UDC-HD-XMUX4
CRC-HD-XMUX4
UPC-HD-XMUX4

HD/SD-SDI Format converter with

Frame Synchronizer and 4x AES I/O

User manual

Rev. 1

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Revision history

Current revision of this document is the uppermost in the table below.

Rev.	Repl.	Date	Sign	Change description
1	0	2011-06-09	TB	Added sections on difference between variants, maximum audio delay, and new scaling logic. Added Declaration of Conformity.
0	-	2010-06-14	JD	Initial release.

Contents

1 Product overview

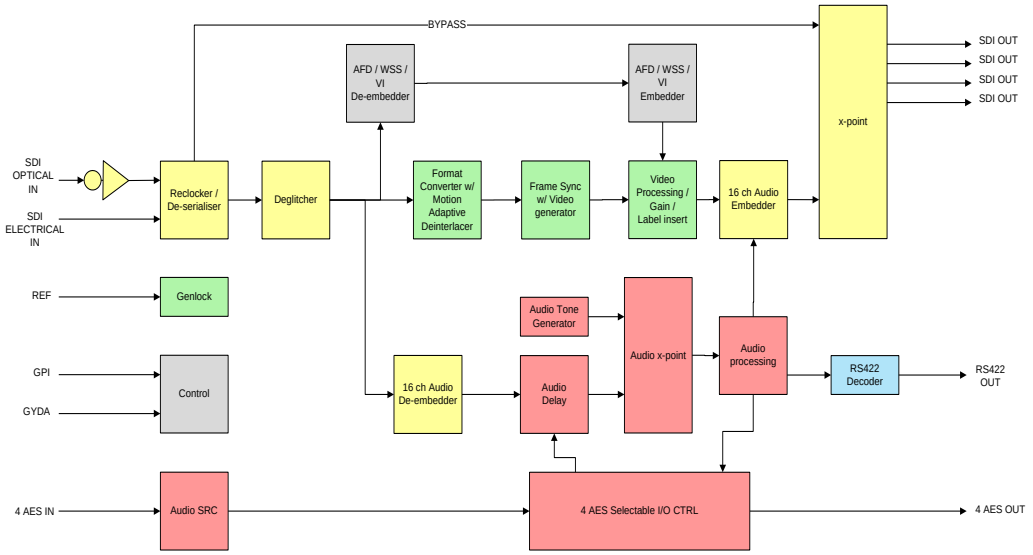


Figure 1: Simplified block diagram of the UDC-HD-XMUX4 card

1.1 Product description

The Flashlink UDC-HD-XMUX4 is a format converter converting between all HD and SD formats of the same frame rate. It can synchronize the outgoing HD-SDI or SD-SDI to a reference, and the reference can either be a traditional black & burst signal or tri-level sync. The HD-SDI/SD-SDI outputs can be adjusted relative to the sync signal. All product variants also have a de-glitcher to give error-free synchronous switching.

The audio embedded on the SDI is de-embedded and can be delayed relative to the video. Each audio stereo pair can be swapped in a matrix before they are embedded back into the SDI stream.

The parameters of the card can be adjusted either manually by switches on the board, or via the control interface MULTICON GYDA.

1.2 Product versions

UDC-HD-XMUX4	Up / cross / down converter converting between 1080i, 720p and SD, 4AES I/O, 4 SDI outputs
UDC-HD-XMUX4-R	Up / cross / down converter with short haul optical receiver, 9/125um single mode optical input, 4AES I/O, 4 SDI outputs
UDC-HD-XMUX4-R-L	Up / cross / down converter with long haul optical receiver 9/125um single mode optical input, 4AES I/O, 4 SDI outputs
CRC-HD-XMUX4	Cross converter converting between 1080i and 720p, 4AES I/O, 4 SDI outputs
CRC-HD-XMUX4-R	Cross converter with short haul optical receiver, 9/125um single mode optical input, 4AES I/O, 4 SDI outputs
CRC-HD-XMUX4-R-L	Cross converter with long haul optical receiver 9/125um single mode optical input, 4AES I/O, 4 SDI outputs
UPC-HD-XMUX4	Up converter converting from SD to 1080i or 720p, 4AES I/O, 4 SDI outputs
UPC-HD-XMUX4-R	Up converter with short haul optical receiver, 9/125um single mode

	optical input, 4AES I/O, 4 SDI outputs
UPC-HD-XMUX4-R-L	Up converter with long haul optical receiver 9/125um single mode optical input, 4AES I/O, 4 SDI outputs

1.3 Key features for all product variants

- Motion adaptive de-interlacing
- Long haul optical input available (-30dBm sensitivity)
- 4 x HD-SDI outputs
- 4 x AES I/O
- AFD, WSS, WSS-EXT, VI support
- De-glitching of input video signal (always seamless output)
- Frame synchronizer
- Luma/chroma gain and level adjustment
- Audio delay enabling Dolby-E processing delay correction
- Audio router for embedded audio
- Embedded audio gain adjustment
- SDI in-monitor label inserter
- EDH processing
- 12 predefined aspect ratio conversions
- 12 user defined aspect ratio conversions

1.4 Differences between the product variants

The UDC-HD-XMUX4(-R(-L)) is the full featured product, the up-/down-/cross-scaler. There is nothing that can be done with the lesser versions of the module that can't be done with the UDC-HD-XMUX4(-R(-L)).

The UPC-HD-XMUX4(-R(-L)) is an up-scaler only. The only differences from the full featured product is that the UPC-HD-XMUX4(-R(-L)) is unable to lock onto HD-SDI inputs, and that no SD-SDI formats can be selected as output.

The CRC-HD-XMUX4(-R(-L)) is an HD cross-scaler only. The only differences from the full featured product is that the CRC-HD-XMUX4(-R(-L)) is unable to lock onto SD-SDI inputs, and that no SD-SDI formats can be selected as output.

The UDC-HD-XMUX4(-R(-L)) is thus the only variant of this module that can do aspect ratio conversions with SD-SDI as both input and output. The lower-cost versions of this module are complemented by the ARC-SD-DMUX and the ARC-SD-XMUX4, which are both dedicated SD-SDI aspect ratio converters available in several variants.

2 Specifications

Optical SDI input

Data rate optical:	270 – 1485 Mbps
Sensitivity	
- SD-/HD-SDI (270/1485 Mbps):	Better than -20dBm (short haul) /-30dBm (long haul)
Detector overload threshold:	Min. -3dBm (-7dBm long haul version)
Detector damage threshold:	>+1dBm
Optical wavelength:	1200-1620nm
Transmission circuit fiber:	9/125um Single Mode
Connector return loss:	>40dB w/ SM fiber
Connector:	SC/UPC

Electrical SDI input

Connectors	75 Ohm BNC
Equalization	Automatic; >300m @270Mbps w/Belden 8281, with BER < 10E-12 >100m @1485Mbps w/Belden 1694A, with BER < 10E-12
Input Return loss	>15dB, 5MHz -1.5GHz
Jitter tolerance	SD limit: 10Hz-1kHz: >1 UI 10kHz – 5MHz: >0.2 UI HD limit: 10Hz-100kHz: >1 UI 100kHz–10MHz: >0.2 UI

Electrical Sync input

Connector	75 Ohm BNC
Format	Black & Burst, Tri-level
Input Return loss	>35dB @ < 10MHz, 30dB @ < 30MHz
Termination	Selectable internal or external 75 Ohm termination

Electrical SDI outputs

Number of outputs	4
Connectors	75 Ohm BNC
Output Return loss	>15dB, 5MHz -1.5GHz
Output signal level	800mV +/- 10%
Output signal rise / fall time	SD limit: [0.4ns – 1.5ns]; <0.5ns rise/fall var.
20% - 80%	HD limit: < 270ps, <100ps rise/fall var.
Amplitude overshoot	<10%
Output timing jitter	SD: <0.2 UI

	HD: <1 UI
Output alignment jitter	SD: <0.15 UI
	HD: <0.15 UI

AES I/O

Number of inputs/outputs	4
Connectors	WECO
Return loss	110R +/-20% 0.1MHz – 6.144MHz
Output jitter	<0.0025UI peak
Impedance	110 ohm transformer balanced
Input audio data rate	24 kHz to 100kHz, converted to 48 kHz if not isochronous to either SDI input or sync input.
Embedded audio word length	24 bits
Embedded audio Channels status	As received when isochronous, otherwise replaced by a static value.

Supported standards

SD, 270 Mbps	SMPTE 259M, SMPTE 272M-AC
HD, 1485 Mbps	SMPTE 292M, SMPTE 274M, SMPTE 291M, SMPTE 296M, SMPTE 299M
Color space conversions	BT.601, BT.709
Video switch point definition and sync	SMPTE RP168 (tri-level), SMPTE 170m, ITU-R. BT.470
AES	AES3-1996
Optical	SMPTE 297M, SMPTE 292M
EDH	Compliant to SMPTE-RP165
Video Payload Identification	SMPTE 352M-2002

Power consumption (+5VDC)

	UPC-HD-XMUX4	CRC-HD-XMUX4	UDC-HD-XMUX4
Absolute maximum	6.4W	8.0W	8.0W
W/o optical input module	-0.3W	-0.3W	-0.3W
All AES configured as inputs (unused)	-0.5W	-0.5W	-0.5W

3 Configuration

The board can be configured either manually or through the Network control system *Multicon GYDA.* Only a subset of the configurable parameters is available when operating in manual mode.

3.1 Manual mode

To reach manual mode, the DIP16 labeled OVR on the board must be switched on (to the right) and the board must be re-booted. This takes the board out of Multicon GYDA control (if it was previously set to off) and into DIP switches and rotary switch control. Settings not affected by any of these switches are kept unchanged from previous session (factory default or Multicon GYDA setup).

The Manual Mode configuration controls are all found on the front side of the board. There are three sets of DIP switches, one rotary switch, and two push buttons. The slide switch in the lower right in Figure 2 below selects the source for the sync input (backplane or frame distributed). No software override exists for this switch, it is active in both modes of operation.

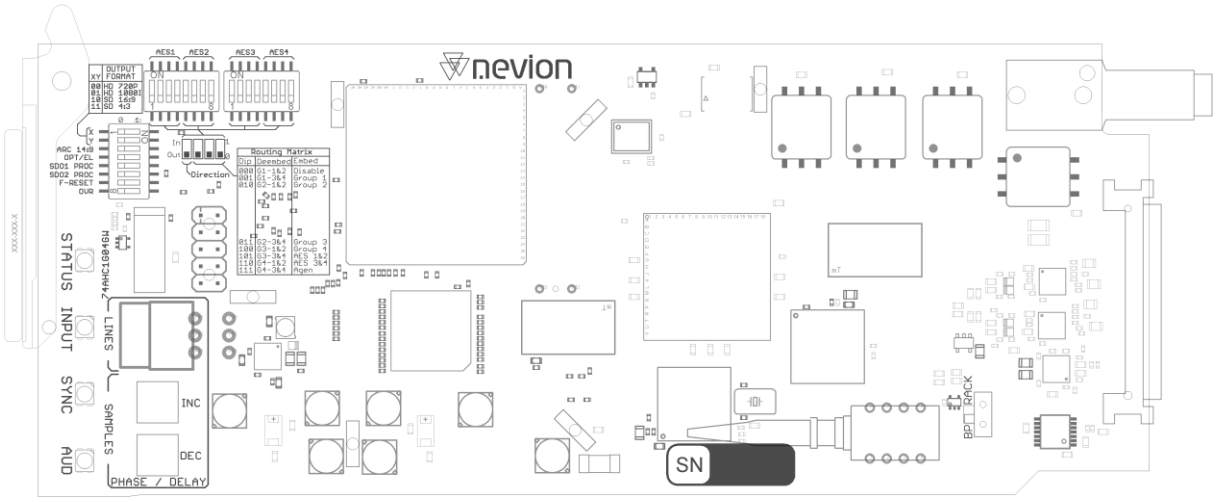


Figure 2: The figure shows a top view component printout of the board.

3.1.1 Rotary switch and push buttons

The *rotary switch*, labeled DLY, adjusts the *phase delay* from -5 to +4 video lines. It is only functional when a sync signal, black & burst or tri-level, is present at the selected sync input. The rotary switch is accessible from the card front.

The *push buttons,* labeled INC and DEC, are used to fine adjust the *phase delay* one sample at a time. It can adjust within +/- ½ video lines for the present video standard. Pressing both buttons simultaneously will reset the number of samples to 0.

3.1.2 Factory reset function

The factory reset puts the card back to its initial settings at delivery. These settings are just a start condition for the board, and new settings applied by the user will still take effect and be stored.

The factory reset is initiated by setting the DIPs marked F-RESET and OVR to the ON position and booting the card. The card will display an orange status LED, while all the other LEDs are dark. The card should then be booted again with the F-RESET DIP returned to the OFF position. The card will then complete the internal reset and start as normal.

3.1.3 DIP switch functions

Note that the left DIP switch of the horizontal DIP package is number 1. The top DIP switch of the vertical DIP package is number 17.

<table>
<tr><th>Switch #</th><th>Function name</th><th colspan="3">Function DIPs</th><th>Comment</th></tr>
<tr><td>1</td><td>AES1 dir</td><td colspan="3">Off = output
On = input</td><td>AES 1 input or output, if AES1 is input, DIP 2-4 routes GROUP 1.</td></tr>
<tr><td rowspan="9">2-4</td><td rowspan="9">AES1/GRP 1 routing</td><td>DIP 234</td><td>Group 1 Embeddin g</td><td>AES1 output Deembed ding</td><td rowspan="9">Routing matrix to AES1 or GROUP 1</td></tr>
<tr><td>000</td><td>Disable</td><td>Group 1 ch 1&2</td></tr>
<tr><td>001</td><td>Group 1</td><td>Group 1 ch 3&4</td></tr>
<tr><td>010</td><td>Group 2</td><td>Group 2 ch 1&2</td></tr>
<tr><td>011</td><td>Group 3</td><td>Group 2 ch 3&4</td></tr>
<tr><td>100</td><td>Group 4</td><td>Group 3 ch 1&2</td></tr>
<tr><td>101</td><td>AES1&2</td><td>Group 3 ch 3&4</td></tr>
<tr><td>110</td><td>AES3&4</td><td>Group 4 ch 1&2</td></tr>
<tr><td>111</td><td>Generator</td><td>Group 4 ch 3&4</td></tr>
<tr><td>5</td><td>AES2 dir</td><td colspan="3">Off = output
On = input</td><td>AES 2 input or output</td></tr>
<tr><td>6-8</td><td>AES2/GRP2</td><td colspan="3">See table for AES1/GRP1</td><td>Routing AES2 or GROUP 2</td></tr>
<tr><td>9</td><td>AES3 dir</td><td colspan="3">Off = output
On = input</td><td>AES 3 input or output</td></tr>
<tr><td>10-12</td><td>AES3/GRP 3</td><td colspan="3">See table for AES1/GRP1</td><td>Routing AES3 or GROUP 3</td></tr>
<tr><td>13</td><td>AES4 dir</td><td colspan="3">Off = output
On = input</td><td>AES 4 input or output</td></tr>
<tr><td>14-16</td><td>AES4/GRP 4</td><td colspan="3">See table for AES1/GRP1</td><td>Routing AES4 or GROUP 4</td></tr>
<tr><td>X- Y</td><td>Output format</td><td colspan="3">DIP[1 2] = [Off Off] => 720P
DIP[1 2] = [Off On] => 1080I
DIP[1 2] = [On Off] => SD16:9
DIP[1 2] = [On On] => SD 4:3</td><td>The XY sets the output format. The frame rate out will be selected automatically based on the frame rate of the input.</td></tr>
<tr><td>ARC 14:9</td><td>Aspect ratio conversion</td><td colspan="3">On: Aspect ratio is forced to 14:9 if converting from HD to SD or SD to HD.
Off: Aspect ratio is handled by AFD / VI / WSS / SMPTE352.</td><td>If on, AFD/ VI/ SMPTE control is turned off.
If off, Aspect ratio is handled by AFD, VI, WSS or SMPTE352. If no such information exists, the card assumes input and output have the same AR environment.</td></tr>
</table>

OPT/EL	OPT/EL	Off = Optical input is main On = Electrical input is main	Optical / Electrical input priority. If the optical input is not installed, this DIP will have no effect.
SDO1 PROC	SDI OUT 1	Off: through mode On: processed mode	In through mode the video only goes through a re-clocker.
SDO2 PROC	SDI OUT 2	Off: through mode On: processed mode	In through mode the video only goes through a re-clocker.
F-RESET	F-RESET	Off: Use values preset by MULTICON GYDA. On: RESET to factory defaults	This DIP is only read at power up. See chapter 3.1.2.
OVR	OVR	Off: MULTICON GYDA mode On: Manual mode	This DIP is only read at power up. OVR is short term for MULTICON GYDA override

Table 1: DIP SWITCH FUNCTIONS

3.2 Multicon GYDA mode

All functions of the card can be controlled through the Multicon GYDA control system. The Multicon GYDA has an information page and a configuration page.

3.2.1 Information page

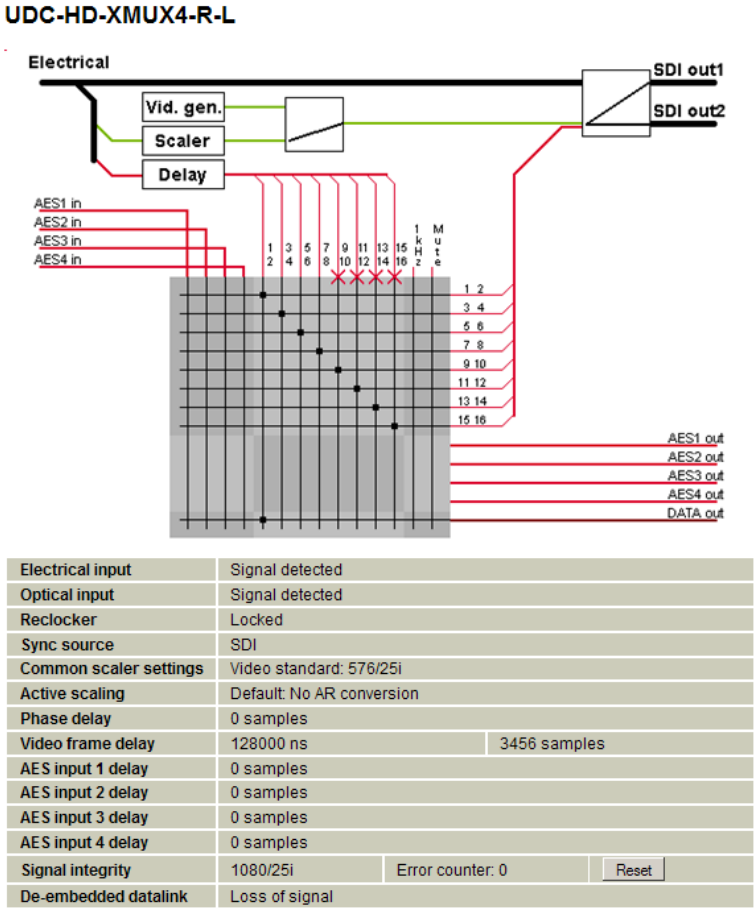


Figure 3: Multicon GYDA information page

The information page shows a dynamic block-diagram of the board and some additional informative text. The block diagram updates with the board status, showing input signal selected and signals missing (by red crosses over signal lines). It also shows the audio matrix selections that have been made in the configuration page.

> Note that if an audio input is not present, the user will still be allowed to select this input from the matrix, but the output will go to a fallback position. Missing audio inputs will be shown in the block-diagram as a red cross over the corresponding matrix input line.

The information text below the dynamic block diagram lists information not easily conveyed in a graphical manner.

Common scaler settings denote the output format, which is selectable under the same heading in the Configuration page.

Active scaling: This shows which aspect ratio conversion is currently performed by the card. Indirectly it also shows *why* this conversion has been selected: If the text starts with "Default:" it means that this is the conversion that the user has selected as the default scaling. This in turn means that the user has either selected the scaling manually,or that no aspect ratio information was detected in the video to select the proper scaling automatically. Conversely, of the text starts with "Auto:" it means that the card has valid aspect ratio information in the form of AFD, VI, WSS or SMPTE352, and that the conversion has been selected automatically to suit the output environment specified by the user.

Phase delay denotes the time difference in samples between incoming sync source and outgoing video signal.

The *video frame delay* represents the actual delay between input and output video.

AES input delay shows the delay (in 48 kHz audio samples) between incoming AES stream and AES stream going into the cross-point switch. These delay blocks are not shown in the graphics.

Signal integrity shows the incoming video format and counts errors found on this signal. The error mask is set up in the *Signal integrity* block on the configuration page. To reset the counter to 0, press the *Reset button.*

DE-embedded datalink gives the status and bitrate of the data de-embedded from an AES stream. Which AES stream to de-embed data from is selected in the audio cross-point switch. This datalink is a Nevion proprietary standard and embedding of such data can be done with the AV/AAV-HD(SD)-XMUX.

3.2.2 Configuration page

The different configuration parameters are explained in detail in Chapter 5, under their corresponding functions.

3.3 Connections

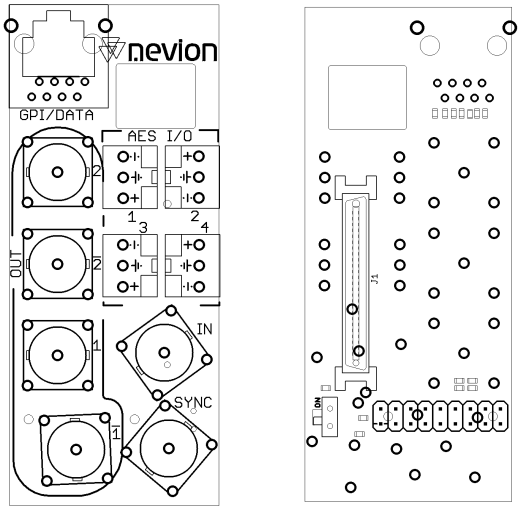


Figure 4: FRS-HD-XMUX4-C1 backplane
left: connection side right: component side

The backplane for the UDC-HD-XMUX4 is labeled UDC-HD-XMUX4-C1. The table below shows the connectors and their functions.

Function	Label	Connector type
HD/SD-SDI input	IN	BNC
HD/SD-SDI output 1	1	BNC
HD/SD-SDI output 1 inverted	$\overline{1}$	BNC
HD/SD-SDI output 2	2	BNC
HD/SD-SDI output 2 inverted	$\overline{2}$	BNC
Black & Burst/ tri-level input	SYNC	BNC
AES I/O 1	1	WECO
AES I/O 2	2	WECO
AES I/O 3	3	WECO
AES I/O 4	4	WECO
GPI in	GPI/DATA	TP45, pin 2, 3, 6 & 7
GPI out	GPI/DATA	TP45 pin 1 (pin 8 = GND)
DATA out	GPI/DATA	TP45 pin 4 & 5

Table 2: Connector functions

Unused SDI-inputs/outputs must be terminated with 75 Ohm.

3.4 Sync input

The backplane also features a switchable termination. By setting the slide switch in Figure 4 to *on*, the sync input will be terminated to 75 Ohm.

4 Operation

4.1 Front panel LED indicators

Diode \ state	Red LED	Orange LED	Green LED	No light
Card status	PTC fuse has been triggered or FPGA programming has failed	Module has not been programmed, or RESET and OVR DIPS are both on, or module is loading firmware.	Module is OK	Module has no power
SDI input status	Video signal absent.	Video signal present but card unable to lock VCXO	Video signal present and locked	Module has not been programmed
Sync input status	Sync signal absent	Sync signal present but card unable to lock VCXO	B&B or Tri-level sync in lock	Module has not been programmed
Audio input status	No audio embedded in incoming video	One, two or three audio groups embedded in incoming video	4 audio groups embedded in incoming video	Module has not been programmed

Exceptions for the LEDS

The *locate* command will make all four LEDs blink on and off synchronously. The condition of the card is not otherwise affected.

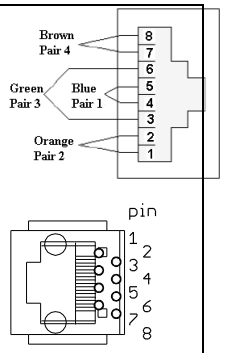
Firmware upgrades will activate running lights after the firmware download has finished. Do not remove power to the card when running lights are active, the card is unpacking and installing the new firmware. The UDC-HD-XMUX4 will automatically reboot after a successful upgrade.

4.2 GPI alarms

The UDC-HD-XMUX4 has one GPI output. This reflects the status of the card, se the table below.

4.2.1 Functions of 8pin modular jack

GPI name	Function	Pin #	Mode	Direction
Status	General error status for the module. Will also activate at firmware upgrades.	Pin 1	Inverted Open Collector (open is alarm)	Output
GPI 1	GPI default scaling select. Least significant bit.	Pin 2	TTL, 0V = active level	Input
GPI 2	GPI default scaling select	Pin 3	TTL, 0V = active level	Input
DATA-link output	RS422+	Pin 4	RS422	Output
DATA-link output	RS422-	Pin 5	RS422	Output
GPI 4	GPI default scaling select. Most significant bit.	Pin 6	TTL, 0V = active level	Input
GPI 3	GPI default scaling select.	Pin 7	TTL, 0V = active level	Input
Ground	0 volt pin	Pin 8	0V.	



5 Functional description

5.1 Data path

HD/SD-SDI input is selected from either optical or electrical input and equalized, re-clocked and de-serialized and transferred to a processing unit called an FPGA. In the FPGA the signal is first sent through a *de-glitcher* that cleans up small single-line errors that might appear for instance due to switching. In the de-glitcher the ancillary data to be remapped in the output video stream is also de-embedded. The video is then passed over to the audio de-embedder that de-embeds all audio from the video.

The 16 audio channels coming from the de-embedder are bundled **in pairs** and sent to an audio buffer. The audio is fetched from the *audio buffer* according to a user specified delay and sent to an *Audio cross point.* The audio from the Audio cross point can be any pair of audio channels de-embedded from the incoming video stream, AES inputs, an internal 1 kHz sine or an internal silence generator. The silence generator (labeled mute) produces valid audio, just silent. These audio generators can be set as fallback when no valid audio is available, but the options also exist to turn the AES outputs completely off or set the delete flag for embedded audio. From the cross point outputs each channel pair enters an A*udio Processing Block*, where the paired channels may be shuffled. After the audio processing block the audio enters the *Audio Embedder*.

After the audio de-embedder, the active area of the video is sent through the scaler blocks and to a frame buffer. The video is then fetched from the frame buffer with the user specified delay and sent to a *Video processing block* followed by an *EDH processing block*. After the EDH block the video and audio is embedded according to the user settings and the video is sent from the FPGA to a serializer that re-clocks the data and outputs the SDI to a buffered output switch.

The buffered output switch is a 2x2 cross point with input 1 being the equalized and re-clocked input (non-processed) and input 2 being the output of the video processing. The two outputs are sent to two paired (non-inverting and inverting) outputs.

There are also 4 I/O ports for AES. These can be setup to be either inputs, outputs or a mix. The outputs are taken from the Audio cross point and can be any stereo pair of audio channels embedded on the incoming video stream, AES inputs (if any), the internal 1 kHz sine generator or the internal “black sound” generator. The inputs are routed through optional audio delays and sample rate converters before they enter the audio cross point matrix.

5.2 Video input selection

The UDC-HD-XMUX4 has one electrical and one (optional) optical input. The input can be chosen either by an automatic selection with priorities and rule of switching, or by manual selection. When the input is selected manually, the fallback if the input disappears will be *frame freeze*.

Manual selection mode

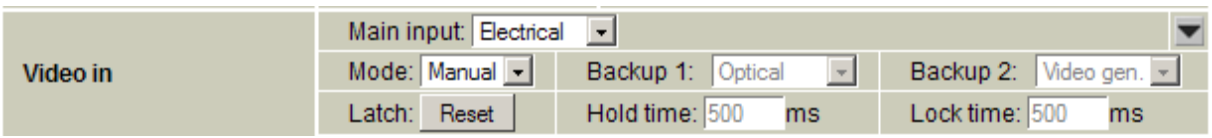


Figure 5: Multicon GYDA view of electrical input selected in manual mode.

Automatic selection mode

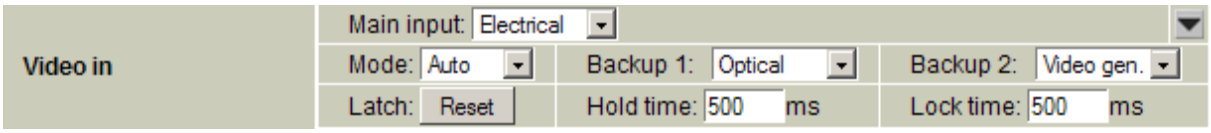


Figure 6: Multicon GYDA view of the input selection

If the *video in mode* choice is set to auto in Multicon GYDA, three input choices (priorities) must be made. The available choices are electrical, optical, mute, generator or '–' (none). When signal is missing on the input selected as 'Main', the change-over logic will switch to the next priority and look for a signal there, and so on. If the user doesn't want to use all three priority levels, the unused ones can be set to '–'. Should the user specify a list of priorities where it is actually impossible to reach one or both of the backup levels (because the main input is selected to be an internal generator, and therefore always present), the card will also display the unreachable levels as '–'.

The switching is always latching, and to get back to the main input while the other input is still present, the user must press *Reset*.

Hold time and lock time can also be adjusted. These specify how long a signal can be missing before the next input in the prioritized list is attempted, and how long a lost signal has to be present before it is considered OK again, respectively.

5.3 De-glitcher

The de-glitcher corrects timing errors within a line. The de-glitcher has a 2048 samples buffer. When the first signal is present, we call it the "initial phase signal", data is taken from the centre of this buffer. If the timing reference of the video signal changes, when for instance a new source being switched into the signal path, the timing errors occurring by this change will be corrected if the new timing reference is within +/-1024 samples of the "initial phase signal". This also goes for all consecutive timing references.

If a signal is more than +/-1024 samples off relative to the "initial phase signal", the output will repeat the last frame, refill the 2048 samples buffer and take new data from the centre of the buffer. This new signal is now considered the "initial phase signal". Audio will fade out when a frame repeat is being done, and fade in at the new frame.

This mechanism produces an error free video output without frame wrapping when the video input comes from a router with synchronous input video signals that all lies within +/-1024 samples of each other.

> The de-glitcher output is always seamless. When a signal is repeated, the audio is faded out. It fades in again at the next frame.

5.4 The scaling blocks

5.4.1 Motion adaptive de-interlacer

This block converts an interlaced image to progressive. It is only part of the signal path for interlaced video formats.

5.4.2 Format converter block

This block converts between the different video formats. If the input is interlaced, it is de-interlaced before entering this block. The input format is automatically detected. The output format is selected in *Common scaler settings.*

> The outgoing video standard selected should be of the same *frequency base* as that of the incoming video standard.

Example: 720/50p can be converted to 1080/25i, 576/25i or 720/25p because they are all 50 Hz-based standards. 720/59p would not be OK, because it is 60 Hz-based.

5.4.3 Aspect Ratio Converter block

The aspect ratio converter block may be used to stretch or shrink a picture vertically and/or horizontally. The picture may also be offset with respect to the original centre of the picture.

The primary difficulty with selecting the conversion is the sheer number of possible conversions. This can be greatly reduced by specifying the desired output aspect ratio (4:3 or 16:9). We call this setting the **output environment**. The actual scaling will depend on the input signal.

The **output environment** setting actually describes the aspect ratio of the pixels. The **fill factor** is a term to describe the degree to which the output picture will fill the output frame, or the presence of horizontal or vertical curtains or black bars.

After conversion the output signal will have the appropriate AFD, VI, WSS and S352M embedded. These types of metadata can also be individually disabled.

There are four operational modes for the module:

1. AFD -> Frame fill setting -> default conversion
2. AFD -> default conversion
3. Frame fill setting -> default conversion
4. Default conversion, no auto

The primary assumption for the first three modes is that an input signal with the same aspect ratio as the output environment *will not be scaled.* (There are a couple of exceptions if the picture has both horizontal and vertical curtains.)

In mode 4 the zoom and position settings from the selected scaling will be applied for all input signals, regardless of the detected input environment. If one of the pre-defined fixed scalings is used, the output environment will be given by the selected scaling. The only exception is “No conversion”, which has no inherent output aspect ratio; when this scaling is selected, the output environment is taken from the general output environment setting. For the user scalings, the user must specify the output environment. This also provides an opportunity to change the output environment via GPIs, see chapter 5.4.7.

5.4.4 Automatic scaling modes

The following applies to the first three (automatic) modes of operation:

The scaling performed by the module is determined by the input picture aspect ratio and fill factor (presence of ‘curtains’) but normal SD video does not natively state of what aspect ratio the pixels are, or if another conversion has already been applied. There are three sources of information that *may* be present in the video that can provide some or all of this information.

Active Format Descripton (SMPTE 2016 and SMPTE RP186, the latter referred to as Video Index) describes both the aspect ratio and the fill factor of the picture. However, the fill factor descriptor *may* contain a code to indicate that the fill factor of the picture is unknown. In that case, the selected fill factor setting is used.

SMPTE352M is a data packet that can be used to identify the aspect ratio of the picture, and thereby the pixels.

Common scaler settings	Rule: Default			Video format: 720/59p	
	Non-AFD conversion: Protect input frame				
	Insert: ☑ SMPTE2016-1 ☑ VI ☑ SMPTE352 ☑ WSS ☐ WSS-Ext				
Output environment	○ Always 4:3 ◉ Always 16:9 ○ Best fit (fallback to 4:3) ○ Best fit (fallback to 16:9)				
WSS in interpreted as	○ WSS Extended ◉ WSS				
Default scaling	User scaling 6				
User scaling 1	Zoom: H: 0.300 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 2	Zoom: H: 0.990 V: 0.990	Pos: H: 0 V: 0	Output environment: 16:9		
	AFD: 1000 - Full frame				
User scaling 3	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 4	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 5	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 0100 - Wider than 16:9				
User scaling 6	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 16:9		
	AFD: 0010 - 16:9Top				
User scaling 7	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 8	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 9	Zoom: H: 1.378 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 10	Zoom: H: 1.000 V: 1.100	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				
User scaling 11	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1010 - 16:9				
User scaling 12	Zoom: H: 1.000 V: 1.000	Pos: H: 0 V: 0	Output environment: 4:3		
	AFD: 1000 - Full frame				

Figure 7: Multicon Gyda view of scaler settings

5.4.4.1 Mode 1: Full automatic mode

The aspect ratio control block will start by looking for AFD presence in the input signal to select the aspect conversion. If this is not present it will look for VI, then WSS and finally SMPTE S352M information. If no aspect ratio information is present in the video, the default scaling will be used.

When a valid format descriptor is present, either from SMPTE 2016, VI or WSS, all the conversions in the AFD code drawing in Figure 8 are possible for the given output environment.

In the case where only the input/output environment information is available, a subset of the conversions is used. The desired filling method must be set. This may be one of the following:

- Zoom to fill frame - The image will be zoomed and cropped. No curtains.
- 14:9 - The image will be zoomed and cropped. Narrow curtains.
- Protect input frame - The image will not be zoomed or cropped. Full curtains.

If the input environment is the same as the output environment, no conversion will be performed.

5.4.4.2 Mode 2: AFD or default

This mode will only use the AFD information. The default scaling will be used if SMPTE 2016, VI, and WSS are all missing, or if the active format descriptor is set to ‘Unknown’.

5.4.4.3 Mode 3: Fill mode or default

This mode will only use the input aspect ratio part of the information from the SMPTE 2016/VI/WSS and disregard the active format descriptor. If SMPTE 2016, VI nor WSS are present, the S352M packet will be used, if present. If S352M is also missing, the default scaling will be used.

5.4.4.4 AFD conversions

Figure 8 shows the different transitions that are defined. The incoming format is given by the AFD/VI/WSS, and the user has supplied the output environment. To avoid clutter, transitions from a state to itself are not shown in the figure. The corresponding AFD format is shown for reference.

The figure looks confusing at first, but observe that each of the states have only one arrow leading from itself to the other column. This arrow defines the normal conversion when the input environment is different from the output environment. Find the picture type that you have on the input and follow the arrow to the other column to find the conversion that will be performed when the AFD code is present.

There are a few states where the input picture has both horizontal and vertical curtains and these also have arrows within the same column. These are conversions that will be performed when the input environment is the same as the output environment.

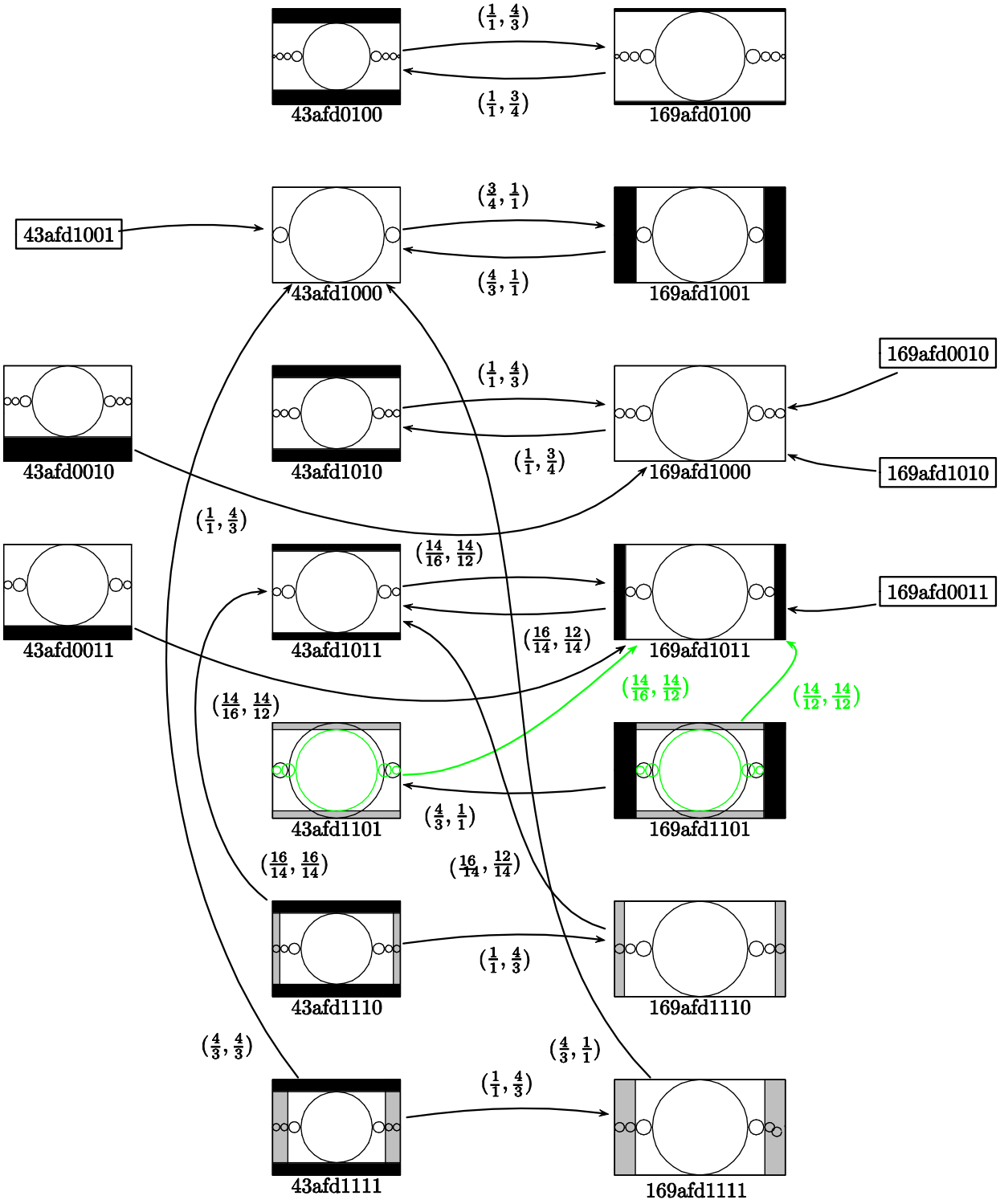


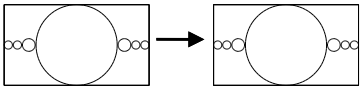
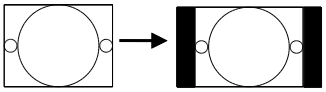
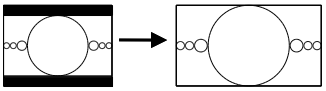
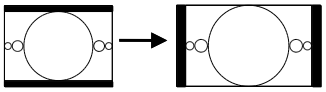
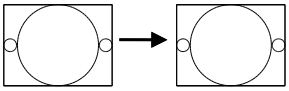
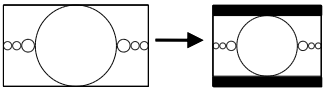
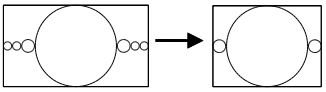
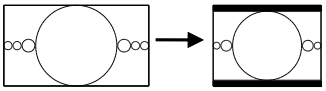
Figure 8: AFD controlled aspect ratio conversions

5.4.4.5 Fill mode conversions

If the module can not find any fill factor information but has aspect ratio information, it will perform one of three conversions when the input environment is different from the output environment.

1. Protect input frame.
2. Zoom to fill frame.
3. Zoom to 14:9.

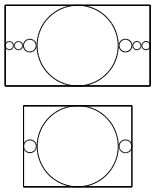
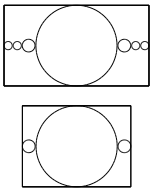
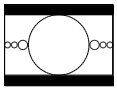
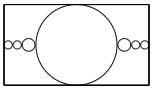
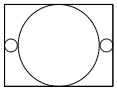
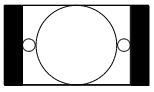
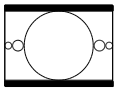
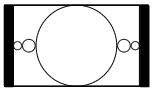
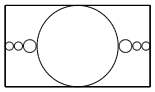
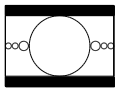
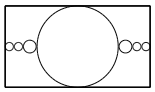
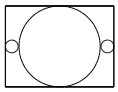
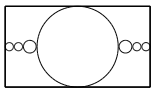
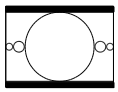
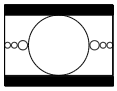
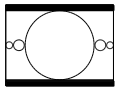
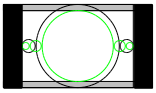
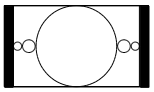
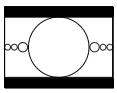
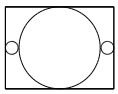
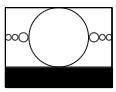
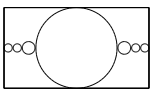
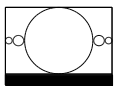
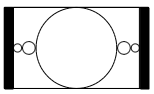
The table shows the conversions that will be performed when this mode is active.

Output Environment	Non-AFD Conversion	Input environment	Conversion performed
16:9	Any.	16:9	
16:9	Protect input frame	4:3	
16:9	Zoom to fill frame	4:3	
16:9	14:9	4:3	
4:3	Any.	4:3	
4:3	Protect input frame	16:9	
4:3	Zoom to fill frame	16:9	
4:3	14:9	16:9	

5.4.4.6 Default scaling mode

This mode is used when no information about the input video is detected by the ARC-SD-DMUX. This mode uses the fixed scaling setting. The scaling and offset of the output picture is fixed.

5.4.5 Pre-defined settings

Input	Conversion	Output
	No conversion	
	4:3 cropped to 16:9 full frame	
	4:3 to 16:9 with 4:3 pillar box	
	4:3 cropped to 16:9 with 14:9 pillar box	
	16:9 to 4:3 with 16:9 letterbox	
	16:9 cropped to 4:3 full frame	
	16:9 cropped to 4:3 with 14:9 letterbox	
	4:3 with 16:9 letterbox cropped to 4:3 with 14:9 letterbox (zoom 1.143)	
	16:9 with 4:3 pillarbox cropped to 16:9 with 14:9 pillarbox (zoom 1.167)	
	4:3 with 16:9 letterbox cropped to 4:3 full frame (zoom 1.333)	
	Top 4:3 cropped to 16:9 full frame	
	Top 4:3 cropped to 16:9 with 14:9 pillarbox	

5.4.6 User defined settings

It is possible to set the scaling values and AFD codes of twelve settings named “User scaling” 1 to 12. The scaling values control horizontal and vertical zoom, and horizontal and vertical centre offset.

Vertical and horizontal zoom can be adjusted within the range 0 to 2. The values denote the enlargements of the output image.

Vertical and horizontal centre offset or position values are slightly more complicated as the calculation depends on whether the *effective* zoom factors are greater than or less than unity. ‘Effective’ means that it also incorporates the scaling factors when converting from one input standard to another output standard, i.e. 1.5 horizontal (1920/1280) and 1.5 vertical (1080/720) if going from a 720-standard to a 1080-standard.

The embedded AFD code for each User setting may be set. Use Figure 8 in the AFD conversion section to find the code that best describes the output.

5.4.6.1 *Pos* when zoom is greater than 1:

The setting is in lines (vertical offset) and pixels (horizontal offset) on the output. A position value of P will result in the picture moving P pixels or lines.

5.4.6.2 *Pos* when zoom is less than 1:

The setting is in lines (vertical offset) and pixels (horizontal offset) but the values are also scaled by the zoom factor. A zoom value less than 1 with a position value of P will result in the picture moving (P x zoom) pixels or lines.

Positive position values moves image right/up, negative values left/down.

5.4.7 Selecting Default scaling by GPI

There are 4 GPI input lines that can be controlled individually by external equipment, and therefore 16 different combinations. Each of these 16 states can be mapped to one of the scalings available under Default scaling. The GPI lines will then select the Default scaling, which means that they will either control the active scaling directly (if the scaler rule is in Default scaling mode) or the fallback scaling that will be chosen when no AFD/VI/WSS/SMPTE352 information is available (if the scaler rule is set to one of the automatic modes, see chapter 5.4.4).

In is also possible to map one or more states to “No action”, which means that the card will simply ignore this GPI condition. This option can be particularly useful if a subset of the GPI values is used and the external equipment is unable to switch the GPI lines simultaneously. Although the GPI lines are de-bounced (filtered), unintended states could be visited by the GPI lines in a transition from one intended value to another. It’s therefore recommended to map all unused states to “No action” to get the cleanest possible switch between scalings.

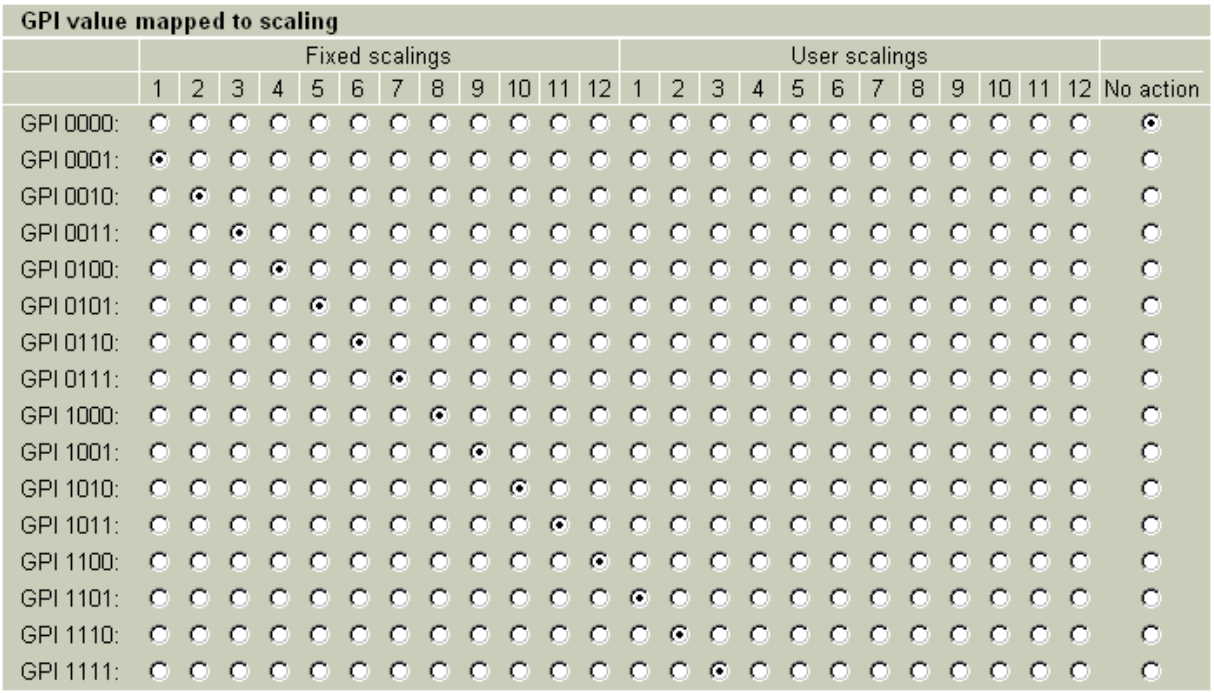


Figure 9: Multicon GYDA view of the GPI to scaling map.
GPI value is read from left to right: GPI 4, GPI 3, GPI 2 and GPI 1.

5.5 Frame synchronizer

The frame synchronizer consists of a frame store buffer and some control logic. The frame store buffer can store up to 4 full HD frames. Data is fetched from this buffer according to the

user settings by force of the control logic. The control logic sets the frame synchronizer into different modes dependent on the presence of a sync input.

> For the first release of the software, the Video frame delay is not implemented. This means that while the frame synchronizer is working correctly with sync input, it's not possible to add additional frames of delay.

5.5.1 Frame sync mode

If a sync input (B&B or Tri-level) is present, the frame synchronizer will output a signal that has a delay relative to this signal. Two parameters can be set; "**Phase delay**" and "**Frame delay**".

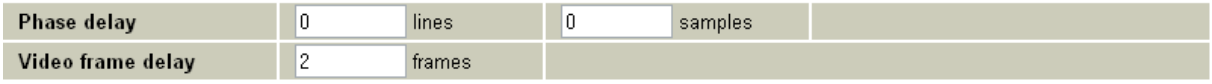


Figure 10: Multicon GYDA view of the video delay settings

Let us first focus on the *phase delay*, which also may be called "output phase delay". This parameter can be positive or negative, and determines the relationship between the outgoing video and the sync signal.

The *phase delay* can thus be written in several ways, a large positive delay will equal a small negative delay, because there is wrap-around on a frame basis. It follows that it is not useful to specify a *phase delay* larger than 1 frame. Strictly speaking the range could have been limited to -1/2 frame to 1/2 frame. For convenience, the delay range is allowed to be from -1 frame + 1100 samples to 1 frame – 1100 samples.

In addition to the *phase delay,* the user may specify additional frames delay. When *frame delay* is set to 1 frame, the delay through the card will be between 1 and 2 frames, depending on the input phase between SDI-input and sync input.

The frames and lines are measured in units of the output SDI video standard. If the output SDI standard is 1080i25, a delay of one line is equal to 35.5us. If the output SDI standard is 720p50, a delay of one line is equal to 26.6us. If the output SDI standard is 625i25, a delay of one line is equal to 64us.

> For a scenario where the card receives different HD video standards, (e.g. 1080i25 and 720p50) the user may want to conserve a specific delay in microseconds for all HD video standards. This is accomplished by specifying the delay in number of samples instead of frames and lines. (For HD video standards the sample frequency is equal over standards, but the line and frame frequencies are different for the different standards).

If video input disappears

Given that stable SDI input and sync input exists: If the SDI input disappears, the picture will freeze for *<hold time>* and then go to video generator if the card is in default configuration.

If video input reappears

Given stable sync input, the video will reappear after *<lock time>* of locked video input if card is in default settings.

If sync input disappears

Given that stable SDI input and sync input exists: If the sync signal disappears, the card will act as in frame delay mode, see Chapter 5.5.2.

NOTE: This will result in a frame roll as the delay changes.

If sync input reappears

Given that a stable SDI input exists: If the sync signal reappears the delay mode will change back to Frame Sync mode. Hence the internal clock will be locked to the sync signal and the delay will again change.

NOTE: This will result in a frame roll as the delay changes.

If both signals disappears

The picture will first freeze for <*hold time*> and then go to video generator. The output is now referenced to the local clock source. This clock source will however be kept within 1 ppm of the last sync source.

5.5.2 Frame delay mode

In this mode a sync signal is not present. The phase delay will now be relative to the SDI-input. The phase delay + additional frame delay sets the total video delay.

If video signal disappears

The picture will first freeze <*hold time*> and then go to video generator. The output is now referenced to the local clock source. However this clock source will be kept within 1 ppm of the last video source.

If video signal reappears

If the input video signal reappears, the video will reappear on the output <*lock time*> after stable input video. The delay will be set to the same as before input was lost.

NOTE: This may cause a frame roll.

If a sync input appears

Given that a stable SDI input exists: If a sync signal appears the delay mode will change to Frame Sync mode, see Chapter 5.5.1. Hence the internal clock will be locked to the sync signal and the delay will again change.

NOTE: This will result in a frame roll as the delay changes.

5.6 Video generator

The video generator can produce several simple signals: Color bar, Check field and flat field.

The flat field can be set up with 10bit (0-1023) luma and chroma values, or by selecting a predefined color.

The generator may be used as the video source if there is no video signal present at either of the video inputs. The generator may also be switched on with Multicon GYDA even though a video input is present. This will override video input, but the generator signal will be synchronous to the input signal or sync input if one or both are present.

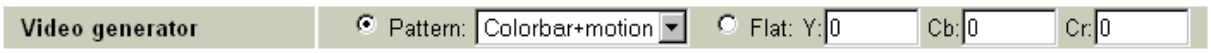


Figure 11: Multicon GYDA view of the video generator

5.7 Label generator

The label generator consist of 2 lines of 16 characters each that are placed at the lower left corner of the active area.

Its main function is to enable the user to automatically add a label to the internal generator at loss of input signal. This is done by selecting the auto tick-box on the “Label gen” block in the Multicon GYDA configuration.

It is also possible to superimpose the label on the incoming SDI by ticking the “On” box.

Note that to see the label on an output the video output selection must be set to "processed" for this specific output.

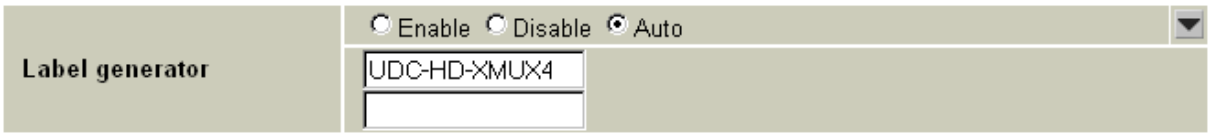


Figure 12: Multicon GYDA view of label generator

5.8 Video processing block

The video processing block consists of a *gain and offset* adjustment, and a video payload *legalizer*.

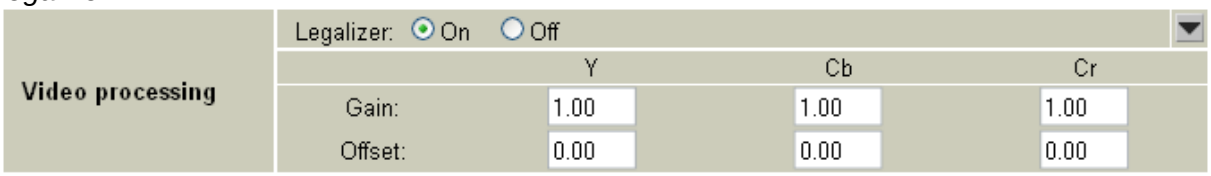


Figure 13: Multicon GYDA view of the video processing block

5.8.1 Gain and offset

The gain and offset adjustments are done separately for the Y, Cb and Cr samples.

	Range Multicon GYDA
Luma gain	0 – 3.9999
Chroma gain	0 – 3.9999
Luma offset (gain =1)	511.75 – 511.75 in sample values
Chroma offset (gain = 1)	255.75 – 255.75 in sample values

5.8.2 Video payload legalizer

The legalizer hard clips the upper and lower limit of the video payload. With the legalizer enabled these limits are:

Upper limit	Luma:	3ACh
	Chroma:	3C0h
Lower limit	Luma:	040h
	Chroma:	040h

With the legalizer disabled the video processing block hard clips both luma and chroma to 3FBh and 004h.

5.9 Color space conversion

HD and SD use different color spaces. The conversion from one color space to another will be handled automatically by the card when converting from SD to HD (or vice versa), but the user also has the option to turn the color space converter off.

Figure 14: Multicon GYDA view of the color space conversion block

5.10 Video filters

Two video filters are available to help reduce noise and/or get a better looking picture. Each filter can be set to four different levels/strengths, in addition to being turned completely off.

The filters are ordinary low-pass filters, one used with up-conversion and one used with down-conversion. The four settings of the low-pass filters will reduce the full bandwidth (f_0) to $0.8 \cdot f_0$, $0.6 \cdot f_0$, $0.4 \cdot f_0$ and $0.2 \cdot f_0$, respectively. This can be useful to remove some of the detail/information content before video compression, or simply as a trade-off between detail and smoothness for sources that already have severe artifacts.

Note that when pixels can be mapped directly from input to output (an *effective* zoom factor of exactly 1.0) no conversion will take place and no filter will be applied.

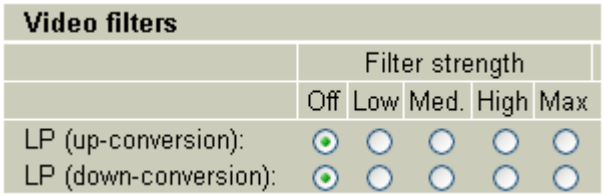


Figure 15: Multicon GYDA view of the video filter block

5.11 EDH processing block

If enabled, the EDH processing block extracts the EDH package from the video, updates the EDH flags according to SMPTE RP165 and inserts the EDH package into the ancillary data of the video.

If disabled, The EDH processing block only reads, processes, and reports the EDH package contents without doing any modifications to the packet in the video stream.

5.12 Video output selection

The board has four outputs where two pairs (non-inverting and inverting) can be routed either directly from the re-clocker (Through) or via the processing unit (Processed).

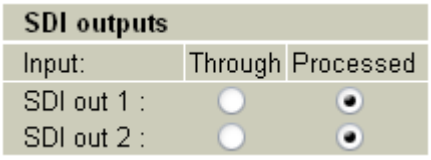


Figure 16: Multicon GYDA view of the SDI output selection block

When Processed is selected, the output can also come from the internal video generators. They can act as fallback when video input is missing, or the module can be used as a standalone generator. This is controlled from the *Video in* block. In Through mode the output can only be muted (i.e. output drivers turned off) when the video input is missing.

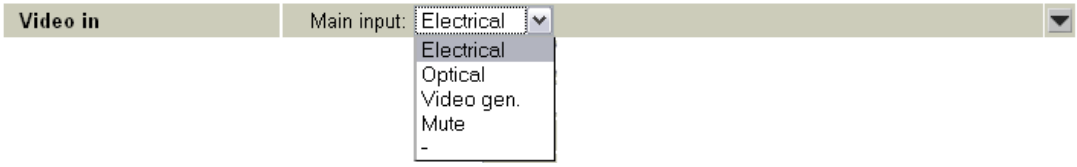


Figure 17: Multicon GYDA view of video input mode.

5.13 Audio blocks overview

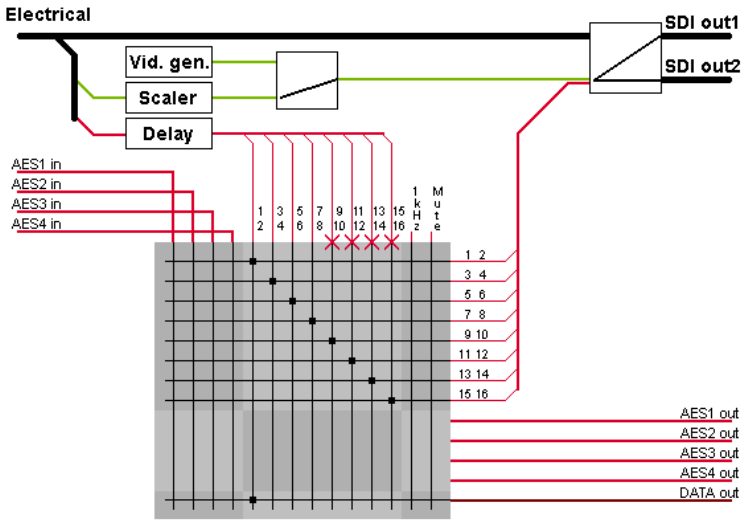


Figure 18: Audio function blocks

5.14 Audio de-embedder

The Audio de-embedder extracts all audio embedded in the video stream. The de-embedder is always enabled.

5.15 Audio delay

An audio delay relative to the video output can be specified commonly for all de-embedded channels. This is done in Multicon GYDA. The audio delay is specified in audio samples relative to the output video, and can be both positive and negative.

> Note that because the audio delay is relative to the video output it is possible to specify an audio delay that will actually be negative. This will cause audio errors.

While the maximum *negative* relative audio delay will be limited by the actual video delay, the maximum positive relative audio delay is 2^{14} - 1 = 16383 audio samples (at 48 kHz, which is approximately 1/3 second).

Dolby-E delay handling

The UDC-HD-XMUX4 can be used to re-align Dolby-E with video. Dolby-E processing equipment typically causes one frame delay for the audio.

The positive *video delay* needs to be set higher than the wanted negative relative audio delay. Then set a negative relative audio delay that corresponds to a whole number of full frames of audio samples[1]. A delay example setting is shown in Figure 19. The de-embedded audio can be routed to one or more AES outputs and through a Dolby encoder/decoder and back into one or more AES inputs. The delay on the AES inputs should probably be set to zero, but may be adjusted to align audio with video.

[1] To calculate number of audio samples/frame simply divide 48000 with frame rate (24Hz, 25Hz, 29.97Hz, 30Hz, 50Hz, 59.94Hz or 60Hz)

Phase delay	0	lines	0	samples
Video frame delay	2	frames		
Relative Audio demb. del	-960	samples		
AES input 1 delay	0	samples		
AES input 2 delay	0	samples		
AES input 3 delay	0	samples		
AES input 4 delay	0	samples		

Figure 19: Multicon GYDA view of the delay settings. The video is delayed 1 frames compared with the de-embedded audio for a 50Hz signal.

5.16 Audio cross point matrix

The audio cross point matrix is an 8x10 cross point with inputs and outputs as shown in Figure 18. The 8 de-embedded channels, a 1 kHz sine and “black sound” are selectable inputs. “Black sound” is explained in Chapter 5.1. The outputs of the cross point are 8 stereo channels for re-embedding, 0-4 AES outputs (depending on I/O configuration) and 1 data output.

Audio matrix

	AES input				Group 1		Group 2		Group 3		Group 4			
	1	2	3	4	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1 kHz	Mute
Group 1 ch1-2:	○	○	○	○	◉	○	○	○	○	○	○	○	○	○
Group 1 ch3-4:	○	○	○	○	○	◉	○	○	○	○	○	○	○	○
Group 2 ch5-6:	○	○	○	○	○	○	◉	○	○	○	○	○	○	○
Group 2 ch7-8:	○	○	○	○	○	○	○	◉	○	○	○	○	○	○
Group 3 ch9-10:	○	○	○	○	○	○	○	○	◉	○	○	○	○	○
Group 3 ch11-12:	○	○	○	○	○	○	○	○	○	◉	○	○	○	○
Group 4 ch13-14:	○	○	○	○	○	○	○	○	○	○	◉	○	○	○
Group 4 ch15-16:	○	○	○	○	○	○	○	○	○	○	○	◉	○	○
AES output 1:	○	○	○	○	○	○	○	○	○	○	○	○	○	○
AES output 2:	○	○	○	○	○	○	○	○	○	○	○	○	○	○
AES output 3:	○	○	○	○	○	○	○	○	○	○	○	○	○	○
AES output 4:	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Data output:	○	○	○	○	◉	○	○	○	○	○	○	○	○	○

Figure 20: Multicon GYDA configuration view of the audio cross point matrix

All embedded outputs have a common fallback option that can be set in Multicon GYDA. The priorities can be selected between *matrix* (being the choice from the cross point matrix), *sine, black or mute.* Mute deletes the audio content and set the audio control package to channel delete for its respective channels.

Emb audio fallback	Main input:	◉ Matrix	○ Sine	○ Black	○ Mute	▼
	Backup 1:	Black ▼				
AES fallback 1	Main input:		○ Sine	○ Black	○ Mute	▼
AES fallback 2	Main input:		○ Sine	○ Black	○ Mute	▼
AES fallback 3	Main input:		○ Sine	○ Black	○ Mute	▼
AES fallback 4	Main input:	◉ Matrix	○ Sine	○ Black	○ Mute	▼

Matrix
Sine
Black
Mute

5.17 AES I/O

The directions of the four AES ports can be selected individually by the user. This means that the user has any combination of inputs and outputs available: 4 inputs, 3 inputs plus 1 output, 2 inputs + 2 outputs, 1 input + 3 outputs, or 4 outputs.

5.17.1 Audio inputs

When an AES I/O port is set to be an input, the sample frequency of the input is monitored to see if the signal is synchronous with the system clock. If not, the audio input is passed through a sample-rate converter. After the input block the audio can be delayed with a delay individual for each AES port, before it is routed to the audio matrix. The audio delay for AES inputs are set relative to the AES input port.

If the AES input port is synchronous with the SDI-input, the user can select the AES input delay to track to the video delay. The card will then calculate the relative delay for the audio based on the delay setting for video and audio. This is useful if the SDI-in and AES has a common clock source and the sync input has a different clock source.

5.17.2 Audio outputs

The AES outputs are routed from the audio matrix via individual audio processing blocks. The outputs are always 48kHz and synchronous to the system clock. The AES outputs have individual fallback options.

5.18 Audio generator

The stereo audio generator is available in the audio cross point matrix as a source. It is a high purity 1 kHz sine wave with a 250ms interruption on the left channel every 3 seconds. The audio level may be set to one of two standards. The two levels are -18 dBFS and -20 dBFS. These two levels correspond to EBU R68 and SMPTE RP 155.

5.19 Audio processing block

The output of each stereo signal from the audio cross point matrix may be processed in the audio processing block. This is controlled with the Multicon GYDA controller. The processing includes channel L/R manipulation and audio gain.

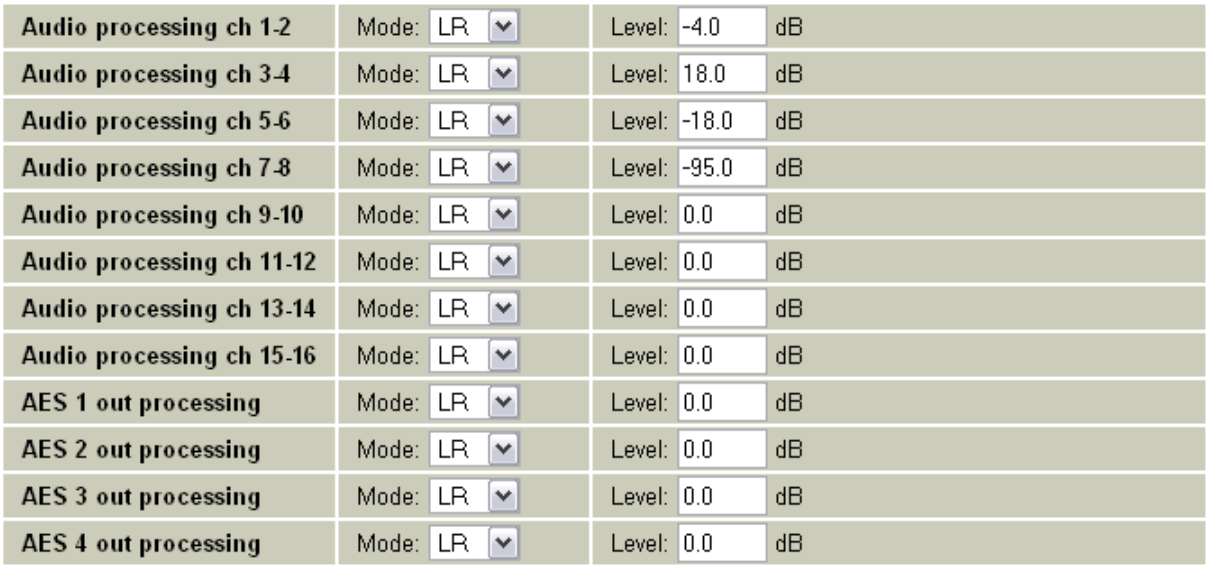


Figure 21: The figure shows the Multicon GYDA configuration view of the audio processing block

Channel L/R manipulation

The stereo signals may be output in one of the following ways:

- LR, Left / Right	No change.
- RL, Right/ Left	Channels are swapped.
- LL, Left/ Left	Left channel is copied into the right channel.
- RR, Right/ Right	Right channel is copied into the left channel.
- nLR, ØLeft/ Right	The left channel is phase inverted.
- LnR, Left/ ØRight	The right channel is phase inverted.
- MM, (Left + Right)/2	The left and right channels are summed.
- MS, MS/AB	The left and right channels are converted from AB stereo to MS stereo.

The sum products (L+R/2 and MS) are reduced in level by 6 dB to avoid any possibility of clipping.

Audio gain

Audio gain can be set for each stereo pair going into the audio processing block. The gain range is set to [+96dB, -96dB] with a gain step of 0.1dB.

Note that non-audio data is ignored and left unchanged by the gain function.

5.20 Audio embedder

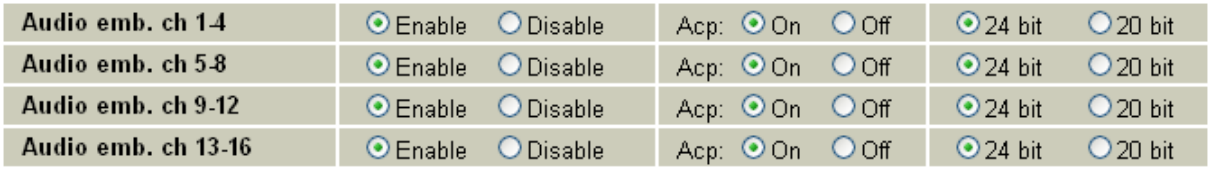


Figure 22: Multicon GYDA view of the audio embedders

The audio embedder can be enabled per group in Multicon GYDA. When a group is disabled the audio inside that group is removed.

When in SD mode, a 24 bit audio signal can be converted to 20 bit. This means that the 4 least significant bits are removed. The audio control package is left unchanged as the bit range is still present. This setting is controlled from Multicon GYDA.

In SD mode the entire audio control package can also be switched on and off via Multicon GYDA.

6 RS422 commands

6.1 FLP4.0 required commands

Block	Blk#	Commands	Example	Response	Control
-	-	?	?	*product name*\ SW rev *n.m*\ FW rev *r.s*\ protocol ver 4.0\	***Hello* command**. *Note 1: No other commands will be available until the card has received this hello.* *Note 2: This command will also enable checksums.* *Note 3: Cards are designed to be hot-swappable. To sync with the start of a new command, the cards will wait for a <lf> character before looking for a valid command.*
conf	0	-	conf 0	*too long to list*	**Configuration settings** Retrieves the card's configurable settings. Each addressable block is represented by a single line. Dynamic status *may* be included in response, but is usually reported in *info* only.
-	-	info	info	*too long to list*	**Dynamic status info** Blocks with static settings only will usually not be included, see *conf* above.
-	-	chk off	chk off	ok	**Checksum off** If issued twice in succession, this command will disable checksums. Note: Responses will still have the checksums appended. *NOTE1: ? command turns the checksum back on*
-	-	locate on <seconds> locate off	locate on 3 locate off	ok	**Card locator** This command will cause all the LEDs to flash for a user specified number of seconds. If omitted, the value <seconds> will be set to a default of 120 seconds. The flashing can be terminated at any time with *locate off*.
-	-	address	address	address <address>	**Card address** This command will check and update the card's current rack and slot address, which is normally only done at start-up.
-	-	filename	filename udchdxmux4-0-151.ffw filename udchdxmux4-0-102.mfw	<name>'.'<extension>	**Firmware upgrades** The <name> part must match the card's hardware and include a revision number, and the extension must be either 'ffw' for FPGA firmware or 'mfw' for microcontroller firmware. After running this command the board will wait for the firmware in Intel-hex format.
-	-	fin	fin	ok	**Finalize** Finalize the programming of the microcontroller. See description of the uC bootloader (separate document).

misc	0	-	NOT AVAILABLE BY COMMAND. ONLY FOUND in Conf 0	prog | fin ' ' | ovr	**Misc info** *prog* if the card is freshly programmed by the bootloader and the program is still un-finalized. *fin* is the normal condition. *ovr* if DIP-switch 16 is set to the ON position and the card is under DIP-switch control. Note 1: The info part of misc has additional functionality when locate is used: *locating <remaining seconds>*. This enables a visible countdown clock in Multicon GYDA, but is not a required part of FLP400.

6.2 Normal control blocks

Block	Blk#	Commands	Example	Response	Control
ablk	0-3	dir in | out track none | video	ablk 0 dir in ablk 0 track video	dir in | out track video | none	**AES I/O port 1-4** dir in | out sets the direction of the AES I/O. track selects whether AES delay tracks the video delay.
agen	0	lvl <sine_level>cBFS	agen 0 lvl -180 agen 0 lvl -200	sine 1kHz lvl <sine_level>cBFS	**Audio generator** The amplitude of the generated sine that can be chosen as fallback in audio change-overs. Legal values are -180cBFS or -200cBFS (centiBel referred to full scale output). Units are optional, but if included must be written as cBFS (case sensitive).
aprc	0-11	lr | rl | ll | rr | nlr | lnr | mm | ms | lvl <gain>	aprc 0 lr aprc 3 ll aprc 6 mm aprc 7 lvl -400	lr | rl | ll | rr | nlr | lnr | mm | ms	**Audio processing** One block for each output from cho 2-13. The meaning of the commands are as follows: lr = Normal rl = Channel swapped ll = Left channel to both output channels rr = Right channel to both output channels nlr = Left channel phase inverted lnr = Right channel phase inverted mm = Mono, both channels = (r+l)/2 ms = Mono/stereo, m=(l+r)/2, s=(l-r)/2 lvl means level and is the gain setting.
ceq	0	-	ceq 0	cd | ncd	Cable equalizer for electrical input. No control; only used to report *carrier detect* or *no carrier detect.*
cho	0	pri <k> | pri <k> <l> | pri <k> <l> <m> pos man <k> | pos auto latch reset t1 <hold_time>	cho 0 pri 0 cho pri 0 1 cho pri 10 2 cho 0 pos man 1 cho 0 pos auto cho 0 latch reset	size 3 pri *k,l,m* auto t1 <hold time> t2 <lock time> size 5 pri *k,l,m* man *m* latch t1 <hold time> t2 <lock time>	**Video input select** ***pri*:** a prioritized list of inputs, used when change-over is automatic. The list can have 1, 2 or 3 entries, or *levels*. Manual mode is effectively the same as automatic mode with one priority level only, but has its own command. 0 = from electrical input

		t2 <lock_time>	cho 0 t1 1000 cho 0 t2 1000		1 = from optical input 2 = internal video generator 3 = mute 4 = none The module will always respond with 3 levels, filling in 4=none for the levels not used. ***t1* and *t2*:** change-over doesn't happen immediately, as a precaution against glitches and unstable signals. The timers t1 and t2 let the user decide how long (in ms) we will cling on to a missing input before we consider it gone and move on to the next pri level, and how long an input with a higher priority should be present before we consider it repaired and switch back, respectively.
cho	1			size 3 pri *k*,*l* auto size 3 pri *k*,*l* man *m*	No commands available. Included to show internal status and to update Multicon GYDA graphics.
cho	2-13	pri <k> | pri <k> <l>	cho 2 pri 1 cho 5 pri 0 2	size 4 pri *k*,*l*	**Audio fallback setting** Audio change-over blocks, one cho per audio output from the audio matrix, mtx 0. No other settings but the priority list. 0 = from audio matrix 1 = sine 2 = AES with silence 3 = mute *Note: Only generators (pri 1, 2 or 3) are allowed to be set as first and only priority.*
cho	14	pri <k> | pri <k> <l>	cho 12 pri 1 cho 12 pri 0 2	size 4 pri *k*,*l*	**Embedded audio common fallback setting** A short-cut to set change-overs 2-9 all at once. Will of course not report anything in info, that's left to the individual cho blocks.
demb	0-3	-	demb 0 demb 2	grp *k* en	**Audio de-embedders** one permanently assigned to each incoming group, always enabled. No control available.
dly	0	<frames>frms	dly 0 2frms	'tgt' <frames> frms	**Video delay** This sets the additional video delay of the card. In info this block reports back the current delay in nanoseconds. This will vary with the incoming video standard.
dly	1	<audio_samples>sps	dly 1 -30sps	'tgt' <audio_samples> sps	**audio delay for deembedded audio** The audio delay is given in audio samples. Audio delay is always given relative to video.
dly	2	<audio_samples>sps	dly 1 -30sps	'tgt' <audio_samples> sps	**audio delay for input AES 1** The audio delay is given in audio samples. Audio delay is always given relative to input AES 1.
dly	3	<audio_samples>sps	dly 1 -30sps	'tgt' <audio_samples> sps	**audio delay for input AES 2** The audio delay is given in audio

					samples. Audio delay is always given relative to input AES 2.
dly	4	<audio_samples>sps	dly 1 -30sps	'tgt' <audio_samples> sps	**audio delay for input AES 3** The audio delay is given in audio samples. Audio delay is always given relative to input AES 3.
dly	5	<audio_samples>sps	dly 1 -30sps	'tgt' <audio_samples> sps	**audio delay for input AES 4** The audio delay is given in audio samples. Audio delay is always given relative to input AES 4.
dly	6	<lines>lines <samples>sps	dly 2 1lines -30sps	'phase' <lines> lines <samples> sps	**Video phase** If lines != 0 the resulting phase will vary with incoming video standard, see dly 0 above.
emb	0-3	en | dis acp (on | off) use24 (on | off) del (off | (on <del12> <del34>))	emb 0 en emb 2 dis emb 1 acp on emb 3 acp off emb 1 use24 on emb 2 use24 off emb 0 del off emb 2 del on 54 -432	(en | dis) use24 (on | off) acp (on | off) del (off | (on <del12> <del34>))	**Audio embedder block** **en/dis:** Enables or disables the embedding of the group into the ancillary area. **acp on/off:** This is valid only for SD and enables the audio control package. **use24 on/off:** This is only valid for SD and selects between 24bit and 20bit sound. **del off/on delay12 delay34:** For each of the embedder groups the delay bits for ch1+2 and for ch3+4 can be inserted into the ACP. The delay value can be positive and negative and is put directly into the ACP as it is written. *Note: To set both delays to 0 would be the same as turning the delays off. The response reflects this.*
gpi	0	act | inact	gpi 0 act gpi 0 inact		**WSS interpretation** inact: Normal WSS act: WSS Extended
gpi	1	act | inact	gpi 0 act gpi 0 inact		**Color space conversion disable** inact: auto (convert when needed) act: disabled
gpi	2	act | inact	gpi 0 act gpi 0 inact		**EDH insert select** This gpi works as a simple 2:1 switch. inact : EDH off act : EDH on
mtx	0	<i1> <o1> ...<iN> <oN> <i1> <o1>,<o2>,...<oN> <i1> <o1> - <o2> ..or the above combined	mtx 0 0 2 1 4 5 5 mtx 0 0 0, 1 1, 2 2 mtx 0 0 0-9 mtx 0 0 0 1 1 2 2-7	size M:N i1 i2 i3... iN	**Audio matrix** mtx 0 (size 14:13) controls the audio matrix; outputs 0-7 are embedded sound; outputs 8-11 are AES output 1 to 4; output 12 is datalink; inputs 0-3 are AES inputs, inputs 4-11 are deembedded sound; 12=1kHz sine, 13=Black/silence *Note: Any combination of the three basic commands are allowed, for instance the following command to*

					set up a 10x10 audio matrix in a single line: *mtx 0 1 1 2 2 3 0,3-7* *=> mtx 0 size 10:10 3 1 2 3 3 3 3 3 3*
mtx	1	<i1> <o1> ...<i2> <o2> <i1> <o1>,<o2>	mtx 1 0 0 1 1 mtx 1 0 0,1	size M:N i1 i2 i3... iN	**Video output matrix** mtx 1 (size 2:2) controls the video output switches. 0: Through mode (re-clocked only) 1: Processed mode (SDI from FPGA
mtx	2	<i1> <o1>	mtx 2 0 0 mtx 2 1 0	size M:N i1 i2 i3... iN	- This block has no functions in this code.
mtx	3	<i1> <o1>	mtx 3 23 0	size M:N i1 i2 i3... iN	**Default scaling select** mtx 3 (size 24:1) controls the default scaling. The 12 fixed scalings are 0-11, the 12 user scalings are 12-23.
mtx	4	<i1> <o1> ...<iN> <oN> <i1> <o1>,<o2>,...<oN> <i1> <o1> - <o2> ..or the above combined	mtx 4 0 2 1 4 5 5 mtx 4 0 0, 1 1, 2 2 mtx 4 0 0-9 mtx 4 0 0 1 1 2 2-7	size M:N i1 i2 i3... iN	**GPIs mapped to scalings** mtx 4 (size 25:16) controls how the 4-bit GPI values are mapped to the 24 available scalings. The 12 fixed scalings are 0-11, the 12 user scalings are 12-23. The 25th option is to not perform any action at all.
mtx	5	-	-	size M:N i1 i2 i3... iN	**Current scaling** mtx 5 (size 37:1) has no control, it is only used to report the current scaling back to the system contoller. The 12 fixed scalings are 0-11, the 12 user scalings are 12-23. 24-34 represent scalings 1-11 when they are selected by the auto logic, 35 and 36 represent scaling 0 (no conversion) for output environments 16:9 and 4:3 respectively.
mtx	6	<i1> <o1>	mtx 6 0 0 mtx 6 0 1	size M:N i1 i2 i3... iN	**Video filters** mtx 6 (size 5:2) controls the strength of 6 video filters: 0: Low-pass when up-converting 1: Low-pass when down-converting For all filters the following filter strengths can be applied: 0: Off (No filtering) 1: Low 2: Medium 3: High 4: Maximum
pin	0			cd | ncd	**Pin diode for optical input** No control; only used to report *carrier detect* or not *carrier detect*.
pwr	0-3	-	pwr 0	<nom_voltage>Vnom <voltage>V	**Power monitoring** The nominal voltages are listet with the measured voltages. For this product the following voltages are measured: 0: 1.2Vnom 1: 2.5Vnom 2: 1.2Vnom

					3: 5.0Vnom
rcl	0	-	rcl 0	lock | lol	**Reclocker** No control, only used to report *lock status.*
scale	0-11	-	-	out zoom <Hscale> <Vscale> pos <Hpos> <Vpos> afd <AFD-code>	**Fixed scaler blocks.** 12 fixed scale settings. The user can't change anything, but can use the settings for his own reference.
scale	12-23	out zoom <Hzoom> <Vzoom> out pos <Hpos> <Vpos> out env (16/9 | 4/3) out afd <AFD-code>	scale 12 out zoom 1.33 1.33 scale 12 out pos 0.002 0.002 scale 12 out env 16/9 scale 12 out env 4/3 scale 12 out afd 8 scale 12 out afd 11	out zoom <Hscale> <Vscale> pos <Hpos> <Vpos> env (16/9 | 4/3) afd <AFD-code>	**User scale blocks.** 12 user scale settings. **Zoom:** Zoom range is from 0.5 to 1.5. **Position:** Position when zoom is < 0 defines where in the output frame the box is placed. The box will never move outside of the frame. When zoom is > 0 the position defines which part of the input picture to use. A value of 0 is center. Positive values moves picture to the right or up. Negative values moves picture to the left or down. AFD code: The AFD code that is inserted is 5 bits. The user can specify the 4 least significant bits here, while the 5th bit is taken from the 'output environment' setting in scale 24.
scale	24	out <lines>'/'<framerate>('i'/'p') out env (16/9 | 4/3) out fill (full | crop | 14/9) rule <rule-value> ins <insert-value>	Scale 24 out 1080/25i scale 24 out env 16/9 scale 24 out fill full rule 0x02 insert 0x20	scale 24 rule 0x1 use 0xF ins 0x20 use 0x3E fill full out env 16/9 1080/25i	**Master scale control block** This block sets the output video standard and the output environment. In addition it also controls the conversion mode of the card and what aspect ratio information will be inserted in the output video. **Frame rate:** 576/25i 486/29i 720/50p 720/59p 720/25p 720/29p 1080/25i 1080/29i 1080/25p 1080/29p (more standards may be supported at a later stage) **Output environment:** out env can be 16/9 or 4/3. This controls the pixel aspect ratio of the output video. **Fill:** Fill selects how much of the picture is preserved. full: protect input frame

					crop: zoom to fill frame 14:9: scale to 14:9 PB or LB **Rule:** <rule-value> can take on the following values, and tells the card which incoming aspect ratio information to use: 0x01: AFD -> Fill -> Default 0x02: AFD -> Default 0x04: Fill -> Default 0x08: Default No other values will be accepted by the card, no combinations are available. **Insert:** The <insert -value> can be any binary combination of the following values: 0x02: WSS Extended 0x04: WSS 0x08: SMPTE352 0x10: Video Index 0x20: AFD Note that the value 0x01 is not currently supported, and that the card therefore will only accept even numbers as <insert-values>. Also note that WSS and WSS Extended cannot be inserted at the same time, as they only differ in the bit interpretation.
supr	0	en | dis | auto lb <page> <L1> <L2>…<L16> font <tag>	supr 0 auto supr 0 lbl 0 65 66 67 0 supr 0 font 1252	Supr 0 en font 0x4e4 lb 0 86 73 68 69 79 10 76 65 66 69 76	**Label generator** A label generator can be superimposed on the video. The setting ‘en’ means it is always superimposed, ‘dis’ means it is never superimposed, and ‘auto’ means it is superimposed on the internal video generator only. The text in the label can be set or modified by the lb <page> sub-command, where page is 0 to operate on letters 1-16 or 1 to operate on the letters 17-32. The letters follow as a string of ASCII numbers. To write more than 16 letters, two commands must be issued. A string is always terminated at an ASCII 0, and ASCII 10 is linefeed/new line. Only the first ASCII 10 will be honored. In the second example command, the label string is set to ‘ABC’ and terminated with ASCII 0. If not terminated, the command would’ve modified the first 3 letters of the string, but any remains of a previous string would still be present (until ASCII 0 or 33rd letter encountered). *Note 1: When the flash is busy programming the FPGA or is being programmed with new FPGA code, label information can not be*

					updated. *Note 2: At the present, only one font/codepage (codepage 1252) is included in the module.*
sync	0	-	sync 0	'lol' | ('lock' ('trilvl' | 'bb' | 'sdi'))	Frequency reference for video output. Status only, no commands available.
uart	0	-		tx	The embedded data link, selectable by cho 13. No control possible, the word tx indicates that this is a transceiver only. Uart info reports link status: *los* (loss of signal), *raw*, or the speed of the embedded link (example: *115200/8/n/1*).
vgen	0	cbar | mcbar | chkfield | white | yellow | cyan | green | magenta | red | blue | black flat <Y> <Cb> <Cr> video <lns>/<rate><scan> wss (auto|off | (on <wss_val>))	vgen 0 cbar vgen 0 flat 200 0 100 vgen 0 video 1080/24p vgen 0 video 1080/25p vgen 0 video 1080/25i vgen 0 video 1080/29i vgen 0 video 1080/30i vgen 0 video 720/24p vgen 0 video 720/25p vgen 0 video 720/29p vgen 0 video 720/30p vgen 0 wss auto vgen 0 wss on 7	video <lns>/<rate><scan> wss (auto| off | (on <wss_value>)) (cbar | chkfield | mcbar | white | yellow | cyan | green | magenta | red | blue | black | (flat <Y> <Cb> <Cr>))	**Internal video generator.** The video generator will be activated in two different ways: If selected as a fallback option the generator will generate the selected pattern when the other input(s) are missing, and then use the video settings from the last external source present. It can also be selected as the main input in cho 1, in which case its own video settings will also be used.
vmon	0	msk <16b_mask> reset	vmon 0 msk 0xFFFF vmon 0 reset	msk <16b_mask>	**Video monitoring.** Error counting. The count itself is reported in info. Errors can be masked off and not counted; this is the purpose of the mask. The counter itself is 16b and will wrap around, but can also be reset by issuing *reset*.
vprc	0	lglz on | lglz off (y | cb | cr) <gain> <offset>	vprc 0 lglz on vprc 0 lglz off vprc 0 y 1.0000 0 vprc 0 cb 1.0000 0 vprc 0 cr 1.0000 0		**Video processing block** Gain and offset are both signed fixed point numbers. Gain is in 2.13-format, while offset for Y and the chroma channels are given in 10.2 and 9.2 respectively. Gain range is 0 – 3.9999, $Gain_{=0x}$ = 0, $Gain_{=1x}$ = 1.0, $Gain_{\sim 4x}$ = 3.9999

					Luma Offset range is -511.75 – 511.75, $Offset_{=0}$ = 0 Chroma Offset range is -255.75 – 255.75, $Offset_{=0}$ = 0

6.3 Commands intended for debug/lab use only

Block	Blk#	Commands	example	Response	Control
spi	-	on | off	spi on spi off		spi off used to isolate the uC from the SPI lines during programming of the flash by external programmer. spi on must be issued in order to re-enable normal card operation with the uC as the SPI master.
spir	-	<address>	spir 0x0004		Read a single word (or byte) from SPI registers. Addressing is 16b and most significant nibble determines which chip. These are the address ranges: 0x0000 – 0x0fff : iChip 0x1000 – 0x1fff : de-serializer 0x2000 – 0x2fff : FPGA 0x3000 – 0x3fff : flash 0x4000 – 0x4fff : serializer 0x5000 – 0x5fff : F-RAM
spiw	-	<address> <data>	spiw 0x0004 0x2c		With the same address ranges as for spir above, this command allows the user to modify SPI registers.
thebug	-	-	thebug		A collection of debug information that is presented in a Multicon GYDA block-like format. First line tells which image is currently loaded. Second line contains the filename and version of the uC software, including the AVR controller it was compiled for. The third line contains the SW flags in uC, the number of times the watchdog timer has kicked in, readout of dip-switches, input select for deserializer, SDOn on/off, slew rates, and status for the video changeovers. The next two lines contain raster information from the deserializer and serializer respectively, while the next two lines contain sample values for mlines and VCXO.

General environmental requirements for Nevion equipment

1. The equipment will meet the guaranteed performance specification under the following environmental conditions:
   - Operating room temperature range: 0°C to 45°C
   - Operating relative humidity range: <90% (non-condensing)

2. The equipment will operate without damage under the following environmental conditions:
   - Temperature range: -10°C to 55°C
   - Relative humidity range: <95% (non-condensing)

Product Warranty

The warranty terms and conditions for the product(s) covered by this manual follow the General Sales Conditions by Nevion, which are available on the company web site:

www.nevion.com

Appendix A Materials declaration and recycling information

A.1 Materials declaration

For product sold into China after 1st March 2007, we comply with the “Administrative Measure on the Control of Pollution by Electronic Information Products”. In the first stage of this legislation, content of six hazardous materials has to be declared. The table below shows the required information.

組成名稱 Part Name	Toxic or hazardous substances and elements					
	鉛 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr(VI))	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
UDC-HD-XMUX4 CRC-HD-XMUX4 UPC-HD-XMUX4	O	O	O	O	O	O
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006. X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.						

This is indicated by the product marking:

A.2 Recycling information

Nevion provides assistance to customers and recyclers through our web site http://www.nevion.com/. Please contact Nevion Customer Support for assistance with recycling if this site does not show the information you require.

Where it is not possible to return the product to Nevion or its agents for recycling, the following general information may be of assistance:

- Before attempting disassembly, ensure the product is completely disconnected from power and signal connections.
- All major parts are marked or labeled to show their material content.
- Depending on the date of manufacture, this product may contain lead in solder.

Some circuit boards may contain battery-backed memory devices.

EC Declaration of Conformity

MANUFACTURER	Nevion Europe AS P.O. Box 1020, 3204 Sandefjord, Norway	
AUTHORIZED REPRESENTATIVE (Established within the EEA)	Not applicable	
MODEL NUMBER(S)	UDC-HD-XMUX4 CRC-HD-XMUX4 UPC-HD-XMUX4	
DESCRIPTION	HD/SD-SDI Format converter with Frame Synchronizer and 4x AES I/O	
DIRECTIVES this equipment complies with	Low voltage (EU Directive 2006/95/EC) EMC (EU Directive 2004/108/EC) RoHS (EU Directive 2002/95/EC) China RoHS[2] WEEE (EU Directive 2002/96/EC) REACH	
HARMONISED STANDARDS applied in order to verify compliance with Directive(s)	EN 55103-1:1996 EN 55103-2:1996	
TEST REPORTS ISSUED BY	**Notified/Competent Body**	**Report no:**
	-	-
TECHNICAL CONSTRUCTION FILE NO	Not applicable	
YEAR WHICH THE CE-MARK WAS AFFIXED	2010	
TEST AUTHORIZED SIGNATORY		
MANUFACTURER	**AUTHORIZED REPRESENTATIVE (Established within EEA)**	**Date of Issue**
		2011-06-16
		Place of Issue
	Not applicable	Sandefjord, Norway

NEVION EUROPE AS
O.nr. 976 584 201 MVA

Name Thomas Øhrbom

Position VP of Quality, Nevion
(authorized signature)

[2] Administration on the Control of Pollution Caused by Electronic Information Products