Lumagen Vision™
Groundbreaking Video Processor

GREG ROGERS

Introduction

Lumagen is a new video company with an exciting goal and two Visions. It believes that existing video scalers are too expensive and intends to provide high-performance video processors at more affordable prices. The Vision™ ($999) and VisionPro™ ($1,895) are the first entries in the Lumagen product line. Both share the same video processing circuits, but the VisionPro includes additional input switching capabilities. The groundbreaking Vision is the subject of this review.

Product Overview

The Vision upconverts standard-definition interlaced video to match the native, or optimal resolution of projectors, flat-panel displays, and high-definition direct-view monitors. It will produce virtually any progressive video format from 480p to 1080p, and also generates 1080i for the many CRT-based rear-projection TVs that accept that format.

Video upconverters are usually referred to as scalers in the consumer world, but scaling is only part of the upconversion process. Analog interlaced signals must first be digitized and converted to a progressive format by a deinterlacing process. Then the progressive format is scaled to a display format with more scan lines per frame, and finally converted back to analog component video to drive a high-resolution projector or monitor. When 1080i signals are required, an additional progressive-to-interlaced step occurs prior to the digital-to-analog conversion.

Every step in the upconversion process is critical to the ultimate picture quality, and you might expect a product at this price to cut some corners in its signal processing. But that isn't the case. The Vision uses 10-bit oversampled analog-to-digital and digital-to-analog converters to maximize signal linearity and minimize noise. Inverse-telecine deinterlacing with 3-2 field pull-down detection is used to optimally deinterlace film sources, and motion-adaptive deinterlacing is used for original interlaced video sources. Lumagen has even developed their own proprietary scaling algorithms.

You might also expect a video scaler priced at $999 to be limited to only a single output format. Instead, the Vision provides more image sizing features and display format options than scalers many times its price. It also provides YPbPr or RGB output signals, with a complete selection of sync options.

The Vision does have a few limitations when compared with far more expensive scalers. It doesn't have variable adaptive detail enhancement, and it only upconverts standard-definition interlaced video formats. Hence, it won't scale 480p input signals, nor deinterlace 1080i signals. But it provides a high-bandwidth pass-through input to connect 480p or high-definition signal sources to the display.

Why Deinterlace Or Scale?

The purpose of deinterlacing and scaling is to eliminate interlaced video artifacts, and reduce the visibility of scan lines on CRT projectors, or match the native resolution of fixed-pixel displays. The larger the screen the more visible artifacts become. The most objectionable interlace artifacts are inter-line flicker (line twitter), jagged edges, and motion combing. I'll briefly discuss each of these artifacts.

Interlaced video is composed of a sequence of fields, where each field contains only the odd or the even horizontal lines of picture information. In the 480i-interlaced format, each field contains 240 active (visible) lines of picture information. When the fields are sequentially displayed on a CRT monitor, we perceive that the odd and even lines create a picture with twice the horizontal lines of a single field. To avoid wide-area flicker a new field is displayed approximately 60 times per second.

Inter-line flicker occurs along horizontal edges because the top or bottom edge of an object appears to lie on an odd line in one field and an even line in another. As odd and even fields are alternately displayed, the edge appears to move up and down by one line in the picture. Since odd fields and even fields are each displayed approximately 30 times per second, the edge appears to blink on and off, or bob up and down, at a 30 Hz rate. This is most commonly called line-twitter.

Line twitter is not limited to the edges of objects. It can appear wherever there are high-contrast horizontal lines in an interlaced image. The addition of slow vertical motion increases the twittering as horizontal edges move across field lines.

Inverse-telecine deinterlacing can eliminate line twitter from interlaced film-sources, and motion-adaptive deinterlacing can reduce line twitter from original interlaced-video sources. But to reduce line twitter on interlaced displays, vertical filtering is applied in video cameras and film-to-video DVD transfers to soften horizontal edges. For that reason, deinterlacing 480i video can never produce the full vertical resolution that would otherwise be possible from an unfiltered 480p source.

Jagged edges (jaggies) along diagonal lines are an unavoidable consequence of a discrete line or pixel structure, but interlacing exacerbates jaggies. Segments along a diagonal edge will appear to flicker on and off because they lie in different interlaced fields. If there is slow vertical movement the

jaggies may appear to strobe or move (running jaggies).

Interlaced combing occurs when an object is in motion. Our eyes tend to track the object, particularly on a wide screen. Since the object appears at different locations in the odd and even fields, we perceive the odd and even scan lines separately, rather than integrating them into a full picture. Vertical and diagonal edges of moving objects may appear like the teeth in a comb because each field has only half the scan lines of the frame. Even when objects aren't in motion, a small component of vertical jitter in the picture may cause our eyes to lock onto the fields and see scan lines as individual fields rather than frames. This is far more likely on larger screens, where the scan line spacing is greater.

The remedy for interlace artifacts is to deinterlace the video and display progressive frames. Then by scaling the video to have more horizontal lines per frame, the visibility of the individual lines and jaggies along diagonal edges can be reduced or eliminated.

Do You Need A Scaler?

CRT front projectors always require deinterlacing and scaling for standard-definition interlaced video signals, and very few of them have built-in scalers. CRT projectors also have a "sweet spot," or "golden" display format that maximizes their performance. The Vision has the ability to create a custom display format to match the "sweet spot" of virtually any CRT projector.

Most current generation fixed-pixel projectors and flat-panels intended for home theatre applications include excellent built-in deinterlacing and scaling processors, as do the best current generation HD-capable rear-projection TVs. But the built-in deinterlacing and scaling in many previous generation displays was less than ideal. The picture quality of those products may be significantly enhanced with the addition of a high-quality external scaler.

Product Appearance

The Vision proves the old adage to not judge a book by its cover. Its austere black case is fashioned from two pieces of sheet metal to form a simple box two-inches in height, eight-inches wide, and nine-inches deep. There are no buttons or controls on the front panel—only an IR (infrared) sensor and a single LED that flashes whenever a command is received from the remote control. That is the only front panel indication that the processor has power. It operates silently without the need of a fan.

The remote control includes On and Standby buttons, but there is no power switch on the processor. The Vision includes a small external power module that supplies 5-volts DC through a cable to a rear panel jack. The power module includes a separate power cord to connect to an AC power line, and an LED that indicates when the module is receiving power.

Inputs And Outputs

The rear panel includes composite, S-video, and YPbPr component video inputs for standard-definition interlaced video sources. The Vision is compatible with NTSC, PAL, and SECAM signals. The S-video input accepts a standard 4-pin mini-DIN connector while the other inputs use RCA jacks. There is also a 15-pin D-sub (VGA style) pass-through input with a 300-MHz rated bandwidth for RGB or YPbPr signals.

The Vision outputs RGB or YPbPr signals through a 15-pin D-sub connector. It will produce RGB signals with separate H and V sync, composite sync, or sync on green. Any combination of H, V, or composite sync polarities are selectable from the remote control. It will output YPbPr signals with bi-level or tri-level sync in any output display format, but only 480p, 720p, 1080i, and 1080p are standard SMPTE YPbPr formats.

The rear panel jacks are a bit too tightly packed together. There is little room for finger space while inserting or removing cables, and connectors enter the jacks at a slight angle because interference between the connector bodies pushes them apart.

Configuration Memories

Each input, except the pass-through input, is provided with two configuration memories, which are selected with the MEMA and MEMB buttons on the remote control.

Configuration memories contain all settings that pertain to processing signals from a particular input, plus the output display format settings. By default, all configuration memories share the same output format. But the user can also chose to save independent output display formats in each configuration memory.

Two COPY functions simplify setting up the configuration memories by allowing the current configuration's input settings, or output format, to be separately copied to any one, or all configuration memories. A SAVE command is provided to separately store each individual configuration in non-volatile memory, which will be retained even when the unit is unplugged.

Menu Functions

The Vision has an exceptionally broad list of features, some of which are accessed with dedicated buttons on the remote control, and others through an on-screen hierarchical menu structure.

The menu functions are logically arranged into four main groups—IN, OUT, MISC, and SAVE.

Input Features

The IN group submenus include COLR, ADJ, BIAS, NAME, and COPY. The COLR submenu provides adjustments for black level, contrast, color saturation, and hue. As always, it is critical to calibrate these adjustments for each input source with *AVIA: Guide To Home Theater* or *Video Essentials*. The PDSTL item in the ADJ submenu should be set to match the black level (0 or 7.5 IRE) of the input signal prior to making these adjustments.

The ADJ submenu includes SIZE, CPHASE, SHARP, PDSTL, ENHNCE, and SYNC. The SIZE item provides adjustments to scale and position the incoming image with respect to the output frame. This feature will allow you to remove an annoying line of vertical blanking interval data at the top of an image, or match image positions and widths for several sources.

The CPHASE adjustment delays the luma signal relative to the chroma signal by ±7 steps at 1/4 pixel (about 18.5 nS) per step.

The SHARP adjustment provides four settings. The default setting is 1, but the flat frequency response setting is 0. The ENHNCE item slightly expands the bottom 2 IRE of the input signal and may be useful with a display that can't produce totally dark black levels.

The SYNC item only appears when using the pass-through input. It permits RGB sync signals to be converted to the same polarity as internally generated sync signals, or to pass through without altering their polarity. This is important if the display changes configuration settings for input signals with different sync polarities, as my CRT projector does. External sync signals should have an amplitude of 2.0-volts or greater.

The BIAS submenu selects FILM or VIDEO bias for the deinterlacing algorithms that determine whether incoming signals are from original interlaced-video or film sources. In most cases, the VIDEO setting works well even for film-sources, but on movies with edit errors the FILM setting might produce superior results.

The NAME item permits the input configuration memories to be assigned names with four or less characters. The COPY item saves time by providing the ability to copy the IN group settings between configuration memories.

Output Features

The OUT group submenus are used to set up the display format. The submenus include RES, ASPECT, GBAR, MODE, and COPY.

The RES submenu provides adjustments to specify the number of active scan lines in the display format, the vertical frame rate, and the horizontal line rate. Dedicated buttons are also provided on the remote control for each of these functions. The RES submenu also includes output size and position adjustments for displays without these user controls, or to match pass-through signals.

The ASPECT submenu is used to select the screen aspect ratio from 1.33:1 to 2.35:1 in 0.01 increments. The remote control also includes a dedicated button for this function.

The GBAR submenu adjusts the intensity of the gray vertical sidebars when displaying a 4:3 (1:33:1) image on a wider screen. The MODE submenu specifies whether the configuration memories all use the same output format or independent formats. The COPY submenu allows the current output format to be copied to one or all configuration memories.

Other Menu Features

The MISC submenu includes items to enable or disable on-screen status messages, lock configurations to prevent changes, set the power up state, and enter a user-defined power-on message. Test patterns with the current display format can also be selected. The patterns include a full screen white field or a smaller white window, and a crosshatch pattern. The intensity of each pattern can be selected in 10 IRE increments from 10-100 IRE.

The SAVE submenu provides a command to save the current configuration in non-volatile memory, and an UNDO command that restores the configuration that was overwritten by the last SAVE command. The FCTRY command sets all parameters to the factory defaults without overwriting the non-volatile memory.

Remote Control

The remote control takes a "more is better" approach with 40 buttons that include dedicated keys for eight preset display formats, three input aspect ratios (4:3, letterbox, 16:9), YPbPr and RGB signal and sync types, A and B configuration memories, and four display format parameters. There are also buttons to directly select each of the four inputs, but those are shared with the numeric keypad and are only labeled with the digits 1 to 4.

None of the buttons are backlit, and all are the same size and shape with most arranged in two tightly packed arrays. That makes the remote more difficult to learn to use in a dark room. However, Lumagen provides component configuration files (.ccf) for a Pronto remote control on its Web site (www.lumagen.com).

Input Aspect Ratio Formats

The Vision will scale incoming signals with different aspect ratio formats to display properly on a screen with a specified aspect ratio. When this feature is used, any aspect ratio switching that a display may have will not be used. This will be a welcome feature for owners of some early HD-capable rear projectors that only display 480p signals correctly when they are in the 16:9 format. By selecting the 4:3 input aspect ratio on the Vision, a full-frame 4:3 picture will be correctly displayed in the center of a wider screen. The letterbox (LBOX) aspect ratio can be used to correctly display widescreen movies that are not available in the 16:9 (anamorphic) DVD format.

Owners of CRT front projectors have the choice of using the aspect ratio scaling features of the Vision, or using the display sizing features of their projector to create the appropriate display aspect ratios for different sources. It is certainly more convenient to set up and maintain a CRT projector to only display a single frame format and use the Vision to scale the input aspect ratio as appropriate. But in some cases, better image quality may be achieved by using the analog sizing capabilities of a CRT front projector instead.

The Vision also includes a special 1.85:1 input aspect ratio mode that is intended to correct film material that was vertically stretched by about 4 percent to convert an original 1.85:1 film aspect ratio to the 16:9 (1.78:1) DVD format. However, this doesn't apply to all 1.85:1 films using the 16:9 DVD format. The same aspect ratio conversion may have been accomplished by cropping the width of the picture by 4 percent, or by including 4 percent more of the image height on the DVD than was seen at the cinema.

Image Zoom

Another feature of the Vision is the ability to enlarge the incoming image using Zoom scaling. The Zoom function enlarges the image by 15 or 33 percent. The latter will fill the height of a 16:9 screen with a 2.40:1 widescreen movie image, but a significant portion of the film frame will be lost on each side.

An Optimal Format For Every Display

The Vision provides eight preset display formats—480p, 540p, 600p, 720p, 768p, 840p, 1080p, and 1080i. The format designates the number of active (visible) scan lines in the picture area.

When used with fixed-pixel projectors or flat panel monitors, the format should be selected to match the native vertical pixel resolution of the display. If you have a display that doesn't match one of the preset formats you can specify any format from 480p to 1080p in single line increments. For instance, you can match a plasma display panel with a 1024 pixel vertical resolution by using the VRES button and numeric keypad on the remote control to specify 1024 active (visible) lines per frame.

Most HD-capable rear projectors accept only a few formats—normally 480p and 1080i, and sometimes 540p or 720p. But CRT front projectors are usually compatible with a wide range of scan formats. Although 720p or 768p is a good choice for 7-inch and 8-inch CRT projectors, it may not be optimum, and most 9-inch CRT projectors perform best between 840p and 1080p. Optimum performance is normally obtained when each horizontal scan line just touches the line above and below it. This is the "sweet spot," or "golden" display format, referred to earlier. The Vision's ability to exactly specify the number of active scan lines per frame allows it to operate at each projector's "sweet spot."

Contrary to popular belief, this alone does not increase the brightness of the display, but it allows a CRT projector to be calibrated to produce a brighter picture without degrading gray scale performance. The maximum picture brightness and gray scale tracking are tradeoffs that should be calibrated by a professional with appropriate instrumentation.

The service menu provides a special feature to improve gray scale calibration. The red, green, and blue signal gains can be independently adjusted at 20, 30, 50, 80, and 100 IRE to optimize the color temperature at those levels. This is particularly useful with CRT projectors, which often have a bluish color temperature in the middle of the brightness range.

Display Format Adjustments

The Vision provides other display format adjustments in addition to the number of active lines per frame (VRES). These include the horizontal line rate (HRATE) and the vertical frame rate (VRATE). I recommend that users leave these last two adjust-

ments set to the factory values, with the exceptions noted below.

The HRATE value (along with the VRATE value) determines the total scan lines per frame, which includes the active scan lines plus additional black lines for the vertical retrace interval. When the VRES (active scan lines) value is altered, the HRATE value is changed automatically to maintain an acceptable vertical retrace interval. Hence, there is no reason for a user to alter the HRATE setting unless a display specifically requires a particular timing that is different from the Vision's automatic setting. Monitor specifications can be difficult to interpret so I recommend consulting with the display manufacturer or Lumagen before deviating from the automatic HRATE settings.

The VRATE setting specifies the number of video frames displayed per second. The North American broadcast standard is 59.94 frames-per-second (to be more precise it is exactly 60/1.001), although SMPTE standards also permit 60 FPS (frames-per-second). My evaluation sample was set to a factory default value of 60 FPS. The difference between 60 FPS and 59.94 FPS is 0.06 FPS, so an additional frame must be repeated every 16.67 (1/0.06) seconds. While watching basketball broadcasts the repeated frame created a very noticeable break in the motion as the camera panned to follow the players running up and down the court. I also observed the same stutter while watching the bridge pan early in the Montage of Images on the *Video Essentials* DVD. Consequently, Lumagen has changed the factory default to 59.94 FPS.

The VRATE setting can be adjusted from 48-75 FPS in 0.01 steps. But I can't envision a reason to use any setting other than 59.94 FPS. Higher settings force repeated frames and lower settings result in dropped frames. Due to the adjustability of this critical parameter, it is best to verify the setting with a frequency counter.

You may wonder if setting the vertical frame rate to 72 FPS will create smoother motion when displaying film sources. (It should actually be 3*24/1.001 = 71.93 FPS.) Unfortunately, the Vision can't ensure that each deinterlaced film frame is repeated exactly three-times (3-3 pattern). I verified that experimentally, and directly with Lumagen. Instead the output will slowly shift between a 3-3 and 4-2 pattern, but 60-percent of the time it will produce a 4-2 pattern, which makes judder appear worse.

Other Format Adjustments

The SIZE and POS adjustments in the OUT menu can be used to match internally scaled signals to a pass-through source, so a display will only need one set of size and position adjustments. The POS adjustments reposition the video output image horizontally and vertically within the total scan lines of the frame. The SIZE adjustments scale the output image to occupy more or fewer scan lines, and more or fewer pixels per scan line, without changing the total number of scan lines in the frame, or the total number of pixels per line.

Resolution And Scaling

I used *AVIA* test patterns to check resolution. The vertical and horizontal wedge patterns showed excellent response out to the limits of standard-definition video using the 480p output format. The modulation depth (contrast between the closely spaced black and white lines) in the resolution wedges and the 6.75 MHz vertical line pattern was only slightly reduced by scaling to other formats. This illustrates that contrary to popular myth, scaling can't add resolution to an image! In fact, scaling slightly softens images. But the goal of scaling is not to increase resolution, but to eliminate the visibility of scan lines and reduce the visibility of stair-step jaggies that appear along diagonal edges.

I used the *AVIA* Sharpness pattern to look for edge ringing, outlining and static scaling artifacts on vertical and horizontal lines. The Sharpness control adds band-pass peaking, centered at about 2.6 MHz, to the horizontal frequency response, which produces outlining (halo) around vertical and diagonal lines even at the default (1) setting.

But with the Sharpness control set at 0, which is the flat frequency response position, there was virtually no visible edge ringing or outlining using the 480p display format. This is excellent performance and better than most progressive-scan DVD players achieve. Some other display formats showed a slight thickening of horizontal lines as a result of vertical scaling, but no ringing or outlining. This was extremely good scaler performance.

The performance of the S-video input was particularly impressive. The chroma response of the S-video and YPbPr inputs were nearly indistinguishable on the 1.0 MHz color stripes of *Video Essentials*' Snell & Wilcox test pattern. The S-video chroma response was still good at 1.5 MHz, but the YPbPr chroma resolution was significantly better.

The composite input also had excellent chroma response, but its 2D Y/C separation filter exhibited significant cross-color and some cross-luminance artifacts. The *AVIA* resolution pattern reveals the cross-color (rainbows) on the 3.0-4.1 MHz patterns and the Snell & Wilcox pattern from *Video Essentials* shows cross-luminance (dot-crawl) within the color stripes. There is also some luma smear on diagonal edges that produce a softer picture than the S-video or YPbPr inputs.

Pass-Through Input

I tested the pass-through input with the 720p and 1080i Sharpness pattern from the AccuPel HDTV Calibration Generator and found no visible edge ringing or outlining. The pass-through frequency response was down only -0.47 dB at 30 MHz, and just -1.00 dB at 60 MHz.

Deinterlacing

The Vision uses the Silicon Image SiI-504 Digital Video Processor to provide ideal inverse-telecine deinterlacing for film sources, and motion-adaptive deinterlacing for original interlaced-video sources.

Successful inverse-telecine deinterlacing depends on accurately detecting the 3-2 field pulldown pattern that is used to convert film to interlaced video and smoothly handling breaks in that cadence at edit points. The Vision did an excellent job of handling the transitions between the film and video segments of *Video Essentials*' Montage of Images. There were no glitches or flashes of line combing at any transition. It also performed flawlessly on a broad selection of DVD movies.

It is much more difficult to deinterlace original video sources, since the images originate as interlaced fields and not progressive frames. Unlike inverse-telecine deinterlacing for film-sources, there are no ideal motion-adaptive deinterlacing algorithms, and there are inevitably tradeoffs between jaggies, line twitter, and picture softening depending on image content and the specific processing algorithms that are used.

On the Montage of Images, the Vision did an exceptionally fine job with the zoom and pan shots of the vertical and diagonal bridge structures, and the difficult zoom into the leafy tree. It exhibited only a few jaggies on the bobbing frozen branch and the waving American flag. That is excellent performance, but not quite state-of-the-art on the latter two segments.

The most severe test for video source deinterlacing is live sports. I watched portions of several basketball games and the Vision did a good job minimizing jaggies along the on-court lines and logos, but produced a slightly soft picture. Line wobble was the most prominent artifact when camera movement created vertical motion over horizontal edges, such as the steps in the stadium seating behind the court.

Viewing Impressions

I used a Runco IDP-980 Ultra CRT front projector to evaluate the Vision's performance with DVD film sources. I examined all eight preset display formats, but did most of my final DVD viewing using 720p since that will probably be the most commonly used format.

I was extremely impressed by the picture quality of DVD movies. Scaling and deinterlacing artifacts were virtually non-existent. There was the slightest softening of picture detail on display formats other than 480p, but that is an unavoidable consequence of scaling and essentially a non-factor with the Vision. Film grain on movies such as *Minority Report* was scarcely affected by scaling.

Color decoding accuracy on all inputs was virtually perfect after adjusting the color saturation control with *AVIA*. Flesh colors were ideal even on a film with as deeply saturated colors as *Austin Powers: The Spy Who Shagged Me*. The S-video input has such excellent chroma response that color differences with the YPbPr input were subtle. Small color details were just slightly brighter using the YPbPr input.

The digitized signal linearity was excellent as evidenced by the superb shadow-level detail and low light contrast in *Memento*. Video noise from the 10-bit A/D converters appeared to be below the level of perception.

I tried the Sharpness control at the default setting (1), but I didn't like the additional emphasis and brightness that it added to edges. The symbols engraved in stone in the opening scene of *The Fifth Element* provide a good example. The Vision produces exceptional detail at the minimum (flat response) setting of the Sharpness control and additional enhancement is unnecessary. In fact, I was struck by how little I missed the variable adaptive detail-enhancement found on some much more expensive scalers.

The Vision's digital-to-analog conversion is so free of edge ringing and outlining artifacts that particular care should given to mating it with a DVD player that has equally good interlaced signal quality. Since many DVD players produce less edge ringing on their interlaced signals than their progressive signals, deinterlaced signals from the Vision can outperform the progressive signals from such a DVD player.

I was unable to detect any degradation of picture quality from the pass-through input using 720p or 1080i broadcast signals.

Summary

The Lumagen Vision brings high performance video scaling to a much lower price level. Although some cost considerations are apparent in its mechanical design, there are no short cuts in its video processing performance. Film-mode deinterlacing and scaling are particularly exceptional. Its ability to size incoming video and create custom output formats exceed the capabilities of scalers that are many times more expensive. ■

Lumagen Vision™ Video Processor

Inputs
- Composite, S-video, And Component Video
- Pass-Through, With 300 MHz Bandwidth
- Studio-Quality TV Decoder With 10-Bit A/D
- Adaptive Comb Filter (Three- Or Four-Line) For Reduction Of Cross-Luma And Cross-Chroma Artifacts
- Automatic Selection Of NTSC (M, Japan, 4.43), PAL (B, D, G, H, I, M, N, Nc), Or SECAM (B, D, G, K, K1, L) For Composite And S-video

Video Processing
- Film Pull-Down Reconstruction (3:2 And 2:2)
- Per-Pixel Motion-Adaptive Video Deinterlacing
- Detail-Enhancing Resolution Scaling
- Programmable Cropping For Each Input Memory
- Black Level, Contrast, Color, And Hue Calibration
- Chroma-Phase Calibration
- Source Aspect Ratio Selection Of 4:3, Letterbox, And 16:9, With Two Zoom Levels For Each
- Two Memories Per Input, For Input Calibration, And Output Setup

Output
- Programmable Output Resolution From 480p To 1080p In Scan Line Increments, Plus 1080i
- Programmable Vertical Refresh Rate From 48 To 75 Hz, In Steps Of 0.01 Hz
- Programmable Output Aspect Ratio From 1.33 To 2.35, In Steps Of 0.01
- 10-Bit Oversampled Digital-To-Analog Conversion
- RGBHV, RGBS, RGB, Or YPrPb Output Format
- Embedded Bi-Level Or Tri-Level Sync
- Discrete RGB Sync Polarities Are Programmable

Power Supply: 100-240 V At 47-63 Hz
Dimesions (WHD Inches): 8 x 2 x 9
Price: $999

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