SONY®

Product Information Manual

Sony Professional LCD Monitors

LUMA

Preface

From the advent of television broadcasting, CRT displays have been the default choice for monitoring video images in all areas of the production chain - from acquisition, editing, and playout at the broadcaster end, to the viewing and enjoyment of content by the end user.

With the introduction of many new flat panel display technologies, broadcasters and video production staff are now confronted with a crucial question - which display technology will replace CRT and which technology should they invest in next.

While LCD monitors have gained a considerable amount of attention in many video production areas, none have proven the true potential that LCD technology can really offer.

This manual addresses Sony's approach to this issue, and why we offer the LUMA™ Series of professional LCD monitors as our solution.

By reading through this manual, you will understand how SONY LUMA Series monitors will benefit a variety of video production environments, plus other professional areas where LCD technology can fully be enjoyed. You will also discover how this technology will co-exist with the Sony BVM Series of CRT monitors, which will remain the first choice for the highest-grade monitoring applications.

We hope this manual serves as a valuable asset in your LUMA Series sales activities.

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1 Current Display technologies at a glance

The following chart compares key purchase decision parameters between CRT, Plasma, and LCD (LUMA Series) monitors. While the LUMA Series monitors show better results for most parameters, some are marked inferior to CRT and PDP. These parameters are continually evolving in the LUMA Series and, with current models, have surpassed the levels suitable for use in typical broadcast and professional picture - monitoring applications.
At the same time, for top-end monitoring applications where such parameters may be extremely sensitive, Sony continues to offer the BVM Series of CRT monitors.

Table 1-1. CRT, Plasma and LCD Comparison

	CRT	LCD	PDP
Mechanism to Emit Light	Electron Beam stimulation	Backlight control using LCD shutter	Electric discharge of xenon gas
Luminance Flux Control	Beam intensity	Opening of pixels	Number of times electric discharge occurs
Light source	Phosphor	Backlight	Phosphor
Display method	Line scanning (variable)	Fixed pixel array	Fixed pixel array
Pixel Pitch	○	◎	○
Brightness	◎	◎	○
Contrast	◎	○	○
Black Reproduction	◎	△	○
Image Burn-in Tolerance	◎	◎	△
Response Time	◎	△	◎
Viewing Angle	◎	△ ~ ○	◎
Horizontal Resolution	◎	◎	○
Convergence	△	◎	◎
Geometric Distortion Characteristics	△	◎	◎
Resistance to Magnetic Fields	△	◎	◎
Flicker Characteristics	△	○ ~ ◎	◎
Color Reproduction	○	◎	○
Life Span	◎	◎	◎
Weight	△	◎	◎
Depth	△	◎	◎
Power Consumption	△	◎	△

Note:
Some ratings in the above chart may change depending on the lighting environment of where the monitor is used.
Also, please note that these comparisons are ratings as of 2005/03/01.

2 The basic mechanisms of display devices

This section provides you with a general overview of some common display devices available on the market today. It describes the basic mechanisms of a CRT monitor, LCD monitor, and a Plasma display. Each display device has its unique mechanism and, therefore, its characteristics are fundamentally different from others.
Recognizing these differences will lead you on to an understanding of why LCD technology was chosen for the LUMA Series of professional monitors.

The mechanism of a CRT monitor

The Cathode Ray Tube, commonly known by the acronym CRT, is the most historically used display system and therefore the first best to understand. A CRT displays pictures by emitting light from its phosphors, as a result of stimulating these by electronic beams. Although the black and white CRT is the easiest to understand, we will now consider the mechanism of a color CRT, since most other display technologies available today are designed to reproduce color images.

Phosphors emit light

As mentioned above, the CRT monitor reproduces images by stimulating phosphor materials.
Inside the CRT tube, there is an inner phosphor panel situated in front of the CRT's glass faceplate (Trinitron's cylindrical screen). The phosphor panel appears black, however, a white powdery substance can be seen by observing it closely.

This powdery substance is the phosphor* material, a chemical coating applied to the metal phosphor panel. A unique characteristic of phosphor material is that it emits light with a specific color when electrically stimulated.

** In reality, a color CRT uses three types of phosphor material on its phosphor panel to emit red light, green light, and blue light, respectively.*

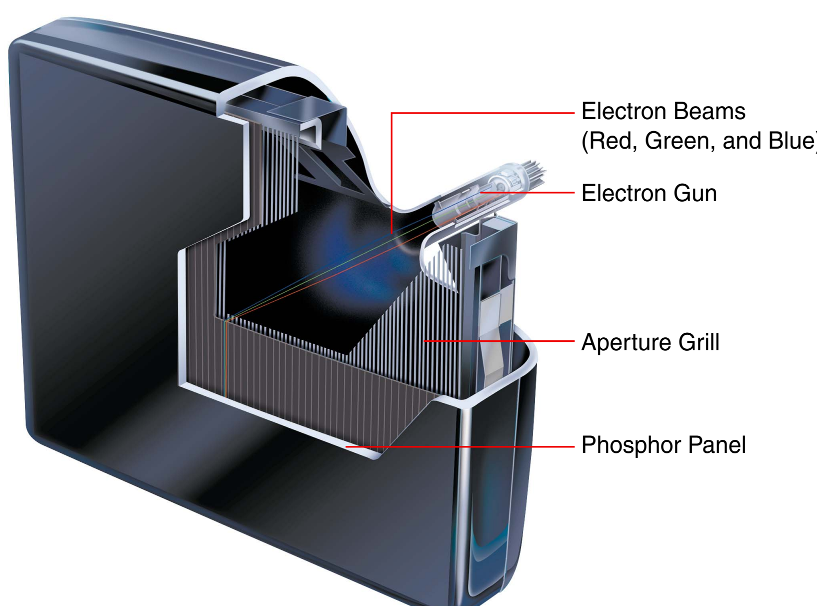


Figure 2-1. The Trinitron® CRT

Scanning

An electronic stimulus is applied to the phosphors by shooting an electron beam at the area that should light up. The beam, which is driven by supplying high voltage to the electron gun, is steered across the phosphor panel from top to bottom, hitting one point at a time. This is called 'scanning'. The electron beam scans the phosphor panel at the field or frame rate of the input video signal.

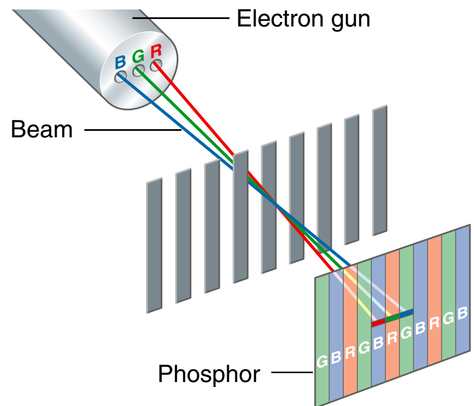


Figure 2-2.

Additive Mixing

As earlier mentioned, in a color CRT, three beams are used in combination with three types of phosphors, which emit either red (R), green (G), or blue (B) light when stimulated. The scan pattern of each electron beam is accurately controlled so the beam hits its corresponding phosphor - R, G, or B. The phosphors, in turn, react to the energy provided by these beams and emit light in proportion to the intensity of the beams.
Each beam's intensity is controlled according to the R, G, and B video signals supplied to the electron gun. Accordingly, the R, G, and B phosphors each emit light in proportion to the input video signal's R, G, and B components. To the human eye, these R, G, and B lights appear as one ray of light, as a mixture of the three colors. This principle is known as 'additive mixing' (see Figure 2-3). In additive mixing, most hues visible to the human eye can be composed using the three primary colors: red, green, and blue. It is important to note that all other color display systems, regardless of their operating mechanisms, also use this principle* to produce color.

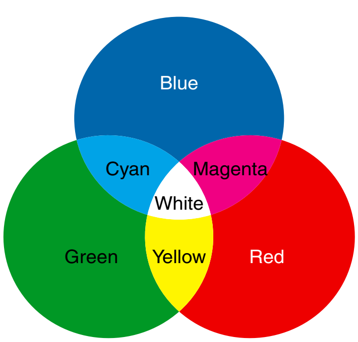


Figure 2-3. Additive Mixing

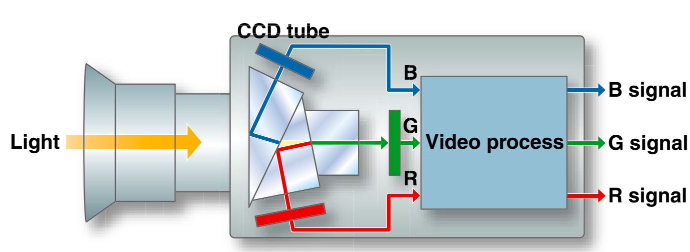


Figure 2-4. * Compared to the color CRT, color cameras use a reverse process and convert the captured images into R, G, and B electric signals.

2 The basic mechanisms of display devices

Aperture Grille

In order for the three electron beams to generate light in accordance with the input R, G, and B video signals, they must scan their phosphors very precisely. To achieve precise scanning, two key technologies are used: the 'Aperture Grille' and 'Beam Convergence'.
The Aperture Grille is used so that the R, G, and B electron beams scan only their corresponding phosphors, i.e., the grille prevents the electron beams from hitting the incorrect phosphors. This is extremely important since the beam representing the green signal component should only hit the green phosphor, which is the same case for the red and blue components.
As shown in Figure 2-5, the three electron beams also need to cross each other when they pass through the Aperture Grille in order to land on their associated phosphors. This is called 'beam convergence', which is adjusted at the electron gun's convergence plates by applying the appropriate electric field and 'bending' the direction of the beam.

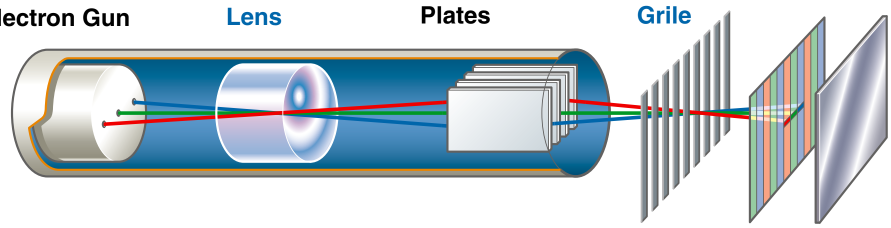


Figure 2-5.

Beam focus

One other key technology worth understanding is beam focus. While electron beams will generally tend to diffuse in a CRT monitor, the R, G, and B beam diameters must be kept as small as possible in order to pass through the narrow slits of the Aperture Grille. The electron gun has a focus lens, which functions to electrically tune the electron beams and make their diameters small enough to pass through the Grille.

CRT monitors- in summary

CRT displays, used from the advent of television broadcast, have undergone decades of refinements to reach the picture performance they provide today. The pictures reproduced on CRT monitors/televisions thus represent a fundamental and absolute reference for judging the picture quality that newer display technologies should challenge and that the Sony LUMA Series monitors closely approach.

The mechanism of an LCD monitor

Compared to CRT monitors, LCD monitors use an entirely different mechanism for displaying pictures. While the LCD device itself could be viewed as playing a similar role to a CRT phosphor, it actually works in a very different way. CRT phosphors 'glow' or emit light while LCD devices only control (or filter) the amount of light that passes through them. The light source of an LCD monitor is a fluorescent light placed behind the LCD device. What the LCD device does, is determine the amount of light that should be directed to the face of the monitor.
LCD devices consist of a number of small pixels, all of which operate in a similar way to a camera's lens iris. For example, an XGA LCD has a pixel array of 1024 x 768, or 1024 x 768 tiny irises*. By applying the appropriate drive voltage according to the input signal, these tiny irises either open or close to reproduce the images that must be displayed.
The LUMA Series monitors use wide aperture LCDs, meaning that the widest opening (aperture) for each pixel is very wide. This alone contributes to effective use of the backlight source for the reproduction of bright pictures.
While many systems place the light back along the edges of the screen, the backlight of LUMA monitors is placed right behind the LCD device - another element making them so bright.

** In reality, LCDs use a liquid crystal substance, sandwiched by two polarized panels to determine the amount of light that passes through each pixel. Refer to 'A deeper look into LCD's' (page 30) for more information. The iris analogy is used for simplicity.*

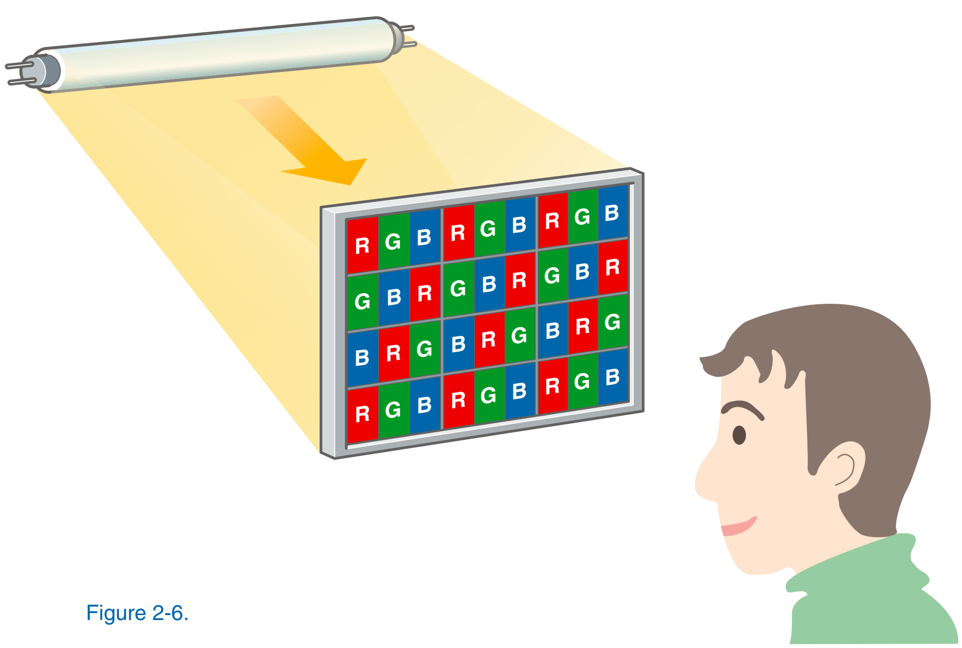


Figure 2-6.

2 The basic mechanisms of display devices

Color reproduced on an LCD monitor

Trinitron® CRTs use RGB phosphors to display color pictures. Similarly, LCD panels use three sub-pixels as one set to reproduce color. The three sub-pixels have either a red, green, or blue color filter on their front surface to reproduce the RGB components of the color signal supplied to the monitor. Simply put, when an LCD monitor receives a color signal, each RGB signal component is used to control the opening of only the pixels corresponding with the same R, G, or B color filter.

Line conversion on an LCD monitor

CRTs scan the same number of lines as the input video signal. In contrast, LCD monitors have a 'fixed' number of lines or fixed number of vertical pixels. For this reason, two conversion processes, generally known as I/P conversion and scaling, are required to map video signals to match the LCD's vertical pixel count.
LCD devices do not operate in interlace mode - all images must be displayed as progressive frames. Accordingly, interlace video signals must first be converted to progressive signals. This is called I/P (Interlace-to-Progressive) conversion. The line count of these signals must then be matched to the LCD's vertical pixel count using up or down conversion. This is known as scan conversion. It is extremely critical to use the correct algorithm in these processes to maintain image quality, such as the unique Sony X-Algorithm* adopted in the LUMA product line.

** X-Algorithm is used only in the separate type LUMA monitors.*

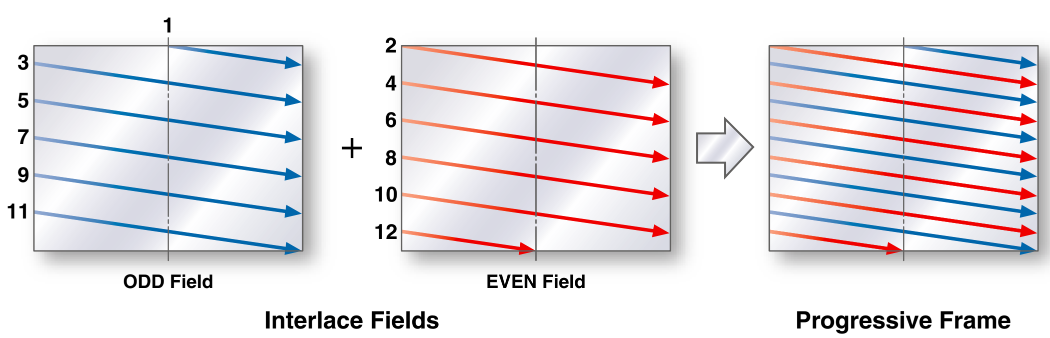
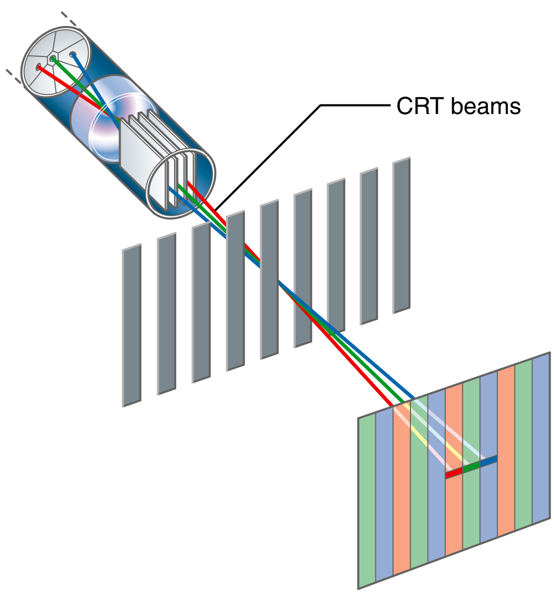


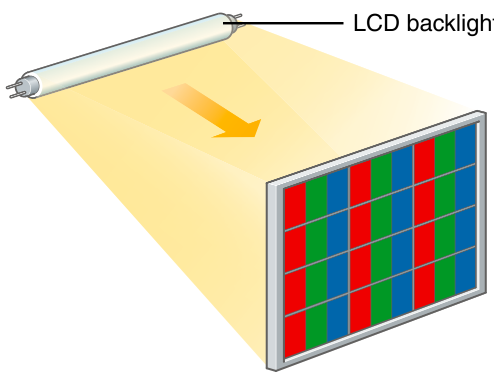
Figure 2-7.

Forming an image on the LCD pixel array

CRTs scan their phosphors point-by-point, from left to right and top to bottom of the screen. Therefore at any given time, only one point on each R, G, and B phosphor will emit light. LCD monitors, in contrast, do not use 'scanning' to display pictures. The entire image or frame is displayed on the screen at once for the full vertical frequency period. This difference is somewhat similar to the difference between tube camera imagers and CCDs - where tubes scan the imaging plane point-by-point, as opposed to CCDs, which capture the entire picture frame at once.



Formimg an image on a CRT



Formimg an image on an LCD

Figure 2-8.

About LCD response time

CRT phosphors emit light at the moment they are hit by their electron beams, so the response time of a CRT monitor has never become an issue. With LCD monitors, however, the issue of response time can be a concern. The response time of an LCD is the time required to open (or close) the pixel's aperture to the desired opening from when the drive voltage was applied. Slow response time in conventional or non-professional LCD monitors can result in picture blur across fast-moving objects.

The response time of the LUMA Series monitors is extremely short due to the use of highly advanced LCD technology. This makes them particularly suitable for professional picture monitoring.

LCD monitors - in summary

Since first used in simple numeric and character displays, LCD technology has come a long way in terms of picture quality, reliability, and cost. By nature, LCD displays are also immune to the many undesired effects unavoidable in CRT or Plasma displays. This manual describes these in detail, leading your understanding as to why LCD has become the preferred choice for a majority of professional video production applications.

2

The basic mechanisms of display devices

The mechanism of a Plasma Display Panel

Plasma display panels have the characteristics of both CRT and LCD displays, in addition to some unique characteristics of their own. These similarities and differences can be summarized as follows:

1. As with CRTs, Plasma display panels emit light by stimulating phosphor material.
2. As with LCDs, Plasma display panels use a fixed pixel array to form an image, and require I/P conversion and scaling process.
3. Unlike either of these devices, Plasma display panels discharge a gas (in 'plasma' state) in order to convert video signals into light.

By keeping these three facts in mind, the approach to understanding the mechanism of a Plasma display panel should be an easy one.

Plasma displays - An array of tiny fluorescent lights

As earlier described, LCD panels consist of a number of small pixels, each of which operate like a camera's lens iris (refer to page 9). In contrast, Plasma display panels consist of an array of tiny cells that generate plasma, a state of gas separated into ions and electrons. Similar to an LCD device, a Plasma display's resolution is determined by the number of cells it has in its array, i.e., an XGA Plasma display consists of 1024 x 768 cells.

A significant difference between the two is the way they generate images. Pixels in an LCD panel control the amount of light (from the backlight) that should pass through them to create the corresponding image.
In contrast, Plasma displays do not use a backlight, but instead, each cell in the array emits light on its own. The mechanism used to produce light in each tiny cell is similar to the way a typical fluorescent tube generates light.

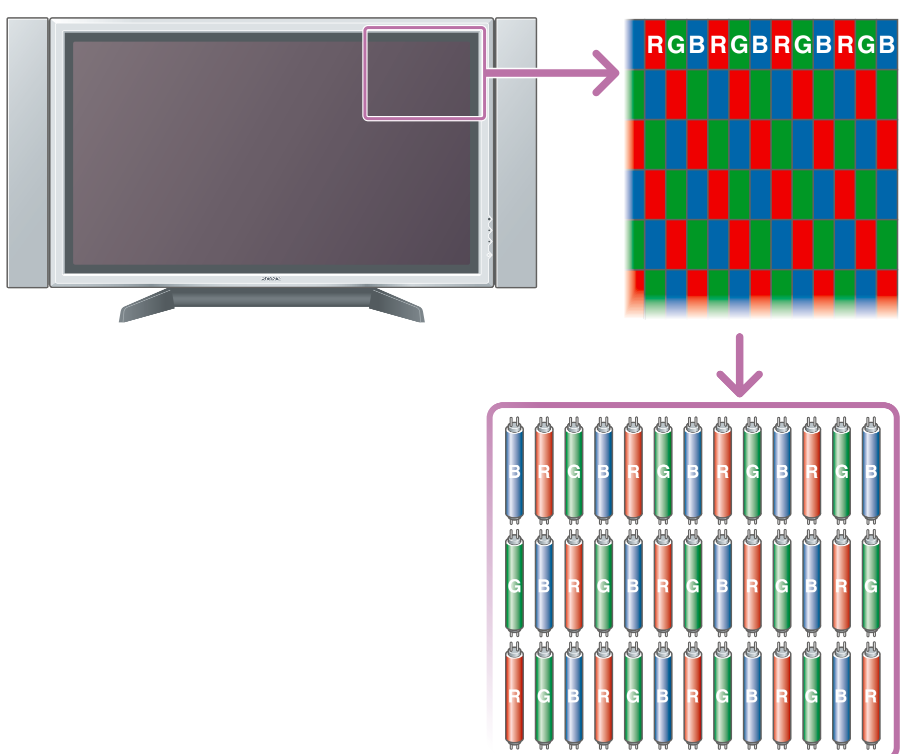


Figure 2-9. Plasma displays are like an array of tiny fluorescent lights

The use of Ultraviolet rays

In CRTs, the R, G, and B phosphors emit light by the physical impact of the electronic beam hitting the phosphors. The phosphors convert the physical energy of the electrons to a different energy, known to us as light.
Plasma displays also use phosphor material to emit light, but in a different manner.
Each tiny cell in a plasma display is coated along the inside with a phosphor material, which produces either red, green, or blue light when stimulated.
An important fact to note is that when exposed to ultraviolet rays (invisible light), phosphor material converts (the energy of) these rays to viewable light (visible light). The color of the visible light produced is governed by the type of phosphor material used. This energy conversion - from ultraviolet rays (invisible) to visible light - is the central mechanism enabling the cells of a Plasma display to produce color images.
In reality, ultraviolet rays are produced in Plasma display cells by discharging a gas (usually xenon gas) concealed within each cell. Each cell is sandwiched by several electrodes, positioned on the top and bottom of the cell, to carry out this role. When voltage is applied to these electrodes in the appropriate sequence, a current starts running through the gas, discharging it (see Figure 2-10), which in turn produces ultraviolet waves. The phosphor material coated within the cell is then exposed to these ultraviolet rays, producing R, G, or B light according to the phosphor type.

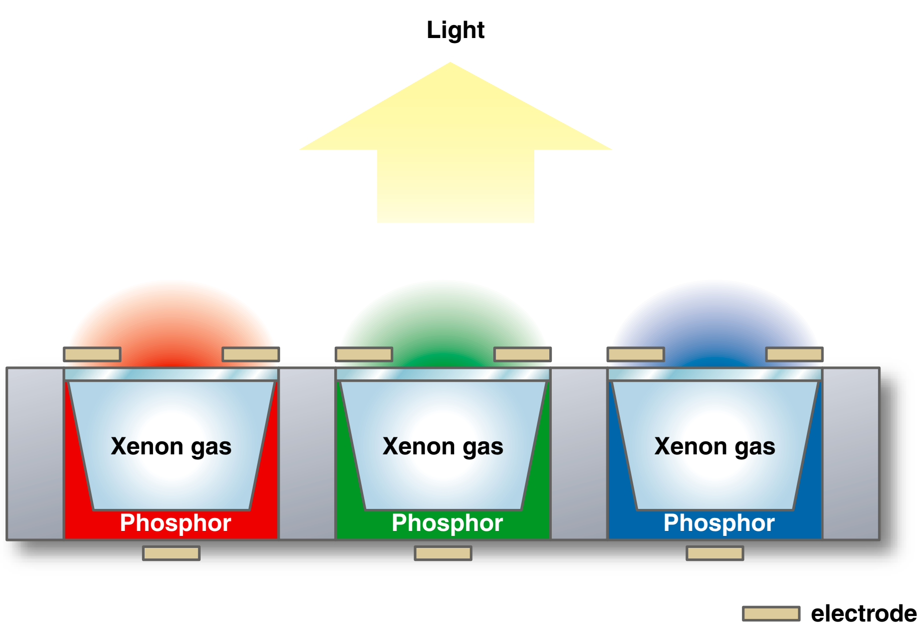


Figure 2-10. The red, green and blue cells of a plasma display

2 The basic mechanisms of display devices

Electric discharge and forming a plasma

Electricity (or electrons) flows through metal materials by applying voltage to the two opposite ends of the metal (using a battery or AC source). We refer to this as an electric 'current', which is the result of electrons (which exist in a metal's normal state), being pushed from one end of the metal to the other by the power of a battery or AC source.
With gases however, this is not the case. In normal state, the atoms in a gas have no electrical charge, which means the gas cannot conduct electricity. An electrically charged particle or 'carrier' must exist to create an electric flow or 'current'.
However, a gas is able to conduct electricity when a plasma state is established within it. The easiest way to describe a plasma is a gas with its atoms separated into ions and electrons. Ions have a positive charge and electrons have a negative charge, and both particles act as 'electrical carriers'. Once a plasma is established, the gas becomes capable of conducting electricity, just like a piece of metal wire.
When voltage is applied to a gas in plasma state, a current (an electrical flow) is generated, which is accompanied by the emission of some sort of light either in the visible or invisible spectrum.
In the case of a Plasma display, the gas concealed in each cell is electrically charged to establish a plasma state - which enables a current to flow through it when voltage is applied. This process of establishing a plasma state and conducting electricity through a gas is called 'electric discharge'.
Plasma displays specifically use xenon gas, which emits ultraviolet rays when discharged.

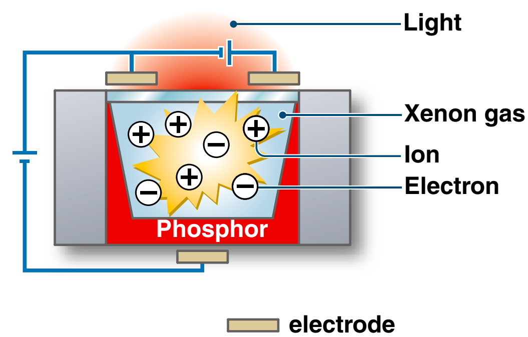


Figure 2-11. Discharging a plasma display's cell

Brightness control

In Plasma displays, the brightness of a cell is controlled by the number of times it is made to flash (or emit light) due to electric discharge. Simply put, for bright areas of an image, cells are discharged at a high frequency, while cells displaying dark areas are discharged less and do not flash as much within the given frame rate period.

Color Reproduction on a plasma display

CRTs use RGB phosphors and LCDs use color filters to display color pictures. Similarly, Plasma displays use three R, G, and B sub-pixels as one set to reproduce color. As mentioned earlier, each sub-pixel has a phosphor material coating, which - when exposed to ultraviolet rays - emits either red, green, or blue light to produce the required color. (see Figure 2-10)

Plasma displays - in summary

Since their introduction, Plasma displays have established a position in consumer and industrial applications for their superb brightness and contrast ratio. However, they are not the preferred choice for professional video production applications due to their insufficient tolerance to image burn-in when displaying still images. Considering this fact, and the purpose of this manual, we have avoided describing Plasma technology hereafter.

3 LCD Benefits in General

The use of LCDs in the LUMA Series monitors eliminates many concerns inherent in CRTs. The following describes how these benefit professional picture monitoring applications.

Here, we have intentionally dismissed Plasma technology from the discussion, due to its insufficient tolerance (image burn-in) for use in production and broadcast applications.

Flicker Free

In today's production environments, a variety of signal formats - each with a different frame rate - must be handled. The current 625/50i signal is known to exhibit a considerable amount of flicker. Formats operating at slower rates, including 24PsF can exhibit even more flicker when displayed at their raw frame rates.
Compared to CRTs, LCD monitors are, by nature, easier on the human eye. Plus, with a mechanism that displays the entire picture frame at once, they do not cause flicker either, which can cause fatigue on the human eye.
This is a huge benefit in areas where vast amounts of acquisition footage must be checked or when logging material into news server systems, where operators must keep their eyes on the same display over a period of time.

Convergence Free

With CRTs, accurate color reproduction can only be achieved by converging the three R, G, and B beams to pass the aperture or shadow mask grille and accurately hit their associated phosphors.
Although convergence is aligned to be precise in the screen center, this alignment can slightly be inaccurate near the four corners of the screen.
This is because the R, G, and B beams must travel towards the screen corners at different angles both vertically and horizontally. In such cases, the R, G, and B phosphors will not emit light in accurate proportion to the R, G, and B input signals, resulting in a shift in color reproduction.
A typical example is when a white digital clock is "keyed' into the corner of the screen, introducing color smear on the edges of the digits.
To avoid this effect in CRTs, different convergence alignments must be applied to each area of the screen - however, this technology is only available on top-end CRT monitors such as the Sony BVM Series.
LCD displays do not use beams and therefore are free from convergence alignments. Instead they use fixed pixels, each with R, G, and B sub-pixels so R, G, and B alignment is correct at all times.

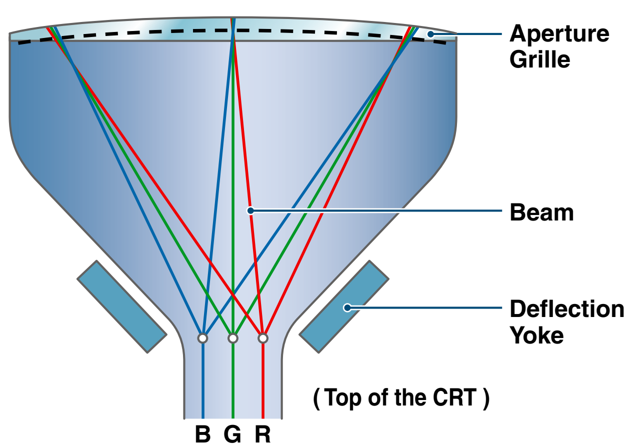


Figure 3-1. Horizontal mis-convergence in a CRT

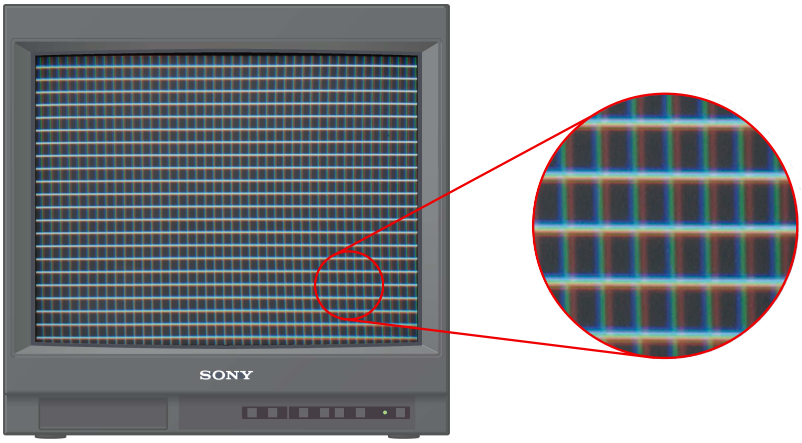


Figure 3-2. An example of color shifted due to convergence misalignment

Resistant to magnetic fields

CRT color reproduction can be affected by terrestrial magnetism. This is because CRT beam paths can react to even weak magnetic fields, causing a shift in where the R, G, and B beams land on the phosphors.

A typical example of this effect can be observed when using a perfectly aligned CRT monitor in an OB van. OB vans can be parked in different directions, which can change the effect of terrestrial magnetism. If the van is parked in a different direction from when the CRT was aligned, a color shift will be seen in the four corners of the screen. The larger the CRT screen, the larger the color shift. Needless to say, a similar effect will be seen when placing a CRT close to any device that produces a magnetic field, including large speakers.

As with convergence, LCD displays are completely free from terrestrial magnetism effects since they do not use beams.

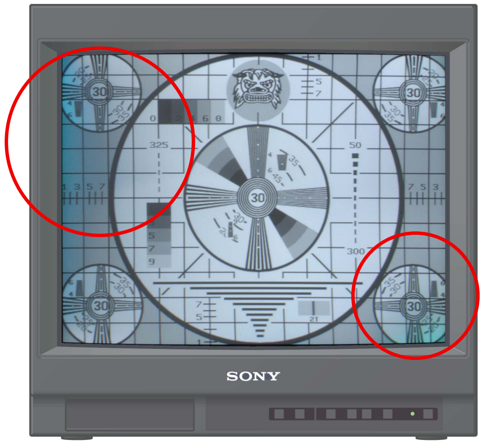


Figure 3-3. The affect of magnetic fields on a CRT

3 LCD Benefits in General

Free of Geometric Distortion

The“raw’ scanning pattern of a CRT monitor is such that a “pincushion’-shaped picture frame would be displayed on the screen - as shown in Figure 3-4 below. This is because today’s CRTs are made to be as flat as possible, while technically, the best scanning characteristics would result from a CRT screen with a curved surface.

To compensate for this pincushion nature or geometric discrepancy between the beam scan and the screen’s flatness, many technologies have been developed to align the beam scan to the CRT’s rectangular screen. As shown in Figure 3-4, the areas in the middle of the screen must be expanded to fit the CRT screen. This naturally results in the picture content, especially along the vertical edges of the screen, being geometrically distorted. For example, circular objects displayed in the corners of the screen will tend to appear as oval-shaped objects, and characters scrolled across the screen will look wider near the screen edges compared to the screen center.

In contrast, LCD displays use fixed pixels and therefore do not have geometric distortion. This is important when using the display as a monitor for creating graphics, titles, and logos that will be placed near the edges of a display.

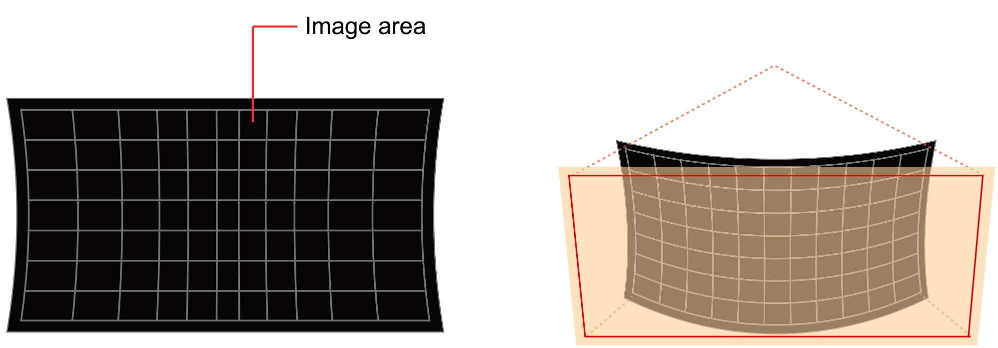


Figure 3-4. Pincushion shaped frame

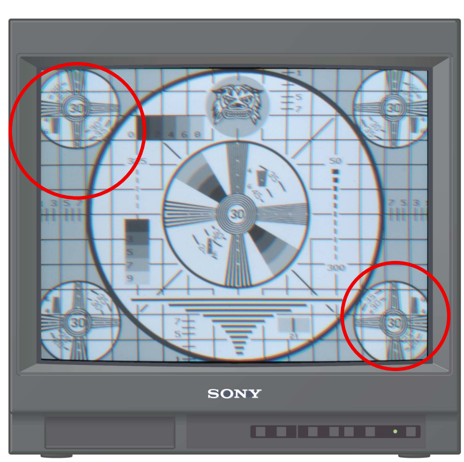


Figure 3-5. Geometric Distortion

Free of Image Burn-in

In CRTs, the amount of light that the phosphors emit decreases as the monitor is used over a long period of time.
This is not a problem when displaying moving images - as the beams hit all areas of the phosphors in a random manner and the decreased ability to emit light is averaged across the entire screen. This decrease can be electronically compensated for by applying appropriate adjustments to the CRT beams.
However, when a bright still image (which requires a strong beam intensity) is displayed on a fixed area of the phosphors over a long period of time, their ability to emit light from that area decreases faster. Consequently, they can emit less light from these areas compared to other areas of the phosphors.
This is how CRTs cause image burn-in, which is displayed as a 'ghost' of the still image.

In contrast, LCDs are completely immune to image burn-in, no matter how long a still image is displayed on the screen. This is because they do not use beams or phosphors - they simply act as a switch to guide the light emitted from the display’s backlight.
The absence of image burn-in is a huge benefit in all types of picture monitoring applications. A good example is when checking source material, or when viewing input sources in a control room where time code is constantly superimposed on the screen.
Since the time-code value itself continuously changes, this does not burn in to the screen. However, the static time code matte or 'TCR' indications constantly displayed on the screen are at high risk of burning in to the phosphors.
In POP/POI/POS applications, opaque logos or still graphics can burn into the CRT screens.
These worries are no longer the case with an LCD monitor.

4

A look into LUMA Series vs. consumer LCD displays

While the performance of consumer LCD displays can be mistakenly perceived as close to that of the professional LUMA Series monitors, there are drastic differences between the two, which must clearly be understood.
This section compares the fundamental differences between the LUMA Series monitors with home LCD TVs and PC LCD displays. It discusses several important design considerations made in the LUMA Series, critical for professional video monitoring, and how they offer added value over less-expensive consumer LCD displays.

LUMA Series vs. home LCD TVs - Interface flexibility

The ability to accept different input formats cannot be overlooked in any professional application. This is because using interface converters can result in a higher-priced and awkward system configuration.
LUMA monitors are designed for operations today, and for DTV operations tomorrow. The LUMA Series offers models that can accept almost any SD or HD video format, both analog and digital.
These include composite NTSC and PAL, component 480/60i and 575/50i, progressive 480/60P and 575/50P, and high-definition 1080/50i, 1080/60i, 720/60P, and 720/50P. The LUMA Series can also accept 1080/24PsF and 1080/25PsF.

Table 4-1. LUMA Series Interface Flexibility

	Separate Type LUMA Monitors				One-piece Type LUMA Monitors		Handheld Type LUMA Monitor	Multi-display Type LUMA Monitors	
	Standard	Option			Standard	Option*	Standard	Standard	Option
		BKM-220D	BKM-243HS	BKM-255DV		BKM-320D			BKM-320D
Composite	○				○		○	○	
Y/C	○				○		○		
RGB	○				○		○		
Component	○				○		○		
SD-SDI		○	○			○	○		○
HD-SDI			○				○		
DV	○			○			○		
VGA							○		

** The LMD-2010 and LMD-1410 do not offer SDI input.*

Figure 4-1. Separate Type LUMA monitor Connector Panel

LUMA Series vs. home LCD TVs - faithful reproduction

The signal processing used in LUMA Series monitors has been developed to reproduce input signals as naturally as possible. Simply put, a clean and high-quality signal will look clean, while a signal with noise will look noisy. This is extremely important in professional applications since picture monitors are used to check signal content as well as quality. In contrast, home LCD TVs are designed to make pictures look as clean as possible, regardless of the input signal quality. This is usually achieved by the use of noise-reduction processes. Color and contrast are also emphasized in home LCD TVs to make pictures appear as eye-catching as possible.
Manipulating the input signal for such reasons makes it difficult to judge the true signal quality on a home LCD TV.

LUMA Series vs. PC LCD displays -picture quality

Compared to PC LCD displays, LUMA Series monitors offer an incredible reduction in response time to keep motion blur of fast-moving objects to a minimum. This alone is a huge benefit of using the LUMA Series monitors over PC LCD displays, especially for monitoring video images. As with a CRT, the screen refresh rate of a LUMA Series LCD panel is synchronized to the frame rate of the input signal's vertical frequency. PC LCD displays typically refresh their screens at a fixed rate regardless of the input signal. Simply put, LUMA Series monitors will display video images with more faithfulness to the input signal.

LUMA Series vs. PC LCD displays - viewing angle

As earlier mentioned, the LCD panel used in the LUMA Series monitors has been designed for use in almost any professional picture-monitoring application. A criterion that cannot be overlooked in such applications is that pictures must be viewed by many individuals, from different angles and from different distances. With this in mind, the LUMA Series monitors have been designed to provide a wide viewing angle of 170 degrees* with minimum drop in picture contrast and brightness, and color shift.
PC LCD displays are not designed with such considerations and do not need to be. They are designed for operators sitting directly in front of a PC at the best viewing angle.

** The multi-display type LUMA monitors do not provide this feature.*

5 LUMA monitors in professional applications

This section provides details on the technical benefits of using the LUMA Series monitors in actual professional applications. It describes why the performance of the LUMA Series monitors is optimized for professional applications with respect to the characteristics of LCD technology.

LUMA Series monitor applications

The LUMA Series is suited for picture monitoring in almost any professional picture-monitoring application. Applications range from use in OB vans, studio control rooms, edit suites, machine rooms, and office desk environments of producers, directors, and other production staff.

Wide viewing angle*

Conventional LCDs have been known for having limited viewing angles. Specifically, image brightness, color saturation, and contrast would tend to look different depending on the viewing angle. This was due to the use of Twisted Nematic (TN) LCDs in which picture reproduction was accurate only when viewing the LCD panel from directly in front. To solve the viewing-angle limitations of TN-type LCDs, many new LCD operating methods and types have been developed. These include the Multi-domain, Multi-domain Vertical Alignment (MVA), and recent In-Plane Switching (IPS) types.
The LUMA Series monitors use an advanced IPS or MVA type LCD panel to provide a wide viewing angle of 170 degrees - practically equivalent to CRT monitors.

** The multi-display type LUMA Series monitors use TN-type LCDs and do not provide this feature.*

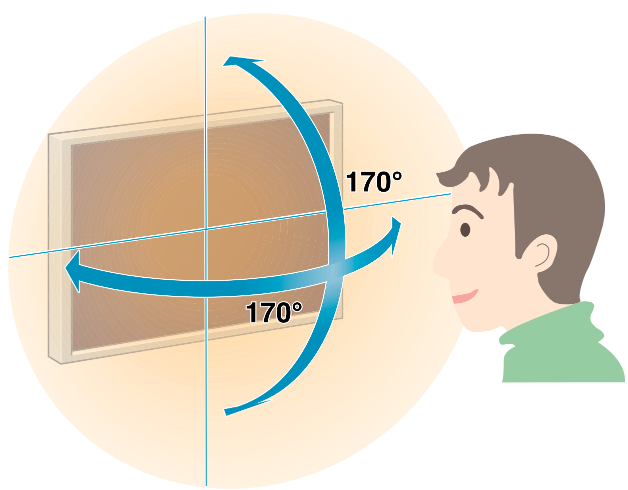


Figure 5-1.

X-Algorithm - the highest quality I/P conversion

As described earlier, LCD monitors are designed to display all video signals in progressive mode. For interlace signals, this means they must first be converted to progressive signals to be displayed on the LCD panel. For example, to display a 60-Hz interlace signal, 60 progressive frames must be created.

Although many technologies have been developed to handle this task, this process can have a large effect on picture quality.

For example, conventional LCD monitors display interlace signals on the progressive LCD array by combining two adjacent picture fields into one picture frame. However, since each frame is formed of two fields, this method is effective for static areas of the image but can also introduce jagged shape noise along the oblique direction of fast-moving objects.

For fast-moving objects, 'line interpolation', which concludes within each field, can reduce this jagged shape noise. In this method, the absent lines of the interlace field are created by using data from the lines above and below them to form a progressive frame. This is called 'linear interpolation' a method that works well for moving objects but is not appropriate for static images.

Combining the best of the two, LUMA Series monitors* use a picture-adaptive 'Still Mode' and 'Motion Mode' in the I/P conversion process. This is called X-Algorithm. By examining a sufficient number of preceding fields, X-Algorithm accurately detects the 'Motion' factors of the image on a pixel basis. For pixels where motion is not detected, the I/P conversion will simply copy pixels from the preceding field to create the absent scanning lines and form a progressive frame.

In contrast, when motion is detected, picture frames are created from interlace signals on a field basis by interpolating each pixel in the absent lines. X-Algorithm carefully examines a larger area of the image surrounding the absent pixel, and uses information from the two most logical pixels to generate and insert a most natural pixel.

The direct result of this adaptive I/P conversion - much smoother image reproduction for pictures both in the still and moving areas.

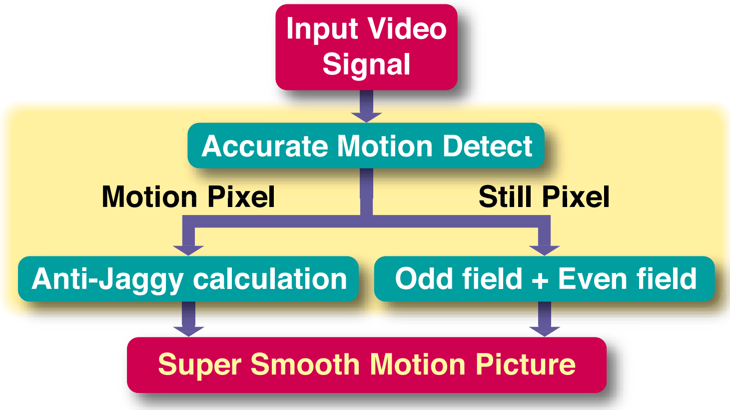


Figure 5-2. X-Algorithm I/P conversion process

** X-Algorithm is a technology used to display clean interlaced SD images on HD-capable LUMA Series models. When displaying interlaced SD signals on such monitors, the signal must be up-converted to match the higher vertical resolution of the LCD panel. In such cases, the accuracy of the line interpolation process becomes extremely critical, making the use of X-Algorithm essential. In contrast, for SD exclusive models that use LCD panels optimized for SD images, this feature has less impact on picture quality and therefore is not required.*

In summary, X-Algorithm is used to display clean 480/60i and 575/50i on the separate type LUMA Series models.

5 LUMA monitors in professional applications

The uniqueness of X-Algorithm

As explained above, when an interlace SD signal is displayed on a high-resolution LUMA Series LCD panel, X-Algorithm is used to interpolate absent scanning lines for moving picture areas. In general, video signals with busy picture content can have abrupt changes in the horizontal, vertical, or diagonal directions. This can have a critical effect on interpolation accuracy. Compared to other interpolation methods, X-Algorithm keeps this effect to a minimum through the use of highly advanced and unique technology in its three core processes:

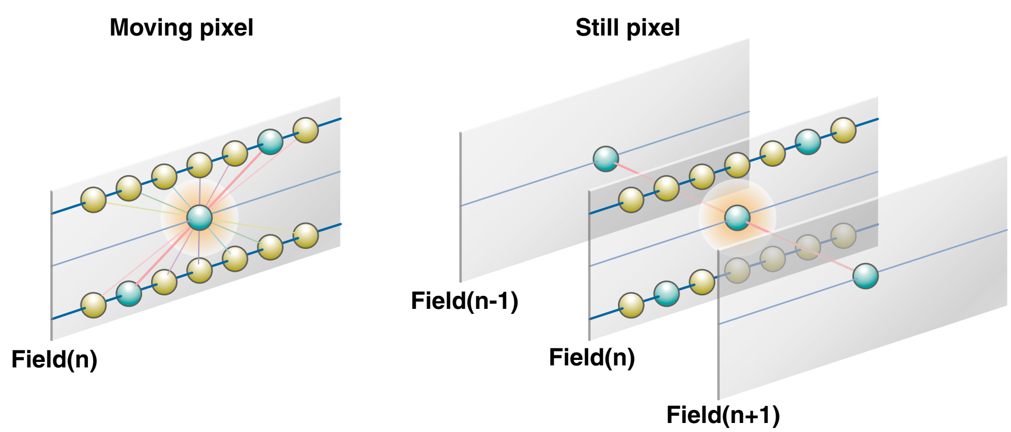


Figure 5-3 'Liniar imterpolation' and 'pixel copying' in X-Algorithm

1. Accurate detection of motion or still content

To obtain the best I/P conversion results, line interpolation should be used for moving picture content only, while for still picture content, pixels should be simply copied from the preceding field. Simply put, extremely accurate judgment between motion and still picture content is required.
In X-Algorithm, a larger number of preceding fields are examined and compared to analyze whether the I/P conversion for a given field should operate in motion or still mode. When motion mode is selected, an intelligent line interpolation method - unique to X-Algorithm - is used.

2. More variations of line interpolation

When line interpolation is used, the key to creating an accurate pixel depends on which existing pixels are used to calculate the absent pixel.
As shown in Figure 5-3, X-Algorithm selects the best combination of pixel pairs along seven different directions to calculate the missing data. This allows absent pixels to be accurately calculated for any type of picture content, including images with diagonal moving edges, which can be a challenge for other I/P algorithms.

3. More advanced image analysis for choosing the correct interpolation direction

To take full advantage of the seven line interpolation combinations, correct analysis of the surrounding picture content is required.
X-Algorithm carefully examines a larger area of the picture content surrounding the absent pixels and makes the best selection from the seven interpolation choices.

Three choices of I/P conversion

X-Algorithm offers the best I/P conversion results, but also causes a delay of 0.5 frames due to the motion-detection process.

In typical professional picture-monitoring applications, this delay is virtually unintelligible and does not become an issue.

However, for the rare case that this cannot be ignored, Sony separate type LUMA Series monitors offer two other types of I/P conversion methods. These are:

- X-Algorithm with no motion detect
- Line Doubling

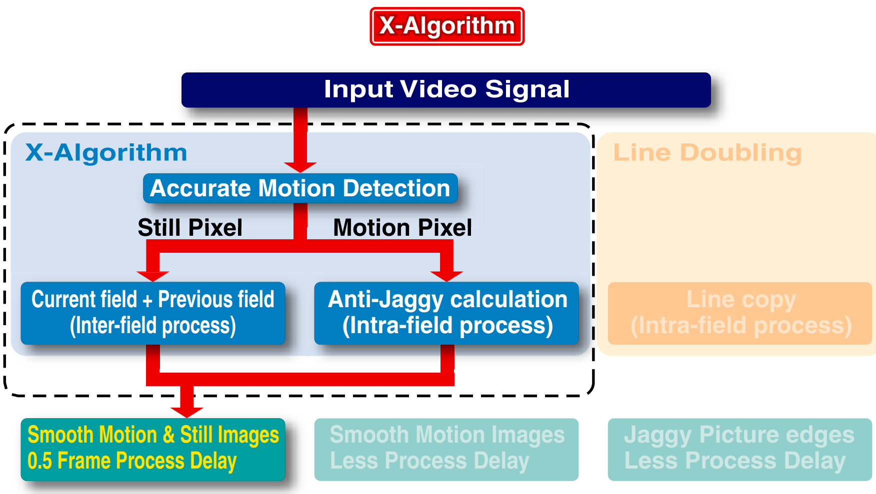


Figure 5-4. X-Algorithm

- X-Algorithm with no motion detect

This method uses the same line interpolation algorithm as X-Algorithm, however, the motion-detection process is bypassed and line interpolation is applied to all picture content - both static and moving. This method has the same effect of keeping jagged shaped noise to a minimum for moving images, but does not offer the same quality as X-Algorithm for still images. This can be an issue when monitoring station logos, superimposed time code, static text characters, and photo images.

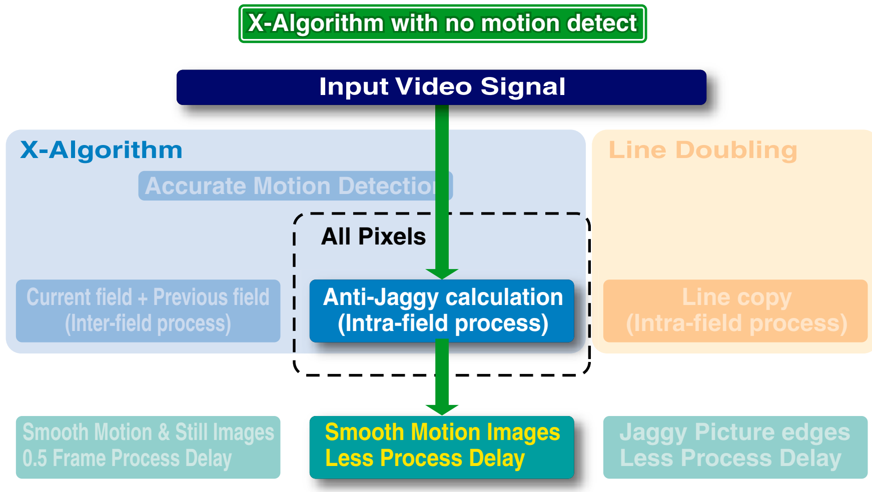


Figure 5-5. X-Algorithm with no motion detect

5

LUMA monitors in professional applications

- Line Doubling

'Line Doubling' is one of the most commonly used I/P conversion methods in conventional systems. To create a progressive frame from an interlace field, the existing lines adjacent to the absent lines are simply copied. The advantage of this method is that it is technically simple and is achieved with minimal signal delay. However, since it is not picture-content adaptive and because lines are simply copied, it can often introduce jaggy noise along picture edges.

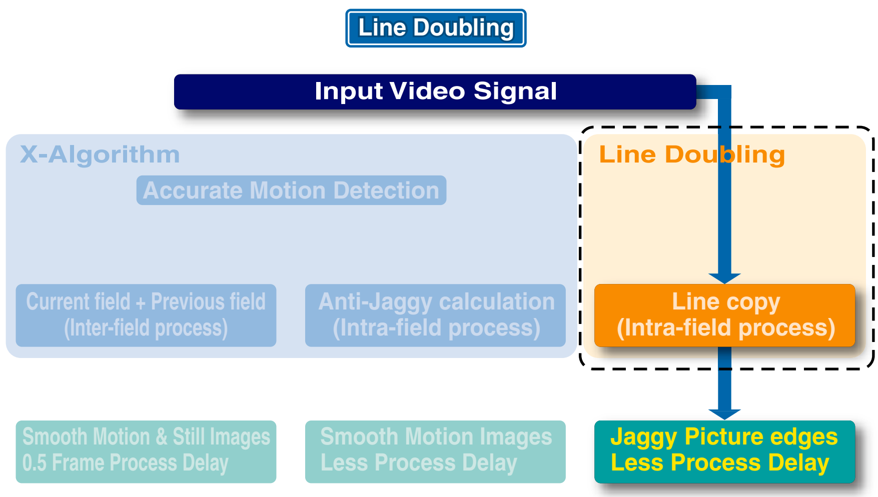


Figure 5-6. Line Doubling

- Summary

The following is a quick-reference chart that provides a comparison between the three I/P conversion methods available on high-end separate type LUMA Series monitors.

Table 5-1. Picture Quality Comparison

	X-Algorithm	X-Algorithm with no motion detect	Line Doubling
Motion image	◎	◎	△
Still image	◎	○	○
Process Delay	△	◎	◎

Precise LCD driver bit resolution

In all LCD displays, each pixel in the LCD array is digitally controlled by a driver signal created from the input video signal. The key concern with this driver signal is how many bits are used, an important parameter that governs the dynamic range of the LCD display.

While most conventional LCDs use a 6-bit driver signal, the LUMA Series monitors use an 8-bit signal for this task, another essential feature that allows them to reproduce high-contrast images with stunning color depth and saturation.

Bright panel performance even in bright environments

With CRT monitors, picture contrast can largely be affected when the monitor is subjected to strong ambient light. In general, strong ambient light can reflect from both the CRT's face glass as well as from the R, G, and B phosphors - the latter causing contrast degradation, or making the picture look creamy. This is because CRT phosphors are actually white in color, and can reflect a considerable amount of ambient light depending on its intensity. This effect is particularly notable in dark areas of the picture. Needless to say, LUMA Series monitors do not use phosphors. The surface of the LCD device by nature does not reflect light, avoiding contrast drop due to strong ambient light.

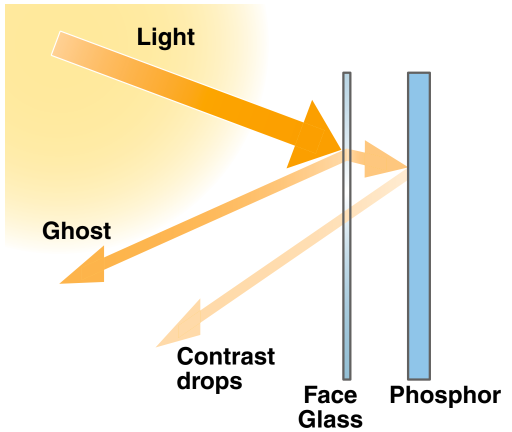


Figure 5-7. Reflection on a CRT

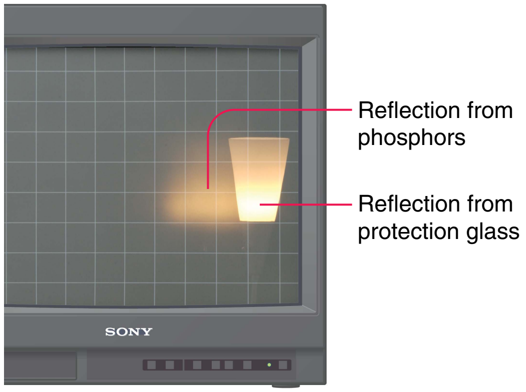


Figure 5-8.
Reflection on a CRT -
An example of both the phosphors and protection glass reflecting bright ambient light.

Anti-reflection coating* (AR layer)

Although the LCD device itself does not reflect light, an effect similar to light reflecting from a CRT's face glass can occur depending on the material used for the LCD display's surface. This effect typically occurs as an ambient light source, such as a fluorescent light, appearing as a ghost in the screen.

However, the LUMA Series monitors keep this effect to a minimum by adopting an extremely effective anti-reflection coating on the panel surface. This coating contributes to changing the refractive index of ambient light, preventing it from bouncing off the display's surface to the viewer's eye.

** The multi-display type LUMA monitors and One-piece type LMD-2010, LMD-1410 do not provide this feature.*

5 LUMA monitors in professional applications

The benefits of reduced reflection characteristics

With CRT monitors, special care has been required to keep ambient light from reflecting off the panel glass or CRT phosphors. Studio control rooms and edit suites must be kept dark to avoid contrast degradation, and special spotlights pointed directly at production documents are required to avoid ghosts appearing on the screen. Using CRT monitors in ENG and EFP applications has also been a challenge, requiring special monitor hoods and careful placement of the unit to avoid sunlight entering the screen.
The LUMA Series monitors reduce such concerns and bring an innovation into picture monitoring. And equally important, their panels are slim and compact, allowing use in bright and space-constrained office environments. For example, they are ideal for checking video material on a busy producer's or director's desk.

Accurate white balance

Needless to say, the white balance of a professional-grade monitor should be as accurate as possible, not only in the high-light levels but throughout the entire grayscale range from black to white. Conventional LCD monitors only allow adjustment at the brightest light level. This won't compensate for any inaccuracies in grayscale as the picture changes, especially in the darker areas.
With the LUMA Series monitors, white balance can be adjusted at both the low-light and high-light levels. Having the ability to adjust the white balance at two points naturally allows the LUMA Series monitors to provide more accurate white balance throughout the grayscale range.

Accurate color reproduction

The R, G, and B sub-pixels of LUMA Series monitors use carefully selected color filters with the highest level of purity, to provide a color gamut extremely close to the color phosphors used in professional CRT monitors. This largely contributes to the rich color reproduction of the LUMA Series monitors.

Flexible color temperature adjustment

LCD displays use one light source type with a fixed color temperature. For this reason, one might think that the color temperature of an LCD display cannot be adjusted.
LUMA Series monitors allow the adjustment of color temperature by applying offsets to the driver voltage supplied to each R, G, and B sub-pixel. Since the aperture of each sub-pixel is controlled by this voltage, an offset in the color balance will also occur, allowing different color temperatures to be produced on the LCD screen.

Gamma control

In CRTs, the picture brightness and the input signal voltage have an exponential relationship, instead of being directly proportional or 'linear'. The exponent factor used to describe this relationship is called the CRT's gamma - which is about 2.2.
The 'raw' relationship between brightness and input voltage of an LCD is completely different from a CRT, due to the different mechanism used to produce pictures.
However, LUMA Series monitors are capable of providing similar gamma characteristics to a CRT monitor by controlling the LCD drivers to emulate a CRT monitor.
With LUMA Series monitors, gamma settings can be flexibly selected in the same way as a CRT monitor.

6

A deeper look into LCDs

In order to establish a correct assessment on LCD monitors, it is important to know the fundamentals of how an LCD device works.
The following explains the basics of how an LCD device controls light by observing the characteristics of Liquid Crystals and other key components used in the device. The conventional TN (Twisted Nematic)-type LCD is used as an example. By reading through this section, you should get a good grasp on the general mechanism of an LCD device to help build your knowledge and understanding of current and future devices.

Liquid Crystal - a unique substance

As its name indicates, a Liquid Crystal has the characteristics of both a liquid and a crystal (solid) or can be said to be a combination of both. The molecules of a Liquid Crystal have an orderly orientation like a solid, while they can also move around like a liquid. This nature of the Liquid Crystal is the key to controlling the light that passes through the LCD device.

The Liquid Crystal characteristics used in an LCD device

Liquid Crystal substances have many interesting characteristics, but the ones used to control light in an LCD device can be summarized as follows:

1. Liquid Crystal substances consist of long molecules. Interestingly, these molecules align orderly in their long directions. When the molecules come in contact with a so-called 'alignment film', which has microscopic grooves, the molecules align themselves with the grooves. By 'sandwiching' the Liquid Crystal substance between two alignment films arranged with their grooves at a 90-degree angle, each layer of molecules gradually rotates to form a spiral chain of molecules, so the entire twist (of molecule layers) is 90 degrees from film to film.
2. The orientation of Liquid Crystal molecules can be changed by applying an electric field. More specifically, the molecule layers twisted at 90 degrees can be untwisted by applying voltage in the vertical direction of the LCD device. The amount that layers untwist depends on the voltage applied.
3. Liquid Crystal molecules change the vibration plane of light to match their own orientation.
4. Liquid Crystal substances are transparent and transmit light.

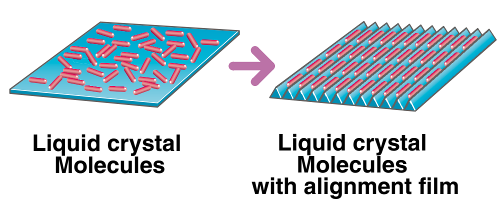


Figure 6-1.

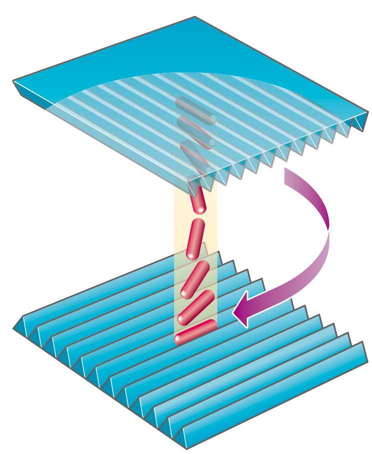


Figure 6-2. Molecule chain twisted 90 degrees by allgnment films

The characteristics of light and LCD polarized panels

LCD devices use the unique characteristics of light and how it travels through polarized panels for its control.

-The characteristics of light

Light consists of a number of waves that vibrate in a 90-degree angle to the direction that they travel. In other words, one beam of light is formed of many waves that vibrate along many different planes. When light enters the Liquid Crystal, the vibration planes of these waves are twisted to match the long direction of the Liquid Crystal molecules.

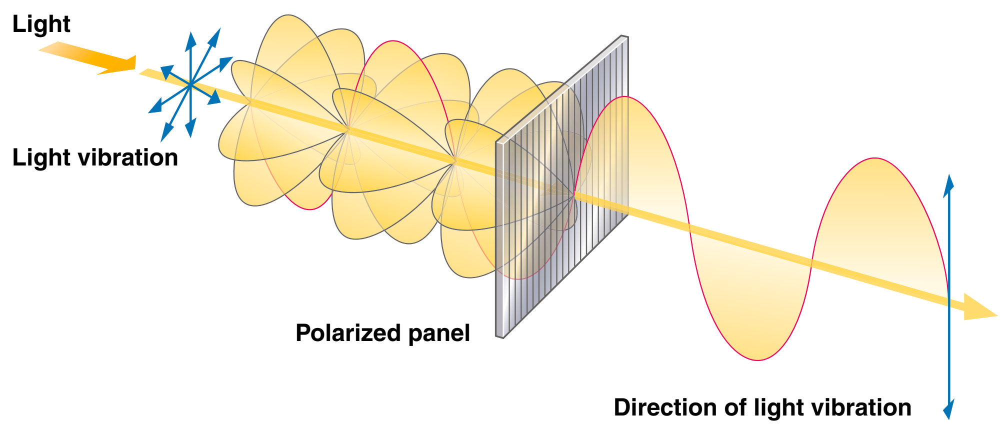


Figure 6-3.

-Polarized panels

Polarized panels are used in LCD devices to filter or pass light waves vibrating only along a specific plane. Light waves vibrating along different planes are 'blocked' or do not pass through the polarized panel. Only the light that passes the two polarized panels sandwiching the Liquid Crystal will be seen on the display.
In LCDs, the polarized panels are aligned in the same direction as the alignment films.

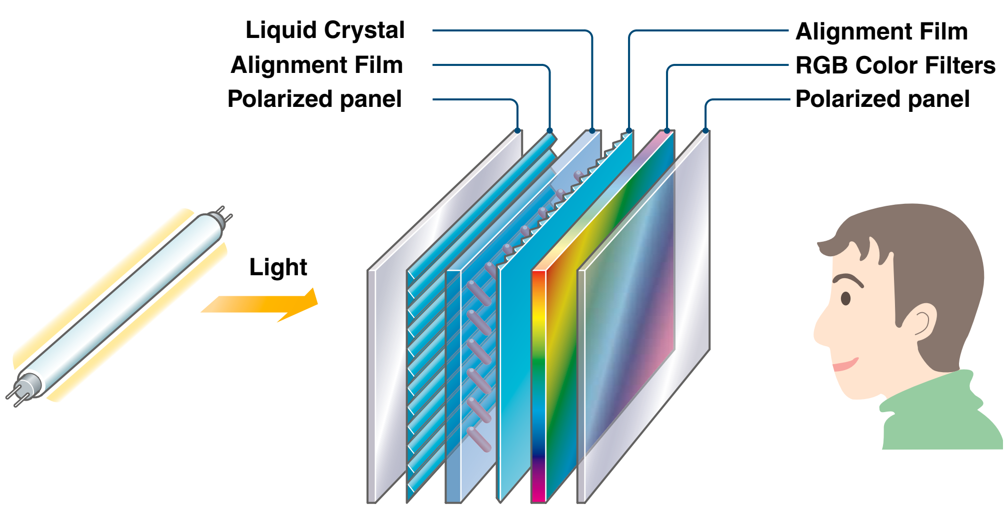


Figure 6-4.

6 A deeper look into LCDs

-The mechanism of controlling light

As explained above, the Liquid Crystal molecules in contact with the two alignment films align themselves with the filter grooves and, therefore, are at a 90-degree angle. The molecules in-between rotate in directions such that the molecules from top to bottom of the Liquid Crystal form a twisted chain.
This twisted chain is the normal orientation of the molecules when voltage is not applied. In this orientation, the light wave that passes the first polarized filter is twisted along the twist of the molecule chain, and therefore passes the second polarized filter. Because light passes when voltage is not applied, this mode is called 'normally white'.
When voltage is applied, the molecules gradually untwist and stand vertical. When they stand completely vertical, the light entering the first polarized filter will no longer be twisted (by the molecules) and its vibration plane will no longer match the second filter. Needless to say, this light will be blocked at the second filter and will not go to the other side of the LCD device. The amount of light that passes can be linearly controlled depending on the voltage applied, i.e., how much the molecule chain is untwisted or how vertical the molecules stand.

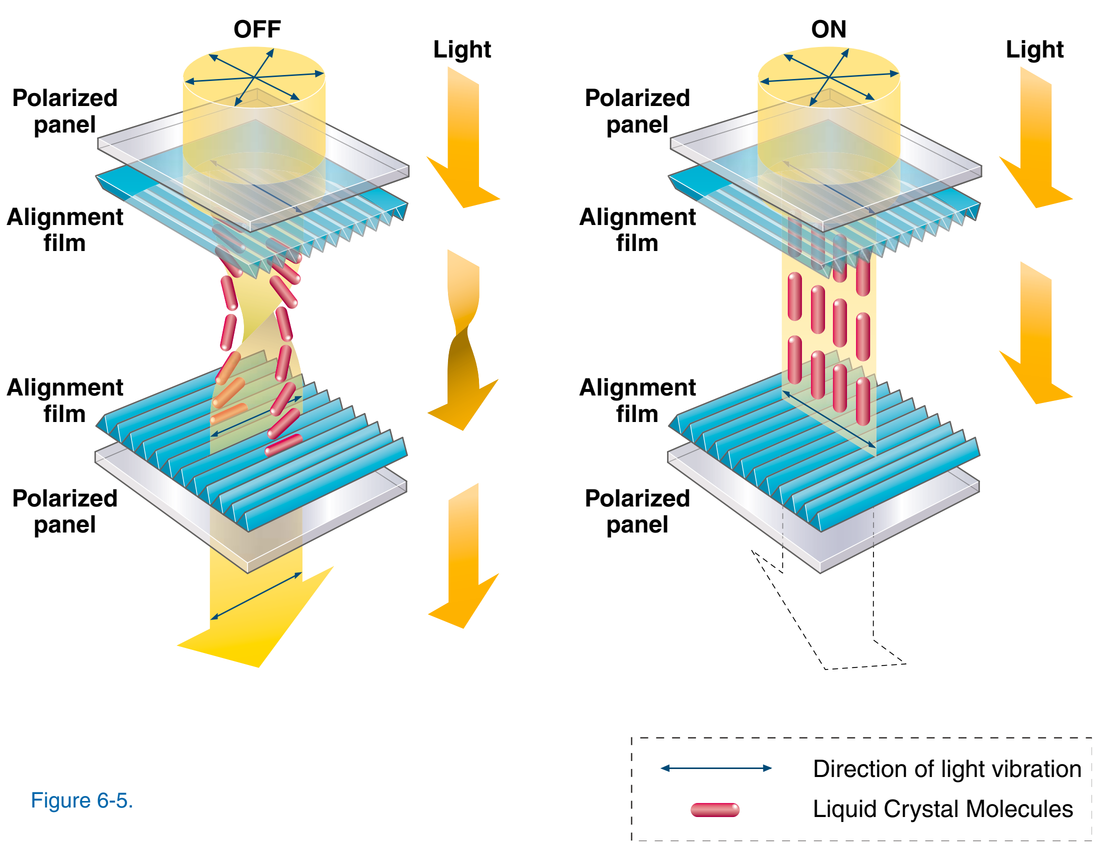


Figure 6-5.

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