



***TECHNICAL BULLETIN***

***Understanding Aspect Ratios***

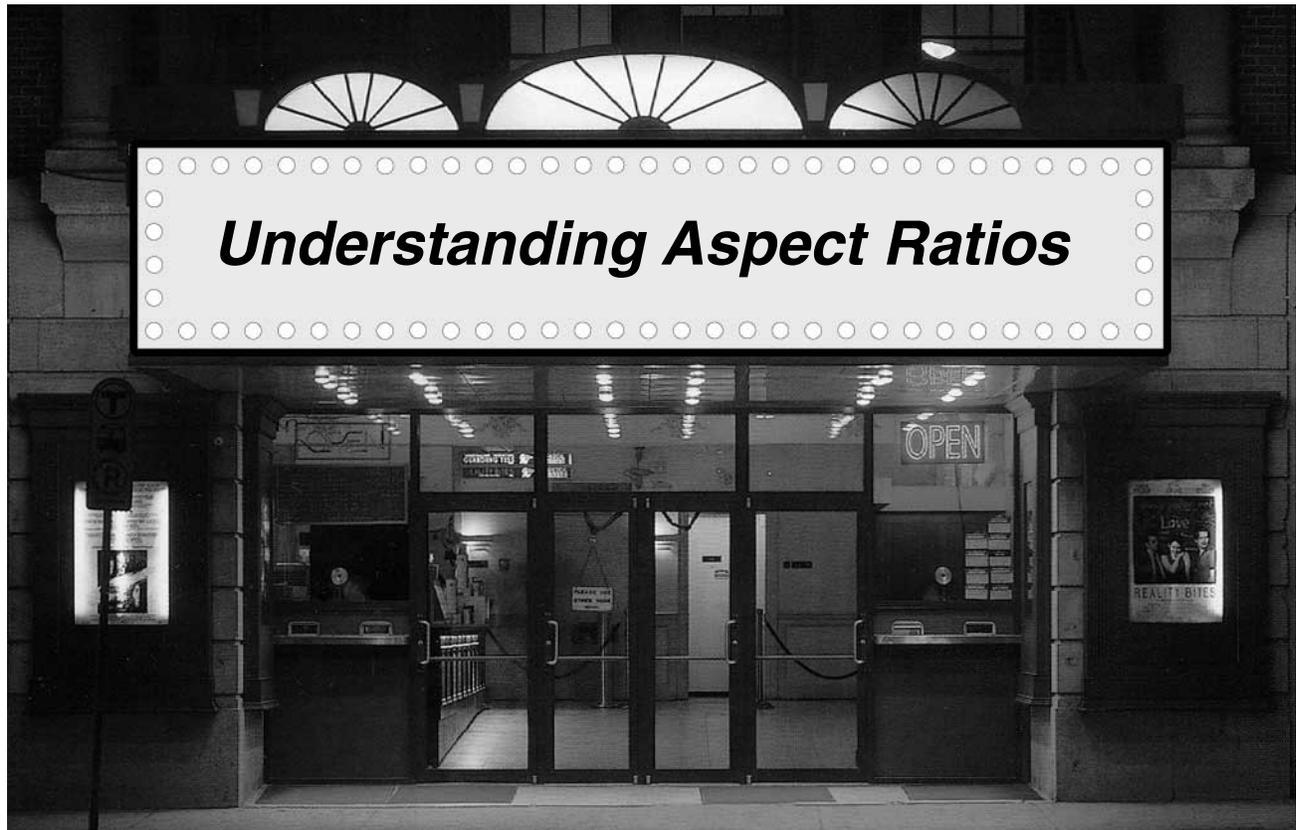
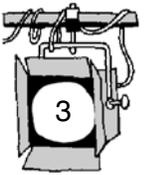


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**T**he first thing we want to do is demystify this phrase. An aspect ratio is simply a numerical way of describing a rectangular shape. The aspect ratio of your standard television, for example, is 4:3. This means that the picture is 4 “units” wide and 3 “units” high. Interestingly, professional cinematographers tend to prefer a single number to describe screen shapes and reduce the familiar 4:3 television ratio down to 1.33:1, or just 1.33. This is most likely because they deal with a vastly larger number of screen shapes than television people do and out of necessity, long ago, jettisoned bulky fractional descriptions.

### The History Of Cinema Aspect Ratios

The original aspect ratio utilized by the motion picture industry was 4:3 and according to historical accounts, was decided in the late 19th century by Thomas Edison while he was working with one of his chief assistants, William L.K. Dickson. As the story goes, Dickson was working with a new 70MM celluloid-based film stock supplied by photographic entrepreneur George Eastman. Because the 70MM format was considered unnecessarily wasteful by Edison, he asked Dickson to cut it down into smaller strips. When Dickson asked Edison what shape he wanted imaged on these strips, Edison replied, “about like this”

and held his fingers apart in the shape of a rectangle with approximately a 4:3 aspect ratio. Over the years there has been quite a bit of conjecture about what Edison had in mind when he dictated this shape. Theories vary from from Euclid's famous Greek "Golden Section", a shape of approximately 1.6 to 1, to a shape that simply saved money by cutting the existing 70MM Eastman film stock in half. Whatever the true story may be, Edison's 4:3 aspect ratio was officially adopted in 1917 by the Society Of Motion Picture Engineers as their first engineering standard, and the film industry used it almost exclusively for the next 35 years.

Because of the early precedent set by the motion picture industry with the 4:3 aspect ratio, the television industry adopted the same when television broadcasting began in the 1930s, and today the 4:3 aspect ratio is still the standard for virtually all television monitor and receiver designs. The same situation applies to video programming and software. Only until recently has there been any software available except in 4:3 format (letterboxed videos are the same thing electronically). There simply wasn't any reason to shoot or transfer in any other aspect ratio because of the standard 4:3 shape of the television displays. For the home theater owner, this situation means that compatibility issues are essentially nonexistent with



## Understanding Aspect Ratios

standard 4:3 television receivers and standard 4:3 programming. They are all "plug and play", so to speak, at least when it comes to the shape of image.

### Getting Wide

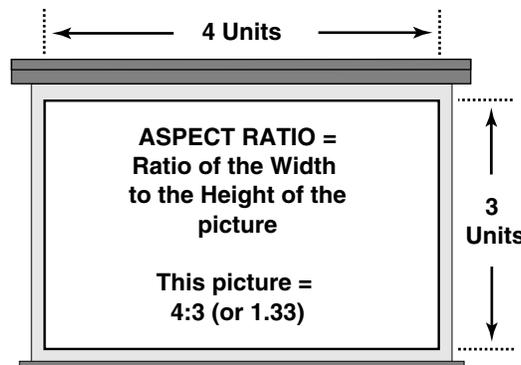
Back to our history lesson. After many years of experimentation, television broadcasting formally began on April 30, 1939 when NBC broadcasted Franklin Roosevelt's opening of the 1939 World's Fair. As you might imagine, the availability of a device that delivered sound and pictures in the home immediately concerned the Hollywood studios. After all, this medium had the potential to erode their lifeblood; their vital paying customer base. When color was introduced in late 1953, the studios stopped wringing their hands and sprang into action. The result was the rapid development of a multitude of new widescreen projection ratios and several multichannel sound formats. Today, just a few of these widescreen formats survive, but a permanent parting of the ways had occurred: film was now a wide aspect ratio medium, and television remained at the academy standard 4:3 aspect ratio.

As we mentioned, the fact that film formats went "wide" in the 1950s never really impacted the production end of television. Everything stayed at 4:3 for them because of the uniformity of 4:3 television design. However, the transfer of motion pictures to video...that was another story. The question is: How do you make a wide shape fit into a narrow one? One way you've undoubtedly heard about "panning and scanning". This technique of transferring film to video requires that a telecine (video transfer) operator crop a smaller 4:3 section out of a widescreen movie while panning around following the movie's action. This technique, when properly done, actually works pretty well, but not everyone likes the artistic compromise of "throwing away part of the director's vision". Not the least of which is the film directors themselves, and one of the first to really object to this process was Woody Allen. In 1979, when his film *Manhattan* was being transferred for television release, he steadfastly refused to have it panned and scanned. He insisted that the feature be shown with the widescreen aspect ratio intact, and this led to the technique of "letterboxing". Letterboxing, a method where the middle of a 4:3 image is filled with a smaller, but wider, aspect ratio image, may have had the blessing of Hollywood directors but was originally shunned by the viewing public. The objection was the black bars on the top and the bottom of the picture, people just didn't like them. Today, letterboxing

has gained much broader acceptance and you can find it available from sources such as prerecorded tapes (occasionally), broadcast television (occasionally), on cable and DSS (AMC and other movie channels broadcast in letterbox), on laserdisc (fairly common), and DVD releases (very common).

So, what about displaying letterbox material with a projection display? On a standard 4:3 display, the situation is pretty simple, letterboxed software can be seen basically one way: as a stripe across the center of the display with black bars top and bottom. On a widescreen display, you can do something different. The letterbox section of the frame can be "zoomed into" so that the image fills the wider screen essentially eliminating the black bars. What is interesting about this technique is that it is conceptually similar to what is done in professional cinemas with standard widescreen releases with "matting". Our diagrams on following at the end of this chapter

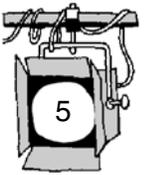
illustrate this. By zooming the letterbox section in to fill the screen, the audience simply sees a widescreen image. The main difference between video display and film display, however, is the way the zooming is done. In a movie theater, an optical zoom lens is used. In a CRT-based video display, it is done by increasing the size of the picture electronically in the picture tube, but with an LCD/DLP-based device it is again done with an optical lens. (Note: one LCD projector does "zoom" electronically, the SONY VPL-400Q.)



Are there any drawbacks to letterboxing as a general technique? As we mentioned, with the right equipment, letterboxed software can be zoomed to fill a wide screen, but you should know that this comes at a certain price. The issue is loss of vertical resolution. Let's take a matted widescreen film frame, as an example. There is finite amount of resolution in a 35MM frame and, unfortunately, a great deal is taken up with matting. In video, the same principle applies. In a standard video frame there is some 480 lines of vertical resolution available and in the letterbox section, this number is reduced to about 320 to 360 lines (depending on the degree of letterboxing). True, this doesn't have to affect the size of the letterbox section, depending on the size of your television, you have it as wide as what your display allows. However, regardless of the size of your display, the resolution will be less than a full video frame's capability.

### A Bit Of A Stretch

# Understanding Aspect Ratios



Back in the 1950s, the people at CinemaScope came up with a novel solution to the resolution problem outlined above. The solution was to optically squeeze a full widescreen image into a 4:3 film frame via a special device called an "anamorphic lens". The genius of this idea was that no major change was necessary in the camera equipment or the theater projection equipment, all that was necessary was to place an anamorphic lens on the filming cameras to squeeze the image, and a reverse one in the theaters to unsqueeze it. At first, it was said, the Hollywood film community didn't care much for this odd technique, but after using it awhile embraced it hardily. The reason: it was an undeniably elegant solution to the problem of producing and delivering widescreen movies with equipment basically designed for 4:3 format. What is particularly interesting about this 40 year old technique is that a similar concept is now being applied to widescreen electronic video releases. As we mentioned before, the black bars in a letterbox video release also represent lost resolution, just like in the cinema, and the letterbox section is thus lower resolution. Again our concept of anamorphic compression can be used to squeeze more picture into a 4:3 space, but instead of lens, it is done electronically. Some of the first anamorphic video programs were pressed on laserdiscs but with the new DVD format, the concept is catching on big.

Displaying anamorphic images in a home theater requires a display device with the capability of stretching out the anamorphic image horizontally. Most CRT-based projectors with digital convergence and picture memories (typically graphics-grade projectors) should be able to unsqueeze anamorphic material, however some may require some special setup. For example, AmPro Corporation, a major manufacturer of front projectors for the home theater market, found that some dealer confusion existed about the proper setup procedure for multiple aspect ratio configurations. This resulted in the company releasing a detailed technical bulletin that guides an AmPro dealer/installer through the proper set-up procedure so that different aspect ratios can be displayed and switched easily. If you are buying a front projector from another manufacturer, make sure you are briefed on the proper factory technique. With LCD/DLP-based front projectors, the situation concerning anamorphic software is more clear cut than CRT projectors. Most *do not* unsqueeze anamorphic material because picture size changes are accomplished optically via a zoom lens. The only LCD projector that we know of that does unsqueeze anamorphic material is the SONY VPL-400Q. It has a "full" mode that is designed specifically for this.

## Variable Aspect Ratio Screens

As we mentioned before, many CRT-based projectors,

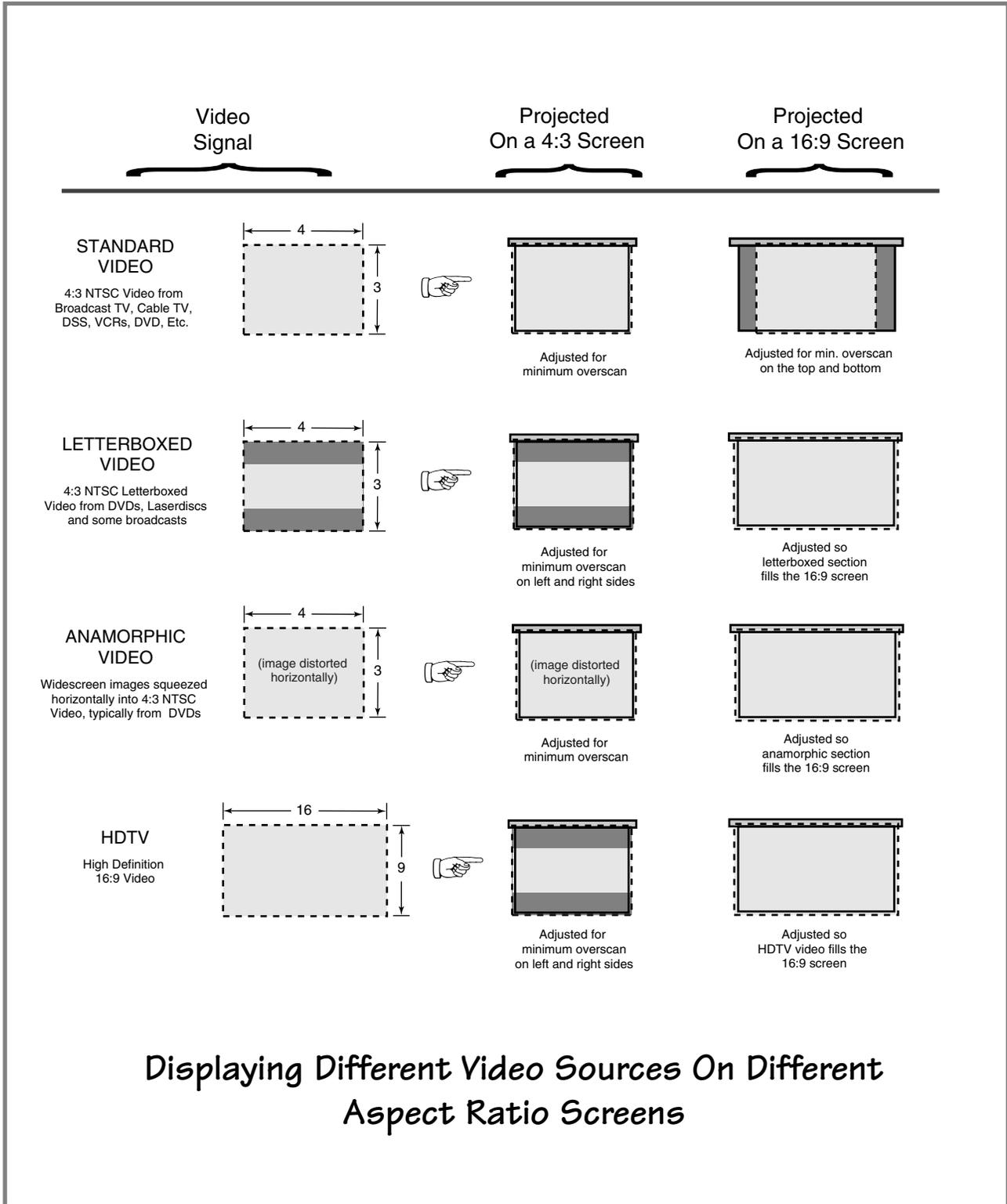
• Television = 1.33 (4:3) Aspect Ratio

• HDTV, Many Letterboxed movies = 1.77 (16:9) Aspect ratio

• Standard Cinema Widescreen = 1.85 Aspect Ratio

• CinemaScope Widescreen = 2.35 Aspect Ratio

### Four Common Aspect Ratios



**Displaying Different Video Sources On Different Aspect Ratio Screens**

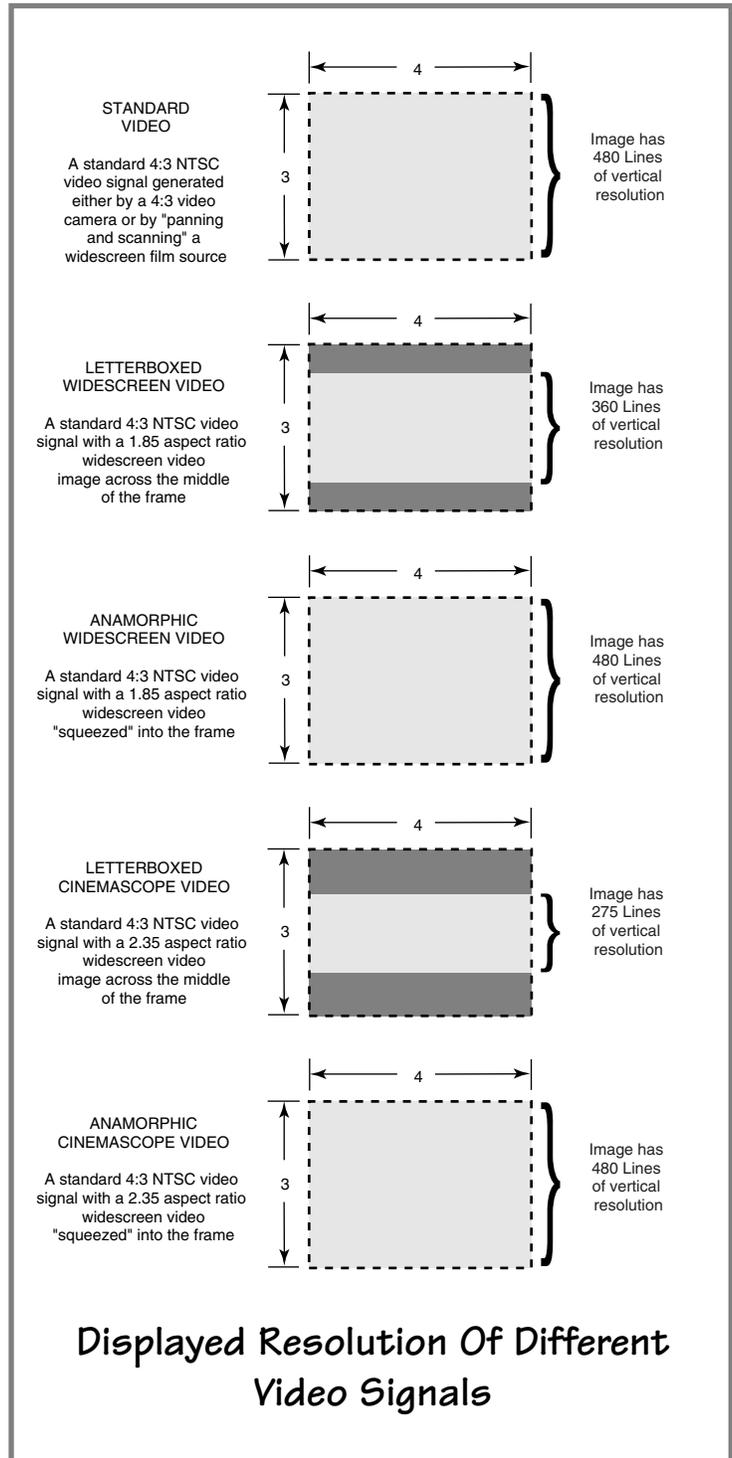
# Understanding Aspect Ratios



and at least one LCD projector allow one to easily switch between aspect ratios. If you are going to use one of these projectors, you have a choice of what aspect ratio screen to use in your home theater. Most people go with a 16:9 screen to display 16:9 material and display 4:3 material in the middle of the screen surface (see our diagram). However, a more elegant solution is to use a variable aspect ratio screen. Most of the major screen manufacturers offer variable aspect ratio screens but they accomplish the switch by lowering masking panels. Vutec corporation has a more elegant solution. They build two separate screens into one assembly. This allows the home theater owner to drop the correct surface for the software being displayed. This screen, which Vutec calls their Pro-Duplex, lowers both screen surfaces in exactly the same plane so that focusing adjustments on the display device are unnecessary.

## The Future of Widescreen Video

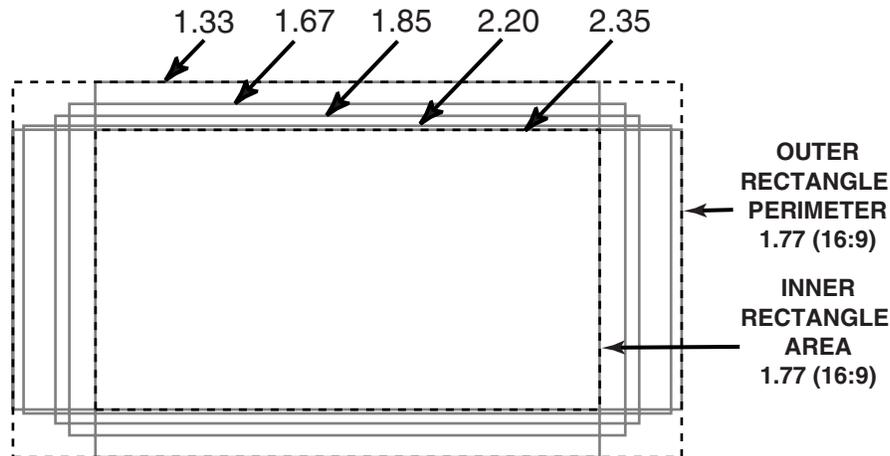
The old proverb "The only thing constant about the world is change" certainly applies to home theater. It wasn't too many years ago that you could build a home theater around a 4:3 display device and be perfectly happy. After all, your television display was 4:3, the software was 4:3, and compatibility was assured. Modern home theaters, however, have to contend with multiple aspect ratios. As for the future, the big thing now is digital television (DTV). If you have been following the tortured progress of DTV, then you know the situation is still evolving however, if there is one feature of DTV (and HDTV) that we can speak about with some certainty, believe it or not, it is the aspect ratio. Almost all of the programming should be in 4:3 and/or 16:9. The reason that we can state this with some certainty is that the "Grand Alliance Format Table", which has become the unofficial guideline for the DTV rollout, only specifies those two ratios. Unfortunately, this table, which was once a proposed standard has been demoted to guideline status by the FCC, but, it appears that the broadcasters and equipment manufacturers are going to adopt a great deal of it anyway. Kerns Powers, I think we are going to be seeing a lot more of your work in the future.



## The Father Of 16:9

The most prevalent aspect ratios filmmakers deal with today are: 1.33 (The Academy standard aspect ratio), 1.67 (The European widescreen aspect ratio), 1.85 (The American widescreen aspect ratio), 2.20 (Panavision), and 2.35 (CinemaScope). Attentive videophiles may note that 1.77 (16:9) isn't on this list and may ask: "If 16:9 isn't a film format, then just exactly where did this ratio come from". The answer to this question is: "Kerns Powers".

The story begins in the early 1980s when the issue of high definition video as a replacement for film in movie theaters first began to arise. During this time, the Society Of Motion Picture And Television Engineers (SMPTE) formed a committee, the Working Group On High-Definition Electronic Production, to look into standards for this emerging technology. Kerns H. Powers was then research manager for the Television Communications Division at the David Sarnoff Research Center. As a prominent member of the television industry, he was asked to join the working group, and immediately became embroiled in the issue of aspect ratios and HDTV. The problem was simple to define. The film community for decades has been used to the flexibility of many aspect ratios, but the television community had just one. Obviously a compromise was needed.



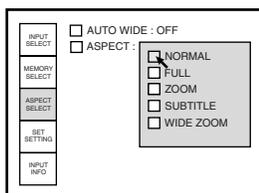
### KERNS POWERS' SOLUTION

As the story goes, using a pencil and a piece of paper, Powers drew the rectangles of all the popular film aspect ratios (each normalized for equal area) and dropped them on top of each other. When he finished, he discovered an amazing thing. Not only did all the rectangles fall within a 1.77 shape, the edges of all the rectangles also fell outside an inner rectangle which also had a 1.77 shape. Powers realized that he had the makings of a "Shoot and Protect" scheme that with the proper masks would permit motion pictures to be released in any aspect ratio. In 1984, this concept was unanimously accepted by the SMPTE working group and soon became the standard for HDTV production worldwide.

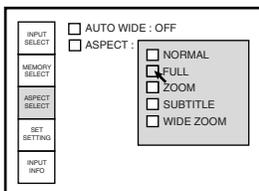
Ironically, it should be noted, the High-Definition Electronic Production Committee wasn't looking for a display aspect ratio for HDTV monitors, but that's what the 16:9 ratio is used for today. "It was about the electronic production of movies," Kerns Powers states, "that's where the emphasis was". Interestingly, today, there is little talk today about the extinction of film as a motion picture technology, but there is a lot of talk about delivering HDTV into the home. And, as a testament to Kern H. Powers clever solution, it's all going to be on monitors with a 16:9 aspect ratio.



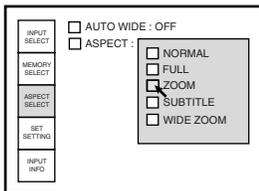
## USING THE DIFFERENT PICTURE MODES IN THE SONY VPL-W400Q LCD PROJECTOR ON A 16:9 SCREEN



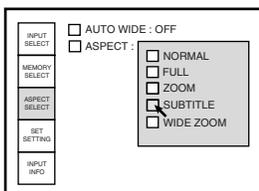
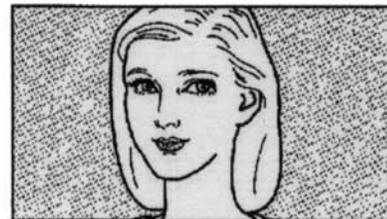
**NORMAL MODE:** Picture is displayed with the normal 4:3 aspect ratio



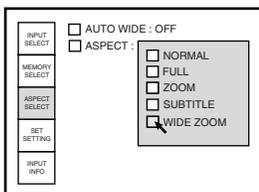
**FULL MODE:** Picture is enlarged horizontally, this mode can be used to expand anamorphically compressed DVDs



**ZOOM MODE:** The picture is enlarged both horizontally and vertically (some picture is lost vertically)

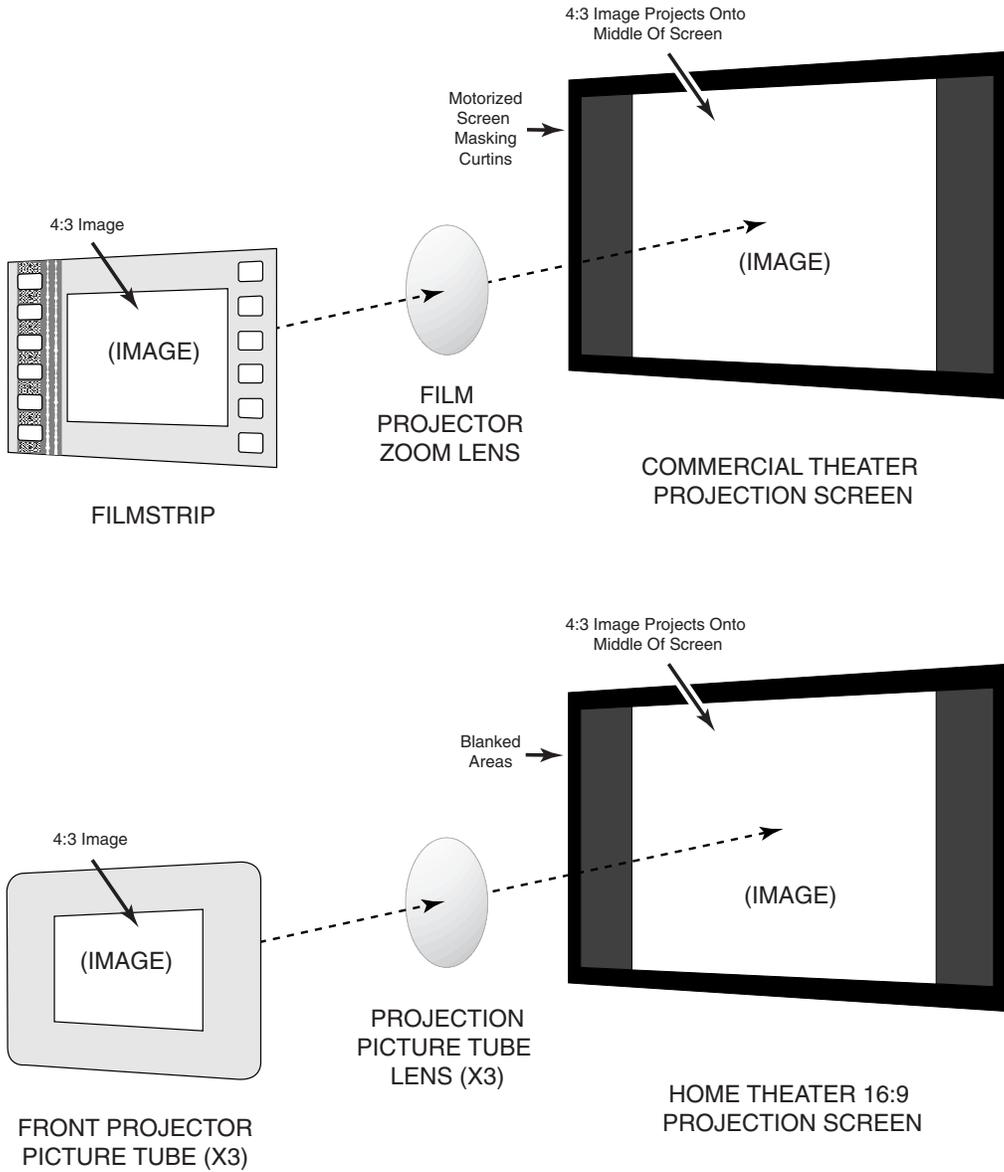


**SUBTITLE MODE:** The picture is enlarged horizontally and vertically but subtitles are left on the screen

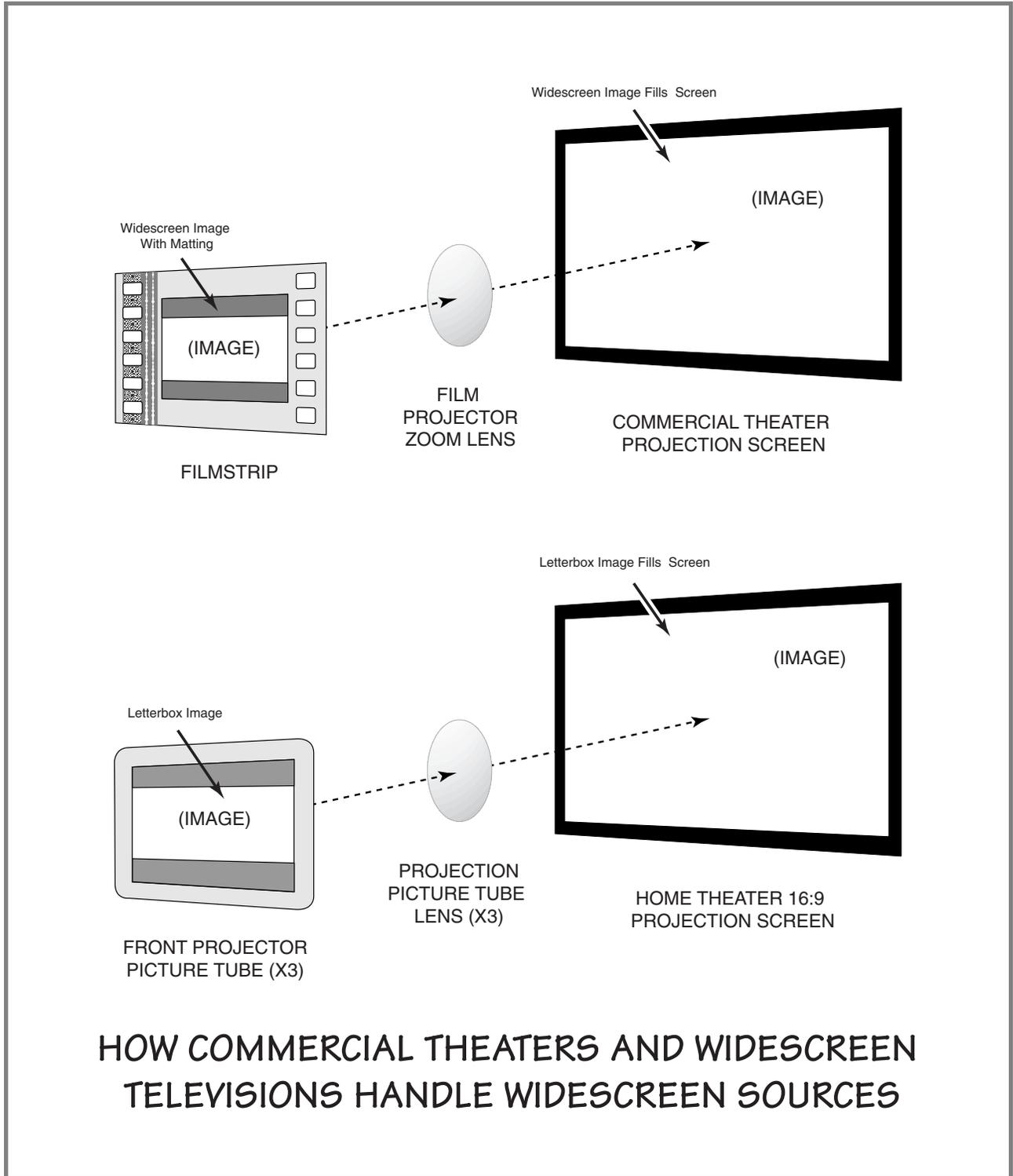


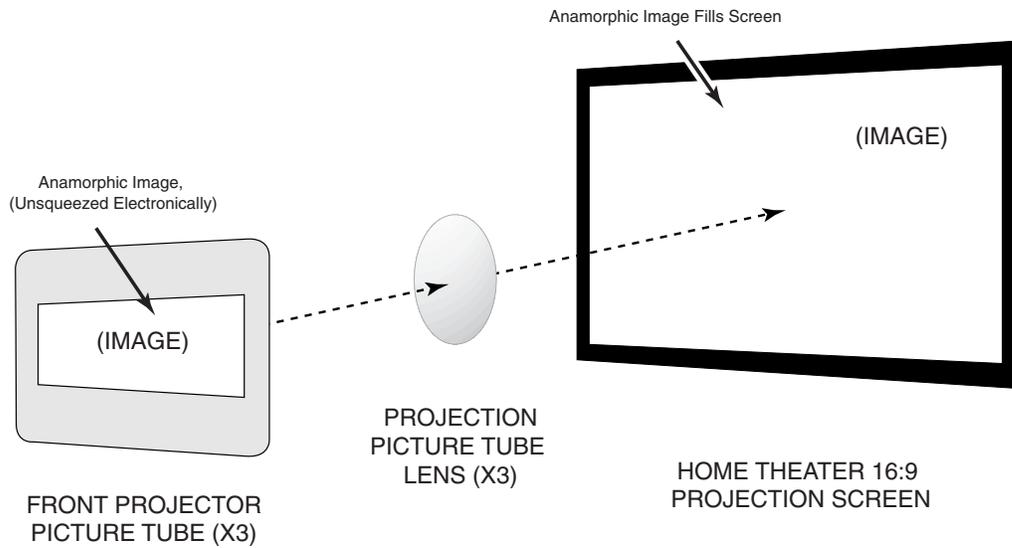
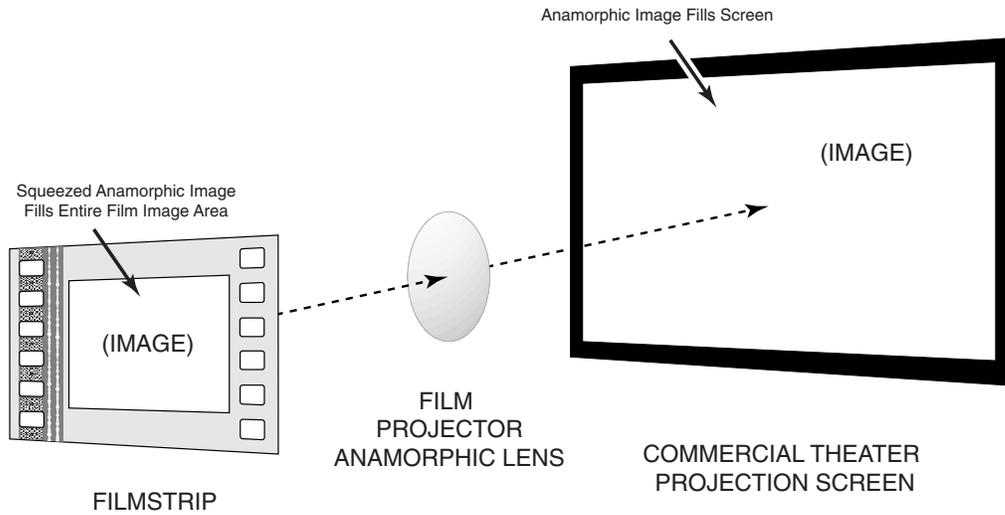
**WIDE ZOOM MODE:** The picture is expanded horizontally, but more on the outside edges than at the center



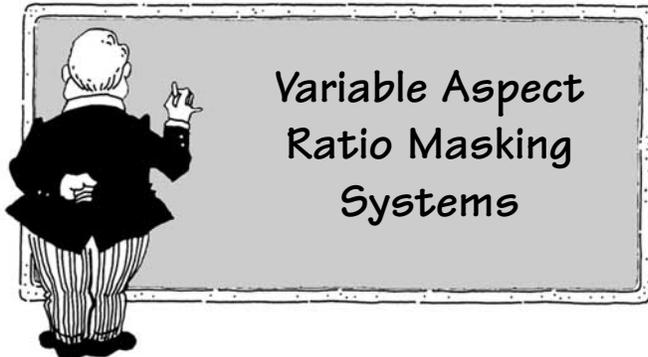


## HOW COMMERCIAL THEATERS AND WIDESCREEN TELEVISIONS HANDLE 4:3 SOURCES





## HOW COMMERCIAL THEATERS AND WIDESCREEN TELEVISIONS HANDLE ANAMORPHIC SOURCES



Variable aspect ratio screen systems are a convenient way to add professional looking screen masking to home theater rooms. Each of the products we describe here are available in many sizes and configurations. This page is simply to illustrate the four basic systems that you can chose from. Call us for further details and pricing.

**A) Stretched Flat Screen with Motorized Left and Right Masking Panel Assembly**

Offered as DRAPER Eclipse H™ and STEWART Electrismask-Screenwall™ systems. These masking systems consist of a fixed frame assembly that mounts over a stretched flat screen. It has motorized panels that lower on the left and right sides changing a 16:9 screen to a 4:3.

**B) Stretched Flat Screen with Motorized Top and Bottom Masking Panel Assembly**

Offered as DRAPER Eclipse V™ and STEWART Electrismask-Screenwall™ systems. These masking systems consist of a fixed frame assembly that mounts over a stretched flat screen. It has motorized panels that lower on the top and raise on the bottom changing a 4:3 screen to a 16:9.

**C) Electric Roll-Down Screen with Motorized Left and Right Masking Panels**

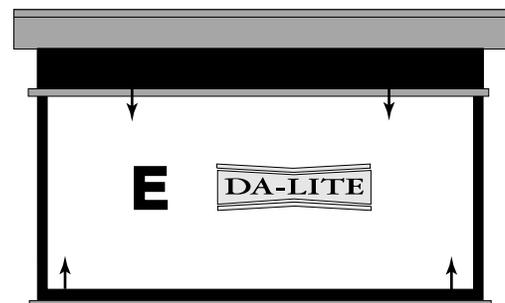
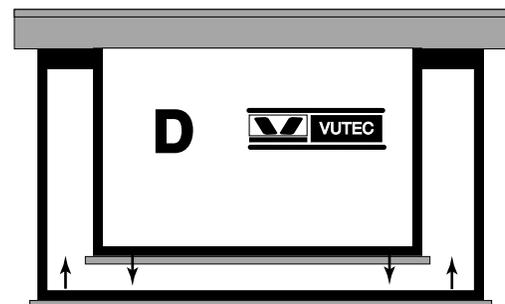
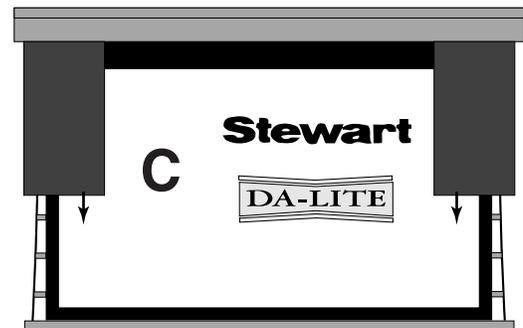
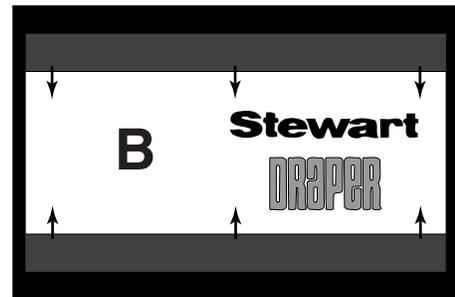
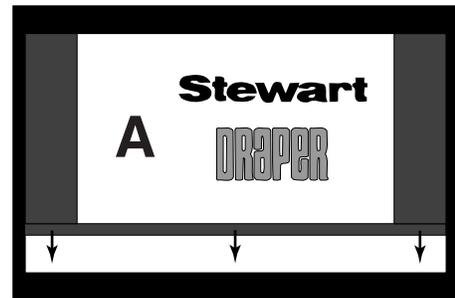
Offered as DA-LITE Dual Masking ElectroI™ and STEWART Electrismask-Electriscreen™ systems. These masking systems consist of a regular roll-down screen assembly with left and right masking panels built into the same housing. When lowered they convert a 16:9 screen into a 4:3.

**D) Dual Aspect Ratio Screen Assembly**

Offered as VUTECH Vu-Flex Pro Duplex™. This system consists of two separate screen 16:9 and 4:3) surfaces housed in the same assembly. One surface is used at a time and both roll down in the same plane so image focus is constant.

**E) Dual Aspect Ratio Screen Assembly**

Offered as Da-Lite Horizon ElectroI™. This system consists of one screen surface (4:3) and one upper masking panel. The 4:3 surface is lowered for 4:3 sources and when 16:9 sources are viewed, the 4:3 screen moves up several inches and the black upper masking panel rolls down. The result is a 16:9 viewing surface.



## Variable Aspect Ratio Screens: what's more important, constant height or constant width ?

Not long ago, all CRT-based front projection monitors had analog-controlled convergence systems. This meant that the color registration of the three projection tubes was controlled by a complex bank of waveform pots driving analog convergence circuitry. These analog systems worked well enough but suffered from a significant limitation; most allowed registration alignment for one aspect ratio only. Today, CRT projectors are more advanced and most offer digital convergence systems which allow for easy switching of image aspect ratios. The result of this advancement, though, is that those that are building a home theater with a front projector have to give some serious thought as to what aspect ratio switching

*philosophy* to follow; constant height or constant width.

**The Constant Height Method:** This method keeps the height of the two different projection screens the same. This method works well enough, as far as switching aspect ratios is concerned, but may lead to uneven phosphor utilization. See our diagram below.

**The Constant Width Method:** This method keeps the width of the two different projection screens the same. Many manufacturers prefer this method because it utilizes the full area of the 4:3 phosphor target in the projection tube. See our diagram

Vu-Flex Pro Duplex/ Vision 2X Screen  
Constant Height Design

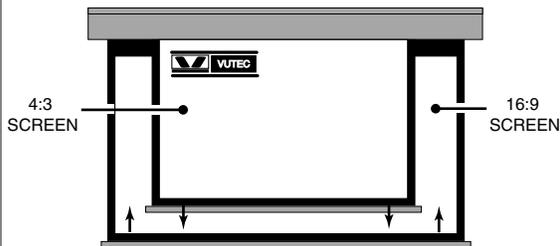
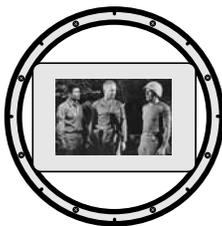
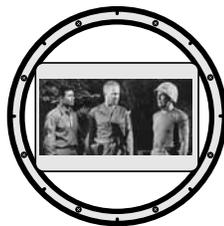


Image on Picture Tube Phosphor:



4:3 image is smaller than phosphor



16:9 image fills width of phosphor

Vu-Flex Pro Duplex/ Vision 2X Screen  
Constant Width Design

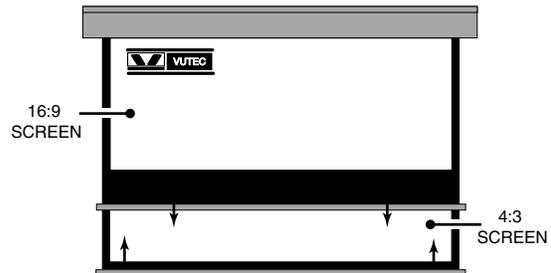
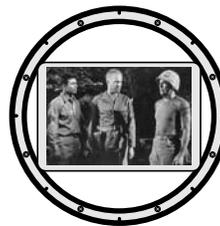
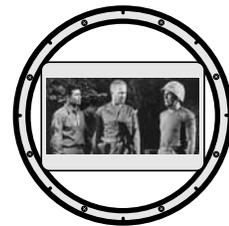


Image on Picture Tube Phosphor:



4:3 image fills the phosphor



16:9 image fills width of phosphor