Interactive
Media
Systems

CD-I

TSA APPLICATION NOTES NR. TSA-003 July-23-1992

# Image formats for Compatibility

This application note describes the various CD-I screen considerations in 525, 625 line and wide screen (16:9) television formats. It emphasizes what a producer can do when 625 line production equipment is used. For the USA perspective, a Technical note from the same author is published by PIMA, 11050 St. Monica Blvd, Los Angeles. ( Technical note #48 )

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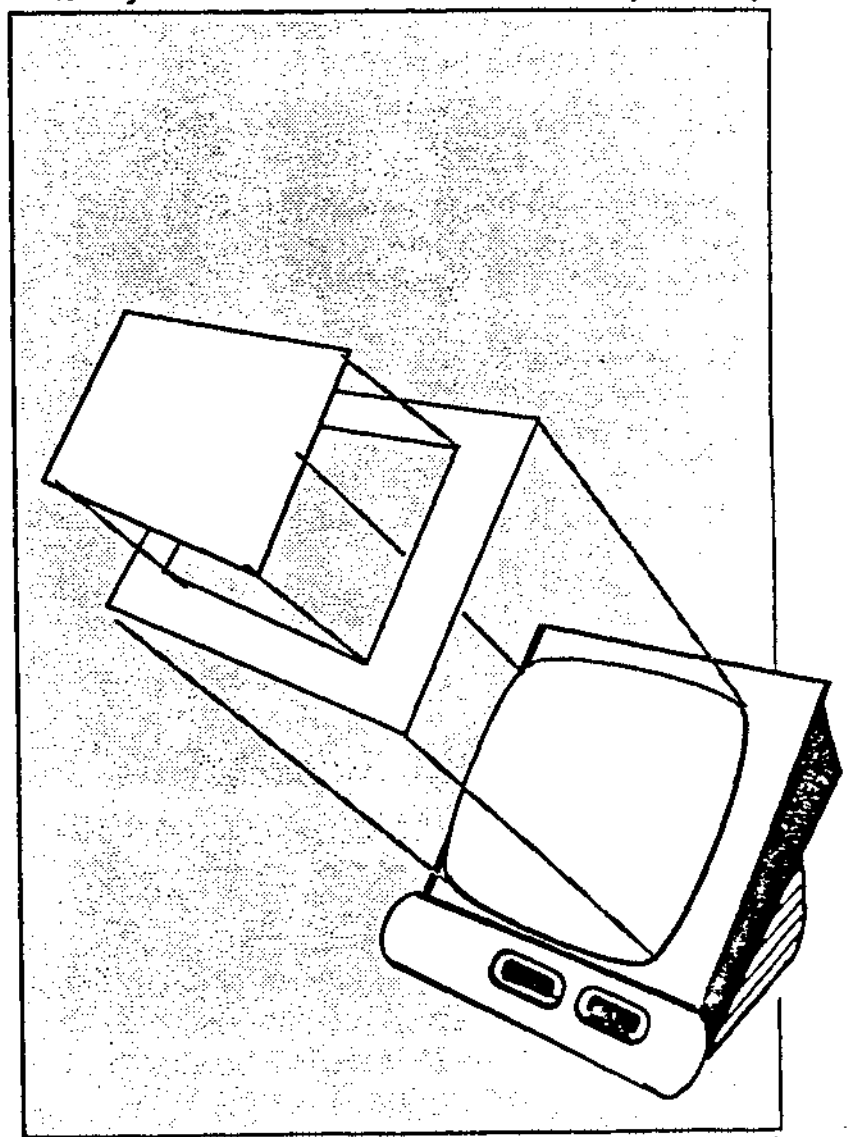



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## 1. Introduction.

CD-I is a worldwide medium. Just like in the case of CD-Digital Audio and compact cassettes, it is specified in such a way, that discs from any manufacturer will play on any player from any other manufacturer, regardless of the country of origin, if they comply with the standard. In this sense it differs from other image carriers, like VCR tapes, Laserdiscs or other multimedia machines, that are TV system dependent or have their own dedicated monitor. However, in order to accomplish this compatibility, the producer of the CD-I disc has to prepare the material appropriately. This note describes what special considerations have to be observed from a video production perspective.

## 2. The Various Television Standards.

Traditionally the world has known two main standards for the timing of television: 525 lines/60 Hz. and 625 lines/50 Hz. Within these main groups there are variations (Like PAL and SECAM), but these are mostly concerned with how images are encoded and modulated for broadcast purposes. These specific encoders and modulators are part of the CD-I player hardware, so that the disc doesn't have to worry about them. Sometimes they are even bypassed altogether, for instance by connecting the player directly to the Television on RGB level by means of a SCART or EURO-Connector. What is an issue for the application software on the disc is the fundamental difference between 525 line/60 Hz. systems (as in use in the USA and Japan), and the 625 line/50 Hz. systems (as used in Europe and some other parts of the world). The CD-I player has a mechanism to notify the application on what type of decoder the disc is being played. This information is stored in the so-called CSD ( Configuration Status Descriptor), that is defined in the Green Book on page VII-9 and appendix A VII-2-13. The knowledge of the type of playback system will allow the application to adapt itself to the specific configuration.

In recent days some new developments have taken place in the Television industry that have an influence on how the CD-I application should behave for optimal results: The 16:9 image formats, as well as the various HDTV formats, which basically have a resolution of four times the conventional TV standards, combined with the wider screen aspect ratio. The extreme case would be a totally new special CD-I format that is optimized for 16:9 or for HDTV. This currently does not exist; It might become subject for further standardization. However, all 16:9 and HDTV sets will have a mode in which they accept conventional standard signals,

and internally process them to best display them on the new format. This is done by storing the incoming images in a resident frame store, and processing them by resampling, filtering and interpolation before actually displaying them. This allows a 16:9 Television set to display the whole picture of a 4:3 image either as a smaller image with black side panels, or -in movie expand mode- display the center part of a 50 Hz. interlaced CD-I PAL image with a 4:3 aspect ratio as a full screen, 16:9, 100 Hz. progressive scan image.

### 3. Pixel aspect ratio.

The images on a CD-I screen consist of an array of pixels. The vertical number of pixels is determined by the number of lines in the Television system used. The horizontal number (384) is defined in the Green Book (Chapter V.2 describes this in detail) and is a compromise between image resolution, memory usage, and the wish to approximate square pixels. A measure for this latter is the so called "aspect ratio" which is defined as Pixel Height/Pixel width. The theoretical figures for CD-I displays on 525 line and 625 line televisions are 1.19 and 1.05 respectively. This means that the same digital bit pattern in the picture memory will be displayed with a different aspect ratio on the two different decoders. The result is that on 625 line systems, where the lines are closer together, the image will be looking somewhat compacted vertically, whereas in 525 the image will be slightly stretched vertically.

There are two ways to cope with this difference: The first one is to use a format that is dedicated to the target standard. This is usually the correct solution when very critical images are involved, e.g. geometric lessons where a circle has to remain a circle, or art discs, where people possibly have a printed copy of the painting that is displayed and might want to compare. This means however that two images are stored on the disc, or when this would exceed the disc capacity, that two different discs will have to be produced for the different target markets. Please note, that even when two different discs are being published for the two different television target systems, they still should adhere to the rule of worldwide playability. In other words, a dedicated 525 line disc will play on a 625 line system, however there will be some 14 % aspect ratio distortion and letter-boxing. So while it is better to use the dedicated format on it's intended television system, compatibility in the sense of worldwide playability still needs to be guaranteed by the producer; if this condition is not respected, the disc is not a valid CD-I disc.

The alternative way to cope with the difference is to go for the compromise: an

image aspect ratio on the disc that is in the middle of the 525 and 625 target aspect ratios. This is called the compatible mode. Please notice that this is a virtual format: there are no "compatible" systems on the market. So it is truly a compromise format. When using an aspect ratio on the disc of 1.1 (= 1.05*1.19), the distortion to each of the target systems is in the order of 6 to 7 %, which is typically not noticeable for non-critical image content. As a matter of fact, many televisions in the field are so mal-adjusted that distortions like this are quite common, even for normal broadcast transmissions. Please note that the figures that are used in this note differ from the description in the Green Book. The reason for that is that the Green Book describes a compromise between the 625 line TV and the 525 line MONITOR standard, which gives better results, because the timings for monitors are much more accurately controlled. The figures in this note pertain to the more practical situation of a compromise between the 625 and 525 TV standards.

The various expand modes that are available on 16:9 and HDTV sets typically try to preserve aspect ratio of the source image, so that no special precautions are required in this respect.

## 4. Safety area.

A concept that is alien to most people coming from the computer field is the so-called safety area. Whereas computer monitors are professional products with closely controlled tolerances and adjustment facilities, television receivers have fixed settings; they have much larger tolerances that also vary with age. Therefore in production of materials for broadcast the concept of various types of safety areas is in common use. They all boil down to the fact that the producer has to constrain critical content ( text, action elements) to a central part of the screen, that is guaranteed to remain visible even under worst case tolerances. In NTSC productions, two such areas are known as "Title Safe" and "Action Safe". Both of these are recommended by the SMPTE, an association of broadcasters. The "Action Safe" area roughly corresponds to the "CD-I safety area", as defined in the Green Book ( the central 320 x 210 pixel array ). You can be reasonably sure that new TV sets display all of "Action Safe", so that when these rules are observed, in the shops and for demonstrations no readability problems will exist. "Title Safe" is a more stringent recommendation that also caters for the existing televisions in the field, even the cheap ones that are 10 years old by now. In pixel coordinates the value that corresponds to 525 "Title Safe" are 316 x 191. In the first AIM or PIMA titles care has been taken that "Title Safe" was observed. This has

indeed led to the situation that there are no complaints from the field in this respect. However, for compatible products, this might pose a very severe artistic constraint, especially in the vertical dimension. So the Green Book requires "Action Safe" or "CD-I Safe" for compatible productions. The risk that one takes by doing that is that American customers with a very poor television set might loose some of the vital information that is in the area between "Title Safe" and "Action Safe", so whenever possible from an esthetics and design point of view it is recommended to respect "Title Safe". In case of adaptive programs, it is possible for an application to consult the CSD and use a larger safety area when it determines that it is playing back on a 625 line system. In that case 320 x 250 pixels is allowed according to the Green Book. However also here is advisable to take a small extra margin to take the older sets in the field into account. Although I am not aware of a formal standard in this respect, 316 x 240 seems like a safe bet.
One complication in this respect is caused by the 16:9 compatibility:
when a 4:3 CD-I image of 384 x 280 pixels gets expanded onto a 16:9 screen, the central 384 x 210 pixels are remapped on the wider screen. Since these sets are very modern and have better tolerance control properties, not much additional margin is required. So 320 x 200 should approximately always be readable. This nicely corresponds to the figures used for 525 line systems. At the moment there is no indication available in the CSD as to the wide screen playback. This will need to be a topic for further standardization. That implies that for now the best strategy, even for 625 systems, is not to make the application automatically adaptive, but simply to respect the 525 line safety area at all times. That will generate images with proper safety areas on all current displays.

## 5. Timing.

One other aspect of the compatibility issue is timing. If a timing is derived from the display rate (e.g. for smooth visual effects), attention has to be paid to the influence on the rest of the application. A separate application note will address these timing issues in more detail. In this context it is sufficient to just mention the difference.

## 6. Production aspects.

Let's look at some practical production aspects that take the issues as described in the previous chapters into account. Specifically, the situation using an ATVista board from Truevision in its nominal PAL mode will be described, but it is fairly

simple to derive a similar reasoning for other platforms or settings. First of all, you have to determine the pixel aspect ratio of the board you intend to use. In the case of the ATVista, the nominal pixel clock is 14.1875 Mhz., when used to grab PAL images. Using the formula on page V-10 of the Green Book, this yields a pixel aspect ratio of 0.96 for the nominal case of 740 pixels by 576 lines. These pixels are too wide for any of the CD-I formats, so you will have to scale from the Vista resolution and aspect ratio down to the CD-I resolution and aspect ratio. The exact calculation on the basis of aspect ratios of target and original system is rather confusing, because it involves the discussion of line timing, overscan tolerances and number of active lines in the display. I will make a couple of simplifying (yet realistic) assumptions, so that the reasoning is easier to follow. Assumption number one is that the overscan tolerances and adjustments on the monitor that is connected to your Vista system is identical to the monitor that is connected to your CD-I player for PAL. Assumption number two is that 240 lines on an NTSC screen cover the same surface as 280 lines on a PAL screen. Under these assumptions it is easy to see that a theoretical "compatible" player would have a resolution of 384 * 260 lines. With some simple math one can determine that a cutout of 726*576 out of the Vista image would be reduced to 384*260 with the proper aspect ratio. Since you want to get 280 lines worth of data instead of 260, you would have to expand this to a Vista area of 726*620. The problem now of course is that you cannot produce 620 lines with Vista but only 576. The solution to this is to scale horizontally and vertically by the same percentage, thus preserving the image aspect ratio. This results in a Vista image of 674*576. So the solution is to grab in Vista, take a part of 674*576 of the total image, scale that down to 384*280, and you will have produced a compatible image.

There are two more complications that you need to be aware of in order to make the right production setup. Number one is that most cameras that are available at reasonable prices have some sort of non-linearity on the edges of their images. Therefore it might be wise to take a smaller part of the Vista screen as the basis for conversion, excluding the edges. Keep in mind that as long as you scale horizontally and vertically in the same proportion, that the resulting aspect ratio remains constant. For example, Philips IMS in Italy found experimentally that their camera gives the best results only in a central area of 730*570 pixels. So they would not use 674*576 as the starting point for "compatible" conversion, but limit the area to 667*570. You will have to figure out what the best starting point will be for your particular setup.
The second additional complication is that the current Philips players do not exactly implement the Green Book recommended timings. All current Hasselt

players ( 601/602/605/205/910 etc.) display 384 pixels in 51.2 usec in PAL (7.5 MHz) and 384 pixels in 50.84 usec in NTSC (7.5524 MHz.). These values give higher aspect ratio deviations from the "compatible" format than the ones used in the Green Book recommendations. (PAL in reality now has wider pixels than recommended; actual aspect ratio is 1.025. Actual NTSC on the player has taller pixels than recommended; actual pixel aspect ratio is 1.225) Luckily however, the "compatible" format for the Green Book recommended timings is also still a very good compromise for the actual player implementation, so it is recommended for application creators to use the compatible format based on the Green Book recommended values. Please keep these differences in mind if you want to experimentally verify the image formats on a Philips player.

## 7. Conclusion.

In a 625 line production environment respecting the safety area rules for 525 line systems automatically creates the right type of display for 16:9 systems. As for aspect ratio distortion, a choice will have to be made for brute force duplication of assets or for a compromise resolution. It depends on the nature of each production which alternative is preferred.

## 8. Acknowledgement.

Special thanks to M. Fumagalli and G. Giudici of the IMS Italy team for their contribution in verifying the figures on aspect ratio conversions, both theoretically as well as experimentally.

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# TSA Note 3: Addendum: Title Safe

TSA Application Note 3 describes the various CD-I screen considerations in 525, 625 line and wide screen (16:9) television formats. After the original publication of this Note additional measurements have been performed on a variety of fairly recent NTSC television sets in the USA. This new information has led PIME to change the status of "NTSC Title Safe" from a "strong recommendation" to a "requirement"

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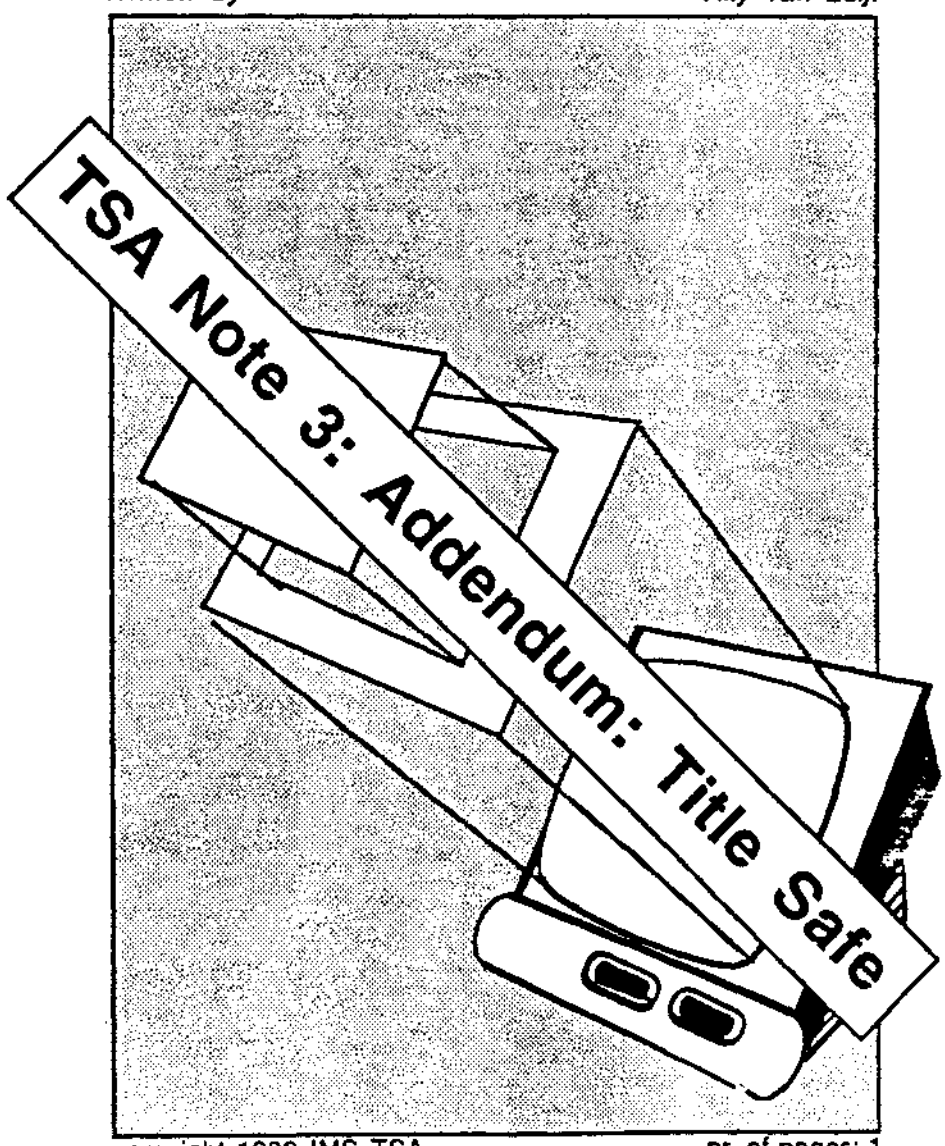


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**addendum to application note 3.**

After the original publication of the application note on producing compatible images from a PAL production environment, additional measurements have been performed on a variety of fairly recent NTSC television sets in the USA. The results of this have led to a further emphasis on the need to respect the "title safe" area on the screen, because with quite a few TV sets the descenders (in characters like "g,y,j,p") of text that extended to the "CD-I safe" area (210 pixels high) were cut off. So in a future revision of this application note, the text will be modified to reflect these new findings. In the meantime, please consider this addendum as a warning that it is wise to respect "NTSC title safe" ( 316 x 191) under all circumstances.

This new information has led PIME, the European Philips publishing organisation, to change the status of "NTSC title safe" from a "strong recommendation" to a "requirement" for any title that is published by them. PIMA, the American publisher, has always had this more stringent rule. Exceptions for individual cases that have been developed under the old European guidelines can be applied for, and will be decided on an individual basis.

***For all new productions, the requirements are strict!***