

Digitally Archiving Film Using Lumenera's Lt16059H



Background: Preserving and Archiving Film

The scanning and archiving of film is an extremely important endeavour as it seeks to preserve footage for future generations. However, conventional cellulose acetate-based film is subject to decay due to its organic composition. Accelerated by heat, moisture, and acid, the decomposition of film leads to warping and shrinkage of the medium. As acetic acid leaches out from the film it causes irreversible chemical degradation, known as vinegar syndrome. The leaching acid makes the syndrome contagious as it comes into contact with other portions of the film. The decay leads to film becoming extremely brittle, eventually reducing it to powder.

Consequently, long before this occurs, it is important to archive the footage, preferably via digital media, for preservation. A film archiving solution vendor has

consulted with and selected Lumenera as their camera supplier to image and preserve film in varying states of decay.

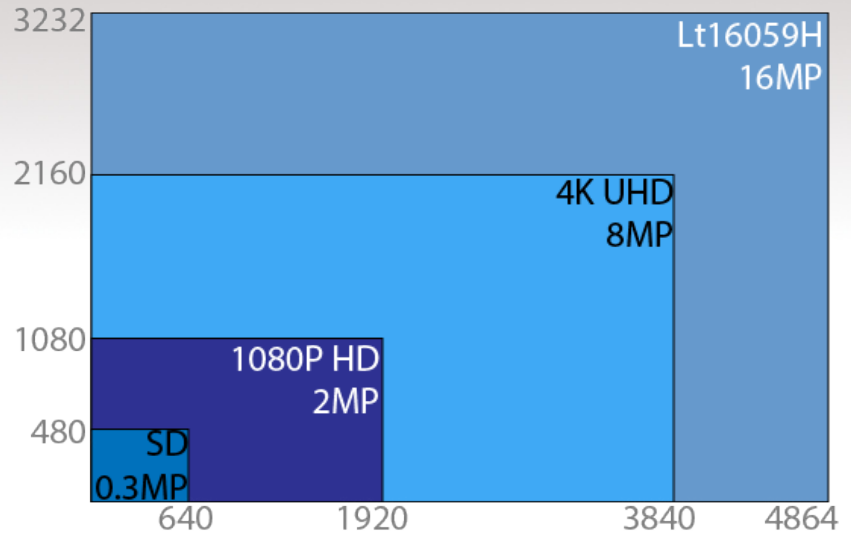


Film in advanced state of decay due to vinegar syndrome.



The Ideal Camera

Lumenera's high performance Lt16059H is the ideal camera for this application for many reasons. Its 16 megapixel OnSemi KAI-16070 CCD image sensor is capable of capturing well over 4K resolution at an industry-leading speed of 12 frames per second (fps) with incredible color reproduction. This speed is achieved by overclocking the sensor and using its 4 available image taps to process the frames. The 4 quarter frames are then recombined into one using Lumenera's proprietary tap-matching algorithm resulting in seam-free images. Lumenera is an industry leader in tap matching, capable of generating full frames without any noticeable tap seams.



Resolution Comparison: TV standards & Lt16059H

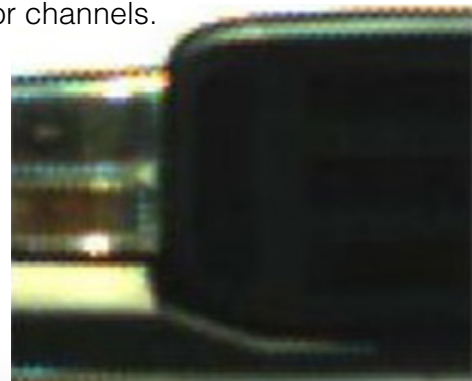
Vendor Specific Requirements Met by Lumenera

With the ability to do large-to-small customizations, Lumenera can provide an imaging solution to meet the exact application needs of their customers. In the case of one vendor's application, access to the unmatched tap data was crucial for their specific archival requirements. Lumenera's engineers were able to provide the vendor with a custom feature within their archival imaging software to access the essential data. This partnership between Lumenera and the vendor resulted in timely camera integration with the exact specifications required for the application.

If a customer requires color accuracy and sharpness within the image scanning process, Lumenera is able to use the monochrome version of the OnSemi sensor coupled with a color wheel. This method produces a full color frame by combining 3 monochrome images exposed to red, green, and blue light. The use of a color wheel allows a light source of consistent intensity to be broken up into the three primary colors used in film. Conventional color image sensors have these color filters broken up into a Bayer pattern and applied to each pixel individually. The two missing color channels for each pixel are then interpolated through a process known as demosaicing. Depending on the demosaicing algorithms used, artifacts such as false color and zippering can be introduced into the image. The usage of a color wheel and a monochrome image sensor will completely eliminate these artifacts as each pixel will be exposed to all 3 color channels.



Example of false coloring. (Source: Wikipedia)



Example of zippering. (Source: Wikipedia)



Two Approaches to High Dynamic Range

Using a color wheel will naturally slow the archiving process, however it does create the opportunity of imaging with high dynamic range (HDR). By capturing each frame with varying intensities of light, the film can be enhanced resulting in more detailed and better quality images.

Using the Lt16059H's General Purpose Input/Output (GPIO), the camera can trigger the flash or be triggered by the flash with a very high level of determinism. The hardware trigger on the camera has a delay in the order of microseconds, facilitating synchronisation with both the light source and system as a whole.

An alternative to exposing the frame multiple times and post processing the images to create HDR frames would be to use the sensor's built-in HDR mode. At the time of this publication, Lumenera is the only industrial camera manufacturer who has successfully made this feature available for demonstrative purposes. Slowing the frame rate to 6 fps, the sensor captures a single image with two different gain levels and outputs a single HDR frame with no post processing required by software. The resulting merged HDR frame has better dynamic range than the original frames. Development is ongoing for this feature, with future enhancements planned to offer even wider dynamic range and end user customization.



Archival film scanner at Reflex Technologies.



The effect of high dynamic range imaging. (Source: Wikimedia)



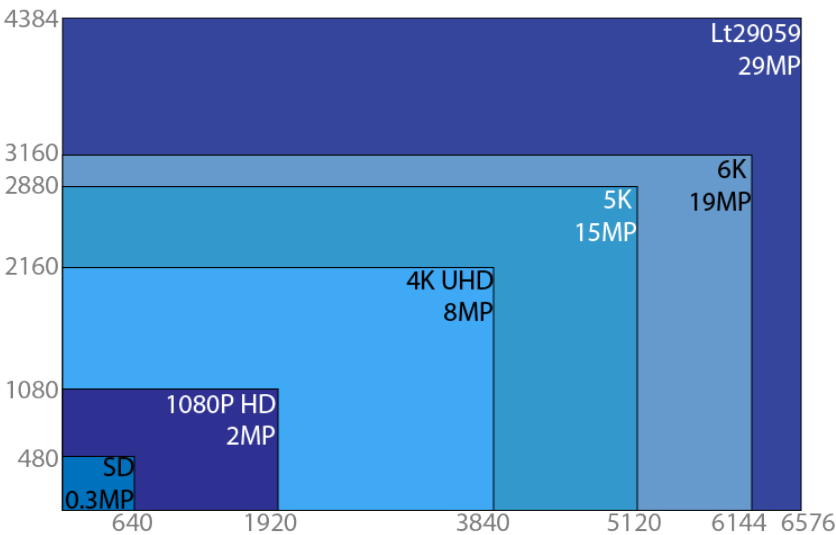
The Lt16059H – The Right Choice for Digitally Archiving Film

Both the color and monochrome variants of the Lt16059H support a bit depth of up to 14-bits per pixel, capturing a high degree of variance in light that is crucial for archiving. Combined with the high resolution and frame rate of the camera, the large data payload generated by the Lt16059H is transferred by a USB 3.0 interface with speeds of up to 5Gbps. Currently, Lumenera is the only one in the industry with USB 3.0 connectivity for the OnSemi KAI-16070 sensor.

The sensor has a 35mm optical format with large 7.4 x 7.4 micron pixels for superior dynamic range. Even without the built in HDR mode, the camera boasts a dynamic range of 66.7 dB and a full well capacity of just under 34,000 electrons. Industrial reliability, onboard HDR imaging, and a USB 3.0 interface make the Lt16059H a leader in the market and an ideal candidate for the digital archival of film.

Future Considerations – The Lt29059

With high resolution demand on the rise, the first 5k displays started appearing in 2014. To help supply the demand for resolution imaging, Lumenera is introducing the Lt29059, a 29 megapixel variant of the Lt16059H, in 2016. Capable of capturing above 6k resolution, imaging at 6576 x 4384 pixels, the Lt29059 can capture archival data that will be rich in detail, and compatible with future displays.



Resolution Comparison: TV standards & Lt29059

Lt16059H Highlights

Bit Depth	14 bits per pixel
Dynamic Range	66.7 dB
Pixel Size	7.4 x 7.4 μ m
Optical Format	35 mm (43.2 mm diagonal)
Frame Rate	12 fps at full resolution
Resolution	4864 x 3232 pixels
Warranty	4 years



Lt29059 Highlights

Bit Depth	14 bits per pixel
Dynamic Range	64 dB
Pixel Size	5.5 x 5.5 μ m
Optical Format	35 mm (43.47 mm diagonal)
Frame Rate	6 fps at full resolution
Resolution	6576 x 4384 pixels
Warranty	4 years

