Yamaha DPX-1200

Digital Cinema Projector

Greg Rogers

Higher-Contrast DarkChip3™ DLP™ Video Projector

The DPX-1200 is Yamaha's fourth generation DLP™ projector and the first I've received with Texas Instruments' latest 720p DarkChip3™ Digital Light Processing™ technology. It produces a higher contrast ratio than Yamaha's prior DPX-1100, which delivered the best contrast ratio and black level I had previously measured for a fixed-pixel projector.

The new DPX-1200 includes Yamaha's superior Natural Color Adjustment system, and it is now factory-programmed to automatically switch between Rec. 601 primary colors for standard-definition formats and Rec. 709 primary colors for high-definition formats. The DPX-1200 ($12,495) also has improved gamma curves and a new memory copy function.

"The Yamaha DPX-1200 Digital Cinema Projector utilizes Texas Instruments' latest 720p DarkChip3™ DLP technology to establish a new level of excellence for fixed-pixel projectors."

Description

The DarkChip3 DMD™ (Digital Micromirror Device™) and its associated driver electronics are the only hardware changes in the DPX-1200. It uses the same 5x-speed, seven-segment color wheel and zoom lens that were introduced in the DPX-1100. Yamaha has also wisely retained the excellent case design used by that projector. The DPX-1200 is somewhat larger than many of its competitors, but the case ensures that no light leaks into the room, and the projector is especially quiet. At maximum lamp power the fan noise measured 52 dB, C-weighted, 12 inches from the exhaust side of the projector. The sound level dropped to 50 dB at a lamp power setting of 90, and below the 50 dB sensitivity of my meter with the lamp power set to 80.

SPECIFICATIONS

Projection System: Digital Light Processing (DLP™), 1280 x 720, 0.8 inch DMD™ DarkChip3™
Projection Lens: F=2.7-5.0, f=24.3-38.9mm, Electronic zoom (x1.6), Electronic Focus and Electronic Lens Shift
Vertical Up/Down: 50%
Iris (Motorized): 3-Step
Projection Ratio: 1.355-2.168 (3.0-4.8m, 100-inch 16:9)
Screen Size: 60 - 200 inch (16:9)
Lamp: 270W SHP, 2,000 hours
Brightness: 800 ANSI lumens (White Boost On, Iris: Off) 400 ANSI lumens (White Boost On, Iris: Fully on)
Contrast Ratio: 5,000:1 (White Boost On, Iris Fully on) 2,500:1 (White Boost On, Iris: Off)
Color Format: NTSC, PAL, SECAM, NTSC 4.43, PAL-M, PAL-N and PAL60
Inputs
Video: Composite, S-Video, S-video D4 Video, YPbPr
Input A/Input B: YPbPr/RGB
HDMI: Digital RGB/YCbCr
Power Consumption: 375W
Dimensions (WHD In Inches): 19-1/2 x 7-7/16 x 18-5/16
Weight (In Pounds): 30.4
Price: $12,495

Manufactured In Japan For:
Yamaha Electronics Corporation, USA
6660 Orangethorpe Avenue
Buena Park, California 90620
Tel: 714 522 9105
www.yamaha.com/yec

Setup

A 16:9 (1.78:1) screen should be used to match the projector's native aspect ratio. The 1.6x zoom lens provides an extremely wide lens-to-screen throw range between 9 feet 10 inches and 15 feet 10 inches for a 100-inch diagonal (87- x 49-inch) screen. Lens focus and zoom are adjustable from the remote control, so you can stand at the screen and optimize the focus based on the appearance of individual pixels. The vertical lens shift function can also be adjusted from the remote control.

The lens shift function permits the projector to be mounted at any height between the top and bottom of the screen. If the projector must be mounted above or below the screen, the projector can be tilted, but that will cause the picture to keystone. A Digital Keystone adjustment is included, but digital keystone correction produces moiré patterns on closely spaced vertical lines, so it should be avoided if possible.

Connections

The rear panel has six video inputs, including one HDMI connector. There are two analog component inputs (15-pin D-sub connector and 5 BNC jacks) that accept standard- and high-definition YPbPr or RGB video. RGB signals can include separate HV or composite sync. There is one composite video input (RCA jack) and one S-video input (4-pin mini-DIN). A D-4 input, which is primarily used in Japan, is also included for analog YPbPr signals.

The composite and S-video inputs are compatible with NTSC, PAL, SECAM, PAL60, NTSC4.43, PAL-M, and PAL-N interlaced-video signals. The analog YPbPr and RGB video inputs are compatible with 480i/p, 576i/p, 720p, 1035i, and 1080i video signals at 50, 59.94, and 60 Hz rates. The analog RGB inputs accept a variety of VESA PC formats, including VGA and SVGA signals up to 85 Hz, and XGA (1024 x 768) signals at 60 Hz.

The rear panel includes a 12 V trigger output to control a screen, and jacks for an optional wired connection to the infrared (IR) remote control. There is also an RS-232 connector, which is used for service. The power cord plugs into the rear panel.

HDMI/DVI Compatibility

The HDMI input accepts HDMI or DVI digital video signals. DVI signals require a connector adapter, or an HDMI to DVI cable.

The HDMI digital video input accepts RGB, YCbCr (4:4:4), and YCbCr (4:2:2) signals. The YCbCr (4:4:4) format is part of the DVI standard, but it is seldom used. The YCbCr (4:2:2) format is new to HDMI. A menu item selects the digital video format—Component (YCbCr), RGB, or Auto. The latter automatically uses the format provided by an HDMI source. There is also a menu item to select DVI RGB-Video (16 to 235) or RGB-PC (0 to 235) levels, which provides an accurate Black Level and White Level without readjusting those controls. The HDMI (DVI) input is compatible with 1080i, 720p, 480i/p, and 576i/p digital video (50/59.94 Hz) formats, and VGA (59.94 Hz) digital-RGB signals. HDCP decryption is provided for HDMI (DVI) signals that include copy protection.

I used the DPX-1200 with 480p, 720p, and 1080i DVI signals from a Samsung SIR-T165 HDTV Receiver and a V. Inc. Bravo-D2 DVD player. The former produces RGB-PC levels, while the latter produces RGB-Video levels. I also tested the YCbCr (4:4:4), RGB-Video, and RGB-PC formats with 1080i, 720p, 480p and 480i signals from an AccuPel HDG-3000 HD/SD/DVI Calibration Generator.

Controls

The remote control includes a spring-loaded toggle switch that illuminates just six of its buttons. On-screen menus are navigated with Menu and Escape buttons and a tilt-pad that provides cursor and Enter functions. There are dedicated buttons for the Zoom, Focus, Vertical (Lens) Position, and Iris functions. There are also dedicated buttons to select each of the six inputs and six memories. Other buttons include Aspect (ratio), (setup) Pattern, Hide (picture), Still (picture), Input, Auto (sync adjust) and Reset. There are three built-in test patterns. The crosshatch/focus pattern is useful to adjust vertical lens shift, focus, keystone, and zoom size. There is also a gray scale and a color bar pattern.

A large control panel on the top-rear of the projector duplicates the menu navigation controls and provides Input, Pattern, Lens Adjustment and Aspect buttons in addition to a Standby/On button and indicator. There are lamp, temperature, cover and fan warning indicators. The lamp warning indictor blinks after 2000 hours of lamp operation. The 270W SHP (Super High Pressure) lamp is user-replaceable and priced at $649.95.

Menu Functions

The DPX-1200 has one of the best menu systems of any projector. The Menu window has four menu groups that open below the menu bar. The menu groups are Image, Signal, Initial, and Setup. The menu window also displays the current Input and Memory number. The entire Menu window can be moved anywhere on the screen while making adjustments.

The Image menu includes Black Level (Brightness), White Level (Contrast), Gamma, (Color) Saturation, Hue, Sharpness Type and Gain, Color Adjustment, White Peaking, Iris, and Level Adjustment. Individual parameters can be reset to the factory setting by pressing the Reset button on the remote control when an item is selected in a menu. If the Enter button is pressed when the Menu window isn't on screen, the Image menu items can be selected and adjusted in a single line at the bottom of the screen.

The Signal menu provides Display Aspect (ratio), Overscan, 3D Y/C Separation (composite signals), Noise Reduction, Video Type (DVD or VCR, for composite and S-video), Progressive Mode (Auto or Video, for standard-definition signals), Color Space Conversion (Auto, SDTV or HDTV), Setup Level (7.5 IRE or 0 IRE) for SDTV and HDTV, (Digital) Signal Level (Video 16 to 235 or PC 0 to 255), Clamp Position, and Signal Status (HDMI source, signal format and sync information). When analog RGB PC signals are used the menu also includes Sync Adjustment, Tracking, Horizontal Display Position, and Vertical Display Position.

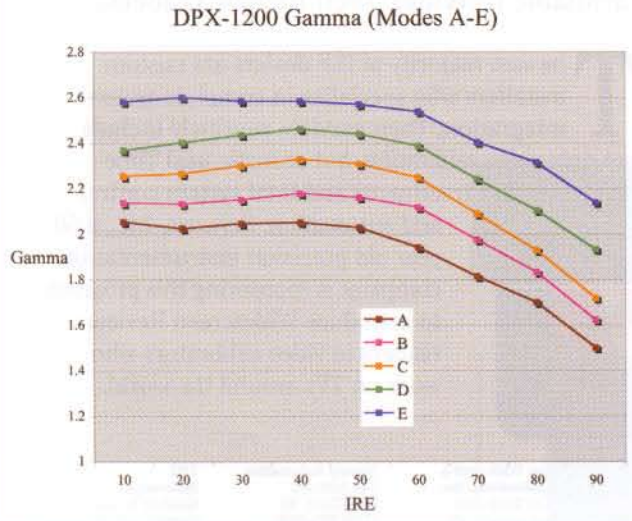
The Initial menu includes Color System (Auto. NTSC, PAL, etc.), Input A Signal (YPbPr Component, RGB-PC, or RGB-TV) and Sync Type (Auto, HV sync, composite sync, or sync-on-green), Input B Signal and Sync Type, HDMI Signal Type (Auto, YCbCr Component, RGB Video), Auto Power Off, Auto Input Search, Display Language, Lamp Running Time, and Reset. The latter provides a submenu to reset the current memory, all memories, or all projector parameters to the factory settings.

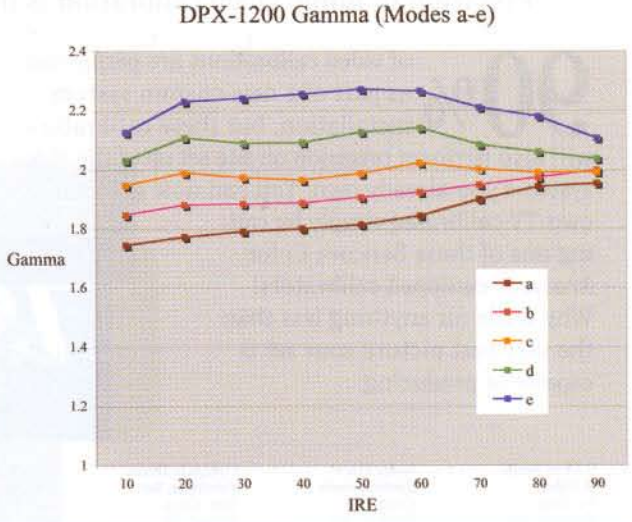
The Setup menu includes Location (table/ceiling, front/rear projection), Keystone Correction, Remote Control Sensor, Remote Control ID, Lens Adjustment Lock, Lamp Power, Menu Color (Monotone or Color), Menu Mode, Message, Trigger Out, and Baud Rate.

There are six memories for each of the six inputs (36 memories), plus each memory saves separate settings for SD, HD, and PC signals if they are applicable to a particular input (72 total memories). Nearly all of the Image and Signal menu settings are stored in each memory, including the extensive Natural Color System adjustments. In my previous reviews of the DPX-1200 predecessors I requested a function to copy settings between memories. Yamaha has now added a function to copy settings from one memory to another for the same input and for the same signal type (HD, SD, or PC). This is a welcome addition, but it is still tedious to copy settings between inputs and between signal types for the same input. Hopefully, Yamaha will further extend the copy function and also permit the memories to be named in the next projector.

Like many projectors, whenever a setting is changed it is immediately saved in the current memory, which can make it a bit too easy to unintentionally modify a saved setting. The Memory Lock function locks individual memories so changes aren't saved.

G A M M A M O D E S





Gamma

Yamaha has greatly improved the DPX-1200 gamma modes, compared to the previous projectors. There are ten selectable gamma modes that are labeled a-e and A-E. The a-e gamma modes now have a relatively constant gamma from 10 to 100 IRE, instead of decreasing dramatically as the brightness increases. The 10 IRE gamma values increase from about 1.75 for mode "a" to about 2.15 for mode "e." At 90-IRE the gamma value varies from about 1.95 for mode "a" to about 2.1 for mode "e." (See the Gamma Modes "a-e" chart.)

The gamma values of the A-E modes are relatively constant from 10 to 60 IRE and then decrease as they sometimes do in CRT front projectors. The 10 IRE gamma values vary from about 2.05 for mode "A" to 2.6 for mode "E." At the highest brightness levels the gamma values vary from about 1.5 for mode "A" to 2.15 for mode "E." (See the Gamma Modes "A-E" chart.)

The video signal gamma standard is 0.45, therefore, a display gamma of 2.2 is required to produce a system gamma of 1.0. (System gamma is equal to the signal gamma multiplied by the display gamma.) Gamma mode "e" comes closest to a constant 2.2. Gamma selection is always a subject of controversy, but research indicates that a system gamma of 1.1 to 1.2 is advantageous when viewing a picture with a dark surround. I usually prefer a display gamma of about 2.4 to 2.5, which produces a system gamma of 1.08 to 1.125. Hence, I preferred gamma mode "D," which has a gamma of about 2.4 from 10 to 60 IRE and then decreases to about 1.95 at 90 IRE.

Rather than provide so many preset gamma curves, it would be great if future projectors allowed users to create their own gamma curve, preferably from within the menu system without needing an external PC.

Lamp And Iris Modes

There are three iris modes that can be selected with a button on the remote control or in a menu. As the size of the iris aperture is reduced the brightness is reduced, but the contrast ratio is increased.

The lamp power adjustment has five steps from approximately 80 to 100 percent of full power. (The brightness of the lowest setting measured about 76 percent of the full power brightness.) This excellent feature makes it possible to initially adjust the projector to a preferred brightness and then maintain the brightness as the lamp ages.

Black Level And Contrast Ratio

An AccuPel HDG-3000 Calibration generator (www.accupel.com) was used to generate test patterns to measure light output, contrast ratio, gray scale, and color accuracy. Light output and contrast measurements were made using the HDMI input with the white reference calibrated to D65. The projector was adjusted for maximum calibrated light output (White Level control) with a peak-white PLUGE pattern (98 IRE stripe against a 100 IRE background), and optimum black level (Black Level control) with a conventional PLUGE pattern.

The DarkChip3 technology increased the full-field (on-off) contrast ratio by about 22 percent compared to the DPX-1100, which previously produced the best full-field contrast ratio (3590:1) I had measured from a fixed-pixel projector. With the lamp power at 80 and minimum iris aperture, the DPX-1200 produced 13.3 foot-Lamberts (fL) from my 1.3 gain, 85.3-inch wide, 16:9 Stewart StudioTek screen (more than the 12 fL recommended by SMPTE for digital cinema). The 100 IRE color temperature was 6482K with a dE value of 1. The full-field contrast ratio measured a superb 4390:1, with an exceptional black level of only 0.0030 fL.

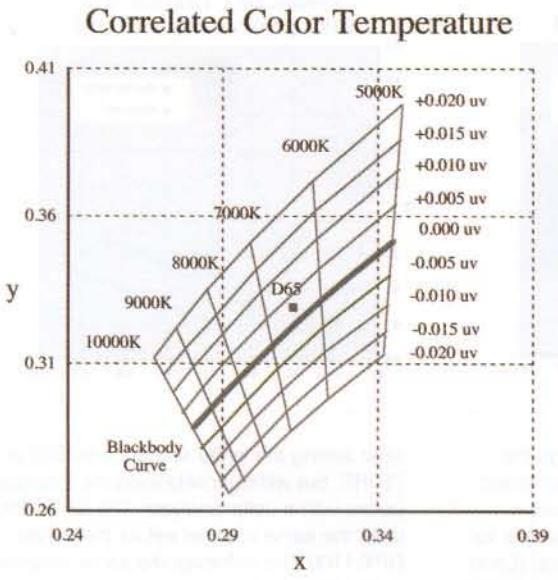
(The full-field contrast ratio measured 5530:1 with the White Peaking at maximum and minimum iris aperture, but I wouldn't use that mode for serious viewing. The 100 IRE color temperature increased to 6830K with a dE value of 10.)

With the lamp power at 100 and the iris at minimum aperture, the projector produced 17.6 fL from the screen, which is equivalent to 385 lumens. With the middle iris aperture, the luminance increased to 18.1 fL with a full-field contrast ratio of 2980:1. With the maximum iris aperture, the projector produced 668 lumens, which is equivalent to 30.5 fL, and the full-field contrast ratio measured 2270:1.

The White Peaking can be used to create an even brighter picture for watching sports or other non-critical viewing in a dimly lit room. With the White Peaking at maximum and the lamp power at 100, the projector produced 848 lumens, which is equivalent to about 38.7 fL from my screen.

The full-field contrast ratio is crucial for LCD and DLP projectors because it specifies

COLOR ADJUSTMENT



PRIMARY AND COMPLEMENTARY COLOR CHROMATICITY

	Red	Green	Blue	Yellow	Cyan	Magenta
Rec. 601 'SD'						
x	0.630	0.310	0.155	0.421	0.231	0.314
y	0.340	0.595	0.070	0.507	0.326	0.161
Rec. 709 'HD'						
x	0.640	0.300	0.150	0.419	0.225	0.321
y	0.330	0.600	0.060	0.505	0.329	0.154

the absolute blackest level in dark scenes when the projector is set up to produce the desired peak-white brightness in bright scenes. A small increase in the black level severely reduces shadow detail discrimination in predominantly dark images. But now that the black level has reached acceptable levels in many fixed-pixel projectors, it is also important to consider intra-field image contrast. Intra-field contrast is a measure of the ability to see contrast differences when there are bright objects in a scene. The displayable contrast ratio is then much lower because light from bright objects will be scattered over the image obscuring darker objects. The light scattering occurs within the lens and the optical system of the projector, but it may also occur within your home theatre if light reflects around the room and back onto the screen.

I use a modified "ANSI" checkerboard contrast ratio as a figure-of-merit to characterize intra-field contrast performance. My modified "ANSI" method is designed to minimize the influence of room reflections and other variables that would affect measurement accuracy. The modified "ANSI" contrast ratio of the DPX-1200 measured an excellent 500:1, which is 28 percent higher than the 390:1 that I measured for a DPX-1100.

White Field Uniformity

Brightness uniformity on a white-field test pattern is exceptional. In the highest contrast, minimum iris aperture mode, the brightness varied by 12 percent or less at the sides, top or bottom of the screen. Brightness varied by 9 percent or less in the maximum aperture mode. The color temperature uniformity varied by 310K in the minimum aperture mode, and 190K in the maximum aperture mode.

The exceptionally wide range zoom lens exhibited a small amount of chromatic aberration. Sub-pixel color fringing on white lines at the edge of the picture was visible when standing near the screen, but wasn't noticeable from normal viewing distances.

Color Adjustment System

The DPX-1200 includes Yamaha's advanced Natural Color Adjustment system that permits the user to individually adjust the chromaticity of the white reference and each of the primary (red, green, and blue) and complementary (yellow, cyan, and magenta) colors.

The Color Adjustment function has three modes—Standard, WRGB, and WRGBYCM. The Standard mode provides adjustment of the white reference using the projector's native primary colors. The WRGB mode adds adjustments for the primary colors and automatically derives the complementary colors. The WRGBYCM mode provides additional adjustments for the complementary colors.

Color accuracy requires an accurate D65 gray scale and primary colors that match the ITU Rec. 601 standard (SMPTE C primaries) for standard-definition sources, and the ITU Rec. 709 standard for high-definition video. The primary colors, and hence the complementary colors, are not the same for the two standards. The color-wheel filters produce a native primary color triangle that is larger than either of the video standards, which allows effective (pseudo) primary and complementary colors to be adjusted to match the standards.

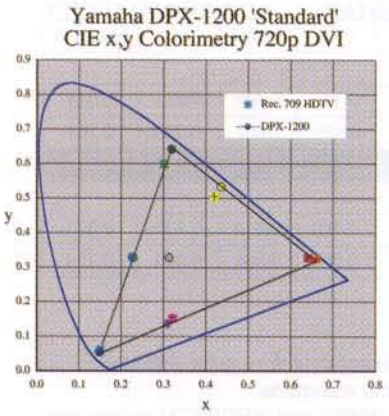
The WRGB and WRGBYCM modes are now factory preset with the Rec. 601 primary colors for standard-definition formats and the Rec. 709 primary colors for high-definition formats. Therefore, when input signals are switched, the color standard is also automatically switched. (DPX-1200 predecessors were factory preset with the Rec. 709 colors for all input formats, and the knowledgeable user had to manually enter the Rec. 601 color coordinates for the standard-definition formats of each input.)

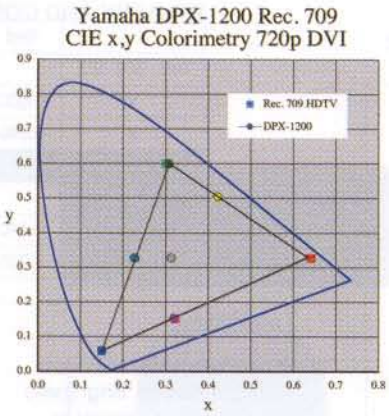
Unfortunately, the professional CRT monitors used for creating high-definition video still have Rec. 601 (SMPTE-C) primary colors. When those monitors are not color corrected, the DPX-1200 should be set to the Rec. 601 primaries to most accurately duplicate the colors seen on the professional monitors, even when viewing high-definition video. For that reason I set the WRGB mode to the Rec. 601 primary colors for high-definition formats. I could then switch from WRGB to WRGBYCM to quickly try both colorimetry standards when viewing high-definition sources.

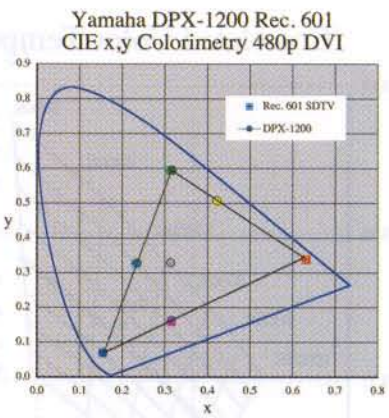
The DPX-1200 Natural Color Adjustment system is an extraordinarily valuable feature that permits the projector to produce nearly perfect color accuracy. The user can directly enter values for a colorimetry standard (i.e. Rec. 601) and obtain excellent results, or a color analyzer can be used to further optimize accuracy. The primary and complementary colors are adjusted by setting the (x,y) values in 0.001 increments. A CIE diagram is displayed in the menu window to select the color to adjust. Then the CIE diagram expands to show the nominal (x,y) position of the color as it is being adjusted. It is rather complex to compute the (x,y) coordinates of the complimentary colors, so I created a table for you with all of the color coordinates for Rec. 601 and Rec. 709.

A gain (brightness) adjustment is also provided for each color. The DPX-1200 can

P E R F O R M A N C E







automatically adjust the gain of the individual colors, or they can be manually set using the red, green, and blue filters supplied with *AVIA: Guide To Home Theater* or *Digital Video Essentials*.

When the white reference is selected, the menu window shows a graph of the central portion of the CIE diagram. The white reference is adjusted by setting the color temperature in 100K increments from 5000K to 10000K, and a "uv" deviation in 0.002 uv increments. These are orthogonal adjustments. The color temperature setting moves the white reference point along lines parallel to the blackbody curve, and the "uv" deviation moves the white reference above or below the blackbody curve along isothermal (same temperature) lines. Hence, the color temperature adjustment sets the Correlated Color Temperature (CCT), and the "uv" adjustment sets the vertical position at the specified CCT. (Refer to the CCT diagram.) The hue of the white reference changes from red to blue as the CCT increases and becomes less green and more magenta as the "uv" value changes from positive to negative.

Gray Scale Accuracy

The Color Adjustment system provides the means to adjust the white reference at a single video level. To achieve accurate color reproduction, the white reference must ideally remain at D65 (x=0.313, y=0.329) for all brightness levels from 0-IRE (black) to 100-IRE (peak white). That ability is called gray scale tracking. Most projectors provide gray scale tracking controls (RGB offset and gain) that apply to all input signals. The DPX-1200 only provides those controls (Level Adjustments) for analog RGB signals, and relies on fixed parameters to provide acceptable gray scale tracking for HDMI and other analog signals. Although the DPX-1200 gray scale tracking performed well, it would be better to have user adjustable gray scale tracking controls for all input signals in future projectors. (Level Adjustments are provided for analog YPbPr signals, but those only affect color decoding and not gray scale accuracy.)

I tested the HDMI input first with the color temperature set to 6500K, and because D65 is just above the blackbody curve I set the "uv" value to +0.002. A 720p, 75-IRE gray window measured 6360K with a dE value of 3. To obtain D65 at 75 IRE, I set the projector's color temperature to 6700K +0.002uv. At that setting the gray scale measured 6500K +160/-62K from 20-IRE to 100-IRE, but most importantly the dE value was 2 or less over most of that gray scale range, increasing to 9 at 10 IRE. The dE value expresses the distance from D65 in a color space that is perceptually more uniform than the CIE x,y color space. A dE value of 1 is considered a just noticeable difference (JND), but values of 3 or less are negligible differences in most practical situations.

The analog YPbPr input also produced good gray scale tracking. The dE value was less than 2 from 30 to 100 IRE, 5 at 20 IRE, and 11 at 10 IRE. These results are included in the Gray Scale Tracking table.

I used the Level Adjustments that are provided for analog RGB signals to improve the gray scale tracking at the darker levels. The dE value at 10-IRE improved from 9 to 2. My calibrated settings for the analog RGB input measured 6500K +94/-83K from 10 to 100 IRE with a maximum dE of 2, which is exceptional performance.

Color Accuracy

The primary and complementary color measurements in this section were made after setting the white reference to D65 at 75 IRE, but without calibrating the individual colors with a color analyzer. The DPX-1200 uses the same color wheel as the earlier DPX-1100 and achieves the same excellent color accuracy.

The first CIE diagram shows the "Standard" Color mode. The DPX-1200 native primary colors extend beyond the Rec. 601 and Rec. 709 primaries. This produces extremely vivid colors, but reds and greens appear oversaturated, particularly with standard-definition sources.

The second CIE diagram shows the factory preset WRGB mode with 720p digital RGB signals. There is a close match with the Rec. 709 HDTV standard colors without any additional calibration with a color analyzer. Measurements with 720p digital YCbCr signals produced the same CIE (x,y) values within 0.001, which indicates there is negligible error in the high-definition YCbCr (YPbPr) to RGB color decoder.

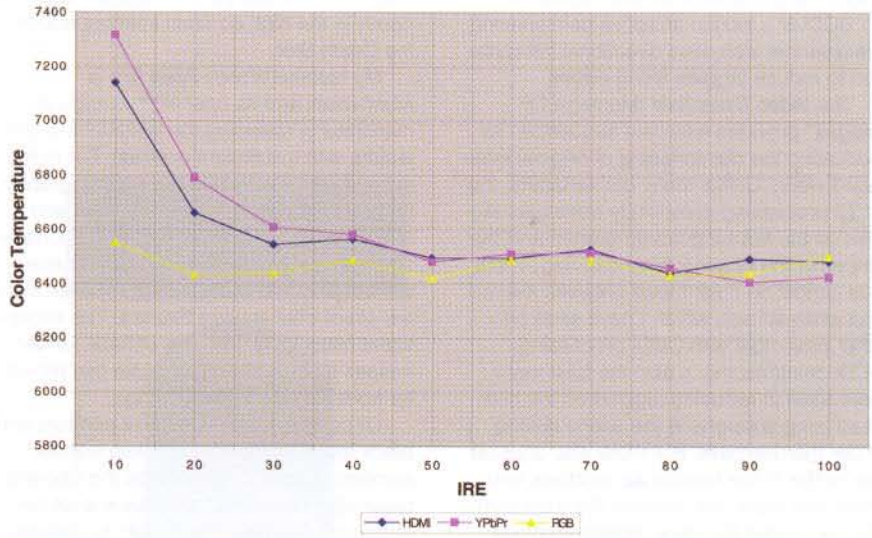
I repeated the measurements with analog 720p RGB signals, and again all of the CIE (x,y) values agreed within 0.001. This is superb performance that indicates the analog A/D converters are precisely calibrated to produce negligible error in the analog video signal path.

The third CIE diagram shows the WRGB mode with digital 480p RGB signals. Again, there is an excellent match with the Rec. 601 standard-definition colors. When digital 480p YCbCr signals were used, the primary colors exactly matched the digital 480p RGB primaries, and the largest complementary color error was 0.003. That indicates a very slight error in the standard definition YCbCr to RGB color decoder. I then calibrated each individual color with a color analyzer, but the visual differences in the image were nearly insignificant.

GRAY SCALE TRACKING

Yamaha DPX-1200

	HDMI		YPbPr		RGB	
	Fixed		Fixed		Calibrated	
IRE	°K	dE	°K	dE	°K	dE
10	7104	9	7315	11	6549	2
20	6660	3	6789	5	6430	1
30	6543	2	6606	2	6437	1
40	6563	2	6579	1	6485	1
50	6493	1	6479	2	6417	2
60	6493	1	6508	2	6485	1
70	6526	1	6514	1	6485	1
80	6438	1	6456	2	6430	1
90	6490	0	6404	2	6477	1
100	6482	1	6423	1	6499	1



Scaling And Overscan

The DPX-1200 provides a choice of two overscan modes. In the Standard mode, I measured about 2 to 4.5 percent overscan for the analog and digital signal formats. The overscan measurements below are for the Full mode, which is intended to produce frames with little or no overscan.

Except for some blanking along the edges of the frame, the DPX-1200 produces a spatially "pixel perfect" image when its HDMI input is driven by 720p digital video signals. When the Sharpness control is off, each visible pixel from the source is precisely mapped to a single projector pixel, without scaling or edge enhancement. There is no edge outlining on horizontal or vertical lines, which are displayed with precisely the pixel widths or thickness produced by the source. The single pixel vertical lines within the high frequency multiburst pattern are rendered as single pixel lines with full contrast. However, there are two blank pixel columns (vertical lines) on both the left and right sides of the screen, and three blank pixel rows (horizontal lines) at the bottom of the screen. There are no horizontal or vertical position adjustments for HDMI (or DVI) signals to make the blank pixels visible.

The scaling was exceptional for 480i, 480p, and 1080i signals. With the AccuPel generator set to produce video-edge transition rates, there was only a single pixel of visible edge outlining around 1080i vertical lines, and outlining around 480i and 480p vertical lines was so faint it could barely be detected when standing within a few feet of the screen. There was only about one pixel of outlining above and below 1080i horizontal edges and only two pixels for 480i and 480p horizontal edges. Digital video signals from set-top boxes or DVD players will be similarly transition-rate limited for movies or other broadcast video sources. With faster PC-edge transitions (analog or digital signals) there was only one (720p) pixel of outlining around vertical lines for 1080i signals, but there were about 4 to 5 pixels of moderately bright outlining for 480i and 480p signals.

The single pixel lines in the top burst of the 1080i multiburst pattern (1920 pixels per picture-width) are beyond the resolution of a 720p projector. They were smoothly widened and rolled off by the 1080i to 720p scaling.

For 1080i analog (YPbPr) or digital signals there was no overscan on the left and right edges and only 1 to 3 pixels missing at the top or bottom of the frame. There was about 1 percent overscan on the left and right sides of 480i and 480p frames, and less than 0.5 percent overscan at the bottom for 480p analog signals.

The four-band Sharpness control adds significant edge outlining to 720p/1080i vertical lines and to 480i/p horizontal and vertical lines. I didn't see any need to use the Sharpness control on HDTV or good quality DVDs, but it may be a useful tradeoff with some lower resolution broadcast video.

AVIA PRO's polyphasic chroma sweeps showed good S-video chroma response to about 1.6 MHz. The YPbPr chroma response extends to over 3.0 MHz, nearly reaching the 3.375 MHz limit of the DVD format.

Deinterlacing

The DPX-1200 uses Faroudja deinterlacing technology, which includes inverse-telecine (film-mode) processing for standard-definition movies, and DCDi™ (Directional Correlational Deinterlacing) deinterlacing for standard-definition original interlaced video.

Inverse-telecine deinterlacing is an ideal process for artifact-free deinterlacing of film-source video, as long as the video processor can 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 video fields that originated from the same film frames. That eliminates interlaced line twitter and avoids interpolation that would soften the image. The inverse-telecine processing only rarely produced noticeable deinterlacing artifacts on the DVD movies that I viewed.

There are two standard-definition deinterlacing modes—Auto and Video. In the Auto mode, the projector automatically switches between inverse-telecine deinterlacing for film sources and DCDi motion-adaptive deinterlacing for original interlaced-video sources. I only noticed one combing artifact during a scene switch on the *Video Essentials* "Montage Of Images," which cuts back and forth between segments transferred from film and original interlaced video.

It is much more difficult to deinterlace original interlaced video sources than it is to deinterlace video from film sources. There are no ideal methods for video source deinterlacing, and regardless of the technique

there are always tradeoffs between line twitter, jaggies (static or moving stair-steps on edges), and a loss of picture resolution.

DCDi is a motion-adaptive deinterlacing process that also uses directional interpolation to reduce jaggies along edges.

The *Video Essentials* "Montage Of Images" provides excellent sequences for evaluating the deinterlacing of original interlaced video. Unlike many deinterlacers, the DCDi processing completely eliminates jaggies on the bobbing frozen branch and the stripes of the rippling American flag. There was almost no color-bleed between the red and white stripes, which I have seen on other projectors with DCDi processing. DCDi deinterlacing is also the best that I have seen in reducing jaggies on the overhead lamp supports in the scene driving under the overpass. But there was unusual line twitter in the boathouse windows and there was more line twitter in the train yard than produced by some motion-adaptive deinterlacing processes.

DVD Viewing

I supplied the DPX-1200 with 480i YPbPr analog signals from my reference DVD player so that I could evaluate the projector's analog-to-digital conversion, internal deinterlacing, and scaling. I also connected the 720p DVI and analog RGB outputs from a DVDO iScan™ HD+ video processor to the DPX-1200. The iScan HD+ was driven from a variety of DVD sources, including the 720p DVI output of a V. Inc. Bravo D-2 DVD player, and 480i digital video signals from an SDI (Serial Digital Interface) equipped DVD player.

The new DarkChip3 DLP technology increased the full-field contrast ratio by 22 percent and the intra-field contrast ratio by 28 percent, compared to the previous DPX-1100 projector. The DPX-1200 comes closer to achieving the dark scene contrast performance of a CRT front projector than any other fixed-pixel projector I've tested. In addition, the intra-field contrast ratio is much higher than any CRT projector, which enables the DPX-1200 to provide superior contrast and image depth in brighter scenes.

These improvements made a significant difference when viewing *The Star Wars Trilogy*. The superlative restoration and DVD transfers of the original *Star Wars* films have exceptional black levels and shadow detail that is outstanding on the DPX-1200. You need to look no further than the capture of R2-D2 by the Jawa on *Star Wars: Episode IV—A New Hope* to appreciate how the additional contrast improves the clarity of dark details and further reveals the textures of the Tatooine landscape. The near-black features of Darth Vader's clothing and helmet are particularly well-delineated, and the superior intra-field contrast adds image depth to the high contrast interiors aboard the Death Star.

My favorite Woody Allen film is *Manhattan*, and its opening montage is merciless in revealing the limitations of projectors with insufficient contrast. But in this case, the black and white cinematography looks marvelous with great contrast and image depth. Another revealing demonstration of the superior contrast is the scene where Allen and Michael Murphy walk along the street after leaving Elaine's. The exceptional black level and lack of haze render images that clearly differentiate this projector from earlier DLP technology.

Of course, no evaluation of contrast and black levels would be complete without mention of *Dark City*, perhaps the ultimate barometer of contrast and black level performance. No matter how high its contrast ratio, no fixed-pixel projector has reproduced the shadowy world of *Dark City* with quite the same clarity as a CRT front projector. But the DPX-1100 made a major step toward equivalence, and the DPX-1200 closes the gap further. The film looks great with excellent image depth and detail in the darkest scenes, but an astute reviewer must acknowledge that there are still scenes with room for improvement. It may take another doubling of the contrast ratio to lift the final veil that shrouds this unusual film.

The DarkChip3 DMD and its associated driver electronics have eliminated the slight contouring (discrete brightness steps around bright objects in patterns like a topological map) that I noticed on the DPX-1100. There is now no visible contouring around the swinging overhead light or the wall lamps in Chapter 2 of *Dark City*. Dithering noise in dark scenes is also insignificant from normal viewing distances. I had to stand close to the screen to see faint dithering on a 1-10 IRE luma pattern from an AccuPel generator.

The DPX-1200 internal scaler adds no visible edge outlining artifacts. Image sharpness and clarity are strongly correlated with static scaling quality, so it was no surprise that the best DVD transfers are rendered with exceptional definition. The Columbia TriStar Superbit™ version of *The Fifth Element* looked superb with superior edge sharpness and image depth. The opening montage on *Manhattan* also has exceptional resolution that exhibited outstanding image definition.

A completely digital video path (HDMI, DVI, SDI) from the source to the projector avoids a digital-to-analog and analog-to-digital conversion, but only makes a just-noticeable difference in DVD picture definition, when compared to analog signals with minimal edge artifacts. However, many DVD players have significant edge outlining or ringing on their analog outputs, and that can significantly degrade image clarity.

I'm particularly passionate about color accuracy, and the DPX-1200 Natural Color Adjustment system provides a major advantage over CRT-based projectors and other fixed-pixel projectors without similar processing. However, to benefit from this feature the WRGB or WRGBYCM color mode must be set to Rec. 601 colorimetry values when displaying DVDs. This happens automatically if you supply the projector with 480i or 480p signals. But if the video signals are upconverted to 720p external to the projector, you must enter the Rec. 601 colorimetry values manually. The "Standard" color mode (native primaries) and the high-definition Rec. 709 color settings will produce inaccurate color for DVD viewing, and in particular produce skin tones that are slightly too red.

Another important feature of the DPX-1200 is the ability to manually switch the YCbCr (YPbPr) to RGB color decoding matrix. This is valuable because some upconverting DVD players with HDMI outputs produce 720p (and 1080i) YCbCr signals with incorrect (Rec. 601) color encoding. Displays automatically apply Rec. 709 (HDTV) decoding when they receive 720p or 1080i YCbCr signals and will, therefore, produce incorrect colors with those DVD players. The DPX-1200 is one of only a few projectors that allow a user to manually select the Rec. 601 (SDTV) YCbCr decoding to work around this DVD player problem.

Optimum color accuracy can be obtained using analog RGB signals because that is the only signal type that allows the DPX-1200 gray scale tracking to be user calibrated. Fortunately, for other signal types the darkest part of the grayscale moves just slightly toward blue, which is usually less noticeable than a green or red shift.

Color accuracy is the key to producing brilliant, vivid color while maintaining natural flesh tones, and nothing bothers me more than overly saturated skin tones. Telecine colorists are often blamed for poor flesh colors, when the fault is usually inaccurate home-theatre display systems. One of the best examples is *Austin Powers: The Spy Who Shagged Me*. The DPX-1200 flesh tones are natural, even though other colors are brilliant and deeply saturated. *The Star Wars Trilogy* and *Notting Hill* are other examples with vividly saturated color palettes, but the skin tones remain natural.

I'm particularly concerned about accurate color in more visually subtle films where color and lighting play an important role in establishing a mood or an environment. *Mulholland Dr.* is a mesmerizing David Lynch film, beautifully rendered by this projector. The DVD transfer has rich, warm colors and exceptional clarity with minimal edge enhancement. Color and lighting are used very differently to establish the look and feel of another time and place in *American Graffiti.* An excellent black level and proper gamma are essential to realistically portray the dusk to dawn time span of the film. I used gamma mode "D" for all of my viewing. The street lighting produces great contrast, gleaming color, and accurate flesh tones, even though the film is shot entirely at night.

HDTV Viewing

I used the DPX-1200 to watch the FOX high-definition broadcast of Super Bowl XXXIX. The 720p broadcast matched the native resolution of the projector, producing exceptionally clear images with vivid color. I commend FOX for transmitting a high quality picture with very few MPEG motion artifacts. But I quickly tired of the excessive computer graphics that constantly reminded me that this was television—not an open window into the stadium, which is what it appeared to be when I managed to ignore the distracting graphics.

The DPX-1200 produces an impressive high-definition picture that is exceptionally coherent. It doesn't have motion-adaptive deinterlacing for 1080i video sources, which results in a slightly softer picture, but in return it has fewer annoying deinterlacing artifacts. The picture is especially free of pixelization when a camera pans across an area of complex structure and fine detail. There is also no abrupt change in sharpness at the transition between a still image and a slowly moving image.

I used a Samsung HDTV broadcast receiver with DVI output and a JVC HM-DH5U D-Theater™ HD VCR with HDMI output as HDTV sources. I compared the analog outputs of both sources to their digital video outputs. In both cases I preferred the HDMI/DVI digital video output for slightly better image definition.

NBC's *Tonight Show With Jay Leno* still provides some of the best 1080i images for evaluating HDTV picture quality. The vivid colors in the set's cityscape background are brilliant, while the skin tones of Jay and his guests remain natural. Despite the 1080i to 720p conversion, picture clarity is impressive with no visible edge outlining. Fine lines in Clint Eastwood's suit and tie were well-defined and exhibited no line twitter as the actor/director moved about during a recent guest appearance.

Some network HDTV series tend to be slightly over-saturated, while most high-definition movies aren't. The flesh tones on NBC's *NCIS* were excessively red, but slightly reducing the (color) saturation control easily corrected the problem. The DPX-1200 wisely provides a saturation control for analog and digital video signals. Other HDTV programming, such as the ABC series *According To Jim*, displayed a vivid color palette without over-saturation.

As I mentioned earlier, many of the professional CRT monitors used for HDTV production still have SMPTE-C (Rec. 601) primaries with no electronic color correction, so the best HDTV color accuracy is often obtained by using the Rec. 601 primary colors. But don't use SDTV YCbCr color decoding for HDTV, which is called Color Space Conversion in the DPX-1200.

The DPX-1200 doesn't have inverse-telecine deinterlacing for 1080i film-source video with 3-2 pulldown. The primary consequence is that line twitter (wobble) is occasionally noticeable when a camera moves vertically over sharp horizontal edges. Fortunately, line twitter is less objectionable with high-definition video because horizontal lines (rows of pixels) are much closer together than they are for standard-definition video.

Images are also slightly softened because 1080i fields (1920 x 540) are interpolated into 720p frames, rather than merged into 1080p frames. But 1080i sources are vertically pre-filtered to prevent inter-line flicker on CRT-based interlaced displays, so 1080i vertical resolution is already limited. Even with inverse-telecine deinterlacing, the resulting 1080p frames would have to be scaled (interpolated) down to the native 720p resolution. So, there is only a small difference in the sharpness of 1080i film sources between 720p projectors with inverse-telecine and those without it.

The improved contrast ratio of the DPX-1200 is most noticeable on *U-571*. The dark submarine interiors are rendered with additional image depth and better discrimination of shadow detail. *U-571* approaches the three-dimensionality that it exhibits on a high-end CRT front projector.

K-PAX is the D-Theater movie that takes best advantage of both the superb color accuracy of the DPX-1200 and its exceptional contrast ratio. *K-PAX* uses light as a key plot element and to create its cinematic ambiance. There are intensely bright and extremely dark images that take advantage of the projector's full dynamic range and exceptional contrast ratio. The results are visually stunning. The color accuracy is superb, and the film is filled with brilliantly vivid colors, but never looks oversaturated. The exceptional black level, combined with deep blues and purples, make the planetarium scene breathtaking.

Summary

The Yamaha DPX-1200 Digital Cinema Projector utilizes Texas Instruments' latest 720p DarkChip3 DLP technology to establish a new level of excellence for fixed-pixel projectors. It delivers the highest contrast ratio and best black levels I have ever measured from a non-CRT display, while still achieving negligible gray scale deviation at the brightest picture levels. Its Natural Color Adjustment system provides exceptional DVD and HDTV color accuracy by modifying the projector's native primary colors in accordance with the high-definition and standard-definition colorimetry standards. The Yamaha DPX-1200 earns the top spot on my current list of favorite 720p home theatre projectors. ■