



Warpbox LUNA



Figure 1: Preview of LUNA chassis, actual product may vary.

The Warpbox LUNA is a warp and image correction processor for 2d media and 3d simulation purposes, which includes rotation up to +/-180° as well as upscaling and downscaling. Due to the pixel warping ability the warpbox can process complex and even non-linear warp configurations. Bilinear and bicubic subpixel interpolation is available with up to 1/16 in x and y resolution.

Blend and black level adjustment (MPCDI Alpha and Beta Mapping) can be applied for each color down to pixel level as well. For further color correction purposes a RGB LUT and RGB primaries are implemented according to MPCDI v2.0.

The high image quality is guaranteed by the internal color processing, with 24 bits per color (72 bits per pixel) used continuously during the image processing pipeline. Therefore, true 10-bit support is available on DisplayPort 1.4 input and output.

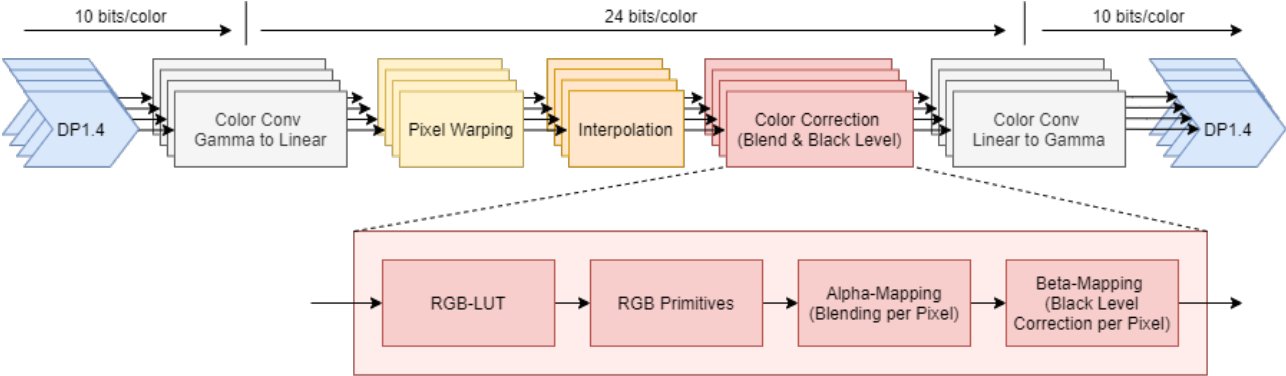
The warp processing has an interframe processing with a fixed processing time of 50 image lines added to the vertical warp displacement. Together with the color correction ability this makes LUNA Warpbox the perfect choice for multi projector systems displaying high level simulations and other interactive content.

Key Features

- Warp capabilities
- MPCDI 2d/3d level 2
- MPCDI color correction level 4 blend and black level correction
- Filtering: bilinear and bicubic interpolation
- All corrections applied with full resolution
- 4K with 60 Hz
- True 10-bit color input and output
- 24-bit internal color processing
- Build-in and customizable test images

The chassis can be equipped with up to 4 DisplayPort 1.4 video channel cards. Furthermore, it has a mode to upload custom test images.

The Warpbox LUNA is integrated with domeprojection.com® ProjectionTools, and therefore providing ideal multi-channel projection support.



In contrast to other warp processors our video pipeline works entirely in linear color space using a resolution of 24 bits per color. This includes warping, interpolation, color correction, and blend and black level correction.

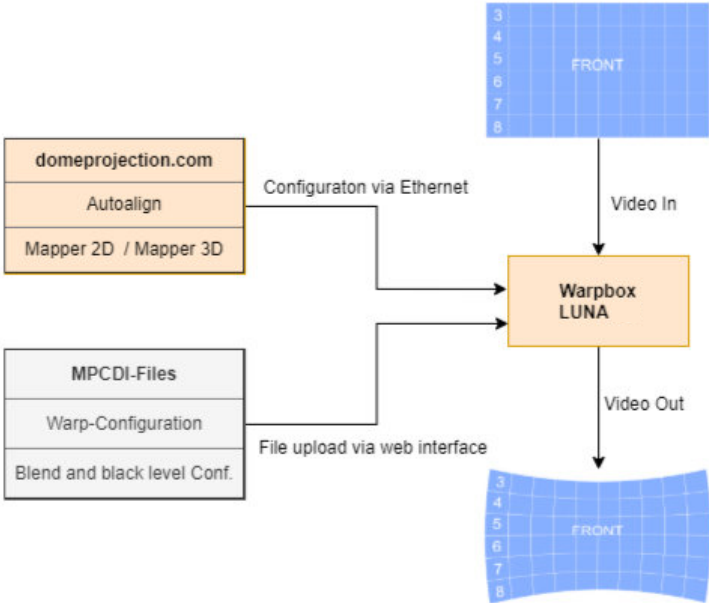
The system is interpolating while warping, with bilinear and bicubic subpixel interpolation on the input video stream in order to provide the best interpolation results.

Warpbox Configuration

The LUNA Warpbox configuration is generated by tools such as domeprojection.com® ProjectionTools.

It comprises a MPCDI conform warp-configuration as well as blend and black level configurations.

The LUNA Warpbox is fully configurable via Ethernet using either the web front end or the configuration file upload.



Warping for Single & Multi-Channel Projections

The warp processor can apply pixel warping conforming to MPCDI v2.0 on 2d media level 2 and 3d simulation level 2 to a video stream at full resolution. The 4K version of LUNA can process resolutions up to 4K at 60 Hz or pixel clock up to 600 Mpixels/sec. At resolutions of 3840x2400px and 4096x2160px at 60 Hz or 2560x1600px at 120 Hz in true 10-bit per color (24 bits per color internal), 1.8 times as many pixels can be written to the framebuffer, allowing an average image stretch of 80% at full resolution. Due to pixel warping, complex or nonlinear warp geometry is possible, such as flipping and rotating the image by any angle.

The warp processor is implemented with low latency interframe processing capabilities, meaning the write framebuffer can be safely read while writing. There is a fixed processing time of 50 image lines for any resolution, with the vertical warp shift making up the rest of the total processing time. The LUNA warpbox is integrated into ProjectionTools, providing ideal multi-channel projection support.

Blend & Black Level Correction

To achieve seamless projections the projection areas of the channels must overlap. In the overlapping areas the brightness is higher, so the blending reduces the brightness of the overlapping areas and corrects the overall brightness level in the projections down to pixel level.

Most projectors cannot project true black. Therefore, the black level is higher in overlapping sections of the screen. Thus, black level in the non-overlapping areas of the screen must be raised to the same black level. For color correction an additional RGB LUT and RGB primaries are implemented. Blend and black level correction as well as color correction are calculated with 24 bits per color.



Figure 2: Initial image.



Figure 3: Image with low level warp.



Figure 4: Image with non-linear warp, turned 90°



Figure 5: Image with high-level warp, turned 180°.

Workflow with LUNA Warpbox

After planning and setting up a multi-channel projection system, the systems must be calibrated, using a tool such as domeprojection.com® ProjectionTools. To facilitate this, the warpbox channels can project test patterns and custom test images directly, thus no additional software installation is required on the image generators (IG). After calibrating the warpbox configuration is generated by domeprojection.com® ProjectionTools and transferred via Ethernet to each warpbox channel. Each channel of the warpbox is fed with a video stream via DisplayPort containing overlapping and non-warped parts of the final projection. The warpbox then applies warping, blending and black level configuration with the same delay on all channels for an optimal viewing experience. The resulting video streams for each channel are then sent to the projectors and merged in the final projection.

Combine several LUNA Warpboxes to increase the number of channels.

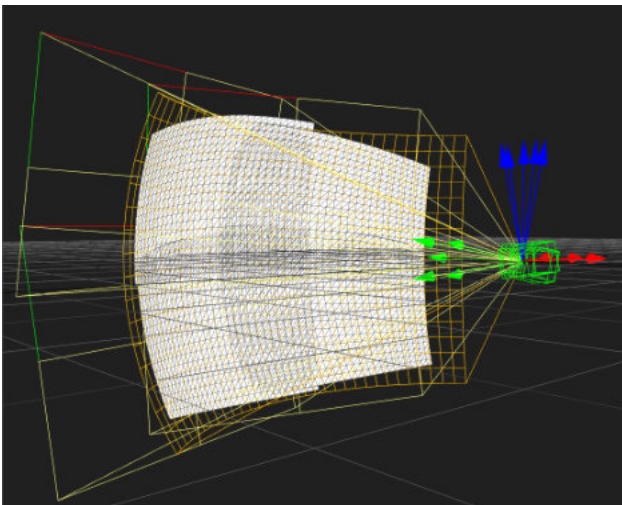
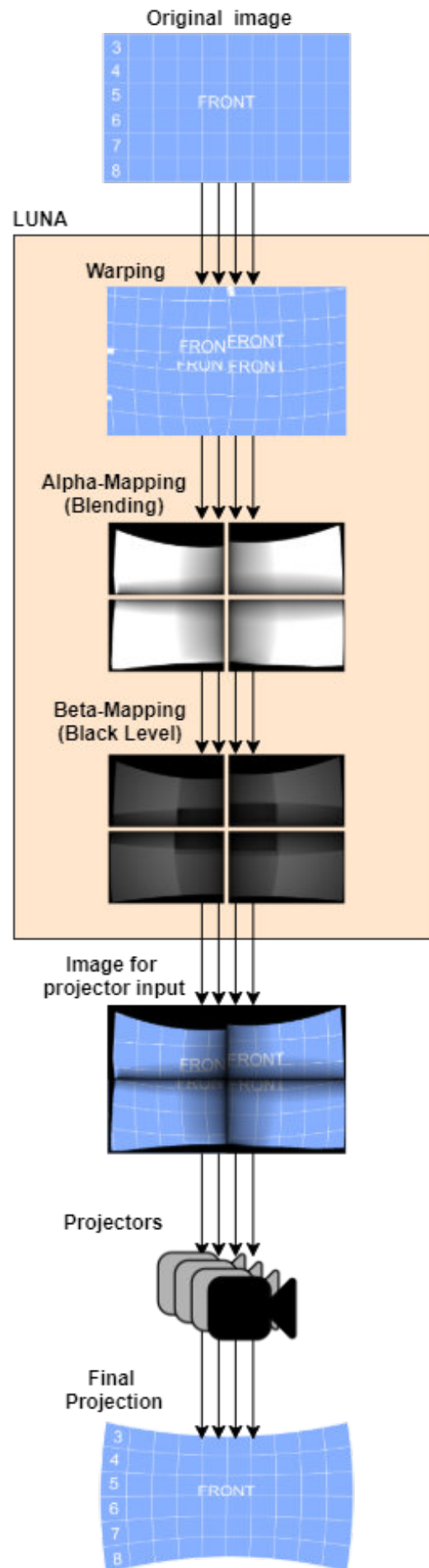


Figure 6: Multi-projector setup.



Specification Warpbox LUNA*

TECHNICAL DATA	LUNA 4K	LUNA 2K	
		WUXGA (default)	Custom Config. Example
Video type	DisplayPort 1.4 (17.28 Gbit/s) Input/ Output	DP / HDMI	DVI-I in / HDMI out
Number of channels	Up to 4 channels per case 3 U	Up to 2 channels per case 1 U	1 channel
Pixel rate	Warping with up to 600 Mpixels/sec	Warping with up to 300 Mpixels/sec	
Example resolutions	2560x1600x10bpc at 120 Hz, 3840x2400x10bpc at 60 Hz; 4096x2160x10bpc at 60 Hz	Input: up to 1920 x 1200 at 60 Hz; Output: up to 1920x1200	Input: 1024 x 768 at 60 Hz Output: 1080x1920 at 60 Hz
Input/ Output Interface	DisplayPort 1.4 (17.28 Gbit/s) Input/Output	Input: DisplayPort 1.2/ HDMI Output: DisplayPort 1.2	Input: DVI-I/VGA Output: HDMI 1.4
Processing	10-bit per color on input and output/ 24-bit per color internal color processing	8-bit per color on input and output/ 18-bit per color internal color processing	
Warping	MPCDI 2D Media level 2 and MPCDI 3D Simulation level 2 (pixel warping)		
Image stretch	Average image stretch < 80% at full resolution		
Latency and video timing	Interframe processing with a fixed processing time of 50 image lines, added to the vertical warp displacement;		
Interpolation	Bilinear and bicubic interpolation 1/16 Pixel subpixel accuracy; Preinstalled interpolation methods including bell shaped and B-spline		
Color correction	Color correction MPCDI level 4, (including gamma LUTs, RGB color LUTs and RGB primaries)	Color correction MPCDI level 3, (including gamma LUTs, RGB color LUTs and RGB primaries)	
Blend and black level correction	Down to per pixel RGB blend and black level correction	Down to per pixel single channel blend and black level correction	
EDID control	Loadable EDID, EDID passthrough	---	---
Configuration	Via Ethernet (including a web interface), Start configuration; backup and restore, Integrated with domeprojection.com® ProjectionTools		
Features	Video pass-through; User defined resolution and timing; Predefined, loadable pattern/images; OSD and Display	UART	
Input power	100-240 VAC, 47-63Hz, 150 Watt	100-240 VAC, 47-63 Hz, 50 Watt	
Size	(W x H x D) 438 x 133 x 320mm (3 U)	438 x 44 x 320 mm (1 U)	438 x 88 x 320 mm (2 U)
Weight	9,6 kg		
Certificates	CE, FCC Class A		
Warranty	2 years		

*Final specification subject to change.

