

# **An NTSC Reader**

**1998/4/2 SEGA ENTERPRISES, LTD.**

# The History of NTSC

Until 1953, Japan broadcast only radio, but in that year it began broadcasting black and white images. (The United States began NTSC broadcasts in 1954)

In 1960, Japan started broadcasting color television in time for the Tokyo Olympic games.

The NTSC format is a standard which was originally designed for display on black and white televisions. It was later modified so that color broadcasts would not look strange when received on black and white televisions.

NTSC is an abbreviation of the National Television System Committee. It is a standard, like MPEG or JPEG, which was developed in order to

“ standardize worldwide color broadcasts ! ”

NTSC was also jokingly referred to as meaning, “Never Twice Same Color”...

However, very few countries decided to adopt this standard. This is because the PAL and SECAM formats developed later were far superior to NTSC.

Japan chose the NTSC format shortly after it was announced, because it was preparing for the Tokyo Olympic games.

# NTSC' Shortcomings in Comparison to PAL

- (1) Color shifting occurs due to reception interference when the broadcast signal is transmitted.

It is said that this is the reason why Europe rejected NTSC.

- (2) It was obvious that the color information was mixed into the black and white signal.

Color information is mixed into NTSC's 290 lines of resolution and PAL's 360 lines.

Under the NTSC format, this mixing of color information was a concern on black and white televisions, which had a lower resolution.

Note) The names NTSC and PAL refer to ways of adding color not to the respective field frequencies of 60 Hz or 50 Hz. As a matter of fact, 60 Hz PAL also exists.

# With Advances in Technology...

NTSC was supposed to have **poor image quality**, but it was a very **simple** broadcast format. Thus, TV manufacturers worked hard to improve TV performance so that NTSC would look better. (three dimensional YC separator circuits, comb-shaped filters, etc...)

As a result, **the display quality greatly differed** according to the TV model and manufacturer even when receiving the same NTSC format.

Conversely, the elaborately designed PAL and SECAM standards were difficult to improve using better TV technology like the simpler NTSC standard.

(The SECAM standard requires especially complex hardware so there are no game consoles which support the SECAM format. )

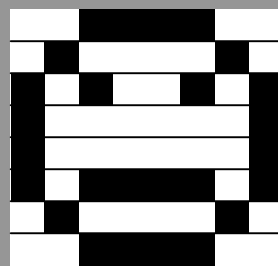
# Causes of Poor Image Quality

# Deterioration of Image Quality Due to the NTSC Video Signal (1)

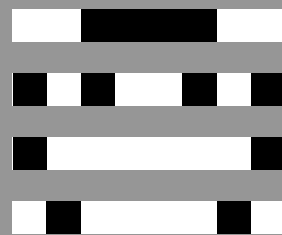
## Flicker

Interlace scanning divides an image into ODD and EVEN line and displays them every 1/60 of a second. By using the afterimage effect of the human eye, it appears as if 480 lines are being displayed, but this causes flashes of light and darkness when the brightness of the ODD and EVEN lines greatly differ. This effect is called "flicker".

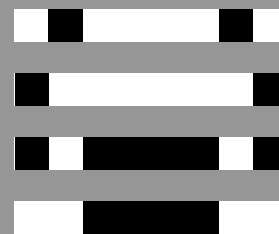
The image is displayed in this manner in a comb-like pattern every 1/60th of a second.  
(This is similar to the flashing effect used in games)



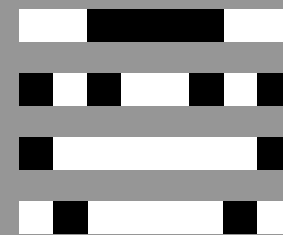
Original image



ODD

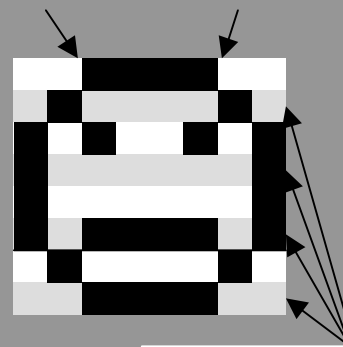


EVEN

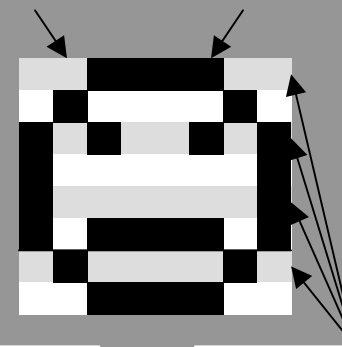


ODD

Actual screen image



EVEN afterimage

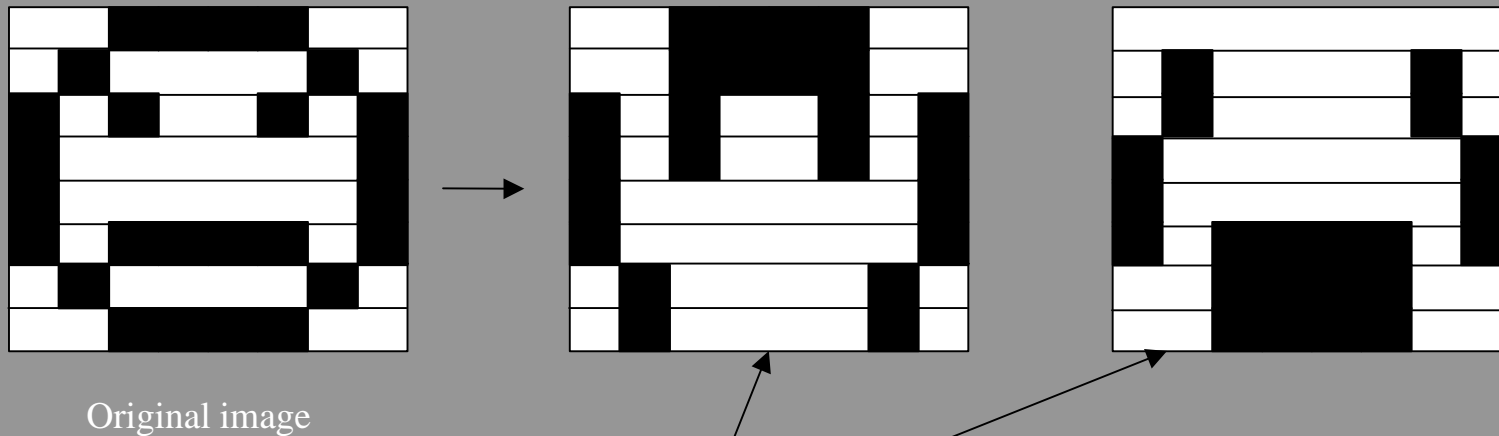


ODD afterimage

## Deterioration of Image Quality Due to the NTSC Video Signal (2)

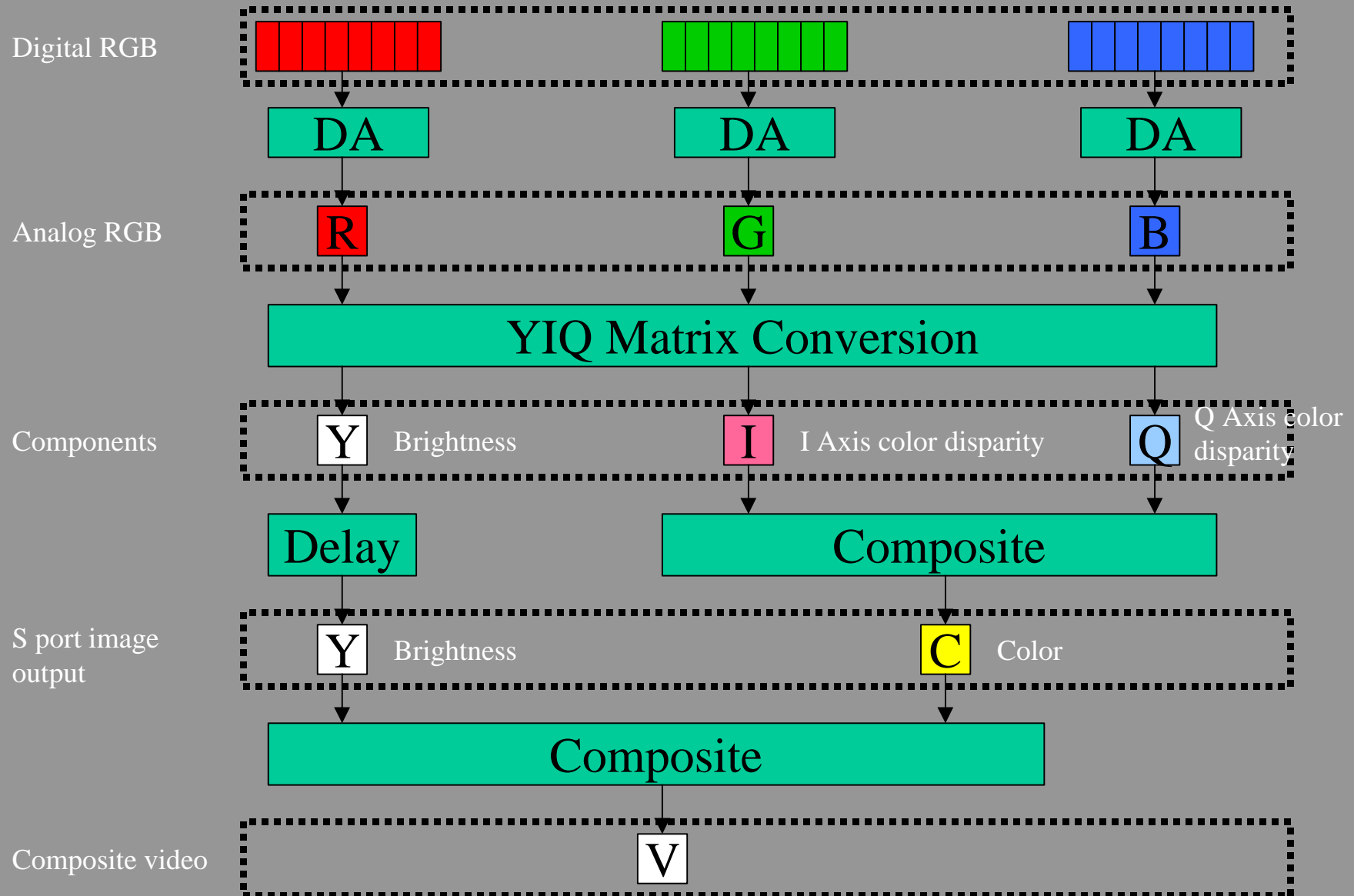
### Resolution Decrease Phenomenon

With interlace scanning, when a 640 X 480 image is scrolled vertically by 1 dot in 1/60th of a second, only a 640 X 240 area is displayed.



When moved vertically by 1 dot in 1/60th of a second, one or the other is displayed according to the timing.

# Image Signal Disparity (Deterioration when moving down)

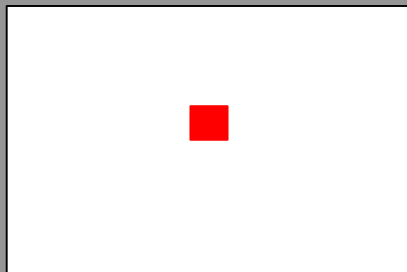




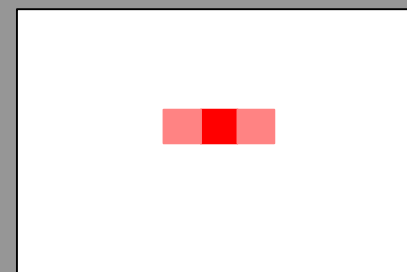
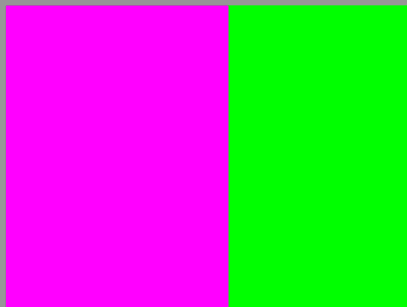
# Deterioration of Image Quality Due to the NTSC Video Signal (3)

## Color spreading

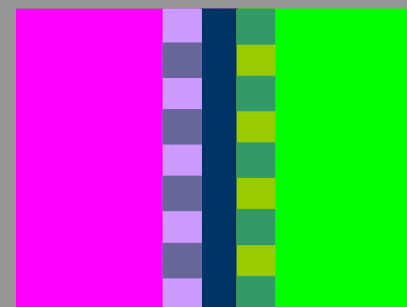
Because the color signal is mixed in with the black and white brightness signal, the color response becomes dim. Thus, when a red dot is drawn, the brightness component is only one dot, but the color can spread 1.5 dots or more to the right and left. In addition, unnecessary colors appear when the complementary colors are converted, because the change process occurs slowly. (status of the range between green and red violet on the color bar, can be dragged for 3 dots or more)



Original  
RGB image



After NTSC  
conversion

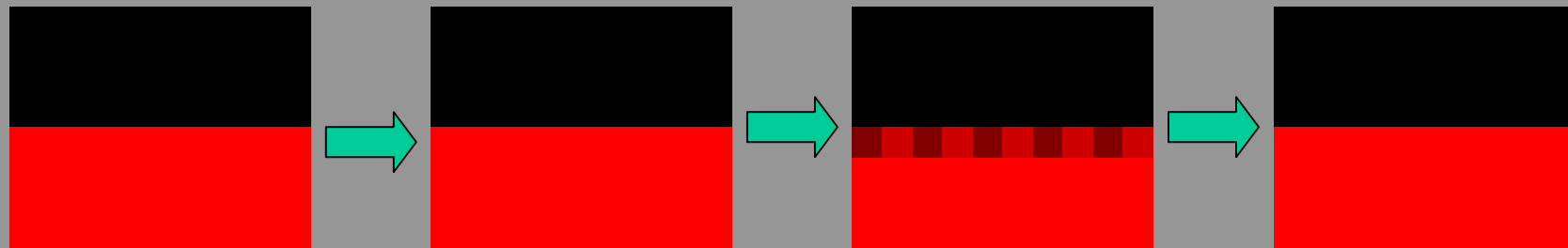


# Deterioration of Image Quality Due to the NTSC Video Signal (4)

## Dot Interference (Dot crawl)

Because the color signal is mixed into the black and white brightness signal, sometimes the TV receiving the signal cannot distinguish whether it is brightness or color. If it interprets color as brightness, dot noise will occur when the color changes in the vertical direction. (can be avoided by using a TV with a three dimensional Y/C separator circuit)

### Still image



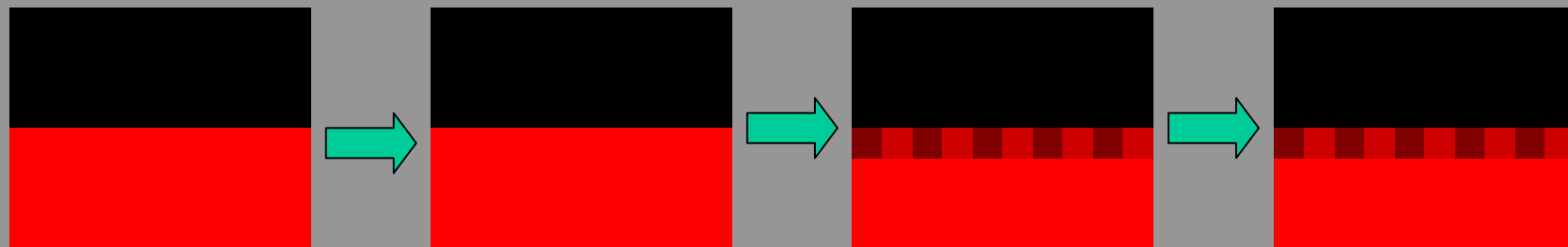
Original image

1 dimensional  
Y/C separator

2 dimensional  
Y/C separator

3 dimensional  
Y/C separator

### Moving image



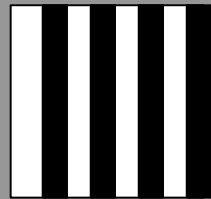
# Deterioration of Image Quality Due to the NTSC Video Signal (5)

## Cross color 1

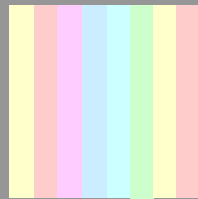
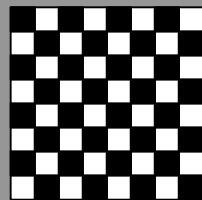
When the brightness is incorrectly interpreted as brightness, a rainbow colored flash occurs. If a one dot wide black and white mesh (horizontal resolution of 320) is displayed, it will appear as if the entire mesh is rainbow colored. In addition, since the signal is not interpreted as brightness, the mesh image will be collapsed and difficult to distinguish.

This problem also applies to characters. When a 1 dot wide character is written on the screen, the rainbow color will appear on the edges and the character will look dim. This phenomenon happens often when the frequency of the image pixel and the color signal (3.58 MHz) are close to each other. This occurs often in 320 X 240, 320 X 480 mode and does not happen very much at 640 X 240 and 640 X 480. However, recognizing the horizontal resolution at 640 is difficult.

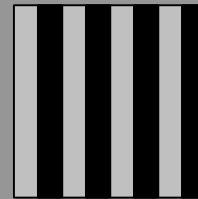
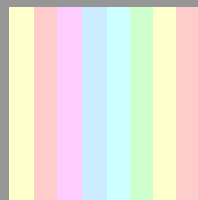
### Still image



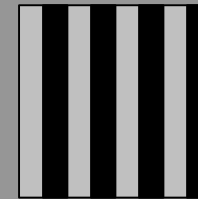
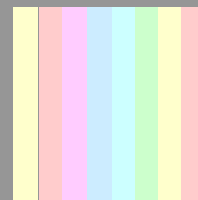
Original image



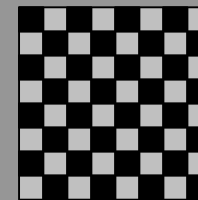
1 dimensional  
Y/C separator



2 dimensional  
Y/C separator



3 dimensional  
Y/C separator



Flashing

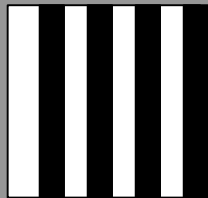
# Deterioration of Image Quality Due to the NTSC Video Signal (6)

## Cross color 2

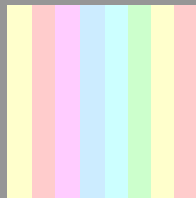
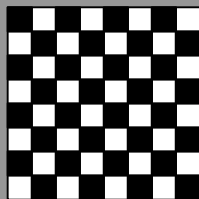
In order to mix the color information into the brightness, it is also compressed in the time axis direction. Thus, when something moves cross color can occur. This happens especially when something moves by 1 dot in 1/60th of a second.

(When horizontal movement of 1 dot occurs in 1/60th of a second, cross color flicker does not occur.)

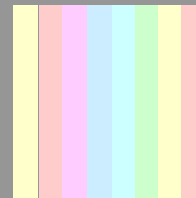
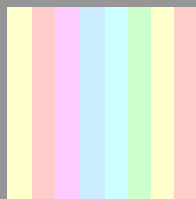
### Moving image



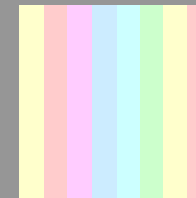
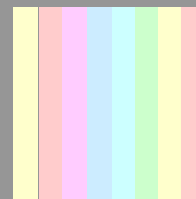
Original image



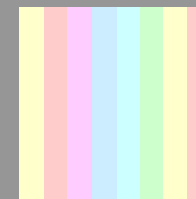
1 dimensional  
Y/C separator



2 dimensional  
Y/C separator

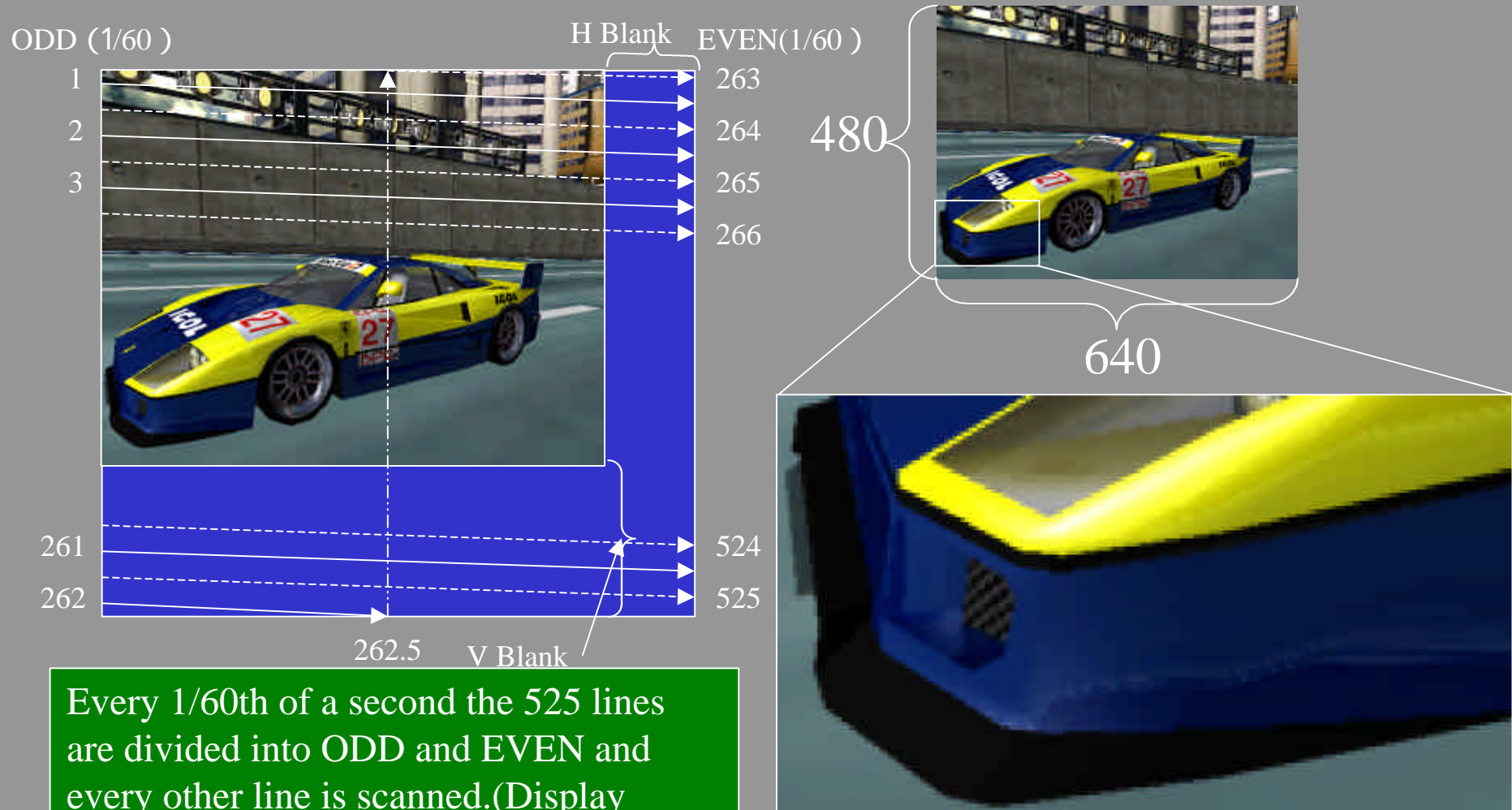


3 dimensional  
Y/C separator



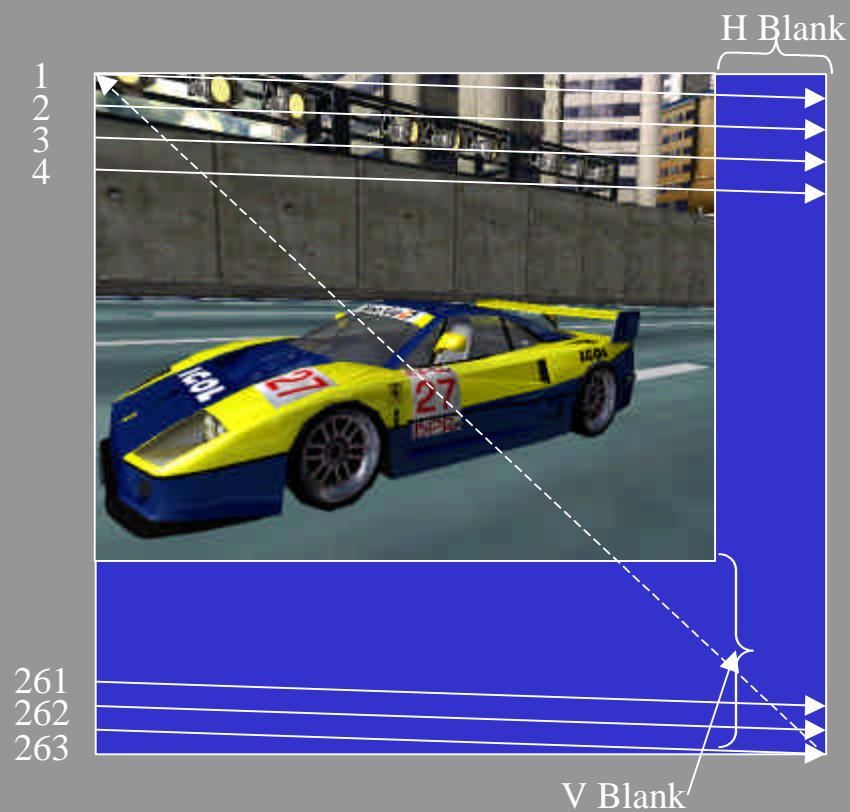
Katana's display

# NTSC Interlacing (Jump over scanning)

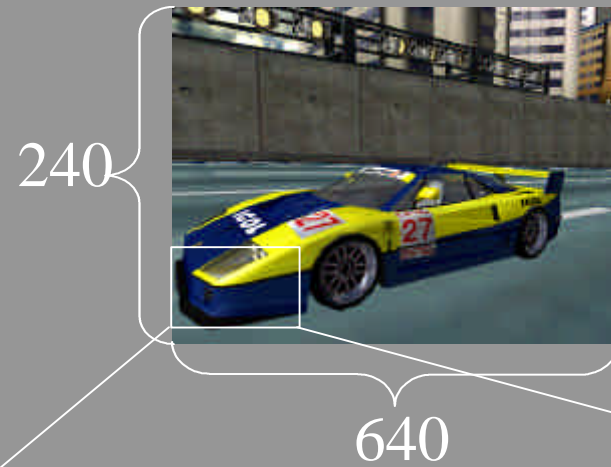


Every 1/60th of a second the 525 lines are divided into ODD and EVEN and every other line is scanned. (Display makes use of the eye's afterimage effect)

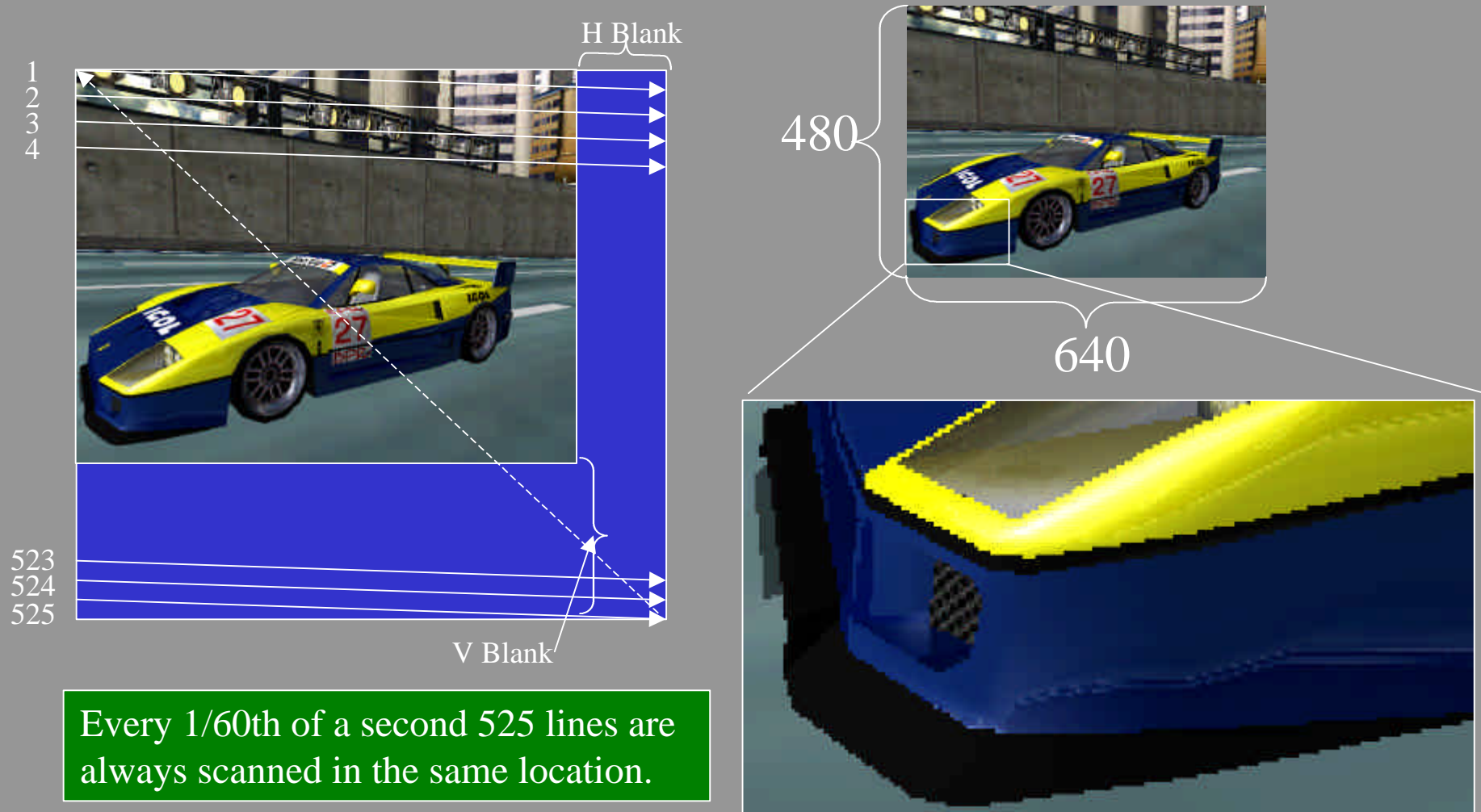
# NTSC Interlacing (Sequential scanning)



Every 1/60th of a second 263 lines are always scanned in the same location.

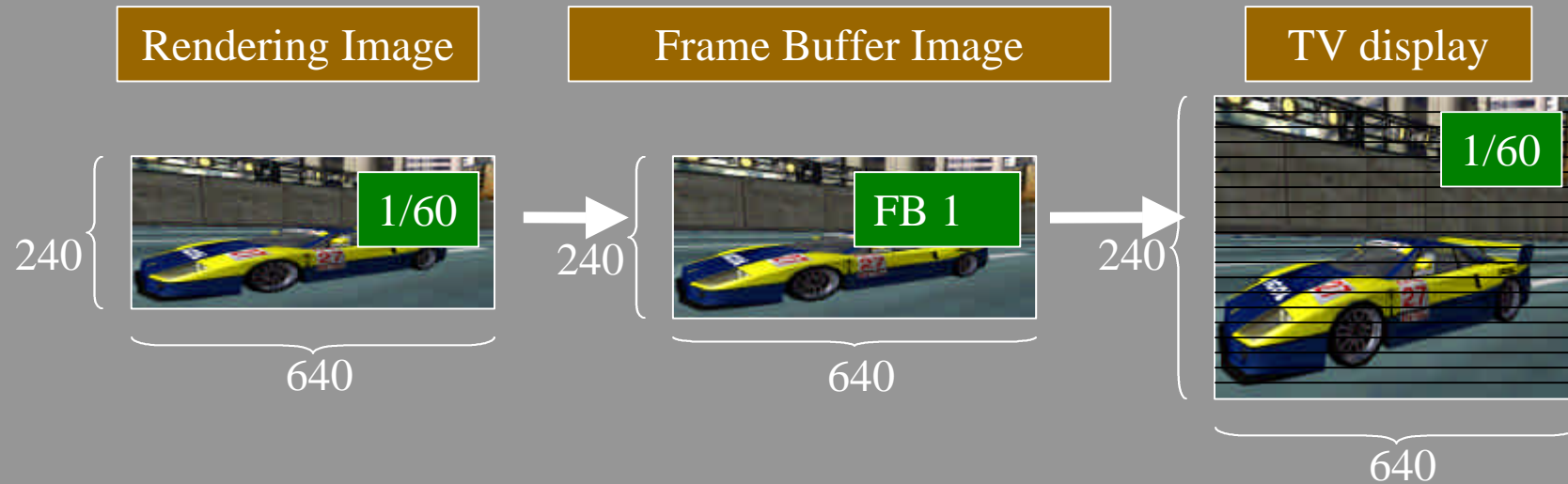


# Standard VGA (Sequential scanning)





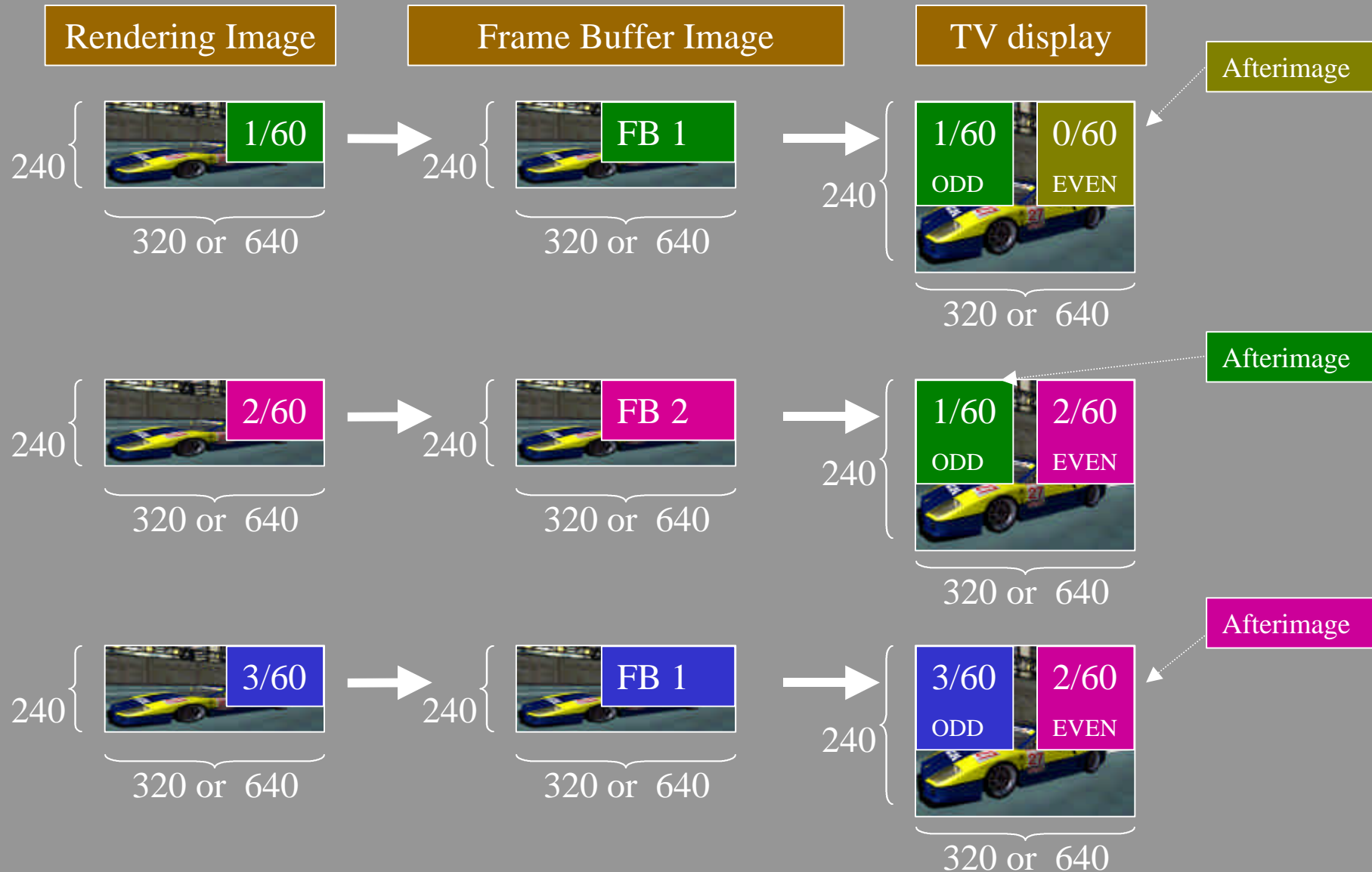
# 640 X 240 Non-interlaced



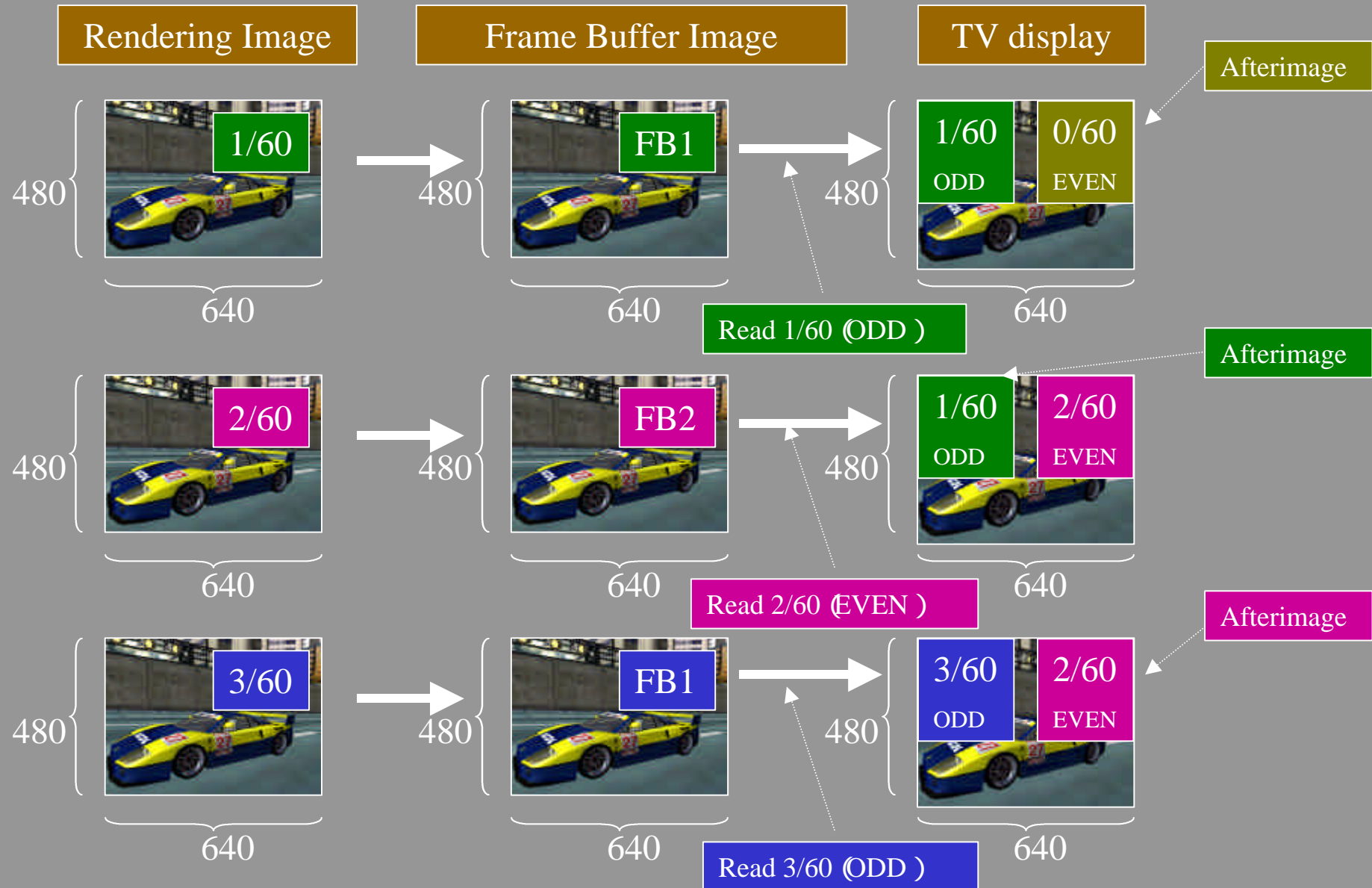
# 640 × 480 VGA



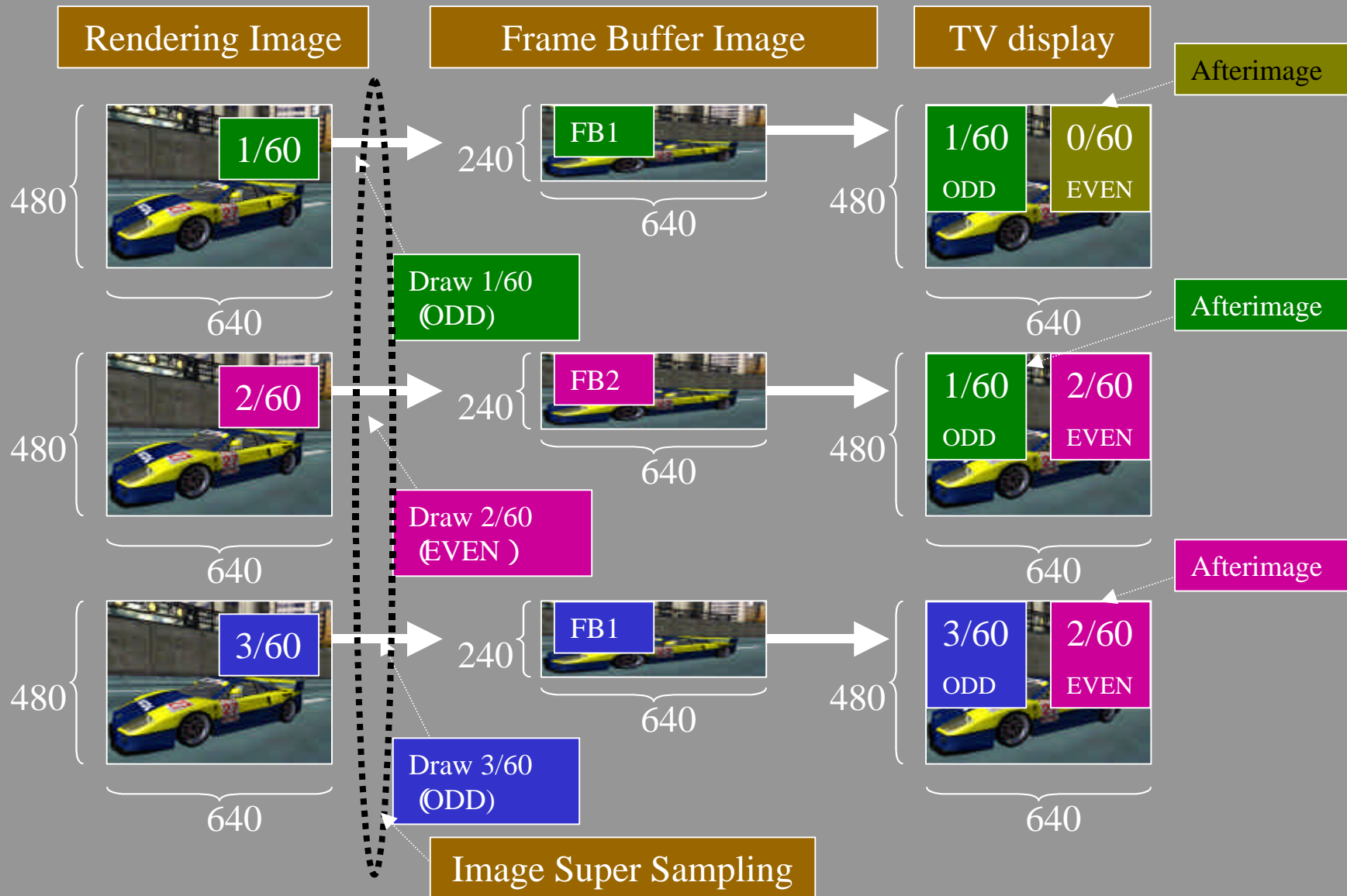
# 640 X 240 Single density interlace



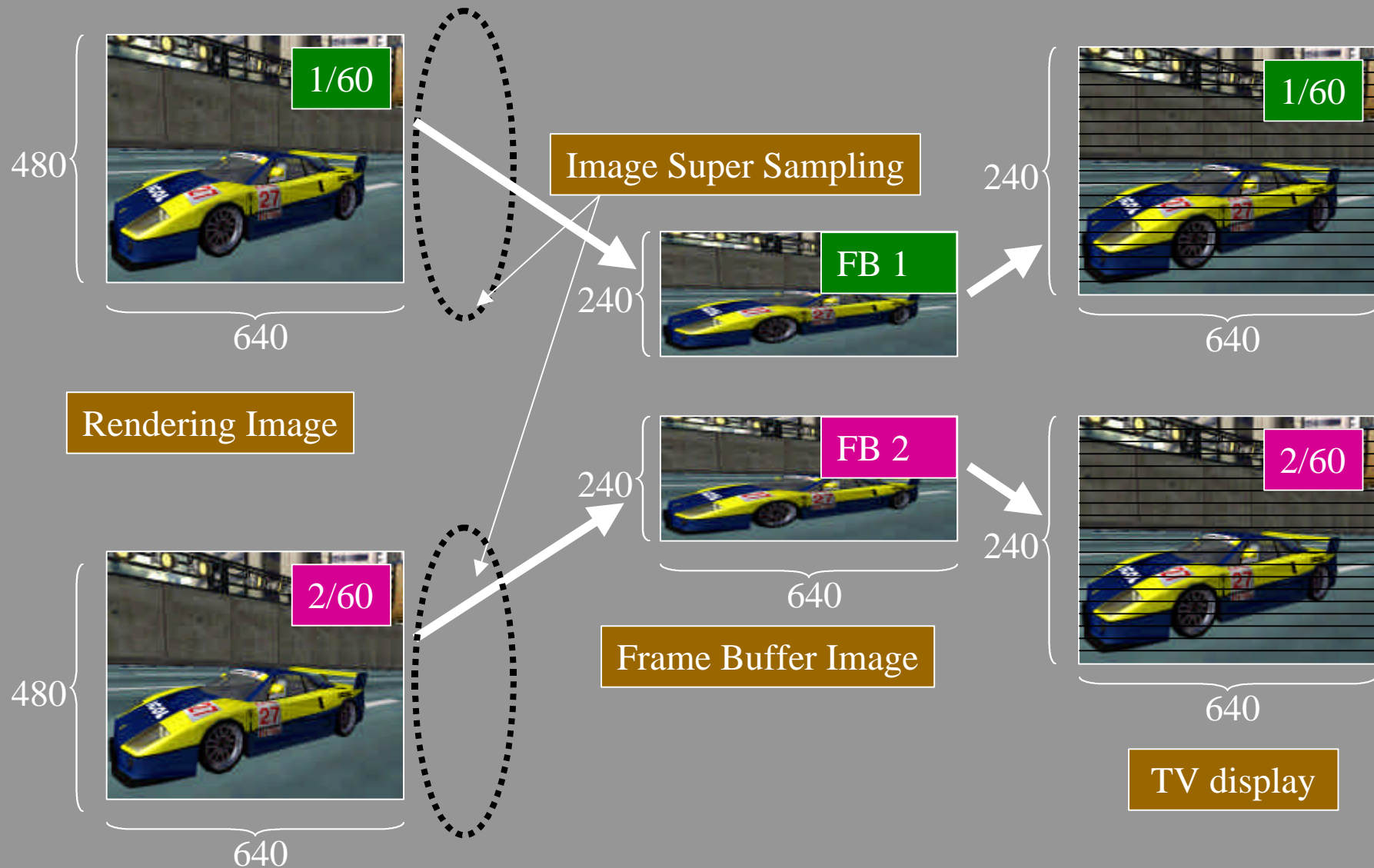
# 640 X 480 Multiple interlace



# Frame Buffer reduction method for (the Frame Buffer change is fixed at 1 int only) 640 X 480 multiple interlacing



An image displayed using non-interlacing at a resolution of 640 X 480 (1/60). (technique uses the Katana functionality)



Addition

# TV Terminology

## Resolution (TV resolution, TV lines)

Resolution is a measure of how detailed an image a TV can display. In the NTSC standard the vertical display density is fixed, so 486 white and black lines are alternately displayed in the vertical direction for a horizontal resolution of 486 lines.

(Of course, the interlace display flickers a lot)

When the same density is used in the vertical direction, it gives a vertical resolution of 486 lines.

(On a 4:3 TV, the frequency multiplied by 80 gives the vertical resolution)

That is, the resolution determines how many vertical lines can be displayed. At one time, resolution also described how many characters could be written on a personal computer display.

(For example 4000 characters, etc)

In this way, the Saturn's 704 dot mode displays black and white 1 dot at a time to give a resolution of 570 lines.

Because the standard varies greatly according to the manufacturer, it is a good idea to check it.

That way it can be visually determined as to how many lines can be seen on the screen.

## Fields

In order to send one image, the signal is thinly sliced from the top and sent to the TV. One image is called a field. Also, one thin slice is called a line. (With interlacing, 2 screens make up a frame and one screen is called a field)

On a game console, the image is shown using ODD and EVEN lines.

# TV Terminology

## Synchronization signal

This is the timing signal which indicates the TV screen's vertical and horizontal starting positions.

Because the TV image is sliced from the top down and sent, this signal is used to put the sliced image back together.

## PAL

An abbreviation for phase-alteration by line, this color TV broadcast format corrects the color so that it does not get corrupted when the signal is scattered. The main adopters of this format are Britain, Spain, Germany, China and Australia.

## SECAM

SECAM is an abbreviation of Sequentiel colors a memoire. While NTSC and PAL mix the color into the brightness using voltage, SECAM mixes it in using the frequency. (Similar to the difference between AM and FM radio broadcasts) The countries which have adopted this standard are France, Russia and other neighboring countries. Despite the complex hardware, there are many areas where the brightness corrupts the color so it is not a very superior format.

## RGB

In the natural world, all colors can be expressed using the three primary colors of red, green and blue. Thus, if you have these three colors you can display color. (R=RED G=GREEN B=BLUE) It is not the case that all colors are reproduced using red, blue and green dyes or pigments. (NHK is also conducting research on 4 color picture tubes) This means that the color changes depending on the characteristics of the pigments used by each picture tube manufacturer. Under current methods, fluorescent colors are especially difficult. (The F1 McLaren red during the era of Sena and Prost)



# TV Terminology

## Y signal (Brightness signal, luminance signal, luminance)

When the synchronization signal is added to the brightness signal (black and white signal) it is called Y + S. The reason it is called the Y signal is because television research was done using X-Y coordinates with time on the X axis and voltage on the Y axis.

When converting from RGB to black and white,

$$Y=0.299R+0.587G+0.114B$$

That is, the black and white signal is 30% red + 60% green + 10% blue.

\*The black and white algorithm differs for each television system. Hi-vision uses  $Y=0.2125R+0.7154G+0.0721B$

## C Signal (Color signal, chrominance signal, chroma)

This is the hue and saturation (color depth) expressed in the amplitude and phase of a sine wave. when the amplitude gets larger the color deepens. Conversely, when it gets smaller it becomes colorless and only gray is output for the brightness component. Because it is compressed to less than 1/3 of the brightness signal, it cannot achieve detailed colors.

## Composite signal (Compound image signal, VBS signal)

This is a black and white signal (Y signal + a synchronous signal) to which a color signal (C signal) has been added and mixed.

The circuit which separates these mixed components is called a one, two or three dimensional Y/C separation circuit. They each have their own strengths and weaknesses. The standard type is the two dimensional (also called the comb shaped filter).

# TV Terminology

## S Port

Because the television can be connected with the Y and C signals separate, it gives a better image than the component signal. Broadcast signals are already mixed so there is no effect, but it is very common in home video cameras, game consoles, etc. However, the C signal is compressed, so the color fragments are not good.