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MIPI® Alliance Specification for Stereocopic Display Formats (SDF)

Version 1.0 – 22 November 2011

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This Specification is intended for use with two other Specifications:

MIPI Alliance Specification for Display Serial Interface (DSI), Version 1.1

MIPI Alliance Specification for Display Command Set (DCS), Version 1.1

At the time of release of this Specification, only *MIPI Alliance Specification for Display Serial Interface (DSI)* has been amended to support stereoscopic content over an interconnect. However, this methodology does not preclude use of SDF over parallel MIPI Alliance display interconnects such as DBI-2.

MIPI® Alliance Specification for Stereoscopic Display Formats (SDF)

Version 1.0 – 22 November 2011

MIPI Board Approved 14-Mar-2012

Further technical changes to this document are expected as work continues in the Display Working Group.

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MIPI Alliance, Inc.
c/o IEEE-ISTO
445 Hoes Lane
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Release History

Date	Release	Description
2011-08-15	0.5	Initial release.
2012-04-06	1.0	Board-approved release.

MIPI Alliance Specification for Stereoscopic Display Formats

1 Introduction

This document defines methods to transmit stereoscopic image data between a mobile device host processor and a display peripheral usually over a high-speed serial link. The nature of mobile devices and how these devices are used lead to various parameters and design options available for a stereoscopic display defined within this specification.

1.1 Scope

This document details how stereoscopic display options can be implemented using a simple control function. It provides examples of how stereoscopic images are mapped from the host processor over a serial link to the display peripheral, the order of pixel data and orientation of the stereoscopic image.

Technical data not within the scope of this document include, color order within pixel data, the commands for image manipulation and control, and mechanisms for controlling the serial link. The reader should refer to other relevant documents.

1.2 Purpose

This document allows implementers to design display peripherals that can operate in the video modes and command mode as defined by [MIPI02].

2 Terminology

The MIPI Alliance has adopted Section 13.1 of the *IEEE Standards Style Manual*, which dictates use of the words “shall”, “should”, “may”, and “can” in the development of documentation, as follows:

> The word *shall* is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).
>
> The use of the word *must* is deprecated and shall not be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
>
> The use of the word *will* is deprecated and shall not be used when stating mandatory requirements; *will* is only used in statements of fact.
>
> The word *should* is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (*should* equals *is recommended that*).
>
> The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted*).
>
> The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

All sections are normative, unless they are explicitly indicated to be informative.

2.1 Definitions

3D Mode: An operating state in which a stereoscopic-capable display renders a stereoscopic image with a unique view for each eye.

Landscape Scanning: The pixel writing direction from the display driver to the display in which the number of pixels written per line exceeds the number of lines. See Figure 1.

Landscape/Portrait Orientation: The orientation the display is viewed by a user.

Landscape/Portrait Switchable: A display where the stereoscopic effect can be switched between landscape and portrait orientation.

Left View: Part of the stereoscopic image intended to be viewed by the user’s left eye.

Left-Right Order: This value defines whether the first pixel**,** line**,** or frame of 3D Mode content sent across the physical link is intended for viewing by the left eye or the right eye. The order may apply with respect to pixel-based**,** line-based or frame-based modes of transmission

Line-based: The data transfer mode that sends an entire left or right line followed by the corresponding right or left line**,** respectively.

Portrait: The vertical dimension exceeds the horizontal dimension. If square**,** defined by the manufacturer.

Portrait Scanning: The pixel writing direction from the display driver to the display in which the number of lines written exceeds the number of pixels per line.

Right View: Part of the stereoscopic image intended to be viewed by the user's right eye.

Spatial: The left and right views are shown simultaneously to the viewer.

Stereoscopic Image: A pair of offset images of a scene (views) that renders content to both the left eye and right eye to produce the perception of depth.

Temporal Mode: A time-sequential stereoscopic image in which the left view and right view are alternately presented to the user and directed to the appropriate eye.

2.2 Abbreviations

e.g. For example (Latin: exempli gratia)

i.e. That is (Latin: id est)

2.3 Acronyms

DCS Display Command Set

DSI Display Serial Interface

DSI Display Serial Interface

3 References

[MIPI01] *MIPI Alliance Specification for Display Command Set (DCS)*, version 1.1, MIPI Alliance, Inc., 22 November 2011.

[MIPI02] *MIPI Alliance Specification for Display Serial Interface (DSI)*, version 1.1, MIPI Alliance, Inc., 22 November 2011.

[MIPI03] *MIPI Alliance Standard for Display Bus Interface*, version 2.00, MIPI Alliance, Inc., 29 November 2005.

4 Specification System Requirements

This document contains requirements and implementation examples relating to the control and transport of stereoscopic image information on the interconnect technology between a mobile application, host processor or image processor, and display peripherals. Two other Specifications, [MIPI01] and [MIPI02], contain requirements for transmission of stereoscopic control parameters, and the effect they have on other operating behavior.

MIPI Alliance display technology can operate in either Video Mode or Command Mode. Refer to [MIPI01] and [MIPI02] for the requirements of these modes. Stereoscopic display operation in Command Mode over a DBI-2 interconnect [MIPI03] is not prohibited, but is outside the scope of this document. Requirements applied during stereoscopic display operation are summarized in Table 1.

Table 1 Stereoscopic Specification Set

Specification	Contents Relevant to a Stereoscopic Display	Video Mode	Command Mode
MIPI Alliance Specification for Stereoscopic Display Formats	Describes arrangement of pixel-based data and methods to set 3D modes.	Required	Required
MIPI Alliance Specification for Display Command Set (DCS)	Describes commands used to set 3D controls and how to manipulate 3D views.	Optional	Required
MIPI Alliance Specification for Display Serial Interface (DSI)	Describes a method to embed 3D Control modes into a video stream.	Required[1]	Required[2]

1. *When supporting stereoscopic display in Video Mode, support in Command Mode is optional.*
2. *When supporting stereoscopic display in Command Mode, support in Video Mode is optional.*

4.1 Display and Host Requirements

In order for a stereoscopic image to be correctly displayed, the display module and host must support the same stereoscopic display formats. This document describes support for line-, pixel- and frame-based, spatial formats, as well as a temporal, or frame-sequential, format. If the host sends image data in a format that is not supported by the display module, an indeterminate result might occur, depending on which technologies are used to present the image.

A display module shall support at least one of the available stereoscopic formats. In order to display stereoscopic images in portrait and landscape orientations, the display module might need support for two different formats.

A host processor does not have any stereoscopic format requirements. However, since image format conversion is not required on a display module, a host processor should support all stereoscopic formats at the resolutions supported by the display module.

Depending on the display technology, a display module might need different amounts of data to be sent when displaying 2D and stereoscopic images.

5 3D Control Function and Effects on Host, Data Transfer and Display

The 3D Control Function is a two-byte value containing all information regarding the transport of stereoscopic content between host processor and display module, i.e., stereoscopic image format, data order, whether or not the stereoscopic display panel is active, and the display orientation. The parameters for the 3D Control Function are shown in Table 2.

Table 2 3D Control Function Parameters

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Name	Rsvd	Rsvd	3DL/R	3DVSYNC	3DFMT[1:0]		3DMODE[1:0]	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Name	Reserved							

In Table 2, reserved (Rsvd) bits shall be set to '0' by the host processor. A display module shall ignore reserved bits.

The Parameter 1 field descriptions are shown in Table 3.

Table 3 3D Control Function Parameter 1 Field Definitions

Field	Description
D7	Reserved, set to '0'.
D6	Reserved, set to '0'.
3DL/R	Left / Right Order '0' = Data sent left eye first, right eye next. '1' = Data sent right eye first, left eye next.
3DVSYNC	Second VSYNC Enabled between Left and Right Images '0' = No sync pulses between left and right data. '1' = Sync pulse (HSYNC, VSYNC, blanking) between left and right data.
3DFMT[1:0]	3D Image Format '00' = Line (alternating lines of left and right data). '01' = Frame (alternating frames of left and right data). '10' = Pixel (alternating pixels of left and right data). '11' = Reserved
3DMODE[1:0]	3D Mode On / Off, Display Orientation '00' = 3D Mode Off (2D Mode On). '01' = 3D Mode On, Portrait Orientation. '10' = 3D Mode On, Landscape Orientation. '11' = Reserved.

Two fields within the 3D Control Function define the data transfer between the host and display module memory. For example, if 3DFMT = 00b the host sends alternating lines of left-eye and right-eye data, with the left-eye data first then the corresponding right-eye line data (3DL/R = 0b), or right-eye data then the corresponding left-eye data (3DL/R = 1b). The format used to store the data within the host memory and

the display module memory, and the method used to transfer data from the display module memory to the display panel are specified by the component manufacturer, and are out of scope of this document.

Operation of the 3D Control Function in Command Mode (set_3D_control) and Video Mode (V Sync Start payload) is described in Section 6.26 of [MIPI01] and Section 8.8.1.2 of [MIPI02], respectively.

Note:

Only the first byte of the 3D Control Function payload is sent when operating in Video Mode.

6 SDF Implementation (informative)

The following display and orientation combinations have been considered in the examples in this section:

- Landscape scanning display, landscape orientation
- Landscape scanning display, portrait orientation
- Portrait scanning display, portrait orientation,
- Portrait scanning display, landscape orientation

Each combination is shown, including scanning direction, in Figure 1 and Figure 2.

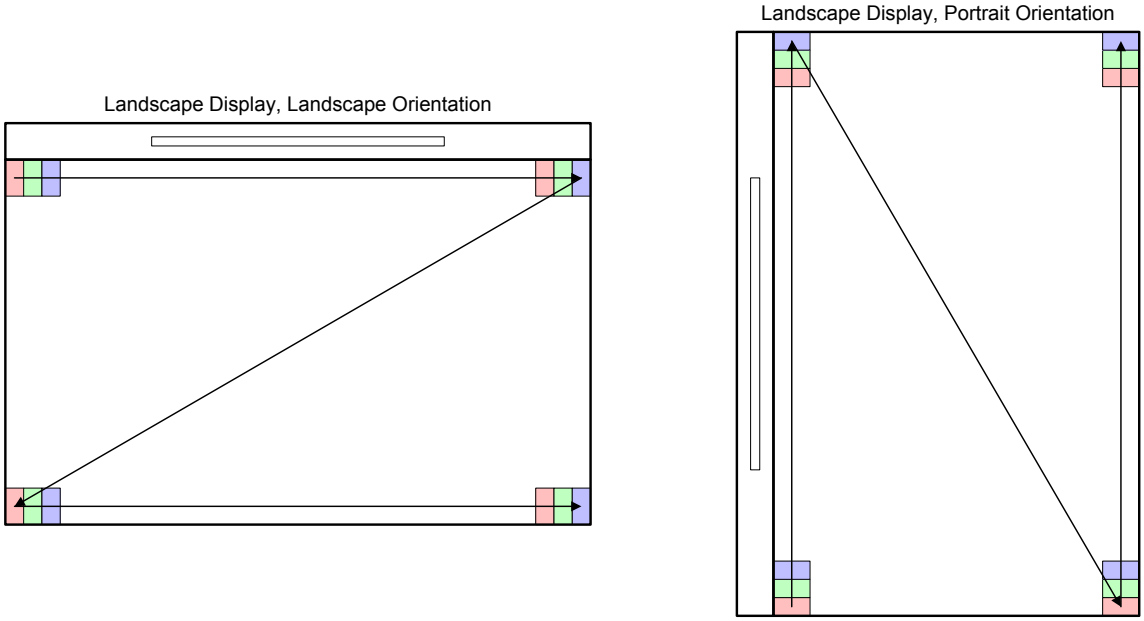


Figure 1 Landscape Scanning Display Orientations

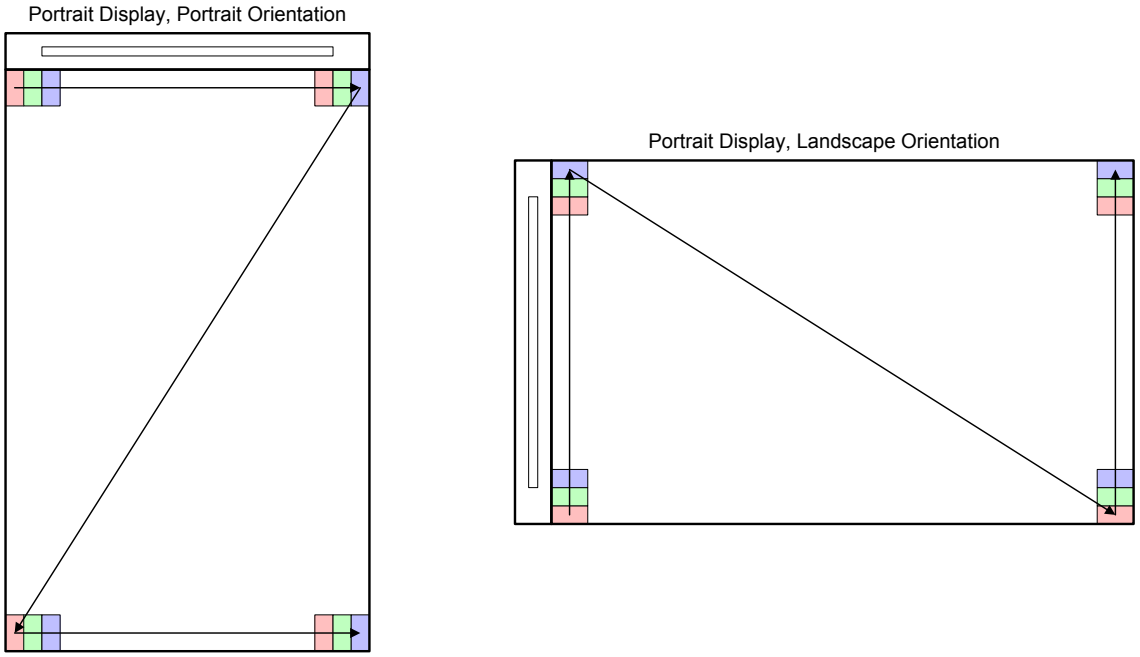


Figure 2 Portrait Scanning Display Orientations

6.1 Stereoscopic Image Formats

Stereoscopic image formats are defined as the data formats used to send stereoscopic image data from the host processor to the display module. Figure 3 through Figure 6 show examples of the image formats as defined by the 3D Control Function.

Note:

All formats are shown with left eye content sent first, however they can also be used with right eye content sent first.

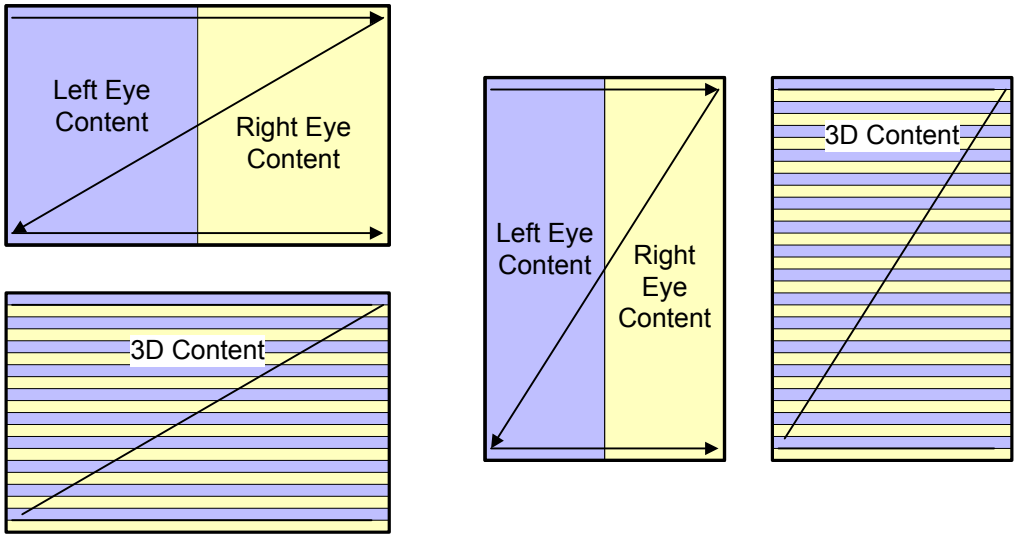


Figure 3 Line-based Stereoscopic Formats

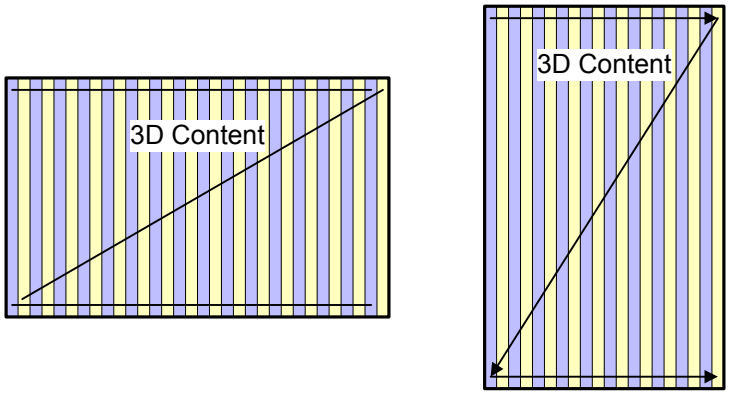


Figure 4 Pixel-based Stereoscopic Formats

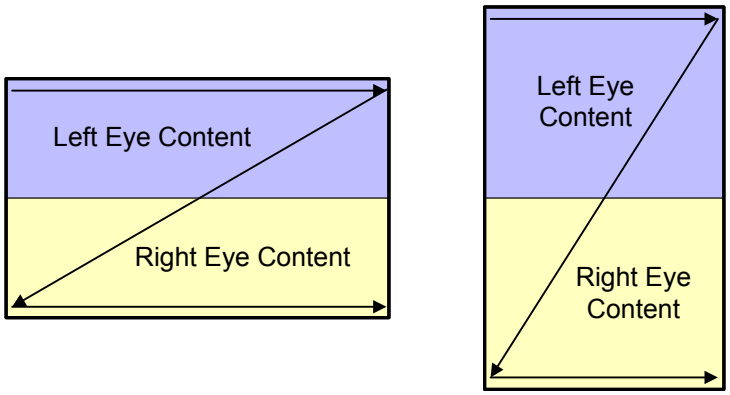


Figure 5 Frame-based Stereoscopic Formats

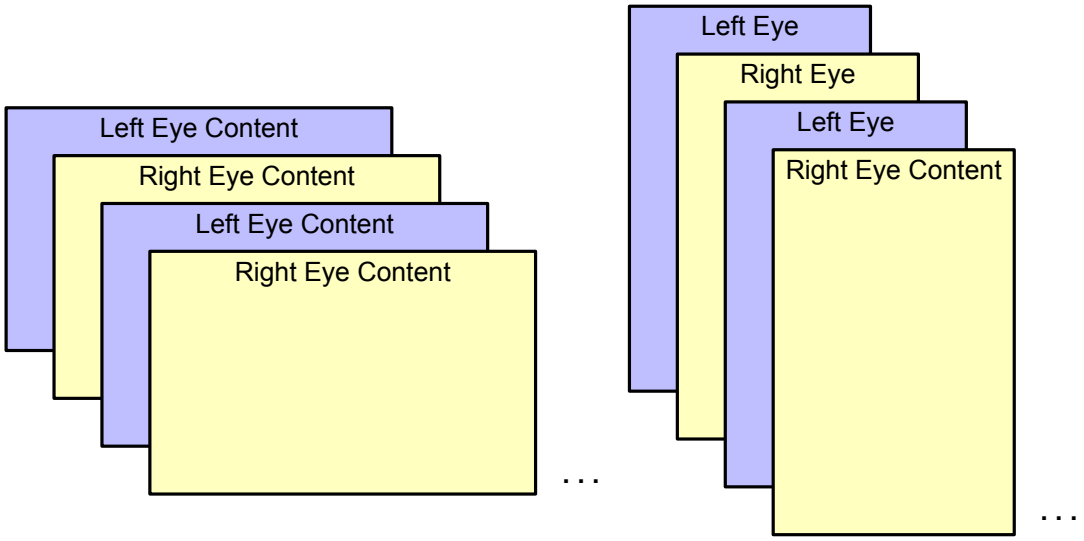


Figure 6 Frame-sequential (Temporal) Stereoscopic Formats

6.2 Examples

The following sections show examples of how stereoscopic image formats and the 3D Control Function can be implemented. The formats presented are some of the most common formats, but other configurations of display and host may be used. The transfer format is defined by this specification. How the data is stored in

the Host memory, display module memory and how it is transferred from display module memory to the display panel is defined by manufacturers.

All examples in this section use full-frame display module memory. Some of the examples can be implemented without frame memory, or with partial frame memory. The manufacturer shall specify the stereoscopic image formats supported by a display module in the device data sheet.

6.2.1 Landscape Scanning Display in Landscape Orientation, Line-based Example

Figure 7 shows a method of transferring data to a landscape scanning display in landscape orientation. The data is packaged as line-based, sending X/2 pixels left data, followed by X/2 pixels right data from the host memory to the display module memory. The data is then sent as alternating left and right pixels from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 4.

Table 4 3D Control Bits (Landscape Display, Landscape Orientation, Line-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	1	0
Description	Rsvd	Rsvd	Left First	No Sync	Line-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

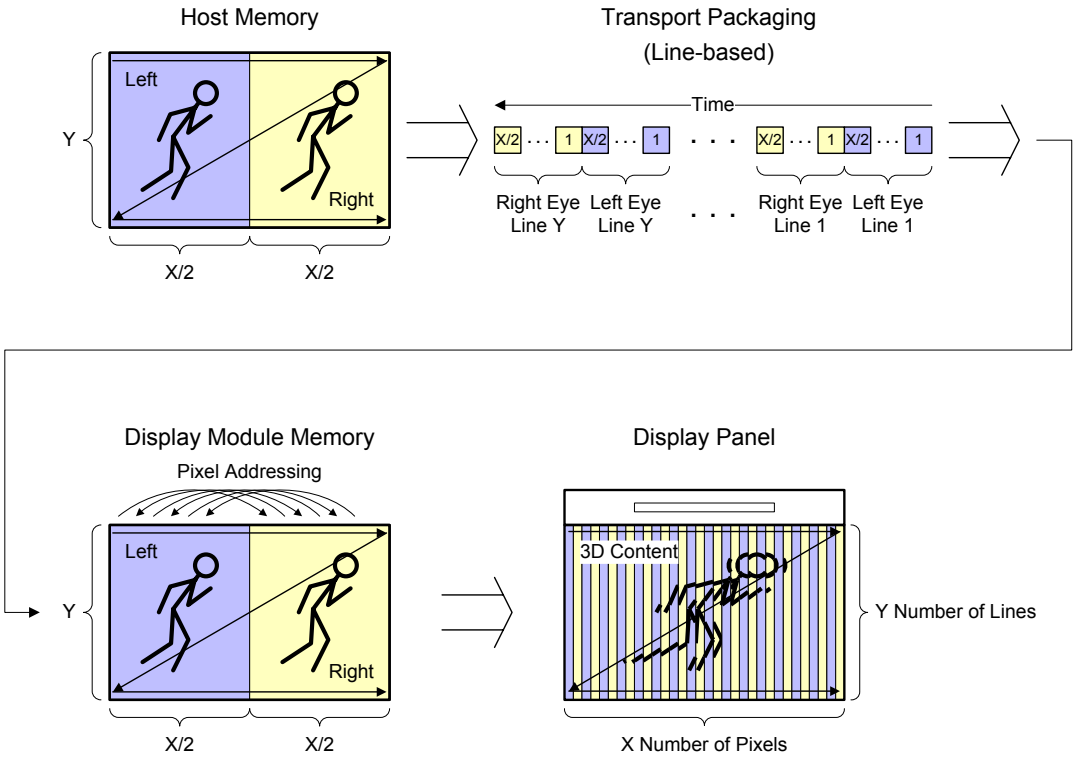


Figure 7 Landscape Scanning Display in Landscape Orientation, Line-based Example

6.2.2 Landscape Scanning Display in Landscape Orientation, Pixel-based Example

Figure 8 shows an alternative method of transferring data to a landscape scanning display in landscape orientation. The data is packaged as pixel-based, sending alternating left and right pixel data from the host memory to the display module memory. The data is then sent as alternating left and right pixels from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 5.

Table 5 3D Control Bits (Landscape Display, Landscape, Pixel-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	1	0	1	0
Description	Rsvd	Rsvd	Left First	No Sync	Pixel-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

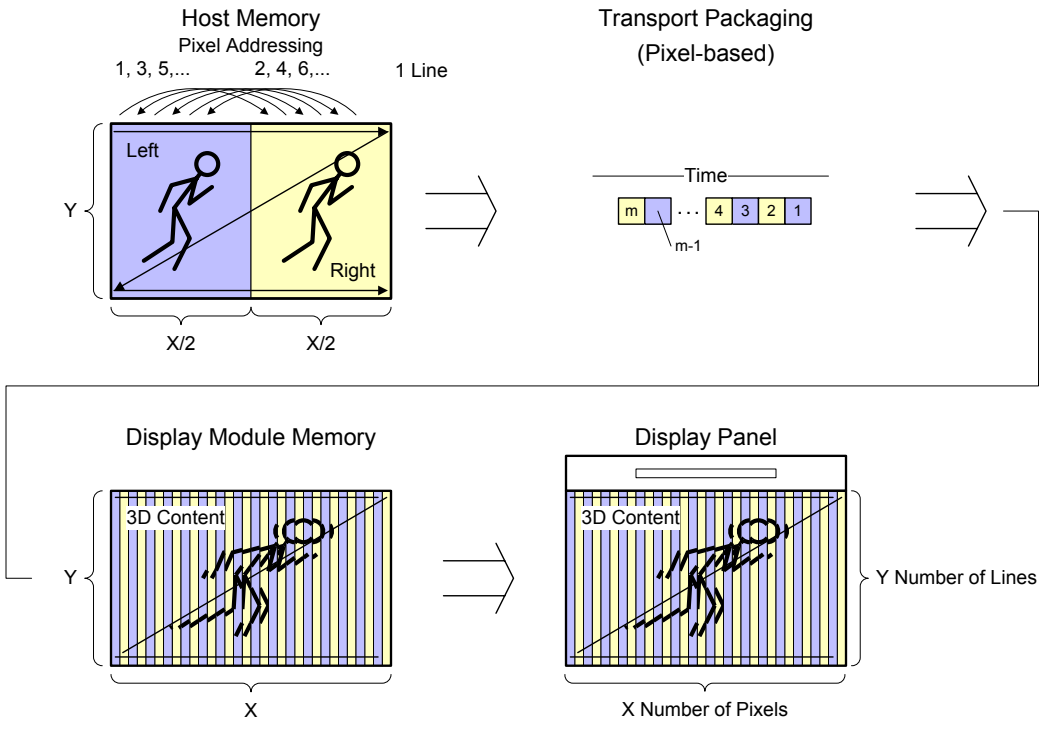


Figure 8 Landscape Scanning Display in Landscape Orientation, Pixel-based Example

6.2.3 Landscape Scanning Display in Portrait Orientation, Frame-based Example

Figure 9 shows a method of transferring data to a landscape scanning display in portrait orientation. The data is packaged as frame-based, sending X by Y/2 pixels left data, followed by X by Y/2 pixels right data from the host memory to the display module memory. The data is then sent as X pixels left followed by X pixels right from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 6.

Table 6 3D Control Bits (Landscape Display, Landscape Orientation, Frame-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	1	0	1
Description	Rsvd	Rsvd	Left First	No Sync	Frame-based		Portrait	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

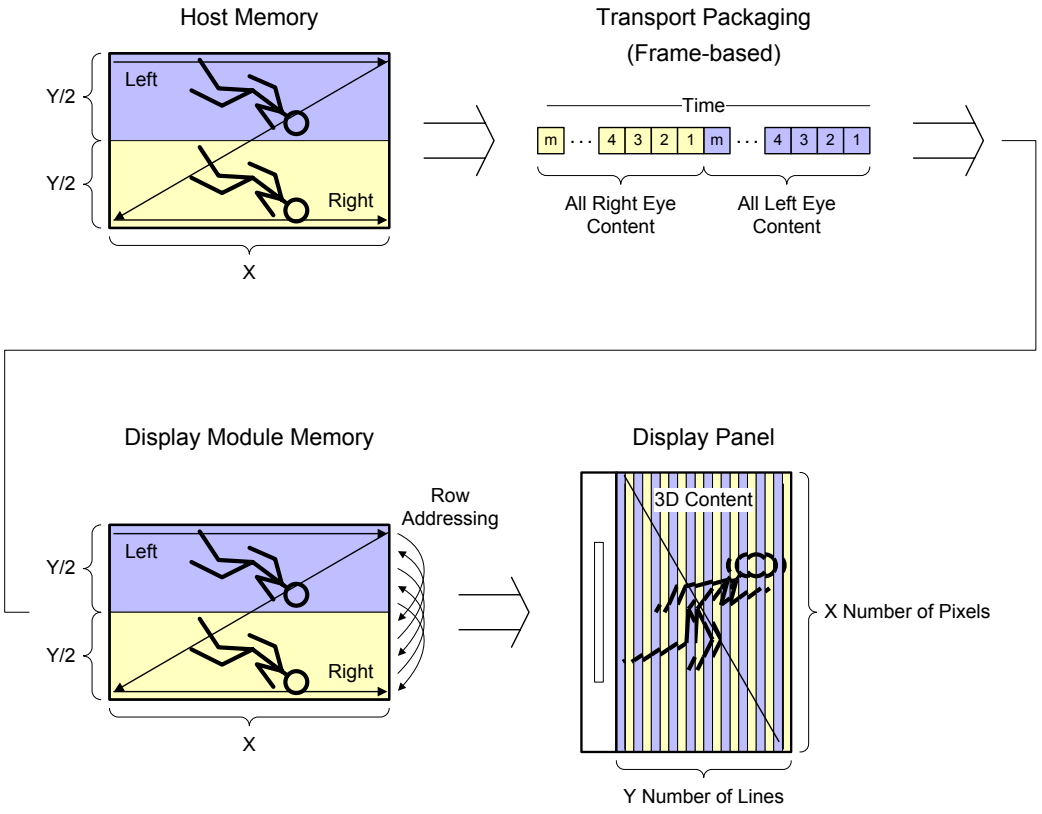


Figure 9 Landscape Scanning Display in Portrait Orientation, Frame-based Example

6.2.4 Landscape Scanning Display in Portrait Orientation, Line-based Example

Figure 10 shows an alternative method of transferring data to a landscape scanning display in portrait orientation. The data is packaged as line-based, sending X pixels left data, followed by X pixels right data from the host memory to the display module memory. The data is then sent as X pixels left followed by X pixels right from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 7.

Table 7 3D Control Bits (Landscape Display, Portrait Orientation, Line-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	1
Description	Rsvd	Rsvd	Left First	No Sync	Line-based		Portrait	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

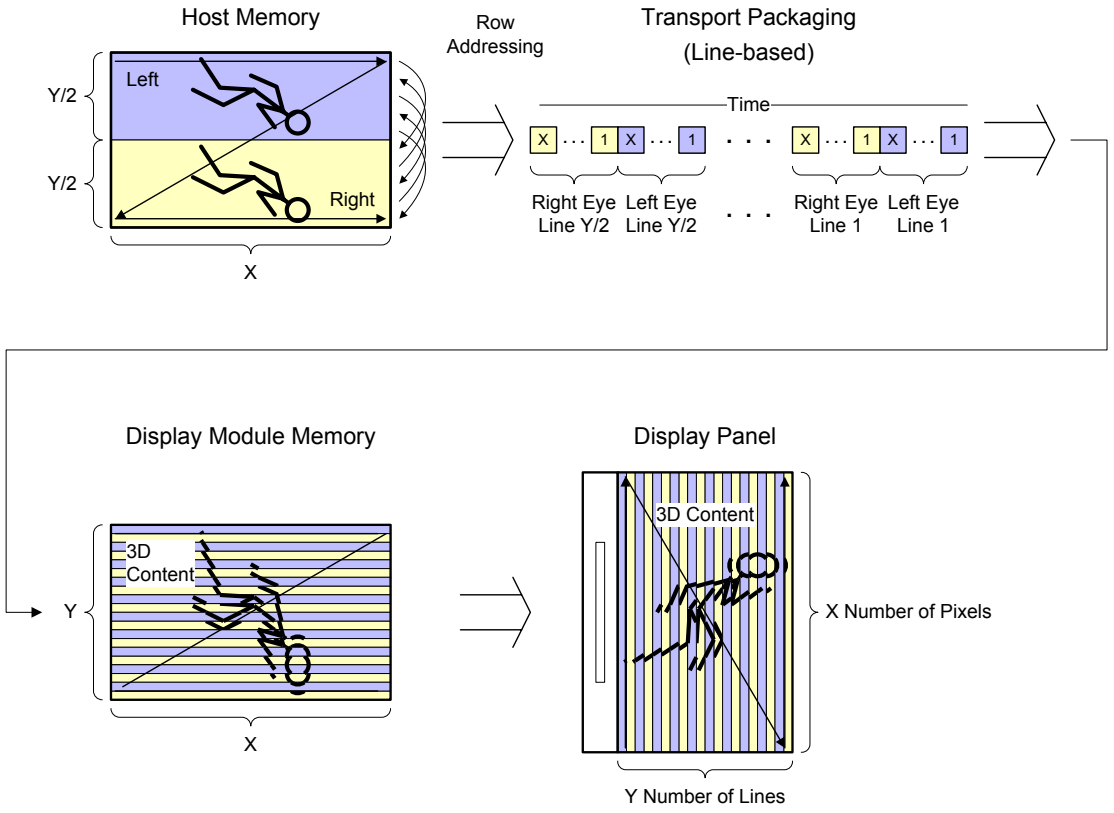


Figure 10 Landscape Scanning Display in Portrait Orientation, Line-based Example

6.2.5 Portrait Scanning Display in Portrait Orientation, Line-based Example

Figure 11 shows a method of transferring data to a portrait scanning display in portrait orientation. The data is packaged as line-based, sending X/2 pixels left data, followed by X/2 pixels right data from the host memory to the display module memory. The data is then sent as alternating left and right pixels from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 8.

Table 8 3D Control Bits (Portrait Display, Portrait Orientation, Line-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	1
Description	Rsvd	Rsvd	Left First	No Sync	Line-based		Portrait	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

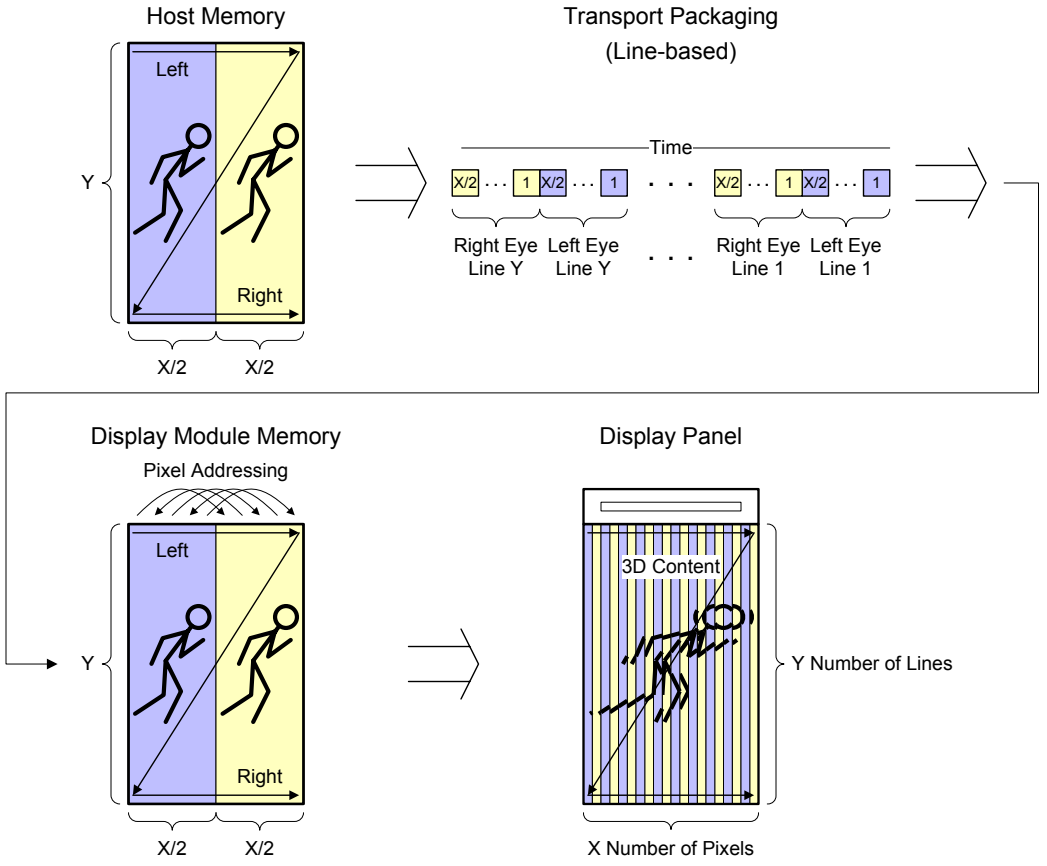


Figure 11 Portrait Scanning Display in Portrait Orientation, Line-based Example

6.2.6 Portrait Scanning Display in Portrait Orientation, Pixel-based Example

Figure 12 shows an alternative method of transferring data to a portrait scanning display in portrait orientation. The data is packaged as pixel-based, sending alternating left and right pixel data from the host memory to the display module memory. The data is then sent as alternating left and right pixels from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 9 .

Table 9 3D Control Bits (Portrait Display, Portrait Orientation, Pixel-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	1	0	0	1
Description	Rsvd	Rsvd	Left First	No Sync	Pixel-based		Portrait	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

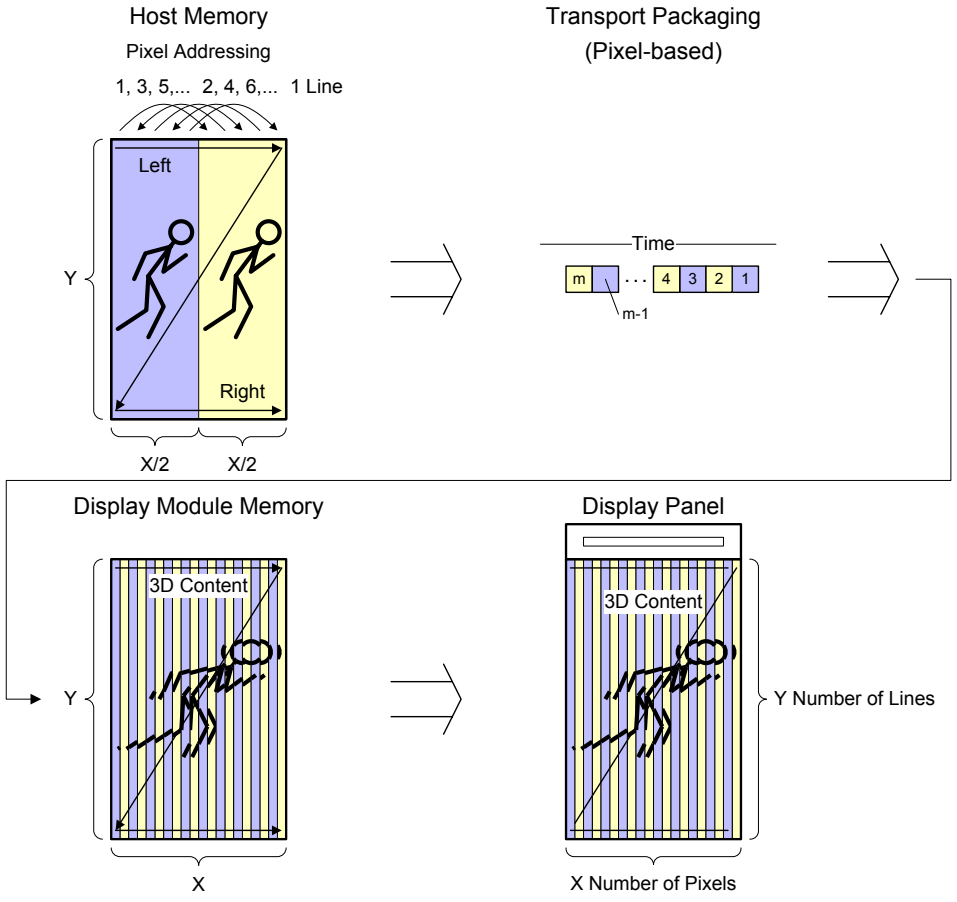


Figure 12 Portrait Scanning Display in Portrait Orientation, Pixel-based Example

6.2.7 Portrait Scanning Display in Landscape Orientation, Frame-based Example

Figure 13 shows a method of transferring data to a portrait scanning display in landscape orientation. The data is packaged as frame-based, sending X by Y/2 pixels left data, followed by X by Y/2 pixels right data from the host memory to the display memory. The data is then sent as X pixels left followed by X pixels right from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 10.

Table 10 3D Control Bits (Portrait Display, Landscape Orientation, Frame-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	1	1	0
Description	Rsvd	Rsvd	Left First	No Sync	Frame-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

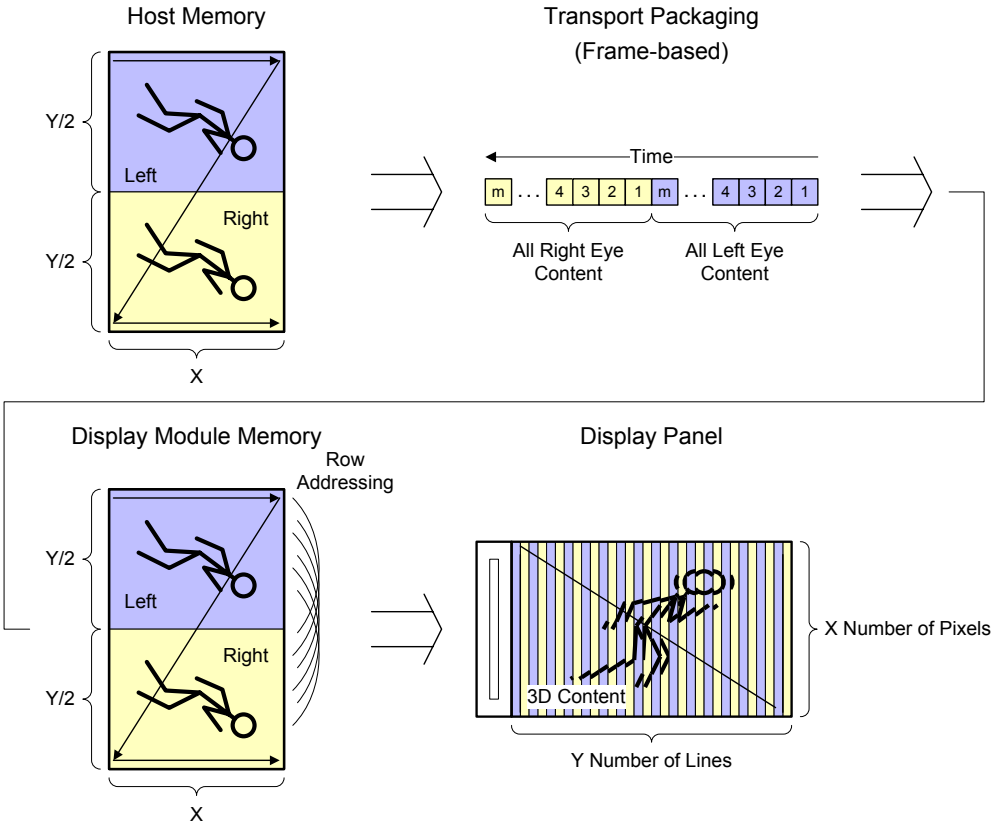


Figure 13 Portrait Scanning Display in Landscape Orientation, Frame-based Example

6.2.8 Portrait Scanning Display in Landscape Orientation, Line-based Example

Figure 14 shows an alternative method of transferring data to a portrait scanning display in landscape orientation. The data is packaged as line-based, sending X pixels left data, followed by X pixels right data from the host memory to the display module memory. The data is then sent as X pixels left followed by X pixels right from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 11.

Table 11 3D Control Bits (Portrait Display, Landscape Orientation, Line-based)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	1	0
Description	Rsvd	Rsvd	Left First	No Sync	Line-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

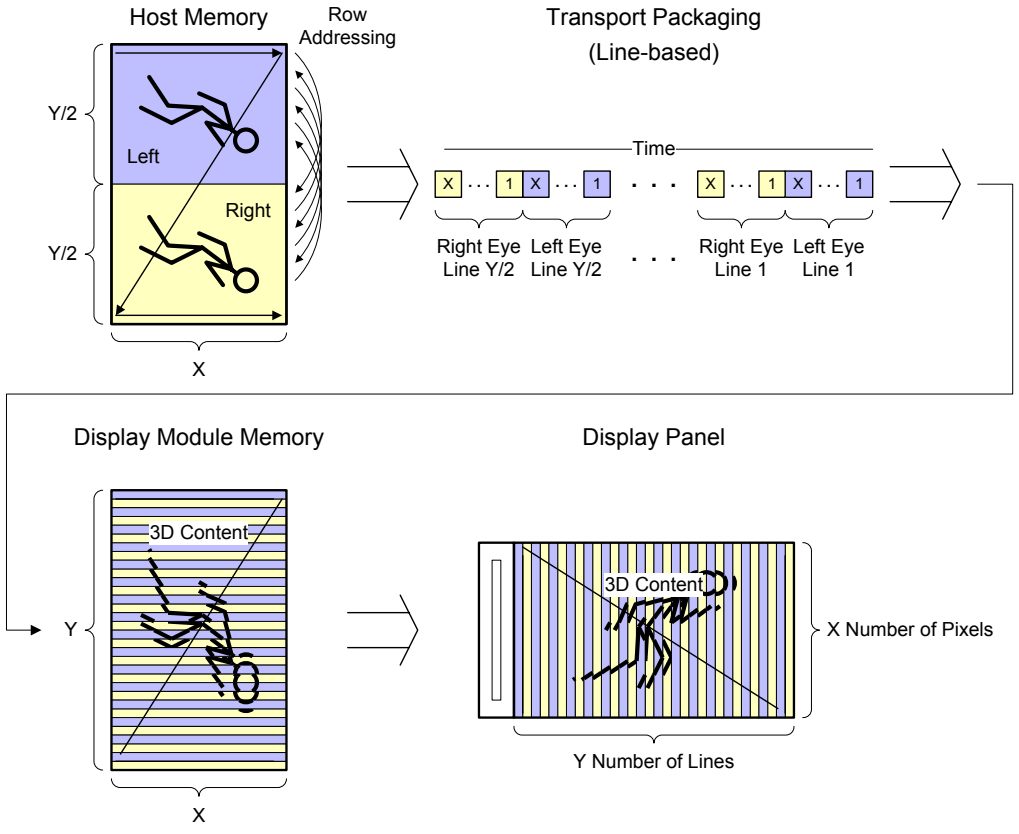


Figure 14 Portrait Scanning Display in Landscape Orientation, Line-based Example

6.2.9 Landscape Scanning Display in Landscape Orientation, Temporal Mode Example

Figure 15 shows a method of transferring data to a landscape scanning display in landscape orientation for a frame-sequential display. The data is packaged as frame-based, a frame of left data, followed by a frame of right data from the host memory to the display module memory. The data is then sent a frame of left data, followed by a frame of right data from the display module memory to the display panel. The 3D Control Function bit fields are provided in Table 12.

Table 12 3D Control Bits (Landscape Display, Landscape Orientation, Temporal Mode)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	1	0	1	1	0
Description	Rsvd	Rsvd	Left First	Sync	Frame-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

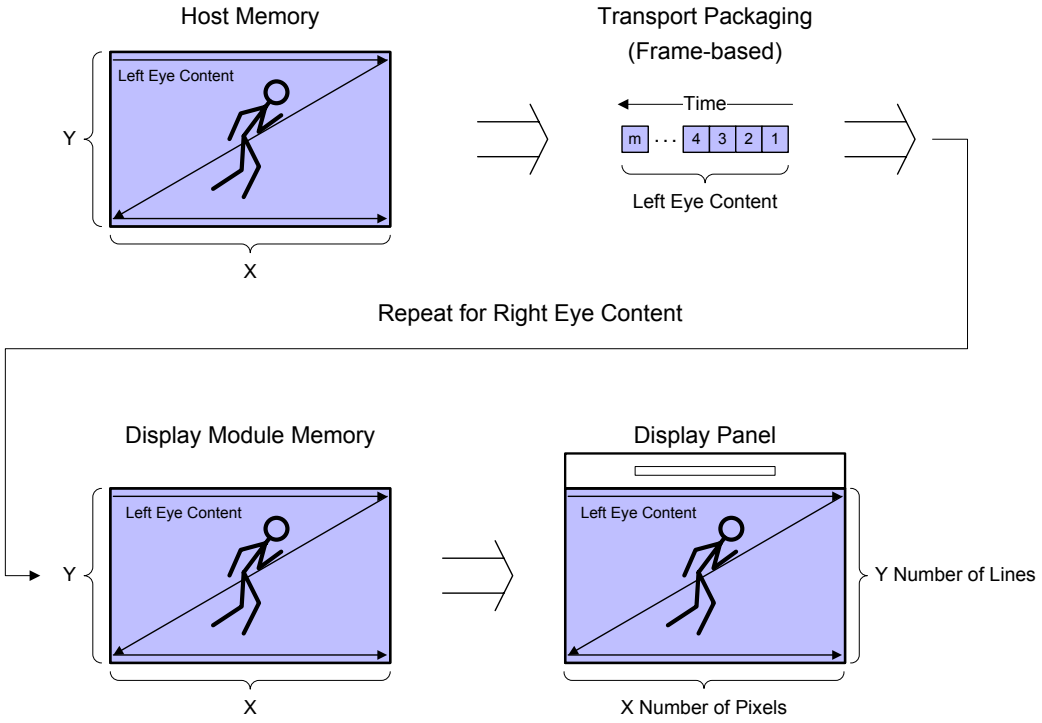


Figure 15 Landscape Scanning Display in Landscape Orientation, Temporal Example

6.2.10 Portrait Scanning Display in Landscape Orientation, Temporal Mode Example

Figure 16 shows a method of transferring data to a portrait scanning display in landscape orientation for a frame-sequential display. The data is packaged as frame-based, a frame of left data, followed by a frame of right data from the host memory to the display memory. The data is then sent a frame of left data, followed by a frame of right data from the display memory to the display panel. The 3D Control Function bit fields are provided in Table 13.

Table 13 3D Control Bits (Portrait Display, Landscape Orientation, Temporal Mode)

Parameter 1								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	1	0	1	1	0
Description	Rsvd	Rsvd	Left First	Sync	Frame-based		Landscape	
Parameter 2								
Position	D7	D6	D5	D4	D3	D2	D1	D0
Value	0	0	0	0	0	0	0	0
Description	Reserved							

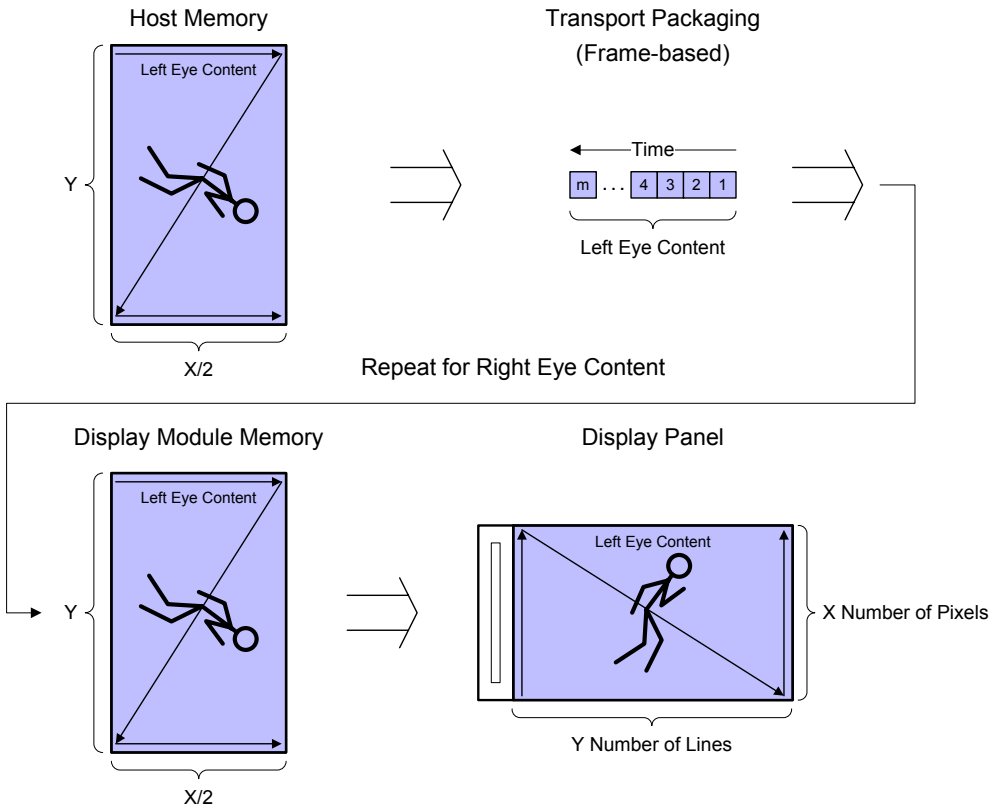


Figure 16 Portrait Scanning Display in Landscape Orientation, Temporal Example

6.3 DCS Commands in Temporal Mode

Figure 17 shows the effect 3DVSYNC bit of the 3D Control Function in Temporal Mode.

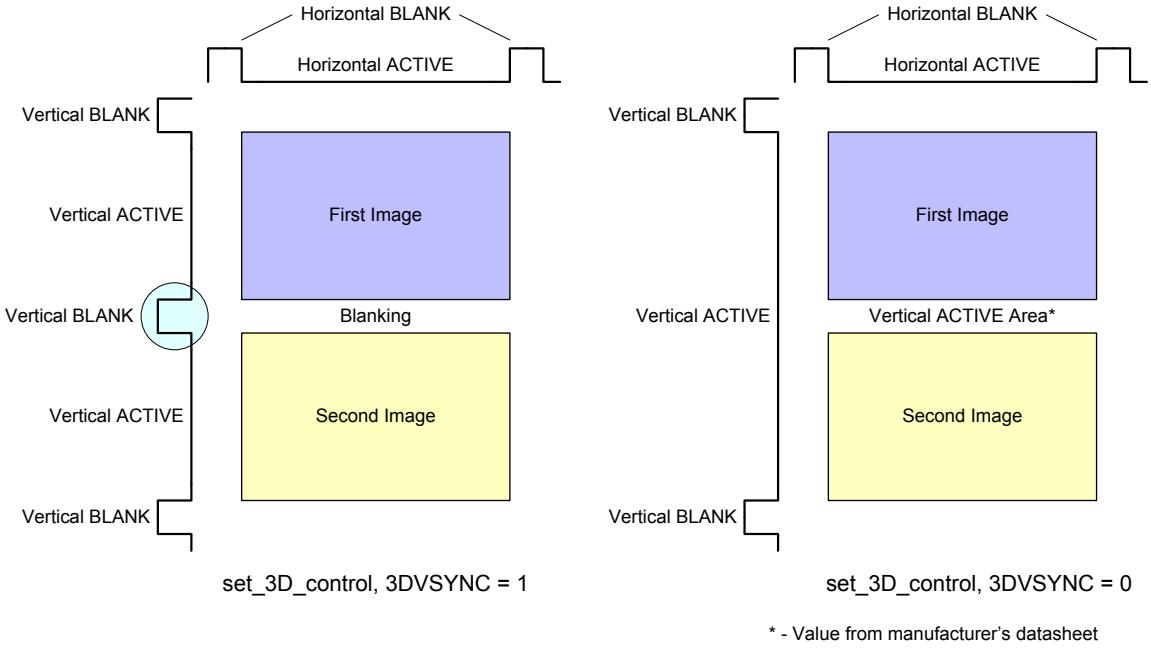
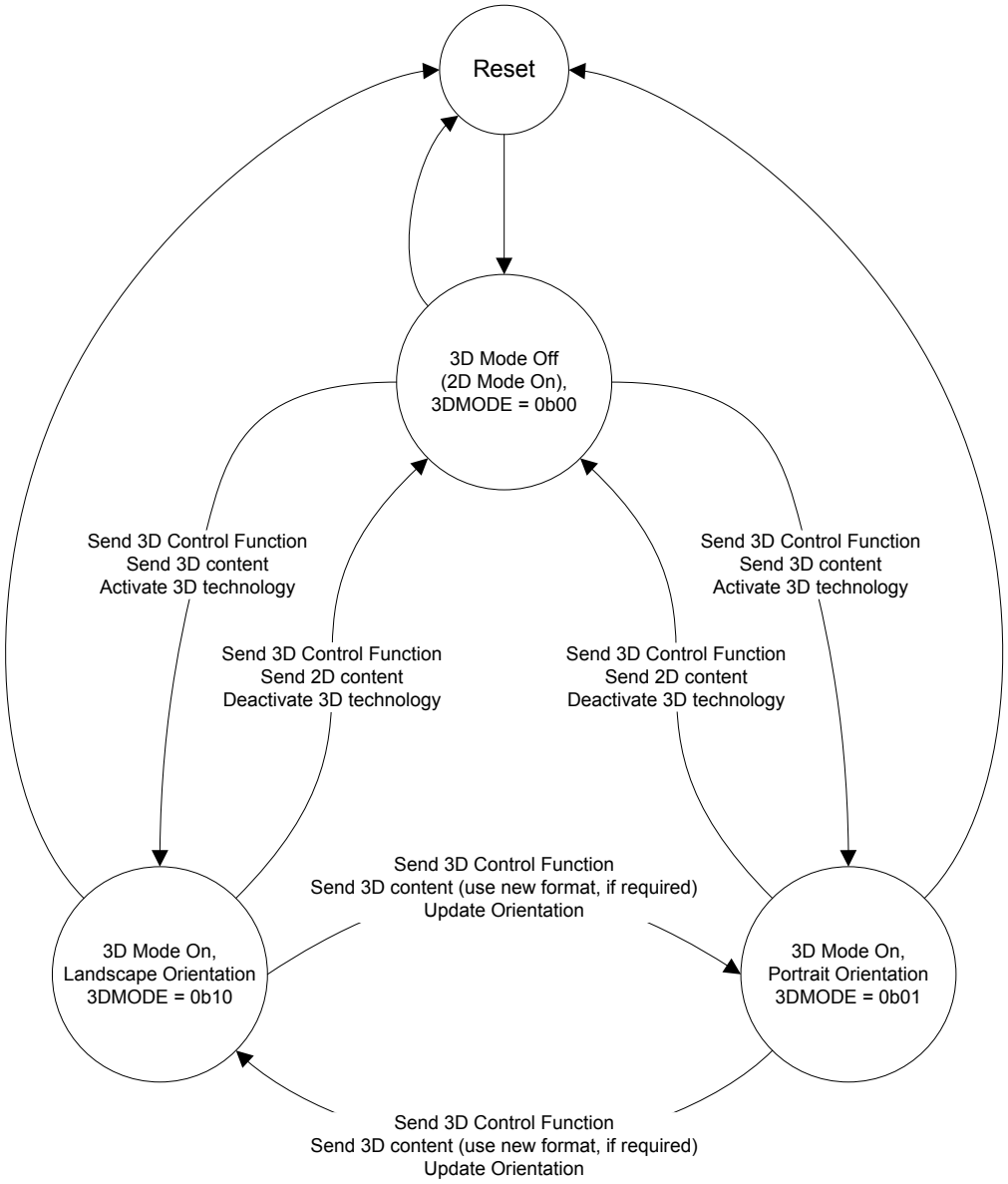


Figure 17 Effect of 3DSYNC Bit

6.4 Transitions between 2D Mode and 3D Mode

As with changing any parameter within the display module, care has to be taken to ensure unintended effects do not occur. When updating the 3D Mode, the 3D technology has to change orientation as well as update the transport packaging.

Figure 18 shows the state transitions involved when changing between 2D Mode and 3D Mode, and when changing display panel orientations in 3D Mode. The method to change modes is dependent on the display driver and 3D technology. The display driver is also responsible for ensuring a tearing effect does not occur, and that the transition between modes occurs within a single frame.



Transitions between 2D Mode and 3D Mode, and between orientations in 3D Mode, occur within one frame, and without tearing effect.

Figure 18 2D to 3D Image Transition Example