

# WHITE PAPER

## Why viewing angle is a key element in choosing an LCD screen

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## Executive Summary

Excellent viewing angle is a key element by which an LCD monitor is picked in a buying decision. The cost-benefit of moving from CRT monitors to flat panels is now compelling, and advances in screen technology mean that some LCDs are capable of competing with the older technology and winning.

Given the small footprint of LCDs it is possible to use much larger displays on desktops and elsewhere. Larger displays need to have the highest possible contrast at greater viewing angles to let the user get the best from the screen's width and height.

Now that LCD screens can be produced to meet these exacting standards it is possible to gain even more benefit from using them. Their increasing use in retail, interiors enhancement and in the home, as well as in the office, attests that all will benefit from greatly more usable viewing angle.

Combining the technological advances in LCD screen manufacture with flexibility of design and operation, ViewSonic's VP range of LCD monitors represents the combination of size, viewing angle, image representation and ergonomic design.

## Introduction

Traditional monitors are on the way out. The arguments for moving to LCD (liquid crystal display) rather than CRT (cathode ray tube) computer monitors are now so compelling that it is hard to imagine more than a few niche business where CRTs are preferable.

One perceived issue with moving to LCDs is cost efficiency, in that they are priced higher than traditional CRTs, but this is missing the point.

Though it can be true that a superficially attractive price difference may exist, especially for lower-end units, it does not factor in the greatly increased longevity of LCDs, their greater flexibility, their greatly reduced footprint, their impact on the health and safety of employees, and their lower environmental impact. In other words, it's necessary to factor in the total cost of ownership, or TCO, of buying an LCD.

We are likely to make buying decisions based on what we can see as much as what we abstractly know. Therefore, LCDs find themselves competing with CRTs based on certain key factors. ViewSonic believes that perhaps the most important of these factors is viewing angle.

ViewSonic's screens, especially its flagship VP range of monitors, represent excellent value for money and superb viewing angles.

A screen's viewing angle is vitally important in making a buying decision for several reasons:

- As the size of LCD monitors increases, viewing angle becomes vitally important in everyday use
- The greater the useful viewing angle is, the more flexibly the monitor can be deployed
- Employees want their equipment to work around them, rather than the other way round. User satisfaction and health and safety means deploying a screen that can adjust to the working environment
- When using multiple screens, only one of those screens will normally be directly in front of the user

We will delve into these reasons more in Part Two — Why is viewing angle important.

But what does any vendor mean when it gives viewing angle specifications for its products?

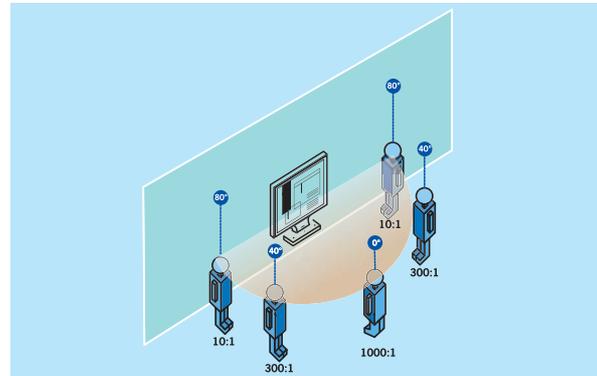
## Part One — Viewing angles

Viewing angles are a key feature in buying LCD screens. Why, otherwise, would those numbers always be touted by LCD screen vendors? Each vendor wants you to believe their product is superior in viewability, but just quoting an angle is so far from the full story that it could be construed as misleading.

Finding out why means explaining how viewing angles are calculated, which allows us to see where figures can be massaged.

Simply quoting the number 150/140, for example, would mean that the screen has viewability over a total angle side to side of 150 degrees and up and down 140 degrees. So in theory we have our number, and we can base our buying decision on that. Well, not quite. We can see images on the display at up to 75 degrees away from dead-ahead of the screen in the horizontal plane, so left or right of dead-ahead. We can see images on the display at up to 70 degrees in the vertical plane, above and below dead-ahead. For this paper will use dead-ahead to mean a user looking at the screen's centre, perpendicular on both axes to the panel — 0 degrees.

But what of the quality of those images, and how do they degrade from dead-ahead? Fundamentally this comes down to contrast ratio (CR), the foremost element of the buying decision made on what one can see.



Contrast at different angles away from 0° or straight-ahead, based on the ViewSonic VP930 19in screen

### What is contrast ratio and why is it important?

Contrast ratio is the ratio of the brightest image to the darkest image on the screen. For a 1000:1 contrast ratio screen, such as the 19in, 20in, and 21in VP screens, the 'white' is one thousand times brighter than the 'black'. Ambient conditions will of course impact the measurement. It is important to note here that LCD screens do not suffer from adverse ambient conditions such as reflections or glare nearly as much as do CRTs.

Contrast is the main measurement that determines viewing angle, because it is the primary measurement of how well the image as displayed can be seen. In other words, how much contrast you can see will depend on how near to dead-ahead your eyes are positioned to the optimum viewing angle of the screen.

Contrast ratio as quoted is always primarily the maximum possible achievable in the dead ahead position, and is usually measured in optimum conditions. By how much this decreases, ie becomes ever closer to 1:1 (no perceivable image), is a vital factor in viewing angle because it is the amount of contrast, as well as other perceived image quality issues (such as colour shift and response time), at how much of an angle that matters.

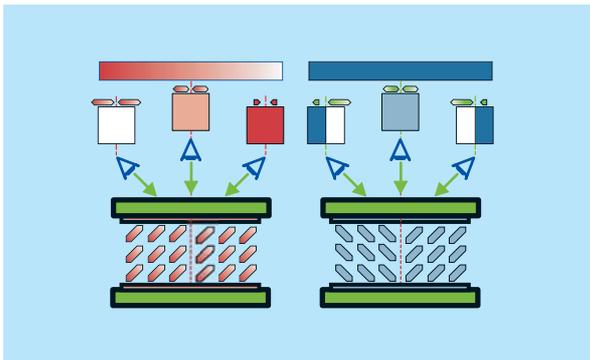
To an extent, a simple statement of viewing angle is arbitrary, because the angles alone cannot incorporate the quality of the image at the outer limit of a screen's viewing range. This is why it is important in making buying decisions to know more than just the straightforward angle numbers.

One vital element in determining viewing angle in relation to contrast ratio is to know by what measure that limit is set? In other words, what is the contrast ratio at the limits for viewing angle given?

So it's vitally important to know what the lower limit of contrast ratio is when looking at the seemingly straightforward viewing angle figures. ViewSonic states both 10:1 and 5:1 limits. The important thing is to have that limit stated.

With the ViewSonic VP930 19in screen, for example, the contrast ratio will be at least 10:1 at 85 degrees from dead-ahead both in the vertical and horizontal planes. At that angle the user is almost looking at the screen side-on, which is hardly likely to be necessary in normal working conditions.

But viewing angle is not so much to do with pushing back the 10:1 limit, but how much contrast there is across rest of the range. For example, the VP930, during engineering evaluation, gave between 310:1 and 353:1 contrast ratio at 45 degrees either side of dead-ahead.



**Non-MVA screens (left) can shift colour at different angles due to crystal alignment. MVA units (right) counter this by shining light in many directions**

Another key aspect of determining actual viewing angle, ie how good your screen really is at increasing angles, is colour shifting.

At increasing angles away from dead-ahead colours in different kinds of screens may shift, discolouring the image. Obviously you want the best contrast ratio and the least colour shifting as you move away from dead-ahead. Using the latest Premium MVA technology, colour shift is dramatically reduced over the broadest possible range of viewing.

Premium MVA can achieve a dramatic reduction on colour shift, which makes colours look more correct and the overall colour mix of the image more consistent

across a greater viewing angle. All but one of the screens in ViewSonic's new VP range use Premium MVA technology.

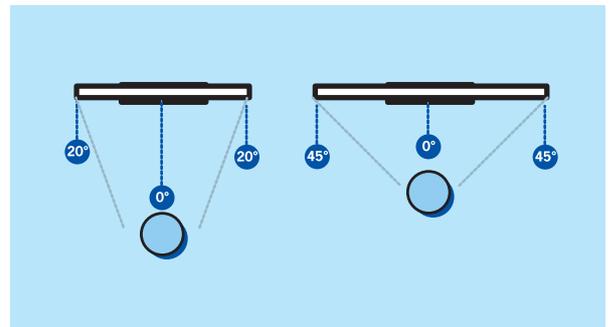
## Part Two — Why is viewing angle important?

Viewing angle comes into play whenever LCD monitors are deployed. In this section we will look at the primary reasons why viewing angle is a key consideration when making a buying decision on which type of screen should be used, and briefly examine the technologies that make LCDs capable of ever increasing viewability.

*As size increases, so does the need for good image representation at higher angles*

As the size of LCD monitors increases, viewing angle becomes vitally important in everyday use. In large and especially widescreen formats, LCDs will be as sharp as they can possibly be in the centre but, because the user is looking at the edges of the screen at an angle that increases in proportion to screen size, outer edges may suffer in perceived quality of image. This is not so much of a problem for LCD TVs, where the audience is normally further away, but in the workplace users generally sit close enough to make this important.

Therefore, for larger LCD screens, higher quality image representation at higher viewing angles is vital to maintain image consistency from the user's perspective.



**Smaller screen (left) edges are near enough not to cause large viewing angles, but further edges of larger screens cause larger angles**

*Combining the natural advantages of LCDs with excellent representation at high viewing angles expands deployment possibilities*

The greater the useful viewing angle is, the more flexibly the monitor can be deployed. There are many environments that screens are or can be deployed in which several or many people will be viewing the screen, eg meeting rooms, reception areas and the growing use of screens to enhance retail environments. Excellent viewing angle makes these scenarios possible and practical.

*For multi-screen users some LCDs can approach the functionality of CRTs while dramatically reducing footprint and TCO*

For users with multiple screens, only one of those screens will normally be placed in the dead-ahead position. With excellent viewing angles, the other screens can safely be changed to LCDs without sacrificing viewability, at the same time gaining the great advantages of LCD.

Let us take two examples of multi-screen users: traders and IT support personnel. For both these types of users, several applications are regularly open simultaneously, and large amounts of data need to be represented to the user without needing to flick from application view to application view. Traditionally the approach to this problem was to provide several screens arrayed in front of the user. Using CRTs this meant a large section of available physical desktop was taken up with monitors. With LCD units, monitor footprint can be drastically reduced, but in the past deployment may have been impacted by concerns over viewing angle.

LCDs with high quality representation at higher angles, such as ViewSonic's VP930, can be deployed without pushing the user into confronting a circle of LCDs, something that would be necessary if viewing angle was low. Also, if data is represented through colour-coded systems, as is often the case in trading or in IT, then it is vitally important to ensure maximum possible colour representation even at angles that depart from the dead-ahead. Of course, IT and trading are far from the only areas in which high-quality representation at angles away from straight-on are important.

There is also the possibility now that units such as ViewSonic's VP2330wb are available to move some multi-screen users over to a single screen without significant loss of virtual desk space. This is primarily because the VP2330wb has almost the same total screen area in terms of pixels as two 17in screens — up from 1280 to 1920 pixels horizontal. This could significantly cut the number of total screens deployed in multi-screen environments, and in terms of asset management alone this represents a step forward.

For other users who have two screens because they manage multiple applications habitually, a large-format widescreen LCD monitor such as the VP2330wb would allow for multiple windows to be open while maintaining high contrast from the user's perspective out to the edge of the screen.

*Switching to ergonomic, high-VA LCDs reduces workstation stress and enhances user experience*

Employees want their equipment to work around them, rather than the other way round. This is far easier to do with an LCD, but LCDs have in the past suffered from not being practically viewable from angles other than straight on.

If there is no need to position a monitor away from the dead-ahead position, and the working environment is such that the users can and are willing to adjust themselves to suit the screen's placement, then highly cost-efficient LCDs with slightly lower viewing angles can be put in place. But if this is not the case, it is far better in terms of employee satisfaction as well as health and safety to deploy a screen that can adjust to the working environment. Higher quality, high viewing-angle LCDs such as those from ViewSonic have plenty of ergonomic features to help with this.



Multi-panel LCD screen for market trader

There are two classes to the ergonomics of screens: the mechanical or physical ergonomics of the unit, and the performance of the unit itself, referred to as front of screen performance (FOS).

Screens such as those in the VP range possess a great deal of physical flexibility — they can be adjusted to pivot (landscape to portrait), height, tilt and swivel to 270 degrees. This adds a huge ergonomic capability to the screens, allowing a unit that has excellent viewing angle to be positioned with far greater flexibility than can be achieved with a CRT. This applies both to uses on desktops and in diverse situations such as retail and conferencing.

High-quality, high viewing-angle LCDs such as the VPs also possess excellent FOS qualities. LCD monitors by their nature do not flicker as CRTs must, to a greater or lesser extent. Also, reflections from environmental light sources such as internal lighting or sunlight are drastically reduced using LCD monitors. Reflection problems are a greatly understated issue users have with CRT monitors, and cause eye fatigue and dissatisfaction with office placement and equipment.

## Technologies making LCD monitors easier to see at any angle

There are several key technologies used in LCD screen manufacture that enhance viewing angle:

### Reduced cell depth

One of the determining factors of how much light escapes a cell, or sub-pixel, in an LCD screen is the depth of the cell. Light passes from the backlight through each cell, which then escapes through the front or top of the cell. The shallower the cell is, the more light can escape out at greater angles.

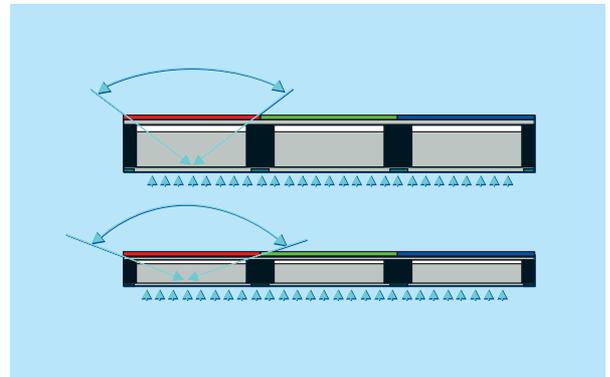
Combine this effect with increasing the light from each cell, and you get brighter colours at increased angles. Increasing the light comes partly from increasing the aperture ratio of each cell.

### Increased aperture ratio

In roughly the same way as you might want to let more light onto a CCD or photographic film in a camera by opening the aperture, increasing the aperture ratio of each LCD cell or sub-pixel will allow more light through from the backlight, meaning greater brightness for no more power consumption. This allows more complex and more

capable technology such as MVA units to produce very high brightness levels, measured in Nits, which are equivalent to candelas per square metre  $\text{cd/m}^2$ .

This is achieved by reducing the size of electronic elements of each cell. By reducing the size of the thin film transistor and the bus lines which transmit energy to the cell, more of the surface area of the cell, or sub-pixel, can emit light.



Advantages of reduced cell depth

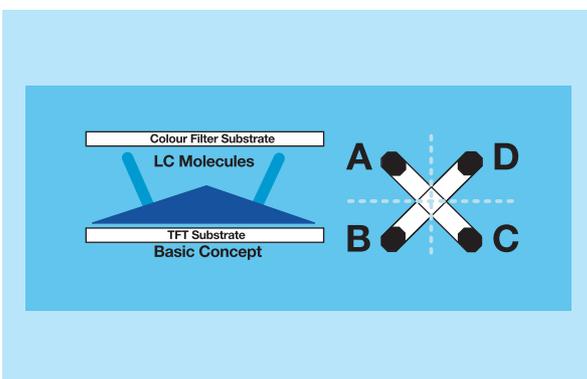
## MVA technology

MVA, or multi-domain vertical alignment LCD technology, gives a uniform dispersal of incident light. Higher levels of contrast can be observed over a wide viewing angle. ViewSonic's VP range uses Premium MVA technology in all but the VP730.

The technology works by 'spraying' the light from the backlight uniformly in four directions, which can be likened to North East, South East, South West and North West on a compass, which we will call A, B, C and D here. This light is of course also focused straight out. This is achieved using an added prismatic element on the bottom of the LCD cell to direct light out in the four directions.

Premium MVA technology achieves remarkable response time from white to black as well as grey to grey. White to black (or black to white for some types of panels) means the speed with which a cell on a screen can

cycle from 10 percent to 90 percent 'on'. The extremes of 0 and 100 are difficult to detect and measure. The intermediate contrast range (grey to grey) response times are also improved. Overall response times for ViewSonic's VP range rival what was once the domain of fast but low viewing-angle screens and plasma screens, at 8ms.



Shining light through a prism mounted on the bottom of each cell (left) allows light to emerge from each viewing quadrant (right)

This MVA technology used by ViewSonic combines a wide aperture ratio for superior brightness and very crisp detail, super-wide viewing angles, fast response times giving excellent motion image display, very high contrast ratio for clear vibrant colours and lower power consumption, reducing running costs.

## Part Three — Fitting the screens to your needs

This paper has outlined why excellent image representation at higher viewing angles is vital, but this does not mean that all your varied business needs will be met by screens that meet those criteria. Sometimes you need to weigh outlay against usability.

ViewSonic's VP range commences with a 17in unit, the VP730, which uses tried and tested TFT twisted nematic (TN) technology. The VP730 is perfect for deployment in single-user environments where response time, image sticking and cost are the most important buying decisions.

Gaming and video editing are areas where the fast response time of TN screens is very useful. TN screens also serve well in environments where the screen will not be used all the time, or where there is little change in the image used on the screen. Server unit screens, for example, are not regularly used but display roughly the same screen image for large amounts of time. With CRTs, for example, this can result in image sticking, or screen burn. Customer-facing electronic points of sale also often show a relatively static image. TN screens can be significantly more cost effective than other LCD screens — sometimes up to 40 percent less outlay than larger screens.



**ViewSonic VP730 17in  
TFT-TN screen**

### When size matters

But for many modern business environments, more capable and flexible units are required.

All other screens in ViewSonic's VP range from the 19in VP930 upwards use Premium MVA technology. ViewSonic's Premium MVA units provide high image stability, excellent colour representation and very fast response times, as well as very wide viewing angles with high contrast ratio. They are ideal corporate workhorses, suitable for a wide variety of business applications, from meeting rooms to receptions, multi-user environments to presentations.

Most users now find themselves having three to four applications open at once. This is the environment in which larger monitors come into their own, especially when they can boast excellent consistency of contrast ratio in all directions.



**ViewSonic VP2330wb 23in widescreen panel**

ViewSonic's 19 and 20in monitors, the VP930 and VP2030b, provide large desktops with superb brightness, excellent contrast ratio (1000:1) and colour representation alongside minimal colour shifting and very fast response times of 8ms. The 20in VP2030b outperforms the VP930 in terms of brightness (250 vs 300 nits) and in resolution, offering 1600x1200 pixels. A 21in unit, the VP2130b, will add to this possible selection for standard format screens.

ViewSonic's VP range is topped by a 23in widescreen 16:10 format monitor. The VP2330wb represents the next generation of widescreen Premium MVA monitors, allowing the user to display a desktop not far from that which two 17in monitors can display, without the accompanying footprint.

With an 8ms response time, resolution of 1920x1200 and 800:1 contrast ratio, the VP2330wb is as capable of delivering video as it is maintaining excellent colour for presentations. But the VP range's strength really lies in the fact that, using the latest technologies, a user can adjust the screens to suit his or her working environment and use the whole width of the screen, keeping contrast ratio and colour representation high. Running multiple applications and keeping track on them on the same desktop has never been so easy.

## Part Four — Business benefits

LCD monitors cost less to run, take up less space, cost businesses less in cooling as they give out less heat than CRTs, and save money on maintaining health and safety and workstation ergonomics for employees. LCD monitors are inherently easier to manipulate into the optimum viewing position than CRTs. Employers standardising on LCD screens are clearly doing everything in their power to address employees' ergonomic needs.

It is not always possible to put a finely tuned cash value on maintaining employees' workstation safety and health, but reducing reflections and making screens capable of vastly flexible ergonomic changes to suit the user cannot but increase workplace health, decrease user dissatisfaction and increase productivity. With more desk space, less reflection and excellent adjustability, staff will be happier using LCDs.

Flat panel LCDs use up to 75 percent less power than equivalent CRTs and can save more than 75 percent of the running costs in energy alone. But these savings depend in part upon what kind of LCD panel is used.

The VPs, like other quality flat panels, can also outlast CRTs by 100 percent. A well-made LCD monitor will last for around 50,000 hours on a daily 10-hour cycle, which equates to around 20 years useful life. This is twice the life of a CRT of around 20,000 hours, and a CRT monitor will degrade over a longer time before this happens. LCDs, however, degrade in the same way as a high-performance battery — they continue to give high-quality service until they are almost end-of-life.

There is, of course, a caveat. As with many other buying decisions, the major benefits to business and the bottom line are not necessarily gained by going for generic product. LCDs are no different in this regard. Lower end LCDs might incorporate the basic pluses of flat panels but they will not deliver the business benefits that can be gained from higher quality LCDs. They will certainly not be able to compete with CRTs, as good quality LCDs can.

ViewSonic's VP range also comes with another business benefit that directly impacts the bottom line. Built into every VP screen is ViewSonic's PerfectSuite, professional level LCD control software that not only allows the user to perform perfect colour calibration according to a user's particular environment, and use wizards for other settings, it also allows your company to effectively asset manage the unit, deter thieves and remotely control the screens.

How can this help impact the bottom line? ViewSonic screens equipped with PerfectSuite can be remotely switched off by IT support, banishing the hidden costs of screens left on indefinitely after users leave their workstations, saving power costs and prolonging the service life of the screens. PerfectSuite can also lock a screen to only be used with a certain computer using a PIN, deterring thieves from attempting to steal it for use anywhere else.

Using LCDs such as ViewSonic's VP range can also impact your environmental policy. Because they use less energy, they directly influence your costs and energy usage. But they are also far more environmentally friendly to recycle and dispose of than CRTs, and they last twice as long and put out far less heat. This means less spent on office cooling and the concomitant reduction in air conditioning load.

## Conclusion

Viewing angles are no longer a stumbling block to companies considering moving from traditional CRTs or earlier LCDs (or early or cheap LCDs with minimum feature/benefit set) to modern LCD flat panel monitors.

The cost-benefit is clear that LCDs can provide a positive impact on a company's bottom line, as well as making workstations more pleasurable and productive environments for users. Increases in real, usable viewing angle mean that 'good quality' LCD screens can now compete with CRTs and lesser LCDs and often outclass them overall, especially in terms of large screens in a business environment.

ViewSonic has created a range of business and home-use LCD screens that combine the advantages of CRTs with the footprint, flexibility, ergonomics and performance of LCDs. ViewSonic has in its VP range of LCD monitors a solution to almost any need that companies and individuals might have had satisfied by CRTs and lower end LCDs. The benefits of moving to the latest models of LCD sooner rather than later are now greater than ever.

With ViewSonic's VP range you can get more on your real and virtual desktops without compromising on viewing angle, contrast, visual quality, response time or ergonomics.