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Making sense out of complex Pro A/V and Broadcast technologies.

# edu Guide

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## Video Scaling

An in-depth look at Video Scaling technology and how it differs from doubling and quadrupling.

CSI™ Communications Specialties, Inc.

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# edu Guide

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October 8, 2009

## Introduction

If it's your job to devise presentation solutions, chances are high that you've encountered the challenge of presenting standard TV video on today's high-res LCD and DLP projectors. Although many of these devices offer a video input, you've probably discovered that using a line doubler or quadrupler to first convert from TV video to computer video format provides a better end result. And if you've ever attempted to display TV video on flat panel computer screens, you'll have discovered that these devices don't offer the option of a direct TV video input, making a line doubler or quadrupler indispensable.

However, there is a whole new way to think about converting TV video to computer video. Intelligent video scaling will make line doubling and quadrupling, if not obsolete, then at least a distant second choice option.

The following guide will discuss exactly what intelligent video scaling is, how it differs from traditional line doubling and quadrupling, and why it can provide you with the clearest, crispest, most brilliant video for display on LCD, DLP projectors and plasma displays.

## Converting TV Video to Computer Video

What does this involve? Regardless of what approach you use to convert an interlaced, TV signal to a non-interlaced, computer video signal, the fact remains that the two signal formats are inherently different and any conversion device must accommodate for these differences. Briefly, let's review what these differences are: (If you are already familiar with these differences, you may want to skip to the "Intelligent Video Scaling" section on page 8.)

### Resolution:

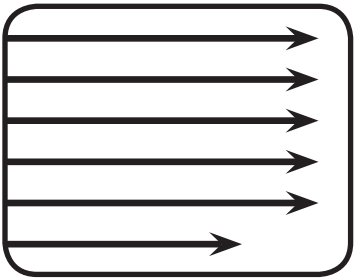
A TV signal has a set number of horizontal lines. In NTSC, that number is 525; in PAL and SECAM, it's 625. However, not all of these lines are visible. In fact, only 483 lines in NTSC and 576 lines in PAL and SECAM are seen by the TV viewer; the remainder are called blanking lines, which contain no picture information and are hidden at the top and bottom of the screen. By contrast, the number of horizontal lines on a computer display can range dramatically, from lower resolutions of 480 visible horizontal lines or less, up to very high resolutions with 1280 or more lines. Most newer computers contain video cards that allow the user to choose between several different display resolutions. Obviously, the higher the resolution, the more crisp and clear small details and text become. For example, a computer screen composed

of 768 horizontal lines is able to contain and display more detail than a computer picture composed of only 480 lines, or a TV picture composed of 483. The relatively small number of horizontal lines in a TV video picture limits the ability to display very small text or other intricate visual details.

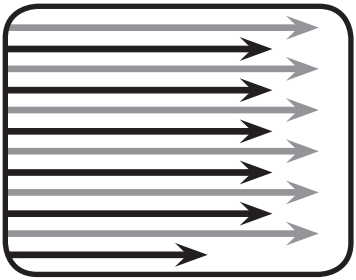
**Interlaced Versus Non-Interlaced:**

A TV signal is "interlaced," meaning that each full "screen" of information is actually composed of two separate "fields" - the odd lines and the even lines. First the odd lines are painted on the screen. Then, before the odd lines have had time to completely fade, the even lines are "painted" in between the odd lines. This happens so quickly that it is difficult for the human eye to perceive, especially when viewing moving images. However, the interlaced format is inadequate for clearly displaying certain non-moving objects, particularly those with thin horizontal lines. The appearance and disappearance of the odd and even picture fields causes noticeable flickering of thin, horizontal lines, such as those in spreadsheets. The computer signal, by contrast, was designed specifically for displaying non-moving, detailed images - such as small text and spreadsheets. This is accomplished with a non-interlaced signal, also called "progressive scanning." In progressive scanning, the horizontal lines on a computer screen are "painted" progressively, left to right, top to bottom, in a single pass. Therefore, the flickering problem encountered in interlaced TV video does not exist in computer video.

*One Full "Frame" of Interlaced TV Video*



Odd lines appear from top to bottom, left to right.



Before odd lines fade completely, even lines appear between the odd lines from top to botttom, left to right

**Signal Format**

TV video is defined by either the NTSC, PAL or SECAM standard, which dictates the number of lines in the picture, how the color information is defined and the speed with which the lines are painted on the screen (refresh rate). However, within NTSC, PAL and SECAM, there are actually several signal formats that meet these standards. Composite video is the most commonly used format. In composite video, all the video information – for red, green,

blue (RGB) and sync – are all combined into a single signal. S-Video, which provides a superior picture quality, separates the chromanance (color) from the luminance and sync information. Other variations of NTSC and PAL include RGB at 15 kHz, component video and SDI (digital) video.

Remember, while all of these formats differ in the way the video information is combined into a signal, they still have certain things in common. They are all interlaced, they have either 483 (NTSC) or 576 (PAL and SECAM) visible lines, and they have an established, unvarying refresh rate. For NTSC, two interlaced fields, making up a single "screen," are painted onto the screen 30 times each second (a rate of 30 Hz), and for PAL and SECAM, this occurs 25 times each second (25Hz).

Unlike TV video, there is no single standard by which all computer video signals must abide. As discussed earlier, there is a wide range of commonly used display resolutions. There is an equally wide range of refresh rates, most falling between 60 and 85 Hz. And, while almost all computer displays are non-interlaced, some video display cards do offer an interlaced display option. However, what computer video signals do all have in common is the way in which they describe chromanance and luminance information to the monitor. All VGA, SVGA and Mac video formats transmit the red, green and blue information as separate signals. (There is some variation between computers in the way sync information is combined with the color signals.) By keeping red, green and blue separate from each other, computer monitors are able to display a wide range of colors with minimal distortion.

**Review**

So, in review, any device that converts a TV video signal to a computer signal needs to:

1. Accommodate for the differences in resolution (number of visible lines)

2. When necessary, adjust the refresh rate to that of the display device

3. Convert from an interlaced to non-interlaced format, and

4. Output separate red, green and blue information

## Line Doublers and Quadruplers

How do line doublers and quadruplers perform the conversion from TV video to computer video?

Doublers and quadruplers generate a computer video signal that is "a function of" or "related to" the original TV signal. By performing certain manipulations to the interlaced TV signal, they are able to modify it in such a way that it can be accepted by equipment that receives only non-interlaced, computer video signals. **However, the type of signal you put into the doubler or quadrupler determines the type of signal you can get out of it.**

As discussed in the previous section, there are 483 visible lines in an NTSC signal; 576 in PAL and SECAM. A line doubler takes these numbers of interlaced lines and converts them into a non-interlaced format. However, there are still the same number of total lines; 483 and 576 respectively. Quadruplers differ from line doublers in that they repeat each line twice, converting an NTSC signal into a non-interlaced signal with 966 visible lines, and a PAL/SECAM signal to 1152 visible lines.

The refresh rate of the converted signal generated by line doublers and quadruplers is also a function of the incoming signal format. The NTSC signal has a vertical refresh rate of 30 Hz. In other words, a full "screen" of information is painted 30 times each second. Line doublers and quadruplers simply double this 30 Hz refresh rate, creating an output with a 60 Hz refresh rate. When starting with a PAL or SECAM signal with a vertical refresh rate of 25 Hz, doublers and quadruplers generate a converted signal with a refresh rate of 50 Hz.

## What's In A Name?

Many people mistakenly think that line doublers output twice as many lines as the original video picture, and quadrupler, four times. This is not exactly true. Line doublers double the number of lines in each individual vertical sweep, and quadruplers quadruple it. However, the total number of lines comprising the picture remains the same as the original when using a doubler and is doubled when using a quadupler. (Yes, this is a bit confusing!)

"Doubling" and "quadrupling" may also refer to the change in the horizontal refresh rate of the output video in relation to the original TV video. In other words, each individual horizontal line in the converted output from a line doubler is "painted," left to right, twice as quickly as each individual line in the original TV video. And using a quadrupler, each individual line is generated four times as fast.

## An Important Word About Motion Compensation

Different line doublers, quadruplers and video scalers (yet to be discussed) offer different sets of features. The purpose of this guide is not to review these various features and their respective functions. However, *motion compensation* is one feature that merits discussion within the context of this guide. To help you understand what it is, it is easiest to explain the problem it is designed to address.

As we've already discussed, one of the jobs of line doublers, quadruplers and video scalers is to convert an interlaced signal into a non-interlaced format. One way that these products accomplish this is by storing the first *field* of an incoming interlaced picture and "holding" it for a fraction of a second, while the second *field*, containing the remaining lines of the picture, are taken in.

The odd and even fields are then combined into a single frame that can be output in a non-interlaced format at twice the original frame rate.

Now, imagine that the TV video you are converting to computer video is of a football game. In many of the frames, there would be a football moving across the screen. In the original NTSC TV video, the odd fields of the picture would be generated 1/60th of a second apart from the even frames. The football, if moving quickly, would appear at a slightly different position in the odd and even fields. So, when the fields are combined into a single, non-interlaced frame, the football may appear to have jagged edges, as its location in the even lines is slightly different than in the odd lines. The not-so-technical term for this condition is called "the jaggies." (The technical term is called *temporal distortion*.) There are a variety of techniques applied by line doublers, quadruplers and video scalers to eliminate, or at least reduce, the appearance of "jaggies." The effectiveness, as well as the associated price, of these techniques vary, and not all line doublers, quadruplers and video scalers offer a *motion compensation* feature.

## Limitations of Line Doublers and Quadruplers

The limitations of line doublers and quadruplers are due to the very nature of how they work. Because the format of the input affects key aspects of the converted output, namely the number of lines and the vertical refresh rate, line doublers and quadruplers are limited in the types of output they can provide.

As mentioned earlier, when starting with an NTSC signal, line doublers always produce a signal with 483 non-interlaced visible lines; quadruplers generate a picture with 966. When using a PAL or SECAM signal, line doublers create a picture with 576 non-interlaced visible lines; quadruplers create 1152.

If you are familiar with standard computer resolutions, you know that there are not any standard computer resolutions that have these number of lines. Therefore, incompatibilities arise when trying to input a picture with a different number of lines than the projector or display is designed to accept.

One of several things happens:

1. The picture gets cropped

2. The picture gets stretched and/or distorted

3. The projector or display performs additional processing on the incoming image to make it compatible with its display format

This additional processing almost always further degrades the quality of the picture. Another limitation is the set vertical refresh rate generated by doublers and quadruplers.

The converted output from a doubler or quadrupler always has either a 60 Hz or 50 Hz vertical refresh rate, depending on whether the original signal was in NTSC or PAL/SECAM. Most display devices in the US are capable of taking in a picture with a 60 Hz refresh rate, and in countries using a PAL or SECAM standard, equipment is designed to take in signals at 50Hz. However, many projectors have the ability to take in and display higher refresh rates, therefore offering a better picture. When using a line doubler or quadrupler, you are limited to using the lower 60 or 50 Hz rate.

Finally, many line doublers and quadruplers can only generate a picture with a 4:3 aspect ratio. This does not allow for the ability to display letterbox formatted video on new widescreen plasma display panels or CRT monitors. And in the future, as we see more and more devices, such as LCD panels, offering widescreen displays, line doublers and quadruplers will not provide a means to tap into this capability.

Having reviewed the technology of line doubling and quadrupling, along with the associated limitations, we will now explore a new alternative to these techniques: intelligent video scaling.

**Intelligent Video Scaling**

Intelligent video scaling is a new way to think about converting TV video to computer video format. Rather than generating an output that is dependent on the input format, a video scaler is able to produce a converted image in a wide range of resolutions and refresh rates, completely independent of the original, incoming TV video format.

How does it do this? Like line doublers and quadruplers, a video scaler combines the information in the odd and even fields of an incoming video signal into a combined, non-interlaced picture. Then, taking advantage of the latest electronics technology, the video scaler uses sophisticated, processing algorithms to manipulate the image, changing its resolution, refresh rate, and even aspect ratio, to exactly match the desired output specifications. Rather than generating "odd-ball"resolutions of 483 or 966 lines, video scalers provide converted output in standard resolutions like 640 x 480, 800 x 600, and as high as 1280 x 1024, all at a variety of refresh rates.

**Advantages of Video Scaling**

The advantages of video scaling are obvious. Video scaling eliminates the many limitations imposed by line doubling and quadrupling technology.

- When using a video scaler, a projector or display device is not forced to crop, distort, or further process the image in order to display it.

- Video scalers can provide outputs at multiple refresh rates. One example of how this might be beneficial is in providing the ability to display converted PAL video on projectors that do not support 50 Hz refresh rates. Another example would be displaying converted video at 75 Hz, eliminating all visible flicker, improving the light output of the display or projector, and easing eye strain

- Video scalers are not limited to a 4:3 aspect ratio. This opens new opportunities for displaying letterbox formatted video in aspect ratios like 16:9 and 2.35:1

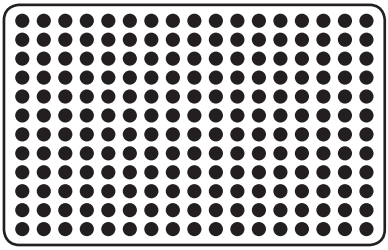
- In addition to these many advantages, there is one more that requires a bit of explanation. Video scalers allow you to generate an output that exactly matches the *native resolution* of your LCD or DLP projector or plasma display – something impossible to do when using a line doubler or quadrupler

LCD and DLP projectors and plasma displays are the types of products most commonly used in conjunction with line doublers, quadruplers and video scalers. And unlike CRT monitors (standard computer monitors), these devices have a set number of pixels that comprise their display. The number of pixels is commonly referred to as the device's "native resolution" or "sweet spot," and although most panels and projectors have the ability to display additional resolutions beyond the "native resolution," using the native resolution always provides the very best picture. For example, imagine using a projector that has a native resolution of 800 x 600 but can also display

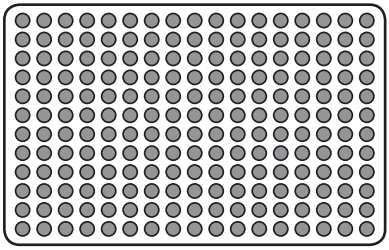
resolutions of 640 x 480. It is easy to conceptualize why a projected image that actually contains 800 x 600 pixels of distinct information would look better than an image with 640 x 480 pixels of information, spread out to take up the space of the actual 800 x 600 pixels in the display. (See illustration on page 10.)

Because video scalers can generate an output that exactly matches the native resolution of most LCD and DLP projectors and plasma displays, these devices are able to perform to their maximum potential, displaying the clearest, crispest picture possible.

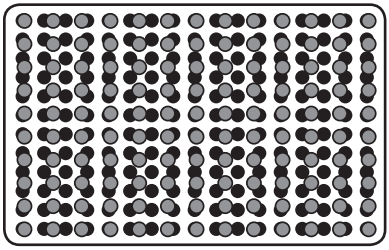
*Displaying the Native Resolution Provides the Sharpest Image:*



800 x 600 LCD Panel



800 x 600 image displayed
on an 800 x 600 LCD Panel



640 x 480 image displayed
on an 800 x 600 LCD Panel

**One Other Very Important Advantage**

Would you believe it's the price?! Video scaling need not be an expensive process. Because of recent technological break-throughs in the world of electronics, new video scalers are able to perform TV-to-computer video conversion for an extremely competitive price. Of course the combination of additional features, such as motion compensation, video processing controls, positioning controls, input formats and types of connectors, all affect the cost of video scalers as well as traditional doublers and quadruplers.

But if comparing the basic functionality of a video scaler to a line doubler or quadrupler, there simply is no comparison. Video scalers can be used for all the same applications as line doublers and quadruplers, and do a better job, all for the price of a simple line doubler and one-fifth the price of some quadruplers.

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## About Communications Specialties, Inc.

Communications Specialties, Inc. (CSI) is an award-winning, Long Island based company that manufactures and sells a variety of products for the distribution, conversion or transmission of television and computer video signals, including fiber optic transmission systems, scan converters and video scalers.

The company was founded in 1983 by veterans of the broadcast industry. Since then, CSI has managed to consistently design innovative products that are used worldwide by Fortune 500 Companies and Government Agencies in a variety of markets such as Broadcast, Professional A/V, Videoconferencing, Education, Home Theater, Security, ITS, Industrial Monitoring, Digital Signage, Government/Military and more!

The **Pure Digital Fiberlink®** line offers an extensive and affordable family of fiber optic transmission systems for the Professional A/V marketplace and includes several ground-breaking products for the transmission of high-resolution RGB signals. Systems for point-to-point and point-to-multipoint signal distribution make these products highly desirable for any Pro A/V applications.

Our premier product line, the **Scan Do®** family of computer to video scan converters, has redefined industry standards in computer video to NTSC/PAL technology with unsurpassed performance in its price range. All models support high resolutions and refresh rates and are VGA and Mac® compatible. The feature-rich and versatile Scan Do family offers the widest range of scan converters on the market.

The award-winning, **Deuce®** video scalers convert NTSC and PAL to high-resolution, non-interlaced video and offer a far superior and affordable alternative to line doubling and quadrupling. The new generation of Deuce products offer a wide range of non-interlaced resolutions and refresh rates for every application, from professional A/V installations to home theater, including a model designed especially for use with HDTV displays.

In addition, CSI manufactures a comprehensive selection of distribution amplifiers, VGA monitor, keyboard and mouse extenders and accessories for our entire product line.

Communications Specialties and its products have been the recipient of numerous industry awards. In 2005, the Pure Digital Fiberlink® 7220 Series for high-resolution RGB and Stereo Audio was honored as one of the AV industry's best technological innovations of the year by receiving a "rAVe Radical Product of the Year" award as "Best New Analog Signal Processing Product". The rAVe email newsletter is published by professional audiovisual industry veterans and is read industry-wide.

Among CSI's many other awards are AV Video Magazine's Platinum Award (given to Scan Do® Ultra and Deuce®) and the Video Systems' Vanguard Award (given to Deuce).

The company is headquartered in the United States on Long Island, New York, with Sales Offices in Florida, Indiana and Virginia. Research, development, design, engineering, manufacturing and customer support operations are performed at the New York headquarters. Other locations include Communications Specialties Pte Ltd (CSPL) - a wholly owned subsidiary office in Singapore that provides support to distributors in the Far East and Pacific Rim.

Our in-house sales department handles complete product-line sales directly to end-users as well as to an international network of representatives and resellers. All of our products are backed by an exceptional warranty.

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