4K UHD explained

White paper

What is 4K UHD?

4K UHD (Ultra High Definition) is an affordable way to display a native 4K resolution image by making use of Texas Instruments' pixel shifting technology and Barco's unique Single Step Processing (SSP™) image processing technique to display the input image on the screen without any artefacts and with the lowest possible processing latency.

Why do you want to use 4K UHD?

There is a definite trend toward 4K solutions in the consumer world. Today's marketing communications and the developments in consumer television sets are driving people to buy a 4K TV. Shiny gold labels are making people more knowledgeable about resolution and image quality than ever before. Laptops have a Retina® display, and the graphical cards of current PCs are capable of outputting a 4K image.

In the professional markets as well, there is a trend toward eye-limiting resolution simulators, replacing a lower resolution multi-channel system with a single 4K projector, and displaying more detailed content in large spreadsheets.

The reason is that the imager chips need to have 8 million small pixels in order to create a 4K image – and this is very hard to do in an affordable way. Due to the minimum pixel size that's achievable, the chips end up being quite big, and larger chip sizes mean higher cost and lower manufacturing yield. The native 4K chip can only be used in a 3-chip setup, again increasing the cost. On top of that, the associated projection lenses are very big and very expensive too. And not only is cost an issue for native 4K projectors, size is also important. As current native 4K chips cannot be used in a single-chip projector, a native 4K projector is quite large.

Texas Instruments has developed a way to display a native 4K input image using a lower-resolution DLP® chip, and thus avoiding the need for a very expensive native 4K chip with 8 million addressable pixels. This technology is called 4K UHD. Internally, it even creates an intermediate grid of 16 million addressable pixels – so that, when the original 4K native image is displayed, the internal processing has preserved all of the rich details.

Figure 1. Conventional sequential processing steps in a projector

Figure 1 shows the conventional way of performing the necessary manipulations on the input image. To manipulate the image, the different steps are performed sequentially, and in most cases, these steps are carried out in different dedicated electronic chips on the board. However, one large drawback of doing the steps sequentially is that you lose details in every step.

How does it work in a Barco projector?

Barco has chosen another approach in its quest for the best possible image quality (see Figure 2). Barco has developed a process that gathers the necessary information for every pixel:

- what color and brightness it needs (scaling, blending),
- where it needs to be positioned (warping)
- and in what frame the pixel needs to be (preparing the image for the DMD)

and then processes this information in a single step. This process not only avoids the loss of detail, but also minimizes latency by doing everything in parallel. (This also means that no dedicated third-party electronic chips are used.)

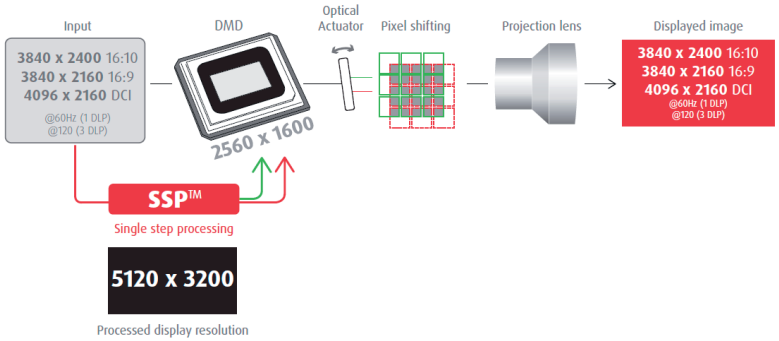

Figure 2. The 4K UHD method in a Barco projector

To summarize: When 4K content is fed to the projector, that complete 4K input information is processed in a single step (SSP™) and presented to the single chip (in a single-chip DLP® projector) or to the 3 DLP® chips (in a 3-chip DLP® projector).

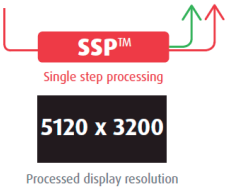

Figure 3. Barco's unique Single Step Processin

Barco's unique Single Step Processing (SSP™) image processing technique includes all possible electronic manipulations of the image - warping, blending, scaling, preparing the image for the pixel shifting device, gamma correction, color correction, etc. – and integrates them into a single module. Barco's SSP™ has clear advantages over sequential processing (see Figure 3):

- Better image quality, because intermediate sub-sampling is reduced
- Processed Display Resolution of 5120x3200, to preserve all of the image's details
- Lower latency, thanks to parallel processing

The image presented on the DLP® chip is synchronized with the (optical) pixel shifting device – called the Optical Actuator – with the result that, after the pixel shift of half a pixel over the diagonal, a Processed Display Resolution of 5120x3200 addressable pixels is created. This means an addressable canvas of 16 million pixels.

These 16 million pixels guarantee the accurate and (quasi) lossless formation of the 4K UHD image on the screen, which includes all of the 4K content that was present in the 4K input. And this is achieved without using an expensive native 4K DLP® chip but with a more affordable DLP® chip and the Optical Actuator.

Barco uses a native WQXGA chip to do pixelshifting – a higher resolution than WUXGA, allowing to get sufficiently close to native 4K without losing image content. In addition, it even matches native 4K quality when using warp.

Figure 4 illustrates the working principle of the Optical Actuator. The half-pixel shift (which makes it possible to position pieces of information at half distances) increases the resolution (right side of figure) – which is clearly impossible in the limited native resolution grid on the left.

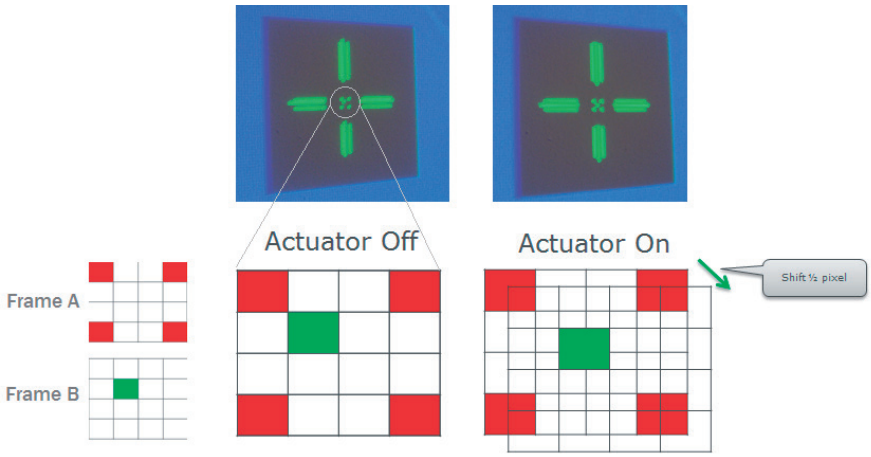

Figure 4. Working principle of the Optical Actuator

Barco has chosen this 2-position pixelshifting method over other methods because it allows for displaying full 3840 x 2400 stereo images at 120Hz. It also can show all 4K content without losing lots of brightness in a 3-chip DLP setup when activating the actuator. This is because, at every switch of the actuator, a dark time is needed to allow the actuator to change position. A 1-chip DLP setup doesn't lose brightness as the switching is done in the blue sequence.

What are 4K resolutions?

The literature on 4K presents a lot of possible resolutions that can be categorized as 4K. Figure 5 shows an overview:

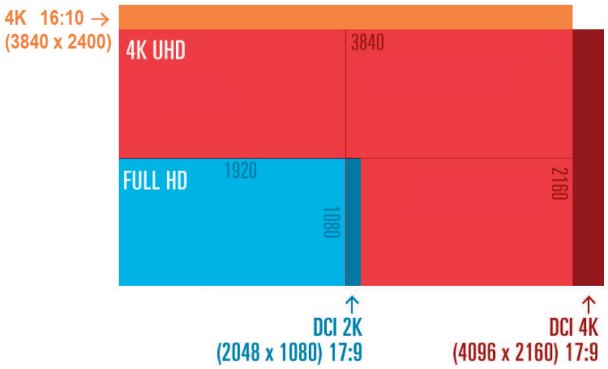

Figure 5. From Inside Media & Barco white paper, Better Pixels in Professional Projectors, January 2016. (DCI = Digital Cinema Initiatives – UHD = Ultra High Definition)

All of these resolutions also entail different frame rates, different color coding, different compression levels, and so on – and Barco's SSP™ can handle all of these variations.

What about the inputs?

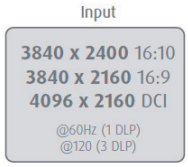

Figure 6. Inputs to the projector

You can feed any input, just as you would do with any other projector (see Figure 6). The projector handles all inputs up to 4K@120Hz internally and processes this input resolution in one step to the one or more DLP® chips. The Optical Actuator is synchronized with the DLP® chip, and the correct images are displayed to form the 4K UHD image on the screen.

The maximum input resolution is 3840 x 2400, which is higher than standard 4K UHD! The warping and blending can be done on that high resolution and at 120Hz, for 3-chip DLP projectors. For 1-chip DLP projectors, warping and blending can be done at 3840 x 2400 @ 60Hz.

The aspect ratio is preserved or changed (just like in any other projector), and the processing latency is less than half a frame. As Barco uses the SSP™ technology, the pixel shifting doesn't add any additional latency to the system.

4K images can be fed to the projector via different inputs – HDMI, DisplayPort, 3G-SDI, … – and they can be composed in different layouts via one or two input connectors.

Conclusion

When using an affordable DLP® chip, with a resolution that is lower than native 4K, it's possible to display 4K images with all the rich details of the original image.

You can achieve the best possible image quality by using Texas Instruments' pixel shifting technology together with the superb Single Step Processing (SSP™) image processing technique from Barco.

References

http://www.trustedreviews.com/texas-instruments-4k-dlp-projection-for-the-home-review