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Pixel Magic™ Systems

Crystalio® II Video Processor

Greg Rogers

10-bit, 1080p Video Processing

The Crystalio® II from Pixel Magic™ Systems is an advanced high-definition video processor that provides 10-bit deinterlacing, scaling, and image processing, in addition to versatile audio and video signal switching. It has an exceptionally user-friendly on-screen human interface, but also provides the video enthusiast access to an uncommonly large set of processing parameters.

There are two versions of the Crystalio II. I received the VPS3300 ($4,500) for this review. There is also a VPS3800 Pro ($5,500) that includes HD-SDI inputs instead of SD-SDI inputs, adds two Firewire (IEEE 1394) inputs for future use, and includes MPEG 1/2/4 decoding for HD media playback from its internal 200 GB hard disk or external USB disks.

Description

The Crystalio II is an attractive product that can be ordered with either a silver or black brushed-aluminum front panel. The front panel includes an eight-line LCD display and flush-fitting aluminum buttons that have an excellent tactile feel. The 2-RU (rack unit) processor includes detachable 19-inch rack-mount ears.

Connections

The Crystalio II has an excellent complement of audio and video inputs. There are four HDMI digital video inputs and a flexible set of analog video inputs that support a variety of signal formats. The analog Component 1 input (3 BNCs) accepts YPbPr or RGsB (sync-on-green) signals, and the Component 2 input (5 BNCs) accepts YPbPr, RGsB, RGBS (separate composite sync), or RGBHV signals. The Component 1 and Component 2 inputs are compatible with 480i/p, 576 i/p, 720p, and 1080i signals, but not 1080p signals. The Component 3 input (4 BNCs) and the Component 4 input (4 BNCs) are only compatible with 480i or 576i signals. Each of them accepts RGBS signals, YPbPr or RGsB signals and one composite video signal, or one S-video (Y/C) and two composite video signals.

The HDMI inputs are compatible with 480i/p, 576i/p, 720p, and 1080i/p video formats, as well as many other PC-related formats from 640 x 480 pixels to 1920 x 1080 pixels.

There are also two SDI (Serial Digital Interface) video inputs (BNC) that accept SD-SDI video signals (480i and 576i) on the VPS3300, or SD-SDI and HD-SDI video signals (480p, 576p, 1080i and 1080p24sf) on the VPS3800 Pro.

There are two HDMI digital video outputs, and one component video output (five BNCs) that can be configured to provide YPbPr, RGBHV, or RGBS signals. The HDMI outputs can produce RGB, YCbCr 4:4:4, or YCbCr 4:2:2 signals, with digital Video or PC levels. H and V sync polarities can also be selected for the analog and HDMI outputs. All of the video outputs are active simultaneously.

There are three pairs of analog stereo audio inputs, three coaxial digital audio inputs, and a TOSLink digital audio input. There is one analog stereo audio output, one coaxial digital audio output, and a TOSLink digital audio output. The HDMI inputs and outputs also carry digital audio as well as digital video.

An RS-232 (DB-9) port is included for home theatre control systems. A USB port is included for firmware updates and for importing and exporting settings. There is also an Ethernet port for use with the Media Player (VPS3800 only). Finally, there is also a pair of infrared remote control In/Out jacks.

I tested the analog YPbPr and digital YCbCr inputs for correct color-matrix decoding. Analog 480p YPbPr input signals were processed with the wrong decoding matrix (digital 480p YCbCr input signals were processed correctly). All other YPbPr signal formats were decoded correctly. In addition to fixing this bug, I would like to see analog YPbPr and digital YCbCr input decoding matrix selections added to the Input Configuration menu. That would allow the Crystalio II to correct YPbPr and YCbCr encoding errors that are so frequent in source components.

Output Formats

The processor can produce an almost unlimited number of output formats. The Output Resolution menu includes six basic video formats (480p, 576p, 720p, 1080i, 1080p, and 1080p24sf) and five frame rates (59.94, 50, 23.98, 35, and 29.97 Hz). There is also another menu that includes an additional 23 preset formats listed by pixel resolution (640 x 480 up to 1920 x 1200) with an accompanying choice of preset frame rates that adds 47.95, 71.93, and 75 Hz to the previous list. Nearly all the formats are available for analog RGB or HDMI output. However, the analog YPbPr output is limited to 480p, 576p, 720p50/59.94, and 1080i50/59.94.

When any of the preset formats and frame rates are selected, the menu also presents a complete description of the format, including sync width, blanking periods, active video width, total pixels and lines, and clock rate. This is great feature because you can verify how the processor is programmed to produce the selected format. If the preset formats are not sufficient, you can also create custom formats by entering all of the pixel and line-related settings in another menu.

HDMI/DVI Compatibility

The Crystalio II provides Auto and manual selection of HDMI Input Color Space (RGB, YCbCr 4:2:2, YCbCr 4:4:4) and Input Levels—either Video Levels (16 to 235 for black to reference white) or PC Levels (0 to 255). That is an essential feature because some source products do not work properly using one color space or another, or when using particular levels. However, there is no manual selection of the YCbCr decoding matrix for HDMI input signals, and I think every video processor and display should also provide that feature. As I mentioned earlier, it is common for source components to use the wrong YCbCr encoding matrix, and it is important for video processors (and displays) to provide manual selection of the YCbCr decoding matrix to correct those problems.

The Output Color Space can be manually selected as RGB, YCbCr 4:2:2, or YCbCr 4:4:4, and either Video or PC digital signal levels can be selected. However, selecting a YCbCr output did not automatically change the input color space on my projectors. I had to manually select the YCbCr input format on the projector, and not all projectors have manual controls to select YCbCr formats. Although RGB output signals are often the best choice for this processor, an HDMI-equipped processor should be able to force an HDMI-equipped projector into the YCbCr 4:2:2 or YCbCr 4:4:4 input modes.

Front Panel Controls

Many of the processor functions can be controlled using the eight-line LCD menu on the front panel. It can be especially useful when you initially set up the processor for a new projector. The front panel LCD also provides status information when its menu functions are not being used.

In addition to six LCD menu navigation buttons, the front panel also includes a Power button and indicator LED, and separate buttons to cycle through the input and output signal ports. There is also a Passthru indicator LED, and two LEDs that indicate the instantaneous deinterlacing mode (Video, 3:2 Film, or 2:2 Film). The deinterlacing mode indicators are extremely valuable as an aid to ensure that the processor set-up is correct and that the processor is functioning as expected. Every deinterlacing video processor should have equivalent status indicators, but few do.

Pixel Magic™ Systems Crystalio® II Video Processor

SPECIFICATIONS

General
Dual Deinterlacer architecture for SDTV material allows choice of VXP by Gennum and DCDi by Faroudja
Clock: Video circuits and audio delay circuits are clocked by 1ppm high precision low jitter TCXOs (temperature compensated crystal oscillators)
Media player included (VPS3800 only): MPEG1/2/4 decoding capability to provide high-quality media playback. External USB disks and/or the included 200GB internal hard disk can be used to store various video clips
Video Inputs: SDI (2; support SDTV only); HD-SDI (2; support SDTV/EDTV/HDTV; VPS3800 only); HDMI with HDCP (4); SDTV YPbPr component (2); SD/ED/HDTV YPbPr component (2);
Audio Inputs: Analog stereo (3); Digital (3 coaxial; 1 optical); HDMI (4)
Other Inputs: Firewire IEEE1394 inputs (2; reserved for future use; VP3800 only); RS232; Infrared In/Out; USB 2.0 (2)
Video Outputs: HDMI with HDCP (2); RGBHV/RGsB/RGBS or YPbPr (BNC; one set of 5)
Audio Outputs: Analog stereo (1); Digital (1 coaxial; 1 optical; 2 HDMI)
Output Resolutions: 480p; 540p; 576p; 720p; 1080i; 1080p24sf; 640 x 480; 800 x 600; 852 x 480; 1024 x 576; 1024 x 768; 1024 x 1024 ALiS; 1280 x 720; 1280 x 768; 1280 x 1024; 1360 x 768; 1360 x 1024; 1366 x 768; 1368 x 768; 1400 x 788; 1400 x 1050; 1920 x 1080; 1920 x 1200; custom
Power supply: 100-240 VAC 50/60Hz auto-ranging

Dimensions (WHD In Inches): 17.2 x 3.5 x 13.7 without feet
17.2 x 3.9 x 13.7 with feet
Weight (In Pounds): 17.6
Price: $4,500 (VPS3300)
$5,500 (VPS3800)

Manufactured In China By:
Pixel Magic Systems, Inc.
111 North Market St. 6th Fl
San Jose, CA 95113
Phone: 408 351 3324
www.pixelmagicsystems.com

IR Remote Control

The slender 1.75-inch-wide IR remote control includes a button in the upper left corner that turns on backlighting. Blue labels by each button and a symbol on each button are illuminated. The remote control includes OSD menu navigation buttons, and buttons that bring up mini-menus for input selection, output port selection, picture controls, aspect ratio selection, and deinterlacing modes. There are also dedicated buttons for recalling video profiles, user-defined macros, and selecting Passthru mode. The numeric buttons can be used to enter values and alpha-characters in menus, or when menus are not onscreen they can be used to directly select some video inputs and aspect ratios.

Pressing the OK button when no menu is onscreen produces a useful information window that identifies the input source and format, the primary output port and format, screen shape, aspect ratio, percent overscan, deinterlacing mode, and the firmware version.

Each button on the remote control can be reconfigured using the user-defined Macros feature. There are over 180 functions that can be included in a macro definition, and each macro can include up to ten functions that will be executed with a single button press. There are also 20 Virtual Keys that can be assigned macros and used with a programmable remote control.

Menus

The onscreen menu system is perhaps the best that I have seen. It uses the same human interface elements that are found in the most

user-friendly computer programs to provide easy access to a wealth of processing parameters and functions. A menu bar across the top of the OSD window includes five menu titles—Input, Image, Output, Audio, and System. Selecting one of the five menu titles displays submenu items in a vertical column at the left side of the window. Selecting a submenu item displays a carefully designed layout of controls in the main window that are tailored to selecting or adjusting each particular function. The only human interface feature that I would like to see added is more Reset or Undo buttons in the individual function windows.

The Input menu includes Input Select, Input Port Configuration, Hide Input Source, DynamicVP™, and Input Profile. The Input Port Configuration window includes setup options for the HDMI, SDI, and analog inputs. Each input can also be assigned a user-defined name with up to 20 characters, which will appear in the input selection lists and status window. Input Profiles (up to 10) save all of the settings in the Input menu, which can later be recalled from memory. Each Input Profile can be named with up to 20 characters.

The Image menu includes all of the picture adjustments. Those include Video Settings (Brightness, Contrast, Color, Sharpness, Hue), Color Temperature, Gamma Correction, Aspect Ratio, Overscan, Position (0.5 percent horizontal and vertical steps), Crop, Deinterlace, Y/C Delay, Noise Reducer (VXP, Faroudja®, Analog SD), Smooth Scaling, Video Filters (CUE, 3D Comb Filter, Dot Crawl, Chroma Notch Filter), DCDi (Faroudja SD Deinterlacing Enable or Disable), and Video Profile. I'll discuss most of the Image functions in separate sections. The Color Temperature function is similar to that found in projectors, with gain and bias adjustments for each red, green, and blue signal channel. The Video Profile window stores and recalls all of the above Image parameters with up to ten profiles for each individual input, and each Video Profile can be named.

There is no 0 IRE / 7.5 IRE black-level setting for analog signals, which would be a useful additional feature. The default YPbPr black level corresponds to 0 IRE. Below-black signals were passed to the HDMI output, even for analog signals with black at 0 IRE.

The Output menu includes Primary Output Port (HDMI 1, HDMI 2, Analog), Port Configuration (analog and HDMI color space, and HDMI levels), Output Resolution, Screen Shape (4:3, 16:9, 2.35:1, same as input aspect ratio, Custom), Screen Masking, DynamicVP™, Output Gamma Correction, Color, Master Levels (Brightness, Contrast, Sharpness), and Output Profile. The Output Profile window stores and recalls all of the above Output parameters in up to ten profiles, and each Output Profile can be named.

The Audio menu includes Input Select, Input Port Configuration, Audio Delay, and Output Port Configuration. The Input Select submenu selects which audio input is used with the current video input. However, there are a few restrictions that prevent the audio of some HDMI inputs from being used with the video of other HDMI inputs. The selected audio source is routed to all of the audio outputs simultaneously. A name can be user-defined for each of the audio input ports and each of the audio output ports. The Audio Delay provides compensation for video-processing delays. The default delays are set automatically, based on the video formats and processing modes, but the user can add or subtract delay from those values for each video source.

The System menu includes OSD Options (Transparency, Size, Timeout, Status Message, Animation), Front Panel (LCD Off, Active, On and LED Off, Active), Video Test Patterns, Passthru, Picture In Picture, Advanced Option (Hide, Show), Macros, Import/Export Settings, Factory Settings Reset, and Firmware Upgrade. The Import/Export Settings submenu allows all of the various Profiles and settings to be saved to or recalled from a USB drive. Firmware Upgrades can also be downloaded to a USB drive attached to a computer and then uploaded from the USB drive to the processor.

Y/C Delay

The Y/C delay function can be used with analog or digital input signals. There are two Y/C delay controls. The Pixel control produces single pixel steps, and the Sub Pixel control produces 0.25 pixel steps. However, the controls function in an unusual way. They shift the luma (Y) pixels relative to sync rather than shifting the chroma (C) pixels. That causes the input signal frame to be shifted horizontally relative to the output frame, which results in pixels being lost at either the left or right side of the frame. In addition, the Sub Pixel control apparently shifts the internal sampling relative to the incoming pixels. That will usually degrade the high-frequency video response, although with analog signals it could also improve the response, depending on the precise sync to pixel timing. However, the high frequency response of incoming HDMI (digital) signals is always degraded by the Sub Pixel delays. It was easy to verify these effects with signals from an AccuPel video generator (www.accupel.com).

"The Crystalio II's motion-adaptive deinterlacing with directional interpolation did a superb job converting 1080i video to 1080p."

Aspect Ratio

There are nine preset Aspect Ratio modes, plus a custom mode. They include the usual Full Screen, 4:3, 16:9, and 4:3 Letter Box modes for standard-definition and high-definition DVD and broadcast video sources. There are also 1:1 Pixel Mapping and NLS (non-linear stretch) modes. The latter stretches an incoming 4:3 image more at the sides than the center to fill a 16:9 output frame. The 1:1 Pixel Mapping mode places the incoming pixel format within the specified output pixel format. For instance, an incoming 720p signal is presented as a 1280 x 720 pixel image within a 1920 x 1080 pixel frame when the processor is set to output 1080p. This mode worked perfectly. It displayed a true 1:1 pixel mapping without losing any edge pixels for 480i/p, 576i/p, 720p, and of course, 1080i/p formats. Although I never use this mode for normal viewing, it is extremely valuable when trying to diagnose problems in source formats that are not the native display format.

There are several aspect ratio modes that are intended for use with projectors that are equipped with an anamorphic lens. (You must also set the actual Screen Shape in the Output Menu.) The preset modes include 16:9 Letterbox/1.85:1, 16:9 LetterBox/2.35:1, and 16:9 Letterbox/2.40:1. There is also a Customize mode that permits the user to enter an aspect ratio from 1.00 to 3.00 in 0.01 steps.

Overscan, Crop, Masking

The processor provides Overscan, Crop, and Screen Masking functions to adjust the visible areas of an image within the video frame. The first two functions are Input functions and can be adjusted

independently for each input, while the latter is an Output function that affects all output signals.

Overscan enlarges or shrinks the image in approximately 0.5 percent (per edge) steps to overscan or underscan the video frame. The single control changes the horizontal and vertical overscan or underscan by the same percentage at all four edges. The Crop control provides four slider adjustments to individually blank each edge. As any edge is cropped, the image is re-centered within the video frame. You can also select a background color that replaces the cropped area in the frame, but when I turned on a color other than the default black color, the Crop controls no longer functioned independently.

There is also an Output Screen Masking function. That function provides two slider controls—one for the Top/Bottom of the screen and one for the Left/Right of the screen. That function also blanks the specified edges in 0.5 percent increments. It also provides a choice of 24 colors or shades of gray to replace the blanked areas of the image, and that feature worked correctly.

Picture In Picture

The Crystalio II provides Picture In Picture and Picture By Picture features that are usually not available in front projectors. The Picture In Picture feature places a sub-picture within the same frame as the main picture, while the Picture By Picture feature places the main and sub-picture side by side. These features provide even more versatility than is normally found in rear projectors. The size, position, and transparency of the main and sub-picture can be varied, and frames with user-selectable colors can be placed around the pictures. In addition, cropping and overscan can be set independently for the Sub-Picture if desired. You can swap the main and sub-pictures and the audio will follow the main picture. You can also choose to route the two audio sources to two audio outputs. You can select almost any of the video sources for the main and sub-pictures, including using two HDMI or two analog component video sources, but there are a few restrictions on which of those sources you can use together. You can save and name up to ten Picture in Picture Profiles with all of the applicable settings.

Video Test Patterns

There are five groups of video test patterns that can be used to set the display calibration to match the processor's output signals. The groups are Pixel Perfect, Video Levels, Color Temperature, Windowed IRE, and Gamma. The Pixel Perfect patterns can be used to determine if images are 1:1 pixel mapped from the processor to the display. The remaining patterns can be used to adjust the display Brightness and Contrast, Color Temperature, Gray Scale Tracking, and Gamma to conform to the processor's output signals. The test patterns are generated at the output of the processor and can't be applied to the processor inputs. Therefore, you must still apply test signals from a generator or source component to the processor inputs to ensure that the entire path through the processor is calibrated correctly.

DynamicVP

DynamicVP is a feature that allows the processor to perform a set of actions based on the incoming video format. When the video input format changes, the processor performs the actions set for that format. The user can specify a Video Profile or an Output Profile, and/or any Output Format to be used with a specified input signal format. For instance, the user could specify that Video Profile 3 and 1080p 59.94 Hz output signals be used with any 480i input signals but Video Profile 2 be used for any other input signal format. Another user with both 50 Hz and 59.94 Hz source signals could specify that 720p 50 Hz output signals be used with any 50 Hz input signals but 59.94 Hz output signals be used with any other input signals.

Gamma Correction

The Crystalio II can provide Gamma Correction for each individual input and for the processor's output signals. The primary purpose of output gamma correction would be to correct an undesirable, and otherwise uncorrectable gamma curve in a display.

There are several pre-defined gamma curve shapes provided by the processor, including the default option to turn the gamma correction completely off. The amount of gamma correction can be adjusted for each of the pre-defined curves. There is also a User mode to define a custom gamma curve by specifying the digital output level at 5 IRE input increments. The processor will create a smooth curve between the user-specified values.

Ordinarily the same gamma correction is applied to each of the internal RGB signal components so that the gray scale of the video signals is not affected. However, there is also an option to use the gamma correction independently on each of the individual red, green, and blue signal channels. That allows the User custom gamma function to compensate for otherwise uncorrectable errors in a display's gray scale tracking.

The same gamma correction functions can be applied to the individual inputs. I don't know of an application for that feature because video source components (DVD players, set-top boxes, etc.) should not modify the standard video gamma that is encoded in the original source data (DVDs, broadcast transmissions, etc.). Perhaps there are applications for PC images that have not been pre-processed with the standard video gamma transfer functions.

I didn't have time to take a meaningful look at the gamma correction feature for this review. I would primarily be interested in assessing whether YCbCr 4:2:2 signals (10-bit HDMI output from this processor) or RGB 4:4:4 signals (8-bit HDMI output) provide better overall performance when using gamma correction. There are various factors (the effectiveness of 8-bit dither versus 10-bit chroma sub-sampling on potential banding artifacts and image resolution) that require a more detailed examination than I had time to do for this review.

Dual SD Deinterlacing

The Crystalio II employs a unique architecture that gives the user a choice between Gennum VXP™ and Faroudja standard-definition deinterlacing. The Gennum VXP Image Processor provides 10-bit video processing, including scaling and noise reduction, in addition to inverse-telecine (film-mode) and per-pixel motion-adaptive deinterlacing for standard-definition and high-definition video. A Faroudja FLI2300 video processor is also included, which alternatively provides 480i and 576i standard-definition deinterlacing, image enhancement, and noise reduction when it is selected.

The Faroudja processor can only be used with the Component 3 and Component 4 inputs, or when they are configured as composite or S-video inputs. The Faroudja or Gennum processor is selected in the DCDi™ submenu. That menu title is a misnomer because DCDi (Directional Correlation Deinterlacing) refers to directional interpolation, which is only applied during motion-adaptive deinterlacing for video sources, and not during inverse-telecine deinterlacing for film sources. Nevertheless, enabling "DCDi" enables the Faroudja processor for standard-definition deinterlacing, as long as the output rate is not 24, 48, or 72 Hz. Disabling "DCDi", enables the Gennum

processor to be used for all SD deinterlacing.

The on-screen Deinterlace menu provides multiple setup options for the Gennum VXP and Faroudja Deinterlacing. You can select Auto, Video, or Film Bias modes for VXP deinterlacing. The Auto mode dynamically switches between motion-adaptive deinterlacing for video sources and inverse-telecine deinterlacing for film sources. The Film Bias mode also switches automatically, but is more likely to stay in the inverse-telecine deinterlacing mode when viewing film-sources that may have cadence errors that might confuse the Auto mode. The Video mode forces the processor to use motion-adaptive deinterlacing only, and should only be used when viewing original interlaced video sources. There are also multiple deinterlacing modes for the Faroudja processor, including Auto and Video modes plus additional 2-2 field pulldown cadence modes.

Inverse-Telecine Deinterlacing

Inverse-telecine deinterlacing is an ideal, artifact-free process that converts interlaced video transferred from film to progressive video. The video processor must lock onto the 3-2 field pulldown cadence that results from transferring 24-frame-per-second film to 60-field-per-second interlaced video. It then merges the odd and even video fields that originated from the same film frames. That eliminates interlaced line twitter and avoids using vertical interpolation that would soften the image. Inverse-telecine deinterlacing is particularly effective in reducing moiré patterns and eliminating line flicker during vertical movement of closely spaced horizontal lines.

In the Auto mode, both the Gennum and Faroudja automatically switch between inverse-telecine deinterlacing for film sources, and motion-adaptive deinterlacing for original interlaced-video sources. The automatic switching worked seamlessly for both processors without any glitches or combing artifacts on the *Video Essentials* "Montage Of Images," which cuts back and forth between segments transferred from film and original interlaced video.

The Faroudja motion detection sometimes locks to a 3-2 cadence quicker than the Gennum when jumping between chapters of a DVD. But it would only lock to very brief portions of the relatively complex *AVIA Pro* 3-2 motion test pattern that includes a circular zone plate and resolution wedges moving at varying speeds and directions. The Gennum processor cadence locked to everything in that pattern except the very slowest vertical motion.

Both processors locked on to the slowly scrolling yellow text at the beginning of *Star Wars: Episode IV—A New Hope*, which had not worked when I tested a previous product that used a Gennum VXP processor. This time the text characters had smooth edges with no jaggies, and exhibited only very slight line twitter in characters with thin horizontal lines. It is important to remember that processing algorithms can be changed via firmware in the latest generation of video processing ICs, and critical performance parameters are often set by firmware for previous generation processors. Therefore, you can't conclude that all products that use the same processor ICs will perform the same. It is also important to make sure that all products with video processors can be upgraded with firmware updates without having to return them to the manufacturer.

The Gennum VXP processor performs all of the deinterlacing for 1080i sources, and it includes inverse-telecine deinterlacing for 1080i film sources. However, it doesn't include processing to detect other unusual cadence sequences, particularly those sometimes used in animation or anime. Nevertheless, it performed flawlessly with the high-definition movies I viewed using 1080i output signals from an HD DVD player. However, the VXP processor would not detect the 3-2 field pulldown cadence on one HD DVD test pattern unless it was set to Film Bias mode. That also revealed an apparent firmware bug in the Crystalio II. Although the menu indicated that the Film Bias mode was selected, it had to be re-selected each time the HDMI input was changed, otherwise it didn't affect the deinterlacing.

Video Deinterlacing

Unlike film-source video, there's no 3-2 field cadence in original interlaced video. Instead, each odd and even video field captures images at different instances in time. Most video processors have traditionally converted 1080i video to 1080p using vertical interpolation to scale each individual 1080i field directly to a 1080p frame. The vertical resolution of the displayed image is then limited to the 540 line-vertical resolution of each original interlaced field. Furthermore, vertical interpolation acts as a filter, which also reduces vertical resolution and softens the image.

The Gennum VXP processor instead converts 1080i video to 1080p, using pixel-based motion-adaptive deinterlacing. It applies interpolation to image areas that are in motion, but merges information from odd and even fields in static image areas. Merging field information produces 1080 line vertical resolution in static image areas. The Gennum processor also includes its FineEdge™ adaptive edge-correction, which adds directional interpolation to reduce jaggies on diagonal lines and optimize the resolution of areas that are in motion.

The Gennum VXP processor was exceptional in eliminating 1080i jaggies and line twitter, while still producing excellent resolution. In addition, there was very little resolution pumping (breathing), which is a highly annoying artifact that occurs if the image resolution suddenly and severely decreases with movement. The Silicon Optix Realta™ HQV™ image processor is the other latest-generation video-processing chip that I have evaluated in recent reviews. Both processors can provide 1080i image clarity that far exceeds what I have seen from previous generation deinterlacing solutions.

I also prefer the Gennum VXP motion-adaptive deinterlacing for 480i original video sources. Line twitter and jaggies are more difficult to eliminate in the lower resolution, standard-definition format where the spacing between the original video lines is greater. I evaluate the trade offs between line twitter, jaggies, and a loss of picture resolution using the *Video Essentials* "Montage Of Images" as a repeatable source of difficult-to-deinterlace interlaced-video sequences.

The VXP algorithms produced a sharper, clearer picture with less line twitter than the Faroudja DCDi deinterlacing. However, in some cases the DCDi deinterlacing produced fewer jaggies. There were no jaggies on the bobbing frozen branch, but for a brief instant there were jaggies on the stripes of the rippling American flag using the VXP processing that didn't occur with the DCDi processing. There were also significantly fewer jaggies on the street lamp supports after the underpass using the DCDi processing. However, the VXP deinterlacing produced much less line twitter during the zoom-out of the city and in the railroad yard. The VXP processing was consistently clearer in images with more detail. Although I would choose the VXP deinterlacing, the Crystalio II gives you the ability to make that choice based on content and your own preferences.

24p/48p/72p Output

One of the features I want the most in a video processor is the ability to produce judder-free 1080p24 or 1080p48 video from 480i or 1080i film-sources. Normally the 3-2 pulldown cadence in film-source video causes smoothly moving objects to stutter when they alternately appear at one position for three fields and then another position for only two fields. That is called judder in video terminology. Even when 480i film-sources are converted to 60p progressive video, judder occurs because a sequence of three frames followed by two frames is repeated to produce 60-frame-per-second video from the original

24-frame-per-second film. To eliminate judder the processor must always repeat each progressive frame exactly once (24p), twice (48p), or three times (72p). (Note: these rates are standard abbreviations for the actual video frame rates used in North America. The actual rates are the abbreviated rates divided by 1.001, which are approximately 59.94p, 47.95p, and 71.93p.)

Judder-free 24p, 48p, or 72p frame rates can be produced by first using inverse-telecine deinterlacing to reconstruct the original 24p film frame rate. Then the video output is locked to an exact multiple of that rate. That is required to ensure that every progressive video frame is produced with precisely the correct number of repetitions. Without locking the frame rate, 48p video would slip into a 3-1 frame sequence rather than the correct 2-2 frame sequence, which would make judder much worse. The ability to precisely lock the frame rates is known as genlocking.

To benefit from these frame rates you must have a display that will produce images at one of those rates (or an exact multiple), otherwise the incoming video may be converted back to 60p, which re-creates the judder. Some newer DLP and LCoS front projectors will produce images at those judder-free rates, or an exact multiple of one of those rates, and many CRT front projectors can display 72p.

The Crystalio II can be set to output at 24p, 48p, or 72p frame rates, and should be judder-free when using 480i or 1080i film-source input signals. I tried using 1080i HDMI signals from HD DVD movies and 480i analog signals from DVD movies without success. The output only remained judder-free for brief periods before heavy judder occurred. Sometimes the output frame rate would temporarily relock by itself or when jumping between source chapters, but it would not remain frame-locked. Hopefully, Pixel Magic Systems can correct this, and I can test this feature again in the future.

1080i/p Pixel Perfect

I used a Marantz® VP-11S1 1080p DLP Projector to display the Crystalio II's 1080p HDMI output. That combination produced spatially "pixel perfect" images from 1080i and 1080p digital test pattern signals. Every pixel from the static test patterns were precisely mapped to a single projector pixel without scaling, No pixels were blanked, and single pixel lines in an AccuPel multiburst pattern were precisely rendered as single pixel lines with full amplitude contrast. Even static 1080i analog signals into the Crystalio II were almost perfectly 1:1 pixel mapped after deinterlacing with almost no noticeable frequency response roll-off on their edges. Formats with fewer pixels were also precisely pixel-for-pixel mapped inside the 1080p frame when using the 1:1 Pixel Mapping aspect ratio mode. That's a great feature when looking for problems in source signals.

Scaling And Overscan

The Crystalio II scaled 480i/p, 576i/p, and 720p digital signals with zero pixels of overscan. The Component 1 and Component 2 analog inputs produced about one or two pixels of overscan on a single edge for each input format. Scaling was exceptional with only one or two (1080p) pixels of extremely faint outlining around horizontal and vertical 720p lines with digital and analog signals. There were only two or three pixels of outlining around the AccuPel generator's 480i/p video edges, except for 480i analog signals, which had about four to five pixels of extremely faint outlining around vertical edges using the Component 1 and Component 2 inputs. There was some increased outlining and ringing on the Component 3 and Component 4 analog inputs. The color bar transitions were also faster on the Component 1 and Component 2 inputs. I would use those inputs for 480i signals unless you want to use the Faroudja deinterlacing, or need S-video or composite inputs.

The Smooth Scaling adjustment acts similar to a detail enhancement function. Increasing its setting from the default value (0) results in less sharpness, but also less edge outlining. Reducing the setting produces slightly sharper edges with slightly brighter outlining. That was an acceptable trade off for sharpening some 480i DVD signals. The Sharpness control can also be used judiciously to increase horizontal and vertical edge sharpness, but it will noticeably increase the brightness of edge-outlining artifacts if set too high. However, I found it more useful than the Sharpness controls on most processors and projectors.

Viewing Impressions

I connected the Crystalio II to a Marantz VP-11S1 front projector using 1080p HDMI signals for all of my viewing. The Marantz is a 1080p single-chip DLP projector, which completely eliminates any RGB misconvergence that would be produced by a three-panel projector. It also has exceptional optics and a "clean" HDMI signal path that doesn't add any edge enhancement to incoming 1080p digital signals. The absence of color fringing and edge artifacts, coupled with its high-resolution optics, makes the VP-11S1 a nearly ideal 1080p display for revealing the Crystalio II's deinterlacing and scaling performance.

I used a Toshiba HD-XA2 HD DVD player as a source for high-definition movies. The HD DVD player provided 1080p60 and 1080i HDMI signals. The 1080i signals were used to evaluate the processor's high-definition film-mode deinterlacing quality. I also used over-the-air HDTV broadcasts through the processor's HDMI input to evaluate its 1080i motion-adaptive deinterlacing and 720p scaling performance. Finally, I used 480i YPbPr analog signals from a DVD player to evaluate the processor's analog signal path, 480i inverse-telecine (film-mode) deinterlacing, and 480i scaling.

The basic functions of an external video processor are to provide video—and perhaps audio signal switching—analog to digital conversion, signal transcoding (e.g. YPbPr to RGB conversion), frame rate conversion (e.g. 60i to 24p conversion), scale signals to the display's native format, and to provide deinterlacing of interlaced video. The video processor should be essentially transparent with regard to other signal parameters such as color, sharpness, amplitude, noise, and linearity (gamma), unless you have a reason to modify those characteristics of the original signal.

I used the Component 1 and Component 2 YPbPr input, which contributed very little to the slight edge enhancement found on *The Fifth Element*, *Stars Wars: Episode IV—A New Hope*, or other superior DVD transfers. Film grain looked natural, and detail and clarity were impressive. Alternatively, you can completely eliminate any effects of the analog signal path and analog to digital conversion by using 480i HDMI signals. The default position of the Smooth Scaling adjustment was about optimum for the best DVDs. On some DVDs I preferred to use a lower Smooth Scaling setting to sharpen the edges slightly, but that will exacerbate noise and MPEG artifacts on poor transfers. The Sharpness control was also particularly useful on some movies, as long as it was used very sparingly. Unfortunately, most of my favorite films are still only available on standard-definition DVDs and it is getting harder to watch even the best SD DVDs as HD DVDs consume a large portion of my viewing time. I suppose that explains my slightly increased tolerance for applying a little detail enhancement to some standard-definition DVDs.

The Crystalio II color conversion matrices were accurate and had no effect on the display's colorimetry. The processor added no additional noise to the 1 to 10 IRE luma pattern from an AccuPel generator. The VXP noise-reduction feature was quite effective on some older film transfers, providing several settings that trade off various degrees of image softening for noise reduction. The VXP 480i

inverse-telecine deinterlacing performed extremely well, with no glitches or unexpected line twitter as I watched about a dozen movies. I watched passages of several films using the judder-free 1080p48 output mode for short periods when it would work correctly. That is my favorite video processing feature, so I really hope Pixel Magic Systems can fix it quickly. If they do, I will put an update with this review on the *Widescreen Review* subscriber's Web site (www.WidescreenReview.com).

The first HD DVD that I usually look at to check 1080i inverse-telecine deinterlacing is *Grand Prix* (1966). It is filled with motion that provides plenty of opportunities for the film-mode deinterlacing to lose cadence. But there were no deinterlacing problems with this film or any of the other HD DVDs that I viewed. *Grand Prix* also has superb resolution and a distinctive color palette that looked exactly right with Crystalio II. Once again, I sampled the 1080p48 output of the processor, which will be perfect for this movie when it works reliably.

I took advantage of this review to watch a couple of recent HD DVDs for the first time. *The Bourne Identity* (2002) is an excellent film with an outstanding high-definition transfer. The colors are exceptionally realistic with overcast skies dictating the lighting and subdued hues in the outdoor scenes. The fine detail and image clarity look marvelous.

Breach (2007) is a recent film that didn't get much attention at the box office. It has cold, slightly undersaturated hues, but the color looks quite realistic for the venues. There is some visible edge enhancement in a few scenes. I wanted to be certain none of it was added by the Crystalio II, so I fed the 1080p60 output of the HD DVD player directly to the Marantz and compared that to 1080p60 and 1080i signals going to the processor. As expected, the Crystalio II was not responsible for any edge artifacts.

I am especially pleased that *The Big Lebowski* (1998) was released on HD DVD. This Coen Brothers film has attained cult classic status with its fans. Although there is still edge enhancement on the high-definition transfer, the HD DVD is a huge improvement over my previous DVD. The color is excellent, and there is much better detail throughout the film.

I used NBC's *Tonight Show With Jay Leno*, NBC's *Late Night With Conan O'Brien*, and the CBS *Late Show With David Letterman*, to evaluate deinterlacing of high-definition broadcast video. The Crystalio II's motion-adaptive deinterlacing with directional interpolation did a superb job converting the 1080i video to 1080p. The detail and clarity displayed by the Marantz 1080p projector were outstanding, and there was very little resolution pumping during movement. There were virtually no jaggies on the text of Conan's mugs, and fewer jaggies than I had previously seen on the *Tonight Show* mugs. There was only slight flicker as the camera panned across the vertical lines in the complex backdrop behind Leno. There was no line twitter when the camera moved vertically over the edges of the desktops and sets behind Conan and Letterman.

Summary

The Crystalio II is an excellent video processor with 10-bit Gennum VXP high-definition deinterlacing, scaling, and image processing technology. It will be an exceptional video processor when its ability to provide judder-free 24p and 48p video from SD and HD film sources is fully functional. It provides versatile audio and video signal switching, highlighted by four HDMI inputs and two high-definition analog video inputs. The Crystalio II provides the video enthusiast with exceptionally easy access to processing parameters and some functions that are often not available on other video processors. I was quite impressed by this product and look forward to its continued refinement. WSR