

AccuPel

HDG-4000 Documentation - User Manual

HDG-4000

Analog/Digital Video Calibration Generator

AccuPel HDG-4000

Analog/Digital Video Calibration Generator

USER MANUAL

Version 0.92

Safety Information

- To reduce the risk of electric shock, do not expose the HDG-4000 to rain or moisture. Do not operate the HDG-4000 with the covers removed.
- Use only the supplied power module. Route power cords so they will not be stepped on or pinched by anything placed on or against them.
- Keep the HDG-4000 away from wet locations such as bathtubs, sinks, wet basements or swimming pools.
- Unplug the HDG-4000 before cleaning. Use a damp cloth for cleaning. Do not use cleaning fluids or aerosols, which could enter the unit and cause damage, fire or electrical shock.
- Do not attempt to calibrate or service this unit. Never remove the covers. Disconnect it and contact AccuPel directly for service.

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Introduction

AccuPel HDG-4000 Analog/Digital Video Calibration Generators are professional test equipment exclusively for commercial or industrial calibration and testing of video monitors, projectors, and signal processors.

Versatile Signal Outputs

The HDG-4000 produces YPbPr and RGB analog component video compliant with EIA/CEA-770.2 (480i/p), EBU-N10 (480i/576i), and EIA/CEA-770.3 (1080i/p & 720p) standards. YPbPr and RGB analog component video is also compliant with SMPTE-274M (1080i/p), and SMPTE-296M (720p) standards, except that sync is present on Y or G signals only in accordance with EIA/CEA consumer standards. The HDG-4000 also produces Y/C (S-video) and CVBS (Composite) video compliant with NTSC and PAL standards.

The YPbPrs and RGBs analog output modes are intended for compatibility with professional transcoders and scalers that retain 7.5-IRE black-level setup when converting standard-definition component video with 7.5 IRE setup. The YPbPrs mode is also compatible with DVD players that produce Panasonic MII component video signals (480i) with black-level setup.

Digital video output signals are compliant with EIA/CEA-861-B (480i/480p/1080i/720p/1080p). Digital RGB signals are selectable for compatibility with RGB-PC levels or RGB-Video levels. Digital YCbCr 4:2:2 and YCbCr 4:4:4 signals are provided for compatibility with HDMI inputs.

22 Video Signal Formats

The HDG-4000 produces up to 22 video signal formats. The HDG-4000 L1 (Level 1) produces 16 video formats including 480i, 480p, 720p59.94, 720p60, 1080i59.94, 1080i60, 1080p59.94, 1080p60, 1080p23.976, 1080p24, 1080p23.976sf, 1080p24sf, 1080p29.97, 1080p30, 1080p47.95, and 1080p48. The HDG-4000 L2 (Level 2) adds six additional 50 Hz formats including 576i, 576p, 720p50, 1080i50, 1080p25, and 1080p50.

Digital YCbCr 4:4:4/4:2:2 Signals & Digital RGB Signals With Video and PC Levels

The Digital output produces digital RGB signals and digital YCbCr 4:4:4/4:2:2 signals for DVI or HDMI inputs. The 8-bit digital RGB signals can be selected to comply with RGB-PC or RGB-Video signal levels. RGB-PC digital levels are 0-255 for black (0%) to reference white (100%), and therefore below-black or above reference white RGB-PC levels are not permitted. RGB-Video digital levels are 16-235 for black (0%) to reference white (100%), and therefore below-black and above reference white (to 109%) RGB-Video levels are available for PLUGE patterns and dynamic range calibration.

Versatile Sync Options

High-definition (1080i/p & 720p) analog signals have selectable Tri-Level Sync per EIA/CEA-770.3 (sync on Y or G only) or Bi-Level Sync for compatibility with older video upconverters that lacked Tri-Level sync generation. Standard-definition (480i/p, 576i/p) signals have Bi-Level sync (on Y or G only per EIA/CEA-770.2).

Embedded Bi-Level and Tri-Level sync-on-green/sync-on-Y can be disabled for RGB signals. Separate H, V sync is available with positive or negative polarity for RGB signals, or a special scope trigger output can be selected to trigger oscilloscopes or other test equipment when using YPbPr or digital video output signals.

10-Bit Analog Video DACs & Separate Sync Generation

The YPbPr and RGB analog component video signals, and the Y component of Y/C and CVBS signals, are generated by 10-bit Digital to Analog Converters from internal 10-bit 4:4:4 YPbPr and RGB digital signals. The analog embedded sync signals are produced without using any of the 10-bit video DAC dynamic range. Other generators may trade-off 30% of the video signal resolution to generate sync signals, or use 8-bit Digital to Analog Converters with less resolution or linearity.

Direct-Drive Digital (D³) Pattern Generation

All video patterns & sync signal timing is generated using three low-noise, high-stability, crystal oscillator clocks. There are separate oscillators for 480i/p and 576i/p, for 59.94 Hz based high-definition (HD) formats, and for 50.00/60.00 Hz based HD formats, per applicable SMPTE and EIA/CEA standards. A proprietary AccuPel 30-bit digital RGB/YPbPr pattern generation IC directly drives precision 10-bit resolution Digital-to-Analog Converters for analog component video output. Completely separate 24-bit RGB-Video, RGB-PC, and YCbCr digital values directly drive the digital video output transmitter without any digital truncation or conversion errors. No clock synthesizers, format converters, color-space converters, or frame buffers are used to ensure maximum signal accuracy.

Professional Quality Analog Signal Interfaces

True 75-ohm BNC signal outputs provide the highest-quality analog YPbPr or RGB interface to front projectors and other displays over long cable runs. All analog YPbPr or RGB signals are simultaneously available through the DVI-I output connector to drive a separate monitor or test system. All video and HV sync signals are 75-ohm reverse terminated for optimum pulse fidelity.

Infrared Remote Control

The 41-key IR remote control provides dedicated buttons to directly select each Output mode, Format mode, Pattern Group, and individual patterns within the current group. There are also dedicated rocker buttons to move forward or backward through Groups or Patterns. A user-defined Pattern List provides the easiest way to switch back and forth between several patterns as you work. A single button push will store or delete up to 6 patterns from a Pattern List, and then move forward or backward through the user-defined Pattern List.

The IR remote control also provides dedicated buttons to enter User-defined Luma and Color values, select special features, and to navigate the On-Screen-Display (OSD) menus.

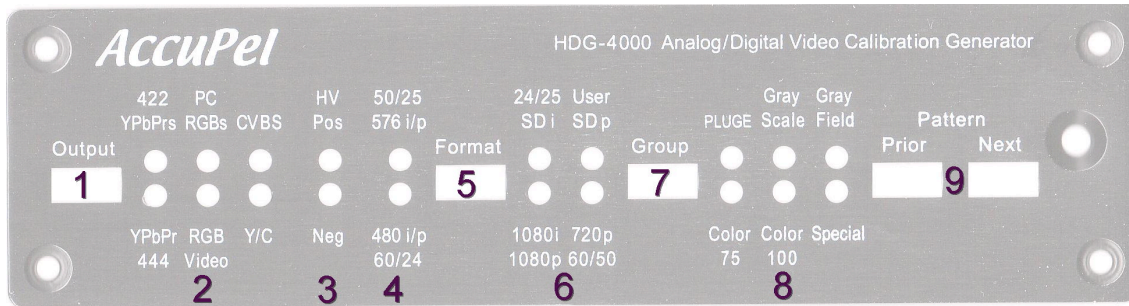
Detailed documentation for the IR remote control can be downloaded from the AccuPel website at www.accupel.com.

OSD Menus

OSD (On-Screen-Display) menus provide access to many advanced features including the ability to specify user defined Luma and Color values, choose Y/C and CVBS chroma bandwidths, enable/disable output channels, select sync options, set power up default modes, and configure the serial interface ports.

USB & RS-232C Serial Control Interfaces

The USB and RS-232 Serial Control Interfaces provide full operation of all HDG-4000 functions, including direct selection of each pattern. Complete documentation for the Serial Interfaces can be downloaded from the AccuPel website www.accupel.com.



Front Panel Controls

LED Indicators

Each time power is applied to the HDG-4000 the PLUGE, Gray Scale, and Gray Field LEDs will illuminate in sequence for about 4 seconds as the generator is initialized.

All unused Format LEDs blink once when an IR remote control command is received. All unused Format LEDs blink rapidly 4-times if a currently invalid command is received. Any slowly blinking LED indicates that a Special Feature mode (e.g. Slow Edge) is active.

1 Output Selector

*YPbPr and RGB
EIA/CEA-770.2, EBU-
N10, EIA/CEA-770.3,
SMPTE274M/296M*

The Output button selects the type of analog and digital video signals produced by the HDG-4000. The YPbPr and RGB analog video signals comply with the standard-definition (SD) EIA/CEA 770.2 and EBU-N10 standards, and the EIA/CEA 770.3 high-definition (HD) standards. HD signals also comply with SMPTE 274M and SMPTE 296M levels and color encoding, but the tri-level sync is on the Y/G signal only (per the 770.3 consumer standard), unlike the SMPTE standards that have sync on all three component signals.

*YPbPrs and RGBs
Upconverters/scalers,
Panasonic MII,
480i YPbPr with setup*

The YPbPrs and RGBs signals mimic the behavior of professional upconverters and scalars that convert standard-definition video with black-level setup to 1080i or 720p video without removing the setup. The YPbPrs (480i) mode also complies with the professional Panasonic MII standard, and early DVD players that included black-level setup on their 480i YPbPr output.

Y/C and CVBS video

Y/C (S-video) and CVBS (Composite video) standards are only defined for standard-definition interlaced signals. Therefore, the Y/C and CVBS output modes produce 480i and 576i (HDG-4000 L2 only) format signals only. When the Y/C or CVBS output is selected the signal format will automatically change to either 480i or 576i (depending on whether the previous format was based on 60 Hz or 50 Hz respectively). The previous format will be restored when the Output type is changed again, which allows the Output button to cycle "through" the Y/C and CVBS modes without having to reselect the original Format. Similarly, the Output type must be changed from Y/C or CVBS before the Format can be changed to anything other than 480i or 576i.

Digital signals are always available from the DVI-I connector. When the Y/C or CVBS mode is selected the digital output signals are YCbCr 4:4:4.

2 Output Indicator LEDs

YPbPr also selects digital YCbCr 4:4:4 signals.

YPbPr / 444 – Analog YPbPr and digital YCbCr 4:4:4 signals are selected. The black level is set to 0-IRE (blanking level). Bi-Level sync is always used for 480i/p or 576i/p. For 1080i/p or 720p, Tri-Level sync on Y (only) is used by default to comply with EIA/CEA-770.3. (Bi-level sync can be selected in the OSD menu).

RGB also selects digital RGB-Video signals.

RGB Video – Analog RGB and digital RGB-Video signals are selected. The black level is set to 0-IRE (blanking level). Analog HV sync polarity, or SoG can be selected.

YPbPrs also selects YCbCr 4:2:2 signals.

YPbPrs - Analog YPbPrs and digital YCbCr 4:2:2 signals are selected. The analog output black level is set to 7.5-IRE. This mode is compatible with older DVD players that include black-level setup on their 480i YPbPr output. It is also compatible with scalers or video converters that output black at 7.5 IRE.

RGBs also selects RGB-PC signals.

RGBs PC - Analog RGBs and digital RGB-PC signals are selected. The analog output black level is set to 7.5-IRE. This mode is compatible with scalers or video converters that output black at 7.5 IRE.

Y/C (S-video) Video

Y/C - Analog Y/C (S-video) signals are selected. Other analog signal outputs are disabled. The analog black level is set to 7.5-IRE for 480i signals (default), but there is no black level setup on 576i signals. The 480i black level setup can be disabled in the OSD Output menu.

CVBS (Composite) Video

CVBS - Analog CVBS (Composite video) signals are selected. Other analog signal outputs are disabled. The analog black level is set to 7.5-IRE for 480i signals (default), but there is no black level setup on 576i signals. The 480i black level setup can be disabled in the OSD Output menu.

3 Sync Selection

RGB Sync Polarity & RGB Sync-on-Green

In the RGB or RGBs mode, press and hold the Output button for about 1 second and the front panel HV Pos and Neg LEDs will change to indicate the RGB HV sync polarity. Hold the Output button until both LEDs are off to select the SoG mode. The RGB HV sync polarity or RGB SoG (sync-on-green) can also be directly selected with dedicated buttons on the HDG-4 remote control.

Bi-level embedded sync for HD signals, and HV sync polarity for digital signals can be selected in the OSD Sync menu.

4 50 Hz / 60 Hz Selection

50 Hz / 60 Hz Selection

Select 50 Hz modes (HDG-4000 L2 only) by pressing and holding the Format button for about 1 second. When the 50 Hz LED illuminates release the Format button. If you continue to hold the Format button the 50 Hz/60 Hz mode will alternate about once per second.

5 Format Selector

480i, 480p, 720p & 1080i formats

Press and release the Format button to change the video format in the following order - 1080i, 720p, SD i, SD p, 1080p60(50), 1080p24(25), and the 1080p User format (when 60 Hz is selected). The User format can be selected in the OSD Defaults menu to produce 1080p24sf, 1080p30, or 1080p48. All formats can be selected directly using the HDG-4 remote control.

6 Format Indicator LEDs

The SD i LED indicates 480i when the 480i/p LED is illuminated, and 576i when the 576i/p LED is illuminated. Similarly, the SD p LED indicates 480p and 576p.

The 1080p LED and one other LED, which indicates the 1080p frame rate (60/50/24/25/User), will be illuminated at the same time to indicate 1080p formats.

7 Group Selector

The Group button selects the group of calibration signal patterns. Repeatedly pressing the Group key circulates through the pattern groups.

8 Group Indicator LEDs

*8 pattern groups
89 total patterns*

Color 75 - 9 calibration patterns that include color bars and primary, complementary, and gray color windows at 75% signal levels. User color values can be selected from the OSD User Level menu.

Color 100 - 9 calibration patterns that include color bars and primary, complementary, and gray color fields at 100% signal levels. User color values can be selected from the OSD User Level menu.

Special - 12 patterns for calibrating and evaluating horizontal and vertical size, geometry, convergence, contrast, sharpness, and detail enhancement. User checkerboard luma values can be selected from the OSD User Level menu.

PLUGE - 9 patterns for adjusting black-level, contrast, and grayscale

Gray Scale – 3 Groups of 14 patterns for measuring and adjusting linearity, gamma, color temperature, and grayscale tracking. The default group includes 14 patterns with 0%-100% luma values in 10% increments. The Low GS group includes 14 patterns with 0% to 10% luma values in 1% increments, and the High GS group includes 14 patterns with 100% to 109% luma values in 0.9% increments. The Low GS and High GS groups are selected from the HDG-4 remote control. User window luma values can also be selected from the OSD User Level menu.

Gray Field - 8 patterns for measuring and adjusting overscan, full field uniformity, color temperature and grayscale tracking using full field patterns. User field luma values can be selected from the OSD User Level menu.

Gray Scale Window Values (binary code)

Gray Scale Window Values - When the Gray Scale window patterns are changed (from the front panel or the IR remote control) the PLUGE, Color 75, Color 100, and Special LEDs temporarily produce a binary code that represents the luma value of the window. The binary code persists for about 1 second and will then disappear.

Gray Scale Window Values (text display)

The LED binary display is for the benefit of users connected to devices other than displays. The OSD Pattern Information provides a direct text display of the window's luma value.

Window % Luma Value (Low GS) (High GS)	PLUGE LED	Color 75 LED	Color 100 LED	Special LED
10 (1) (100.9)				On
20 (2) (101.8)			On	
30 (3) (102.7)			On	On
40 (4) (103.6)		On		
50 (5) (104.5)		On		On
60 (6) (105.4)		On	On	
70 (7) (106.3)		On	On	On
80 (8) (107.2)	On			
90 (9) (108.1)	On			On
100 (10) (109.0)	On		On	

9 Prior & Next Pattern Selector Buttons

Selects the next or prior pattern in the current pattern group.

On Screen Display (OSD) Systems

Pattern Information

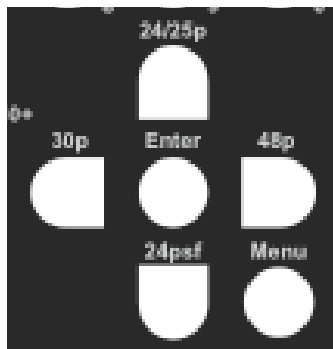
Info – Each time a pattern is changed the name of the pattern, which includes important signal identification information, is displayed on-screen for approximately one second. Press the Info button on the remote control to display the pattern information continuously. Press the Info button again to resume the default display period.

OSD Menu System

The OSD Menu is produced by all analog and digital outputs, for all signal formats. The OSD Menu provides additional features such as user definable luma values and colors, access to advanced signal parameters, communications port control, and the ability to specify generator power-up default modes.

OSD Menu Navigation

Press the Menu button to display the OSD window, which is organized into three columns. The left column of the OSD window currently lists six menus – User Level, Output, Sync, Misc, Com Ports, and Defaults. Use the cursor keys to highlight the desired menu, and then move into the middle column and highlight a menu item. The current status of each highlighted menu item is shown in the right column. To change a setting move into the right column and highlight one of the alternative settings that will then be listed in that column. In most cases it is not necessary to press the Enter key unless “Enter” appears in the right column. In that case highlight “Enter” and press the remote control Enter key to proceed.



Press the Menu button to turn the OSD menu on or off. The highlighted cursor position in the OSD menu is maintained when the menu is turned on or off, so it is easy to turn the menu off when making measurements or adjusting a calibration setting, and then turn it back on again to make additional changes to the same menu item.

OSD Menus

User Level

Field – Set a user defined integer luma value for the User Field in the Gray Field group. Select Factory and press Enter to restore the original 100% User Field. Select “Cancel” and press Enter to leave the menu without making any change.

Window – Set a user defined integer luma value for the User Window in the Gray Scale group. Select Factory and press Enter to restore the original 100% User Window. Select “Cancel” and press Enter to leave the menu without making any change.

Checkerboard – Set a user defined integer luma value for the User Checkerboard and User Inverse Checkerboard in the Special group. Select Factory and press Enter to restore the original 50% User Checkerboards. Select “Cancel” and press Enter to leave the menu without making any change.

Color – Set user-defined integer R, G, B values for the User Window and User Field in the Color 75 and Color 100 groups. The “White” bars in the color bar patterns are also changed to allow comparison with other known colors. Select Factory and press Enter to restore the original 75% gray and 100% white colors. Select “Cancel” to leave the menu without making any change.

The HDG-4 Remote Control manual has more information on entering User values.

Output

CVBS/YC – Select 0 IRE or 7.5 IRE black level setup for NTSC (480i) CVBS or Y/C signals.

Channels – Enable/disable any combination of RGB or YCbCr (YPbPr) output signals.

CVBS C BW – Select the CVBS (composite video) chroma signal bandwidth.

YC C BW – Select the Y/C (S-video) chroma signal bandwidth.

Color Matrix – Select standard YCbCr/YPbPr HD/SD Rec. 709/Rec. 601 color-matrix encoding, or reverse the encoding (HD/SD Rec. 601/Rec. 709).

HD V Rate – Select 59.94 or 60.00 Hz HD signals.

Sync

HD DVI – Select positive or negative HD digital sync.

SD DVI – Select positive or negative SD digital sync.

HD Y Type – Select Tri-level or Bi-level HD analog YPbPr embedded sync.

HD G Type – Select Tri-level or Bi-level HD analog RGB embedded sync (SoG).

HD HV Time – Select Normal or SMPTE analog RGB HV Sync positioning.

Y/G Phase – Select sub-pixel analog YPbPr embedded sync positioning.

Scope Trigger – Select normal analog HV sync or special V sync for an oscilloscope trigger.

Misc

Info – Serial number, levels, and options information.

Com Ports (See HDG-4000 Serial Interface Manual for details)

RS232 Baud – Baud rate selection.

USB Baud – Baud rate selection.

RS232 Flow – Flow control selection.

RS232 Flow – Flow control selection.

Defaults (Power up)

60/50 Hz – Power up in 60 Hz or 50 Hz mode (HDG-4000 L2 only).

RGB Sync – Power up analog RGB signals with SoG, or Positive or Negative HV sync.

CVBS/YC – Power up with 0 IRE or 7.5 IRE setup for NTSC (480i) CVBS and Y/C signals.

RS232 Baud – Power up baud rate.

USB Baud – Power up baud rate.

User Format – Power up with front panel User Format set to select 1080p24sf, 1080p30, or 1080p48.

Save Items – Save all of the above power up defaults.

Selected Remote Control Functions

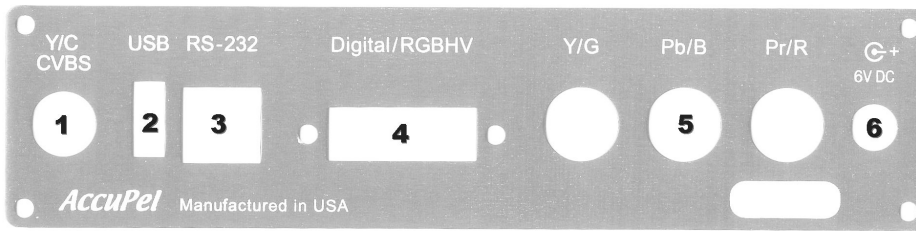
Please read the HDG-4 Remote Control manual for a complete discussion of additional remote control features including how to enter User Luma & Color Levels, and User Pattern Lists.

Edge - Selects Fast or Slow analog video edge transitions. The Slow Edge mode changes the edge transition rate of the HDG-4000 analog signals to a rate chosen specifically for each video format. The Edge mode only affects analog signals. It does not affect the digital video output. The currently selected Output LED will blink slowly when the Slow Edge mode is enabled.

ALT Gray Scale – Press this button combination to select or alternate between 0%-10% Low-GS (Gray Scale) patterns and 100%-109% High-GS patterns. Press the Gray Scale button only to return to the 0%-100% Gray Scale patterns. The Gray Scale LED will blink slowly when the Low-GS or High-GS mode is enabled.

Note: 100%-109% patterns are not available for digital RGB-PC signals because the maximum signal amplitude is 100% (digital 255) for RGB PC signals.

Mute - This button produces a 0% black field. Press any button on the remote control (including Mute) to restore the previous pattern.



Rear Panel I/O

1 Y/C, CVBS Video Output

The 4-pin mini-DIN output connector provides Y/C (S-video) video signals, and CVBS (Composite) video signals (on the Y pin). Use an S-video to RCA adapter or cable to access the CVBS signals.

2 USB Serial Input/Output

USB input/output. Use a Type A to Type A USB cable to connect the HDG-4000 to a computer or controller. Requires an HDG-4000 USB driver that can be downloaded from www.accupel.com. (See the HDG-4000 Serial Interface manual for details.)

3 RS-232 Serial Input/Output

RS-232 input/output. Use a 4-wire telephone extension cable to connect the HDG-4000 to an RJ-12 to DB-9 adapter at a PC or controller. (See the HDG-4000 Serial Interface manual for details.)

4 Digital / RGBHV Video Output

The DVI-I connector provides RGB-Video, RGB-PC, YCbCr 4:4:4, or YCbCr 4:2:2 digital video signals, and RGBHV, RGB SoG, or YPbPr analog video signals. Analog video and sync signals have 75-ohm output impedance and produce specified signal levels into 75-ohm inputs. If you connect YCbCr 4:2:2 or YCbCr 4:4:4 signals to an HDMI input, the receiving device must have the capability to be manually set to receive those input signal types - otherwise the receiving device will automatically be set to accept RGB digital signals.

5 G/Y, B/Pb, R/Pr Video Output

The 75-ohm BNC connectors output YPbPr or RGB (with sync-on-green) video. Use these outputs with 75-ohm cables for the highest quality video. Signals have 75-ohm output impedance and produce specified levels into 75-ohm inputs.

6 +6V DC Regulated Input

Power from the +6V DC Regulated power module. **Use the supplied HDG-4000 power module only.** Do **NOT** any other power module, which invalidates the HDG-4000 warranty.

Sync Modes

Standard Sync Modes

Sync pulses are always embedded in the Y signal for YPbPr analog signals. Sync pulses may also be embedded in the G signal (sync-on-green - SoG) for RGB signals (3-wire interface), but it is more common for RGB signal interfaces to use separate H (horizontal) and V (vertical) sync signals (RGBHV 5-wire interface). The HV sync signals may have either positive or negative pulse polarity. The HDG-4000 provides a choice of SoG or positive or negative HV sync polarity for analog RGB signals.

Standard-definition (480i/p and 576i/p) embedded sync is always Bi-Level (a negative pulse), but high-definition standards specify Tri-Level embedded sync (a negative pulse followed immediately by a positive pulse). The HDG-4000 always initializes with those sync modes. However, some older scalars produce Bi-Level sync when upconverting SD video to HD formats, so Bi-level sync for HD formats can be selected in the OSD Sync menu.

Automatically Stored Sync Modes

Unfortunately the sync modes used for SD and HD video are different. SD YPbPr video always uses Bi-Level sync, while HD YPbPr standards specify Tri-level sync. Another major difference exists between YPbPr and RGB video. While YPbPr always uses embedded sync, RGB video usually uses separate HV sync. These differences would normally make it cumbersome to switch back and forth between SD and HD formats, or YPbPr and RGB output signals while calibrating a projector.

The HDG-4000 addresses this problem in two ways. First, it always powers up set to the most common or standard modes. Secondly, it automatically saves and restores the previous sync modes when switching Format (SD or HD) or Output signal type (YPbPr or RGB). The default modes are shown below, and in most cases will not need to be changed.

Initial Sync Modes vs. Output Type & Format

	SD (480i/p, 576i/p)	HD (1080i/p, 720p)
YPbPr/YPbPrs	Bi-Level HV off	Tri-Level HV off
RGB/RGBs	No embedded sync Neg HV Sync	No embedded sync Neg HV Sync

Test Pattern Notes

Color 75 Group

- **75% Tri-split Color Bars** - Adjust Color Saturation and Hue controls by matching color bars while individually viewing each primary color. (Use display controls to enable single primary colors, or view through color filters.) Similar to SMPTE Color Bars, but offset and split for easier use.
- **75% Color Bars** - Standard Color Bars
- **75% Color Windows (7)** – Primary, complementary, and gray windows provide accurate CIE color measurements by using the same screen area.

Color 100 Group

- **100% Tri-split Color Bars** - Check Color Saturation & Hue at 100% levels.
- **100% Color Bars** - Standard Color Bars at 100% levels.
- **100% Color Fields (7)** - Measure color field uniformity and chroma noise.

User Colors - Replaces 75% and 100% gray colors in both Color 75 and Color 100 group patterns to provide easy comparison with other standard colors.

Special Group

- **Cross-Hatch** - Low APL pattern to measure geometry & convergence.
- **Inverse Cross-Hatch** - High APL pattern for geometry & convergence.
- **Dual Needle Pulse** – Adjust CRT Contrast. Measure short-term CRT high-voltage stability and check for CRT Scan Velocity Modulation.
- **Color Pixel Multiburst** - Adjust chroma-luma delay and signal peaking (Sharpness/Detail Controls). Red/cyan, black/white, and blue/yellow bursts.
1080i/p & 720p - 5,4,3,2,1 pixel bursts - 7.4, 9.3, 12.4, 18.5, 37.1 MHz
480p & 576p – 5,4,3,2,1 pixel bursts - 2.7, 3.4, 4.5, 6.75, 13.5 MHz
480i & 576i –
- **Luma Pixel Multiburst** - Adjust signal peaking (Sharpness/Detail Controls).
1080i/720p - 5,4,3,2,1 pixel bursts - 7.4, 9.3, 12.4, 18.5, 37.1 MHz
480p & 576p – 5,4,3,2,1 pixel bursts - 2.7, 3.4, 4.5, 6.75, 13.5 MHz
480i & 576i –
- **Polyphase Chroma Sweep** – Measure Y/C and CVBS Pb & Pr chroma bandwidth with 1.0, 1.5, 2.0, 2.5, and 3.0 MHz frequency markers.
- **CrossHair** – Check centering and edge artifacts on lines.
- **Sharpness** - 1,2,3,4,5 pixel-width black vertical lines, 1,2,3,4,5 pixel-height (480p/576p/720p/1080p) or 2,4,6,8,10 (480i/576i/1080i) pixel-height black horizontal lines. Adjust Sharpness, Detail Enhancement. 50% background.
- **4x4 100% Checkerboard/Inverse & 4x4 User Level Checkerboard/Inverse (4)** - Measure ANSI & m-ANSI contrast ratio at multiple luma levels.

PLUGE Group

- **0% APL PLUGE** - Calibrate black level and measure black level stability at 0% Average Picture Level. +/- 4% stripes, 0% background.
- **25% APL PLUGE** - Calibrate black level and measure black level stability at 25% Average Picture Level. +/- 4% stripes, 0%/50% split background.
- **50% APL PLUGE with 98%/102% PLUGE** - Calibrate black level and Contrast (for LCoS/LCD/DLP displays), and measure black level stability at 50% APL. +/- 4% & 98%/102% stripes, 0%/100% split background.
- **25%, 50%, 75%, 100% Windows w/PLUGE (4)** - Calibrate color temperature & grayscale tracking. +/- 4% PLUGE pattern to ensure black level doesn't shift while adjusting grayscale tracking.
- **100% Window with 98%/100% PLUGE** - Calibrate color temperature & grayscale tracking. +/- 4% PLUGE pattern to ensure black level doesn't shift, and 98%/100% vertical bars to ensure peak-white level doesn't clip while adjusting grayscale tracking on LCoS/LCD/DLP displays.
- **50/100 IRE Window with PLUGE** - Check 100% window size for CRT blooming while adjusting Contrast. +/- 4% PLUGE to maintain black-level setting.

Gray Scale Groups - Low GS, High GS values in ()

- **10-Step Vertical Gray Scale Linearity** - Check grayscale tracking and color temperature. 0%-100% (0%-10%) (100%-109%) in 10% (1%) (0.9%) steps.
- **10-Step Split Vertical Gray Scale Linearity** - Check grayscale tracking and color temperature. 0%-100% (0%-10%) (100%-109%) in 10% (1%) (0.9%) steps
- **10-Step Horizontal Gray Scale Linearity** - Check grayscale tracking and color temperature. 0%-100% (0%-10%) (100%-109%) in 10% (1%) (0.9%) steps
- **User, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, (User, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10), (User, 100.9, 101.8, 102.7, 103.6, 104.5, 105.4, 106.3, 107.2, 108.1, 109.0) % Windows w/PLUGE** - Calibrate color temperature, grayscale, and gamma. PLUGE ensures black level doesn't shift while adjusting grayscale tracking. The background of the High-GS windows is 100% luma to examine a display's ability to differentiate levels near 100%.

Gray Field Group

- **Low APL Overscan** - Measure/adjust overscan and corner/edge geometry, convergence, and focus. 0% luma background. 0%-7% horizontal and vertical overscan lines in 1% overscan intervals.
- **High APL Overscan** - Measure/adjust overscan and corner/edge geometry, convergence, and focus. 100% luma background. 0%-7% horizontal and vertical overscan lines in 1% overscan intervals.
- **User Luma Level Field** – Enter luma value in OSD User Level menu.
- **0%, 25%, 50%, 75%, 100% Gray Fields (5)** - Measure full-field (on-off, 0%/100%) contrast ratio. Measure flat field uniformity, brightness, and grayscale tracking with full-field output levels.

Characteristics

Picture Formats (59.94 & 60.00 Hz based)

1080p59.94/60 (per EIA/CEA 770.3, SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2200 x 1125 Pixels - Progressive Total Frame 148.35164 (148.5/1.001) / 148.50000 MHz Pixel Clock Rate 59.94 Hz / 60.00 Hz Frame Rate
1080p47.95/48 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2750 x 1125 Pixels - Progressive Total Frame 148.35164 (148.5/1.001) / 148.50000 MHz Pixel Clock Rate 47.95 Hz / 48.00 Hz Frame Rate
1080p29.97/30 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2200 x 1125 Pixels - Progressive Total Frame 74.17582 (74.25/1.001) / 74.25000 MHz Pixel Clock Rate 29.97 Hz / 30.00 Hz Frame Rate
1080p23.976/24 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2750 x 1125 Pixels - Progressive Total Frame 74.17582 (74.25/1.001) / 74.25000 MHz Pixel Clock Rate 23.97 Hz / 24.00 Hz Frame Rate
1080p23.976/24sf (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels – Segmented Frame Active Picture Area 2750 x 1125 Pixels – Segmented Total Frame 74.17582 (74.25/1.001) / 74.25000 MHz Pixel Clock Rate 23.97 Hz / 24.00 Hz Frame Rate
1080i59.94/60 (per EIA/CEA 770.3, SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Interlaced Active Picture Area 2200 x 1125 Pixels - Interlaced Total Frame 74.17582 (74.25/1.001) / 74.25000 MHz Pixel Clock Rate 59.94 Hz / 60.00 Hz Frame Rate
720p59.94/60 (per EIA/CEA 770.3, SMPTE 296M EIA/CEA 861-B)	1280 x 720 Pixels Progressive Active Picture Area 1650 x 750 Pixels - Progressive Total Frame 74.17582 (74.25/1.001) / 74.25000 MHz Pixel Clock Rate 59.94 Hz / 60.00 Hz Frame Rate
480p (per EIA/CEA 770.2 EIA/CEA 861-B)	720 x 480 Pixels - Progressive Active Picture Area 858 x 525 Pixels - Progressive Total Frame 27 MHz Pixel Clock Rate 59.94 Hz (60/1.001) Frame Rate
480i Analog (per ITU Rec. 601, SMPTE/EBU N10)	720 x 480 Pixels Interlaced Active Picture Area 858 x 525 Pixels - Interlaced Total Frame 13.5 MHz Pixel Clock Rate 59.94 Hz (60/1.001) Field Rate, 29.97 Hz (30/1.001) Frame Rate
480i Digital (per EIA/CEA 861-B)	1440 x 480 Pixels Interlaced Active Picture Area 1716 x 525 Pixels - Interlaced Total Frame 27 MHz Pixel Clock Rate 59.94 Hz (60/1.001) Field Rate, 29.97 Hz (30/1.001) Frame Rate

Characteristics (cont)

Picture Formats (50.00 Hz based)

1080p50 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2640 x 1125 Pixels - Progressive Total Frame 148.50000 MHz Pixel Clock Rate 50.00 Hz Frame Rate
1080p25 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Progressive Active Picture Area 2640 x 1125 Pixels - Progressive Total Frame 74.25000 MHz Pixel Clock Rate 25.00 Hz Frame Rate
1080i50 (per SMPTE 274M EIA/CEA 861-B)	1920 x 1080 Pixels - Interlaced Active Picture Area 2640 x 1125 Pixels - Interlaced Total Frame 74.25000 MHz Pixel Clock Rate 50.00 Hz Frame Rate
720p50 (per EIA/CEA 770.3, SMPTE 296M EIA/CEA 861-B)	1280 x 720 Pixels Progressive Active Picture Area 1980 x 750 Pixels - Progressive Total Frame 74.25000 MHz Pixel Clock Rate 50.00 Hz Frame Rate
576p (per EIA/CEA 770.2 EIA/CEA 861-B)	720 x 576 Pixels - Progressive Active Picture Area 864 x 625 Pixels - Progressive Total Frame 27 MHz Pixel Clock Rate 50.00 Hz Frame Rate
576i Analog (per ITU Rec. 601, SMPTE/EBU N10)	720 x 576 Pixels Interlaced Active Picture Area 864 x 625 Pixels - Interlaced Total Frame 13.5 MHz Pixel Clock Rate 50.00 Hz Field Rate, 25.00 Hz Frame Rate
576i Digital (per EIA/CEA 861-B)	1440 x 576 Pixels Interlaced Active Picture Area 1728 x 625 Pixels - Interlaced Total Frame 27 MHz Pixel Clock Rate 50.00 Hz Field Rate, 25.00 Hz Frame Rate

Digital Output Formats

RGB-Video	Digital RGB 16-235 (for 0-100%, 109% maximum)
RGB-PC	Digital RGB 0-255 (for 0-100%, 109% maximum)
YCbCr 4:4:4, YCbCr 4:2:2	Digital Y 16-235 (for 0-100%, 109% maximum) Digital Cb/Cr 16-240

Characteristics (cont)

Analog Output Formats (All signals into 75 ohm loads, all signals include 75 ohm reverse termination)

EIA/CEA 770.2/770.3, SMPTE 274M/296M, SMPTE/EBU N10

YPbPr	Y - 700 mV Pb/Pr - ± 350 mV
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RGB	700 mV
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MII, Upconverters (with Setup)

YPbPrs	Y - 700 mV peak includes 7.5 IRE Setup Pb/Pr - ± 324 mV
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RGBs	700 mV peak includes 7.5 IRE Setup
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Y/C, CVBS

Y, CVBS (480i) w/setup	714.3 mV peak includes 7.5 IRE Setup
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Y, CVBS (480i) no setup	714.3 mV peak
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Y, CVBS (576i)	700 mV peak
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YPbPr, RGB Sync Formats (All signals into 75 ohm loads, all signals include 75 ohm reverse termination)

YPbPr, YPbPrs	Bi-Level or Tri-Level Sync
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RGB, RGBs	Bi-Level, Tri-Level, or separate HV-, HV+
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Tri-Level Sync	EIA/CEA 770.3 ± 300 mV on Y & G signals only
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Bi-Level Sync	-300 mV on Y or G signals only
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HV+ Sync	0 to +2.5V
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HV- Sync	+2.5 to 0V
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Y/C, CVBS Sync Formats (All signals into 75 ohm loads, all signals include 75 ohm reverse termination)

Bi-Level Sync	-286 mV on Y or CVBS signal for 480i -300 mV on Y or CVBS signal for 576i
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Characteristics (cont)

Calibration Patterns (89 Patterns)

Color 75 (9)	75% Color Bars & 75% Tri-Split Bars, User Color Window 75% Red/Green/Blue/Cyan/Magenta/Yellow/Gray Window
Color 100 (9)	100% Color Bars & 100% Tri-Split Bars, User Color Field 100% Red/Green/Blue/Cyan/Magenta/Yellow/Gray Fields
Special (12)	16:9 Crosshatch, 16:9 Inverse Crosshatch, Dual Needle Pulse, Color Multi-burst, Chroma Color Bandwidth, Luma Multi-burst, CrossHair, Sharpness, Checkerboard, Inverse Checkerboard, User Checkerboard, User Inverse Checkerboard
PLUGE (9)	±4% PLUGE with 0%, 25%, 50% Average Picture Level 25%, 50%, 75%, 100% Gray Windows with ±4% PLUGE, 100% Gray Window with ±4 IRE, 98%/100% PLUGE 50%/100% Split Gray Window with ±4%, 98%/100% PLUGE
Gray Scale (14) Low Gray Scale (14) High Gray Scale (14)	0-100 (0-10) (0-109)* % 10-step Vertical Linearity 0-100 (0-10) (0-109)* % 10-step Split Vertical Linearity 0-100 (0-10) (0-109)* % 10-step Horizontal Linearity User, 10,20,30,40,50,60,70,80,90,100 % Windows with ±4% PLUGE (User, 1,2,3,4,5,6,7,8,9,10 % Windows with ±4% PLUGE) (User, 100.9,101.8,102.7,103.6,104.5,105.4,106.3,107.2,108.1,109.0 % Windows with ±4% PLUGE) * * High GS mode not possible for RGB-PC signals
Gray Field (8)	H/V % Overscan, Inverse H/V % Overscan, User Level Field, 0%, 25%, 50%, 75%, 100% Gray Fields

Video Output Connectors (All analog & digital video outputs simultaneously active)

Analog YPbPr, GBR	Three 75-ohm BNCs - G/Y, B/Pb, R/Pr
Analog Y/C, CVBS	4-pin mini-DIN connector
Analog RGBHV	DVI-I connector - R/Pr, G/Y, B/Pb, H sync, V sync
Digital YCbCr, RGB	DVI-I connector - R/Cr, G/Y, B/Cb, Pixel Clock

Control Interfaces

USB	USB Type A connector, full serial interface control of all functions
RS-232C	RJ-12 connector, full serial interface control of all functions
IR Sensor	Front panel infrared receiver provides full control of all functions (HDG-4 IR remote control included)

Other

Power	100-240 VAC, 50/60 Hz (+/- 3 Hz), less than 6 watts
Size	6.5" (W) x 1.75" (H) x 4.5" (D)
Weight	Approximately 2 lbs, shipping weight approximately 4 lbs.

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