bar. There are still a lot of FTA (free to air) broadcasts available. If you take it to the factory for repair, they may recycle the dish in another way.

Once you or a professional has replaced feedhorn supports, the centering of the feedhorn and the focus *must* be checked.

Microwave absorber panel damage – In Ku-Band's infancy, many dishes did not even meet 3^{o} compliance (they must now be 2^{o} compliance) because they were built for C-Band transmission, so they were outfitted with microwave absorbing materials to help the dishes maintain their sidelobe compliance. Many of them also used microwave absorbent material in the center or the feedhorn mount to prevent any secondary reflections off the feedhorn or the feedhorn supports.

This issue has been largely solved now that most Ku-Band and some C-Band trucks use an offset dish, where nothing is in the way of the outgoing or incoming beams once they reflect off the dish.

If this absorbing material is used on a dish you are operating or maintaining, be sure to keep the material clean and free of dirt. And replace the pads when they get old or worn out.

Positional system damage – Absolutely no horizontal *play* is allowed in the antenna system. This should be checked regularly. If you have a cable driven antenna, you should be aware of whether or not the cables have slipped (if the dish won't stow, that's a pretty good sign!).

Some antenna positioning systems can be "flexed." Try it out when you aren't transmitting: Push on the edge of the dish (don't force it). When you let it go, does it return to the original position? If so, then you are fine and there is no play in the system.

Many antenna positioning systems have gears, ball bearings, cables, or jam blocks with support screws that loosen up over time of being bounced down roads and shaken up by the wind. These things need to be checked regularly, and tightened if necessary.

- On one occasion while uplinking in Wichita, Kansas our truck was hit with a wind shear, the type that can take down an airplane. It was a beautiful day, not a cloud in the sky, then *bam,* we all grabbed onto something and it felt like we'd been bumped hard by a bus. There was a loud *thump* on the roof of the truck.

I and jumped out of the truck to find that the wind sheer had shoved the offset dish so hard, it slipped through the grasp of the cables (said to withstand 80 mile and hour winds). The feed support came slamming down onto the roof. The dish did exactly what it was designed to do. Instead of bending the dish, it allowed the dish to slip instead of holding it there to be bent. However, it took a long time to convince the dish it was now in a different place. The dishes often need to be moved back through this tension, by loosening the cables and slipping the dish through them, or you can have soft limits removed from their programming, or if you are lucky, you might be able to manually move the dish like I did.

Always have a backup plan, and figure out what you can do when technology fails you. It keeps you on top of your game, and you won't panic when the worst happens to you.

Feedhorn damage – The feedhorn is a very critical part of the satellite antenna. Leave the repair up to the manufacturer, and only attempt repair if you know it has not changed the manufacturer's specifications. A crack might only need repair with JB Weld. However, this should only be your last option.

Damage to the waveguide going into the feedhorn can often be repaired by professionals who know how to repair waveguide. There are many of these professionals around the country. But make sure this person knows what they are doing. Don't just take the part to a farm welder.

Antenna stabilization damage – All uplinks need to have a means of stabilizing the antenna, the truck, or the van.

These stabilizers need to be in perfect working order. Stabilization is important not only for the optimum operation, but it is also important because it eliminates interference.

If the truck, van, or flypack is not stable, small movements are amplified by the antenna itself or the antenna's feedhorn stabilizer. The downlink can lose your signal, and you can cause interference from your swinging dish.

The most common stabilizers used in trucks and vans are hydraulic and hand-crank levelers used for uplinks, production trailers, Recreational Vehicles (RV), and various utility trucks.

Maintaining these stabilizers is often a full-time job in itself. Understand how to use them, how to fix them, how to replace them, and if you have hydraulic jacks, know how to clean up after them should they blow a hydraulic line.

Spectrum Analyzer or Monitor damage – The uplink system must have a spectrum analyzer or spectrum monitor connected to the receive system.

The analyzer must be able to display all 500 MHz of the Ku-Band and/or all 500 MHz of the C-Band. Usually this can be done with the same monitor.

The analyzer or monitor must also be of sufficient quality to identify the satellite and the various types of satellite traffic, digital or analog traffic. And it must also be capable of displaying a 2db per division or greater expansion (able to zoom in or magnify) for the purpose of fine-pointing.

These requirements do not mean you will have to spend boatloads of money. The application is a modest one, in that you are only verifying satellites and signals. But this equipment must be well built enough to withstand the abuse of travel. Two of the most popular brands today are Tektronix and Avcom.

System indicators and control damage – The uplink chain and all of its components must power up in a safe, non-radiating state and power down in the same safe way.

Indicator lights on baseball switches and indicators for power should be driven from sensors and not control circuits or remotes. Waveguide baseball switches should use telemetry contacts to give the true status of the switch. However, even engineers who design these switches promise that every switch, no matter how well it will built, will someday fail. You just don't know if that will be today, or 1,000 years from now.

Any automatic system running antenna control, crosspol control, or waveguide control must give a continuous indication of its status or you must visually be able to see these things with your own eyes.

Switches and indicators critical to all of these processes, especially RF power must have a visually obvious way of indicating in some way whether the equipment is operating or has failed. LED lights are the preferred choice because of their longevity and ease of replacement.

How to test for a dead LNB

Plug the LNB or LNA into your spectrum monitor or spectrum analyzer and turn the power to the LNB or LNA on and off. The noise level should change. If it doesn't, then the LNA or LNB is not working, or there is something wrong .

The Sun is the great test generator in the sky. Note the level on the floor of the spectrum analyzer, then aim the dish at the Sun. The noise floor should raise 10 db or more.

At night, try a portable fluorescent bulb. A trouble light used in a garage, equipped with a fluorescent bulb should be enough. Have somebody wave the bulb in front of the LNB or LNA and see if you see a change in the noise floor.

There are cases of intermittent or fading LNBs or LNAs but overall this is a rare occurrence. There are also cases where LNBs have become less *frequency stable,* but this is also a rare occurrence. Usually an LNB is either working or is dead.

Frequency Stability of an LNB

In the early days of satellite, it was not as important to have a stable frequency. LNBs were known to drift up or down in frequency by 5 MHz or 5,000 kHz. This has become unacceptable for most digital satellite receivers, for many signals these days are only 5 MHz apart from each other. It was discovered that some IRDs would lock up, but then go dark or lock up on another nearby signal over the course of a few hours because the LNB frequency had drifted.

Most LNBs are labeled by a metal stamp, not unlike a military “dog tag” that can wear out but cannot fade in the sun. You will find most LNBs in use today have 2000 kHz (2 MHz) or 1000 kHz (1 MHz) stability.

IRDs have a setting where they will “scan” up or down to compensate for this LNB drift. It is suggested you set this to no more than 2000 kHz, unless your LNB is not that stable. Then set it to 1 MHz less than its stability. Otherwise, if the satellite signal should drop, the IRD will automatically look for anything within that 2000 kHz range. If you have it set higher, say 5000 kHz (5 MHz), and your signal drops while you are live and on the air, it might lock up on a reporter picking his nose, cursing out his producer, or worse. If you set it to no more than 2000 kHz, you should not have this problem.

Powering an LNB

In order for an LNB to operate, it must be powered by a source. Each piece of equipment can usually power an LNB on its own, however truck companies often use a separate power source to power the LNB, should you need to pull a receiver, IRD, Spectrum Display.

The voltages do not add up at the LNB, because signal splitters usually only pass power on one of the inputs/outputs. Be sure to remember this or take note of it if you are changing something in the L-Band path. If you unplug the power, you might lose power to the LNB.

This is why it won't matter if you select “on” or “off” on any receive equipment. Most likely, the the truck, you can choose the “off” setting.

Operating in a Hurricane or very Inclement Weather

The first posting of advice on how to work in a Hurricane came almost a decade ago from Robb Radford of Lynchburg, Virginia. Like me, he has a decade of experience in covering Hurricanes and dealing with inclement weather. As you will see, Robb likes to use a lot of exclamation points AND ALL CAPS:

1. YOU ARE RESPONSIBLE FOR YOUR TRUCK! Not your gung-ho reporter wanting to move from market 78 to the upper 20. If he/she wants to stand in a VORTEX to do live shots, FINE! But if the conditions for your truck are not right, blow them off! Again, YOU are responsible, and you should operate your truck SAFELY! That means, no power lines, wind speeds in which your dish will not be damaged! That also means look out for flying debris. (More on this later!)
2. FIND A SAFE SPOT for the truck! Chances are you are going to be on a coastline somewhere. My experience is on the East Coast. Find a TALL BEACH FRONT HOTEL that you can "tuck" the truck into tight. "L" shaped hotels are AWSOME! IF they allow you a SW exposure. KEEP IN MIND PROJECTED STORM SURGE! This is always the BIG unknown! You might know Winds, speed. Direction, but you DON'T know how HIGH or how FAR the water will go! This is up to your best judgment! My advice, talk to as many LOCALS as you can that have been through previous hurricanes before, and find out how HIGH the water got LAST TIME!
3. Take as much 'stuff' as you can. WATER, snacks, food, BEER;), cans of weenies, etc. Also, Plenty dry clothes. The obvious, flashlights, batteries, any camping supply. CASH, and also spare EMPTY FUEL CONTAINERS! You might need Diesel, Gas, whatever!
4. Be aware of winds and blowing objects! I was told to do an uplink at 5:30 AM in Morehead City, NC. !! I looked out the door and sheet metal was blowing off the Hampton Inn’s roof! I'll be DAMNED if I'm gonna walk out there! You do the BEST you can do! Flat out and simple! Do NOT let reporters resume' tapes get in the way of your judgement! Protect the truck! Protect YOURSELF!!
5. 5. One of the MAIN things you will find is your signal being degraded by a number of factors. First Wind. Wind blows your antenna and enough wind will momentarily cause your signal to take a Hit. Really not much you can do. I have run into VSWR overloads. As the rain comes down HARD enough, it can cause the signal on the feedhorn to reflect back into the HPA. Again, not much you can do, but try to tuck into a building's corner somewhere and shield the wind/rain. Our truck had one of these late 80's / early 90's Andrews 3.4 offsets with the locking handles on The back. They are pretty much useless in most situations, but in hurricanes, they actually help. The problem is once you engage them; you cannot lower the dish until you pop them off. A trick I did numerous times was to tie a small rope on the handles. Put the dish up, engage the locking Clamps. I don't want to get up on top of the truck in a hurricane to move the truck if needed. The ropes allow you to simply pull the locking handles and open the clamps in about 3 seconds. If you have a dish like this, do it!
6. Again, keep your head and think responsibly! DO NOT THINK NEWS!! If you have the attitude that it's NEWS and it's GOT TO GET ON THE AIR, you are headed for trouble!

In addition

You should know that in a hurricane, once the eye wall hits and you get the calm inside the storm, you must move your truck so that it can take that same wind in exactly the opposite direction. Just as quickly as it went away, it will come back just as powerful. Be prepared!

Should I change bandwidth during a storm?

The short answer is no. There are a couple of things you should keep in mind with the size of your "slice." First of all, smaller slices typically "cut through" better than wider slices. More bandwidth usually means more noise.

But, keep in mind that power spikes, bandits (people who aren't supposed to be on the air) and other errant noise are all less apparent with a nice big slice of bandwidth. An analog transmission is more likely to fade out, and fade back in giving your talent time to toss away from the live location before you fade out altogether. And one other thing... no matter how much power you throw at the satellite, at some point YOU WILL LOSE SIGNAL.

When you have miles and miles of water between you and the satellite, at some point you won't be able to see the satellite, much less transmit to it. Back in the old days at USSB, it was discovered that even 11- and 13-meter dishes can experience total rain or total snow fade. The engineers came up with the idea of a diversity site, which was basically a mirror site located an hour away, or in another part of the country, with similar transmission facilities which took over when the primary site lost transmission power due to rain fade.

Just make sure you've done everything you can: peaked as best as you can, made sure your station is using their largest dish and best receiver or IRD to take you in. Think about convincing your station to do a "look-live" just in case you really can't get a signal to go through.

But keep your people on the phone, or maybe even someone at your downlink center to stick with you to monitor your signal. If you are running a lot of power, and the rain goes away (as always happens when the eye comes) you will quickly blow away everyone around you, and mess up everyone's day. Should you have another site a half-hour or hour away, maybe your station should be ready to go to them while your signal is down, or vice-versa.

Water in your fuel

Remember that both your truck engine and generator engine have fuel filters that serve dual purpose as an impurities filter and a water separator. If you believe you have water mixed with your fuel, you need to take your fuel filter off, dump it out (some shops will recycle the fuel for you), and fill up the filter with fresh diesel before you put it back into the system.

Most of the time, engines will run on a percentage of water. Once that percentage of water becomes too much, the generator will lose power, eventually losing too much power to run properly.

Diesel, unlike Gasoline, does not “go bad” or become “old” and stores for much, much longer. However, it can gain water inside the tank from simply sitting and allowing condensation to collect on the inside of the tank (which eventually falls into the diesel). Filling tanks to the top each time you fill up will clear condensation and keep it from collecting inside the tank while the tank is full.

That being said, keeping tanks full if you plan to store the truck or generator for any length of time without use is a really good idea.

Partly serious, partly in jest, a list of Hurricane Supplies...

Stuff to pack in your uplink truck for Hurricanes and other Natural Disasters

1. Water Jug

Farm stores, Lowe’s and other large hardware supply stores sell a 5 to 7 gallon water jug you will find invaluable, pending you find it a good home where it won’t drip on valuable equipment. I place mine in one of my truck’s side panels, and there is still enough room for a few stingers to fit next to the water jug.

Keep in mind this adds to the weight of your truck.

In an emergency, or in a desolate area, water is the first thing that runs out. And besides for drastic situations, I often find comfort in knowing where the water comes from. I take mine from a filter out of my own tap. And my hometown has some really good water, according to the annual quality reports. Water in, let's say, Florida may be another story. We used to say that nothing runs faster than tap water through a tourist.

2. **Wet Ones, Baby Wipes or Orange Hand Cleaner (w/Pumice)**

While you may not have trouble finding food, you may not have time to find a place to wash your hands. While pulling cable, you often will start to wonder where your cable has been. Sports arenas are quite possibly the worst spot for making cables gross. Hurricanes run a very close second place to that special dirt under the bleachers.

These little hand wipes are typically found in the pharmacy section of your local walmart, kmart or grocery store. Baby wipes also work, but I find that they smell weird.

Goop and Quik orange cleaners can be used, too. They have pumice to get out any deep oil stains. They also smell better than most wipes. But you need paper towels to wipe them off, or you will need wet ones to get the pumice out of your hands.

3. **Big Garbage Bags**

You will have a lot of trash. My record was 17 bags of trash, set by affiliate station KCNC out of Denver. Trash will come blowing down the street to you. Your crew will leave trash everywhere. Television compounds are always full of trash. But that's not the only reason why you need lots and lots of garbage bags.

You have to cover everything, and the only thing that really ever works is a garbage bag. Cover the camera. (yes, you have a Porta-Brace or KATA cover, but I'll tell you right now that's not good enough)

After you've covered the camera (and left only the glass of the lens exposed – lens hood should cover the outer plastic or you should tape the bag to the lens hood if it will hold), cover the camera with another garbage bag. You will look ridiculous with such a getup – but your gear won't get wet, and that is what's 100% important.

With more bags (or a load of some type of plastic) duct tape plastic or garbage bags over all your connections, monitors, or anything else that is not supposed to get wet.

You should almost be able to take your gear and dip it in the pool. That's how much you need to cover your gear.

Don't think for a second that you only need to cover the top of your gear. Hard, pounding rain in a hurricane falls down, sideways, even up (bounced off the ground), and you will watch everything get soaked within seconds. Soon after, your gear will stop working.

4. Duct Tape, Gaffers Tape

You will need to tape down garbage bags. You will need to tape up cable. You will need to fix stuff. Duct Tape does it all. Neither tape works when it gets soaked, so you will need to re-tape everything. Bring a lot of tape. And don't pay a lot for it. You pay 12 dollars for a roll of stupid tape? What a waste of money. In a hurricane that could add up to a thousand dollars pretty fast.

5. Swimming Suit

You will get soaked. It will dry up for a while, and then you will get soaked again. Imagine wearing raingear you purchased for a big sum, thinking it would keep you dry. And then imagine steady streams of water flowing from your collar on the rainsuit, down into your shoes.

There's the first "rainband." You change into dry clothes, and in another hour or so another rainband hits, and you're soaked again. By the end of the day, you will be out of clothes.

Don't bother with looking formal. No one cares. Even reporters look out of place in anything too nice. It's only going to be you and your crew. Wear a good suimsuit and pick up a "rash guard" (surf shop – they'll know what you want). A rash guard is a spandex-style shirt that dries very fast. Get a swimsuit that dries really fast, too. If you wear a cotton shirt over the rash guard, you can put it up to dry during each rainband.

At some point you will be able to guess when the next rainband is on it's way, and you can change clothes, if you wish. Otherwise, wear your swimsuit and keep your rain gear nearby, just in case the wind is cool.

While you're at it, buy a few swimsuits. Buy a few rashguards & bring some extra t-shirts. Leave the t-shirts with the holes at home. Even people covering hurricanes should have some standards.

6. **Rope, Moose Straps, Ratchet Straps, Struts**

Strap your dish down. It will be hit by the most powerful wind you've ever seen. And even after you've painstakingly tied the dish to four different places, you will look at the spectrum monitor and see it moving. Your jacks are down, and you couldn't move the dish if you tried. And as you step back to look at your spider-web of ropes and straps, you realize the whole truck is moving. And you realize that the whole box is just a big windsail, even minus the dish sitting up on top.

Strap the truck to something. A tree works, concrete pillars work. Another car works (granted it's not getting hit by wind, too).

Use moose straps. They are like ratchet straps, except without the dumb ratchets. You hook up the two hooks on each end, and then pull them tight with the little buckle.

And don't let anyone tell you that they don't work, or that they aren't worthy of trusting. I can hold a 600-pound motorcycle up in the back of my truck with two of them, for six hundred miles, and they've never come undone. We also suspended a snowmobile on a set of Moose straps, and they never slipped.

Better yet, I used these straps to strap my satellite truck to a parking garage pillar. Every hour or so I gave them another pull to make sure they were still tight. And they made this neat sound in the strong wind: "bbbbbbbbbbbbbbbbbbbb!"

7. **Money**

Bring a bunch of money. You should have a lot of cash. Most likely you will be buying sandwiches or gas and sandwiches that give you gas.

You should make sure you or your company has paid your credit card balance. After the storm coverage, you may need to pay the balance (again). You may be shocked how much money you will need, especially if you came unprepared. On the other hand, if you came too prepared, you may have some money left over. But I doubt it.

8. **Make mental and written notes of open stores**

As you're driving toward the beach, keep notes of where to find Home Depot, Lowe's, Winn-Dixie, Walmart, Phillips 66, BP-Amoco… anywhere you may need to go to get more supplies. You will mostly need food and gas, but you never know what you might need. And you never know when you might have to improvise with your gear.

Anything hit by the storm surge could be under 15 feet of water, so you need to start looking for stores when you get within 15 to 30-miles of where you are going.

Keep in mind the variety of things you can buy at these stores. I was in Home Depot the other day, and I noticed they are now stocking various video cables. They had the regular RG6 and RG11, but they also had RG59, CAT 3, 5, 5E, 6 and some other types of hard wires and electrical wires you might find useful. I wouldn't be surprised if one of these days they started carrying spools of fiber.

Granted, what you can buy at a hardware store may not the best stuff on the market, but you never know when you might need another set of cables to wire up another camera, or set up another crew with a live shot location. You might even lose your existing cable when your crew put themselves in a dangerous situation and barely made it out before the surge came in. You could have a tree fall, or have something sharp cut your cable in half. It pays to know where you can get backup. Remember, they can't always Fed Ex you something by the next day, nor should you trust your busy people to back you up when you most need them. They have a lot of work to do, too. And the next day might not be soon enough anyway. They may want something in a matter of hours.

When you get to your location, find out if there are locals sticking around who own restaurants, sandwich shops, radio shacks. Most of them will be glad to make a sale or two during a storm where they weren't expecting any business. They might even put you up (sometimes for a small fee – hence the money in note #7). If you are pretty sure you are going to stick around for a while, it's probably a good idea to pay these people well, or at least buy a lot of stuff. Buy some stuff you don't think you'll need. Why not?

9. Booze and Cigars

I'll leave this one open for discussion/debate. Do not have either on your truck when you cross the border at Canada or Mexico, unless you have it on your manifest. Don't carry it in any other circumstances except Hurricanes.

Keep a couple of things in mind when you take along either one. First, you should be aware of addiction and take care of your crew according to their needs and wants. But don't forget that it may not be for you. A nice bottle of something may buy your way into someplace, or get a favor somewhere where money will not.

And before you email and chastise me, let me remind you that booze and tobacco trade this has been going on for a long, long time. I don't necessarily condone it, but I am aware of it. And it does work.

10. Sundries

This is typically non-edible.

I sometimes use this word to describe all of the non-edible things you need to bring with you. But the word also includes food dried in the sun, including raisins, gorp, and trail mix.

Sundries could also refer things you might have in your bathroom. You have soap, shampoo, shaving stuff, toothpaste and brush, hair products, foot powder. You will think of tons of things I've left out. Just go through your bathroom and stuff it all into a bag. Again, Walmart or Target have bins of sample-sized stuff you can bring with you. All of us men should have our wife or girlfriend put together a bag of feminine products together, since we don't know anything about anything. Heck, I made it through college with a can of Barbasol, some razors, a comb and some deodorant. Ask most women if they could live off of that, and they just might kick you in the face.

On top of the sundries list should also be a first aid kit. You should always have a kit together on your truck, and it should be a recent kit. Bandages get old, people use band-aids and don't tell you when they run out. And hurricanes are dangerous things. Your crew might not be injured, but you could run across an injury at any time. Make sure the kit includes some Bactine or iodine, or you just might have to use some booze from your stash of #9. Use them to disinfect cuts.

During hurricane Bonnie, a photographer and I watched a stop sign skip down the street at about 80 miles an hour. It could have sliced somebody in half. Tree branches come crashing down on things and people. It's a dangerous situation out there and you should probably know how to make a turnicate or splint. If you know nothing about first aid, pick up a book or take a class. The Red Cross is a good source of training, as is the local Ambulance Service. Even an old boy scout or girl scout manual will tell you about first aid.

11. Extra Log Books

You will make mistakes. They will send you this way, and then that way. Once you are into the hurricane area, nobody really cares what your logbook looks like. But once you start heading home, I can guarantee you are going to want to start all over again. Nobody will be able to make hide-nor-hair of your logbook. And if it's all screwed up, they will make you sit there at the "Chicken Coup," or weigh scale for eight hours or more until you are properly rested. But you just want to get home to your wife or kids, or if you're single, you just want to get home to your own bed. Instead, you're sitting at a weigh scale. Of course, if you want to stay legal, now that the hurricane is over, you might as well hang out on the beach for a few more days. Who cares right? It's all good when you're sipping cocktails on the beach. See if you can get one of those gas powered blenders and make some frozen drinks for everyone!

12. Lawn Chairs

Don't forget that when you go to cover hurricanes, you're going to the beach. Some of your time will be spent waiting for the hurricane to get there. You will need lawn chairs for hanging out on the beach. If you're into sandcastles, a little pail & shovel might be a good idea too.

After several days of covering one hurricane, I found a lawn chair was the only place I could go to get a little rest. Everyone else was in the sat truck, and there was no place for me. So I fell asleep. Luckily someone woke me up, because it was raining again, and I could have drowned there with my mouth gaping open to the sky.

13. New pair of shoes

Your shoes will be soaked for several days. On about the third day, a rancid funk will hang in the hotel room if you weren't smart enough to leave your shoes tied to something outside. After this hurricane is over and you start heading home, you will be throwing your shoes away. Have a new pair of shoes (and fresh socks) and you will feel reborn.

If you don't, nobody will want to stand near you. If I had to place the odor, it smells like a goat died… and then barfed on you.

14. Tools

The more tools, the better. And you need more than the standard tools. Chances are that if you really need a certain tool, it will probably be a "star key" so be sure to think outside the box when you're putting your tool kit together. And if you have room for that 4-foot long bolt cutter, dude, go for it. I once had to weld a part of the truck box together. I was able to find a guy with a welding kit and a grinder, and then I luckily had an 8-ton bottle jack that was enough to lift that corner of the truck. It looked like a grade-schooler or a crack addict did the welding, but it held together. Hey, don't make fun of me! I don't weld every day! I'd like to see you do any better!

15. Large coolers, other cooking appliances

Food, food holders and food cookers are limited by how much room you have in your truck, and how many crews are working out of your truck. Chances are you will find places to eat, but if you want to eat well, you'd better hit the grocery store before you go.

Your choice of food is also dependent on how you plan to cook it. Your choices may be a grill of some type, or a Foreman-type grill you can plug into your truck. You might have room for a microwave or even a toaster oven. I would suggest against the latter. I wouldn't want to be the first truck operator in the country to burn down a satellite truck because a five-dollar garage sale toaster went haywire. I can just see it now. It’s the final story in the last segment of the show, and the anchor reads the story, and then turns to the other turtle-neck donning anchors on the desks and says something ever-witty like, “Boy, I wouldn’t want to be THAT guy.”

The nice part about the baby boomer generation is that they over-simplified their life. Most of the food in today’s grocery store is pre-made and/or precooked. You can buy a lot of ready-made meals found in your frozen food isle, and many are much better than the traditional TV dinners.

Many of the brats or hot dogs you can buy have been pre-cooked, so all you have to do is warm them up. Johnsonville, for example, are pre-cooked. They are suitable brats when all you have is a microwave to warm things up. Don’t try to feed one to a Wisconsinite. They will only laugh at you.

It’s not a bad idea to think of some dried foods or powdered drinks, especially if you should end up somewhere for several days. And if you don’t use them up, you can always save them for later. Heck, most have a 50-100 year shelf life. These products, however, can go too far. Even the astronauts get sick of Tang by the third day.

16. **Radios**

Two-way radios are available at electronics shops and sporting goods places. Keep in mind that their RF messes with monitors and other electronics. But they can be a handy item to have. Cabella’s sells a 2-mile and a 7-mile radio, making it very handy if your crew left to go shoot some video. Keeping them charged is another story. Get yourself another set of batteries that can be charged while you’re using the other set.

Cheaper 2-ways can be had for under a $100. Motorola is one popular brand. These are classified in the “family band.”

If you do not go the option of 2-way radios, gather a list of everyone's cell phone numbers and have it laminated at a local Kinko's. That way you can tell the camera person to wake up or get to the live position.

17. **Football, Frisbee, Softball, Gloves, Bat**

Chances are that you will have some downtime. It might not happen, but plan for the event that at least one of your crews will have some downtime, in-between the 5 and 6 p.m. newscast or between shots at the top and bottom half of the hour.

If you have something to throw around, it makes that time go very fast. It also keeps people awake or gets them pumped up for the late shots, especially if they’ve been working 24-hour shifts.

Lightning

Lightning is a pretty well-contested weather phenomenon. And while some engineers will drop the dish (or certainly the ENG mast) at the first sign of a flash, others do not (and choose to leave the truck and sit elsewhere while the storm blows through).

This is another, in a long list of things, that will not get you fired if you chose to do the best thing. No one job is worth baking the truck and killing your entire crew.

Now, that being said, I will tell you that 7 of my years operating satellite trucks were spent in Kansas and the surrounding states. If I had dropped my dish every time I saw lightening, I would have never been up on the air from late February to October.

Don't believe anybody who tells you that the truck is insulated enough, because it is not. Don't let anybody convince you that putting in an 8 foot ground rod or special antennas will save you from a lightning strike. They are trying to sell you something, and that something is a false sense of security.

If you are the only target out on the open prairie, then your chances of getting hit are pretty good.

But if you are one of a thousand other targets, your chances are excellent. Use your best judgement, and don't stow the dish until you have to. If you aren't transmitting, then by all means, stow the dish. Get the truck to a spot where it won't get hit. Use common sense.

Wind Shear and Straight-Line Winds

Wind shear is something that happens but is hard to measure and hard to explain, unless you've been hit by one. In ten years I have only experienced one, in Wichita, Kansas.

- We were parked on one of the main streets downtown, in front of the courthouse, and something hit the truck. It was as if a semi hit us at about 5 to 10 miles per hour. Everybody grabbed on to tables and the wall, and then looked at me. I shut off the amplifiers and jumped out of the truck to find nobody and nothing around us (no car was even within 50 feet). The dish (which was built to withstand 80 mph winds) had been pushed down to where it was now pointing at the top of the truck.

The Andrews dish (AVL and several others use the same design) uses a series of cables to turn the dish left, right, up, and down. When the dish experienced this massive blast of wind, it did what it was supposed to do. It slipped through the cables to keep from bending or damaging the dish.

When this happens, in order to get back on the air, you will likely have to move the dish manually to get back on the air. You will also have to make manual movements to stow the dish. If the dish has slipped far enough, you may have to slip the dish back through the cables. This requires a socket, and you will need to get inside the drum of the antenna where the cables wrap around.

Loosen the nuts, but do not take them off completely. If you do, you will lose them from the inside of the drum and will have to feed them back through.

You will also need help with moving the dish or holding the dish up in place while you loosen or tighten the cables.

While taking it apart, and putting it back together, you need to consider cleaning up the aluminum and aluminum cables with an aluminum or chrome cleaner, available at any truck stop. This should slow or clean up the corrosion built up over a period of time. You may find, if the antenna is old enough, that you may need to replace the aluminum cables.

Straight-line winds can be just as dangerous, but are a little more predictable (can be picked up on radar, versus the rare “airport” warning that doesn't always make the news or local weather report). If you need to transmit in these conditions, consider finding an alleyway, or place where a building can help to protect the antenna from rocking in the wind or shaking off the satellite. You might also consider strapping the antenna, or truck itself to something solid (heavy sewer grates, park benches, concrete columns) with ratchet straps available at any hardware store.

Chapter 5
Vehicle Safety, Maintenance and D.O.T. Regulations

Driving the Truck or Van

Vans and trucks with satellite antennas and racks full of equipment are very heavy for their size. Axles are often within one hundred pounds short of their legal limit (where they were built for these weights for short periods and not every day).

All of these vans and trucks have a high center of gravity. Diesel burns hot, gasoline is explosive, and you will be driving with often 40 to 150 gallons of one of these fuels inside.

The vehicles, by their nature, are poor around curves. They don't stop without plenty of distance, and they are in general a very dangerous object in an accident. As a one-piece vehicle, they are essentially a 10-Thousand to 48-Thousand pound projectile.

An April 16, 2008 Crash involving WCSH. The 24-year old in the Toyota died after surgery.

This go without saying, but the truck is not a sports car. Don't drive dumb. If you're tired, pull over. If you've had one alcoholic drink, that is enough to lose your CDL in most states. Do what pilots do, and let 12 to 24 hours pass between the bottle and the throttle.

Two photographers were also fired in 2008 for “drag racing” their live trucks. After the video appeared on youtube.com their stations gave them the axe.

In inclement weather, get there alive, and don't drive recklessly and cause an accident for somebody else. No job is that important no matter what your producer or assignment editor or boss tells you.

Hours of Service, Driving

The following rules of service apply to any truck over 10-Thousand pounds (over 5 tons). To drive a vehicle over this weight (combined weight, if you are hauling a trailer), then you must carry a logbook *and* have a DOT medical card proving you are well-rested (logbook) and medically fit enough to drive (DOT medical card).

The rules about how many hours you can work and still drive have changed, and became effective on January 4, 2004.

The brochure outlining the new hours of service rule may be downloaded from the FMCSA web site at:

PDF: http://www.fmcsa.dot.gov/Home_Files/hos/brochure.pdf
Web: http://www.fmcsa.dot.gov/Home_Files/hos/brochure.htm

You can also find updated trucking regulations at: http://www.jjkeller.com

The former rule: We may drive 10 hours per day. We may work and drive a combination of 15 hours so long as no more then 10 of those hours is driving. The 15 hour clock stops when you are off duty. That means you can do a morning show beginning at 4:00 am. and be back home in bed by 9:00 am. and still ten hours left on your 15 hour clock once you go on duty again. The 15 hour clock is reset when you've been off duty 8 hours or more.

The new rule: The day is reduced to 14 hours with no more then 11 hours driving. That gives us one more hour to drive, but one less hour to work. Here's the kicker. Unless you have a sleeper, the 14 hour clock doesn't stop. If you begin your day at 4:00 am. for a morning show you will be illegal to drive after 6:00 pm. no matter what you've done with the rest of your day. You can no longer stop the on duty clock if you are off duty. The only way to reset the 14 hour clock is to be off duty for 10 consecutive hours. The Exception to this rule is if your truck has a sleeper as described in 49 CFR 393.76. These regulations can be found at: http://www.fmcsa.dot.gov/rulesregs/fmcsr/r...egs/393.76.htm#

A KTTV news van crashed Feb. 22 in L.A.

Under the new rule, you may take 34 hours off, note it in your logbook, and you will immediately reset your logbook hours back to zero at the start of that day. It's hard to plan for this, although getting a truck serviced while on the road can usually make up for these 34-hours off. Be sure you mark in your logbook the actual time you had your 34-hours off.

Look Up and Live!

If there's one thing you simply can never forget, it is this statement: **LOOK UP AND LIVE!** For quite a few years, Mark Bell has taught a course on ENG and SNG safety, about training engineers to never be in a hurry, and to always look up before raising a microwave mast or a satellite dish. His ongoing effort includes his course, along with a website engsafety.com and a lot of online writing and time dedicated to teaching ENG safety.

No live shot is ever worth your life or the life of others. Look up, look down (don't park on hollow sidewalks or out on lake ice). And when reporters, producers and camera people are about to put you in a dangerous situation, grow a pair of balls and stand up for yourself and your crew. Like I said before, and I'll say again. You are the Engineer in Charge.

Just like there have been very rare cases of people killed from high doses of RF, there have been rare cases of people killed by putting their dish or ENG mast into high power lines.

From Mark Bell's efforts:

- On Feb. 22, 1994, Lloyd Alfred "Al" Battle, on assignment for CNN in Alexandria, Va., was killed after he raised the mast of his ENG van into a 19,900 volt power line. Reports stated he was in a rush to get a signal back to the network because he had been kicked out of a parking lot where he planned to transmit. The time to set up the needed signal was running short.

- Reports also indicated that producers and assignment desk people at the network's signal-receive location were anxious to get the shot, creating or elevating an existing tension level.

- Because of the tragedy, the live shot never happened. In a site report, an emergency medical technician (EMT) stated that Battle "had no pulse, was not breathing, and his feet were off."

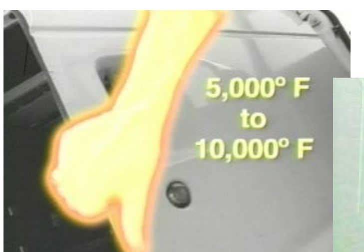
- Al was not the first ENG technician injured or killed performing his or her duty. What was unusual was that Battle was an experienced industry veteran of 20 years of experience. What also was unusual was that his death was demonstrated in a way which had not been demonstrated previously -- it was videotaped.

- The tape shows Al's van parked on the same side of the road where the power company had run its overhead high voltage power lines. As on so many streets in so many communities, the road had a crown, meaning that the center of the road was higher than the sides to facilitate water drainage. The crown tilted the truck enough so that the mast actually angled closer to the wires as it raised.

- Al was setting up in clear, daylight conditions. In looking at the tape, it is hard to explain how anybody could purposely put an aluminum mast somewhere between 30 and 60 feet into the obvious overhead high voltage power lines. The footage of the explosion had wild sound of the electrical arcing and one observer saying, "Is Al still in there? God damn.” The scene was captured in a way from which we stand obligated to learn.

- As of April, 1998, there has never been an accident involving a person with documented education of laws regarding the use of elevated structures near power lines. Federal law requires that employees who are operating equipment with capability to reach overhead high voltage lines need to be familiar with such laws (Code of Federal Regulations (CFR) 29 1910.268). The law also requires that training needs to be documented. In virtually all of the accidents involving power lines, citations mention violation of CFR29 -1910.268. In this author's definition, an event cannot be deemed an accident if untrained people are operating equipment inasmuch as injuries are contingencies of untrained operators. Accidents are unexpected events.

- Al Battle's death was not the first. A truck operator in Bakersfield, Calif., was killed in the mid 1980s. To this day, his story remains untold, except to a few. Cara Crosby, a technician for an East Coast station, was injured severely in the same period of time, as was Don Hayford, who lost both legs in an overhead high voltage line incident. Hayford has graced the effort for ENG safety by telling his story for publication. He reached into the vehicle to try to rectify the fact that the mast of his truck was in contact with power lines. "Running away is not the first thing I thought about," Hayford recalled later. "You get in trouble for screwing up your truck." It was his last voluntary move Don made on the legs he was born with.





- Don was lucky. He lived. Another person involved in a similar circumstance did not. Andrew Austin died in Greenville, Miss., after the mast on his truck contacted power lines. Andrew was the second employee at his station to lose his life in an electrical accident within a three-month period. Can you imagine a station that lost two employees to electrical accidents and the only thought process which the second one was aware of was that he didn't do the same electrical work the first one did so he wasn't in danger? At least that's what Andrew Austin told his mother when she expressed concern about Andrew's exposure to electrical dangers at his workplace.

One more thing from Mark Bell:

- (The People of) the industry, namely employers AND employees, have an obligation to transmit easily learned information and prevent senseless tragedies.

In other words, do what you can to record the mistakes that were made, and help everybody learn from the mistakes made in this universal safety effort. This can be done simply by becoming a part of sngforum.com and sharing your experiences with other fellow engineers.

Electrical Shock and its Biological Effects

The effects of electric current on the human body depend upon a variety of circumstances including current, resistance, frequency, and voltage (60 Hz happens to be the worst frequency), pathway, duration of the contact and environmental conditions affecting body's resistance.

According to the Department of Energy's Occupational Safety and Health Agency, the most damaging route of electricity is through the chest cavity or brain. Ventricular fibrillation of the heart (stopping of rhythmic pumping action) can be initiated by a current flow of 75 milliamps or greater for 5 seconds or more through the chest cavity of a 150 pound (68.2 kg) person.

Nearly instantaneous fatalities can result from either direct paralysis of the respiratory system, failure of rhythmic pumping action, or immediate heart stoppage. Even if the current does not pass through the vital organs or nerve center, severe injuries, such as deep internal burns, can still occur. Burns suffered in electrical accidents can be of three basic types: Electrical burns, arc burns, and thermal contact burns. In electrical burns, tissue damage (whether skin deep or deeper) is caused by the heat from the current flow. The body is unable to dissipate this heat.

Typically, electrical burns are slow to heal. Arc burns, caused by electric arcs, are heat burns similar to burns from high-temperature sources. The temperatures generated by electric arcs can melt material nearby, vaporize metal in close vicinity, and burn flesh and ignite clothing at distances up to 10 feet (3 meters). Lastly, thermal contact burns are those normally experienced from the skin's contact with hot surfaces of overheated electric conductors. Electric shock currents, even at 3 to 10 milliamps, can also cause injuries of an indirect or secondary nature through involuntary muscle reactions. In this case, the involuntary muscle reaction to the electric shock can cause bruises, bone fractures, and even death resulting from collisions or falls.

Delayed Effects

Damage to the internal tissues may not be immediately apparent after contact with the current. Internal tissue swelling and irritation are also possible. Prompt medical attention can help minimize these effects and avoid possible death. An electrical injury, more often than not, is forever.

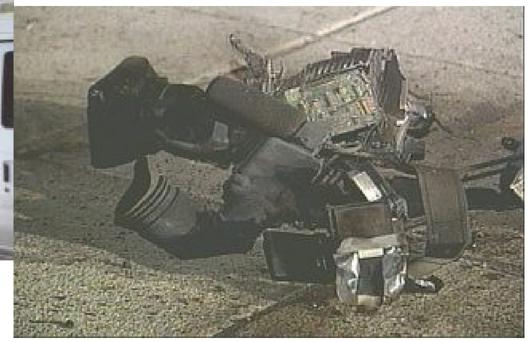
David eventually returned to work at WOI in a somewhat restricted condition, typical of burn victims. Kimberly, far more seriously injured, never returned and moved away from the area. Both are facing years of rehabilitation.

WOI-TV was cited by IOSHA for these violations:

1. No certification of training maintained. Serious Violation. $1,375.
2. 2. Safety related work practices were not employed to prevent electrical shock or other injuries resulting from either direct or indirect electrical contacts, when work was performed near or on equipment or circuits which were or could be energized. Serious Violation. $1,375.
3. 3. Vehicles or mechanical equipment capable of having parts of its structure elevated near energized overhead lines were not operated so that a clearance of 10 feet (305 cm) was maintained. Serious Violation. $1,375.

Total fines = $4,125

WOI's attorney persuaded IOSHA to reduce the those fines to $1,000.



One award was for injuries to a man whose accident took him out of work for almost a year and left him with scarring on his hand and foot, with possible full or fractional loss of the use of his foot. The award was approximately $200,000, most likely made up of settlements from a variety of manufacturers. His accident occurred in the first week of work at his station and he had no previous ENG experience. He AND the person teaching him were not properly trained, nor had they ever had access to training literature provided by the manufacturer. Vehicle staff assignments and training were handled by the news department, independent of the engineering department, until after the accident.

In product liability suits, joint-and-several liability laws apply. This means that everyone who may have any connection to the incident would be named in a suit. As time goes on, many may be removed for one reason or another, leaving those who cannot disassociate from liability. On a mast, for example, there would be a few companies involved, such as the manufacturers of the van, mast, pan and tilt head, microwave antenna, mounting bracket, and other accessory manufacturers.

When asked about safety, one veteran chief photographer might have said it best when he that safety is an issue to management when employees make it an issue. Consistent with that point of view, it is up to every person in any professional environment to understand the dangers of their environment and then work with their management to create a knowledge base for information which will protect the employee, AND the station, broadcast group, or corporation.

Stephen Myers, the young man who put out the fires on David's and Kimberly's bodies? Professional electric industry observers who have analyzed that incident can only attribute the fact that he was not electrocuted from the actions he took to luck. The actions of would-be rescuers like Kimberly and Stephen who approach bodies of the electric-shock-injured people frequently have led to more injuries. Had Stephen been injured or killed without the protection of employer-employee relationship laws which prevent employees from suing their employers, such as workers' compensation laws, the liability of the station and subsequent lawsuit would have been potentially huge for the station and its parent corporation. Really huge.

One electrical accident on record in Brazil killed 29 people and injured more than 50 when a utility pole fell and its power line hit rain-soaked ground. It was reported that there were "rings" of voltage being conducted in the area that measured up to 450 feet from the point of contact. People 90 feet away from the grounding site, touching a metal fence, were part of the number of those electrocuted.

There is no doubt that training, beginning with familiarity with the principles of electricity in compliance with federal regulations, and following through to specifics of operation of EVERY station or network's remote vehicles, is paramount to diminishing the possibility of accidents. It is an issue which every employee should make the highest priority because it has one of the highest penalties.

There is no easy financial pot of gold at the end of the injured-on-the-job rainbow. As more and more cases are settled in and out of the courts, it is ever more apparent, as stated earlier, that the person with the last clear chance to safety is you.

Periodic Maintenance

The truck and the onboard generator are connected to the truck in a complex, trouble-ridden system. There are high and low current DC and AC outputs everywhere. There are shore and battery jumping terminals for DC and AC inputs.

Under the truck and inside the engine compartment there are fuel lines, air lines, and even hydraulic lines. Inspect these lines often. Watch carefully for fluid leaks on the ground whenever you park.

Get to know the inner workings of diesel (or gasoline) motors, how to fix them, and where to find parts. Many of the repairs you will not be able to fix yourself, but knowing how to diagnose the problem will aide in a faster repair if a mechanic knows where to start.

You will find most times when you have a breakdown, it is on Labor Day weekend, or Memorial Day weekend, or someday when a mechanic can't be found. On more than one occasion, I have been able to fix a problem well enough to get myself to the uplink or at least the next town. And on at least two occasions, I have been towed to the site of a scheduled uplink. Always have a plan "b."

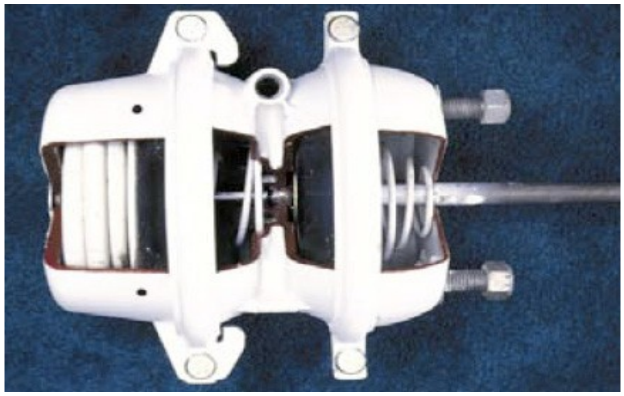
Air Brakes

Whether or not you operate a satellite truck with air brakes at this time, you need to understand how they work, should the time come for you to move a truck with air brakes. It is highly suggested that you work on getting a CDL (Commercial Driver's License) with an air brake endorsement. If you do not, you will likely never drive a large satellite truck. Some companies, networks, and television affiliates who own satellite trucks will not allow non-CDL drivers to drive their satellite trucks even when the trucks are under 26,000 lbs.

Air brakes use compressed air to make the brakes function. So the first thing you need to know with each truck is where each of these parts of the air brake system are located. You need to be able to find the air compressor, the air hoses, the valves directing the flow and control of the compressed air, and the air storage tanks (a primary and a backup, often called left and right or front and back tanks) on each truck you drive. If you can't find these things, you won't even pass your CDL test!

If your air brake system is not working properly, your life, and everyone else in your path is in danger. Do not misunderstand what the system is doing, or how to care for air brakes.

Air brakes use the stored, compressed air and deliver it on-demand to the brake chambers located at each wheel. The brake chamber then converts air pressure into mechanical movement.



Cutaway view of a common brake chamber

By pressing the brake pedal in the truck, air pressure is increased in the system and is essentially sent to the brake chamber. The increase in pressure displaces a rubber diaphragm, which extends a steel push rod. The push rod rolls and rotates a perpendicular rod, which ultimately activates the brakes. The brakes use friction to slow and eventually stop the wheels.

If you drive a larger truck that uses air brakes on the trailer, there are two airlines, due to a federal safety standard that requires all trailers must have a backup system. The blue line (called the service or control line) is used to send a pressure signal to the trailer brakes. The red line (also called the supply or emergency line) allows compressed air produced straight from the compressor on the engine to fill the trailer's air reservoir tanks. In addition, the compressed air from the red hose is used to keep the spring brakes from activating.

The spring brake is a simple, large spring incorporated into the brake chamber. In an emergency, if the air pressure in the brake lines drops below about 35 psi (pounds per square inch), the tractor protection valve is activated which closes off the air supply to the trailer. The lack of air pressure activates the spring brakes on the trailer, or in the back wheels of the truck, and stops the vehicle.

Straight trucks, tractors, and trailers with air brakes must have at least one axle equipped with spring brakes. On a tractor, it must be a non-steer axle.

- If you are driving a trailer with air brakes, and the blue (service) line gets disconnected, there will be no indication there is a problem until you step on the brake pedal. When you do, you should realize you are losing a large amount of air each time you press on the foot brake. Use the brakes sparingly, and bring the tractor and trailer to a controlled stop.

There is a slack adjuster at the end of the push rod coming from the brake chamber. It is simply a way of adjusting the slack between the brake shoes and the brake drum. And it is necessary to check the slack on the brakes as a part of your pre-trip inspection, every day (or at the start of every trip), according to the Federal Motor Carrier Safety Regulations. You must note this pre-trip inspection in your logbook.

- There are self-adjusting and manual slack adjusters. But don't let your guard down if you have automatic slack adjusters! EVERY SLACK ADJUSTER MUST BE INSPECTED AS PART OF THE PRE-TRIP. Any officer whose jurisdiction includes motor vehicles can shut down your truck if your brakes are not properly adjusted. And an automatic, self-adjusting brake system might stick!

Brake lag is another concern when driving a large truck with air brakes. Brake lag is the time it takes for air to pass through a brake system before brakes actually engage. Know and test each truck you drive, and get to know its stopping capabilities and stopping distances.

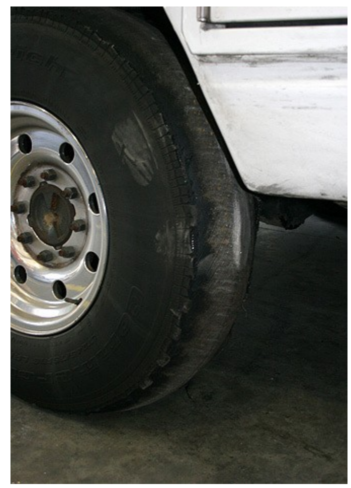
Whether you drive an air brake vehicle or a hydraulic brake vehicle (or air-assisted brakes), be sure you never depend completely on the word of mechanics who work on your vehicle. Test the brake systems thoroughly before you leave the area after any work is done on your vehicle's brakes.

In addition, if you have an air brake system and are experiencing “soft” brakes, a regurgitating or “cycling” of the air valve, or anything else out of the ordinary (such as a brake that appears to “stick” open or closed), be sure to have the mechanic replace the brake chamber. They may tell you that the brake chamber is fine, or that it “passed their test” but they are likely wrong. Simply put, the brake chamber is at the lowest point in the brake system. It collects a lot of water in the system, and it collects dust, grime, rust, and whatever else the compressor, filter, and air dryer miss.

Tire Ratings

One of the biggest problems discovered in the past few years has been related to tire ratings. More specifically, cargo vans and “sprinter” vans have been replacing the larger vans, and more and more equipment is being installed inside these vans bringing their weight up.

There have always been accidents, but not until a Chicago affiliate van blew a tire, crossed the center line, and killed a couple did anyone investigate what was wrong.



Recent pictures of a van accident caused by tires not rated for the weight they carried.

The tires on the van were rated for 8-Thousand pounds. However, the van weighed in at over 10-Thousand pounds. And that weight was after it was towed in, dry. At the time of the accident, there was an engineer, a camera person, and a reporter, and all of their gear. The weight on the tires is estimated at over 10,700 pounds.

In larger satellite trucks, most use a “G-Rated” tire. And even if the truck is under 26-Thousand pounds, it is highly suggested to use “G-Rated” tires and not “F-Rated” tires. The Gs are more expensive, but they tend to last much longer and are very unlikely to have a blowout, since they are rated for 33,000 lb vehicles.

As trucker's logs demand, you need to account for a 15-minute inspection. And you need to actually do that inspection, even if your truck is under the 10-Thousand pound weight limit. Walk around the truck, put on some gloves (you should have gloves to pump diesel or all your food will taste like diesel), and run your hands down all the tires. Do this before every trip. Do this during every fuel up. You will tend to catch tire wear more easily, and you will catch punctures or other foreign objects in the tire.

When you are responsible for a purchase, do some background research, and talk to truckers and other drivers who spend a lot of time driving.

Whatever you do, do not ever put a retread on a satellite truck. Retreads belong on farm trucks and cheap trailers, not on a million dollar piece of equipment (or even a fraction thereof).

First Reported Accident in 2004 involving improper rated tires

Telemundo news van involved in fatal crash *- Associated Press - September 21, 2004 (Dwight,IL) — Illinois State Police are investigating a crash in Interstate 55 near Dwight that left two people dead and four injured.*

The accident involved a news van from Telemundo -- a Spanish-language TV station in Chicago.

Station spokeswoman Toni Falvo says the news crew was en route to Springfield to cover a fatal shooting at the state Capitol when the crash happened yesterday.

State police say the van went out of control, crossed the median and struck two cars.

Livingston County Coroner Michael Burke says the accident killed Wendy and Terry Allie of Oak Lawn. Falvo says two Telemundo employees were treated at Morris Hospital and a third remains hospitalized in Peoria with a broken leg.

A Morris Hospital spokeswoman says the driver of the second car, Mohammad Ali of Villa Park, remains in fair condition.

When the van was towed in, it was later reported that the van weighed in at nearly 12,000 lbs. This was after a photographer, reporter, and a producer were all removed from the van with their gear. While the van's manufacturer claimed the truck rolled off the line at under 10,000 lbs, it was later found that this didn't matter. For the tires on the van were only rated for 8,000 lbs.

Tire Blowout systems

Started in 1979, the Tyron company came up with a tire blowout solution for the military where soldiers in the line of fire could still drive away from a dangerous place with flat tires.

An internet search for Tyron will get you the best results, but www.tyron.com or www.runflat.com will get you to the company's worldwide and U.S. websites.

What the Tyron system does is uses a ring around the wheel hub that essentially is a spring that fills the space (and then some) taken up by the tire's hub, allowing a gap of air between the wheel hub and the road. This allows you to get over to the side of the road should you have a blowout. It also allows you to drive on many blown tires until you get to a safe place to stop, or when the tire comes completely off the hub, whichever comes first.

Should you blow a tire, especially a steer tire, your steering, braking, and traction can be lost. Flapping tires in the front or back can cause serious damage to the vehicle's brakes, suspension and the $5-10,000 paint job on your satellite van or truck.

If you should experience a blowout in a dually, pull over and check to see that the blown tire is not causing rubbing or any other damage to brakes, suspension or the paint job or body work. Then, continue on, but get to a tire repair place as soon as possible. This always tended to happen to me on Memorial Day weekend or Labor Day weekend. I was usually able to find help at 24-hour truck stops, such as TA. Just cross your fingers that they have your tire size in stock!

The difference between #1 and #2 Diesel and "Off-Road diesel"

Do not confuse these three, especially Off-Road diesel. You do not ever want to be caught with Off-Road diesel in your tanks. Off-Road diesel is for farm machinery or construction equipment only and does not come taxed. D.O.T. Officers can "dip" your tanks to find even a trace of this diesel because it has in it a heavy red die. Heating Oil used in homes can also be used to run a diesel engine. But again, it has a dye that will show up in your fuel system. It is illegal to run red-dyed diesel in any engine that drives down a road.

#2 Diesel is common diesel, originally a by-product of gasoline. You can use #2 from about 40 degrees and up. When it gets colder, you need to think about using an anti-gelling agent available at truck stops, or using "straight diesel" or #1 diesel, which should not gel even in extremely cold situations.

You need to understand gelling in this way: #2 Diesel has parafins (wax) in it. This wax helps to lubricate the cylinders of the diesel engine and adds to the heat and combustion produced inside the cylinder, so refineries don't bother to filter it out. When temperatures reach arctic levels, these parafins solidify inside your tank and your fuel lines, slowing and eventually stopping the flow of fuel by hardening up to what one would compare to a hard candle in your fuel lines.

Diesel additives like the Howes brand or "Diesel 911" help to keep the parafins from solidifying and running freely through the fuel lines. You may also use #1 Diesel which has these parafins filtered out or removed.

The only other way to get a diesel engine started after it has fully gelled is to either move it into a warm building for a while, or to call a tow company that can use special tools to blow hot air into your fuel tanks and/or warm your fuel lines. If your diesel gels, it only needs to be warmed. It has not gone bad. In fact, diesel can get water or other impurities in it, which can be filtered out, but it will not go bad.

A quick solution can be to remove your fuel filter, and fill it with diesel treatment or #1 diesel.

Block Heaters, Tank Heaters, and Coolant Heaters

This comes as a strange idea to southerners, to plug in your car or truck. But luckily, most satellite truck companies have installed engine heaters for the vehicle and the generator. Block heaters typically are magnates that stick to the metal block, or are physically bolted onto the engine block and provide direct heat to the metal of the engine.

Tank heaters heat the fuel, as I mentioned in the previous section.

And coolant heaters, often mistakenly called block heaters, use a pump to heat the engine coolant and keep it flowing through the "coolant or anti-freeze" sections of the engine. So, rather than cooling off the engine, it is used in reverse to keep it warm in frigid temperatures.

There isn't much more than that you will need to know about heaters. Except that you can turn them off when you go to start the engine. The engine will have enough heat to keep the engine warm at this point.

Diesel engines also tend to pump fuel at a constant rate, and send unspent fuel back to the fuel tank. So not only will a diesel engine warm itself when it is running, it will warm the fuel tank, too.

Carbon Monoxide and Carbon Dioxide Poisoning

Diesel and Gasoline motors (this includes generators!) give off large amounts of Carbon Monoxide, Dioxide, Ash, Paraffins, Sulfur oxides, sulfates, and other impurities.

Carbon monoxide poisoning occurs after the inhalation of carbon monoxide gas. It is colorless, odorless, tasteless, and non-irritating, making it difficult for people to detect.

Carbon monoxide is a significantly toxic gas with poisoning being the most common type of fatal poisoning in many countries. Symptoms of mild poisoning include headaches, vertigo, and flu-like effects; larger exposures can lead to significant toxicity of the central nervous system and heart.

Following poisoning, long-term sequelae often occur (pathological conditions stemming from a traumatic or long-exposure event). Carbon monoxide can also have severe effects on the fetus of a pregnant woman.

The mechanisms by which carbon monoxide produces toxic effects are not yet fully understood, but it is believed that hemoglobin, myoglobin, and mitochondrial cytochrome oxidase are compromised.

The effects of carbon monoxide in parts per million are listed below:

- 35 ppm (0.0035%) Headache and dizziness within six to eight hours of constant exposure
- 100 ppm (0.01%) Slight headache in two to three hours
- 200 ppm (0.02%) Slight headache within two to three hours
- 400 ppm (0.04%) Frontal headache within one to two hours
- 800 ppm (0.08%) Dizziness, nausea, and convulsions within 45 minutes. Insensible within two hours.
- 1,600 ppm (0.16%) Headache, dizziness, and nausea within 20 minutes. Death in less than two hours.
- 3,200 ppm (0.32%) Headache, dizziness and nausea in five to ten minutes. Death within 30 minutes.
- 6,400 ppm (0.64%) Headache and dizziness in one to two minutes. Death in less than 20 minutes.
- 12,800 ppm (1.28%) Unconsciousness after 2-3 breaths (theoretical). Death in less than three minutes.

Carbon dioxide content in fresh air varies between 0.03% (300 ppm) and 0.06% (600 ppm), depending on the location. A person's exhaled breath is approximately 4.5% carbon dioxide by volume.

It is dangerous when inhaled in high concentrations (greater than 5% by volume, or 50,000 ppm). The current threshold limit value (TLV) or maximum level that is considered safe for healthy adults for an eight-hour work day is 0.5% (5,000 ppm). It's never a bad idea to keep a door open, if you can. Besides, fresh air helps to keep you awake!

Know how to identify carbon monoxide poisoning, and make sure carbon monoxide detectors (yes, plural, you should have two!) are inside the truck and are working.

Should you or somebody on your crew be exposed to large amounts of Carbon monoxide, or the many other things I have mentioned above, get that person away from the exposure to an area with clean air. If the situation is deemed more serious, call 911 or get them to a hospital or place where they can breathe 100% oxygen for a while.

Trip Permits for Interstate and International Travel

If your vehicle is over 10,000 pounds (8,000 in some states) you may have to stop at state weigh scales or register your trip with the state. You must have a medical card, where a doctor will give you a D.O.T. (Department of Transportation) physical. You can get this form at the following website:

www.fmcsa.dot.gov/documents/safetyprograms/Medical-Report.pdf

If your truck is over 26,000 lbs., in addition to a medical card, you also need to have a Class B CDL (Commercial Drivers License). It would be wise to get this endorsement with airbrakes (in many states it is not possible to get a Class B without airbrakes anymore).

The Class B is good up to any weight, as long as the vehicle is one unit and no axle weighs at or over 20,000 lbs. You may only pull a trailer less than 10,000 lbs.

A Class A license allows a driver to drive any combination, including trailers over 10,000 lb s.

For every license class, you are allowed up to 15 passengers (including the driver). And you may not drive anything containing hazardous materials without an endorsement for that material. Here are some of the endorsements available:

- T - Double/Triple Trailers (Knowledge test only)
- P - Passenger (Knowledge and Skills Tests)

- N - Tank Vehicle (Knowledge Test only)
- H - Hazardous Materials (Knowledge Test only)
- X - Combination of Tank Vehicle and Hazardous Materials

In addition to your license, the truck also requires licensing. There is a license for the vehicle, but there is also a sort of licensing for fuel purchases and interstate driving. Some states will charge you for fuel permits if your truck weighs more than 26,000 lbs. And most of them will "wave you through" if you become a part of IFTA (International Fuel Tax Agreement) and place their stickers on your vehicle.

If your vehicle is over 26,000 lbs., it is *required* that you pay the fuel tax for each state where you work and drive. IFTA simplifies how you report your fuel use by giving you IFTA stickers if you regularly file a quarterly fuel tax report. Your license plates, for most states, will also often say your truck is "Apportioned." The report is filled out by the driver and the dispatcher or office showing the exact amount of miles driven in each state, the roads used, and all of the fuel purchased in each state. You may start with a few states, and at any moment call your state office to add any, or all of the continental 48 states in the United States, as well as 10 Canadian Provinces. The report is used to redistribute fuel taxes from collecting states to states where that tax is due (...say, if you bought fuel one mile after you left Iowa, not purchasing any fuel after doing most of your driving there).

Additional Permits

You may find yourself in a state requiring you pay what I'd like to call a "nuisance tax." Kansas is one of them. They require you buy a $15 (cash) permit to drive through their state. They have no good reason for this permit, and they charge you even if you live in the state or the truck is based in the state.

South Dakota is another state that will hit you with a permit, but they only charge you if you are staying, stopping to work, or turning around in their state. If you can show you are or were driving through, it is likely they will not charge you for the permit. It is usually $15, cash. Colorado will sometimes (usually) hit you with a $50 permit fee. This usually goes away with IFTA stickers and proper ID stickers on your vehicle. Arizona charges a $55 permit, but only until 7 pm. If you enter after that time, they are closed for the day. New Mexico usually charges $14.

In some western states, you may have to pay a permit fee if your vehicle combined weight is over 15,000 lbs. Oregon requires a PUCO card. And I have been told that Colorado, New Mexico and Arizona will get into your wallet if you're over 10,000 and you're not apportioned for their state.

Many eastern states have changed from weigh scales and port of entry (POE) pull-offs and gone with Toll Roads and Turnpikes. In these cases, you may end up paying more per axle, if you drive something with more than 3 axles. However, you won't have to show your logbook, you won't have to stop except to pay the toll, and you may find yourself driving nicer roads. Toll roads are often maintained better than state-owned, tax-payer roads.

CHAPTER 6
Shore Power and Generators

Shore Power

From an obvious boating term, in our industry shore power for an uplink is actually defined as any power taken from a power company.

However, you will find in the uplink world, many engineers are calling shore power any power that is not onboard or part of the satellite truck. So a portable generator, to many truck operators, counts as getting shore power and is often labeled this way.

In either case, this is the part of the book where I tell you that I can't include every part of the electrical code (the book is thicker than a dictionary), but this is a chance for you to become informed. Again, don't let this book be the last thing you read about electricity, how it works, and how to stay safe when using it. A simple search for "NEC code book" will get you many sources. Many books on the subject are available at any library or bookstore.

Hooking your truck or van up to Shore Power

Most trucks and vans have in them an independent transformer and a step-down converter. The transformer or step-down converter is typically switchable, allowing you to take electricity in at 200, 210, 220, 230 or 240 volts. Whatever the output voltage of the electricity of the building is, you will need to choose a setting that is *higher* than that with your electrical input switch. If you don't select a higher voltage, it is likely that the main breaker in your system will heat up and trip, cutting the power to everything.

You will hook up two hots and a ground (normally the hots are red, blue, or black... neutral is white, and ground is green).

Once you set this up and plug everything in, you can then flip the main breaker to the truck. Most trucks have a GEN/EXT switch that allows you to choose between the generator or external (shore) power. Make this switch *before* you flip the main breaker (or any breaker) on for the truck. The GEN/EXT switch was not made to make a "hot switch" and you will likely weld the internal parts together!

At this point, before you turn anything on, you need to get a reading of the voltage going through the truck. You can check the voltage on the main breaker panel, or you can check the voltage by testing one of the regular wall plugs (110-120 volt common household plugs).

If your reading in either place is lower than 110 volts, or higher than 120 volts, then you have chosen the wrong setting on your 200-240 volt switch. Shut it all down and start over again.

- Whatever you do, do not switch this selector, or make the switch between the Generator and the External (shore) power when power is hot. It will be fine for about a dozen switches, but at some point this will cause these switches to fail. They are not made to do this! Only the main breakers are designed to do this. It is *always* best to make the voltage input switch, then turn on the main breaker, then turn on each of the smaller breakers, in that order. Shut everything off in the opposite order.

AMPS X VOLTS = WATTS

This is the most important equation you will need. Whether you are working with a lighting crew, or are trying to figure out where a video hum is coming from, you need to understand the basics of electricity. And they lie in this equation.

If you are plugging in a "1-K" light into a common wall outlet that is putting out 110 volts, then you have 1,000 Watts/110 Volts, then you are pulling about 9.1 amps. If you are using an extension cord that is rated for 15 amps, then that means you can add up to 5.9 more amps.

If you are pulling 51 amps with your truck, and the building voltage is reading 208 volts, then your truck is using 10,608 Watts or about 10.6 Kilowatts.

One thing you need to be aware of is that voltage from Shore power, and sometimes generators, can drift up or down depending on the amount of amps being pulled from all of the sources.

If you are the first one to plug into a power source and the voltage is reading 218, and then a few large production trucks (semi-trucks) plug in, you could see the voltage drop down to 208. If the voltage drop is large enough to set off alarms in your equipment, you need to think strongly about shutting down, switching to a lower voltage setting, and powering up again.

Often, when this happens to truck operators, they focus on the alarms and not what is actually going on. Always be aware of everything going around you, even if it's not in your truck.

This is often called a "brown out." They have them in California and places with large populations that have trouble meeting their energy needs. Conversely, if large trucks like this were to shut off all their power at once, you could have over voltage alarms on your equipment.

There is a small book called "Ugly's Electrical Reference" that will give you many of the equations used by electricians. Books like this also give you Underwriters Laboratories power levels allowed on different gages of cable.

Floating the Ground

One difference between the big book of electrical code and what I will tell you is that sometimes you will be forced to "float the ground." You do this by unplugging the ground or lifting the ground with a ground lifter, or by finding another way to separate the ground from the building or non-truck ground source.

Every electrician agrees this is a bad, bad idea. But every engineer shrugs his shoulders and says sometime it must be done. You are the latter. But you never forget the electrician. Be safe if you have to float the ground on any piece of equipment.

Generators

I called up one of the old engineers who had been building satellite trucks since the first Ku SNG satellite truck. I knew he was a straight shooter. I knew I could get a truthful answer from him. And I asked him why they used Kohler generators in so many satellite trucks.

Of all the answers, I expected to hear, "Yeah, they have their troubles, but they really are the best generator available." Instead, I heard old Darryl say, "Well, we picked them because they fit."

With that, I discovered that I would have to learn everything I could about Kohler generators. They, along with many other generators break down. They overheat. They don't like to work in high altitudes. Sometimes the fuel pump doesn't work to pull fuel so it must be reattached near the fuel tank in order for it to push fuel from the tank.

A word about biodiesel

I will sing a lot of high praises for biodiesel. But you should be aware of a few things. First, there is not a lot of study on biodiesel gelling. It works great in weather over 40 degrees, but since there is no one mix, no one ingredient, you may risk freezing up, or "gelling" in the winter. This problem is not easily remedied.

There is good news about biodiesel emissions. C02, or carbon monoxide emissions using biodiesel are substantially reduced, on the order of 50% compared to most petrodiesel fuels. The exhaust emissions of particulate matter from biodiesel have been found to be 30 percent lower than overall particulate matter emissions from petrodiesel. The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are up to 93 percent lower for biodiesel than diesel fuel. Biodiesel emissions of nitrogen oxides can sometimes increase slightly, but at this point it is believed that biodiesel makers will be able to control these nitrogen oxide emissions.

If you should figure out a way to make your own biodiesel, then I would personally like to shake your hand, and say, "way to go!" However, if the government (tax man) figures out you haven't been paying taxes on each gallon, then I don't know you.

One last word of warning on biodiesel: It often foams up much more than petrolium-based diesel.

- Robert Borchard-Young told me once about when he was working at an earth day concert in Australia. The event was packed with bands, and they were going live across the country and around the world.

- Since the event was promoting "everything green," event coordinators decided to bring in large generators and run them off of biodiesel. The person who filled them up didn't know that biodiesel foams so much, and since the tank was so large, what appeared to her as full was actually about ¾ or less of a tank.

- As Crowded House (my favorite band, and quite possibly Australia's most famous band) took the stage, the lights, the production trailer, and the uplink all went dark. The generators were out of fuel.

- Tim and Neil Finn gracefully cracked a couple of jokes, and continued with an acoustic set until they could get the power back on. And it takes a while to start a diesel when you've run out. You have to either physically pump the fluid from the tank, or take off the fuel filter and fill it with diesel to get the process started (prime the pump). You may also have an air gap that could shut you down again before the air works its way out of the system. Be prepared, because you never know when the whole world might be watching.

The basics of diesel engines (a focus on diesel generators)

Diesel engines work by using compression, rather than a spark like gasoline generators. You start them by first warming up "glow plugs" which help to heat the fuel and the air inside the compression chamber of the diesel engine. The engine starts, and remains running, when fuel makes it inside the chamber and achieves compression, which pushes out the pistons and starts a chain of reactions which keeps the diesel motor running.

If the diesel motor is constantly spewing white smoke, that means you have unburnt fuel leaving the chamber. If you have black smoke, it could be carbon buildup in the motor, or it could be oil which has seeped down the piston rings into the combustion chamber. It could also mean that your turbo has failed. The turbo is a screw-type device made to push a large amount of fuel and air into the chamber, not at all times but rather when the engine or the operator request more fuel and air.

The starter can go bad in a generator. The starter switch or the solenoid could also go bad. You can cross the solenoid by wearing gloves and placing a screwdriver across the solenoid leads. If the starter works, you have a bad switch or bad wires to and from the switch.

This test across the solenoid may also say you have a bad solenoid. Try replacing both the solenoid and the switch. If the starter still doesn't work (and you know you have battery power), then your starter is likely to be bad. The starter can be taken into any parts store and they will test it.

The alternator can also be troubled, and this will sometimes lead to the batteries not receiving enough charge. However, this is hard to diagnose, since once the generator is running and everything is on in the truck, the onboard DC charger does most of the work to charge the batteries. Parts stores can also test your alternator.

Most generators these days also have a PCM or PCB board near the starter and glow plug warmup switch. This is a harder thing to diagnose, and if you are having generator problems, it might be a good idea to just replace this part anyway. It will run about $40-$50.

Changing Oil, Oil Filter, Fuel Filter, and Air Filter

There are a couple of methods to changing oil in generators. One is to run the generator for 5 to 10 minutes until the oil is hot (but not too hot that you will get burned). When you pull the generator's oil plug, this hotter oil will flow out much faster than it would at normal temperatures.

Another method, used whether the oil is hot or not, is to drain the oil from the motor, and then “wash out the old stuff” by putting in a quart of clean oil and letting that drain, too, essentially washing out the old dirty oil.

People tend to change oil every 100 to 200 hours on a generator. If you drove 50 miles per hour on a car or truck engine, that would mean the generator ran the equivalent of 5,000 to 10,000 hours, except that the generator runs at a set speed and doesn't take the equivalent loads of a car. And since the satellite truck or van is not moving like a car, it is typically taking in less dust, debris, bugs, and road grime.

One thing that has been forgotten over the past generation, is that whenever you change oil in any engine, you also either need to change or dump out the fuel filter, too. The reason for this is that the fuel filter does two things. It removes impurities from the fuel, but it also separates water from the fuel.

Old farm tractors and heavy machinery used to have a valve where a person could open up the bottom of the fuel filter/water separator and drain the water out. But they also didn't tend to drain it into a pan, and many users drained the water and fuel out onto the ground. This put the kibosh on allowing this design. Now, to remove water from the system, you must take the fuel filter off in order to dump it out.

When changing oil, it is a good idea to change the fuel filter, too. If you can't get a hold of a fuel filter, be sure to at least dump the watery fuel out of it. Fill the filter with clean diesel (or gas, if you have a gas engine). In-line fuel filters also need to be replaced in gas engines either every oil change or every other oil change.

Air filters need to be replaced when they look dirty. If they don't look too bad, be sure to use an air compressor to clean the dust, seeds, leaves, or whatever else became caught in the engine's intake.

Think about ways to make your oil-changing experience easier. Add a hose and a valve system so that it only takes a second to reach up and drain the oil. Find the right funnel to make it easier to add oil to the engine. If the generator holds a gallon or two of oil, carry a 2-gallon gas can and use it to keep used oil in it until you find a shop that can recycle to oil.

Be sure you carry shop towels (oil-absorbing blue rolls are good), and hand cleaner with pumice so if you find yourself in a spot where you really need to change the oil, you can clean up after you are done.

I've changed oil in downtown Chicago, once at a PGA tournament, at a truck stop, and at a few parks. I was able to clean up the truck, take the oil with me, clean myself up, and nobody was the wiser. Take care of the generator, and it will take care of you.

Listen to Grandpa

My grandpa Burt used to tell his kids and all of us grandkids, “You can run an engine out of gas as much as you want. Just don't ever let one run out of any other fluids.”

Grandpa should have been an engine designer. Because now, if you run a generator, or most other engines low on oil or anti-freeze/coolant, the engine will shut itself down before you ruin it. Oh, and grandpa would be wrong today. Don't run an engine out of fuel either. In some rare cases, it overheats the fuel pump, fries it out, and it must be replaced with a new one. Most well-built pumps will not die if you run them dry. But they may be weakened from the experience.

Keep track of your oil levels. Change the oil every 100 hours. Keep a couple of gallons of oil on your truck, an empty gas can, oil-absorbing shop towels, and anything else you might need to do an oil change wherever you might end up. I've done oil changes on the streets of downtown Chicago, I did one on a military base. If you don't like to do oil changes, then I'd suggest trying to figure out how to get shore power as often as you can. Don't let laziness get the best of you. And oh, yeah, if the oil thins out enough... the generator engine will *think* it is low on oil and shut itself off.

Coolant usually isn't as picky. Normally you just need to keep an eye on the overflow bottle. But do keep an eye on it, and pop the top off the radiator once in a while. You might be fooled. Watch for leaks, and know the color of your coolant.

I have a cousin who has worked in the anti-freeze/coolant business for 30 years, and he told me that there is very little difference in the red, yellow or green coolants. *However,* DO NOT MIX THEM! If you have red, go find red. Red is common in diesel engines and diesel generators. You can find it at truck stops and car parts stores everywhere.

Gasoline Engines

If you've been cursed with a Gasoline engine, you have quite a few more steps to worry about. For one, you have higher levels of Carbon Monoxide, and you should reread and get to know a lot more about poisoning. Your vehicle is also much more explosive than its diesel cousins. Oh, and your engine takes more fuel to run than diesels. So watch your gas gage if you have to operate for a long, long time with a heavy load. Turn off what equipment you can when you aren't using it. (And actually, this goes for diesel engines, too.)

Adding to the things that can go wrong, gasoline engines have spark plugs that can go bad, or foul. (There is a difference. A “fouled plug” can be cleaned and used again.) They backfire if the gas engine's timing is off, and if it's bad enough they will blow the muffler apart.

And unless you're lucky enough to have a fuel-injected gasoline generator (which is unlikely), you will also need to learn how to tune a carburetor... while the generator is running. You will know when you're good at tuning one, because it happens about the time you will go deaf.

Basically, to tune a carburetor, you will need to find the float screw on the bottom, find the air intake screw, and the fuel intake screw. Read the manual, and adjust for more air when you are at higher altitudes or intense heat. Back the air off (or risk blowing up the engine) closer to sea level or in cooler weather.

If you are heading to an uplink at very high altitudes (above 8- or 10- thousand feet) I would highly suggest finding a generator guy to work on your generator, or simplify everything and rent a generator. Most rental companies will even drop off a generator for you! Do yourself a favor and park the thing 100-feet away (or whatever length of shore power cable you have), so you don't have to hear it or smell it.

CHAPTER 7
Digital Encoding and Modulation

Analog Video Exciters (Modulators)

While most analog video exciters and modulators have been replaced by digital modulators, as of the writing of this book there is no announced “sunset” on analog Ku-Band and C-Band transmission.

The latest word is that the FCC plans to let Ku-Band go away by itself, since it requires a minimum of a full transponder. Several factors will force users to make the transition:

- Full transponder space becomes hard to come by
- Full transponder space becomes too expensive
- Analog equipment becomes hard to come by, new or used
- Digital equipment, new or used, becomes cheap enough users will receive a (ROI) return on their investment by purchasing less bandwidth
- Downlink sites may not have the real estate to keep analog satellite receivers in their racks

There has also been word amongst industry insiders that C-Band analog transmission will *never* go away.

In either case, because you have the potential of working in any satellite truck in the world, you need to learn about analog satellite transmission.

Unlike digital, analog modulators (they were called exciters, but they are technically modulators), do not have video processing capabilities. What this means is that sending static, noise, switching between non-synchronous sources, and sending non-standard video levels we talked about in Chapter 2 will cause an analog signal to overdeviate.

If you are overdeviating, you are likely causing interference.

On older exciters, and newer analog modulators, there is a switch or internal setting that allows you to turn on Energy Dispersal, also known as ED or spreading waveform. Unless there is a problem with the dispersal and you need to shut it off, or you are setting levels and need to turn off the “ED” to make this happen, *leave it on.*

The analog video modulator takes audio into each of the 2, 3, or 4 audio subcarrier modulators, And the outputs of these can vary, but are typically set at:

- 1 (Left channel) 6.20
- 2 (Right channel) 6.80
- 3 (International or 2nd Left Channel) 5.76 or 5.80
- 4 (International or 2nd Right Channel) Varies & is rare

In addition to these audio subcarriers, the analog modulator also sends an ATIS signal which transmits a looped audio signal in Morse Code. This code identifies your uplink and includes your phone number.

The FCC ruling on ATIS in Analog Video Transmission

The FCC first adopted ATIS on April 13, 1990 and released its ruling on May 17 of 1990. ATIS, or

Automatic Transmitter Identification System ruling basically said that anyone who transmits video must have a unique identifier transmitted with their video. If that person causes interference, they will be quickly identified.

At the time this was released, updating every uplink engineer across the country required about 2-Thousand dollars for *each* exciter or modulator. They had until March 1 of 1991 to make the ATIS work in their uplink chain.

The reason I include all of this is twofold: For one, you need to know that the FCC rule is and will always be in effect. If you run Analog Video on a satellite in the United States, you must run an ATIS with your uplink signal. You should also find a way to identify your digital signal, even though there is no direct rule about digital signals. The FCC was vague for a reason, and may be able to use the old rule should you become the reason for interference on any satellite.

The other reason I share this with you is that at any moment, you might find out you need to add a piece of gear or change something in your uplink chain to remain compliant. Be aware of the rules, and be aware of the changes. It might require an update in gear and a large hit to your budget.

70 MHz IF

70 MHz is an IF (Intermediate Frequency), and is used to carry one or more services from the Modulator to the Upconverter. In some newer units, the encoder/modulator/upconverter is all in one unit. This is an amazing savings in rack space and real estate inside a truck, van, or flypack.

However, since most of the trucks on the road are older and have separate encoders, modulators and upconverters, it is important to understand why 70 MHz is used to send signals in the states.

Like I mentioned earlier in this book, higher frequencies just don't like to travel very far. Since C-Band and Ku-Band signals don't like to travel very far on common coax cable, the LNB (low noise block) converts the Gigahertz signals into L-Band signals ranging from 950 to 1450 MHz, allowing them to travel much farther down regular hardware-store RG6 cable.

The same goes for 70 MHz signals. They can travel much farther, allowing engineers to place the encoders and modulators quite a distance from the upconverter and satellite antenna.

Mobile Contribution Encoder

The mobile contribution encoder, also called an encoder or encoder/modulator, is a transportable digital exciter designed specifically for mobile DVB-S (Digital Video Broadcast Via Satellite). It was made to emulate an analog exciter, by using 70 MHz IF, and allowed truck operators to use both analog and digital exciters interchangeably by patching a digital exciter into an upconverter rather than an analog exciter.

Video is input into the unit like the analog exciter, except that encoders usually offer more options, including SDI and/or HD-SDI inputs, Analog or Digital (AES/EBU), AC-3, or Dolby-E.

Transponder bandwidth in SDTV encoders can be traded with video quality by operating the video compression bit-rate in the range 1.5-45 Mbps. Most SD encoders nowadays will send up to four channels of audio (some older models made by Wegener and Tadiran-Scopus only sent two in their early models). They can be sent as mono, stereo, and in many cases AC-3 or Dolby-E if the Dolby license was paid, and if the manufacturer bothered to put Dolby software into the unit.

The encoder multiplexes the video, audio (and data, if it is set up to do so), and the digital stream is then processed for FEC or forward error correction. The stream is then modulated (typically QPSK or 8PSK for satellite modulation in the United States), and then sent out as a 70 MHz IF carrier.

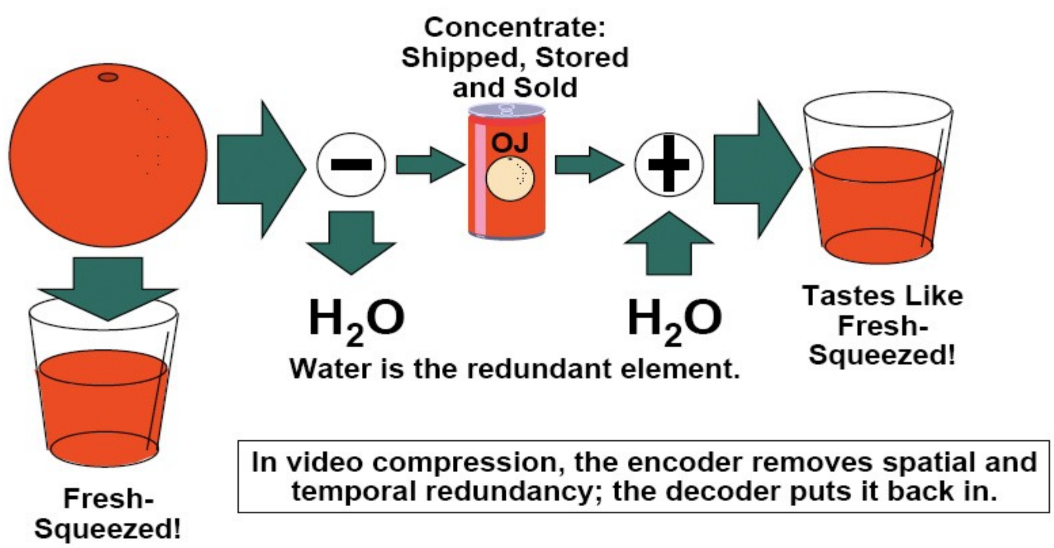
Why do we use Digital Compression?

When Digital Compression first came along, it was almost immediately discovered that four, five, six or more signals could all be placed in the same space where one signal used to be transmitted.

By using standardized (and non-standardized) compression schemes, engineers were able to cut their satellite space budgets in half, by thirds, or even a fourth of what they were once purchasing.

To understand compression better, you may want to think about Orange Juice:

...Orange Juice Analogy...



Rather than removing water, compression removes redundancy. Rather than repeat the color red across the screen, algorithms in the encoder tell them to repeat until told to stop.

After the encoder builds the transport stream, of video and audio, that information is cut in half and reassembled by using Quadrature Phase Shift Keying (QPSK). If other modulations are used, such as 8PSK, that original transport stream is cut into fourths, and then put back together at the demodulator.

The only downside in the orange juice analogy? If you've ever had fresh-squeezed orange juice, or ever seen 1.485 Gbps uncompressed video, it just isn't the same when you taste or see the end product! Hopefully as we continue to develop our transportation methods we can get a better tasting and better visual product than we get at home today.

Turning on the Encoder/Modulator

The encoder and modulator should be allowed to warm up or cool down depending on the temperature, and you should also allow the generator time to warm up so you don't have power fluctuations throughout the truck. The encoder/modulator is a piece of equipment that is particularly touchy when it comes to power fluctuations. Your upconverter and router are other such pieces. You will find others over time.

When you have let some time transpire, are sure the inside of the truck is at a decent temperature and the generator is running well, turn on the encoder and modulator. The boot sequence is much like a computer, and it will take anywhere from 15 to 45 seconds for you to start to see the menus.

This is where you really need to spend some time in the encoder and modulator manuals, or at least spend some time going through the menu structures of your equipment.

Digital Encoding Standards

Most SD encoders made for DVB-S in the United States comply to these two standards:

- The MPEG-2 Main profile @ Main level (called MP @ ML) specification (ISO/IEC 13818)
- The MPEG-2 4:2:2 Profile @ Main level (called 422P @ ML) specification (ISO/IEC 13818)

SDI and HD-SDI Input Error Detection and Handling (EDH)

SMPTE-standard RP 165-1994 called for error detection in units taking in SDI signals. The EDH may be a red light, check words or status flags, a warning message, or a display error. Sometimes it is all of the above.

Encoders can often be set up to show, in the event of video input loss (digital or analog) one of several things, including:

- Test patterns
- Freeze frame of the last good video
- Cut to a black screen
- A custom-made slate

I would personally like to add JPEG stills of old "technical difficulty" slides once used at television stations across the country. Or better yet, the "technical difficulty" slate once used in the television series "The Simpsons" which showed a drunken cameraman with a mostly empty bottle in one hand and the camera pointing up in the other.

Calculating Bandwidth

For standard definition DVB-S (Satellite) broadcasts, the easiest way to calculate bandwidth is by taking the Symbol Rate X 1.35. DVB-S2 and 8PSK are different, this calculation is only for QPSK standard definition.

Here are some examples of information bit rates versus transponder bandwidth at each code rate using QPSK modulation. *Keep in mind that older QPSK encoders are not capable (fast enough) to run very high information rates. Many are limited to 30 Mbps. New ones are often able to push 80 Mbps or more.*

Transponder Bandwidth(MHz)	QPSK ½ Mbps	QPSK 2/3 Mbps	QPSK ¾ Mbps	QPSK 5/6 Mbps	QPSK 7/8 Mbps
54	36.8627	49.1503	55.2941	61.4379	64.5098
46	31.4016	41.8668	47.1024	52.3360	54.9528
41	27.9884	37.3178	41.9826	46.6473	48.9797
36	24.5752	32.7669	36.8627	40.9586	43.0065
33	22.5272	30.0363	33.7908	37.5454	39.4227
30	20.4793	27.3057	30.7190	34.1322	35.8388
27	18.4314	24.5752	27.6471	30.7190	32.2549
18	12.2876	16.3834	18.4314	20.4793	21.5033

You will probably immediately notice that running a higher FEC rate will allow you to run a higher data rate (information bit rate). However, this will also increase your delay. If your broadcast requires a talk-back with a studio or talk-back with "phoners" it is strongly advised that you do not add more Forward Error Correction (FEC).

Even though most Encoder and Modulator units will set your rate automatically, I have included the calculations for figuring out Symbol Rates and Data Rates. If you wish, try using some of the Data Rates or Symbol Rates from the table below to see how the equation works:

SR = DR x ½ x 204/188 x (1/FEC)

or

DR = SR x 2 x 188/204 x (FEC)

Where:
SR = Symbol Rate
DR = Data Rate
½ or 2 = Modulation Factor (QPSK is ½ or 2)
204/188 or 188/204 = Reed/Solomon
1/FEC = 1, must be divided by the divisor of FEC (Forward Error Correction of ½, 2/3, ¾, 5/6, or 7/8) So, for instance, ¾ would be .75 and you would take 1/.75 and get 1.333333333 or if figuring for Data Rate, you would multiply by .75 for ¾ FEC.

Common Data Rate, Symbol Rate and FEC rate calculations

Bandwidth	5 MHz	9 MHz	18 MHz	36 MHz
Standard Definition	5.5 Data Rate ¾ FEC 3.97872 Symbol QPSK Modulation 4:2:0	8.448 Data Rate ¾ FEC 6.1113 Symbol QPSK Modulation 4:2:0	18.021 Data Rate ¾ FEC 13.235 Symbol QPSK Modulation 4:2:2	27.647 Data ¾ FEC 20.0 Symbol QPSK Modulation 4:2:2
	6.5 Data Rate 5/6 FEC 4.232 Symbol QPSK Modulation 4:2:0	9.1512 Data Rate ¾ FEC 6.62 Symbol QPSK Modulation 4:2:0	18.0 ¾ FEC 13.021 Symbol QPSK Modulation 4:2:2	
High Definition			41.47 Data Rate ¾ FEC 29.999564 Symbol QPSK 4:2:0	Data Rate ¾ FEC 26.0 Symbol QPSK 4:2:0

FEC, or Forward Error Correction is calculated from the number of bits input into the buffer, and the number of bits that are output by the buffer, so if you are set to ¾, then for every 3 bits that enter the buffer, 4 are output by the buffer. ½ has the most delay in a broadcast, and 7/8 has the least. But ½ has the least errors, and 7/8 often has the most. Most networks balance these rates by accepting ¾ as the most standard FEC rate. Why? It just seems to work the best.

Minimum and Maximum Symbol Rates and Data Rates

This varies from brand-to-brand, and encoder model-to-encoder model, but basically early models of IRDs (and encoders) will run symbol rates from 1 Mbaud to 30 Mbaud. Once chipsets and ICs became faster, models would run up to 50 Mbps or greater.

Information rates (Data Rates) typically run as such (different for each brand, and only if the chips are fast enough to run at the higher or lower rates):

FEC	½	2/3	¾	5/6	7/8
Minimum Data Rate	.92	1.23	1.38	1.54	1.61
Maximum Data Rate	27.6	36.8	41.5	46.1	48.4

Understanding Eb/No

IRDs typically give a receive-level reading by either an Eb/No, BER status, or C/N level number. These levels mean different things from receiver model to receiver model, and from brand to brand. For instance, a 7 might be good on a Scopus model, but bad on a Tandberg.

Eb/No is defined in this way:

- Eb=Energy per information bit
- No=Noise energy per Hz.

Translating Eb/No to dB can be done with this equation:

$$Eb/No = C(dBm) - No(dBm/Hz) - 10\log(IR)$$

Where:

- C = Carrier Power
- IR = Information Rate

Tiernan IRDs use Eb/No by estimating using an algorithm. The algorithm takes the incoming data from the decoder, and compares it to that same information once it is re-encoded. The difference over time is constantly monitored and sent as a level. Therefore, the readings are actually more accurate the lower the rate you are getting. So you will never really know how good a picture you are getting, only how bad a picture you are getting. (Less than 10 in a Tiernan Standard-Definition IRD). The reason for this is that when you are receiving a good signal, there are not enough bit errors at higher Eb/No readings to give you a truly accurate estimate. Of course, that's good.

You can use a spectrum analyzer to estimate your Eb/No. And you can do this with this equation:

$$Eb/No = 10 \log_{10}[(10^{D/10}-1)(SR/IR)]$$

Where:

- D = Distance in dB from top of spectrum to noise floor
- SR = Symbol Rate (symbols per second)
- IR = Information Rate (bits/sec)

Find out where your IRD faults off by talking with the downlink site and determining how much power and at what point your low power warning alarm goes off on the IRD (make a note at how much power the satellite access center set you at – you should keep a log of this), and note your local Eb/No reading in the truck. You should always try to keep at least two dB above where your warning lights go off at the downlink site, and in relation to your local IRD readings. When you have determined this number, put your power back to where the access center set your power and transponder saturation levels.

- Always keep in mind that throwing more power at the satellite when you are sending a digital signal will not always fix your problem. This is the biggest mistake truck operators and control rooms make! IRDs are supposed to take less-than perfect signals. They have buffers that have what is considered a "sweet spot" of just the right amount of information. Too much or too little information in these buffers often causes problems in the signal, and buffers can have an "under-buffer" or "over-buffer" error which can cause hits in the video or audio. If this happens, go to a backup IRD and reboot. The IRD will clean out the buffer and start over again. (Come to think of it, you should do this once in a while anyway!)

Chips are meant to get hot

One of the biggest mistakes people make is to buy a piece of electronics, especially encoders and IRDs, and set them in a rack and never use them. They should be used and turned on every day. If that's not possible, then they should be turned on and used at least once a week.

ICs (Integrated Circuits) are meant to get hot, and just like a car's engine, if you do not use them they will have problems. Turn them on, use them, and send them in for repair when you cannot get screens or buttons to work. Because technology and chipsets are changing so fast, Encoder and IRD designers are having to stockpile a 10-year supply of parts for each product they make, and when they run out they will no longer be able to help you. Therefore, if you wish to use these pieces of equipment for a long, long time, you need to make sure you get them fixed while you still can.

Selectable picture resolutions

Encoder designers often give operators the ability to change picture resolution. Sometimes this is done to save bandwidth, or improve picture quality.

The encoded picture resolution is normally controlled automatically according to the video Bit Rate. However, the user can override this and select the resolution manually. Below are some typical resolutions used for typical Bit Rates:

525 Line Mode	Typical Bit Rate (4:2:0)	Typical Bit Rate (4:2:2)
720 pixels x 480 lines	4.0-8.0 Mbps	up to 50 Mbps
704 pixels x 480 lines	4.0-8.0 Mbps	up to 50 Mbps
544 pixels x 480 lines	2.5-6.0 Mbps	-
480 pixels x 480 lines	2.0-6.0 Mbps	-
352 pixels x 480 lines	1.5-4.0 Mbps	-

The decision between 4:2:2 and 4:2:0 encoding

In standard-definition, it is suggested to use 4:2:0 encoding if you are sending an overall bit rate between 1.5 Mbps and 15 Mbps. It is also suggested to use this standard (4:2:0) if you wish to reach the maximum amount of viewers. 4:2:0 IRDs are cheaper, now available for as little as $100.

It is suggested you use 4:2:2 encoding if you are sending an overall bit rate up to 50 Mbps. If you are using an IRD capable of capturing a 4:2:2 video signal, you will also be able to receive a 4:2:0 signal. But this does not work the other way around. A 4:2:0 only IRD will only receive a 4:2:0 signal. It will lock up onto the transport stream, but it will not be able to decode the video because it lacks the hardware and software to understand how the video was encoded. That extra hardware and software comes with a cost. And since most broadcasters have decided to jump to HD 4:2:0 instead of using 4:2:2 MPEG-2, it is unlikely that the cost of 4:2:2 for DVB-S is likely to come down like it did for 4:2:0.

Audio Encoding

Audio is encoded in many ways. Some of the most popular are:

- MPEG-1 Audio (layer 2) standard (sampling rate of 32 kHz or 48 kHz).
- Dolby Digital (sampling rate of 32 kHz, 44.1 kHz or 48 kHz). Output Bit Rate is selectable in the range of 32-384 kbps for MPEG-1 Audio (layer 2) and 56-640 kbps (dependent on configuration) for Dolby Digital.
- Embedded audio (pre-compressed or pre-encoded according to standard IEC 61937) is encoded externally and passes through to the output, typically operating at 44.1 or 48 kHz). This type of audio is supported in Dolby Digital. And precompressed or pre-encoded audio usually comes in via SDI or HD-SDI signals, but can also be sent in via an SDI input of the audio connector (if one is available).

Audio Inputs

Video inputs are pretty self-explanatory on most encoders. However, audio has become a different story. It is in part because XLR audio connectors take up more space on the back of an encoder. Therefore, companies like Tandberg have changed to 15-pin audio "breakouts" where the unit accepts a 15-pin D-type connector that breaks out to 4 female XLR connector and one BNC connector.

If you need to remove a Tandberg from the rack, it is advised that you take off this 15-pin connector carefully to keep from breaking it off or bending the pins. Replacement requires that the whole board be replaced at a cost of several thousand dollars. Chipsets change so much from year to year that the whole board gets redesigned by the time the original unit ships out.

Tiernan often uses a typical XLR-chassis connector. But you need to pay particular attention to where you are plugging in each audio connector. Many of the SD and some of the HD encoders are labeled, Audio 1b, Audio 1a, Audio 1d, Audio 1c. So, in essence, you must plug them in with the order: 2, 1, 4, 3.

AES/EBU Audio

Another way to send audio can be from a digital source. AES/EBU audio can be sent down an XLR, just like analog, or down a BNC cable, just like analog video. However, you will often only need one cable because one or two channels can be sent down one line.

Audio can also be embedded as AES/EBU and placed onto or embedded into the SDI or HD-SDI signal. In this mode, up to four stereo pairs can be embedded and then extracted at the encoder from any two Data Identifiers (DIDs). Audio may be converted to either of the standard output sampling frequencies, 32 kHz or 48 kHz. You must select SD-SDI or HD-SDI embedded, source 1, 2, 3, or 4 in order for your encoder to pick up the audio.

QPSK Modulators

The QPSK modulator, like its analog predecessor, performs energy-disperal scrambling, Reed-Solomon mapping, baseband shaping and modulation. Modulators used in the United States adhere to EN 300 421 specs.

In addition, the 70 MHz IF can be changed to ±20 MHz, so the signals can be combined with other SCPC IF signals. Multiple signals and MUXing will be covered in Chapter 9.

The spectrum can be set to Normal or Inverted. And the FEC can be set to ½, 2/3, ¾, 5/6, or 7/8.

- The more error correction (FEC) you add (½ is the most and 7/8 is the least), the more delay you will have in your broadcast! ¾ is the most common FEC.

Modulators also allow you to change your output power from -20 dBm to +5 dBm. It is strongly advised that you leave the modulator at -20 dBm unless you are balancing power in a combined SCPC situation.

Sending ASI

ASI (Asynchronous Serial Interface) is a standard where (in your case), equipment will send an encoded stream of data from your encoder to your modulator. This can be two separate pieces of equipment, or one, or you can bring in a separate encoder or modulator to make the run.

If the unit is all-in-one, then you will not need to cable from the ASI output of the encoder to the ASI input on the modulator, unless for some reason something is not working right.. The unit was made to do this internally.

ASI has been used more and more since companies started having trouble sending SDI and HD-SDI streams. HD-SDI, for example, is a 1.487 GBps stream. And that's a lot of data to push down a copper coax cable. I've seen losses down as little as 6 feet of cable with HD-SDI feeds.

One way to fix the problem is to encode the video, and use the ASI output on the encoder to send ASI to the modulator. ASI runs often make 300, 500, and in rare times even 1000 feet.

ASI is 270 MHz and is clocked, and will be running at the data rate you have set at the encoder. If you are running 26 Mbps, then that's roughly what you will be running out of your ASI, or at least nowhere near to the original uncompressed HD-SDI (1.487 GBps).

ASI is also used for MUXing purposes (covered more in Chapter 9). In this case, you will take one, or two, or more feeds into an ASI input on a MUX-capable modulator. You may also take an internal feed from an attached encoder. So if your encoder/modulator has 3 inputs, you have the capability of putting up 4 MUXed channels.

Whether you are sending ASI, SDI, or HD-SDI, use the proper cable. You should be using nothing less than 1694, 1505a, or BBC PSF 1/3. Nothing else is rated for this use.

JVC recently introduced a camera that sends ASI, which eliminates the need for an encoder. It will be interesting to see if this turns into a trend.

Conditional Access and BISS

The history of paid television (HBO, Showtime, Pay-Per-View, and Closed-Circuit) and in some cases military closed-circuit telecommunications will undoubtedly give you the basics of why and how people decide to *encrypt* or *scramble* a video and audio signal.

For much of the analog video age, scrambling was done with something called BMAC. I won't go into it in depth, because it isn't used anymore. (On very, very rare occasions, but who cares?)

Digital encoding brings us the two biggest scrambling systems used today: BISS and Conditional Access.

BISS or Basic Interoperable Scrambling System

BISS was developed by the European Broadcasting Union (EBU) and is used to scramble the outgoing transport stream.

BISS has three levels of operation: Mode 1, Mode 2 and Mode 3. Mode 0 means you are not scrambling. BISS-E is also available. You must have the hardware *and* the software installed to make BISS work.

BISS Mode 1 uses a fixed value for the control word to scramble the services in the transport stream from the encoder. If you wish to descramble the transmission, you must know and input that word into your IRD.

Closed Captioning

Closed Captioning is the term referring to placing text on a television screen for the benefit of reading the audio text, if users wish to access that capability. Closed refers to this ability to turn it on or off, 'open' captioning would refer to other Character Generation that you can't turn off.

The most common usage is for people who are deaf or hard of hearing. But there are many other users. The National Captioning Institute has noted that an increasing number of ESL (English as a Second Language) learners have become notable users. The last, and probably most under-recognized Closed Captioning users have become noisy bars.

Whatever the case or reason for Closed Captioning, there are a few things you need to know as a satellite truck operator. As of 2007, all over-the-air live broadcasts must have Closed Captioning inserted... by law. And if your broadcast is going to many different over-the-air sources, your location may be the place where Closed Captioning must be inserted.

Cable, by the way, does not have any law like this in place, only free, over-the-air TV.

If this is the case, you will be given an “inserter-box” which has a phone line, a video in, and a video out. On the other end of the phone line is somebody's typing machine, and the signal it is sending to the box.

In order for that person to hear, you will have to dial in with another phone line. In that phone line, you will need to send program audio.

Once that encoded signal reaches your truck, you need to turn on Line 21 in your digital video encoder (unless for some odd reason you are sending an analog signal). More than likely you will be sending Line 21 by “pass-thru” or by selecting Closed Captioning. Go through all of your options. More than likely it will be in pass-thru.

Line 21, by the way, is in an *active* line of video. Some televisions are capable of seeing this line, but most (pre-digital or HD) are not. If you wish to see if the CC is working, try using the “underscan” button on your monitor.

CHAPTER 8
Satellite Space and Space Brokering

Avoiding Interference

There is always something on a satellite more important than what you are broadcasting on any given day.

Ku- and C-Band satellite uplink trucks, if not operated properly, have the potential of doing immeasurable financial damage.

You could shut down a television network feed, data, telephone, and pager services for the government, on-call doctors, banks and ATM transactions are flying up and down from the satellite at every moment of the day, every day of the year. Swipe your credit card at a small gas station in Montana, and your transaction is probably hitting a satellite for a fraction of a second. It's all up there. And that lost data is irrecoverable.

Ever since the inception of the transportable uplink, the full-time users of communications satellites have viewed trucks with dishes as a nightmare-come-true. Fears of a poorly built or poorly operated truck could do millions or even billions in damage.

The FCC tends to agree with the satellite industry, but has given transportable uplinks a lot of leeway over the years.

This is all being said because it is true. And it solidifies your importance as the Uplink EIC (Engineer in Charge). You must never let any reason get in the way of you doing your job properly, with correct and necessary procedures that have been used since the beginning of satellite transmissions.

Just like you would be chastised and asked to walk the plank should you refuse to call the left side of a ship the *port* and the right side of the ship the *starboard,* you must now promise you will always do your best to use the correct terms and the correct procedures.

We will start with a phone call

From now on, when receiving or sending a phone call, you will always properly identify yourself. I don't care if your caller ID says it's your mother. If you work for CNN, drive truck 8, and your name is Drew, you'd better answer the phone, "Hello, CNN truck 8, this is Drew."

If you don't properly identify yourself, especially in a tense, breaking news situation, it will take you twice as long to complete what you need to complete.

Besides that, even though you are running a dish licensed by the FCC, don't forget that FCC rules still adhere to the use of phones and cell phones. Basically, don't say anything on any phone you wouldn't want your grandmother to hear. Behave yourself. Identify yourself.

Add to that, if you expect to go anywhere in this business, people have to remember you. You could have the best attitude, work the hardest, and make tons of friends in this business. But if they can't remember your name is Drew, you won't go anywhere. Get on it. Use it. You won't be sorry.

Satellite Procedures

Satellite operators back in 1988 asked for the FCC's help in resolving ongoing interference problems 59 times that year. This required scrambling of vans, and triangulating a signal to find the interference source (called a bandit). And the offenders were very, very sorry once they were caught.

All of the problems appeared to be accidental, and about 90% of the situations were due to human error.

The causes of these human errors, in order of the most instances to least were:

1 – Polarization error
2 – Uplinking at the wrong time
3 – Uplinking to the wrong transponder
4 – Uplinking to the wrong satellite

More importantly, these were the 59 instances that were reported to the FCC. And it was, sadly, a small fraction of the interferences that actually occurred that year.

Now, because of the number of uplinks on the road in North and South America, and the reduced cost of satellite space, added to the availability of more space segments, you can probably multiply these numbers by 100. The interference count may be too high to even attempt today.

The truth

The truth about the industry standards regarding satellite access is that they are inadequate. There are a lot less engineers and a lot more operators in trucks today than ever before. Most operators receive less than a day's training before they are told to go out and make a live shot work.

Most operators barely know how to make the truck work, and do little to no maintenance on the truck, never learning how anything in the truck works.

Operators train other operators, and those operators train other operators. And just like the MP3 trade is now called an action not unlike "sheep that defecate grass" there is very little knowledge about anything being passed from one person to the next, only the bare minimum. It's dangerous, and it's stupid.

The awful truth

Many people who have been doing this for years have become lazy. 2007 was a perfect example:

- A "bandit" appeared at medium power on Galaxy 26, in the middle of ABC ABSAT space. The transmission was likely a fixed uplink, because it sat there for a week. The source was analog, modulated, and in black. The power was low enough that satellite providers couldn't seem to get an ATIS lock on the signal. But they were growing deeply annoyed.

  ABSAT first made their calls in-house, trying to figure out if one of their affiliates was putting the signal up. They called all truck companies. Intelsat, the satellite provider became involved. They had no luck. The call went out to practically every company that provides satellite service, every university that has an uplink. Emails hit every known account.

  While the ATIS should have been identified less than an hour after the signal appeared, nobody bothered to try to tune it in.

  Neal Mastel, working for STS, took some time to tune in the signal. He recorded the faint ATIS and put it through an audio "cleanup" program on his computer. Then, he learned Morse Code off the internet! An hour or so later, they had their answer:

  The Mayo Clinic! An early adopter of Ku-Satellite technology, the Mayo Clinic, with offices in Rochester, Minnesota, Phoenix, Arizona and Jacksonville, Florida, started using satellites so their doctors to talk to each other. They now rarely use their satellite links, and when they did use them, they had forgotten to shut it off (not following proper procedures). Not knowing it was on, somebody swung the dish across the sky, illuminating a series of satellites, until it landed on Galaxy 26 and sat for more than a week. They caused a lot of damage in that time.

  Not only was this whole episode an embarrassment for the Mayo Clinic, it was deeply embarrassing for Intelsat. With all their advanced, and highly-paid people, not one was able to figure out in a week what a kid only working in the business a few years was able to figure out in a matter of hours.

Buying Satellite Space

There are basically three companies selling satellite space over North America today, and the rest of the satellite space providers are brokering companies. There are benefits and disadvantages to either companies, just as there are advantages and disadvantages to buying anything or everything at Walmart.

And this is due to a lot of reasons. Buying a lot of space will get you better rates. Having a long-standing relationship with a company can get you better rates. Bartering can get you better rates. But, just like the ad-line says at the end of every Master Card commercial, the value of calling up somebody you can trust and have them fix your problem: *Priceless.*

One example for me is Marianne Woody at Vista Satellite. While I can certainly get *slightly* better rates by going straight to Intelsat, I would rather book with Marianne. I have known her for over ten years, and I trust her them to always get me the space I need, especially if I find the need to extend a window. When something goes wrong, she is in my corner to help me. So I might be penny-wise by going straight to the satellite provider, but I am dollar-foolish because they are a larger company who doesn't care if my live broadcast fails.

Whatever your choice for satellite space, you should try to keep on top of who owns what, who controls what, and who controls and brokers each piece of space. Every time I print this manual, a lot of this info will change.

The companies providing *and* selling satellite space in the United States are:

Intelsat -
- Booking 202-944-7500
- Access at 800-321-3959 or 800-975-9638 or 866-727-7641 or 404-381-2600

SES Americom -
- Booking 800-273-0329
- or at 609-987-4200
- Access at 800-772-2363
- AMC 9 Access at 800-255-6122

Echostar –
- Booking
- Access at 877-358-2263

Ascent -
- Booking
- Access at 800-764-4622

Hughes Global Services -
- Booking 888-HGS-4203
- Access at

Telesat -
- Booking at 800-361-0804
- Access at

Each of these companies can sell you space, access your truck, help you extend your window, and take a goodnight call and post it to their records.

There are several companies who broker space and will sell you space on any satellite. Sometimes they will provide space better suited to fit your needs. A company like this is helpful if you are on an Intelsat bird, and need to move to an adjacent SES Americom bird, for example. Brokers can often sell on satellites run by one, two or all of the companies listed above. And they can often help you to set up a feed that needs to be sent overseas (called, "booking a turn"):

Vista Satellite – 954-838-0900

Space Connection - 818-754-1100
*Space Connection is the only *broker* at this time who will sell you less than a 15-minute window.

BAF - 800-223-1860

VYVX - 800-364-0807

Globecast - 877-456-2322

Cancom - 905-272-4960

Centrex Communications - 845-987-1666

Domenet - 800-558-4128

5th Dimension Communications – 800-558-4128 or 613-248-1000

Television networks who own their own space will gladly sell you space, too:

ABC's ABSAT - 212-456-4134

CBS Newspath - 212-975-6074

CNN - 404-827-5200

FOX - 212-301-3379

NBC Newschannel – (MSNBC Sat Ops) - 212-664-4721

How Companies Book Space

The following is an example of what a booking sheet might look like:

Time	Gal 11, Ku 1a	Gal 11, Ku 1b	Gal 11, Ku 1c	Gal 11, Ku 1d	Gal 11, Ku 1e
0600	KTVT	WCBS		C-SPAN	CBS DC
0615	|	B		TEST N/C	|
0630	|	KARE			|
0645	X	|			|

0700		|	KCNC		|
0715		|	B		|
0730		|	B		|
0745		X 0755	B		|
0800			B	C-SPAN	|
0815			B	|	|
0830			B	|	|
0845			X	|	X
0900			APX	|	APX
0915			APX	|	
0930				|	
0945				|	
1000				X	
1015				APX	
1013				APX	

Unless you book or broker space, it is very unlikely you will ever get to see a sheet like this. They are typically kept very secret. But I will give you a brief explanation about each of their meanings to help you understand how many different ways you can book satellite space.

KTVT has booked a window on Galaxy 11, Ku 1 – Alpha from 0600-0700 EMT. Their window ends at exactly one second before 7:00 am eastern. However, if they needed extra time, they will be able to extend their window if they call the access center and ask for more time, because as you can see there is no one behind them.

WCBS booked a window on 1-Bravo from 0600-0615 EMT. Their window is only fifteen minutes long, but a broker blocked it out so that they can have a few extra minutes in their window if they need it. However, they must be done with their window by 0630 EMT when KARE is scheduled to come up on the bird. KARE, to save a few dollars, knows they will be done by 0755, so they have only ordered their space until exactly that time. Some companies allow you to book in 5-minute increments. Others will only allow you to book in 5-minute increments if you have purchased at least 15-minutes of satellite space. And some others do not let you book at all in less than 15-minute increments.

KCNC has "blocked" a window. They aren't sure if they need it. But if they do not firm book this space (usually 24 to 48 hours before the window starts depending on the company), they will lose this space and will have to find other space. Most satellite brokers will not block space for anyone during election coverage, political conventions, and other large events such as the SuperBowl.

KCNC has also added a half hour approx, as did C-SPAN. CBS DC added only a 15-minute approx. Whatever you have ordered for an approx, if you use it, you will be incurred the fee for the entire approx. So if you use one minute of a 15-minute approx, you will be charged for 15-minutes. If you use one minute of a half-hour approx, you will be charged for a half hour.

Many companies, if you do not call them after you have called the satellite access center with a goodnight, they may also charge you for using an approx, even if you did not use it. Their rule says if you do not call them to goodnight, that means you have used the approx. If you have ordered space with a "hard-out," then you do not need to call with a goodnight. However, it is always a good idea to always call with a goodnight. This often allows the next operator anxiously awaiting access to the satellite to go up early. Next time, that operator might be you.

I also included a test window. Some satellite space providers will allow free test time, or time to cross-pol if there is no one else using the space during that time, and if the control room is not too busy.

Sometimes operators have been known to cross-pol when they know they will have very little time to get up on the satellite before they must go live. By cross-poling early, an operator who calls in can say, "I'm coming back up on Galaxy 11, Ku-1-delta, and I haven't moved the antenna." This should allow you a much faster access, providing your antenna is still peaked.

If you get free test time, or wish to cross-pol early, do not waste the access center person's time. You are one of 1-thousand other calls they will take that day.

Booking Fiber

Booking fiber is a lot like booking satellite space, except that there is a finite amount of fiber and bandwidth available.

Just like satellite brokers can sell you the space they lease, so can fiber brokers sell you the fiber they lease. VYVX is a major fiber provider, and Ascent (for example) leases *dark fiber* from Williams VYVX.

One thing you need to know about fiber, is that if you can't get it to your studio, you must have a fiber broadcast "turned" to you.

Booking a "Turn"

As I mentioned in Chapter 1, many of the early companies (called Common Carriers) would help send live events. Often called a "Teleport," these places could take in a microwave feed, a short-distance fiber feed, or a Ku-Band or C-Band feed and resend them or "turn" them to Ku-Band or C-Band on the same satellite or another satellite.

Most of these teleports have disappeared, disbanded, or gone out of business. But there are still a few around. I only listed the best-known ones in use today. Keep their numbers handy:

Ascent Media – 612-330-2639

DCI Teleport – 202-775-4300 (bookings) and 202-470-5151 (MCR direct line)
2000 M Street NW, Washington, DC

MicroSpace – 919-850-4500 main # and 919-850-4565 for Video Services Direct #

Napa Teleport - 707-251-1100

Upsouth – 404-325-0818

Waterfront Communications - 212-599-1011

Sun Outages

Two times a year, the sun will pass directly behind each satellite from your position on earth. Nothing you, or I, or anyone can do will fix this problem because you just can't compete with the Sun.

Most sun outages last about 3 to 5 minutes, and they do not damage equipment. In Chapter 1, I mentioned how you can test your LNB by pointing your antenna at the sun. If you haven't done this yet, then you will discover now what it will look like. The entire noise floor on your spectrum display jumps up during the sun outage, and will eventually drop back down when it is done.

Do not change any of your settings, and just ride it out! Just because *you* can't see your signal, doesn't mean the rest of the country can't see it. You, and about a 50-mile radius are the only ones in the world experiencing this problem. Don't turn your power up or down, don't re-peak the dish, and don't change any video or audio settings.

Sun outages are sometimes quite amusing. I was sending a signal to 50 downlink sites across the country, and I knew where most of them were located. Indianapolis called me to say their signal went away. I told them it was probably a sun outage, and that they would need to make an announcement, have people go get some coffee or take a restroom break, and come back in three minutes.

Less than a half hour later, Springfield, Illinois called to say their signal went away. A while later, Des Moines called. I guessed the exact minute on my clock when Omaha would call. When I picked up the phone, I asked, “Hello Omaha, did your satellite signal go away?”

There are really only two ways to avoid a sun outage. Find the satellite you will be using and change your event earlier or later in the day according to the posted time of the satellite sun outage. Or, if you're really worried about it, change the event to the evening.

Sun outages only happen in the fall and the spring.

CHAPTER 9
Multiple Paths, MUXing, Multiple Cameras and Multiple Crews

IF combining

Putting multiple paths up to a satellite is actually a very simple project. It requires an IF combiner (basically a video splitter used in reverse), two or more encoders, and enough video cable to carry the 70 MHz signal to the upconverter.

When truck companies first started to integrate multiple paths, they tried cheap switches and cheap splitters turned backwards to create a combiner, and then moved to expensive combiner units taking up two rack spaces, but finally settled on simply using a (normalizing) patch bay and simple Micro-Circuits 70 MHz combiners.

This remains as one of the best ways to put multiple paths on a satellite for occasional use. The reason is that once you are finished with one path, you can simply drop it off the satellite. If you have gone through the pains of MUXing the signal, then you can end service on one of the channels, but you will remain at the same bandwidth and will have to pay for it even though you aren't using it.

Combining by IF is done by offsetting the 70 MHz IF frequency output from each modulator.

- Keep in mind that the further you get from 70 MHz, the more information you are potentially losing in your signal. Try to keep them close to 70 MHz!

So, let's say you are putting up three paths, and your channel spacing is 5 MHz apart (and you are running 5.5 Data Rate according to ABC specs). ABC has given you the uplink frequencies of: 14.225, 14.230, and 14.235. You would set modulator “A” to 65 MHz IF, leave modulator “B” at 70 MHz IF, and set modulator “C” at 75 MHz IF.

- Not all modulators are created the same! Older Tiernan Encoders, for example, will not go below 52 MHz or above 88 MHz, where Tandbergs and newer Tiernans will go from 50 to 90 MHz. Check to make sure this will work before you promise you can do this!

Multiplexing or MUXing of signals

Encoder/modulator units are often fitted with multiplexing or muxing capabilities. And it is possible to buy or rent a separate unit to mux your signals. Typically a mux unit is capable of taking in three or more transport streams via ASI connectors and, (together with the host encoder transport stream) send out four (or more) transport streams into one multiplexed signal.

ASI (Asynchronous Serial Interface) is a 270 MHz, clocked signal that is commonly used to send encoded video over long distances. You are fully capable of taking an ASI output from your encoder to feed a fiber line, should you choose to do so. You can feed a MUX, a modulator, or anything else built to take an ASI input.

These transport streams can be set up as “channel numbers” in the service description or in the IRD menu.

MUXing is the way to go if you know you will be using several channels for a long, long time. A muxed signal is a stronger signal, and each transport stream with, say, a lot of moving video will balance out with another transport stream with still or unmoving video.

One huge advantage to MUXing signals perhaps comes with 24-7-365 operation. If you are MUXing a signal with several channels, you have the option of adding music channels, radio stations, data, and future services with very little to no change to the other services being run through the MUX.

If you need to slim down your bandwidth and use half of your allocated satellite bandwidth at some point during your broadcast, then MCPC or MUXing is not the way to go. You will be better off sending your video and audio down separate SCPC streams.

Encoders with built-in L-Band upconverters

Offering what may be the most flexibility, encoder/modulator units are now being built with upconverters built in. Or rather, they send L-Band (950-1450 MHz) to the amplifier. They can be patched with an unknown (numerous, but not infinite) number of other encoder/modulator/upconverter units.

This means you will have to enter in more parameters, but it also means you have less equipment in your RF chain. It means you can place one signal on one transponder and another signal in a totally different end of the satellite (but restricted to one polarity if you only have one amplifier).

This feature in most uplinks is a fancy toy. But it will be more and more important should satellite space ever become hard to come by again, and as more end users have the need to put up multiple paths with ease.

CHAPTER 10
The Future of the Satellite Industry

Equipment

Equipment will keep changing, ever faster, ever more diverse in its ability. And this is due in a large way to Moore's Law, Sarnoff's Law, Metcalf's Law and Reed's Law:

Sarnoff's Law (David Sarnoff) – Small number of stations with a large number of viewership equals the value of the network. Network Value = Viewership

Sarnoff appeared to be mostly worried about selling and coming up with a model for selling advertising space. But he pointed out something obvious. The value of a network is proportionate to the number of viewers. Moving beyond this means looking at the future.

Moore's Law (Gordon Moore, founder of Intel wrote this "law" in 1965) – Number of elements (transistors) doubles each year without taking up more space. Basically, speed on a chip doubles each year.

Moore's Law is the the reason electronic miniaturization has driven this crazy hyper-evolution in computing, handheld devices, gadget-freak culture. Moore forecast that the number of elements on a chip would double every year, and they basically have, for the last forty years.

By 2019, Physicists first believed Moore's Law would reach an end, but now there is new hope keeping Moore's Law alive. Quantum computing is the latest buzzword, as scientists at IBM proved quantum teleportation works. Nanotechnology is another decades-old buzzword. And now computer scientists are looking at DNA computing, considering getting away from traditional transistors completely.

Speed at this point is increased in many different ways. Apple has already created computers using several Intel CPUs to speed up their computers. Beowulf-type computer clusters and shared computing power may be the next step in increasing equipment speed and capabilities.

In addition to better, faster chip design, better software may also finally be a focus: Can you design software to be leaner, meaner, and with less or no errors? Will cost have reached an all-time low by this time? The trend is toward pervasive computing, where we will wear more computers.

A few years later, in the 1970s, Bob Metcalf came along while working at Xerox and later founding 3Com. His work in creating interconnects between early computers gave us the first value in a computer network:

Metcalfe's Law (Bob Metcalf, founder of Ethernet) – Number of potential connections grows faster than the actual number of connections. The power of a network is the number of nodes, squared.

Metcalfe, like Sarnoff was pointing out the obvious: Connecting two nodes (people, or access points) creates far more value than the sum of their values as independent nodes.

Then, along came David Reed.

Reed's Law (David Reed) – The value of the network is two to the power of the number of nodes. Under Metcalf's Law and Reed's law, the power of two nodes is four. But the power of 10 nodes under Metcalf's Law is 100 (ten to the second power) and is 1024 (two to the tenth power) under Reed's Law.

Networks are more powerful by Reed's Law because of sharing, and of the power in each person knowing more than one thing and able to multitask.

Without Reed's Law, we could not begin to understand the power of Ebay, or Craig's List, or YouTube. To describe any of these things is to describe an unexplained phenomenon and nothing anyone could have guessed would have existed one year before each of them was invented.

Reed's law explains something more than just the power of the network. It describes the power in working together, sharing resources and information. It describes the power in working for reputation rather than monetary gain, yet somehow sometimes reaping a large monetary benefit anyway.

Equipment will do more, and people will do more if they are given or provided with the right equipment. And think about this: The power of user-created content is one of, if not *the* fastest growing areas in our business today.

Satellite Frequency Bands

C-Band and Ku-Band are the most used frequency bands for mobile uplinks. But someday that could change.

Engineers and satellite space providers have been considering Ka-Band for some time now. However, Ka-Band has some issues, including issues with inclement weather (even fog in some cases), and higher power requirements for its higher frequencies (27.5 – 30 GHz for uplinking, 17.7 – 20.2 GHz for downlinking).

Right now, one of the biggest uses for Ka-Band Capacity in our field is broadband access. And everybody who's used it knows the problems they've had with it. When it's raining, when it's foggy, when it's raining somewhere to the south of your dish. It's extremely frustrating.

Satellite providers using Ka-Band also aren't very interested in allowing its use for occasional users because of the many interference problems that didn't always get addressed during all these years of Ku-Band occasional traffic.

When enough Ka-Band satellites are in the sky, and bandwidth becomes plentiful, we will start to see Ka-Band use. If it's available, and vendors can sell it, they will. Hughes SpaceWay and SES Astra are two early pushers of using Ka-Band for SNG and occasional uplinking.

One idea under experiment for the last few years is figuring out how to change modulation and encoding on the fly, allowing the IRD to tell the encoder when it needs more or less bits in the buffer. However, this requires an uplink site with at least broadband access to allow the units to communicate. This will not work in a very remote site with poor or no cell phone coverage.

Spot Beams

Another possibility in the satellite industry will be the possibility that satellite space providers could offer some clients the use of spot beams. Each spot beam purchased would give satellite users a 150-mile radius of an area, and would not require an uplink to send a signal out to the entire country, and thus, you would not be charged for that extra area because those other spots would be resold to other users.

Some countries, such as Japan, use spot beams for full-time transmission. These spot beams in some cases work so well, users only need a very tiny antenna to receive a feed.

Satellite feeds are already made up of spot beams. The ability to request transmission on one, or two of these spot beams will make for a very tricky pricing structure, but will make satellite service available to a lot more people if they can ever figure it out here in the U.S.

RFIs for Ku-Band?

Remember Chapter 1 where I described how every C-Band uplink must first have a frequency coordination done before the uplink, to prevent terrestrial interference? Well, there is always a possibility that this could happen here in the United States for Ku-Band, too.

This is already the case in the UK. This comes from Jonathan Higgins of beaconseek.com:

Here in the UK, we have to apply to the UK regulatory authority (Ofcom) for site clearance frequency co-ordination <u>every time</u> we want to uplink from a location. This is done as an online process, but when you set off from base to the location, you may not have a clear idea of where you will be parking. The accuracy of your position has to be within 100m, or else you risk a fine of GBP 5,000 and revocation of your license.

This difficulty has lead to uplinks and uplink operators needing EVDO cards, WIMAX, or other wireless internet capabilities, because they need to apply for the license online often minutes or hours before the satellite window. 3G networks have made this online process easier. Uplink providers hope 4G networks will continue to make the process faster.

In addition to RFI satellite clearance, you also have to obtain frequency coordination for any wireless mics, IFB, cameras, or 2-way radios. Oh, and have your Visa or Master Card ready!

Encoder/Modulator/Upconverter

Once three separate pieces of equipment (and sometimes still available as separate units today), companies are finding ways to not only get pieces of equipment smaller, they are finding ways to integrate everything into one piece of equipment. Add to that, some chip designers are working to give integrated circuits more and more abilities.

This was first a popular choice for uplink providers who needed to save real estate in their racks. These three things once took up six rack spaces or more. And now, they can take up two. Mixing the units together also often means less power consumption.

The other thing combining these units has done is offer operators the option of putting up many multiple paths in several different places on a satellite. Before, multiple SCPC paths had to be booked either on one transponder or less than 40 MHz apart in an "offset" mode. Now, combined encoder/modulator/upconverter units offer the ability to put one path up on, say, transponder 1, and another on, say, transponder 21. They won't offer you the other polarity using this method, unless you have another HPA and another port on the satellite antenna.

Equipment with ASI out

JVC recently released a camera with an ASI out, which eliminates the need for an encoder at the truck. It will be interesting to see how this develops, and if it will become a trend. Such a camera could be plugged directly into a fiber "drop" or sent to a satellite truck with MUXing capabilities with no additional real estate needed in the uplink racks.

Leased Lines

One of the largest forces of change in the satellite industry has been due to the availability of leased lines, better Ethernet and Giganet availability throughout the United States and the world, and their placement in even the most rural and remote places.

Two of the largest companies offering Leased Line service include the VYVX company and Ascent Media. Both have fiber as well as satellite booking divisions, but if you spend enough time with either company you will quickly realize they owe their biggest success to their fiber or leased line capabilities.

VYVX built their fiber and leased line capability by adding much of their service along the gas and oil pipelines throughout the United States. Adding fiber along all this pipe was genius, and it made them a company that was close to impossible to compete with. They are now owned by Level 3, formerly known as L3, started in the mid '80s by Kiewit Diversified Group, a construction and coal mining group also known as the company who builds all the airport runways, many of the very large buildings in the United

States, and now owns most of the fiber in the country.

Level 3 claims their backbone is capable of carrying over 5.1 Peta bytes of traffic per day.

Ascent Media was more of a “built-from-the-ground-up” company, mixing fiber, production, satellite, teleports, and was more of a company built by acquisitions.

What both of these companies, as well as phone companies, cable companies, and other internet and leased line services have done was give us more and more bandwidth in more and more places each year. Understanding this system is a full-time job. But understanding the best use of these lines is not much different than satellite.

More than likely your job will fluctuate in the future between using satellite, and using leased lines or Giganet lines. Luckily, the only difference will likely be in the settings you and your master control choose to send encoded video and audio, or MUX of more than one channel using the ASI output, or by sending 70 MHz or some other standard video compression and modulation.

To give you an idea of some of the leased lined standards and their ability to send information, I have made up this table. Since most satellite standards start at 5.5 Mbps, I have not included anything less than this number, with the exception of the T1 line (because it has been a standard for so long):

Standard	bits per second	Bytes per second
DS1 (T1 Line)	1.5 Mbps	
DOCSIS v1.0 (Cable Modem)	10-38 Mbps	1.2 – 4.7 MBps
DOCSIS v2.0 (Cable Modem)	30-40 Mbps	3.7 – 5 MBps
FiOS	10-50 Mbps	1.2 – 6.2 MBps
DS3 (T3 Line)	44.7 Mbps	
DOCSIS v3.0 (Cable Modem)	120-160 Mbps	15 – 20 MBps
Uni-DSL	200 Mbps	25 MBps
VDSL ITU G.933.1	200 Mbps	25 MBps
VDSL ITU G.993.2	250 Mbps	31.2 MBps
FiOS BPON (G.983)	155-622 Mbps	19.3 – 77.7 MBps
FiOS GPON (G.984)	1.2 – 2.4 Gbps	155.5 – 311 MBps

FIOS (Fiber to the Home)

The elections of 2008 became a drastic change in newsgathering. FTP (File Transfer Protocol) was used more than ever to feed video. Handheld videocameras capable of High Definition video brought street protests and every word, every stumble and every slip-up to sources from the BBC to
www.youtube.com
and there is no sign of user-generated video slowing down anytime soon. While several people would like to give “bloggers,” or “internet journalists” less rights than mainstream journalists, it should be noted that the founding fathers kept the 1st Amendment rather vague. And so far, judges seem to uphold the rights of anyone who practices journalism.

In addition, television networks drastically slashed their budgets for live video by installing FIOS at homes and hotels for the month surrounding the Democratic and Republican National Conventions. With broadband speeds of 20 Mbps, networks were able to install a 24-7 video feed line to be used for tape or "live shots" and still have room to run a few VoIP (Voice over IP) telephone lines for IFB, PL, and incoming and outgoing lines. The cost was comparable to hiring a satellite truck for two or three days, but the only limitation is the crews were limited to tape feeds or limited to the length of cable they can add from the location of the Fiber (Fios) drop. This means live shots would have to be within 300-1000 feet of the Fiber drop, where a satellite uplink can go almost anywhere.

IP over Satellite

It isn't a new idea, pushing data... any data over a satellite rather than using video and audio only streams. RBGAN and BGAN services were only the start, and their services (like many early Internet services) didn't always live up to the hype of how many Mb they could push per second.

Now, the number of Mbps is getting close to broadcast quality. In 2008, NSSL (and, essentially, Paradise Datacom) became the first company to push the IP streams to 3 Mbps download speeds by changing from DVB-S to DVB-S2 Modems. When the IP streams can double that in the upload speed, and IP streaming companies can bring down their *exorbitant* prices, it will be likely that satellite trucks will start to be replaced for many standard-definition broadcasts.

The "Big Switch"

By now, unless you've been hibernating or had your head in a hole for the last two years, you have heard that U.S. Broadcasters must switch off their Analog signals and may only transmit in Digital.

However, there are some flies in the FCC's ointment. First of all, they didn't demand the switch of low power stations. And they didn't demand that new tuner boxes must be able to tune in analog as well as digital.

So 2,600 low power stations across the country have banded together and essentially have thrown a "yellow flag" asking a federal judge for a reprieve. Their actions are unlikely to work, but are an example of how technology is changing.

Analysis of Different Formats and the Bandwidth Requirements

Format or Common Term	Description	Bandwidth
Ultra HD (NHK)	(7680x4020)	(?) Introduced at NAB
High End	4k at 24 FPS (4096x2160)	About 7 Gbps
	2k at 24 FPS, 12-bit (2048x1080)	About 7 Gbps
Low End	2k at 24 FPS (2048x1080)	3.0 Gbps
("Super, Full, or True") HDTV	1080p (1920x1080)	3.0 Gbps
HDTV	1080i (1920x1080)/720p (1280x720)	1.485 Gbps
	480p/576p	540 Mbps
SDTV – Digital	480i/576i	143-270 Mbps
SDTV – Analog	525/625	5 MHz

It's important, when talking about high definition to remember that the first television signal ever broadcast was a scan of 8 lines of resolution. When developers made the second generation, they put in 16 lines of resolution. And they called it *high definition*.

They would be shocked to hear the Japanese have introduced and shown that it is possible to scan 4,020 lines of resolution.

However, looking at the bandwidth requirements at the right side of the chart above, it's easy to see why it will be hard to push higher and higher definition signals. Bandwidth today is mostly available in the three bottom formats in the chart, and Gbps speeds are just becoming practice rather than just theory. And Terabytes, which were once theoretical, are now available as a hard drive, for only two hundred dollars.

We are now reaching the Petabyte age, where websites (collective efforts and collaborations) like www.ancestry.com has now reached a half a Petabyte. Since most websites only started in the early '90s, that means www.ancestry.com reached this size in less than 20 years.

Pervasive Computing

Although this sounds more like a Star Trek fantasy, the future is here and so is wearable computing. The biggest trend today comes in the form of a blackberry, where the cell phone and internet combo unit has become so much a part of our lives we have come to calling the unit a "crackberry" because of its addictive use. The truth is that people with these blackberries or palm pilots have become so used to depending on the units for so many things, they have essentially "melded" with the units. People have added bluetooth for wearable earpieces, they add "bling" to their blackberry (dressing them up or protecting them like small babies or children).

In addition to their use in the television and satellite industry, people are downloading videos and audio, and are able to share with other users in "ad hoc" mode when their small computers are within reach of each other. Video and Audio file sharing are only in their infancy. P2P, or Peer-to-Peer, has by its nature tried to avoid perpetual shut-down by copyright holders. This has lead to a whole new idea in file storage, and that is through shared processing power and shared storage.

Cloud Computing

For most of our lives, information and entertainment came from sources such as CBS, ABC, and NBC. While these three have kept a lot of our attention, information and entertainment is increasingly coming from another place, "the cloud."

In this cloud, we can store our pictures on flikr or facebook, we can order food from SimonDelivers.com or make reservations at our restaurant from our iphone. We can watch our favorite TV shows on hulu.com or listen to radio stations from around the world on liveradio.net.

For information, we contribute to user-generated, open-source websites like youtube.com or wikipedia.org and add to this cloud. Old forces such as CBS, ABC, and NBC also contribute to the cloud, store their information there, and now use user-generated content in their information gathering.

The cloud is what Ray Kurtzweil was trying to call (in 2005) a worldwide, collective intelligence in his book The Singularity is Near. As of the writing of this version of the SNG Training Manual, there are basically three main kinds of cloud computing:

1. Utility computing. Amazon.com was one of the first out of the gate, offering hard-drive storage of 1 Gigabite for $15 a month. Their success in providing virtual machine instances, storage, and computation at pay-as-you-go utility pricing was the breakthrough in this category, and now others are quickly trying to catch up, including software giant Microsoft. Developers and producers seem to be the first major users of this type of cloud computing. The biggest winners just might be anyone involved in working with open source software, books, and product development.

2. Platform as a Service. One of the best examples is probably Google.com itself. While Google and its applications used to be written by its own people, it has moved to “the cloud” in that Google's success is only possible because there are people who make sites for you to visit, pictures for you to see, maps for you to follow, and videos for you to watch. Google is very much an open-source company, in that they depend on their users to contribute and help them become better.

3. Cloud-based end-user applications. Any web application is a cloud application in the sense that it resides in the cloud. Facebook.com, Twitter.com, Flickr.com, Photobucket.com and virtually every other Web 2.0 application is a cloud application in this sense. (Web 2.0 is usually defined as a “user-generated” web site or web application.)

These applications can also refer to any application that resides on a server-farm on a general format such as spreadsheets, word processing, even email. 8 Years ago Apple founder Steve “Woz” Wozniak announced that he could fit his new computer in his pocket. He then pulled out a flash drive. No more did anyone really need a sole computer terminal, only to lose all of their information when a laptop drive crashed.

Now that we in the Satellite and Television industry are moving to non-tape formats, we will take our P2 cards, XD discs, or Red-Camera hard-drives and send much of our video into “the cloud.”

CHAPTER 11
Proper Cable and Fiber Termination Techniques

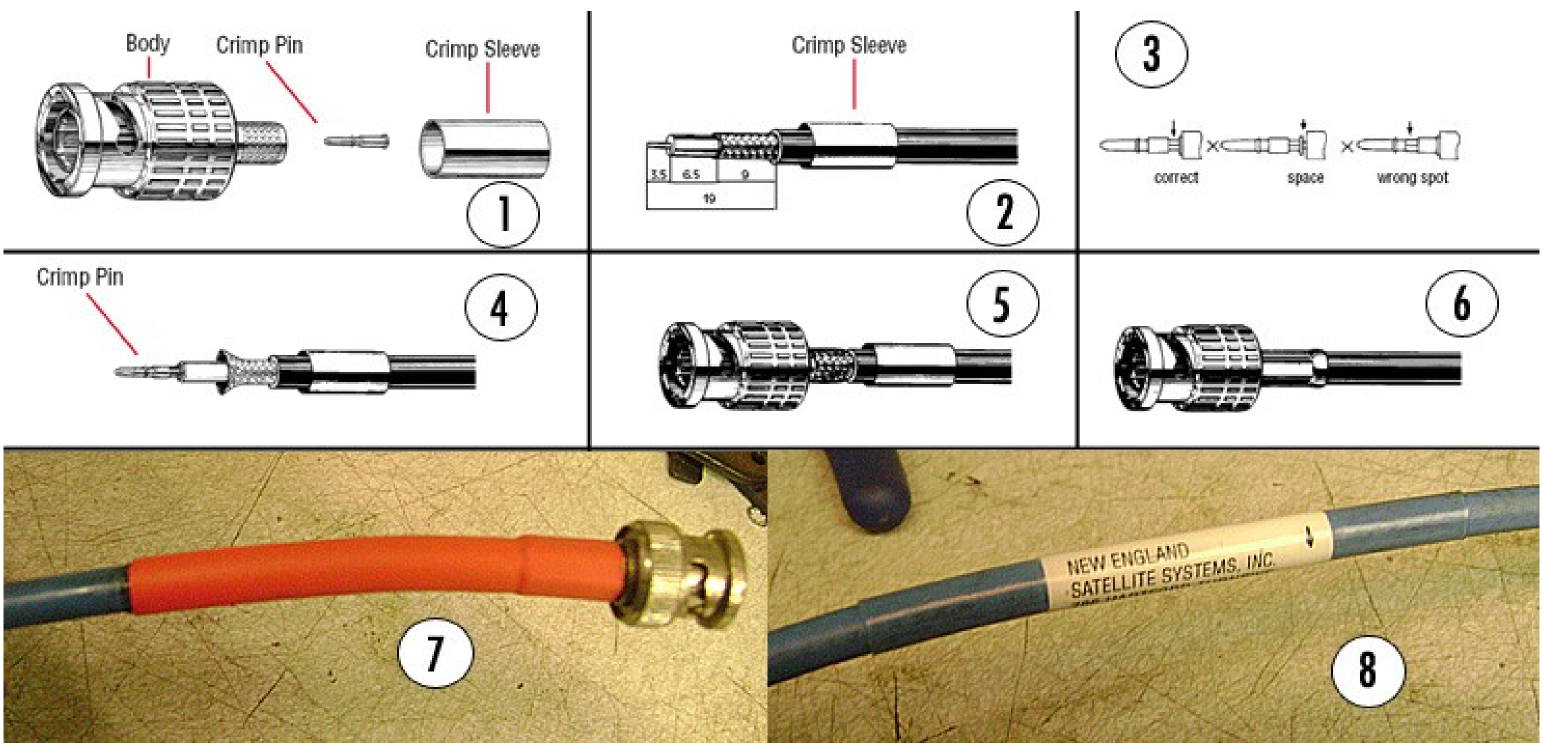
BNC Termination

The three most popular companies for 75Ω BNC termination here in the United States today are Kings, Amphenol, and Canare. These companies are favored because of their high quality, availability, and price. Companies create proprietary crimping tools to go along with the sales of their BNC cable "ends," however it is not always entirely necessary to use proprietary tools. The tools and the dies used to crimp the BNC barrels onto the ends of the cable are very expensive. Buying a special cable stripper is also pricey, but the time you will save in the years and years of use will be worth it. Take care of your tools and they will last a long time.

The cable strippers often need to be tested on a scrap piece of cable to set up the blades to the proper height. Set too deep, the strippers will cut into the wire. Set too shallow, and you won't be able to pull off the plastic or rubber jacket from the cable. But if you set up a stripper properly, you will be able to terminate hundreds of cables in a day.

More than half of the problems at a live television site are from poor cable termination. Some of the other problems are due to poor BNC barrels (a common female-to-female BNC adapter).

But consider this: Even a *good* termination can result in a 0.3 to 0.5 db loss. This is insignificant if there are very few terminations and barrels in a video cable run. But it does go to show there is loss in even the best termination job. Ten good terminations could result in losing half of your signal! Corrosion and oxidation will lead to more loss as the cable is exposed to elements or even air, and that loss will increase. So looking for ways to protect the cable with boots, shrink tubing, or even anti-corrosion sprays will extend the life of any coax cable. Good terminations have been known to last 20 years or more. However, exposure to salt used on roads, or salt exposure during the horizontal rains of a hurricane have been known to corrode a cable in a week or two. Cut back 3, 6, or 10 feet, and terminate the cable with new connectors. Fix the cable jacket with a silicone, epoxy, or "liquid electrical tape" and let the substance cure overnight.



1. There are three parts to most professional BNCs, the Body, a Crimp Pin, and a Crimp Sleeve. I also

like to add shrink tube, to help protect the cable and BNC. Different colored shrink tube can be used to “color code” your wires. I also try to add a label to identify the cable is mine, and clear shrink tube to protect the ID label.

2. Slide the crimp sleeve over the cable. Use either the proprietary wire stripping tool, or use non-proprietary tools being careful to strip the outer jacket, the braided wire, the dielectric (white core of cable insulation) and the center conductor... doing all of this without severely nicking the center conductor, making a mess of the braided wire, or damaging the outer jacket or dielectric. Like I said before, the proprietary tools are expensive, but will pay themselves off in the long run in the time you will save.
3. The center conductor of the cable should be in the most contact with the center pin of the BNC. Too little, it won't hold, too much, and the center pin hangs out too far and you risk shorting the connector, risk the pin coming off, or risk bending the center conductor or pin. Some engineers also add solder at this point, but a good crimp will do the same if you take care of your cables.
4. Flair out the braided wire. If you have trouble with the aluminum wrap, take it off the white dielectric, too.
5. Push the body carefully down onto the wire. The body will audibly “snap” or “click” into place. If you jam the pin, bend the wire, or bend the center pin, you will probably have to start all over with new pieces. You have damaged the ones you are working with too much to make a good, long-lasting connection.
6. Slide the crimp sleeve over the braided wire. You may need to trim the braided wire so it doesn't stick out. Once the crimp sleeve is in place, you should not see any braided wire. If you do, you cut back the outer jacket too far. Place a second crimp on the crimp sleeve, especially if you plan to put shrink tube over the crimp sleeve.
7. Push the shrink tube up over the crimped crimp sleeve, heat it up to shrink it down.
8. Place a label on your cable. (There are many methods to labeling cable.) Putting clear shrink-tube over the label will protect your label.

F-Connector Termination

F-Connectors are typically used on RG-6 cable, and can be found in neighborhood hardware stores as well as large lumber and electric supply chains such as Lowe's and Home Depot. The most common F-Connector crimp tools and F-Connectors these days are compression-style, and are usually purchased in bags or boxes of 50 to 100.

There is very little difference between the best F-Connector and the worst F-Connector. However, your technique is still important, as well as how well you protect an F-Connector against the elements. F-Connectors used on satellite dish LNBs and other outdoor connectors such as home cable or MATV, SMATV, or other mobile cable systems will see corrosion on the fittings in as little as a few days if you do not protect the F-Connector from the elements. There is an anti-corrosion spray, you can use silicone, putty, clay, or any other element that will keep water out of the fitting. Buying something that can be easily removed is often worth it. And some sprays, silicones, and putty has lasted out in the rain and freezing cold for more than 10 years. It's worth the research to see what works best for your area, and satellite or cable installers are usually willing to give up that information and places where you can buy the products. They might be willing to sell you half a can of whatever they have if you only need to make a few connections.

XLR Termination

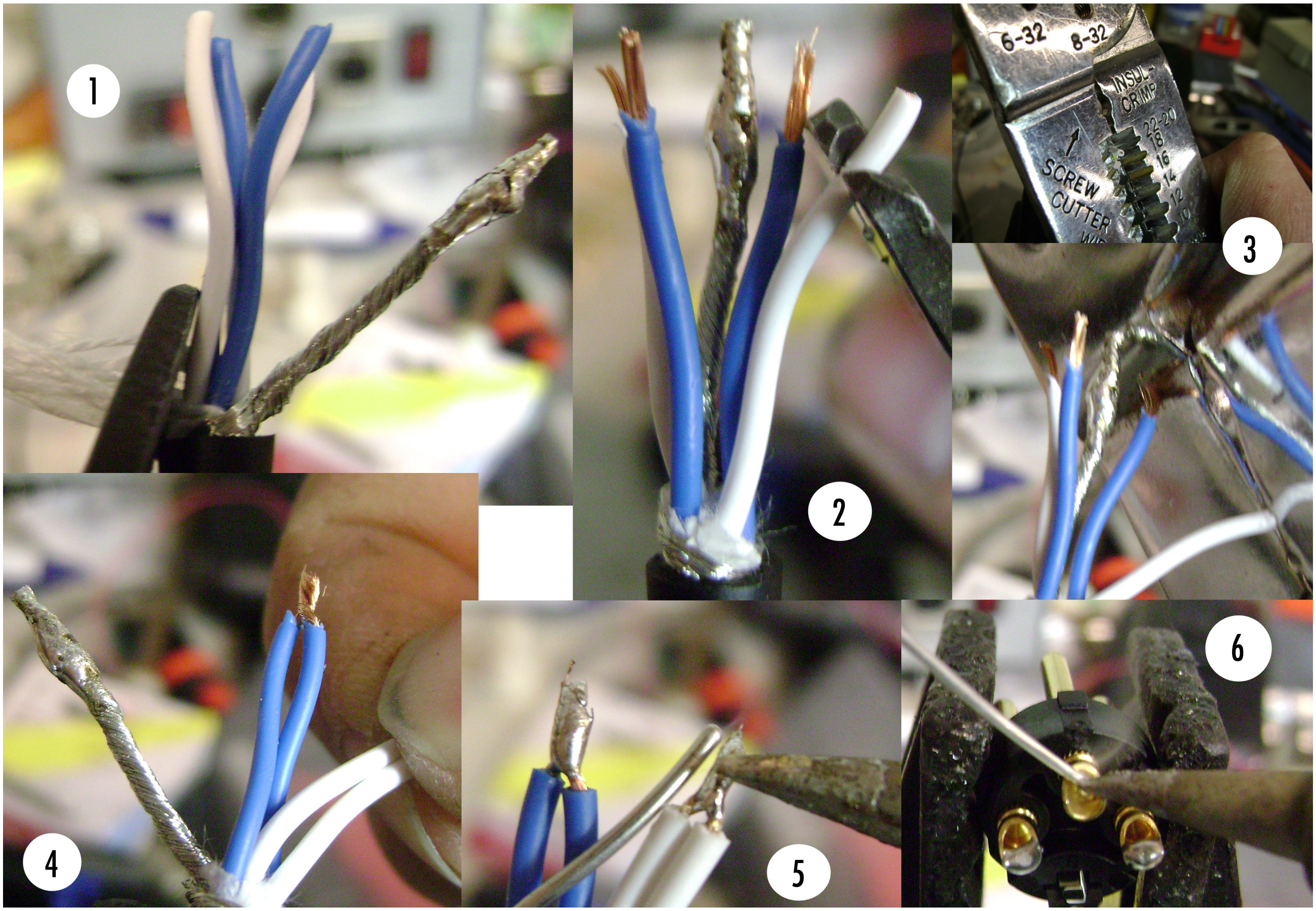
Moving up to more and more complicated connectors, the XLR connector is typically a soldered connection, with exception of the Amphenol Company out of Australia who makes a twist on (or smash on, if you want) connector for engineers in a hurry. Neutrik now also makes a “smash-on” connector, but they appear to be a new product. Smash on connectors (no kidding, they actually sell a “smasher”) are typically used by engineers who have to set up hundreds of audio runs in a matter of hours. In situations like this, these lines are typically thrown away or recycled at the end of a shoot anyway, so soldering would be a waste of time. These are meant to be temporary solutions, and not a solution for a cable meant to last for years and years.

Most of the broadcast industry uses XLR connectors from the companies Neutrik and Switchcraft, although I am starting to see more MilesTek (a company out of Taiwan that is somewhat adaptable with some Neutrik connectors). Neutrik are top of the line, certainly raising the bar for all XLR connectors by using gold or silver in their 3 inside pins or pin holes (I later call them “leads”). They also compress the cable and hold it in place much better than other connectors. However, Switchcraft jackets last longer. They last much, much longer, and take a lot more abuse. In fact, I've seen Switchcraft connectors that are older than me, and they still work. They have a lot of loss when they get this old and abused, but they still work. You might still find Canon-brand connectors, but I wouldn't suggest their use for the broadcast industry. They have screws that disappear, they weren't made to take corrosion from weather, and the company makes awesome lenses... but not awesome XLR connectors.

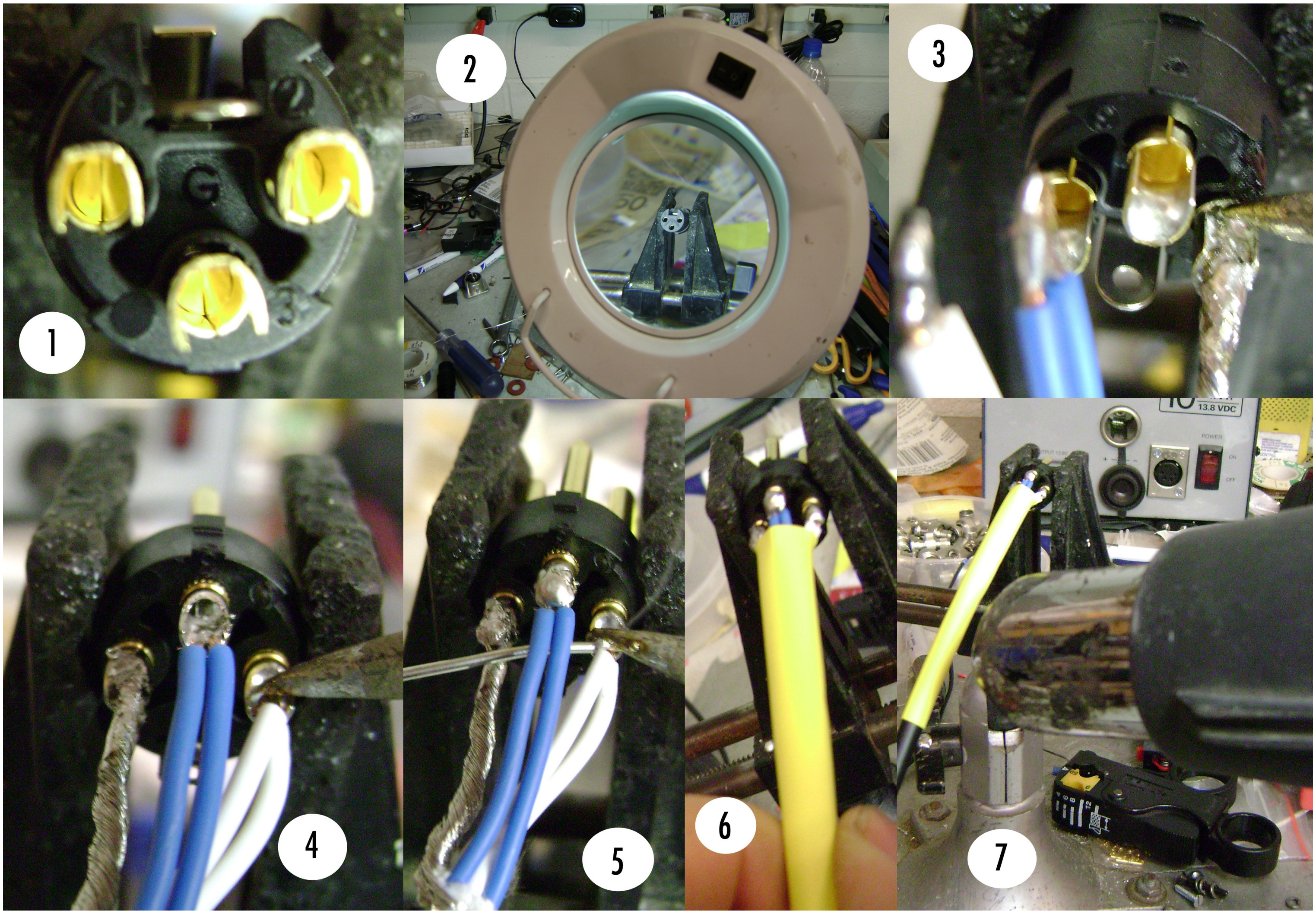
Cable choice is also important. If you are using this for short jumpers (I make up a 50' audio cable in a step-by-step demonstration below) then braided cable with a braided ground shield is the best. Canare makes the cable I am using below. There are many others, and some of them are listed at the end of this book.

The following instruction guide will help you terminate your first XLR cable. Even an experienced satellite truck operator might find a good tip here. Mike Hall gave me the idea of using Liquid Electrical Tape in one of the steps. I'm still playing with the best way to make this work... (There's drying time involved in this step.)

1. Begin by cutting the edge of the cable off so it is square. It should show no signs of corrosion if it is a used cable. If you detect corrosion, cut the cable back another foot or two. I have had to cut cable back up to 15' to be rid of corrosion seeping back into the wire! Slide the boot of the connector (I'm using Neutrik-brand connectors in the first example) on first. Slide a piece of shrink tube on next. You don't have to use shrink tube, but it will help the cable last longer and help to identify the cable. It is possible to order shrink-tube with your name, number or even company logo. It is possible to order shrink tube from the DYNO company where you can print on shrink tube with a label maker.
2. Using a razor blade, a snips, or a wire cutter to cut off the rubber jacket from the cable. Cut only the rubber jacket, and do not nick or cut the braided wire underneath. It takes some practice, so take your time at first. If you make a mistake, cut the wire off square again, and start from the beginning.
3. Pull the rubber jacket off the end of the cable.
4. Undo the braided wire, being careful to not tear the wire.
5. Your undone braided wire should look something like this. If it doesn't, cut the wire off and start over again. You have lost a lot of your ground. And while this is fine for sending regular audio down your wire, a bad ground will cause you problems when you use the cable for IFB, or PL lines using 3-wire communications by company equipment such as RTS (Telex) or Clearcom.
6. Twist the undone braided wire so that it essentially creates one wire.
7. Before you go any further, put some solder on the twisted ground wire to keep it from getting frayed, or untwisting. It is too hard to get it twisted as clean and as well as you did the first time! Again, if you screw up any of these steps, cut it off and start over! (You may want to start with a 50' foot cord on your first try. You'll get plenty of chances to get it right and start over if you need to start over.)



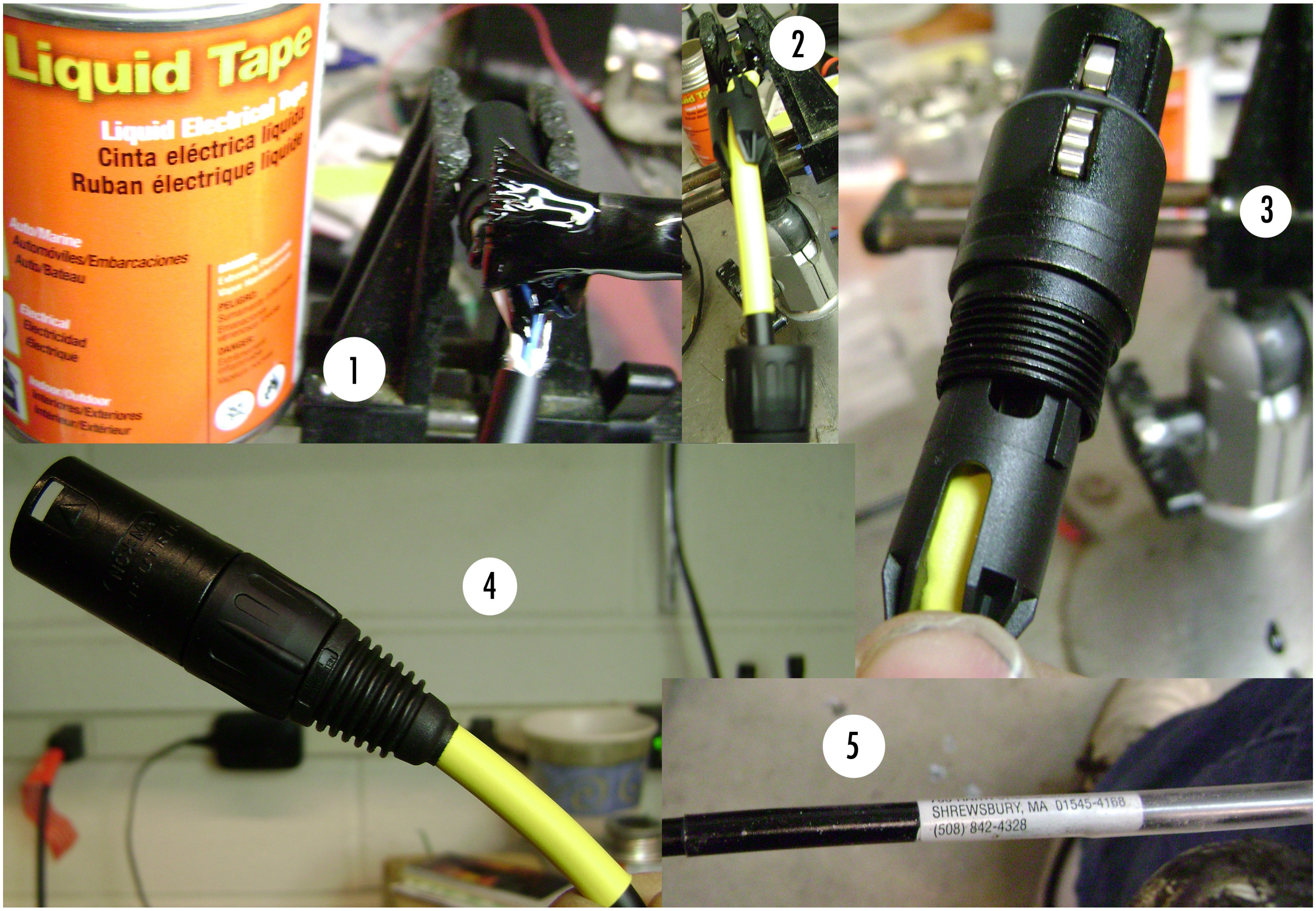
1. **1.** Pull back the paper and twisted cotton or plastic contained inside your cord. The paper is there in part to keep the plastic clean and keep wires in order during the company's winding process. The twisted cotton (along with the braided ground wire) is there to provide strength to the cord. The connector itself was made to provide this strength from the cable to the termination, so there is no reason to keep it. It will just get in the way.
2. **2.** Use a wire cutter or “nips” to cut and pull the plastic/rubber jacket off of the wire. This particular wire has two blues (often black in some cables) and white (often red in some cables).
3. **3.** If you have trouble using a nips, try using a wire cutter. Spin the wire cutter on the wire while squeezing to cut the jacket, then squeeze and pull the plastic off the wire. Like many steps, this takes some practice.
4. **4.** Since this audio cord comes with two blues and two whites, you will need to marry them together. Twist the copper ends together.
5. **5.** Place some solder on the blue and white wires to keep them from unraveling. Remember that solder only needs to get hot enough to melt. Don't over-melt the solder! There is a flux, and sometimes a resin or epoxy present in many solders, and you shouldn't burn it out or it won't hold as well. You also have to wait a few seconds as the solder cools before you move on to the next step. If the solder hasn't turned cloudy, it is still a liquid!
6. **6.** Your wire has been prepped at this point. Now prep your XLR connector by placing small dabs of solder inside the back side of the connectors. Keep in mind your soldering iron can not stay in contact with the XLR connector for a long, long time. You will melt the plastic connector and the XLR pins will no longer line up! Also keep in mind that the XLR in this picture is gold-plated and runs for $4-$6 *per connector*! Melting them becomes one very expensive mistake after another.



1. Take a good look at the XLR connector (this is the inside of a female Neutrik). There is a number 1, 2, and 3. And you must pay attention to these numbers! Number 1 is always the Ground. Ground is usually the one wire that doesn't have a jacket on it. Ground used to touch the outside jacket of the XLR cable, but that is not true anymore. Do not intentionally Ground this wire to the outside jacket of the XLR! Like I said in an earlier step, this wire could carry voltage in IFB or PL uses. You will send that voltage into the jacket, the I/O panel of the uplink, and could send it into other audio lines. Number 2 is across from the ground and is the positive (hot) lead. This is where the white (red) wire will live. Number 3 is the Negative (Neutral) lead where the blue (black) will live. *No matter what else you hear, this is the standard.* If you don't adhere to this, you will cause problems with yourself and fellow operators into the future. It also means you will have to take apart the other end to see what you or the other engineer did, rather than simply replacing one end of the cable. Not fun if you're in a hurry. I was told this was the original standard so that if you needed to, you could quickly pair 3 and Ground together. When I worked out on the east coast, Audio and TV engineers always remembered the XLR standard by remembering “George Washington Bridge” which is G-1, W-2, B-3.
2. If you have trouble seeing things this small, you may want to look into getting a magnifying mirror with a light attachment.
3. Solder the Ground wire first. It is the only wire you can't hold with your fingers as you solder.
4. Solder the Blue and the White wires in place. Check to make sure they're in the right order. And remember the female XLR connector will be the opposite numerical order from the male XLR connector!
5. Once you're sure you're in the right order, fill in the XLR with more solder. Some engineers choose to

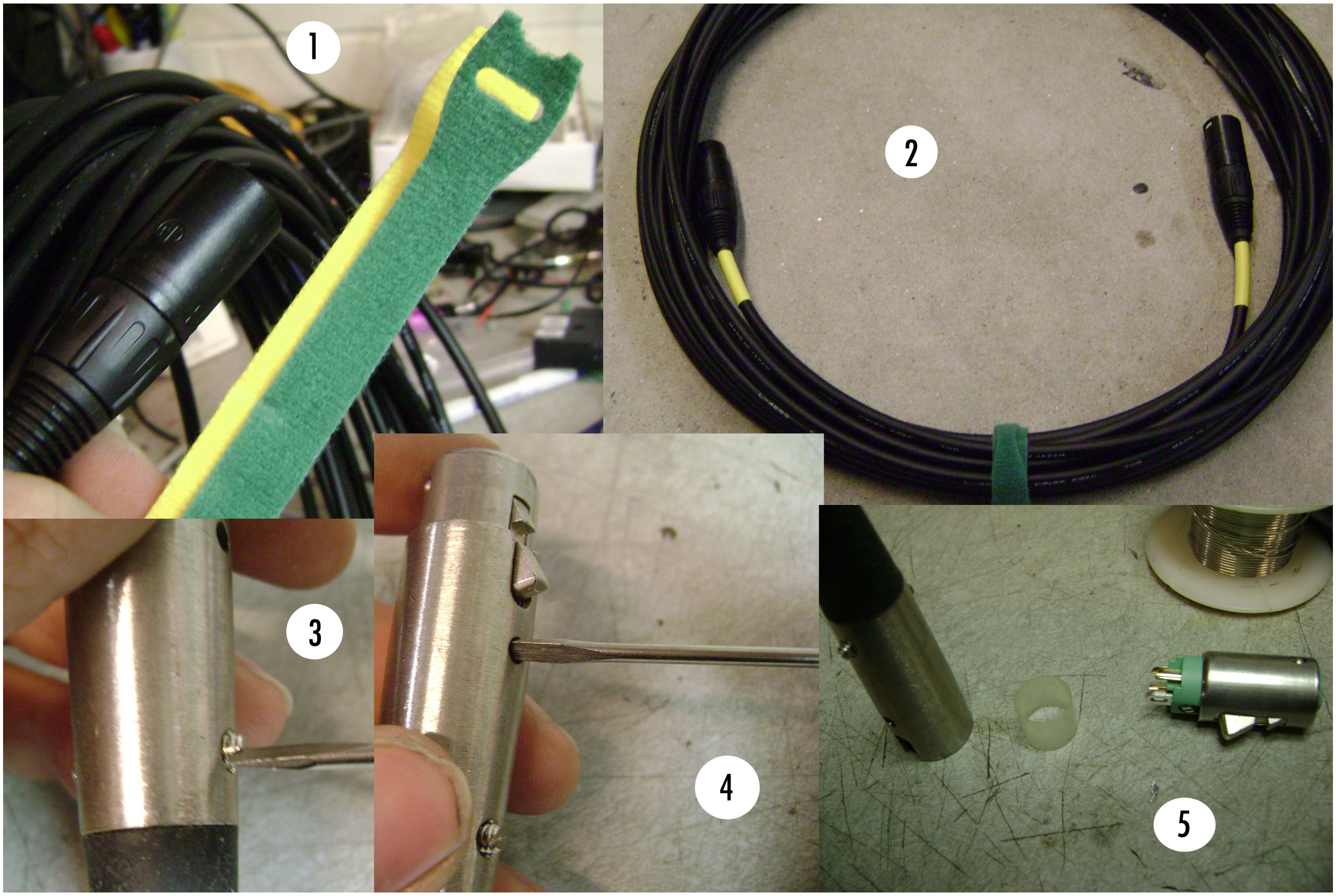
skip this step, either assuming less solder will mean less chance of impurities between the wire and the gold/silver leads or because they're in a hurry. Or, maybe they're cheap and they're saving solder. However, like I mentioned before, most solder contains flux, epoxy or resin, and the more glue to hold your wire in place, the better. Besides, having more surface area in contact with the solder means more area making contact between the wire and the XLR pin.

6. Side your shrink tube up over your work.
7. Heat up the shrink tube with a heat gun. Don't overheat it or it will split. Heat it just enough so that it shrinks down to the size of the cable or whatever you are covering.



1. Mike Hall suggested using Liquid Electrical Tape (it comes in a yellow can in the midwest, and in a red can on the east coast, and I don't know why) on the connections to better weatherproof them. You need to let this stuff dry, apply another coat, let it dry. But do as I say, and not as I do.
2. Place the pressure/inside piece (Neutrik calls it the “chuck”) over the cable There is a slit in it so you don't have to put it on until now.
3. Slide the chuck, which will push the insert ahead of it through the XLR housing until you reach the end of the connector. The female (pictured in #3 above) is a little trickier than the male connector, in that you may have to spin the connector 180-degrees so that the latch falls toward the floor and allows you to push the chuck and the insert all the way through.
4. Twist the end cap (Neutrik calls this piece the “bushing”) on to the connector. Hand tight is good enough to get a seal. Don't over-tighten or you won't be able to get it apart in the field.
5. Before you get both XLRs on the cable, you may also want to think about marking or identifying your cable in some way. You can place clear shrink-tubing over the company name, address and number, such as I have done in picture #5. You may choose to engrave or order custom XLR

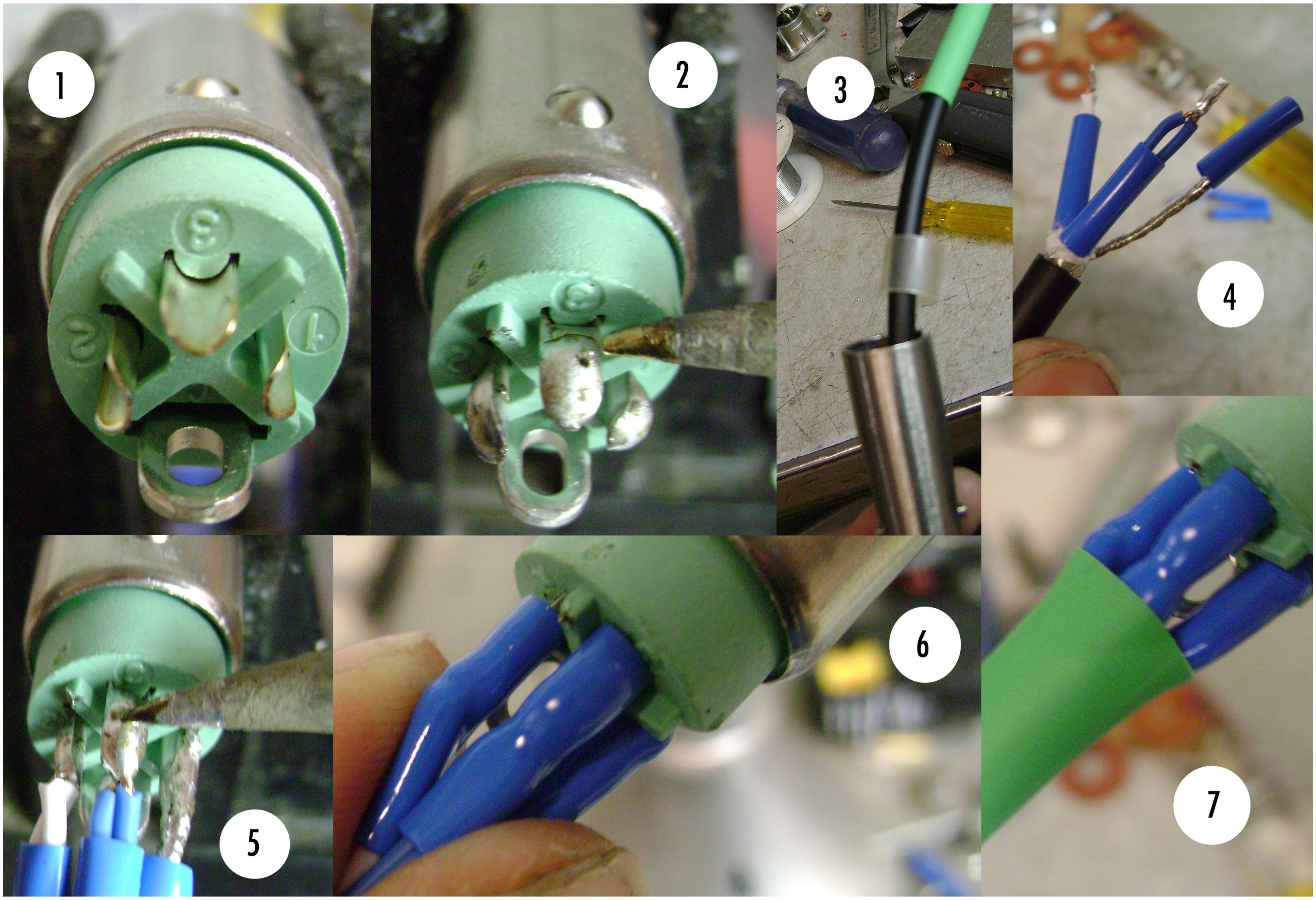
connectors with you company logo. Alan Maretsky orders different colored end caps (bushings) to help him identify his cables. When you're packing up for the day, it is common to get audio and video cables confused, so it's not a bad idea to identify them in some way. You may even want to mark the cables by how many feet they are, if you should choose to separate, say, 50' cables from 30' cables.



1. Use (and learn) the over-under technique to wrap your cables. The over-under technique is the only technique that allows you to quickly throw-out or unfurl cables. *Again, it is the standard amongst almost every uplink and production company across the country, and possibly around the world!* Use either velcro straps, string, cord, gaffer's tape, electrical tape, or some kind of tape that won't leave goo on your cables. Duct tape is a big no-no. It leaves a nasty, funky goo if left in hot sun, or exposed to heat, or left on the cable too long.
2. Once your cable is complete, it should look something like this. When you are done, TEST YOUR CABLE! Use a multi-meter to make sure 1 goes to 1, 2 goes to 2, and 3 goes to 3. Hook it up to a tone generator, or a cable tester. Also test the audio cable using an IFB or PL system and make sure you don't get cross-talk between channels 1 and 2. Store the cable in a place that it won't get wet or damaged. One of the most common places XLRs can get damaged is by getting slammed in a bunk door.
3. Without going through all of the steps for a Switchcraft connector, I will go through the differences. Turn the cable tension screws as far out as they will go without falling out.
4. Take the Switchcraft connector apart by loosening the set screw. It is set in reverse, but turns like a regular screw! Turn clockwise to tighten, turn counter-clockwise to loosen, and to take the connector

apart. Use the proper size screwdriver for the job.

5. There are basically three parts to a Switchcraft XLR. The housing is aluminum, it has a rubber boot on the end, tension screws to hold the connector onto the cable, and there are two tiny metal flanges that the set screws press against to place pressure on the cable. DO NOT TAKE THE RUBBER BOOT AND THESE METAL FLANGES APART AND OUT OF THE HOUSING... YOU WON'T GET THEM BACK IN... AT LEAST VERY EASILY!



1. Notice the Switchcraft connector has the same 1, 2, and 3. They are standard, and Ground will go to 1, White (red) will go to 2, and Blue (black) will go to 3. #1 on a Switchcraft connector is set a little deeper than the others on the female connector.
2. Place a little bit of solder in the pins, just like the Neutrik.
3. You may want to stick a small screwdriver into the end of the Switchcraft and work it around to work the rubber and the metal flanges out a little bit and loosen them up to make putting the connector onto the cable a little easier. After the connector, place the shrink-tubing onto the cable. Don't forget to place the clear plastic insulator onto the cable before you solder. This helps to keep the ground and wires from making contact with the outside XLR connector, putting hum, buzz, or stray voltage into whatever you're plugging into (or vice-versa).
4. Dan Magden suggested putting small pieces of shrink-tube on the hot lead. I added them on all three wires for effect. This would essentially do the same as Liquid Electrical Tape, but is apparently very common in the Northwest (Washington and Oregon). Both examples are not necessary, just like shrink-tubing isn't absolutely necessary, but both things show how many engineers take a lot of pride in, and would go a long way to protect, their cables.
5. Solder the wires in place. Fill in with extra solder to provide more epoxy, resin, and contact between

the wire and the XLR lead.

6. If you put shrink tube on the wires, slide them up over the connection. Use the heat gun to shrink the shrink tube.
7. Slide the larger heat shrink up over the connections, use the heat gun to shrink the heat shrink down. Pull up the Switchcraft connector and tighten the set screw first. Lastly, tighten the two tension screws. If you used shrink tube, on this sized cable, the set screws should be tight enough when you are just a little tighter than flush with the outside of the connector. If your wire is thinner than this, don't tighten the tension screws too tight or you will lose them inside the XLR connector.

* Keep in mind, when working with solder, that most solder contains lead. Always, always wash your hands when working with solder. Keep your workbench or wherever you are working with solder well-ventilated.

Fiber ST and SC Termination

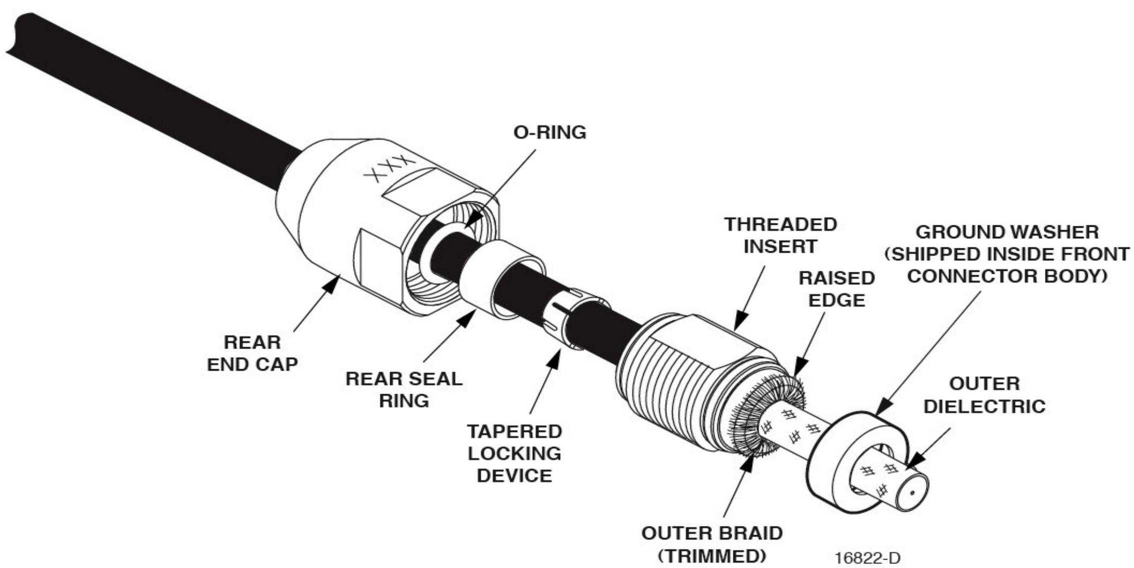
There is no doubt that Fiber is the future. It's the current, and it's the future. Once a fiber connection is made, if it is well made, it usually takes a lot of abuse to get the connector to break off. That being said, the connectors are ever-changing in style, but the two connectors, ST and SC, have become the standard. They are so much the standard, that there are adapters now made that can quickly change from one to the other with minimal effort.

The Corning company makes the most popular fiber termination equipment in the United States, and versus a $100 or $200 set of tools for terminating copper connections, fiber termination gear often runs upwards of $1,000 or more.

Triax Termination

Much more difficult to accomplish than a BNC connector, a Triax connector is basically a very, very hefty BNC cable, with two outer jackets. However, putting a Triax connector together and maintaining it is much more difficult.

By multiplexing, the camera can send audio and video signals along the Triax while the CCU can send camera control information such as exposure settings, intercom, return video, a tally light, and power for the camera.

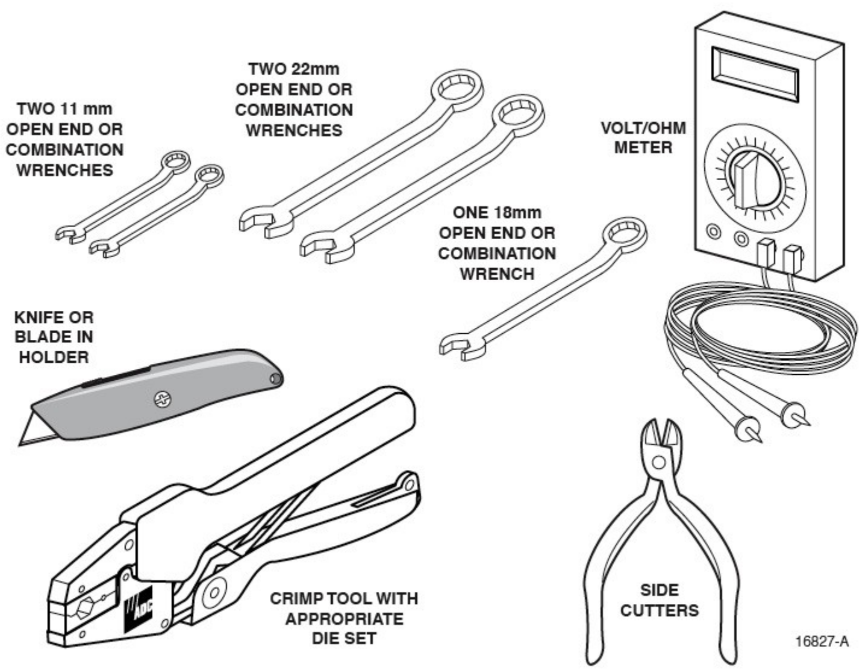


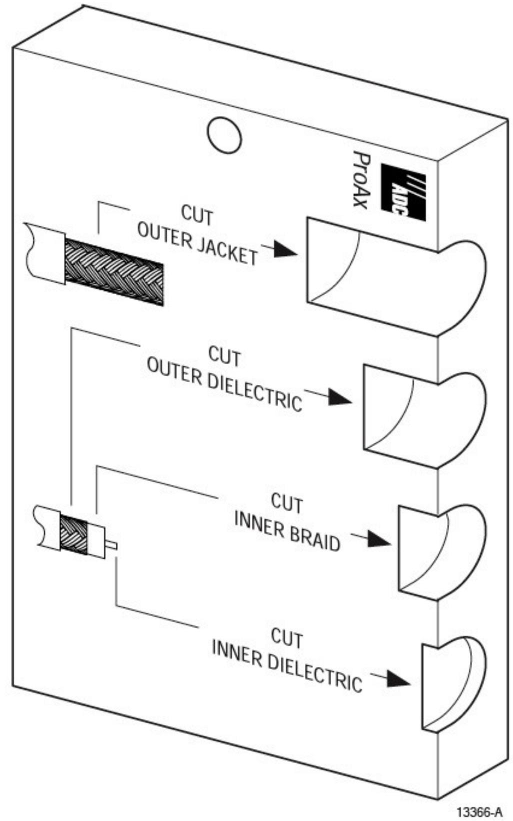
Terminating the outer shield of a Triax Connector.

There are about a dozen pieces to Triax Connectors. Be sure that you don't lose the pieces as you work on the connectors. The inner pieces or “guts” can be re-ordered, and it is unnecessary to buy the entire Triax connector each time you re-terminate the connector. ADC, Amphenol, Kings, and a few other companies build Triax connectors, but it is extremely unlikely that the pieces work interchangeably.

Keep spare parts around, if you have them. Use the rubber boots for the ends if they are available. ADC now ships the boots with all of their new connectors to help you keep the ends from getting corroded.

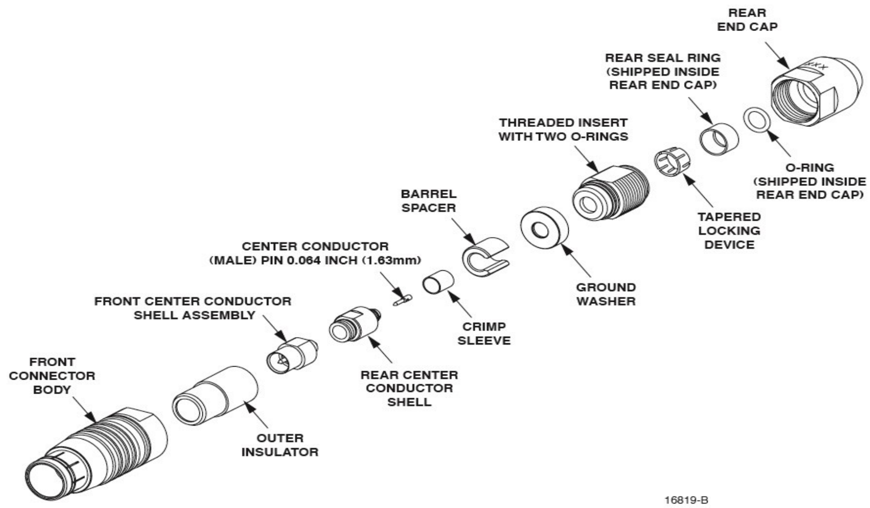
Tools you will need





Pair of Dikes
Wrenches (in a pinch, a small- to medium-sized crescent wrench will do)
Multimeter (volt/ohm meter)
Box cutter or Stanley knife
Small side cutter or small wire utter
Proper crimp tool with the proper die set for the center pin *and* crimp sleeve
Cable strip gauge to determine how far you need to cut back the outer jacket of the cable

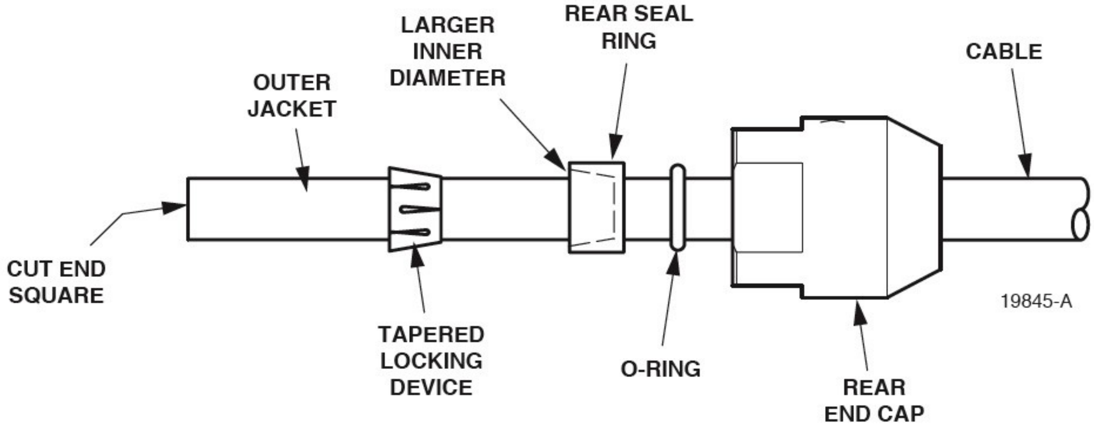
Notes on Repairing and replacing only “the guts” of a Triax connector



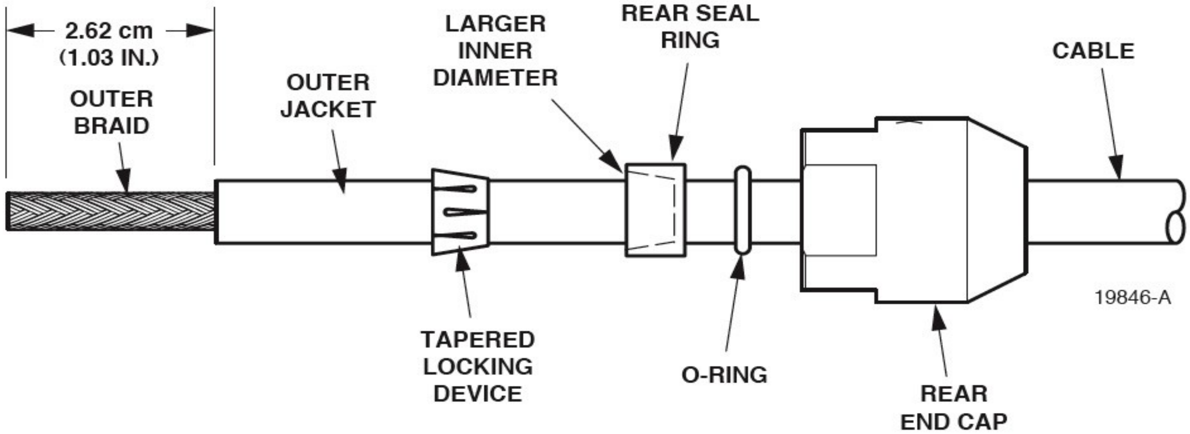
Be sure to save all of the parts, and place them in order. Only the center pin and the crimp sleeve will be thrown away when you are done.

Look for excessive wear, corrosion, or broken pieces that would warrant you needing to buy a complete assembly. If you do, keep as many good pieces as possible. You might need them later.

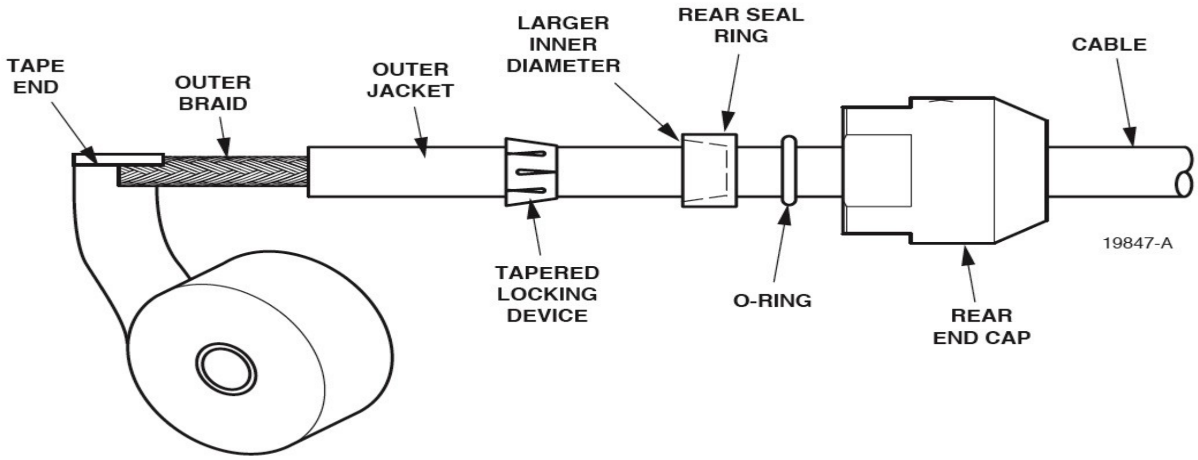
Assembly Procedure for ADC Triax Connections



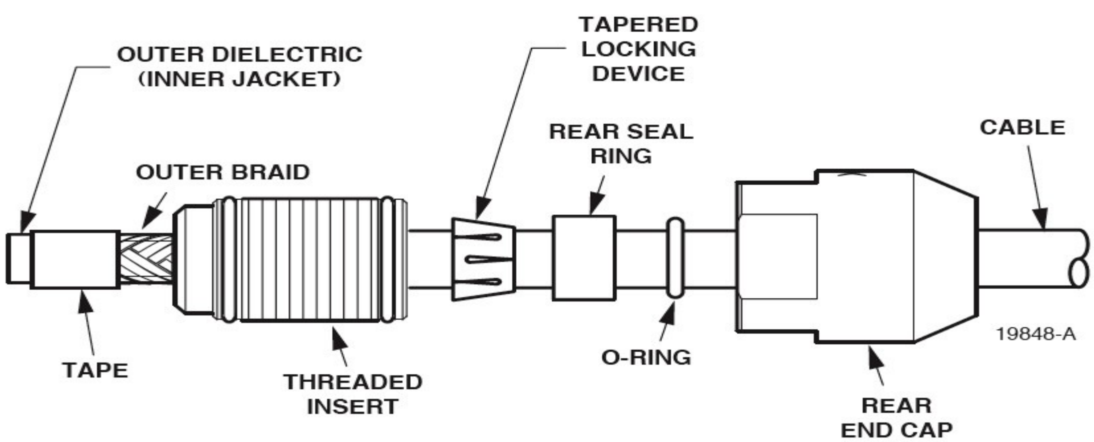
1. Place the protective boot for the Triax end on the cable, if you have one available.
2. Use a wire-cutting pair of dikes to cleanly cut off the end of the cable.
3. Slide the rear end cap onto the cable.
4. Slide the O-ring onto the cable.
5. Slide the rear seal ring onto the cable. *If the cap, o-ring and rear seal rings are loose, you may place heat shrink onto the cable at this point. It will not fit over any parts, or help to seal, but will protect the jacket of the cable and help to mark or color-code your cable if you wish to do so.



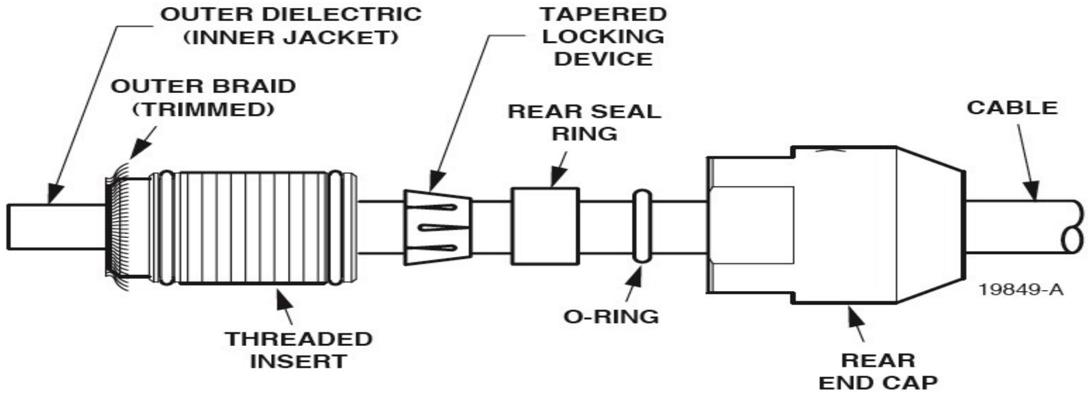
6. Using a blade, cut a 1.1 inch length of outer jacket from the cable. Do not cut into the braid, and make an effort to not mark up the braid or nick it in any way with your blade. If you have a strip gauge, or a professional wire stripper, use it. The wire stripper must be set up properly, and should not mark the braid.



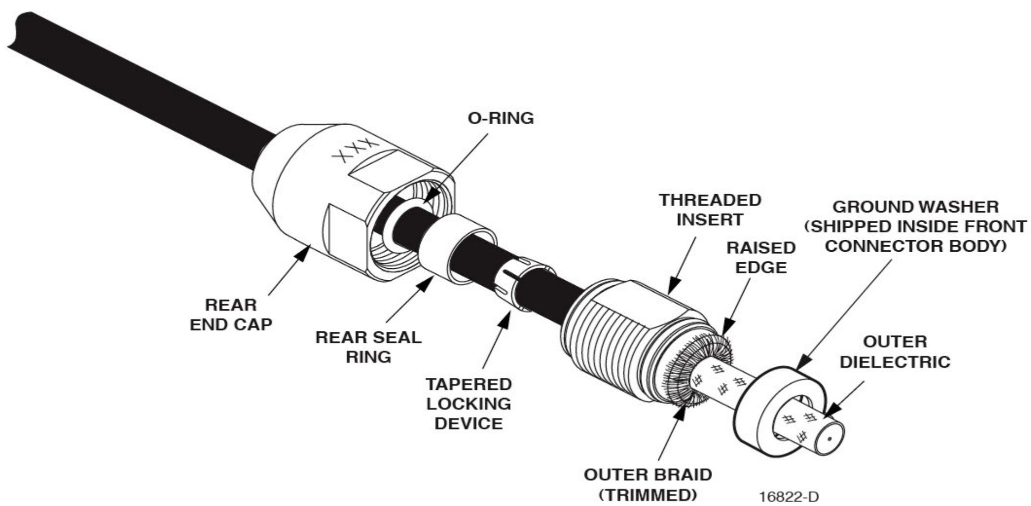
7. Place a piece of electrical tape over the braid so it doesn't become frayed.



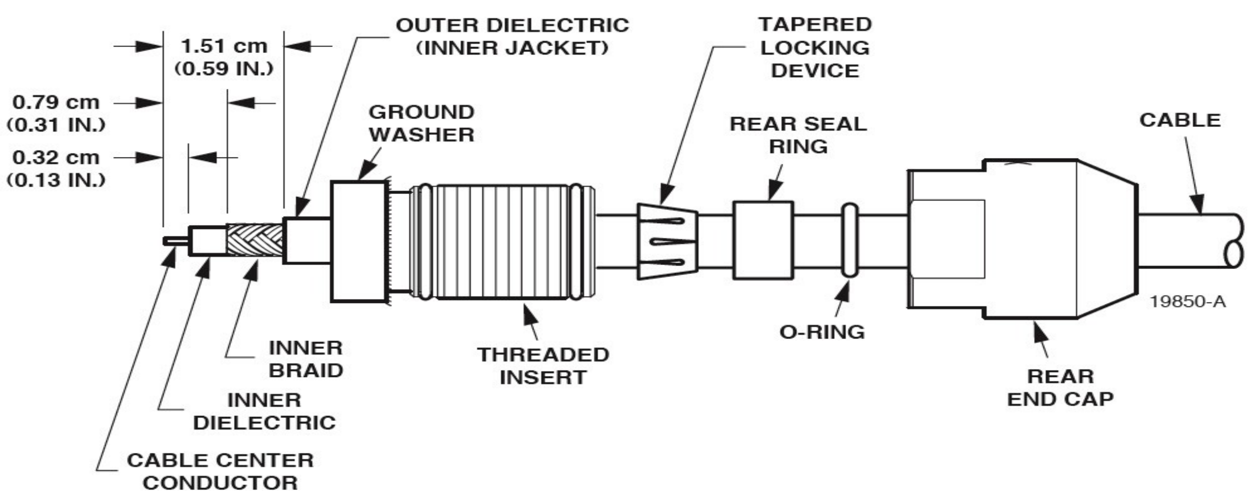
8. Push the end of the threaded insert onto the cable until it seats against the outer rubber jacket.



9. Remove the electrical tape.
10. Pull back the braid and comb it back over the threaded insert.
11. Using a side cutter or small wire cutter, trim the excess braid so it extends just beyond the lip.

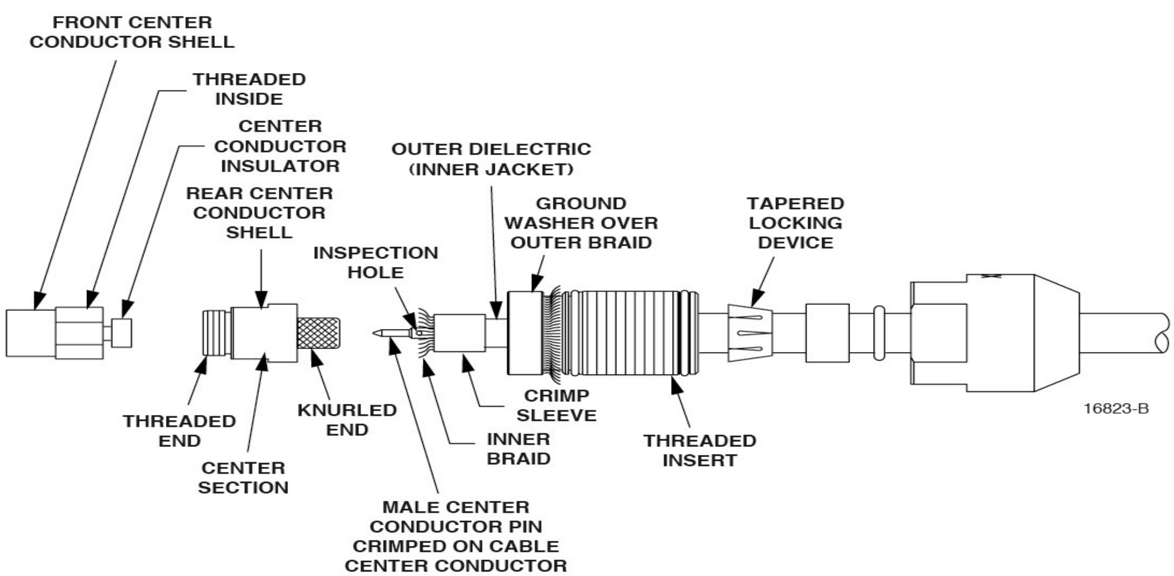


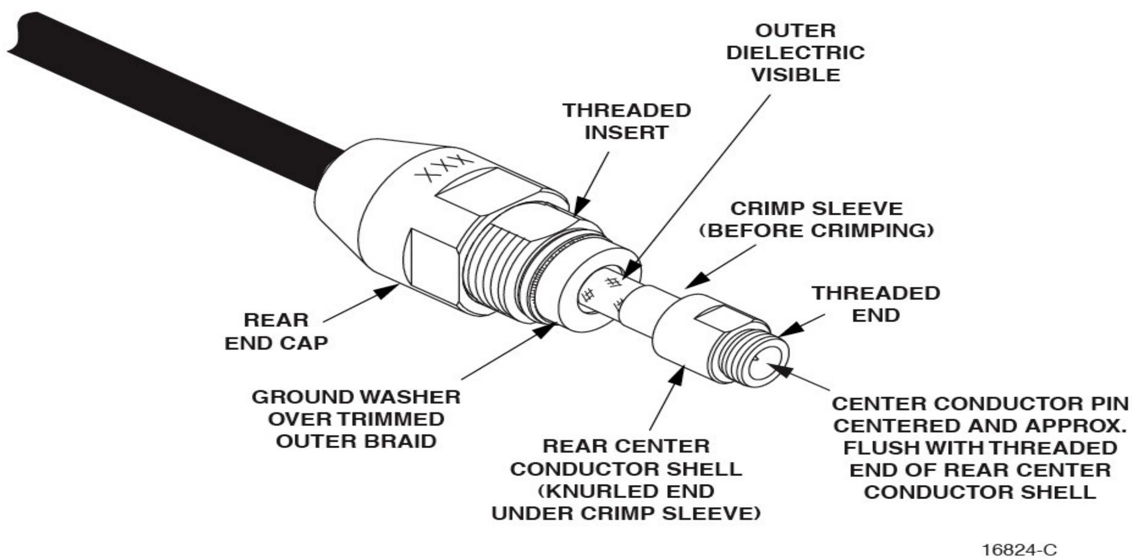
12. Slide the ground washer over the cable and push it against the trimmed braid and threaded insert.



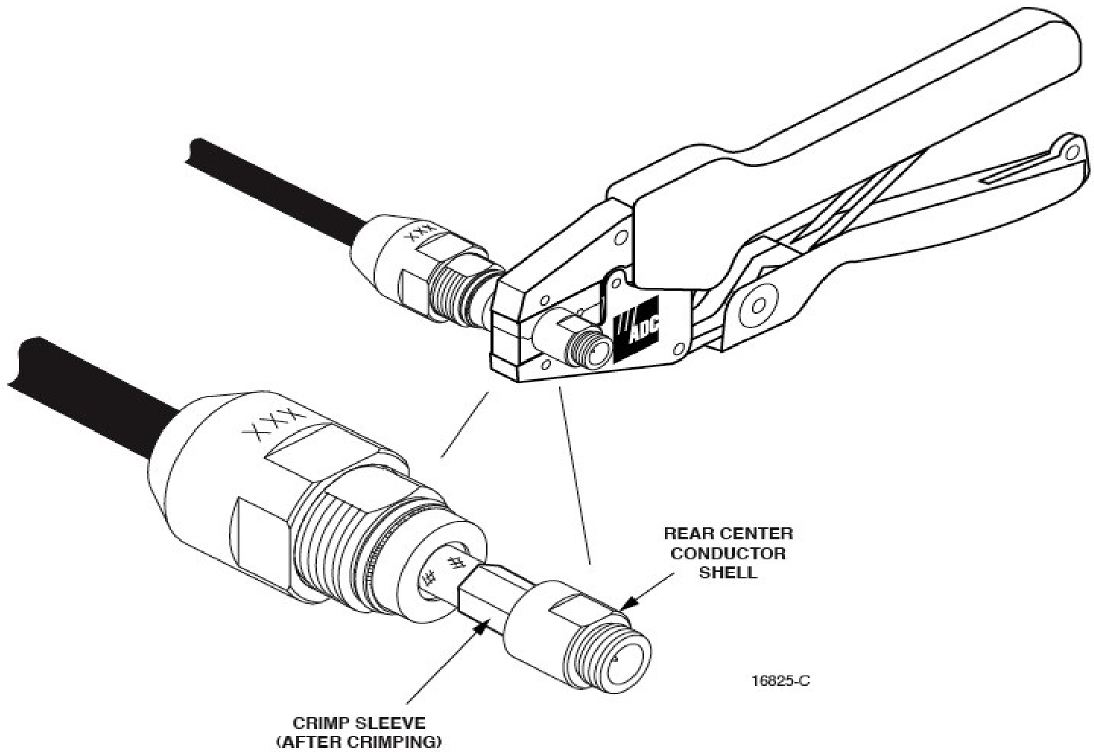
13. Use a blade (box cutter or Stanley knife) to cut back the end of the middle jacket of the cable. Either cut it from the end (.59 inches) or simply cut it at the length of the crimp sleeve by placing the crimp sleeve in place while you make the cut. You may need to remove a little more jacket to make the piece fit. Again, cut only the rubber jacket, and do not mark up or nick the braid underneath! Take

your time with this, because this cable (if done properly) could last ten years! If you have a wire gauge, use it to make sure you are cutting back the right amount.

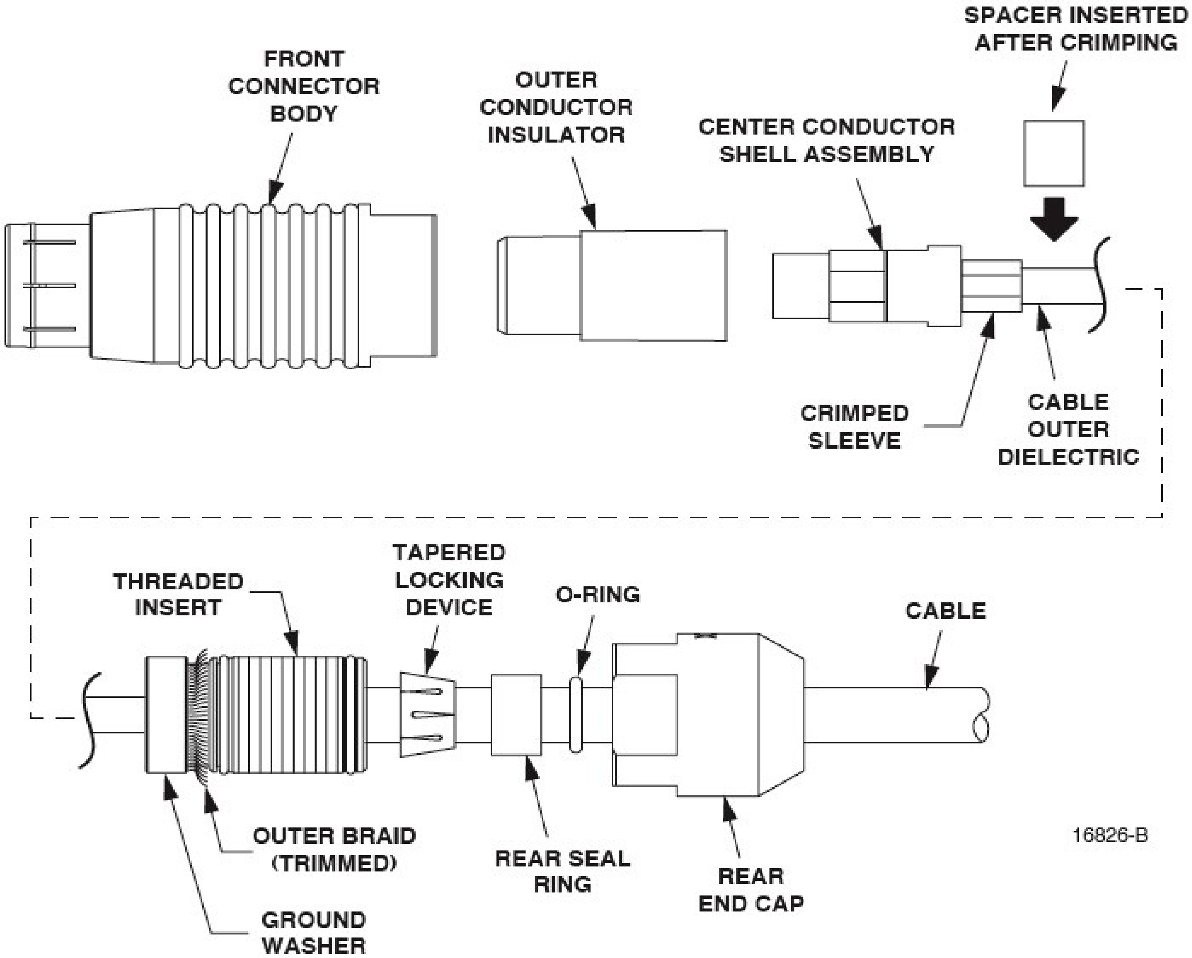




14. Place the crimp collar on the cable, but do not cut back the braid yet. Pull the braid back over the collar. Now cut just enough of the center dielectric (foam rubber jacket) to place the center pin onto the cable. You should be able to fit the entire center pin over the middle braid or solid-core cable center conductor.



15. Using the proper crimp tool and proper crimp die set, crimp the center pin. *You do not get a second chance with this step, there are no "do-overs." If you fail at this, go back to step one with a whole new set of "guts" which you will have to order!* Some center pins are long enough, you can place a crimp mark, then move the crimper slightly up to crimp the pin again, placing more pressure between the center pin and the braided or solid cable center conductor. *This connection can also be made using solder (hence the hole). However, do not do this unless you are really good at soldering, have a proper-sized soldering iron and tools, and know you will not burn the rubber jackets and dielectric when you make the soldered connection.
16. Slide the rear center conductor shell over the cable and down inside the crimp sleeve, eventually pulling the crimp sleeve up over the rear center conductor shell. Twist the shell carefully down onto the cable. Trim the braid just enough so that it does not show, as you slide the collar over the rear center conductor shell. The center conductor pin should now be flush with the outer edge of the rear center conductor shell.
17. Using the proper crimp tool and proper crimp die set, crimp the crimp sleeve. Again, you can make two crimps on this sleeve if necessary (and if it fits) to crimp once, slide it down, and crimp the rest of the sleeve.



18. You can now place the plastic slotted placer over the top of the crimped sleeve.
19. Screw the front center conductor shell down over the rear center conductor shell. Be careful that the pin lines up with the hole. You can use wrenches to tighten these fittings, but do not over tighten. Tighten them just a little more than as tight as your fingers can get them.
20. Place the plastic outer conductor insulator over your cable assembly.
21. Place the front connector body over the entire cable assembly, and begin to tighten the connections.
22. If you placed heat shrink on the cable, (step 4) now is the time to draw it up to the edge (not over the flanged pieces of the threaded insert) and melt it down to the size of the cable. Heat shrink only needs to be slightly larger than the size of the cable it is protecting.
23. Bring up the rear seal, the o-ring, and the end cap and tighten them. Tighten up all of the connections by hand, then use a wrench to tighten them just a little bit more. I usually use a wrench on the end cap, and tighten the front connector with my hand. This should be enough pressure to keep it from coming off in the field, as well as keep water out.

Glossary of Terms

OH – The reference point of horizontal sync. Cameras, decks, character generators, and other video sources can all be synchronized (or "timed") by associating a line sync datum, OH, with the scan line of each source. In analog NTSC video, sync is conveyed by voltage levels. And OH is defined by the 50% point of the leading (or falling) edge of sync. Each source is best timed using the same point of reference, all points referenced to black, or the first camera or video source on a video switcher or router. In SDI, most reference black simply needs to be plugged in, in order for each source to lock up and synchronize.

OV – The reference point of vertical sync. In analog NTSC, vertical sync is defined by broad pulses. The pulses are serrated in order for a receiver to maintain horizontal sync even during the vertical sync interval. The start of the first broad pulse identifies the field sync datum, O_v**.**

µm – Micrometer (former name – micron): a unit of length equal to one millionth of a meter (10^{-6})

1080i – An interlaced scanning standard for HDTV, having an image structure of 1920X1080, and a frame rate (written after the i) of either 29.97 Hz or 30.00 Hz.

1080p – A progressive scanning standard for HDTV, having an image structure of 1920X1080, and any of several frame rates (written after the p) including 23.976, 24, 29.97, or 30.00 Hz, and potentially 59.94 (works as 29.97) and 60.00 (works as 30.00) Hz.

16PSK – An experimental modulation technique, following the Phase shift keying techniques of BPSK, QPSK, and 8PSK, all in use today.

16-QAM – Second generation Quadrature Amplitude Modulation technique. The first was QAM.

16VSB – Vestigial sideband modulation with 16 discrete amplitude levels.

2º Compliance – A satellite antenna or dish compliance which keeps your transmission or your receive to send to or receive from only one satellite. Satellites, at this point, tend to be no more than 2 degrees away from each other.

3:2 pulldown – A technique used when converting film material (operating at 24 pictures per second or fps) to 525-line video (operating at 30 pictures per second).

3G Mobile – The "Third Generation" of mobile devices, in which motion picture, still picture, internet, walkie-talkie, and other services have become available that were not available in the past two generations.

4:2:0 – 1. Digital video coding method in which the color difference signals are sampled on alternate lines at half the luminance rate.

2. Chroma subsampling where C_B and C_R components are horizontally subsampled by a factor of 4 with respect to luma. There are two variants of 4:2:0 chroma: interstitial 4:2:0 is used in JPEGs and JFIFs, H.261, and MPEG 1. And in the first heavily used satellite broadcast standard, there is cosited 4:2:0, used in MPEG 2.

4:2:2 – 1. Digital video coding method in which the color difference signals are sampled on all lines at half the luminance rate.

2. Chroma subsampling where each C_B and C_R component is horizontally subsampled by a factor of 2 with respect to luma, and not subsampled vertically.

3. An SDTV component digital video coding or interface standard, based upon Rec. 601, using 4:2:2 chroma subsampling, having versions for both 480i or 576i scanning. The corresponding 19 mm videotape is denoted D-1.

422P – The 4:2:2 profile of MPEG-2. (Colons are omitted; the P is written in Roman uppercase.)

422P @ ML – 422 profile at Main Level: a subset of the MPEG-2 standard, which supports digital video storage (DVD, etc.) and transmissions up to 50 Mbps over various mediums. Used heavily in live satellite video distribution, especially where standard definition sports or heavy movement and action are present.

4:2:2p – A 483p 59.94, 4:2:2 progressive-sc an system specified in SMPTE 294M, typically transmitted on dual SDI links each operating at 270 Mbps.

4:4:4 – Component digital video, typically SDTV, where RGB or YC_BC_R components are conveyed with equal data rate (not subsampled as in 4:2:2 and 4:2:0).

480i, 480i29.97 – An interlaced scanning standard used primarily in North America and the Far East, having 525 total lines per frame, approximately 480 picture lines (usually in an image structure of 720X480), and 29.97 frames per second. A raster notation such as 480i29.97 does not specify color coding; color in 480i29.97 systems is conveyed in the studio using RGB, YC_BC_R, or YP_BP_R components, and encoded for transmission using composite NTSC. Also incorrectly called NTSC, which more specifically refers to a color-encoding standard and not a scanning standard.

601 – See Rec. 601.

64-QAM – The third generation of Quadrature Amplitude Modulation techniques. The first was QAM, the second was 16-QAM.

7.5% setup – See Setup

720p – A progressive scanning standard for HDTV, having an image structure of 1280X720, and any of several frame rates including 23.976, 24, 29.97, 30, 59.94, or 60 Hz.

8PSK – The third generation in Phase Shift Keying modulation techniques. The first was Binary (BPSK), the second was Quadrature (QPSK), and 8PSK is the latest to be adopted by many users. 16PSK is only experimental at this point.

8VSB – Vestigial sideband modulation with 8 discrete amplitude levels.

AAC – Advanced audio coding

AC – 1. Alternating current: Historically, an electrical current or voltage that reverses in polarity periodically – that is, whose sign alternates periodically between positive and negative.

2. In modern usage, a signal whose value varies periodically between positive and negative. Distinguished from DC, direct current.

3. In JPEG and MPEG, any or all DCT coefficints in an 8¥8 block apart from the DC coefficient.

AC-3 – Audio Coding algorithm number 3. See Dolby Digital.

AC Switching Power Supply – A pulse-width modulation, AC to DC converter. Many AC power supplies are capable of converting 100V to 240V at either 50 or 60 Hz.

Active – Usually referring to a signal element (a sample or a line) defined by a scanning standard to contain part of the picture or its associated blanking transition. Closed captioning, in the United States, for example, typically lives on active line 21. VITC (Vertical Interval Time Code) usually live on lines 14 and/or 16, but can be set anywhere from lines 4 to 20, all of them considered active lines, despite they do not contain pictures).

ADA – Audio distribution amplifier is used to increase voltage on an audio line, often to send to multiple sources. One example of an ADA is a Mult Box.

A/D Converter – A circuit which converts a signal from analog to digital.

ADPCM – Adaptive Differential Pulse Code Modulation is a reduced bit rate variant of PCM (Pulse Code Modulation). It is an algorithm that encodes the difference between an actual audio sample amplitude and a predicted amplitude and adapts the resolution based on recent differential values.

ADT – Audio, Data and Teletext.

AES – Audio Engineering Society

AFC – Automatic frequency control.

AGC – Automatic gain control, a circuit made to automatically adjust the input gain of a signal. AGC is present in many consumer-level and pro-sumer electronics. Professional products typically demand manual gain control to get the best results.

Aliasing – A type of distortion found in video, and still images as well as audio. The distortion could be due to power bleeding into the signal. It could be due to insufficient sampling. It could be due to poor filtering. Noise in video and still images appear as sparkles, or with jagged edges. Audio typically has a hiss, buzz, or drop-outs.

AM – Amplitude Modulation, a transmission method which sends information as variations in amplitude of a carrier wave. While there is an AM radio band, Amplitude Modulation can be accomplished at any frequency.

Ambient – The current environmental conditions, for example, ambient temperature, ambient light, or ambient moisture (often called relative humidity).

Amp or Ampere – The standard unit of measure for electrical strength defined as the amount of current that would be produced by an elecrotomotive force of one volt acting through a resistance of one ohm. A=Amps or Current, V=Voltage and W=Wattage

$$A \times V = W$$

Amplifier – A device which increases signal amplitude. A high powered amplifier (HPA) often uses several amplification methods to achieve a desired power output.

Amplify – To increase amplitude.

Amplitude – The strength or power of a wave signal. On the wave, increasing amplitude would increase the size or width of the wave.

Analog – (British = Analogue) – Video or audio stored, transmitted or displayed as a continuously variable signal. Analogue formats technically have a more accurate representation of the original signal. However, digital formats (which use discrete values rather than gracious curves) have advantages such as bandwidth savings, storage savings, and lack of static or better noise filtering.

Anamorphic – A subsidiary format, or its associated lens, in which the horizontal dimension of a widescreen image is squeezed by some factor with respect to the horizontal dimension of a base format having narrower aspect ratio. In film, the widescreen (anamorphic) image conventionally has 2:4:1 aspect ratio and the squeeze is by a factor of 2. In video, the widescreen (anamorphic) image has 16:9 aspect ratio, and the squeeze is typically by a factor of 4:3. An anamorphic lens stretches the width of the image without stretching the height. The image is often later stretched back to normal on a widescreen display.

Antenna – A device that radiates and/or receives electromagnetic waves.

Aperture – (From the Latin word, Aperire, "to open") An opening to a camera, telescope, binoculars, or any device made to catch light. The size of the aperture is measured in f-stops (also called full-stops, f-number, aperture stops, or lens speed). F-stops are a ratio of focal length to the effective aperture diameter.

- A smaller stop (reducing the aperture size) develops a better depth of field in image capturing devices.

Aperture area can be calculated as follows:

$$\text{Area} = \pi \left(\frac{\int}{2N}\right)^2 \qquad \text{Where: } \int = \text{focal length}, \quad N = \text{f-stop}$$

Artifacts or Artifacting – The correct term for digital breakup. The British tend to use "Blockiness" and it means the same thing. Large pixel blocks become visible in parts of the screen when there is not enough information (or there is too much in the buffer) to fill in the missing parts of the transmission.

ASI – Asynchronous serial interface: An industry standard electrical interface, standardized by DVB, used to convey an MPEG-2 transport stream. Also referred to as DVB ASI.

ASIC – A customized chip designed to perform a specific function.

Aspect Ratio – The ratio of the width of an image to its height. This is commonly referred to in television and motion picture standards such as 2.4:1 or 16:9 or 4:3.

ATM – Asynchronous Transfer Mode is a source-independent transport mechanism. It can use variable bit-rate transmission, which uses fixed length packets (called cells) to transfer user data.

ATSC – Advanced Television Systems Committee: A U.S.-based organization founded in 1983 that researched, developed, helped to standardize and promote digital SDTV and HDTV broadcasting for the United States. ATSC advocates MPEG-2 video compression and Dolby Digital (AC-3) audio compression, supplemented by ATSC terrestrial broadcasting transmission standards. In late 1996, the FCC adopted the ATSC standard, and it is considered the "digital counterpart" of the original NTSC standard.

Audio – Sound. For broadcast use, only the frequency range which are picked up by the common human ear.

Audio Dub – The process of adding audio to video. Original audio may be replaced, or kept with the additional audio.

Auto Detecting – The capability of a unit to automatically sense and set its configuration to match the operational parameters of an incoming signal.

Auto Ranging – The capability of a power supply unit to accept variable voltage rates.

Auto Sensing – The capability of a power supply unit to detect variable voltage rates.

Auxiliary Channel – (commonly called an "Aux" channel to fit the word on an audio mixer) is an additional output from the primary program feed output on an audio mixer. Auxiliary channels exist to offer additional channels, a different output level from the program output level, to provide additional signal processing or lack of signal processing from the program output, or to loop back into the main program to create "reverb" in the program channel.

AV - Audio/Video

Back porch – The time interval between the trailing edge of a normal line sync pulse and the left-hand edge of active video on the associated video line. This interval is often used as a clamp reference.

Backlight (also called a Rim Light) – A light positioned behind, and usually also elevated from, a subject. Its primary purpose is to make the subject stand out from the background (essentially making the subject more 3-dimensional on a 2-dimensional image), by highlighting the subject's outline.

Back Focus – A focus adjustment between the lens and the camera. It is typically adjusted by loosening a screw on a ring closest to the camera body. If the camera appears to be focused when zoomed in, but becomes out of focus when widened out (called "pushing-in" or "pushing-out"), then it is said that the back focus "is off" and needs adjustment.

Backward compatibility – Refers to hardware or software that is compatible with earlier versions.

Balanced Audio -

Bandwidth – 1. The transmission capacity of an electronic line such as (among others) a communications network, computer bus, or broadcast link. It is expressed in bits per second, bytes per second or in Hertz (cycles per second). When expressed in Hertz, the frequency may be a greater number than the actual bits per second, because the bandwidth is the difference between the lowest and highest frequencies transmitted. Higher bandwidth allows faster transmission or higher-volume transmission. New modulation techniques tend to offer faster transmission or higher-volume transmission in the same amount of bandwidth.

2. The frequency or frequency range where an analog or digital signal's magnitude has fallen 3 dB – that is, to 0.707 – from its value at a reference frequency (usually zero frequency, DC). Distinguished from data rate (contrary to popular belief).

Tandberg calculates its bandwidth requirements for SDTV DVB in such a way:

$$\text{Symbol Rate} = \frac{\text{Bandwidth}}{1.28}$$

$$\text{Bit Rate} = \text{Symbol Rate} \times m \times \frac{\text{Packet Length (204 bytes)}}{204} \times \text{FEC Rate}$$

Where: m = 2 for QPSK factor

And where “Reed Solomon Rate” is typically 188/204 and not 204/204. 188/204 = 0.9215686

So, for instance, we use one common standard: 6.1113 Symbol Rate, ¾ FEC and 8.448 Data Rate.

Symbol Rate X 1.28 = 7.822 MHz of bandwidth.

8.448 = 6.1113 x 2 x .9215686 x .75

8.448 Data Rate = 7.822 MHz of bandwidth (not accounting for guardband)

- this is a perfect example of why bandwidth does not equal data rate and visa-versa
- 8.448 has been rounded up from 8.447973

Baseband multimedia – The non-modulated transmission of audio and video signals.

Baud rate – 1. The measure of transmission speed over a transmission medium.

2. The rate of transfer of digital data when the data comprises information symbols that may consist of a number of possible states. Equivalent to bit-rate when the symbols only have two states (1 and 0). Measured in Baud.

Beacon – A carrier, usually identified as a spike or series of spikes on a satellite used by satellite control centers to aid in keeping the satellite in orbit. Some are used to properly identify signals.

BER – Bit error rate: 1. A measure of transmission quality.

2. The rate at which errors occur in the transmission of data bits over a link.

3. The probability that recording or transmission in an error-prone medium corrupts any single bit transmitted or recorded. It is generally shown as a negative exponent (for example, 10^{-7} means that 1 in 10-million bits are in error or 1 out of 10-Million bits are in error).
- Bit error ratio: The ratio or error bits to total error bits in a transport stream.

4. A bit error rate is a calculation that varies dramatically depending on cable distance, cable quality, transmission distance, transmission quality, the amount of noise any of these things are susceptible to, as well as the overall quality of the receiver. (The Belden coaxial cable company suggests using cable runs of 90% of their recommended maximum cable distances.) Bit error rate is also affected by connector loss, patching equipment loss, as well as loss from distribution or routing equipment.

Betacam – Sony's trademarked term for a professional component analog videotape format for 480i or 576i, using CTDM on ½-inch tape. The successor system, with higher bandwidth, is denoted Betacam SP. There have also been several digital beta tape formats. Betacam is now the longest used and most popular tape format in television history.

Bilevel sync – Sync information conveyed through a single pulse having a transision from blanking level to a level more negative than blanking (synctip level), then a transition back to blanking level. In analog systems, synctip level is either -285 (5/7) mV or -300 mV. Bilevel sync is used in SDTV; distinguished from trilevel sync, used in HDTV.

BISS – Basic Interoperable Scrambling System: Non-proprietary encryption from EBU (Tech3290).

BIST – Built-in-self-test. An evaluation procedure used to provide diagnostic information regarding the operational state of a unit.

Bit error rate – See BER

Bit-rate – 1. The number of bits of data transmitted over a given time period.

2. The rate of transfer of digital data when the data comprises two logical states, 1 and 0. Measured in bits per second (bps or b/s). Data rate.
3. The rate at which the compressed bit stream is delivered from the channel to the input of a decoder.

BITC - Burnt-in timecode: Timecode keyed into picture content.

Black level - the level representing black: nominally 7.5 IRE for System M and the arcaic RS-343-A, and zero in other systems. See Pedestal.

2. User-accessible means to adjust BLACK LEVEL. This term is also preferred to BRIGHTNESS. See Brightness.

Blanking (n) - The time interval – in the vertical domain, the horizontal domain, or both – during which a video signal is defined by a scanning standard not to contain picture. Ancillary signals such as VITS and VITC may be conveyed during vertical blanking – they are not blanked during transmission, but are blanked at the display. (Exceptionally, closed caption signals in analog 480i NTSC are considered to be part of the active picture.)

Blanking (v) – The process of turning off the beam in a CRT, such as a display tube, so that the tube can accomplish beam retrace without disturbing the picture.

Blanking level – Zero level; 0 IRE by definition.

Block – 1. Pixel block. An 8-row by 8-column matrix of luminance sample values, or 64 DCT coefficients (source, quantized, or dequantized)

2. In JPEG, M-JPEG AND MPEG, an 8X8 array of samples, or coded information representing them. Not to be confused with Low Noise Block converter used in satellite receive antennas.

BNC - Bayonet Neill-Concelman (contrary to the entry in the IEEE Standard Dictionary of Electrical and Electronics Terms): A coaxial connector, now standardized in IEC 169-8, used in video. Paul Neill, working at Bell Telephone Laboratories, developed a threaded connector adopted by the U.S. Navy and named the N connector, after him. Carl Concelman, working at Amphenol, came up with a bayonet version (slide on and twist), called the C connector. The two collaborated on a miniature version, which became the BNC. A screw-on relative, the threaded Neill-Concelman connector, is the TNC.

- Commonly believed to be called the British Naval Connector. This is wrong, but makes for a great story.

BOB – Break-out box: Similar to an I/O panel, a panel of connectors remote from the associated equipment.

Bottom Field – In MPEG, the field that contains the bottom coded image row. Typically the first field in 480i and the second field in 576i.

B-Frame or B-Picture – Bi-directionally Predictive Coded Picture or Frame: A picture that is coded using motion-compensated prediction from previous I or P frames (called future prediction) and/or future I or P frames (called backward prediction). B frames are not used in any prediction.

BPS – Bits Per Second: A ratio of the number of bits of data transmitted to the number of seconds elapsed, expressed as bits per second.

BPSK – Binary phase shift keying: A data modulation technique, replaced by QPSK.

Brightness – 1. The attribute of a visual sensation according to which an area appears to emit more or less light (CIE definition). Brightness is, by definition, subjective. Related objective qualities are lightness, luma, and luminance.

2. User-accessible means to adjust Black level; preferably called BLACK LEVEL.

Broad pulse – A pulse, part of the vertical sync sequence, that remains at sync level for substantially longer than normal line sync and indicates vertical sync. In bilevel sync, it is standard for a broad pulse to have a duration of half a line time less the duration of normal line sync.

BUC – A type of high-powered amplifier that uses an L-Band input rather than 70 MHz.

Buffer – 1. A memory store used to provide a consistent rate of data flow.

2. In data transmission, a buffer is a temporary storage location for information being sent or received. A buffer is usually located between two different devices that have different abilities or speeds for handling the data.

Buffer Overflow – Within a data buffering system, the condition occurring whenever the number of data bits entering the buffer exceeds the data capacity of the buffer.

Buffer Underflow – Within a data buffering system, the condition occurring whenever the number of data bits entering the buffer is not sufficient to maintain the buffer minimum output rate.

Built-In-Self-Test – See BIST.

Burst – A brief sample of eight to ten cycles of unmodulated color subcarrier inserted by an NTSC or PAL encoder onto the back porch of a composite video signal. An encoder inserts burst to enable a decoder to regenerate the continuous-wave color subcarrier.

BW – Bandwidth.

CA – Conditional access: The technology used to control the access to viewing services to authorized subscribers through the transmission of encrypted signals and the programmable regulation of their decryption by a system such as viewing cards.

CAT – Conditional access table: Part of the MPEG-2 Program Specific Information (PSI) data. Mandatory for MPEG-2 compliance if CA is in use.

CAT6 – Category 6: A cable standard for Gigabit Ethernet

CAV – 1. Component analog video

2. Constant angular velocity: A method of recording on optical disc where the media rotates at a

constant rate. Contrasted with CLV (constant linear velocity).

C-Band – 1. A portion of the electromagnetic spectrum used heavily for satellite transmissions. The uplink portion for satellite is at 6 GHz, and the downlink portion is at 4 GHz. Traditionally, C-Band satellite transmissions have carried voice communications, video conferencing, broadcast TV and radio.

2. The portion of the electromagnetic spectrum, which spans the frequency range of approximately 4 Ghz to 6 Ghz. Used in communication satellites as well as some terrestrial broadcasts. Preferred in tropical climates because it is not as susceptible to fading (from rain or fog) as higher frequencies such as Ku-Band and Ka-Band.

Cable Loss – Loss of signal quality within a cable, typically due to impedance as a result of excessive cable length, material construction, or corrosion and deterioration of the cable or terminations on the cable.

Carrier Offset – The frequency difference in Hertz measured between the programmed receive frequency and the actual frequency received.

C_B, C_R – 1. Digital color (or chrominance) difference signals. These signals, in combination with luminance (Y or Y'), define the color and brightness of each picture element (pixel) on a TV line. See Chrominance.

2. Versions of color difference components B-Y and R-Y, scaled and offset for digital component transmission. At an 8-bit interface, C_B and C_R have excursion 16 through 240. In systems using Rec. 601 luma, such as 480i and 576i, it is standard to apply these scale factors (and interface offsets) to B-Y and R-Y.

$$C_B = 128 + 112\left(\frac{1}{0.886}\right)(B-Y); \qquad C_R = 128 + 112\left(\frac{1}{0.701}\right)(R-Y)$$

In HDTV systems using Rec. 709 luma, such as 1280X720 and 1920X1080, it is standard to apply these scale factors (and offsets) to B-Y and R-Y.

$$C_B = 128 + 112\left(\frac{1}{0.9278}\right)(B-Y); \qquad C_R = 128 + 112\left(\frac{1}{0.7874}\right)(R-Y)$$

2. Versions of color difference components B-Y and R-Y, scaled to “full range” (±128 with code +128 clipped) for use in still-frame JPEG/JFIF. It is usual to apply these scale factor (and offsets) to B-Y and R-Y.

CC – See Closed Caption.

CCTV – Closed Circuit Television: Usually used in surveillance systems, industrial production monitoring, or in hospital or university environments, a television system not meant for broadcast purposes and usually used to remotely monitor people, equipment, plants, or animals. Quality in CCTV systems can range from “poor” and “who cares” to demanding video of more than 5,000 frames per second (such as ballistics testing).

CDR – Common data rate: A single (common) worldwide standard sampling rate for digital video; the approach taken in Rec. 601, where a sampling rate of 13.5 MHz is standardized for both 480i and 576i. Contrasted with CIF, common image format.

CGI – Computer-generated imagery: Synthetic image data, generated by computation (as opposed to being acquired from a physical scene). Also known as CG. Newer CGI generators are capable of taking in and using still and motion pictures from a physical scene and using them with and as a part of computer-generated images.

Channel – 1. A narrow range of frequencies, part of a frequency band, for the transmission of radio and television signals without interference from other channels.

2. In OFDM, a large number of carriers spaced apart at precise frequencies are said to be allocated to a channel
3. A single path for transmitting electric or electromagnetic signals.
4. See Channel Coding.

Channel coding – A way of encoding data in a comunications channel that adds patterns of redundancy into the transmission path in order to improve the error rate. Such methods are widely used in wireless communications.

Channel Rate – The rate of data in the demodulator, before the FEC decoding. The channel rate equals the information rate plus the FEC encoding overhead, measured in bits per second.

Chroma – 1. Generally, a component or set of components that conveys color independent of luma or luminance.

2. In component video, color independent of (or accompanied by) luma, conveyed as a pair of color difference signals such as (C_B ,C_R) or (P_B, P_R).
3. In composite video, color subcarrier modulated using the NTSC or PAL technique by two color difference components (U, V) or (I, Q), to form a modulated chroma signal, C.
4. User-assessible means to adjust Saturation (chroma gain); preferably, SATURATION.

Chromaticity – 1. Specification of color (in the absence of luminance), in terms of CIE (x, y) or (u, v) coordinates.

2. Loosely, the chromaticity of the red, green, and blue primaries, and the chromaticity of the white reference, of a video system.

Chrominance - The color part of a TV picture signal, relating to the hue and saturation but not the luminance of the signal. In a composite-coded color system, the color information is modulated onto a high frequency carrier and added to the monochrome-format video signal carrying the luminance (Y or Y'). In a component-coded color system, the two color-difference signals such as (C_B ,C_R) or (P_B, P_R) or (U, V) or (I, Q). When they are added together, the chrominance is displayed as Y and the subset (such as Y'C_B ,C_R).

2. Formally, the color of a scene or scene element independent of its luminace; usually, expressed in the form of CIE (x, y) chromaticity.
2. Loosely, chroma.

CIE – Commission Internationale de L'Eclairage (International Commission on Illumination): The international standards organization that sets colorimetry standards.

CIF – Common image format: The elusive goal of a single (common) worldwide standard pixel array for digital video, perhaps at different frame rates. Distiguished from CDR. Confusingly, the acronym collides with CIF, Common intermediate format.

2. In MPEG-2 or other video compression systems excepting those for videoconferencing, an image format of either 720X480 or 720X576. The term is an oxymoron, since there is not a single ("common") format, but two different formats. (In the deliverations that led to digital SDTV studio

standards, agreement upon a common image format was never reached!)

CIF – Common intermediate format: In ITU-T Rec. H.261, a progressive 352X288 image format with 4:2:0 chroma subsampling and a frame rate of 29.97 Hz. CIF image data is ordinarily subsampled from SDTV. The format is a compromise derived from the image structure of 576i25 and the frame rate of 480i29.97. (often used term in film or movie image to TV image transfers)

Clamp (v) – 1. Imposition of a DC offset onto a signal, so as to place a certain waveform feature (such as back porch) at a specific level (such as blanking level).

2. Loosely, Clip.

Clean aperture – The specified or standardized rectangular portion of the pixel array that remains subjectively free from intrusion of artifacts resulting from filtering of the picture edges.

Clip (v) – Forcing a signal to a certain maximum (or minimum) level, so as to avoid excursion above (or below) that level.

Closed Caption – (CC) 1. A "subtitle" system for television standardized for NTSC analog transmission. SDI and HD-SDI are still under experimentation.

2. Digital data conveying textual information that can be decoded and displayed for the benefit of hearing-impaired viewers. (And probably used as much or more for the benefit of noisy sports bars.) In 480i NTSC analog video, closed caption data is inserted into line 21. (Unlike other vertical interval signals, NTSC line 21 is classified as active picture video.)

CLV – Constant linear velocity: A method of recording on optical disc where rotational speed is varied as a function of head actuator position so as to keep speed constant with respect to the head. Contrasted with CAV (constant angular velocity).

CM – In DV compression, a coded (compressed) macroblock.

C/N – Carrier-to-Noise ratio. 1.This is a reading or measurement, typically in dB, from the top of a given carrier to where it is sitting on the noise floor. On a satellite, this reading goes from the carrier to the noise floor on the satellite transponder pad, not where a pad is not existent. Therefore, on a satellite, this is a saturation reading, not a true Carrier-to-Noise ratio. Therefore, satellite IRD and receiver readings are often given in BER or Eb/No levels. As a measurement of antenna and TVRO (Television Receive Only) systems, the formula for C/N usually reads as follows... for a 30 MHz wide signal:

C/N = G/T + EIRP -43

(Carrier over Noise) = (System Gain Over Temperature) + (EIRP -43)

Calculating G/T (System Gain over Temperature) is done as follows:

G/T = Ag -10 Log (AT + LNAT)

*Where: Ag = Antenna Gain (dB)
AT = Antenna Temperature (°Kelvin)
LNAT = Low Noise Amp Temperature (°K)

To calculate C/N for any other bandwidth, use the following formula and substitute your bandwidth for "X":

$$C/N = (10 \text{ Log } \frac{30}{X})$$

Codec – 1. The combination of an Encoder and a complementary Decoder located respectively at the input and output of a transmission path.

2. Coder/decoder: Circuitry, software, or equipment to encode or decode data between two formats (perhaps between analog and digital).
3. In video, compressor/decompressor: Circuitry, software, or equipment to compress or decompress video signals.

COFDM – Coded orthogonal frequency-division multiplexing or Coded OFDM: 1. A modulation system used particularly for terrestrial digital broadcasting.

2. COFDM adds forward error correction to the OFDM transmission consisting of Reed-Solomon (RS) coding followed by convolutional coding to add extra bits to the transmitted signal. This allows a large umber of errors at the receive end to be corrected by convolutional (Viterbi) decoding followed by RS decoding.
3. An RF-modulation system using a large number of subcarriers to spread the information content of a signal evenly across a channel. The subcarriers of COFDM are individually modulated, typically using QPSK or QAM. COFDM is used in DVB-T. (Terrestrial DVB)

Coherence, frequency – The property whereby two or more periodic signals are phase-locked to a common reference frequency. The unmodulated color subcarrier of a studio-quality NTSC or PAL composite video signal is coherent with its sync.

Coherence, spacial – In a single image, the property whereby adjacent samples have values that are correlated.

Coherence, temporal – In a motion image sequence, the property whereby corresponding samples in successive images, perhaps subject to spacial displacement, are correlated.

COLOR – A user-accessible (consumer) means of adjusting Hue; preferably, HUE.

Colorburst – See Burst.

Colorimetry – 1. Formally, the science of measuring color, especially as standardized by the CIE.

2. In video, Colorimetry as above, augmented by two concerns outside the domain of classicla colorimetry: the parameters of the nonlinear transfer function applied to the linear-light (tristimulus) RGB components of classical colorimetry to form RGB; and the parameters of the 3X3 matrix transofrm applied to RGB to form luma and two color difference components.

Color difference – 1. A numerical measure of the perceptual distance between two colors.

2. A signal that vanishes – that is, becomes identically zero – for pure luma without color. A video system conveys a color image using a set of three signals: a luma signal (Y) and a pair of color difference signals. Spacial filtering may be applied to reduce the information rate of the color difference components without perceptible degradation. Usual color difference pairs are (B-Y, R-Y), (C_B,C_R), (P_B, P_R), (I, Q), and (U, V).

Color standard – The parameters associated with encoding of color information. For example, RGB, YC_BC_R, or MAC component video standards, or NTSC, PAL, or SECAM composite video standards. Distinguished from scanning standard.

Color subcarrier – 1. A continuous sine wave signal at about 3.58 MHz or 4.43 MHz used as the basis for quadrature modulation or demodulation of Chroma in an NTSC or PAL composite video system. See also Burst.

2. Color subcarrier, onto which two color difference signals have been imposed by quadrature modulation. Properly, modulated chroma.

Color temperature – Characterization of an illuminant or a white reference in terms of the absolute temperature (in units of kelvin) of a black body radiator having the same chromaticity.

Color-under – A degenerate form of composite analog NTSC or PAL video recording where modulated chroma is heterodyned onto a subcarrier whose frequency (roughly 1/6 of the NTSC or PAL color subcarrier frequency) is crystal-stable but no coherent with line rate. The heterodyning process destroys the phase relationship of color subcarrier to sync, and severely limits chroma bandwidth. The technique is used in U-matic (¾-inch), VHS, S-VHS, 8 mm (Video 8) and Hi8 videocassette recorders.

Comb filter – 1. Generally, a filter having magnitude frequency response with periodic equal-magnitude maxima and minima.

2. In video, a comb filter incorporating delay elements with line, field, or frame time duration.
3. In a composite NTSC video decoder, circuitry incorporating one or more line delay elements (linestores) to exploit the frequency interleaving of modulated chroma to seperate chroma from luma. A comb filter provides better seperation than a notch filter, owing to its suppression of cross-color and cross-luma artifacts.

Common data rate – See CDR.

Common image format – See CIF – Common image format.

Component (adj) – In video, a system that conveys three color values or signals independently, free from mutual interference. Examples are RGB, $YC_B C_R$, and MAC. Distinguished from composite video (adj).

Component (n) – 1. One value or signal from the set of three necessary to completely specify a color.

2. A value, channel, or signal, such as transparency or depth, that is spacially associated with image data, or temporarily associated with an image in a sequence, that does not contribute to the specification of color.

Component analog – An analog video system (as opposed to digital), using RGB or $YC_B C_R$ component color coding (as opposed to using composite color coding such as NTSC or PAL).

Component digital – A digital video system (as opposed to analog), using RGB or $YC_B C_R$ component color coding (as opposed to using composite color coding such as NTSC or PAL). Component digital SDTV systems are sometimes called "4:2:2," though this notation strictly refers to just the color subsampling, not any of the other encoding parameters.

Composite (adj) – Combined, as in combined vertical and horizontal sync elements (as in Composite sync); combined luma and chroma (as in Composite video); or combined video and sync (also as in Composite video).

Composite (v) – To combine images by layering, keying, or matting.

Composite digital – A digital video system (as opposed to analog), using composite color coding such as NTSC or PAL (as opposed to using component color coding such as YC_BC_R). Because all standard composite systems sample at four times the subcarrier frequency, also known as $4f_{SC}$.

Composite sync – A deprecated term meaning sync. The word sync alone implies both horizontal and vertical elements, so composite is redundant. The adjective composite more meaningfully applies to video or color, so its use with sync is confusing.

Composite video – 1. A video system in which three color components are simultaneously present in a single signal. Examples are NTSC and PAL, which use the frequency-interleaving principle to encode (combine) luma and chroma. SECAM is another form of composite video. Distinguished from Component (adj).

Compression – Reduction in the number of bits used to represent the same information. For the purposes of a broadcast system, it is the process of reducing digital picture information by discarding redundant portions of information that are not required when reconstituting the picture to produce viewing clarity. Compression allows a higher bit-rate to be transmitted through a given bandwidth.

Compression system – Responsible for compressing and multiplexing the video/audio/data bit streams, together with the authorization stream. The multiplexed data stream is then ready for transmission.

Concatenated – In compression, two or more compression systems in series. Also known as tandem codecs.

Constant luminance – In a color video system that dedicates one component to lightness-related information, the propery that true (CIE) relative luminance reproduced at the display is unaffected by the values of the other two components. All standard video systems, including NTSC, PAL, YC_BC_R, and HDTV, approximage constand luminance operation. However, because luma is computed as a weighted sum of gamma-corrected primary components, a certain amount of true luminance "leaks" into the color difference components and induces second-order artifacts.

Contrast – 1. Contrast ratio

2. The luminance of subjectively correct midscale image information, compared to its reproduced luminance.
3. User-accessible means to adjust video gain. Preferably called VIDEO GAIN; sometimes called PICTURE.

Contrast ratio – The ratio between specified light and dark luminances.

CoP - Code of Practice.

Cosited – Chroma subsampling in which each subsampled chroma sample is located at the same horizontal position as a luma sample. Rec. 601, Rec. 709, and MPEG-2 standards specify cosited chroma subsampling. (MPEG-2, 4:2:0 chroma subsampling places chroma samples interstitially in the vertical domain.)

CRC – Cyclic redundancy check (a check inside the software code): 1. A mathematical algorithm that computes a numerical value based on the bits in a block of video. This number is transmitted with the data, and the receiver uses this information and the same algorithm while comparing the results of the algorithm and the number received. If the number does not compare, an error in transmission is presumed.

2. Information inserted prior to recording or transmission that allows playback or receiver equipment to determine whether errors were introduced. A CRC with a small number of bits provides error-detection capability; a CRC with a large number of bits provides error-correction capability. CRC codes involve multiplying and dividing polynomials whose coefficients are restricted to the set {0, 1}. Similar capability can be achieved using codes based upon mathematical principles other than CRC; See ECC.

Cross-color – An artifact of composite video encoding and/or decoding that involves the erroneous interpretation of luma information as color. The cross-color artifact appears frequently when luman information having a frequency near that of the color subcarrier appears as a swirling color rainbow pattern.

Cross-luma – An artifact of composite video encoding and/or decoding that involves the erroneous interpretation of color information as luma. Cross-luma frequently appears as dot crawl or hanging dots.

CSA – Canadian Standards Association – The Canadian counterpart of the U.S. Underwriters Laboratories.

CVCT – Cable Virtual Channel Table.

CTDM – Chroma time-division multiplexed: A system of recording component video, used in Betacam, whereby P_B and P_R components are each time-compressed then combined in one recording channel.

D-1 – 1. A SMPTE-standard component SDTV digital videotape format utilizing 19 mm tape cassettes to record component digital Rec. 601, 8-bit YC_BC_R video signals having either 480i or 576i scanning.

2. Often improperly used to denote Rec. 601 YC_BC_R SDI interface for composite digital 480i NTSC or 576i PAL.

D-2 – 1. A SMPTE-standard composite digital SDTV videotape format utilizing 19 mm tape cassettes and recording either 480i NTSC video or 576i PAL video, sampled at $4f_{SC}$. D-2 recording is unrelated to the now obsolete D2-MAC transmission system used for a time in Europe for satellite broadcasting.

2. Often improperly used to refer to $4f_{SC}$ SDI interface for composite digital 480i NTSC or 576i PAL.

D-3 – A SMPTE-standard composite SDTV digital videotape format utilizing ½-inch tape cassettes and recording either 480i NTSC video or 576i PAL video, sampled at $4f_{SC}$.

D-5 – A SMPTE-standard component SDTV digital videotape format utilizing ½-inch tape cassettes and recording uncompressed Rec. 601 YC_BC_R video signals, having either 480i or 576i scanning.

D-5 HD – A component HDTV digital videotape format utilizing ½-inch tape cassettes and recording Rec. 709 YC_BC_R signals, based upon either 720p60 or 1080i30, mildly compressed to about 270 Mbps (ASI) using motion-JPEG. Also known as HD-D5.

D-6 – A SMPTE–standard component HDTV digital videotape format utilizing ½-inch tape cassettes and recording uncompressed Rec. 709 YC_BC_R signals, subsampled 4:2:2, at about 1.5 Gbps.

D-7 – A SMPTE-standard component SDTV digital videotape format for professional use, utilizing 6.35 mm tape encased in a cassette of one of three sizes (small, medium, or large), recording Rec. 601 YC_BC_R signals, based upon either 480i or 576i scanning, compressed using the DV motion-JPEG technique to about 25 Mbps (DV25) or to about 50 Mbps (DV50). Panasonic refers to D-7 by their trademarked term DVCPRO (at 25 Mbps) or DVCPRO50 (at 50 Mbps). Sony refers to the tape format as DVCAM.

D-9 – A SMPTE-standard component SDTV digital videotape format for professional use, utilizing ½-inch tape in VHS-type cassettes and recording Rec. 601 YC_BC_R signals based upon either 480i or 576i scanning, mildly compressed to about 50 Mbps using the DV motion-JPEG technique (DV50). Also known by JVC's trademarked term Digital-S.

D-10 – A SMPTE-standard component SDTV digital videotape format for professional use, utilizing ½-inch tape in Beta-type cassettes and recording Rec. 601 YC_BC_R signals based upon either 480i or 576i scanning, mildly compressed to about 50 Mbps using a motion-JPEG technique. Also known by Sony's trademarked term MPEG IMX.

D-11 – A SMPTE-standard component HDTV digital videotape format for professional use, utilizing ½-inch tape in Beta-type cassettes and recording YC_BC_R signals based upon 1440¥1080 image, scanned progressive or interlaced at any of several frame rates, chroma subsampled 3:1:1, and mildly compressed to about 50 Mbps using a motion-JPEG technique. Also known by Sony's trademarked term HDCAM.

D-12 – A SMPTE-standard component HDTV digital videotape format for professional use, utilizing 6.35 mm tape encased in a cassette of one of three sizes (small, medium, or large), recording 720p, 1080i, or 1080p, 4:2:2 signals, compressed to about 100 Mbps using the DV motion-JPEG technique (DV100). Also known by Panasonic's trademarked term DVCPRO HD.

Data – Typically referes to the information content of a signal including video, audio, graphic, or character-based information. Often expressed in bits or bytes. Also often expressed by the bit or byte packet size, or the ability of an integrated circuit to handle these packets of bits (8-bit, 16-bit, 32-bit, 64-bit, etc...)

Data Bits – Within a data packet, the bits which represent the information content of a packet.

Data Rate – Information rate of digital transmission, in bits per second (bps) or bytes per second (Bps). NOT TO BE CONFUSED WITH BANDWIDTH. THEY ARE OFTEN CLOSE, BUT NOT THE SAME! SEE BANDWIDTH!

dB – Decibel: 1. a ratio of one quantity (usually signal power) to another using logarithmic scales to give results related to human aural or visual perception. dB is a ratio whereas dBm, for example, is an absolute value, quoted as a ratio to a fixed point of 0 dBm. 0 dBm is 1 mW at 1 kHz terminated in 600Ω. 0 dBm is 1 mV terminated in 75Ω. Common variants are suffixed by an additional letter signifying that a single power measurement is referenced a standard value:

dBm = decibels relative to 1 mW
dBW = decibels relative to 1 W

2. A unit of measure of signal strength, usually the relation between a transmitted signal and a standard signal source. An increase of 3 dB results in a doubling of the signal strength. An increase of 6 dB results in a quadrupling of the signal strength. Conversely, a decrease of 3 dB and 6 dB results in a reduction in signal strength by one half and three quarters.
3. A means of representing large power ratios as manageable, small numbers. The measurement allows overall gains and losses in a component or network to be calculated by addition and subtraction, rather than by multiplication and division.
4. A unit originally named the “Bel” after Alexander Graham Bell, but actually measured at one-tenth of a Bel.
5. A power ratio of two power measurements, calculated as follows:

   Ratio of power P_1 to P_2 in dB:

$$dB = 10 \bullet \log \left(\frac{P_1}{P_2}\right)$$

6. The power ratio of two voltage measurements, calculated as follows:

$$dB = 20 \bullet \log \left(\frac{V_1}{V_2}\right)$$

DC – Direct Current: 1. Historically, an electrical current or voltage having no periodic reversal in polarity. (It is deadly at high voltages!)

2. In modern usage, having zero frequency.
3. In video, a signal having frequency substantially lower than the frame rate.
4. In JPEG and MPEG, that spacial frequency component having uniform response over an 8X8 block. Distinguished from AC.

DC restoration – Clamp at blanking level (or in low-quality systems, at synctip level).

DCT – Discrete cosine transform: In video, this is the mathematics at the heart of JPEG and MPEG algorithms.

2. DCT is also an obsolete digital videotape format by the Ampex company. (Asking an older engineer who Ampex is is like asking who Sony is today.)

Decibel – See dB.

Decode – To convert a coded signal into its original form.

Decoder – The unit containing the electronic circuitry necessary to decode encrypted signals. Some decoders are separate from the receiver but in satellite TV broadcasting, the term is often used interchangeably as a name for an Integrated Receiver Decoder (IRD). The term IRD, or IRD/Decoder, is usually associated with satellite TV broadcasting while Cable systems are based on Converters or on Set-Top Boxes/Converters.

Decoding – 1. Generally, converting one or more coded signals into uncompressed form, reversing a previous encoding operation that was applied to reduce data rate for transmission or recording.

2. In traditional video usage, taking composite video, such as NTSC or PAL, performing luma and chroma seperation and chroma demodulation, and producing component video output such as $YC_B C_R$ or RGB.
3. In modern video usage, taking coded picture information (such as JPEG, M-JPEG, or MPEG compressed downstream) and recovering uncompressed picture data.

Decoding Time-Stamp – A field that may be present in a PES packet header that indicates the time that an access unit is to be decoded in the system target Decoder.

Demod – Demodulation. See Demodulate.

Demodulate – To retrieve an electrical signal from a carrier signal or wave.

DHCP – Dynamic Host Configuration Protocol.

DIF – Digital interface standardized for DV bitstreams.

Differential coding – Method of coding using the difference between the value of a sample and a predicted value.

Digital8 – Sony's trademarked term for a component SDTV digital videotape format for consumer use, utilizing 8 mm tape cassettes and recording Rec. 601 YC_BC_R signals, based upon either 480i or 576i scanning, mildly compressed using the DV motion-JPEG technique.

Digital Betacam, Digital-ß – Sony's trademarked term for a component SDTV digital videotape format for professional use, utilizing ½-inch tape and recording Rec. 601 YC_BC_R signals, based upon either 480i or 576i scanning, mildly compressed using M-JPEG to about 90 Mbps.

Digital-S – JVC's trademarked term for the digital videotape format now standardized as SMPTE D-9.

Dolby digital – Formerly AC-3. An audio coding system based on transform coding techniques and psychoacoustic principles.

Dot crawl – A cross-luma artifact that results from a notch filter decoder, appearing as fine luma detail crawling up a vertical edge in a picture that contains a saturated color transition.

Downconversion – In video, conversion to a scanning standard, usually at the same frame rate, having substantially lower pixel count (for example, HDTV to SDTV).

Downlink – The part of the satellite communication circuit that extends from the satellite to an Earth station.

Downconvert – The process by which the frequency of a broadcast transport stream is shifted to a lower frequency range. (in satellite communication, this lower frequency is often either L-Band or 70 MHz)

Downsampling – Resampling that produces fewer output samples than the number of input samples provided.

DPCM – Differential Pulse Code Modulation is a process in which a signal is sampled and the difference between each sample of a signal and its predicted value is derived from the succession of quantized values is converted by coding into a digital signal.

Drive (n) – A periodic pulse signal that conveys synchronization information.

Dropframe – a timecode stream associated with scanning at a field or frame rate of 59.97 Hz, wherein timecodes are omitted so that counting frames stay close to clock time. This adjustment almost exactly componsates for the field or framerate being a factor of exactly 1000/1001 slower than 60 Hz. This effect can also be accomplished when trying to get a lipsync to match up. Dolby encoders, and other video and audio encoders often have the ability to input or output timing in order to dropframe and avoid the lip sync being off, or glitches in video or audio from mis-timing of equipment.

DS3 – A commercial leased line that has the capacity to handle up to 44.763 Mbps of digital information.

Dsec – Deci-seconds – A measurement of time that is equal to 0.1 seconds. For example, 15 dsec is equal to 1.5 seconds.

DSNG – Digital Satellite News-Gathering. Often used to describe a mobile satellite earth station that does not have analog satellite modulation capabilities.

DSP – Digital Signal Processor.

DTE – Data Termination Equipment – A generic name for any device that generated information to be transmitted to another device or over a transmission system. For example, visual display units, computers, and office workstations.

DTH – Direct to Home: The term used to describe uninterrupted (and sometimes occasional) transmission from the satellite directly to the subscriber, that is, no intermediary cable or terrestrial network is involved.

DTV – Digital television: A generic term including digital SDTV and digital HDTV. Generally, broadcast is implied.

DTVCC – Digital Television Closed Captioning. See Closed Captioning.

DV – 1. Digital video

2. A specific motion-JPEG compression technique, videotape recording format, and/or digital interface (DIF) bitstream, for YC_BC_R digital video.

DV25 – DV (digital video), coded at 25 Mbps. DV25 is widely implemented in consumer DVC and Digital8 equipment, and in professional D-7 (DVCPRO) and DVCAM equipment.

DV50 – DV (digital video), coded at 50 Mbps. DV50 is used in professional D-7 (DVCPRO50), D-9 (Digital-S), DVCAM, and DVCPRO equipment.

DV100 – DV (digital video) coded at 100 Mbps. DV100 is used in DVCPRO HD equipment.

DVB – Digital Video Broadcasting: 1. A European project which has defined transmission standards for digital broadcasting systems using satellite (DVB-S), cable (DVB-C) and terrestrial (DVB-T) mediums. The standards were created by the EP-DVB group and approved by the ITU. The standards specify modulation, error correction, and many other parameters. See EN 300 421 for satellite, EN 300 429 for cable, and EN 300 744 for terrestrial.

2. An organization of the EBU that standardizes and promotes DTV broadcasting. DVB advocates MPEG-2 video and audio compression, supplemented by DVB transmission standards for cable (DVB-C), satellite (DVB-S), and terrestrial (DVB-T) broadcasting (for which DVB-T specifies COFDM transmission).
3. A set of standards providing the specifications for transmission and reception of digitally processed broadcasting signals.

DVC – Digital video cassette: A component SDTV digital videotape format for consumer use, taking Rec. 601 YC_BC_R video having either 480i or 576i scanning, compressing to about 25 Mbps using the DV motion-JPEG technique (DV25), and recording on 6.35 mm tape encased in a cassette of one of two sizes – small (often called “mini-DV”) or large.

DVCAM – Sony's trademarked term for a component SDTV digital videotape format for professional use, utilizing 6.35 mm tape cassettes and recording Rec. 601 YC_BC_R video having either 480i or 576i scanning, compressed to about 25 Mbps using the DV motion-JPEG technique.

DVCPRO – Panasonic's trademarked term for the digital videotape format now standardied as SMPTE D-7. Similar to Sony's DVCAM.

DVCPRO50 – Panasonic's trademarked professional version, 50 Mbps digital videocassette. The format was incorporated by SMPTE into the D-7 series of standards.

DVCPROHD – Panasonic's trademarked term for a high-definition professional version of the SMPTE-standardized D-12.

DVCPRO P – A P denotes professional and perhaps, progressive: Panasonic's trademarked term for another 6.35 mm tape cassette recording Rec. 601 $YC_B C_R$ signals based upon either 480p59.94 or 480p60 scanning, mildly compressed to about 50 Mbps using DV motion-JPEG. Sometimes this is denoted DVCPRO50 P. It is the same thing.

DVI – Digital Visual Interface: An HDCP compliant digital connector that is a digital video interface standard, especially for digital video monitoring. Widely used in flat panel monitors (LCD, Plasma or LED displays) and projectors, it was developed by the Digital Display Working Group (DDWG). It is partially compatible with HDMI (High-Definition Multimedia Interface), DVI-D (standard in digital mode), and VGA (standard in analog mode) and there are adapters to change from one to the other.

DVTR – Digital VTR or Digital videotape recorder.

Earth – 1. Technical Earth: Ensures that all equipment chassis within a rack are at the same potential, usually by connecting a wire between the Technical earth terminal and a suitable point on the rack. This is sometimes known as Functional earth.

2. Protective Earth: Used for electric shock protection. This is sometimes known as safety earth.

EAV – End of active video: A sequence of four words inserted into a 4:2:2 component digital video data stream, marking the end of active samples on a line.

Eb/No – 1. A approximate measurement of satellite "Carrier-to-Noise" Ratio, plus satellite transponder saturation readings.

2. Eb = Energy per information bit; No = Noise energy per Hertz.

3. Signal energy with respect to noise, expressed in energy per bit/noise in 1 Hz bandwidth.

EBU – European Broadcasting Union: An organization of European state broadcasters and others.

ECC – Error checking and correction: A method of inserting redundant information prior to digital storage, recording or transmission, and processing that information upon subsequent playback or reception, so that recording or transmission errors can be detected (and in some cases, perfectly corrected). ECC systems can perfectly correct errors having certain statistical properties. Also known as EDC or Error Detection and Correction.

ECM – Entitlement Control Message.

EDH – Error detection and handling: A system standardized by SMPTE for encoding transmission error status into data conveyed across a series of SDI interfaces.

Edison Cord – A common, everyday extension cord. Also called a "stinger."

EIA – The U.S. Electronic Industries Alliance. (not "Association")

EIRP -

EIT – Event Information Table.

Elementary Stream – A generic term for a coded video, coded audio or other coded bit stream.

EMC – Electromagnetic Compatibility.

Encoding – 1. Generally, the process of converting one or more signals into a more complex representation, with the goal of reducing data rate for transmission or recording.

2. In traditional video usage, the process of taking component video input ($YC_B C_R$ signals or RGB signals), performing chroma modulation and luma and chroma summation, and producting composite video (NTSC, PAL, or SECAM).
3. In modern video usage, the processing of uncompressed image data to produce a compressed bitstream (such as JPEG, M-JPEG, or MPEG compression).

Encryption – Encoding of a transmission to prevent access without the appropriate decryption equipment and authorization.

ENG – (Electronic News Gathering) can mean anything from a lone reporter taking a single camcorder out to get a story, to an entire television crew taking a microwave or satellite truck on location to do a live report for a newscast.

Equalization – The correction of undesired frequency or phase response. Coaxial cable introduces a high-frequency rollof that is dependent upon cable length and proportional to $1/\sqrt{\int}$ (one over root f); this is corrected by a subsystem called an equalizer. A naively designed analog lowpass filter, or a simple digital IIR filter, has poor phase response; this can be corrected by an equalizer filter section.

Equalization pulse – A sync pulse, part of vertical sync, that is approzimately half the duration of a normal sync and occurs at 0_H or halfway between two 0_H data. The original purpose of equalization pulses was to eliminate the line pairing that would otherwise occur with cheap, passive sync separator circuits. Equalization pulses are unnecessary today, except for reverse compatibility.

EPG – Electronic Program Guide.

Error concealment – Masking, by playback or receiver circuits, of errors introduced in recording or transmission. Concealment is enabled by the playback or receiver circuits' detection of errors by using ECC codes. Concealment is accomplished by replacing errored samples by interpolated (estimated) signal information.

Error cliff – The point at which a digital signal receives far too few bits (BER or Bit Error Rate is too low) in order to keep a picture or audio from being received. At this point, the IRD (Integrated Receiver Decoder) or other receiving instrument "drops off" and "goes to black" essentially losing a picture and producing an internally generated black burst signal, or some type of an error message.

Error correction – Perfect correction, by playback or receiver circuits of errors introduced in recording or transmission. Correction is effected by the decoder's using the redundant ECC information inserted by the recorder or transmitter to perfectly reconstruct the errored bits.

Ethernet – The most widely used local area network (LAN) defined by the IEEE as the 802.3 standard. Transmission speeds vary according to the configuration. Ethernet uses copper or fiber-optic cables. Invented, in part, by Bob Metcalf (writer of Metcalf's Law).

ETM – Extended Text Message

ETT – Extended Text Table

Even field – Historically, in 480i (interlaced) scanning, the field whose first broad pulse starts halfway between two line syncs. When referring to Odd and Even fields, it is actually more proper to refer to them as first and second fields.

Event – A collection of elementary streams with a common time base, an associated start time, and an associated end time.

Event Information Table – (EIT) Also called a service table, a table in the SI (Service Information) stream which contains information about events or programs such as the event name, start time, duration and other downlink information.

Excursion – The amplitude difference between two levels. Unless otherwise noted, reference excursion.

Fault – A disturbance that impairs or disrupts normal operations.

FCC – Federal Communications Commission.

FDM – Frequency Division Multiplex is a common communication channel for a number of signals, each with its own allotted frequency.

FEC – Forward Error Correction: 1. A method of catching errors in a transmission. The data is processed through an algorithm that adds extra bits and sends these with the transmitted data (along with a number representing how many bits were actually with each line). The extra bits sent ahead (in the Forward) are then used at the receiving end to check the accuracy of the transmission and correct any errors by filling in the missing bits. The higher the FEC, the more Data, however, the higher the FEC, the more delay in encoding and decoding.

2. A synonym for ECC, particularly when used in transmission or video recording systems.

Field – 1. In interlaced scanning, the smallest time interval that contains a set of scanning lines covering the height of the entire picture, along with all associated preceding sync elements. Fields were once denoted odd and even, these terms should be avoided and replaced with first and second. In MPEG-2, top and bottom are more proper.

2. The assembly of alternate lines of a frame. Therefore, an interlaced frame is composed of two fields, a top field and a bottom field.

Field dominance – In an interlaced motion image sequence, the first parity (first or second) where temporal coherence is susceptible to interruption due to editing. In principle, video edits can be made at any field, but good practice calls for edits at the beginning of the first field (for example, the first field is dominant).

Field sync – In interlaced scanning, the analog sync pulse pattern that defines the start of a field. Field sync contains the O_V datum. In 480i and 576i systems, field sync is a sequence comprising preequalization pulses, broad pulses, and postequalization pulses. In 480i systems there are six of each; in 576i systems there are five.

FIFO – First In, First Out, a type of data buffer.

Fill Light - The main light on a subject which comes from the camera's right side.

First field – In interlaced scanning, the first field of the pair of fields comprising a frame. In analog 480i, the field whose first equalization pulse starts coincident with O_H. In analog 576i, the field whose first broad pulse starts coincident with O_H.

Footprint (NTSC and PAL) – The first time that the luma and modulated chroma components of an image are added together into a single composite signal, cross-luma and cross-color artifacts become permanently embedded: Subsequent decoding and reencoding cannot remove them. The permanence of these artifacts is referred to as the NTSC footpring or the PAL footprint.

Footprint (Satellite) – 1. The area of the Earth's surface covered by a satellite's downlink transmission.
2. The area from which the satellite can receive uplink transmissions.

Format conversion – An ambiguous term. Transcoding, scan conversion, downconversion, upconversion, or standards conversion are more proper.

FPGA – Field Programmable Gate Array – A chip that can be reprogrammed for various uses.

Frame – 1. The time interval of a video signal that contains all of the elements of one picture, complete with all of the associated preceding sync elements. In analog, measured between 0_V instants; In digital, measured between the EAV's (End of active video's) preceding line.

2. In an interlaced system, a frame comprises two fields (first and second), which normally have temporal coherence; each field contains half the scanning lines and half the picture lines of the frame.

3. Lines of spacial information of a video signal. For progressive video, these lines contain samples starting from one time constant and continuing through successive lines to the bottom of the frame. For interlaced video a frame consists of two fields, a top field and a bottom field. One of these fields will commence one field later than the other.

Frequency interleaving – Modulation of chroma, and summation with luma, such that the modulated chroma signal occupies frequencies disjoint from the integer multiples of the line rate at and near which the luma signal is concentrated.

Front porch – The time interval between the right-hand edge of active video on a line and the 50%-point of the leading edge of the immediately following sync pulse.

FTP – File Transfer Protocol: A protocol used to transfer files over a TCP/IP network (Internet, UNIX, etc.). FTP is heavily used by webmasters and anyone needing to handle large files, or binary files directly with little to no encoding or decoding (compression) of data.

Functional Block – A component that performs a specific process within a unit. For example, a video encoder is a functional block within an Encoder/Modulator unit.

GBR – An alternative of RGB (red, green and blue) to associate with $YC_B C_R$. G (green) associates with Y (luminance) because green dominates the luma.

GOP – Group of Pictures: MPEG video compression works more effectively by processing a number of video frames as a block. Tandberg equipment typically uses 12-frame GOP (every 12th frame is an I frame).

Guardband – A section of bandwidth set aside to put space between signals to avoid interference.

GUI – Pronounced "Gooey" - Graphical User Interface: The use of pictures rather than just words to represent the input and output of a program. A program with GUI runs under a windowing system and has a screen interface capable of displaying graphics in the form of icons, drop-down menus and a movable pointer. The on-screen information is usually controlled or manipulated by a mouse or keyboard.

HANC – Horizontal Ancillary

Hanging dots – A cross-luma artifact appearing as a fine alternating pattern of dark and light dots along a horizontal edge in a picture having a saturated vertical color transition, when decoded by a comb filter. Hanging dots are particularly evident when viewing the SMPTE colorbar test signal.

Hardline – An "old fashioned" phone line delivered to you down a "twisted pair" from the phone company. Phone line can be sent via twisted pair, Cat 3, Cat5, Cat5e or Cat 6.

HD – High Definition, Home Depot, or Harley Davidson

HD-SDI – High-definition serial digital interface: A SMPTE-standard interface, having a data rate of about 1.485 Gbps, for uncompressed studio-quality HDTV.

HDCAM – Sony's trademarked term for the digital videotape format now standardized as SMPTE D-11.

HDTV – High-definition television: A video system having aspect ratio 16:9 whose image comprises ¾-million pixels or more. The first TV image had 8 lines of resolution. When 16 line cameras and TVs were invented soon after, they called the image: High Definition.

Hertz – Hz – A measurement of frequency in cycles of a waveform occurring in one second. One Hertz is one cycle per second.

Hi8 – A consumer analog videocassette system using color-under recording onto 8 mm tape; the successor to Video-8.

High Level – A range of allowed picture parameters defined by the MPEG-2 video encoding specification which corresponds to high definition television.

Homerun – A cable run that has no breaks in it. If given an option, this is the way to go.

Horizontal blanking – The time interval – usually expressed in microseconds or sample counts, or sometimes as a fraction of line time – between the right edge of picture information on one line and the left edge of picture information on the following picture line.

Horizontal drive (HD) – A pulse containing horizontal synchronization information that begins at the right edge of picture on a line and ends at the trailing edge of normal sync.

HPA – High Power Amplifier (also see Amplifier): **1.** Used in the signal path to amplify the modulated and up-converted broadcast signal for feeding to the uplink antenna.

2. In satellites, a device which provides the high power necessary to transmit radio signals from an earth terminal to a satellite (There are HPAs on satellites to re-broadcast the signal back at the downlink frequency).

HSYNC – Horizontal (line) sync.

Hub – Any device in a multi-point network at which branch nodes interconnect.

Hue – 1. The attribute of a visual sensation according to which an area appears to be similar to one of the perceived colors, red, yellow, green and blue, or a combination of two of them. Roughly speaking, if the dominant wavelength of an SPD shifts, the hue of the associated color will shift.

2. In color science, h_{UV}, the polar coordinate angle of a color difference value in L U V components put together by the CIE.
3. In video, the polar-coordinate angle of a color difference value as displayed on a vectorscope, in C_B, C_R coordinates for component digital video, P_B, P_R coordinates for component analog video, or U, V coordinates for composite video.
4. User (consumer or sometimes professional) adjustable means to adjust HUE.

IEC – International Electrotechnical Commission – A Geneva, Switzerland-based organization that sets international electrical and electronics standards and includes national committees from over 40 countries.

IF – Intermediate Frequency 1. Usually refers to the 70 MHz or 140 MHz output of the modulator in satellite and cable transmission RF chains.

2. A frequency to which a signal wave is shifted locally as an intermediate step in transmission or reception.
3. The fixed frequency resulting from heterodyning the incoming signal with a signal from a local oscillator.

IFB - (Interruptable Feedback) A program audio channel fed from a station, network, phone or cell phone and fed into a talent's earphone or receiver and earpiece.

I-field – In MPEG, a field-coded I-picture. I-fields come in pairs, either top then bottom, or bottom then top.

IFL – Interfacility link – Typically refers to an interfacility link cable used to connect a low-noise block (LNB) to an IRD. Often this IFL carries power from the IRD to the LNB.

IF Looptest – A diagnostic, troubleshooting, or operational test procedure designed to test operate satllite equipment by passing video and audio test signals through an encoder and satellite modulator, looping the output of the modulator to the input of the IRD, and monitoring the video and audio output of the IRD.

I-frame – In MPEG, either a frame-coded I picture, or a field-coded I-picture followed by a field coded I-picture or P-picture (of opposite parity). In the second case the two fields form what is sometimes called an IP frame; the P-field may involve prediction from the I-field.

Impedance – The total opposition of a device offers to the flow of alternating current. Measured in Ohms and varies at different frequencies.

Integrated Receiver/Decoder – See IRD.

Interruptable Foldback – See IFB.

I-picture – In MPEG, an intraframe picture (field or frame): A picture, or coded picture information, that makes no reference to preceding or following pictures. An I-picture is coded independently, and it makes no temporal coherence.

I, Q – In-phase and Quadrature color difference components of NTSC: U and V components rotated +33° and then axis-exchanged. NTSC-modulated chroma was originally based on I and Q color differences, where I had considerably more bandwidth than Q. Today, NTSC color modulation is usually performed on equiband U and V components. Except perhaps for bandwidth difference, it is impossible to tell from a composite analog NTSC signal whether it was encoded along (U, V), (I, Q) or any other pair of axes.

Information Rate – (Data Rate) The rate of data leaving the modulator or demodulator measured in bits per second. This rate is generally equal to the aggregate transport stream rate.

Intensity – Intensity is a measure over some interval of the electromagnetic spectrum of power (usually radiated from, or incident on, a surface), in a specified direction. Intensity on a transponder is not exactly proportional to your applied wattage. Intensity produced by a CRT monitor is not proportional to the applied voltage, rather 5/2 of the applied voltage. In satellite access centers, engineers should be more interested in intensity per unit area weighted by a visual response of transponder saturation. These cues are not determined by an already inaccurate measure of your HPA's power output. The same measures happen in the study of video and electronics. And that is why the study of electronics is often a study in theory.

Interlace – A scanning standard in which alternate raster lines of a frame are displaced vertically by half the scan-line pitch and displaced temporally by half the scan-line pitch and displaced temporarily by half the frame time to form a first field and a second field. Examples are 480i29.97 (525/59.94), 576i25 (625/50) and 1080i30 (1125/60). Systems with high-order interlace have been proposed but none has been deployed. Therefore, the term interlace implies 2:1 interlace.

Interlace factor – The ratio between the number of picture lines in a reference progressive system and the number of picture lines necessary to defeat twitter in an interlaced system having equivalent spatial resolution.

Interpolation – Resampling that produces more output samples than original samples (synonymous with upsampling), or that produces the same number of output samples as input samples (phase shifting).

Interstitial – 1. Chroma subsampling wherein each subsampled chroma sample is effectively horizontally positioned halfway between adjacent luma samples. Intersitial 4:2:0 chroma subsampling is implicit in the JPEG/JFIF, H.261, and MPEG-1 standards.

2. In television programming, a short element such as a commercial inserted into or between programs.

I/O - Input/Output

I/O Panel - Input and Output Panel: A panel of connectors remote from the associated equipment. Typically, but not always, an I/O Panel is different from a breakout box in that it is built into the side of a truck or piece of equipment. An I/O Panel is used mostly to keep weather (rain and snow) out of a truck or equipment rack and off of the equipment.

IP – Internet Protocol.

IRD – Integrated receiver-decoder: **1.** A device that receives an RF signal carrying digital television, and produces an uncompressed video signal, typically in analog form. An IRD performs demodulation, demultiplexing, and MPEG-2 decoding. An IRD is typically a set-top or rack-mounted device.

2. Within a satellite downlink system, a piece of equipment used to demodulate and decode a transport stream.

IRE – Institute of Radio Engineers. The predecessor of the IEEE.

IRE unit – One-hundredth of the excursion from blanking level to reference white level. Originally standardized by the IRE. In systems having picture-to-sync ratio of 10:4 (such as ITU-R System M and the archaic EIA RS-343-A), one IRE unit corresponds to 7 1/7 mV. In systems having picture-to-sync ratio of 7:3, one IRE unit corresponds to exactly 7 mV. In 50 Hz systems, levels are usually expressed in millivolts and not IRE units.

ITU-R – International Telecommunications Union, Radiocommunications Sector; successor to the CCIR (Comite Consultatif Internationale des Radiocommunications... or International Radio Consultative Committee): A treaty organization that obtains international agreement on standards for radio and television broadcasting. The ITU-R BT series of Recommendations and Reports deals with television. Although studio standards do not involve radio transmission in a strict sense, they are used in the international exchange of programs and therefore are under the jurisdiction of ITU-R.

JFIF – JPEG file interchange format. A file format that encapsulates a JPEG image along with supplementary data. If you are presented with an image data file described as JPEG, it is likely a JFIF.

JPEG – 1. Joint Photographic Experts Group: A standards committee, constituted jointly by the ISO and IEC and formally denoted ISO/IEC JTC1.

2. A standard, formally denoted ISO/IEC 10918, adopted by JPEG for the lossy compression of digital still images (either color or grayscale).

K – Kelvin: Unit of absolute temperature. Kelvin is properly written with no degree sign. In color science, commonly used to quantify color temperature. (Incandescent = 2800 K) (Sunlight = 5600 K)

kbps – Kilobits per second – A ratio of 1000 bits transmitted per second. For example, 10 Kbps equals 10-Thousand bits transmitted per second.

K-factor – Kell factor: The Kell effect and Kell factor refer to the loss of resolution, compared to the Nyquist limit, caused by the spacial dispersion of light power. Kell factor is a ratio and theoretically obtainable resolution between 0.7 and 0.9. Now deprecated. Distinguished from interlace factor.

Key – A component signal indicating transparency of the accompanying foreground image data, coded between zero (fully transparent) and unity (fully opaque). The keying operation is performed as:

$$R = a \cdot FG + (1-a) \cdot BG$$

FG represents foreground (fill) video and BG represents Background video. Foreground image data that has been premultiplied by the key is called shaped in video. Foreground image data that has not been premultiplied by the key is called unshaped in video.

Key Light – The main light on a subject which comes from the camera's left side.

Ku-Band – A portion of the electromagnetic spectrum in the 12 GHz to 14 GHz range. Used for satellites, employing 14 GHz on the uplink and 11-12 GHz on the downlink in support of such applications as broadcast TV typically requiring more portability. Ku is used in police radar detectors, and is also used in Direct Broadcast Satellite (DBS) systems and Direct Satellite Systems (DSS), both direct-to-home satellite systems.

LASER – Acronym for Light Amplification by Stimulated Emission of Radiation.

1. A device that produces monochromatic EMR (Electromagnetic Radiation) of high intensity.
2. Any frequency made to operate by amplifying and stimulating radiation (microwaves, for example, can be used to create a MASER.

L_A active lines – The count of scan lines containing the picture. L_A for a frame is equivalent to the number of rows of image samples. (Vertical interval lines including VITC are not considered active; however, closed captioning lines in 480i are considered active.)

L-Band – 1. Portion of the electromagnetic spectrum commonly used in satellite applications, with frequencies in the 390 – 1550 MHz range.

2. For an IRD, the frequency received from the LNB, usually rated for a range of 950 – 1450 MHz or 950 – 2050 MHz.

L_T total lines – The count of total scan lines in a frame.

LCD – Liquid crystal display – A display technology that uses liquid crystals to form displayed characters.

LED – Light emitting diode – a display and lumination technology that uses a light emitting diode to form displayed characters, luminate a display, or give simple operational or fault messages, often according to color.

Legal – 1. In component video signal coding, the condition where each signal of a component set lies within its reference range. In an RGB "legal" combination, Red, Green, and Blue all lie within their reference ranges. This is nearly impossible if the reporter insists on wearing a Red jacket. (Red and Green are the most saturating colors.)

2. In NTSC and PAL coding and transmission, compliance with broadcast standards. (NTSC broadcast transmission has a 120 IRE amplitude limit that requires limiting the saturation of colors near pure yellow and pure cyan.)
3. In JPEG or MPEG, a bitstream that is compliant with standards, an encoder that produces only compliant bitstreams, or a decoder that correctly decodes any compliant bitstream.

Letterbox – A widescreen image (such as 16:9 aspect ratio) conveyed or presented in a format having a narrower aspect ratio (such as 4:3), using the full width of the narrower format but not using the full height.

Level – 1. In video, generally, the amplitude of a video signal, of one of its components, expressed in volts, millivolts, IRE units, or digital code value.

2. In JPEG, MPEG, and DV compression, the magnitude of a DCT coefficient.

Lightness – An objective quantity related to brightness; approximately equal to relative luminance raised to the 0.4-power.

Line, active – Also called a picture line, a scanning line that is specified by a scanning standard to contain picture elements. (In 480i systems, closed captioning lines are also considered to be active.)

Line frequency – 1. in video, the frequency of horizontal scanning; about 15.7 kHz for SDTV, and 33.7 Khz or higher for HDTV.

2. AC power line frequency, which is 60 Hz in the United States and a few other places, 50 Hz in a large part of the world, and is a large reason frequency is chosen in scanning rates (to match the power frequency). Some video (especially video security and surveillance systems) literally lock their vertical scan frequency to the AC power line frequency, called "line locking."

Line resolution – The degree of sharpness of a displayed video image.

Line sync – The sync pulse that defines the start of a scan line. In 480i and 576i systems, line sync may be the start of a normal sync or the start of certain equalization or broad pulses.

Lines – 1. Total number of lines per frame, or L_T.

2. Active lines, L_A.
3. A unit of resolution; properly, TV lines per picture height, TVL/PH.

LNB – Low Noise Block – A combination low noise amplifier and local oscillator used in most satellite downconverter systems. The LNB "LO" or Local Oscillating Frequency defines the down converting frequency. It allows one satellite receiver or IRD to use either Ku-Band, C-Band, or other frequency bands.

LO – Local Oscillator – A device within a frequency converter that is used to reduce or increase the frequency of the signal passed from the device input to output. LNB LO Frequencies change in accordance with the band type:

- Ku-Band LO frequency range is 9.0 to 20.00 but is set at 10.750 or 10750 in the United States.
- C-Band LO frequency range is 5.0 to 6.0 but is set at 5.150 or 5150 in the United States.

Loss-Less – A video term that means the equipment offers very low compression ratios (usually not more than 3 to 4 times) and was first used widely in broadcast and video editing houses.

Lossy – A video term that means certain details of the image (video) are lost and cannot be retrieved, no matter what you do with the video after it is compressed. Good compression offers the best squeeze, yet offers the best compromise between quality and small file size.

Luma – A video signal representative of the monochrome – or roughly, lightness – component of a scene. For SDTV, Rec. 601 standardizes these coefficients:

$$^{601}Y = 0.299\ R+0.587\ G+0.114\ B$$

For HDTV, Rec. 709 standardizes these coefficients:

$$^{601}Y = 0.2126\ R+0.7152\ G+0.0722\ B$$

Luma coefficients – The coefficients of nonlinear (gamma-corrected) RGB in the weighted sum that forms luma.

Luminance – 1. Luminous flux density in a particular direction: the spectral radiance of a scene, weighted by the luminous efficiency function Y of the CIE Standard Observer. Denoted L_V or Y; properly expressed in units of $cd \cdot m^{-2}$, or colloquially, nit. Luminance is the photometric analog of radiance. Luminance is related to the brightness sensation of human vision.

2. Luminance, normalized to an excursion of 1 or 100 with respect to a reference white luminance. Properly called relative luminance.
3. The term luminance is often not used correctly when engineers refer to luma. A lot of confusion surrounds this term. In color science, luminance is proportional to intensity and carries the symbol Y. It can be computed as a properly weighted sum of RGB. But in video, *Luma* is computed and tends to refer to it's computations with Y in a nonlinear fashion. Luminance should be used only when you are talking or writing about a linear equation according to CIE specs.

Luminance, relative – Luminance normalized to an excursion of 1 or 100 with respect to reference white luminance. In video, absolute production of luminance is unnecessary, because video normally involves relative luminance.

MAC – 1. Multiplexed analog component. A now defunct component video standard once used overseas.
2. Medium Access Control.

Macroblock – 1. In MPEG, image data comprising, or coded picture information representing, one of the 16X16 arrays of luma samples that tile the image, accompanied by the requisite number and arrangement of associated blocks of C_B and C_R. In the common MPEG-2 case of 4:2:0 chroma subsampling, four 8X8 luma blocks are accompanied by an 8X8 block of C_B and 8X8 block of C_R. Therefore, in 4:2:0 a macroblock comprises six blocks.

2. In DV, image data comprising, or coded picture information representing, an 8X8 block of C_B and 8X8 block of C_R and the associated two (4:2:2), three (3:1:1), four (4:1:1 or 4:2:0) or six (3:1:0) 8X8 blocks of luma.
3. In JPEG, an MCU (minimum coded unit).

Main Level – A range of allowed picture parameters defined by the MPEG-2 video coding specification with maximum resolution equivalent to ITU-R Recommendation 601.

Main Profile – A subset of syntax of the MPEG-2 video coding specification that is expected to be supported over a large range of applications.

MB – 1. Megabyte: 2^{20} (or 1048576) bytes, or in disk storage, $2^{10} \cdot 10^{3}$ (or 1024000) bytes.

2. Macroblock

Mbps – Megabits per second – A ratio of 1-Million (1,000,000) bits transmitted per second. For example, 15 Mbps equals 15-Million bits transmitted per second.

MCPC – Multi-channel-per-carrier – Two or more video and/or audio programs transmitted per digital transport stream.

Melt – A post-event video feed of highlights fed to a network, station, or headend to be edited, archived, and used at a later date. Melts at one time were edited on a tape format. Now, most production melts are edited on one or more hard drives.

MER – Modulation Error Ratio.

Metamerism – When a camera or image capture device "sees" different colors than a normal (non-colorblind) human observer, that device has metamerism errors.

Metcalf's Law (Bob Metcalf, founder of Ethernet) – Number of potential connections grows faster than the actual number of connections. The power of a network is the number of nodes, squared.

MGT – Master Guide Table.

MIB – Management Information Base.

MiniDV – The smallest cassette size the DVC tape family.

Mix-Minus – Using an auxiliary program channel from a mixer, and the ability to mute each input to that mixer, Mix-Minus audio refers to a full program "mix" from every source, "minus" your source, to prevent feedback, or worse, an echo or delayed feed into the talent's ear or room audio. You must understand mix-minus to operate satellite feeds!

M-JPEG – A technique or file format using JPEG, or a JPEG-like algorithm, to individually compress each field or frame in a motion image sequence, without exploiting interfield or interframe coherence. M-JPEG is not standardized.

Modulated chroma – 1. In NTSC and PAL, a color subcarrier onto which two color difference signals (typically U and V) have been imposed by quadrature modulation.

2. In SECAM, a frequency modulated signal conveying line-alternate color difference components.

Monochrome – 1. In color science, shades of a single hue.

2. In video, the black and white (grayscale, or lightness) component of image data.

Moore's Law (Gordon Moore, founder of Intel in 1965) – Number of elements (transistors) doubles each year without taking up more space. Basically, speed on a chip doubles each year.

MP3 – Formally, MPEG Audio Layer III: An audio compression standard, defined in MPEG-1 and MPEG-2, that is widely used for distributing music on the Internet: See also "Sheep that Shit Grass." Sometimes incorrectly called MPEG-3, by morons.

MPEG – Moving (not Motion!) Picture Experts Group: **1.** A standards committee, jointly constituted by ISO (International Standards Organization) and IEC (International Electrotechnical Commission), that has developed standards for the lossy compression of digital motion images. The MPEG algorithms exploit the temporal coherence found in motion image sequences The MPEG-2 standard is of interest to digital video and HDTV. Its predecessor, now denoted MPEG-1, offers VHS quality. Other emergent MPEG standards, such as MPEG-4, MPEG-7, and MPEG-21, are for applications other than broadcast television.

2. A series of hardware and software standards designed to reduce the storage requirements of digital video.
3. A compression scheme for full motion video.
4. Refers to standards developed by the ISO/IEC JTC1/SC29 WG11 of the Moving Picture Experts Group.

MPEG-1 – 1. A standard, adopted by MPEG, formally denoted ISO/IEC 11172, optimized for data rates of about 1.5 Mbps and having approximately the quality of VHS.

2. An standard developed in 1991 by the ISO/IEC JTC1/SC29 WG11, Moving Picture Experts Group.

MPEG-2 – 1. A standard, formally denoted ISO/IEC 13818, adopted by MPEG, optimized for data rates of 1.5 Mbps to about much higher (1.5 Gbps and theoretically higher) of interest to digital video and HDTV.

2. Standard defined by MPEG as 13818-1 (Systems), 13818-2 (Video), 13818-3 (Audio), 13818-4 (Compliance).

MPEG-4 – 1. A collection of methods made into a set of 23 standards (or more), formally denoted ISO/IEC 14496, adopted by MPEG, is efficient across a variety of bit-rates ranging from a few kilobits per second to tens of megabits per second. MPEG-4 uses many of the features of MPEG-1 and MPEG-2 and adds more features such as VRML (Virtual Reality Modeling Language), Digital Rights Management, and some interactive abilities.

MPEG IMX – SMPTE standardized D-10.

MP@HL – Main Profile at High Level

MP@ML – Main Profile at Main Level

MPTS – Multiprogram Transport Stream.

MRD – Modular Receiver Decoder.

MTBF – Mean time between failures – The length of time a user may reasonably expect a device or system to work before an incapacitating fault occurs.

Mult Box – Also called a "press feed box" or "press mult" this allows you to input one video and one audio and send them to many multiple sources.

Network Management System – A system designed to keep a network operating near maximum efficiency and to provide operator interface to the managed system for configuring, isolating and correcting faults, and monitoring operational performance.

Nit – Candela per meter squared, $cd \cdot m^{-2}$. Derived from the Latin *nitere,* to shine.

Non-volatile, field-programmable memory – A type of Flash ROM used to store configuration parameters. The ROM memory is configurable by the user but will not clear if the unit loses power.

Normal line sync – In analog SDTV, a line sync pulse that remains at sync level for about 4.7 milliseconds. In interlaced systems, the leading edge of equalization and broad pulses are ulitilized as line syncs.

Notch filter – In a composite video decoder, circuitry that seperates chroma from a composite signal using a simple bandpass filter centered at the color subcarrier frequency. A notch filter introduces dot crawl artifacts into any picture that has luma detail at frequencies near the color subcarrier. In newer frame syncs and newer encoders and decoders, it is sometimes possible to notch, or pass, individual lines in active or inactive video.

NTSC – National Television System Committee (of the EIA or Electronic Industries Association): 1. The group, now referred to as NTSC-I, that in 1941 standardized 525-line, 59.94 Hz field rate, interlaced color television in the United States. NTSC-II introduced the composite video technique.

2. The group, formally referred to as NTSC-II, that in 1953 standardized 525-line, 59.94 Hz field rate,

interlaced color television in the United States. NTSC-II introduced the composite video technique.
3. A method of composite video encoding based on quadrature modulation of I and Q (or U and V) color difference components onto a color subcarrier, then summing the resulting chroma signal with luma. Used only with 480i scanning, with a subcarrier frequency nominally 455/2 times the horizontal line rate (i.e., a subcarrier frequency of about 3.579545 Mhz).
4. Often incorrectly used to denote 480i29.97 (525/59.94) scanning.

NTSC-4.43 – A version of NTSC with chroma modulated onto a 4.43 Mhz color subcarrier instead of 3.58 Mhz to allow European consumer equipment the ability to play NTSC tapes.

NTSC-J – Used in Japan, it is similar to U.S. NTSC except in that visible black is set at zero, rather than 7.5% IRE. Luma and chroma levels also have to be modified to make up for the drop (or raising of levels if being transferred from NTSC-J).

NTSC-legal – The condition where an NTSC signal is RGB-legal and additionally has no chroma content that would cause the composite signal to exceed more than +120 IRE units.

Odd field - Historically, in 480i (interlaced) scanning, the field whose first broad pulse is coincident with line sync. This term should be avoided, and first field should be used instead.

OFDM – Orthogonal frequency-division multiplexing. In video transmission, OFDM is always applied to digital data, and referred to as coded (COFDM).

Ohm – A unit of measure for resistance symbolized by the greek letter omega Ω. Defined as the electrical resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these points produces in this conductor a current of 1 ampere, the conductor not being the source of any electromotive force.

OSD – On Screen Display.

Overhead – The number of data bits used for error – checking, control, timing, and other communications functions that are inserted in the data steam as an additional to the individual data rates of the transport stream components. Overhead must be included when calculating the aggregate transport stream output data rate.

PAL – Phase Alteration (not Alternating) Line **1.** A broadcast television standard that uses a subcarrier which is alternated 90 degrees in phase from one line to the next to minimize hue errors in color transmission.
2. The color television transmission standard used in Europe and many other parts of the world.

PAL-I – A European color television transmission standard that uses a 4.43361875 MHz subcarrier. A single frame in this standard consists of 625 scanning lines, and frames are scanned at a rate of 25 frames per second.

PAL-M – A color television transmission standard that uses a 3.57561149 MHz subcarrier. A single frame in this standard consists of 525 scanning lines, and frames are scanned at a rate of 30 frames per second.

PAT – Program Association Table.

P_B, P_R – Scaled color difference components, blue and red, used in component analog video: Versions of B minus luma (B-Y) and R minus luma (R-Y) scaled for excursion nominally identical to luma for component analog transmission. P_B and P_R according to the EBU N10 standard are equivalent to C_B and C_R or U and V.

PCM – Pulse-Code Modulation.

PCR – Program Clock Reference.

Peak white – The most positive excursion of a luma, R, G, or B component. Distinguished from reference white: Reference white is usually not a peak, because studio video systems typically allow signals to exurse to a peak somewhat above the reference white level. Reference white should tend to come from reflected white, peak white from light sources or mirrored surfaces shining light sources.

Pedestal – Black level expressed as an offset in voltage or IRE units relative to blanking level. Conventionally about 54 mV (7.5 IRE) in ITU-R System M, SMPTE 170M, and the archaic EIA RS-343-A. Conventionally zero in all other systems, where blanking level and black level are identical. Pedestal is properly a voltage offset or a level. And it is incorrect to express pedestal as a percentage.

P-field – In MPEG, a field-coded P-picture. P-fields come in pairs (either top then bottom, or bottom then top).

PGCA – A proprietary (to Tiernan) conditional access method that provides basic signal protection and the ability to authorize individual IRDs based on their ID number.

P-frame – In MPEG, either a frame-coded P-picture, or a pair of P-fields (one top field and one bottom field, in either order).

Picture – In MPEG-2, one of a top field, a bottom field, or a progressive frame.

Picture excursion – The excursion from blanking to reference white. In 480i, 100 IRE by definition. In other systems, the level is often 700 mV.

PID – Packet Identifier – **1.** Within a data packet, the bits used for its identification.
2. A unique integer value used to associate elementary streams of a program in a single or multi-program transport stream.

Pillarbox format – An image (such as 4:3 aspect ratio) conveyed or presented in a format having a wider aspect ratio (such as 16:9), using the full height of the widescreen format but not using the full width. The term echoes letterbox; and it derives from the name for a tall postbox in the U.K.

Pixel – 1. A picture element.
2. The smallest unit of area of a video screen image that can be turned on or off, or varied in intensity.
3. The smallest division that makes up the raster scan line for a video display.
4. The collection of quantized samples that are specific to a single spatial sampling site in an image; usually three color component samples, perhaps augmented by a transparency (alpha or key) component sample.

PL - (Producer Line) A two-way audio channel fed from a station, network, phone or cell phone into headsets used by photographers, producers, and other non-talent television professionals.
Several volumes have been written about how to establish and use IFB and PL. And despite popular opinion, there are many choices, and quite a few different ways to provide IFBs to talent and PLs to camera

people and producers. The only wrong way is the way where it doesn't work. The only right way is the way that makes the most people happy. That leaves you with a lot of options.

PMT – Program Map Table.

P-picture – In MPEG, a predictive-coded picture: A picture, or coded picture information, in which one or more macroblocks are predicted from a preceding anchor picture, and which may itself be used as the basis of subsequent predictions. P-pictures exploit temporal coherence.

Producer Line – See PL.

Profile – A defined subset of the syntax specified in the MPEG-2 video coding specifications.

Program – A collection of program elements. Program elements may be elementary streams. Program elements need not have any defined time base; those that do, have a common time base and are intended for synchronized presentation.

Program Specific Information (PSI) – Normative data which is necessary for the demuxiplexing of transport streams and the successful regeneration of programs.

Progressive – A scanning standard in which spatially adjacent picture lines are associated with consecutive periodic (or even identical) instants in time. Examples are 1080p24 and 720p60. Distinguished from interlace.

PSI – Program Specific Information.

PTS – Presentation Time Stamp.

QAM – Quadrature amplitude modulation: A modulation system wherein two information signals independently modulate two subcarriers that are in quadrature (that is, offset in phase by 90°), which are then summed to form the modulated subcarrier. An analog version in QAM, usually called just quadrature modulation, combines two color difference components onto a color subcarrier in NTSC and PAL composite video. A digital version of QAM is used for RF modulation in some digital television transmission systems (16QAM, 64QAM and 128QAM), usually by cable television providers.

QCIF – Quarter common intermediate format: In the ITU-T Rec. H.261 standard for videoconferencing, a progressively scanned raster with 4:2:0 chroma subsampling having 176X144 luma samples at 29.97 frames per second. QCIF image data is ordinarily subsampled from SDTV.

QPSK – Quadrature phase-shift keying: **1.** A modulation system wherein a signal alters the phase of a carrier (or subcarrier). In video, digital QPSK is used for RF modulation.

2. The transmission of 2 bits per symbol, with each symbol being a phase range of the sine wave. In this fashion, a 2:1 compression ratio is achieved, resulting in a doubling of the efficiency with which a circuit is employed.

Quantization – The process of assigning a discrete, numbered level to each of two or more intervals of amplitude of a sample (In video or audio, there are typically hundreds of thousands of intervals.) In the usual uniform quantization, the steps between levels have equal amplitude.

Radiance – Intensity per unit projected area.

Raster – The pattern of parallel horizontal scan lines that paints out a picture. The raster is the spatial pattern that is refreshed with successive frames of video.

RCA – Radio Corporation of America:

1. RCA cables are the simplest audio or video connectors, are very small and very cheap. The Radio Corporation of America standardized the popular connector. They are commonly called Phono jacks, composite jacks, and Cinch/AV connectors.

RCD – Remote Control Device – A computer terminal used to configure and monitor an encoder, an IRD, amplifier, or other device in an RF chain without using the unit's front control panel. The first RCDs used serial ports, many companies are today trying to use web browsers to control equipment.

RDS – Receiver Decoder System.

Rec. 601 – Formally, ITU-R Recommendation BT.601: The international standard for studio digital video sampling. Rec. 601 specifies a sampling frequency of 13.5 MHz, YC_BC_R coding, and this luma equation:

$$^{601}Y = 0.299\,R + 0.587\,G + 0.114\,B$$

Rec. 601 is silent concerning RGB chromaticities. It is implicit that 480i systems use SMPTE RP 145 primaries, and that 576i systems use EBU Tech. 3213 primaries. Rec. 601 is also silent concerning encoding gamma.

Rec. 656 – 1. Formally, ITU-R Recommendation BT.656: The international standard for parallel or serial interface of Rec. 601 digital video signals.

2. Loosely, in computer graphics, a parallel interface for Rec. 601-style video, where synchronization is accomplished with embedded SAV and EAV sequences.

Rec. 709 – Formally, ITU-R Recommendation BT.709: The international standard for HDTV studio signals. Chromaticity and transfer function parameters of Rec. 709 have been introduced into modern studio standards for 480i and 576i. Rec. 709 specifies this luma equation (whose coefficients are unfortunately different from the Rec. 601 coefficients):

$$^{709}Y = 0.2126\,R + 0.7152\,G + 0.0722\,B$$

Reed's Law (David Reed) – The value of the network is two to the power of the number of nodes. Under Metcalf's Law and Reed's law, the power of two nodes is four. But the power of 10 nodes under Metcalf's Law is 100 (ten to the second power) and is 1024 (two to the tenth power) under Reed's Law.

Networks are more powerful by Reed's Law because of sharing, and of the power in each person knowing more than one thing and able to multitask.

Reference black – The level corresponding to picture black. In systems having 7.5% setup, such as 480i, reference black is nominally at a level of 7.5 IRE units. In systems with zero setup, such as 576i, NTSC-J, and HDTV, reference black is nominally set at zero level.

Reference white – The level corresponding to white, 100 IRE units by definition. In video, it is standard for reference white to correspond to light having the spectral and/or colorimetric properties of CIE illuminant D_{65} (except in Japan, where the standard white reference is 9300K).

RF – Radio Frequency or Radiation Frequency.

RF Input – The L-band, C-band, or Ku-band input to an IRD.

RGB – Red, Green, and Blue.

RGBHV – Red, Green, Blue, Horizontal, Vertical.

Rim Light – Also called a "backlight" but traditionally not hanging from the ceiling, like a backlight. A rim light hits the camera's subject from the back, but is typically on a stand placed on the ground.

RJ11 – A common name for a USOC RJ11C (The Standard Modular Telephone Jack in the United States and several parts of the world), referring to a plug or jack. An RJ11 usually has 4 or 6 metal connections, with the first twisted pair of phone lines placed on the two middle connections. The next pair is placed around the first, in the next outward set of connections. If there is a third line, the next pair is on the outside of the first two. RJ11 adapters are commonly used for voice and data. However, some companies are now using RJ11 jacks to carry low-voltage power to a piece of electronics. Most of these connections are colored red to avoid using them improperly.

RJ45 – Similar to the RJ-11, an RJ-45 has 8 connections. However, there are several ways to wire an RJ-45, depending on the application. For voice, an RJ45 can carry one to four pairs of ring and tip POTS (Plain Old Telephone Service) lines. For common computer data, RJ45 wiring is typically called normal (10Base-T) or serial cable. And there are an almost endless list of adaptations from or to RJ45 connectors for other uses beyond these most common.

RO – Read Only.

RPM – Revolutions per Minute.

RRT – Rating Region Table.

RS-232 – Recommended Standard. A standard for serial binary data interconnection.

RU – Rack Unit, measured at approximately 1.75 inches (44 mm) high and 19 inches (483 mm) wide. A 19-inch rack, therefore, is the measured width of the front panel of gear or blank panel in a rack. This unit of measurement is generally accepted worldwide. Many new pieces of gear are half-rack, which means two pieces of the same gear can fit side-by-side in a 19-inch rack space.

RW – Read/Write.

Sample Rate – The number of times per second that an analog signal is measured and converted to a binary number in order to convert the analog signal to a digital signal.

Sarnoff's Law (David Sarnoff) – Small number of stations with a large number of viewership equals the value of the network. NETWORK VALUE = Viewership

Satellite downlink frequency – Within a satellite system, the frequency, either C-Band or Ku-Band, of the signal transmitted from the satellite to the receiving dish or antenna.

Saturation – 1. The colorfulness of an area judged in proportion to light (as defined by the CIE). Saturation runs from neutral gray through pastel to saturated colors. Roughly speaking, the more an SPD is concentrated at one wavelength, the more saturated the associated color becomes. You can desaturate a color by adding light that contains power at all wavelengths.

2. in radius in polar coordinates, of a color difference value as displayed on a vectorscope, In C_B, C_R coordinates for component digital video, P_B, P_R coordinates for component analog video, or U, V coordinates associated with composite video.
3. User-accessible (consumer) means to adjust saturation.

SAV – Start of active video: A sequence of four words inserted into a 4:2:2 component digital video stream, marking the start of active samples on a line.

Scan conversion – Conversion, without temporal filtering, among scanning standards having different spacial structures.

Scanning standard – The parameters of raster scanning of a pickup device or a display device, or of the associated signal. Historically, a scanning standard was denoted by its total line count and its field rate (in hertz), seperated by a virgule (slash); for example, 525/59.94, 625/50, or 1125/60. Interlace was implicit. Modern notation gives the count of picture lines, p for progressive or i for interlace, and the frame rate; for example, 480i29.97, 576i25, 1080i30, or 720p60.

SCPC – Single Channel Per Carrier.

SD – Standard Definition.

SDI – Serial digital interface: A SMPTE-standard studio video interface having datarate between 143 Mbps and 360 Mbps. Usually, uncompressed SDTV video is conveyed, though the SDTI variant may be used to encapsulate compressed data.

SDTI – Serial data transmission interface: A SMPTE-standard variant of SDI used to convey arbitrary data instead of uncompressed digital video.

SDTV – Standard-definition television: A video system whose image comprises fewer than ¾-million pixels. The most widely deployed SDTV broadcasting systems are 480i.

SECAM – Sequential coluler avec memoire: A composite video system based on line-alternate B-Y and R-Y color difference signals, frequency modulated onto a subcarrier, then summed with luma. Neither quadrature modulation nor frequency interleaving is used. SECAM is used as a broadcast standard in certain countries with 576i scanning (France and Russia are two examples). SECAM production equipment has fallen into disuse: 576i component equipment or PAL is often used instead, and the signal is transcoded into SECAM before transmission. Countries using SECAM are now also using MPEG-2 and changing it to SECAM before transmission, or not changing it from digital at all.

Second field – In interlaced scanning, the second field of the pair of fields comprising a frame. In analog 480i, the field whose first equalization pulse starts midline. In analog 576i, the field whose first broad pulse starts at midline.

Setup – Black level expressed as a percentage of the blanking-to-reference-white excursion. Conventionally 7.5% in System M and the archaic EIA RS-343-A; and zero in all other systems, where blanking level and black level are identical. It is for this reason why black levels between older NTSC analog video and newer SDI need to be monitored and corrected, if possible. Setup is properly expressed as a percentage, and it is incorrect to express setup as a voltage, level, or IRE units. Also referred to as Pedestal.

SFP – Small Form-Factor Pluggable

SI – System Information

Sidebar format – Pillarbox format.

SMPTE – Society of Motion Picture and Television Engineers: A professional society that is also an ANSI-accredited standards-writing organization.

S/N – (Signal over Noise) is a power reading of signal over the noise in a transmission. The formula to convert Signal/Noise from or to Carrier/Noise is simple:

$$S/N = C/N + 38$$

SNG – (Satellite News Gathering) means the same as ENG, but rather than using land-based to land-based transmitters and receivers, requires satellite equipment used to uplink and downlink the video and audio signal.

SNMP – Simple Network Management Protocol.

SP – Used when Sony introduced higher-bandwidth tape in Betacam (which became Betacam SP) and ¾-inch U-matic (which became U-matic SP). SP decks would playback the older formats (they were "backwards-compatible") but older format machines would not play the new SP unless they recorded them in the old bandwidth.

SPD – Spectral power distribution: spectral radiance.

SSRC – Synchronization Source.

Standards conversion – Conversion, involving temporal filtering, of a video input signal having one scanning standard into an output signal having a different scanning standard and a different frame rate. Historically, the output signal had similar pixel count to the input, for example, a 480i-to-576i standards converter (loosely known as an NTSC-to-PAL standards converter). Nowadays, standards conversion may incorporate upconversion or downconversion. (Transcoding)

STD – System Target Decoder: A hypothetical reference model of a decoding process used to describe the semantics of the Digital Television Standard multiplexed bit stream.

STD input buffer – A first in, first out (FIFO) buffer at the input of a system target decoder for storage of compressed data from elementary streams before decoding.

Stereo Pair – Two audio signals consisting of sound reproduction of the same audio source.

Stinger – A common usage of what most consumers know as an electrical extension cord. Also called an "Edison Cord."

STL – Studio-transmitter link: A communications circuit, often microwave, that connects the output of a television studio to the input of a remotely situated transmitter.

STT – System Time Table

Symbol – In digital transmission, a recognizable electrical state that is associated with a signal element, which is an electrical signal within a defined period of time.

Symbol rate – The rate of symbols being transmitted through the channel measured in bits per second. For QPSK modulation, there are 2 bits per symbol.

Sync (n) – 1. A signal comprising just the horizontal and vertical elements necessary to accomplish synchronization.

2. The component of a video signal that conveys horizontal and vertical synchronization information.
3. Sync level.
4. Sync pulse.

Sync (v) – Synchronization, to a video source, of the scan timing of receiving, processing, or display equipment.

Sync level – The level of synctip. Conventionally -40 IRE (-285 5/7 mV) in analog System M and the archaic EIA RS-343-A, and -300 mV in other analog systems.

Sync pulse – A normal line sync pulse, equalization pulse, or broad pulse.

System M – Formerly CCIR System M; now properly referred to as ITU-R System M: A television system having 480i29.97 scanning, interlace, 4.2 MHz video bandwidth, and 6 Mhz channel spacing. The designation does not specify color encoding. Most 480i broadcasting uses System M/NTSC, although Brazil uses M/PAL.

Timecode – A number of the form HH:MM:SS:FF (hours, minutes, seconds, frames) that designates a single frame in a video or film motion image sequence.

TINT – User-accessible (consumer) means to adjust Hue; preferably, HUE.

Top field – In MPEG, the field that contains the top coded image row.

Transcoding – 1. Traditionally, converting a video signal having one color-encoding method into a signal having a different color-encoding method, without altering the scanning standard; for example, 576i PAL to 576i SECAM.

2. In compressed digital video distribution, various methods of recording a compressed bitstream, or decompressing then recompressing.

Transition sample – An active sample near the left or right edge of the picture whose amplitude is reduced or forced to blanking level so as to limit the high-frequency content of the video signal at the picture edges.

Trichromaticity – The property and action of human vision where additive mixtures of exactly three mixtures of colors can come to represent a wide range of colors. This is because the retina contains just three types of photoresistor cone cells.

Trilevel sync – Used in HDTV, where sync information is conveyed through an analog pulse having a transition from blanking level to +300 mV, then a transition from +300 mV to -300 mV, then a final transition back to blanking level. Bilevel sync is used in SDTV.

TRS – Timing reference signal: A sequence of four words that signals sync, inserted into 4:2:2 or $4f_{SC}$ data stream. Used similarly to SAV and EAV.

TS – Transport Stream

TVCT – Terrestrial Virtual Channel Table.

TV lines per picture height (TVL/PH) – In video, a unit of horizontal resolution defined by the ratio of the distance between spatially adjacent scan lines in the frame (as numerator) and the picture height (as denominator). In an interlaced system, adjacent scan lines are in opposite fields. One TV line corresponds to a pixel, half a cycle, or half a line pair in film.

Twisted Pair – Common usage of what most people know as phone wire.

UL – See Underwriters Laboratories.

U, V – 1. Color difference components, blue minus luma (B-Y) and red minus luma (R-Y), scaled prior to quadrature modulation by the factors 0.49211 and 0.877283, respsectively, to contain the reference excursion of the composite video signal within the range -33 1/3 IRE to +133 1/3 IRE.

2. The symbols U and V are sometimes used loosely or incorrectly to refer to unscaled B-Y and R-Y components; to components C_B and C_R that are scaled for component digital transmission; to components P_B and P_R that are scaled for component analog transmission; or to color difference components having unspecified, nonstandard, or unknown scaling.

U-matic – An analog videocassette system for 480i NTSC or 576i PAL, using color-under recording on ¾-inch tape; its successor (with higher bandwidth) is denoted U-matic SP.

Uncompressed – In video, signal recording or transmission without using JPEG or MPEG techniques. (Chroma subsampling effects lossy compression with a ratio of about 1.5:1 or 2:1; however, the term compression in video is reserved for JPEG, M-JPEG, or MPEG techniques.)

Underwriters Laboratories – (U.L.) A U.S. Organization responsible for testing electric components to be sure they are safe for corporations and consumers.

Unit – See IRE unit.

Upconversion – In video, conversion to a scanning standard, usually at the same frame rate, having substantially higher pixel count (for example, SDTV to HDTV).

Upsampling – Resampling where more output samples are produced than the number of input samples provided.

UTC – Universal Time Code, a coordinated universal time.

VAC – Volts, AC.

VANC – Vertical Ancillary

VCR – Videocassette recorder. Implicitly, consumer-grade: In professional usage, VTR (with T for tape) is preferred even if the tape medium is encased in a cassette (early versions of VTRs included 2-inch and 1-inch machines which did not use cassettes).

VCT – Virtual Channel Table: Used in reference to either TVCT or CVCT.

VDA – Video distribution amplifier, is used to increase gain on a video cable. Usually this is done to send the video to several sources. Some VDAs have equalization ability, which allows you to increase chroma modulation. One example of a VDA is a Mult Box.

VDC – Volts, DC.

Vertical blanking interval (VBI) – Those scan lines of a field (or frame) that are precluded by a scanning standard from containing picture. The original FCC, NTSC, and EIA standards measured vertical blanking in microseconds; modern usage counts integral scan lines. The vertical interval may contain nonpicture video – such as test signals (VITS), timecode (VITC), teletext, or other data – that is blanked by display equipment. This is done sometimes so that information is carried in each frame. And it is done so that tests can be sent and checked during a live broadcast without interruption.

Vertical drive (VD) – A pulse that conveys vertical synchronization information. This information today is usually extracted from sync, rather than a separate signal.

Vertical frequency – 1. The vertical component of spacial frequency.

2. In interlaced scanning, field rate; in progressive scanning, frame rate.

Vertical interval – Vertical blanking interval (VBI).

Vertical sync – Those nonpicture elements of a video signal that mark the boundary between fields (or frames).

VHS – Video Home System: A consumer analog videocassette system, invented by JVC, to record 480i or 576i using the color-under method on ½-inch tape.

VHS-C – VHS, Compact: A consumer analog videocassette system identical to VHS but with a smaller cassette, and the ability to use a converter cassette to use in a normal VHS machine.

Video-8 – A consumer analog videocassette system using 8 mm tape; also known as 8 mm. Its successor is Hi8.

VITC – Vertical interval timecode: Timecode data encoded in an analog representation and conveyed in the VBI.

Viterbi Code Rate – Forward error-correction scheme.

VITS – Vertical interval test signal. One or a few lines of analog test signals conveyed in the VBI.

VPP – Volts, peak-to-peak.

VSB – Vestigial sideband: An RF modulation system. Analog VSB is used in the NTSC and PAL standards for terrestrial television. A form of digital VSB (8-VSB) is used in the ATSC standard for terrestrial digital television.

VTR – Videotape recorder. Implies professional: T for tape is used whether or not the tape medium is in a cassette.

White – Reference white.

XLR – A universally-known audio connection standard developed by Cannon (series "X"), which uses a (L)atch, and (R)ubber around the contacts.

Y – 1. In physics and color science, and when used carefully in video and computer graphics, the symbol for (linear-light) luminance, and CIE Y tristimulus component.

2. In video, in digital image processing, and in computer graphics, the symbol Y is often carelessly used to denote luma (properly Y or Y').
3. In video, the symbol for luma: The sum of nonlinear (gamma-corrected) red, green, and blue primary components, each weighted by its luma coefficient. Distinguished from luminance, Y, which can be formed as a weighted sum of linear-light (tristimulus) red, green, and blue primary components. Historically, the Y symbol in video was primed (Y') but the prime is often carelessly elided in modern times, leading to widespread confusion with luminance.

YC_B, C_R - In video, MPEG and M-JPEG, luma, Y, accompanied by two color difference components scaled independently. In an 8-bit Rec. 601 interface, C_B and C_R are scaled to a reference excursion of ±112; an offset of +128 is added.

YP_B, P_R – Luma, Y, accompanied by analog color difference components. P historically stood for parallel. The EBU N10 standard specifies luma excursion of 700 mV and P_BP_R excursion of ±350 mV. This standard is used in 576i and in HDTV; however, different industry standards are usually used for 480i.

YUV – 1. Properly, luma, Y, and two color difference components (U and V) scaled for subsequent encoding into a composite video signal, such as NTSC or PAL. For component analog video (U, V) components are inappropriate, and P_B, P_R should be used.

2. YUV denotes any two color difference components based upon B-Y and R-Y, where scaling of B-Y and R-Y is unknown or implicit.

Useful Tables for Engineers

Converting mW to dBm (milliwatts to decibel milliwatts)

mw	dbm	mw	dbm
0.1	-10	2	3.01
0.2	-6.99	3	4.77
0.3	-5.23	4	6.02
0.4	-3.97	5	6.99
0.5	-3	6	7.78
0.6	-2.2	7	8.45
0.7	-1.55	8	9.03
0.8	-0.96	9	9.54
0.9	-0.45	10	10
1	0	11	10.41
1.1	0.41	12	10.79
1.2	0.79	13	11.14
1.3	1.14	14	11.46
1.4	1.46	15	11.76
1.5	1.76	16	12.04
1.6	2.04	17	12.3
1.7	2.3	18	12.55
1.8	2.55	19	12.79
1.9	2.79	20	13.01

SI (Systeme International d' unite prefixes (SI unit prefixes)

* Computer storage needs as of 2008 is carrying us into the "peta-byte age." Doctors may soon be using "nanotechnology" to help patients. Here is a list of other terms you will use in your lifetime:

Symbol	Name	Exp.	Multiplier
Y	yotta	10^{24}	1,000,000,000,000,000,000,000,000
Z	zetta	10^{21}	1,000,000,000,000,000,000,000
E	exa	10^{18}	1,000,000,000,000,000,000
P	peta	10^{15}	1,000,000,000,000,000
T	tera	10^{12}	1,000,000,000,000
G	giga	10^{9}	1,000,000,000
M	mega	10^{6}	1,000,000
k	kilo	10^{3}	1,000
m	milli	10^{0}	1
µ	micro	10^{-3}	0.001
n	nano	10^{-6}	0.000 001
p	pico	10^{-9}	0.000 000 001
f	femto	10^{-12}	0.000 000 000 001
a	atto	10^{-15}	0.000 000 000 000 001
z	zepto	10^{-19}	0.000 000 000 000 000 001
y	yocto	10^{-24}	0.000 000 000 000 000 000 001

Dealers, Repair and Parts

Encoders/IRDs

Advent - +44 (0)1494 774400 – Nashleigh Hill, Chesham, Buckinghamshire, HP5 3HE, UK – sales@adventcomms.com – www.adventcomms.com

Bram Flynn and Associates – Dallas, TX - 214-353-0770

Coolsat (Consumer or Monitoring IRD) – Available via a Google Search

Frontline – 727-573-0400 – www.frontlinecomm.com

Link Research Limited – www.linkres.co.uk - Century House , 2 Century Court , Tolpits Lane, Watford, Hertfordshire, WD18 9RS , England - +44 (0) 1923 474060

NDS Broadcast – 35 Parham Drive, Boyatt Wood Industrial Estate, Eastleigh, Hampshire SO50 4NU, United Kingdom – International Telephone +44 (0) 1703 498 111 – www.ndsworld.com – fieldservice@ndsuk.com – U.S. Office - +1-888-637-0023 (Now owned by Tandberg)

PanSat (Consumer or Monitoring IRD) – Available via a Google Search (PanSat 5000 or 9200 HD)

Scopus – 609-987-8090 - Scopus Video Networks Inc. 3 Independence Way, 1st Floor, Princeton, NJ 08540 www.scopus.net - info_us@scopus.net

Sencore Inc. - 800-SENCORE – 800-736-2673 – 605-339-0100 – 3200 Sencore Drive, Sioux Falls, SD 57107 – www.sencore.com – mail@sencore.com

Tandberg – 678-812-6300 – 888-671-1268 - TANDBERG Television, Inc. 4500 River Green Parkway , Duluth , GA 30096 – www.tandbergtv.com – fieldservice-americas@tandbergtv.com

Tiernan – 508-791-1950 – 858-805-7000 - 7330 Trade Street, San Diego, CA 92121 - customerservice@radn.com – www.tiernan.com – RMA (repair) and FTP (software upgrades) are available through the Tiernan website.

Wegener (now only making IRDs)– 770-814-4057 – service@wegener.com

Wolf Coach (Tom Jennings) – 508-791-1950 - www.l-3com.com/wolfcoach/ - 7 B Street, Auburn, MA 01501 – 508-791-1950

Encoder Rental

ABSAT (ABC Affiliates, ABSAT Member stations, or Vendors working for ABSAT) – 15 encoders available, based on availability – cost is shipping only

Bram Flynn 214-353-0770

DCI Teleport – Bob - bob@dciteleport.com

DTags – 918-398-0061 - Fx 918-398-0546 – www.dtags.tv

New and Used Inc. - 301-540-2623 - Robert

RTM – Robert Dutcher

Dolby Encoders

Dolby Laboratories, Inc. - 100 Potrero Avenue, San Francisco, CA 94103-4813 – 415-558-0200 – Fx 415-863-1373 – info@dolby.com – www.dolby.com

Upconverters

L3 (Formerly known as Level3 and LNR) – 435 Moreland Road, Hauppauge, NY 11788 – www.nardamicrowave.com or www.l-3com.com – nardaeast@L-3COM.com
- 631-231-1700

Miteq (MCL) – Hauppauge, NY – 631-439-9108 – www.miteq.com

Amplifiers

Advent - +44 (0)1494 774400 – Nashleigh Hill, Chesham, Buckinghamshire, HP5 3HE, UK – sales@adventcomms.com – www.adventcomms.com

CPI (SatCom)– 650-846-3803 – www.cpii.com/satcom -

ETM Electromagnetic Incorporated – Jenandra Pratap – www.etm-inc.com - 800-883-4ETM
35451 Dumbarton Court Newark, California 94560 510-797-1100 - supportetm@etm-inc.com

MCL – Fernando Soto – 630-715-6683 – sales@mcl.com – 501 South Woodcreek, Bolingbrook, IL 60440 – 630-759-9500

Paradise Datacom LLC – 328 Innovation Blvd., State College, PA 16803 – 814-238-3450 – www.paradisedata.com – sales@paradisedata.com

Varian (no longer in business, sold to CPI) – Bob Green at www.greensatellite.com may be able to fix Varian Amplifiers. His info is listed below.

Xicom Technology - +44(0) 1753 549 999 – www.xicomtech.com – Sales@xicomeurope.com - 4 Portland Business Centre, Manor House Lane, Datchet, Berkshire, UK

Amplifier Repair

Bob Green – www.greensatellite.com – Green Satellite Systems, Inc. 209 Parkside Lane, Oswego, IL 60543-8210 – 630-554-0800 – Cell 630-640-9898 – GreenSat@att.net

Bram Flynn and Associates - 214-353-0770

ETM Electromagnetic Incorporated – Jenandra Pratap – www.etm-inc.com - 800-883-4ETM
35451 Dumbarton Court Newark, California 94560 510-797-1100 - supportetm@etm-inc.com

MCL – Fernando Soto – 630-715-6683 – sales@mcl.com – 501 South Woodcreek, Bolingbrook, IL 60440 - 630-759-9500

Analog Modulator Repair

Kevin Dennis - MRC (Microwave Radio Communications) - Southeast Regional Sales Manager - 101 Billerica Ave, Building 6 - North Billerica, MA USA 01862-1256 - 978-671-5700 Ext. 5756 - kdennis@mrcbroadcast.com

Satellite Trucks and Vans

Bickford Communications, Chantilly, VA – www.apogeeindustriesltd.com/bickford.aspx - 815-344-4808

Frontline Communications, Clearwater, FL – www.frontlinecomm.com – 12770 44th St. N. Clearwater, FL 33762 - 727-573-0400

Gerling & Associates, Sunbury, OH – www.gerlinggroup.com – 138 Stelzer Court, Sunbury, OH 43074 - 740-965-2888

Sat-Comm - +44(0)1638 515000 – sales@sat-comm.com – www.sat-comm.com – 15 Chiswick Avenue, Mildenhall, Suffolk, IP28 7PU United Kingdom

Shook Mobile Technology – www.shook-usa.com – 7451 FM 3009, Shertz, Texas 78154 -
210-651-5700 – 888-651-5775 – Shook@shook-usa.com

Wolf Coach (L3) – www.l-3com.com/wolfcoach/ - 7 B Street, Auburn, MA 01501 -

508-791-1950

Flypacks or Small Vehicle-mount Packages

Advent Communications (Vislink) - +44 (0) 1494 774400 – www.adventcomms.com – www.vislink.com

Holkirk Communications – www.holkirk.com - +44 (0) 1525 721118 - Unit 17 , Pulloxhill Business Park, Greenfield Road , Pulloxhill, Bedfordshire MK45 5EU , UK

Sat-Comm – +44(0)1638 515000 – sales@sat-comm.com – www.sat-comm.com – 15 Chiswick Avenue, Mildenhall, Suffolk, IP28 7PU United Kingdom

SISLink & Intelsat – www.sislink.tv – sales@sislink.tv - +44 (0)1908 865500 or www.sislink.co.uk

SweDish Satellite Systems AB – www.swe-dish.com – P.O. Box 6075, S. 171 06 Solna, Sweden - +46 8 728 50 00 – sales@swe-dish.se

Antennas

Andrews (sold)

ASC Signal Corporation (formerly Andrews) – www.ascsignal.com – 919-329-8700 -
620 North Greenfield Parkway, Garner, North Carolina 27529 –CustomerCare@ascsignal.com

AuraSat (Sat-Comm) - Sat-Comm – +44(0)1638 515000 – sales@sat-comm.com – www.sat-comm.com – 15 Chiswick Avenue, Mildenhall, Suffolk, IP28 7PU United Kingdom

AVL Technologies – www.avltech.com – 130 Roberts Street, Asheville, NC 28801 -
828-250-9950 – support@avltech.com

Gatr -

Immeon Communications – Carlsbad, CA 800-925-4662 or 888-272-7232

Patriot -

Vertex RSI (General Dynamics) – www.tripointglobal.com – 1104 Energy Drive, Kilgore, Texas 75662 – 903-984-7811 – vertexrsi@gdsatcom.com

Stabilizing Jacks

HWH – Moscow, IA

Cable

Belden Cable – www.belden.com - 1-800-Belden-1

Clark Wire and Cable – Bill Schmitz - 1355 Armour Boulevard, Mundelein, IL 60060-4401 – 800-Cable-It or 800-222-5348 - 847-949-9944 – shane@clarkwc.com – www.clarkwc.com

Canare Corporation of America – www.canare.com – 45 Commerce Way, Unit C, Totowa, NJ 07512 – 973-837-0070

Cable Trays

Line Backer – Available through cablesplususa.com

Yellow Jacket – Available through Markertek 800-522-2025

Equipment and Parts

B&H – www.bhphotovideo.com – 420 9th Avenue, New York, NY 10001 – 800-952-1815 - 212-444-6708

Full Compass – www.fullcompass.com – 8001 Terrace Ave., Middleton, WI 53562 - 608-831-7330 - 800-356-5844

HL Dalis – www.hldalis.com – 35-35 24th Street, Long Island City, NY 11106 – 800-HLDALIS - 718-361-1100

Markertek – www.markertek.com – 800-522-2025

Components

Digikey – www.digikey.com – 701 Brooks Avenue South, Thief River Falls, MN 56701 - 800-344-4539 – 218-681-6674 – webmaster@digikey.com

Sony Parts – bssc.sel.sony.com/ - Eastern Service Facility - Sony Electronics Customer Service , 123 W. Tryon Ave. , Teaneck, NJ 07666 - 201-833-5300

Western Service Facility - Sony Electronics Customer Service, 2706 Media Center Dr. , Suite 130, Los Angeles, CA 90065 - 866-766-9272

National Service Facility - Sony Electronics Customer Service, 2520 Zanker Road, San Jose, CA 95131 - 408-352-8282

Panasonic - www.panasonic.com/business/provideo/support/parts.asp - 800-334-4881

Broadcast Rental

Bexel – www.bexel.com – rentals@bexel.com – 800-225-6185 - 818-841-5051

Vaughn Broadcast Rental – www.alliedvaughn.com – 800-323-0281 - 952-832-3100

Cell Phone Components

Dock and Talk – www.phonelabs.com - 212-481-6166

Tellular – www.tellular.com - 800-229-2326 - 678-945-7770

JK Audio

PL, IFB and Audio Coupling Equipment

Audio Implements

Clearcom

Comrex

David Clark

JK Audio

Prospect

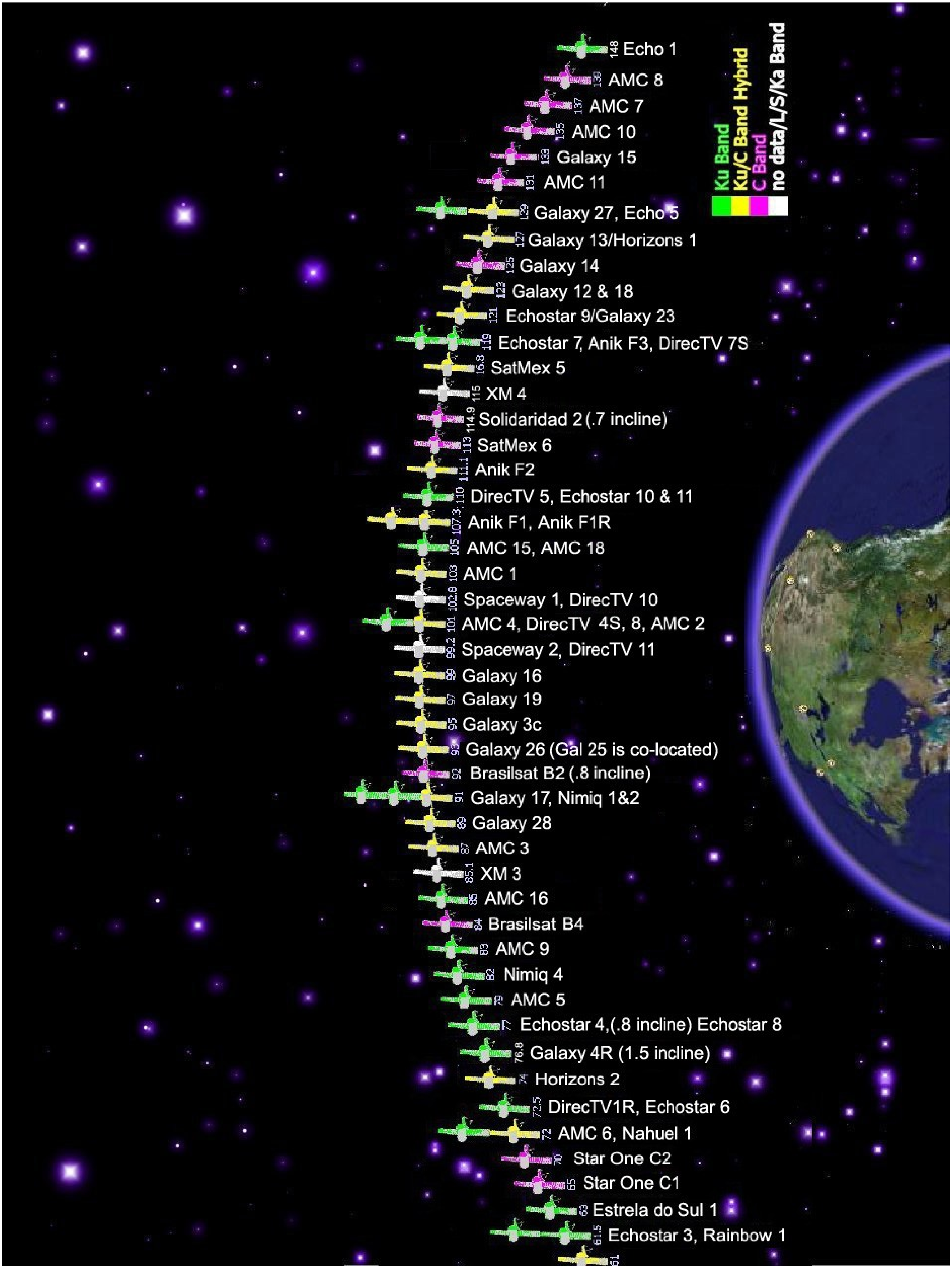
Studio Technologies

Telex (RTS)

Audio Solutions (non-IFB and -PL)

Dan Magden – 5 Pin Pro Audio – dan@5pinproaudio.com

Peter Eng -


Ku Band
Ku/C Band Hybrid
C Band
no data/L/S/Ka Band
148 Echo 1
139 AMC 8
137 AMC 7
135 AMC 10
133 Galaxy 15
131 AMC 11
129 Galaxy 27, Echo 5
127 Galaxy 13/Horizons 1
125 Galaxy 14
123 Galaxy 12 & 18
121 Echostar 9/Galaxy 23
119 Echostar 7, Anik F3, DirecTV 7S
16.8 SatMex 5
115 XM 4
114.9 Solidaridad 2 (.7 incline)
113 SatMex 6
111.1 Anik F2
110 DirecTV 5, Echostar 10 & 11
107.3 Anik F1, Anik F1R
105 AMC 15, AMC 18
103 AMC 1
102.8 Spaceway 1, DirecTV 10
101 AMC 4, DirecTV 4S, 8, AMC 2
99.2 Spaceway 2, DirecTV 11
99 Galaxy 16
97 Galaxy 19
95 Galaxy 3c
93 Galaxy 26 (Gal 25 is co-located)
92 Brasilsat B2 (.8 incline)
91 Galaxy 17, Nimiq 1&2
89 Galaxy 28
87 AMC 3
85.1 XM 3
85 AMC 16
84 Brasilsat B4
83 AMC 9
82 Nimiq 4
79 AMC 5
77 Echostar 4,(.8 incline) Echostar 8
76.8 Galaxy 4R (1.5 incline)
74 Horizons 2
72.5 DirecTV1R, Echostar 6
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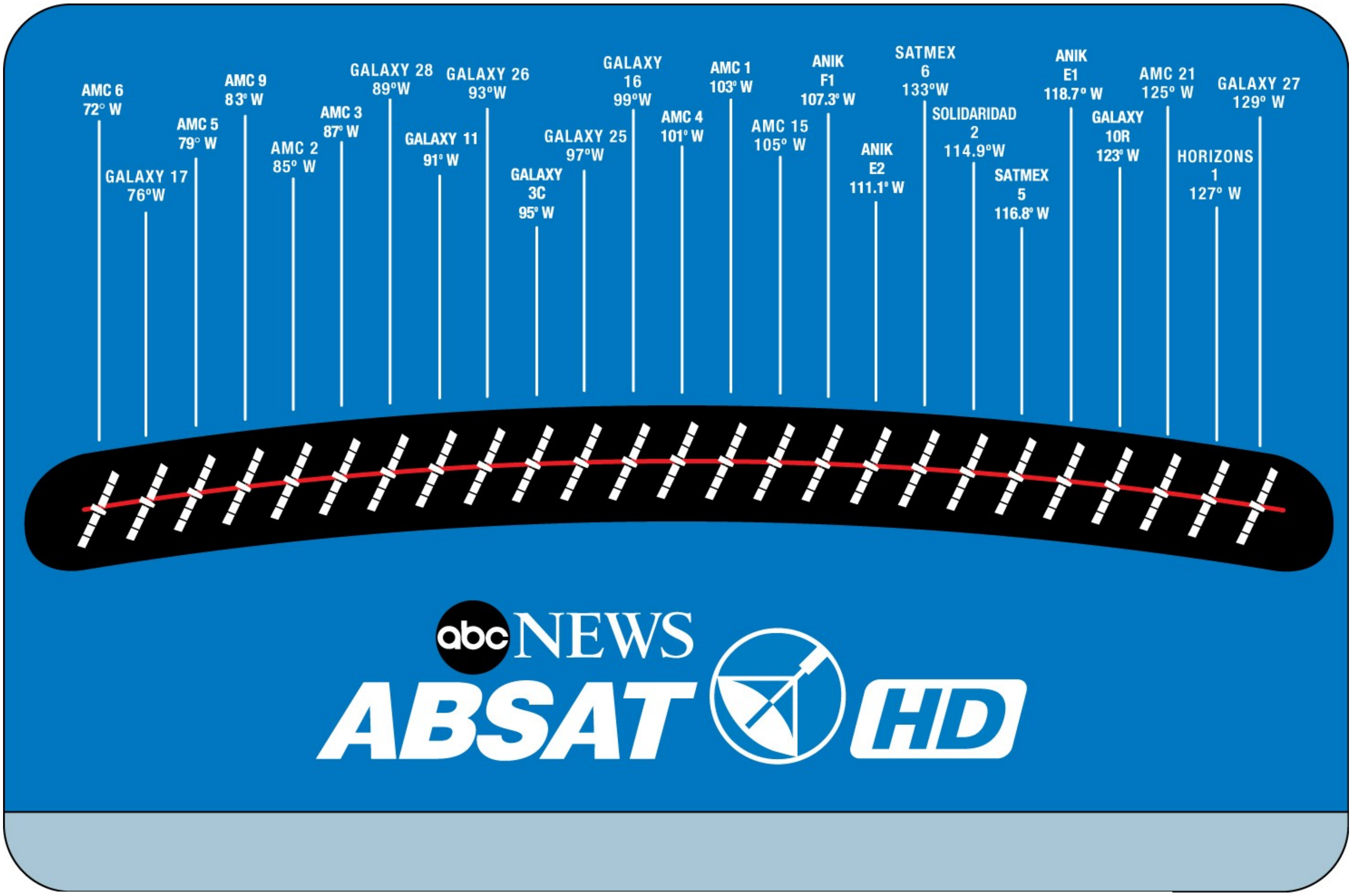
70 Star One C2
65 Star One C1
63 Estrela do Sul 1
61.5 Echostar 3, Rainbow 1
61



GALAXY-28 ANALOG *FORMERLY IA-8* *89° West*

Transponder	*Uplink*	*Downlink*	*Bndwdth*
K13 | **ABSAT**	14260.0 H	11960.0 V	36 MHz
K14 | **ABSAT**	14280.0 V	11980.0 H	36 MHz

Transponder	*Uplink*	*Downlink*	*Bndwdth*
K24 | Hearst	14480.0 V	12180.0 H	36 MHz

GALAXY-28 DIGITAL *FORMERLY IA-8* *89° West*

Channel	*Uplink*	*Downlink*	*ABC Data Rate*	*Bndwdth*
K13S8	14270.000 H	11970.000 V	4.32 Mbps	4.00
K13S9	14275.000 H	11975.000 V	4.32 Mbps	4.00
K13D06	14270.000 H	11970.000 V	5.5 Mbps	5.00
K13D07	14275.000 H	11975.000 V	5.5 Mbps	5.00
K14S1	14264.00 V	11964.000 H	4.32 Mbps	4.00
K14S2	14268.00 V	11968.000 H	4.32 Mbps	4.00
K14S3	14272.00 V	11972.000 H	4.32 Mbps	4.00
K14S4	14276.00 V	11976.000 H	4.32 Mbps	4.00
K14S5	14280.00 V	11980.000 H	4.32 Mbps	4.00
K14S6	14284.00 V	11984.000 H	4.32 Mbps	4.00
K14S7	14288.00 V	11988.000 H	4.32 Mbps	4.00
K14S8	14292.00 V	11992.000 H	4.32 Mbps	4.00
K14S9	14296.00 V	12164.500 H	4.32 Mbps	4.00
K14D01	14265.000 V	11965.000 H	5.5 Mbps	5.00
K14D02	14270.000 V	11970.000 H	5.5 Mbps	5.00
K14D03	14275.000 V	11975.000 H	5.5 Mbps	5.00
K14D04	14280.000 V	11980.000 H	5.5 Mbps	5.00
K14D05	14285.000 V	11985.000 H	5.5 Mbps	5.00
K14D06	14290.000 V	11990.000 H	5.5 Mbps	5.00
K14D07	14295.000 V	11995.000 H	5.5 Mbps	5.00

Channel	*Uplink*	*Downlink*	*ABC Data Rate*	*Bndwdth*
K14M1	14266.500 V	11966.500 H	6.1113 Mbps	9.00
K14M2	14275.500 V	11975.500 H	6.1113 Mbps	9.00
K14M3	14284.500 V	11984.500 H	6.1113 Mbps	9.00
K14M4	14293.500 V	11993.500 H	6.1113 Mbps	9.00
K14L1	14281.000 V	11981.000 H	19.886 Mbps	18.00
K14L2	14289.000 V	11989.000 H	19.886 Mbps	18.00
K24H01 | Hearst	14463.750 V	12163.750 H	3.85 Mbps	3.50
K24H02 | Hearst	14467.250 V	12167.250 H	3.85 Mbps	3.50
K24H03 | Hearst	14470.750 V	12170.750 H	3.85 Mbps	3.50
K24H04 | Hearst	14474.250 V	12174.250 H	3.85 Mbps	3.50
K24H05 | Hearst	14477.750 V	12177.750 H	3.85 Mbps	3.50
K24H06 | Hearst	14481.250 V	12181.250 H	3.85 Mbps	3.50
K24H07 | Hearst	14484.750 V	12184.750 H	3.85 Mbps	3.50
K24H08 | Hearst	14488.250 V	12188.250 H	3.85 Mbps	3.50
K24H09 | Hearst	14491.750 V	12191.750 H	3.85 Mbps	3.50
K24H10 | Hearst	14495.250 V	12195.250 H	3.85 Mbps	3.50

Galaxy 28 Access for ABC *(FORMERLY IA-8)* **800.975.9638 or 866.727.7641**

Intelsat *Ellenwood GA - 24 hours a day*

GALAXY 11 — ANALOG — 91° West

Transponder	Uplink	Downlink	Bndwdth
K01	14020.0 V	11720.0 H	36 MHz
K02	14040.0 H	11740.0 V	36 MHz
K03	14060.0 V	11760.0 H	36 MHz
K04	14080.0 H	11780.0 V	36 MHz
K05	14100.0 V	11800.0 H	36 MHz
K06	14120.0 H	11820.0 V	36 MHz
K07	14140.0 V	11840.0 H	36 MHz
K08	14160.0 H	11860.0 V	36 MHz
K09	14180.0 V	11880.0 H	36 MHz
K10	14200.0 H	11900.0 V	36 MHz
K11	14220.0 V	11920.0 H	36 MHz
K12 | ABSAT	14240.0 H	11940.0 V	36 MHz

Transponder	Uplink	Downlink	Bndwdth
K13	14260.0 V	11960.0 H	36 MHz
K14 | ABSAT	14280.0 H	11980.0 V	36 MHz
K15	14303.0 V	12003.0 H	36 MHz
K16 | ABSAT	14318.0 H	12018.0 V	36 MHz
K17	14338.0 V	12038.0 H	36 MHz
K18	14358.0 H	12058.0 V	36 MHz
K19	14378.0 V	12078.0 H	36 MHz
K20	14400.0 H	12100.0 V	36 MHz
K21	14420.0 V	12120.0 H	36 MHz
K22	14440.0 H	12140.0 V	36 MHz
K23	14460.0 V	12160.0 H	36 MHz
K24	14480.0 H	12180.0 V	36 MHz

GALAXY 11 — DIGITAL — 91° West

Channel	Uplink	Downlink	ABC Data Rate	Bndwdth
K12S1	14224.000 H	11924.000 V	4.32 Mbps	4.00
K12S2	14228.000 H	11928.000 V	4.32 Mbps	4.00
K12S3	14232.000 H	11932.000 V	4.32 Mbps	4.00
K12S4	14236.000 H	11936.000 V	4.32 Mbps	4.00
K12S5	14240.000 H	11940.000 V	4.32 Mbps	4.00
K12S6	14244.000 H	11944.000 V	4.32 Mbps	4.00
K12S7	14248.000 H	11948.000 V	4.32 Mbps	4.00
K12S8	14252.000 H	11952.000 V	4.32 Mbps	4.00
K12S9	14256.000 H	11956.000 V	4.32 Mbps	4.00
K12A	14225.000 H	11925.000 V	5.5 Mbps	5.00
K12B	14230.000 H	11930.000 V	5.5 Mbps	5.00
K12C	14235.000 H	11935.000 V	5.5 Mbps	5.00
K12D	14240.000 H	11940.000 V	5.5 Mbps	5.00
K12E	14245.000 H	11945.000 V	5.5 Mbps	5.00
K12F	14250.000 H	11950.000 V	5.5 Mbps	5.00
K12G	14255.000 H	11955.000 V	5.5 Mbps	5.00
K12M1	14226.500 H	11926.500 V	6.1113 Mbps	9.00
K12M2	14235.500 H	11935.500 V	6.1113 Mbps	9.00
K12M3	14244.500 H	11944.500 V	6.1113 Mbps	9.00
K12M4	14253.500 H	11953.500 V	6.1113 Mbps	9.00
K12L1	14231.000 H	11931.000 V	19.886 Mbps	18.00
K12L2	14249.000 H	11949.000 V	19.886 Mbps	18.00
K14S1	14264.000 H	11964.000 V	4.32 Mbps	4.00
K14S2	14268.000 H	11968.000 V	4.32 Mbps	4.00
K14S3	14272.000 H	11972.000 V	4.32 Mbps	4.00
K14S4	14276.000 H	11976.000 V	4.32 Mbps	4.00
K14S5	14280.000 H	11980.000 V	4.32 Mbps	4.00
K14S6	14284.000 H	11984.000 V	4.32 Mbps	4.00
K14S7	14288.000 H	11988.000 V	4.32 Mbps	4.00
K14S8	14292.000 H	11992.000 V	4.32 Mbps	4.00
K14S9	14296.000 H	11996.000 V	4.32 Mbps	4.00

Channel	Uplink	Downlink	ABC Data Rate	Bndwdth
K14A	14265.000 H	11965.000 V	5.5 Mbps	5.00
K14B	14270.000 H	11970.000 V	5.5 Mbps	5.00
K14C	14275.000 H	11975.000 V	5.5 Mbps	5.00
K14D	14280.000 H	11980.000 V	5.5 Mbps	5.00
K14E	14285.000 H	11985.000 V	5.5 Mbps	5.00
K14F	14290.000 H	11990.000 V	5.5 Mbps	5.00
K14G	14295.000 H	11995.000 V	5.5 Mbps	5.00
K14M1	14266.500 H	11966.500 V	6.1113 Mbps	9.00
K14M2	14275.500 H	11975.500 V	6.1113 Mbps	9.00
K14M3	14284.500 H	11984.500 V	6.1113 Mbps	9.00
K14M4	14293.500 H	11993.500 V	6.1113 Mbps	9.00
K14L1	14281.000 H	11981.000 V	19.886 Mbps	18.00
K14L2	14289.000 H	11989.000 V	19.886 Mbps	18.00
K16S1	14304.000 H	12004.000 V	4.32 Mbps	4.00
K16S2	14308.000 H	12008.000 V	4.32 Mbps	4.00
K16S3	14312.000 H	12012.000 V	4.32 Mbps	4.00
K16S4	14316.000 H	12016.000 V	4.32 Mbps	4.00
K16S5	14320.000 H	11940.000 V	4.32 Mbps	4.00
K16S6	14324.000 H	11944.000 V	4.32 Mbps	4.00
K16S7	14328.000 H	11948.000 V	4.32 Mbps	4.00
K16S8	14332.000 H	11952.000 V	4.32 Mbps	4.00
K16S9	14336.000 H	11956.000 V	4.32 Mbps	4.00
K16A	14305.000 H	11925.000 V	5.5 Mbps	5.00
K16B	14310.000 H	11930.000 V	5.5 Mbps	5.00
K16C	14315.000 H	12015.000 V	5.5 Mbps	5.00
K16D	14320.000 H	12020.000 V	5.5 Mbps	5.00
K16E	14325.000 H	12025.000 V	5.5 Mbps	5.00
K16F	14330.000 H	12030.000 V	5.5 Mbps	5.00
K16G	14335.000 H	12035.000 V	5.5 Mbps	5.00
K16M1	14306.500 H	12006.500 V	6.1113 Mbps	9.00
K16M2	14315.500 H	12015.500 V	6.1113 Mbps	9.00
K16M3	14324.500 H	12024.500 V	6.1113 Mbps	9.00
K16M4	14333.500 H	12033.500 V	6.1113 Mbps	9.00
K16L1	14311.000 H	12011.000 V	19.886 Mbps	18.00
K16L2	14329.000 H	12029.000 V	19.886 Mbps	18.00

Galaxy 11 Access for ABC

Intelsat — *Ellenwood GA - 24 hours a day* — **800.975.9638 or 866.727.7641**

GALAXY-11

DIGITAL

91° West

Channel	Uplink	Downlink	Nominal Data Rate	Bndwdth
K13 Slot 1A	14244.250 V	11944.250 H	4.32 Mbps	4.00
K13 Slot 1B	14248.750 V	11948.750 H	4.32 Mbps	4.00
K13 Slot 2A	14253.250 V	11953.250 H	4.32 Mbps	4.00
K13 Slot 2B	14257.750 V	11957.750 H	4.32 Mbps	4.00
K13 Slot 3A	14262.250 V	11962.250 H	4.32 Mbps	4.00
K13 Slot 3B	14266.750 V	11966.750 H	4.32 Mbps	4.00
K13 Slot 4A	14271.250 V	11971.250 H	4.32 Mbps	4.00
K13 Slot 4B	14275.750 V	11975.750 H	4.32 Mbps	4.00
K13 5A	14245.000 V	11945.000 H	5.5 Mbps	5.00
K13 5B	14250.000 V	11950.000 H	5.5 Mbps	5.00
K13 5C	14255.000 V	11955.000 H	5.5 Mbps	5.00
K13 5D	14260.000 V	11960.000 H	5.5 Mbps	5.00
K13 5E	14265.000 V	11965.000 H	5.5 Mbps	5.00
K13 5F	14270.000 V	11970.000 H	5.5 Mbps	5.00
K13 5G	14275.000 V	11975.000 H	5.5 Mbps	5.00
K13 Slot A	14246.500 V	11946.500 H	6.1113 Mbps	9.00
K13 Slot B	14255.500 V	11955.500 H	6.1113 Mbps	9.00
K13 Slot C	14264.500 V	11964.500 H	6.1113 Mbps	9.00
K13 Slot D	14273.500 V	11973.500 H	6.1113 Mbps	9.00
K13 Lower	14251.000 V	11951.000 H	19.886 Mbps	18.00
K13 Upper	14269.000 V	11969.000 H	19.886 Mbps	18.00
K15 Slot A1	14284.250 V	11984.250 H	4.32 Mbps	4.00
K15 Slot A2	14288.750 V	11988.750 H	4.32 Mbps	4.00
K15 Slot B1	14293.250 V	11993.250 H	4.32 Mbps	4.00
K15 Slot B2	14297.750 V	11997.750 H	4.32 Mbps	4.00
K15 Slot C1	14302.250 V	12002.250 H	4.32 Mbps	4.00
K15 Slot C2	14306.750 V	12006.750 H	4.32 Mbps	4.00
K15 Slot D1	14311.250 V	12011.250 H	4.32 Mbps	4.00
K15 Slot D2	14315.750 V	12015.750 H	4.32 Mbps	4.00
K15 5A	14285.000 V	11985.000 H	5.5 Mbps	5.00
K15 5B	14290.000 V	11990.000 H	5.5 Mbps	5.00
K15 5C	14295.000 V	11995.000 H	5.5 Mbps	5.00
K15 5D	14300.000 V	12000.000 H	5.5 Mbps	5.00
K15 5E	14305.000 V	12005.000 H	5.5 Mbps	5.00
K15 5F	14310.000 V	12010.000 H	5.5 Mbps	5.00
K15 5G	14315.000 V	12015.000 H	5.5 Mbps	5.00
K15 Slot A	14286.500 V	11986.500 H	6.1113 Mbps	9.00
K15 Slot B	14295.500 V	11995.500 H	6.1113 Mbps	9.00
K15 Slot C	14304.500 V	12004.500 H	6.1113 Mbps	9.00
K15 Slot D	14313.500 V	12013.500 H	6.1113 Mbps	9.00
K15 Lower	14291.000 V	11991.000 H	19.886 Mbps	18.00
K15 Upper	14309.000 V	12009.000 H	19.886 Mbps	18.00
K19 Slot A1	14364.250 V	12064.250 H	4.32 Mbps	4.00
K19 Slot A2	14368.750 V	12068.750 H	4.32 Mbps	4.00
K19 Slot B1	14373.250 V	12073.250 H	4.32 Mbps	4.00
K19 Slot B2	14377.750 V	12077.750 H	4.32 Mbps	4.00
K19 Slot C1	14382.250 V	12086.750 H	4.32 Mbps	4.00
K19 Slot C2	14386.750 V	12086.750 H	4.32 Mbps	4.00
K19 Slot D1	14391.250 V	12091.250 H	4.32 Mbps	4.00
K19 Slot D2	14395.750 V	12095.750 H	4.32 Mbps	4.00

Channel	Uplink	Downlink	Nominal Data Rate	Bndwdth
K19 5A	14365.000 V	12065.000 H	5.5 Mbps	5.00
K19 5B	14370.000 V	12070.000 H	5.5 Mbps	5.00
K19 5C	14375.000 V	12075.000 H	5.5 Mbps	5.00
K19 5D	14380.000 V	12080.000 H	5.5 Mbps	5.00
K19 5E	14385.000 V	12085.000 H	5.5 Mbps	5.00
K19 5F	14390.000 V	12090.000 H	5.5 Mbps	5.00
K19 5G	14395.000 V	12095.000 H	5.5 Mbps	5.00
K19 Slot A	14366.500 V	12066.500 H	6.1113 Mbps	9.00
K19 Slot B	14375.500 V	12075.500 H	6.1113 Mbps	9.00
K19 Slot C	14384.500 V	12084.500 H	6.1113 Mbps	9.00
K19 Slot D	14393.500 V	12093.500 H	6.1113 Mbps	9.00
K19 Lower	14371.000 V	12071.000 H	19.886 Mbps	18.00
K19 Upper	14389.000 V	12089.000 H	19.886 Mbps	18.00
K20 5A	14384.500 H	12084.500 V	5.5 Mbps	5.00
K20 5B	14389.500 H	12089.500 V	5.5 Mbps	5.00
K20 5C	14394.500 H	12094.500 V	5.5 Mbps	5.00
K20 5D	14399.500 H	12099.500 V	5.5 Mbps	5.00
K20 5E	14404.500 H	12104.500 V	5.5 Mbps	5.00
K20 5F	14409.500 H	12109.500 V	5.5 Mbps	5.00
K20 5G	14414.500 H	12114.500 V	5.5 Mbps	5.00
K20 Slot A	14386.500 H	12086.500 V	6.1113 Mbps	9.00
K20 Slot B	14395.500 H	12095.500 V	6.1113 Mbps	9.00
K20 Slot C	14404.500 H	12104.500 V	6.1113 Mbps	9.00
K20 Slot D	14413.500 H	12113.500 V	6.1113 Mbps	9.00
K20 Lower	14391.000 H	12091.000 V	19.886 Mbps	18.00
K20 Upper	14409.000 H	12109.000 V	19.886 Mbps	18.00
K22 Slot 5	14449.000 H	12149.000 V	5.5 Mbps	5.00
K22 Slot 6	14455.000 H	12155.000 V	5.5 Mbps	5.00
K22 Slot D	14453.500 H	12153.500 V	6.1113 Mbps	9.00
K24 Slot A1	14464.250 H	12164.250 V	4.32 Mbps	4.00
K24 Slot A2	14468.750 H	12168.750 V	4.32 Mbps	4.00
K24 Slot B1	14472.250 H	12172.250 V	4.32 Mbps	4.00
K24 Slot B2	14477.750 H	12177.750 V	4.32 Mbps	4.00
K24 Slot C1	14480.250 H	12180.250 V	4.32 Mbps	4.00
K24 Slot C2	14484.750 H	12184.750 V	4.32 Mbps	4.00
K24 Slot D1	14488.250 H	12188.250 V	4.32 Mbps	4.00
K24 Slot D2	14492.750 H	12192.750 V	4.32 Mbps	4.00
K24 5A	14465.000 H	12165.000 V	5.5 Mbps	5.00
K24 5B	14470.000 H	12170.000 V	5.5 Mbps	5.00
K24 5C	14475.000 H	12175.000 V	5.5 Mbps	5.00
K24 5D	14480.000 H	12180.000 V	5.5 Mbps	5.00
K24 5E	14485.000 H	12185.000 V	5.5 Mbps	5.00
K24 5F	14490.000 H	12190.000 V	5.5 Mbps	5.00
K24 5G	14495.000 H	12195.000 V	5.5 Mbps	5.00
K24 Slot A	14466.500 H	12166.500 V	6.1113 Mbps	9.00
K24 Slot B	14475.500 H	12175.500 V	6.1113 Mbps	9.00
K24 Slot C	14484.500 H	12184.500 V	6.1113 Mbps	9.00
K24 Slot D	14493.500 H	12193.500 V	6.1113 Mbps	9.00
K24 Lower	14471.000 H	12171.000 V	19.886 Mbps	18.00
K24 Upper	14489.000 H	12189.000 V	19.886 Mbps	18.00

CNN Center
5th Floor Newsroom
Atlanta, GA 30303

Booking: (404) 827-1094
Access: (404) 827-5200
Fax Line: (404) 827-2094

CNN NEWSBEAM

CNN Affiliate Rates:

Analog	$8.00	Per Minute
Digital (5-7 MHz)	$5.00	Per Minute
Digital (9 MHz)	$6.00	Per Minute

CNN Non-Affiliate Rates:

Analog	$12.00	Per Minute
Digital	$9.00	Per Minute

Non-Affiliates will be booked in 15-minute increments.

Frequency Chart:

AMC-3 (Located at 87° West) Analog

Transponder	Deviation	Uplink Frequency	POL	Downlink Frequency	POL
3 Center	Half	14060	V	11760	H
8 Center	Half	14160	H	11860	V
9 Center	Half	14180	V	11880	H
12 Center	Half	14240	H	11940	V

AMC-3 (Located at 87° West) Digital

TXR	Slot	Wegener IRD Preset	MHz	Up Freq	POL	FEC	Information Rate	Symbol Rate	Down Freq	POL	L-Band
3	A	-	5.125	14044.625	V	¾	5.5	3.9787	11745	H	994.6
*3	B	-	5.125	14049.750	V	¾	5.5	3.9787	11750	H	999.8
*3	C	-	5.125	14054.875	V	¾	5.5	3.9787	11755	H	1004.9
*3	D	-	5.125	14060.000	V	¾	5.5	3.9787	11760	H	1010.0
*3	E	-	5.125	14065.125	V	¾	5.5	3.9787	11765	H	1015.1
*3	F	-	5.125	14070.250	V	¾	5.5	3.9787	11770	H	1020.3
3	G	-	5.125	14075.375	V	¾	5.5	3.9787	11775	H	12025.4
8	A	35	5.125	14144.625	H	¾	5.5	3.9787	11845	V	1094.6
*8	B	36	5.125	14149.750	H	¾	5.5	3.9787	11850	V	1099.8
*8	C	37	5.125	14154.875	H	¾	5.5	3.9787	11855	V	1104.9
*8	D	38	5.125	14160	H	¾	5.5	3.9787	11860	V	1110.0
*8	E	39	5.125	14165.125	H	¾	5.5	3.9787	11865	V	1115.1
*8	F	40	5.125	14170.250	H	¾	5.5	3.9787	11870	V	1120.3
8	G	41	5.125	14175.375	H	¾	5.5	3.9787	11875	V	1125.4
9	A	42	5.125	14164.625	V	¾	5.5	3.9787	11865	H	1114.6
*9	B	43	5.125	14169.750	V	¾	5.5	3.9787	11870	H	1119.8
*9	C	44	5.125	14174.875	V	¾	5.5	3.9787	11875	H	1124.9
*9	D	45	5.125	14180	V	¾	5.5	3.9787	11880	H	1130.0
*9	E	46	5.125	14185.125	V	¾	5.5	3.9787	11885	H	1135.1
*9	F	47	5.125	14190.250	V	¾	5.5	3.9787	11890	H	1140.3
9	G	48	5.125	14195.375	V	¾	5.5	3.9787	11895	H	1145.4
12	A	49	5.125	14224.625	H	¾	5.5	3.9787	11925	V	1174.6
*12	B	50	5.125	14229.750	H	¾	5.5	3.9787	11930	V	1179.8
*12	C	51	5.125	14234.875	H	¾	5.5	3.9787	11935	V	1184.9
*12	D	52	5.125	14240	H	¾	5.5	3.9787	11940	V	1190.0
*12	E	53	5.125	14245.125	H	¾	5.5	3.9787	11945	V	1195.1
*12	F	54	5.125	14250.250	H	¾	5.5	3.9787	11950	V	1200.3
12	G	55	5.125	14255.375	H	¾	5.5	3.9787	11955	V	1205.4

*During special events these transponders will take the place of the analog portion of our satellite space.

AMC-5 (Located at 79° West) Analog

Transponder	Deviation	Uplink Frequency	POL	Downlink Frequency	POL
10 Lower	Half	14272	V	11972	H
10 Upper	Half	14302	V	12002	H
11 Lower	Half	14320`	H	12020	V
11 Upper	Half	14350	H	12050	V
12 Lower	Half	14333	V	12033	H
12 Upper	Half	14363	V	12063	H
13 Lower	Half	14381	H	12081	V
13 Upper	Half	14411	H	12111	V
14 Lower	Half	14394	V	12094	H
14 Upper	Half	14424	V	12124	H

AMC-5 (Located at 79° West) Digital

TXR	Slot	Wegener IRD Preset	MHz	Up Freq	POL	FEC	Information Rate	Symbol Rate	Down Freq	POL	L-Band
10	A	-	5.25	14263.375	V	¾	5.5	3.9787	11963	H	1213.4
10	B	-	5.25	14268.625	V	¾	5.5	3.9787	11969	H	1218.6
10	C	-	5.25	14273.875	V	¾	5.5	3.9787	11974	H	1223.9
10	D	-	5.25	14279.125	V	¾	5.5	3.9787	11979	H	1229.1
10	E	-	5.25	14284.375	V	¾	5.5	3.9787	11984	H	1234.4
10	F	-	5.25	14289.625	V	¾	5.5	3.9787	11990	H	1239.6
10	G	-	5.25	14294.875	V	¾	5.5	3.9787	11995	H	1244.9
10	H	-	5.25	14300.125	V	¾	5.5	3.9787	12000	H	1250.1
10	I	-	5.25	14305.375	V	¾	5.5	3.9787	12005	H	1255.4
10	J	-	5.25	14310.625	V	¾	5.5	3.9787	12011	H	1260.6

11	A	7	5.25	14311.375	H	¾	5.5	3.9787	12011	V	1261.4
11	B	8	5.25	14316.625	H	¾	5.5	3.9787	12017	V	1266.6
11	C	9	5.25	14321.875	H	¾	5.5	3.9787	12022	V	1271.9
11	D	10	5.25	14327.125	H	¾	5.5	3.9787	12027	V	1277.1
11	E	11	5.25	14332.375	H	¾	5.5	3.9787	12032	V	1282.4
11	F	12	5.25	14337.625	H	¾	5.5	3.9787	12038	V	1287.6
11	G	13	5.25	14342.875	H	¾	5.5	3.9787	12043	V	1292.9
11	H	14	5.25	14348.125	H	¾	5.5	3.9787	12048	V	1298.1
11	I	15	5.25	14353.375	H	¾	5.5	3.9787	12053	V	1303.4
11	J	16	5.25	14358.625	H	¾	5.5	3.9787	12059	V	1308.6

12	A	17	5.25	14324.375	V	¾	5.5	3.9787	12024	H	1274.4
12	B	18	5.25	14329.625	V	¾	5.5	3.9787	12030	H	1279.6
12	C	19	5.25	14334.875	V	¾	5.5	3.9787	12035	H	1284.9
12	D	20	5.25	14340.125	V	¾	5.5	3.9787	12040	H	1290.1
12	E	21	5.25	14345.375	V	¾	5.5	3.9787	12045	H	1295.4
12	F	22	5.25	14350.625	V	¾	5.5	3.9787	12050	H	1300.6
12	G	23	5.25	14355.875	V	¾	5.5	3.9787	12056	H	1305.9
12	H	24	5.25	14361.125	V	¾	5.5	3.9787	12061	H	1311.1
12	I	25	5.25	14366.375	V	¾	5.5	3.9787	12066	H	1316.4
12	J	26	5.25	14371.625	V	¾	5.5	3.9787	12071	H	1321.6

Higher Data Rates may be run on channels with a bandwidth larger than 5.5 MHz. All CNN feeds are run with a 5.5 Information rate (3.9787 symbol rate). Please contact CNN Newsbeam if you are planning on running an alternate data rate on any transponder with a bandwidth larger that 5.5 MHz.

NBC Frequency Plan

Space Owner	Space Segment	Assignment	Uplink Freq (MHz)	Uplink Pole	Downlink Freq (MHz)	Downlink Pole	L-Band Freq (MHz)	IF Freq (MHz)	Symbole Rate	Data Rate	DVR-2000 Data Rate	FEC
NBC	AMC1/17K Slot A	-	14325.000	Verical	12025.000	Horizontal	1275.000	-	4.2320	6.5	7.053	5/6
"	AMC1/17K Slot B	-	14331.000	Verical	12031.000	Horizontal	1281.000	-	4.2320	6.5	7.053	5/6
"	AMC1/17K Slot C	-	14337.000	Verical	12037.000	Horizontal	1287.000	-	4.2320	6.5	7.053	5/6
"	AMC1/17K Slot D	-	14343.000	Verical	12043.000	Horizontal	1293.000	-	4.2320	6.5	7.053	5/6
"	AMC1/17K Slot E	-	14349.000	Verical	12049.000	Horizontal	1299.000	-	4.2320	6.5	7.053	5/6
"	AMC1/17K Slot F	-	14355.000	Verical	12055.000	Horizontal	1305.000	-	4.2320	6.5	7.053	5/6
NBC	AMC1-21K Slot E	-	14429.000	Verical	12129.000	Horizontal	1379.000	-	4.2320	6.5	7.053	5/6
"	AMC1-21K Slot F	-	14435.000	Verical	12135.000	Horizontal	1385.000	-	4.2320	6.5	7.053	5/6
NBC A-Net	AMC1/9K IC-09	NBC East Coast	14,180.000	Vertical	11,880.000	Horizontal	1,130.000	-	26.670000	43.012	46.673	7/8
NBC B-Net	AMC1/9K IC-10	NBC Central	14,180.000	Vertical	11,880.000	Horizontal	1,130.000	-	26.670000	43.012	46.673	7/8
NBC C-Net	AMC1/7K IC-11	NBC Mountain	14,140.000	Vertical	11,840.000	Horizontal	1,090.000	-	26.670000	43.012	46.673	7/8
NBC D-Net	AMC1/7K IC-12	NBC West Coast	14,140.000	Vertical	11,840.000	Horizontal	1,090.000	-	26.670000	43.012	46.673	7/8
NBC	AMC6-1K Slot A	-	14004.750	Horizontal	11704.750	Vertical	954.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot B	-	14010.750	Horizontal	11710.750	Vertical	960.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot C	-	14016.750	Horizontal	11716.750	Vertical	966.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot D	-	14022.750	Horizontal	11722.750	Vertical	972.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot E	-	14028.750	Horizontal	11728.750	Vertical	978.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot F	-	14034.750	Horizontal	11734.750	Vertical	984.750	-	3.9787	5.5	-	3/4
"	AMC6-1K Slot A2	-	14007.750	Horizontal	11707.750	Vertical	957.750	-	-	0.512	-	3/4
"	AMC6-1K Slot B2	-	14013.750	Horizontal	11713.750	Vertical	963.750	-	-	0.512	-	3/4
"	AMC6-1K Slot C2	-	14019.750	Horizontal	11719.750	Vertical	969.750	-	-	0.512	-	3/4
"	AMC6-1K Slot D2	-	14025.750	Horizontal	11725.750	Vertical	975.750	-	-	0.512	-	3/4
"	AMC6-1K Slot E2	-	14031.750	Horizontal	11731.750	Vertical	981.750	-	-	0.512	-	3/4
"	AMC6-1K Slot F2	-	14037.750	Horizontal	11737.750	Vertical	987.750	-	-	0.512	-	3/4
NBC	AMC6-3K Slot A	-	14044.750	Horizontal	11744.750	Vertical	994.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot B	-	14050.750	Horizontal	11750.750	Vertical	1000.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot C	-	14056.750	Horizontal	11756.750	Vertical	1006.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot D	-	14062.750	Horizontal	11762.750	Vertical	1012.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot E	-	14068.750	Horizontal	11768.750	Vertical	1018.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot F	-	14074.750	Horizontal	11774.750	Vertical	1024.750	-	3.9787	5.5	-	3/4
"	AMC6-3K Slot A2	-	14047.750	Horizontal	11747.750	Vertical	11747.750	-	-	0.512	-	3/4
"	AMC6-3K Slot B2	-	14053.750	Horizontal	11753.750	Vertical	11753.750	-	-	0.512	-	3/4
"	AMC6-3K Slot C2	-	14059.750	Horizontal	11759.750	Vertical	11759.750	-	-	0.512	-	3/4
"	AMC6-3K Slot D2	-	14065.750	Horizontal	11765.750	Vertical	11765.750	-	-	0.512	-	3/4
"	AMC6-3K Slot E2	-	14071.750	Horizontal	11771.750	Vertical	11771.750	-	-	0.512	-	3/4
"	AMC6-3K Slot F2	-	14077.750	Horizontal	11777.750	Vertical	11777.750	-	-	0.512	-	3/4
NBC	AMC6-17K Slot A	-	14324.750	Horizontal	12024.750	Vertical	1274.750	-	3.9787	5.5	-	3/4
"	AMC6-17K Slot B	-	14330.750	Horizontal	12030.750	Vertical	1280.750	-	3.9787	5.5	-	3/4
"	AMC6-17K Slot C	-	14336.750	Horizontal	12036.750	Vertical	1286.750	-	3.9787	5.5	-	3/4
"	AMC6-17K Slot D	DAD-4	14342.125	Horizontal	12042.125	Vertical	1292.125	67.125	2.2980	3.706	-	7/8
"	AMC6-17K Slot F	DAD-3	14347.000	Horizontal	12047.000	Vertical	1297.000	72.000	0.468800	0.512	-	7/8
"	AMC6-17K Slot G	DAD-1	14347.750	Horizontal	12047.750	Vertical	1297.750	72.750	0.468800	0.512	-	7/8
"	AMC6-17K Slot A2	-	14327.750	Horizontal	12027.750	Vertical	1277.750	-	-	0.512	-	3/4
"	AMC6-17K Slot B2	-	14333.750	Horizontal	12033.750	Vertical	1283.750	-	-	0.512	-	3/4
"	AMC6-17K Slot C2	-	14340.250	Horizontal	12040.250	Vertical	1290.250	-	-	0.512	-	3/4
"	AMC6-17K Slot Xp1	Dom Comms	14344.750	Horizontal	12044.750	Vertical	1294.750	69.750	1.3682	1.92	-	3/4
"	AMC6-17K Slot J	Pgm Rtn 1, 2, 3, 4	14,353.000	Horizontal	12,053.000	Vertical	1,303.000	78.000	6.8900	10.583	-	5/6
"		Upconverter	14,345.000									

NBC Frequencies, Page Two

Space Owner	Space Segment	Assignment	Uplink Freq (MHz)	Uplink Pole	Downlink Freq (MHz)	Downlink Pole	L-Band Freq (MHz)	IF Freq (MHz)	Symbole Rate	Data Rate	DVR-2000 Data Rate	FEC
NBC	Tel-12K 37 CID: 34186	London 1 & 2	14,382.500	Vertical	12,082.500	Vertical	1,332.500	-	6.396000	10.314	-	7/8
"	Tel-12K 37 CID: 34187	Tel-Aviv	14,389.250	Vertical	12,089.250	Verical	1,339.250	-	3.198000	5.157	-	7/8
"	Tel-12K 37 CID: 36093	Baghdad	14,392.875	Vertical	12,092.875	Verical	1,342.875	-	2.000000	3.225	-	7/8
"	Tel-12K 37 CID: 34190	Baghdad RT Comms	14,394.750	Vertical	12,094.750	Vertical	1,344.750	-	0.374633	0.512	-	3/4
"	Tel-12K 37 CID: 34191	Teaboy RT Comms	14,395.250	Vertical	12,095.250	Verical	1,345.250	-	0.374633	0.512	-	3/4
"	Tel-12K 37 CID: 34192	Moscow RT Comms	14,395.750	Vertical	12,095.750	Verical	1,345.750	-	0.374633	0.512	-	3/4
"	Tel-12K 37 D1 CID: 34202	-	14,398.250	Vertical	12,098.250	Verical	1,348.25	-	3.198000	5.157	-	7/8
"	Tel-12K 37 D1 CID: 34203	-	14,402.750	Vertical	12,102.750	Vertical	1,352.750	-	3.198000	5.157	-	7/8
Loral	Tel-12K 37 D2 CID: 34204	-	14,407.250	Vertical	12,107.250	Verical	1,348.26	-	3.198000	5.157	-	7/8
Occasional	Tel-12K 37 D2 CID: 34205	-	14,411.750	Vertical	12,111.750	Vertical	1,353.750	-	3.198000	5.157	-	7/8
"	Tel-12K 37 D3 CID: 34206	-	14,416.250	Vertical	12,116.250	Verical	1,348.27	-	3.198000	5.157	-	7/8
"	Tel-12K 37 D3 CID: 34207	-	14,420.750	Vertical	12,120.750	Vertical	1,354.750	-	3.198000	5.157	-	7/8
NBC	Tel-12K 14 CID: 34193	London Ret-1 - DAD-5	14,318.875	Horizontal	11,518.875	Horizontal	1,518.875	66.875	3.744000	6.038	-	7/8
"	Tel-12K 14 CID: 35555	Baghdad TX Comms	14,321.750	Horizontal	11,521.750	Horizontal	1,521.750	69.75	0.374633	0.512	-	3/4
"	Tel-12K 14 CID: 36090	DAD-7 TX Comms	14,323.125	Horizontal	11,523.125	Horizontal	1,523.125	71.125	1.500000	2.419	-	7/8
"	Tel-12K 14 CID: 35558	Teaboy TX Comms	14,324.500	Horizontal	11,524.500	Horizontal	1,524.500	72.50	0.374633	0.512	-	3/4
"	Tel-12K 14 CID: 36579	Pgm Return-3 DAD-2	14,325.875	Horizontal	11,525.875	Horizontal	1,525.875	73.875	1.500000	2.419	-	7/8
"	Tel-12K 14 CID: 36XXX	Moscow TX Comms	14,327.250	Horizontal	11,527.250	Horizontal	1,527.250	75.25	0.374633	0.512	-	3/4
"	Tel-12K 14 CID: 36456	Pgm Return-2 DAD-6 Util-52	14,332.000	Horizontal	11,532.000	Horizontal	1,532.000	80.00	3.198000	5.157	-	7/8
News Channel	AMC1-21K Slot C	-	14,417.000	Verical	12,117.000	Horizontal	1,367.000	-	4.232000	6.5	7.053	5/6
	AMC1-21K Slot D	-	14,423.000	Verical	12,123.000	Horizontal	1,373.000	-	4.232000	6.5	7.053	5/6
News Channel	AMC1/19K Slot A	-	14,365.000	Verical	12,065.000	Horizontal	1,315.000	-	4.232000	6.5	7.053	5/6
"	AMC1/19K Slot B	-	14,371.000	Verical	12,071.000	Horizontal	1,321.000	-	4.232000	6.5	7.053	5/6
"	AMC1/19K Slot C	-	14,377.000	Verical	12,077.000	Horizontal	1,327.000	-	4.232000	6.5	7.053	5/6
"	AMC1/19K Slot D	-	14,383.000	Verical	12,083.000	Horizontal	1,333.000	-	4.232000	6.5	7.053	5/6
"	AMC1/19K Slot E	-	14,389.000	Verical	12,089.000	Horizontal	1,339.000	-	4.232000	6.5	7.053	5/6
"	AMC1/19K Slot F	-	14,395.000	Verical	12,095.000	Horizontal	1,345.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot A	-	14,445.000	Verical	12,145.000	Horizontal	1,395.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot B	-	14,451.000	Verical	12,151.000	Horizontal	1,401.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot C	-	14,457.000	Verical	12,157.000	Horizontal	1,407.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot D	-	14,463.000	Verical	12,163.000	Horizontal	1,413.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot E	-	14,469.000	Verical	12,169.000	Horizontal	1,419.000	-	4.232000	6.5	7.053	5/6
"	AMC1/23K Slot F	-	14,475.000	Verical	12,175.000	Horizontal	1,425.000	-	4.232000	6.5	7.053	5/6
News Channel	AMC9/3K Slot A	-	14,045.000	Vertical	11,745.000	Horizontal	995.000	-	4.232000	6.5	7.053	5/6
"	AMC9/3K Slot B	-	14,051.000	Vertical	11,751.000	Horizontal	1,001.000	-	4.232000	6.5	7.053	5/6
"	AMC9/3K Slot C	-	14,057.000	Vertical	11,757.000	Horizontal	1,007.000	-	4.232000	6.5	7.053	5/6
	AMC9/3K Slot D	-	14,063.000	Vertical	11,763.000	Horizontal	1,013.000	-	4.232000	6.5	7.053	5/6
"	AMC9/3K Slot E	-	14,069.000	Vertical	11,769.000	Horizontal	1,019.000	-	4.232000	6.5	7.053	5/6
"	AMC9/3K Slot F	-	14,075.000	Vertical	11,775.000	Horizontal	1,025.000	-	4.232000	6.5	7.053	5/6
News Channel	AMC9/5K Slot A	-	14,085.000	Vertical	11,785.000	Horizontal	1,035.000	-	4.232000	6.5	7.053	5/6
"	AMC9/5K Slot B	-	14,091.000	Vertical	11,791.000	Horizontal	1,041.000	-	4.232000	6.5	7.053	5/6
"	AMC9/5K Slot C	-	14,097.000	Vertical	11,797.000	Horizontal	1,047.000	-	4.232000	6.5	7.053	5/6
"	AMC9/5K Slot D	-	14,103.000	Vertical	11,803.000	Horizontal	1,053.000	-	4.232000	6.5	7.053	5/6
"	AMC9/5K Slot E	-	14,109.000	Vertical	11,809.000	Horizontal	1,059.000	-	4.232000	6.5	7.053	5/6
"	AMC9/5K Slot F	-	14,115.000	Vertical	11,815.000	Horizontal	1,065.000	-	4.232000	6.5	7.053	5/6

Fox News Channel Galaxy 26 Frequency Plan

Satellite Desk: 212-301-3400
satellitedesk@foxnews.com
Intelsat Rapid Access Center (RAC): 800-321-3959

Transponder	Uplink	Pole	Downlink	Pole	Symbol Rate	FEC
Galaxy 26/K16D1	14286.625	V	11986.625	H	3.9787	3/4
Galaxy 26/K16D2	14291.875	V	11991.875	H	3.9787	3/4
Galaxy 26/K16D3	14297.125	V	11997.125	H	3.9787	3/4
Galaxy 26/K16D4	14302.375	V	12002.375	H	3.9787	3/4
Galaxy 26/K16D5	14307.625	V	12007.625	H	3.9787	3/4
Galaxy 26/K20D1	14348.375	V	12048.375	H	3.9787	3/4
Galaxy 26/K20D2	14353.625	V	12053.625	H	3.9787	3/4
Galaxy 26/K20D3	14358.875	V	12058.875	H	3.9787	3/4
Galaxy 26/K20D4	14364.125	V	12064.125	H	3.9787	3/4
Galaxy 26/K20D5	14369.375	V	12069.375	H	3.9787	3/4
Galaxy 26/K24D1	14416.625	V	12116.625	H	3.9787	3/4
Galaxy 26/K24D2	14421.875	V	12121.875	H	3.9787	3/4
Galaxy 26/K24D3	14427.125	V	12127.125	H	3.9787	3/4
Galaxy 26/K24D4	14432.375	V	12132.375	H	3.9787	3/4

Full-Time Analog Satellite Signals (As of December 2008) East to West

Analog C-Band

Satellite	Network/Identifier	Downlink Freq
AMC 6 (72° West)	NASA Feeds	3800 V
AMC 3 (87° West)	The University Network	4100 V
Galaxy 28 (89° West)	ABC Network Feeds (Occasional)	3980 H
Galaxy 26 (93° West)	Fox Network Feeds (Occasional)	3800 V
	Network Feeds (Occasional)	3960 V
	Vista Feeds (Occasional)	4000 V
Galaxy 19 (97° West)	ABC Network Feeds (Occasional)	3720 V
	ABC Network Feeds (Occasional)	3860 H
	ABC Network Feeds (Occasional)	4080 V
	ABC Network Feeds (Occasional)	4100 H
	DG Systems Feeds (Occasional)	4180 H
Galaxy 16 (99° West)	The Shepherd's Chapel	4020 V
	Buena Vista Network Feeds (Occasional)	4040 H
	Fox Feeds (Occasional)	4060 V

AMC 4 (101° West)	PBS x East	4020 H
AMC 1 (103° West)	HUD Feeds (Occasional)	3880 H
	RAI Italia (evenings & Sunday all day)	4160 H
	Univision Network Feeds (Occasional)	4120 H
Anik F1R (107.3° West)	InSight Feeds	3820 V
Anik F2 (111° West)	VSEN Henrico (0845-1130 EMT)	3740 V
	VSEN Varina (0845-1230 EMT)	3820 V
	VSEN Wise (0830-1317 EMT)	3980 V
AMC 11 (131° West)	C-SPAN	3840 V
Galaxy 15 (133° West)	Classic Arts Showplace	3800 H
	EWTN (Eternal Word Television Network)	3920 H
	Shop NBC	3940 V
	INSP (The Inspiration Network)	4040 H
AMC 10 (135° West)	QVC (Home Shopping)	3880 V
	HSN (Home Shopping Network)	3900 H
	C-SPAN 2	4080 V

Analog Ku-Band

Satellite	Network/Identifier	Downlink Frequency
AMC 16 (85° West)	Echostar Slate over Color Bars	12180 H
AMC 3 (87° West)	CNN Feeds (Occasional)	11760 H
AMC 15 (105° West)	Echostar Slate over Color Bars	11949 H

Full-Time Digital Satellite Signals (As of December 2008) East to West
***Limited to 2 or 3 identifiable signals due to space constraints**
I tried to put one of them on Vertical, the other on Horizontal, if available
please visit www.lyngsat.com for more identifiable satellite signals

Digital C-Band (most are 4:2:0 Encoding for even cheap FTA IRDs)

Satellite	Network/Identifier	Downlink Freq	Symbol Rate - FEC
Star One C1 (65° West)	Rede Brasil de TV	3762 H	2.222 - 7/8
	TV Gazeta Canal 10	3792 V	3.393 - 3/4
Star One C2 (70° West)	TV Ceara	3955 H	4.4 - 3/4
	TV Escola	3965 V	2.93 – 2/3
AMC 6 (72° West)	NASA TV	4040 V	26.665 - ¾
	Pennsylvania Cable Network	3953 V	4.167 - ¾
Brasilsat B4 (84° West)	TV Serra Dourada	3705 H	4.28 - 3/4
	TV A Critica	3786 V	4.286 - 3/4

AMC 3 (87º West)	APTN Washington	3719 H	4.167 - 5/6
	APTN Direct	3725 H	4.167 - 5/6
	Horse Racing Feeds (Occasional)	3796 V	3.024 - ¾
Galaxy 28 (89º West)	NET 1 (Nebraska Educational TV)	3754 H	4.442 - 3/4
Galaxy 11 (91º West)	The CW Mux	3720 H	26.70 - ¾
	EWTN (Eternal Word Tel. Net.)	3920 H	26.0 - ¾
Galaxy 3c (95º West)	Faith TV	3744 V	2.206 - ¾
	Equity TV Mux	4040 H	29.120 - 7/8
Galaxy 19 (97º West)	LATV	3744 V	3.25 - 5/6
	TCT	3762 V	4.615 - 5/6
Galaxy 16 (99º West)	KCWY-TV Casper, WY	3776 H	3.255 - ¾
	KCHF-TV Santa Fe, NM	3790 H	3.256 - ¾
AMC 4 (101º West)	Golden Eagle Broadcasting	3716 V	4.34 - ¾
	Comcast MUX	4180 H	24.074 - ¾
AMC 1 (103º West)	CTN	3984 H	2.734 - 5/6
	SES Americom MUX	3740 V	29.270 - 7/8
AMC 18 (105º West)	NBC Network Feeds	3780 H	26.680 – ¾ (ch. 308 sd)
Anik F1R (107.3º W)	Radio Canada Montreal	3962 H	6.5 – 7/8
	INDR/Canada Weather MUX	4100 V	28.346 – 7/8
SatMex 6 (113º West)	Hidalgo TV	3821 H	3.255 - ¾
	Telemax	3847 V	3.219 - ¾
SatMex 5 (116.8º West)	TV Mexiquense	4052 V	4.307 - ¾
	Guatevision	4084 H	3.162 – 7/8
Echo9, Gal 23 (121ºW)	Cox Sports TV	3707 H	5.632 - 3/4
	Canella Response TV	3764 V	2.143 - 7/8
Galaxy 14 (125ºW)	Trinity Broadcasting MUX	3720 H	26.667 - 3/4
Gal13/Horizons 1(127ºW)	Intelsat MUX	3800 V	27.690 - 3/4
	RFD TV	4186 H	4.41 - 2/3
Galaxy 27 (129ºW)	Intelsat Test Card	3974 H	5.632 - 3/4
AMC 11 (131ºW)	QVC MUX	3972 V	14.323 - 5/6
Galaxy 15 (133ºW)	The California Channel	3745 H	3 - 1/2
AMC 10 (135ºW)	HSN	3915 H	3.98 - 3/4
AMC 7 (137ºW)	NASA TV MUX	4060 V	26.665 - 3/4
AMC 8 (139ºW)	Alaska MUX	4056 H	13.25 - 3/4

Digital Ku-Band (most are 4:2:0 Encoding for even cheap FTA IRDs)

Satellite	Network/Identifier	Downlink Freq	Symbol Rate - FEC
Estrela do Sul (61.5º West)	TV Uniao Natal	11905 V	2.362 - 3/4
	Unisa	11979 H	8.888 - 3/4
Star One C2 (70º West)	Embratel Test Card	10976 H	7.505 - 3/4
AMC 6 (72º West)	KFTL -CA	11890 H	1.666 - ¾
	MSNBC MUX	12055 V	6.890 - 5/6
Horizons 2 (74º West)	Ohio News Now	11734 H	6.616 - 2/3
Galaxy 4R (76.8º W)	Test Card	11956 V	2.942 – 2/3
	Test Card	11959 H	21 - 3/4
AMC 5 (79º West)	KTEL-TV	11900 H	2.170 - ¾
	ABC, NBC and CNN Feeds	Various	3.97872 - ¾
	New York Network	12177 H	20.5 - ¾
AMC 9 (83º West)	NBC Feeds	Various	4.232 - 5/6
AMC 16 (85º West)	Echostar Test Card	12196 H	3.979 - ¾
AMC 3 (87º West)	Montana PBS Info Card	12145 H	4.34 - ¾
	PBS Mux	12180 V	30.0 - ¾
Galaxy 28 (89º West)	Test Card	11920 H	17.91 - 2/3
	ABC News Now/Newsone MX	11955 V	19.532 - ¾
Galaxy 17 (91º West)	ABC Affiliate Feeds	11925-12035 V	3.97872 - ¾
Galaxy 26 (93º West)	NBC Weather Plus Feeds	11772 H	3.97872 - ¾
	ABC and CBS Feeds	11919-12063 H/V	3.97872 - ¾
	Macy's TV	11909 V	3.548 - ¾
Galaxy 3c (95º West)	CCTV (Chinese)	11780 H	20.76 - ¾
Galaxy 19 (97º West)	Pittsburg Teleport MUX	11836 V	20.765 - ¾
	Globecast World TV MUX	12152 H	20.0 - ¾
Galaxy 16 (99º West)	CBS Newspath Feeds	11771 V	14.321 - 3/4
	Fox Feeds (Occasional)	11825 H	3.97872 - 3/4
AMC 4 (101º West)	KUIL-TV (Fox) Beaumont, TX	11708 V	2.170 - ¾
	3 ABN (Angels Broadcast Network)	11822 H	5.700 – 2/3
AMC 1 (103º West)	Pentagon Channel	12100 V	20.0 - ¾
	Test Card	12143 V	20.0 - ¾
AMC 15 (105º West)	Echostar slate over Color Bars	11928 H	3.97872 - ¾
SatMex 6 (113º West)	Tele Restauracion	12125 H	2.170 - ¾
	MAC TV	12090 V	3.336 - 2/3
SatMex 5 (116.8º West)	Almavision	12028 H	3.255 – 5/6

	BYU TV	12165 H	3.935 - ¾
Echo9, Gal 23 (121ºW)	Echostar Test Card	12176 H	6.1113 - ¾
Galaxy 18 (123ºW)	Equity Broadcasting Mux	11720 V	27.692 - 3/4
	Veterans Affairs Knowledge Network	11732 H	13.24 - 3/4
AMC 21 (125ºW)	Montana PBS	12104 V	4.34 - 3/4
	PBS Mux	12116 H	30 - 3/4
Galaxy 13/Hor.1 (127ºW)	Horizon Broadcast Network	11849 H	2.012 - 3/4
Galaxy 27 (129ºW)	White Springs TV	11964 H	2.92 - 1/2

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... and there will be many more thanks to come...