3D Input Format Requirements for DLP® Projectors using the new DDP4421/DDP4422 System Controller ASIC

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Overview

Texas Instruments will introduce a new DLP® system controller ASIC in late 2011. This new ASIC will be available in two different versions – the DDP4421 will support projector resolutions below 1080p (SVGA, XGA, WXGA, SXGA+, etc) while the DDP4422 will add support for projector resolution of 1080p and higher (SVGA through WUXGA). This new ASIC will enable a second-generation DLP® projectors which support a wider variety of 3D input formats than legacy DLP® systems.

While the second generation of DLP® projectors can handle a variety of 3D input formats, three 3D input formats have been chosen as the standard method of sending 3D video into the system. These three 3D inputs formats are:

- Side-by-side 3D format. This 3D format is the preferred input format for second-generation DLP® projectors. It eliminates the problem of L/R input synchronization and does not require a video card with quad-buffering capability.

- Frame-sequential 3D format. Legacy DLP® projectors accept this 3D video format which consists of sequential video frames, separated by the vertical sync signal, each frame containing either left eye data or right eye data. It requires that the media player use a video card that supports quad-buffering of the 3D video stream. It traditionally does not support a method of identifying the left/right input frame reference to the DLP® projector which can cause problems with displaying the eye data in the wrong order; however, second-generation DLP® projectors can use the DLP® 3-D Ready encoding scheme to solve this problem.

- Top-and-bottom 3D format. This 3D format is a supported input format for second-generation DLP® projectors. It eliminates the problem of L/R input synchronization and does not require a video card with quad-buffering capability.

These 3D formats are described in greater detail in the sections below.

Media players that adhere to the DLP® 3-D Ready encoding scheme (see Appendix B) when using one of these 3D formats will enable "plug-and-play" 3D operation with second-generation DLP® projectors. No user interaction will be required to switch the DLP® projector between from 2D to 3D operation. **Video that does not adhere to the DLP® 3-D Ready encoding scheme will require the user to manually switch the DLP® projector between 2D and 3D operation.**

Irrespective of the 3D video input format, second-generation DLP® projectors can use any of the available 3D output systems (active glasses with DLP® Link™, active glasses with a separate infrared emitter, and passive 3D glasses, etc).

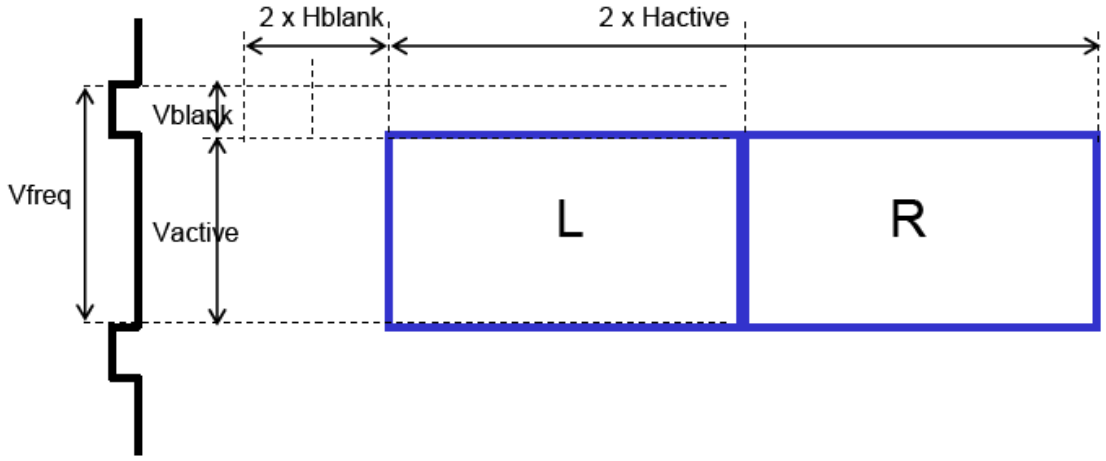
Side-by-side 3D Input Format

The preferred 3D input format for second-generation DLP® projectors is called side-by-side 3D where both the left and right eye portions of the 3D image are presented in one input frame.

The left and right eye portions of the input frame can be sub-sampled (half of the normal image width) or each eye can be full width (equal to the normal image width).

The left eye portion of the 3D input frame is always the first half of each input line; the right eye portion of the 3D input frame is always the last half of each input line.

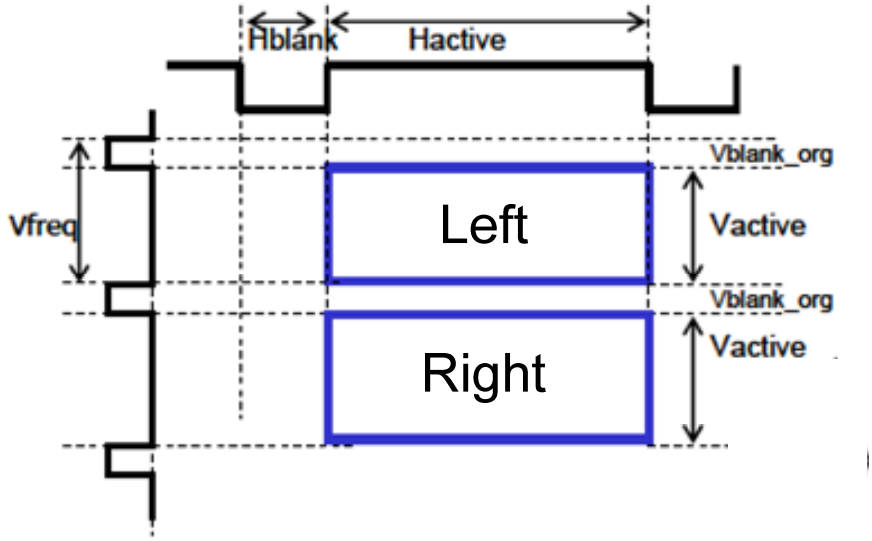
An example of the side-by-side 3D input format where the eye data is full width is shown below:



Frame-sequential 3D Input Format

Legacy DLP® projectors supported 3D video using a frame-sequential format. This 3D format transmits the left and right eye data as separate frames.

An example is shown below:



This 3D format requires that the media player use a video card that employs quad-buffering of the 3D video data.

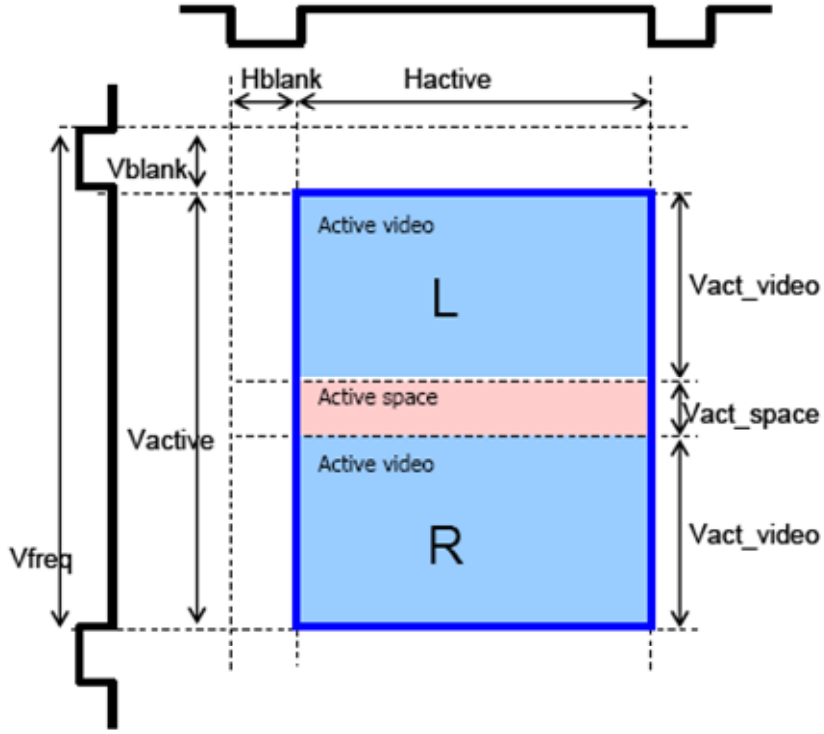
Top-and-bottom 3D Input Format

This supported 3D input format for second-generation DLP® projectors is called top-and-bottom 3D where both the left and right eye portions of the 3D image are presented in one input frame.

The left and right eye portions of the input frame can be sub-sampled (half of the normal image height) or each eye can be full height (equal to the normal image height).

The left eye portion of the 3D input frame is always the top half of each input frame; the right eye portion of the 3D input frame is always the bottom half of each input frame.

An example of the top-and-bottom 3D input format where the eye data is full height is shown below:



Note that the active area between the left and right eye data is not required and should not be used unless required by the video source.

Summary

The various 3D formats supported by both legacy DLP® projectors as well as the new DDP442x-based DLP® projectors are summarized in the table below:

3D Input Format	Legacy DLP® Projector (analog input)	Legacy DLP® Projector (digital input)	Second-generation DLP® Projector (analog input)	Second-generation DLP® Projectors (digital input)
Frame-sequential [1]	Yes [2][3]	Yes [2][3]	Yes [2][3]	Yes [2][3]
Frame-sequential [1] with DLP® 3-D Ready encoding	No	No	Yes	Yes
Side-by-side	No	No	Yes [3]	Yes [3]
Side-by-side with DLP® 3-D Ready encoding	No	No	Yes	Yes
Top-and-bottom	Yes[3]	Yes[3]	Yes [3]	Yes [3]
Top-and-bottom with DLP® 3-D Ready encoding	No	No	Yes	Yes

Note 1: Frame-sequential 3D formats require a video card with quad-buffering support

Note 2: The DLP projector will not be able to determine if the input frame contains left or right eye data. The user may need to toggle the left and right eyes for proper 3D operation.

Note 3: The DLP projector will not be able to determine of the input is 2D or 3D and will not automatically switch into 3D mode; the user will need manually enable 3D operation at the projector.

Appendix A – Media Player Considerations

HDMI 1.4a Support

A media player whose HDMI output port fully complies with the HDMI 1.4a standard, when connected to a second-generation DLP® projector that also supports HDMI 1.4a, will support additional 3D video formats in addition to the 3D formats described above. In this case, the second-generation DLP® projector will automatically handle these additional 3D formats that are commanded by the media player output over secondary communications channels in the HDMI connection. These additional 3D formats are understood by the HDMI receiver in the DLP® projector and do not require the use of DLP® 3-D Ready encoding.

DisplayPort 1.1a Support

A media player whose DisplayPort output fully complies with the DisplayPort 1.1a standard, when connected to a DDP442x-based DLP® projector that also supports DisplayPort 1.1a, will support 3D formats in addition to the 3D formats described above. In this case, the DLP® projector will automatically handle these additional 3D formats that are commanded by the media player output over secondary communications channels in the DisplayPort connection. These additional 3D formats are understood by the DisplayPort receiver in the DLP® projector and do not require the use of DLP® 3-D Ready encoding.

Media Players with DVI Output Port(s) or Analog Output Port(s)

A media player which outputs 3D video over a DVI port or analog port (VGA, component, composite) must do so according to one of the default 3D format described above when connected to a DDP442x-based DLP® projector.

Media Player "Toggle Sync" Command

For any frame-sequential format that cannot use the DLP 3-D Ready encoding scheme, the DLP® projector will not know if an input frame contains left eye or right eye data. In this scenario, the projected 3D image may have the eyes reversed. Media player providers are encouraged to use the F7 key to toggle the left and right eye data.

Media Player Menu Suggestions for 3D Output Configuration

To harmonize the user interface (menu selections) for 3D output configuration across media player vendors, the following menu selections are recommended:

3D Output Configuration
O Frame sequential with DLP® 3-D Ready Sync
O Side-by-side with DLP® 3-D Ready Sync
O Top-and-bottom with DLP® 3-D Ready Sync

Appendix B - DLP® 3-D Ready Encoding

DLP® 3-D Ready encoding requires that the last active line in a video frame be set to a solid color that spans the entire width of the video frame.

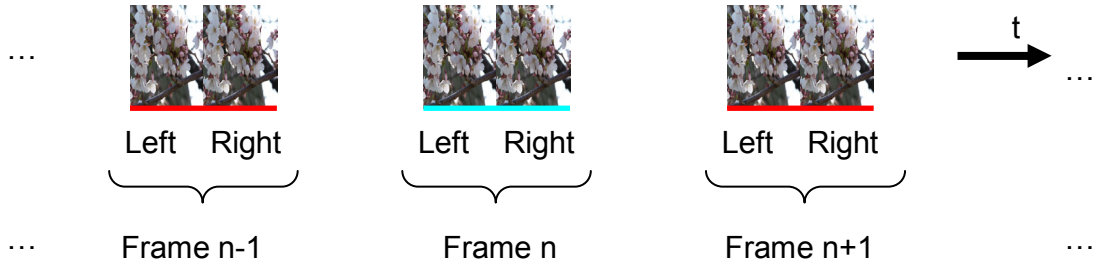
Second-generation DLP® projectors can detect the solid color of the last active line to determine the 3D state (active or inactive) and the 3D input format (frame sequential, side-by-side, etc). The projector will remove the solid color from the last active line so it is not displayed.

Note that the saturation level of the solid color lines is important. While the saturation threshold above which colors will be correctly detected is programmable inside the TI system controller ASIC, player manufacturers should ensure that the colors are as saturated as possible. The threshold in the TI reference software design is a pixel value (R, G, B) of 700 out of a possible 1023 (10-bit resolution). **To avoid any problems with a projector's detection of DLP® 3-D Ready encoding, player manufacturers are advised to fully saturate the colored lines added for DLP® 3-D Ready encoding– this means R/G/B pixel values of 255 for 8-bit outputs and 1023 for 10-bit outputs.**

The color scheme for the supported 3D formats is shown below (pixel values are for 8-bit outputs; substitute 1023 for 10-bit outputs):

Side-by-side 3D (preferred)

The last active line of successive input frames shall alternate between red (R=255, G=0, B=0) and cyan (R=0, G=255, B=255). The left eye data must be the first half of each line in the frame and the right eye data must be the last half of each line in the frame.



Frame-sequential 3D (supported)

The last active line in each stereo pair (left and right frames) shall alternate between two frames of green (G=255, R=0, B=0) and two frames of magenta (G=0, R=255, B=255). The left eye frame must always be transmitted first in each stereo pair.

Top-and-bottom 3D (supported not recommended)

The last active line of each field in successive input frame shall alternate between blue (B=255, G=0, R=0) and yellow (B=0, R=255, G=255). The left eye data must be in the first (top) field in the frame and the right eye data must be in the second (bottom) field of the frame.