Choosing between single-chip DLP and LCD projection technology

Choosing a projector can be a difficult task, if you don’t know your requirements. While from specification sheets many projectors look essentially the same, inside they can be completely different, as well as the image quality they produce. The fundamental reason for the differences is the underlying technology, be it LCD (Liquid Crystal Display), LCoS (Liquid Crystal on Silicon) or DLP® (Digital Light Processing). To add to the confusion DLP itself comes in two varieties: single-chip and three-chip.

While three-chip DLP is widely considered to be the pinnacle of image quality and overall projector standards, applications that don’t require the utmost in any particular aspect of performance are typically covered by single-chip DLP and LCD models. This technology brief provides information to help you choose between these two technologies, whether your application requires displaying data, watching video or both.
Understanding the two technologies

The ABCs of DLP
At the heart of every DLP® projector is a DMD chip (digital micromirror device) covered with square, microscopically tiny mirrors – one mirror for every pixel in the image. Each mirror flips between two different angles. One angle reflects light from the projector’s lamp through the lens to the screen, resulting in a bright pixel, while the other reflects light away from the lens towards the internal light absorber, producing a dark pixel on the screen. To display a gray-shade in between, each mirror is flipped rapidly between the two angles thousands of times each second.

On its own, an image formed by a DLP chip is black and white. To produce color images two methods are typically applied – single-chip or three-chip. The three-chip method uses a DMD for each color primary (red, green, blue) which are optically converged to produce a single image.

The single-chip approach uses just one DLP chip and typically places a rapidly spinning disk, known as a “color wheel”, between the DMD chip and a lamp.

The color wheel is divided into sectors, each containing a color filter – one red, one blue and one green at a minimum. Some projectors add a white segment to boost light output and other projectors include yellow, cyan and/or magenta. These three colors create rich, full-color images when added in various combinations. As the wheel spins, the DLP chip is illuminated by each color in quick succession, repeating the cycle many times per second. The image shown on the DLP chip also cycles between red, green and blue video information in synchronization with the wheel. The colors are cycled at a fast enough rate that the eye sees a full-color image.

Some single-chip DLP projectors use light-emitting diodes (LEDs) or a combination of LEDs and lasers instead of a lamp. Some of these models do not need a color wheel to cycle between the colors, instead doing so electronically.
Understanding the two technologies (continued)

**LCD basics**
LCD projectors use small liquid-crystal panels, which are designed to transmit, rather than reflect, light. Three panels are typically used, one for each color. Some projectors use a fourth panel to improve color reproduction. Optical filters components within the projector split the white light from the lamp into the three colors (red, green and blue) and direct those colors through their respective panels. An image is formed on a panel by varying an electrical signal (a voltage) sent to each pixel in quick succession. This results in either transmission of the light through the LCD panel creating a bright pixel on screen, or absorption of the light by the panel creating a dark pixel on screen. The red, green and blue panels surround a prism that ensures the resulting images are all projected to the same place on the screen.

**Single-chip vs. LCD**

**Data or video content?**
When choosing a projector for a particular application it’s important to consider the type of content you will be primarily displaying. Will it be mostly data for presentations, video playback or a mix of both? Single-chip DLP and LCD projectors can display either type of content. However, if your primary requirement is to display data you want the highest brightness available for a given budget – as such, a single-chip DLP projector intended for fixed installations is likely your best choice. If, on the other hand, your content requirements will focus on video playback, you will need immaculate color reproduction, then the difference between a single-chip DLP or appropriate LCD model will be minimal.
Single-chip vs. LCD (continued)

Image quality
The image quality of today’s single-chip DLP® and LCD projectors is actually quite close, both in brightness and image quality, within a given price range. However, the following list outlines some differences in which to be aware.

Color Reproduction – All projector designs trade brightness for the deepness of the colors they project, choosing more of one for less of the other. As a result, some projectors will have deeper or more accurate colors than others, depending on their applications. Typical business presentations may require more brightness if ambient light conditions exist. Alternatively, if data is being reviewed or corporate branding standards need to be adhered to, color accuracy becomes more of a priority. Color accuracy is also a requirement where video display will be utilized.

As a rule of thumb, LCD projectors lie in the middle, displaying acceptable colors for their brightness, while those intended primarily for watching video typically give up some light output to produce better colors.

Single-chip DLP projectors cover a wider territory, ranging from presentation models with merely adequate colors to video-centric models with very good colors. Some single-chip DLP projectors offer a choice to select display settings that offer optimal brightness or color accuracy.

Color Cycling Speed – With single-chip DLP, the speed at which the colors are cycled can vary depending on the projector and also in some instances with software settings. Presentation models tend to cycle the colors at a slower rate than those intended primarily for watching video, so some viewers may see fleeting multi-color trails (“rainbows”) on bright objects in the picture – especially if the objects are moving. However, the ability to see these artifacts varies between individuals.

Pixel visibility – LCD projectors have larger gaps between their pixels than DLP projectors, making the separation of pixels much easier to see, reducing the visual acuity of the image. That may not matter as much for a presentation, but can be very important when watching video. For this reason, DLP images are considered more “film like” than LCD images.

Misconvergence – Misconvergence is a term for something you might notice in an LCD image: color fringes on horizontal and vertical lines. This is seen if the three LCD panels’ images are not precisely aligned with each other. Manufacturers take care to minimize this but it can still be noticeable with some LCD projectors. On the other hand, single-chip DLP projectors are designed with only one imaging chip, which displays all three colors sequentially, meaning you won’t experience misconvergence with a single-chip DLP projector.
**Single-chip vs. LCD (continued)**

**What about reliability?**
Reliability is just as important as performance and both LCD and single-chip DLP technologies perform well in this category.

**LCD**
In the past, LCD panels in projectors could fail because of progressive breakdown from ultraviolet (UV) light that leaks through from the lamp. A newer technology inside the LCD panel itself, called inorganic alignment layers, has made significant progress in making LCDs far less prone to damage from UV, but still not ideal for 24/7 applications. For more about this, see Christie’s technology guide “Inorganic LCD Technology.”

One issue that affects LCD is image retention. If a static image is displayed on an LCD projector or flat panel for a sufficiently long time, the LCD tends to retain an after-image that can be seen even when new content is later displayed. Most LCD manufacturers warn against this kind of usage. It is especially of concern for applications that require 24/7 (continuous) operation, where the likelihood of image retention is much greater. If 24/7 operation is a requirement, a DLP projector is a much better choice.

**Single-chip DLP**
In the case of DLP one might think that a DMD chip full of moving mirrors would be inherently unreliable due to the mechanics and movement. However, although the mirrors are moving parts, they are so tiny that the forces involved are incredibly small. Long-term tests over many years have shown that DLP chips are extremely reliable and offer long life.

One of the key advantages of DLP technology is that rather than absorbing the light internally on the imaging device to produce black, the mirrors simply redirects the light to an internal light absorber. This reduces the thermal stress on the imaging device (DMD) resulting in a prolonged life.

Another traditional concern in a lamp-based single-chip DLP projector has been with the motor that spins the color wheel. This motor is similar to those found in hard drives which have proven to be very reliable.

One other aspect to be considered with respect to reliability is that single-chip products have sealed optics. This helps to eliminate possible contamination of the panel, which would commonly manifest on screen as dark spots and/or a distortion of colors. Conversely, it is not uncommon for LCD projectors to require a service cleaning.

**Conclusion**
Single-chip DLP and LCD projectors provide great value in a wide variety of applications. In a given price range, products that use either technology tend to be similar in performance and features. However, with fundamental differences between the two technologies, some applications may favor one over the other, depending on content – data or video, image quality and reliability. This technology brief has outlined the most important information to help you choose the best projector for your own application.
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