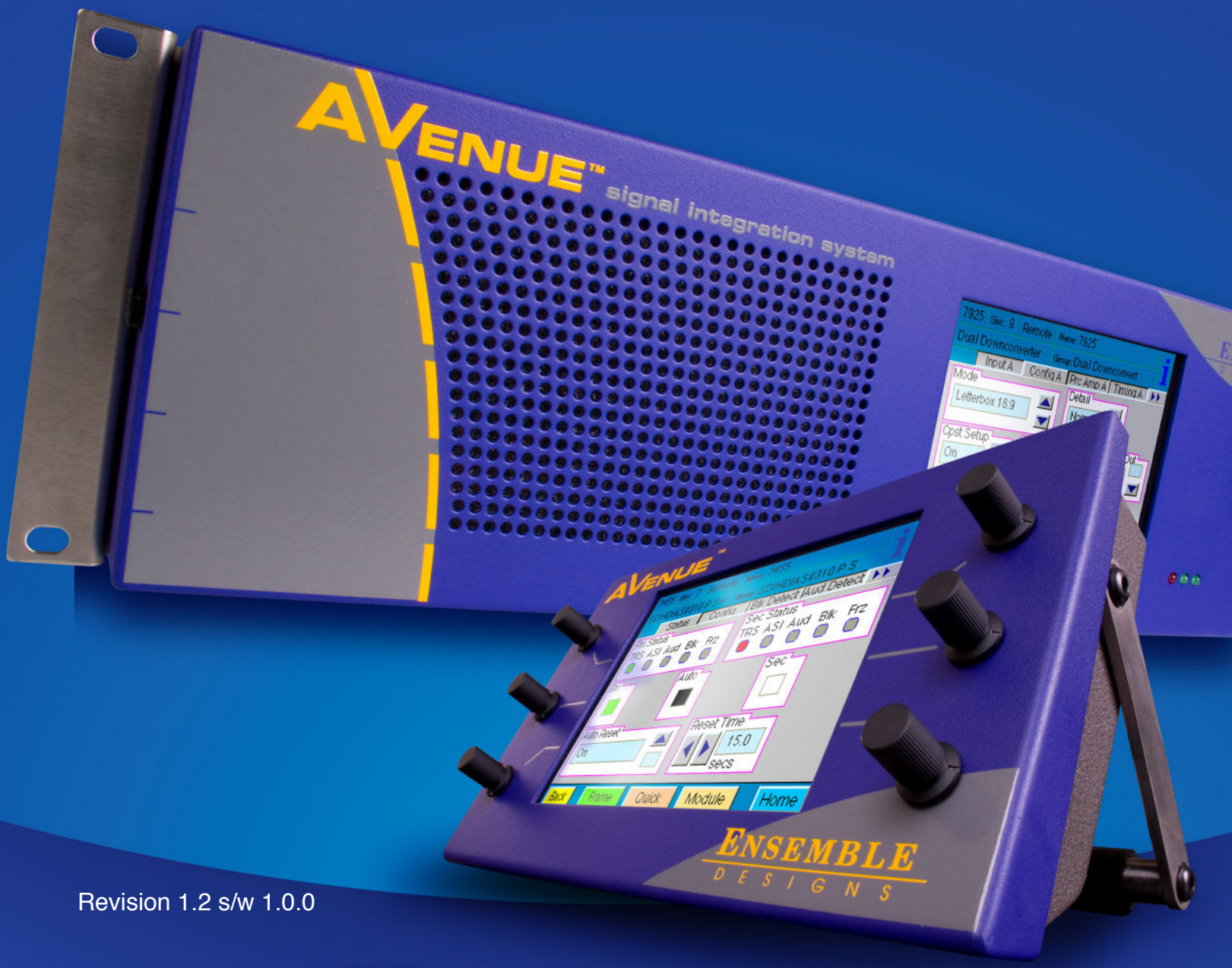
Model 9950

3G Up/Down/Cross Converter and Frame Sync
User Guide



Revision 1.2 s/w 1.0.0

ENSEMBLE
DESIGNS

Purveyors of Fine Video Gear—Loved by Engineers Worldwide

Clearly, Ensemble wants to be in the broadcast equipment business. It's so rare anymore to find a company of this caliber that has not been gobbled up by a large corporation. They are privately held so they don't have to please the money people. They really put their efforts into building products and working with customers.

I'm really happy with the Avenue products and Ensemble's service, and even more important my engineers are happy. We've continued to upgrade the product and add more cards. We will be rebuilding our production control room and we will use Avenue again.

~ *Don McKay, Vice President Engineering, Oregon Public Broadcasting*

Who is Ensemble Designs?

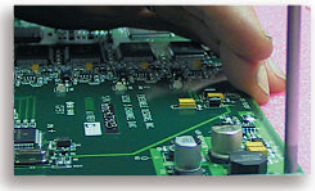
By Engineers, For Engineers

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.

Avenue frames handle 270 Mb/s, 1.5 Gb/s and 3 Gb/s signals, audio and MPEG signals. Used worldwide in broadcast, mobile, production, and post.

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.



We're focused on processing gear– 3G/HD/SD/ASI video, audio and optical modules.

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.

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

Bricks and Mortar of Your Facility

The bricks and mortar of a facility include pieces like up/downconverters, audio embedders, video converters, routers, protection switches, multiviewers 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 broadcasters worldwide, for you.

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

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System Requirements

When using Avenue PC and/or a System Control module with the 9950 the following requirements apply:

Avenue PC

If you are using Avenue PC, please be sure to use version 2.0.20 software or higher with the 9950 module.

System Control

If your system includes a 5030 or 5035 System Control Module, please be sure version 2.2.15 or higher is installed for use with the 9950 module.

Avenue software updates are free for life and can be downloaded onto your PC or Mac from the following website:

http://www.ensembledesigns.com/support/avenue-support/avenue-software

Module Overview

The 9950 is a frame synchronizer and an up, down and cross converter that supports 3 Gb/s, HD and SD SDI signals. Excellent for on-air use, the 9950 is equally at home in a 3G island, in an HD signal ingest installation, or in a production application. All scaling and processing is performed on progressive signals at full bandwidth 4:4:4 for optimum signal quality.

Upconversion

When configured as an upconverter the 9950 outputs 1.5 HD or 3 Gb/s HD video. The incoming signal is converted to progressive 4:4:4 prior to scaling and processing so you get the best looking output. Aspect ratio conversion choices include: Letterbox, Anamorphic, Crop and Zoom.

Downconversion

When used as a downconverter, the 9950 has a 3G/HD SDI input and four outputs. The Aspect Ratio Conversion process offers Resizing and Repositioning with choices for: Letterbox, Anamorphic, Crop and Zoom. The 9950 automatically adjusts between 3G/HD 709 and SD 601 color space.

Cross Conversion

The 9950 provides cross conversion between formats, processing all popular variations of 1080 and 720, making it simple for every facility to ingest any type of 3G, HD or SD signal.

Aspect Ratio Conversion

The 9950 incorporates an aspect ratio converter for standard definition signals. Resizing and Repositioning includes choices for: Letterbox, Anamorphic, Crop and Zoom.

Picture Correction Controls

Input standard and frame rate are auto-detected. The 9950 automatically performs color space conversion. The built-in Proc Amp provides adjustment of signal parameters with controls for video, chroma, setup, hue. Vertical interval data such as closed captioning data, AFD and timecode is faithfully preserved and is passed from input to output. The output is timeable with respect to the reference input.

Flexible Synchronization

An infinitely adjustable timing system genlocks to your house reference. The 9950 genlocks to either composite video (PAL or NTSC) or to Tri-Level Sync. The module can lock to the frame's master reference or reference can be connected directly to the module's external reference BNC. The serial output timing can be set anywhere within a frame of the selected input reference.

Upon loss of signal, the 9950 provides freeze frame or black until the signal is recovered.

Audio Support

The 9950 supports four groups (16 channels) of audio embedded into the SDI stream. The internal processing disembeds the audio so that it can be processed independently of the video. When the video input and output are not synchronous to each other and the 9950 acts as a frame synchronizer;

the audio content is appropriately sample rate converted to the new output sample rate. There is a compensating delay in the audio path to maintain lip sync with the video content. Additionally, delay is adjustable up to one second.

The 9950 includes a full-featured, sixteen-channel audio mixer. The channel swap and shuffle capability allows you to completely rearrange and remix audio channels. It can take embedded content, adjust levels and remap channels, and deliver it to the output as an embedded signal. It provides precise control over audio level, with up to 12 dB of gain to compensate for low level sources.

For discrete AES I/O, analog audio I/O, Dolby encoding, Dolby decoding and automatic gain control, pair the 9950 with the 9600 3G Embedder, Disembedder and Data Inserter. With this 9600 module you can use Dolby encoding and decoding submodules, as well as 9670 Level Track Loudness Control AGC software.

Active Format Description Support

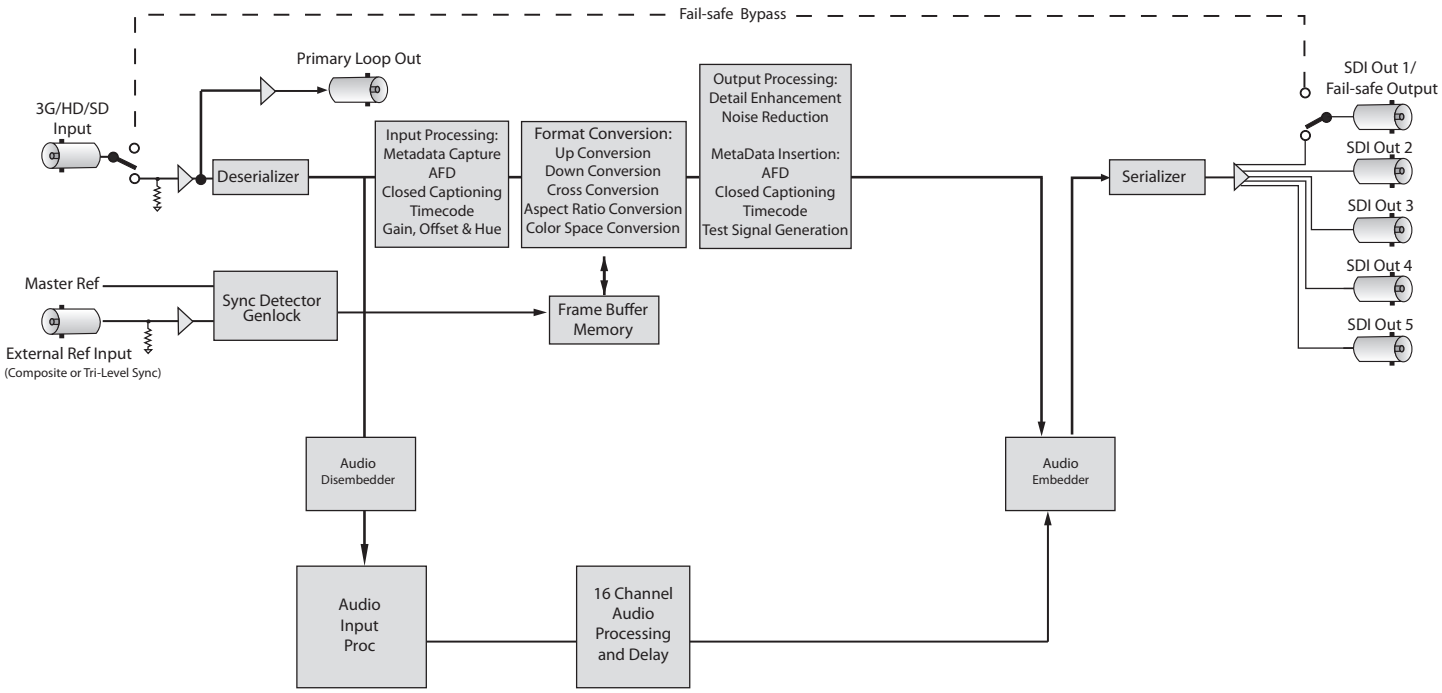
The 9950 supports AFD (Active Format Description) to mark or identify the aspect ratio of the video content. These flags are generated at the output of the module, and they are read at the input. This allows the up and downconversion process to adapt automatically to material that is already in letter or pillarbox form in order to produce the most appropriate conversion.

Complete Control System

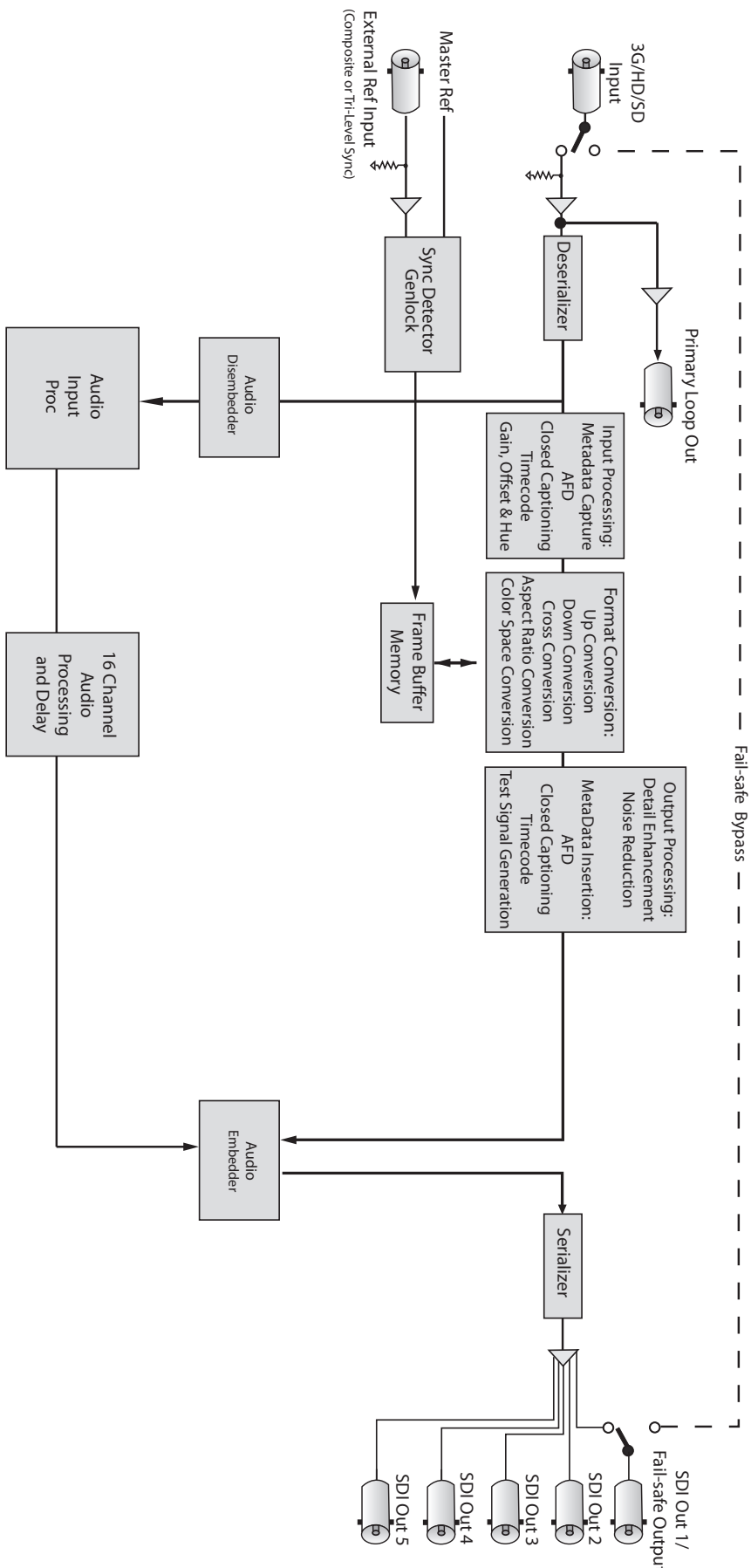
The 9950 can be used locally or controlled and configured remotely with Avenue Touch Screens, Express Panels, or Avenue PC Software. Alarm generation, configurable user levels, module lock out, and customizable menus are just some of the tools included in the Avenue Control System. SNMP support is provided.

Features

- **High-quality upconverter, downconverter, cross converter, aspect ratio converter**
- **3G, HD and SD SDI I/O**
- **Smart auto-config – set output, then feed any input**
- **Proc amp with video, chroma, setup and hue adjustments**
- **Built in bars, black and tone**
- **Passes embedded audio with proper delay compensation and lip sync preservation**
- **Supports four groups of embedded audio**
- **Full frame sync – accepts asynchronous signals**
- **Reference input – output is timeable**
- **Automatically adjusts between SD/HD color space**
- **AFD detection and insertion**
- **16 bit processing**
- **Passes closed captioning**
- **Local and remote control**
- **Memory registers**



9950 3G Up/Down/Cross Converter and Frame Sync Block Diagram, portrait view



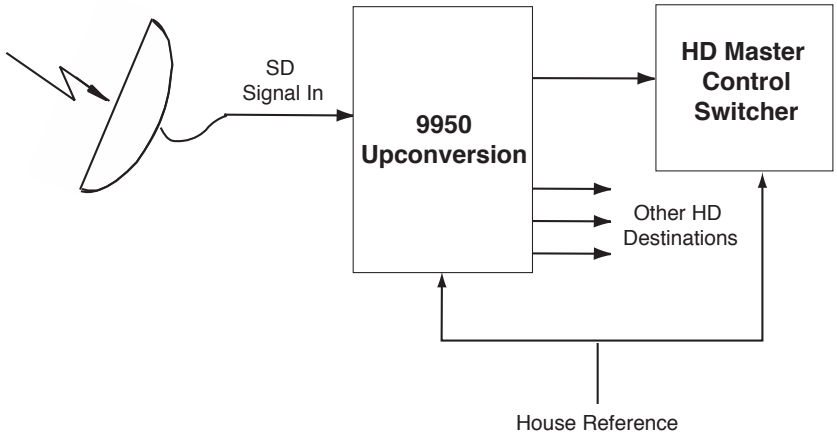
9950 3G Up/Down/Cross Converter and Frame Sync Block Diagram, landscape view

Applications

SD Upconversion

The 9950 module can be utilized to upconvert SD video from many different source types. As shown in the example below, the SD ingest signal from a satellite is fed to a 9950 module where it is upconverted to feed an HD Master Control Switcher. The other three outputs can be sent to other HD destinations such as an ingest server or digital recorder.

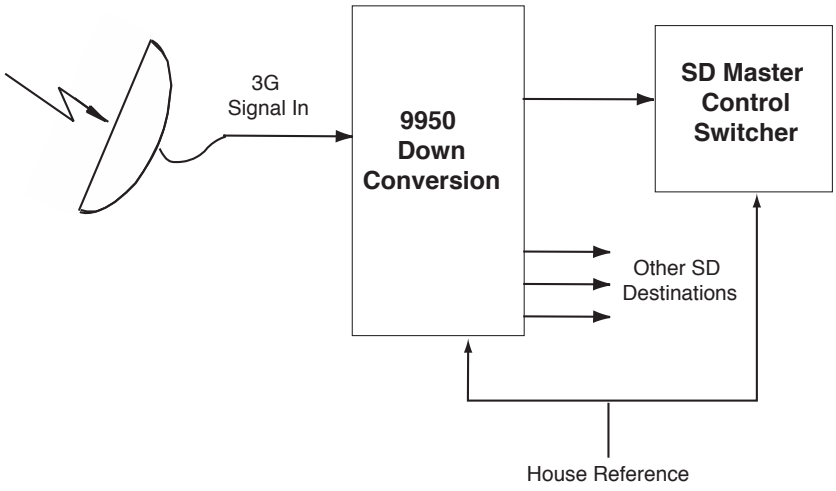
In both up and downconversion, timing to a house reference is available on the module, along with many other controls features for ensuring a clean, stable signal.



9950 SD Upconverter Application

HD Downconversion

The 9950 module can be utilized to down convert HD video to suit many applications. As shown in the example below, the HD ingest signal from a satellite is fed to a 9950 module where it is down converted to feed an SD Master Control Switcher. The other three outputs can be sent to other SD destinations.

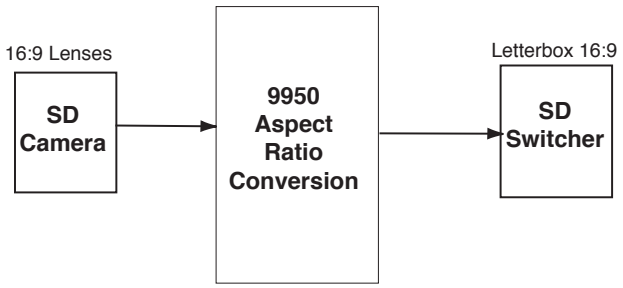


9950 3G Downconverter Application

SD Aspect Ratio Conversion

The 9950 module can perform standard definition aspect ratio conversion to convert the aspect ratio of the SD input signal to a different aspect ratio needed on the output.

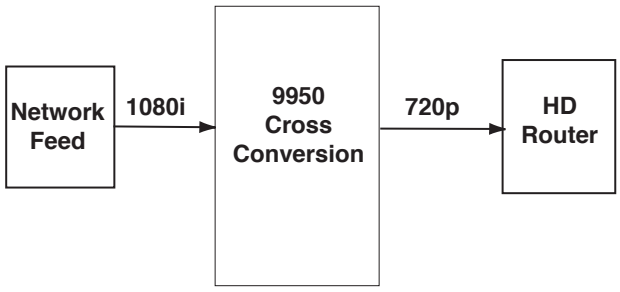
In the example shown below, the input from an SD camera with 16:9 lenses can be fed a an anamorphic signal to the 9950 where the aspect ratio can be corrected for feeding an SD switcher requiring an aspect ratio of Letterbox 16:9.



9950 SD ARC Application

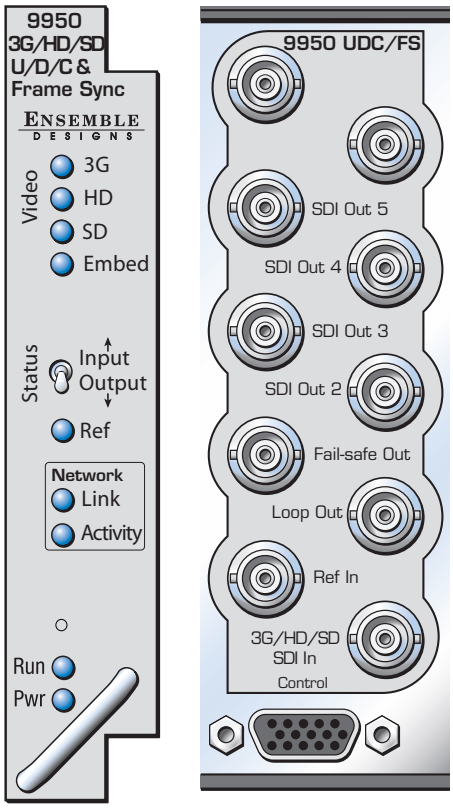
HD Cross Conversion

The 9950 module can perform cross conversion when an HD input signal must be converted for an output application similar to the example shown below. As shown here, the 1080i input from an HD network feed is fed to the 9950 where the format is converted to 720p as required for input to an HD router.

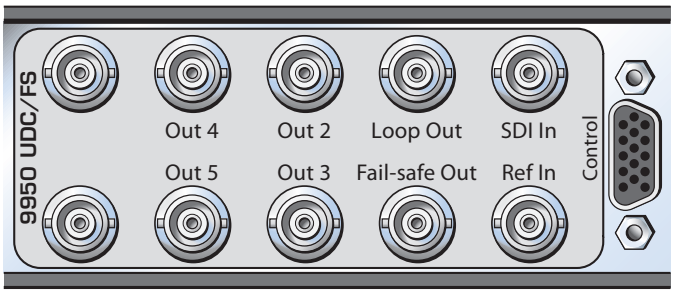


9950 HD Cross Application

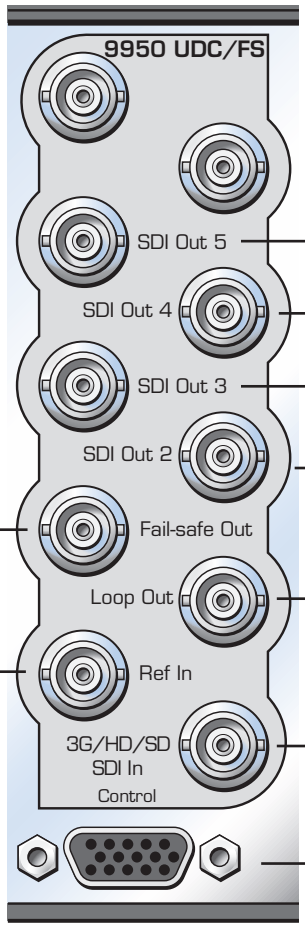
Front and Rear Lexans



***9950** Lexans: front, 3RU rear and 1RU rear*



Backplane Diagram



3RU Backplane

SDI Outputs 2, 3, 4 and 5: Serial digital video supporting 2.97 Gb/s HD, 1.5 Gb/s HD or 270 Mb/s SD video signals.

Connect **Fail-safe Out** to the final destination.

Connect the input signal to the **3G/HD/SD SDI In** BNC and loop the **Loop Out** BNC to another destination in the facility if desired.

Connect NTSC or PAL analog video, Tri-Level Sync or 10 MHz precision reference to the **Reference In** BNC.

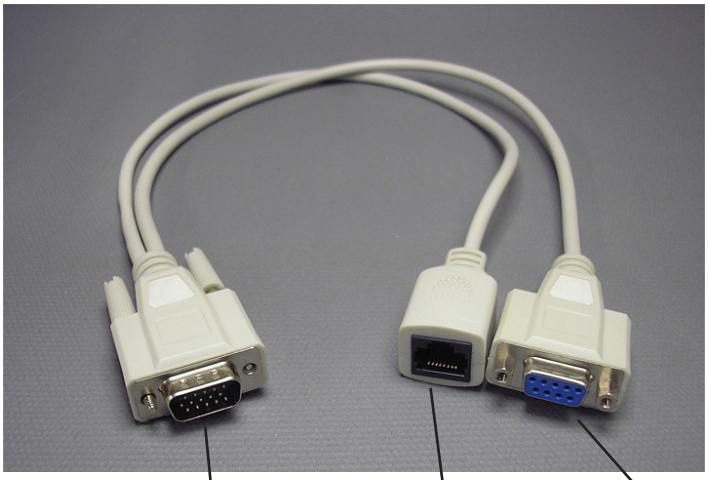
Connect the 23000048 Interface Adapter Cable to provide a 9-pin GPI connector for **Control** and an Ethernet connection for software upgrades. See photo and details on the following page.

23000048 Interface Adapter Cable

The 23000048 Interface Adapter Cable cable connects to the 15 pin D connector on the back of the Avenue frame that is associated with the 9950 module. The Ethernet port is used for software upgrades and the 9 pin D connector is used for GPI control.

Software updates are done with a web browser through the Ethernet connection, not thorough Avenue PC. Please see the "Step by Step Overview for Updating Software in your 9950:" on page 42 for more details.

Please refer to"23000048 Interface Adapter Cable Drawing and Pinouts" on page 39 , and subsequent pages on GPI for more detailed information regarding external control.



Connect the male 15 pin D connector to the female 15 pin D connector on the back of the frame that corresponds to the 9950 module

Ethernet for software upgrades

9 pin female D connector for control. Pinouts and details are in the GPI section of this manual beginning on page 37.

Front Panel Controls and Indicators

Each front edge indicator and switch setting of the 9950 is shown in the diagram below:

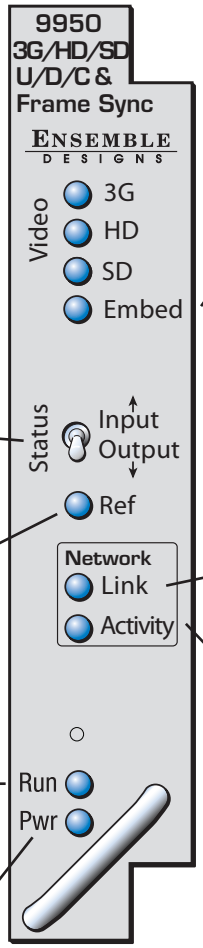
Video green LEDs:
Video LEDs are indicators for the input signal when the Status switch is in the Input position, and indicators for output signal when the Status switch is in the Output position.
Lit LED indicates the video signal is detected as **3G, HD or SD**.

Status Switch:
Switch used to select **Input** or **Output** for the Video LEDs above.

Ref green LED:
ON when locked to a valid reference.
OFF when no reference is detected.

Run green LED:
OFF A power fault or halted CPU
ON A halted CPU
FAST BLINK CPU Run error
SLOW BLINK System OK. (If SPI control is active from the main frame System Control Module, all Run indicators will be synchronized.).

Pwr green LED:
Indicates the presence (**ON**) or absence (**OFF**) of power.



Embed green LED:
The Embed LED is an indicator for the input signal when the Status switch is in the Input position, and an indicator for the output signal when the Status switch is in the Output position.

ON when embedded
. is detected in the serial stream.
OFF when no embedded audio is detected in the serial stream.

Network Link green LED:
ON when there is a valid Ethernet connection.
OFF when no valid Ethernet connection is detected.

Network Activity green LED:
ON/BLINK when there is network traffic.
OFF when no network traffic is detected.

Avenue PC and Touch Screen Remote Configuration

The Avenue PC and Touch Screen remote control status menus for the 9950 module are illustrated and explained in the following section. For more information on using Avenue PC, refer to the Avenue PC Control Application Software data pack that came with the option. For more information on using Avenue Touch Screen, refer to the Avenue Touch Screen data pack.

Parameter fields that are grayed out can indicate one of the following conditions:

- The function is not active
- The module is locked
- The User Level set with Avenue PC is not accessible from the current User Level

Video In Menu

The **Vid In** menu shown on the following page reports the input standard and the AFD In, allows you to select a reference source, and reports the reference status as follows:

- **Input** – reports the video input from the following standards and indicates that the signal is present and equalized:

720p/50	1080i/25	1080sF/23.98
720p/59.94	1080p/23.98	1080sF/24
720p/60	1080p/24	SD525
1080i/50	1080p/50	SD625
1080i/59.94	1080p/59.94	No Input
1080i/60	1080sF/25	Unknown

- **AFD In** – Active Format Descriptions In indicator displays the format of the input signal connected to the Video In BNC as one of the following:

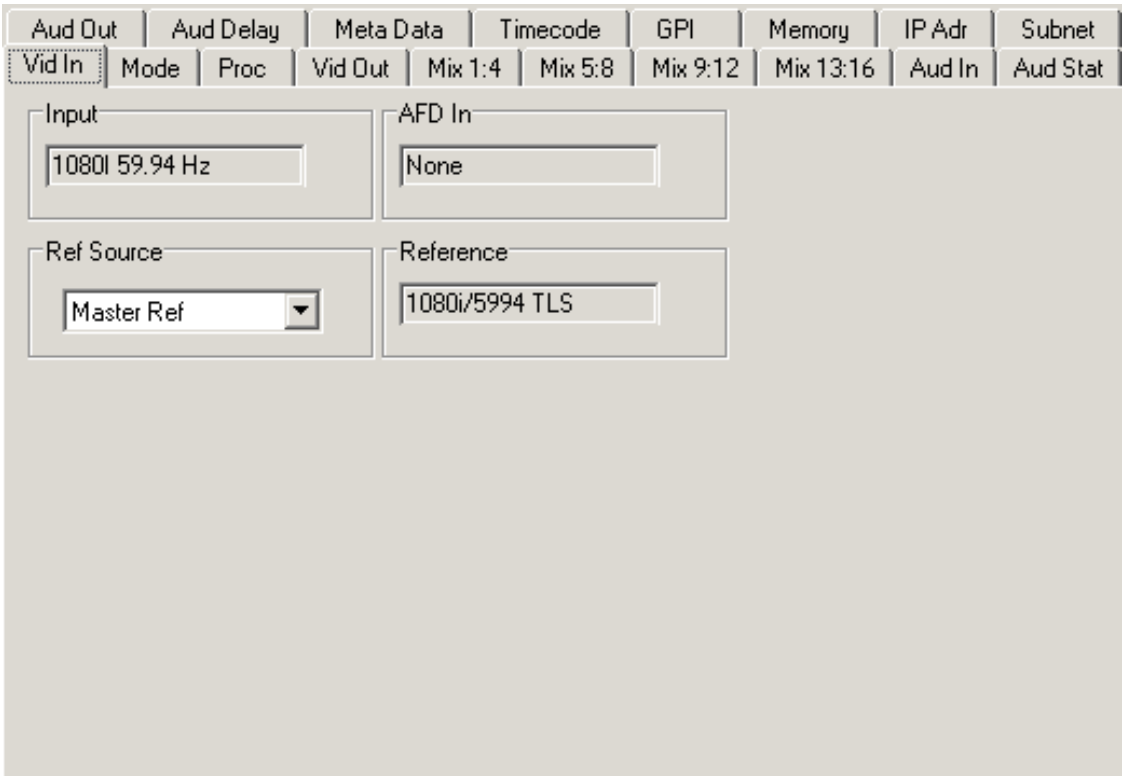
AFD 0000	AFD 0110	AFD 1100
AFD 0001	AFD 0111	AFD 1101
AFD 0010	AFD 1000	AFD 1110
AFD 0011	AFD 1001	AFD 1111
AFD 0100	AFD 1010	None
AFD 0101	AFD 1011	

- **Ref Source** – select the reference source from Video In Ref*, Master Ref or External. Default is Master Ref. If no reference is connected, or the reference fails, the module will switch to its own internal precision reference.

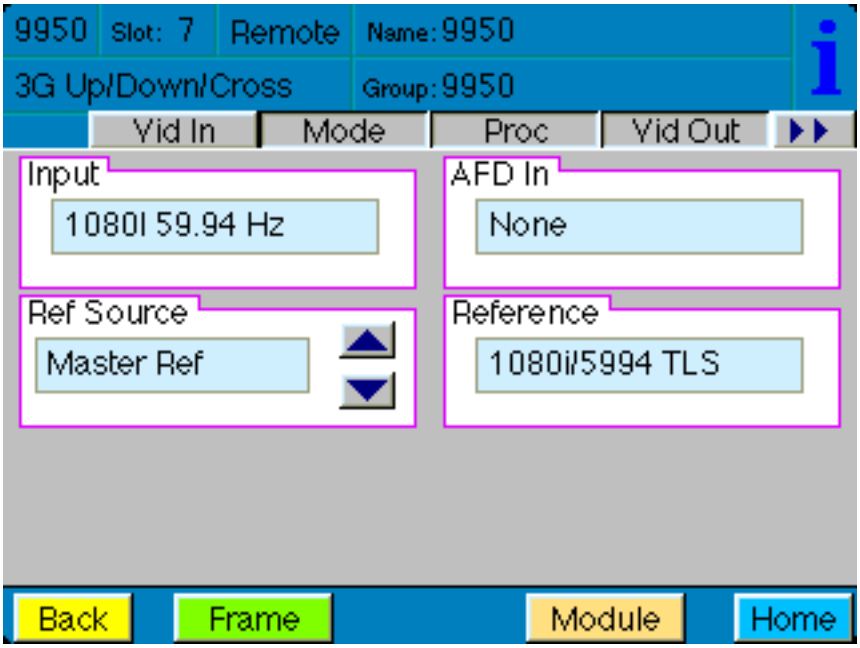
- **Reference** – reports the status and type of reference input as one of the following:

  No Reference
  525
  525 w/VITC
  625
  625 w/VITC
  720p/59.94
  720p/50
  1080i/59.94
  1080i/50
  1080sF/50
  1080p/24
  1080p/25
  10 MHz
  Video Input*

  *__Note__: When the **Ref Source** is set to "Video In Ref", the **Reference** status will display "Video Input". This indicates that the reference signal will be derived from the incoming video input. The **Reference** status will display "Video Input" even if the video input is not detected as present. Concurrently, the Ref LED on the front edge of the module will be illuminated when the **Ref Source** is set to "Video In Ref" even if no video input is detected.



Vid In *Avenue PC Menu*



Vid In *Touch Screen Menu*

Mode Menu

The **Mode** menu shown on the following page reports the current conversion mode of the 9950, allows you to choose an output standard, and select the aspect ratio of the output.

- **Mode** – reports the mode in which the unit is running. The mode is determined by the output selection made in the Format menu.:

  Up Convert
  Down Convert
  HD Cross Convert
  SD ARC

- **Output Standard** – use this control to set the desired output standard. The unit automatically detects the input standard. Choose from the following output standards:

720p/50	1080i/50	3G 1080p/50
720p/59.94	1080i/59.94	3G 1080p/59.94
720p/60	1080i/60	SD525
		SD625

- **Up** – use this control to set the desired output aspect ratio when upconverting the input signal. Select from:

Anamorphic	Crop
Pillar Box	Auto AFD
Pillar Sidepanels	

- **Down** – use this control to set the desired output aspect ratio when downconverting the input signal. Select from:

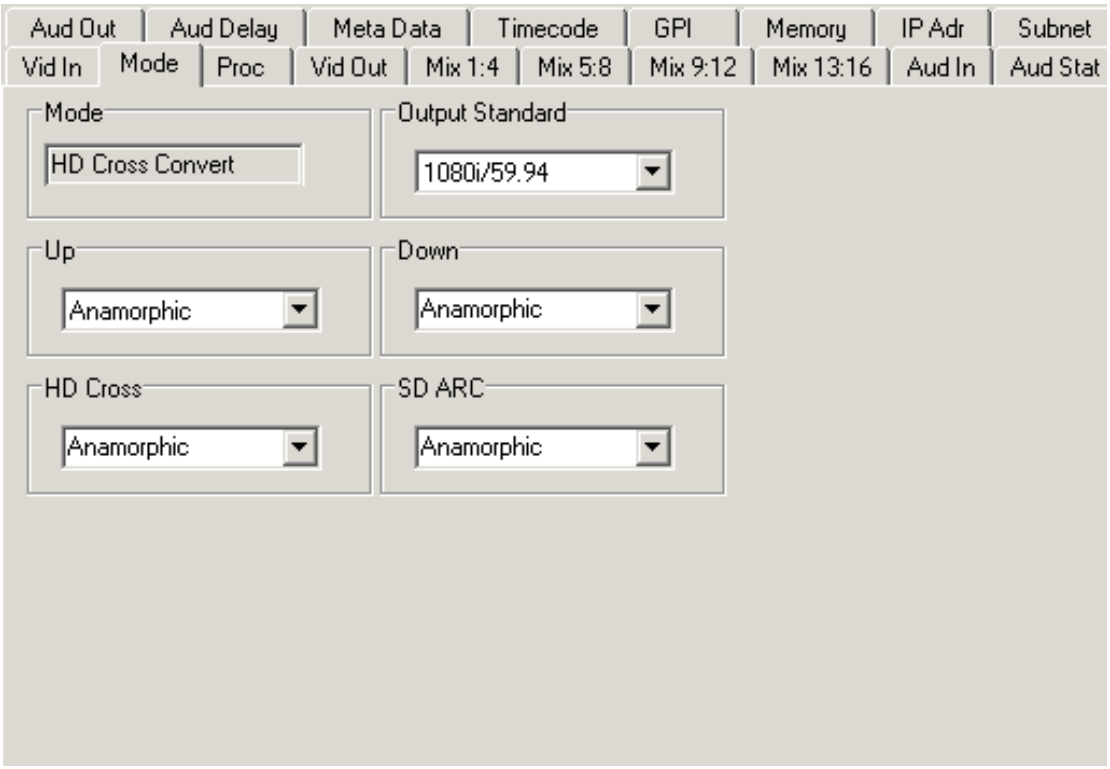
Anamorphic	Crop
Letter Box 16:9	Auto AFD
Letter Box 14:9	

- **HD Cross** – use this control to set the desired output aspect ratio when cross converting from one type of HD signal to another. Select from:

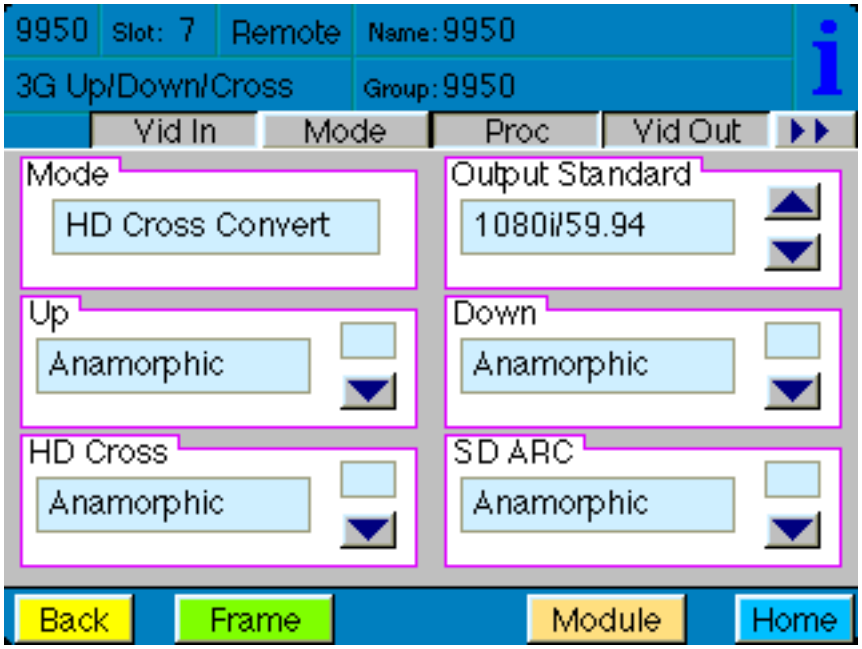
  Anamorphic
  Auto AFD

- **SD ARC** – use this control to set the desired output aspect ratio when aspect ratio converting between 4:3 and 16:9. Select from:

Anamorphic	Pillar	Crop Top/Bot
Letter 16:9	Pillar Sidepanels	Auto AFD
Letter 14:9	Crop Sides 75%	
Letter 13:9	Crop Sides 84%	



***Mode** Avenue PC Menu*

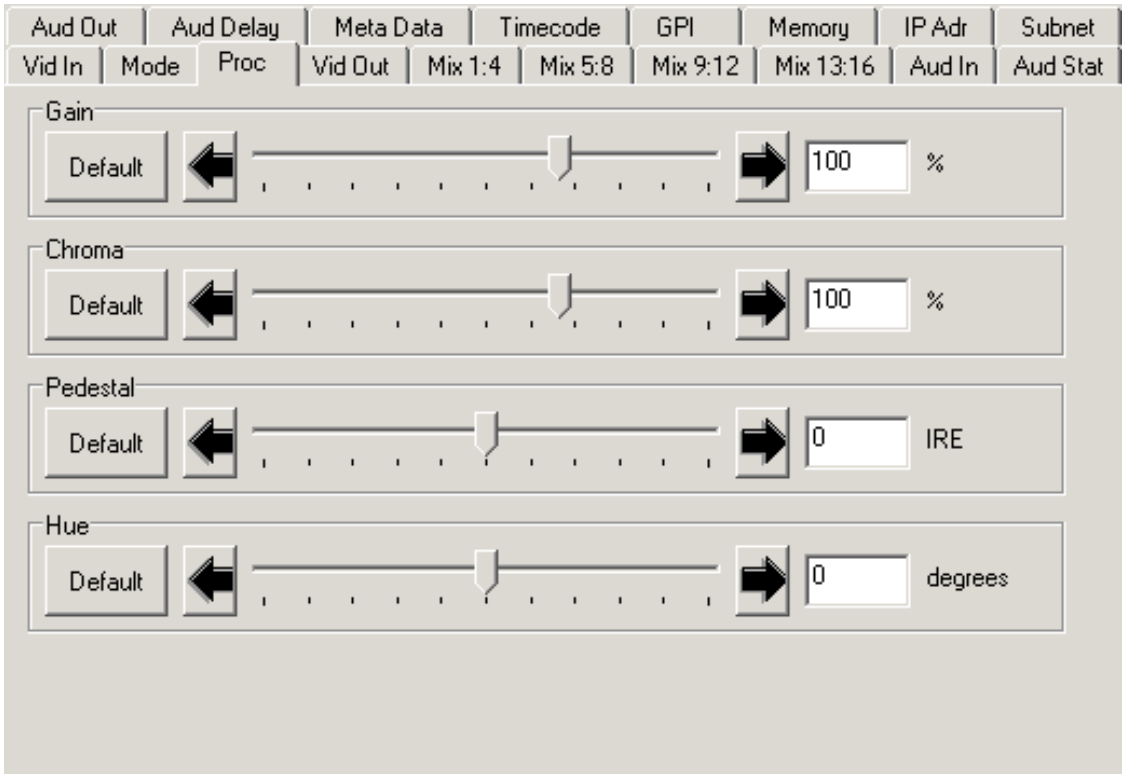


***Mode** Touch Screen Menu*

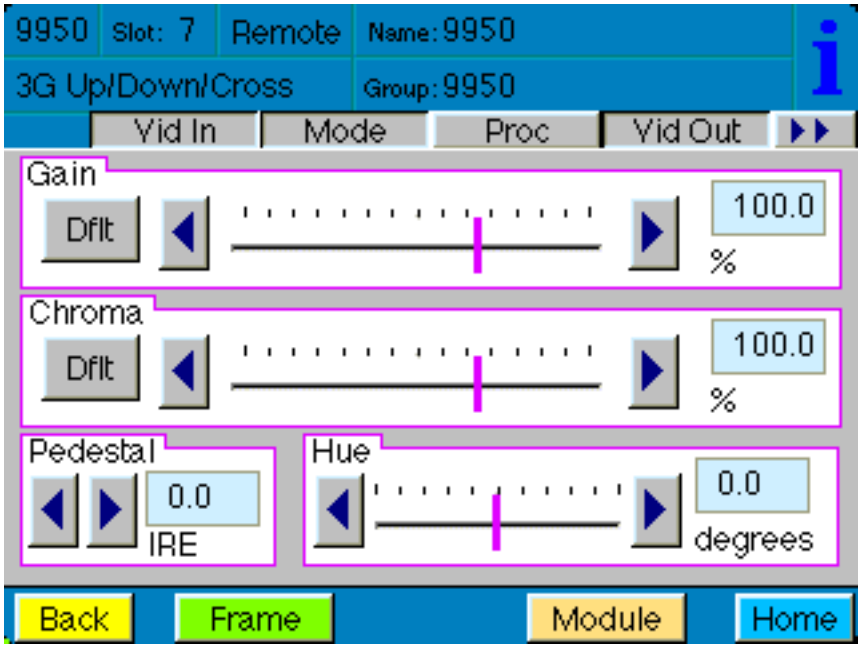
Proc Menu

The **Proc** menu shown on the following page allows you to adjust the following video processing parameters for the signal:

- **Gain** – adjust the percentage of overall gain (luminance and chrominance) from 0% to 150%. Click the Default button to reset to the default value of 100%.
- **Chroma** – adjust the percentage of chroma amplitude from 0% to 150%. Click the Default button to reset to the default value of 100%.
- **Pedestal** – adjust the pedestal (black) level of the signal in IRE from -30 IRE to 30 IRE. Click the Default button to reset to the default value of 0 IRE.
- **Hue** – adjust the hue of the signal ± 180 degrees. Click the Default button to reset to the default value of 0º.



***Proc** Avenue PC Menu*



***Proc** Touch Screen Menu*

Vid Out Menu

The **Vid Out** menu shown on the following page allows you to set the vertical blanking mode, adjust the horizontal and vertical timing, sharpen the picture or soften the picture for bandwidth reduction, and route internally generated bars or black to the output.

The Vertical and Horizontal Timing controls adjust the timing of the video signal relative to the timing reference. Setting the Vertical and Horizontal parameters to 0 (the default setting) will "zero" time the video signal to the reference. Negative values will cause the video signal to be early with respect to the reference. Positive values will make the video signal later in time with respect to the reference.

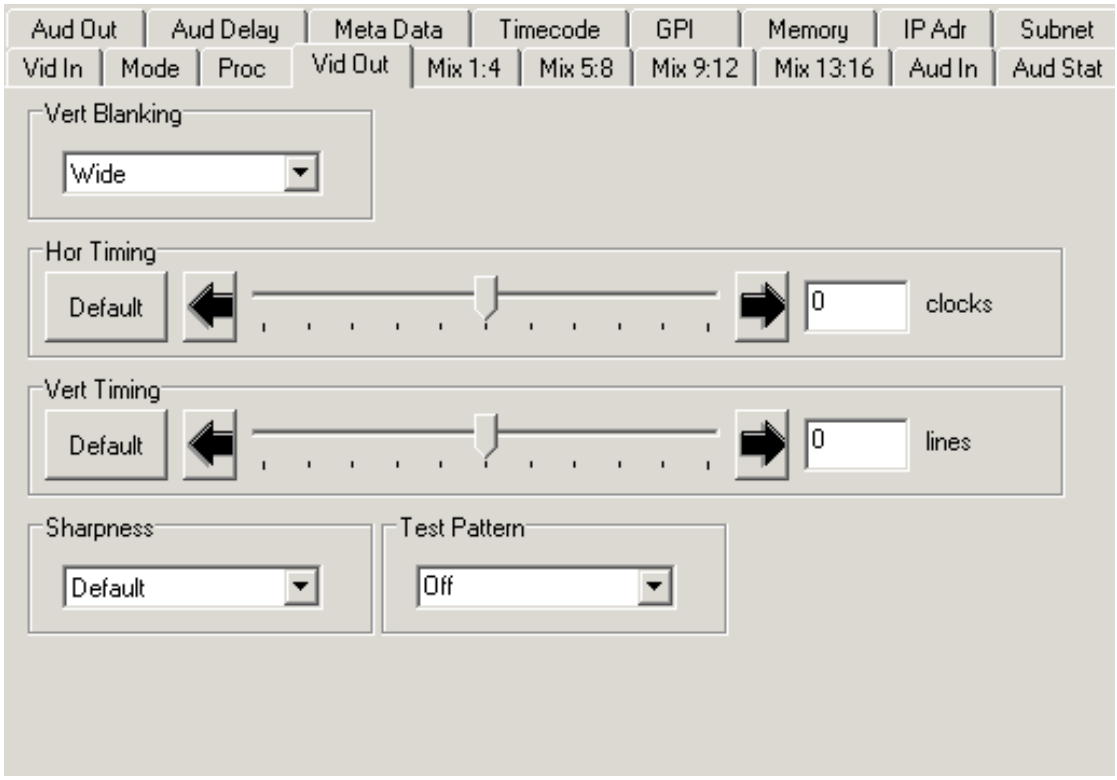
- **Vert Blanking** – set the blanking mode to Narrow (lines 1-9 are blanked in NTSC, lines 1-6 in PAL) or Wide (lines 1-20 in NTSC, lines 1-22 in PAL). Default is Wide.

- **Hor Timing** – adjust the horizontal timing in clocks from -2000 clocks to 2000 clocks. Click the Default button to reset to the default value of 0 clocks.

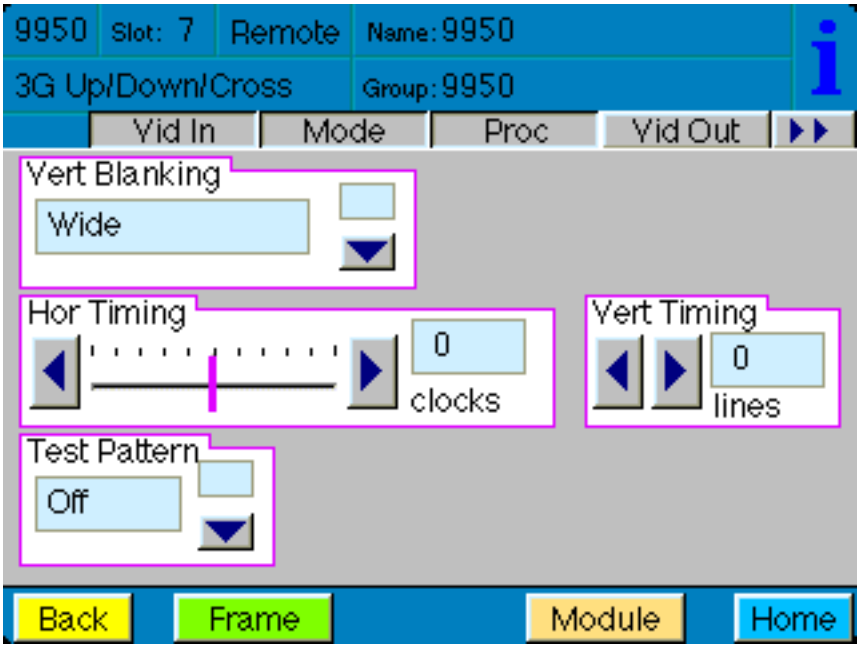
- **Vert Timing** – set the vertical timing in lines from -1000 lines to 1000 lines. Click the Default button to reset to the default value of 0 lines.

- **Sharpness** – use the sharpness control to soften the picture for bandwidth reduction, or to sharpen the picture. The default setting passes the signal with no modification. Settings +1, +2 and + 3 incrementally provide edge enhancement to sharpen the picture. Settings -1, -2 and -3 incrementally reduce bandwidth and soften the picture.

- **Test Pattern** – to send an internally generated test pattern to the video output, select Bars or Black.



Vid Out *Avenue PC Menu*



Vid Out *Touch Screen Menu*

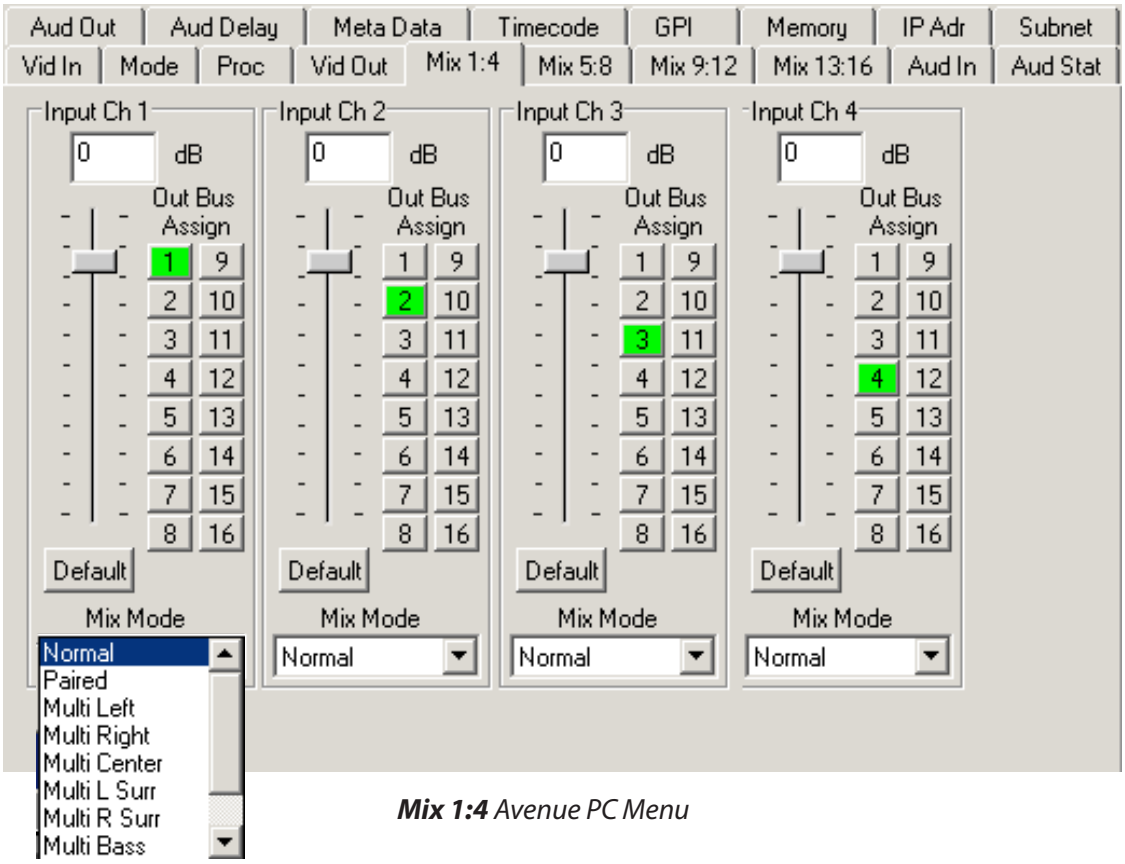
Mix 1:4, Mix 5:8, Mix 9:12, Mix 13:16 Menus

Use the Mix menus to control the audio mixing and shuffling of Input Channels 1 through 16. Mix menu 1:4 is shown on the following page.

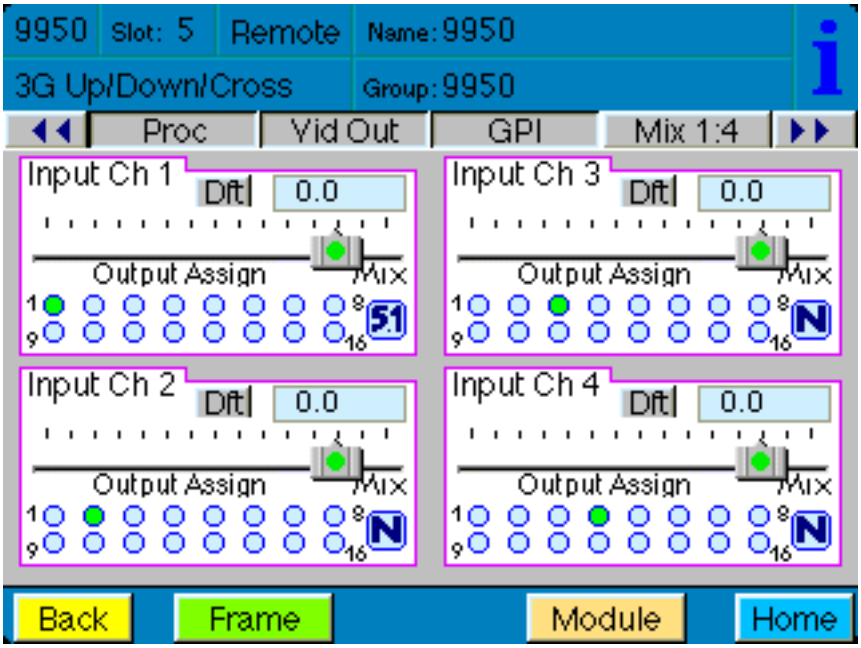
- **Input Ch 1** – assign Input Channel 1 to the desired output bus, the output bus assignment will be indicated by a green box. Set the input level using the slider control or by entering a number (-70 to +12 dB) in the window and pressing the Enter key. Click the Default button to reset to the default value of 0 dB. Each mixer channel has a level control on its input. There is not a separate output gain level control.

- **Out Bus Assign** – route mixer inputs to mixer outputs. The 9950 mixer has 16 input channels and 16 output busses. Initially, each channel is assigned a separate output bus. For example, by default, mixer input channel 1 is assigned to mixer output bus 1, indicated by the green button in the **Input Ch 1** control. However, you can assign multiple input channels to go to the same output bus. Or you can have each input channel going to multiple output busses (from 0 to 16).

- **Mix Mode** – use the drop-down controls to pair channels or associate channels with one another for Surround Sound applications. Please refer to the chart and details in the "Audio Channel Pairing and Surround Sound Groupings" on page 27



Mix 1:4 *Avenue PC Menu*



Mix 1:4 *Touch Screen Menu*

Audio Channel Pairing and Surround Sound Groupings

One common method of working with the mixer is to put the signals through unchanged, using the mixer only to indicate the output bus assignments. However, you can also associate channels with one another using the **Mix Mode** drop-down controls.

Combinations of Input Channels

Any particular channel can be independent or it can be tied to other channels. When multiple channels are associated together, it affects their behavior with respect to gain control and loudness measurement.

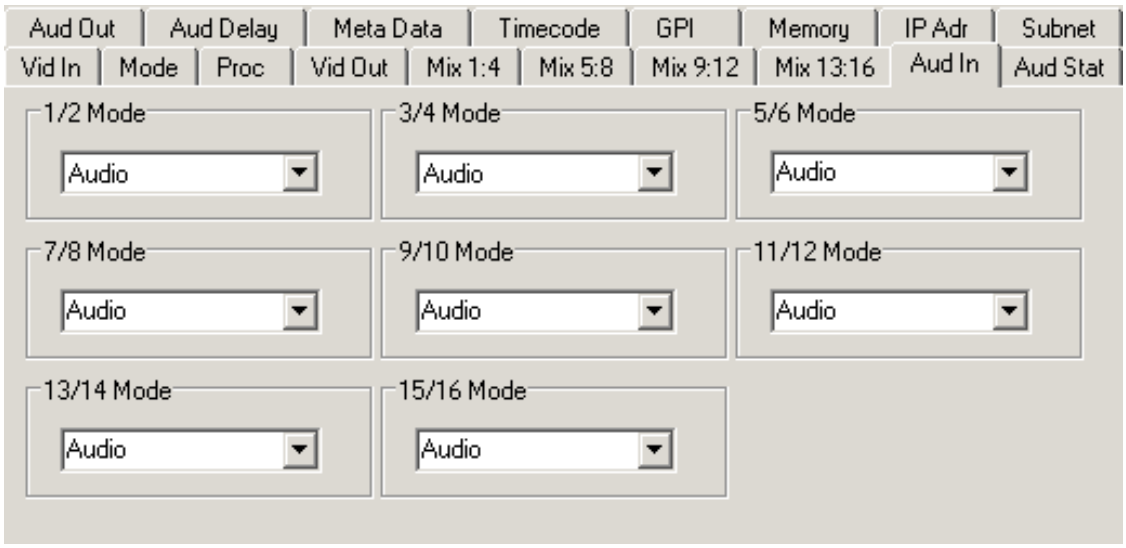
The **Mix Mode** drop-down control provides four approaches for working with the channels, detailed in the chart below. Please note that once you have established a pairing or surround sound grouping, changing the gain on one channel affects all of the associated channels.

Mix Mode	Mixer Behavior
1. Normal	Working with mixer channels independently is the default or "Normal' mix mode.
2. Paired	If you want two channels to be paired so that altering the gain of one will automatically alter the gain of the other, choose Paired from the **Mix Mode** drop-down control for one of the channels you want to pair; for example, channel 9 and 10 will be paired with each other if you select Paired for one of those channels.
3. Surround Sound 5.1	For surround sound 5.1, which uses 6 channels, specify for each channel one of these 6 selections from the **Mix Mode** drop-down control. For example: Input Ch 1 = Multi Left Input Ch 2 = Multi Right Input Ch 3 = Multi Center Input Ch 4 = Multi L Surr Input Ch 5 = Multi R Surr Input Ch 6 = Multi Bass
4. Surround Sound 7.1	For surround sound 7.1, which uses 8 channels, specify for each channel one of the above 6 selections plus two additional Mix Mode selections. For example: Input Ch 7 = Multi L Rear Input Ch 8 = Multi R Rear

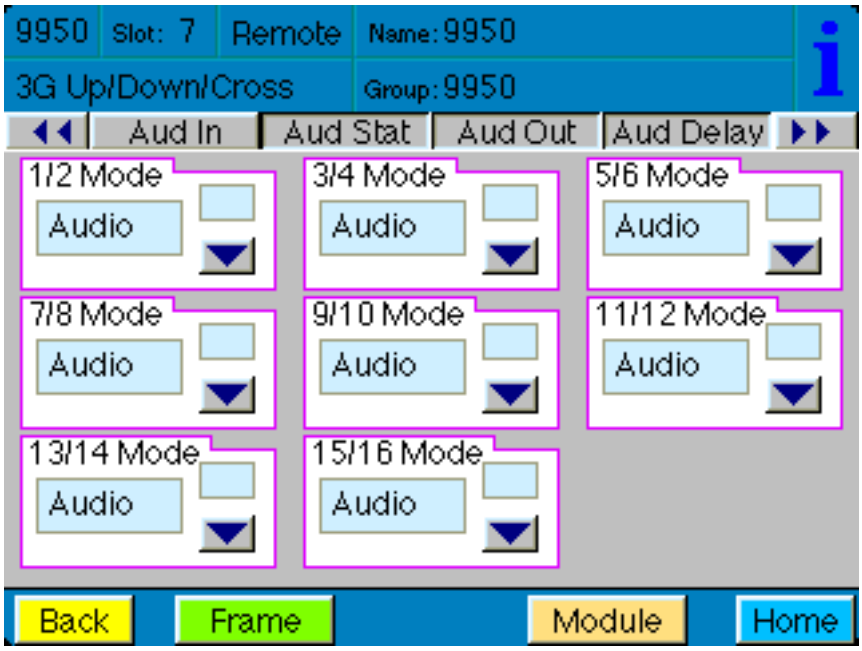
Aud In Menu

Use the **Aud In** menu screen shown on the following page to select the type of audio in the stream for each pair from Audio, Data or Auto as follows:

- **Audio** – the embedded stream is standard audio.
- **Data** – the embedded stream is a non-audio signal.
- **Auto** – the module will detect the type of signal embedded in the stream, audio or data.



***Aud In** Avenue PC Menu*



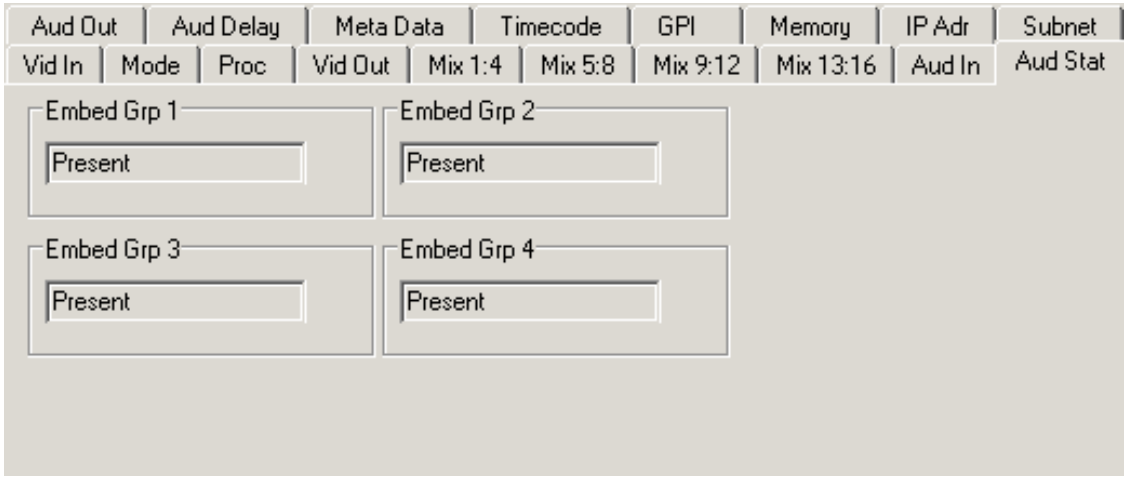
***Aud In** Touch Screen Menu*

Aud Stat Menu

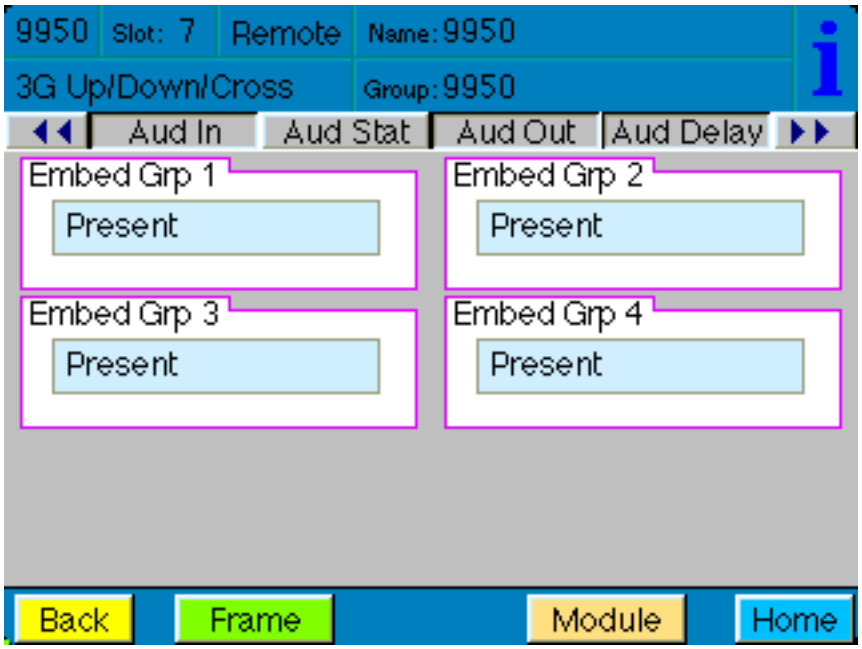
The **Aud Sat** menu reports if embedded audio is detected for each group. Status is reported as None or Present for Group 1, 2, 3 and 4.

- **None** – no embedded audio is detected.
- **Present** – embedded audio is present in the stream.

  Group 1 includes channels 1/2 and 3/4
  Group 2 includes channels 5/6 and 7/8
  Group 3 includes channels 9/10 and 11/12
  Group 4 includes channels 13/14 and 15/16



Aud Stat *Avenue PC Menu*



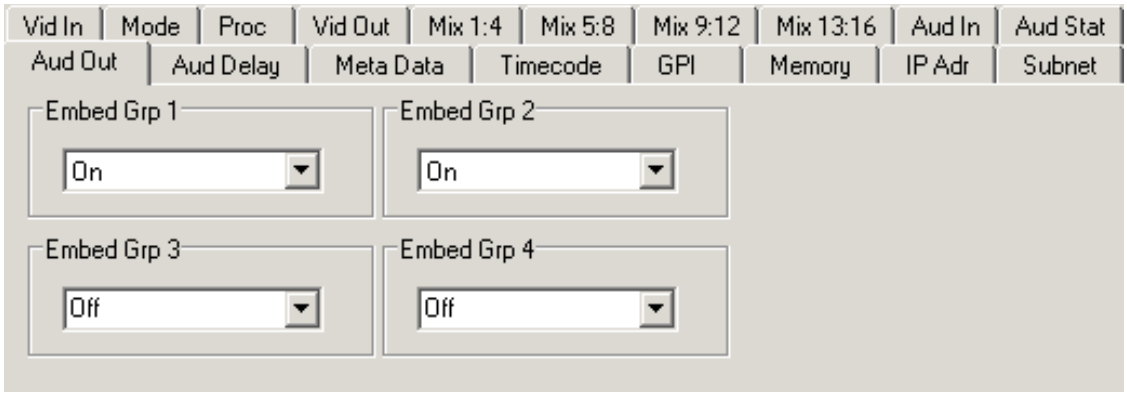
Aud Stat *Touch Screen Menu*

Aud Out Menu

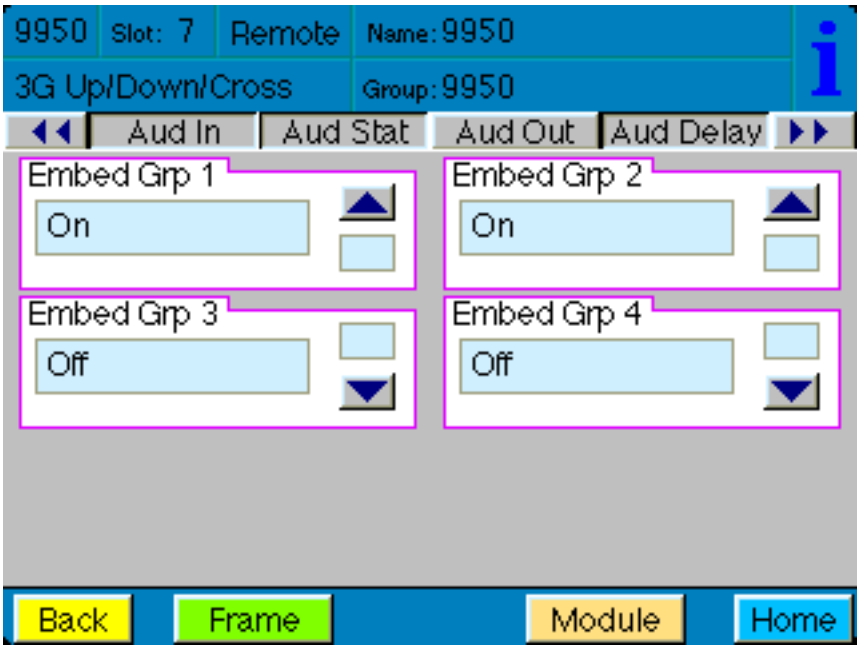
Determining which Audio Channels to Embed into the Outgoing SDI Signal

From the **Aud Out** menu, you can determine which mixer channels are embedded back into the outgoing SDI signal.

In the drop-down controls shown below, **Embed Grp 1** represents embedded channels 1 through 4 and is associated with mixer outputs 1 through 4. Similarly, **Embed Grp 2** represents embedded channels 5 through 8, and is associated with mixer outputs 5 through 8; **Embed Grp 3** represents embedded channels 9 through 12, fed by mixer outputs 9 through 12; **Embed Grp 4** represents embedded channels 13 through 16, fed by mixer outputs 13 through 16. Select **On** for each group of audio channels that you want to embed.



***Aud Out** Avenue PC Menu*

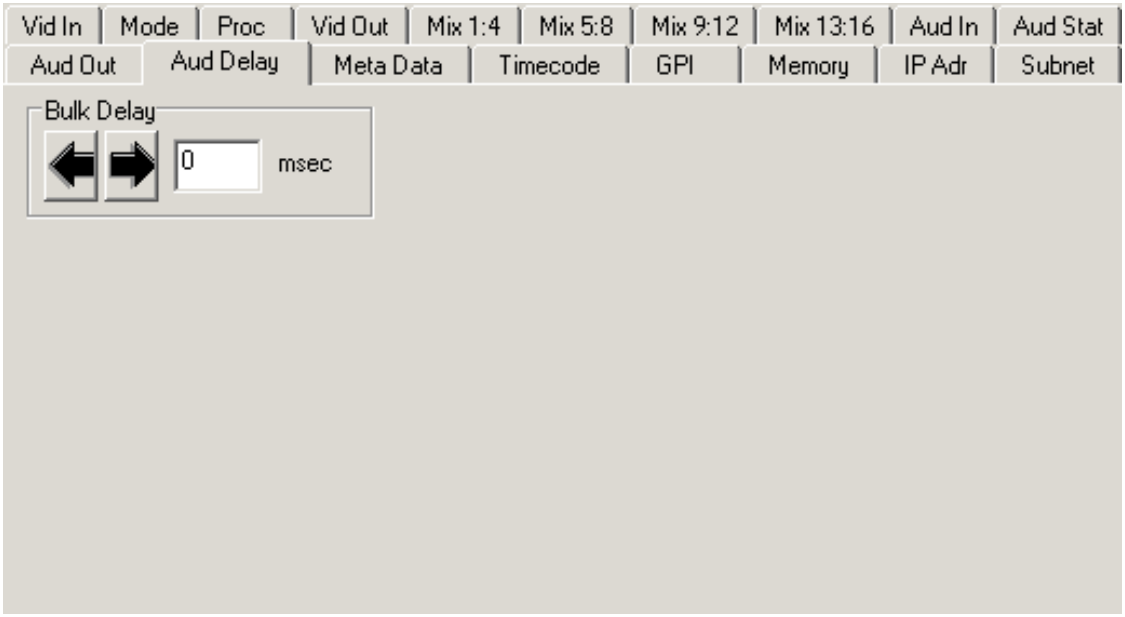


***Aud Out** Touch Screen Menu*

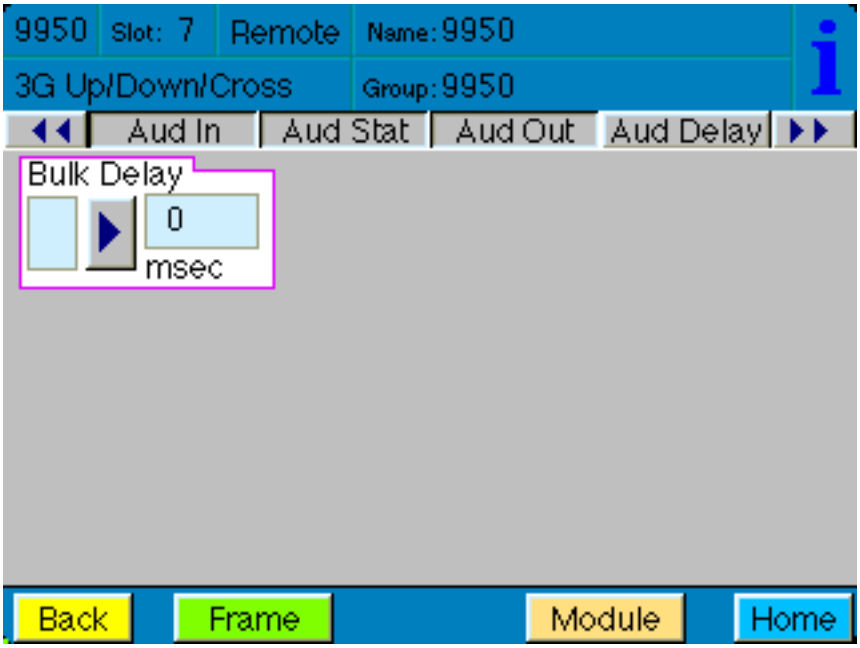
Aud Delay Menu

The **Aud Delay** menu screen shown on the following page allows you to set the amount of additional delay you would like to add to the output.

- **Bulk Delay** – adjust the amount of delay up to 1000 msec.



Aud Delay *Avenue PC Menu*



Aud Delay *Touch Screen Menu*

Meta Data Menu

The **Meta Data** menu shown on the following page auto senses and reports the presence or absence of closed captioning data on the input, allows you to turn closed captions on or off to the output, and provides AFD output selection.

- **CC Input Line -** you do not need to set the value for this control. If an SD signal is present on the input, the module will autosense which line the caption data is on and report that information in the CC Input Line box.

- **Captions In** – reports the status of caption data on the input signal as None, CEA608 or CEA708.

- **Captions Out** – if the **Captions In** display reports the presence of closed captioning, set to:

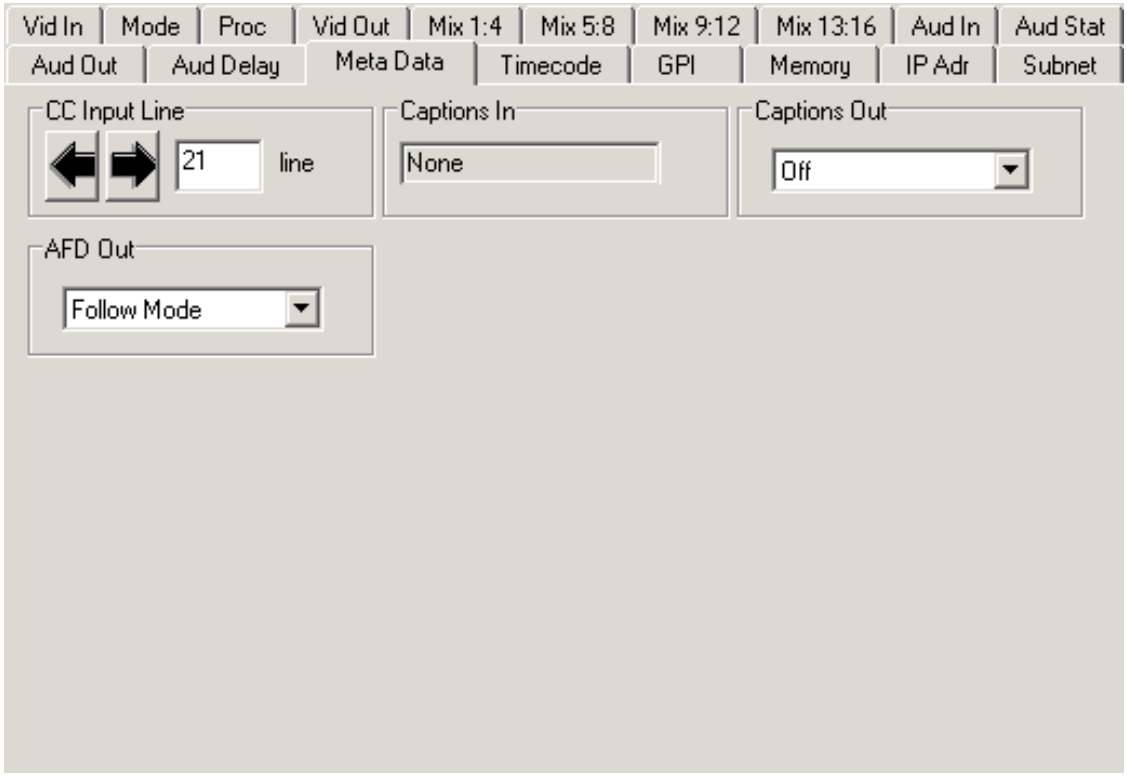
  On – to pass the captions through to the output.

  Off – for no closed captioning on the output.

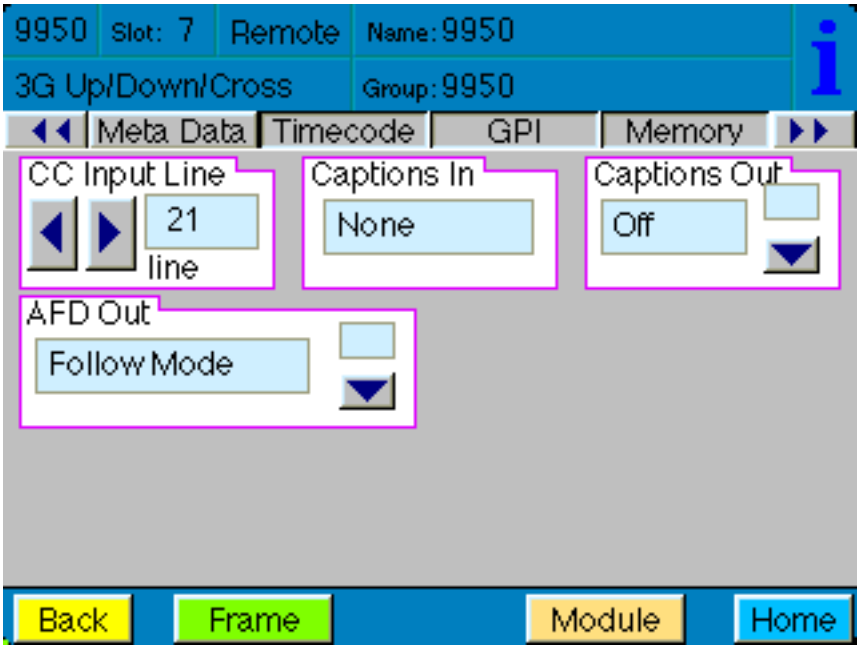
- **AFD Out** – set the AFD (Active Format Description) output code for the desired aspect ratio. AFD is a four-bit code that defines the active image area and protected image areas for various combinations of aspect ratios. This impacts how the aspect ratio of the video content is treated when upconverting or downconverting between the 16:9 and 4:3 aspect ratios. The most commonly used AFD code selections are 1001 and 1010.

  Available selections are:

  Follow Mode – AFD output is determined by the input mode selected
  AFD Off
  AFD 0000
  AFD 0010
  AFD 0011
  AFD 0100
  AFD 1000
  AFD 1001
  AFD 1010
  AFD 1011
  AFD 1101
  AFD 1110
  AFD 1111



Meta Data *Avenue PC Menu*



Meta Data *Touch Screen Menu*

Timecode Menu

The **Timecode** menu shown on the following page allows you to select a timecode source, reports the status of that source, allows you to turn timecode on or off to the output, select the output lines, and enable drop frame correction if desired.

- **TC Src** – select the timecode source from Jam, or VITC lines 14 - 21 as follows:

  Jam – for entering timecode manually into the timecode generator.

  VITC 14-21 – for basing the timecode on the vertical interval timecode found on the line selected.

- **In Status** – reports whether or not timecode is present on the source selected in **TC Src**

- **TC Out** – turn On or Off as follows:

  On – for timecode on the output.

  Off – for no timecode on the output.

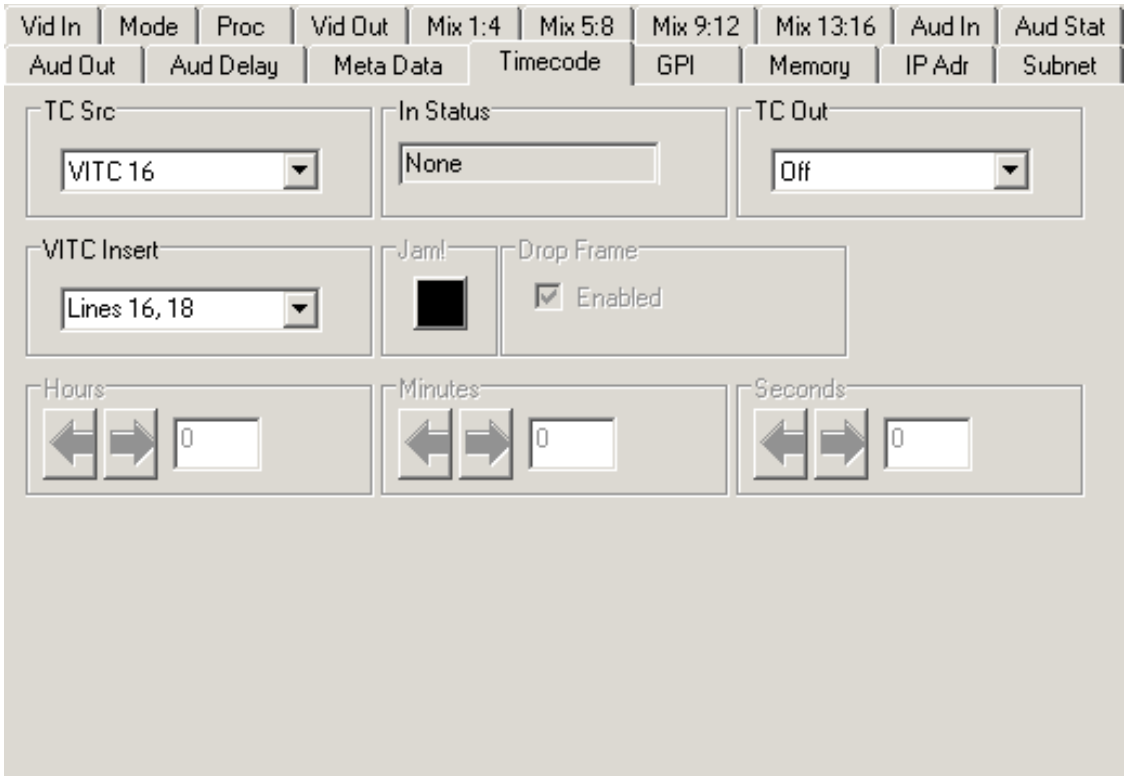
- **VITC Insert** – select the lines on which to insert timecode on the output from:

  Off
  lines 13, 15
  lines 14, 16
  lines 15, 17
  lines 16, 18
  lines 17, 19
  lines 18, 20
  lines 19, 21

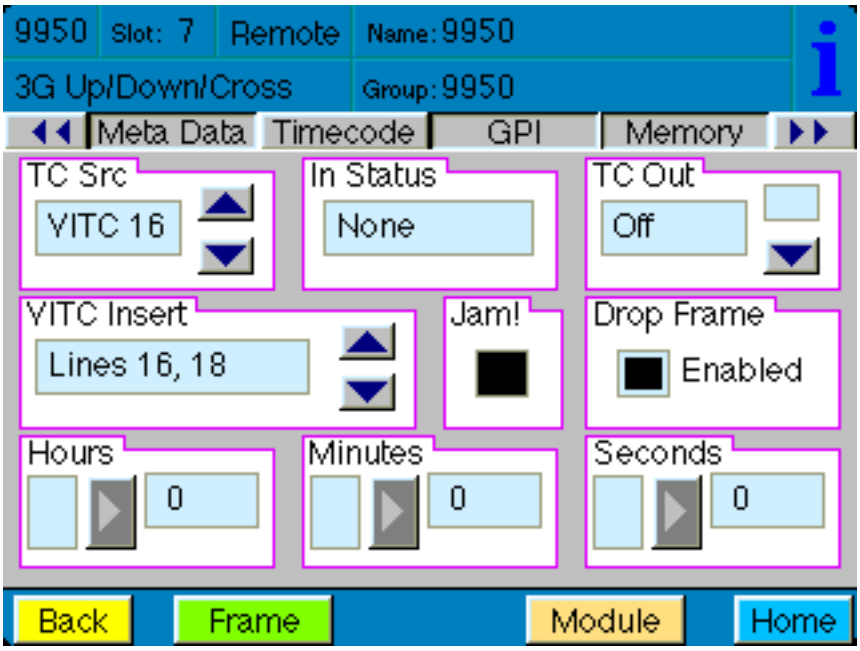
- **Jam!** – to manually enter the starting timecode value into the timecode generator, enter the desired values in the **Hours**, **Minutes** and **Seconds** fields, then click the **Jam!** button to activate.

  Hours – 0 through 23
  Minutes – 0 through 59
  Seconds – 0 through 59

- **Drop Frame** – Select the checkbox to enable Drop Frame (dropping two frames every minute except on every tenth minute) to allow timecode to match a real-time clock.



Timecode *Avenue PC Menu*



Timecode *Touch Screen Menu*

GPI Menu

The **GPI** menu screen shown on the following page allows configuration of the three external GPI inputs. The GPI inputs are asserted when the 9950 detects a negative going edge on the input.

The **GPI 1 Mode** can be set to one of the following:

- **Off** – disables the GPI 1 input, located on pin 7 of the 9 pin female D connector.
- **Neg Edge Reg 1** – tells the processor to switch to the Memory Register 1 presets when the pin transitions from a high voltage to a low voltage.

The **Pri GPI 1 Status** report window indicates the GPI status as either:

- **GPI is Low** – indicates GPI 1 pin 7 is low.
- **GPI is High** – indicates GPI 1 pin 7 is high.

The **GPI 2 Mode** can be set to one of the following:

- **Off** – disables the GPI 2 input, located on pin 8 of the 9 pin female D connector.
- **Neg Edge Reg 2** – tells the processor to switch to the Memory Register 2 presets when the pin transitions from a high voltage to a low voltage.

The **Pri GPI 2 Status** report window indicates the GPI status as either:

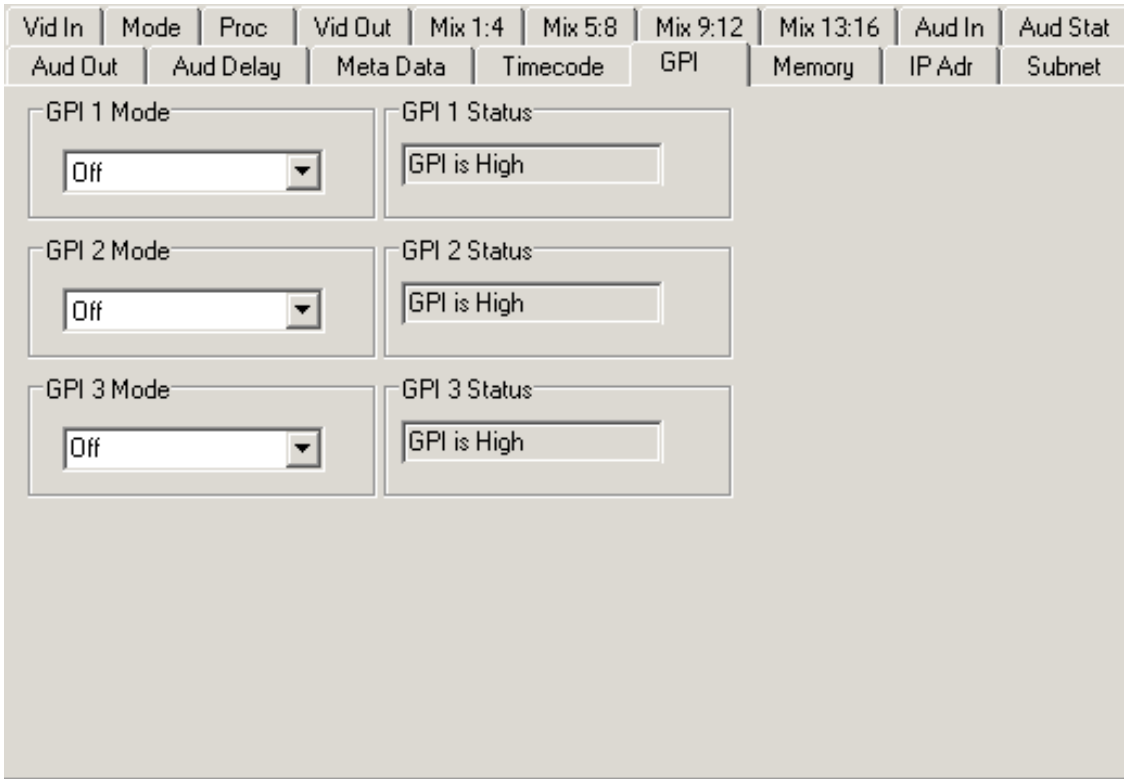
- **GPI is Low** – indicates GPI 2 pin 8 is low.
- **GPI is High** – indicates GPI 2 pin 8 is high.

The **GPI 3 Mode** can be set to one of the following:

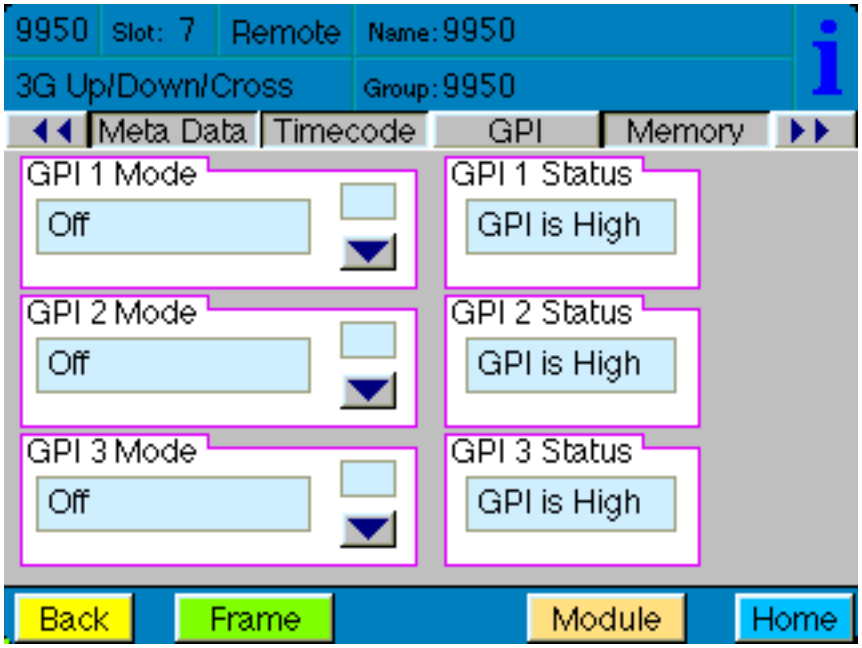
- **Off** – disables the GPI 3 input, located on pin 9 of the 9 pin female D connector.
- **Neg Edge Reg 3** – tells the processor to switch to the Memory Register 3 presets when the pin transitions from a high voltage to a low voltage.

The **Pri GPI 3 Status** report window indicates the GPI status as either:

- **GPI is Low** – indicates GPI 3 pin 9 is low.
- **GPI is High** – indicates GPI 3 pin 9 is high.



***GPI** Avenue PC Menu*



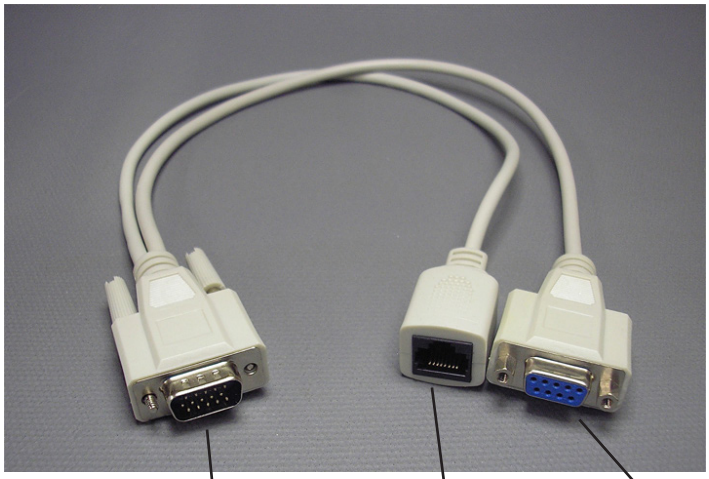
***GPI** Touch Screen Menu*

General Purpose Interface: GPI

In addition to full monitoring and access through the control system, 9950 modules provide contact closure status indications. The 9950 can be configured to work with external devices through the GPI interface via the 23000048 Interface Adapter Cable. The 9950 module's GPI output connections can drive an alarm system or other external devices, including LEDs. The module's two override GPI inputs are accessed through the 9 pin D connector and are enabled through Avenue PC software. The GPI inputs are edge-triggered on a negative pulse, or simply a falling edge.

The 23000048 Interface Adapter Cable connects to the 15 pin D connector on the back of the Avenue frame that is associated with the 9950 module. This cable comes with each 9950 module and provides a 9 pin D connector for GPI control, and an Ethernet port for software upgrades. Please see the photo below as well as the illustrations on the following page for detailed cable and pinout information.

Ensemble Designs p/n 23000048 Interface Adapter Cable, pictured below, is included with each 9950 module.
This "Y" adaptor cable provides a 9-pin D connector for GPI control, and an Ethernet connection for software upgrades.

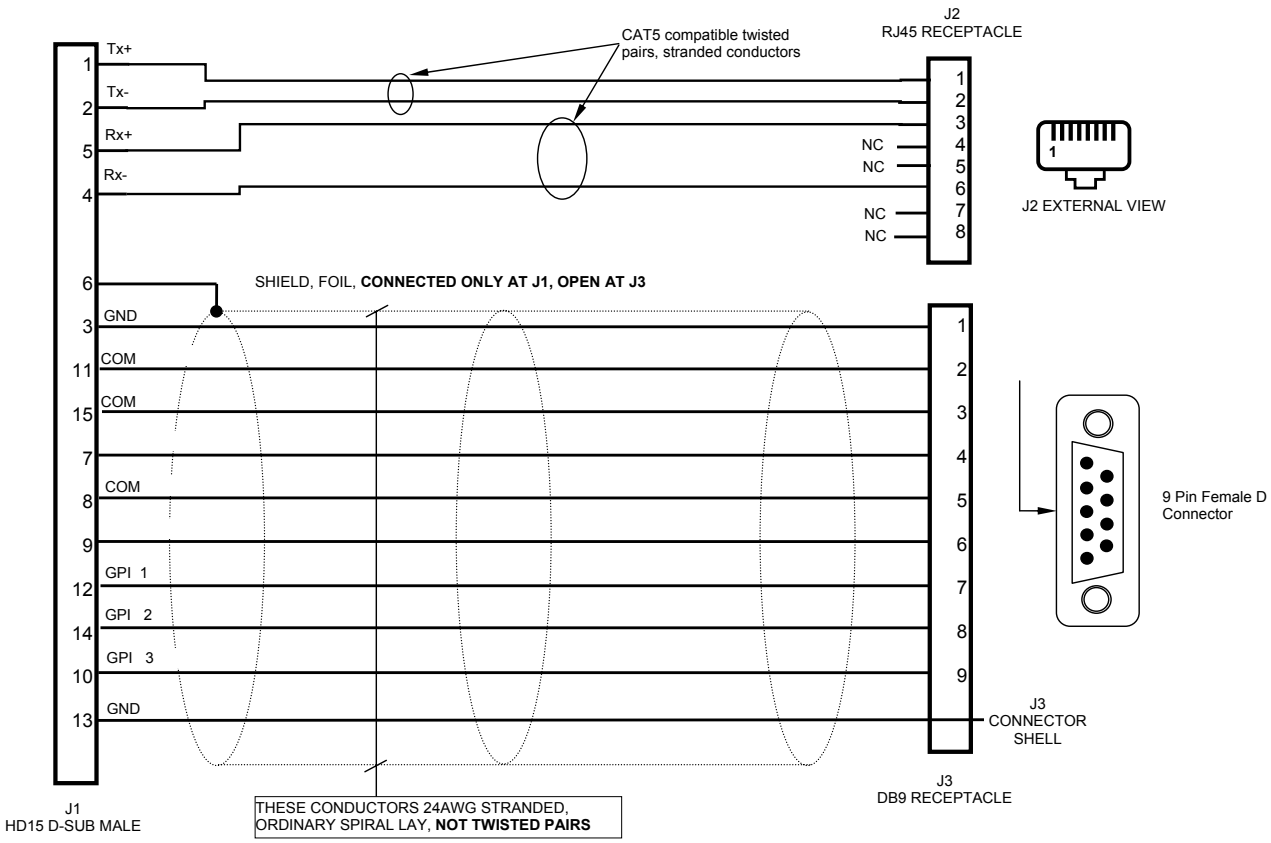


Connect the male 15 pin D connector to the female 15 pin D connector on the rear of the Avenue frame that corresponds to the 9950 module.

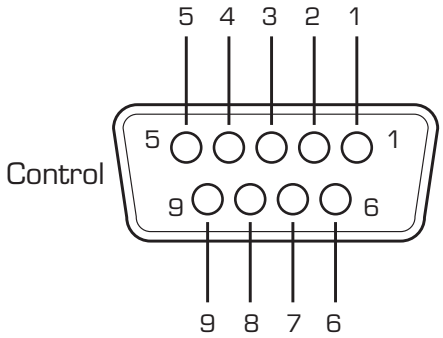
Ethernet port for software upgrades.

9 pin female D connector for control. Pinouts and details are on the following pages.

23000048 Interface Adapter Cable Drawing and Pinouts



9 pin female D connector



PIN	FUNCTION
1	Gnd
2	Com
3	Com
4	
5	Com
6	
7	GPI 1
8	GPI 2
9	GPI 3

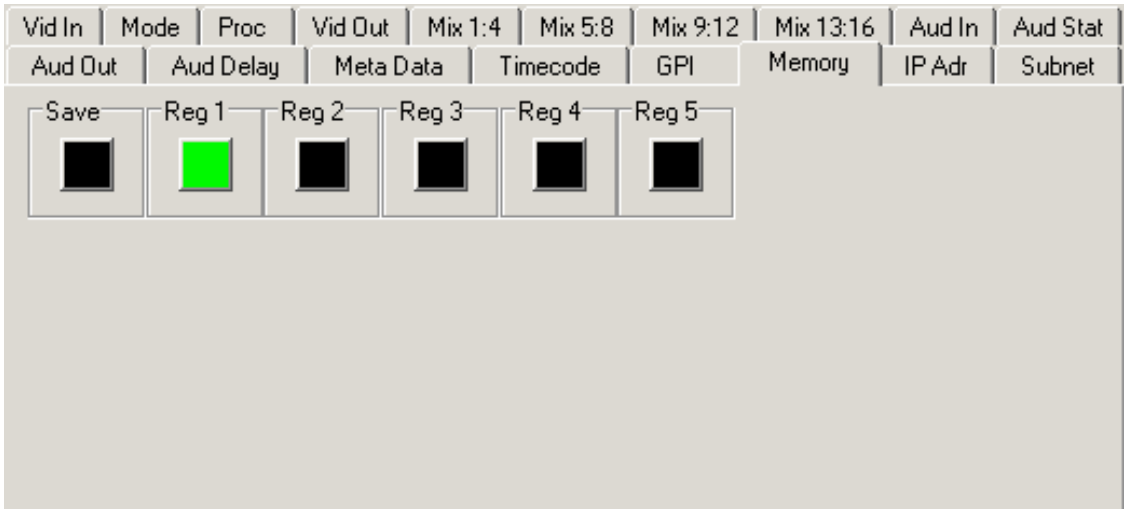
Memory Menu

Saving and Recalling Multiple Configurations for the 9950 Module

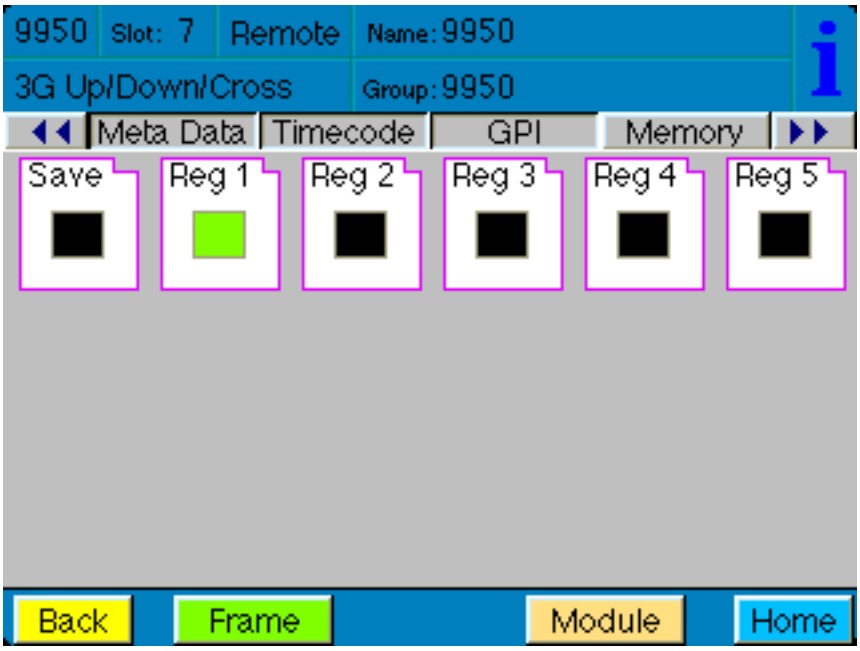
The Memory menu allows you to save and recall overall module setups to five memory registers.

Select **Save**, then select one of the five memory registers **Reg 1 – Reg 5**. The box will turn green. The entire module setup is now saved in the selected memory register.

To recall a register, select the register box. If there is information saved, the box will turn green. The saved setup will now be loaded to the module. Up to five different module setups can be saved and recalled using the individual registers.



***Memory** Avenue PC Menu*



***Memory** Touch Screen Menu*

Software Updates

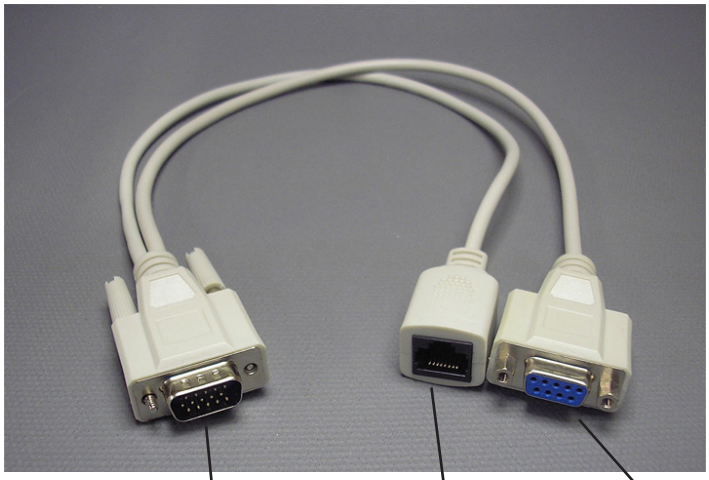
Software updates for the 9950 module are done via Ethernet. Software updates are free for life and can be downloaded onto your PC or Mac from the following website:

http://www.ensembledesigns.com/support/avenue-support/avenue-software

Each 9950 comes with a "Y" adaptor cable that provides Ethernet and GPI control. The 23000048 Interface Adapter Cable cable, shown below, connects to the 15 pin D connector associated with the 9950 module on the back of the Avenue frame. The Ethernet is used for software upgrades and the 9 pin D connector is used for GPI control.

Software updates are done with a web browser through the Ethernet connection, not thorough Avenue PC. A synopsis of the steps for updating software is on the following page. Detailed instruction instructions for updating software in your 9950 module follow, including setting the IP address and subnet mask of the 9950 are on the subsequent pages.

The "Y" adaptor cable pictured below is the Ensemble Designs p/n 23000048 Interface Adapter Cable. It provides an Ethernet connection for software upgrades and a 9-pin GPI connector for control.



Connect the male 15 pin D connector to the female 15 pin D connector on the back of the frame that corresponds to the 9950 module

Ethernet port for software upgrades

9 pin female D connector for control.

Step by Step Overview for Updating Software in your 9950:

Step 1. Connecting the Cable

Attach the 23000048 Interface Adapter Cable to the 15 pin D connector associated with the 9950 module on the back of the Avenue frame. Connect an Ethernet cable from the Ethernet port end of the "Y" cable to your network. The Ethernet port will auto-sense cable direction, so a cross-over cable is not needed.

Step 2. Setting the IP Address

Use the IP Address menu in Avenue PC or on your Touch Screen to assign a unique IP address to the 9950 module.

Step 3. Setting the Subnet Mask

Use the Subnet menu in Avenue PC or on your Touch Screen to set the subnet mask for the 9950 module.

Step 4. Download Current Software

Download the current software for 9950 to your PC or Mac from the following website:

http://www.ensembledesigns.com/support/avenue-support/avenue-software

Step 5. Navigate to your 9950 Module through a Web Browser

On a computer that is networked to the Avenue frame, type the IP address of the 9950 into the address bar of your web browser. The Setting: General Information window will come up.

Step 6. Update the Module Software

In the Setting: General Information window, click the Choose File button. Navigate to the software that you downloaded to your computer in Step 4. Click the Start Update button. The Updating Firmware window will come up. The updating process can take several minutes.

Detailed Instructions for Updating Software in your 9950:

Updating Software: Step 1. Connecting the Cable

Attach the 23000048 Interface Adapter Cable to the 15 pin D connector associated with the 9950 module on the back of the Avenue frame. Connect an Ethernet cable from the Ethernet port end of the "Y" cable to your network. The Ethernet port will auto-sense cable direction, so a cross-over cable is not needed.

Updating Software: Step 2. Setting the IP Address

Assign a unique IP address to the 9950 module. Use the IP Address menu in Avenue PC or on your Touch Screen. The IP Address menu is detailed below an illustrated on the following page.

IP Adr Menu

The **IP Adr** menu shown on the following page allows you to change the IP address of your 9950 module. When you initially power up the 9950 as received from the factory, it will take the self-assigned static IP address of 192.168.1.100. In order to use the Ethernet port to update module software, you will need to assign anew IP address.

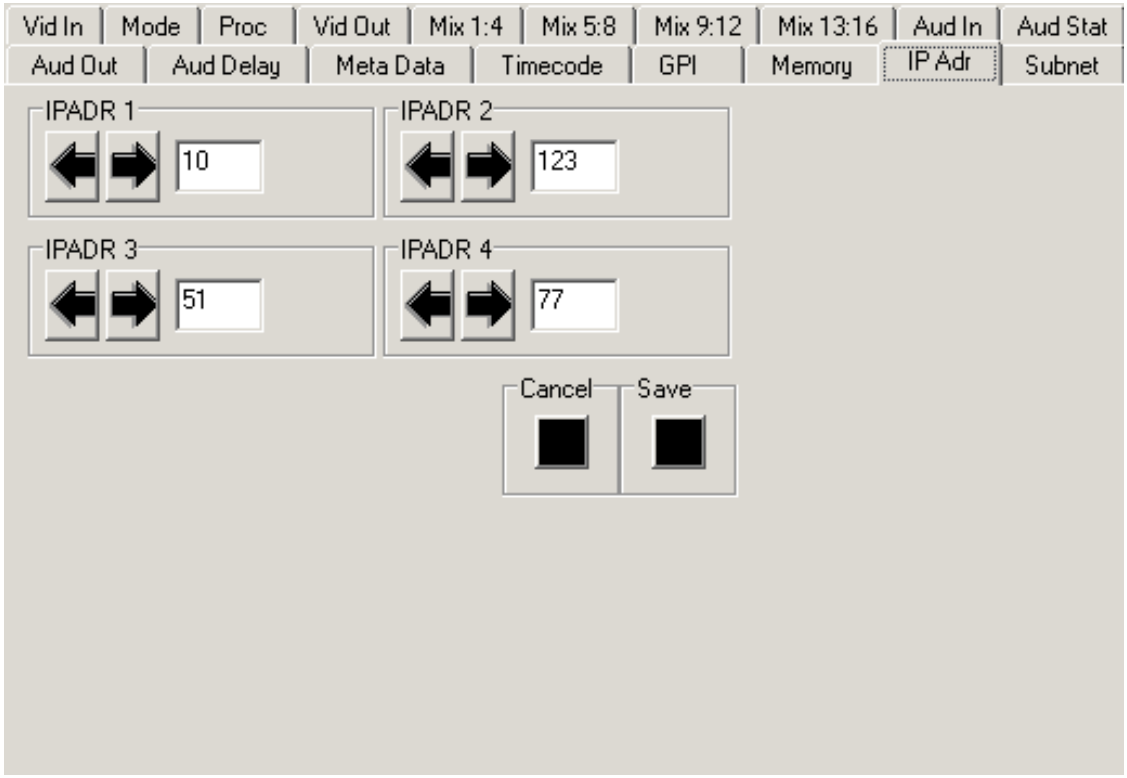
These are general instructions. We recommend that you consult your IT staff if you are uncertain about any of these network configuration settings.

To Set the IP Address

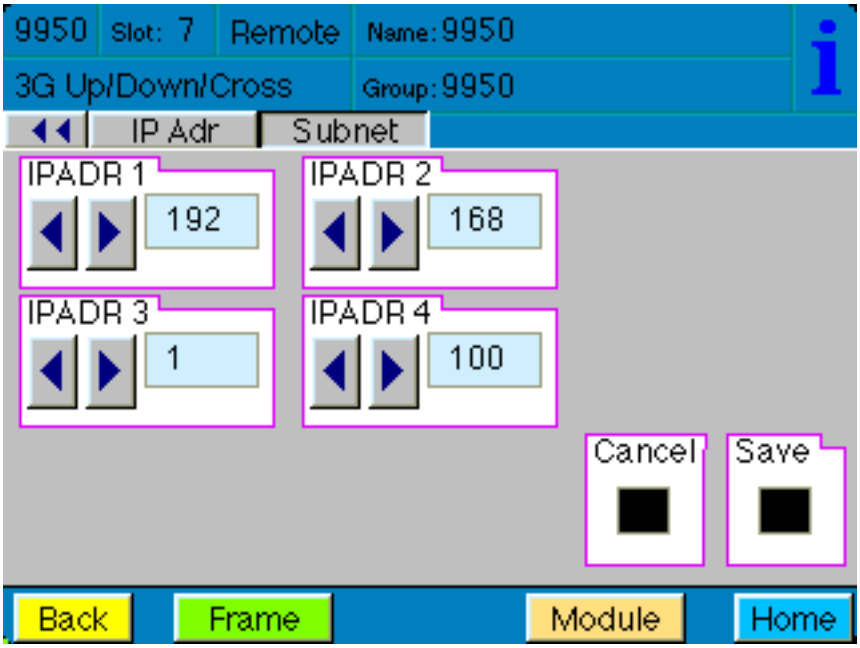
1. From the **IP Adr** menu, enter the IP address you want to use that is compatible with your own network. The simplest method is to touch each number field, using the keypad to enter the new numbers. For example, you may want to change the IP address to something like the following: 10.123.222.100. These are general instructions. We recommend that you consult your IT staff if you are uncertain about any of the network configuration settings.

2. Press **Save**. Both the **Cancel** and **Save** buttons turn black to indicate that your new settings have been saved.

Note that when using Avenue PC instead of the Touch Screen interface, after entering numbers into the number fields, you will need to hit the "enter" or "return" key for the change to register.



***IP Adr** Avenue PC Menu*



***IP Adr** Touch Screen Menu*

Updating Software: Step 3

Set the subnet mask for the 9950 module. Use the Subnet menu in Avenue PC or on your Touch Screen. The Subnet menu is detailed below an illustrated on the following page.

Subnet Menu

The **Subnet** menu shown on the following page allows you to change the subnet mask of your 9950 module. In order to use the Ethernet port to update module software, the subnet mask must be set in accordance with the size and topology of your network. The default setting as received from the factory is for a smaller network: 255.255.255.0. For a larger network, a typical setting is 255.255.0.0. If in doubt, use the setting for a larger network.

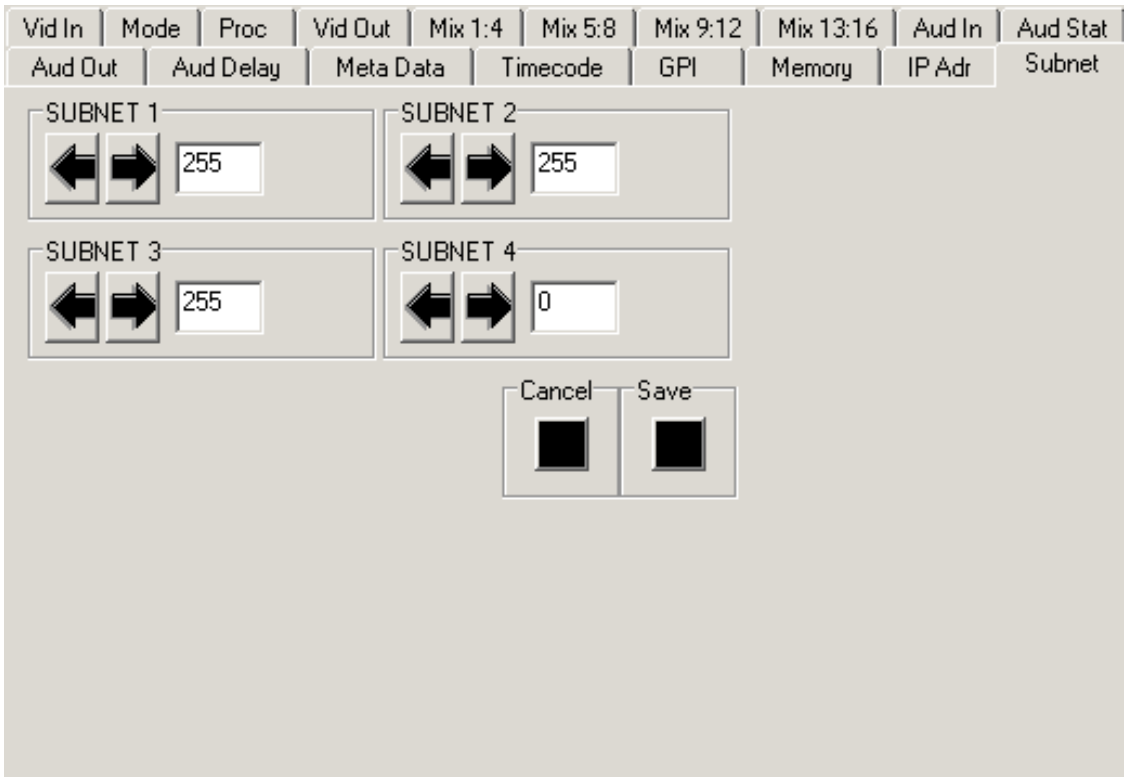
These are general instructions. We recommend that you consult your IT staff if you are uncertain about any of these network configuration settings.

To Set the Subnet Mask

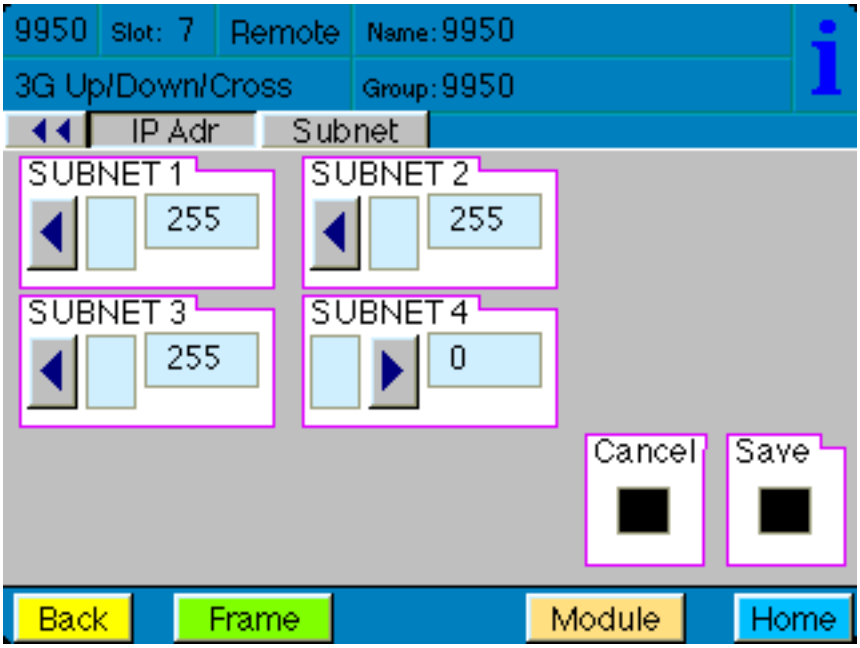
1. From the **Subnet** menu, modify the settings as needed. Use the arrow buttons to change the settings, or touch each number field to use the keypad.

2. When finished, press **Save**. Both the **Cancel** and **Save** buttons turn black to indicate that your new settings have been saved.

Note that when using Avenue PC instead of the Touch Screen interface, after entering numbers into the number fields, you will need to hit the "enter" or "return" key for the change to register.



Subnet *Avenue PC Menu*



Subnet *Touch Screen Menu*

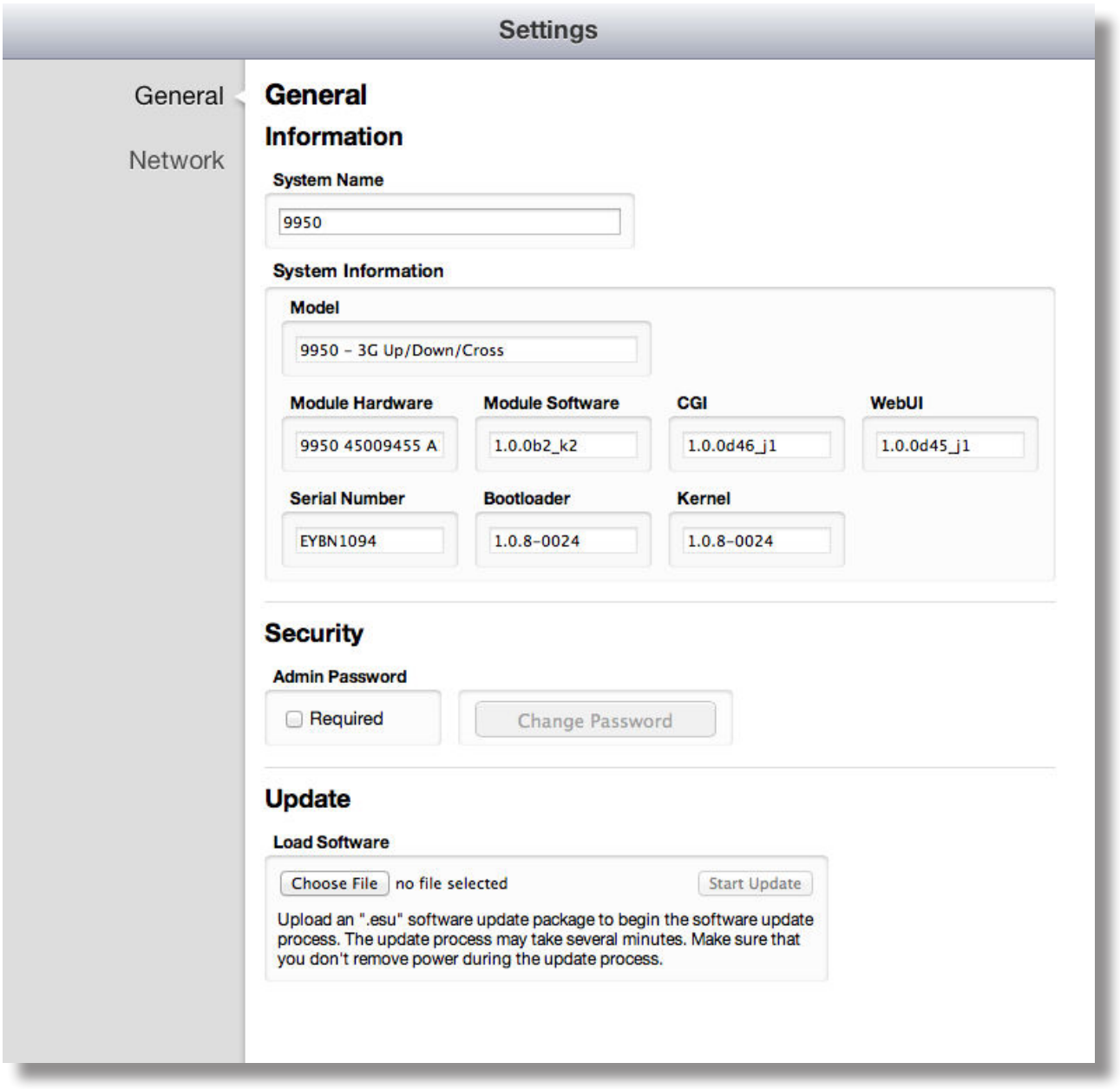
Updating Software: Step 4. Download Current Software

Download the current software for 9950 to your PC or Mac from the following website:

http://www.ensembledesigns.com/support/avenue-support/avenue-software

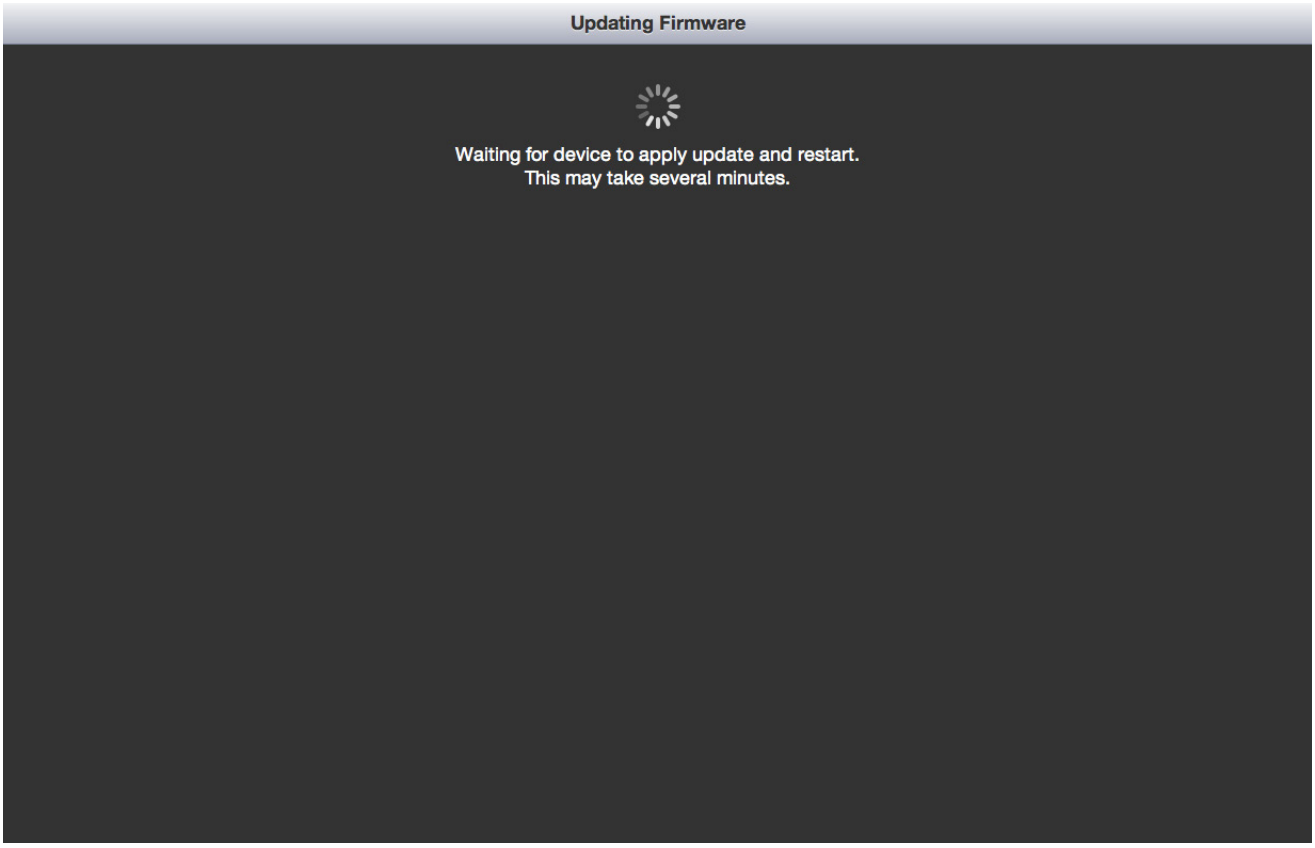
Updating Software: Step 5. Navigate to your 9950 Module through a Web Browser

On a computer that is networked to the Avenue frame, type the IP address of the 9950 into the address bar of your web browser. The Setting: General Information window will come up, shown below.



Updating Software: Step 6. Update the Module Software

In the Setting: General Information window, click the Choose File button and navigate to the software that you downloaded to your computer in Step 4. Click the Start Update button. The Updating Firmware window, shown below, will come up. The updating process can take several minutes.



Troubleshooting

As a troubleshooting aid, reference signal status and presence, as well as power and CPU status can be easily monitored from the front panel of the 9950 module using the front panel indicators.

Refer to the troubleshooting tips below:

Can't control module

- Check status of CPU Run green LED. Should be blinking slowly and in unison with other modules if 5030 System Control module is present. If not, try removing the 9950 and plugging it in again to be sure it is seated properly.
- 5030 System Control module may not be working properly if installed.

Module controls are grayed out

- Module is locked or access to module controls is restricted by User Level.

Mix menus look strange or do not appear at all

- Be sure you are running the most recent version of software for both Avenue PC and your 5030 System Control module.

Please also refer to the technical support section of the Ensemble Designs web site for the latest information on your equipment at the URL below:

http://www.ensembledesigns.com/support

Warranty and Factory Service

Warranty

This module is covered by a five-year limited warranty, as stated in the main Preface of this manual. 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.

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

tel +1 530.478.1830
fax +1 530.478.1832

service@ensembledesigns.com

www.ensembledesigns.com

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

Specifications

Input

Number	One
Signal Type	HD Serial Digital 2.97 Gb/s SMPTE 424M, 425M HD Serial Digital 1.485 Gb/s SMPTE 274M, 292M or 296M SD Serial Digital 270 Mb/s, SMPTE 259M Both 525 and 625 standards
Impedance	75 Ω
Return Loss	>15dB to 1.485 GHz
Max Cable Length	270 Mb/s 300 meters Belden 1694A 1.485 Gb/s 100 meters Belden 1694A 2.97 Gb/s 70 meters Belden 1694A

Automatic Cable Input Equalization

Standards Supported

1080p 50, 59.94 Hz, SMPTE 424M, 425M, Level A
1080i 50, 59.94 or 60 Hz, SMPTE 274M -4,5,6
720p 50, 59.94 or 60 Hz, SMPTE 296M -1,2,3
525i 59.94, 625i 50, SMPTE 259M

Format Conversion

HD 50, 59.94 or 60 Hz to/from HD 50, 59.94 or 60 Hz
SD 50, 59.94 or 60 Hz to/from HD 50, 59.94 or 60 Hz

Serial Digital Output

Number	Four (one fail-safe bypass)
Signal Type	HD Serial Digital 2.97 Gb/s SMPTE 424M, 425M HD Serial Digital 1.485 Gb/s SMPTE 274M, 292M or 296M SD Serial Digital 270 Mb/s, SMPTE 259M Both 525 and 625 standards
Impedance	75 Ω
Delay	Up to 8 frames
Return Loss	>15dB to 1.485 GHz

General Specifications

Power Consumption	13 watts
Temperature Range	0 to 40°C ambient (all specs met)
Relative Humidity	0 to 95%, noncondensing
Altitude	0 to 10,000 ft

9950 module cannot be installed in slot 3 of a 1RU frame when 5035 System Control module is installed

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 sinewave. 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 ever 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 Work 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.