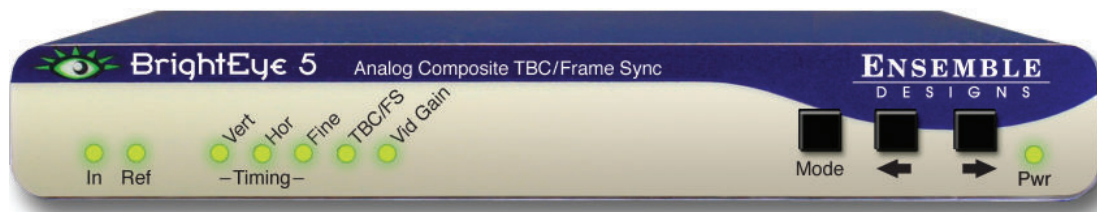


# BrightEye™

## BrightEye™ 5

### Analog Composite TBC and Frame Sync User Guide



Revision 5.1 SW v1.2.2

# ENSEMBLE

---

D E S I G N S

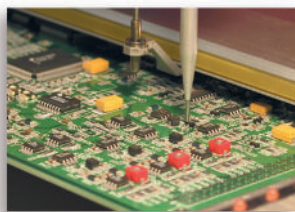
*Purveyors of Fine Video Gear—Loved by Engineers Worldwide*

*“Regardless of how quickly we need to take Mitto to air, it works famously every time. And it looks spectacular. When we covered the blizzards last winter, all of our user-generated content submissions and Skype came through Mitto.”*

*~ John Schilberg, VP of Technology, Griffin Communications, KWTW, KOTV and KQCW*



BrightEye — palm sized video and audio conversion, HD up/down/cross conversion, scan conversion and test signal generators with 3G, HD, SD, ASI, HDMI video, audio and optical choices.



Everything is made at our factory in Nevada City, California.



Shipped with care to television broadcasters and video facilities all over the world.



And consider our Avenue product line when you need a modular system.



Come on by and visit us.  
Drop in for lunch and a tour!

## Who is Ensemble Designs?

### By Engineers, For Engineers

In 1989, a former television station engineer who loved designing and building video equipment, decided to start a new company. He relished the idea of taking an existing group of equipment and adding a few special pieces in order to create an even more elegant ensemble. So, he designed and built his first product and the company was born.

### Focused On What You Need

As the company has grown, more former TV station engineers have joined Ensemble Designs and this wealth of practical experience fuels the company's innovation. Everyone at the company is focused on providing the very equipment you need to complete your ensemble of video and audio gear. We offer those special pieces that tie everything together so that when combined, the whole ensemble is exactly what you need.

### Notably Great Service for You

We listen to you – just tell us what you need and we'll do our best to build it. We are completely focused on you and the equipment you need. Being privately held means we don't have to worry about a big board of directors or anything else that might take attention away from real business. And, you can be sure that when you call a real person will answer the phone. We love this business and we're here to stay.

### Bricks and Mortar of Your Facility

The bricks and mortar of a facility include pieces like up/downconverters, audio embedders, video converters, protection switches, routers and SPGs for SD, HD and 3Gb/s . That's what we're focused on, that's all we do – we make proven and reliable signal processing and infrastructure gear for video facilities worldwide, for you.



# Contents

<b>Product Overview</b>	<b>4</b>
Capabilities Overview for BrightEye 5	4
Free Software Upgrades Forever	4
<b>Functional Description and Block Diagram</b>	<b>5</b>
<b>Applications</b>	<b>6</b>
Time Base Correction of Noisy Microwave Signal	6
<b>Rear Connectors</b>	<b>7</b>
Power Connection	7
USB Connector	7
Input and Output BNCs	8
<b>Operation</b>	<b>9</b>
Front Panel Controls and Indicators	9
<i>Status Indicators</i>	9
<i>Adjusting Parameters from the Front Panel</i>	10
Using the BrightEye Control Application	12
<i>Input Menu</i>	12
<i>Proc Menu</i>	13
<i>Timing Menu</i>	14
<i>Output Menu</i>	15
<i>Config Menu</i>	16
<b>Software Updating</b>	<b>17</b>
<b>Warranty and Factory Service</b>	<b>17</b>
Warranty	17
Factory Service	17
<b>Specifications for BrightEye 5</b>	<b>18</b>
<b>Glossary</b>	<b>19</b>

## Product Overview

BrightEye 5 is a Time Base Corrector with analog composite inputs and outputs. 12 bit digital signal processing ensures the best signal handling and a solid output. BrightEye 5 will time base correct signals from analog sources such as consumer VCRs, cameras and noisy microwave receivers.

The analog input is converted at 12 bits of resolution for digital processing. The signal is time base corrected and frame synchronized to the reference input and converted back to analog for output. BrightEye 5 auto detects the video standard of the input (NTSC or PAL), or can be set manually to either NTSC or PAL if preferred.

Basic controls are provided on the front panel. With BrightEye Mac or PC software, you can control video proc functions: Gain, Chroma, Pedestal, and Hue. The vertical interval can be passed or blanked.

A glossary of commonly used video terms is provided at the end of this user guide.

## Capabilities Overview for BrightEye 5

- Use with VCRs, Cameras, Satellite Receivers
- Analog Video Inputs and Outputs
- TBC and Frame Sync
- 12 Bit Processing
- Intuitive Front Panel Controls
- Easy-to-use Mac and PC User Interface
- Genlockable and Fully Timeable
- Rackmountable
- 5-Year Warranty and Free Software Upgrades

## Free Software Upgrades Forever

BrightEye Mac/PC software is included with each unit at no charge and offers complete control of BrightEye 5. Use BrightEye Mac/PC software to control a single BrightEye unit or any number of units connected to a USB hub. BrightEye Mac/PC software is not required as the BrightEye 5 front panel controls are intuitive and provide extensive control. You can choose what type of control is best for your facility.

BrightEye software is easily upgraded through the unit's USB port. Software upgrades are available at no charge for the life of the product and are conveniently downloadable at the following link:

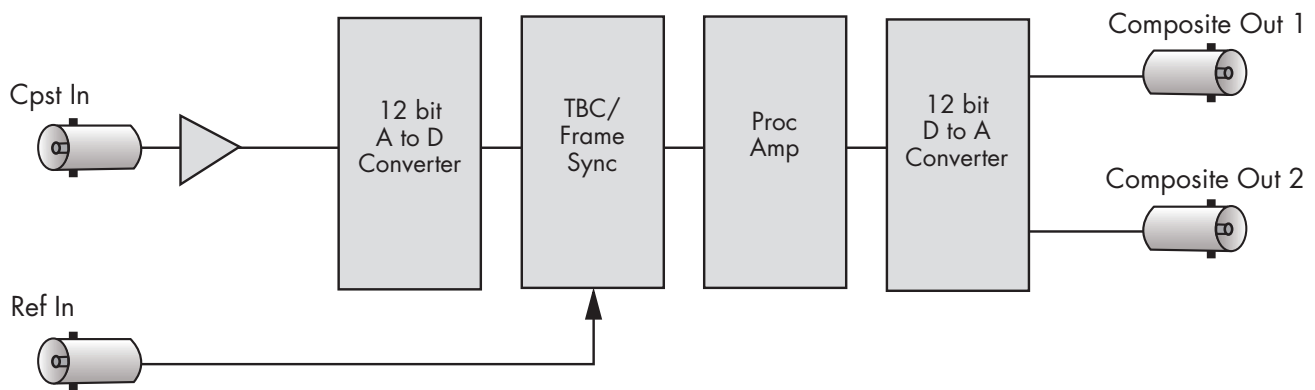
[www.ensembledesigns.com/support/brighteye-support/brighteye-software](http://www.ensembledesigns.com/support/brighteye-support/brighteye-software)

## Functional Description and Block Diagram

As shown in the functional block diagram below, analog video is fed to the unit on a single BNC connector. This analog input is converted at 12 bits of resolution for digital processing. The signal is time base corrected and frame synchronized to the external reference input and converted back to analog for output. The video standard of the input signal is automatically detected. For applications with intermittent or low quality input signals, the video standard can be set manually to either NTSC or PAL. This will improve performance when the input signal is compromised.

BrightEye 5 is powered by a 12 volt DC universal power supply. This power supply can accept an input voltage between 90 and 230 volts, at 50 or 60 Hertz.

BrightEye 5 uses a standard IEC line cord and can be used anywhere in the world. It is normal for the converter to be quite warm to the touch when operating.



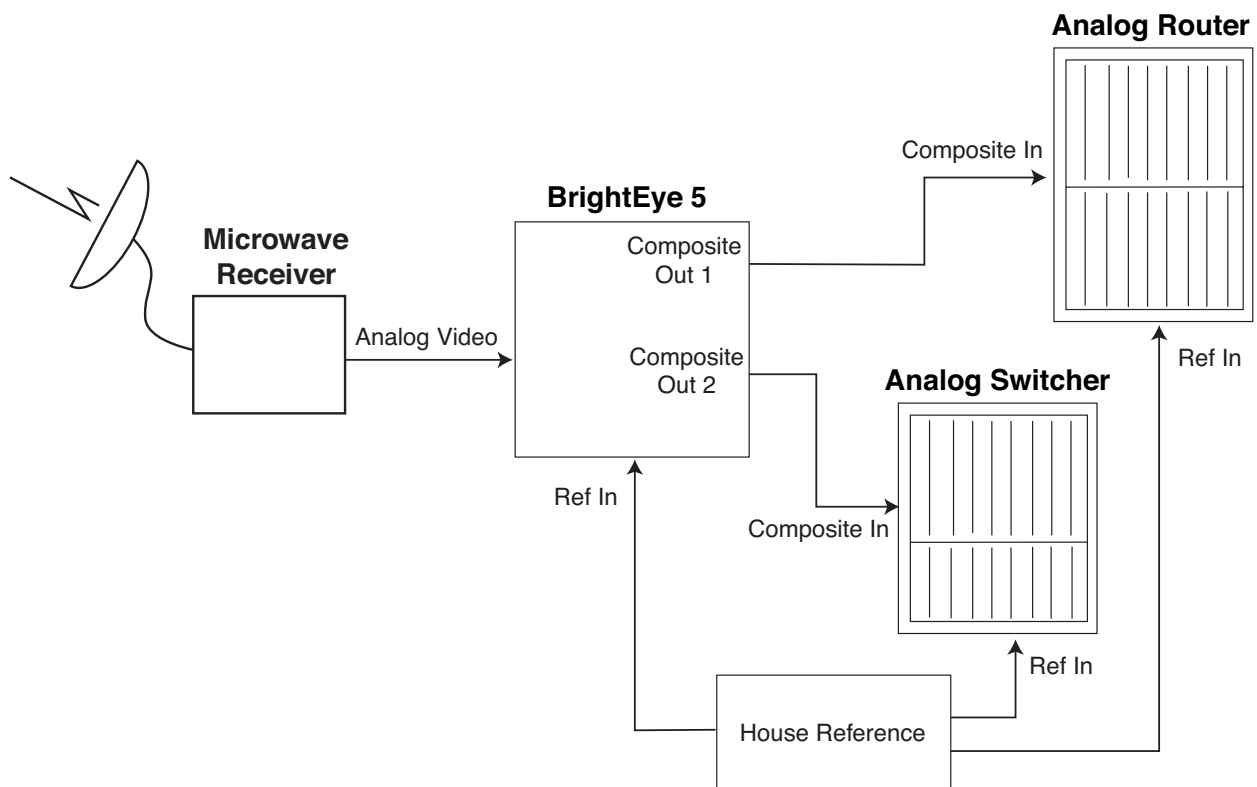
*BrightEye 5 Functional Block Diagram*

## Applications

### Time Base Correction of Noisy Microwave Signal

One useful application for the BrightEye 5 is time base correction of an excessively noisy analog video signal from a microwave receiver. This application utilizes the full functionality of BrightEye 5 by time base correcting a noisy analog video microwave input signal and frame synchronizing it to a house reference which is also feeding analog video devices.

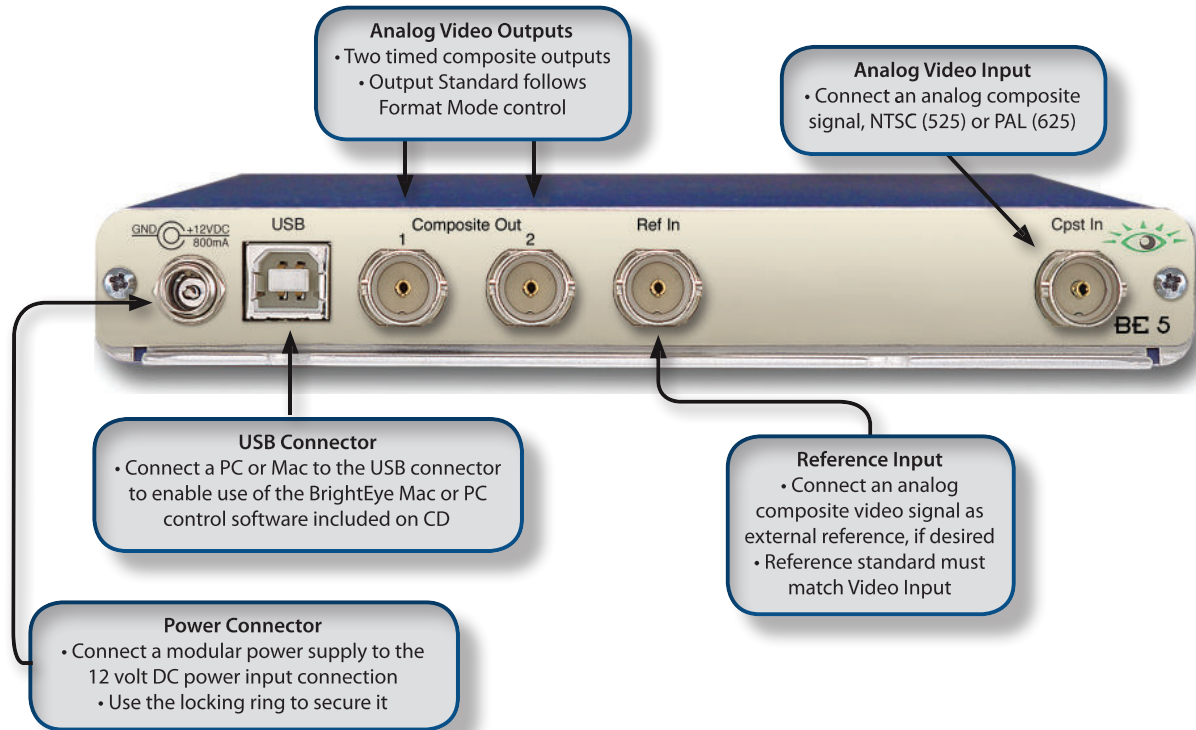
Refer to the application drawing below for an example of using BrightEye 5 for this purpose.



*BrightEye 5 Time Base Correction of Microwave Signal Input*

## Rear Connectors

All connections to the BrightEye 5 are made on the rear of the unit. Refer to the illustration below for a snapshot reference of the rear connectors. A more detailed explanation of the rear connectors follows.



## Power Connection

Connect the modular power supply (ED part number 23118900) to the 12-volt DC power input connection on the far left of the unit. Use the locking ring to secure it.

## USB Connector

Your BrightEye 5 comes with a USB cable, shown to right. Connect the USB port to a PC or Mac running BrightEye software for more comprehensive control, diagnostics, and upgrades to the unit. BrightEye PC/Mac control application software is included on CD that came with your BrightEye 5, or the application can be downloaded for free at the following link:

[www.ensembledesigns.com/support/brighteye-support](http://www.ensembledesigns.com/support/brighteye-support)



*USB cable that is included with your BrightEye*

## Input and Output BNCs

There are four rear BNC connectors which are used as inputs and outputs as follows:

- **Cpst In (Composite Input)** – This BNC input accepts an analog composite signal, 525 or 625 line standard. The input standard is auto-detected.

**Note:** For applications with intermittent or low quality input signals, the video standard can be set manually to either NTSC or PAL in the **Input** menu. This will improve performance when the input signal is compromised.

- **Ref In (Reference Input)** – For synchronizing (genlocking) the input signal to an external reference, connect a composite video signal (PAL or NTSC with the same line rate as the input video) to the **Ref In** BNC.
- **Composite Out 1 and 2** – Two timed composite outputs are provided for feeding analog destinations. The output standard follows the input standard and must be the same standard as the reference, if one is used.



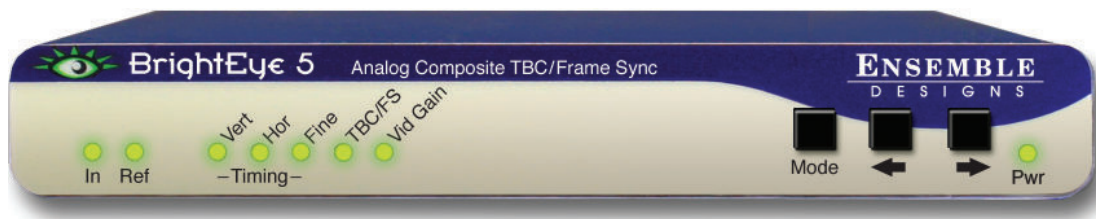
## Operation

Control and operation of the BrightEye 5 is performed from the front panel or remotely from a networked PC with the BrightEye Mac/PC Control application software.

**Note:** Some control settings are only available with BrightEye PC or Mac. These parameters cannot be monitored or controlled from the front panel.

### Front Panel Controls and Indicators

The front panel of the converter, shown in the figure below, provides status and control indicators for adjusting parameters from the front panel.



*BrightEye 5 Front Panel*

#### Status Indicators

- **In (Input)** – Illuminates green when a valid input is detected on the **Cpst In** BNC connector.
- **Ref (Reference)** – Illuminates green when a valid NTSC or PAL reference is detected on the **Ref In** BNC connector.  
  
**Note:** A reference is not required for operation.
- **Pwr (Power)** – The power indicator illuminates green when the BrightEye unit has power and the internal voltage regulator is functioning correctly.

## Adjusting Parameters from the Front Panel

Use the **Mode**, **Right Arrow**, and **Left Arrow** buttons to select and adjust parameters from the front panel.

Pressing the **Mode** button activates the front panel for editing and tabs between each section of editable parameters.

Pressing the **Right Arrow** or **Left Arrow** advances the selection within a given section of parameters, or increases (Right Arrow) or decreases (Left Arrow) the value of a selected parameter.

**Note:** The LED of an edited parameter will blink for 15 seconds, after which time its value is stored in memory. If power is interrupted before this 15 second timeout period has elapsed, the edited state will not be saved.

The controls and their indicators are described below: .

- **Timing** – The timing function operates in one of three modes:
  1. When the **TBC/Frame Sync** control is turned **On** and a proper reference signal is connected to the **Ref In** BNC, the video output of the unit will be synchronous and locked to the external reference. The output may be timed with respect to the **Ref In** using the timing controls. In this case, the unit will accept asynchronous video and time base errors will be corrected.
  2. When the **TBC/Frame Sync** control is turned **On** and no reference signal is connected, the unit will act as a time base corrector only. The output will not be synchronous to any reference, including the input. This mode allows a noisy analog input signal to be time base corrected for a clean stable output.
  3. When the **TBC/Frame Sync** control is turned **Off**, any reference signal to the **Ref In** BNC is ignored. The video input is synchronous to the video output when a nearly perfect, clean video input signal is present (SDI or analog video with no time base correction required).

The output timing of the module can be adjusted with the following controls when the **TBC/Frame Sync** is turned **On**:

**Vert** – Adjust the vertical timing in lines with reference to the Ref In.

**Hor** – Adjust the horizontal timing in clocks with reference to the Ref In.

**Fine** – Adjust the timing in subpixels with reference to the Ref In.

- **TBC/Frame Sync** – This control enables the Frame Sync genlock function and the timing controls when an external reference is present on the **Ref In** BNC.

- **Vid Gain** – This control adjusts the gain of the analog video signals in the Digital-to-Analog converter and encoder circuitry of the converter. The right arrow will increase the gain, the left arrow will decrease it. The **Vid Gain** indicator will illuminate green when the gain is set to its nominal or unity setting.

This is the setting which will produce correct analog output levels from a digital input source which itself is at proper level. The **Vid Gain** indicator will illuminate red whenever the control is adjusted either higher or lower than the nominal setting. The gain can be reset to nominal (green) by pressing both arrows simultaneously.

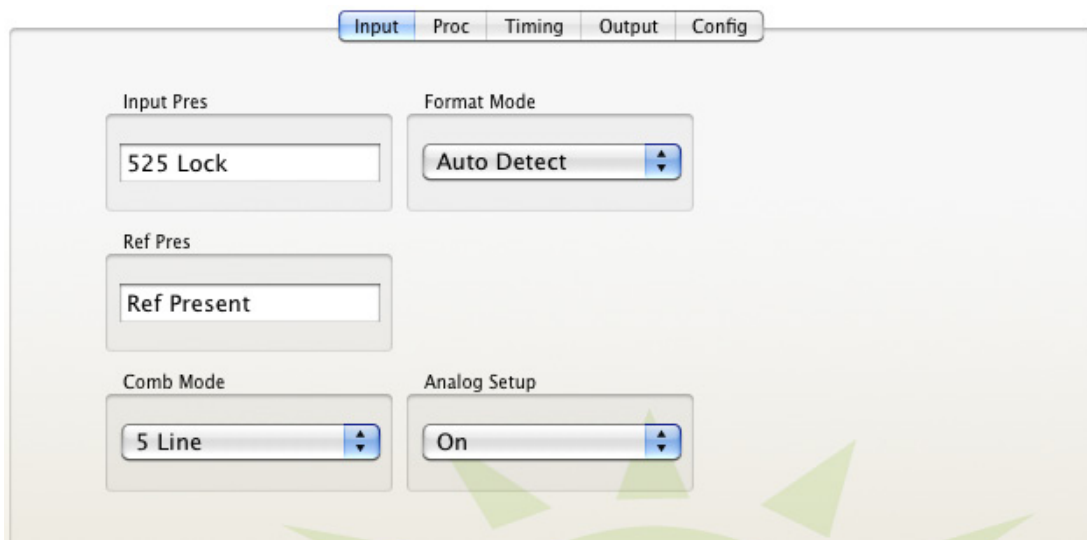
## Using the BrightEye Control Application

BrightEye Mac and PC Control application software is included on a CD with each unit and offers complete control of your BrightEye 5. BrightEye Mac/PC software is designed to allow you to configure and control the BrightEye 5 from a personal computer. Installation and instructions for using this software application are given in the PDF manual on the CD.

If the BrightEye 5 is connected to a computer running BrightEye Mac/PC software, the following menus are available for controlling and monitoring the unit.

### Input Menu

- **Input Pres** – Gives read-only status indication of input video presence (**None, 525 Lock, or 625 Lock**).
- **Format Mode** – Your BrightEye 5 is set at the factory to auto-detect the input standard. For applications with intermittent or low quality input signals, use this control to set the video format standard manually to either NTSC or PAL. This will improve performance when the input signal is compromised.  
  
Select between: **Auto Detect, NTSC Only, or PAL Only.**
- **Ref Pres** – Gives read-only status indication of reference video presence (**No Ref or Ref Present**).
- **Comb Mode** – Set the type of comb filtering from **3 Line** or **5 Line**.
- **Analog Setup** – Use this control to turn Analog Setup **On** or **Off**. Set to **On** if the input signals being used with the BrightEye 5 have Setup present. The On setting will cause Setup to be removed from the input signal in order for the digital processing to have the appropriate black reference level. Further, Setup will be added back into the output when the control is On. Setup is optionally used in NTSC systems, and is never used in PAL. See the Glossary for a discussion of Setup.



*BrightEye 5 Input Menu*

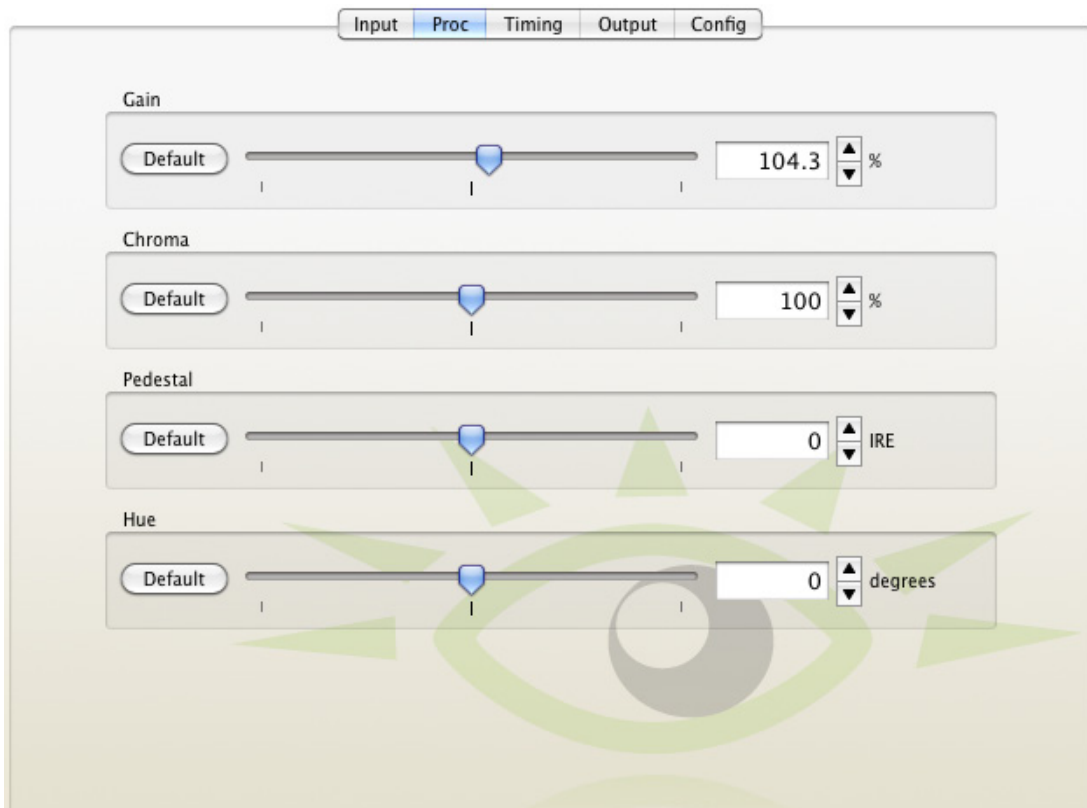
## Proc Menu

The **Proc Amp** menu offers a **Gain** control, which affects the overall video level. The **Proc Menu** also includes controls for the **Chroma** amplitude, the **Pedestal** or black level, and **Hue**. This is an NTSC-style Hue rotation. It can be used to make small adjustments in colorimetry.

The nominal settings for these controls would be 100% of overall Gain and Chroma, zero adjustment to Pedestal and zero degrees of Hue rotation.

You can change these values by clicking and dragging on the slider control, by using the up and down arrow buttons, or by entering values directly into the fields.

- **Gain** – Adjusts the percentage of gain. Range is 50 to 150%, default is 100%.
- **Chroma** – Adjusts the percentage of chroma. Range is 50 to 150%, default is 100%.
- **Pedestal** – Adjusts the pedestal in IRE. Range is -5 to 5 IRE, default is 0 IRE.
- **Hue** – Adjusts the hue of the signal in degrees. Range is -180° to 180°, default is 0°.

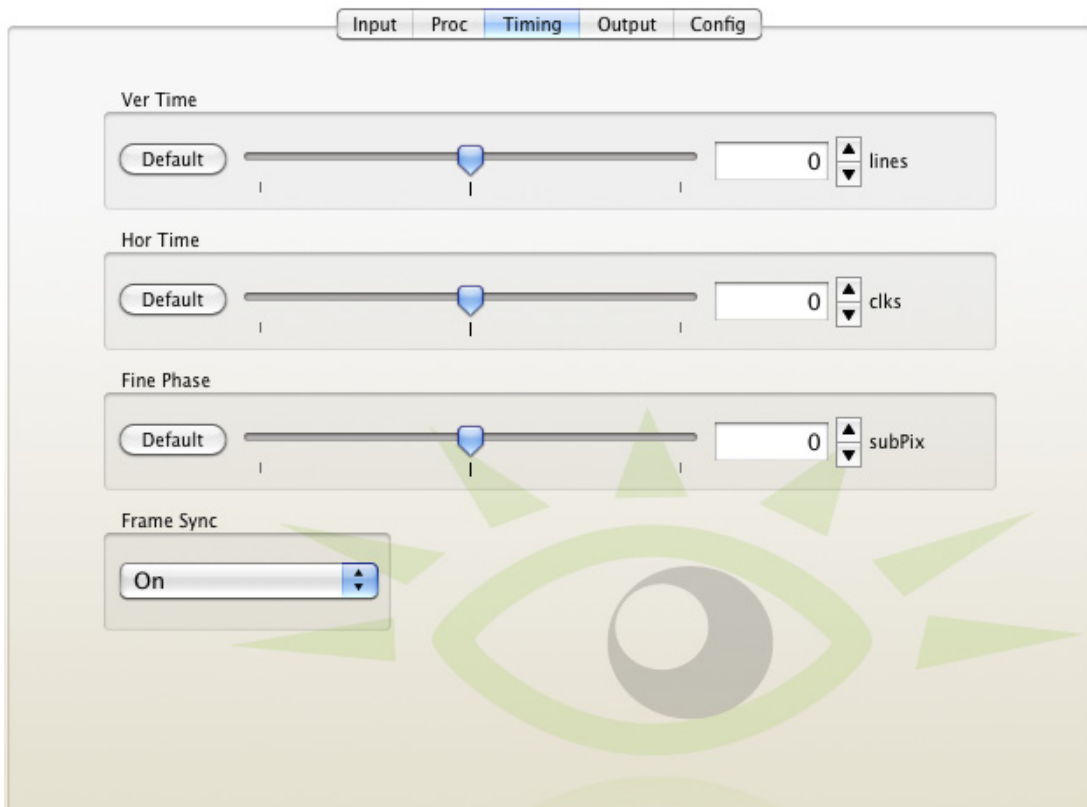


*BrightEye 5 Proc Menu*

## Timing Menu

The **Timing** menu is used to time the input signal to an external reference.

- **Ver Time** – Adjust the vertical timing of the signal in lines with reference to the Frame Sync input. Default is 0 lines.
- **Hor Time** – Adjust the horizontal timing of the signal in clocks with reference to the Frame Sync input. Range is -1700 - 1700 clocks, default is 0 clocks.
- **Fine Phase** – Adjust the fine phase of the signal in subpixels with reference to the Frame Sync input. Range is -100 - 100 subpixels, default is 0 subpixels.
- **Frame Sync** – Set the Frame Sync function **On** to genlock to the external reference input to the module or **Off** for no Frame Sync.

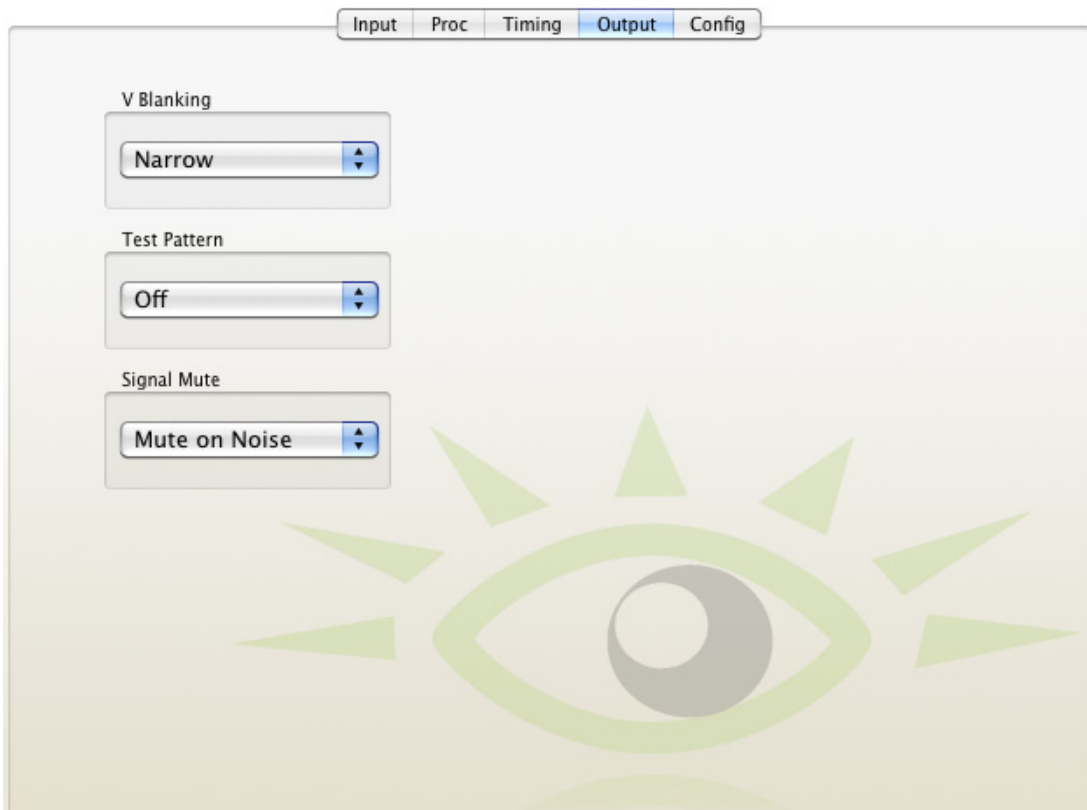


*BrightEye 5 Timing Menu*

## Output Menu

Use the **Output** menu to set the following output conditions for the BrightEye 5:

- **V Blanking** – Set the vertical blanking to **Narrow** (NTSC: lines 1-9, PAL: lines 1-6) or **Wide** (NTSC: lines 1-20, PAL: lines 1-22).
- **Test Pattern** – Select a test pattern at the module output from **Black** or **Color Bars** or turn to **Off** for normal operation.
- **Signal Mute** – The signal muting control affects the behavior of the module when the video input is lost or interrupted. Set the control for one of the following conditions:
  - No Muting** – Nothing is done when the input is lost or intermittent. In this case, the module may present a very disturbed output in response to an intermittent input.
  - Mute on Noise** – The output will go black if the input is lost.
  - Freeze on Noise** – The output will freeze on the last image when the input is lost.

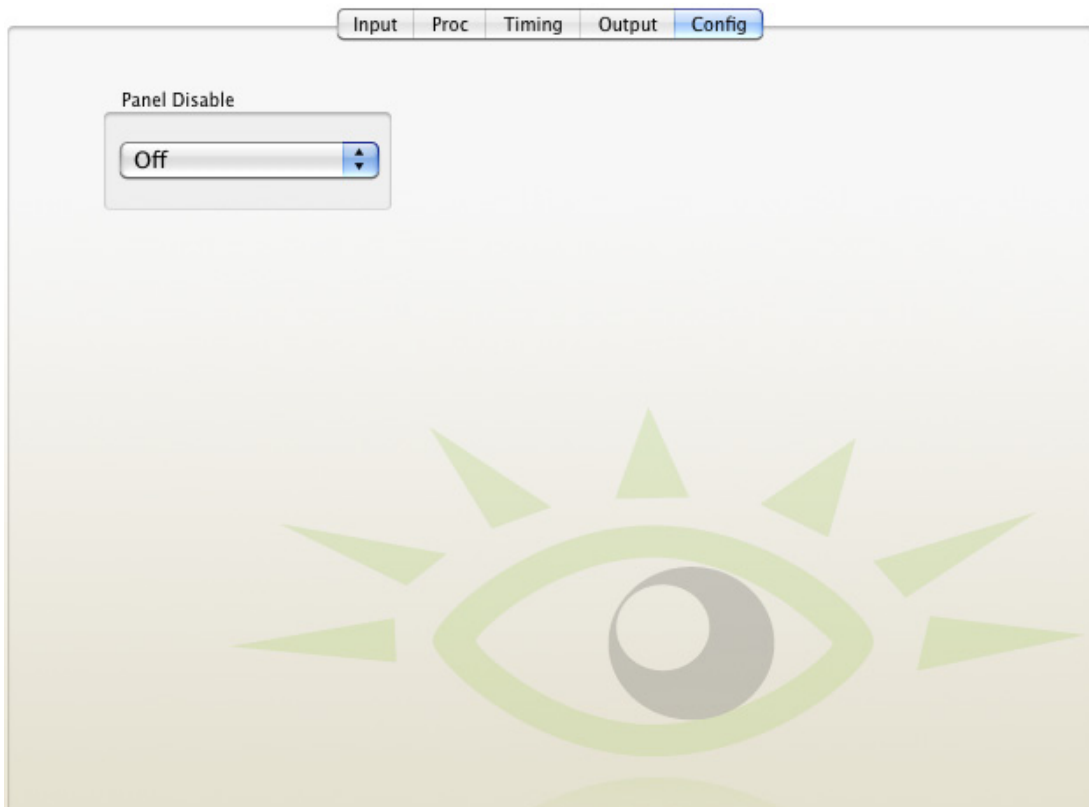


*BrightEye 5 Output Menu*

## Config Menu

Use the **Config** menu to enable or disable the front panel controls.

- **Panel Disable** – Set the Panel Disable to **On** if you want to disable the front panel controls. Set to **Off** to enable standard control from the front panel.



*BrightEye 5 Config Menu*



## Software Updating

Software upgrades for BrightEyes are available free at the following link:

[www.ensembledesigns.com/support/brighteye-support/](http://www.ensembledesigns.com/support/brighteye-support/)

Use BrightEye Mac or PC software to install the software update into your BrightEye.

## Warranty and Factory Service

### Warranty

This module is covered by a five-year limited warranty. If you require service (under warranty or not), please contact Ensemble Designs and ask for customer service before you return the unit. This will allow the service technician an opportunity to provide any other suggestions for identifying the problem and to recommend possible solutions.

### Factory Service

If you return equipment for repair, please get a Return Material Authorization Number (RMA) from the factory first.

tel +1 530.478.1830

fax +1 530.478.1832

[service@ensembledesigns.com](mailto:service@ensembledesigns.com)

[www.ensembledesigns.com](http://www.ensembledesigns.com)

Ship the product and a written description of the problem to:

Ensemble Designs, Inc.  
Attention: Customer Service RMA #####  
870 Gold Flat Rd.  
Nevada City, CA 95959 USA

Be sure to put your RMA number on the outside of the box.

## Specifications for BrightEye 5

### Analog Video Input

Number	One
Type	NTSC, PAL Composite
Impedance	75 $\Omega$ I
Return Loss	>40 dB, DC to 5.5 MHz
Input DC	+/-1 volt DC
Input Hum	<100 mV

### Reference Input

Number	One, BNC
Type	1 V P-P Composite Video, PAL or NTSC
Impedance	75 $\Omega$
Return Loss	>40 dB

### Performance

Frequency Response	$\pm 0.1$ dB, 0 to 5.5 MHz
K Factor	<1%
ScH Phase Error	< $\pm 2^\circ$
Differential Phase	<1°
Differential Gain	<1%
Signal to Noise	>65 dB
Timing Window	Infinite (with respect to reference), Output ScH Phase matches reference
Timing Resolution	Adjustable to within 1° of subcarrier

### Analog Video Output

Number	Two, BNC
Type	Composite PAL or NTSC (follows input)
Delay	Adjustable from < 90 $\mu$ Sec to 1 frame
Return Loss	>40 dB
Output DC	<100 mV

### General Specifications

Size	5.625" W x 1.7" H x 5.5" D (143 mm x 20 mm x 140 mm) including connectors
Weight	14 oz
Power	12 volts, 4 watts (100-230 VAC modular power supply not included)
Temperature Range	0 to 40° C ambient
Relative Humidity	0 to 95° non-condensing

# Glossary

## AES/EBU

The digital audio standard defined as a joint effort of the Audio Engineering Society and the European Broadcast Union. AES/EBU or AES3 describes a serial bitstream that carries two audio channels, thus an AES stream is a stereo pair. The AES/EBU standard covers a wide range of sample rates and quantizations (bit depths). In television systems, these will generally be 48 KHz and either 20 or 24 bits.

## AFD

Active Format Description is a method to carry information regarding the aspect ratio of the video content. The specification of AFD was standardized by SMPTE in 2007 and is now beginning to appear in the marketplace. AFD can be included in both SD and HD SDI transport systems. There is no legacy analog implementation. (See WSS).

## ASI

A commonly used transport method for MPEG video streams, ASI or Asynchronous Serial Interface, operates at the same 270 Mb/s data rate as SD SDI. This makes it easy to carry an ASI stream through existing digital television infrastructure. Known more formally as DVB-ASI, this transport mechanism can be used to carry multiple program channels.

## Aspect Ratio

The ratio of the vertical and horizontal measurements of an image. 4:3 is the aspect ratio for standard definition video formats and television and 16:9 for high definition. Converting formats of unequal ratios is done by letterboxing (horizontal bars) or pillar boxing (vertical pillars) in order to keep the original format's aspect ratio.

## Bandwidth

Strictly speaking, this refers to the range of frequencies (i.e. the width of the band of frequency) used by a signal, or carried by a transmission channel. Generally, wider bandwidth will carry and reproduce a signal with greater fidelity and accuracy.

## Beta

Sony Beta SP video tape machines use an analog component format that is similar to SMPTE, but differs in the amplitude of the color difference signals. It may also carry setup on the luminance channel.

## Bit

A binary digit, or bit, is the smallest amount of information that can be stored or transmitted digitally by electrical, optical, magnetic, or other means. A single bit can take on one of two states: On/Off, Low/High, Asserted/ Deasserted, etc. It is represented numerically by the numerals 1 (one) and 0 (zero). A byte, containing 8 bits, can represent 256 different states. The binary number 11010111, for example, has the value of 215 in our base 10 numbering system. When a value is carried digitally, each

additional bit of resolution will double the number of different states that can be represented. Systems that operate with a greater number of bits of resolution, or quantization, will be able to capture a signal with more detail or fidelity. Thus, a video digitizer with 12 bits of resolution will capture 4 times as much detail as one with 10 bits.

## Blanking

The Horizontal and Vertical blanking intervals of a television signal refer to the time periods between lines and between fields. No picture information is transmitted during these times, which are required in CRT displays to allow the electron beam to be repositioned for the start of the next line or field. They are also used to carry synchronizing pulses which are used in transmission and recovery of the image. Although some of these needs are disappearing, the intervals themselves are retained for compatibility purposes. They have turned out to be very useful for the transmission of additional content, such as teletext and embedded audio.

## CAV

Component Analog Video. This is a convenient shorthand form, but it is subject to confusion. It is sometimes used to mean ONLY color difference component formats (SMPTE or Beta), and other times to include RGB format. In any case, a CAV signal will always require 3 connectors – either Y/R-Y/B-Y, or R/G/B.

## Checkfield

A Checkfield signal is a special test signal that stresses particular aspects of serial digital transmission. The performance of the Phase Locked-Loops (PLLs) in an SDI receiver must be able to tolerate long runs of 0's and 1's. Under normal conditions, only very short runs of these are produced due to a scrambling algorithm that is used. The Checkfield, also referred to as the Pathological test signal, will "undo" the scrambling and cause extremely long runs to occur. This test signal is very useful for testing transmission paths.

## Chroma

The color or chroma content of a signal, consisting of the hue and saturation of the image. See also Color Difference.

## Component

In a component video system, the totality of the image is carried by three separate but related components. This method provides the best image fidelity with the fewest artifacts, but it requires three independent transmission paths (cables). The commonly used component formats are Luminance and Color Difference (Y/Pr/Pb), and RGB. It was far too unwieldy in the early days of color television to even consider component transmission.

## Composite

Composite television dates back to the early days of color transmission. This scheme encodes the color difference information onto a color subcarrier. The instantaneous phase of the subcarrier is the color's hue, and the amplitude is the color's saturation or intensity. This subcarrier is then added onto the existing luminance video signal. This trick works because the subcarrier is set at a high enough frequency to leave spectrum for the luminance information. But it is not a seamless matter to pull

the signal apart again at the destination in order to display it or process it. The resultant artifacts of dot crawl (also referred to as chroma crawl) are only the most obvious result. Composite television is the most commonly used format throughout the world, either as PAL or NTSC. It is also referred to as Encoded video.

### **Color Difference**

Color Difference systems take advantage of the details of human vision. We have more acuity in our black and white vision than we do in color. This means that we need only the luminance information to be carried at full bandwidth, we can scrimp on the color channels. In order to do this, RGB information is converted to carry all of the luminance (Y is the black and white of the scene) in a single channel. The other two channels are used to carry the “color difference”. Noted as B-Y and R-Y, these two signals describe how a particular pixel “differs” from being purely black and white. These channels typically have only half the bandwidth of the luminance.

### **Decibel (dB)**

The decibel is a unit of measure used to express the ratio in the amplitude or power of two signals. A difference of 20 dB corresponds to a 10:1 ratio between two signals, 6 dB is approximately a 2:1 ratio. Decibels add while the ratios multiply, so 26 dB is a 20:1 ratio, and 14 dB is a 5:1 ratio. There are several special cases of the dB scale, where the reference is implied. Thus, dBm refers to power relative to 1 milliwatt, and dBu refers to voltage relative to .775V RMS. The original unit of measure was the Bel (10 times bigger), named after Alexander Graham Bell.

### **dBFS**

In Digital Audio systems, the largest numerical value that can be represented is referred to as Full Scale. No values or audio levels greater than FS can be reproduced because they would be clipped. The nominal operating point (roughly corresponding to 0 VU) must be set below FS in order to have headroom for audio peaks. This operating point is described relative to FS, so a digital reference level of -20 dBFS has 20 dB of headroom before hitting the FS clipping point.

### **DVI**

Digital Visual Interface. DVI-I (integrated) provides both digital and analog connectivity. The larger group of pins on the connector are digital while the four pins on the right are analog.

### **EDH**

Error Detection and Handling is a method to verify proper reception of an SDI or HD-SDI signal at the destination. The originating device inserts a data packet in the vertical interval of the SDI signal and every line of the HD signal which contains a checksum of the entire video frame. This checksum is formed by adding up the numerical values of all of the samples in the frame, using a complex formula. At the destination this same formula is applied to the incoming video and the resulting value is compared to the one included in the transmission. If they match, then the content has all arrived with no errors. If they don't, then an error has occurred.

### **Embedded Audio**

Digital Audio can be carried along in the same bitstream as an SDI or HD-SDI signal by taking advantage of the gaps in the transmission which correspond to the horizontal and vertical intervals

of the television waveform. This technique can be very cost effective in transmission and routing, but can also add complexity to signal handling issues because the audio content can no longer be treated independently of the video.

### **Eye Pattern**

To analyze a digital bitstream, the signal can be displayed visually on an oscilloscope by triggering the horizontal timebase with a clock extracted from the stream. Since the bit positions in the stream form a very regular cadence, the resulting display will look like an eye – an oval with slightly pointed left and right ends. It is easy to see from this display if the eye is “open”, with a large central area that is free of negative or positive transitions, or “closed” where those transitions are encroaching toward the center. In the first case, the open eye indicates that recovery of data from the stream can be made reliably and with few errors. But in the closed case data will be difficult to extract and bit errors will occur. Generally it is jitter in the signal that is the enemy of the eye.

### **Frame Sync**

A Frame Synchronizer is used to synchronize the timing of a video signal to coincide with a timing reference (usually a color black signal that is distributed throughout a facility). The synchronizer accomplishes this by writing the incoming video into a frame buffer memory under the timing direction of the sync information contained in that video. Simultaneously the memory is being read back by a timing system that is genlocked to a house reference. As a result, the timing or alignment of the video frame can be adjusted so that the scan of the upper left corner of the image is happening simultaneously on all sources. This is a requirement for both analog and digital systems in order to perform video effects or switch glitch-free in a router. Frame synchronization can only be performed within a single television line standard. A synchronizer will not convert an NTSC signal to a PAL signal, it takes a standards converter to do that.

### **Frequency Response**

A measurement of the accuracy of a system to carry or reproduce a range of signal frequencies. Similar to Bandwidth.

### **H.264**

The latest salvo in the compression wars is H.264 which is also known as MPEG-4 Part 10. MPEG-4 promises good results at just half the bit rate required by MPEG-2.

### **HD**

High Definition. This two letter acronym has certainly become very popular. Here we thought it was all about the pictures – and the radio industry stole it.

### **HDMI**

The High Definition Multimedia Interface comes to us from the consumer marketplace where it is becoming the de facto standard for the digital interconnect of display devices to audio and video sources. It is an uncompressed, all-digital interface that transmits digital video and eight channels of digital audio. HDMI is a bit serial interface that carries the video content in digital component form over multiple twisted-pairs. HDMI is closely related to the DVI interface for desktop computers and their displays.

## IEC

The International Electrotechnical Commission provides a wide range of worldwide standards. They have provided standardization of the AC power connection to products by means of an IEC line cord. The connection point uses three flat contact blades in a triangular arrangement, set in a rectangular connector. The IEC specification does not dictate line voltage or frequency. Therefore, the user must take care to verify that a device either has a universal input (capable of 90 to 230 volts, either 50 or 60 Hz), or that a line voltage switch, if present, is set correctly.

## Interlace

Human vision can be fooled to see motion by presenting a series of images, each with a small change relative to the previous image. In order to eliminate the flicker, our eyes need to see more than 30 images per second. This is accomplished in television systems by dividing the lines that make up each video frame (which run at 25 or 30 frames per second) into two fields. All of the odd-numbered lines are transmitted in the first field, the even-numbered lines are in the second field. In this way, the repetition rate is 50 or 60 Hz, without using more bandwidth. This trick has worked well for years, but it introduces other temporal artifacts. Motion pictures use a slightly different technique to raise the repetition rate from the original 24 frames that make up each second of film—they just project each one twice.

## IRE

Video level is measured on the IRE scale, where 0 IRE is black, and 100 IRE is full white. The actual voltages that these levels correspond to can vary between formats.

## ITU-R 601

This is the principal standard for standard definition component digital video. It defines the luminance and color difference coding system that is also referred to as 4:2:2. The standard applies to both PAL and NTSC derived signals. They both will result in an image that contains 720 pixels horizontally, with 486 vertical pixels in NTSC, and 576 vertically in PAL. Both systems use a sample clock rate of 27 MHz, and are serialized at 270 Mb/s.

## Jitter

Serial digital signals (either video or audio) are subject to the effects of jitter. This refers to the instantaneous error that can occur from one bit to the next in the exact position of each digital transition. Although the signal may be at the correct frequency on average, in the interim it varies. Some bits come slightly early, others come slightly late. The measurement of this jitter is given either as the amount of time uncertainty or as the fraction of a bit width. For 270 Mb/s SD video, the allowable jitter is 740 picoseconds, or 0.2 UI (Unit Interval – one bit width). For 1.485 Gb/s HD, the same 0.2UI spec corresponds to just 135 pico seconds.

## Luminance

The “black & white” content of the image. Human vision had more acuity in luminance, so television systems generally devote more bandwidth to the luminance content. In component systems, the luminance is referred to as Y.

## **MPEG**

The Moving Picture Experts Group is an industry group that develops standards for the compression of moving pictures for television. Their work is an on-going effort. The understanding of image processing and information theory is constantly expanding. And the raw bandwidth of both the hardware and software used for this work is ever increasing. Accordingly, the compression methods available today are far superior to the algorithms that originally made the real-time compression and decompression of television possible. Today, there are many variations of these techniques, and the term MPEG has to some extent become a broad generic label.

## **Metadata**

This word comes from the Greek, meta means 'beyond' or 'after'. When used as a prefix to 'data', it can be thought of as 'data about the data'. In other words, the metadata in a data stream tells you about that data – but it is not the data itself. In the television industry, this word is sometimes used correctly when, for example, we label as metadata the timecode which accompanies a video signal. That timecode tells you something about the video, i.e. when it was shot, but the timecode in and of itself is of no interest. But in our industry's usual slovenly way in matters linguistic, the term metadata has also come to be used to describe data that is associated with the primary video in a datastream. So embedded audio will (incorrectly) be called metadata when it tells us nothing at all about the pictures. Oh well.

## **Multi-mode**

Multi-mode fibers have a larger diameter core than single mode fibers (either 50 or 62.5 microns compared to 9 microns), and a correspondingly larger aperture. It is much easier to couple light energy into a multi-mode fiber, but internal reflections will cause multiple "modes" of the signal to propagate down the fiber. This will degrade the ability of the fiber to be used over long distances. See also Single Mode.

## **NTSC**

The color television encoding system used in North America was originally defined by the National Television Standards Committee. This American standard has also been adopted by Canada, Mexico, Japan, Korea, and Taiwan. (This standard is referred to disparagingly as Never Twice Same Color.)

## **Optical**

An optical interface between two devices carries data by modulating a light source. This light source is typically a laser or laser diode (similar to an LED) which is turned on and off at the bitrate of the datastream. The light is carried from one device to another through a glass fiber. The fiber's core acts as a waveguide or lightpipe to carry the light energy from one end to another. Optical transmission has two very significant advantages over metallic copper cables. Firstly, it does not require that the two endpoint devices have any electrical connection to each other. This can be very advantageous in large facilities where problems with ground loops appear. And secondly, and most importantly, an optical interface can carry a signal for many kilometers or miles without any degradation or loss in the recovered signal. Copper is barely useful at distances of just 1000 feet.



## **Oversampling**

A technique to perform digital sampling at a multiple of the required sample rate. This has the advantage of raising the Nyquist Rate (the maximum frequency which can be reproduced by a given sample rate) much higher than the desired passband. This allows more easily realized anti-aliasing filters.

## **PAL**

During the early days of color television in North America, European broadcasters developed a competing system called Phase Alternation by Line. This slightly more complex system is better able to withstand the differential gain and phase errors that appear in amplifiers and transmission systems. Engineers at the BBC claim that it stands for Perfection At Last.

**Pathological Test Pattern** – see Checkfield

## **Progressive**

An image scanning technique which progresses through all of the lines in a frame in a single pass. Computer monitors all use progressive displays. This contrasts to the interlace technique common to television systems.

## **Return Loss**

An idealized input or output circuit will exactly match its desired impedance (generally 75 ohms) as a purely resistive element, with no reactive (capacitive or inductive) elements. In the real world, we can only approach the ideal. So, our real inputs and outputs will have some capacitance and inductance. This will create impedance matching errors, especially at higher frequencies. The Return Loss of an input or output measures how much energy is returned (reflected back due to the impedance mismatch). For digital circuits, a return loss of 15 dB is typical. This means that the energy returned is 15 dB less than the original signal. In analog circuits, a 40 dB figure is expected.

## **RGB**

RGB systems carry the totality of the picture information as independent Red, Green, and Blue signals. Television is an additive color system, where all three components add to produce white. Because the luminance (or detail) information is carried partially in each of the RGB channels, all three must be carried at full bandwidth in order to faithfully reproduce an image.

## **Sch Phase**

Used in composite systems, Sch Phase measures the relative phase between the leading edge of sync on line 1 of field 1 and a continuous subcarrier sine wave. Due to the arithmetic details of both PAL and NTSC, this relationship is not the same at the beginning of each frame. In PAL, the pattern repeats every 4 frames (8 fields) which is also known as the Bruch Blanking sequence. In NTSC, the repeat is every 2 frames (4 fields). This creates enormous headaches in editing systems and the system timing of analog composite facilities.

## Setup

In the NTSC Analog Composite standard, the term Setup refers to the addition of an artificial offset or pedestal to the luminance content. This places the Black Level of the analog signal 54 mV (7.5 IRE) positive with respect to ground. The use of Setup is a legacy from the early development of television receivers in the vacuum tube era. This positive offset helped to prevent the horizontal retrace of the electron beam from being visible on the CRT, even if Brightness and Contrast were mis-adjusted. While the use of Setup did help to prevent retrace artifacts, it did so at the expense of dynamic range (contrast) in the signal because the White Level of the signal was not changed.

Setup is optional in NTSC systems, but is never used in PAL systems (see 'Perfection' characteristic of PAL). This legacy of Setup continues to persist in North American NTSC systems, while it has been abandoned in Japan.

In the digital component world (SD and HD SDI) there is obviously no need for, and certainly every reason to avoid, Setup. In order for the interfaces between analog and digital systems to operate as transparently as possible, Setup must be carefully accounted for in conversion products. When performing analog to digital conversion, Setup (if present) must be removed and the signal range gained up to account for the 7.5% reduction in dynamic range. And when a digital signal is converted back to analog form, Setup (if desired on the output) must be created by reducing the dynamic range by 7.5% and adding the 54 mV positive offset. Unfortunately, there is no truly foolproof algorithm to detect the presence of Setup automatically, so it's definitely a case of installer beware.

## SDI

Serial Digital Interface. This term refers to inputs and outputs of devices that support serial digital component video. This could refer to standard definition at 270 Mb/s, HD SDI or High Definition Serial Digital video at 1.485 Gb/s, or to the newer 3G standard of High Definition video at 2.97 Gb/s.

## SMPTE

The Society of Motion Picture and Television Engineers is a professional organization which has done tremendous work in setting standards for both the film and television industries. The term "SMPTE" is also shorthand for one particular component video format - luminance and color difference.

## Single Mode

A Single mode (or mono mode) optical fiber carries an optical signal on a very small diameter (9 micron) core surrounded with cladding. The small diameter means that no internally reflected lightwaves will be propagated. Thus only the original "mode" of the signal passes down the fiber. A single mode fiber used in an optical SDI system can carry a signal for up to 20 kilometers. Single mode fibers require particular care in their installation due to the extremely small optical aperture that they present at splice and connection points. See also Multi-mode.

## TBC

A Time Base Corrector is a system to reduce the Time Base Error in a signal to acceptable levels. It accomplishes this by using a FIFO (First In, First Out) memory. The incoming video is written into the memory using its own jittery timing. This operation is closely associated with the actual digitization of the analog signal because the varying position of the sync timing must be mimicked by the sampling function of the analog to digital converter. A second timing system, genlocked to a stable reference,

is used to read the video back out of the memory. The memory acts as a dynamically adjusting delay to smooth out the imperfections in the original signal's timing. Very often a TBC will also function as a Frame Synchronizer. See also Frame Sync.

### **Time Base Error**

Time base error is present when there is excessive jitter or uncertainty in the line to line output timing of a video signal. This is commonly associated with playback from video tape recorders, and is particularly severe with consumer type heterodyne systems like VHS. Time base error will render a signal unusable for broadcast or editing purposes.

### **Timecode**

Timecode, a method to uniquely identify and label every frame in a video stream, has become one of the most recognized standards ever developed by SMPTE. It uses a 24 hour clock, consisting of hours, minutes, seconds, and television frames. Originally recorded on a spare audio track, this 2400 baud signal was a significant contributor to the development of video tape editing. We now refer to this as LTC or Longitudinal Time Code because it was carried along the edge of the tape. This allowed it to be recovered in rewind and fast forward when the picture itself could not. Timecode continues to be useful today and is carried in the vertical interval as VITC, and as a digital packet as DVITC. Timecode is the true metadata.

### **Tri-Level Sync**

For many, many years, television systems used composite black as a genlock reference source. This was a natural evolution from analog systems to digital implementations. With the advent of High Definition television, with even higher data rates and tighter jitter requirements, problems with this legacy genlock signal surfaced. Further, a reference signal with a 50 or 60 Hz frame rate was useless with 24 Hz HD systems running at film rates. Today we can think of composite black as a bi-level sync signal – it has two levels, one at sync tip and one at blanking. For HD systems, Tri-Level Sync, which has the same blanking level (at ground) of bi-level sync, but the sync pulse now has both a negative and a positive element. This keeps the signal symmetrically balanced so that its DC content is zero. And it also means that the timing pickoff point is now at the point where the signal crosses blanking and is no longer subject to variation with amplitude. This makes Tri-Level Sync a much more robust signal and one which can be delivered with less jitter.

### **USB**

The Universal Serial Bus, developed in the computer industry to replace the previously ubiquitous RS-232 serial interface, now appears in many different forms and with many different uses. It actually forms a small local area network, allowing multiple devices to coexist on a single bus where they can be individually addressed and accessed.

### **VGA**

Video Graphics Array. Traditional 15-pin, analog interface between a PC and monitor.

## **Word Clock**

Use of Word Clock to genlock digital audio devices developed in the audio recording industry. Early digital audio products were interconnected with a massive parallel connector carrying a twisted pair for every bit in the digital audio word. A clock signal, which is a square wave at the audio sampling frequency, is carried on a 75 ohm coaxial cable. Early systems would daisychain this 44.1 or 48 kilohertz clock from one device to another with coax cable and Tee connectors. On the rising edge of this Word Clock these twisted pairs would carry the left channel, while on the falling edge, they would carry the right channel. In most television systems using digital audio, the audio sample clock frequency (and hence the 'genlock' between the audio and video worlds) is derived from the video genlock signal. But products that are purely audio, with no video reference capability, may still require Word Clock.

## **WSS**

Wide Screen Signaling is used in the PAL/625 video standards, both in analog and digital form, to convey information about the aspect ratio and format of the transmitted signal. Carried in the vertical interval, much like closed captioning, it can be used to signal a television receiver to adjust its vertical or horizontal sizing to reflect incoming material. Although an NTSC specification for WSS exists, it never achieved any traction in the marketplace.

## **YUV**

Strictly speaking, YUV does not apply to component video. The letters refer to the Luminance (Y), and the U and V encoding axes using in the PAL composite system. Since the U axis is very close to the B-Y axis, and the V axis is very close to the R-Y axis, YUV is often used as a sort of shorthand for the more long-winded "Y/R-Y/B-Y".

## **Y/Cr/Cb**

In digital component video, the luminance component is Y, and the two color difference signals are Cr (R-Y) and Cb (B-Y).

## **Y/Pr/Pb**

In analog component video, the image is carried in three components. The luminance is Y, the R-Y color difference signal is Pr, and the B-Y color difference signal is Pb.