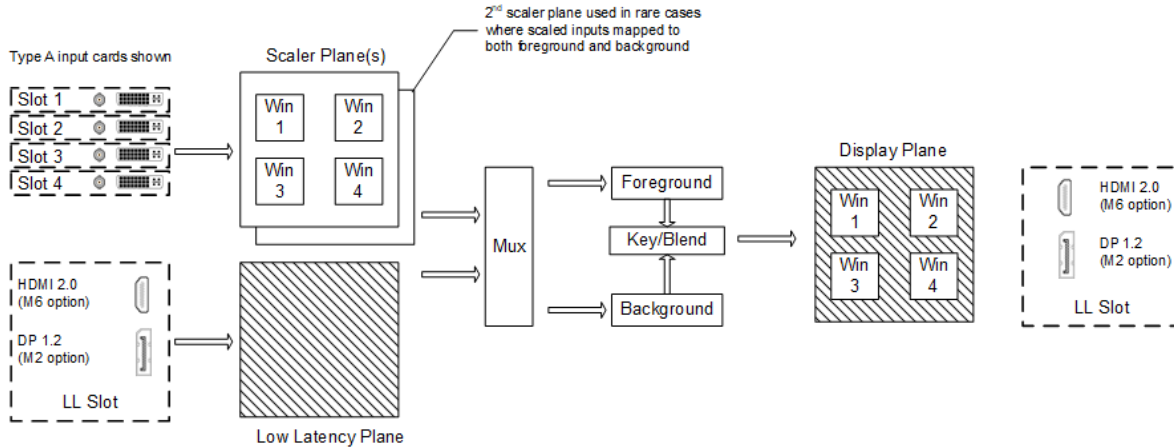


EZwindow4KE™ Ultra HD Video Combiner

Synchronizes 1 to 4 standard video inputs with a high resolution video stream to produce a video output with overlays and/or windows.



EZwindow4KE Video Processor

The EZwindow4KE video combiner provides video combining for displays up to 4096x2400 @ 60 Hz.

Up to 4 input cards are used to populate 4 windows placed in either of 2 Scaler Planes. The Low Latency Plane is populated via DisplayPort 1.2 or HDMI 2.0 low latency inputs. A Scaler Plane can be combined with a 2nd Scaler Plane or the Low Latency (LL) Plane, using various keying techniques, to create the Display Plane. The output video channel is DisplayPort 1.2 or HDMI 2.0.

Order Configuration

The EZwindow4KE has (4) input board slots that may house various input boards, plus (1) low latency slot to support either DisplayPort 1.2 or HDMI 2.0 I/O. The unit is configured at the factory. Table 1 shows the available I/O boards.

The I/O boards and their location are defined directly in the part number, in the following format: EZwindow4KE-wxyzm, where

- w is the input board type in Slot 1
- x is the input board type in Slot 2
- y is the input board type in Slot 3
- z is the input board type in Slot 4
- m is the LL interface type

I/O Board	Function	Location(s)
A	RGBHV, DVI-D, NTSC/PAL Input Card (1 input processed at a time)	Any of Slots 1-4
BB	Dual DVI input (Dual Card occupies Slot 1 and Slot 2)	Slot 1-2 or Slot 3-4
C	DisplayPort, up to 165 MPixels/sec	Any of Slots 1-4
DD	DisplayPort, up to 330 MPixels/sec	Slot 1-2 or Slot 3-4
M2	DisplayPort 1.2 I/O	LL slot
M6	HDMI 2.0 I/O	LL slot

Table 1: Available I/O boards

If a slot is unpopulated, then a # is placed in that location. Examples:

EZwindow4KE-A###M2 has the following configuration:

- Slot 1 Type A input board
- Slot 2 Not populated
- Slot 3 Not populated
- Slot 4 Not populated
- LL DP 1.2

EZwindow4KE-AABBM6 has the following configuration:

- Slot 1 Type A input board
- Slot 2 Type A input board
- Slot 3/4 Type BB input board
- LL HDMI 2.0

Enhancements over EZwindow4K

The EZwindow4KE has many enhancements over the EZwindow4K, including:

- Greater variety of Input cards, including Type C and Type DD DisplayPort input cards,
- Input Mode detection for I/O boards in Slots 1-4
- Up to 4 keying areas (versus 1 for EZwindow4K), each with a uniquely defined alpha blend (with or without key).
- Gamma LUTs and tactical commands

Low Latency Plane Input

The EZwindow4KE low latency input can be either DisplayPort 1.2 or HDMI 2.0 I/O, as identified in Table 1 as M2 or M6 respectively.

If a low latency input is utilized, it forms the Low Latency Plane, and is the basis for the output timing. No re-sizing or re-timing is supported on low latency inputs.

DisplayPort M2 Input Resolutions

The DisplayPort M2 input supports most resolutions up to 3840x2160/60 Hz. The table below shows some resolutions and whether they are supported (YES) or not supported (NO). Please contact the factory for your specific timing.

Timing	YES	NO	Timing	YES	NO
3840x2160/60Hz	✓		1440x2560/60Hz		✓
3840x2160/30Hz	✓		1920x1080/60Hz	✓	
2560x1600/60Hz	✓				
2560x1440/60Hz	✓				

Note: Some applications require only the M2 output, with no M2 input. All timings in the table above are supported on the M2 output for applications without a M2 input.

Low Latency Plane EDID

The EZwindow4KE low latency input has an EDID programmed with a user-selected preferred or custom timing.

Scaler Plane Inputs

The following (4) board types provide inputs for windows that are sized and placed in the Scaler Plane.

Type A: Multi-Format Input Board

- Supports the following inputs: DVI-D, RGBHV, RGBsog, RS170, RS343, composite (NTSC/PAL). Any **one** of these inputs may be selected.
- Resolutions up to WUXGA with pixel rates up to 162MHz.

Type BB: Dual DVI Input Board

- Supports a dual DVI input, for resolutions such as 2560x1600 and 2560x1440.

Type C: DisplayPort Input Board

- Supports DisplayPort 1.1a Resolutions up to WUXGA with pixel rates up to 165MPixels/sec.

Type DD DisplayPort Input Board

- Supports DisplayPort 1.1a Resolutions up to 2560x1600 / 60 Hz, and pixel rates up to 330MPixels/sec.

Scaler Plane Segments

The scaler planes are divided into segments for processing. The number of segments is 1 to 4, depending on output resolution and timing. The configuration application shows the segment boundaries within the output resolution. The segment sizes are based on output resolution, # of scaler planes (1 or 2), and timing. Segments are vertical slices of the overall output resolution.

Examples:

- a 3840x2160 output resolution at 60 Hz requires 4 segments, each 960x2160
- a 3840x2160 output resolution at 30 Hz requires 2 segments, each 1920x2160
- a 2560x1440 output resolution at 60 Hz requires 2 segments, each 1280x1440

Note. In cases where the low latency input is NOT used but keying is still required, a 2nd scaler plane can be defined.

Scaler Plane Windows

Up to 4 windows can be placed in a Scaler plane. Each window is populated with an area-of-interest from any input card in Slots 1-4.

Scaler Plane Methodology and Limitations

Windowing within the scalar plane is accomplished by one of two modes:

1. Independent Windowing (IW)
2. Regional Windowing (RW)

The mode determines how internal scaler assets are allocated, resulting in unique capabilities and limitations. The user will decide the windowing mode via the configuration application.

Independent Windowing (IW):

With this mode, up to 4 windows can be placed in the Scaler plane. The following constraint (IWC#1) is enforced by the configuration application:

of windows

$$\sum_{n=1} (\text{segments utilized by window } n) \leq 4$$

IW allows each window to have independent horizontal and vertical scaling. Windows can be placed anywhere in the output resolution, tempered by IWC#1. IW supports rotation in 90 degree increments. IW also supports robust background fill colors. Figures 1 and 2 show several windowing possibilities for 4K 60 Hz and 4K 30 Hz operation. Westar recommends Independent Windowing for most applications.

Tactical Commands for Independent Windowing

“Tactical” commands allow real-time update of a window’s source, that source’s area-of-interest, window size, location, rotation, and color adjustments. These commands are particularly useful for tactical displays requiring dynamic windowing. Tactical commands are defined in the EZwindow4KE Command Line Description. Please contact the factory for more information.

Regional Windowing (RW):

With this mode, up to 4 regions can be defined in a Scaler plane (see Figure 3). Regions are not windows, but areas in the scaler plane. One or more windows can be placed in a region.

A region is defined with the following parameters:

Region[1-4] = Scaler Offset, Line Offset, Scaler Width, Line Height, Fill Color.

A segment may include one region in the upper portion and another region in the lower portion. Upper and lower regions may have different zoom rates (or no zoom) but not shrink and zoom. RW has the following constraints (RWC):

RWC#	Description
1	A window resides in a single region. The window cannot span across multiple regions.
2	Windows cannot overlap within a region.
3	Horizontally, regions align with segment boundaries.
4	All windows within a region must zoom at the same rate. (Note 1)
5	Rotation is not supported
6	"Window Fill Color" (border) is drawn with the region fill color, so visible active video window borders are not currently possible.
7	The "Video Lost Display Color" is drawn with the region fill color, so a window "disappears" when video is lost at the input.
8	Windows within upper or lower regions of a segment cannot require both shrink and zoom. Note 2

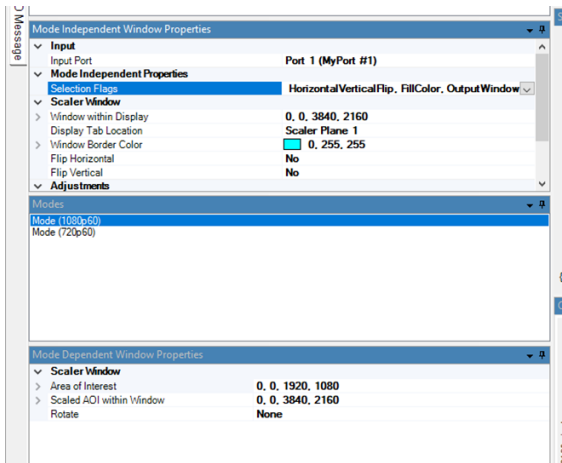
Notes:

1. Windows within a region may shrink at different rates or stay pixel-for-pixel.
2. In other words, there cannot be one window in a segment that is zooming while another window in the segment is shrinking.

Input Mode Detection:

Each window (Window 1-4) and its assigned input has an associated mode handler to support the automatic detection of multiple video modes. Video modes are defined using our EZwindow4KE Configuration application.

Window parameters (Flip, Rotate, Fill color, border color, Scaled Area of Interest, etc) are defined to be mode independent (applies to all detected modes) or mode dependent (defined specifically for each mode). The following screenshot shows both mode independent window properties and mode dependent window properties.



Based on the detected mode, the EZwindow4KE will apply any mode dependent parameters, such as:

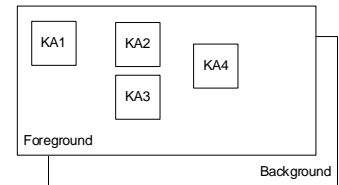
- the size of the window,
- the location of the window,
- the input area-of-interest,
- the scaled area of interest within the window,
- fill color and border color.

Keying and the Display Plane

The Display Plane is formed from the background layer (windowed, but no keying) or a combination of foreground and background (keying). Each of these layers is selectable from 1 of 2 Scaler planes, the Low Latency Plane, or a fixed RGB color. Up to 4 kinds of video combining are defined, as follows:

- **Alpha blend**, with programmable foreground and background alpha values,
- **RGB key**, with a programmable RGB key equation,
- **Luma key**, with a programmable Luma key equation,
- **HSV key**, with a programmable HSV key equation

Up to (4) rectangular key areas (KA1 – KA4) may be defined (with any size and any location) and placed in the foreground plane, as shown below.

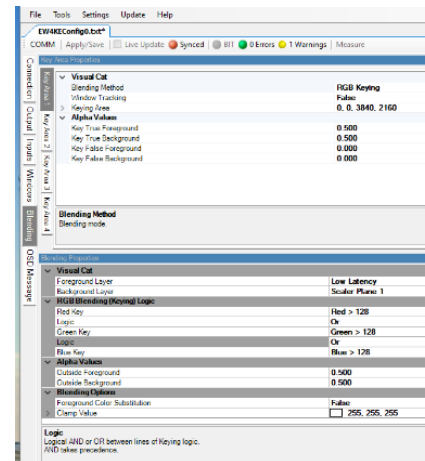


Each key area uses one of the (4) video combining definitions. If more than 1 key area uses a given definition (eg RGB key), the definition is common across

the key areas, but each key area has a unique foreground and background alpha value for key = true and key = false.

The screenshot (to left) shows there is 1 RGB key definition, but each key area that uses that definition can have its own set of alpha values

A foreground and background alpha value is also defined for any area outside the defined key areas.



Every outgoing pixel is calculated as:

$$\text{PixelOut} = \text{foreground alpha} * \text{foreground pixel} + \text{background alpha} * \text{background pixel}$$

Notes:

1. If a key area overlaps with another key area, then the lower number key area has priority (eg KA1 has priority over KA2).
2. The EZwindow4KE configuration application allows a key area to be defined by a corresponding window (eg See Application #2 on Page 8). Alternatively, a key area may be defined completely independent of a window location.

Gamma Adjustments

The EZwindow4KE supports overall panel gamma correction to account for the characteristics of a particular panel. The EZwindow4KE supports mode dependent reverse gamma correction to reverse prior gamma correction on a particular input video source.

The EZwindow4KE gamma LUTs are 1024 element tables (curves) used to re-shape 10bit video luminance profile. Individual R, G and B LUT's are supported. The panel gamma LUT is typically profiled to the inverse characteristic of the panel. The reverse gamma LUT is typically used to reverse a prior gamma profile adjustment on a particular input video source.

The LUT's default to "bypassed" mode. For applications that require gamma adjustments the tables can be incorporated into the downloadable configuration file using the EZwindow4KE Configuration application. A spreadsheet is available from Westar that supports creation of the .csv files that are compatible with the EZwindow4KE Configuration application.

LUT table entries are constructed as follows:

- Panel Gamma (10.2) correction values are 12bit with 10bits integer and two bits fractional (0000-0fff).
- Reverse Gamma (10.5) correction values are 15bit with 10bits integer and 5bits fractional (range 0000-7fff).

Figure 1: Independent Windowing (IW) Examples (4K 60 Hz)
(Background image input on Low Latency channel)

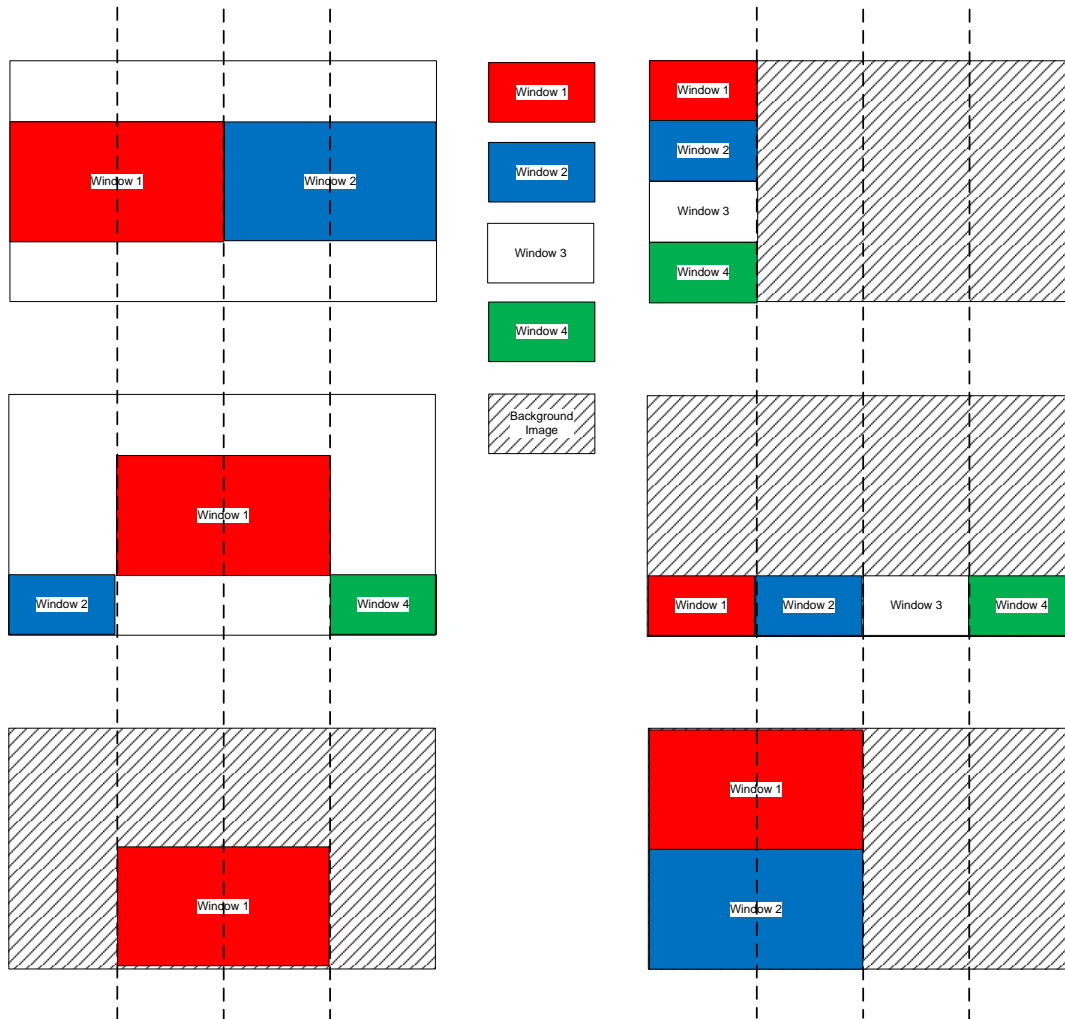


Figure 2: Independent Windowing (IW) Examples (4K 30 Hz)
(Background image input on Low Latency channel)

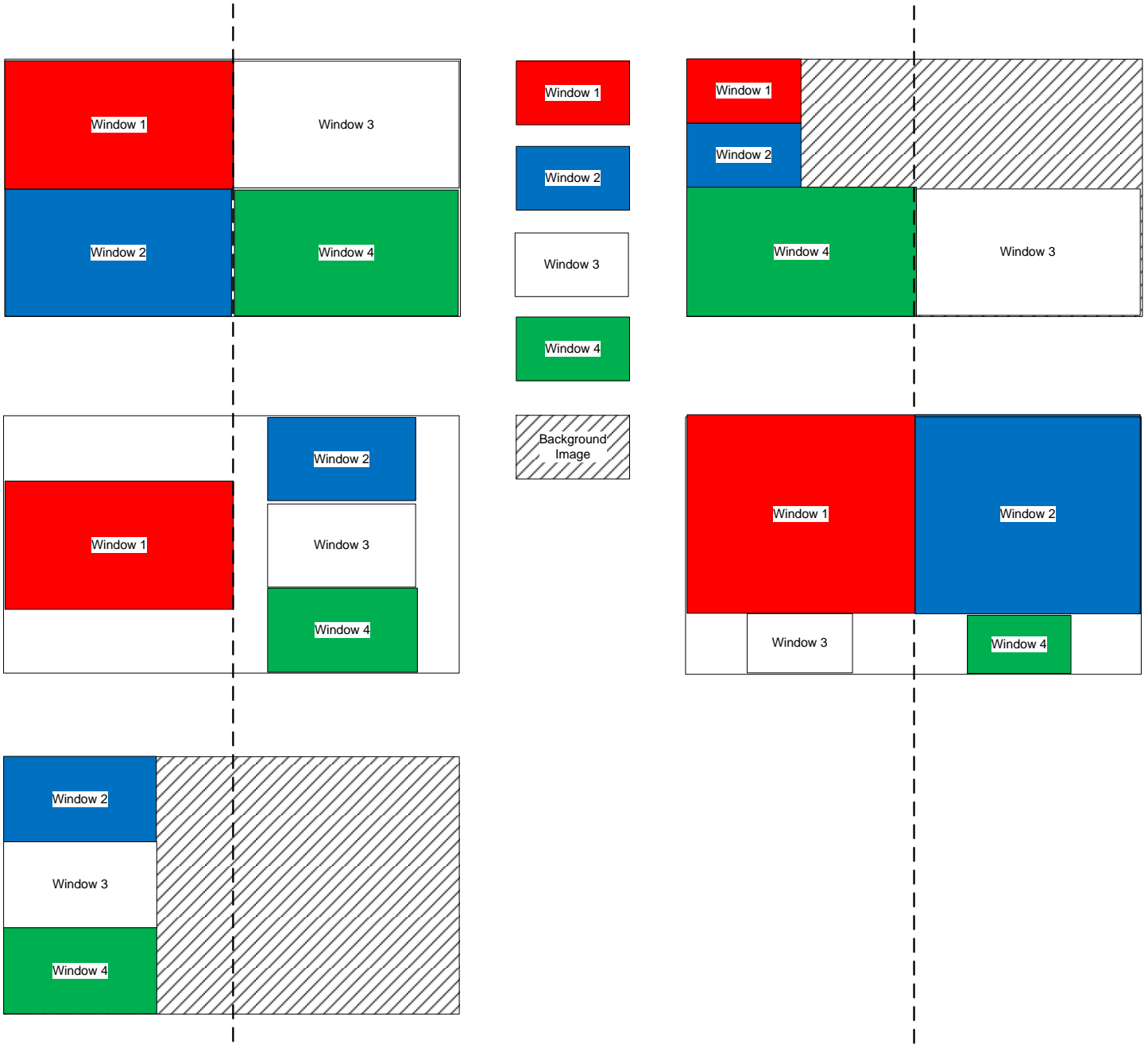
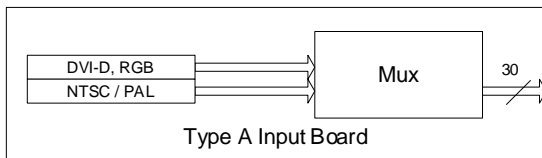
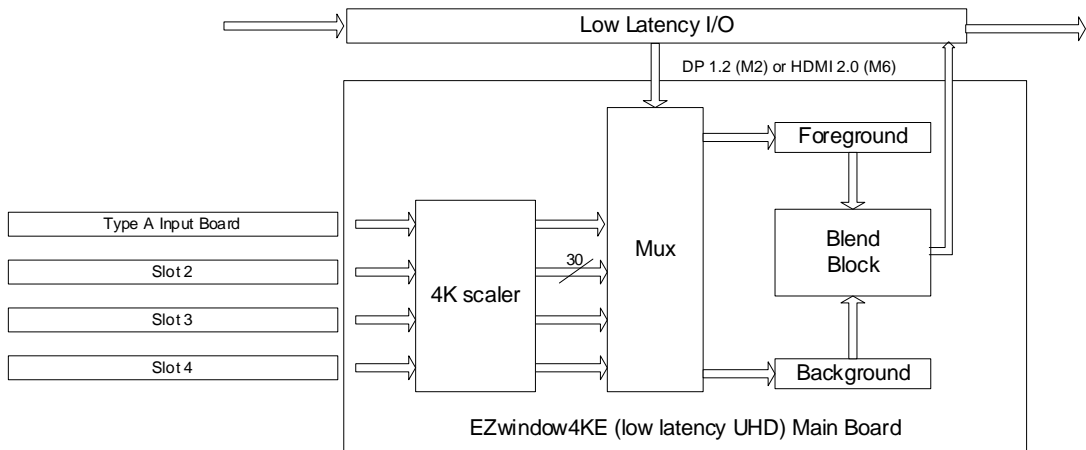
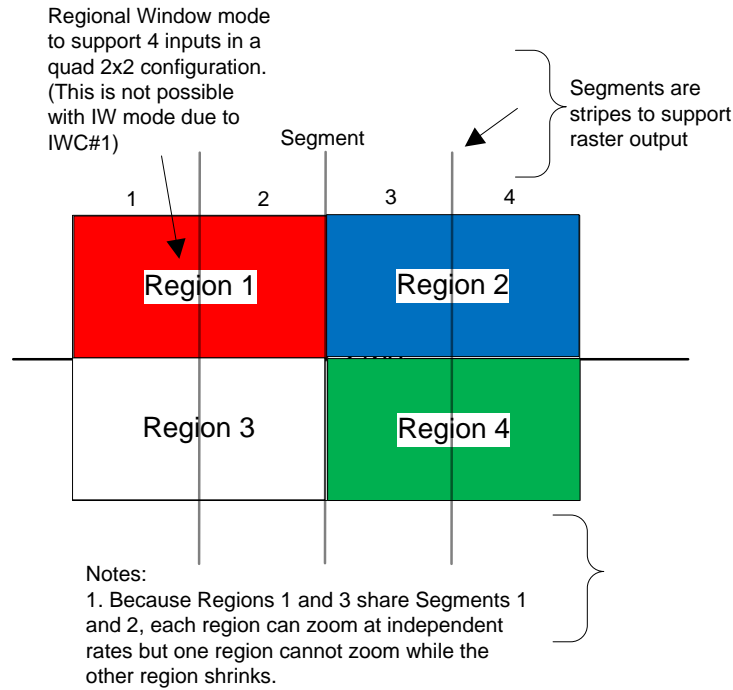


Figure 3: Regional Windowing (RW) Example



Input Board	Video Type
A	(see figure on left)
C	DisplayPort (up to 165 MP/sec)
BB	Dual DVI
DD	DisplayPort (up to 330 MP/sec)
LL I/O	Video Type
M2	DisplayPort I/O
M6	HDMI I/O

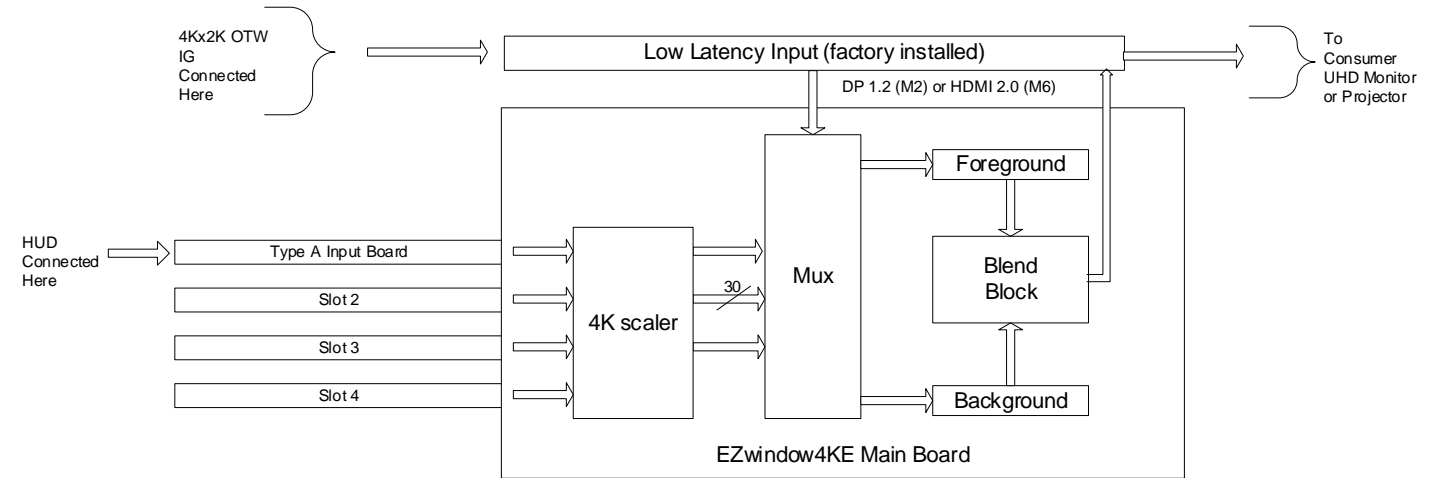
Ordering Configuration is :
EZwindow4KE-wxyzm, where
w is the input board type in Slot 1
x is the input board type in Slot 2
y is the input board type in Slot 3
z is the input board type in Slot 4
m is the LL I/O type

(Place # if location is not populated)

EZwindow4KE Block Diagram

EZwindow Applications

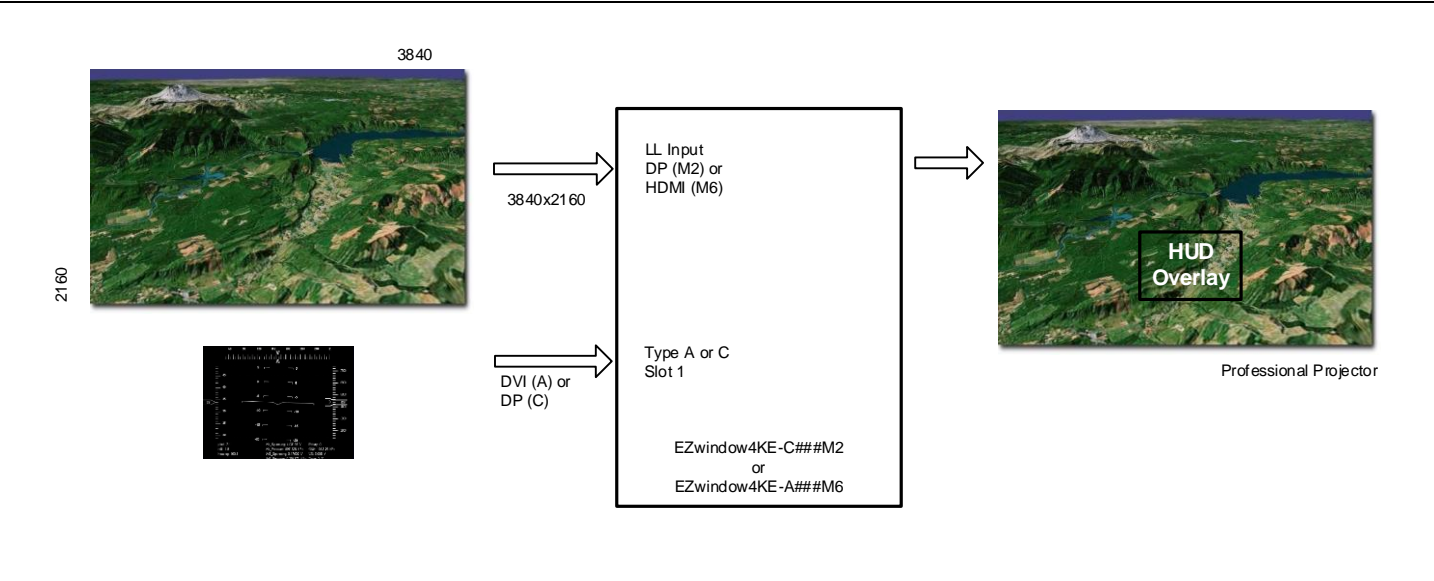
Application #1



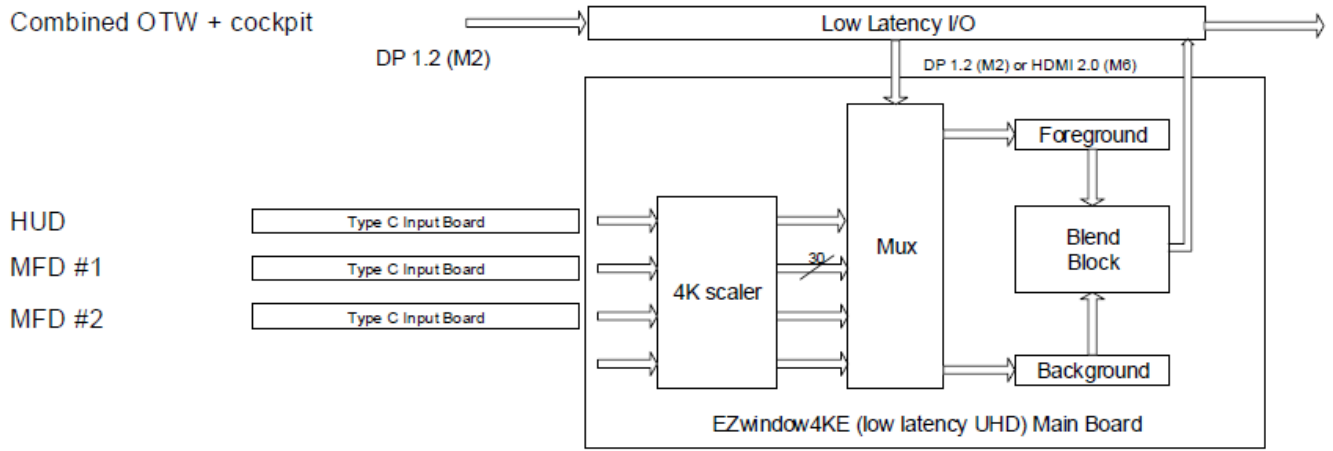
In Application #1, an EZwindow4KE-A###M6 fuses a standard resolution HUD image (1920x1200 or less) into a HDMI 2.0 OTW stream. An RGB key with programmable alpha values (separately programmable foreground and background alpha values outside the key area, when Key= TRUE, and when Key = FALSE) results in a realistic HUD overlay. This enables a single projector to be used for both the OTW image and the HUD overlay.

Alternately, an EZwindow4KE-C###M2 would be applicable for DisplayPort I/O.

Recommended windowing mode: Independent Windowing (IW)



Application #2



In Application #2, an EZwindow4KE-CCC#M6 places a HUD feed and (2) multifunction display feeds into 3 windows in the foreground. A key area is mapped to each of the 3 windows (3 total key areas). A video feed consisting of both an out-the-window scene and simulated cockpit is placed in the background. The Low Latency I/O is 2560x1440@60Hz, which means the scalar plane has 2 segments

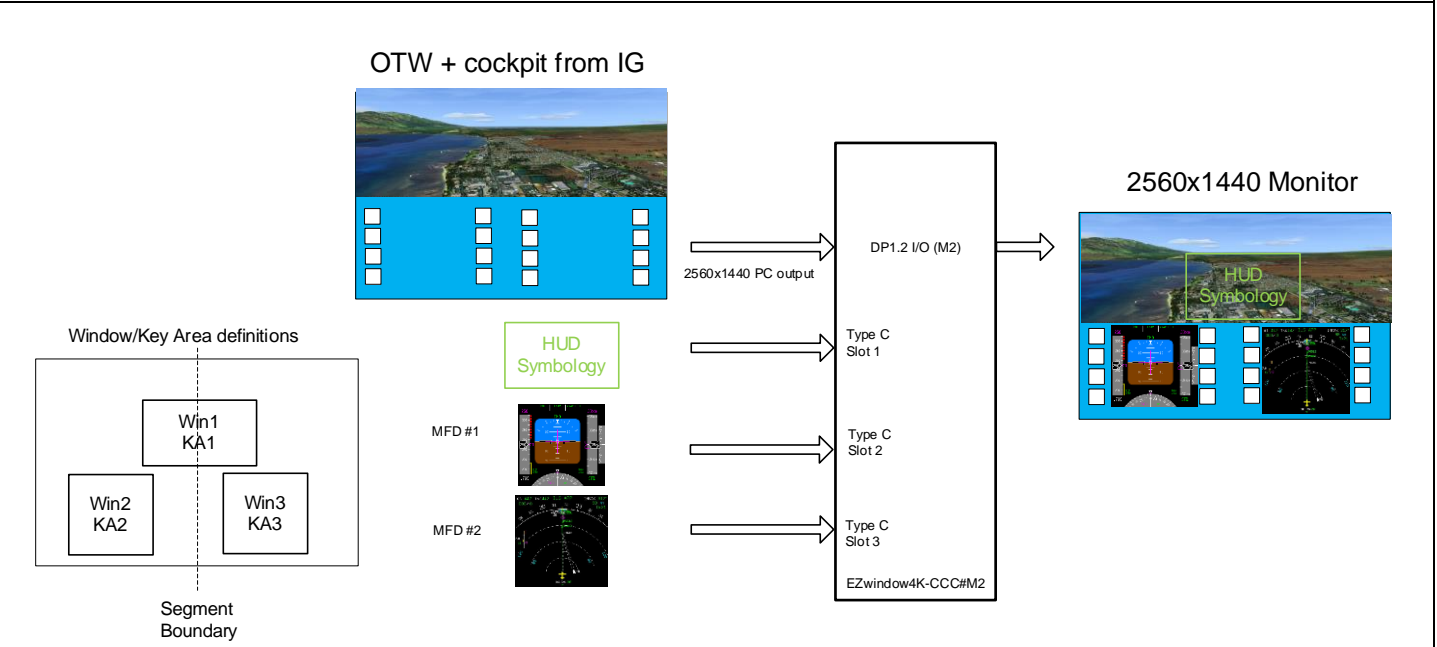
In Key Area 1, RGB keying is used to make a realistic HUD overlay on the out-the-window scene.

In Key Area 2, 100% foreground and 0% background is selected to see MFD #1 content.

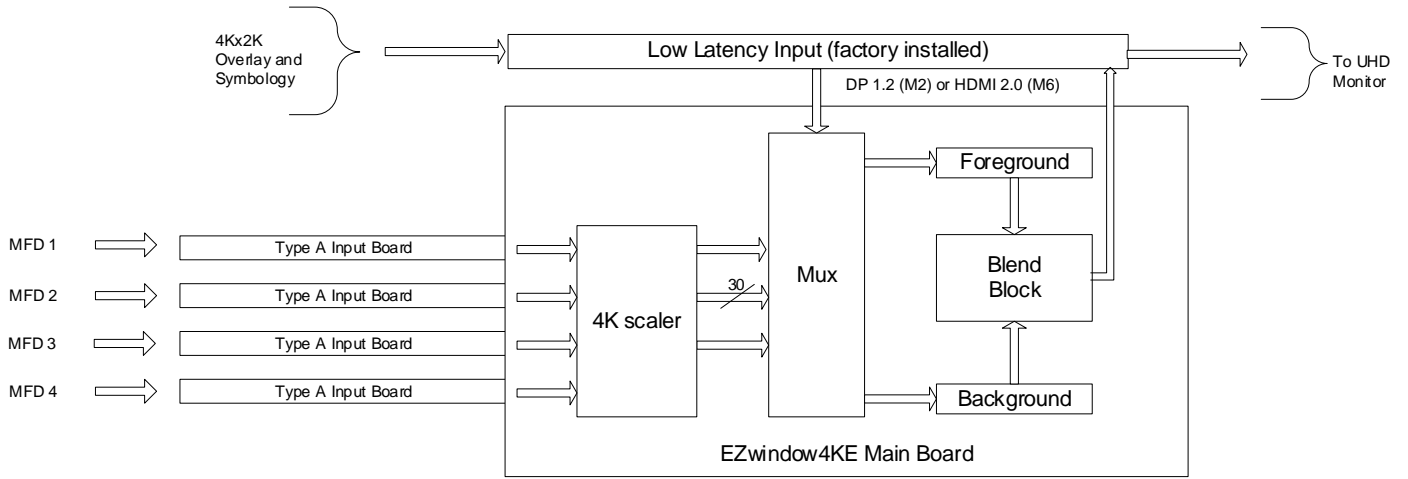
In Key Area 3, 100% foreground and 0% background is selected to see MFD #2 content.

Outside the key areas, 0% foreground and 100% background is selected to the combined OTW / cockpit imagery

Recommended windowing mode: Independent Windowing (IW) (A total of 4 segments are touched by the 3 windows)

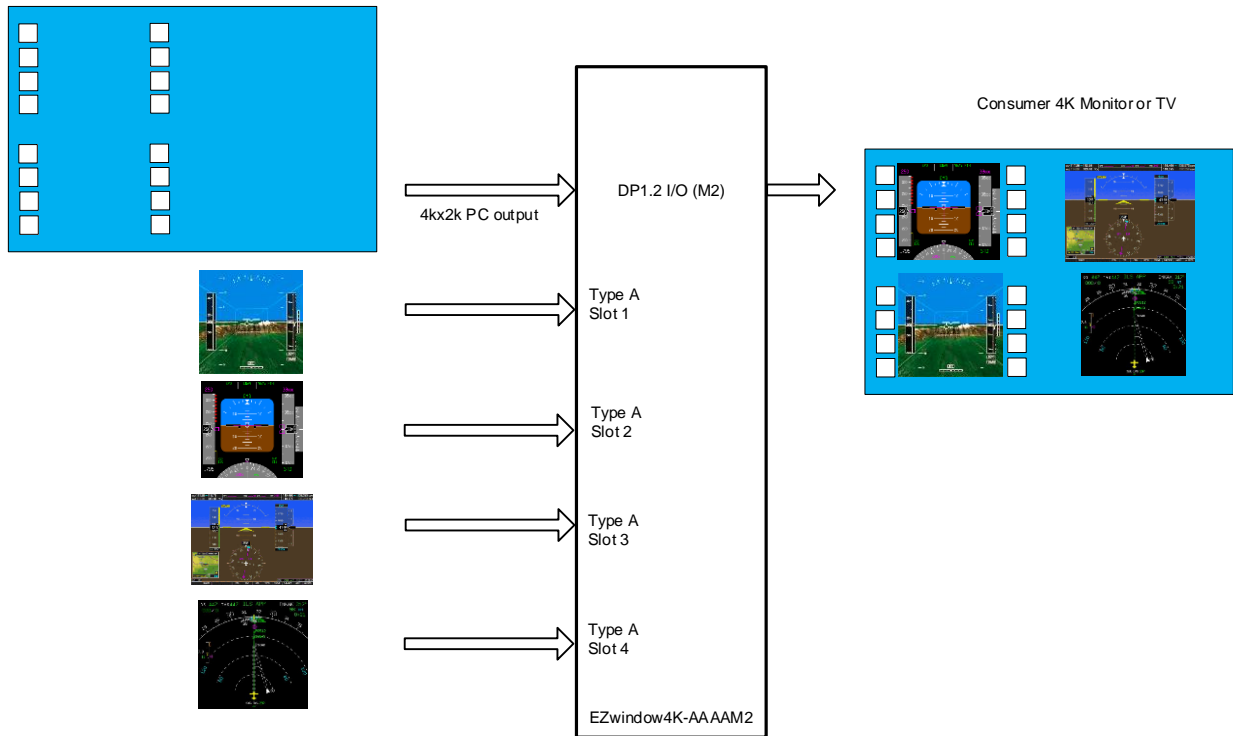


Application #3

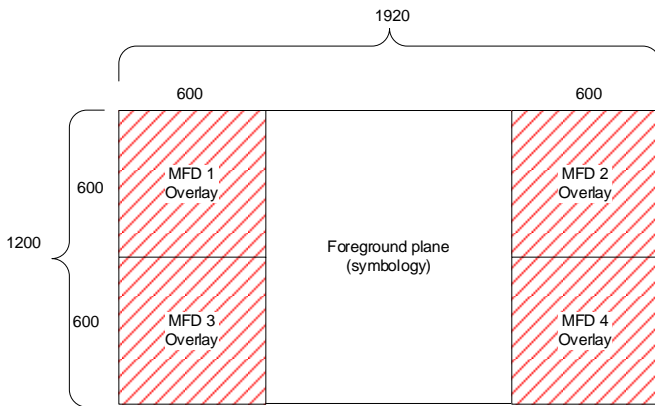
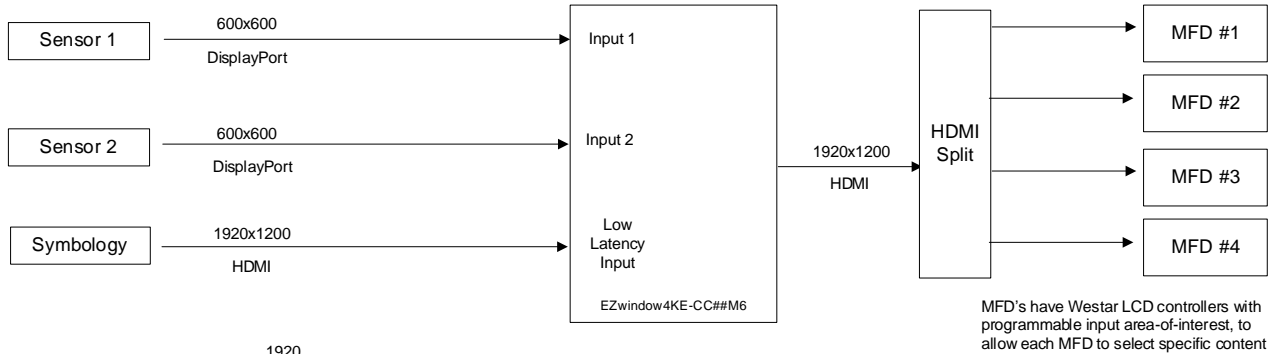


In Application #3, an EZwindow4KE-AAAAM2 fuses (4) Multi-function display feeds with a high resolution overlay for a part task trainer. The overlay is generated in a 4kx2k DisplayPort 1.2 format. The output device is a 4kx2k DisplayPort 1.2 monitor.

Recommended windowing mode: Regional Windowing (RW) at 4K 60 Hz (IW possible with 4K 30 Hz I/O).

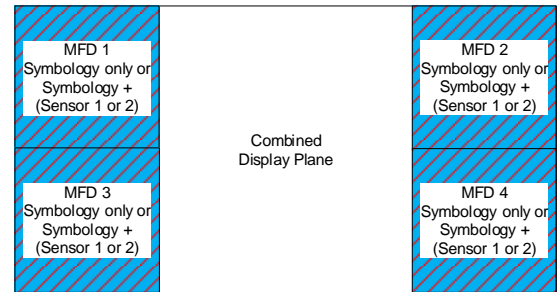
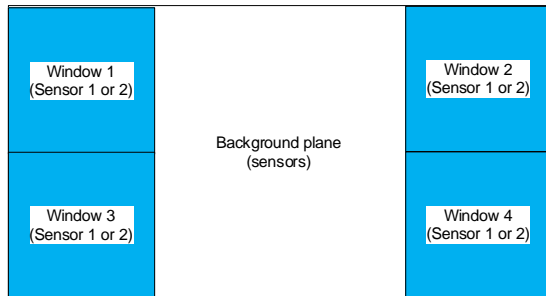


Application #4



Keying is set up on Foreground layer

- MFD#1
- To see Symbology only, close window 1 by setting window's gain to zero.
 - To see Symbology over Sensor 1, Assign Sensor 1 to Window 1 and set Window 1 gain to 1
 - To see Symbology over Sensor 2, Assign Sensor 2 to Window 1 and set Window 1 gain to 1
- MFD #2
- To see Symbology only, close window 2 by setting window's gain to zero.
 - To see Symbology over Sensor 1, Assign Sensor 1 to Window 2 and set Window 2 gain to 1
 - To see Symbology over Sensor 2, Assign Sensor 2 to Window 2 and set Window 2 gain to 1
- MFD #3
- To see Symbology only, close window 3 by setting window's gain to zero.
 - To see Symbology over Sensor 1, Assign Sensor 1 to Window 3 and set Window 3 gain to 1
 - To see Symbology over Sensor 2, Assign Sensor 2 to Window 3 and set Window 3 gain to 1
- MFD #4
- To see Symbology only, close window 4 by setting window's gain to zero.
 - To see Symbology over Sensor 1, Assign Sensor 1 to Window 4 and set Window 4 gain to 1
 - To see Symbology over Sensor 2, Assign Sensor 2 to Window 4 and set Window 4 gain to 1



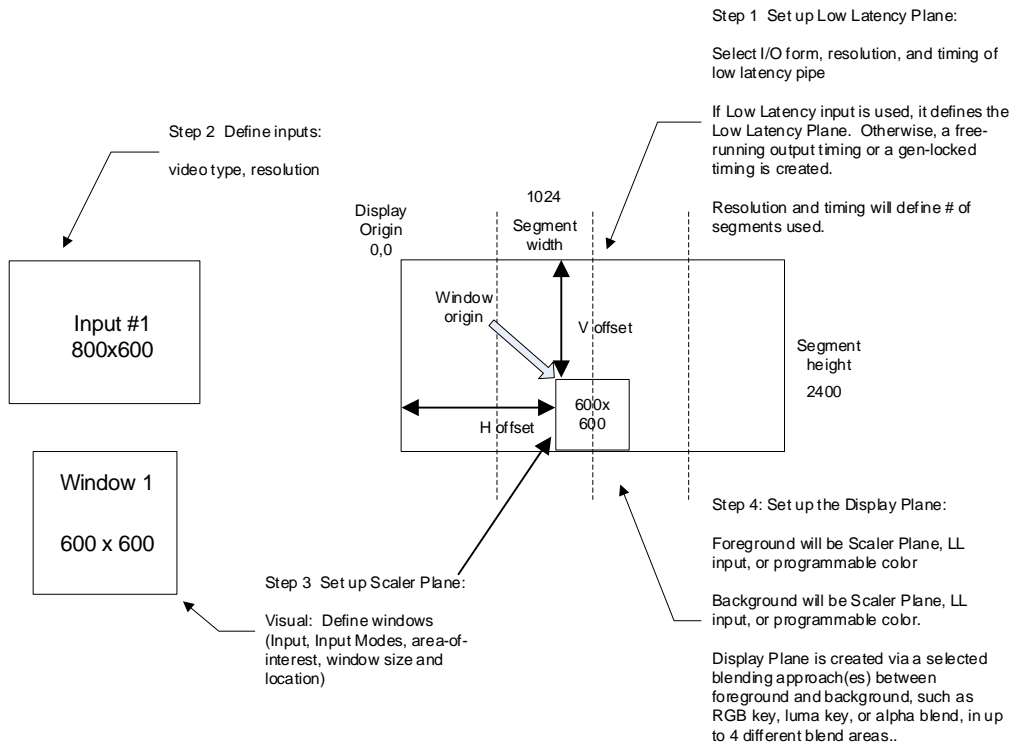
In Application #4, a single EZwindow4KE-CC##M6 implements a (4) Multi-Function Display (MFD) solution. Each of (4) windows is assigned to a specific MFD. The symbology is created in 4 windows by a COTS image generator. In the background plane, each window's associated input can be selected independently as sensor 1 or sensor 2. A window can also be independently selected to show symbology only, by reducing the background window's (1, 2, 3, and/or 4) gain to 0. To show "sensor only" requires the IG to drive the specific MFD overlay to black. Westar LCD controllers are used in many simulated MFD's. The LCD controller can be individually configured to select the appropriate area of interest from the full 1920x1200 video stream.

Note: Higher display resolutions than 600x600 are possible. Please contact Westar for more details.

Recommended windowing mode: Independent Windowing (IW)

Configuring the EZwindow4KE

The EZwindow4KE is primarily used in applications where video is combined into a 4Kx2K image. The figure below shows the steps in setting up the EZwindow4KE:



Approach:

1. User sets up the Low Latency Plane (if used) and Output format.

of segments (stripes) required is calculated from format.

Examples include:

- HDMI 2.0 Input, HDMI 2.0 Output, 3840x2160 60 Hz (4 Stripes)
- HDMI 2.0 Input, HDMI 2.0 Output, 3840x2160 30 Hz (2 Stripes)
- DP1.2 Input, DP1.2 Output, 3840x2160 4 Stripes
- DP1.2 Input, DP1.2 Output, 2560x1600 2 Stripes
- No input, HDMI 2.0 Output, 3840x2160 4 Stripes

2. User configures all Scaler Inputs in slots 1-4. Video type, resolution, etc.

3. User defines windows within the Scaler Plane:

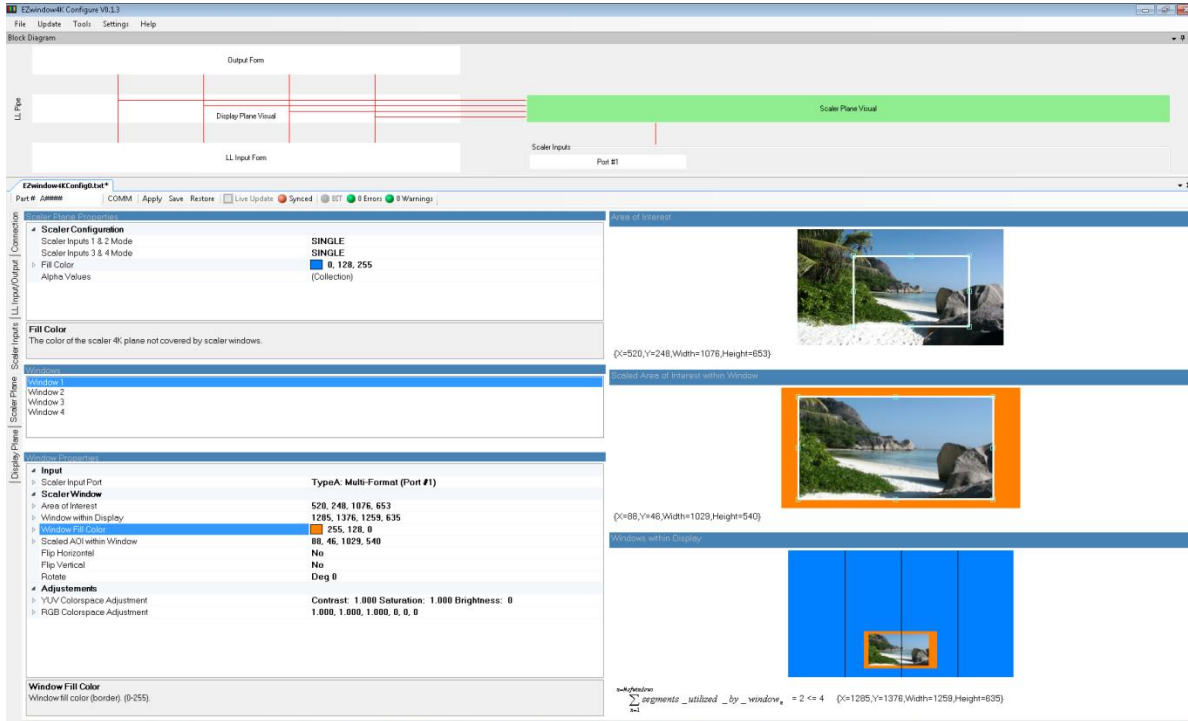
User selects Independent Windowing (IW) or Regional Windowing (RW) approach. For each window, user selects an area-of-interest from an input and then defines the size and location of the corresponding window in the Scaler Plane. For IW mode:

The summation, from n = 1 to the # of windows, of segments utilized by window n must be less than or equal to 4:

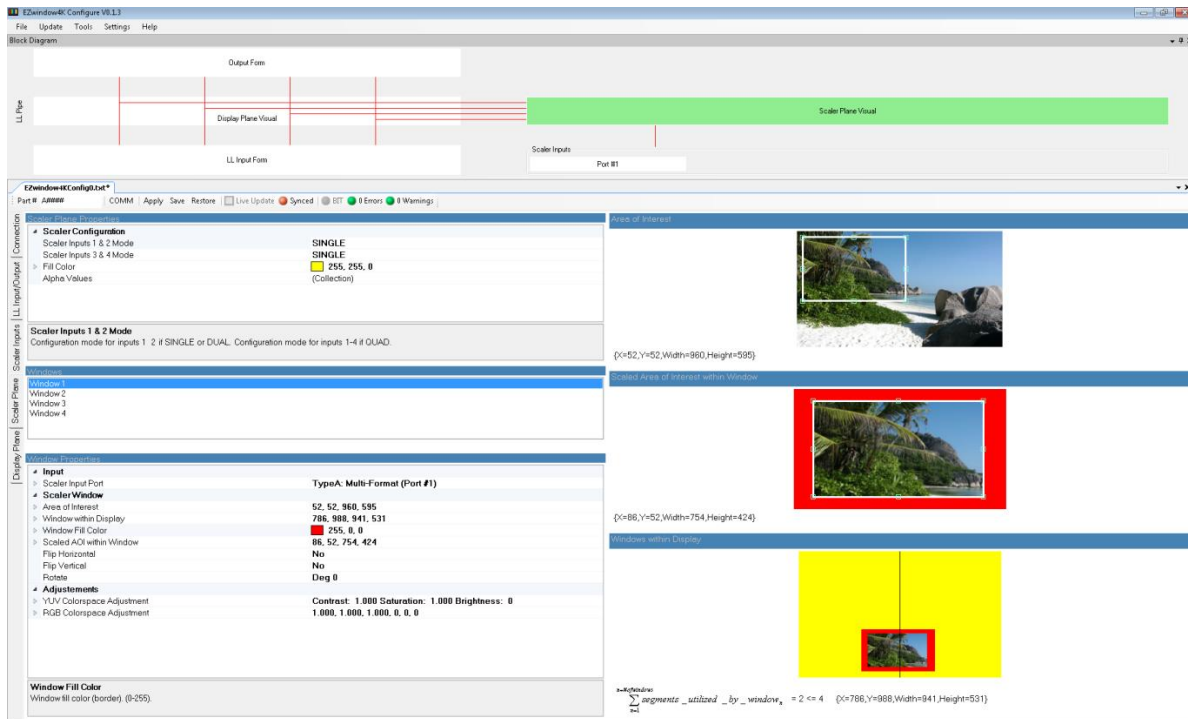
$$\sum_{n=1}^{\# \text{ of windows}} (\text{segments utilized by window } n) \leq 4$$

4. The user creates the Display Plane as a blended version of the Scaler Plane and the Low Latency Plane.

EZwindow4KE Configuration Utility



Above: HUD window within 4 segments for a 4K projector



Above: HUD window within 2 segments for a 2560x1600 projector

Specifications

Low Latency Input /Output	Specification	Input Connector (s)	Output Connector (s)
M2 (Option)	DisplayPort 1.2 (up to 600 MPixels/sec) / 4Kx2K @ 60 Hz, Note 1	DisplayPort (standard connector type)	DisplayPort (standard connector type)
M6 (Option)	HDMI 2.0 (up to 600 MPixels/sec) / 4Kx2K @ 60 Hz, Notes 2, 3	HDMI (standard Type A connector)	HDMI (standard Type A connector)
Scaler Inputs			
Input Types	Type A	Type C	Type BB
Video Type	Analog RGB (0.7 Volt levels, Interfaced or Non-Interfaced), 1xDVI-D, NTSC/PAL, more	DisplayPort 1.1a	DVI-I (dual Pixel)
Pixel Rate	Up to 166 MPixels/sec	Up to 165 MPixels/sec	Up to 330 MPixels/sec
Active Pixels per Line	Up to 4096 (must meet pixel rate constraint)	Up to 4096 (must meet pixel rate constraint)	Up to 4096 (must meet pixel rate constraint)
Lines per frame	Up to 4096	Up to 4096	Up to 4096
Phase Adjustments	Adjustable sample clock to ensure center sampling		
Connectors	DVI-I connector for 1xDVI-D and Analog RGB (included) (1) BNC for NTSC/PAL	DisplayPort (standard)	DVI-I (Dual Pixel)
Slots	1 input slot	1 input slot	2 input slots
Input Types	Type DD		
Video Type	DisplayPort 1.1a		
Pixel Rate	Up to 330 MPixels/sec		
Active Pixels per Line	Up to 4096 (must meet pixel rate constraint)		
Lines per frame	Up to 4096		
Phase Adjustments			
Connectors	DisplayPort (standard)		
Slots	2 input slots		
Functional	Specification	Functional	Specification
Features	<ul style="list-style-type: none"> Image Flip, scaling, rotate Windowing, PIP Alpha Blending Programmable Border Colors Brightness / Contrast Adjustments 	Features (cont.)	Keying Type (RGB, Luma, HSV) or alpha blend for up to (4) key areas. Each key area has programmable foreground and background alphas for key = True and key = False Programmable foreground and background alphas for outside the key area.
Output Sync Modes	Free run, locked to hi-res input, Sync to input	Dimensions (W x D x H)	Rackmount: 19" x 13.75" x 1.75" (1U)
Color Processing Depth	8 bits per color	Weight	Less than 10 lbs.
Re-sizing Limits	Virtually unlimited	Warranty	1 Year Limited
Input Power	IEC Connector, 100-240 VAC, 47-63 Hz, less than 60 Watts	Certifications	RoHS, CE
Control	RS-232, USB, Ethernet		

Notes:

1. DisplayPort I/O supports RGB 4:4:4 mode only, 10 bits per color up to 2560x1600 / 60Hz, 8 bits per color at 3840x2160 / 60Hz. Some non-standard resolutions are not supported on M2 input. See Section "DisplayPort M2 Input Resolutions"
2. HDMI Input supports RGB 4:4:4 mode only
3. HDMI output supports RGB 4:4:4, YCbCr 4:2:0 modes



EZwindow4KE-AC##M2 shown above, with Type A (DVI) in slot 1, Type C (DisplayPort) in Slot 2, and DisplayPort (M2) enabled in the Low Latency slot. An LED indicates whether LL DP or LL HDMI is enabled and operating.

What's Included:

- EZwindow4KE Video Processor
- RS-232 Serial Cable
- USB Cable
- Power Cable

CD Containing:

- Configuration Utility Software
- User's Guide
- Command Line Description