BenQ

For a clear view

Monitor technology guide

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Enjoyment Matters

Setting standards

The BenQ Group is one of the largest global manufacturers of high-quality monitors and innovative liquid crystal displays.

BenQ manages the complete manufacturing process which is carried out in-house – from research and development, to the production of individual components and final assembly. Important technologies are developed, refined and tested – again and again – before they are finally used in BenQ displays.

In this brochure, we want to share some of the experience that we have gained over the years with you, providing you with a basis for making a well-informed purchasing decision.

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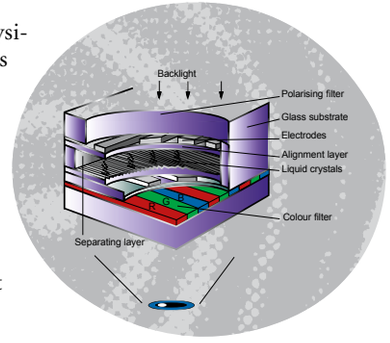
The liquid crystal display – how it works

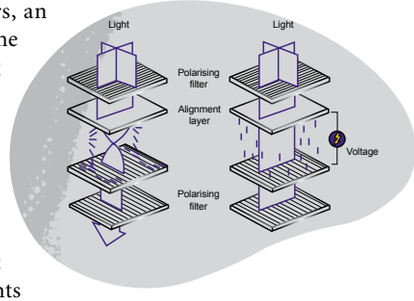
The LCD principle

Liquid crystal displays function thanks to the particular physical characteristics of liquid crystals. The rod-shaped molecules always arrange themselves evenly and in a particular direction, like the molecules of crystals. Liquid crystals are not frozen in that pattern, however, and behave like a liquid. When an electrical voltage is applied they can be manipulated. The layers of the liquid crystal molecule can either stand horizontal or vertical to the polarisation direction of the light, which has different effects on the progress of light waves. In simple terms, the LCD principle operates like a light valve that can be controlled by an electrical voltage.



LCD technology

A liquid crystal display consists of two polarising filters, an alignment layer, colour filters and a liquid crystal layer. The light from a background lamp meets the first polarising film, allowing only certain wavelengths of light to pass through to the liquid crystal layer. Without any electrical voltage applied, the liquid crystal molecules between the two perpendicular polarising layers are forced into a helical structure. The light follows this alignment and is rotated 90°. The second polarising filter only allows light to pass through with this rotated polarisation. The light valve is thus open and, as a result, the activated pixel lights up.



If an electrical voltage is applied, however, the liquid crystal molecules align themselves parallel to the electric field. The 90° helix is reversed and the liquid crystal molecules are parallel to the incoming light and let it pass through the layer without altering the direction of polarisation. The non-rotated beam of light meets the second, rotated polarising filter and cannot pass through. As a consequence the corresponding pixel remains dark.

By altering the voltage applied to the crystal layer and subsequently causing the polarised light to be more or less rotated, the strength of the visible light produced can be regulated. The voltage is maintained so the image does not constantly have to be reassembled. This is the main advantage of LCD technology – the picture doesn't flicker, even when it is activated by low-frequency currents (e.g. 60 Hz).

Panel types

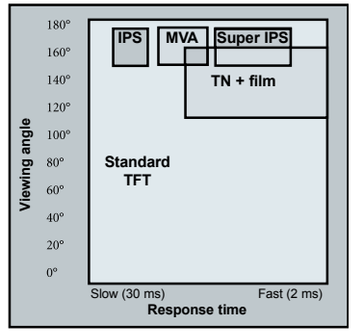
Currently, three different types of panel are used for flat screen displays – TN, MVA and IPS panels. They offer different levels of performance, principally in terms of the response time, viewing angle and contrast ratio.

TN panel

TN stands for 'twisted nematic'. The combination of a special liquid crystal chemistry and intelligent control electronics provides the fastest pixel response times and high contrast ratios and brightness values. To increase the viewing angle a film is affixed to the surface of the TFT (Thin Film Transistor), this is known as TN + film.

MVA panel

MVA stands for 'multi-vertical alignment'. When no voltage is applied, the crystals align themselves vertically. The special feature of MVA panels is that every pixel is divided into several domains. The M stands for 'multi-domain'. The pixels are aligned at an oblique angle to one another. This ensures the light output is maintained. The contrast ratio and colour display remain constant. MVA pixels respond considerably more quickly than IPS pixels. On the other hand, the black level is not as dark as with IPS technology.



IPS panel / Super IPS

IPS stands for 'in-plane switching'. With this technology, the liquid crystals lie parallel to the display surface when voltage is applied. When no voltage is applied, they align themselves at a right angle to the surface. The crystals thus form very homogenous structures and ensure that almost no light leaves the panel in an undesired direction, which provides excellent contrast ratios and a saturated black level. For this reason, IPS panels require a stronger back light in order to achieve the desired light output. Super IPS is a further development of the technology and provides better viewing angles.

Resolution (native, physical)

The resolution tells you how many pixels the monitor has horizontally (per row) and vertically (per column). Every monitor is designed for a particular (native) resolution. If the resolution of the image signal is different from this native resolution, the monitor must 'scale' the image. If, for example, a resolution of 800 x 600 is to be displayed on a monitor with a native resolution of 1,024 x 768, every horizontal pixel has to represent 1.28 pixels. As this is impossible, interim values are generated. This can result in a less sharp image.

For 17-inch and 19-inch displays, a resolution of 1,280 x 1,024 is standard. For 20-inch monitors with a 4:3 aspect ratio, the standard resolution is 1,600 x 1,200. 20-inch monitors in a widescreen format (16:9 and 16:10) are becoming increasingly popular. With a 1,680 x 1,050 resolution, two standard A4 page layouts can be shown simultaneously and large Excel tables can be perfectly displayed without scrolling.

Modern LCD televisions operate with a wide format 16:9 HDTV resolution of 1,080 pixels (1,920 x 1,080). The first computer monitors with a screen diagonal of 24 inches and higher already support this resolution. This is important because of the increasing convergence between IT hardware and traditional electronic entertainment systems.

FULL-HD 1080P

Important LCD variables

Viewing angle
The viewing angle defines the monitor´s field of view. Technically, this value is determined by measuring the contrast ratio across the viewing field until it falls short of a particular value – normally 10:1. Some companies use a benchmark value of 5:1, in order to achieve better results. This doesn't allow true comparison of values, as it is a deliberate falsification. Certification in accordance with ISO 13406-2 offers clarification, as it prescribes categorisation into viewing angle classes and the use of a defined measurement procedure. Ergonomic requirements for the workplace define a minimum horizontal viewing angle of 60°/60° (right/left) and a vertical viewing angle of 45°/45° (up/down). If only two values are given for horizontal and vertical viewing angles, the values for right and left and up and down respectively have been added together. In this case, for example, a viewing angle of 120° horizontal and 90° vertical would be given.

Contrast ratio
The contrast ratio is the relationship between the brightness of the brightest and the darkest pixels in an image. High contrast ratios improve legibility and ergonomic qualities. A display should always achieve contrast values of 500:1. In this respect, liquid crystal displays are significantly superior to conventional CRT displays, as a good CRT display would only offer a ratio of 90:1.

Brightness
Brightness is the light emitted on a particular surface. Compared with conventional CRT displays, LCD monitors offer superior brightness. CRT displays offer only approx. 80 to 100 cd/m² (candela per square metre), whilst values under 250 cd/m² for liquid crystal monitors are considered unacceptable and are only found on outdated displays.

Response time
The response time is the time a TFT cell requires to change its colour. When pixel response times are too long, some lower-performance displays produce 'ghosting' or 'streaming' effects on the screen when the image content is in motion. For standard applications, maximum response times of 8 ms are sufficient. For applications with fast-moving animations such as films, games and video editing, faster image formation is required. The response time should not be more than 4 ms.

'Black-to-Black' and 'Gray-to-Gray' response times
The current ISO standard uses the 'Black-to-Black' response time, which measures how many milliseconds a pixel requires to go from black to white and back to black again. However, this information only has limited relevance. In practice, colour-intensive films and action games hardly contain black-to-white changes. New panels, designed to have optimum 'Gray-to Gray' pixel response times, fulfil the requirements for such applications. Currently a new standard is therefore being established, which entails an indication of the 'Gray-to-Gray' response time in milliseconds. This measures how long a pixel requires to pass through different shades of gray.

Technologies

AMA Advanced Motion Accelerator

Advanced Motion Accelerator
For applications such as films and computer games, fast pixel response times are the most important variable (see 'Response time' for more information). Advanced Motion Accelerator (AMA) technology provides fast response times. By improving the liquid properties of the liquid crystals and optimising the electronic systems, pixels can quickly attain the desired position. The intelligent and dynamic AMA function doesn't only use a simple overdrive of the electrical voltage like conventional systems. The image signal is analysed in real time and then controlled with an optimum voltage using the AMA circuit. This has the advantage of achieving precisely the desired colour value, without overloading the pixels. These technologies are offered exclusively by AU Optronics, a subsidiary of BenQ.

senseye Human vision technology

Senseye® technology
BenQ Senseye® technology provides dynamic optimisation of image quality. Unlike conventional image processing, Senseye® separates the incoming colour signals in order to adjust each colour individually. The result is a perfect image. Along with colour brilliance, Senseye® optimises brightness, the contrast ratio and image sharpness. Senseye® also offers optimum user-friendliness. The user can select a pre-set mode for the desired application (e.g. movies or gaming) and the Senseye® technology adjusts all other settings automatically. At BenQ, we are permanently working on further developments of Senseye® technology for improving image quality.

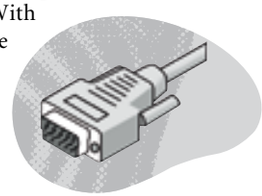
senseye+photo

New Senseye®+photo technology, therefore, offers an additional sRGB colour mode, which precisely adjusts colour temperature and the gamma value to suit the parameters of the sRGB colour space. This ensures that the colours can consistently be reproduced on different peripheral appliances (such as digital cameras and printers).

Senseye®+game technology offers two new operating modes, 'Action Game Mode' and 'Racing Game Mode', which optimise image quality for applications with fast-moving image content. Colours, brightness and contrast are adjusted to provide perfect image quality and thus optimum gaming pleasure.

Ports

VGA/D-sub port (analogue)
As with conventional CRT displays, LC displays have a D-sub port (or VGA port) as a general standard. It consists of a 15-pin D-subminiature connector. With analogue VGA signal transmission, the digital image signal produced by the computer is converted into an analogue signal by the graphics card. This is an advantage for CRT displays as they can only process analogue signals. For digital LC displays, however, this is not ideal. If a digital LC display receives analogue signals, a transducer has to convert the analogue input signal back into a digital signal. This leads to conversion losses and lower image quality. This is why almost all BenQ LC displays also have a digital DVI port (see DVI port).

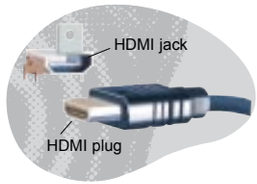


DVI port (digital)
If a display is connected to the computer by an analogue VGA D-sub port, it can result in lower quality images. The digital signal of the computer is converted into an analogue signal before transmission and then back into a digital signal in the monitor. Using DVI, purely digital transmission means that no conversion of the signal is necessary, so optimum picture quality is guaranteed.

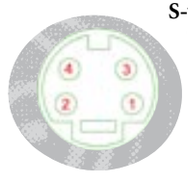
1) DVI-D
This is a purely digital interface. This type of connection is becoming standard on liquid crystal displays.

2) DVI-I
DVI-I processes both digital and analogue signals. With the help of an adapter the display can also be operated by an analogue graphics card, unlike DVI-D. Most graphics cards offer this interface if they are equipped with DVI.

HDMI™ port
The HDMI™ port is a digital video interface that was specially developed for the video sector. It is a particularly compact interface which also integrates HDCP encryption. A particular advantage of this interface is the simplification of the wiring, allowing, for example the wiring in series of individual devices.



Video port (CVBS, or composite)
The interface known as CVBS (colour, video, blank and sync) or composite is standard for VHS and analogue TV. Colour and brightness signals, as well as synchronising signals, are combined and then transmitted. Cinch connectors and SCART connectors, used for video recorders and televisions, have become the standard connectors for the transmission of CVBS video signals. If a flat screen display has a video port, a video picture signal (from a DVD player, for example) can be directly displayed on the screen without a PC. In terms of quality, a composite signal does not provide the best video signal. Fuzzy contours and so-called 'cross-colour effects' may appear.



S-video port
The S-video port offers better image quality because it transmits brightness (luminance) and colour (chroma) separately from one another. In terms of quality, the output image from the S-video connection is similar to the image provided by RGB transmission with a VGA port.

Ergonomics and safety

Low-quality displays or displays used incorrectly can quickly lead to user fatigue. High contrast ratios and brightness values, along with a constant light density and no flickering, affect both ergonomic properties and image quality. A monitor should be low-radiation and free of toxins. The certificates listed below give you the assurance you need in terms of ergonomics, product safety and environmental compatibility.

Important standards and certificates

Vista® Basic
The Vista® Basic logo indicates that a monitor is fully compatible with this operating system. This means it must be possible to download the necessary driver software, for example. The Vista® Basic logo ensures that installation will be problem-free and guarantees stable operation of the monitor.

Vista® Premium
The Vista® Premium logo entails further requirements to be fulfilled in addition to the basic certificate. The monitor must have a digital interface, for example. This rules out conversion losses during signal transmission from the computer to the monitor. In addition, higher standards of colour fidelity for image reproduction are required, in accordance with the Windows® standard. The monitor settings must also be able to be adjusted using the computer through the DDC (Display Data Channel command interface).

TCO 06: Sets particularly high standards of colour fidelity, brightness levels and uniform illumination. These factors are very important for image quality for applications with fast-moving animation.

TCO 03: Quality seal from Sweden, defining strict ergonomic and environmental compatibility standards (TCO 03, as of 2003).

ISO 13406-2: Ergonomic requirements laid down by the International Standards Organization (ISO) relating to image quality for flat screen displays.

TÜV[1] Ergonomics: Defines high ergonomic requirements, including safety standards and low radiation.

TÜV GS: Safety tested in accordance with work and operating safety guidelines and ergonomic requirements for visual display terminals under ISO 9241-3.

CE mark: Manufacturer's declaration in accordance with EU guidelines relating to product safety and electromagnetic compatibility.

Energy Star®: An energy-saving seal of approval established by the EU and the USA for office appliances which operate with high energy efficiency.

ISO 13406-2

Important quality criteria
ISO 13406-2 is the testing standard used for the TÜV Ergonomics inspection and involves controlling the ergonomic properties of display screens. ISO 13406-2 has been specially developed for the assessment of liquid crystal displays, whilst ISO 9241-3-7-8 relates to CRT displays.

TCO seal
The TCO seal is awarded by the Swedish employees' trade union, 'Tjänstemännes Central Organisation' and has become a general standard for display screens. TCO 99 and TCO 03 are currently established. The numbers indicate the year the standard first appeared. TCO 99 regulates particular quality standards such as viewing angle and contrast. TCO 03, a stricter standard dating from 2003, also lays down particular environmental and radiation standards. Harmful substances such as cadmium and lead were banned from monitors. The Swedish trade union guarantees that quality standards are maintained by employing random testing.

[1] TÜV = Technical Control Board

Important criteria for evaluating LC displays:

- Display luminance
- Contrast
- Reflection
- Uniformity of luminance and colours
- Font analysis
- Pixel fault class
- Screen flicker

Viewing direction classification
ISO 13406-2 includes a definition of viewing direction classes. These classes relate to whether an individual user is viewing the screen from the front (class IV), for example, or whether several people can see the display from different angles (class I).

Reflection classification
ISO 13406-2 also takes into account the reflection properties of flat screen displays. This is particularly important in very bright and well-lit environments, as acceptable image quality should still be able to be achieved in such surroundings. The standard thus defines three quality classes. The wording of the standard is, however, not very precise:

(1) 'Generally suitable for office environments' – indicates that the monitor can also be used in difficult circumstances, such as at workstations very close to windows.
(2) 'Mostly suitable for office environments' – suitable for most office environments, if workplace ergonomics are taken into account when the monitor is set up.
(3) 'Suitable for office environments with controlled luminance' – suitable for rooms without windows or with indirect daylight, for example.

Pixel fault classification
With respect to pixel defects, a new standard ensures transparency by establishing pixel fault classes. These must be indicated in the technical specifications provided with the appliance. In adhering to this standard, the manufacturers are obliged not to exceed established pixel fault quotas in series production.

Fault class	Type 1**	Type 2***	Type 3****
I	0*	0*	0*
II	2*	2*	5*
III	5*	15*	50*
IV	50*	150*	500*

Fault class	Resolution	Number of pixels	Type 1**	Type 2***	Type 3****
II	1,024 x 768	786,432	2 (1,579)		

* Per million pixels.
** Illuminated pixels (white).
*** Dark pixels (black).
**** E.g. defect red, green or blue sub-pixel (always lit or unlit).
One LCD pixel consists of three red, green and blue sub-pixels.

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