

Technical Article

Seeing More with 4K UHD Display



Dave Duncan

4K ultra-high-definition (UHD) streaming, broadcast and Blu-ray content is expanding and growing rapidly. 4K UHD content contains over 8 million pixels per data frame – more than four times full HD (1080p) content.

The challenge is how to see the detail, depth and immersive realism that this content offers. We've become used to large TVs – in 1080p, 50-inch screens are almost the norm – and reasonably large 4K TVs are becoming affordable. But if you want to see four times as much detail as 1080p offers, it's not unreasonable to presume that you would also want four times the image size. That means 4K UHD projection, because projection is the only display technology proven to deliver such large image sizes at reasonable prices.

Large projection displays can be very useful for seeing all of the detail in a school or a business environment, and they're wonderfully immersive for home entertainment, as long as you have enough pixels to fill the screen. A real 4K UHD display solution shows the full 8 million pixels that the 4K UHD specification requires, delivering clear, crisp images that let you see all of the detail.

Key Factors of 4K UHD Technology

A pixel is just one tiny portion of the picture. In 4K UHD content, the picture comprises 8 million pixels per frame; however, not all pixels are created equal. It's important to ensure that all 8 million 4K UHD pixels are displayed to deliver precise images. To really leverage the detail available in 4K UHD content, you need great American National Standards Institute (ANSI) contrast, perfect pixel mechanical alignment and extremely fast pixels combined with excellent image processing.

Images with a very high ANSI contrast have very dark blacks and very bright whites in the same picture, indicating the image's true contrast level. Many technologies quote other data points to indicate image contrast, but these contrast options don't deliver both dark blacks and bright whites in the same picture. For example, a simple "on/off" contrast compares a white screen to a dark screen, but since real images are viewed in a single picture, it's critical to have the darkest blacks and brightest whites in the same image. When you have great ANSI contrast, images look sharper, crisper and more immersive.

The heart of a projector is an imager. This device, usually based on liquid-crystal display (LCD), liquid crystal on silicon (LCOS) or Texas Instruments (TI) DLP® technology, implements an array of picture elements. The pixels you see on the screen are created from these picture elements. In DLP technology, the picture element is a series of micromirrors, which individually are about the size of a human blood cell. DLP technology devices can have up to several million mirrors on them, all switching at incredibly fast speeds.

Sometimes projectors use different imagers for the three primary colors: red, green and blue. These imagers each need to be in exact alignment so that every pixel has all of the colors exactly overlapped. The smaller the pixel size, the harder it is to align these imagers during the manufacturing process. If the red, green and blue pixels are out of alignment, the resulting image colors can be incorrect.

By using only one imager to display all colors, DLP one-chip technology avoids potential misalignment issues, making it a great technology for higher-resolution images and 4K UHD content.

Look closely at white text on a black background – if at an edge of the text you can see red, green or blue, the imager pixels are probably out of alignment. These pixel alignment errors – and the actions that projector-makers take to correct them – can lead to color distortion in a 4K UHD image.

Pixel sizes have been shrinking as a result of increased resolution. A 720p imager has 1 million pixels. 1080p has 2 million pixels. 4K UHD has to get 8 million pixels to the screen. The picture element size for 4K UHD is now so small that it is very hard to achieve alignment when using multiple imagers. This has become one of the most significant challenges in 4K UHD projection.

Make Sure You're Getting All the Pixels You Paid for

The Consumer Technology Association (CTA) defines 4K UHD as displaying 8 million pixels on the screen. But not all “4K” projection technologies actually deliver these 4K UHD-specified 8 million pixels to the screen; some deliver only 4 million pixels. To leverage the enormous detail available in 4K UHD content, it's obviously critical to display all 8 million pixels. Check the specification of the technology you plan to use. Look for the UHD acronym.

Part of the mission of displaying 4K UHD content is to get all of the detail to the screen cost-effectively. Extremely high-quality, full 8 million pixels 4K UHD projection can be very cost-effective by using the imager element to create multiple pixels on the screen. This is made possible through a combination of extremely fast pixels and advanced signal processing. DLP 4K UHD technology uses advanced image-processing algorithms to craft a clear, crisp, precise high-resolution picture.

Why 4K?

4K content is full of rich, vibrant detail. With the right 4K UHD projection technology, that detail becomes evident in valuable ways. Think about how display is used in the business world. During a presentation, you want everyone in the room to be able to see the detail on a given slide. How many times have you seen a slide with a dense spreadsheet and strained to see the numbers?

4K UHD projection display has the potential to greatly enhance the readability of such content, delivering crisp characters and executing smooth curves and edges that make reading and visualizing data easier. The same is true for schools, where 4K UHD can help students see and read as much as possible. For home entertainment, 4K UHD has enough detail to fill large screens and help drive the ultimate entertainment experience. Advances in 4K UHD technology also enable a portable 4K experience, allowing users to take their display with them and view on-demand content. 4K UHD DLP technology is known for precision, accuracy and detail, with the potential to help drive more productive business, more effective education and more immersive home entertainment.

The applications for 4K UHD projection display technology extend beyond the traditional projection display markets of business, education and home theater to new areas like digital signage, laser TV and mobile smart TV.

Digital signage allows businesses or organizations to convey real-time information in a public setting, like in a restaurant or on a billboard. 4K UHD delivers immersive detail and big displays, both great ways to convey information.

Laser TV is a 4K UHD ultra-short throw-projection display that specializes in displaying content such as streaming on-demand video in ambient light conditions like your living room. Consumers can place the product on the floor and project a 100-inch or larger display, either onto a special ambient-light rejection screen or just a wall. Laser TVs are designed for a modern lifestyle, delivering very large displays while still being portable. They display 4K UHD content typically using DLP technology imagers in order to maximize the immersive detail within the content.



Figure 1. Laser TV Can Change the Viewing Experience

Mobile smart TV products typically use light-emitting diode (LED) illumination. They focus almost exclusively on streaming on-demand video content and almost never bundle an ambient-light rejection screen. While laser TVs are often up to 3,000 lumens in brightness, mobile smart TVs are typically 1,500 lumens or less. These product category is moving toward 4K UHD display functionality in order to prepare for the influx of 4K UHD streaming content. The compact size of these mobile-class of products allows for portability and flexibility to take 4K UHD display to new locations. For more detail on mobile smart TVs, check out the [online training](#).

Pushing the Boundaries of 4K UHD

In addition to the [DLP660TE](#), DLP Products is taking it a step further with the [DLP471TE](#) and [DLP471TP](#) chipsets. The DLP471TP is the most compact 4K UHD solution from DLP Products, and is optimized for size and power. This chipset is the best fit for applications that demand portability, and brightness levels below 1,500 lumens. The DLP471TE shares many technical characteristics with the DLP471TP, but is optimized for projectors above 1,500 lumens. This device is in a larger package than the DLP471TP, which allows it to withstand a greater amount of heat, enabling brightness up to 4,000 lumens.

With a tiny 0.47-inch diagonal, you can display 8.3 million pixels in a smaller design for a cost-effective display solution for the mainstream market. The DLP471TE and DLP471TP 4K UHD chipsets display four pixels on the screen per micromirror, enabling the smallest 4K UHD digital micromirror device (DMD) that DLP technology has to offer. With a wide range of lumens capabilities, the DLP 4K UHD family of chipsets allows you to broaden your 4K UHD display possibilities by developing systems that use the chipset's high brightness capabilities and small form factor for applications such as laser TV, digital signage, gaming, corporate and education projectors, mobile smart TV, and more.

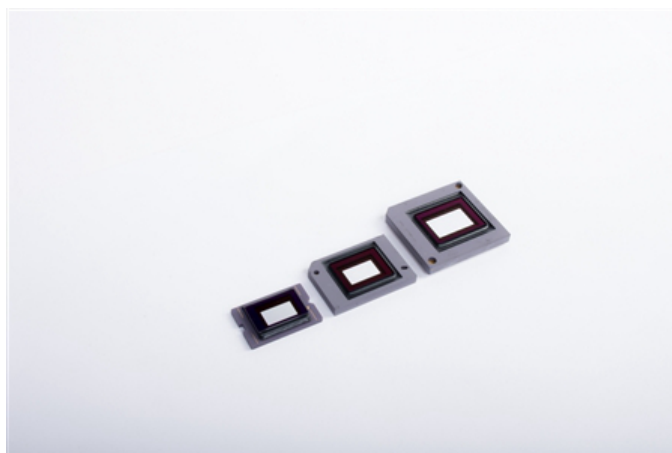


Figure 2. Size Comparison of the DLP660TE, the DLP471TE, and the DLP471TP

It's important to be ready as content transitions to 4K UHD. New 4K UHD solutions like DLP 4K UHD technology deliver outstanding clear, crisp, precise images using new technological advances and advanced image-processing algorithms. True 4K UHD displaying 8 million pixels will bring 4K UHD content to life and make it easier to see, read and be entertained.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated