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The Basics of Camera Technology

Training Department
Grass Valley Cameras

grass valley

Preface

With the development of technologies and endeavors to reduce production costs, various advanced functions, originally available only on high-end video cameras, have been introduced to a wider range of professional video cameras, designed to target larger markets with their versatility.
Thus, it has become imperative for those involved in the marketing and sales activities of such video cameras to understand these functions, as well as become familiar with the meanings of the related terminology.
Having considered this background, we have created
"The Basics of Camera Technology" a useful document that provides comprehensive explanations of all the camera terminologies we consider to be significant.
These terms have been carefully selected and placed into four categories:

Optical System,
CCD & Video Basics,
Video Functions,
Operational Functions (Camera-Basestation)

This allows readers to quickly find relevant information according to the terminology in question.
We hope this document will be helpful in your business.

Serveral items from this manual are copied and pasted from Google search results and Wikipedia.

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Jan Paul Campman

The Basics of camera technology

Optical System

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CCD / CMOS & Video Basics

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Video Functions (Scene)

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Operational Functions (Camera Mon. Menu)

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Angle of View

When shooting a landscape with a camera, as in figure A, there is a certain range that will be displayed on a picture monitor. Angle of view indicates the displayable range of the image (plane) measured by the angle from the center of the
lens to the width of the image in the horizontal, vertical, and diagonal directions. These are called, the horizontal angle of view, vertical angle of view, and diagonal angle of view, respectively.

Angle of view becomes narrow when a telephoto lens is used. On the other hand, angle of view becomes wider with a wide-angle (that is why it is called "wide-angle").
Consequently, the wider the angle of view is, the wider the displayable range becomes.
The angle of view depends on image size, so lenses intended for 2/3-inch and 1/2-inch CCD cameras have different focal lengths.

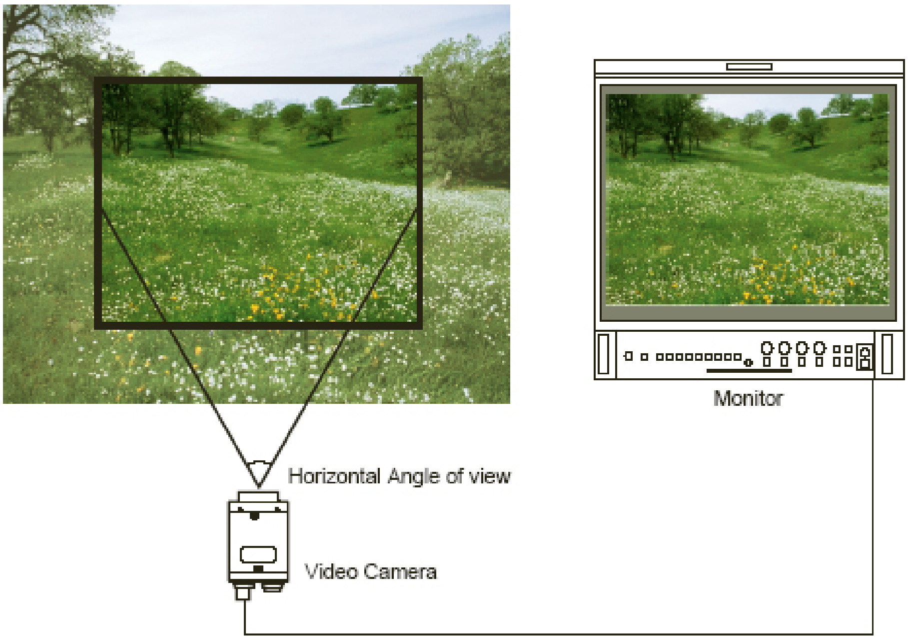


Figure A

Angle of view can be derived from the following equation.

w = 2tan-1 y/2f
w: Angle of view
y: Image size (width of the image in horizontal, vertical, or diagonal direction.)
f: Focal length

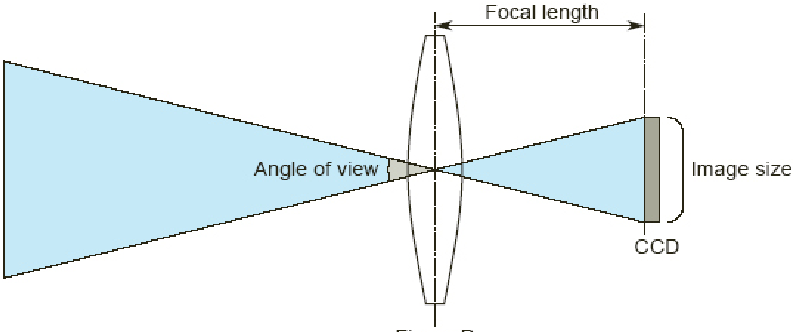
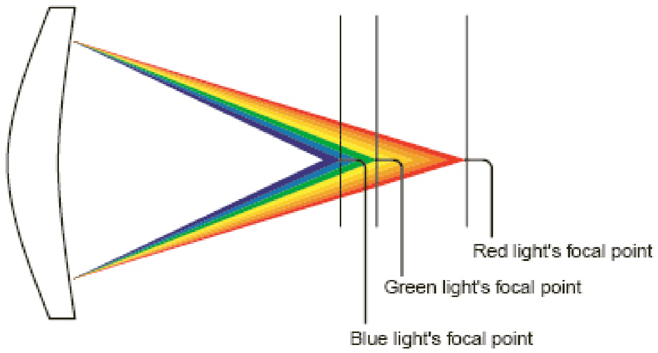


Figure B

Chromatic Aberration

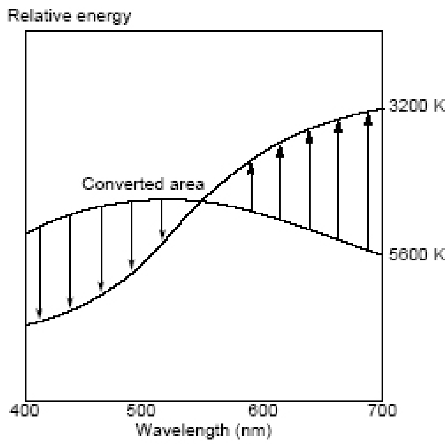
When light passes through glass, the path it follows is 'refracted' or gets bent. The amount of refraction depends on the light's wavelength, which determines its color. This also holds true for lenses used in a video camera lens.
The difference in refraction from color to color directly results in each color light (in a color camera RGB) forming focus on a different image plane. For example, if one color is in focus on the CCD imager, the other colors will be slightly out of focus and look less sharp. This phenomenon is more noticeable in lenses with longer focal lengths, and results in deterioration of the edges of the image.

Recent technology has made it possible to effectively reduce chromatic aberration of a video camera lens. This is achieved by combining a series of converging and diverging lenses with different refraction characteristics to compensate for the aberration. The use of crystalline substances such as fluorite has been practiced to offset the aberration and accordingly the locus of the image reproduced.



All color cameras are designed to operate at a certain color temperature. For example, Grass-Valley professional video cameras are designed to be color balanced at 3200 K (white balance: refer to "White Balance"). This is the color temperature for indoor shooting when using common halogen lamps. However, the camera must also provide the ability to shoot under color temperatures other than 3200 K. For this reason, a number of selectable color conversion filters are placed before the prism (refer to "Prism") system. These filters optically convert the spectrum distribution of the ambient color temperature (illuminant) to that of 3200 K, the camera's operating temperature. For example, when shooting under an illuminant of 5600 K, a 5600 K color conversion filter is used to convert the incoming light's spectrum distribution to that of approximately 3200 K.
Your question now may be, "why do we need color conversion filters if we can correct the change of color temperature electrically (white balance)?". The answer is quite simple.
White balance (refer to "White Balance") electrically adjusts the amplitudes of the red (R) and blue (B) signals to be equally balanced to the green (G) by use of video amplifiers.

We must keep in mind that using electrical amplification will result in degradation of signal-to-noise ratio. Although it may be possible to balance the camera for all color temperatures using the R/G/B amplifier gains, this is not practical from a signal-to-noise ratio point of view, especially when large gain up (refer to "Gain") is required. The color conversion filters reduce the gain adjustments required to achieve correct white balance.



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Color Temperature

The color reproduced by a camera largely depends on the color of the light source (or the illuminant) under which the camera is used. This is sometimes difficult to understand
because the human eye is adaptive to changes in the light source's color and the color of an object will always look the same under any light source: sunlight, halogen lamps, candlelight
etc.

The color of light source is defined by using heated carbon (black body absorbing all radiation without transmission and reflection) as a reference. When heating a piece of carbon,it will start glowing and emitting light when it reaches a certain absolute temperature (expressed in Kelvin or (K)). The spectral distribution of the light emitted from the light source is determined by its corresponding absolute temperature, known as color temperature.

Since, cameras cannot adapt automatically to the color temperature of the light source, it is essential to select the appropriate color conversion filter (refer to “Color Conversion Filters”) for the shooting environment in order to obtain accurate color reproduction. The combination of electronic White Balance (refer to “White Balance”) with appropriate color
conversion filter selection will create more accurate color reproduction.

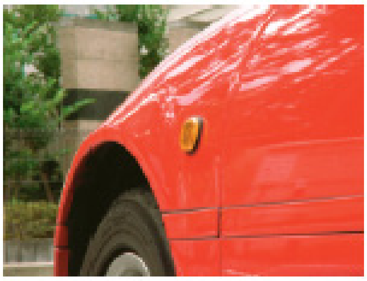
Light Source	Color Temp. (approx.)
Skylight	12000 K - 18000 K
Noon Sunlight	4900 K - 5800 K
Sunrise and Sunset	3000 K
12V Halogen lamp	3200 K
Candlelight	2900 K

Depth of Field

When focusing a lens on an object, there is a certain distance range in front of and behind the object that also comes into focus.
Depth of field indicates the distance between the closest and furthest object that are in focus. When this distance is long, the depth of field is “deep” and when short, the depth of field
is “shallow”. Needless to say, any object outside the depth of field (range) will be out of focus and look blurred.
Depth of field is governed by the three following factors:

1)The larger the iris F-number (refer to “F-number”) (stopping down the amount of incident light), the deeper the depth of field.
2)The shorter the focal length of the lens, the deeper the depth of field.
3)The further the distance between the camera and the subject, the deeper the depth of field.

Thus depth of field can be controlled by changing these factors, allowing the camera operator creative shooting techniques.


Deep depth of field


Shallow depth of field

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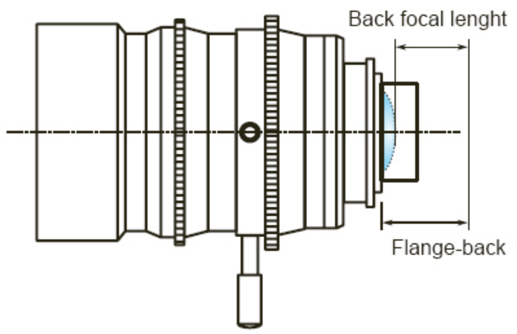
Flange-Back/Back Focal Length

Flange-back is one of the most important matters to consider when choosing a lens. Flange-back describes the distance from the camera's lens-mount reference plane (ring surface or flange) to the image plane (such as CCDs) as shown in the figure below. It is necessary to select a lens with the appropriate flange-back for the given camera. Flange-back is measured differently depending on whether the camera uses glass materials in its light path (like a prism: refer to "Prism") or not. 3-CCD cameras use this system to separate incoming light into their three primary color components, which are then captured by each associated CCD. Single CCD cameras, on the other hand, do not require this system. In a 3-CCD camera, the flange-back additionally includes the distance that the light travels through its prism (the distance the light travels in the glass material, converted to the equivalent distance in air, plus the rest of the distance between the lens mount and CCD surface). In today's camera systems, flange-back is determined by the lens-mount system that the camera uses. 3-CCD cameras use the bayonet mount system, while single CCD cameras use either the C-mount or CS-mount system. The flangeback of the C-mount and CS-mount systems are standardized as 17.526 mm and 12.5 mm respectively.



There are three flange-back standards for the bayonet mount system, 35.74 mm, 38.00 mm, and 48.00mm. Similar to flange-back is back focal length, which describes the distance from the very end of the lens (the end of the cylinder that fits into the camera mount opening) to the image plane. The back focal length of the camera is slightly shorter than its flange-back.

Adjusting the back focus

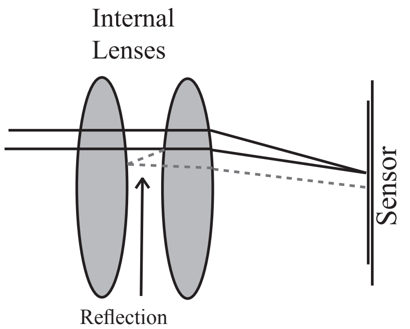
Before starting, put the camera on a tripod and adjust your camera's viewfinder so it is in sharp focus. Ideally, you'd want a test pattern chart (looks like a dart board) to be at least 75 feet/22 meter from the camera. Otherwise, as far as possible. If you don't have a test chart, Use a page from a magazine.

1. Set the iris to manual.
2. Set the zoom to manual.
3. Open the iris to 1.4 or its widest aperature.
   If the illumination on the test chart is too bright for the open iris, reduce the light or move the chart to a darker area.
4. Turn the zoom barrel to extreme telephoto.
5. Focus on the chart.
6. Set the zoom to wide angle.
7. Loosen the back focus ring retaining knob.
8. Adjust the back focus ring for the sharpest focus.
9. Repeat steps 4 through 8 until focus is consis tently sharp.
10. When it is, tighten the back focus ring retaining knob to secure the ring.

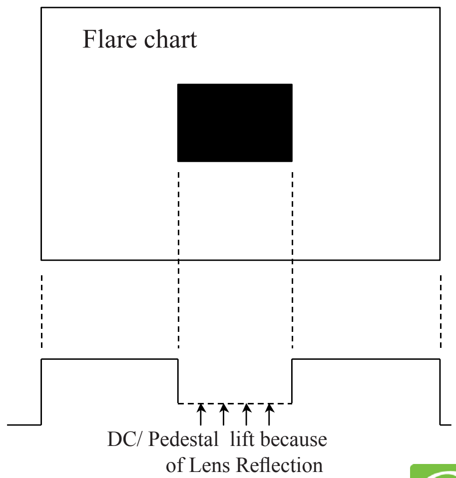
Note: Most lenses are at their sharpest focus at about a middle iris position like F5.6.

Flare

Flare is a phenomenon that is likely to occur when strong light passes through the camera lens. Flare is caused by numerous diffused reflections of the incoming light inside the lens. This results in the black level of each red, green and blue channel being raised, and/or inaccurate color balance between the three channels. On a video monitor, flare causes the picture to appear as a misty image, sometimes with a color shade.



In order to minimize the effects of flare, professional video cameras are provided with a flare adjustment function, which optimizes the pedestal level and corrects the balance between the three channels electronically.
(see also page 38)



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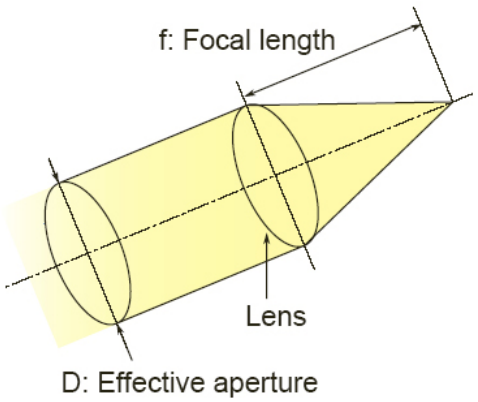
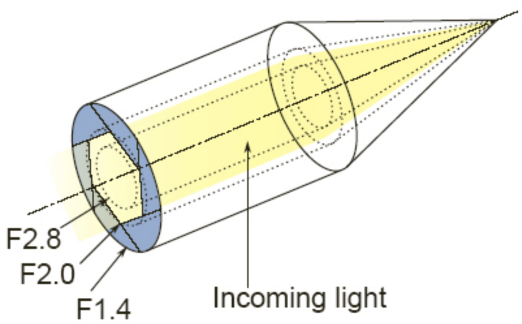
F-number

The maximum aperture of a lens indicates the amount of light that can be gathered by the lens and directed to the camera imager. A larger physical diameter lens will receive light over
a wider area, and therefore is more efficient. The aperture is expressed as an F-number (or F-stop), where the numerical value of the F-number (F) is mathematically calculated by dividing the focal length (refer to “Focal Length”) (f) by the effective aperture of the lens (D), as below: F = f/D
This reciprocal relationship means that the smaller the Fnumber the “faster” the lens, and the higher the sensitivity it will provide on a camera. The maximum aperture F-number is labeled on the front of the lens, and is an important distinguishing factor when comparing lenses. In lenses used with TV cameras, a mechanism is required to reduce the sensitivity of the lens and camera, and this is achieved by a variable diaphragm within the lens (refer to “Iris”). The lens iris ring is also calibrated in F-stops. These calibrations increase by a factor of ✔2 ,so lenses nvhhormally carry calibrations of 1.4, 2,2.8, 4, 5.6, 8, 11, 16, and 22. Since the amount of incoming light is proportional to the cross-sectional area, the brightness of an image is in inverse proportion to the second power of the F-number. Simply put, as the value of the F-number increases by one stop, the brightness will decrease to one half.

It is important to know that the F-number or F-stop is a key factor that affects the depth of field of the scene shot by the camera (refer to “Depth of Field”). The smaller the F-number or F-stop becomes, the shallower the depth of field will become, and vice versa.

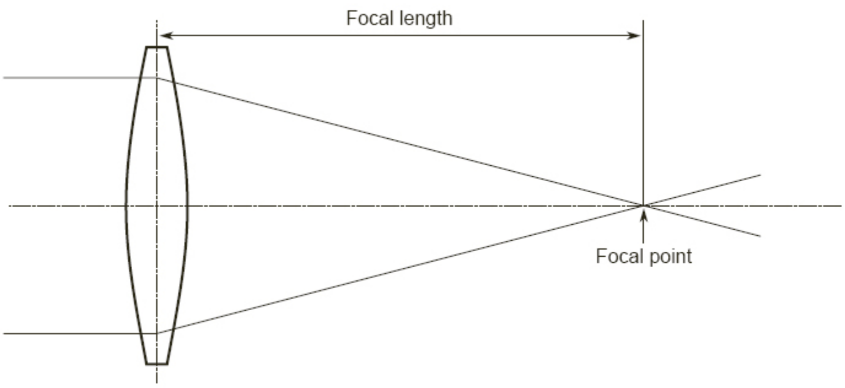




Focal Length

Focal length describes the distance between the lens and the point where the light that passes through it converges on the optical axis. This point is where the lens is in focus and is called the focal point. To capture a focused image on a CCD imager, the focal point must coincide with the CCD imager plane by controlling the focus of the lens.

Video camera lenses usually consist of a series of individual lenses for zooming and aberration-compensation purposes (refer to “Chromatic Aberration”), and thus have a virtual focal point called the principal point.



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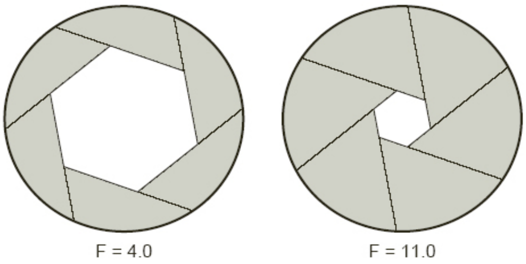
Iris

The amount of light taken into a camera and directed to its imager is adjusted by a combination of diaphragms integrated in the lens. This mechanism is called the lens iris and functions just like the pupil of the human eye.

By opening and closing these diaphragms, the diameter of the opening
(also called aperture) changes, thus controlling the amount of light that passes through it. The amount of the iris opening is expressed by its F-number (refer to “F-number”).



Light and Color

The human eye is sensitive to light. Or in other words, the retina of the human eye reacts to light when we view objects.
Technically, light consists of various electromagnetic waves each with a different wavelength. The human eye is only sensitive to electromagnetic waves whose wavelengths fall between approximately 380 and 760 nanometers. This range of electromagnetic waves is called the visible spectrum,
and indicates the range of light that the human eye can see. To the human eye, each wavelength is viewed as a different light color.
Light emitted from a typical light source (sunlight, fluorescence/halogen lamps) is a combination of a variety of different light colors, although the light source may seem to look white (or transparent).

This can be explained with a prism (refer to “Prism”), in which the light that passes through it is separated into its individual light components - typically, the colors of the rainbow.
Coming back to our main subject, the reason we see each object with a different color is because each object has different light-reflection/absorption characteristics. For example, a piece of white paper reflects almost all light colors and thus looks white. Similarly, a pure blue object only reflects the blue light (spectrum) and absorbs all other light colors. The light colors that each object reflects are governed by the characteristics of the surface of the objects.

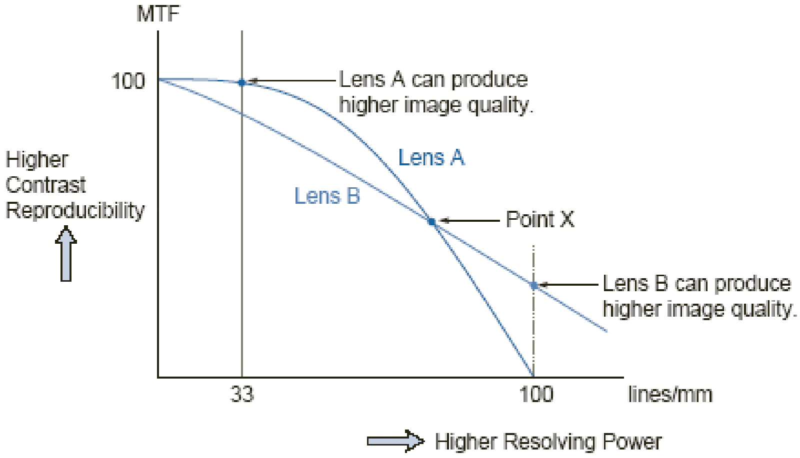
Only a green spectrum is reflected on the leaves.
Other colors are absorbed.

MTF (Modulation Transfer Function)

Modulation Transfer Function (MTF) is an important index that indicates a lens's capability of reproducing the contrast of picture details. MTF is measured as the lens's contrast reproducibility, which is the capability of resolving the fine black and white vertical lines on a resolution chart. Since lenses are typically less sensitive to higher spatial frequencies (narrower black and white lines), the contrast reproducibility attenuates as the frequency increases. The MTF curve indicates this change, shown below as a graph with the spatial frequency on the horizontal axis and contrast reproducibility on the vertical axis. Note that the MTF value changes until it reaches a point where the lines can no longer be resolved. This point indicates the final resolving power of the lens, or the narrowest black and white lines that can be resolved. Needless to say, the higher the value of contrast reproducibility, the more faithfully contrast is reproduced at the given spatial frequency. This means that lenses with higher MTF values at each frequency reproduce contrast better.

When choosing a television lens, it is equally important to inspect the characteristic of the MTF at the low to mid frequencies in addition to the lens's final resolving power. This is because the low to mid frequency areas of a lens usually represent the main frequency areas used in the NTSC or PAL video signal (refer to "NTSC/PAL"). It is essential to have a high response (close to 100%) in this area, otherwise the video picture will not be reproduced with sharp contrast. The figure below shows an example. Lens B is capable of resolving the image at higher spatial frequencies (detailed areas of the image) and may often be misevaluated to having more resolving power than Lens A. However, up to point X, Lens A has the higher resolving power, which can be of more importance in most camera applications.

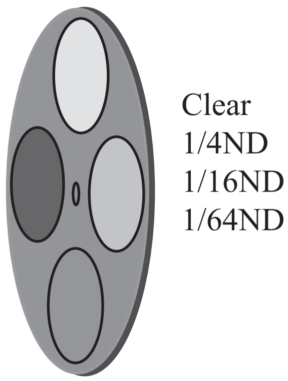
When choosing a lens, both its MTF curve and final resolving power must be considered with care depending on the application.



Neutral Density (ND) Filters

When shooting outdoors, the camera is often subjected to extreme highlights. In some cases, these highlights cannot be handled even with the smallest iris opening of the lens.

For this reason a few types of selectable ND filters are placed before the prism (refer to "Prism") system with the color conversion filters (refer to "Color Conversion Filters"). These ND filters attenuate the magnitude of incoming light to allow brighter images to be handled. The use of ND filters does not affect the color temperature (refer to "Color Temperature") of the incoming light since attenuation is uniform over the entire spectrum. ND filters may also be used to intentionally select a wider iris (refer to "Iris") opening. As the depth of field (refer to "Depth of Field") is in reverse proportion with the iris aperture (opening), the camera operator can intentionally defocus objects in front of and behind the object that is being shot using the appropriate ND filter.



Optical Low Pass Filter

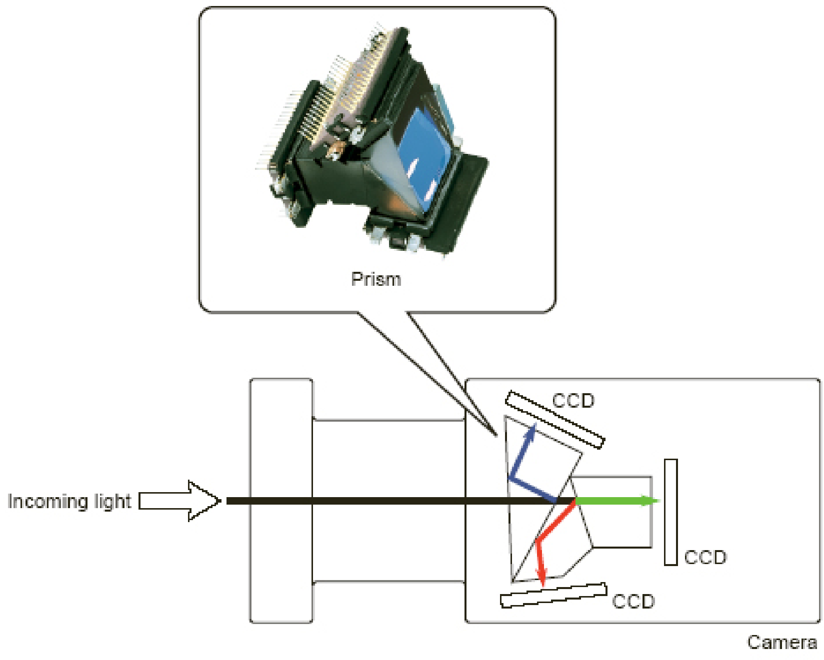
Due to the physical size and alignment of the photo sensors on a CCD imager, when an object with fine detail, such as a fine striped pattern is shot, a rainbow-colored pattern known as Moire may appear across the image. This tends to happen when the frequency of the lens's incoming light exceeds the CCD's spatial-offset frequency (refer to "Spatial Offset Technology") determined by the spacing between each photo sensor. In order to reduce such Moire patterns from appearing, optical low pass filters are used in CCD cameras.

An optical low pass filter is placed in front of the CCD prism block and only allows light with relatively lower frequencies to pass through it. Since this type of filtering may also reduce picture detail, the characteristics of an optical low pass filter are determined with special care - to effectively reduce Moire, but without degrading the camera's maximum resolving power.

Prism

As explained in the section titled Additive Mixing (refer to "Additive Mixing"), 3-CCD video cameras process color video signals by first separating the incoming light into the three primary colors, red, green, and blue. This is done by the camera's prism system, which is an arrangement of three prisms. The prism system utilizes the different reflection characteristics that light has depending on its color or wavelength.

For example, in the figure below, green is not reflected by any of the prisms and thus is directed straight to the green CCD. Red is not reflected at the surface of the second prism, but gets reflected at the third, and through one more reflection within the second prism, it is directed to the red CCD.



Color separation system of a 3-CCD camera

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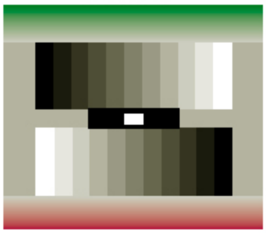
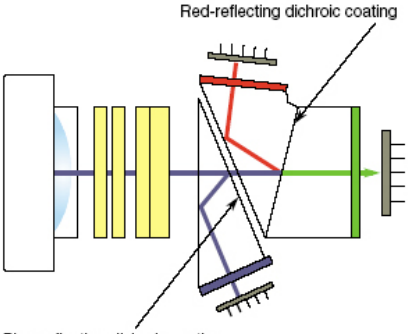
White Shading

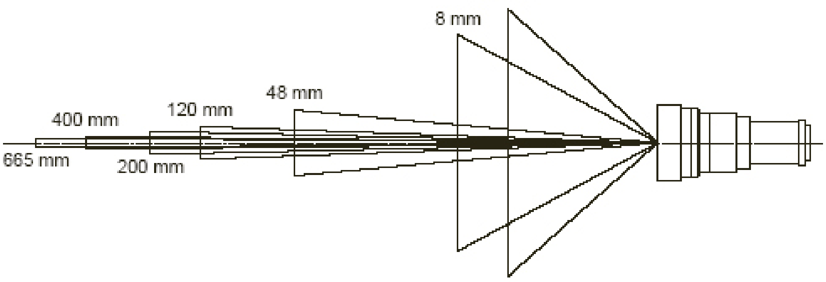
White Shading is a phenomenon in which a green or magenta cast appears on the upper and lower parts of the screen, even when the white balance (refer to “White Balance”) is correctly adjusted in the center of the screen (shown below).
White shading is seen in cameras that adopt a dichroic layer (used to reflect one specific color while passing other colors through) in their color separation system. In this system, the three primary colors (red, green, and blue) are separated using color prisms (refer to “Prism”). The three-color prisms use a combination of total reflection layers and color selective reflection layers to confine a certain color. For example, the blue prism will confine only the blue light, and will direct this to the blue CCD imager. However, the color-filtering characteristics of each prism slightly change depending on the angle that the light enters (angle of incidence) each reflection layer.
This angle of incidence causes different light paths in the multi-layer structure of the dichroic coating layer and results in the change of the spectral characteristics of the prism. This effect is seen as the upper and lower parts of the screen having a green or magenta cast even when the white balance is correctly adjusted in the center.
White shading is more commonly due to the lens having an uneven transmission characteristic and is seen typically as the center of the image being brighter than the edges. This is corrected by applying a parabolic correction waveform to the variable gain amplifiers used for white balancing.
Another cause of White Shading is uneven sensitivity of the photo sensor in the CCD array. In this case, the White Shading phenomenon is not confined in the upper and lower parts of the screen.
Grass Valley high-end professional cameras are equipped with circuitry that manualy performs the proper adjustment to suppress the White Shading phenomenon.





Zoom

Technically, ‘zoom’ refers to changing a lens’s focal length (refer to “Focal Length”). A lens that has the ability to continually alter its focal length is well known as a zoom lens.
Zoom lenses allow the cameraperson to change the angle of view (refer to “Angle of View”). Changing the angle of view in turn changes the area of the image that is directed to the CCD image. For example, by zooming-in to an image (the lens’s telephoto position), less of the image will be directed to the lens and thus that area of the image will appear to be magnified. Zooming-out (wide angle position) means that more of the image is directed to the imager and thus, the image will look smaller.
It also must be noted that the amount of light directed to the imager also changes when changing the zoom position. In the telephoto position, less light is reflected from the subject and directed through the lens, and thus the iris must be adjusted accordingly. Since chromatic aberration (refer to “Chromatic Aberration”)and other light-diffusion characteristics change when the focal length is changed, high-quality zoom lenses use a series of compensation lenses (which account for the higher purchasing cost).
The correlation between the zooming ratio and angle of view can be described as shown in the figure below.



Correlation between zooming and angle of view

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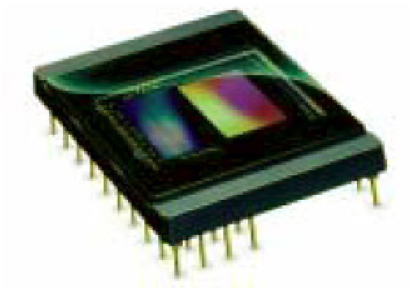
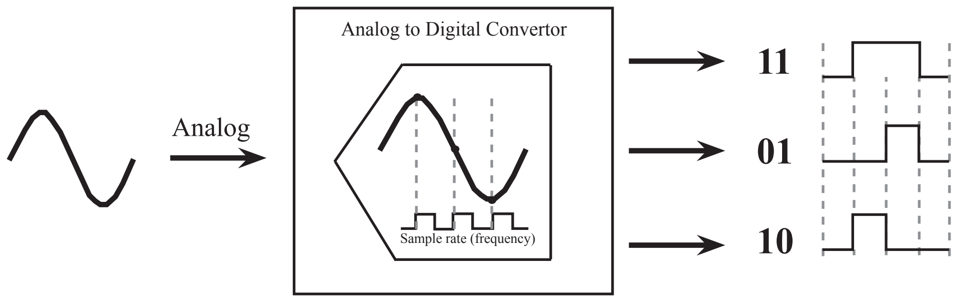
CCD & Video Basics

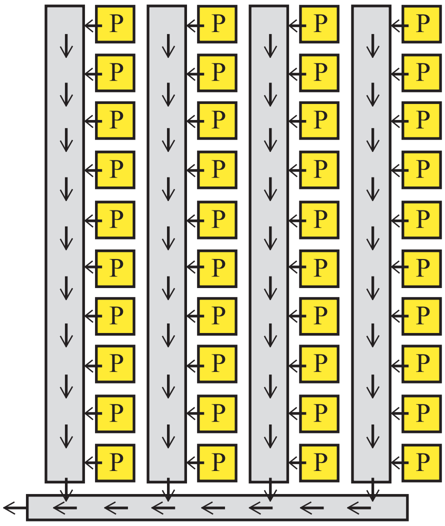




The Sensor IT / FT

IT / Interline Transfer.

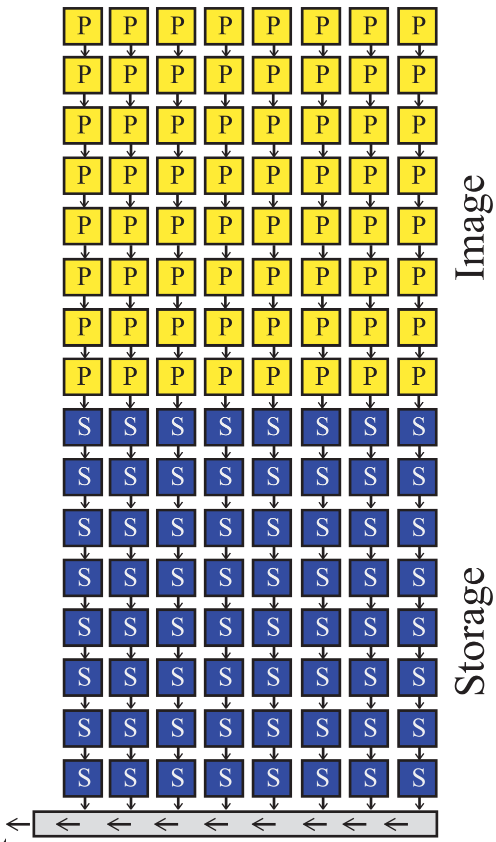
CCDs are categorized into two types, depending on the CCD's structure and the method used to transfer the charge accumulated at each photo site to the output. The IT (Interline-Transfer) CCD takes a structure such that the column of photo-sensing sites and vertical registers are arrayed alternately. The photo-sensing sites (so-called pixels) convert the incoming light into electrical charges over a 1/60-sec period (1/60 secfor NTSC, 1/50 sec for PAL) (refer to "NTSC/PAL"). After this period, the accumulated charges are transferred to the vertical shift registers during the vertical blanking interval. The charges within the same line (the same row in the CCD array) are then shifted down through the vertical shift register in the same sequence and read into the horizontal register, line by line. Once a given line is read into the horizontal register, it is immediately read out (during the same horizontal interval) so the next scanning line can be read into the register. The only significant limitation in the IT imager structure is an artifact called vertical smear (refer to "Vertical Smear"), which appears when the CCD is exposed to an extreme highlight. Smear appears as a vertical line passing through the highlight, often seen when shooting a bright object in the dark. This phenomenon is due to electric charges, accumulated in highly exposed photo sites, leaking into the vertical register before the transfer from the photo sites to the vertical register occurs.



Output to
Pre processor

FT / Frame Transfer.

The expression Frame Transfer indicates that standard TV frames are transfered and delivered. However each transfer contains only 1 field and the next transfer contains the interlaced next field. Together a complete frame will be delivered from the sensor. If we like to store the whole chargepattern from the image area into the storage area then the same amount of pixels and TV lines must be available in the storage area. The construction of the storage area is indentical to that of the image.
That means, that the separation gaps continue into the storage up to the bottom of the storage and stop just before the horizontal shiftregister (=Hor.SRG)
The gate structure is also indentical, although the gate control for the image and storgage area are separate controllled. The physical size for the storage in the vertical derection can be made smaller in order to minimize the total chipsize.
The Storage part is covered with a mask and no effect (light) from outside will enter this part.
During the copying process from Image to Storage the mechanical shutter will cover the image for light from outside.



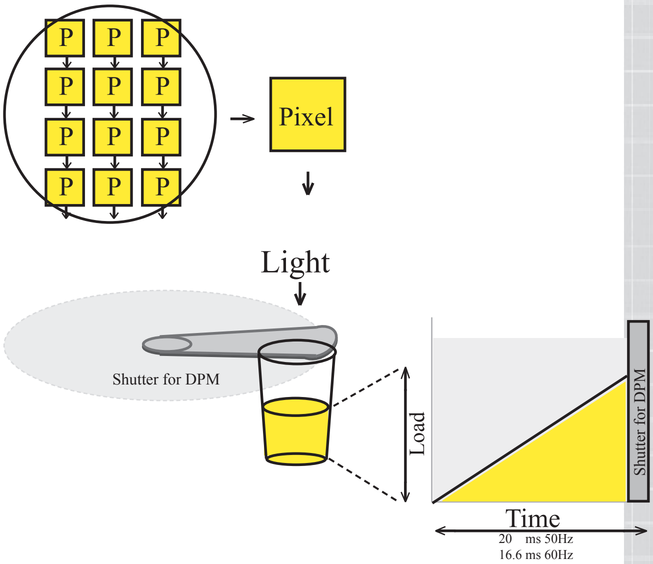
Output to
Pre processor

Pixels and Sub pixels

The Pixel (Frame Transfer)

Light can be explained as fast particles with energy: photons. Photons can enter the Nchannel and bump against a neutral atom. By this energy one or more electrons will come off. Now the atom becomes a **postive ion.**
The electrons are attracted by the positive gate and move upwards and the positive ion is attracted by the negative voltage of the Psubstrate and moves downwards. In the junction area electrons from the Psubstrate will join these positive ions in order to make neutral atoms again. It looks like a glass of water the more light(water) the higher the level will be.

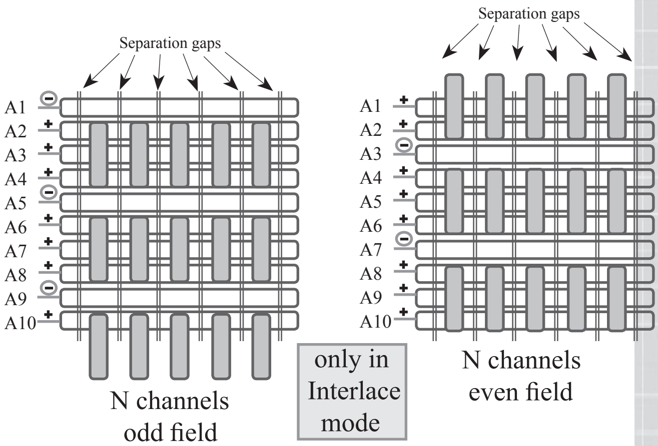
The amount of charge is depending on 3 factors.
1: Linear with the amount of light (LOAD)
2: Linear with the exposure or intergration time.(TIME)
3: Linear with the size of 1 element.
This results in a gamma = 1 for sensors.



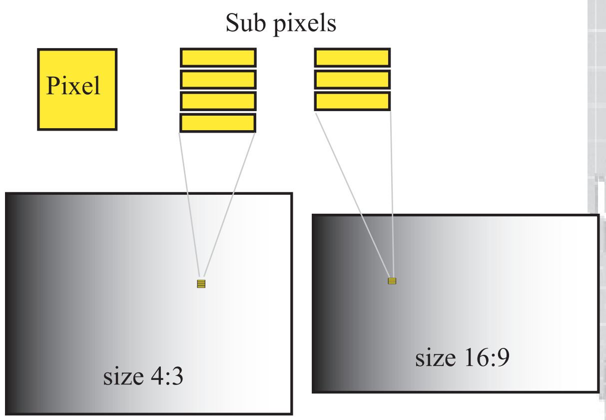
Drawing explanation:
For 1/50 of a second (20ms for Pal) the light can enter the PIXEL.
In FrameTransfer a mechanical shutter is used.
This means that the LOAD time from the sensor is:
PAL 20 ms - shutter = 20 - 2,3 ms is 17,67 ms
NTSC 16.6ms - shutter = 16.6 - 1,8 ms is 14,73 ms

Combining Sub Pixels (DPM).

Vertical SEPERATION GAPS (or Stop Diffusions) prevent mixing the charges in horizontal way the seperations are carried out by negative gates.
All gates cover all vertical N-channel and diffusions, from the complete lefthand up to the most righthand side. Two different modes have to be destinguished for the 4x3 and 16x9 aspect ratios.
In the HDTV FT sensor the mode 1080 and 720 are bassicly created with the same technology.
see next page (Formats)



Static Interlacing in 4x3 or 16x9 format.
4 or 3 (4:3 or 16:9) gates control all charge packets in one horizontal row. One of those gates is made negative (φ A1,5,9) all the others are biased positive. During the intergration of a field these levels are stable. At the end of the fieldtime all gates are controlled in order to transfer the whole chargepattern from IMAGE into the STORAGE. After this transfer the IMAGE is empty and can start intergrating the next field. When interlace format is used this must be opticaly just in between the previous field.
If now (φ A3,7,11) are made negative with all the other gates set positive, the charges are converted out of light that is just in between the line of the previous field, allthough there is some overlap seen from the centers of the charges. So as a matter of fact we don't have "geographical pixel " , but we CREATE pixels by controlling the gatelevels.



Optical
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Video modes.

The design goal for the Frame Transfer imager was to enable imaging in the following scanning formats: 1080P, 1080I, 720P, 480P, 480I constrained by an aspect ratio of 16:9, without prohibiting other aspect ratios, and an image diagonal which is 2/3" for all modes.
The minimum number of pixels per column one needs to make a switchable imager possible is determined by what is known the least common multiple. This is a mathematical approach to find the smallest positive integer that is a multiple of all elements contained within a set of elements. It is the same as taking the maximum of all individual prime numbers in which the elements in a set are decomposed.

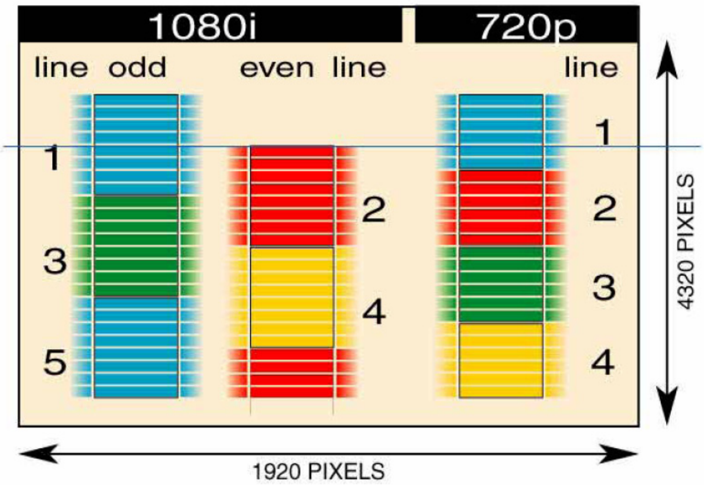
Interlace / Progressive.

In Interlace mode the picture is devided in two parts.
50Hz 625lines / 2 = 312,5 Odd and 312,5 Even lines.
60Hz 525lines / 2 = 262,5 Odd and 262,5 Even lines.

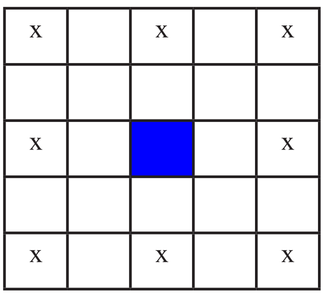
IN HDTV **Interlace** modes
1080I 1080lines / 2 = 540 Odd and 540 Even lines.

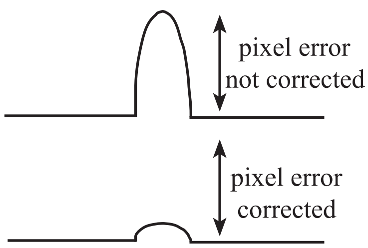
In HDTV **Progressive** mode 720P
There are no Odd or Even lines used.
The picture is created in one action
In 50Hz Interlace mode
the picture is created in 1/50 is **20 ms**
In 50Hz Progressive mode
the picture is created in 1/25 is **40 ms**

So creating an image cell by grouping pixels in numbers of 4, 4320/4=1080 vertical image cells are generated. Combing them into 2 groups of 4 pixels, 4320/8=540 and by shifting 4 pixels each field 1080I is generated. Combining 6 pixels results in 4320/6=720P and 3 at a time 4320/3=1440P.
With a 12 phase addressing system one could make super pixels of 3, 4, 6 or 8 pixels. An image cell is created through the addition of super pixels.
1080 I => 4320/8=540
1080 P => 4320/4=1080
720P => 4320/6=720
1080P => 4320/3=1440 Cinemascope mode 2,37:1
and only 1080 lines are used



Leaking pixel correction (Online)



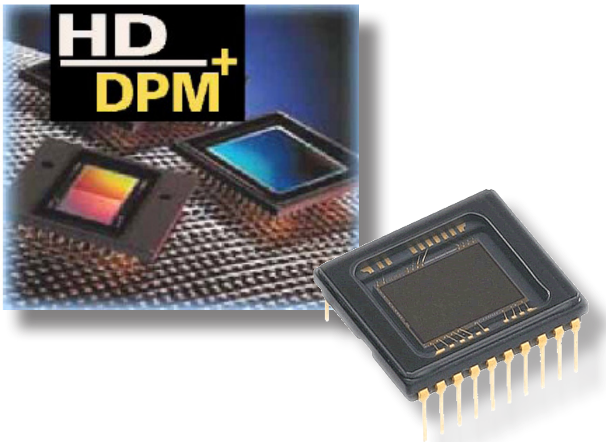


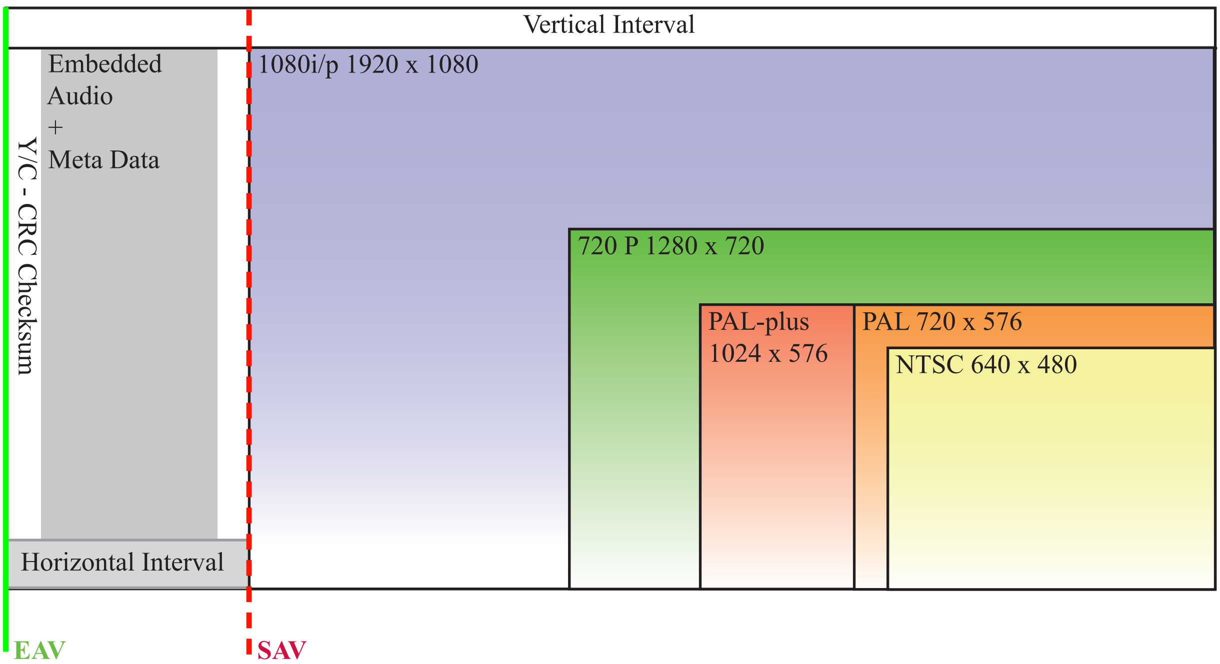
Due to random process deviations, not all pixels in an image sensor array will react in the same way to a given light condition. These variations are known as blemishes or defective pixels.
There are two types of defective pixels:
a: leaking pixel (white in the dark)
b: deveating pixel (in standard light conditions)

Grass Valley cameras using an online (dynamical) pixel correction. By comparing the error with the next neighbours (Hor.&Vert.) it is possible to correct the possible errors.

Formats.

GrassValley) has always supported the imaging community's search for an improved image quality and (HDTV) standards. Starting with the development, in the early 90's, of a HDTV FTimager for the European standard and the LDK9000 camera system . This camera was used as a vehicle for many spatio temporal formats:
1152I50, 1080I60, 1035I60, 970I60, 576P50, 480P60, 480P30.
The next step was the development of an LDK9000-720P camera and FTimager.
The first version was a 60 Hz one, soon to be extended to 72 Hz and 24 Hz.
Starting with the DPM technology for FT-imagers the LDK2000 at 480P30 2 and 480I60 was developed. The temporal spectrum is extended with the LDK23 highspeed camera at 150 Hz and 180 Hz. The massive experience in imagers (FT,DPM) and camera technology was put to a test in the development of the third generation multiformat HDTV cameras. An enabling technology is needed to merge 1080P, 1080I and 720P into one camera head that can be switched from one scanning format to the other without loss in image diagonal or viewing angle. This is found in the newly developed CCD imager based on the DPM Frame Transfer principle. It allows scanning of all the imaging formats natively.





Sensor speed versus Camera Output.

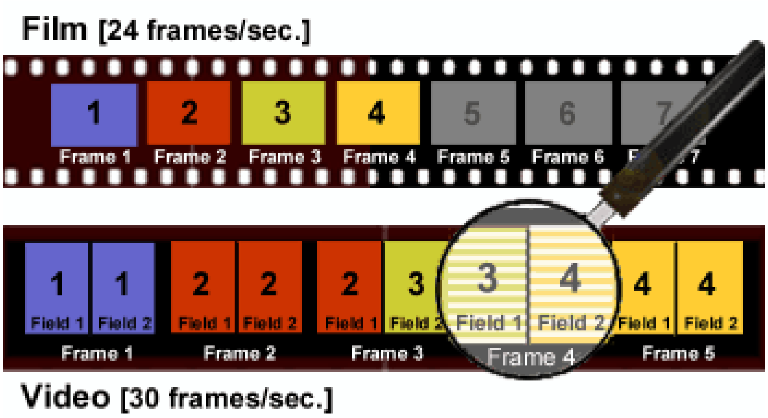
1080 mode versus HD output >>	48 PsF	50 PsF	60 Psf	50 I	60 I
Sensor speed					
24 P	mode 1		mode 2		
25 P		mode 1			
30 P			mode 1		
50 I				mode 0	
60 I					mode 0

720 mode versus HD output >>	24 P	50Rep	60Rep	50P	60P
Sensor speed					
24 P	mode 0		mode 2		
25 P		mode 1			
30 P			mode 1		
50 P				mode 0	
60 P					mode 0

PsF = Progressive Segmented Frame
I = Interlace
P = Progresive

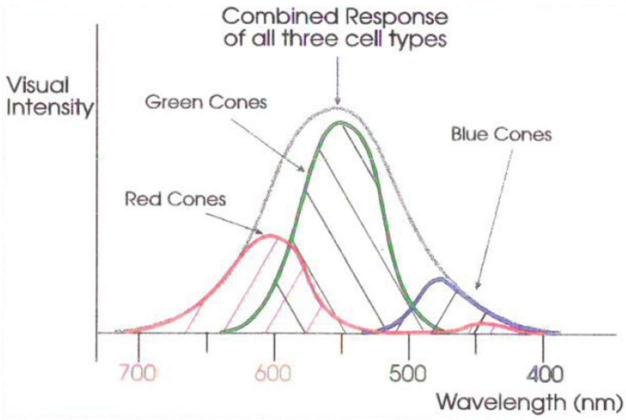
mode 0 = Transparent
mode 1 = Progr => Interlace (psf)
mode 2 = 3:2 PullDown

What is 3:2 pulldown?
How do you stretch 24 frames of film onto 30 frames (60 fields of video)? You improvise. Basically, we stretch four film frames into ten video fields. Even if we simply doubled the film frames, we would still only have eight fields. So, we have to create two brand new video fields. In order to get the motion looking fluid, these new video fields are constructed using two different film frames. Confused? Take a look at the image below.



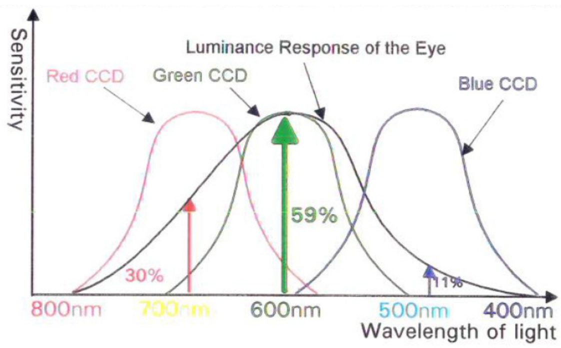
Analog Video
RGB to Y and to R-Y and B-Y

Question:
How the 'Y' and colour difference signals are developed from camera outputs? Why is the 'Y' signal set = 0.3R+0.59G+0.11B?



We all know that Red, Green and Blue are the 3 primary colors. Why in many electronic equipments (including color TV), RGB are not the most common input signals? Instead, we see "Y", "R-Y", "G-Y" signals.

In human eyes, the retinas have three types of cone cells for detecting different colors, namely, blue (447nm), green (540nm) and red (577nm). That's why RGB are considered as the primary colors. However, the cone cells have different sensitivity to different colors. As a result, green color appears to be brighter than the red color and red color is brighter than the blue color for the same light intensity!



Therefore, the luminance (Y) of a color is calculated as

$$Y = 0.3\,R + 0.59\,G + 0.11\,B$$

When the color TV was developed, the signals were designed to be backward compatible with monochrome TV. In monochrome TV, there is only gray scale but the luminance (brightness) actually are representing how our eyes respond were we seeing the color object directly. So a green object is represented as brighter gray than a blue one on monochrome TV. And this is just exactly what "Y" is doing. Therefore, in the color TV system, "Y" is used as the luminance signal and people who are using monochrome TV can still receive color program by just using the "Y" signal.

In order to encode the color messages, "R-Y" and "G-Y" are commonly used. They are called color difference signals. By using the above equation,

$$R-Y = 1R - 1Y \quad = \quad 0.7R - 0.59G - 0.11B$$
$$G-Y = 1G - 1Y \quad = \quad -0.3R - 0.41G - 0.11B$$

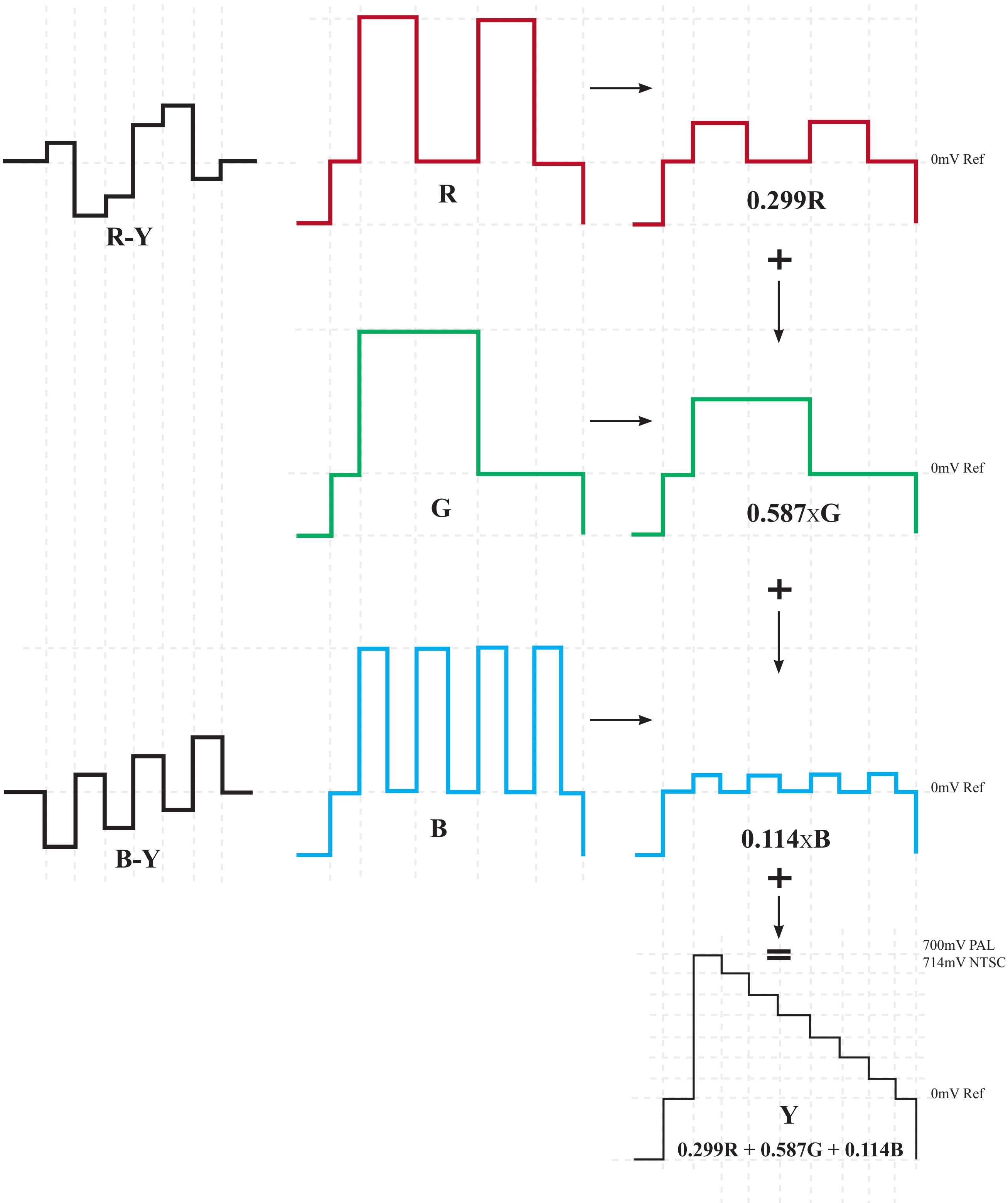
"R-Y" and "G-Y" are chosen because it is easy to encode and decode using simple electronic circuits. (For example, to decode G, just add "Y" signal to "G-Y" signal in the final stage of decoding will be enough.)

Of course, B-Y can be calculated by using "R-Y" and "G-Y". Therefore, it is not necessary to have another signal "B-Y".

In conclusion, Y was used in order to have color TV system compatible with monochrome TV. The coefficients were chosen in order to emulate how the cone cells respond to different colors. And "Y", "R-Y", "G-Y" are nothing but just a transformation of "R", "G", "B" system.

see next page for visual explanation using a Test signal (Colour Bar)

Analog Video SD based
RGB to Y and to R-Y and B-Y



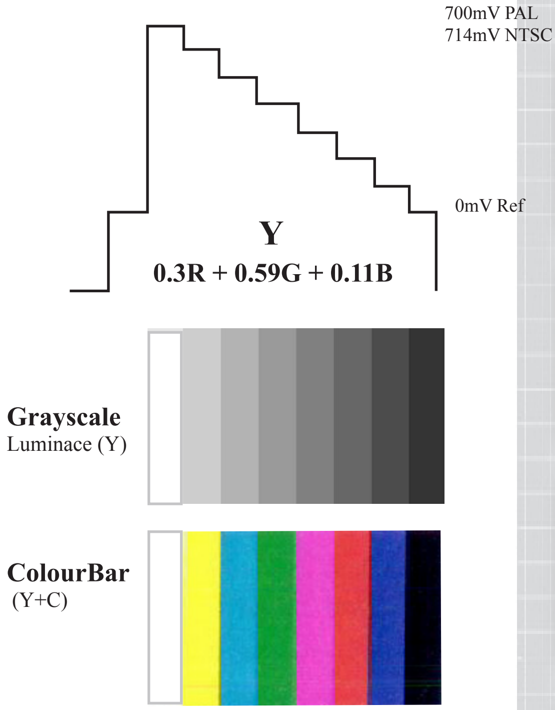
Analog Video SD & HD based
Y and Colour Bars

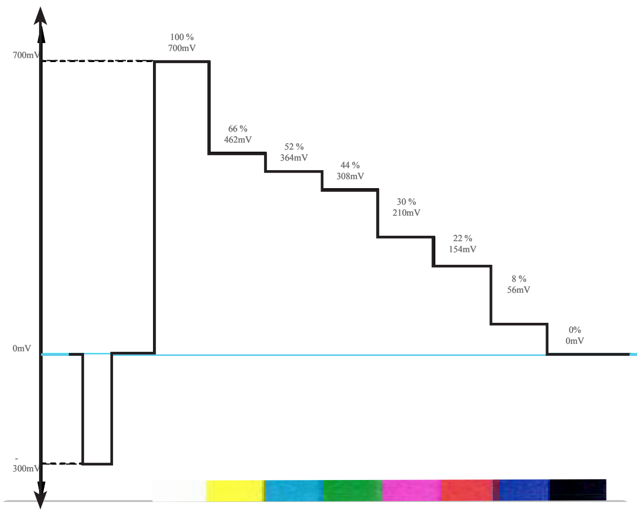
Trying to visualize how **Red, Green, Blue** are combined to make real images is quite an awesome task, and certainly not easy to objectively analyse. Therefore a simple test signal is needed which will provide a full range of brightness, saturation and hue. The standard signal is called **Colour Bars** (see pictures) and incorporates all the primary and secondary colours along black and white.

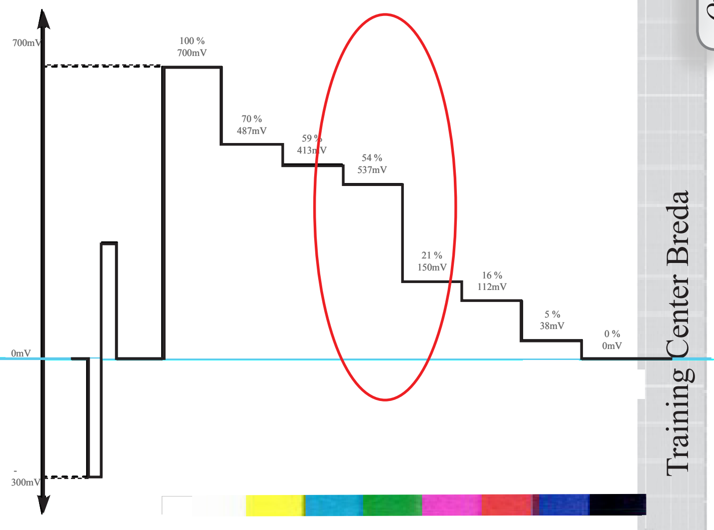
Colour Bars has become the standard test signal for all of television and is used widely to test vision circuits, systems and tape. It is arranged so that it also provides a gray scale for the monochrome viewer.

Colour Bars is composed of a Red, Green and Blue elements. These can then be scaled and added to produce a Luminance (Y) signal.

Take care: There is a difference between SD and HD in this formule.







SDTV 576/50i - ITU-R BT.601-5:

Y = 0,299 (R) + 0,587 (G) + 0,114 (B) = 1

HDTV 1080/50i - ITU-R BT.709-5:

Y = 0,2126 (R) + 0,7152 (G) + 0,0722 (B) = 1

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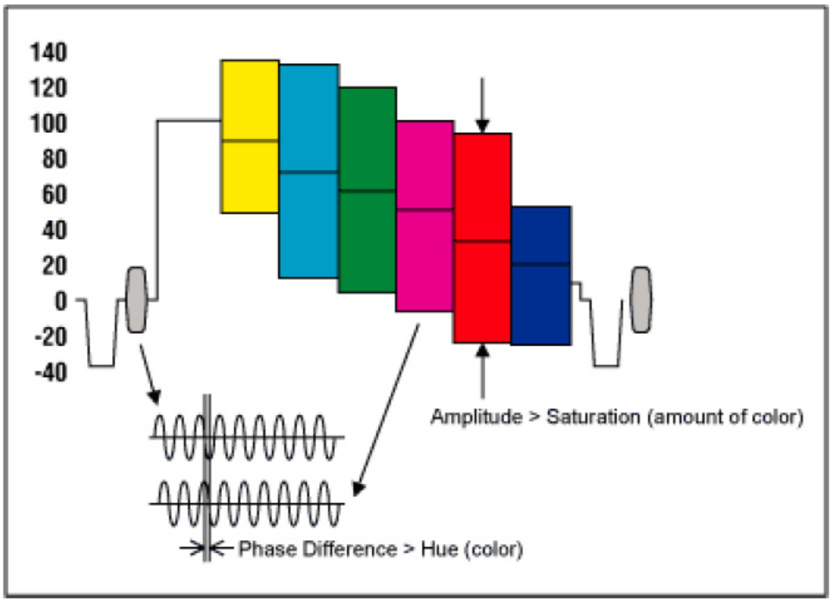
Analog Video Chroma (color)
CVBS

Composite video is the format of an analog television (picture only) signal before it is combined with a sound signal and modulated onto an RF carrier.

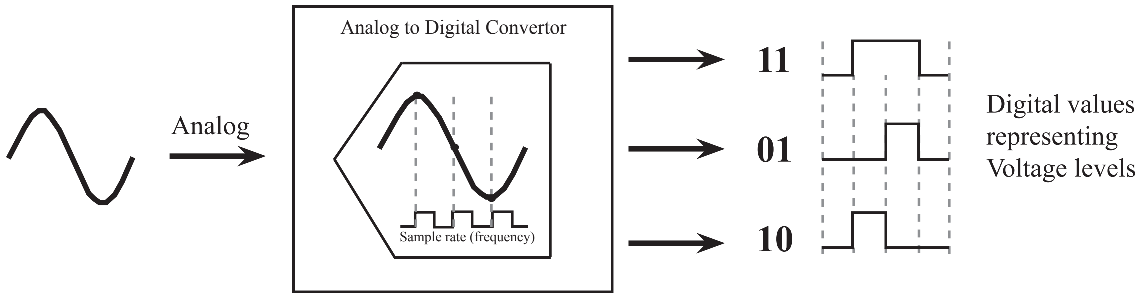
Composite video is often designated by the CVBS acronym, meaning any of "Color, Video, Blank and Sync", "Composite Video Baseband Signal", "Composite Video Burst Signal", or "Composite Video with Burst and Sync".

It is usually in a standard format such as NTSC, PAL, or SECAM. It is a composite of three source signals called Y, U and V (together referred to as YUV) with sync pulses. Y represents the brightness or luminance of the picture and includes synchronizing pulses, so that by itself it could be displayed as a monochrome picture. U and V between them carry the color information. They are first mixed with two orthogonal phases of a color carrier signal to form a signal called the chrominance. Y and UV are then combined. Since Y is a baseband signal and UV has been mixed with a carrier, this addition is equivalent to frequency-division multiplexing. Color information is added on top of the luma signal and is a sine wave with the colors identified by a specific phase difference between it and the color-burst reference phase. This can be seen in Figure down, which shows a horizontal scan line of color bars.



The amplitude of the modulation is proportional to the amount of color (or saturation), and the phase information denotes the tint (or hue) of the color. The horizontal blanking portion contains the horizontal synchronizing pulse (sync pulse) as well as the color reference (color burst) located just after the rising edge of the sync pulse (called the "back porch"). It is important to note that the horizontal blanking portion of the signal is positioned in time such that it is not visible on the display screen.

The step from Analog to Digital
Digital Output Formats.



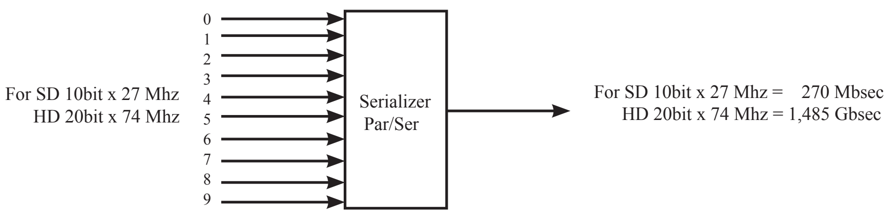
The sample rate is the number of samples of a signal that are taken per second to represent the event digitally.

The more samples taken per second, the more accurate the digital representation of the sound can be.
For example, the current sample rate for CD-quality audio is 44,100 samples per second is 44 Khz.
the sample rate for SD Video is 18 or 27 MHz and the sample rate for HD Video is 74.25 MHz

2 bit 2^2 bits is 4 steps see drawing above.
8 bit 2^8 bits is 256 steps
10 bit 2^{10} bits is 1024 steps
12 bit 2^{12} bits is 4096 steps on 600% Video (6 x 700mV)/ 4096 = 1 mV for each bit
14 bit 2^{14} bits is 16384 steps on 500% Video (5 x 700mV)/16384 = 0,25mV for each bit

12 or 14 bits A/D conversion is used for the LDK video processing.
10 bits are used for external camera video processing (SDI outputs).

Next step is to make a serial signal from the parallel data signals (see next drawings for SD)



Single Link. SD Standard Definition

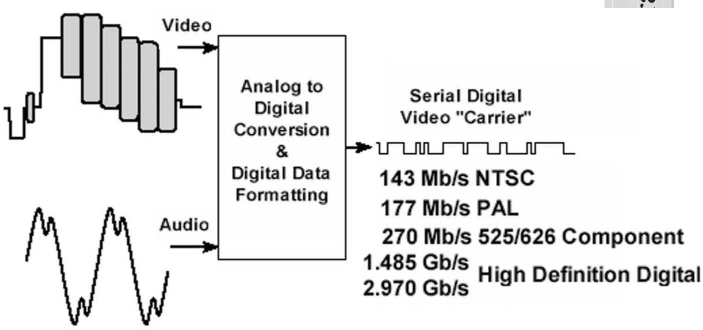
270Mbit Serial Y/Cr/Cb 4:2:2 (10bit x 27Mb)

The 27 MB/s, 10-bit parallel data is then loaded into a shift register, or serializer, where it is clocked out at a 270 Mb/s rate and scrambled for efficient transmission compliant with, in this example, standard definition
ANSI / SMPTE 259M. ITU-R.BT-656

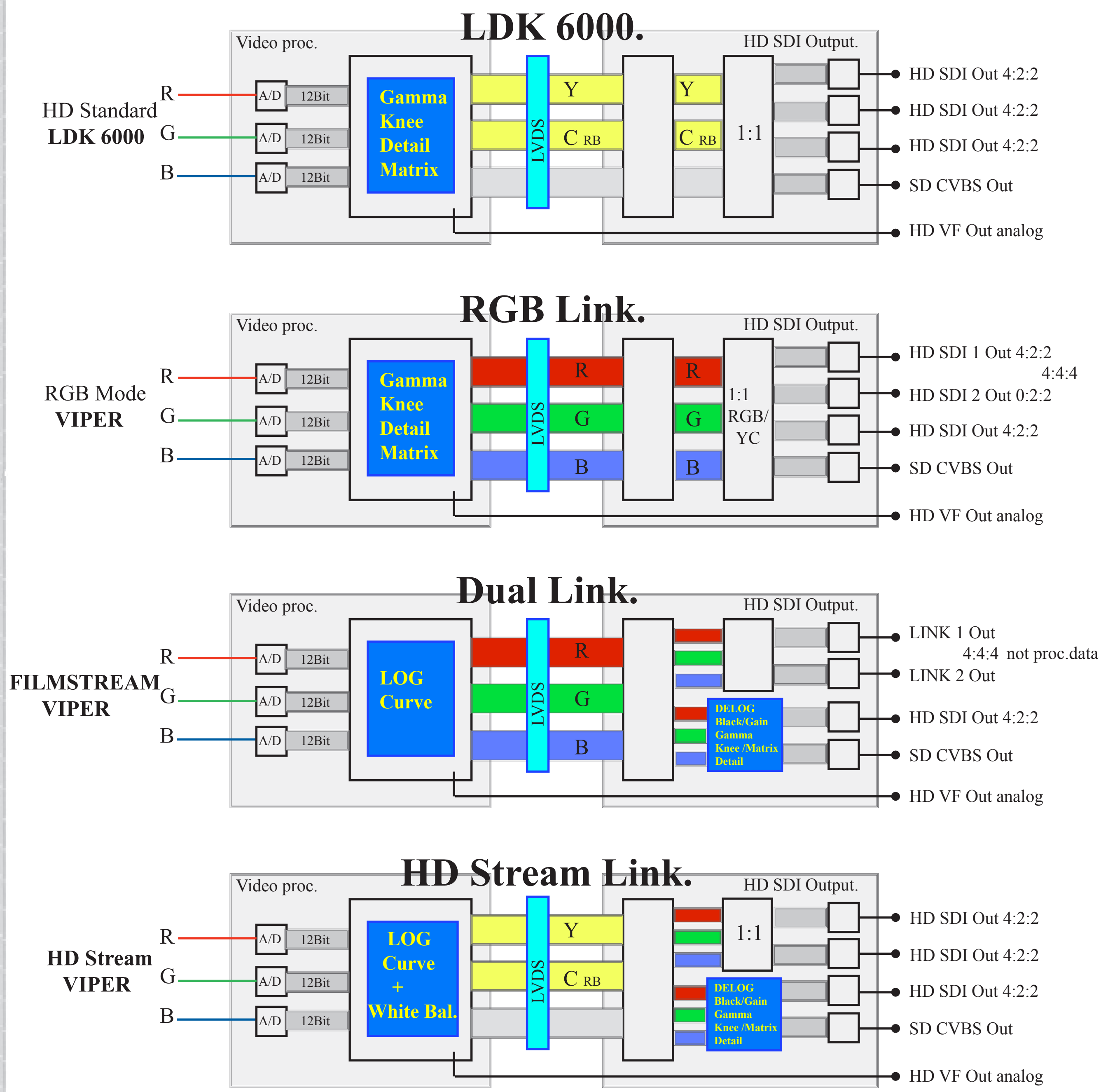
Single Link. HD High Definition

1,5 Gbit Serial Y/Cr/Cb 4:2:2 (20bit x 74Mb)

The 74 MB/s, 20-bit parallel data is then loaded into a shift register, or serializer, where it is clocked out at a 1.485 Mb/s rate and scrambled for efficient transmission compliant with, in this example, High definition
ANSI / SMPTE 292M.



HD serial output types



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The Basics of camera technology

Video Functions

Optical
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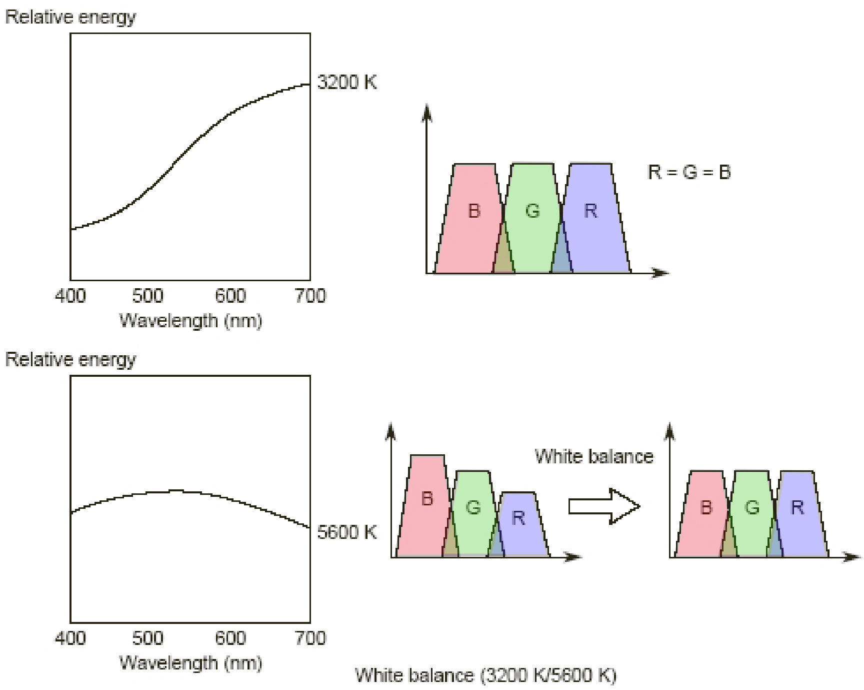
Operational

Color Temperatur and White Balance

As mentioned in the section on Color Temperature (refer to “Color Temperature”), video cameras are not adaptive to the different spectral distributions of each light source color. Therefore, in order to obtain the same color under each different light source, this variation must be compensated for electrically by adjusting the video amps of the camera.
For example, imagine shooting a white object. The ratio between the red, green, and blue channels of the camera video output must be 1:1:1 to reproduce white. This ratio must stay the same under any light source (when shooting a white object). However, as in the earlier discussions of Color Temperature, the spectral distribution of light emitted from each light source differs. This also means that the spectral distribution of the light that reflects from the white object and enters the camera prism will also change according to the light source. As a result, the output of the three red, green, and blue CCDs will vary depending on the light source under which the white object is shot. For example, when the white object is shot under 3200 K, the signal output from the blue CCD will be very small while that of the red CCD will be very large.

This relation reverses for a 5600 K light source.
As earlier mentioned, white can only be produced when the red, green, and blue video channels are balanced (R:G:B = 1:1:1), and therefore, electrical adjustments must be done at the CCD output. In the latter example (5600 K), the video amp of the blue CCD must be adjusted to have a gain smaller than 1, making the red, green, and blue signals equal in amplitude. This adjustment is called white balance.
In brief, white balance refers to the adjustment of the video amps of the three CCDs, according to the color of the light source, to obtain a 1:1:1 ratio for the red, green, and blue signal levels in order to reproduce white.
It is most important to note that, once white balance is adjusted, other colors come into balance as well. White balance should be adjusted frequently when the camera is used outdoors as color temperature changes rapidly with time.

Note: in the figure, white balance for 3200 K seems to require more adjustment of the video amps than 5600 K. However, the video amps of most cameras are preset to operate on color temperatures around 3200 K, and less gain adjustment is required.



White balance (3200 K/5600 K)

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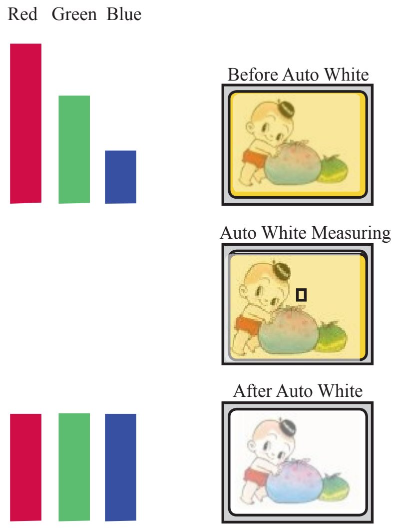
AWB (Auto White Balance)

Unlike the human eye, cameras are not adaptive to the changes in color temperature (refer to “Color Temperature”) of different environments. For this reason, all professional cameras allow ‘White Balance’ adjustments to make a ‘white’ object always look white (refer to “White Balance”). Auto White Balance is a feature that allows white balance to be automatically adjusted simply by the press of a switch. This feature comes in handy when there is not time for manual adjustments or for operators not familiar with white balance. Auto White Balance is often mistaken with Auto Tracing White Balance (ATW) (refer to “ATW (Auto Tracing White Balance)”), a feature equipped in consumer video cameras. While ATW is ‘completely’ automatic and constantly adjusts the white balance in accordance with the change of the lighting environment, AWB is designed to set the correct color balance for only one particular environment. Therefore, the operator must activate it each time a small change is seen in the color temperature. This may sound somewhat inconvenient, however, AWB achieves much more accurate color reproduction as compared to ATW. AWB is achieved by framing the camera on a white object - typically a piece of white paper - that occupies more than 70% of the viewfinder display, and then pressing the AWB button located on the camera body.

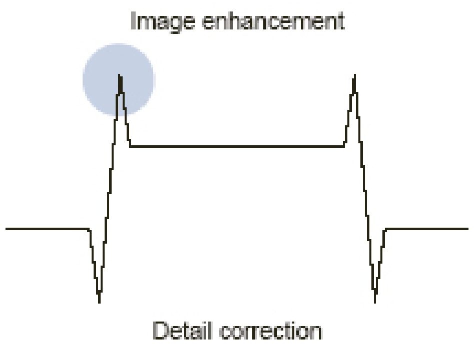


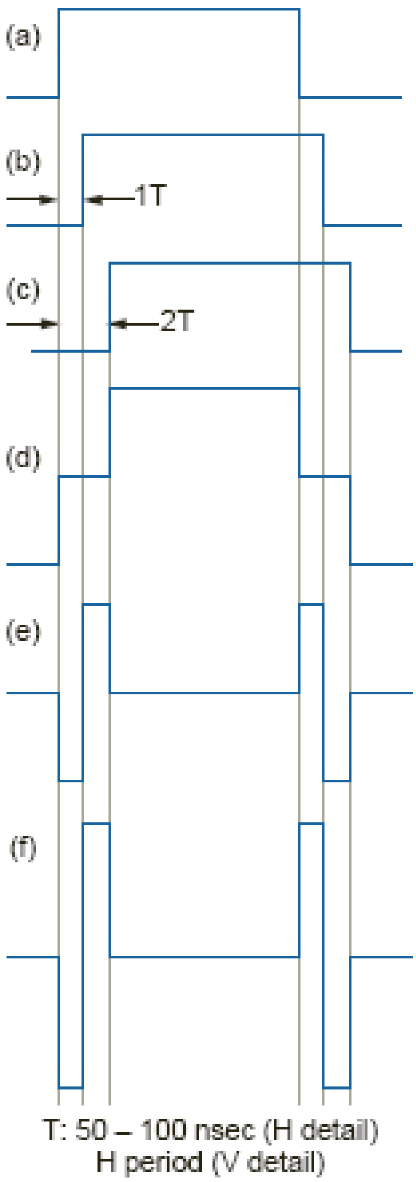
AWC (Auto White Continuesly)

AWC stands for Auto White Continuesly. This feature can be considered an extension of AWB (refer to “AWB (Auto White Balance)”) but with much more convenience. While Auto White Balance is used to set the correct color balance for one particular shooting environment or color temperature (refer to “Color Temperature”), Auto Tracing White Balance corrects the color balance automatically and dynamically with any change in color temperature. For example, imagine shooting a scene that moves from indoors to outdoors. Since the color temperature of indoor lighting and sunlight is obviously different, the white balance must be changed accordingly. If Auto White Balance was used, the operator would have to activate it each time a small change was seen in the color temperature.
The use of Auto White Continuesly eliminates this need, since the white balance will be automatically reset according to the change of color temperature. In other words, the white balance will automatically follow the change of color temperature.
It must be noted however, that while Auto White Continuesly can be convenient, it does have limitations in the accuracy of white balance adjustments.

Detail (Contour)

In all cameras, image enhancement is used as a method to improve picture sharpness. In brief, image enhancement raises the contrast at the dark-to-light and light-to-dark transitions, making the edges of objects appear sharper than provided by the actual resolution of the camera. This process is applied electrically within the camera by overshooting the signal at the edges. In most professional cameras, image enhancement is applied to both vertical and horizontal picture edges.
In camera terminology, this process is called 'detail'. Detail level refers to the amount of image enhancement, or in other words, the amount of sharpness added to the picture.
In most professional cameras, this can be altered with the detail-level control circuitry.
It is worthwhile understanding how the horizontal detail signal is created.
For simplicity, let's examine how this is done in an analog detail-correction process. The original signal (a) is delayed by 50 nsec to obtain signal (b) and by 100 nsec to obtain signal (c). By adding (a) and (c) we have signal (d). The detail signal used for enhancement (signal (e)) is obtained by subtracting (d) from two times (b). This is further added to (b), completing the detail correction (f).
The mechanism for creating the vertical detail signal is basically the same as horizontal detail correction. The only difference is that the delay periods for creating signals (b) and (c) are one horizontal scanning line and two horizontal scanning lines, respectively.
Excessive detail correction will lead to an artificial appearance to the picture, as though objects have been "cut out" from the background.





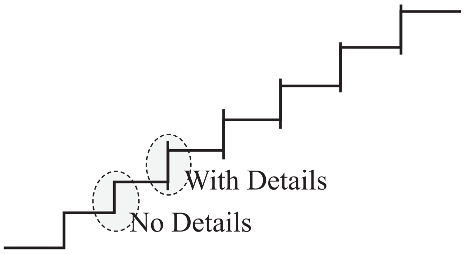
H/V Ratio

As explained in the section on Detail Level (refer to "Detail Level"), detail correction is applied to both horizontal and vertical picture edges using separate horizontal detail and vertical detail circuitries. H/V Ratio refers to the ratio between the amount of detail applied to the horizontal and vertical picture edges. It is important to maintain the balance of the horizontal and vertical detail signals to achieve natural picture enhancement. H/V Ratio should thus be checked every time detail signals are added.

Detail functions

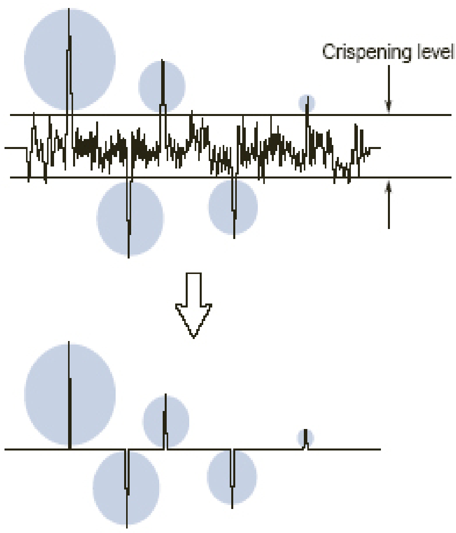
Level Dependency

This is the Detail level related to Video level.
Specfied is, by using the stairstep the first to steps don’t have detail information.
The reason is that in this part of the signal the gamma curve (see gamma) is most active.
When also detail is added to this part there will be to much noise visible.
The level of this correction is adjustable.



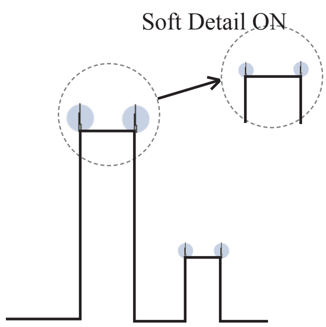
Noise Slicer or Crispening

As mentioned in the section on Detail Level (refer to “Detail Level”), detail signals are used to raise the contrast at the dark-to-light and light-to-dark transitions, making the edges of objects appear sharper both horizontally and vertically.
Simply put, detail correction makes pictures look sharper than the actual resolution provided by the camera. However, since detail correction is applied to the entire picture, its use also emphasizes the noise of the picture, especially when the detail level is high. Noise slice / Crispening is a circuit implemented to avoid detail signals being generated around noise. By activating the Crispening function, detail signals with small amplitudes, which are most likely caused by noise, are removed from the signal.
As shown in the figure below, in the Crispening process, only detail signals that exceed a designated threshold are utilized for image enhancement. Conversely, the detail signals with small amplitudes are regarded as noise and removed .
Crispening allows detail to be adjusted without worrying about its influence over noise.



Soft Detail

A small transision from black to white will have a small detail value added but big transision big detail levels.
With the function Soft Detail it is possible to adjust or equalize the detail level from big details and match them to the small details



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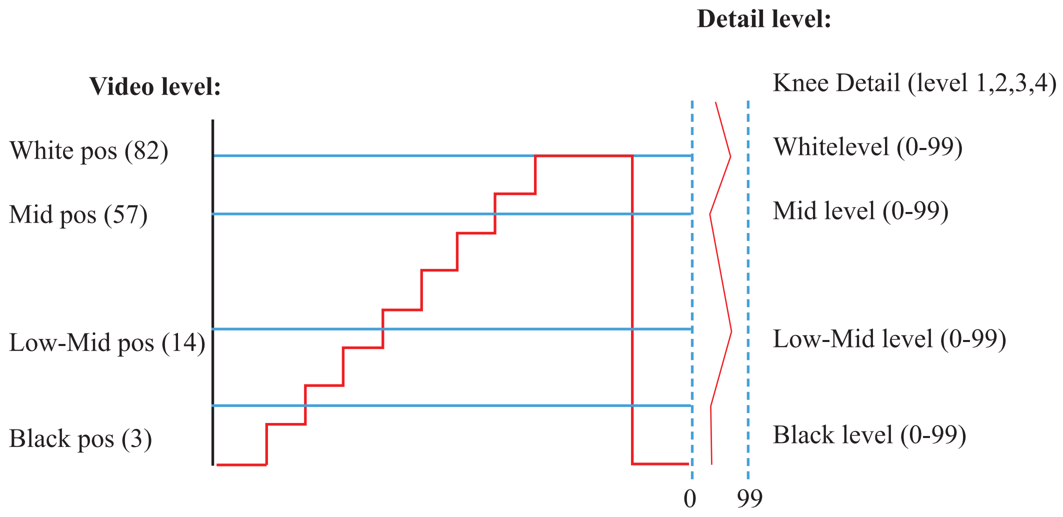
Detail Level Equalizer

This function makes it possible to adjust detail levels individual in five video amplitude ranges. (Together with the improved soft-detailss and noise slicer the detail can be adjusted in a much more flexible way.)
The change of the detail level is linear between two consecutive detail levels
(not available in all products)

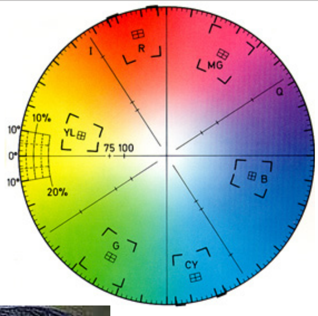


VF VIDEO menu:

Cont. level EQ	OFF = (Knee Contour: Off)			
	ON =	Black level	0-99	(default 50)
		Low-Mid lev.	0-99	(default 50)
		Mid level	0-99	(default 50)
		White level	0-99	(default 50)
		Knee Cont.	1,2,3,4	(default 0)
		Black pos.	0-99	(default 3)
		Low-Mid pos.	0-99	(default 14)
		Mid pos.	0-99	(default 57)
		White pos.	0-99	(default 82)

grass valley

SKIN (color) Detail correction



With the function SKIN contour it is possible to change the amount of detail in one of the colors.
The name is based on the Skintone color but with the current technology it is also possible to make a sample of each color from the color circle.
After a setup procedure it is possible to reduce the detail from a selected color sample.

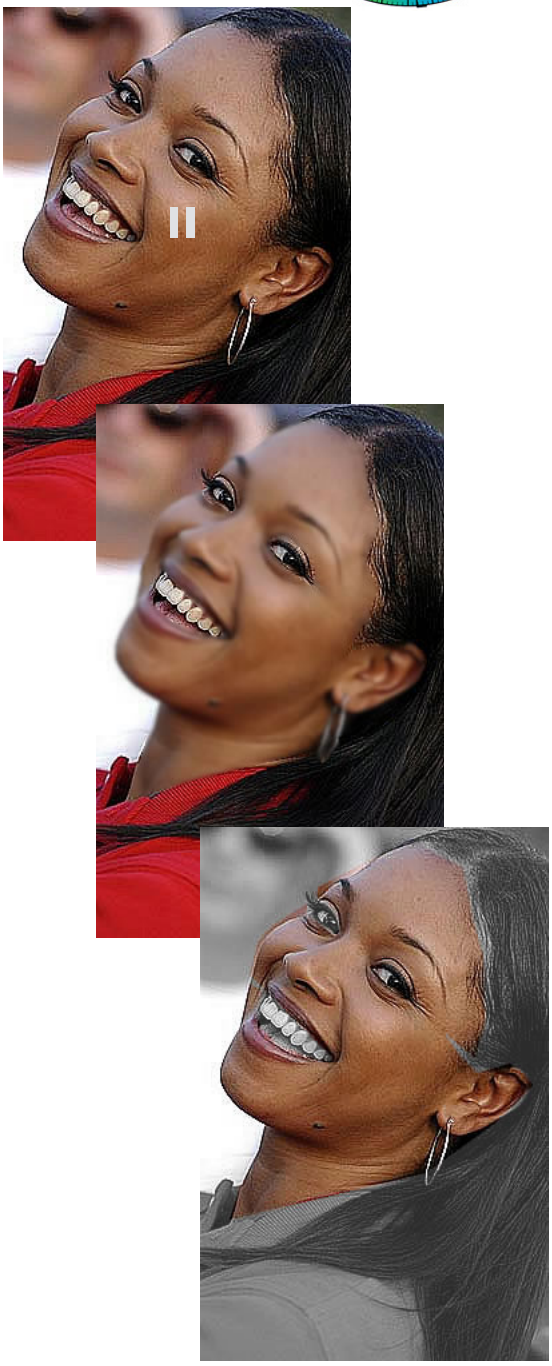
The following steps are needed for this setup.

1: Switch ON the function SKIN (1 or 2) detail

2: Start measuring procedue with SKIN window
steps: a = Marker visible in Viewfinder
b = Auto SKIN measurement is running

3: Select prefered color with the marker.

4: Adjust level from SKIN detail.



Auto Skin contour.

Use Auto skin contour to change Automaticly the contour level in a selected colour range. Decreasing the contour level of a persons skin colour softens only the skin tones.

But not only skin colours can be selected, for example, decrease the contour level of a soccer field to accentuate the soccer players or increase the skin contour level to accentuate a rough surface.

Manual Skin contour.

Use Manual skin contour to change with the controls from MCP /OCP /Menu menu the color location where detail is corrected.
SKIN Color B or R = Color location
SKIN Window B or R = Color area

Skin View.

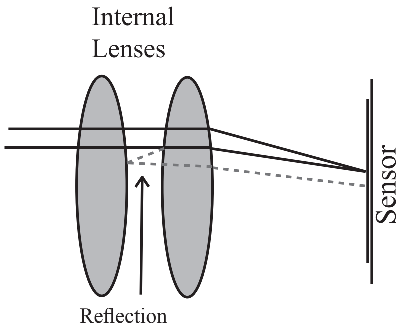
The SKIN VIEW function is available to see the result from the select color Location and Window. The detail reduction is only active in the coloured area.

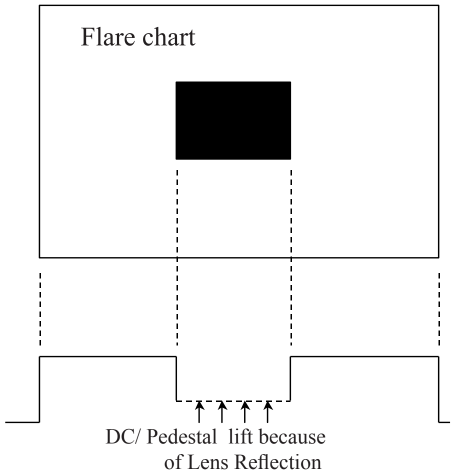
When using a B/W viewfinder this colored area is visible as Zebra pattern.

Flare

Flare is a phenomenon that is likely to occur when strong light passes through the camera lens. Flare is caused by numerous diffused reflections of the incoming light inside the lens. This results in the black level of each red, green and blue channel being raised, and/or inaccurate color balance between the three channels. On a video monitor, flare causes the picture to appear as a misty image, sometimes with a color shade.

In order to minimize the effects of flare, professional video cameras are provided with a flare adjustment function, which optimizes the pedestal level and corrects the balance between the three channels electronically.





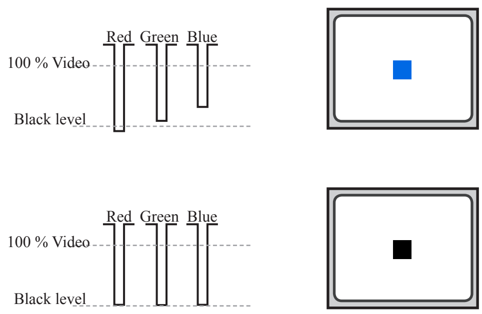
Flare adjustment

The flare adjustment is related to the IRIS level.
In the field it is very important to adjust the flare from the Red, Green and Blue channel.
The procedure is explained in the Drawing

Check with a black area (10%) how the results are from Red, Green, Blue black level.

1: Cap the Lens and check the blacks
2: Open the lens + two stops extra

Calibrate the black parts in the picture with the individuel flares from OCP or MCP.



Black Balance

To ensure accurate color reproduction from a camera, it is imperative that the camera reproduces a true black when the lens iris is closed, otherwise a colorcast may be seen. This requires accurate matching of the R, G, and B black levels.

All LDK cameras are equiped with a dynamical black circuit where continuesly the black are controled.

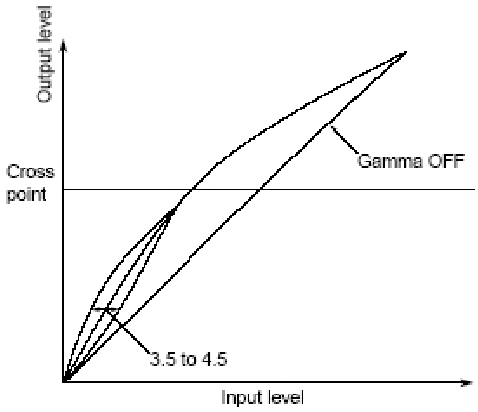
Other cameras provide an Auto Black Balance function, which automatically closes the lens iris and balances the R, G, and B black levels when activated.

The Autoblack feature that is available on the LDK camera (OCP MCP) is only a tool to bring the individual blacks (see next page) to the middle (50) position.

Black Stretch/Press

In LDK cameras, the gamma curve near the black signal levels can be adjusted using the Black Stretch feature.
This feature is achieved without affecting the gamma curve of the mid-tone and high tones areas.
Adjusting black stretch to obtain a steep gamma curve near the black signal levels allows more contrast to be seen in dark parts of the picture, thus resulting in better reproduction of picture detail.
However, it must be noted that using a steep gamma curve near the black signal levels also results in the increase of noise, and black gamma must be adjusted with care. Conversely, black stretch can also be adjusted to reduce noise in dark picture areas but with the drawback of less contrast being seen. This feature is called Black Press.
Reproduction of black is extremely important to obtain the desired color reproduction of entire images, accurately and faithfully.

Thus, professional video cameras, especially those used in broadcast stations, are required to have this capability to reproduce faithful black level stipulated by each broadcast station (different broadcast stations will have their own stipulations on the black level).



Standard Video Setting

Video setting corrected with Black Stretch

Gain

When shooting with a video camera in low-light conditions, a sufficient signal level can often not be obtained due to a lack of light directed to the imager. For such cases, video cameras have a Gain Up function, which electronically boosts the video signal to a sufficient level for viewing on a monitor or recording to a VTR.

The Gain Up function usually offers several Gain Up values, which are selected by the operator depending on the lighting. It must be noted that choosing a large Gain Up value will result in degrading the S/N ratio, since noise is also boosted. Some cameras have a minus Gain Up setting to improve their S/N ratio.

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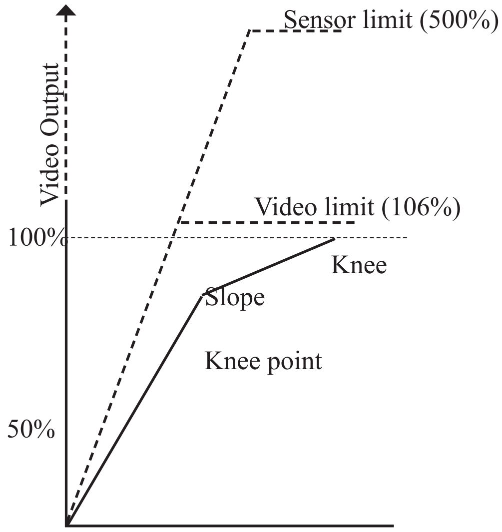
Knee Correction

When we take a photo against a strong backlight, just like shooting a portrait picture in front of a sunlit window, we can still clearly see the subject's face while being able to see the details of scenery outside the room. This is because the human eye can handle wide dynamic range (refer to "Dynamic Range"). However, this is not easily done by video cameras because of the limited video-level dynamic range specified by the television standard. Therefore if the camera lens iris was adjusted for correct exposure of human skin tones, the bright areas of the image would not fit into the video-signal range and would be washed out. Vice versa, if the iris was adjusted for the bright areas, the video level of human skin tones would be very low and would look too dark. In order to obtain an image reproduction like the human eye, as naturally as possible, a function called 'Knee Correction' is widely used on today's video cameras. Knee Correction is a function that compresses the wide dynamic video signals acquired by the imager (CCDs) into the limited video-level range specified by the television standard.

The video level from which signals are compressed is called the knee point. As shown in the figure, the video output above the knee point is compensated for to give a more gradual response. Thus some detail (contrast) can still be observed in the bright areas above the knee point, broadening the dynamic range of the camera.



Auto Knee function

Conventional cameras only have a single knee point/slope (refer to "Knee Aperture" and "Knee Correction") characteristic.
In contrast, the LDK Knee Processing system has Automatic knee point/slope characteristics.
The camera intelligently monitors the brightness of all areas of the picture and adapts the knee point/ slope for optimum reproduction.

A typical example is shooting an interior which includes a sunlit exterior seen through a window. or an exterior scene with clouds , This function applies only to video levels in excess of the knee point, the middle and low luminance parts remaining unchanged.

Knee Off

Auto Knee ON

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Dynamical True Color Knee Control

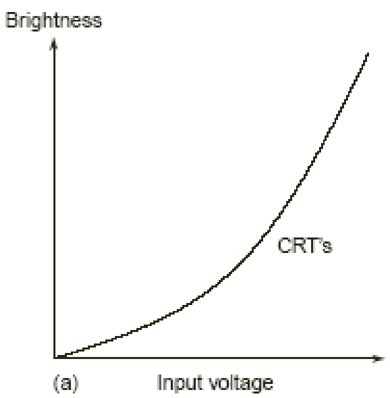
A full Dynamic highlight handling can be arranged with 12 bit A/D for 600%
Two unique patented highlight circuits are used: Pivoting Knee and True Color Knee.

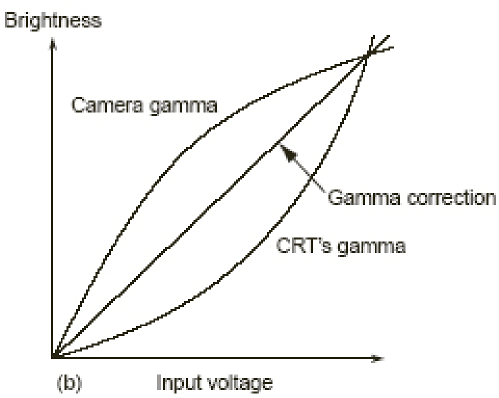
The Basic manual controls on the control panels are Knee point and Knee slope.
With MCP it is possible to select the compression source either Y or the max. signal from RGB (NAM)
The Auto Knee function controls automatically the Knee slope depending on the picture contents.

Gamma Correction

Gamma (γ) is a numerical value that shows the response characteristics between the image brightness of an acquisition device (camera) or display device (CRT monitor) and its input voltage. In order to obtain faithful picture reproduction, the brightness of the picture must be in direct proportion to the input voltage. However, in CRTs used for conventional picture monitors, the brightness of the CRT and the input voltage retain a relationship with an exponential function, instead of a directly proportional relationship. As shown in (a), the beam current (which is in proportion to the CRT's brightness) versus the input voltage rises as an exponential curve, in which the exponent is a factor larger than one. On the monitor screen, the dark areas of the signal will look much darker than they actually are, and bright areas of the signal will look much brighter than they should be. Technically, this relation is expressed in the following equation:
I = C x E γ
where I is the brightness, E is input voltage and C is a specific constant. The exponent in this equation is called the 'gamma' of the CRT.

It is obvious that the gamma of a picture monitor CRT must be compensated for in order to faithfully reproduce pictures taken by the camera. Such compensation is called 'gamma correction'. Properly speaking, gamma correction should be done within the picture monitor. However, this is done within the camera since it is more economically efficient to perform the correction within the cameras used by the broadcaster, rather than in the huge number of picture monitors that exist in the market.
The goal in compensating (gamma correction) for the CRT's gamma is to output a signal so that the light that enters the camera is in proportion to the brightness of the picture tube, as shown in (b).
When the light that enters the camera is proportional to the camera output, it should be compensated for with an exponent of 1/ γ. This exponent γ '(1/ γ) is what we call the camera's gamma. The gamma exponent of a monitor is about 2.2. Thus the camera gamma to compensate for this is about 0.45 (1/2.2).
Although gamma correction in the camera was originally intended for compensating for the CRT's gamma, in today's cameras, gamma can be adjusted to give the camera image a specific look. For example, a film-like look can be achieved by changing the settings of the camera's gamma.





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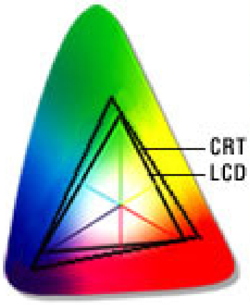
Matrix Correction

Color matrix

A sophisticated six-axis color matrix circuit effectively compensates optics-related color reproduction to ensure more natural, true-to-life tones. Several color matrix presets are provided to give you more creative control over the look and feel of your images.

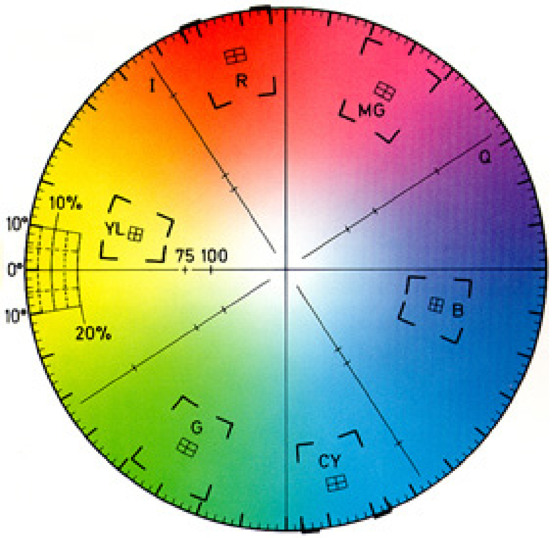


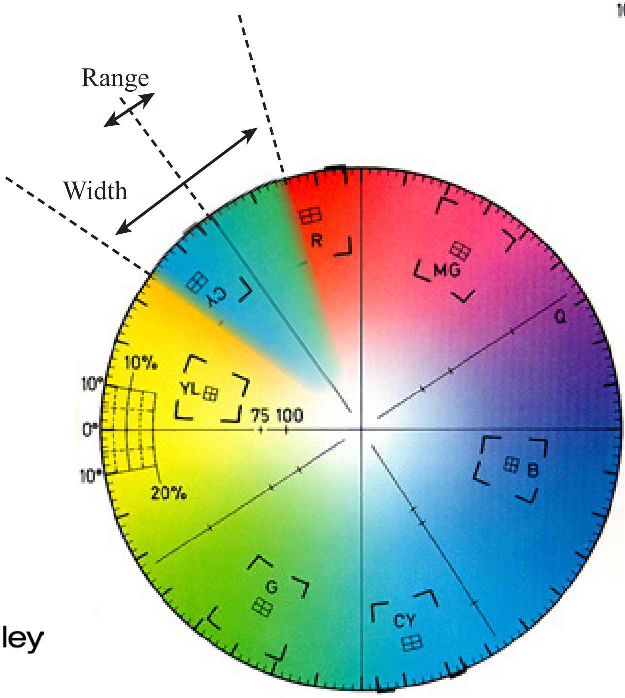
SKIN

EBU

Secondary Color Correction

Here users can select specific colors in a scene and modify them as needed to enhance or highlight certain features within a shot. Color selection is divided into 16 vectors.
Users can select the width or range of colors included in a selection, then choose the color they wish to modify.
Up to three colors can be modified in a scene.
Selected color changes can be saved with scene files during rehearsals then recalled during production.
(not available in all products)

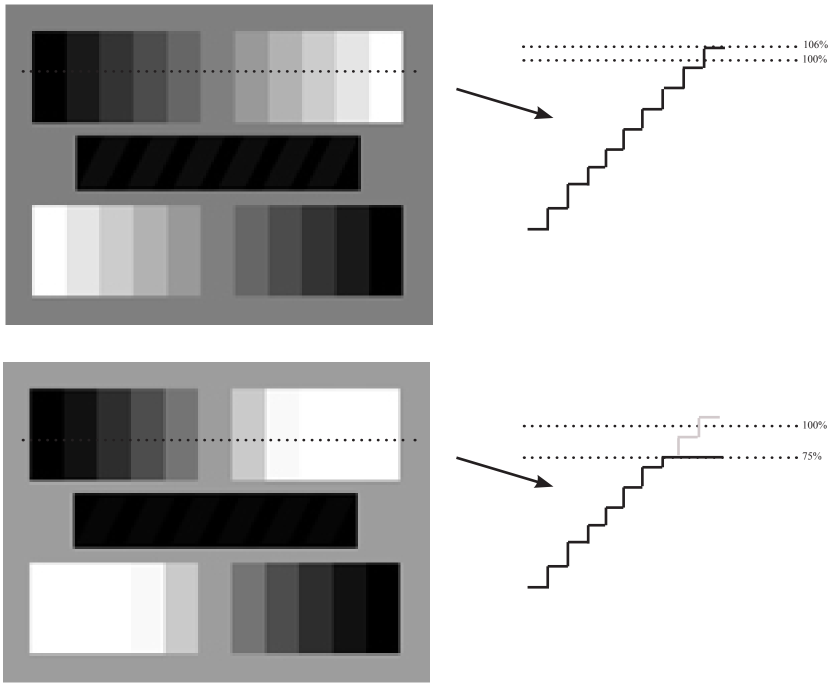




White limiter or White clip

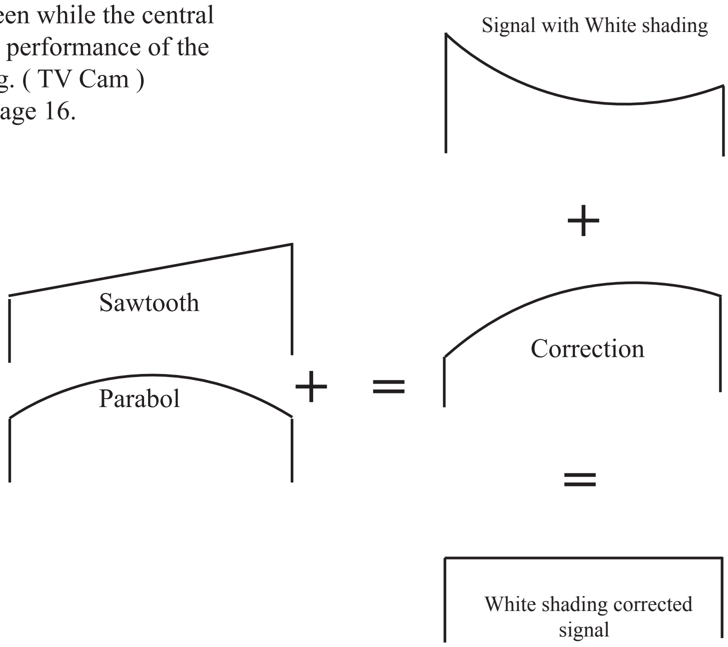
A device which electronically limits the maximum "white" level of a video signal, in order to avoid "over-burned" images on the screen.

The standard LDK value is:
106% or in MCP / OCP 80
5 digits is 1 % level change.



White Shading

When shooting a white object, the upper and lower portions of the screen may appear magenta or green while the central portion appears white, depending on the performance of the camera lens. This is called white shading. (TV Cam)
See also the detailed explanation from page 16.



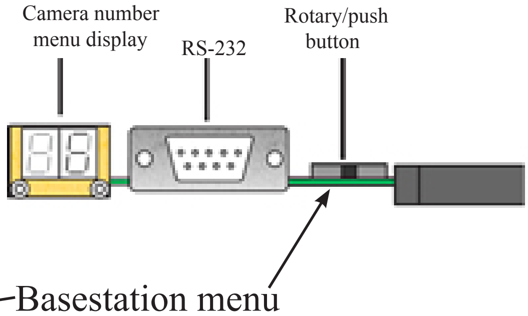
Saturation

In color theory, saturation or purity is the intensity of a specific hue: A highly saturated hue has a vivid, intense color, while a less saturated hue appears more muted and grey. With no saturation at all, the hue becomes a shade of grey. Saturation is one of three components of the HSL color space and the HSV color space.

The saturation of a color is determined by a combination of light intensity and how much it is distributed across the spectrum of different wavelengths. The purest colour is achieved by using just one wavelength at a high intensity such as in laser light. If the intensity drops the saturation also drops. To desaturate a color in a subtractive system (such as watercolor), the person can add white, black, gray, or the hue's complement.

With OCP

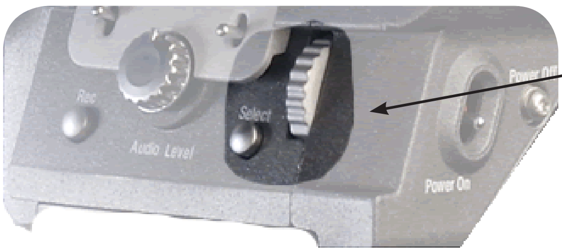
With Databoard basestation



Basestation menu

The Basics of camera technology

Operational Functions (Camera Monitoring Menu)



Camera menu

VF Detail

The cameraman always need to created the best possible picture. There are some tools for him in the VF menu to set the level of the VF detail.

With the VF Detail function in the menu it is possible to select the level of the VF only detail. So even when the main detail is switched off the camera man will have the possibility to add detail to his picture in the Viewer.

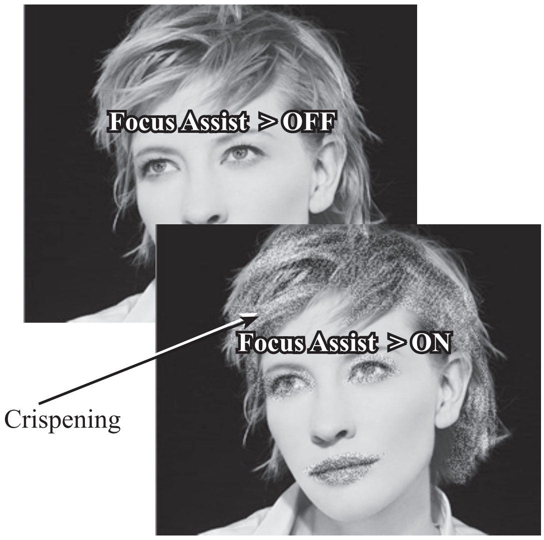
In some version from the LDK camera also the VF boost is avialable

Focus Assist

In the HDTV systems it is quite difficult for the cameraman to find the optimum for the focus setting from the lens

With the Focus Asssist function it is possible that the electronics is helping the cameraman to find this optimum.

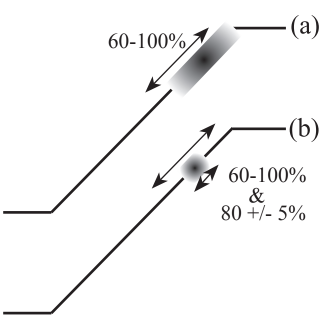
For the highest frequencies in the picture you will find an crispening effect visible in VF.



Zebra

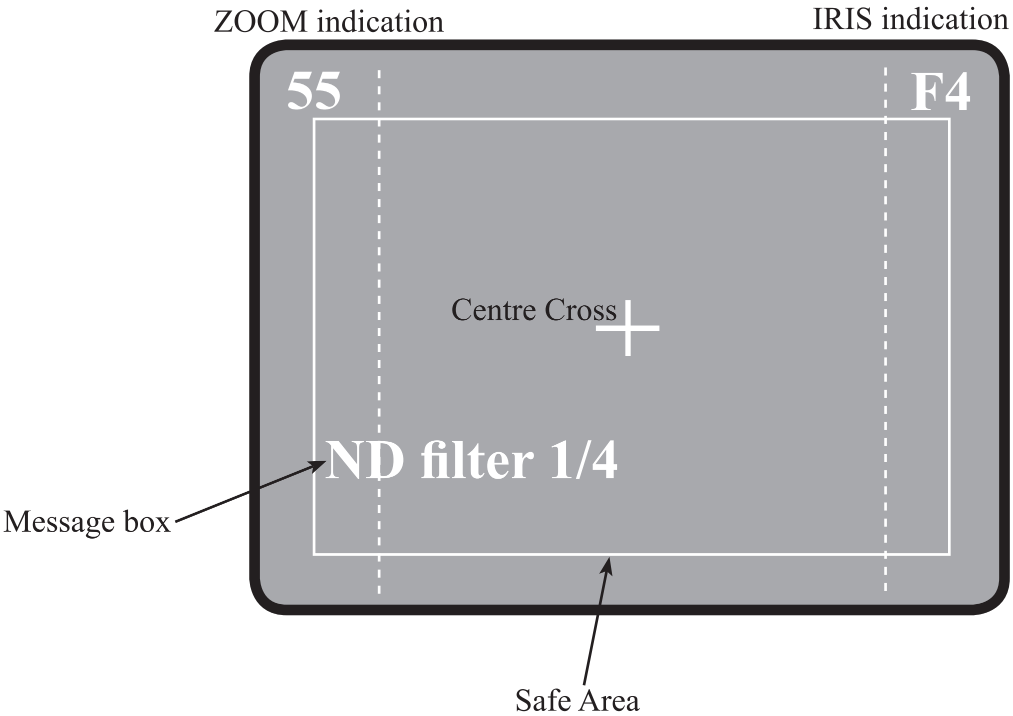
The Zebra is the indication for the cameraman related to the Video level in the picture.
In the menu you will find the following settings

Level = 60 - 90 % Video level setting. (diagram a)
Band = level setting + and - 5% = 10% (diagram b)
Contrast = Visibility from Zebra effect



grass valley

Still in progress



Viewfinder markers

Go to the VF menu to select the markers you wish to see in the viewfinder. The following markers can be set up:

- The Safe area marker encloses an area that represents 80% of the whole viewfinder picture area. This is the minimum area seen on a TV-set.
- The Message box displays information messages.The length of time this box remains on the screen is set by the Info time item of the VF menu.
- The Centre cross marks the centre of the picture.
- The Cadre marker is a dotted white line or a shaded area that shows the limits of a 4:3 (15:9 or 14:9) picture. Exterior marker shading can also be selected.

Ind White
Ind Black
Display
Menu Time
Info Time
Rotary speed
VF Notch
Ext Aspect Ratio
Loc Aspect Ratio

Still under development