HDMI 1.4 3D Video Analysis and Testing

As consumers gear up for the next-generation 3D video technology in their homes, engineers worldwide are gearing up for one of the greatest challenges in multimedia device testing.

For these engineers, understanding the anatomy of traditional digital video signals is the first step in analyzing 3D video content. Digital video signals can be broken into three main parts: the vertical blanking region, the horizontal blanking region, and the active picture region. The vertical blanking region contains the vertical sync pulse that signifies a new frame, and the horizontal blanking region contains a sync pulse that signifies a new line within the frame. The Vendor-Specific Info Frame specifies the frame rate and resolution of the video signal, which defines the timing of the horizontal and vertical sync pulses. For example, a Full High-Definition (HD) 1080p/60 Hz video stream has a vertical blanking pulse every 16.67 ms (60 Hz) to signify a new frame and a horizontal blanking pulse every 14.8 µs to signify a new horizontal line. Within the 14.8 µs horizontal line duration there are 2,200 pixels, which include the horizontal blanking period and the active picture. This requires a pixel clock of 148.5 MHz (1/14.8 µs horizontal line duration*2,200 pixels) to generate the video frame composed of the three regions.

The active picture region is the location of the pixels that a user would see on the display. The pixel color value is stored in three channels that are typically RGB- or YUV (YPbPr)-encoded. The color levels can range from 8 to 12 bits per channel, meaning that each pixel has a 24- to 36-bit color value.

Understanding how content is stored and the various timing aspects of a video signal provides the baseline knowledge for taking measurements to test the quality of the content.

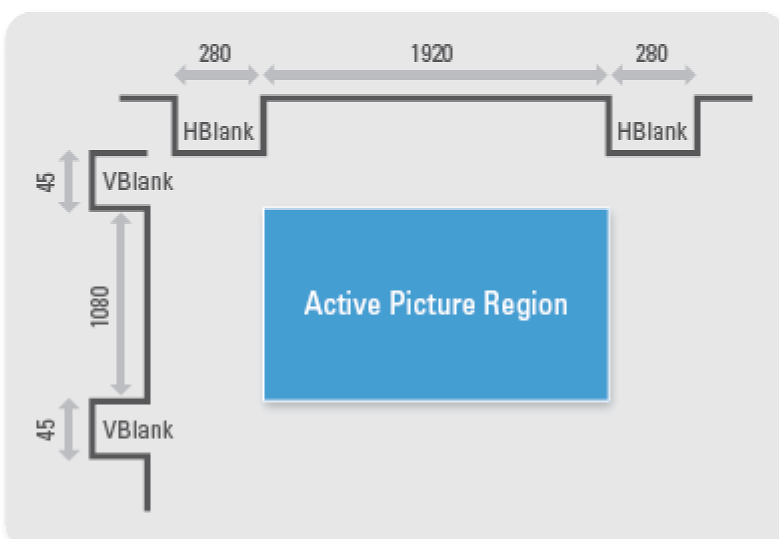

Figure 1. *The horizontal blanking interval, vertical blanking interval, and active picture region make up a high-definition digital video signal.*

Three Types of Measurements for Every Video Test Application

The three types of measurements are used to evaluate video signals are timing, level, and linearity.

Measuring the timing parameters of the horizontal and vertical blanking intervals ensures that a device meets industry standards. The most essential parameters of the signal to evaluate are the horizontal sync amplitude and width, vertical sync amplitude and width, start and end of active video, and the horizontal line time. Additionally, a channel delay measurement tests whether the three channels are synchronized and displaying their content on the correct pixels. A delay of 7 ns (1/148.5 MHz) between the channels could mean the difference between a pixel containing the correct values or not.

The second set of measurements tests the active picture region for image quality and ensures content is packaged correctly. The color bar test pattern is the most common technique for evaluating the content levels of the active picture region because it spans the color spectrum, so engineers can test each channel at minimum and maximum values.

The final set of measurements relates to noise and linearity. Channel and interchannel noise measurements will identify if the system introduces any noise. Even minor alterations to the video content can cause an image to look distorted. The best way to test for channel noise is to use a ramp pattern. Measuring noise on a ramp pattern that increases from zero to full scale will identify any noise on the channel. For interchannel noise, the same measurement can be made using a simultaneous ramp for all channels. Linearity measurements are more complex and characterize the video quality. The channel linearity measurement uses a ramp pattern to test for a linear slope with minimal bit errors on the least-significant bit (LSB) of each channel. If nonlinearities exist, there will not be smooth transitions from black to red, green, or blue for each signal.

Next-Generation 3D Digital Video Test

The latest 3D movies shown in theaters have single-handedly generated enough demand for 3D video that consumer electronics manufacturers are racing to deliver such products to the market, creating a complicated challenge for engineers developing 3D video test requirements. Testing 3D video requires a thorough understanding of the HDMI specification packaging techniques for 3D content. Both the source (Blu-ray Disc player or set-top box) and the sink (HDTV) must be 3D-capable and support a common 3D packaging technique. Engineers must test that a device will package and transmit or receive and unpackage content correctly. The common 3D content packaging techniques are frame packaging, field alternative, line alternative, side-by-side, and L+Depth or L+Depth+Graphics.

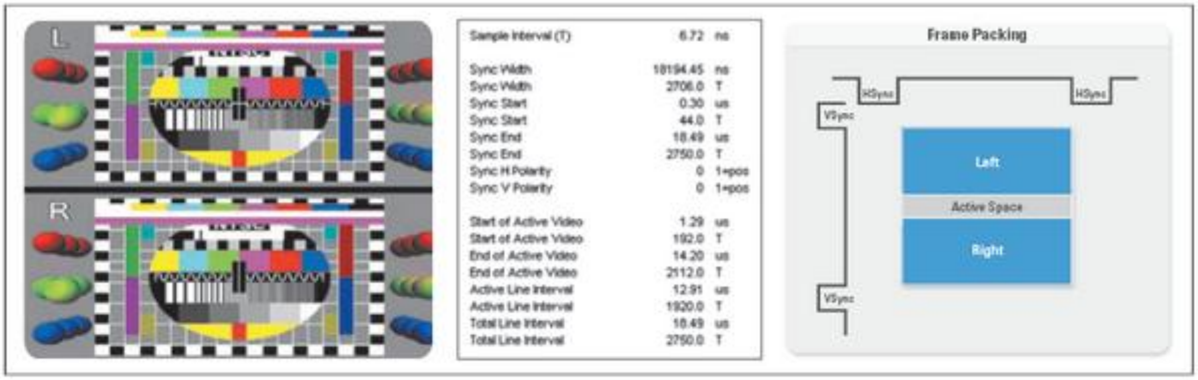

Figure 2. *The frame packaging technique transmits 3D content by lengthening the horizontal and vertical blanking intervals to combine the left and right images in a single vertical sync interval.*

The most important aspect to test is the timing of the horizontal blanking interval and vertical blanking interval. If the timing of these two signals meets the HDMI specification, the 3D content will be transmitted correctly; however, testing the quality of that content requires a second set of tests. Testing the timing parameters of 3D video is challenging because more than two times as much data must be transmitted for a given frame rate. This means that a 1080p/24 Hz video signal, which traditionally requires a 59.4 MHz clock rate for 2D video (24 frames/sec* 2,200 pixels/line*1,125 lines/frame), will require a 148.5 MHz clock rate for 3D content using the frame packaging technique.

Testing the quality of 3D content requires testing the active picture region to the left and rightof the images, including the color levels to see if they meet the CEA-861-D colorimetry or IEC 61966-2-x extended color standard. If the color levels meet the specifications for 8-, 10-, or 12-bit color levels, then the video source has been packaged and transmitted the 3D content correctly. A response time test will show whether errors occur in fast-changing environments, such as an action scene, or whether any stuck bits are causing poor color translation in scenes with rapidly changing or smooth color levels.

The same timing, level, and linearity measurements made on 2D video signals can evaluate the structure and content quality of 3D content. As 3D video test matures, engineers will see the introduction of new video measurements that characterize the relationship between the left and right images of a frame or sequential frames in a video sequence. Because 3D video is only one of several new features in HDMI 1.4, the new specification will likely cause manufacturers around the world to reconsider their test strategies to prepare for next-generation multimedia device test. To meet these challenges, PXISA vendors provide an advanced product suite based on PXI and development software for analog and digital video test. For example, using PXI-based modular instruments with NI VideoMASTER software, engineers are realizing the benefits of higher throughput, higher-performance test solutions to reduce development time, and test time of their latest multimedia devices.