V__remote4
V__link4
User Manual

Version: 1.4.0.98+
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Table of Contents

Welcome

Welcome to the V__link4 / V__remote4, Lawo's all-in-one video-over IP solution:

Figure 1

This documentation is designed for users and technicians, and covers installation and operation.

Due to the similarity of operation, some of the screenshots used in this manual are taken from the V__pro8, a sister product of the V__link4 and V__remote4.

For more information and regular product updates, please register at **www.lawo.com/user-registration**.

Marginal Notes

The following symbols are used to draw your attention to:

Points of clarification

Useful tips and short cuts.

Warnings - alert you when an action should *always* be observed

Important Safety Instructions

Exposure to excessive sound pressure levels can lead to impaired hearing and cause damage to the ear. Please read and observe ALL of the following notes:

- Check all of the hardware devices for transport damage.
- Any devices showing signs of mechanical damage or damage from the spillage of liquids MUST NOT be connected to the mains supply or disconnected from the mains immediately by pulling out the power lead.
- All devices MUST be grounded. Grounding connectors are provided on all devices. In addition, all low voltage devices external to the system must also be grounded before operation.
- For Scandinavian countries, ALWAYS use a grounded mains connection, to prevent the device from being grounded through Ethernet or other signal connections.
- All devices MUST be connected to the mains using the three cord power leads supplied with the system. Only supply electrical interfaces with the voltages and signals described in these instructions.
  - CAUTION: Two pole / Neutral wire Fuse.
  - CAUTION: For continued protection against risk of fire, replace only with same type and rating of fuse (2*4A T / H 250V).
- Neutrik PowerCon and Harting connectors must NOT be disconnected under load.
- Do NOT use the system at extreme temperatures. Proper operation can only be guaranteed between temperatures of 0 C and 40 C and a maximum relative humidity < 90%.
- Do NOT expose devices to liquids which may drip or splash.
- Do NOT place objects filled with liquids, such as vases, upon a device.
- Only service staff may replace batteries.
- Servicing of components inside a device MUST only be carried out by qualified service personnel according to the following guidelines:
  - Before removing parts of the casing, shields, etc. the device MUST be switched off and disconnected from all mains.
  - Before opening a device, the power supply capacitor MUST be discharged with a suitable resistor.
  - Components that carry heavy electrical loads, such as power transistors and resistors, should NOT be touched until cool to avoid burns.
- Servicing unprotected powered devices may only be carried out by qualified service personnel at their own risk. The following instructions MUST be observed:
  - NEVER touch bare wires or circuitry.
  - Use insulated tools ONLY.
  - DO NOT touch metal semi-conductor casings as they can bear high voltages.

Defective Parts/Modules

- V__link4 contains no user serviceable parts. Therefore DO NOT open the devices other than to perform the procedures described in this manual.
- In the event of a hardware defect, please send the system component to your local service representative together with a detailed description of the fault. We would like to remind you to please check carefully whether the failure is caused by erroneous configuration, operation or connection before s ending parts for repair. We recommend contacting our service department before sending parts for repair.

First Aid (in the case of electric shock)

- DO NOT touch the person or his/her clothing before power is turned off, otherwise you risk sustaining an electric shock yourself.
- Separate the person as quickly as possible from the electric power source as follows:
  - Switch off the equipment.
  - Unplug or disconnect the mains cable.
  - Move the person away from the power source by using dry insulating material (such as wood or plastic).
- If the person is unconscious:
  - Check their pulse and reanimate if their respiration is poor.
  - Lay the body down and turn it to one side. Call for a doctor immediately.
- Having sustained an electric shock, ALWAYS consult a doctor.

Overview

This chapter provides an overview of the V__link4 / V__remote4 and its key features:

Introducing the V__remote4 / V__link4

Figure 2 Front View (with optional Hard Key Control Panel)

Figure 3 Rear View

V__link4 / V__remote4 is a compact, fully digital 8-channel video processor with 4 x 3G/HD/SD SDI and 4 x Video-over-IP encoders/decoders with de-embedders / embedders. It features an 8 x 8 video routing matrix (4 x SDI + 4 x IP) and 384 x 384 audio matrix as well as a built-in manageable access layer switch fabric with 4x 1GE 2x 10GE external ports.

Video processing includes 3G conversion, frame synchronization; frame and line phaser modes; RGB color correction & proc amp; timecode insertion, test pattern generator and video ID generator; and master sync generator.

Audio processing includes channel shuffling; freely adjustable video and audio delay; SRCs for all de- embedders and embedders; Dolby E aligner; AV sync measurement and two stereo downmix engines.

Browser-based channel previewing provides waveform monitor and vectorscope displays; thumbnails; and a high quality MultiView output (QuadSplit) with metering overlay, UMD and tally.

Each unit provides:

- **4 x SDI in** - de-embedded to provide 4 video (1 video + 16 audio channels per SDI in).
- **4 x SDI out** - embedded to carry 4 video (1 video + 16 audio channels per SDI out).
- **4 x Video-over-IP in** - de-embedded to provide 4 video (1 video + 16 audio channels per IP stream).
- **4 x Video-over-IP out** - embedded to carry 4 video (1 video + 16 audio channels per IP stream).
- **RAVENNA in** - up to 6 streams providing up to 128 audio input channels.
- **RAVENNA out** - up to 6 streams carrying up to 128 audio output channels.
- **2 x MADI in/out** - 128 audio input + 128 audio output channels (64 channels per MADI link).

The SDI connections support a wide range of 3G, HD (High Definition) and SD (Standard Definition) video standards.

Production-quality Video-over-IP encoders and decoders are RAW (uncompressed), VC-2 (DiracPro low latency compressed) and JPEG2000 (J2k). Monitoring- quality Video-over-IP encoders are MJPEG and H264.

Video and audio can be re-assigned on a channel-by-channel basis. Thus, you can route a single video input to multiple outputs, embed new audio content into a video output and/or convert between Video-over-IP, SDI, MADI and RAVENNA.

For more details, please see the **Signal Flow Block Diagram** and **Technical Data**.

The Front Panel

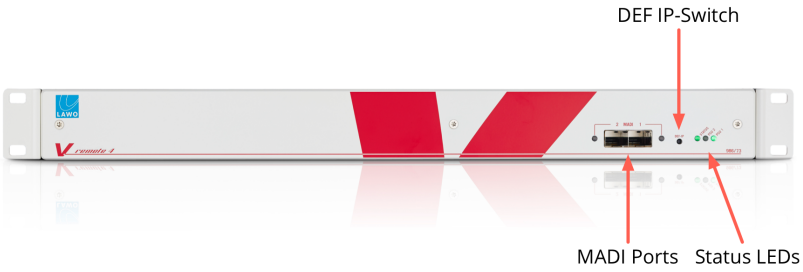


Figure 4

MADI 1 & 2

2 x **MADI in/out** (AES 10) on optical fibre (via **SFP modules**). The two front panel ports can operate in parallel to provide redundancy. An LED for each port indicates the status:

- **Green** = MADI link is active.
- **Flashing Red** = MADI link is asynchronous.
- **Off** = no connection or MADI link is invalid.

DEF-IP

Default IP button (recessed)

Press for a short time to display the **INFO box** on the **MultiView output** (to find out the IP address of the unit).

During a power cycle, press and hold until the **STATUS** LED turns white, to reset *all* settings (except IP addresses) to the factory defaults.

During normal operation, press and hold until the **STATUS** LED turns white, to reset the TCP/IP settings to the factory defaults. The default IP settings are:

- **IP address = 192.168.123.70**
- **Subnet Mask = 255.255.255.0**

STATUS LED

Indicates the system status:

- **Blue** = unit is booting.
- **Flashing Green** = ready for operation.
- **White** = reset to default IP settings.
- **Flashing Yellow** = network activity.
- **Flashing Blue or Red** = boot load error, see **powering on**.

PSU 1 & 2 LEDs

Indicate the status of the two internal **power supplies**:

- **Green** = power supply is active.
- **Off** = power supply is inactive (no mains input or internal supply is faulty).

Front Panel FP1 now also supported

Figure 5

The Rear Panel

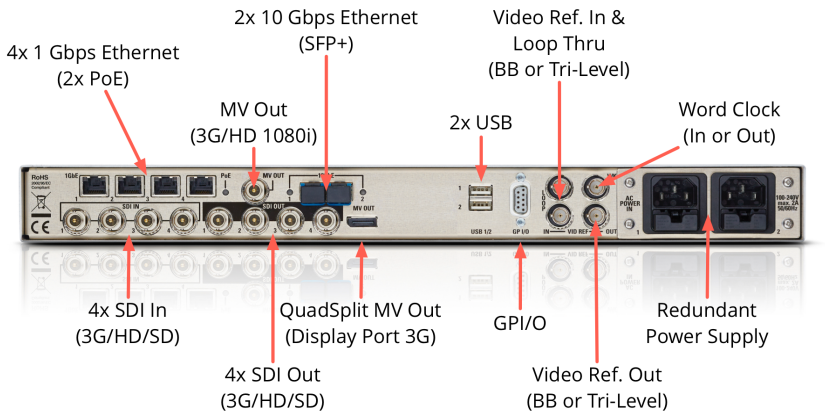


Figure 6

SDI IN 1 to 4 — 4 x **SDI in** on BNC (3G/HD/SD-SDI).

SDI OUT 1 to 4 — 4 x **SDI out** on BNC (3G/HD/SD-SDI).

MV OUT — **MultiView output** for local monitoring of up to 4 SDI outputs simultaneously. Two connector options are provided: 1 x BNC (3G/1080i SDI) and 1 x DisplayPort.

1 GbE 1 to 4 — 4 x 1 **Gigabit Ethernet** on RJ45 Two of the four ports can provide up to 15W of Power over Ethernet (PoE).

PoE LED — Not supported in this release of software.

10 GbE 1 & 2 — 2 x 10 **Gigabit Ethernet** (on optical fibre via **SFP+ modules**) Each physical Ethernet port can send and receive multiple IP streams for Video-over-IP and RAVENNA. The ports are also used to connect your control computer, see **Network Connection**.

USB 1/2 — The USB ports are unused in this release.

GP I/O — 1 x 9-pin D-Sub for **General Purpose** Input/Output connections.

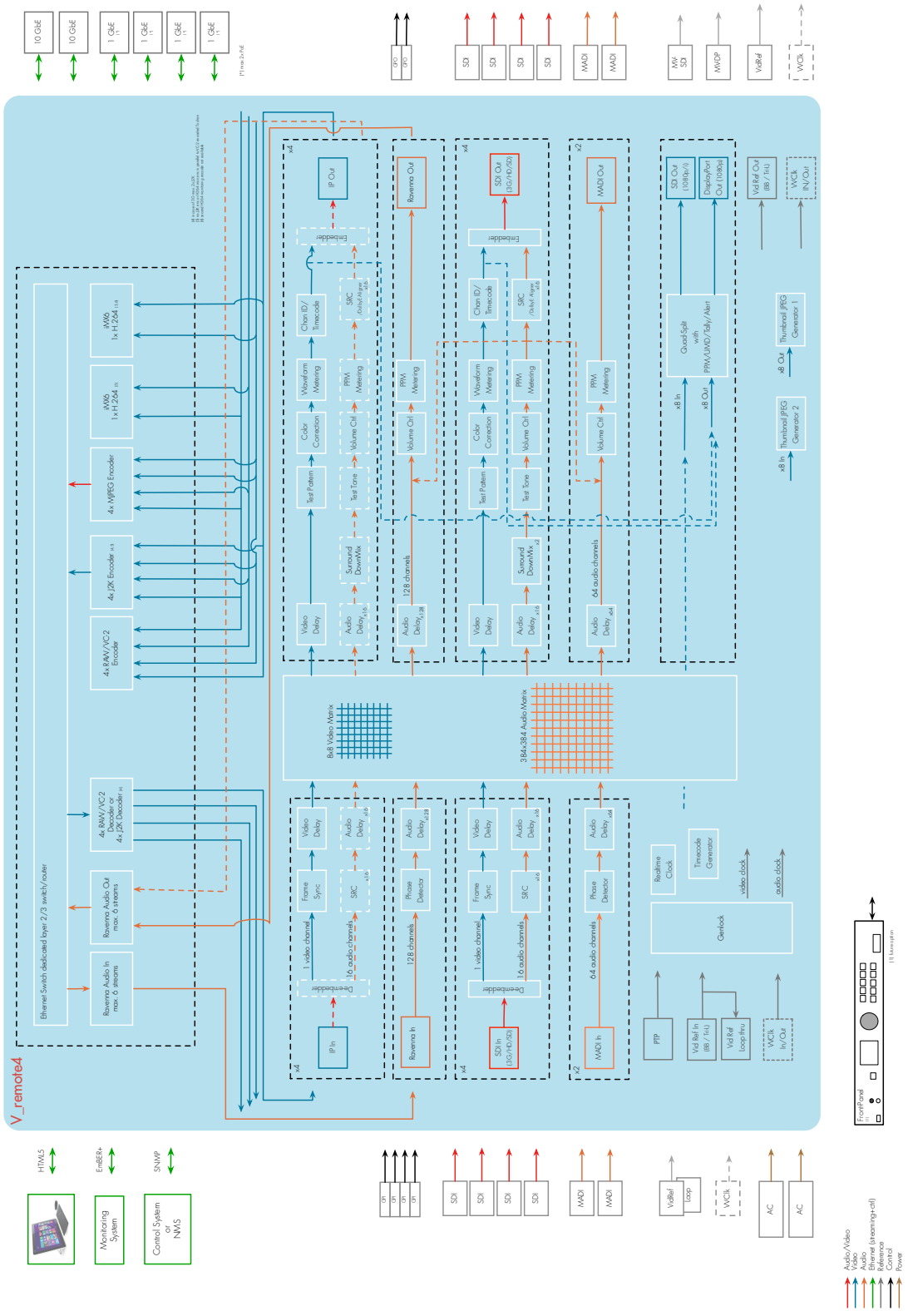
VID REF IN, OUT, LOOP & WK — External **Video reference** and **Wordclock** signals on BNC:

- **IN** - video reference input (e.g. Tri-Level Sync or Black-Burst).
- **LOOP** - passive loop-thru of the video IN (75Ω termination recommended).
- **OUT** - video reference output, as selected by the user interface.
- **WK** - wordclock in or out as selected by the user interface.

AC POWER IN 1 & 2 — 2 x mains **AC power** inputs on IEC (Auto sensing 100-240V VAC, 50/60Hz).

Only one supply is required for operation. For redundancy, connect both supplies, each to a separate AC mains circuit. The power connectors include an IEC locking mechanism. Please unlock the connector properly before removing a power cable.

Signal Flow Block Diagram



Software Options & Licensing

The V__link4 / V__remote4 comes with a range of licenses designed for different requirements. Every unit supports:

- **Status Monitoring**
- **Signal Routing**
- **Frame Sync & SRC**
- **Variable Delay**
- **Timecode, Test Pattern, Channel ID & Test Tone Insertion**
- **RAW and RAVENNA Streaming Capabilities**
- **Layer 2/3 Switch/Router**

You may then add the following by purchasing and installing the relevant license. Multiple licenses may be combined as required:

- **JPEG2000 (J2K) Encoder / Decoder Instances**
- **VC-2 (DiracPro) Codecs**
- **MJPEG Monitoring Encoders**
- **H264 Monitoring Encoder**
- **Color Correction** - YUV & RGB Color Correction.
- **Monitoring Package** - MultiView monitoring, Waveform monitoring (YUV, RGB & Y-only) and the Vectorscope.
- **MADI I/O**
- **AV Sync Measurement** - lip sync measurement on each Video input.
- **Ref PTP GM**
- **DolbyE Auto Align**
- **EPS**
- **Sounding** - Packet Delay Measurement

A single license key file contains *all* the purchased license information relevant to your device (UUID-based).

A trial period may be enabled for licensed software options (for evaluation purposes) as follow:

1. Select a licensed menu option - for example, color correction. If no license is installed, a runtime clock appears:

Figure 7

2. Click on the runtime clock and select *OK* to start the 20-day operational time trial period:

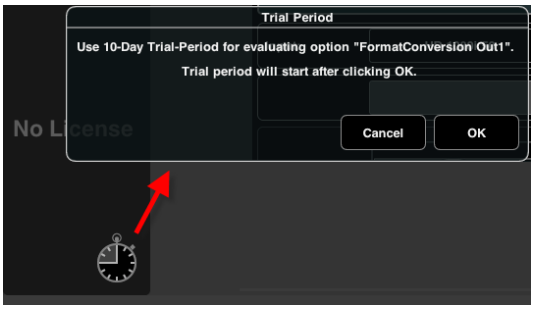


Figure 8

While the trial period is active, an overlay is displayed:

Figure 9

The trial period is per software option, and can be enabled only once. When the 20-day operational time limit is reached, the option expires.

Installation & Configuration

This chapter covers the hardware installation of the V__link4 / V__remote4, and the configuration of your control computer, network and other settings:

Computer System Requirements

To control parameters you will need an external computer, connected to the V__link4 / V__remote4 network and running a web browser session.

Your computer *MUST* meet or exceed the following requirements:

- **Network Interface Card**: operating at a speed of 100 or 1000 Base-TX LAN.
- **Web Browser**: any web browser which supports web worker, HTML5 and JSON. Please use the latest revision of your browser for best performance.
- **Screen Resolution**: >= 1440 x 900 is recommended, in order to view the full operating window without scrolling or scaling.

Installation Checklist

To get your system operational, please complete each of the following steps:

1. Unpack and check the contents of the shipping box.
2. Fit any optical port SFP transceivers. Please take care not to mix up the transceiver types: Fast Ethernet (for the MADI ports) with 10Gb Ethernet. Only 10GbE SFP transceivers are supported.
3. Mount the unit.
4. Connect and turn on the power.
5. Connect and configure the network connection to your computer.
6. Start a web browser session.
7. Check the software revision and, if necessary, update your unit.
8. Connect the remaining video, audio and reference signals.
9. Configure the reference settings for your installation.
10. Install the V__link4 / V__remote4 software package to your computer to run the StreamDirector (downloaded from the V__link4 / V__remote4 via the Web Browser interface, under Settings -> Software Update: Tools).

The rest of this chapter covers these steps in more detail.

Packing List

Your shipping box includes:

- V__link4 / V__remote4 unit
- Two IEC power cables (country-specific)
- Two 19" rack-mounting brackets for the frame
- Two SFP optical fibre Fast Ethernet transceivers for the MADI ports
- Two SFP+ optical fibre 10GE transceivers for the 10 Gb Ethernet ports
- 19" rack-mounting accessory kit (optional)
- The V__link4 / V__remote4 Quick Start Guide and USB memory card (containing all documentation)

Please check the contents, and in the event of any transport damage, contact your local Lawo representative or email **service@lawo.com**.

SFP Module Installation

MADI Ports

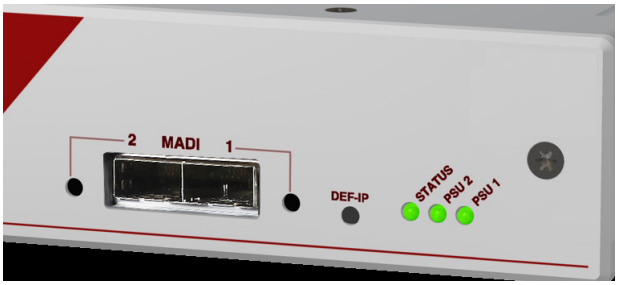


Figure 10 MADI Ports (no SFP modules fitted)

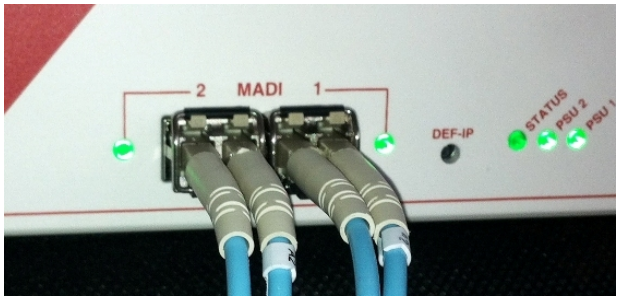


Figure 11 MADI Ports (with Optical LC Duplex Connectors)

The V__link4 / V__remote4 is shipped with two Fast Ethernet SFP transceivers so that you may connect optical fibre to the MADI ports.

Either of the following transceivers are recommended:

- Skylane SFP Transceiver (Part Number SFP13002EG0D000)
- Avago LC Duplex Connector Optical Interface (Part Number HFBR-57E0PZ).

The SFP transceivers are hot-pluggable. To install, push each module into the rectangular **MADI** slot. Press gently and firmly until the module locks into position.

10 Gb Ethernet Ports

The same procedure can be used to fit the 10GE SFP+ modules to the **10 Gb Ethernet** ports on the **rear** of the unit. The following transceivers are recommended:

- Avago AFCT-701ASDZ
- Avago AFCT-739ASMZ

Other transceivers will not be disabled and can be used as well.

CAUTION: Please unlock the transceiver before removing to avoid mechanical damage to the slot.

Frame Installation

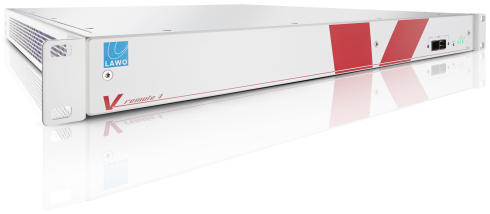


Figure 12 Front View

Figure 13 Rear View

The V__link4 / V__remote4 can be mounted either in a 19" equipment rack or on a table top as follows:

- **19" Rack-Mounting** - fix the rack-mounting brackets to the front of the chassis. Then attach to a standard 19" equipment rack. Please install a supporting rack mount kit to hold the weight of the unit. An optional rack-mounting accessory kit is available.
- **Table Top** - the unit should be laid on a flat, horizontal surface.

Plug-in connectors are located at both the front and rear. Therefore, make sure that all connectors are accessible. When using 19" racks with doors please leave enough room for the cables!

Dimensions and Weight

Width: 480.3mm (19“) Height: 1RU

Depth: 457.5mm (18“) Weight: 5.1kg (11.2 lbs)

Temperature and Cooling

The unit is fitted with six fans inside, and ventilation holes on the left and right. Proper operation is guaranteed between temperatures of 0° C and 40° C and a maximum relative humidity of <= 90% non-condensing.

DO NOT obstruct the ventilation holes as to do so will prevent efficient cooling.

Cooling Airflow

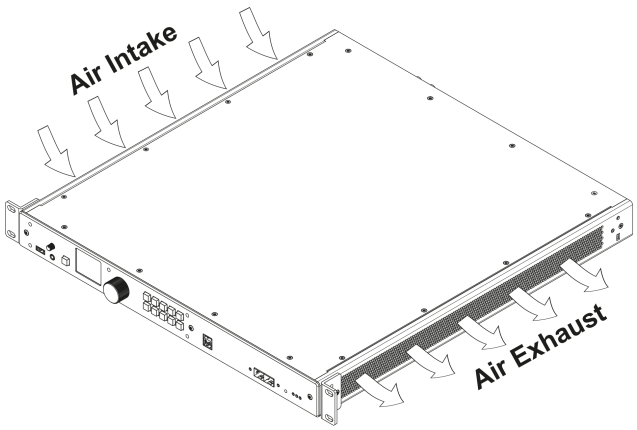


Figure 14

Grounding & Power

Figure 15

Grounding

The V__link4 / V__remote4 is grounded via the 3-pin IEC power connectors on the rear of the unit.

> The unit must be on the same potential as all other system devices/modules. For Scandinavian countries, ALWAYS use a grounded mains connection, to prevent the device from being grounded through Ethernet or other signal connections.

Power

The unit is fitted with two independent power supplies:

- **Input Voltage**: 2 x auto sensing 100-240V VAC power supply, 50/60Hz nominal
- **Power Consumption**: < 130W
- **Connection**: 2 x IEC power connectors

Only one supply is required to operate the system. For redundancy, connect both supplies, each to a separate AC mains circuit. This will ensure continued operation if one of the mains circuits fails.

> Please observe all of the **Safety Instructions** *BEFORE* connecting power to the unit.
>
> The device MUST be connected to the mains using the IEC power cables supplied with the system. Country-specific mains adaptors will be supplied.
>
> When running with multiple mains supplies, make sure that both circuits lie on the same ground potential. Otherwise, an internal bridge of two ground wires will lead to a ground loop!

The power connectors include an IEC locking mechanism. Please unlock the connector properly before removing a power cable.

Powering On

The V__link4 / V__remote4 has no on/off switch but starts automatically when either power supply is connected to the mains. Please install a master system power switch where applicable.

You will hear the fans begin to operate, and the LEDs on the front of the unit illuminate as follows:

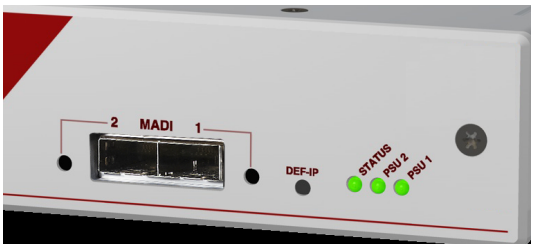


Figure 16 MADI Ports (no SFP modules fitted)

STATUS LED

- **Blue** = unit is booting.
- **Flashing Green** = ready for operation.
- **White** = reset to default IP settings.
- **Flashing Yellow** = network activity.
- **Flashing Blue or Red** = boot load error. Try powering the unit off and on. For further assistance, please contact your local Lawo representative or email service@lawo.com.

PSU 1 and PSU 2 LEDs

- **Green** = power supply is active.
- **Off** = power supply is inactive (no mains input or internal PSU is faulty).

The system takes approximately 40 seconds to boot from power on, and loads the latest settings.

Network Connection (Control Computer)

To control parameters, you will need to connect an external computer to the V__link4 / V__remote4 network and start a web browser session. The computer may connect either directly to the unit, or (more usually) via a network switch or hub. Usually the same physical connection will also transfer video and audio signals, see **Video-over-IP & RAVENNA**:

Figure 17 Direct Connection

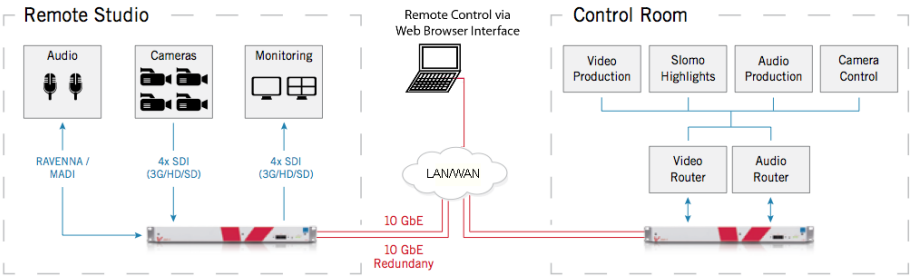


Figure 18 Networked Connection

Each unit provides four **1Gb Ethernet** ports and two 10Gb Ethernet ports on the rear panel. Any port may be used to connect the **link4** to your computer or IP network. Note that there is a managed switch inside the **link4** with a switching capacity of 40Gbit/s.

Figure 19

4 x 1Gb Ethernet Ports:

- **PoE**: two of the four ports can provide up to 15W of Power over Ethernet.
- **Cable Type**: straight (1:1) or crossed Ethernet cable.
- **Connector Type**: RJ45.
- **Speed**: up to 1 Gbit/s.

2 x 10Gb Ethernet Ports (via SFP+ transceivers):

- **Cable Type**: single or multi-mode fibre optic.
- **Connector Type**: depends on the **SFP module**.
- **Speed**: 10 Gbit/s

> 10GE Port 1 and 1GE Port 1 do have larger TX-FIFOs. They are therefore preferred ports for streaming and / or daisy-chaining.

IP Configuration

To establish network communication, you will need to configure the IP settings of your computer's Network Interface card and each V__link4 / V__remote4 unit.

V__link4 / V__remote4 **IP Settings**

The default settings for **VLAN1**, as shipped from the factory, are:

- **IP address** (any port) = 192.168.123.70
- **Subnet Mask** = 255.255.255.0
- **Gateway** = 0.0.0.0

Once you have established a connection, the IP Address can be changed from the **Settings -> Network** menu.

> The easiest way to find out the IP address of the unit is to display the **INFO box** on the **MV (MultiView) Output**. Alternatively, use the **DEF IP** button to reset the IP settings to their defaults.

Direct Connection

If your computer is connected directly to the V__link4 / V__remote4, then configure your computer's Network Interface card as follows:

- **IP Address** - in the same range as that of the V__link4 / V__remote4 network port.

For example, if the V__link4 / V__remote4 IP Address is 192.168.123.70, then set your computer IP Address to 192.168.123.100.

- **Subnet Mask** - identical to that of the V__link4 / V__remote4 network port (default Subnet Mask = 255.255.255.0).

The screenshots on the next page demonstrate this procedure.

Connection via a Network Switch or Hub

In a networked installation, it is likely that you will be connecting multiple devices and/or computers. Each device on the network requires a unique IP address which may be assigned either statically (Static IP) or dynamically (via DHCP). Please consult your network administrator for details.

> The V__link4 / V__remote4 supports Static IP addresses but not DHCP.
>
> Therefore, you will need to manually configure the IP settings on each unit. To do this, connect your computer directly, start a web browser session and use the **Settings -> Network** menu to adjust the IP Address of each network port.

Computer Network Interface IP Settings

The following screenshots demonstrate how to configure the IP settings of your computer's Network Interface card in Windows 7 and Mac OS X:

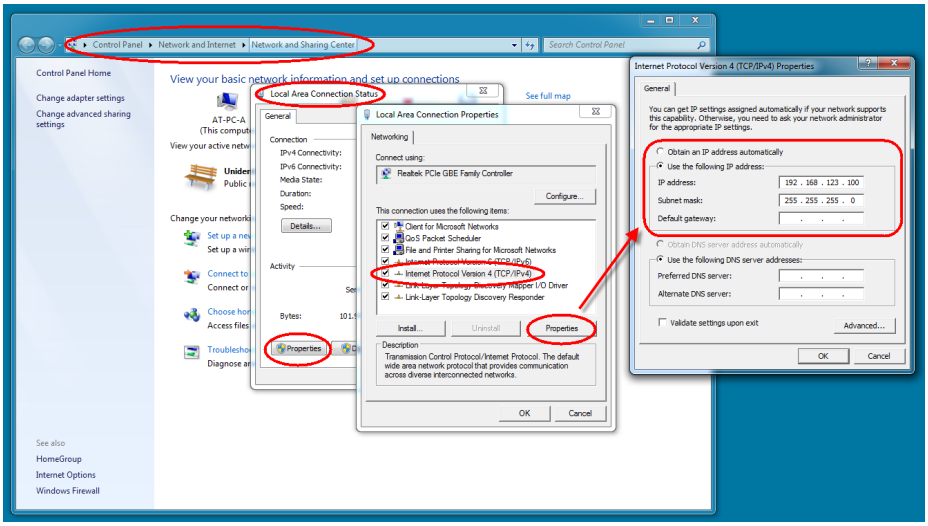


Figure 20 **Windows 7**: see **www.microsoft.com**

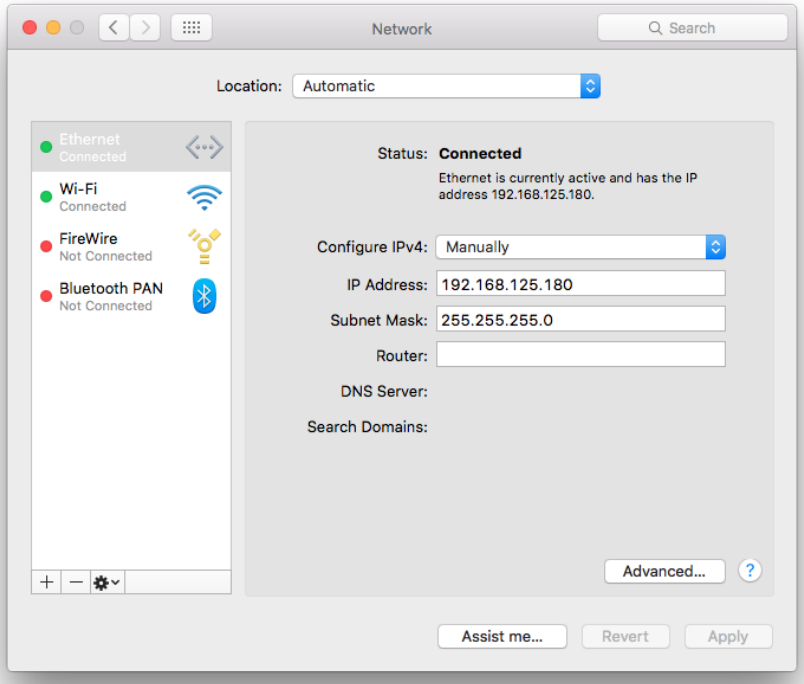


Figure 21 **MAC OS X**: see **www.apple.com**

Displaying the INFO Box

The INFO box appears on both the BNC and Display Port **MV outputs** when you boot up or press the **DEF IP** switch (short press). In either case, the box overlays the MultiView monitoring for 30 seconds before disappearing:

Figure 22

In addition to the **IP settings** for the network ports, the box displays **Device Information** such as the active **software partition**, part number, serial number, etc.

Web Browser Control

Having **connected** and **configured** the network connection between your computer and V__link4 / V__remote4, you may open a web browser session to control the system's parameters.

See **Starting a Web Browser Session** for details.

Troubleshooting the Browser Connection

If the login screen does not appear, then please check the following:

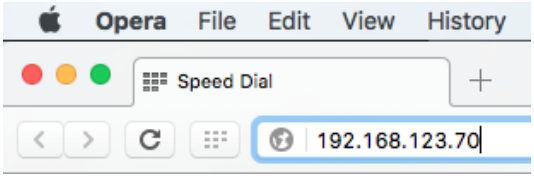


Figure 23

- **URL Address** - this must match that of the V__link4 / V__remote4 system. See **IP configuration**.

> The easiest way to find out the IP address of the unit is to display the **INFO box** on the MV (MultiView) Output. Alternatively, use the **DEF IP** button to reset the IP settings to their defaults.

- **Physical network connection** - See **Network Connection**.
- **IP configuration** - if you are connecting via a network switch or hub, then try a **direct connection** to eliminate the network infrastructure. If the login screen still does not appear, then run a **PING** test to check your network communication.
- **Firewall** or **Antivirus Software** - some software may interfere with web browser communication. Try disabling your Firewall and/or Antivirus to eliminate them as the cause of the problem.

If the login screen appears, but you are unable to login to the V__link4 / V__remote4 system, then check that the following options are enabled in your Web Browser's settings:

- **Java Script**
- **Websocket**

PING Command

The PING command is a built-in Windows and Mac function, that allows you to test whether you have a valid network connection to and from any networked device.

Make sure that your computer is **connected** to the V__link4 / V__remote4's network port, and that you have configured the **IP settings** of your computer's Network Interface card. Then run the test:

1. On a Windows PC, select `START` -> `Run...` and type **cmd** into the Run window followed by `OK`.

This opens the DOS command prompt window.

Alternatively:

1. On a Mac, open the **Terminal** program (found in the **Applications** -> **Utilities** folder).
2. Type the following to test the connection:

ping 192.168.123.70

If the IP Address has been changed from the default, then type the IP Address of your network port.

> The easiest way to find out the IP address of the unit is to display the **INFO box** on the MV (MultiView) Output. Alternatively, use the **DEF IP** button to reset the IP settings to their defaults.

3. Press ENTER.

Your computer will now try to establish communication.

- If the ping command fails, then the request will time out, and you will not receive any successful packets.

Check your physical network connections, and also the IP settings on your computer's network interface card.

- If the ping command is successful, then the result will show that the Sent packets have been successfully Received.

This confirms that the network communication is working. If your browser connection continues to fail, check the URL address and/or disable any Firewall or Antivirus software.

Software Update

Having installed the unit and established web browser communication, it is a good idea to check the software revision and, if necessary, perform a software update. The latest software revision is available from the **Download-Center** at **www.lawo.com** (after **Login**).

See **Settings -> Software Update** for details.

Signal Connections

Having dealt with both **power** and the **control network**, the remaining front and rear panel connections are for video, audio and external reference signals:

- **SDI Connections**
- **Video-over-IP & RAVENNA**
- **MV Out Connections**
- **MADI Connections**
- **External Reference Connections**
- **GPIO Connections**

SDI Connections

Figure 24

4 x SDI inputs and 4 x SDI outputs on BNC connectors.

Each SDI connection carries one digital video and 16 embedded audio channels.

A wide range of 10-bit 3G, HD and SD video standards are supported, please see **Technical Data**.

Video-over-IP & RAVENNA

The Ethernet ports on the rear of the V__link4 / V__remote4 are internally connected to an integrated layer 2/3 Ethernet switch. By default, this appears as an unmanaged switch with enhanced IGMP capabilities, making it ready for “plug and play” operation.

Each physical port can send and receive multiple IP streams for Video-over-IP or RAVENNA. The V__link4 / V__remote4’s own Java application (**StreamDirector**) automatically discovers all units on the network and shows their current streaming configuration.

For Video-over-IP, each unit supports 4 x RAW + 4 x J2K* production-quality encoders and decoders (all in 10bit 4:2:2), plus 4 x MJPEG* (8bit 4:2:2) + 1x or 2x H264* (8bit 4:2:0) monitoring-quality encoders for IP-TV or Internet applications.

> The J2K, VC-2 (DiracPro), MJPEG and H264 encoders/decoders are **licensed** software options.

Note that more IP streams can be sent and received than the inputs and outputs to the video/audio matrix. Thus, internally each V__link4 / V__remote4 supports:

- **4 x IP in** - pre-selected from either the RAW or J2K production-quality decoders.
- **4 x IP out** - encoded to both RAW and J2K production-quality encoders, plus the MJPEG and 1x or 2x H264 monitoring outs.
- **RAVENNA in** - up to 6 streams providing up to 128 audio input channels.
- **RAVENNA out** - up to 6 streams carrying up to 128 audio output channels.

Please see the **Signal Flow Block Diagram** for more details.

The physical connections are made via the rear panel:

Figure 25

4 x 1Gb Ethernet Ports:

- **PoE**: two of the four ports can provide up to 15W of Power over Ethernet.
- **Cable Type**: straight (1:1) or crossed Ethernet cable.
- **Connector Type**: RJ45.
- **Speed**: up to 1 Gbit/s.

2 x 10Gb Ethernet Ports (via SFP+ transceivers):

- **Cable Type**: single or multi-mode fibre optic.
- **Connector Type**: depends on the **SFP module**.
- **Speed**: 10 Gbit/s

10GE Port 1 and 1GE Port 1 do have larger TX-FIFOs. They are therefore preferred ports for streaming and / or daisy-chaining.

MV (MultiView) Out

Figure 26 MV Out

Figure 27 External Display (shows any 4 SDI inputs or outputs simultaneously

The **MV OUT** is used to provide local MultiView monitoring of up to 4 SDI inputs or outputs simultaneously.

Two different connector options are provided:

- 1 x BNC (3G / 1080i SDI, switchable)
- 1 x DisplayPort.

> The HD-SDI output (BNC) defaults to 3G. Therefore, make sure that the external display supports the 3G video format.
>
> When using the DisplayPort output with the V__link4 / V__remote4 operating at 50Hz standard definition, make sure that 50Hz is supported by the external display. The factory default setting for the DisplayPort output is 60Hz.

Once connected, MultiView monitoring is configured from the user interface, see the **MV** menu.

On the external display, each monitor window provides the following information:

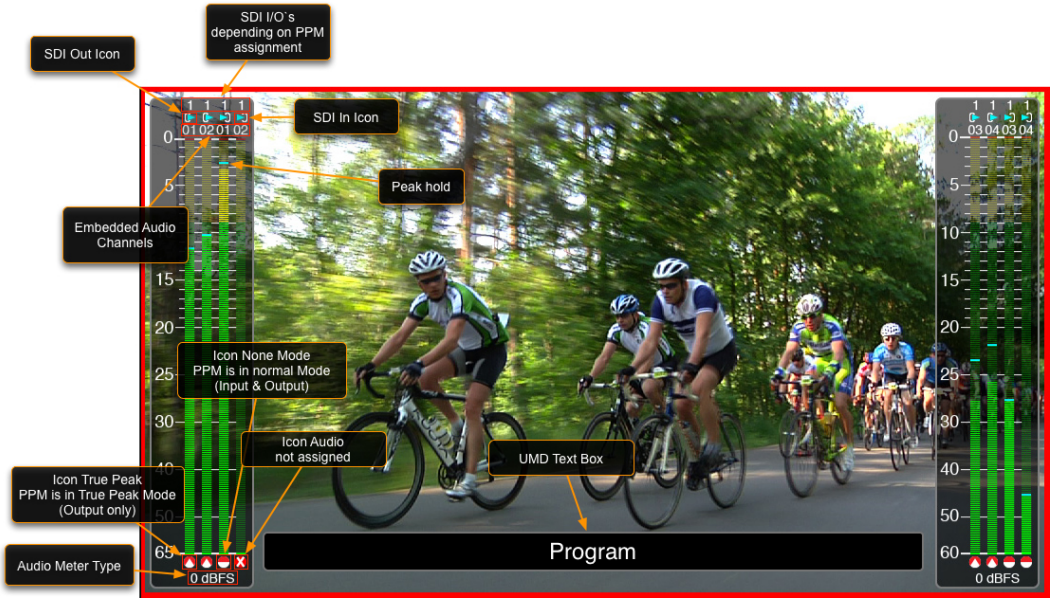


Figure 28

You can also overlay the monitoring with the **INFO box** by pressing the **DEF IP** switch (short press):

Figure 29 MultiView Output

MADI Connections

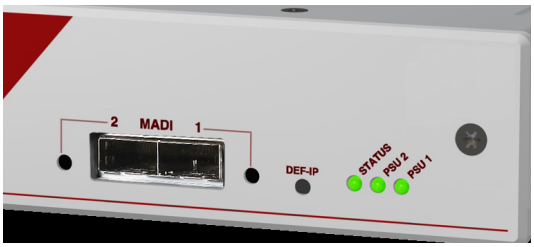


Figure 30 Front Panel

The V__link4 / V__remote4 provides two MADI in/out ports (**MADI 1 & 2**) available for connection from the front panel.

Each port carries up to 64 input *and* output channels and conforms to AES10.

Connections are available on optical fibre LC connectors, once you have fitted the recommended **SFP modules**.

The MADI output mode (56 or 64 channels) can be changed from the Settings -> MADI menu.

The two ports may operate independently or in parallel (for redundancy). Use the Settings -> MADI menu to configure this option.

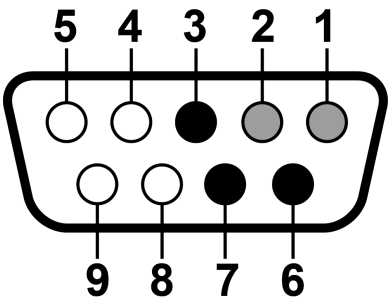
An LED for each port indicates the status:

- **Green** = MADI link is active.
- **Flashing Red** = MADI link is asynchronous.
- **Off** = no connection or MADI link is invalid.

GPIO Connections

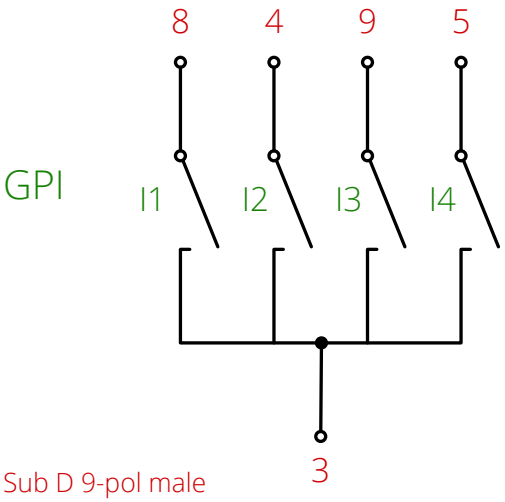
Figure 31

The GP I/O D-sub connector can be used to connect general purpose inputs and outputs. The pin-out for the connector is shown below.



Pin No.	Description
1	GPO 1
2	GPO 2
3	GPI Ground
4	GPI 2
5	GPI 4
6	GPO 1 Com.
7	GPO 2 Com.
8	GPI 1
9	GPI 3

Sample GPI 1...4 adapter



Sample GPO 1...2 adapter

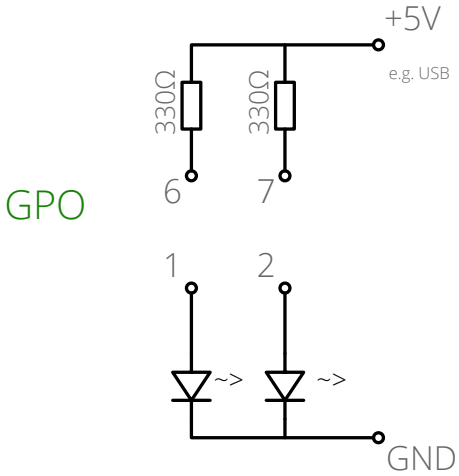


Figure 32

GPIO circuit diagram

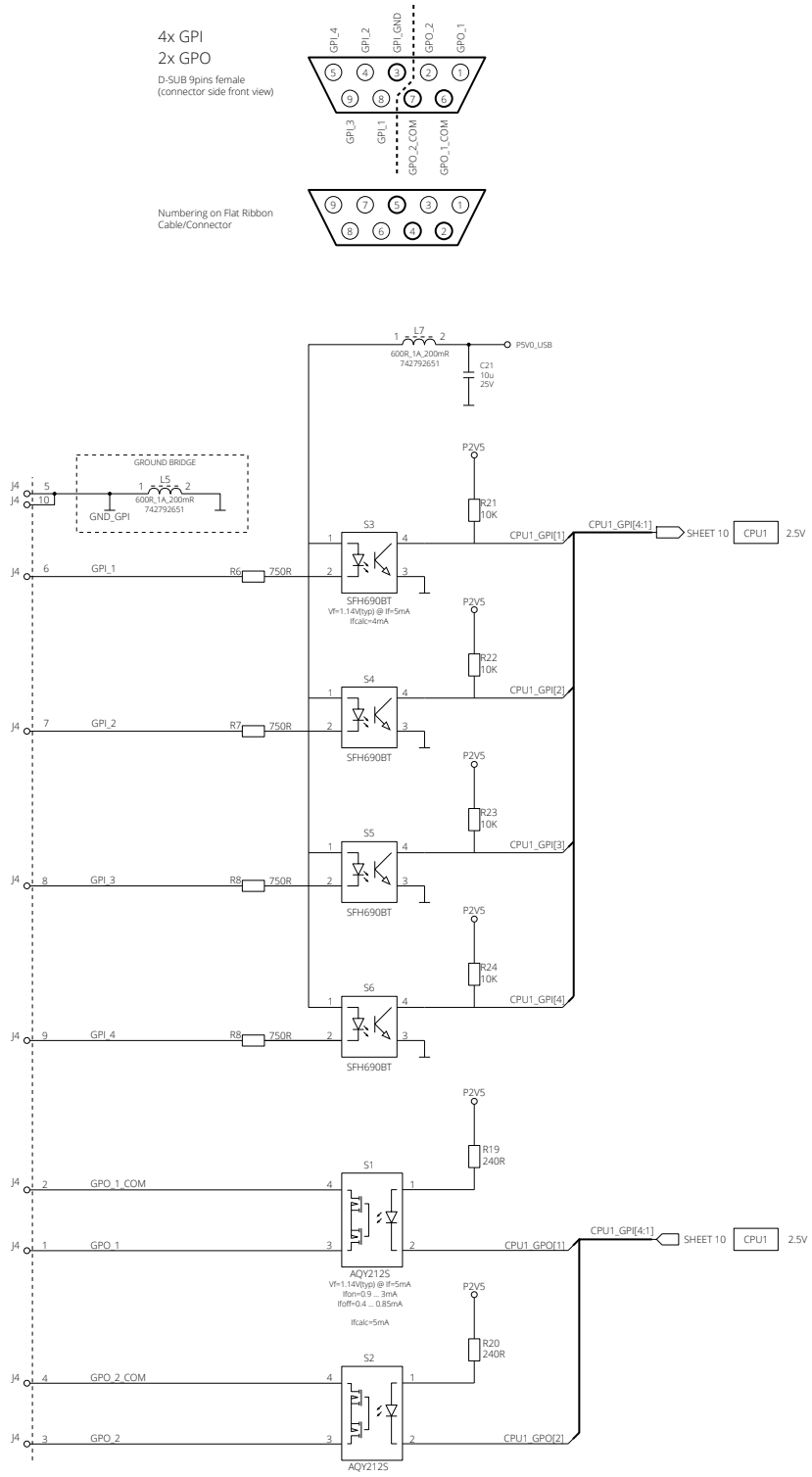


Figure 33

External Reference Connections

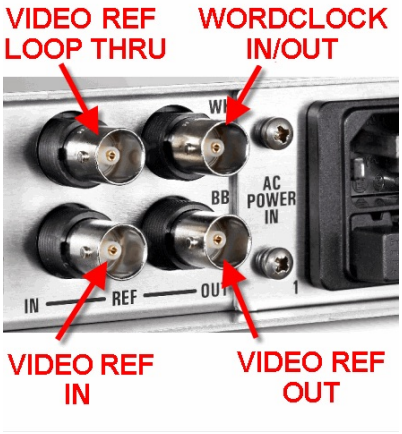


Figure 34

The V__link4 / V__remote4 provides four external reference connections:

- **IN** - external video reference input. Use this input to connect an analog video reference signal such as Tri-Level Sync or Black-Burst (BB). The following reference signal standards are supported:
  - Analog Genlock High Definition Tri-Level Sync (SMPTE-274M/296M)
  - Standard Definition 1V Black-Burst (SMPTE-170M/318M)
- **LOOP** - passive loop-thru output of the video IN (75Ω termination recommended). Use this connection to daisy-chain an external video reference signal in and out of the V__link4 / V__remote4.

> The **REF IN** connection should be terminated by fitting a 75Ω terminator to the **LOOP** output (if unused), or the LOOP THRU connector of the last “looped” device.

- **OUT** - video reference output. Use this connector to feed the system’s video reference, as selected in the user interface, to an external device.
- **WK** - can act either as a wordclock input (with 75Ω termination), a wordclock output or PPS (pulse pr second) output, as set by the **WCLK BNC mode** in the **Timing -> Timing Pos** menu.

Note that the V__link4 / V__remote4 can also be referenced via IP - either by using PTP or genlocking to an incoming IP stream and V__link4 / V__remote4 itself can act as PTP grandmaster.

Reference Settings

The video and audio reference signals for the V__link4 / V__remote4 are selected from the **Reference Setting** options in the **Timing** menu.

The system can be referenced to:

- Analog Genlock High Definition Tri-Level Sync (SMPTE-274M/296M) - connected to the rear panel's **REF IN**.
- Standard Definition 1V Black-Burst (SMPTE-170M/318M) - connected to the rear panel's **REF IN**.
- Internal
- SDI - from any of the 4 digital **SDI inputs**.
- In 5 to 8 - from an incoming IP stream, formats RAW or J2K or virtual BB.
- PTP clk - video reference derived from PTP clock.
- PTP ref - reserved for future use - video reference derived from PTP clock with additional phase info.

> The audio reference is *ALWAYS* set to **Follow Video**. This means that the system is clocked from a single reference source.

Any V__link4 / V__remote4 can also act as PTP grandmaster. With software license "Ref PTP GM" it can also translate an Analog Reference Signal into corresponding PTP clock signal. This is especially useful if IP based infrastructure adds to an existing baseband infrastructure to ensure frequency and phase matching.

Stream Director

To use StreamDirector your computer must be running the latest version of Java, downloaded from **www.java.com**

StreamDirector is a platform-independent Java application that can be used on Windows, Mac or Linux operating systems.

The application is included with the V__link4 / V__remote4 software package delivered with the unit or available from the **Download-Center** at **www.lawo.com** (after **Login**).

StreamDirector automatically discovers all V__link4 / V__remote4 units on the network, as long as they are in the same subnet, and manages the streaming connections:

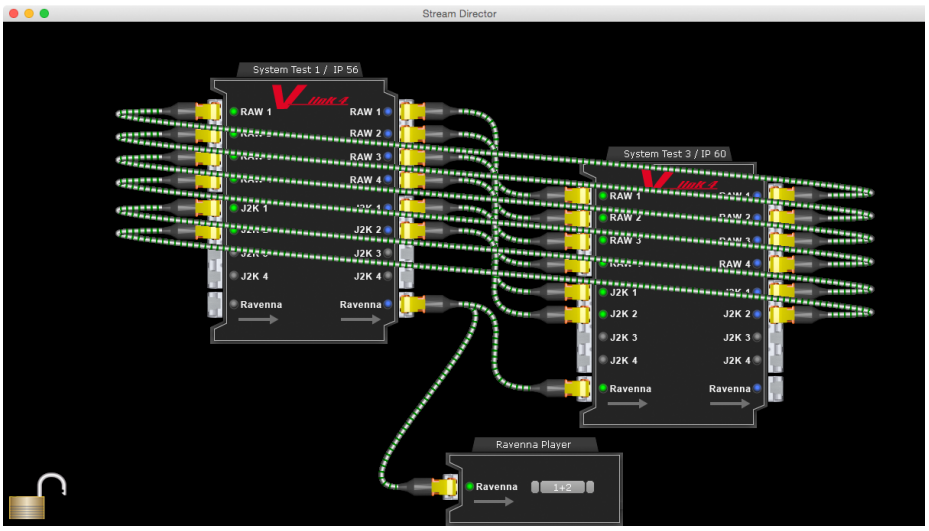


Figure 35

Units in different subnets may be added manually by double-clicking on the background and entering IP address.

To interrogate the current configuration:

1. Download or copy the V__link4 / V__remote4 software package onto your computer and unzip the contents.

2. Select the **StreamDirector.jar** file to start the application - always open the application from its folder environment to ensure the correct usage of libraries.

The application automatically detects the V__link4 / V__remote4 units on the network. The network names and their current streaming connections are displayed - in our example, the multicast RAW and Ravenna streams from each unit. The LED beside each port illuminates if there is network traffic:

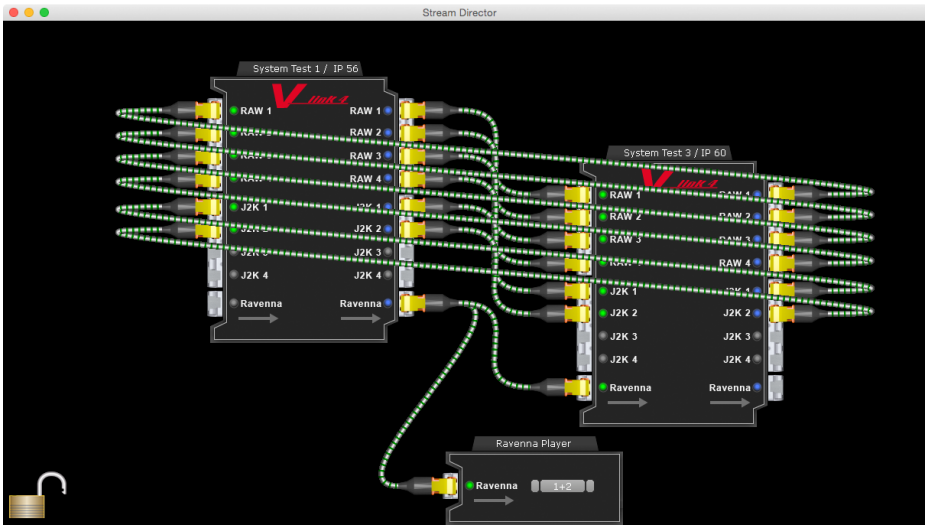


Figure 36

3. Hover your mouse over a transmission port to display the multicast address:

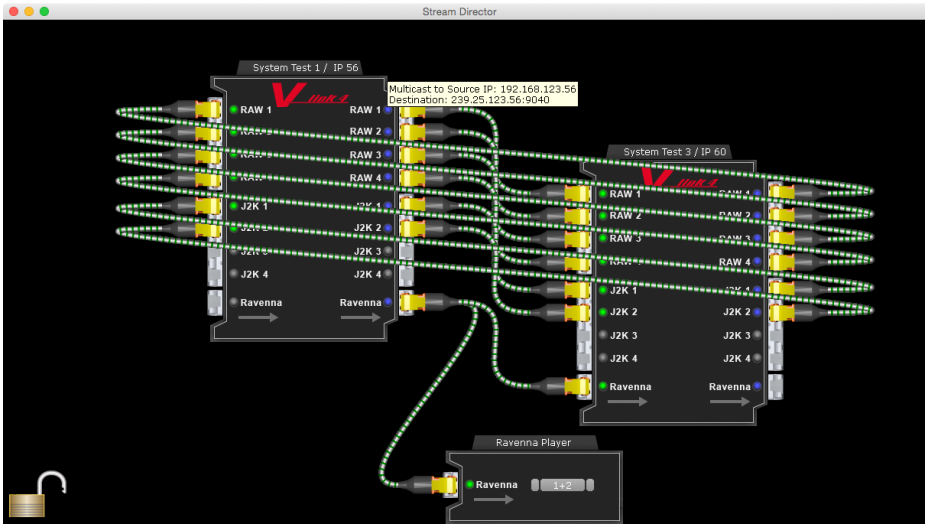


Figure 37

4. Hover your mouse over the centre of the unit to display its IP Address and built-in port statistics:

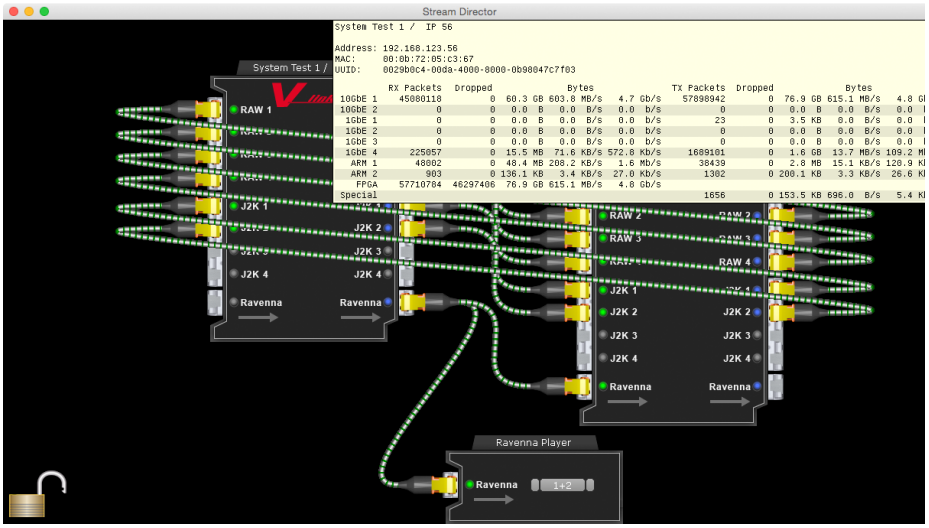


Figure 38

5. Double-click on the centre of a unit to open a new web browser session - the **login screen** appears in a new browser tab. Note that if you double-click on too many units, then the maximum number of browser connections may be exceeded.

To make a connection:

1. Click on a source port and drag and drop a cable to the destination port:

Figure 39

The display updates accordingly:

Figure 40

For multicast services, a single source can be connected to multiple destinations.

To disconnect:

1. Click on the destination port and drag and drop the cable into an empty space - the connection is removed.

Troubleshooting

If connections are lost, then the “Mr Hans” icon appears - check your **network connections** and **IP configuration**.

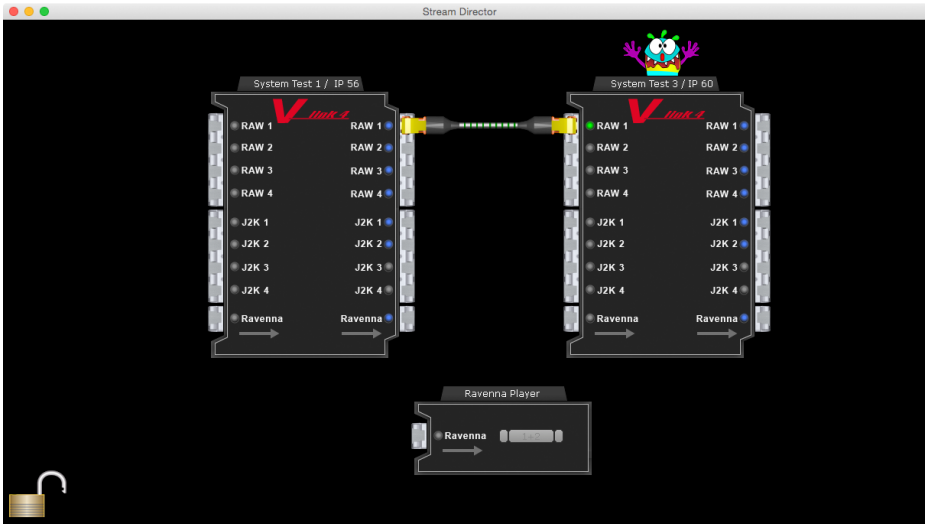


Figure 41

MJPEG Receiver

> To use the MJPEG Receiver your computer must be running the latest version of Java, downloaded from **www.java.com**

The MJPEG Receiver is a platform-independent Java application that can be used on Windows, Mac or Linux operating systems.

The application is included with the V__link4 / V__remote4 software package delivered with the unit or available from the **Download-Center** at **www.lawo.com** (after **Login**).

1. Download or copy the V__link4 / V__remote4 software package onto your computer and unzip the contents.
2. Select the **MJPEGReceiver.jar** file to start the application - always open the application from its folder environment to ensure the correct usage of libraries.

MJPEG Reveiver is a low latency player for MJPEG video streams which are generated by V__link4 / V__remote4 units for monitoring purposes. It also features stereo audio playback. MJPEG receiver may be used alternatively to VLC player when latency matters.

Operation (Web Browser Control)

This chapter covers the operation of the V__link4 / V__remote4 from the web browser user interface.

> Note that your **software license** will affect the available features and menus.
>
> Due to the similarity of operation, some of the screenshots used in this manual are taken from the V__pro8, a sister product of the V__link4 / V__remote4.

Please check that your computer meets the recommended **system requirements** for web browser control. We are assuming that you have **powered on** the V__link4 / V__remote4, and connected and configured a network connection to your computer.

The first part of this chapter covers the user interface and common tasks:

- **Operating Principles**
- **Signal Routing**
- **Delay**
- **Audio Output Level Adjustment**
- Saving Your Settings

The second part covers each menu in detail:

- **The Main Menus: Summary**
- **Status**
- **Video In**
- **Audio In**
- **Video Out**
- **Audio Out**
- **MV (MultiView)**
- **AV Sync**
- **Timing**
- **Settings**

Operating Principles

- **Starting a Web Browser Session**
- **Menu Selection & Navigation**
- **Expanding Menus**
- **Channel Selection & Parameter Control**
  - **Multiple Channel Selection**
- **Data Entry**
- **Alarm Alert**

Starting a Web Browser Session

Having **connected** and configured the network connection between your computer and V__link4 / V__remote4, you may open a web browser session to control the system's parameters.

> You may use any web browser which supports web worker, HTML5 and JSON. Please use the latest revision of your browser for performance requirements.
>
> Web browser applications can be downloaded, free of charge, from the relevant providers.

1. Open your browser software, and enter the IP address of the V__link4 / V__remote4 into the URL field.

For example, if the unit is set to the factory default IP address you would type `http://192.168.123.70` and press Enter:

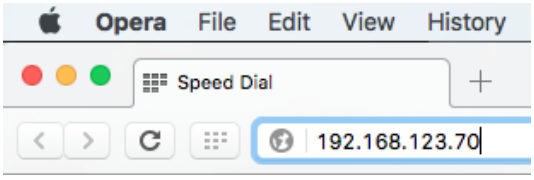


Figure 42

The browser connects and the login screen appears:

Figure 43

If the login screen does not appear, please see the **troubleshooting** tips.

If you have signals connected, then you will see video thumbnails for each of the Video inputs and outputs (1 to 8) at the bottom of the screen. If no video signals are present, then the thumbnails are blank.

- In/Out 1 to 4 = local SDI connections.
- In/Out 5 to 8 = network IP streams. These are identified by the @ symbol.

2. Click on the `Login` button to log in to the system - the button turns red, and the user interface **main menus** appear. Passwords can be defined for roles **admin** and **guest**. Please refer to appropriate section 'Settings' -> 'Access' -> 'Login.

Figure 44

If you are not able to login, please see the **troubleshooting** tips.

3. To “log out”, close your browser window.

If the browser loses its connection to the V__link4 / V__remote4, then click on the browser’s `Refresh` button to reconnect - you are returned to the **main menus**. If the refresh does not work, then restart the web browser and check your physical **connection**.

> The user interface may appear to operate, even without a browser connection. This is because the last known settings are cached into the browser’s memory. When running with live video and audio, it is usually obvious if the connection has been lost. However, if you are working without signals present, and you close and ignore the “connection lost” message, be aware that you are NOT controlling parameters within the V__link4 / V__remote4!

Menu Selection & Navigation

After login you are presented with the main menu bar:

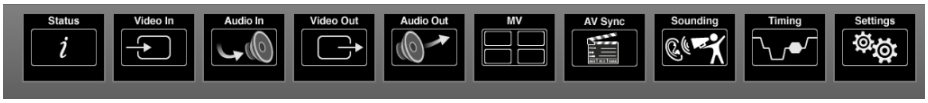


Figure 45

As you move your mouse over the menus, the buttons enlarge to emphasize your intended selection.

1. Click to select a main menu - for example, `Video Out`.

The window updates and the main menu bar **expands**[1]; one of the inner menu items is automatically selected - e.g. `Out 1`.

The user interface is now divided into two areas; the upper area displays information concerning the main menu selection (**Video Out 1**), while the lower area provides access to its parameters:

[1]If windows expansion is active and one or more menu items are shifted outside the browser windows an expansion bar indicator is shown, which can also be used to collapse the window expansion.


Main Menu Bar
Monitoring Area
(e.g. Audio Metering &
Video Monitoring)
Sub Menu Bar
Setup area
PPM
Group A
Group B
Group C
Group D
Video In
Audio In
Delay
Conversion
YUV Corr.
RGB Corr.
Level adjust
Downmix
Embedder
VANC Data
Ch. ID & Pattern
Timing
Status
Brightness
Contrast
Hue
Saturation
Default

Figure 46

If you have signals connected, then you will see audio levels on any metering and live video thumbnail streaming.

The left hand side of the monitoring area can display different options. Click on the current title (e.g. `Y RGB`) to change the option. See Video Out: **Display Options**.

2. Click on a submenu to access a different set of parameters - for example, `Delay`:

Figure 47

3. Click on one of the inner main menus - `Out 1` to `Out 8` - to access a different output.

You can use this to quickly switch between Video outputs and compare parameters.

Figure 48

Figure 49

Expanding Menus

Some of the main and submenus expand when you select them. For example:

1. Click on `Video In` (main menu), and the menu bar expands to reveal `In 01` to `In 08`.

One of the inner items is always selected - in our example, `In 01`:

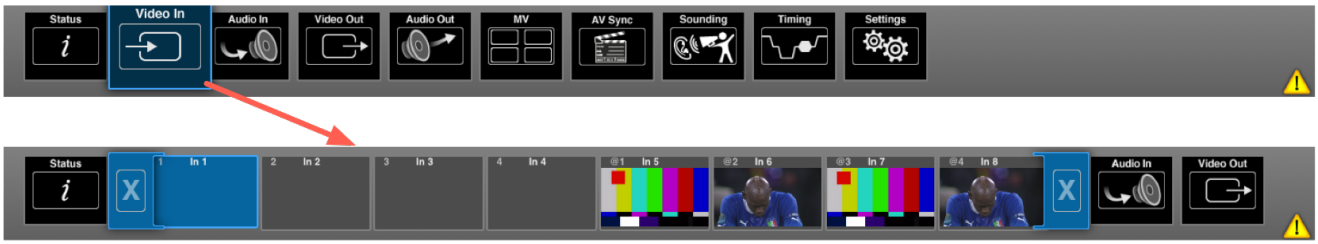


Figure 50

2. Click on a different input - `In 01` to `In 08` - to switch between Video inputs and compare information and parameters.

Note how the menus which were to the right of `Video In` (`Audio In`, `Video Out`, `Audio Out`, etc.) shift across the menu bar and, depending on your selection, disappear off screen.

3. To select a different main menu, click on it (if you can see it).

4. Or, collapse the expanded view, by clicking on either of the blue `X` buttons:

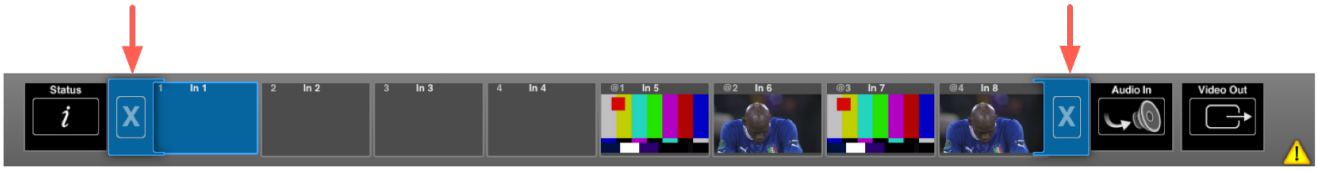


Figure 51

The menu bar returns to its normal size.

The submenus work in a similar manner - for example:

1. Select `Video Out` (main menu) and `Audio In` (submenu) - the submenu expands to reveal the different MADI channel blocks:

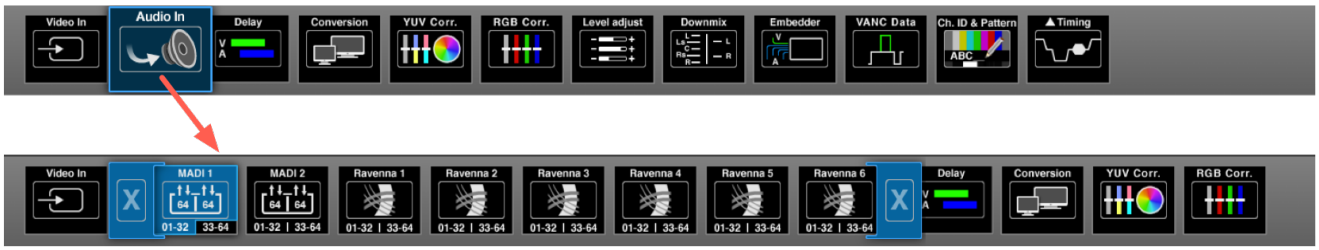


Figure 52

Whenever you return to a menu, your last sub selections remain open. For example, select `Video In` (main menu) and `Delay` (submenu). Then select `Video Out` (main menu) and `Delay` (submenu). If you now switch between `Video In` and `Video Out` from the main menu bar, both submenu selections are set to `Delay`. This makes it very fast to switch between input and output delay parameters.

Channel Selection & Parameter Control

For many operations, you will need to select a channel, or channels, and then adjust a parameter value. To demonstrate this, we are going to apply delay to one of the Video inputs.

1. Select `Video In` and `In 01` (main menu), and then select `Delay` (submenu).

At the bottom of the operating window, you will see the **Input Delay** parameters for **Video In 01**:

Figure 53

Each channel has its own select button. The green buttons indicate that we are looking at Video channels. If you select `Audio In` (main menu) and `MADI Delay` (submenu), then you will see blue channel select buttons.

2. Choose the channels you wish to adjust to clicking on the select buttons. You can either:

- Single-click to make additive selections.
- Double-click to make an isolated selection. This clears all other selections.

> In either case, you can select an individual channel or a block of channels, by clicking directly on the numbered channel button OR clicking in between (on the black lines). See **Multiple Channel Selection**.

The channel buttons change color as follows:

- **Light Blue** = selected channels.
- **Green** (or **Blue**) = unselected Video (or Audio) channels.
- **Dark Blue** = a valid channel selection (you will see this color as you hover your mouse over the buttons).

In our example, we have selected the video channel and audio channels 1 to 4:

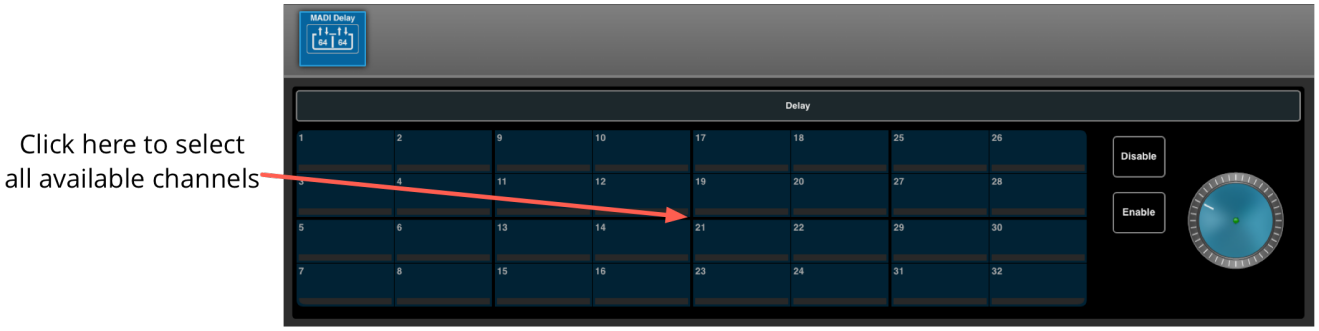
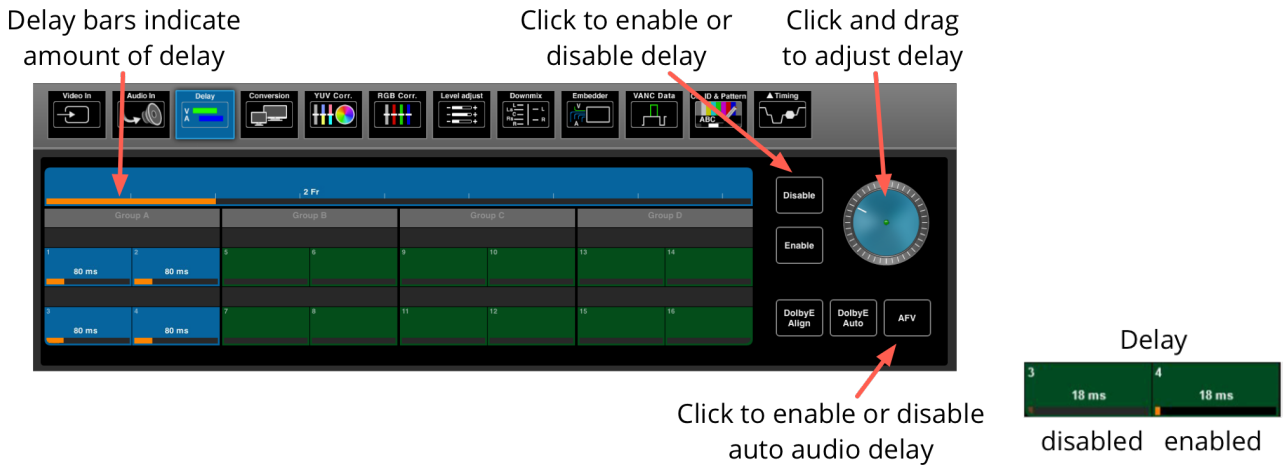


Figure 54

3. Now, adjust the parameters - any changes are applied to all selected channels:



The amount of delay is indicated by the horizontal delay bar and frames/ms value inside each channel button.

If delay is enabled, then the delay bar is clear (Black or Orange).

If delay is disabled, then the delay bar is greyed out.

If channels which already have delay are adjusted, then any offsets are retained.

For more details on input and output delay, see **Delay**.

Multiple Channel Selection

When you select channels for parameter control, you may select multiple channels in one operation.

> Remember that you can:
>
> - Single-click to make additive selections. This allows you to make non-consecutive selections.
> - Double-click to make an isolated selection. This clears all other selections first.
>
> In each case, the channel select buttons turn dark blue as you hover your mouse, indicating which channel blocks can be selected.

To select an individual channel:

Click directly on the channel select button:

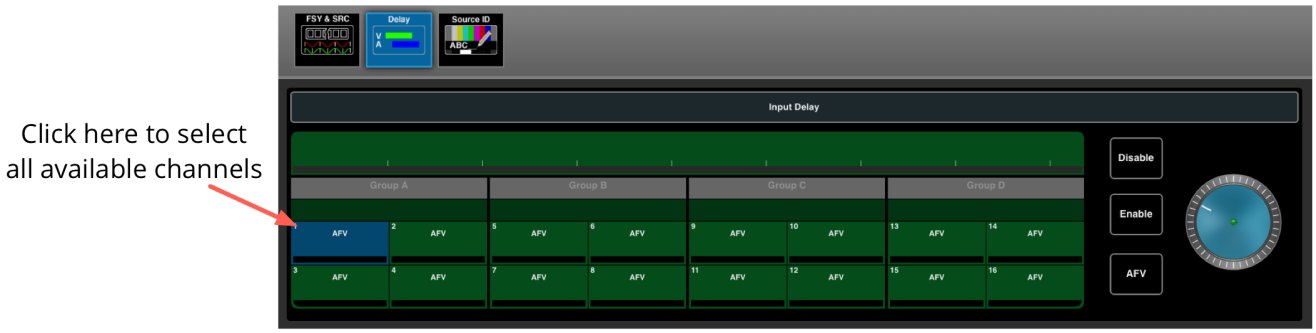


Figure 55

To select all available channels

Click on the central dividing line of the audio channels (MADI):

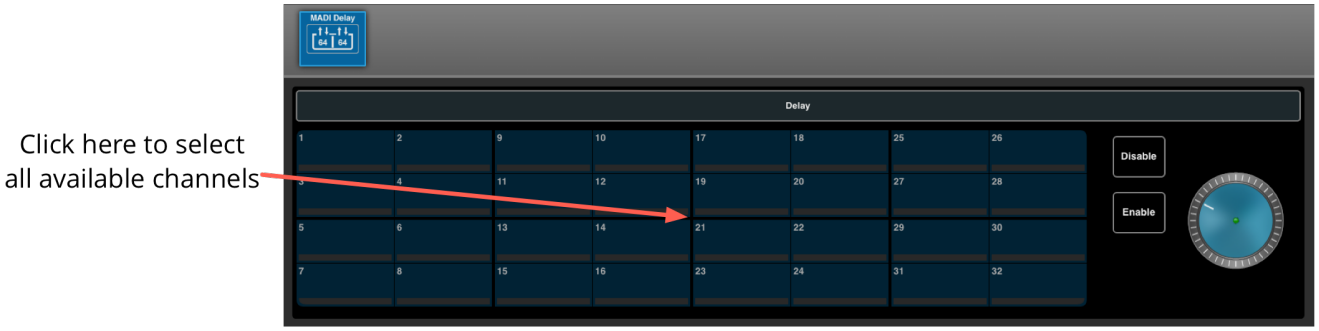


Figure 56

To select a subset of channels

Click on the black dividing line in between the channels you wish to select - for example, between embedded Groups A and B:

Figure 57

Or click on the grey `Group A`, `Group B`, `Group C`, `Group D` indicators to select all the audio channels in a group.

Data Entry

Sometimes you will need to enter a specific value using the on-screen numeric keypad. For example, to enter a timecode value or new IP address. In these instances:

1. Click on the `left` or `right` arrow buttons to highlight the correct set of digits (in red):

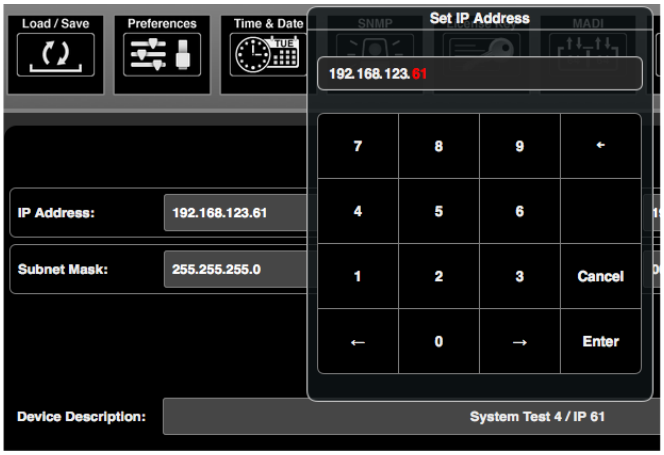


Figure 58

2. Use the on-screen numeric keypad to enter a new value.
3. Click on `Enter` to confirm the data entry.

Alarm Alert

A small yellow warning triangle appears on the GUI whgenever there is a system alarm:

Figure 59

If this appears, then check the **Status** menus or click directly on the warning triangle.

> The alarm status is also remotely available to external control systems via the **Ember+** protocol and as syslog message and snmp trap.

Signal Routing

One of the most common tasks is to change the signal routing of video and audio channels within the V__link4 / V__remote4. The **Video Out** and **Audio Out** main menus can be used to reassign video and audio signals on a channel-by-channel basis.

> Use this function to route a video signal to multiple outputs, embed new audio content into an SDI or Video-over-IP output and/or convert between different formats.

Valid Channel Assignments

Signal routing is output-driven - first, you select the output you wish to re-assign, and then you choose the new input(s):

- For each SDI or IP output, you can assign the video channel from any SDI or IP input, and up to 16 audio channels from any de-embedded SDI , IP or MADI input. Note that for embedded audio, you may enable/disable each audio group - A, B, C and D - and re-assign channels from the **Embedder** submenu.
- For each MADI output, you can assign audio from any de-embedded SDI or IP input, SDI or IP output (for monitoring purposes) or from any MADI input.

Default Signal Routing

The default routing, shipped from the factory, passes signals directly through the V__link4 / V__remote4:

- SDI Inputs 1 to 4 are assigned to IP Outputs 5 to 8 (video & audio).
- IP Inputs 5 to 8 are assigned to SDI Outputs 1 to 4 (video & audio).
- MADI Input channels 1 to 64 are assigned to MADI Output channels 1 to 64 for both MADI ports.
- 6 x 16 RAVENNA In channels are assigned to 6 x 16 RAVENNA Out. Note that the TX streams are disabled by default.

> This means that as soon as you connect video to your SDI or IP inputs, you can preview these signals from the login screen or **Video Out** main menu (providing you haven't altered the default video channel assignments).

Signal Routing Operation

1. First, select the output you wish to re-assign.

You can select any SDI or IP output from the **Video Out** main menu, or any set of MADI output channels from **Audio Out**. In our example, we have selected `SDI Out` and `Out 1`.

2. Then choose the new input type - either `Video In` or `Audio In` (submenu).

The parameter area updates to show the available input channels on the left (under **Input Table**) and the current assignments on the right (under **Output**):

Figure 60

In our example, **SDI Out 1** is currently assigned from the video and audio channels of **SDI In 1**. By selecting the **MADI 1 01-32** submenu, we can access the first 32 audio channels from MADI port 1.

Note that you can determine whether output channel assignments display only the input name (as shown above), or both input and output names via the `Settings` -> `Preferences` -> **Show Names** option.

3. To change the signal routing, drag and drop a channel, or block channels, from left to right - for example:

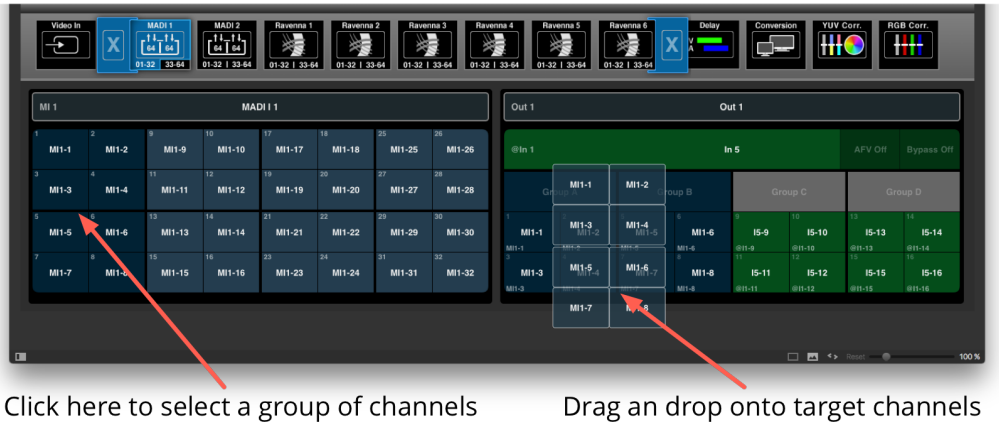


Figure 61

You can select an individual channel, or block of channels, by clicking either directly on the numbered channel buttons OR clicking in between (on the black lines). See **Multiple Channel Assignment**.

As you drag and drop, the target channels temporarily change color to indicate a valid destination. This ensures that you can only make valid routing assignments.

4. When you are happy with the proposed target channels, release your mouse button to complete the operation - the **Output** area updates to indicate the new channel assignments:

Figure 62

The channel buttons are color-coded as follows:

- **Green** = SDI or IP (video and audio channels)
- **Blue** = MADI channels
- **Orange** = Downmix, Silence or Test Tone channels (assigned from the **Embedder** submenu).
- **Dark Blue** = a valid channel selection (you will see this color as you hover your mouse over the **Input Table** or drag and drop onto the **Output** area).

Multiple Channel Assignment

When you assign channels from left (**Input Table**) to right (**Output**), you can select multiple channels in one operation. This allows you to change signal routing very quickly.

> In each case, the channel select buttons turn dark blue as you hover your mouse, indicating which channel blocks can be selected.

To assign an individual channel:

Click directly on the channel select button, and drag and drop onto the target channel:

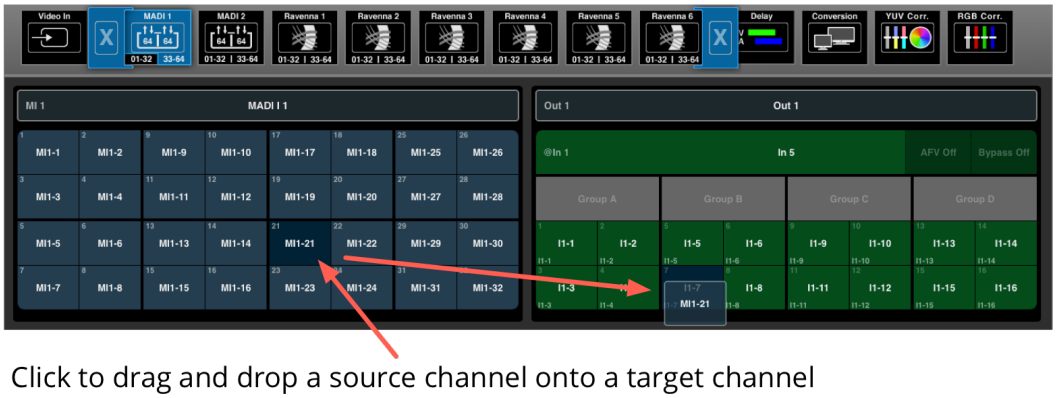


Figure 63

To assign a subset of channels

Click on the black dividing line in between the channels you wish to select - for example, between channels 3, 4, 5 and 6 - and drag and drop onto the first target channel.

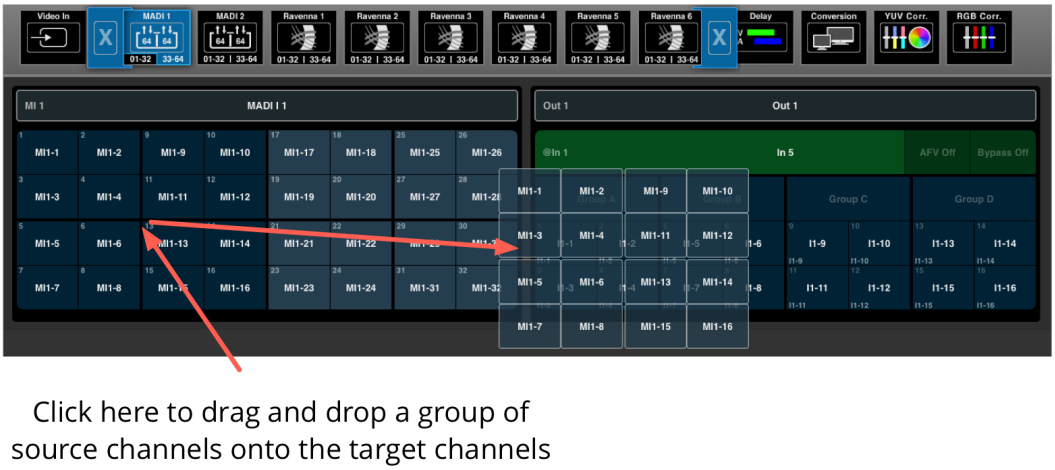


Figure 64

Or click on the grey `Group A`, `Group B`, `Group C`, `Group D` indicators to select all the audio channels in a de-embedded group.

> If multiple channels are selected, then they are assigned in a consecutive manner. So, in our example, MADI channels 1 to 8 are assigned to SDI channels 1 to 8.
>
> You can drop onto any valid target channel. So, for example, release your mouse button over target channel 9 to assign the eight channels to SDI channels 9 to 16.

If you select more source channels than there are targets (for example, all 32 MADI channels), then the first channels from the selection are assigned.

Delay

Variable delay is available for all video and audio channels. It can be applied at the input and/or output to the routing matrix on a channel-by-channel basis.

Valid Delay Parameters

The maximum delay (input + output) is:

- 8 frames per video channel, adjusted in 1 frame steps.
- 320 ms per audio channel, adjusted in 1 ms steps.

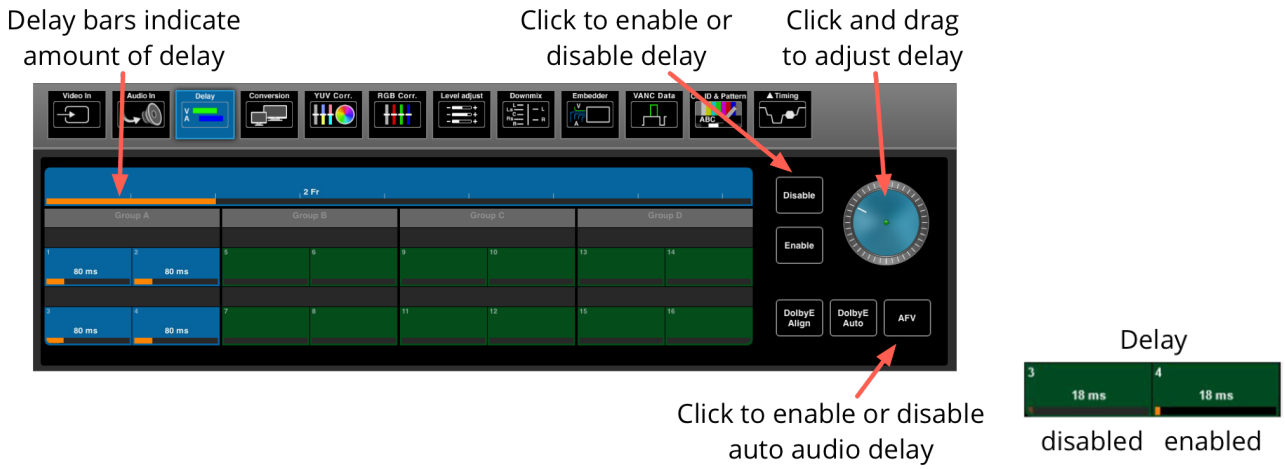
Input Delay Operation

Input delay is applied at the input to the signal routing matrix, and therefore affects all destinations assigned from the delayed channels.

1. First, select the input you wish to delay.

You can select any SDI or IP input from the **Video In** main menu, or any set of MADI input channels from **Audio In**. In our example, we have selected `SDI In` and `In 01`.

2. And select the channels, see **Channel Selection & Parameter Control**.
3. Then adjust the delay parameters:



The amount of delay is indicated by the horizontal delay bar and frames/ms value inside each channel button.

If delay is enabled, then the delay bar is clear (Black or Orange).

If delay is disabled, then the delay bar is greyed out.

If channels which already have delay are adjusted, then any offsets are retained.

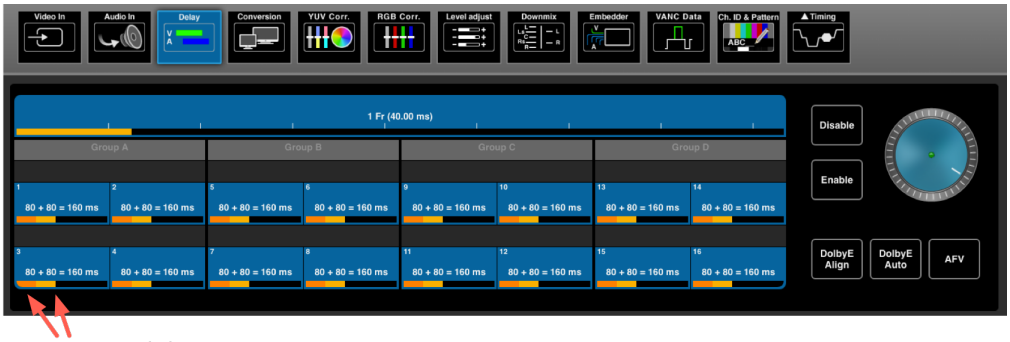
Output Delay Operation

Output delay is controlled in a similar manner, but is applied at the output from the signal routing matrix, and therefore affects only the selected destination.

You can select any SDI or IP output from the **Video Out** main menu, or any set of MADI output channels from **Audio Out**.

As before, select the channels you wish to delay, and then adjust the parameters.

If the output channel is routed from an input channel with delay, then you will see both the input and output delay values:



orange = input delay
yellow = output delay

Figure 65

> The maximum delay per channel (input + output) cannot exceed 8 frames for video channels or 320ms for audio channels.
>
> You cannot adjust audio delay if an embedded SDI channel is routed to a MADI output channel (for monitoring purposes.) In this case, the delay fields are “greyed out”.

For SDI or IP audio channels, you may also use the automatic audio follows video delay (**AFV**) and **Dolby E Align**/**Dolby E Auto Align** functions.

AFV (Audio follow Video) Delay

This mode is used to automatically delay audio channels with respect to the video channel.

The video channel delay may have been set manually or be due to active Frame Synchronization, Frame Phasing, processing latency (e.g. Format Conversion) or a timing difference between input and output video signals.

You will find an `AFV` button on both the **Video In -> Delay** and **Video Out -> Delay** pages:

- Use the input **AFV** delay to automatically delay audio channels if the **Frame Phaser** is active or the input video channel has been delayed **manually**.
- Use the output **AFV** delay to automatically delay audio channels if Format Conversion is active; the output video channel has been delayed **manually**; or there is a **timing** difference between input and video output signals.

In each case:

1. Select the audio channel(s) you wish to delay - see **Channel Selection & Parameter Control**.
2. Click `AFV` to enable the auto audio delay for the selected channels.
3. Click `Enable` to enable audio delay for the selected channels.

The text **AFV** *and the amount of delay is indicated inside each channel button:*

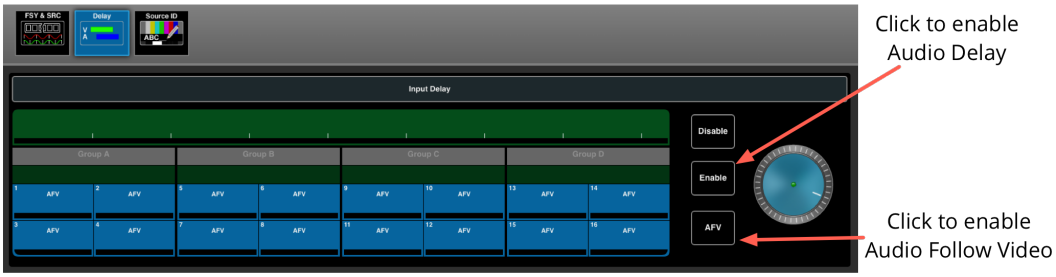


Figure 66

Example: Input AFV Delay (Frame Synchroniser Active)

If the **Frame Synchroniser with freeze buffer** is active, then the audio delay on **AFV**-enabled channels is set to 1.75 frame (equivalent to **70ms** in 50Hz and **58ms** in 60Hz video standards) as shown above.

Note that 1 frame compensates for the additional video frame buffering of the last buffered frame (panic freeze), and 0.75 frame is a fixed average value compensating for the timing difference between the video input and output signals. The timing difference may vary from 0 - 1 frame for asynchronous input signals; 0.75 is used as “more late” audio is better perceived than “early” audio. If Frame Phaser is active, then audio delay on AFV-enabled channels is automatically set to match the video delay.

Example: Input AFV Delay (Video Delay set manually)

If the input video channel is delayed manually (from the **Video In -> Delay** menu), then the delay on any AFV-enabled audio channels automatically follows. You can see this by selecting only the video channel and adjusting the delay wheel:

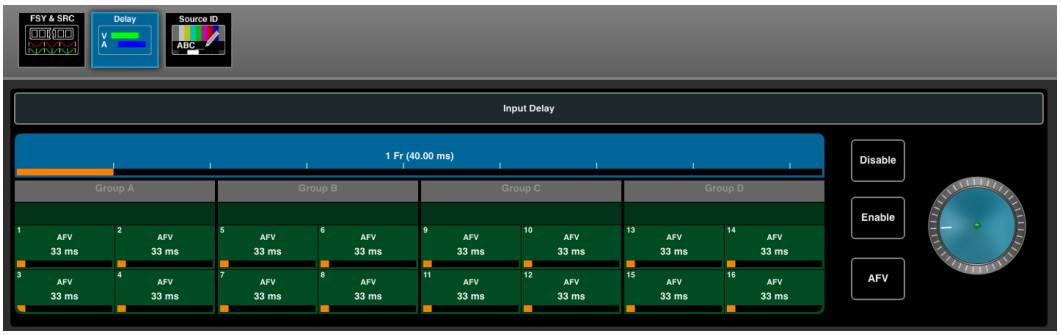


Figure 67

Example: Output AFV Delay (Format Conversion Active)

The processing latency for Format Conversion is 1 frame. Therefore, if Format Conversion is active, the audio delay on **AFV**-enabled channels is set to **40ms** for 50Hz or **33ms** for 60Hz video standards:

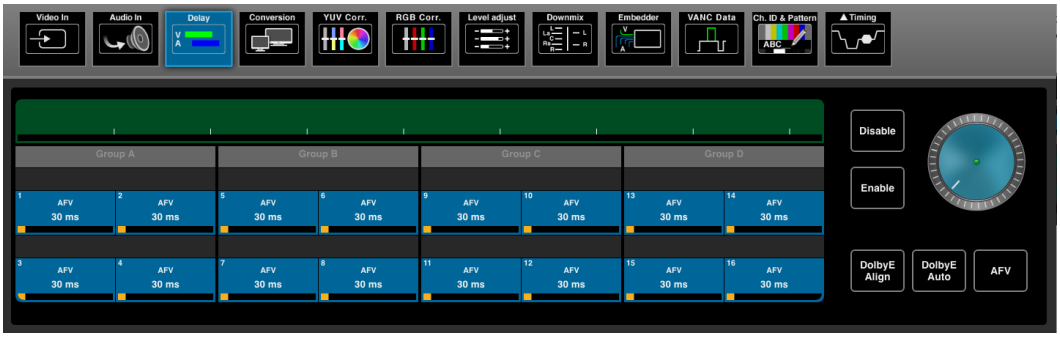


Figure 68

Example: Output AFV Delay (Video Delay set manually)

If the output video channel is delayed manually (from the **Video Out -> Delay** menu), then the delay on any **AFV**-enabled audio channels automatically follows. You can see this by selecting only the video channel and adjusting the delay wheel:

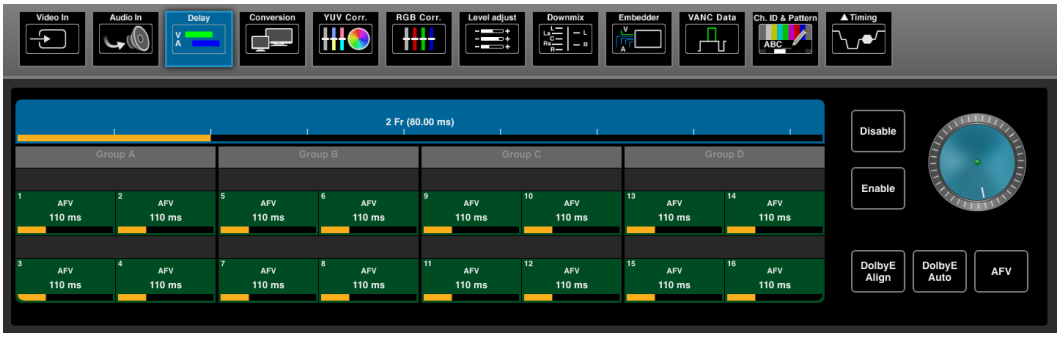


Figure 69

Audio Output Level Adjustment

The output level of any embedded SDI , IP or MADI audio channel may be adjusted from -60dB to +12dB:

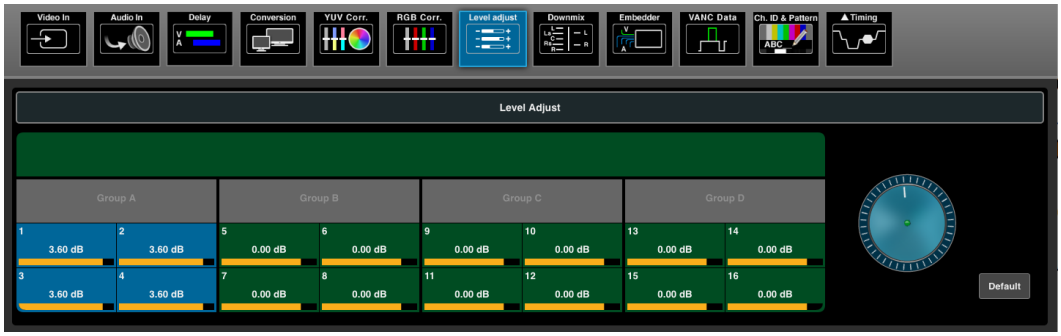


Figure 70

1. Select either **Video Out -> Level Adjust** or **Audio Out -> Level Adjust**.
2. Select the audio channel(s) you wish to adjust, see **Channel Selection & Parameter Control**.
3. Then click and drag the wheel, on the right hand side, to adjust the level.

The output level is indicated by the yellow horizontal bar and dB value inside each channel button.

If channels have already been adjusted, then any offsets are retained.

Saving Settings

The current settings are saved each time you power off the unit. When you power on, these settings are recalled. This ensures that the unit comes back as it was last used for fast recovery from a loss of power.

Settings may also be saved and loaded to/from your control computer or USB memory stick via the **Settings -> Load/Save** menu.

The Main Menus: Summary

The rest of this chapter covers each menu in detail:

Status

- `Video In` - check the video format, and status of embedded audio, timecode, etc.
- `Audio In` - check the status of the MADI ports (front & rear) and audio I/O channels.
- `System` - check the status of the V__link4 / V__remote4 system, for example, power supply status & temperature.
- `RX Stream` - view the performance statistics of incoming network streams.
- `J2K Pfrm.` - view load of J2K encoders
- `Port` - view the performance statistics of the **Ethernet ports**.
- `Switch` - view information about, and the status of, the internal network switch
- `Connections` - information on all active Web Browser sessions.
- `Alert` - check the status of all warnings and alerts.
- `About` - general information about you V__link4 / V__remote4.

Video In - view video, status and meter the 16 embedded audio channels for any SDI or IP input.

- `FSY & SRC` - configure video frame sync with freeze buffer and audio sample rate conversion (for each de-embedded audio channel).
- `Delay` - input delay (for each video and de-embedded audio channel).
- `Source ID` - serves as extra source identifier per video input per device, distributed via SDP info.

Audio In - meter the audio channels from any MADI or RAVENNAinput.

- `Delay` - input delay (for each audio channel).

Video Out - monitor the video plus timecode/color components/audio for any SDI or IP output.

- `Video In & Audio In` - assign video and audio channels from any SDI, IP or MADI input.
- `Delay` - output delay (for each video and embedded audio channel), plus automatic audio delay follows video delay and Dolby E alignment (for embedded audio channels).
- `3G Conversion` - 3G conversion for the video channel and VC-2 encoding for Out 5...8.
- `YUV Corr.` - standard ProcAmp color correction for the video channel.
- `RGB Corr.` - RGB-style color correction for the video channel.
- `Level Adjust` - adjust the output level of each embedded audio channel.
- `Downmix` - adjust settings for the two audio downmix engines.
- `Embedder` - enable or disable, and re-assign the embedded audio channels.
- `VANC Data` - ancillary data such as embedded timecode and audio.
- `Ch. ID & Pattern` - insert a channel ID, timecode and test pattern into the video channel, and test tone to all embedded audio channels.
- `delta Timing` - adjust the output timing of the video channel, and enable or disable the auto phaser.

Audio Out - configuration of audio outputs and meter the audio channels for any MADI or RAVENNAoutput.

- `Video In`, `Video Out` & `Audio In` - assign channels from any SDI, IP or MADI input, or from any SDI or IP output.
- `MADI/Ravenna Delay` - output delay (for each audio channel).
- `Level Adjust` - adjust the output level (of each audio channel).

MultiView - configure local monitoring for the MV/QuadSplit output.

- `Video In`
- `Video Out`
- `Overlay`
- `Output Format`

AV Sync - measure the delay between video and audio channels on any Video input, in order to check lip sync before a production.

Sounding

- `Traffic Mon` - Capture ingress traffic per port
- `PDV` - measure Packet Delay Variation (jitter) and packet loss

Timing - adjust the timing position of the V__link4 / V__remote4 and its video and audio reference signals. You can also check the **Input** and **Output** timing of all 8 Video inputs and outputs.

- `Pos./Ref.` - adjust the timing position of the V__link4 / V__remote4, globally, with respect to the video reference. This submenu also contains the Reference Settings, where you can select the system's video and audio reference.
- `Ref Out` - adjust the timing position and options for the video reference output.
- `Timecode` - configuration of built-in Timecode Generator

Settings

- `Switch` - define IGMP, PTP, RSTP port assignments and static multicast routes.
- `TX Stream` - set parameters for RAW, J2K, Ravenna encoded (outgoing) IP streams and Ravenna/AES67 outgoing streams. Access related SDP data, view/configure MJPEG and h264 encoded monitoring streams. Change/define multicast addresses and unicast ports.
- `RX Stream` - configure stream receivers for video and audio incl. buffer/time offsets. Set/view related SDP data for simple receiving. Seamless protection switching, enhanced protection switching, source-timed frame accurate clean switching and more. Define CRU modi view and configure related.
- `Video` - in preparation
- `Audio` - set the MADI mode (discrete or redundant) and link priority (in redundant mode).
- `Presets` - save and recall presets within the Video and/or Audio matrix.
- `Access` - enable / disable Ember+ / H.264 monitoring encoding, Zeroconf (Bonjour) and GPI config. Define Browser Login Access Passwords.
- `Preferences` - adjust audio metering (PPM) options and other system preferences.
- `Time & Date` - enter the system date and time, or synchronise to an external SNTP server.
- `Logging` - IP address settings for SNMP Trap server(s) and syslog server(s), define syslog filters, download MIB- and Temperature Alert log file.
- `Network` - IP address settings for port-based VLAN1, VLAN2 and management port and device description.
- `Load / Save` - load or save settings from/to a connected computer or USB memory stick.
- `License Key` - install a new license key file (to upgrade your V__link4 / V__remote4).
- `Software Update` - check the software version of the V__link4 / V__remote4, perform a software update or download apps from the app download center.

Status

The upper area of the **Status** menu displays thumbnails for all 8 incoming and 8 outgoing video signals, together with audio group level indicators and status LEDs:

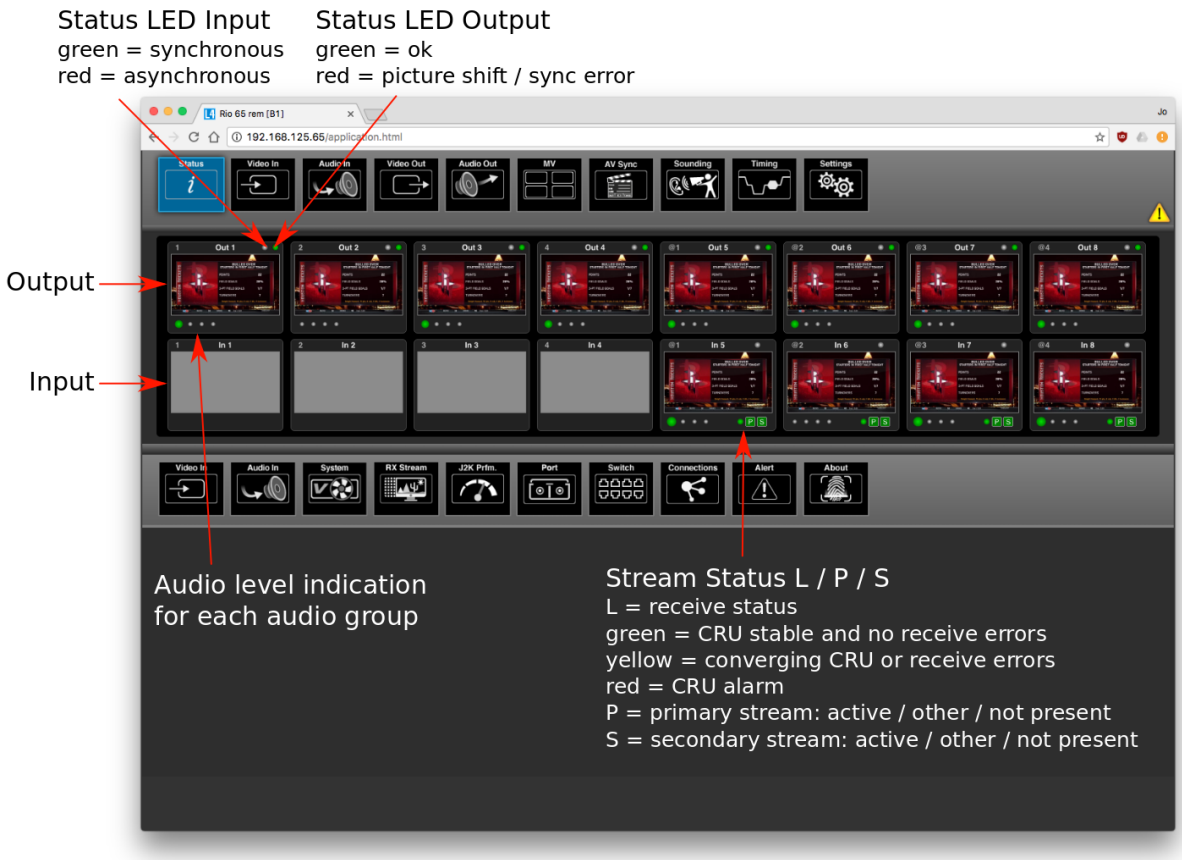


Figure 71

The lower half of the screen displays further status information when you select a submenu.

Status -> Video In

1. Select Status -> Video In, and then select an input (`In 1` to `In 8`) from the submenus:

Figure 72

These fields display standard meta data contained within the SDI or IP input stream:

- `Video Format` - describes the video format.
- `Payload` - the contents of the payload packet.
- `Video Index` - various information on the aspect ratio, color, etc.
- `AFD` - the Active Format Description.
- `Embedded Audio` - information about the 16 embedded audio channels, such as sample rate, bit rate, PCM or Dolby E, etc. In our example, the green circle indicates that signal is present on at least one channel within Group A.
- `Timecode` - embedded timecode (VITC 1, VITC 2 and LTC).

2. Click on a field to open a pop-up with further information:

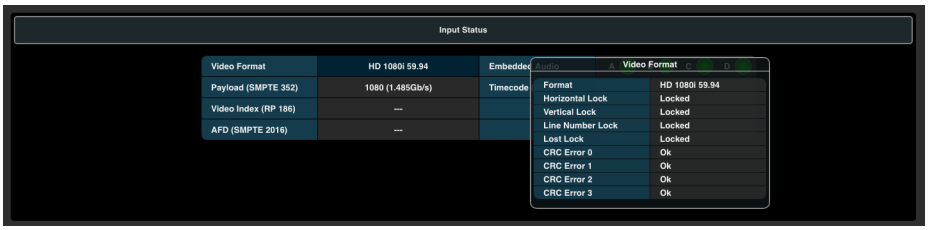


Figure 73 Video Format

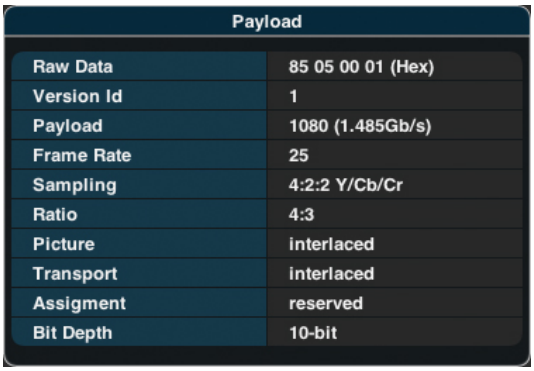


Figure 74 Payload

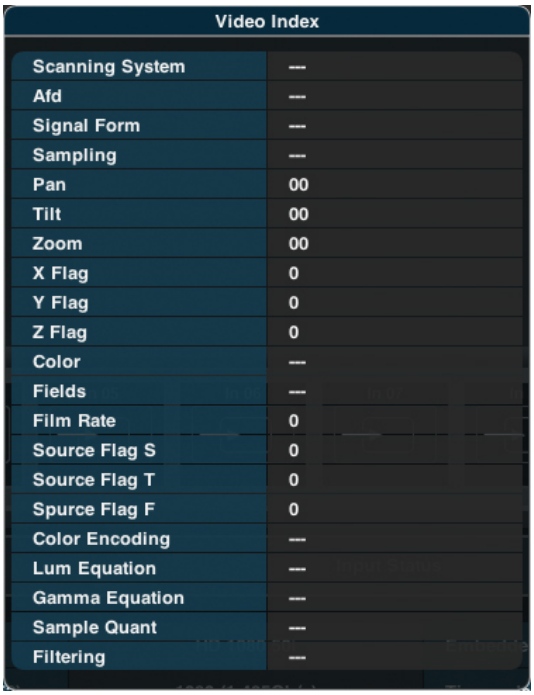


Figure 75 Video Index

Figure 76 AFD

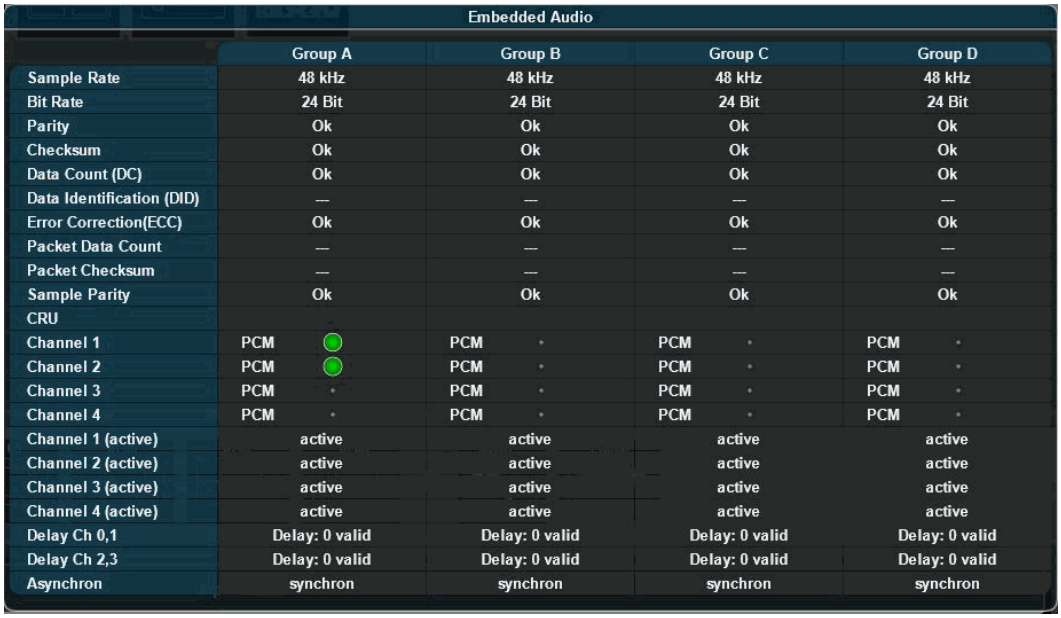


Figure 77 Embedded Audio

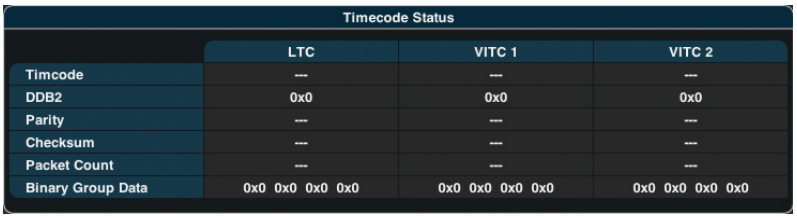


Figure 78 Timecode

Status -> Audio In

1. Select `Status` -> `Audio In`, and then select `MADI Status` from the submenus:

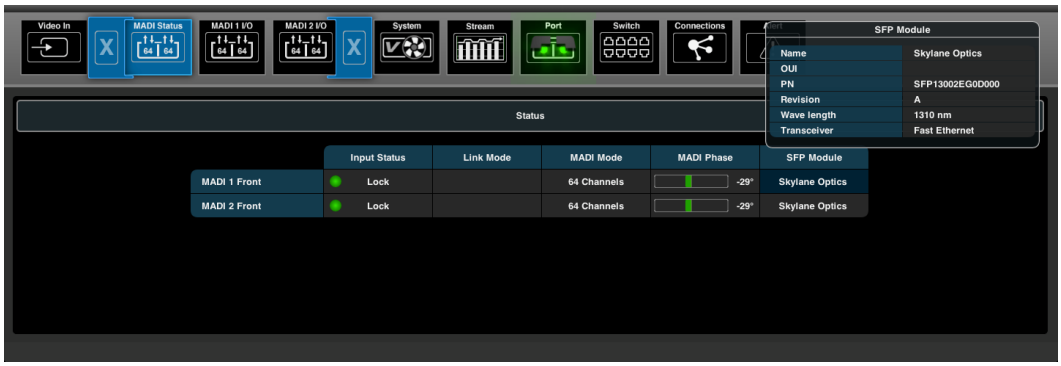


Figure 79

These fields provide information about each port, **MADI 1 & 2** Front panel connections:

- **Input Status** - whether the MADI input data is locked.
- **Link Mode** - whether the link is discrete or redundant. The two MADI ports may be used discretely, or as a main plus redundant link. This option is defined in the Settings -> MADI menu.
- **MADI Mode** - the number of channels per link, 64 or 56. MADI Phase - the timing between the two connected devices.
- **SFP Module** - the SFP module type. Click to open a pop-up with further information (shown above).

2. To interrogate the status of the MADI audio channels, select either **MADI 1 I/O** or **MADI 2 I/O** from the submenus:

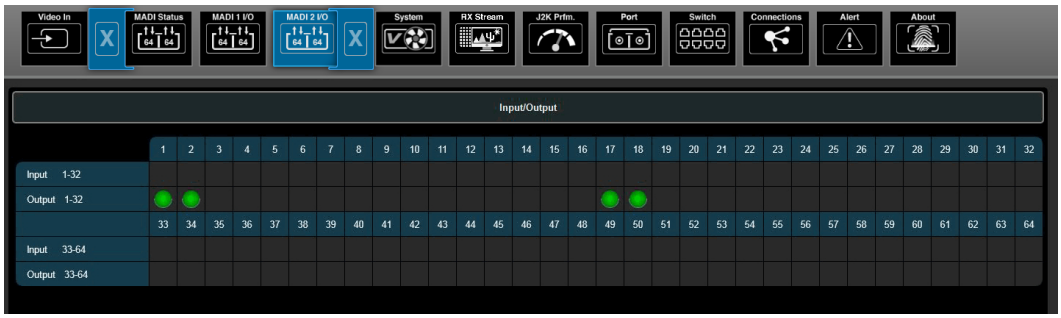


Figure 80

If signal is present on a MADI input or output, then a green circle appears - in our example, audio is present on MADI port 2, Outputs 1 & 2 and 17 & 18.

Status -> System

1. Select `Status` -> `System`:

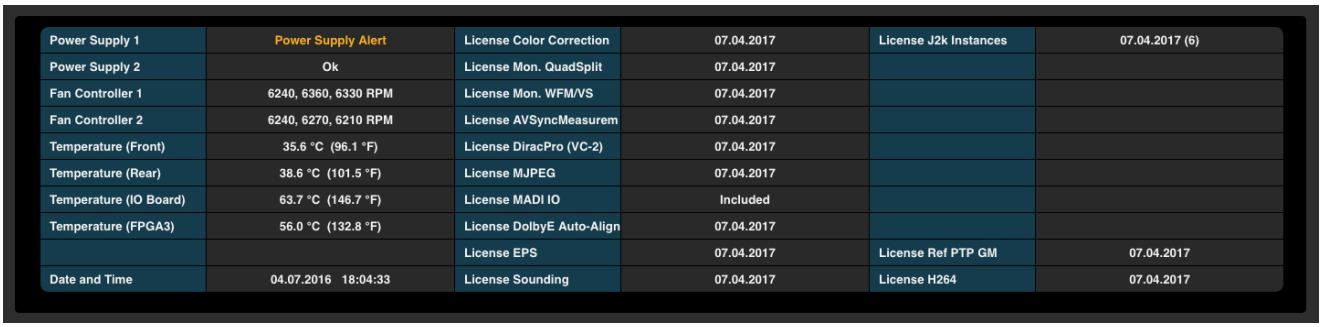


Figure 81

These fields provide general status information about the unit:

- **Power Supply 1 & 2** - the status of the two internal power supplies. See **Grounding & Power** for more details.
- **Temperature** - various readings from the unit's temperature sensors. See **Frame Installation** for recommended operating temperatures. Click on IO Board temperature row to open pop up with more info.
- **Fan Controller 1 & 2** - the fan speeds for each fan group.
- **License** - the license status for each of the V__link4 / V__remote4 software **options**.
- **Date and Time** - the device's **date and time**.

J2k Instance Licenses

J2K licenses are now treated as instances. Each instance can be used for encoding or decoding.

Split between encoders and decoders are preset in `Settings` -> `Preferences`:

Figure 82

Status -> RX Stream

1. Select `Status` -> `RX Stream` to view the performance statistics of incoming network streams. There are four submenu regions:

- **Services:** Video and audio services quality information with:
  - packet rate info
  - error rate per second
  - error total
  - delta read offset tracking per redundant stream
  - delta frequency tracking info
  - stream status as separate LED green / yellow / red

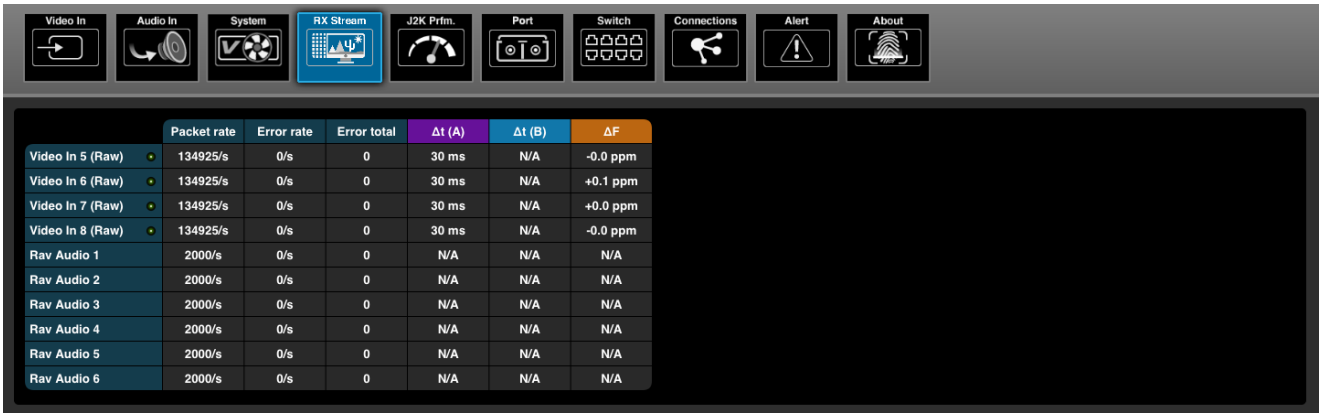


Figure 83

Clicking into video service rows first column displays CRU status statistic data with additional frame period target, jitter, stream status and more.

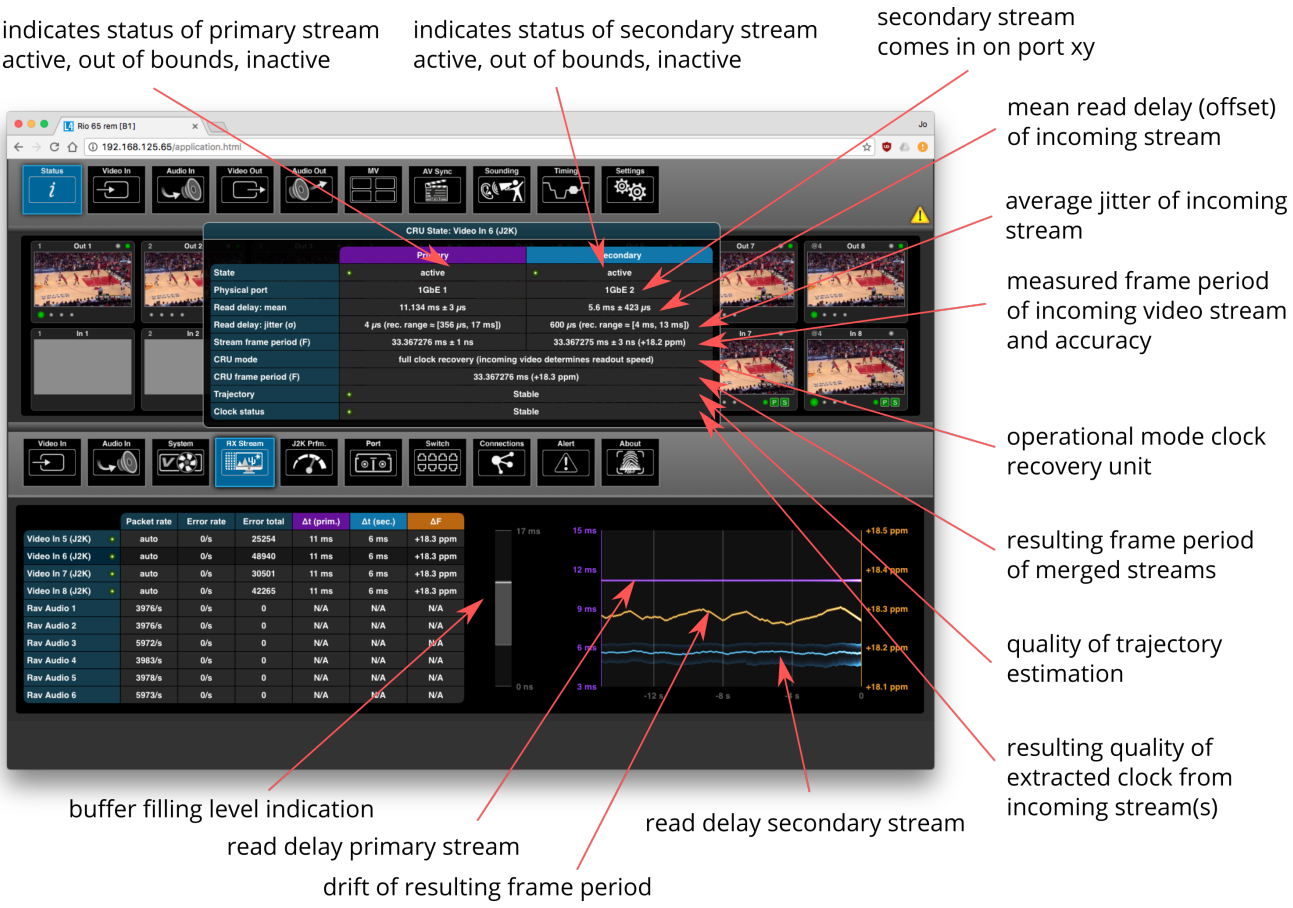


Figure 84

Clicking into video stream service data row displays CRU tracking performance in graphical way on the right hand side.

Please note that while a stream is being established, connection errors may be encountered; the number of errors are reported in the **Error Total** field. During continuous stable streaming operation, there should be no increase in the number of errors. You may reset the error count, manually, by clicking on the stream's error bar.

- **CRU** - Clock Recovery Unit (RAW streams):

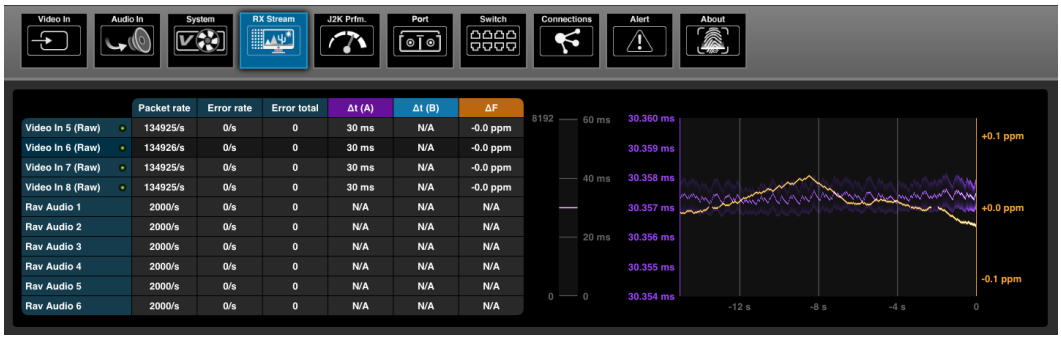


Figure 85

- **CRU** - Clock Recovery Unit (J2K streams):

Figure 86

In case of redundancy (seamless protection switching) CRU is tracking both incoming streams and targeting both streams simultaneously taking path delay offset into account. If one stream fails, the CRU is smoothly phasing to the new single target with a maximum drift within the allowed specifications of SMPTE standard.

Status -> J2K Performance

Monitor the performance/load of J2K encoder and decoder engines.

Load of encoding engine or decoding engine should not exceed 100%.

In dual mode total of both channels should not exceed 100%.

Figure 87

If load of encoding engines exceeds 100% each in single mode or the sum of encoding engines in dual mode exceeds 100% you need to reduce bitrate of sending engine(s) in `Settings` -> `TX Stream` Bitrate.

If load of decoding engines exceed 100% each in single mode or the sum of decoding engines in dual mode exceeds 100% you may either reduce the bitrate of the sending encoder machine or alternatively throttle the decoding engines. Throttling can be set to auto or manual by clicking into title bar of decoder performance display in Status J2K Prfm. “T1 calc relation”. In manual mode you may enter manual throttle parameters by clicking into title rows. One parameter set per engine or engines in dual mode.

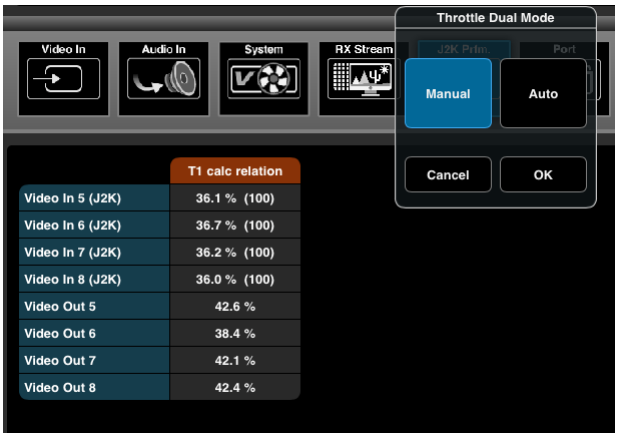


Figure 88 Caption

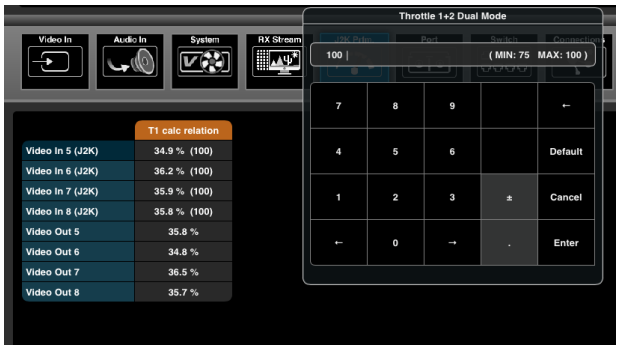


Figure 89 Caption

Status -> Port

1. Select `Status` -> `Port` to view the performance statistics of the physical **Ethernet ports** (on the rear panel) and the internal ports (e.g. the CPU 1/2 and FPGA stream engines):

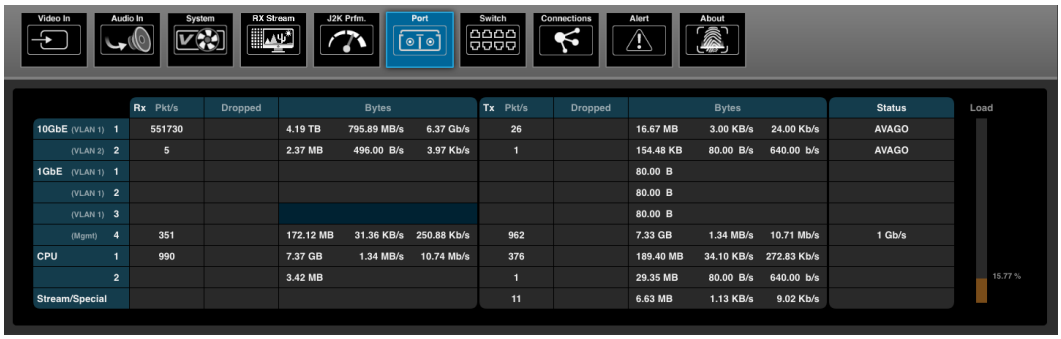


Figure 90

2. Click on the `Status` field to view further information - in our example, information about the 10 Gigabit Ethernet SFP Module:

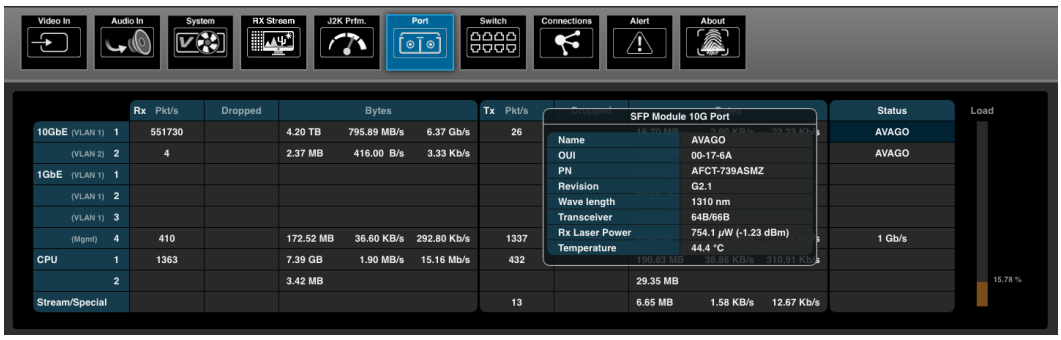


Figure 91

3. Click on the dedicated rows/entries for a more detailed information display.

Status -> Switch

1. Select `Status` -> `Switch` to view information about the internal network switch. There are four submenu options:

- `IGMP` - Internal Group Management Protocol: dynamic information about the IGMP table entries, timeouts, querier information, etc.

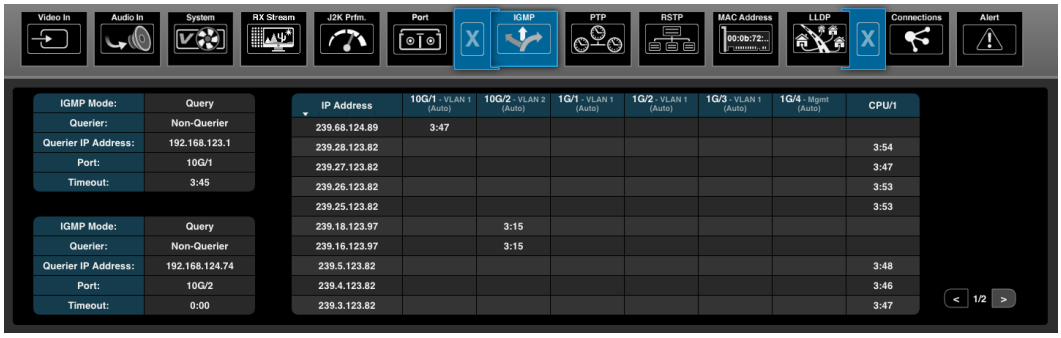


Figure 92

- `MAC Address` - of the internal network switch (Switch-Base) and each external **Ethernet port**:

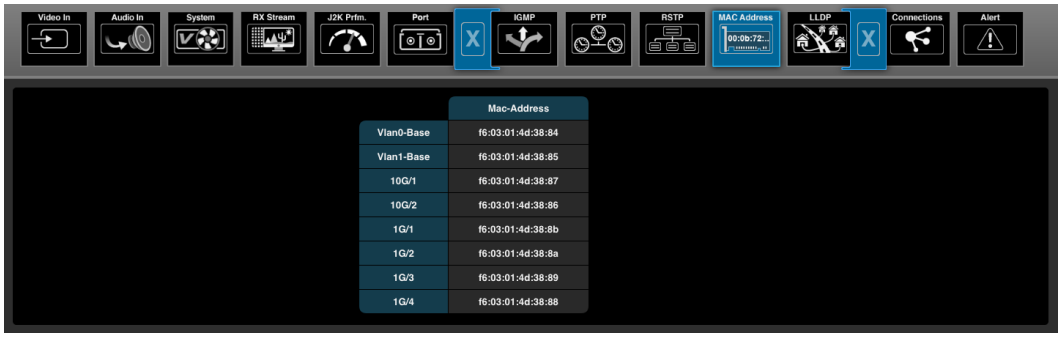


Figure 93

- `PTP` - status information about PTP (Precision Time Protocol). e.g. best master, etc.

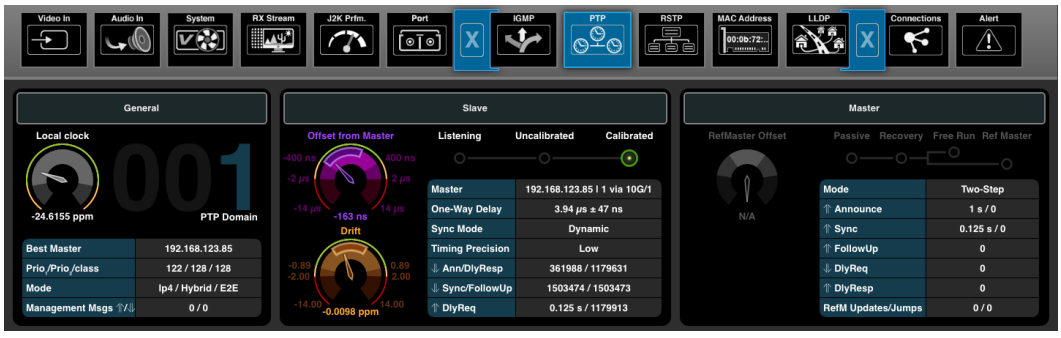


Figure 94

Slave Mode

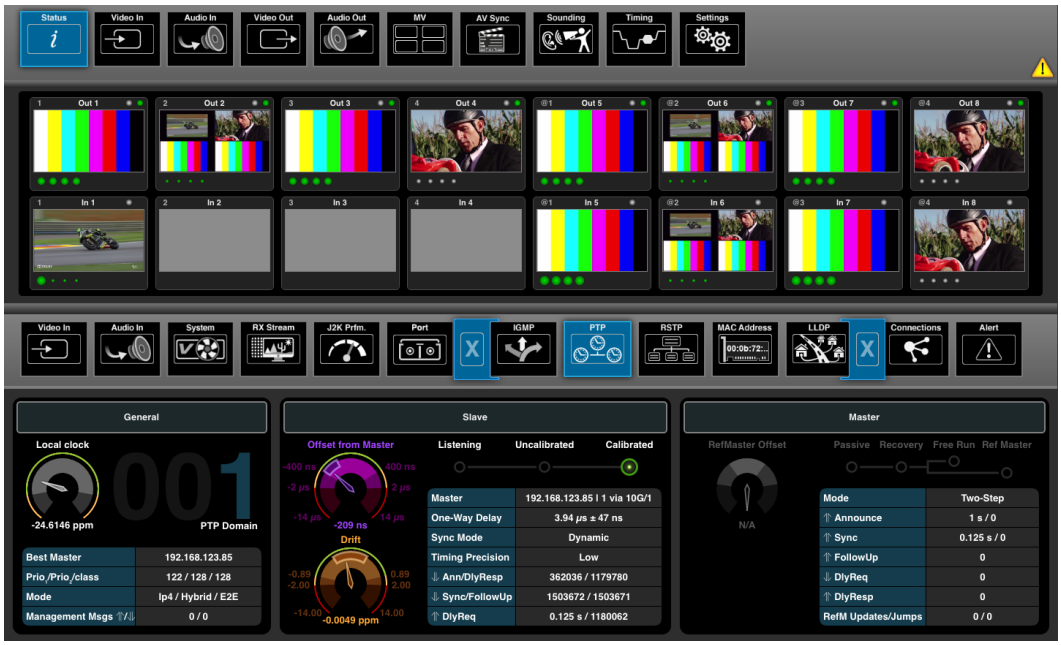


Figure 95 Slave mode PTP status / performance

States

States **Listening**, **Uncalibrated** and **Calibrated**.

The double-circle around **Calibrated** state indicates “locking” mode.

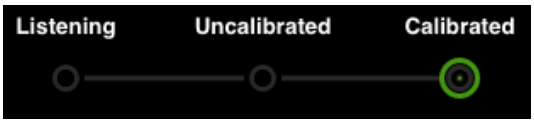


Figure 96 From **Listening** to **Calibrated**

Offset from Master

- Logarithmic metering scale

- Scale depending on Timing Precision setting

- Green / yellow / red indication[1]

- Offset probability window (red arrow marker)

- Current adaptive filtered offset

Figure 97 Show Offset from Master

Remark: offset from master deviation is constantly tracked, weighted and shown as offset probability window. If that window exceeds the green area boundaries the PTP client will not enter the calibrated state or is about to leave the calibrated.

Drift

Figure 98 Show Drift relative to Master

- Logarithmic metering scale
- Scale depending on Timing Precision setting
- Green / yellow / red indication[2]
- Drift probability window
- Current adaptive evaluated drift

Local Clock

Figure 99 Show Local clock quality

- Variation from nominal period

---

[1]

- Range indication with timing precision = High (arkona technologies recommendation, relates to commonly used standards / practises in baseband world)
- Range indication with timing precision = Low (following SMPTE 2059-2 recommendation)
- Range indication derived from custom settings

[2]

- arkona technologies tbd

Master Mode

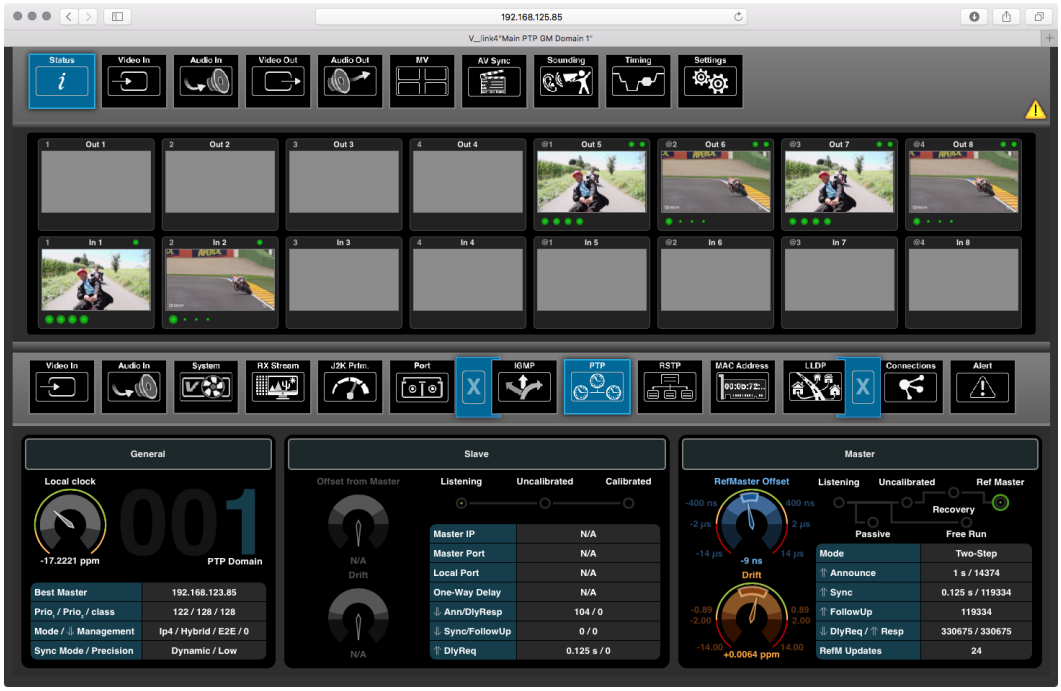


Figure 100 Master Mode status / performance with AnalogRefMaster activated

States

States **Passive**, **Recovery**, **Free Run** and **Ref Master**

Figure 101

RefMaster Offset

Figure 102 RefMaster Offset

- Offset from Analog Reference input

- **RSTP** - status information about RSTP (Rapid Spanning Tree Protocol).

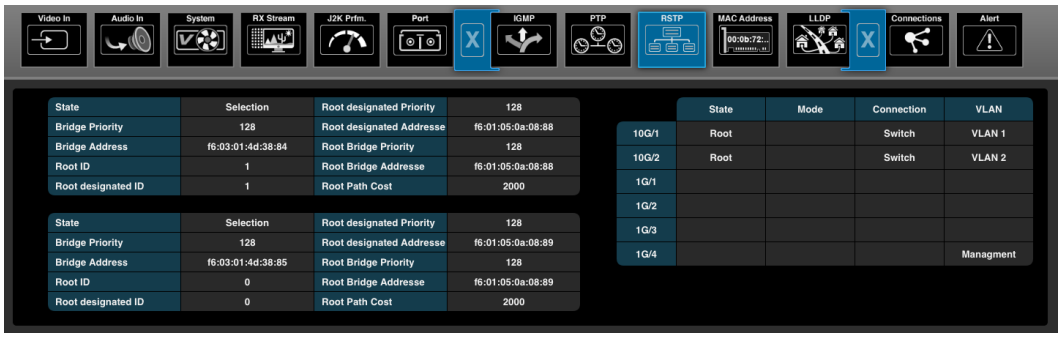


Figure 103

- **LLDP** - neighbourhood information page (Link Layer Discovery Protocol).

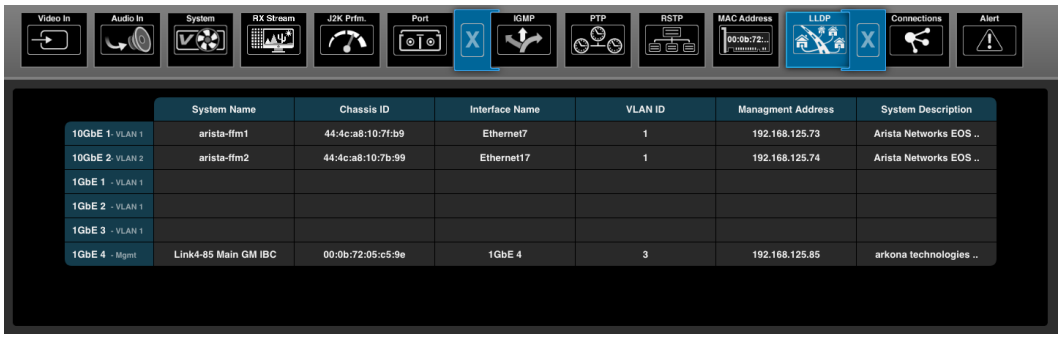


Figure 104

Status -> Connections

1. Select `Status` -> `Connections` to view information on all active Web Browser and control sessions:

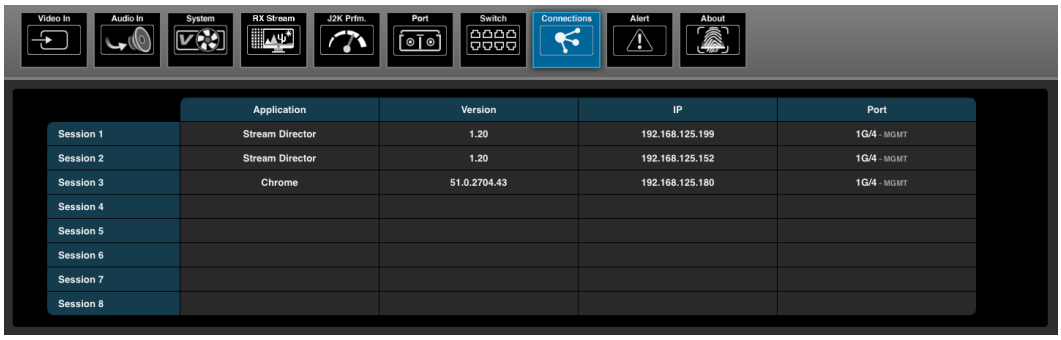


Figure 105

Status -> Alert

1. Select `Status` -> `Alert` to view the status of all warnings and alerts:

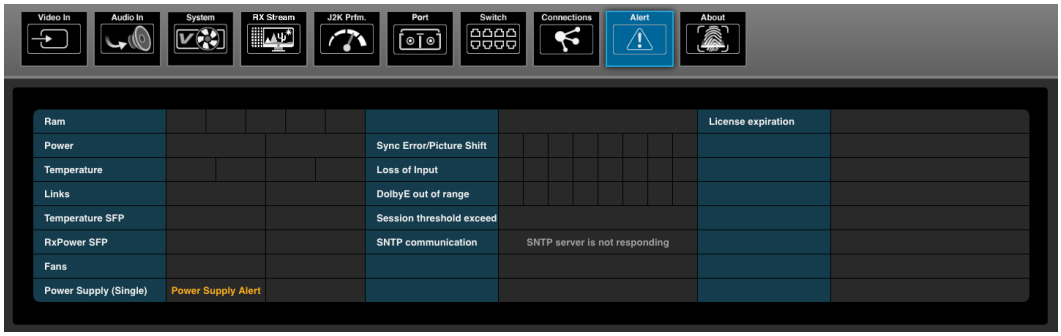


Figure 106

Note that global alerts are also shown in the main menu bar (see **Alarm Alert** and temporarily on the MultiView monitoring output (see the **MV menu**).

> Clicking into temperature alert row opens popup window with internal overheating log.

Status -> About

Device Type information, Hardware revision, CPLD revision, UUID, S/N info, SD card info and Software revision(s).

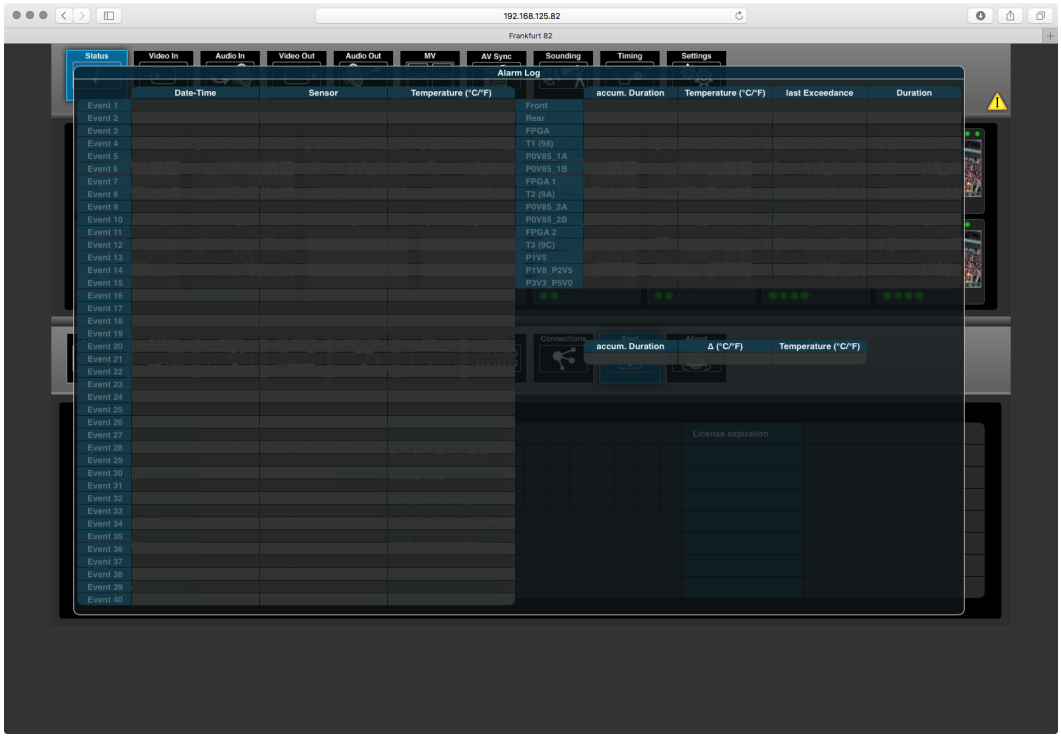


Figure 107

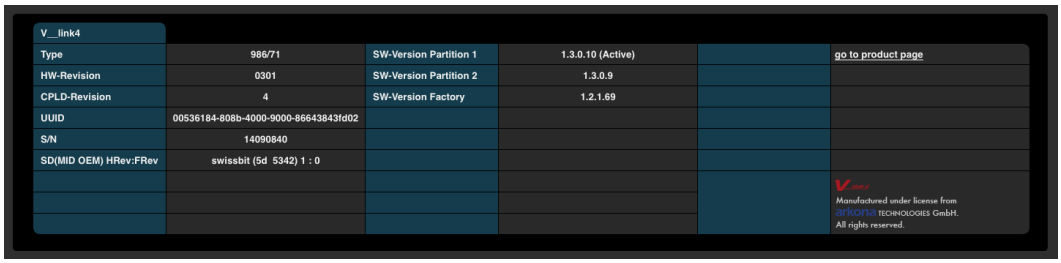


Figure 108

Video In

This main menu displays audio metering and provides access to input delay (video and audio), video frame sync and audio sample rate conversion.

1. Select `Video In` and an input (`In 01` to `In 08`) from the main menus.

In the upper part of the operating window you will see PPM metering for the 16 de-embedded audio channels and live video thumbnail streaming:

Figure 109

The PPM meter scale can be dBFS, Nordic, BBC or DIN, and meters are color-coded (green, yellow, red) to help manage headroom. Each PPM also includes a peak hold indicator (blue) and overload flag (red) if audio levels reach 0dBFS. All metering options are adjusted from the **Settings -> Preferences** menu.

The lower half of the screen can be used to adjust **Delay** or **FSY & SRC** (Frame Synchronization & Sample Rate Conversion) for the selected Video input.

Video -> FSY & SRC

This submenu adjusts frame synchronization for the video, and sample rate conversion for the 16 de-embedded audio channels.

> Use frame phaser or frame sync to align incoming video signals to the reference.
>
> Use sample rate conversion if the audio sample rate is different from, or not locked to, the V__link4 / V__remote4's audio reference signal, see **Timing -> Reference Settings**.

> You should disable **SRC** for any audio channels carrying Dolby E signals.

1. Select the video and/or audio channels you wish to adjust - you can select audio channels in their groups (A to D), but not as individual channels.
2. Then click on `Enable`, or `Disable`, to adjust the frame sync or SRC on/off state for the selected channels:

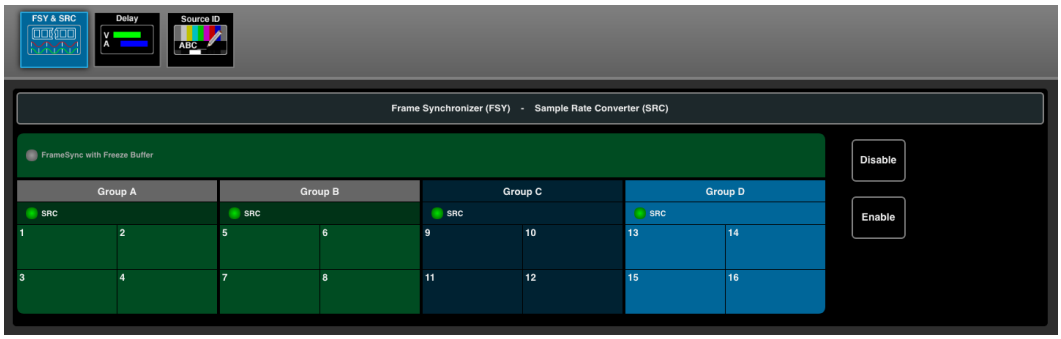


Figure 110

The **FSY** and **SRC** indicators turn green (illuminated) when frame sync or sample rate conversion are enabled.

In our example, frame sync for the video channel and SRC for audio channels 1 to 12 are enabled; SRC is disabled on channels 13 to 16; channels 13 to 16 are selected (light blue select buttons).

See also Video Synchronization / Phasing Modes.

Video In -> Delay

This submenu adjusts input delay for the de-embedded video and audio channels.

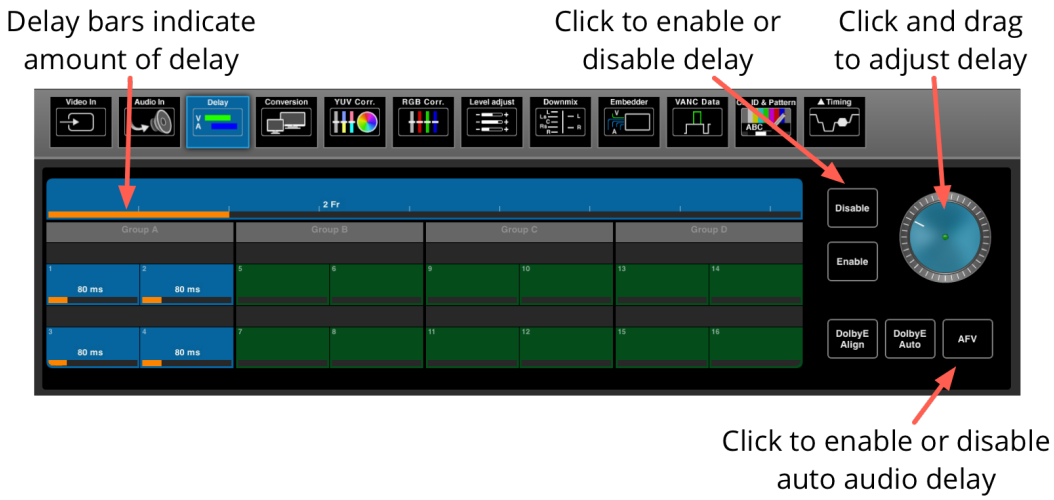


Figure 111

For full details, see **Delay** and **AFV**.

Video In -> Source ID

Define 16 char extra source ID per input, which will be distributed via SDP info and can be displayed on receiver side.

Audio In

This main menu displays audio metering and provides access to input delay for all MADI or RAVENNA input channels.

> You can configure redundant MADI ports by making **connections** to both the front and rear panel. Then select the active MADI input (front or rear) from the Status -> MADI menu.

1. Select Audio In and a set of MADI channels or RAVENNA streamfrom the main menus.

In the upper part of the operating window you will see audio metering for the 32 input channels:

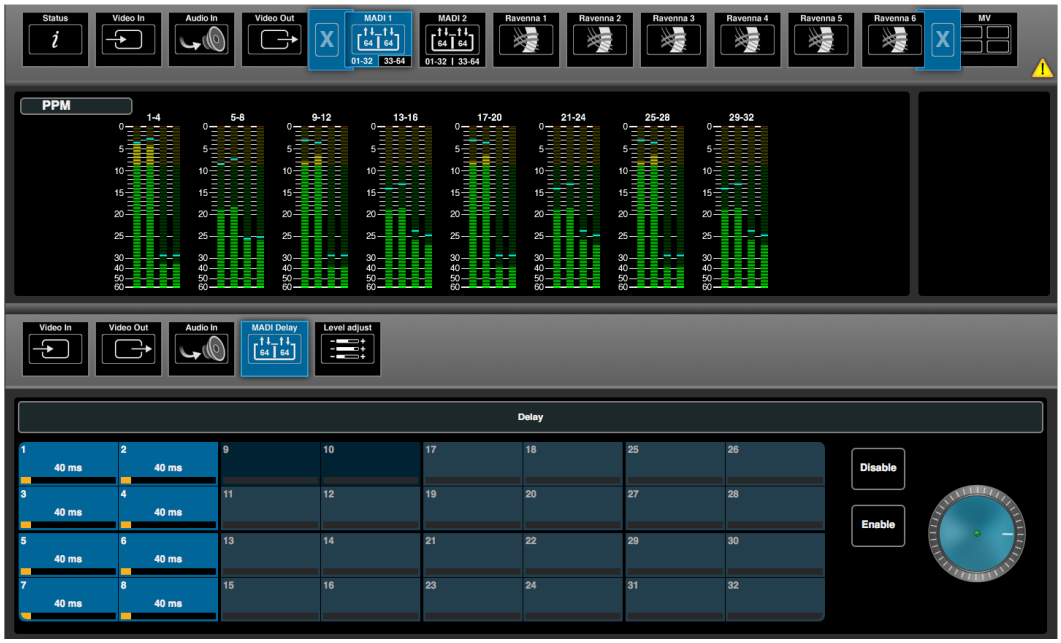


Figure 112

The PPM meter scale can be dBFS, Nordic, BBC or DIN, and meters are color-coded (green, yellow, red) to help manage headroom. Each PPM also includes a peak hold indicator (blue) and overload flag (red) if audio levels reach 0dBFS. All metering options are adjusted from the **Settings -> Preferences** menu.

The lower half of the screen can be used to adjust input **Delay**. For details, see **Delay**.

For RAVENNA stream inputs you can also select/enable the incoming audio channels routed to the audio crossbar. A “**Rx**” indicator means that the channel is present in the audio stream.

Video Out

This main menu is the principle menu for dealing with SDI and IP signals. Here you can monitor the video and adjust signal routing and processing for any SDI or IP output.

1. Select `Video Out` and an output (`Out 1` to `Out 8`) from the main menus. Note that:

- **Out 1 to 4** = local SDI connections.
- **Out 5 to 8** = network IP streams. These are identified by the @ symbol.

If you have signals connected, then you will see audio levels on any metering and live video in the thumbnails and preview. If no signals are present, then these elements will be blank.

In the upper part of the operating window you will see **Timecode** (or one of the other **Display Options**) plus a preview of the embedded video channel:

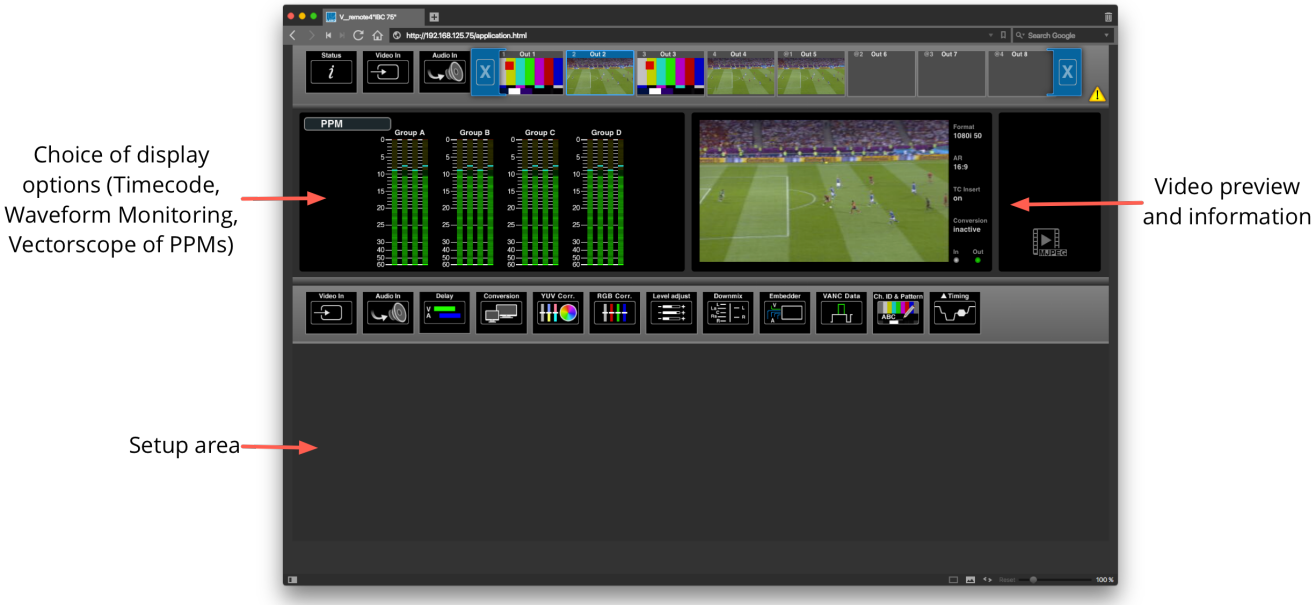


Figure 113

> Note that the video preview is not streamed at broadcast quality. For broadcast quality, use the **MultiView** monitoring feature via the **MV SDI output**.

Beside the video preview is information on the format, aspect ratio, timecode insertion and conversion. The two status LEDs indicate if the assigned video source (In) and video output (Out) are synchronous:

- **In** (green) = source is synchronous
- **In** (white) = source is asynchronous
- **Out** (green) = ok
- **Out** (red) = picture shift or sync error

The lower half of the screen is used to adjust signal routing and video or audio processing for the selected SDI or IP output.

Display Options

The left hand side of the Video Out page can display different options.

1. Click on the current option (e.g. Timecode) to open the selector:

Figure 114

You must have the correct **software license** in order to access the **Vectorscope** and **WFM** options.

Timecode

Displays the three embedded timecode streams (VITC 1, VITC 2 and LTC):

Figure 115

Vectorscope

Vectorscope monitoring of the video channel.

The X-Y plot compares the amplitude of different color components (**R** = Red, **Mg** = Magenta, **B** = Blue, **Cy** = Cyan, **G** = Green, **Yl** = Yellow):

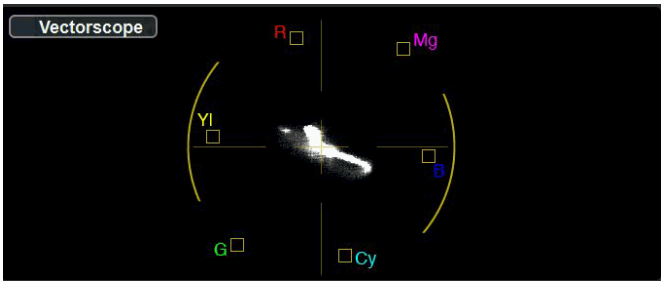


Figure 116

WFM YRGB

Waveform monitoring of the video channel (**Y** = Luminance, **R** = Red, **G** = Green, **B** = Blue).

Compares the amplitude of **luminance** (black & white) and **chrominance** (RGB color) components:

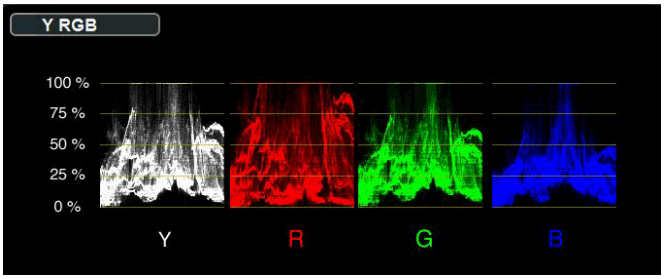


Figure 117

WFM YCbCr

Waveform monitoring of the video channel (**Y** = Luminance, **Cb** = Chroma Blue, **Cr** = Chroma Red).

Similar to YRGB, but this time comparing **luminance** (black & white) with the color difference components (CbCr):

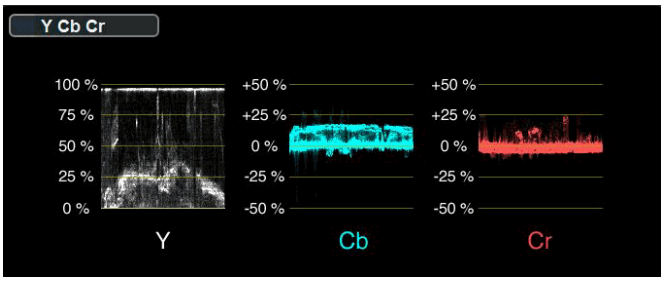


Figure 118

WFM Y

Waveform monitoring of the video channel's Luminance (**Y**) only:

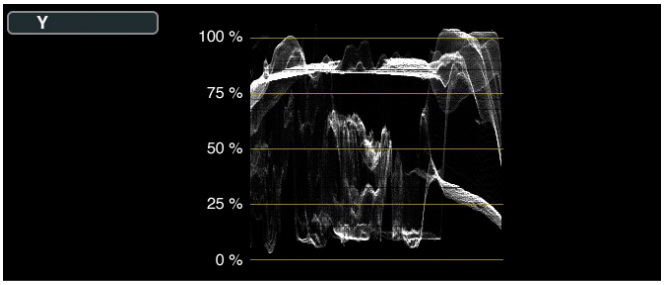


Figure 119

PPM

Peak Programme Metering for the 16 embedded audio channels.

The PPM meter scale can be dBFS, Nordic, BBC or DIN, and meters are color-coded (green, yellow, red) to help manage headroom. Each PPM also includes a peak hold indicator (blue) and overload flag (red) if audio levels reach 0dBFS. All metering options are adjusted from the **Settings -> Preferences** menu.

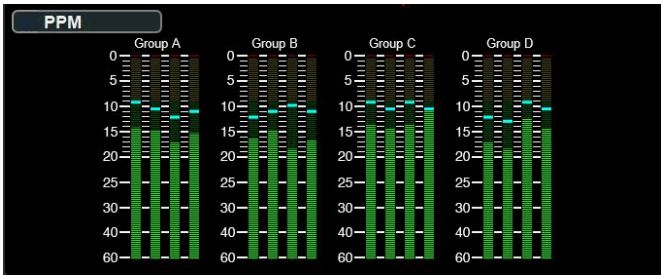


Figure 120

If there is no audio assigned to an output channel, then you will see the text **not present** on the audio bargraph. Or, if the embedded audio group has been disabled (from **Video Out -> VANC**), then you will see **Group disabled**:

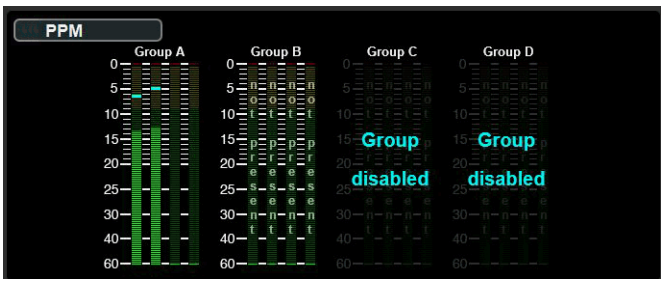


Figure 121

Routing Status

The routing status of the video and audio channels:

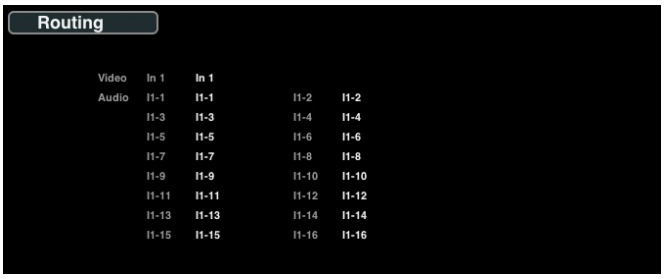


Figure 122

Video Out -> Video In/Audio In

The **Video In** and **Audio In** submenus are used to change the signal routing for the selected SDI or IP output.

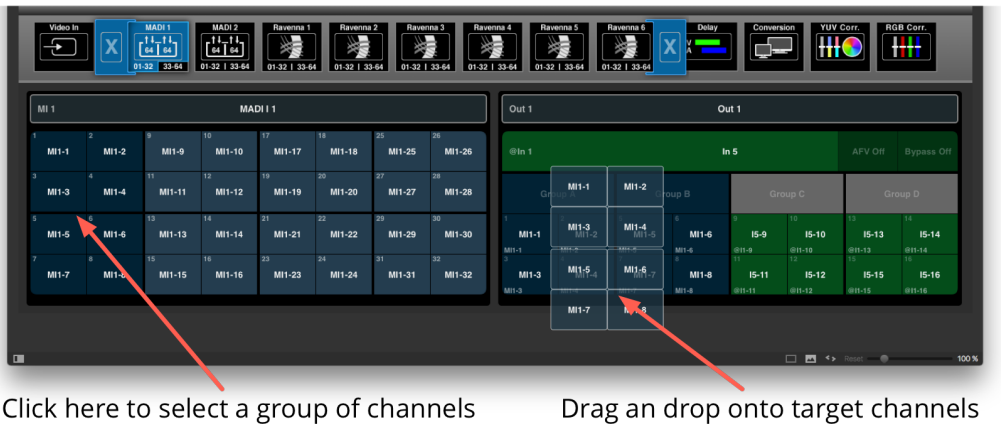


Figure 123

For full details, see **Signal Routing**.

Note that the embedded audio groups can also be enabled or disabled, and audio channels reassigned, from the **Embedder** submenu.

Video Out -> Delay

This submenu adjusts output delay for the video and embedded audio channels. See Delay for details.

Figure 124

In addition, you can enable the following options:

- Dolby E Align
- Dolby E Auto
- **AFV** - audio follows video.

Dolby E Align

The V__link4 / V__remote4 monitors and automatically detects Dolby E signals routed to the embedded audio channels. You may adjust their timing using the Dolby E Auto Align function:

1. Select the audio channels you wish to align, and press the Dolby E Align button.

Any Dolby E signals are automatically aligned, in pairs, to their ideal position. The horizontal red and green bar, above each pair of channels, indicates the delay position:

- **Bright green** = ideal position
- **Dark green** = valid position (earliest or latest)
- **Red** = invalid

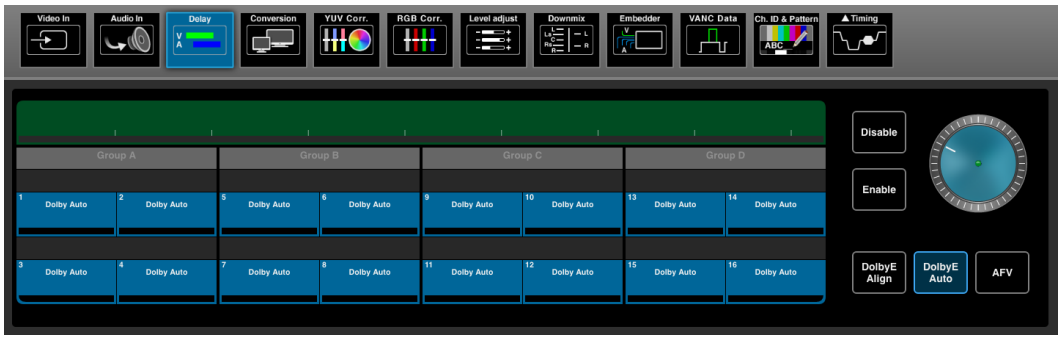


Figure 125

Any audio pair, within each group, can be aligned separately:

Figure 126

The V__link4 / V__remote4's Dolby E Auto Aligner always aligns the Dolby E Frame to the next valid ideal position.

- Figure 1: Dolby E frames are misaligned relative to video frames and need to be aligned.
- Figure 2: Dolby E frames are aligned to the next possible ideal position relative to the video frames, but the audio is now 1 frame late. The solution is to manually delay the video by 1 frame using the V__link4 / V__remote4's **video delay**.
- Figure 3: Dolby E frames are aligned, and audio and video are in sync. Dolby E and video are 1 frame delayed.

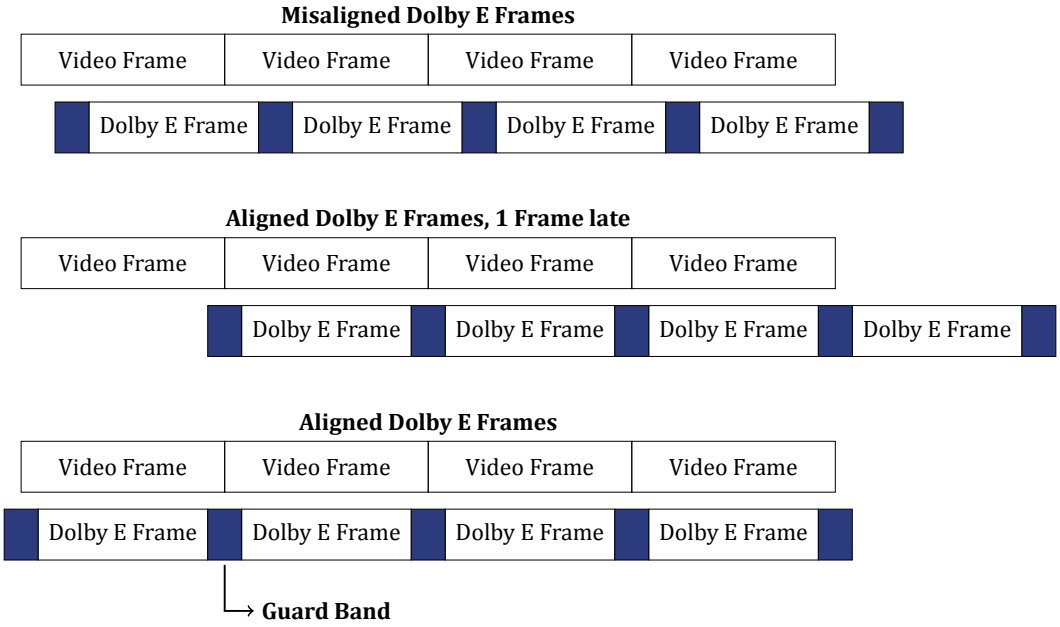


Figure 127

To use the Dolby E Auto Aligner on p50/59/60 video formats, an interlaced or p25/p29,97/ p30 reference signal is recommended.

If an audio pair has a different audio delay then the Dolby E Auto Align won't work. In this case, set the audio delay back to the default, and then select **Dolby E Align** again.

Audio must be synchronous to the video source; this is required for Dolby E.

Video Out -> 3G Conversion and VC-2

This submenu provides 3G conversion of the video channel

ON / OFF function:

- Output 1...4: Define if incoming 3G signal is converted to 1080i or 3G level A DL or 3G level B DL.
- Output 5...8: Define if incoming 3G signal is converted to 1080i or VC-2 encoded. On receiver side VC-2 encoded signals are detected automatically and decoded.

Use this function to convert from 3G Level A to 3G Level B-DL, and vice versa. Or, to convert from 3G Level A or B-DL to 1080i. For IP outputs 5..8 VC-2 can be activated to automatically compress 3G input signals according into HD bandwidth of 1.5G. Enables to get quad 4K signal as 6Gbps load on 10GE IP connections.

Video Out -> YUV Corr

This submenu provides color correction for the video channel using standard Proc Amp controls (YUV). Alternatively, you can use **RGB Corr**. Both sets of controls affect the luminance (black & white) and chrominance (color) components of the embedded video channel. Note that the choice of **Color Mode** (**Black/Gain** vs. **Brightness/Contrast**) defined in `Settings` -> `Preferences` affects the behaviour.

Select either the **Vectorscope** or **WFM (YCbCr)** **display options** to visualize luminance and chrominance as you make adjustments.

You must have the correct **software license** in order to access this menu.

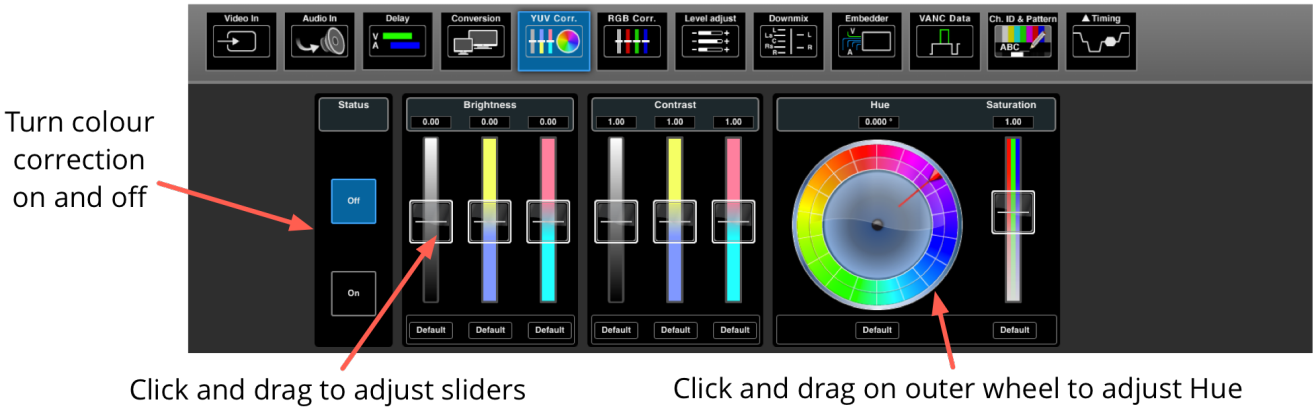


Figure 128

To apply color correction:

1. Select the Status `On` button to enable the controls.
2. Click and drag on a slider to adjust its value. For **Brightness** and **Contrast**, you can adjust the Luminance (Y) and color difference (U & V) components.
3. Click and drag on the outer color wheel to adjust the **Hue** - you can use the inner wheel, which remains static, for reference.
4. To reset a parameter, click on its `Default` button. Or, click between the buttons to reset a parameter block:

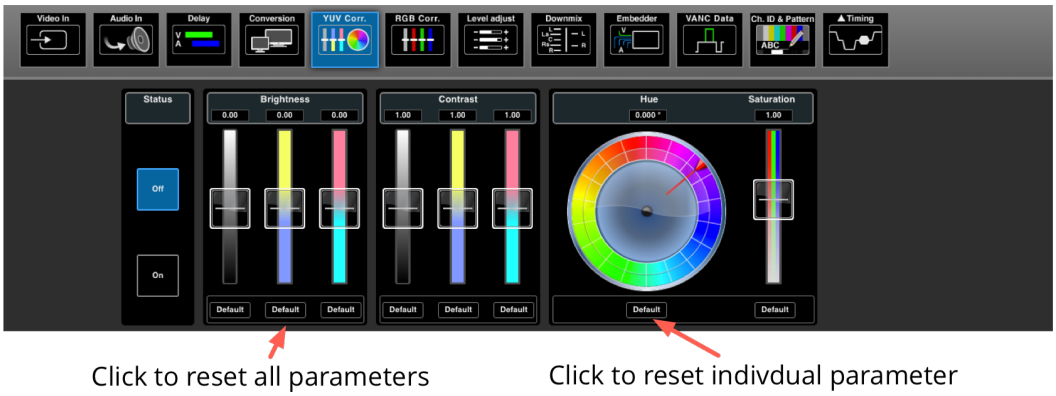

Video In
Audio In
Delay
Conversion
YUV Corr.
RGB Corr.
Level adjust
Downmix
Embedder
VANC Data
Ch. ID & Pattern
Timing
Status
Off
On
Brightness
0.00
0.00
0.00
Default
Default
Default
Contrast
1.00
1.00
1.00
Default
Default
Default
Hue
0.000 °
Saturation
1.00
Default
Default
Click to reset all parameters
Click to reset indivdual parameter

Figure 129

Video Out -> RGB Corr

This submenu provides color correction for the video channel using YRGB. This provides an alternative method of control to **YUV Corr**. For example, to assist with RGB camera matching.

The method of control is very similar, except that this time you may adjust the Luminance (Y) and individual color (RGB) components:

Figure 130

See **YUV Corr** for details on operating the controls.

Video Out -> Level Adjust

This submenu adjusts the output level of each embedded audio channel. See **Audio Output Level Adjustment**.

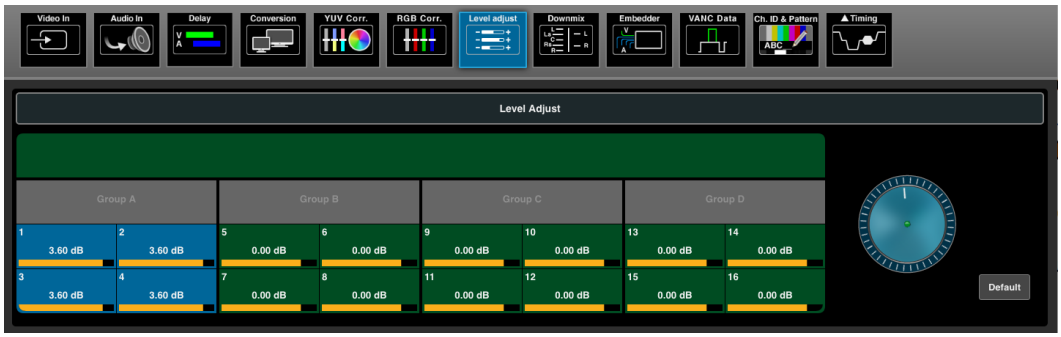


Figure 131

Video Out -> Downmix

This submenu adjusts settings for the two audio downmix engines.

Each engine may convert discrete 5.1 or 7.1 surround to stereo. The downmix results can be assigned to any audio channel via the **Video Out -> Embedder** menu.

The following example demonstrates how to downmix a 5.1 surround production to stereo:

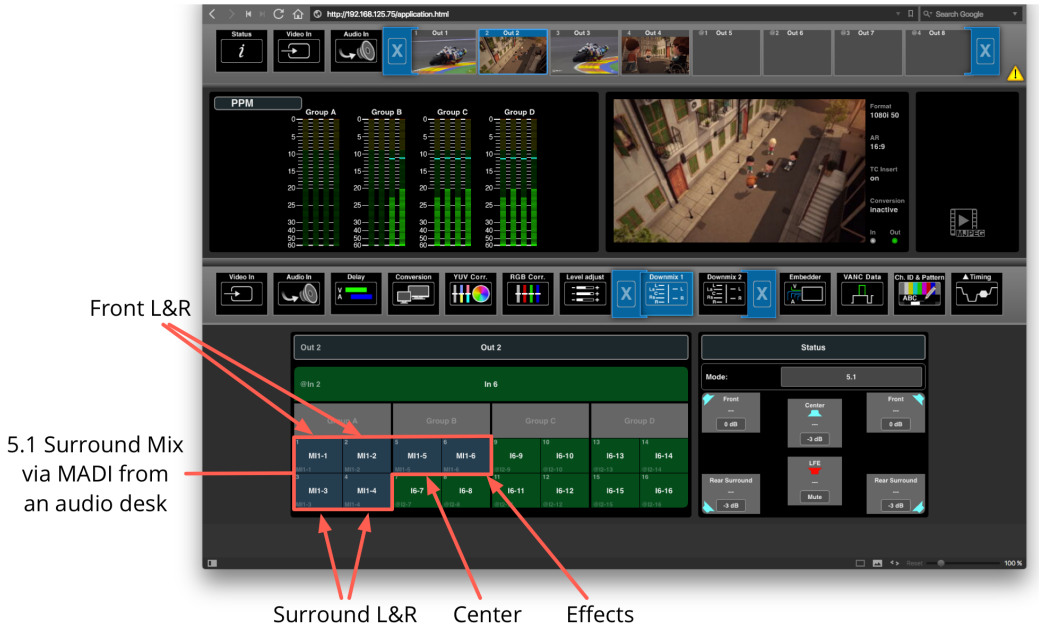


Figure 132

The surround mix is coming from an audio console, via MADI, and is already assigned to SDI Out audio channels 1 to 6. Channels 1 & 2 are for the front speaker, 3 & 4 for the surround speaker, and 5 & 6 are centre and LFE (Low Frequency Effects). The LFE channel is not normally used for a stereo downmix, and is muted. (Note that the LFE channel can be included by changing the default set up.)

Finally, the stereo downmix will be assigned, via the **SDI Out -> Embedder** menu, to SDI Out audio channels 7 & 8. This will provide both the 5.1 surround mix and stereo downmix, in parallel, on an SDI output.

To execute this example:

1. Select the downmix mode (5.1 or 7.1):

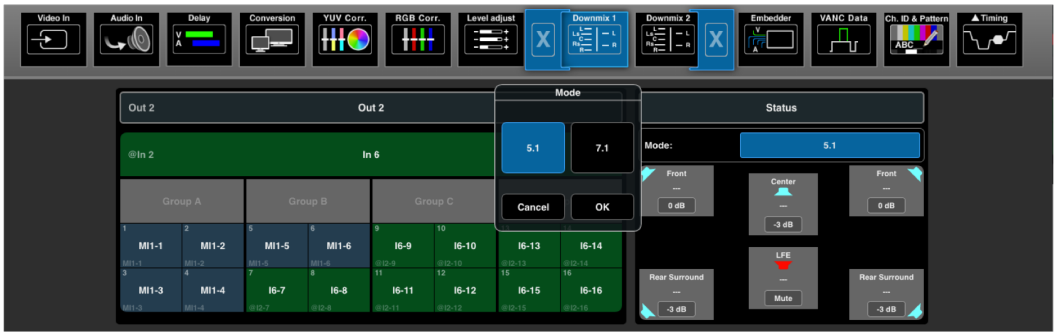


Figure 133

2. Drag and drop the surround mix channels onto the corresponding audio channels of the downmix engine:

Figure 134

3. Click on the grey “level” box to open a pop up window where the audio level can be adjusted if necessary.

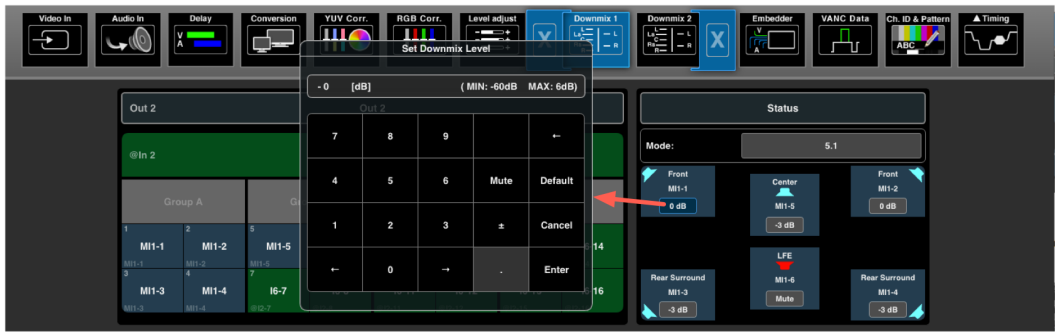


Figure 135

4. Finally open the the **embedder** menu and assign the stereo downmix to channels 7 & 8 of the audio embedder:

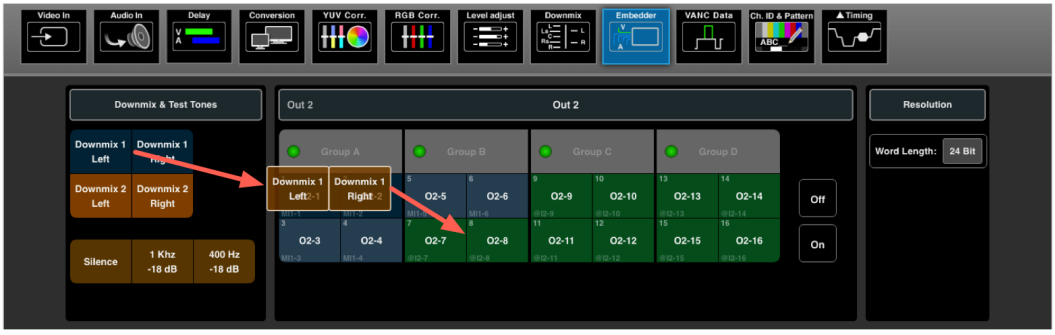


Figure 136

To return to the default assignments, click and drag on the assigned channel(s) - the submenu icons are greyed out and a waste bin appears. Drag and drop the channel(s) into the waste bin:

Figure 137

Video Out -> Embedder

This submenu controls the embedded audio channels. You may enable, or disable, each audio group (**Group A** to **D**), re-assign individual channels (from the **downmix** results, silence or test tone), and control the resolution (word length).

Figure 138

Group Enable/Disable

Enable the **Group A** to **D** buttons to embed audio groups into the SDI output. In our example above, only Groups A and B will be embedded. Note that your selections are reflected in the PPM metering for output.

Downmix, Silence & Test Tones (Channel Reassign)

Audio channels can be reassigned, individually or in blocks, by dragging and dropping the **Downmix & Test Tone** options onto the **Output** channels. Source options include the results of the two **downmix** engines, **Silence** or audio test tone (**1kHz** or **400Hz** sine wave).

Once channels are re-assigned, they are color-coded accordingly:

Figure 139

To undo an assignment, click and drag on the assigned source(s) - the submenu icons are greyed out and a waste bin appears:

Figure 140

Drag and drop the source(s) into the waste bin:

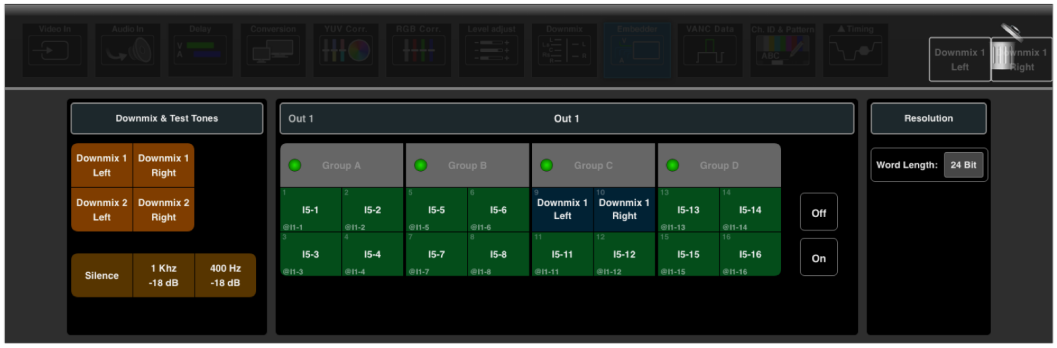


Figure 141

The channels return to their default source assignments.

Resolution

The Word Length can be switched between 20- and 24-bit in SD only. (HD is always 24-bit). Note that Word Length is a global setting for all audio channels.

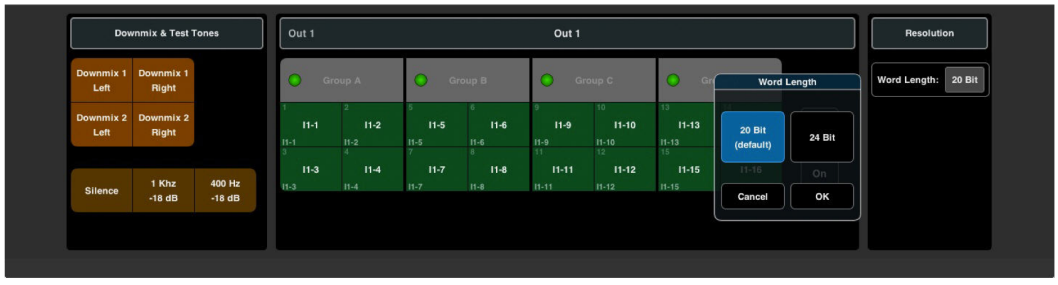


Figure 142

Video Out -> VANC (Vertical Ancillary Data)

This submenu selects and adjusts the various metadata blocks which are inserted into the Video output:

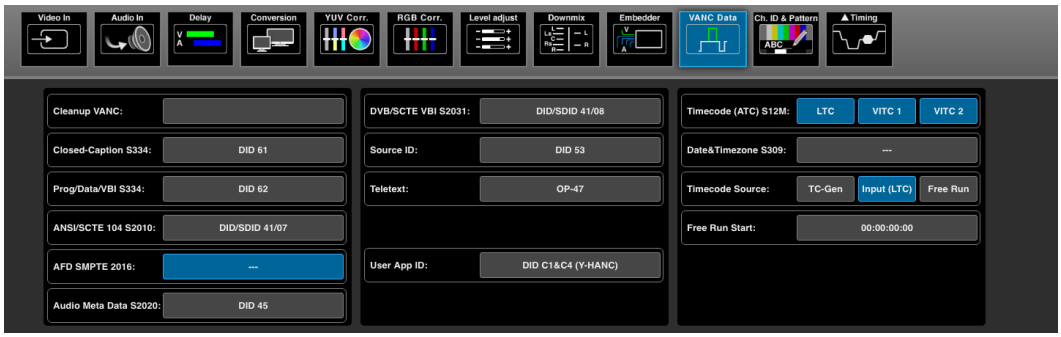


Figure 143

Blue buttons indicate an active setting; grey buttons are inactive. In each case, click to enable or disable the metadata block.

Cleanup VANC

This button wipes the VANC data space before inserting any enabled metadata blocks.

AFD SMPTE 2016

The AFD (Active Format Description) code is embedded into digital video signals, to control the way in which a 16:9 image is adapted for a 4:3 display. Click to select an option:

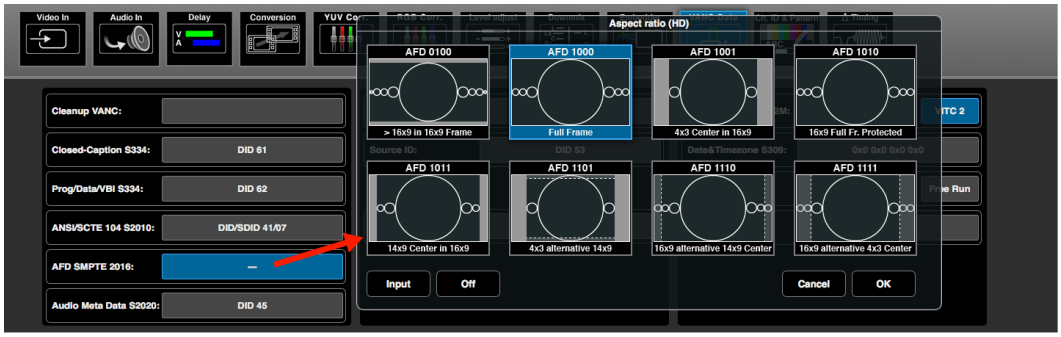


Figure 144

Either choose the Aspect Ratio manually, or select Input (bottom left) to copy the AFD code from the assigned **input**.

Audio Meta Data - enable/disable

Closed-Caption - enable/disable

Prog/Data/VBI - enable/disable

Source ID - enable/disable

User App ID

Enable or disable DID C1/C4 - e.g. for Sony HDC-cam control.

Timecode

LTC, VITC1 and VITC 2 timecode may be embedded into the Video output from the assigned **input**:

1. Enable the **LTC**, **VITC 1** and/or **VITC 2** (**Insert Timecode**) buttons to embed each of the timecode streams - all three may be selected if you wish.
2. For LTC, the **Timecode Source** can be:

- TC Gen - timecode from the internal generator, as defined in the **Timing -> Timecode** menu.
- Input (LTC) - timecode from the assigned input stream..
- Free Run - enables a “free run” mode:
  - Click on the `Free Run Start` field to enter the start timecode (for help, see **Data Entry**).
  - Then enable the `Free Run` button to set the time code running.

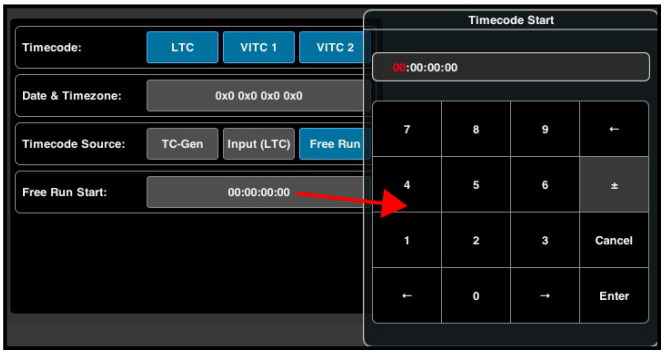


Figure 145

Video Out -> Ch.ID & Pattern

This submenu can be used to insert a channel ID, timecode and test pattern into the video channel, and test tone into all 16 audio channels.

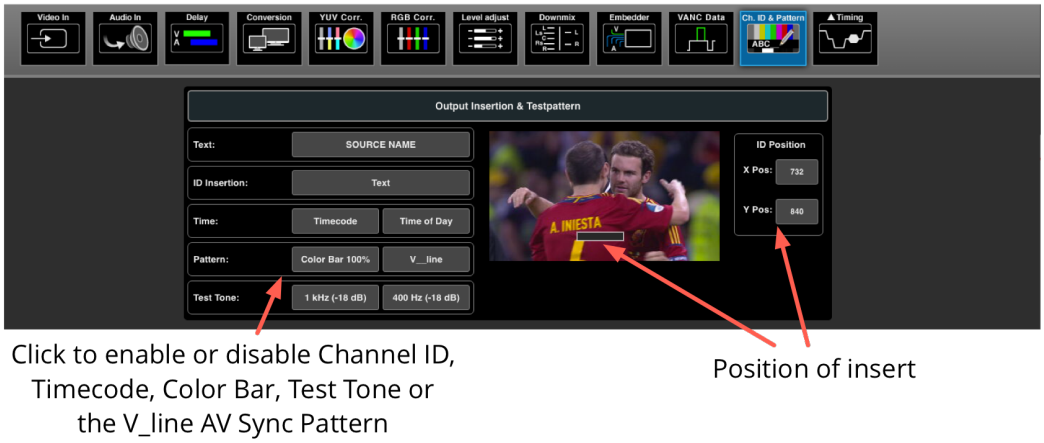


Figure 146

To insert a Channel ID:

1. Select any of the `ID Insertion` buttons (blue = on; grey = off). Only one button may be selected at a time:

- Text - inserts text, as entered in the `Text` field (e.g. **SL 5/HD/SD**). Click on the text to open an on-screen QWERTY keyboard and enter a new text string. You can display up to 16 characters (or 8 characters plus timecode, if the **Timecode/Time of Day** insert is also enabled).
- Source - inserts the channel ID embedded in the source's video channel.
- Date - inserts the date embedded in the source's video channel.
- Source ID, Device description insertion

The insert appears on the video preview; its position is shown in the **ID Position fields**.

2. Click and drag on the insert box, in the video preview, to adjust the ID's position. Or, click on the **X Pos** and **Y Pos** buttons to enter a numerical value.

To insert Timecode or Time of Day:

1. Select either of the 'Time' insertion buttons (blue = on; grey = off). Only one button may be selected at a time:

- Timecode - inserts timecode. You will see the value inside the button if timecode is present.
- Time of Day - inserts the system time of the V__link4 / V__remote4, as defined in the **Settings -> Time & Date**) menu.

The values appear in the insert box, after the Channel ID if both are enabled.

To enable the Test Pattern:

1. Select either the **100% Color Bars** or `V__line` button (blue = on; grey = off).

AV Sync (V__Line) Test Pattern

The **AV Sync** test pattern can be inserted on each of the 8 Video outputs and is used to measure the offset between the video and audio channels, otherwise known as the lip sync error. The test pattern generator is fully independent and can generate 3Gb/s HD or SD output patterns.

Once the **AV Sync** pattern is enabled, the lip sync error can be measured in one of two ways:

- Loop the Video output to a Video input, either on the same or another V__line device. Then use the **AV Sync** menu on the receiving device to measure the audio to video offset.
- Watch the V__line test pattern on a video wall and visually compare the progress bar with the audio beep. The audio beep is played when the vertical white bar reaches the “0” position and a white flash appears in the centre circle:

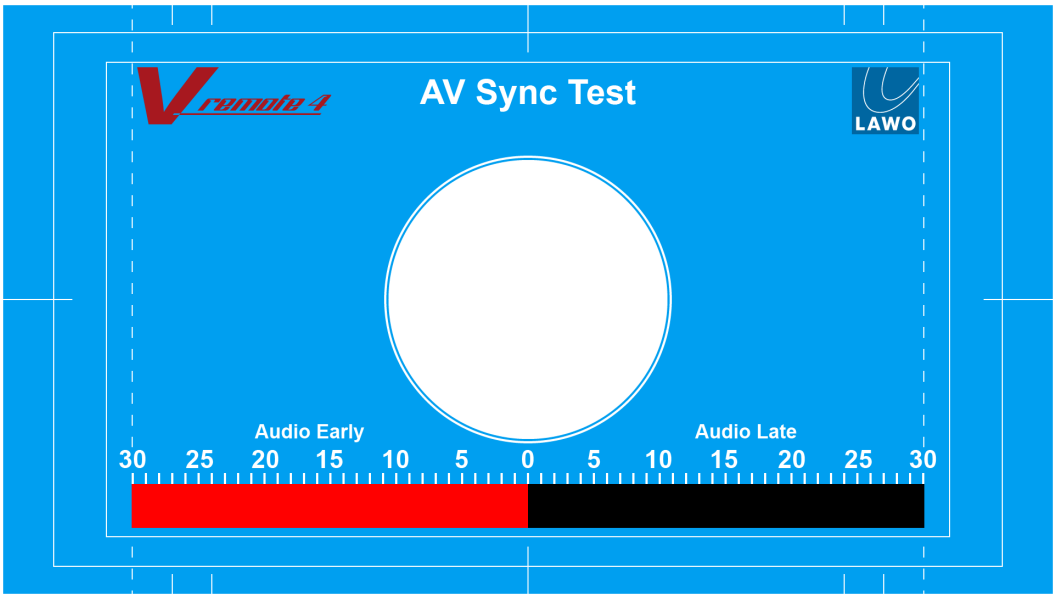


Figure 147

If the audio beeps before the white flash, then the audio is early; if the audio beeps after the flash, then it is late.

The **AV Sync** pattern also includes a number of overlays marking the safe area, image centre, etc:

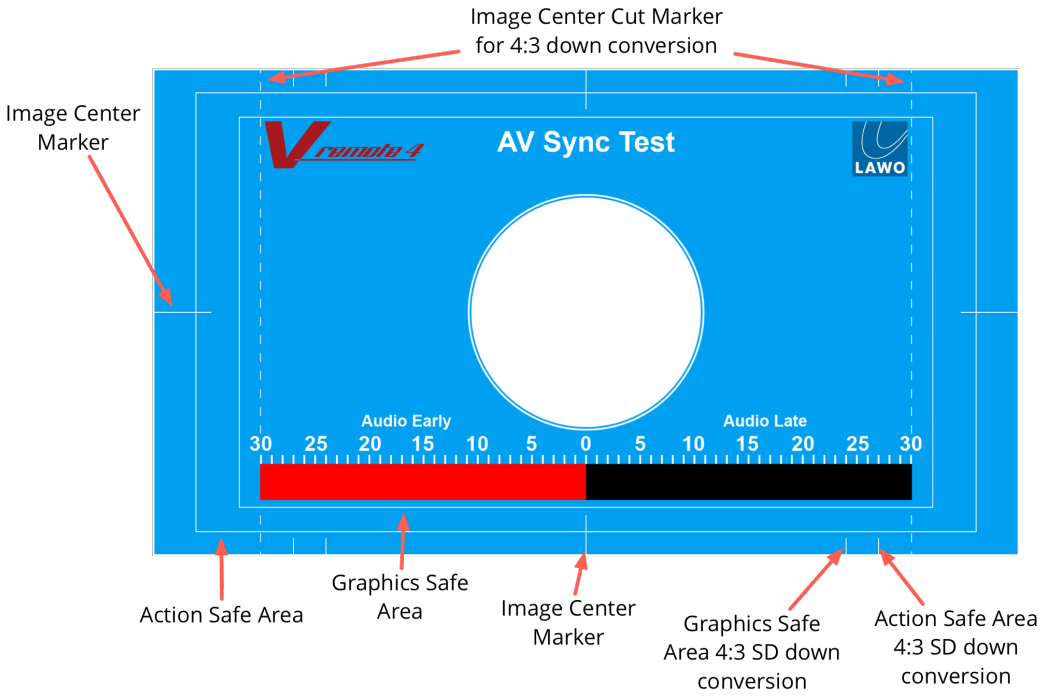


Figure 148

These can be used to verify or adjust the picture position on your video monitor system.

To enable Audio Test Tone

Operation (Web Browser Control) Video Out Select either of the ‘Test Tone’ buttons (blue = on; grey = off). Only one button may be selected at a time:

- **1kHz (-18dB)** - routes a 1 kHz sine wave to all 16 embedded audio channels.
- **400Hz (-18dB)** - routes a 400 Hz sine wave to all 16 embedded audio channels.

The level of the audio test tone can be set to either -18dB or -20dB from the `Settings` -> `Preferences` menu.

Video Out -> Timing

This submenu adjusts the output timing of the video channel:

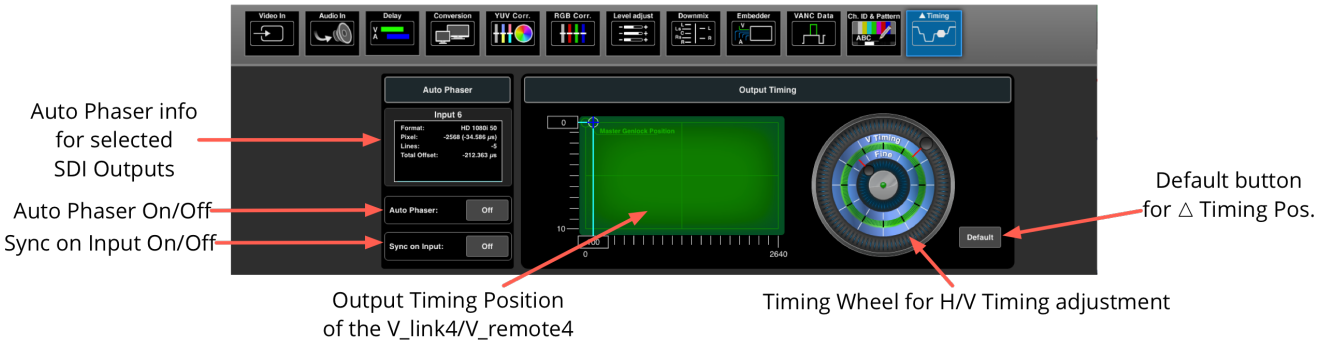


Figure 149

Output Timing

The **Output Timing** graph displays pixels (X axis) versus lines (Y axis).

1. Click and drag the inner timing wheel to adjust the pixel position.
2. Click and drag the outer timing wheel to adjust the line position.
3. Click on the `Default` button to reset the output to its default timing position.

You may adjust each video channel by up to 10 video lines relative to the main **timing position** of the **Video**.

Auto Phaser

The auto phaser (line phaser) is used to automatically align closely-timed video input signals to match the **Video's** horizontal timing. The auto phaser range is "2 lines".

When enabled, the auto phaser ensures the lowest possible latency between video input and video output. However, this mode should be used only for SDI signals. With Video-over-IP streams, the required latency for network jitter compensation usually exceeds the 2 line phaser window.

The default setting is **Auto Phaser Off** (and **FSY Off**) which means the V__link4 / V__remote4 is operating in Frame Phaser mode. If this mode is not sufficient, the **frame synchroniser**can be enabled, but note that this introduces another video frame delay.

You can view the status of the auto phaser for all Video outputs from the `Timing` menu, see **Output Timing**.

> For low latency operation, you should time your sources to the video reference signal: first adjust the V__link4 / V__remote4 **timing position** so that all input signals are ~ 1⁄2 line advanced; then switch on the auto phaser for each Video output.

See also Video Synchronization / Phasing Modes.

Sync on Input

When **Sync on Input** is enabled, the output timing follows the timing position of the incoming video signal.

This option is very useful if incoming signals are likely to vary in their timing position.

For example, a vision mixer is used one day for an SD production and the next day for a HD production. Some of the vision mixer signals are showing different timing behaviour, at the programme or aux output, according to the choice of video format (SD or HD). Normally, the timing of all the equipment following the vision mixer would need to be checked. However, if **Sync on Input** is enabled, the V__link4 / V__remote4 output will follow the timing position of the incoming video signal.

> Note that the incoming signal must be in sync with the V__link4 / V__remote4's system **genlock**. For asynchronous signals, you will need to turn on the **Frame Synchroniser** for the input.

Audio Out

This main menu displays audio metering and provides access to signal routing, delay and levels for all MADI or RAVENNA output channels.

> You can configure redundant MADI ports by making connections from both the front and rear panel.

1. Select `Audio Out` and a set of **MADI** or **RAVENNA** channels from the main menus.

In the upper part of the operating window you will see audio metering for the 32 output channels:

Figure 150

The PPM meter scale can be dBFS, Nordic, BBC or DIN, and meters are color-coded (green, yellow, red) to help manage headroom. Each PPM also includes a peak hold indicator (blue) and overload flag (red) if audio levels reach 0dBFS. All metering options are adjusted from the **Settings -> Preferences** menu.

The lower half of the screen can be used to adjust signal routing, delay and audio levels. See **Signal Routing**, **Delay** and **Audio Output Level Adjustment** for details.

For each MADI output, you can assign audio from any de-embedded SDI or IP input, SDI or IP output (for monitoring purposes) or from any MADI input.

> If an embedded SDI or IP channel is routed to a MADI output channel (for monitoring purposes), then you cannot adjust audio **delay**. In this case, the delay fields are “greyed out”.

MV (Multiview)

This main menu controls the four Monitor outputs (1 to 4) which can be viewed on an external display connected to the **MV OUT**:

Figure 151 External Display (shows any 4 Video inputs or outputs simultaneously):

1. Select `MV` and a `Monitor` (1 to 4) from the main menus.

> You must have the correct **software license** in order to access this menu.

On the lower right you will see the current assignments for the selected Monitor (e.g. **Monitor 1**). Note that the colored outline (yellow) is duplicated on the external display. This provides easy identification for each of the four monitor positions.

The lower left is used to select Video inputs or outputs for assignment.

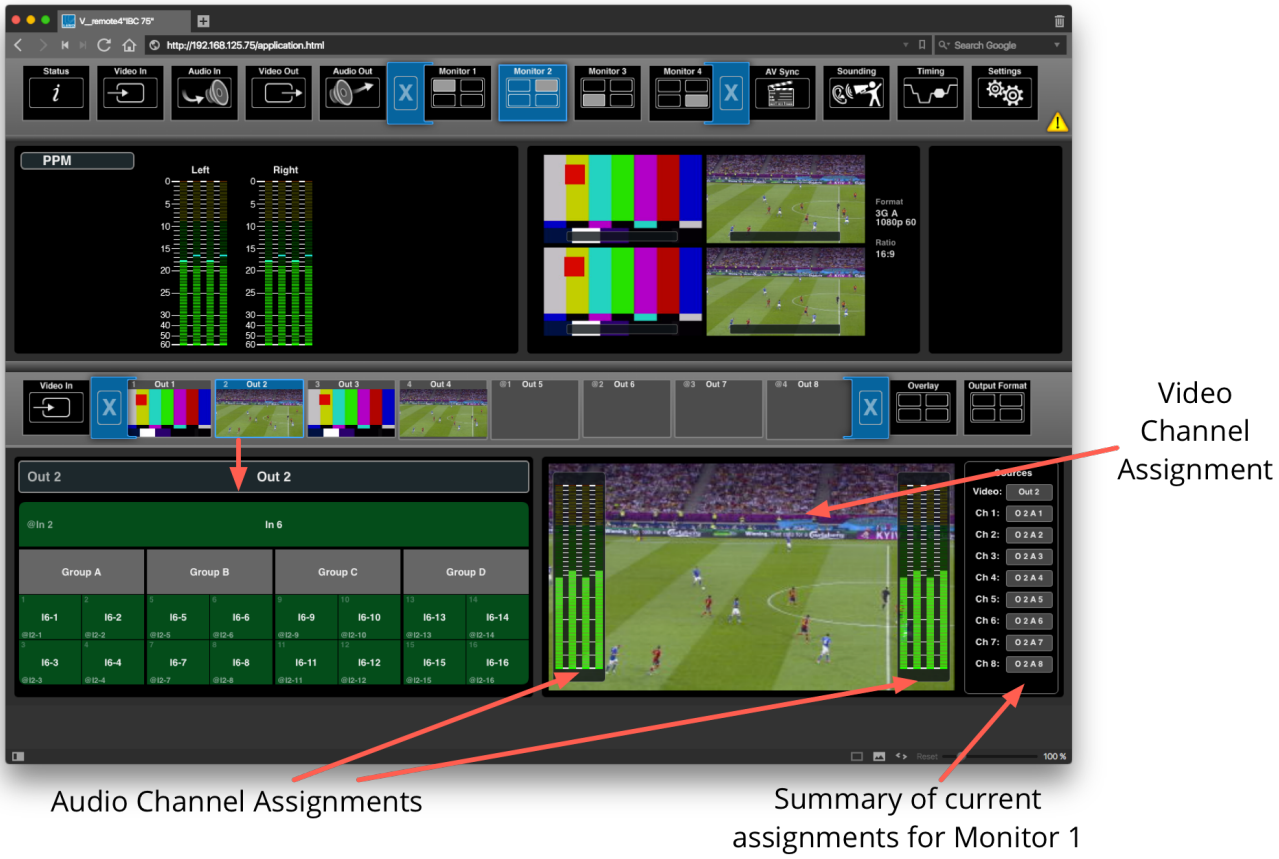


Figure 152

MV -> Video In/Video Out

Use the **Video In** or **Video Out** submenus to assign new sources to the Monitor output. The method is very similar to other I/O assignments, see **Signal Routing**.

You can choose video and audio channels, independently, from any of the SDI or IP inputs or outputs.

For example, to assign all channels (video and audio) from SDI output 1, select Video Out 1, and drag and drop all channels from left to right:

Figure 153

Or, to assign a new pair of audio audio channels only, drag and drop the audio channels onto the appropriate bargraph meters:

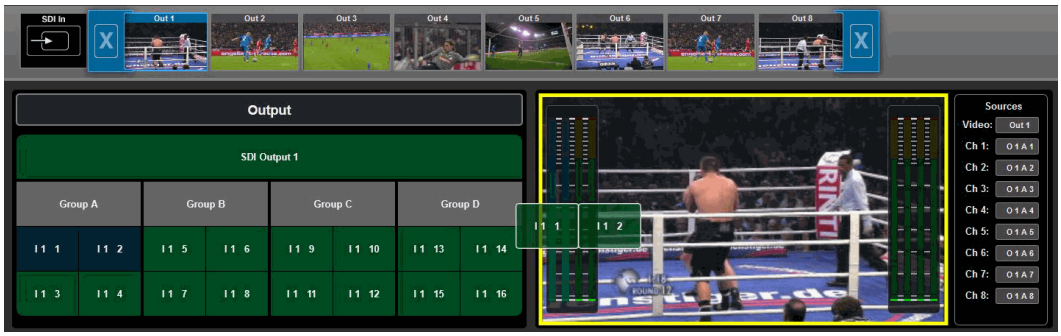


Figure 154

After each new assignment, the Sources summary updates.

For more information on connecting the MV output, or to see what is shown on the external display, see **MV OUT**.

Overlay - configure PPM displays / position, UMD and related info display, Timecode display.

Each quadrant of QuadSplit Multi-Viewer offers Ember+ controllable lamps at the left and right side of each UMD. Lamps can be enabled / disabled. The lamp color is free definable.

AV Sync

This main menu measures the offset between the video and audio channels, otherwise known as the lip sync error, on any of the 8 Video inputs.

> You must have the correct **software license** in order to access the **AV Sync** menu.

The selected video input must present either the V__link4 / V__remote4's own AV Sync or EBU Sync test pattern. The AV Sync test pattern is recommended as this will achieve the most precise result (the measurement accuracy is +/- 2 audio samples).

To use the V__link4 / V__remote4's AV Sync test pattern, loop a Video output (with the AV Sync pattern enabled) to a Video input. This could be on the same or a different V__line device:

1. On the sending device, first make sure that a valid input signal is connected. The corresponding output will follow the video format of the incoming video signal (providing that input is routed to output, and format conversion is disabled).
2. Using an SDI cable, or **Stream Director**, connect the Video Out (from the sending device) to a Video In (on the receiving device).
3. On the sending device, use the Video Out -> Ch.ID & Pattern menu to enable the V__line (AV Sync) test pattern:

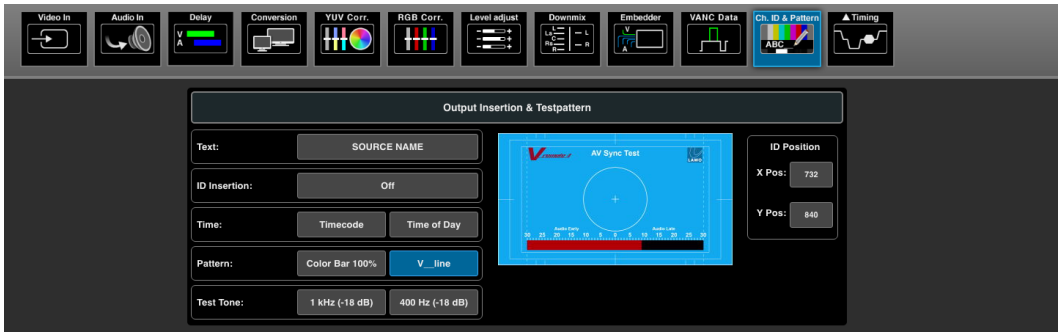


Figure 155

For more details about the test pattern, please see Ch.ID & Pattern: AVSync.

4. On the receiving device, select the `AV Sync` main menu followed by the input you wish to measure - in our example, `In 1`.
5. Click on the `Pattern Source` field to choose the test pattern - **V__line** or **EBU** - and select `OK`:

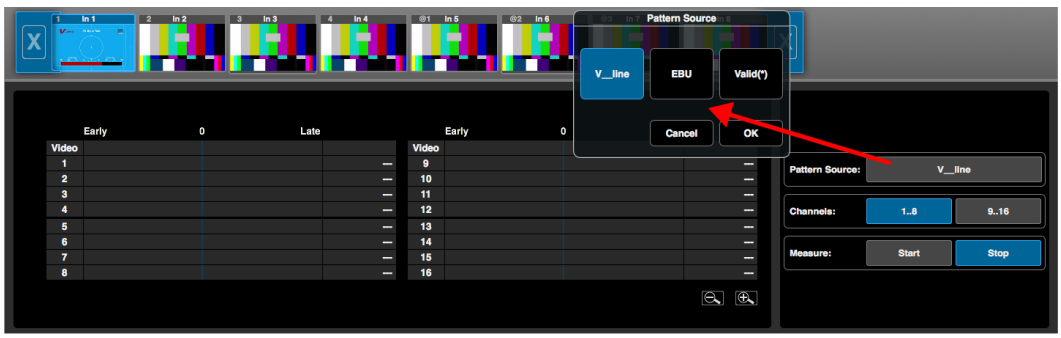


Figure 156

6. Then select the audio channels you wish to measure - **1..8** or **9..16** - and click `Start`:

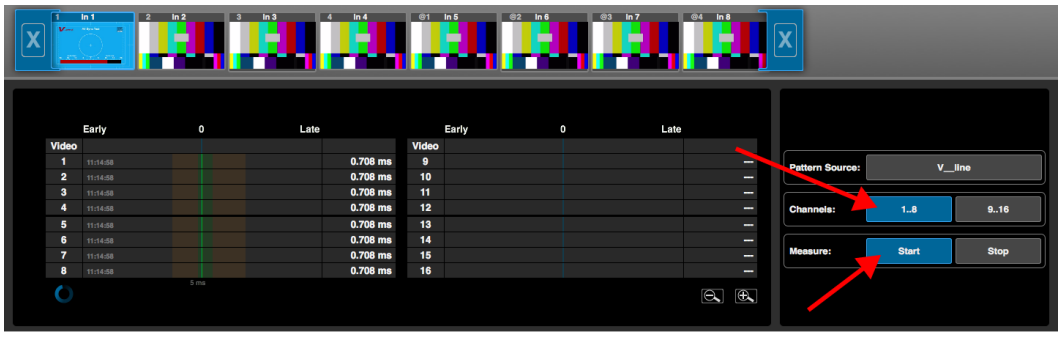


Figure 157

The V__link4 / V__remote4 can measure 8 embedded audio channels at a time: **1..8** or **9..16**.

If all 16 channels are selected, then they are split into two groups and measured alternately on a rolling cycle: **1..8**, then **9..16**, back to **1..8**, and so on.

A small blue rotating circle underneath the audio channels indicates which group is being measured, and a time stamp on the left shows when the audio delay was last measured:

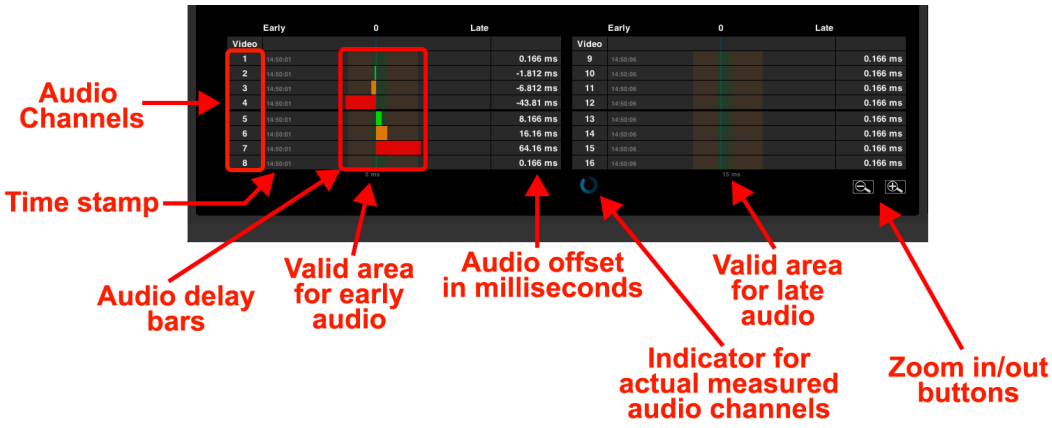


Figure 158

The delay bars are colored green, orange or red depending on the measured value:

- **Green**: is the valid range for lead audio (up to 5ms) or delayed audio (up to 15ms).
- **Orange**: is ok but critical - the range is between 6ms and 40ms (for lead audio) and between 16ms and 60ms (for delayed audio).
- **Red**: is unacceptable.

Note that the default ranges described above are in accordance with the EBU Technical Recommendation R37. The colored ranges can be changed to suit your requirements from the **Settings -> Preferences** menu.

In our example above, **0.708 ms** has been measured on the first 8 audio channels (caused by the enabled sample rate converter on the receiving device). The measurement for channels **9..16** is in progress.

Summary of AV Sync Menu

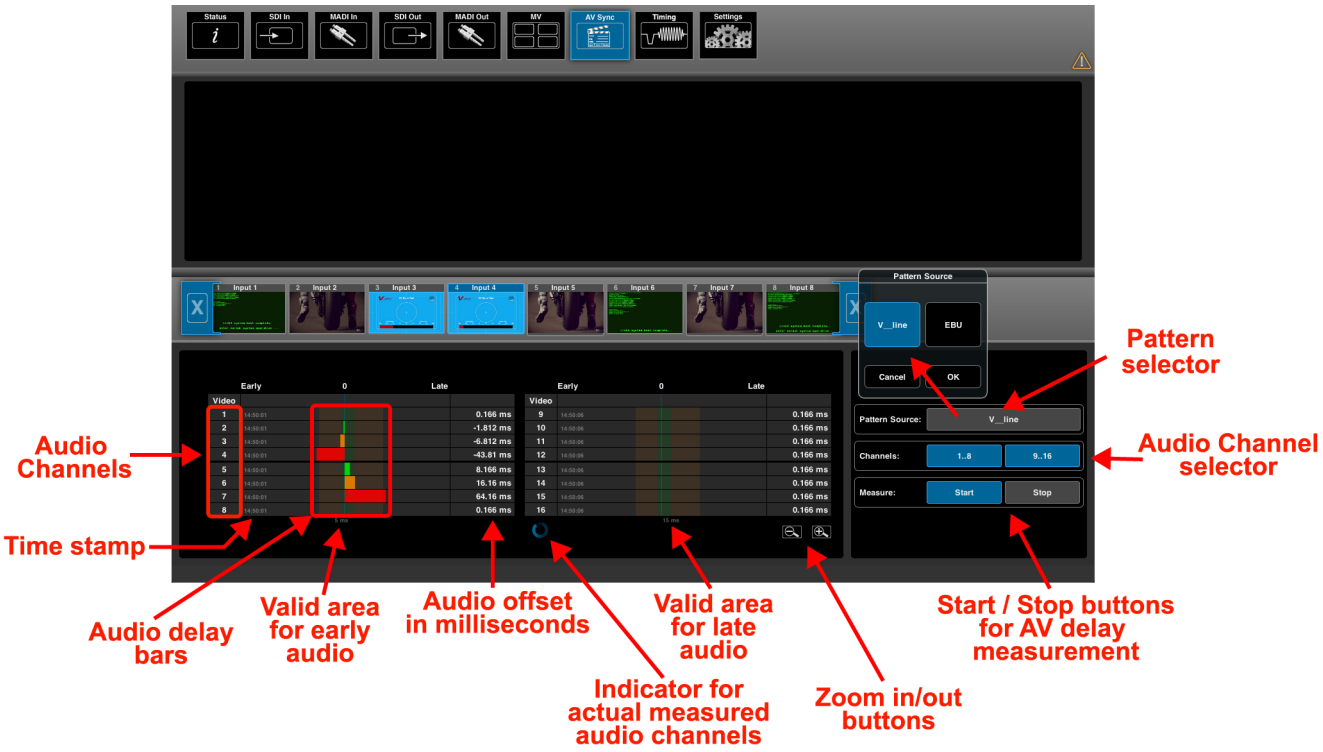


Figure 159

Sounding

First, here's some information regarding the network monitoring & measurement tool "sounding":

V__link4 / V__remote4 can execute packet delay variation measurement including packet loss statistics. It requires two units for measurement sender and receiver. Replaces JDSU or similar dedicated network analysis devices for a lot of applications.

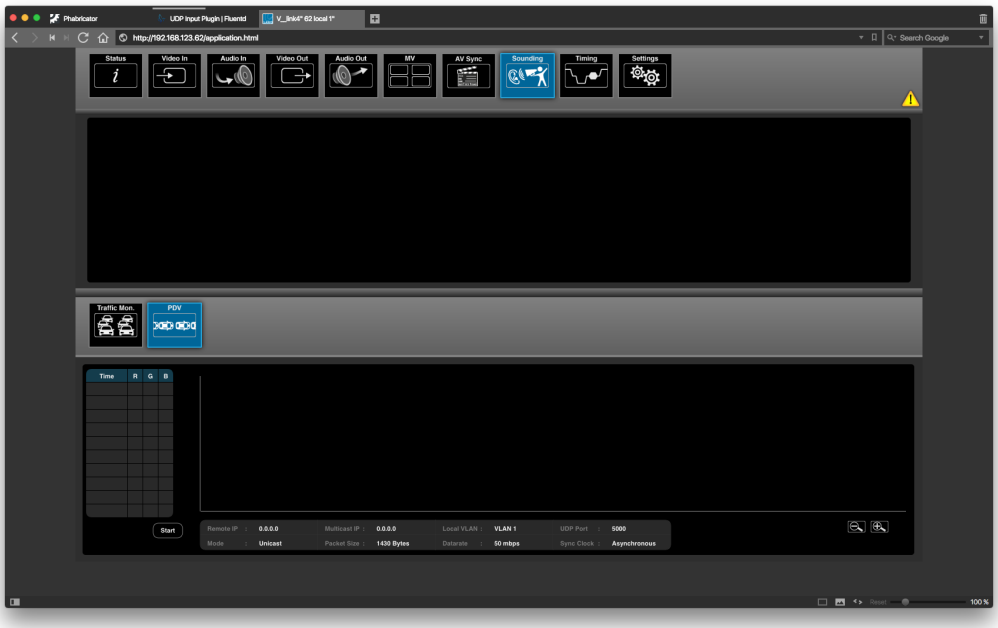


Figure 160

Traffic Monitoring

Click into "packet" row of port opens a pop up menu, press start for capturing.

Results are displayed in left area, filtering possible in categories TCP / UDP / IGMP / others.

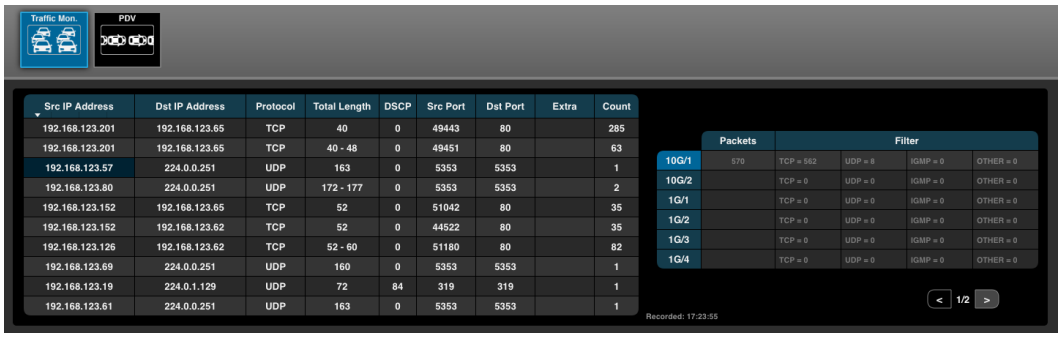


Figure 161

PDV

Configuration:

- Configuration of IP address for remote device, parameter **remote IP**.
- Configuration of transport mechanism unicast vs. multicast, parameter **mode**.

- If multicast is selected then configuration of multicast address, parameter **multicast IP**.
- Configuration of packet size and/or data rate.
- Selection of VLAN and configuration of UDP port.
- Measurement can be done in synchronous mode, means booth units are synchronized via same PTP clock, parameter **Sync Clock** = synchron, otherwise = **Asynchronous** (higher accuracy in sync mode obviously, but async works very precise as well as we do clock drift compensation).

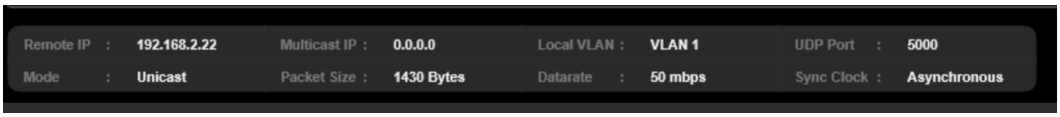


Figure 162

To start measurement:

- Select one slot for storing measurement data in table left column, named “Time”.
- Configure mode for packet delay variation measurement:
  - `Mode`: Unicast/Multicast
  - `Packet Size`
  - `Datarate`
  - `Sync Clock`: Sync/Async
  - `Remote IP` (for `Mode`: Unicast)
  - `Multicast IP` (for `Mode`: Multicast)
  - `VLAN`: 1/2
  - `Port Number`
- Press `Start` button —> capturing data and computing result and showing recorded time in selected slot.

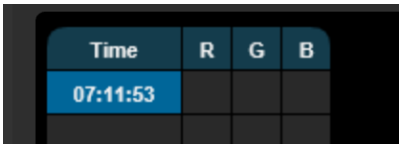


Figure 163

To display result:

- Mark on of `R` / `G` / `B` column.
- Up to 10 measurement results can be stored, RGB coloring can be used to compare results.

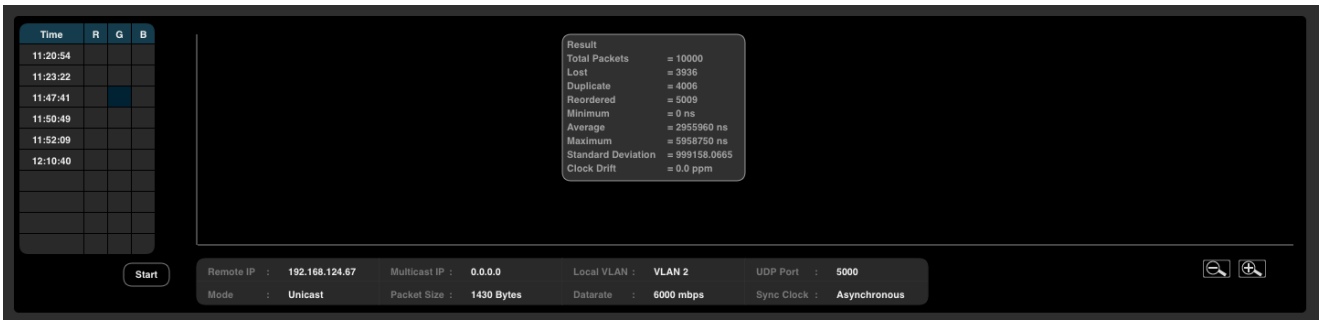


Figure 164 Mouse hovering on **G** slot of third row

- Diagram shows characteristic of packet runtime. The more packets have same or similar runtime the less “jitter” you get on the line. Placing mouse pointer over diagram shows details.

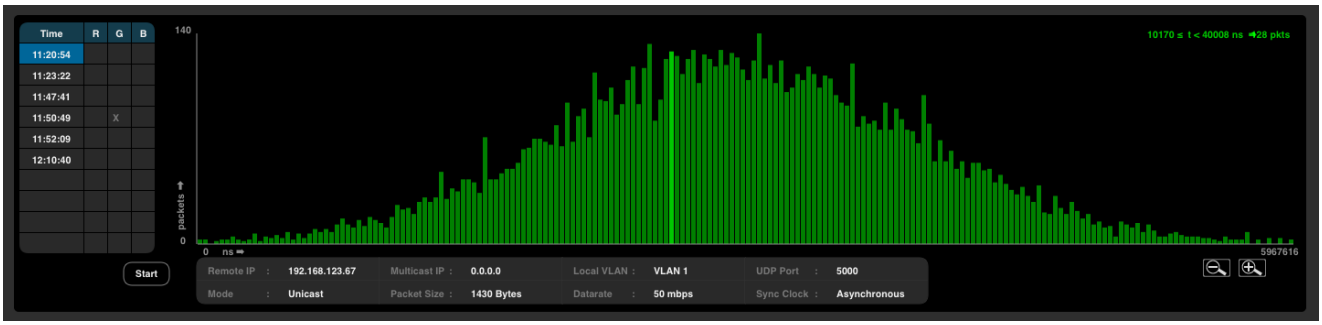


Figure 165 **G** slot marked

Timing

This main menu deals with the timing position of the V__link4 / V__remote4, its video and audio reference signals, and global timecode setup. All settings are applied globally.

1. Select the `Timing` (main menu).

The upper part of the operating window has an **Input** and **Output** timing view - click on the current option (e.g. `Input`) to open the selector and change the view.

The lower half of the screen provides access to:

- **Pos. / Ref.**: the timing position and reference settings of the V__link4 / V__remote4.
- **Ref Out**: the timing position and options for the **video reference OUT** on the V__link4 / V__remote4 's rear panel.
- **Timecode**: options for the timecode generator.

Figure 166

> For low latency operation, you should time your sources to the video reference signal: first adjust the V__link4 / V__remote4 **timing position** so that all input signals are ~ ½ line advanced; then switch on the auto phaser for each Video output.

Input Timing

The Input timing view shows:

- **Input 1** to **Input 8**: the timing status of all 8 Video inputs relative to the main **timing position** of the V__link4 / V__remote4.
- **Video Ref. In**: the timing position of the V__link4 / V__remote4 in relation to the incoming **video reference** signal.
- **TC Gen**: information about the external timecode source, if connected. See **Timing -> Timecode**.

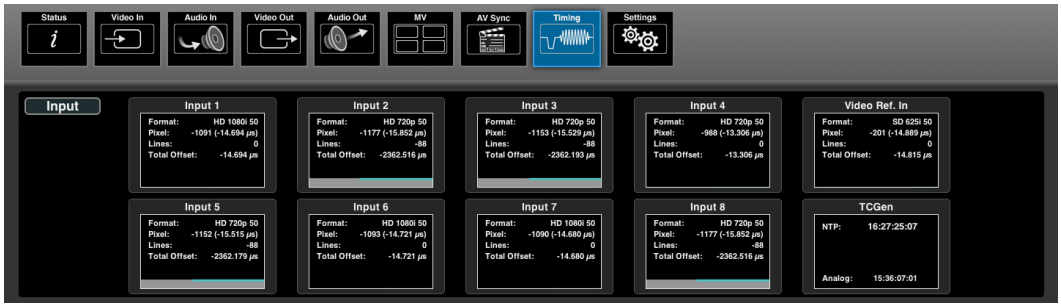


Figure 167

Input 1 to 8

Each box displays the video format and pixel/line content deviation relative to the main **timing position** of the V__link4 / V__remote4:

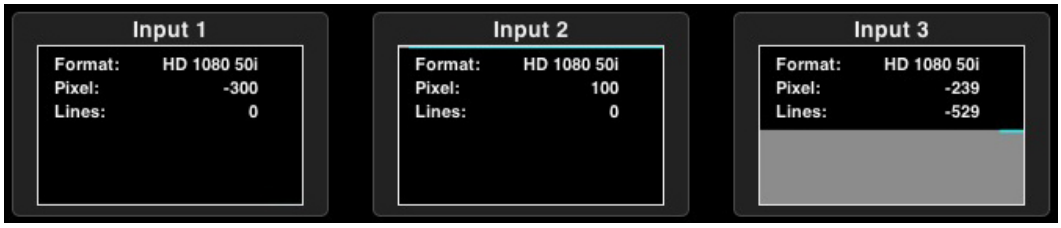


Figure 168

If the incoming video signal is locked to the V__link4 / V__remote4's video reference, or locked to the same reference as the V__link4 / V__remote4, then the pixel/line deviation is fixed and the field shows a static picture.

If the video is not locked (for example, you have disconnected the video reference signal or are using a different one), then the horizontal turquoise bar moves from left to right showing the deviation, and the pixel/line numbers drift accordingly (as shown above for **Input 3**).

In the example above, the signal on **Input 1** is a camera using the same video reference as the V__link4 / V__remote4. The timing of the camera is in H and V timing at 0 pix/lines related to that reference. **Input 1** is shown as **-300** pixels (early) because the main **timing position** of the V__link4 / V__remote4 is **+300** pixels (required to ensure that the camera fits into the **auto phaser** range of the V__link4 / V__remote4):

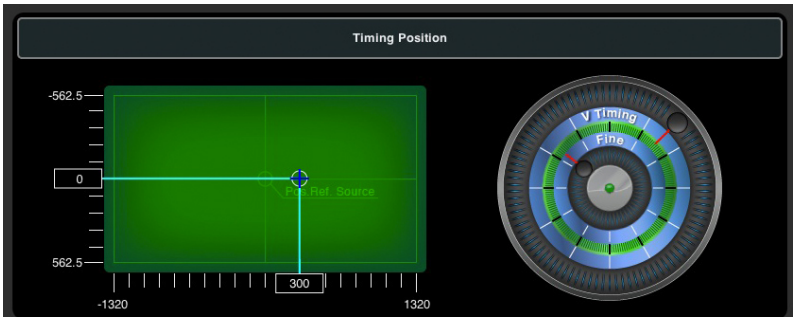


Figure 169

Signal on **Input 2** is **100** pixels (400 pixels late), and out of the **auto phaser** range, because the minimum difference between the main timing position and the incoming source is -100 pixel.

Input 3 is not synced (moving turquoise bar) and should be frame synchronized.

Output Timing

The Output timing view shows:

- **Output 1** to **Output 8**: the timing status of all 8 Video outputs relative to the assigned video input signal, plus the auto phaser status. See below for more details.
- **Video Ref. Out**: the timing position of the **video reference OUT** compared to that of the V__link4 / V__remote4. See **Ref Out: Timing Position**.
- **TC Gen**: information about the timecode generator. See **Timing -> Timecode**.

Figure 170

Output 1 to 8

Each box displays the video output format, video input format and timing deviation in pixel/lines relative to the assigned video input signal.

If the incoming video is not locked by a video reference signal (such as black burst or tri level sync), then the horizontal turquoise bar moves from left to right, and the pixel/line numbers drift accordingly (as shown above for **Output 6**).

The horizontal red and green bar shows the status of the **auto phaser**:

- White marker on green = the incoming video signal is in the valid auto phaser range (of 2 lines).
- White marker on red = the incoming video signal is out of range.

A white marker close to the red (on the right) = signal processing latency is low.

A white marker close to the red (on the left) = signal processing latency is close to 2 lines.

Timing and auto phaser information are *NOT* shown if format conversion is active.

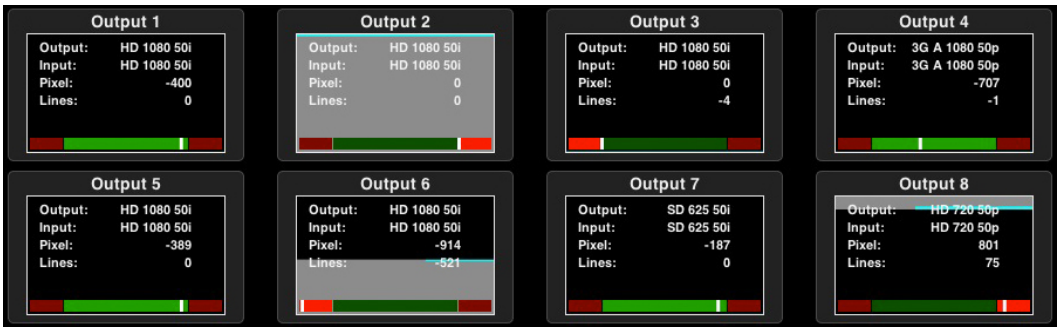


Figure 171

In the example above:

Output 1 shows a perfectly timed input signal. The white marker is in the green area; the timing position is **-400** pixels (early) because the main **timing position** of the V__link4 / V__remote4 is **+300** pixels (required to ensure the input fits into the **auto phaser** range of the V__link4 / V__remote4), and the timing adjustment of **Output 1** has an extra offset of **100** pixels (entered from the Video Out -> Timing menu because the minimum difference between the main timing position and the incoming source is -100 pixel.)

Output 2 shows an input signal which is late relative to the V__link4 / V__remote4 Video out. The white marker is in the red area and out of the **auto phaser** range, and is possibly line shifted. The output must be corrected by adjusting the timing of the input signal (externally to the V__link4 / V__remote4). Or, by adding an extra offset to the main **timing position** (however, this will effect the timing of all Video outputs).

Output 3 shows a signal which is **-4** lines (early) and out of the **auto phaser** range. The timing of this input must be modified (externally to the V__link4 / V__remote4). Or, if this is not possible, the V__link4 / V__remote4's **frame synchroniser** can be enabled to solve the problem, but note that this introduces a one video frame delay.

See the Video Synchronization / Phasing Modes Appendix for further details.

Timing -> Timing Pos

This submenu contains two areas: **Timing Position** and **Reference Setting**:

Figure 172

Timing Position

This area adjusts the timing position of the V__link4 / V__remote4 system with respect to its video reference signal.

> You can use this parameter to set an offset between the V__link4 / V__remote4 and an external video reference. For example, while installing your system. Select the external video reference signal using the **Video Ref** field.

The default timing position is shown below. The graph displays pixels (X axis) versus lines (Y axis):

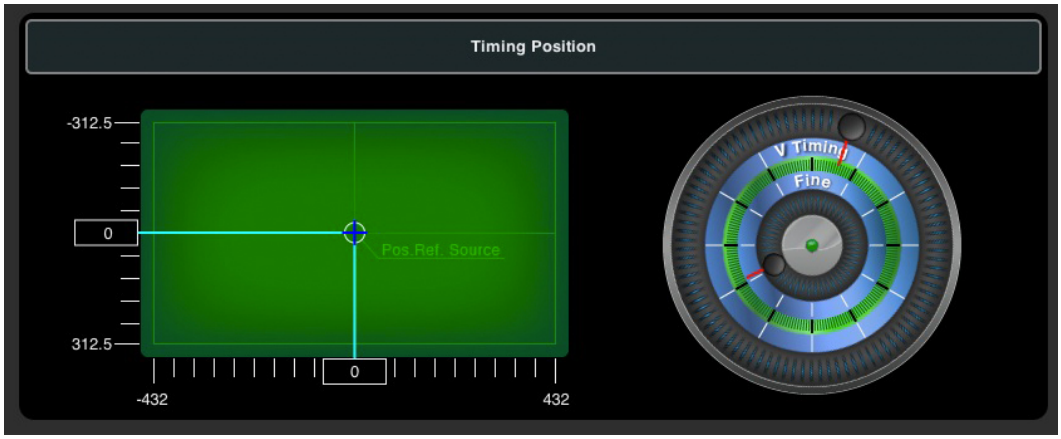


Figure 173

1. Click and drag the inner wheel to adjust the horizontal timing position.
2. Click and drag the outer wheel to adjust the vertical timing position.

The timing position of the V__link4 / V__remote4 moves. You will see the new position compared to that of the reference source on the XY display:

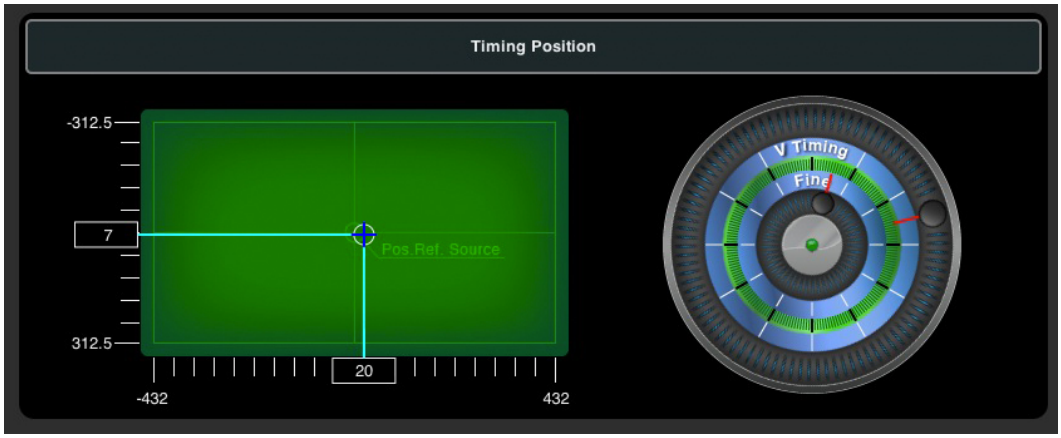


Figure 174

Reference Setting

This area selects the video and audio reference signals for the V__link4 / V__remote4 system:

Figure 175

- **Vid. Ref.** - selects the video reference signal (in our example, Analog). See **Choosing the Video Reference**.
- **Format** - if the **Vid. Ref** is set to an external reference such as **Analog**, then the system automatically detects the format. If a reference source does not exist, then the **Vid. Ref** can be set to **Free Run**, and you can use the `Format` field to select a format to match your production requirements. The Video Ref Out (available on the rear panel) can then be used to synchronise an external device such as a camera video server.
- **Audio Ref.** - currently, the audio reference is *ALWAYS* set to **Follow Video**. This means that the system is clocked from a single reference source. In a future software release, you will be able to lock audio independently, either to an external Wordclock signal or to free run.
- **WCLK BNC Mode** - switches the **WK connector** on the rear panel to act either as a wordclock input (with 75Ω termination) or wordclock output or PTP PPS pulse.
- **Int. WCLK Phase** - can be used for audio reference phase matching. This is useful in environments where audio/video equipment is sync'd from a 59.94Hz video reference signal (where fractions of AES3 frames fit within one video frame, and audio phase aligns with the video reference phase only every 5 frames). In this situation, the correct phase can be obtained via the wordclock or MADI inputs.
- **PTP Clk** - the **Vid. Ref** is derived from PTP time, based on epoch StartOfFrame definition.

Choosing the Video Reference

1. Click on the current video reference - e.g. `Analog` - to open the ‘Video Reference Source’ selector:

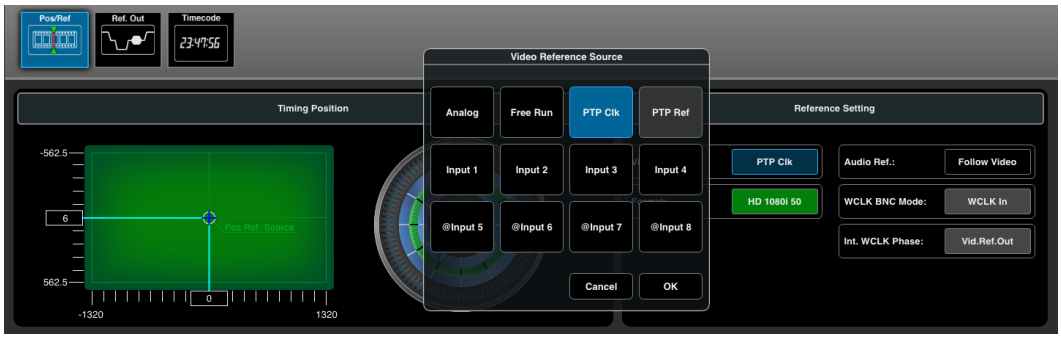


Figure 176

Choose from:

- **Analog** = the **external video reference input** connected to the rear panel. Supported reference signal formats are:
  - Analog Genlock High Definition Tri-Level Sync (SMPTE-274M/296M).
  - Standard Definition 1V Black-Burst (SMPTE-170M/318M).
- **Free Run** = the V__link4 / V__remote4’s internal reference.
- **Input x** = any of the **SDI** or **IP** inputs. Please note that if an IP input is used, then the **Read Delay** must be set to “phase” and you need to ensure that no reference loops are in existence.
- **PTP Clk** = the unit is referenced to the PTP synchronized clock (via IP) for genlocking with fixed phase definition.
- **PTP Ref** = the unit must receive a PTP-based Ref stream (via IP). This option is not available yet.

Timing -> Ref Out

This submenu contains two areas: **Timing Position (Ref Out)** and Video Ref. Out Setting:

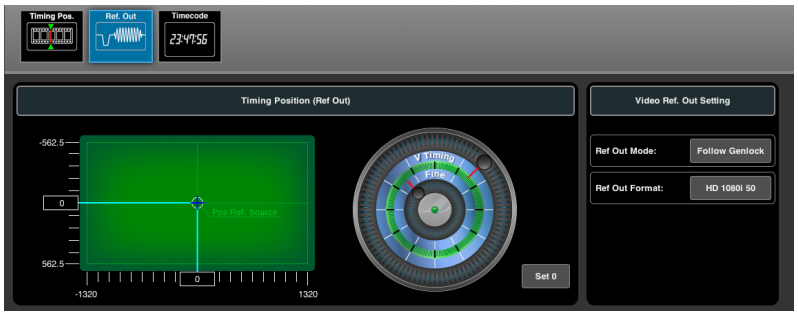


Figure 177

Timing Position (Ref Out)

This area adjusts the timing position of the video reference OUT (on the rear panel) with respect to the timing position of the V__link4 / V__remote4.

The default timing position is shown below. The graph displays pixels (X axis) versus lines (Y axis):

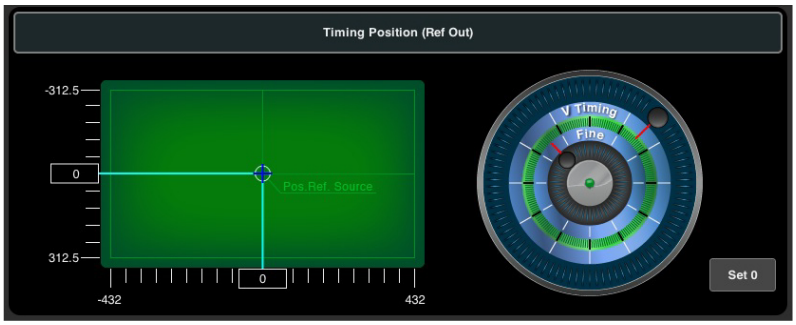


Figure 178

1. Click and drag the inner wheel to adjust the horizontal timing position.
2. Click and drag the outer wheel to adjust the vertical timing position.

The timing position of the **Ref Out** moves. You will see the new position, compared to that of the V__link4 / V__remote4, on the XY display:

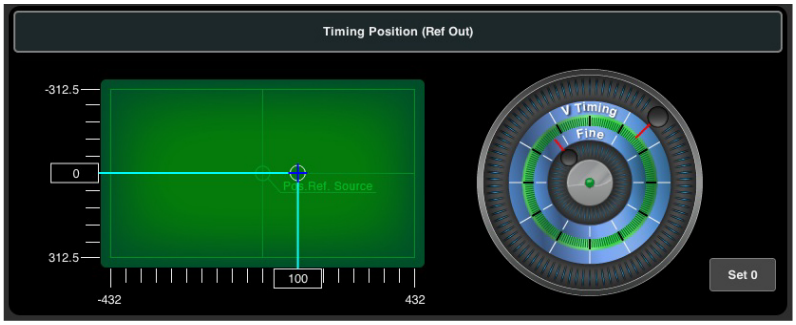


Figure 179

3. Click on `Set 0` to reset the **Ref Out** timing position to its default.

The **Ref Out** timing position, compared to that of the V__link4 / V__remote4, is also shown in the **Video Ref Out** box (displayed in the **Output Timing** view).

Video Ref. Out Setting

This area selects options for the **video reference OUT** (on the V__link4 / V__remote4's rear panel):

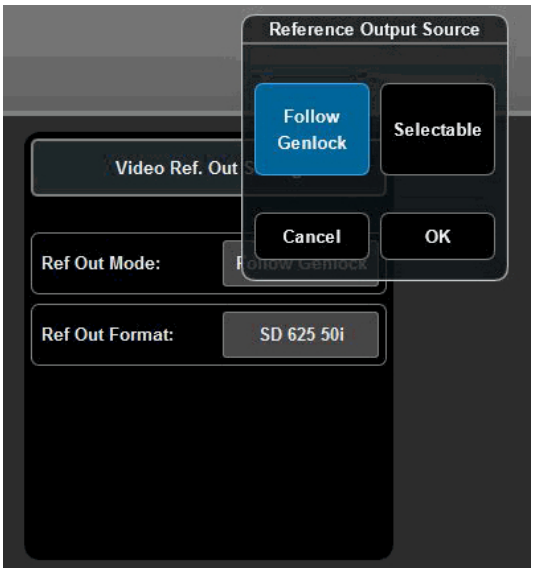


Figure 180

Two different **Ref Out Modes** are available:

- **Follow Genlock** - the video output follows the Master Genlock.
- **Selectable** - click on `Ref Out Format` to select the video output format; black buttons can be selected; grey buttons cannot (as they are not supported by the current video reference). In our example, we can select any 50Hz format or derivatives such as 1080 25p:

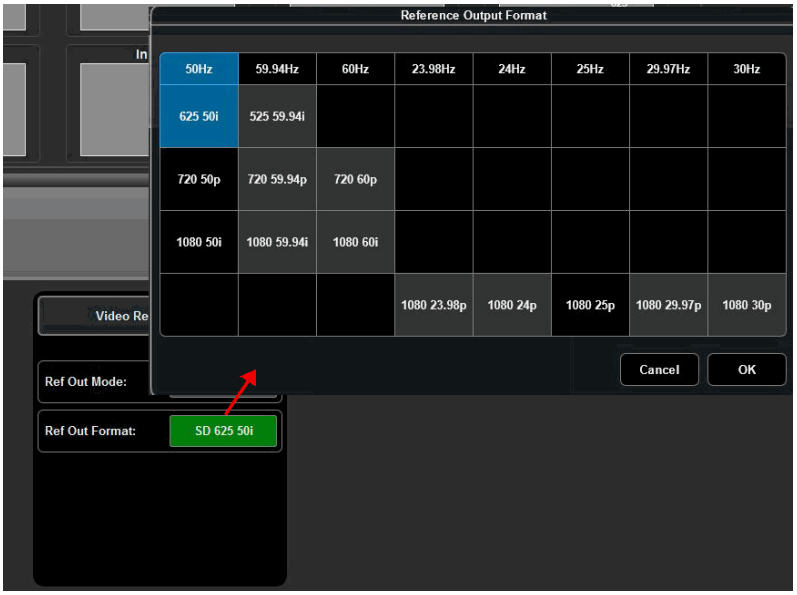


Figure 181

> You can change which output format options are black (selectable) by changing the **Video Reference** and/or **Format** field in the **Timing -> Timing Pos** menu.

Timing -> Timecode

This submenu provides options for the V__link4 / V__remote4's timecode generator which can be selected as a timecode source in the **Video Out -> VANC Data** menu.

Figure 182

Click on `Mode` to select the timecode source - options in grey are not currently available:

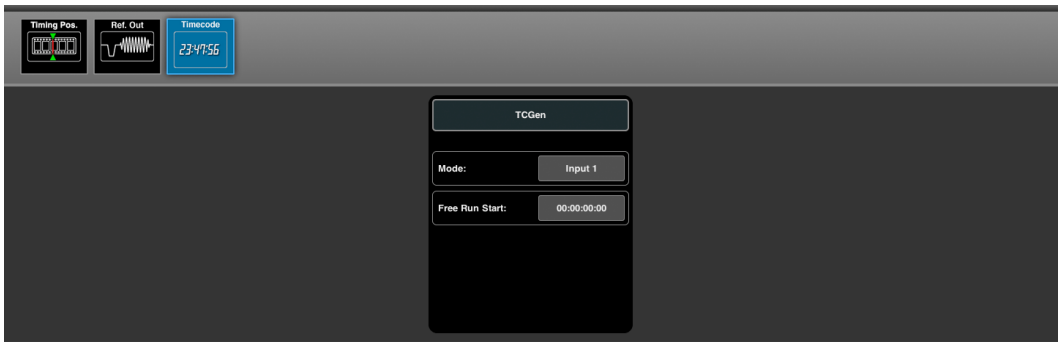


Figure 183

You can choose from:

- Analog - VITC is taken from the Black Burst reference input (when using an Analog **video reference**).
- NTP - timecode is sync'd with the NTP network service (defined in the **Settings -> Time & Date** menu).
- Input 1 to 8 - LTC is taken from the selected Video input.
- Free Run - enables a "free run" mode:
  - Click on the `Free Run Start` field to enter the start timecode (for help, see **Data Entry**).
  - Then enable the `Free Run` button to set the timecode running.

Note that the **Input Timing** and **Output Timing** views both include a **TC Gen** box. These show:

- **Input Timing** - information about external timecode sources (**Analog** and **NTP**).
- **Output Timing** - information about the selected timecode source.

Settings

This main menu provides access to system settings.

The upper area of the operating window is unused. Use the submenus to access:

- `Switch` - define IGMP, PTP, RSTP port assignments and static multicast routes.
- `TX Stream` - set parameters for RAW, J2K, Ravenna encoded (outgoing) IP streams and Ravenna/AES67 outgoing streams. Access related SDP data, view/configure MJPEG and h264 encoded monitoring streams. Change/define multicast addresses and unicast ports.
- `RX Stream` - configure stream receivers for video and audio incl. buffer/time offsets. Set/view related SDP data for simple receiving. Seamless protection switching, enhanced protection switching, source-timed frame accurate clean switching and more. Define Read Delay view and configure related.
- `Video` - in preparation
- `Audio` - set the MADI mode (discrete or redundant) and link priority (in redundant mode).
- `Presets` - save and recall presets within the Video and/or Audio matrix.
- `Access` - enable / disable Ember+ / H.264 monitoring encoding, Zeroconf (Bonjour) and GPI config. Define Browser Login Access Passwords.
- `Preferences` - adjust audio metering (PPM) options and other system preferences.
- `Time & Date` - enter the system date and time, or synchronise to an external SNTP server.
- `Logging` - IP address settings for SNMP Trap server(s) and syslog server(s), define syslog filters, download MIB- and Temperature Alert log file.
- `Network` - IP address settings for port-based VLAN1, VLAN2 and management port and device description.
- `Load / Save` - load or save settings from/to a connected computer or USB memory stick.
- `License Key` - install a new license key file (to upgrade your V__link4 / V__remote4).
- `Software Update` - check the software version of the V__link4 / V__remote4, perform a software update or download apps from the app download center.

Settings -> Switch

This submenu defines IGMP (Internal Group Management Protocol) and PTP (Precision Time Protocol) parameters.

IGMP

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

- `None`: not leave messages are issued or processed; connections are cancelled through timeouts only.
- `Immediate`: enables a fast leave mode, for direct and immediate deletion of routing entries in multicast forwarding tables. You should ensure that managed network switches behave compatible and are configured accordingly. If unsure, then do not enable Immediate leave mode.
  - Static assignments:
    - Host: Only hosts (PC, etc.) will be connected to that port. No forwarding of IGMP leave and not relevant IGMP report messages to this port.
    - Unmanaged Switch: If receiving IGMP leave messages from that port then start local querying to ensure continuous streaming if somebody else on that port is still subscribing / listening to that stream.
    - Managed Switch: Enable proper IGMP report / message forwarding assuming switch with multicast router capabilities and related performance.
    - Link4: Same as “Managed Switch”
- `Query`: enables an active leave mode, with inherent query for remaining subscribers. You should ensure that managed network switches behave in the same way and are configured accordingly.

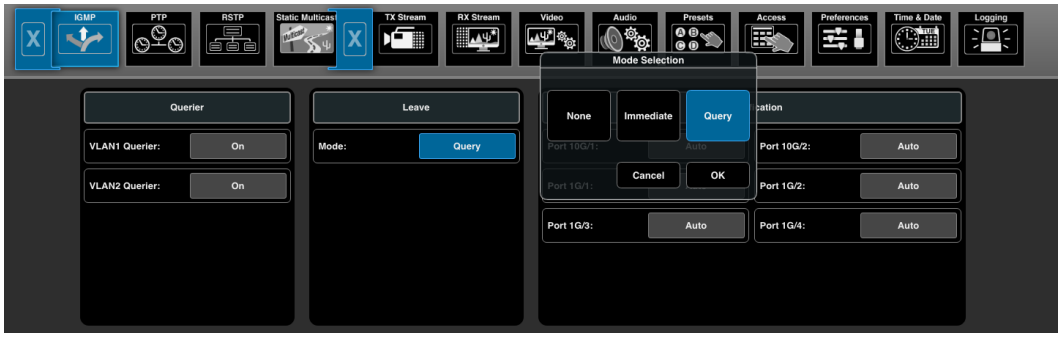


Figure 184

Usually switch implementations fast / immediate leave modes are not compatible to 3rd party equipment.

2. The **Port Classification** options are shown below:

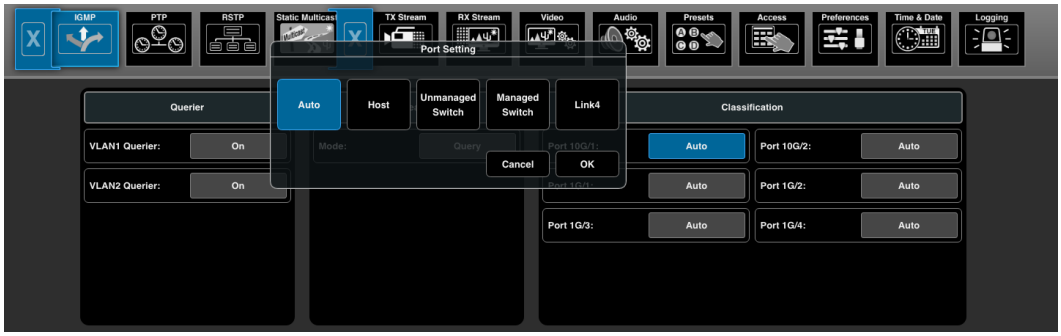


Figure 185

In the default mode (`Auto`), the V__link4 / V__remote4 will auto-detect if a Host, Unmanaged or Managed switch is connected to the port and behave accordingly. If required, you can override the auto-detect mode to select an option manually.

3. Enable / disable **IGMP** querier functionality.

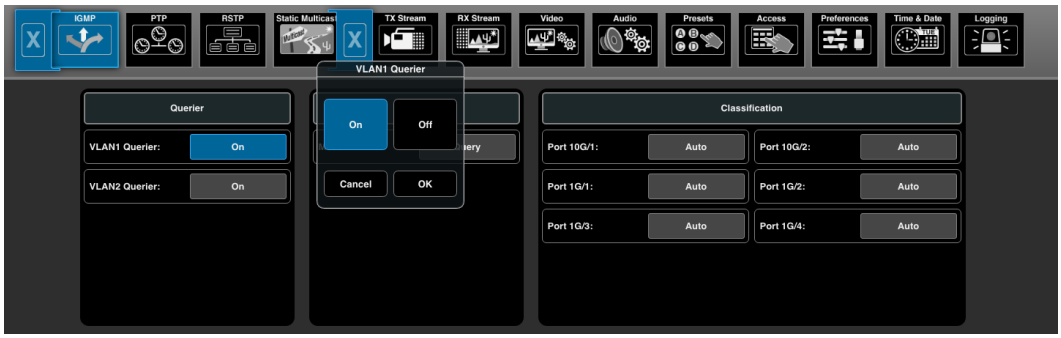


Figure 186

If system is operated in static / half-IGMP mode and connected switch has no provision to disable dynamic Multicast Router detection and no “report flooding” capability, switch off querier to avoid getting multicast router status on that port.

PTP

These options can be used to enable (or disable) **PTP** functionality and preset the **Master/Slave** behaviour. Before changing any other setting, please ensure that you fully understand its functionality.

- `Enable`: ON/OFF
- `Redundant Mode`: ON/OFF
- `Locking Policy`: Dynamic / Locking (MR) / Locking (AR)
- `Announce Timeout`: 2- 255
- `Debug`: always set to 0
- `Preset`: Slave Only / Master Slave / Master Only
- `IP Mode`: Multicast / Hybrid
- `Master behaviour`: Two-step / One-step
- `Delay Request Interval`: 2sec - 1/128sec
- `Resume`: confirm button
- `Domain`: 0 - 127
- `Sync Interval`: 2sec - 1/128sec
- `Announce Interval`: 4sec - 1/4sec
- `Analog Ref Master`: ON/OFF
- `Timing Precision`: High / Low / Custom
- `Priority 1`: 0 -248
- `Priority 2`: 0 - 248
- `Clock Class`: 0-255
- **Safety Lock**: locking status
- `Max Offset`: input in nano seconds

Enable/Disable: Enable to behave according to Preset configuration **Slave Only**, **Master Slave** or **Master Only**.

Redundant Mode: Main and backup PTP GM are operating in Analog Ref mode and getting the same(!) analog reference input signal. Main Grandmaster should have higher priority set compared to backup grandmaster. If main grandmaster fails, switched-off... the backup grandmaster takes over smoothly and slaves are adapting to the new master without disturbances. If main grandmaster is switched on again and set to redundant mode, the main grandmaster are waiting in “recovery” state, until somebody manually or via remote control protocol “resumes” recovery state and main grand master gets master role.

Locking Policy: Dynamic leads to always “follow” PTP Grandmaster clock even if the GM clock is jumping or heavily drifting. Locking enables holdover state which keeps the PTP clock locked to a previous calibrated state and follow master only in a defined range.

There are two Locking modes: Locking (MR) and Locking (AR). (MR) “manual resume” implies that after holdover state and reference is back and outsiden locking window...user actively trigger=enable recalibration or reconverging. (AR) “automatic resume” automatically enables reconverging to new target with max. allowed drift after holdover state and reference is back outside of locking window.

Analog Ref Master: Grandmaster takes Analog Reference input and derives phase accurate PTP clock from that reference. Enables phase accurate “coupling” of PTP driven IP based infrastructure as add-on to existing baseband infrastructure.

Resume: if Analog Ref PTP Grandmaster was running in redundant mode and after reboot, power cycle etc. it stays in “recovery” mode until resume button is pressed or resume command is send via Ember+ control interface, then it’s taken over again. Before pressing resume check if master has already adapted to analog reference input.

Timing Precision: High / Low / Custom

High accuracy is the arkona technologies recommendation which relates to commonly used standards/practise in baseband world.

green = +/- 100nsec; yellow = +/- 1µsec

Low accuracy is following SMPTE 2059-2 recommendation which enables more COTS PTP aware switches to be used for PTP based video referencing or even simply fast enough switches non-PTP aware to be used.

green = +/- 400nsec; yellow = +/- 2µsec

Custom: Enables input field for custom settings, max possible threshold input is 100µsec = 100.000nsec. Enables usage of PTP based video referencing in non-PTP aware “normally” not good enough network environments. Combined with “locking” mode and stream receiving mode “RxPTP” can ensure good timing/syncing of video/audio signals across a definitely “not good enough” network without distributed, dedicated GPS synced SPG’s.

Custom = 100.000nsec = 100µsec

green = +/- 20µsec; yellow = +/- 100µsec.

Safety Lock: Display locking status. Turns into “release lock” button in case of holdover state with two options (pop-up menu): recalibrate or reconverge. Only active if PTP slave operates in locking policy = “locking”.

Recalibrate simply starts new calibration process, e.g. should be used if PTP Ref. Master was getting new or changed analog reference signal.

Reconverge is assuming unchanged Ref. PTP Master but more outliers or higher drift was outside capture range. Reconverge starts smooth converging to new target.

Max Offset: Defines max. offset to master tolerance +/- boundaries for custom defined settings.

RSTP

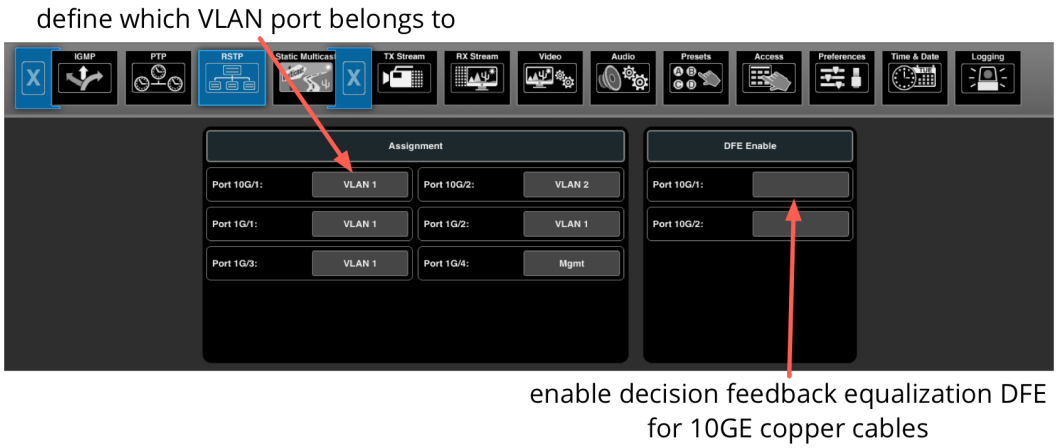


Figure 187

Static Multicast

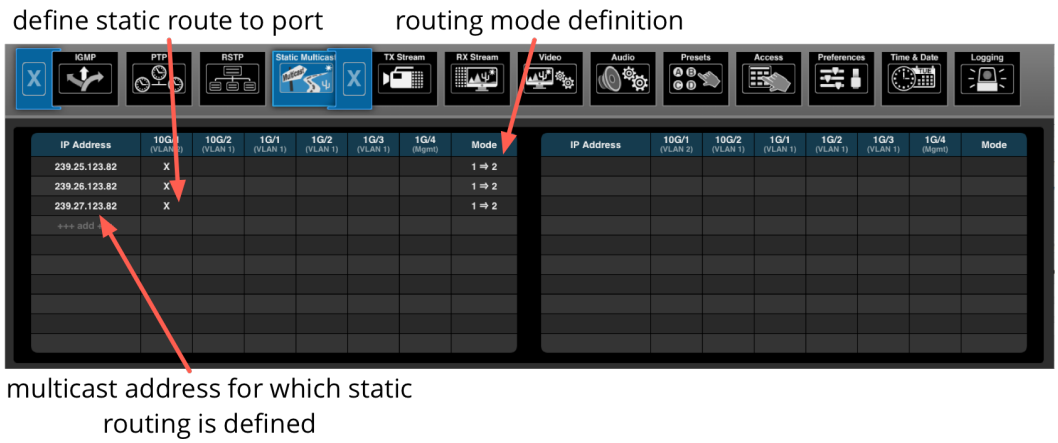


Figure 188

Routing mode options:

- VLAN1 and VLAN2 independent, no IGMP
- VLAN1 and VLAN2 independent and IGMP enabled
- cross VLAN routings 1 —> 2, 1 <— 2, 1 <—> 2

Cross VLAN routing possibility enables aggregation scenarios in path redundant seamless protection mode.

Settings -> TX Stream

This submenu is used to set parameters for RAW and J2K encoded (outgoing) IP streams and RAVENNA streams.

RAW

1. Select `Distribution` to choose either `Multicast` or `Unicast`[1] streaming:

Figure 189

2. Select `Tx Enable` to enable (or disable) the stream.
3. Select `Format` to set the format to RAVENNA (RV), SMPTE 2022-6 or virtual BB (2022-6 without video data).

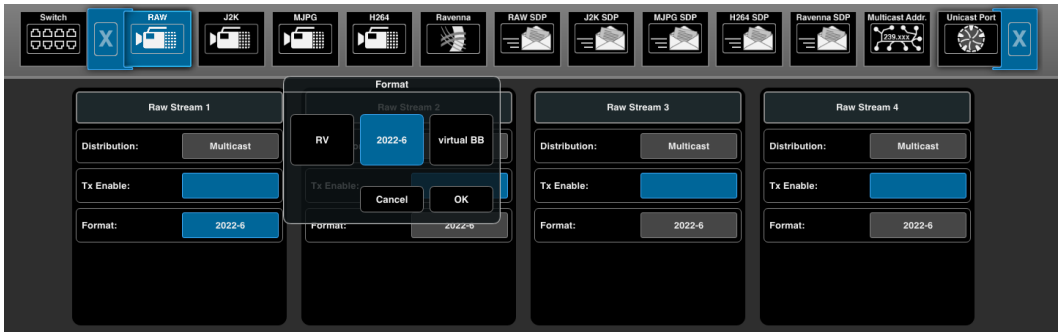


Figure 190

[1]Unicast Operation Mode: Sender address is always VLAN1 sender address.

J2K

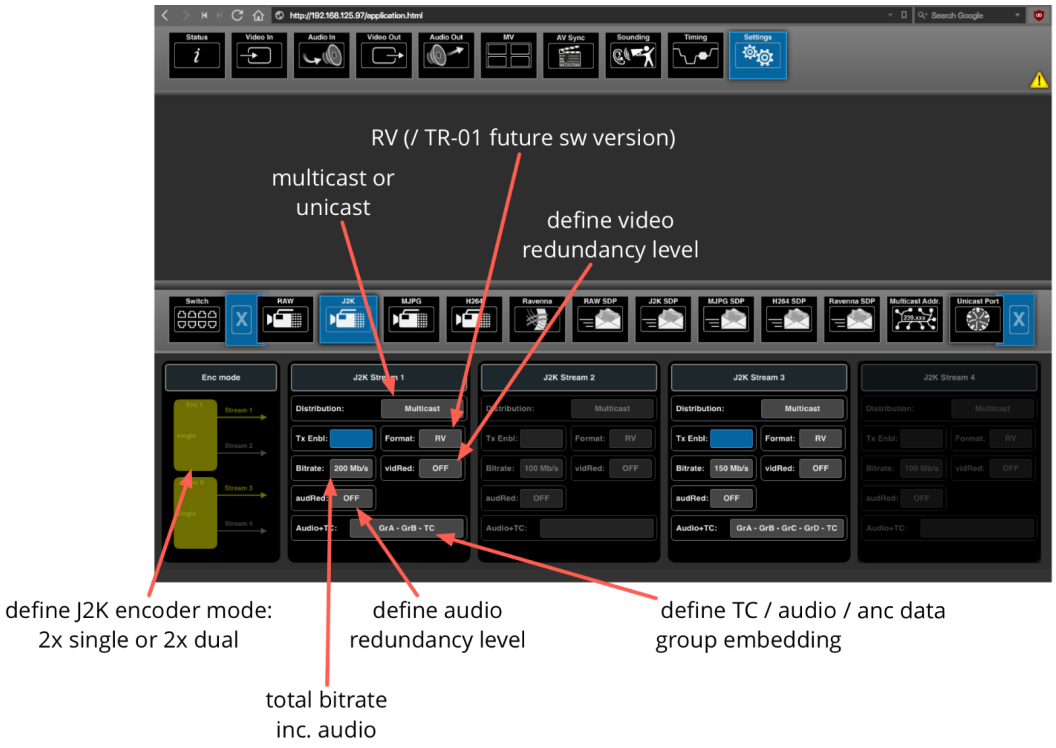


Figure 191

> Apply same level of redundancy if running in dual encoder mode!

J2K redundancy level for RV format.

- `Video`: off, 15%, 50%, 100%

Defines redundancy based on different resolution levels in J2K stream.

Remark: 15% equates roughly overhead of classic FEC.

Concealment is always active in RV format.

- `Audio`: off, 100%, 200%, 300%

100% simply means duplication of related encapsulated audio packets.

Percentage values also relates to bitrate overhead on top of defined bitrate for overall stream.

- J2K single enc mode: Bitrates video up to 300Mbps/240Mbps per channel, two channels max.
- J2K dual enc mode: Bitrates video up to 100Mbps/80Mbps per channel, four channels max.

Benefits of JPEG2000

Outstanding video image quality at standard contribution rates 80Mbps to 150Mbps for HD video due to wavelet compression, as well as 4:2:2 color sampling and 10bit resolution. Frame-by-frame (intra-frame) compression provides video signal which is extremely easy to edit vs. inter-frame compression codecs and provides low latency solution for live applications. JPEG2000 wavelet based compression tend to display bitstream errors as an overall softening of an image, not localized to specific areas of the video image as in block-based compression systems such as h.264. This softening in JPEG2000 systems makes sharp edges within the image somewhat blurry, visual effect which is mostly hard to observe. In RV mode we also ensure encapsulation of JPEG2000 coding structures in single data packets, minimizing effects due to packet losses. Optional configurable level of stream immanent redundancy and concealment of lost data enables video contribution even in cases of very problematic transport network environment. Native support for individual “element/essence streaming”. Automatic post compression rate-distortion optimization for automated quality control without need for user interaction.

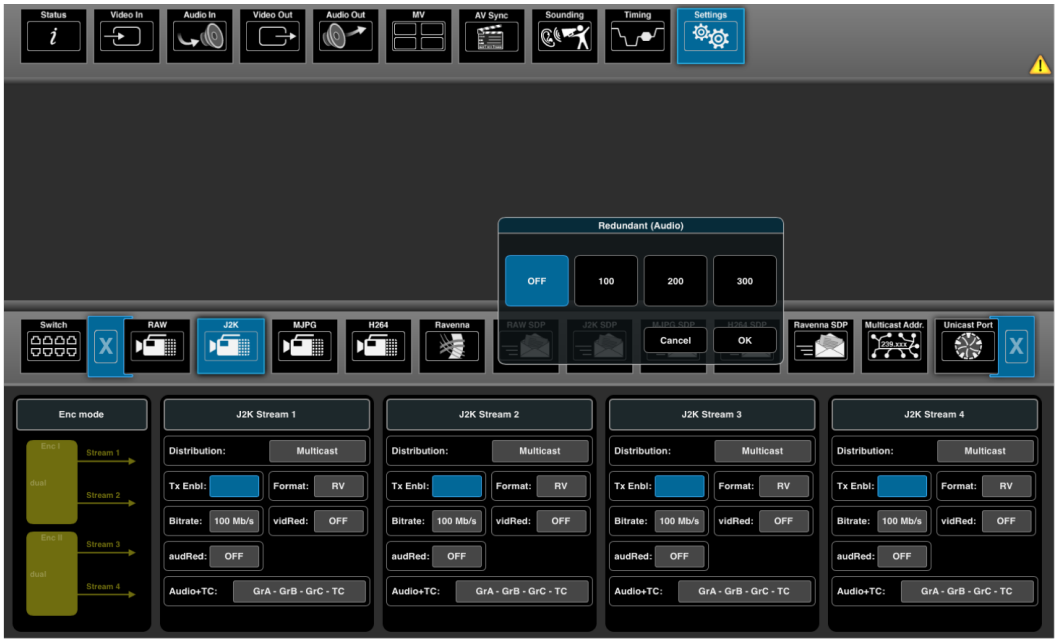


Figure 192 Add redundancy for embedded audio. Only in whole number factors. Results in higher bitrates.

MJPG

Figure 193

H264

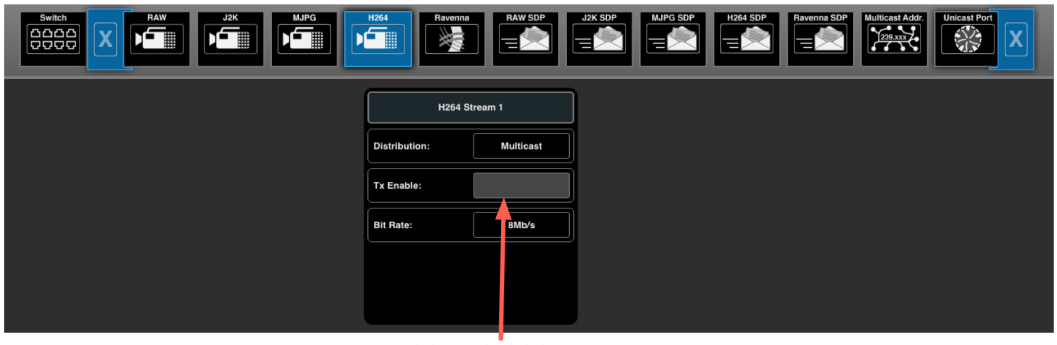


Figure 194

Ravenna

Figure 195

1. Click on the `channel bar` to configure RAVENNA audio streams. For each stream (Stream 1 to 6), you can Disable the stream, or configure 8, 16, 32 or 64 channels.

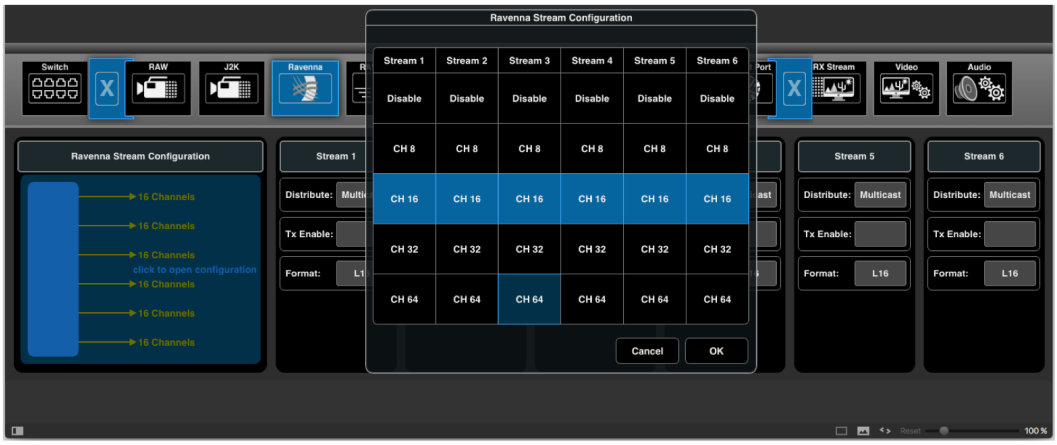


Figure 196

2. Use the `Tx Enable` buttons to enable (or disable) each stream (blue = enabled):

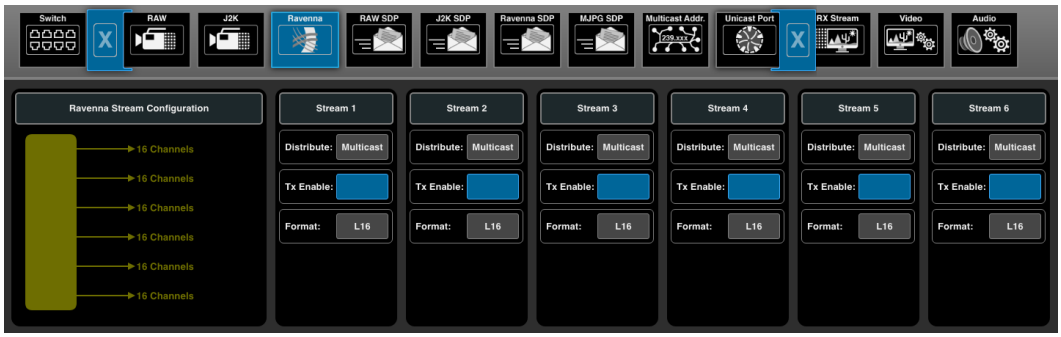


Figure 197

RAW SDP

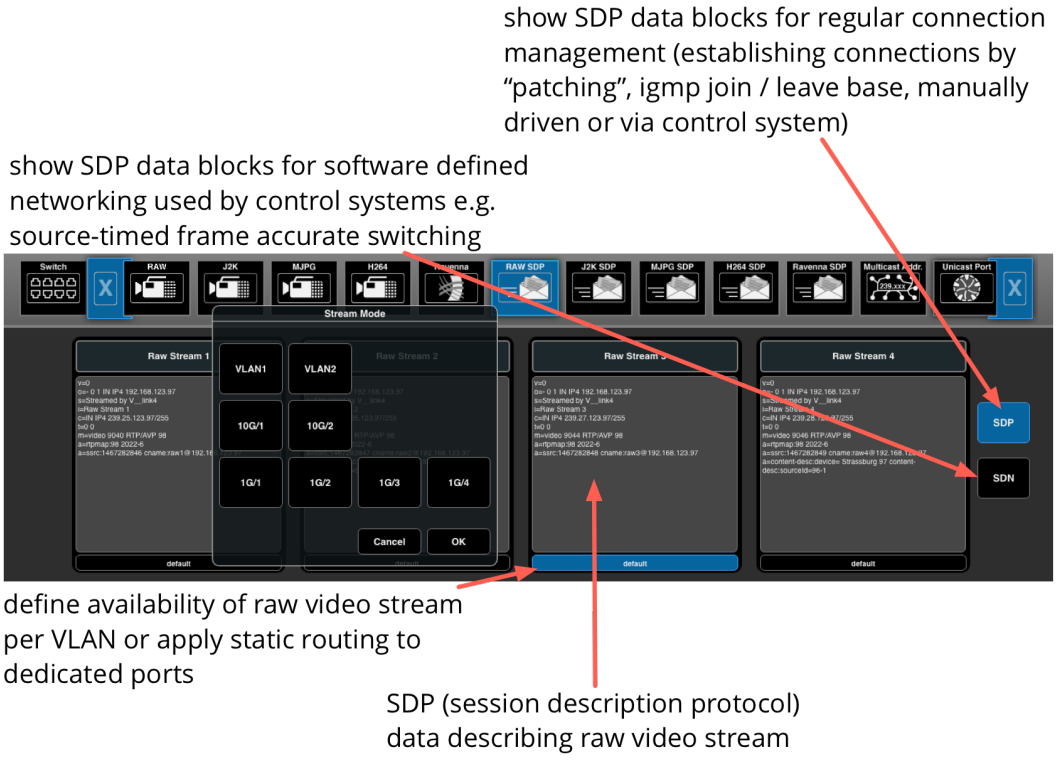


Figure 198

J2K SDP

Figure 199

MJPG SDP

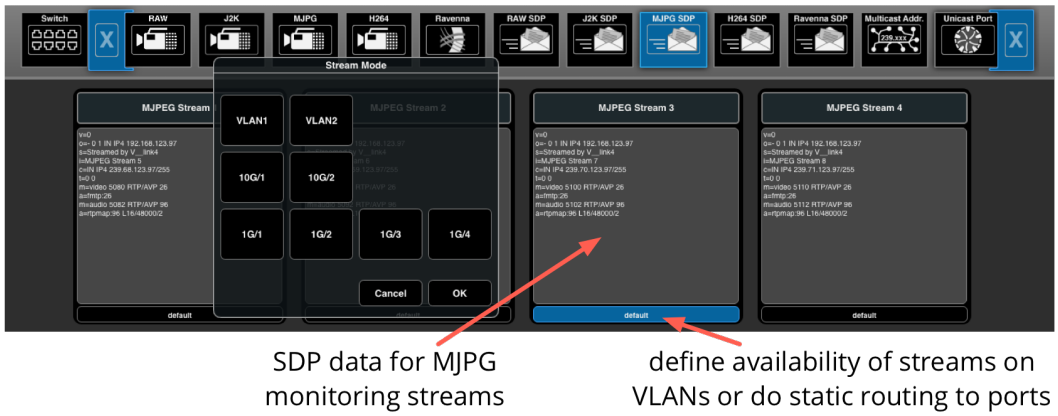


Figure 200

H264 SDP

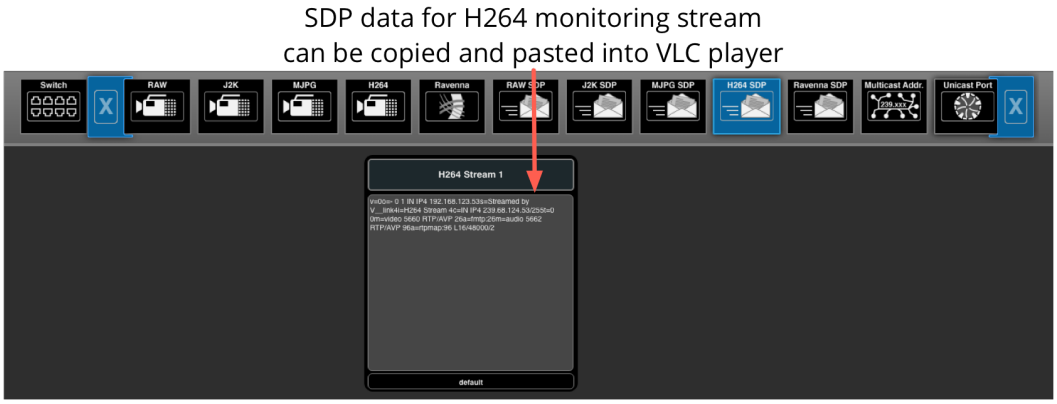


Figure 201

Ravenna SDP

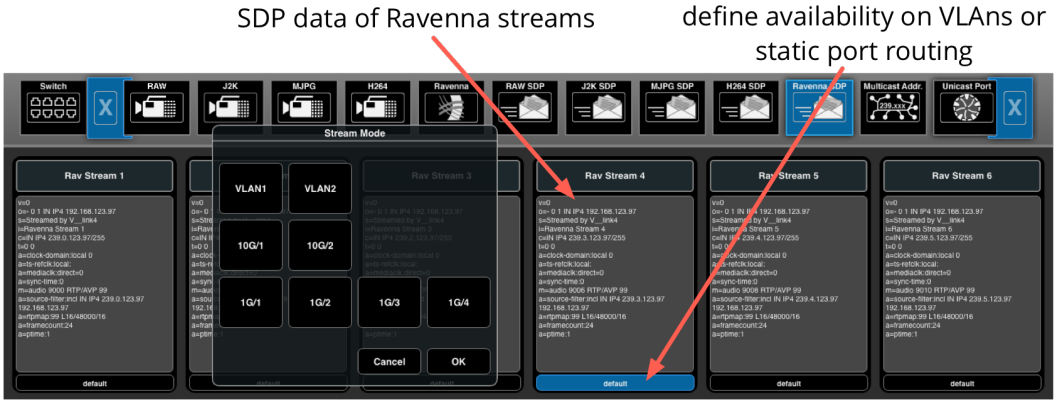


Figure 202

Multicast Addr.

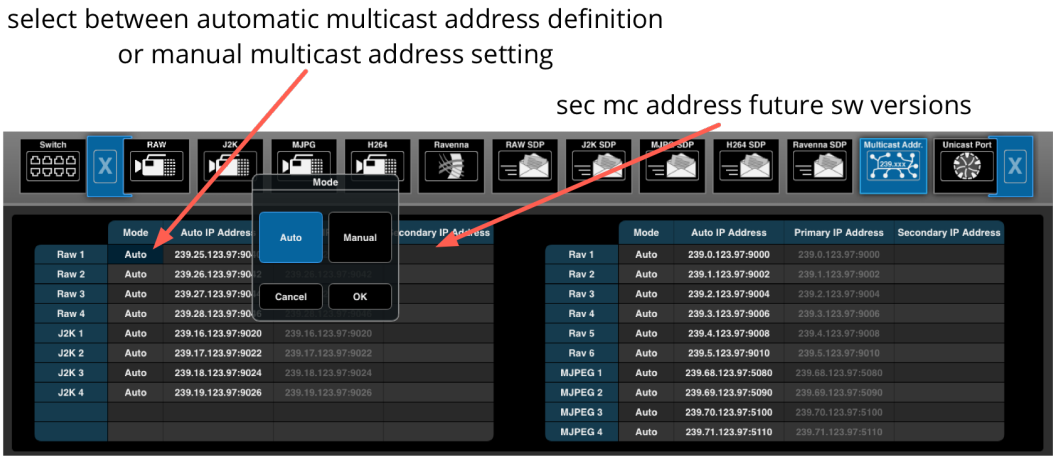


Figure 203

Unicast Port

Change port number for unicast streaming. “Chatty” port always +1.

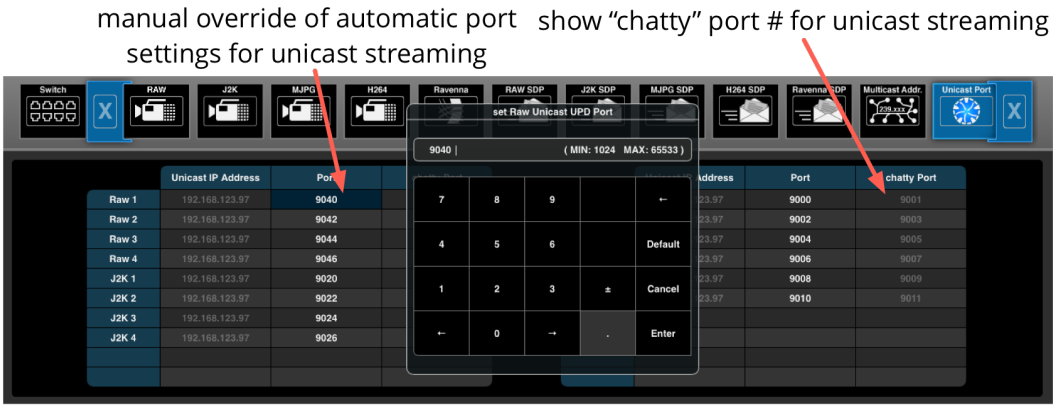


Figure 204

Settings -> RX Stream

This submenu is used to set parameters for CRUs (Clock Recovery Unit) and buffer/time offsets.

VIDEO CRU & TH

Figure 205

> In dual decoder mode: restricted bitrate and higher latency.

Define Read Delay Target for stream receivers. Read Delay compensates for packet delay variation in networks usually known as network jitter.

- `Robust`: Read delay offset is set to field/2 and taking latency offset and jitter between / of two redundant streams in seamless protection mode into account.
- `Max/2`: Read delay offset automatically calculated and set due to available buffer size (format and operation mode dependent) and latency offset / jitter between / of two redundant streams in seamless protection mode.
- `Fast`: Read Delay target is set to 500µsec. Usually only applicable in Local Area Networks.
- `Manual`: Set Read Delay manually to value x.

`inhibit automatic jump`

- off = Clock Recovery Unit (CRU) tracks incoming stream starting with nominal frame period target. If tracked frame period deviation exceeds certain threshold (in ppm) the Clock Recovery Unit performs `jump to target` automatically.
- on = Clock Recovery Unit (CRU) tracks incoming stream starting with nominal frame period target. Clock Recovery Unit converges to tracked frame period of incoming stream. No automatic jump.

`jump to target`

Stream receiver tracks frequency and phase of incoming stream. In case of phase jumps of receiving streams and / or in redundant mode and losing one stream the stream receiver smoothly transitions to new target respecting the maximum allowed drift according to SMPTE specification and ensuring video without distortions. This may take a while and resulting in “moving” signal phase. With `jump to target` button user may decide to take a hit on video, but immediately jumps to new phase target. If you change read delay offset you should always perform `jump to target` function afterwards.

CRU uses PTP timebase. If PTP is enabled and settings are changed, you need to reset CRU using “jump to target” or it may take few minutes to re-track or alternatively disable / enable PRP.

RAVENNA TH

Figure 206

Define Read Delay Target for each Ravenna audio streams in number of audio samples or time.

Remark: Depending on number of audio channels per stream the number of audio samples per packet varies.

Video SDP

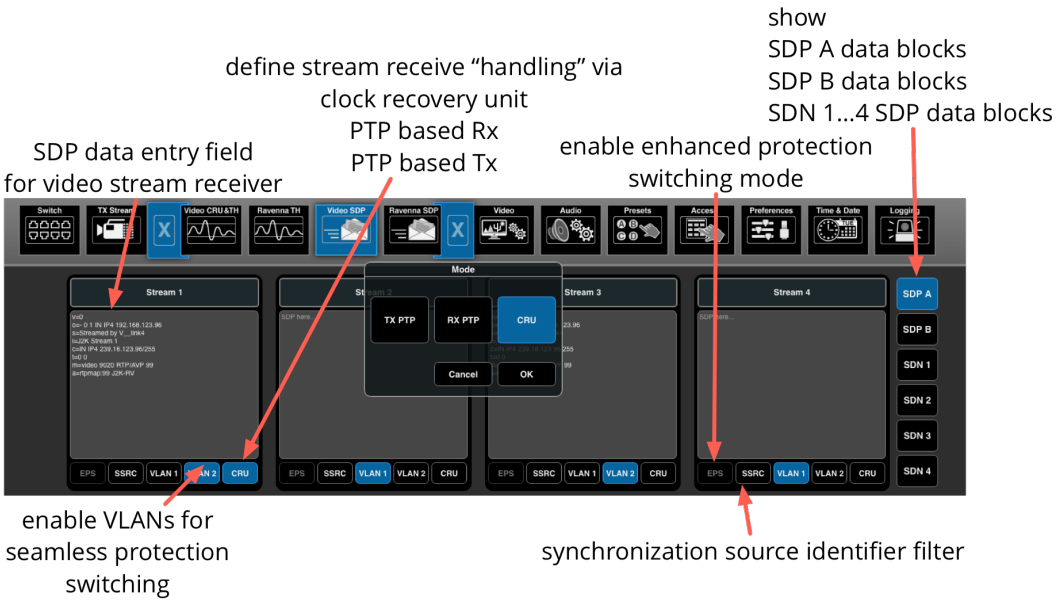


Figure 207

- `SDP A` and `SDP B`:

SDP data entry fields for video stream receivers for manual or Ember+ controlled SDP data entries resulting in IGMP join and / or leaves. Use of SDP A is sufficient for all regular stream connections including seamless protection switching. SDP B is needed for second separate SDP entry for Enhanced Protection Switching mode and can be used as well for Seamless Protection Switching receive with second multicast address.

- `SDN1` ... `SDN4`:

SDP data entry fields for Software Defined Networking via external Network Management & Control System. Accessible via Ember+. Enables Source-timed frame accurate clean switching in combination with seamless protection switching or enhanced protection switching.

- per Stream Receiver 1..4:
  - `VLAN1` / `VLAN2`: Enable or disable respective VLAN for stream receiver.
  - `SSRC`: For RAW streaming enable SSRC filtering. If SSRC of incoming stream is changed due to transmitter reset or similar the filter applies and blocks stream data from processing input. Updating SSRC info into processing block releases blocking.
  - `EPS`: Enable Enhanced Protection Switching mode.
- Receiver mode:
  - `CRU` = enable regular clock recovery unit, tracks frequency and phase of incoming stream based on stream data exclusively
  - `RxPTP` = locks PTP time of first start of frame event of incoming stream and use local PTP data for frequency and phase - requires snychronous operation.
  - `TxPTP` = use absolute PTP data for defining frequency and phase of incoming signal, works in synchronous PTP clk mode only

Remark: TxPTP mode is required for enahnced protection switching and for source-timed frame accurate clean switching.

Ravenna SDP

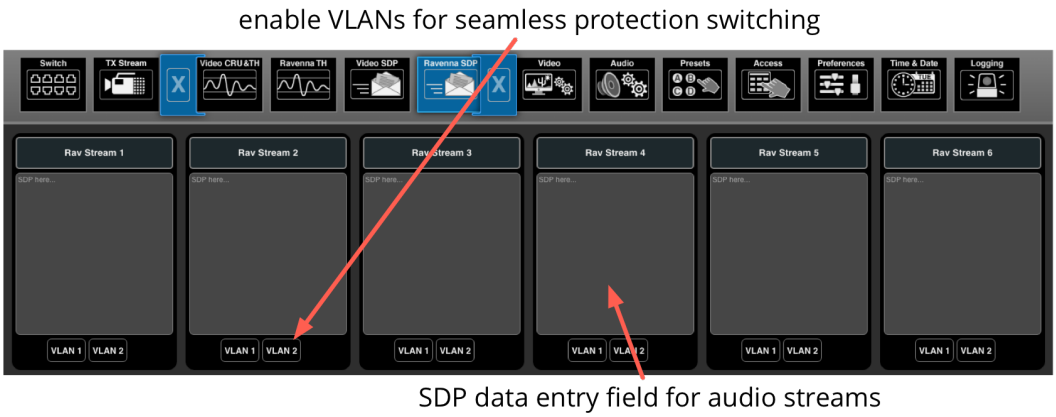


Figure 208

Settings -> Video

- for future release

Settings -> Audio

This submenu is used to configure the two **MADI ports** for discrete or redundant operation:

1. Click on the `Mode` field to select:

- `Redundant` - MADI ports 1 and 2 operate as one main and one redundant port.
- `Discrete` - MADI ports 1 and 2 operate as two independent ports.

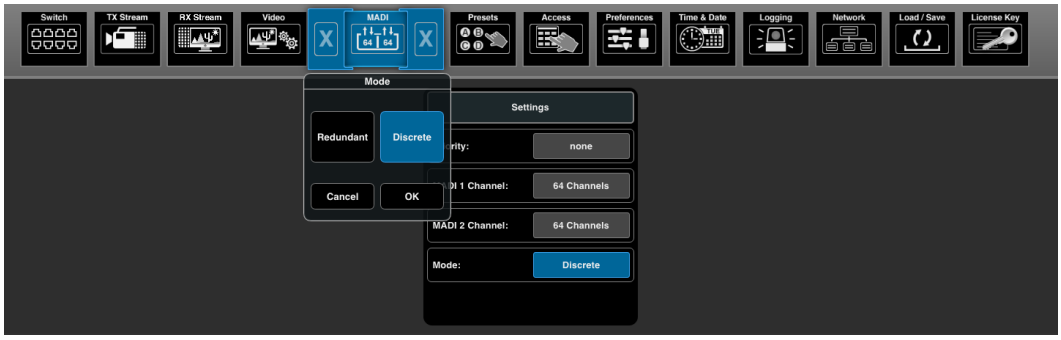


Figure 209

2. If the **Mode** is set to **Redundant**, then the `Priority` field selects which port takes priority for the return link:

- `none` = the first recognized and locked input is used.
- `Madi 1` = MADI 1 takes priority.
- `Madi 2` = MADI 2 takes priority.

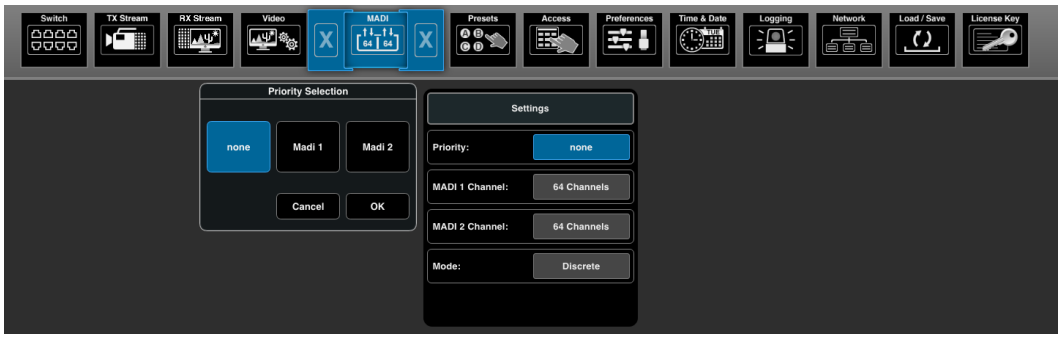


Figure 210

When the MADI mode is set to **Redundant**, the redundant link cannot be used independently, and the following overlay appears in the affected menus - in our example, for `MADI 2`:

Figure 211

Settings -> Presets

This submenu is used to save and recall presets.

Presets store selected routing assignments within the Video and/or Audio matrix. They can be recalled from the Presets submenu, or triggered from an external device using a virtual or physical GPI (configured via the `Settings` -> `Access` or Ember+ protocol.)

Up to four presets - A to D - are saved with the rest of the unit's settings when you power off or save from the Load/Save menu.

To save a preset:

1. Select the preset you wish to use from the expanded submenu - e.g. `Preset A`.
2. Select the matrix outputs you wish to save: light blue = selected; grey = not selected. You can select any combination from the Audio and Video Matrix.
3. Click on the `Save` button - the routing assignments for the selected outputs are saved in the preset. A light blue triangle appears in the top left-hand corner of the selected outputs to indicate which outputs have been saved. In our example, Audio & Video Matrix `Out 1` and `Out 3` have been saved in `Preset A`:

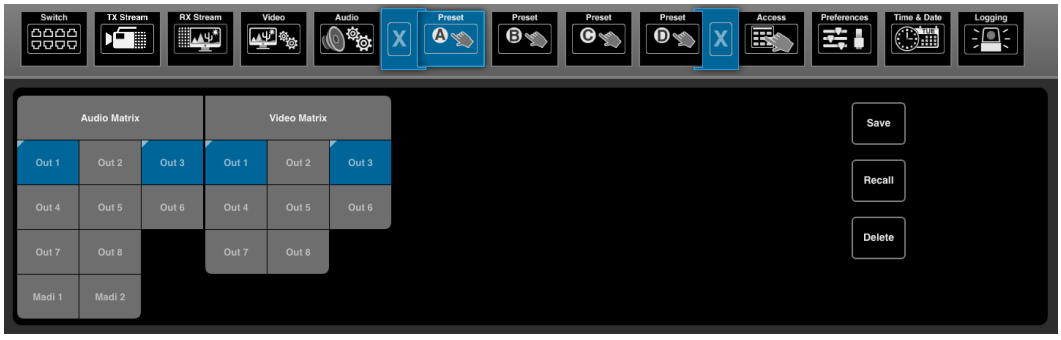


Figure 212

To recall a preset:

1. Select the preset you wish to recall from the expanded submenu - the light blue triangles update to show which outputs are stored in the preset.
2. Click on the Recall button - the stored routing assignments are recalled to the Video/Audio Matrix.

> Note that if there are no light blue triangles, then the preset is empty and a Recall will have no effect on the Video/Audio Matrix.

To delete outputs from a preset:

You can remove output assignments from a preset using the `Delete` button as follows:

1. Select the preset you wish to edit from the expanded submenu - the light blue triangles update to show which outputs are stored in the preset.
2. Select the matrix outputs you wish to delete: light blue = selected; grey = not selected.
3. Click on the `Delete` button - the selected outputs are removed from the preset. In our example above, clicking `Delete` will remove Audio & Video Matrix `Out 1` and `Out 3`, so that `Preset A` becomes empty.

Settings -> Access

This submenu is used to enable external control via Ember+ protocol. For example, to control the V__link4 / V__remote4 from a third-party control system such as VSM.

1. When the `Ember` field is selected (blue), then external control via Ember+ protocol is enabled.
2. When the `Zeroconf` field is selected (blue), then zeroconf is enabled.

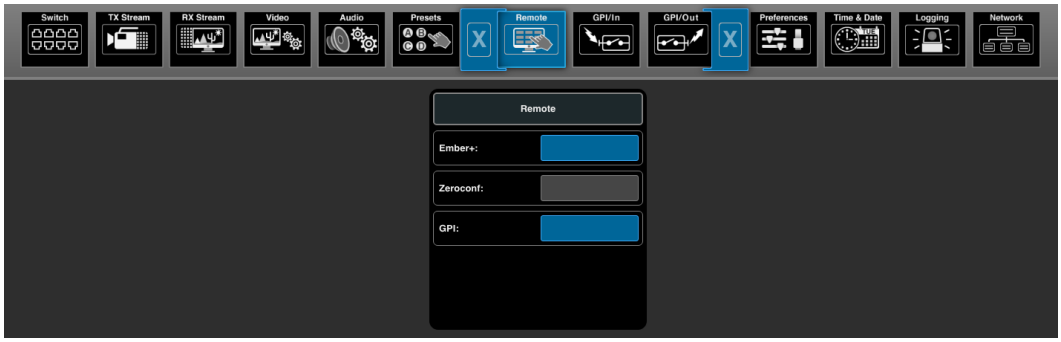


Figure 213

GPI In

This submenu is used to assign one of the four presets (saved under `Settings` -> `Presets`) to a virtual or physical GPI. You can also set the GPI level and trigger the GPI to test its functionality. Up to 8 virtual or physical GPIs can be configured:

1. Click on the `Assign` field to assign a preset (A to D) to the GPI:

Figure 214

2. Click on the `Level` field to define whether the GPI is triggered by the rising or falling edge:

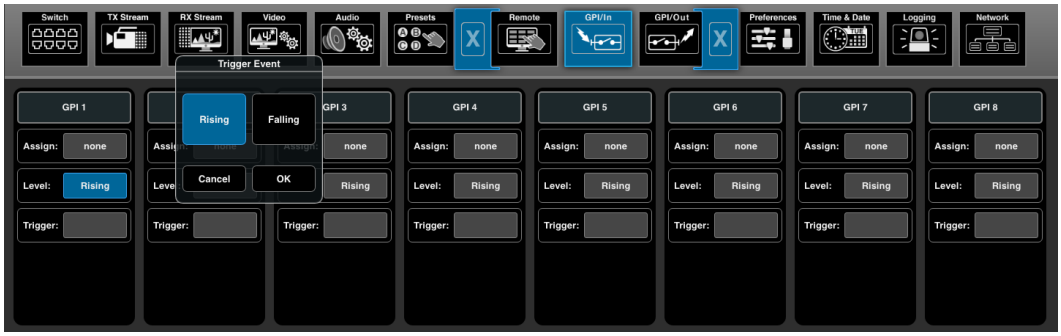


Figure 215

3. Click on the `Trigger` button to trigger the GPI and test your assignments - if a preset has been assigned, then the corresponding routing assignments will be recalled, as defined in `Settings` -> `Presets`.

GPI Out

This submenu configures 8 virtual or physical GPI outputs for alarm monitoring or for any external control usage.

1. Clicking on `Assign` opens a pop-up to select certain alarm conditions to be flagged on that GPI output.

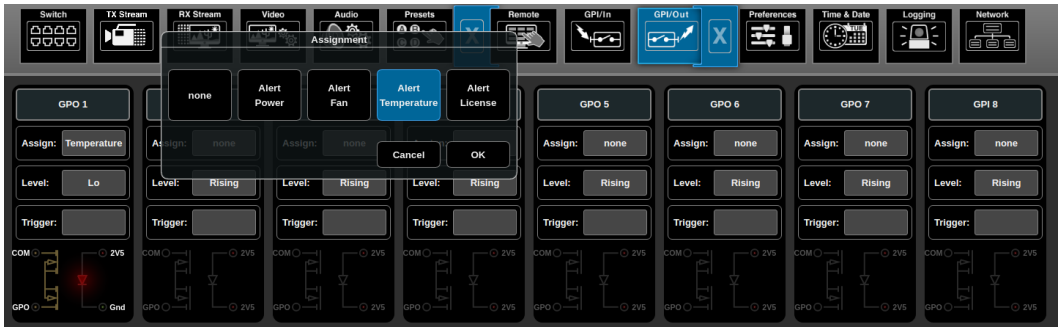


Figure 216

2. Click on `Level` and define whether the GPI output creates a rise or falling edge or if it uses hi or lo level signalling.

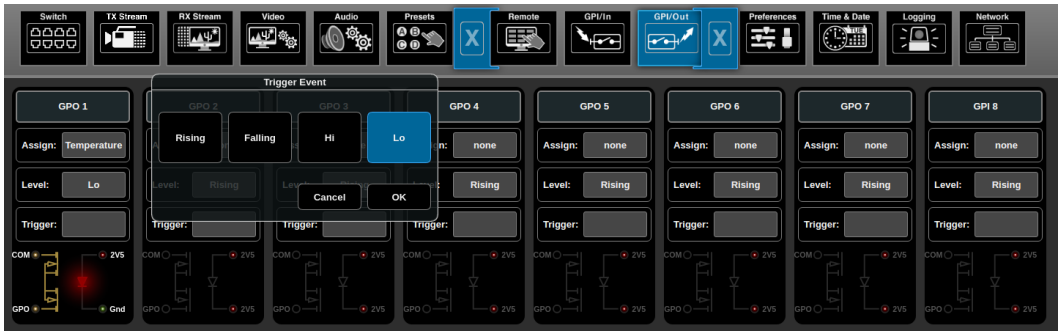


Figure 217

3. Click on `Trigger` for manual triggering the GPI output and/or testing. GPI outputs can be triggered via Ember+ protocol as well.

Current status of GPI output is displayed in lower submenu section.

GPI inputs or GPI outputs can be enabled/disabled in the `Remote` submenu.

Log In

Define passwords for user admin and for user guests.

- admin = all rights
- guest = read only

Settings -> Preferences

PPM Settings

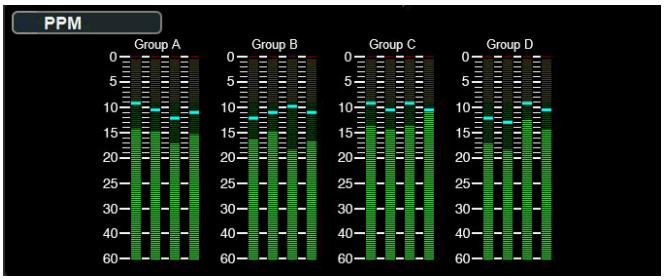


Figure 218

Options for the audio metering (PPM) include:

- `PPM Scale` - can be `dBFS`, `BBC`, `DIN` or `Nordic`:

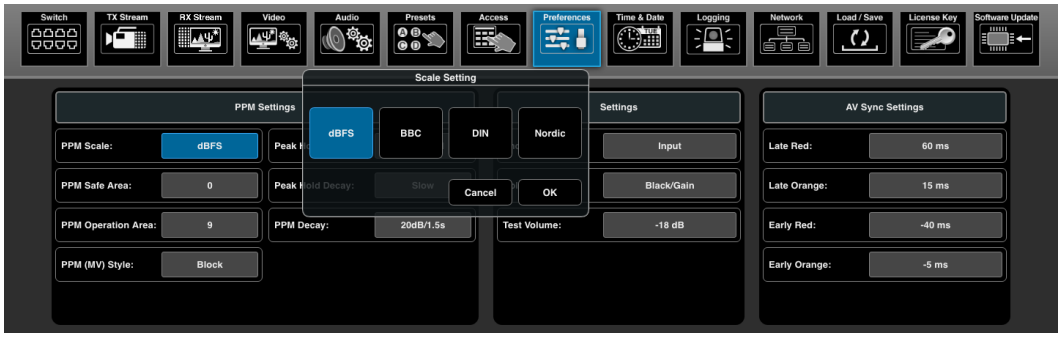


Figure 219

- `PPM Safe Area` - this value sets the point where the meters change from red to yellow at the top of the scale. For example, you could set this to -3dB to mark 3dB's of headroom:

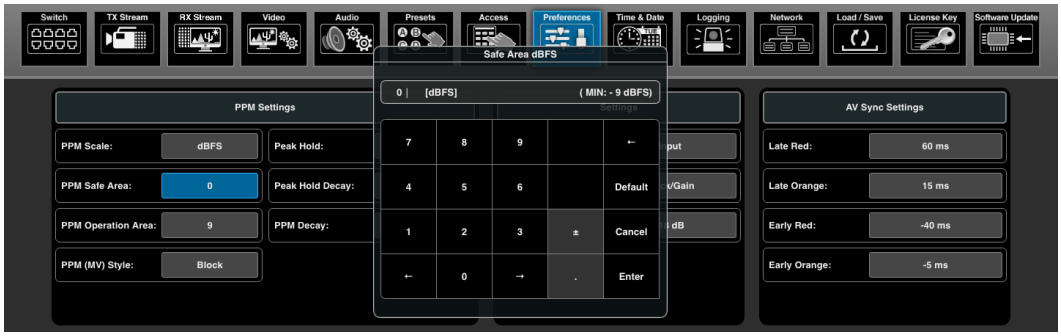


Figure 220

- `PPM Operation Area` - this value sets the point where the meters change from yellow to green in the middle of the scale. For example, you might set this to -9dB so that when signals peak within the yellow area (-12dB to -3dB) you know that they are at a good operating level:

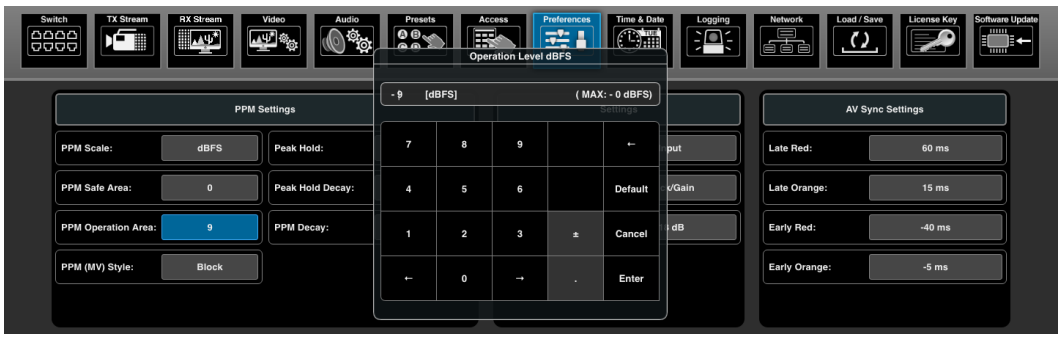


Figure 221

- `PPM (MV) Style` - selects the PPM style (LED or Block) used for **MultiView** monitoring. Block mode should be used to reduce the artifacts added by TV sets, if this type of monitor is connected to the **MV Out**:

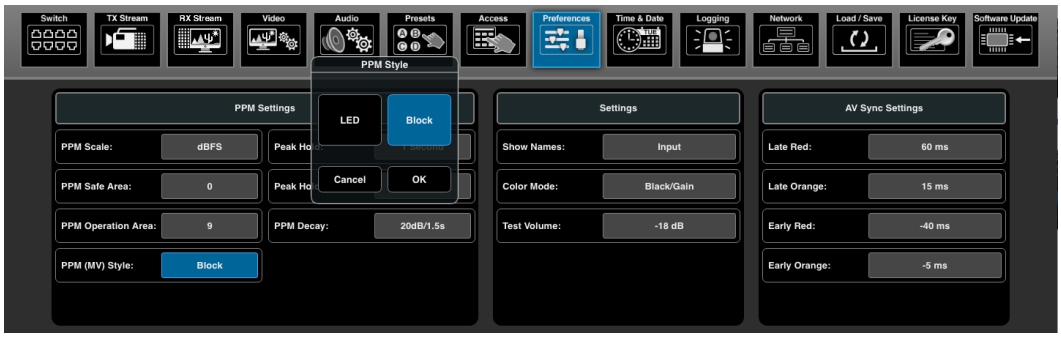


Figure 222

- `Peak Hold` - the peak hold indicator (blue) monitors and marks the peak level reached on each meter. This value determines how long the peak hold indicator remains, before it is cleared and monitoring reset:

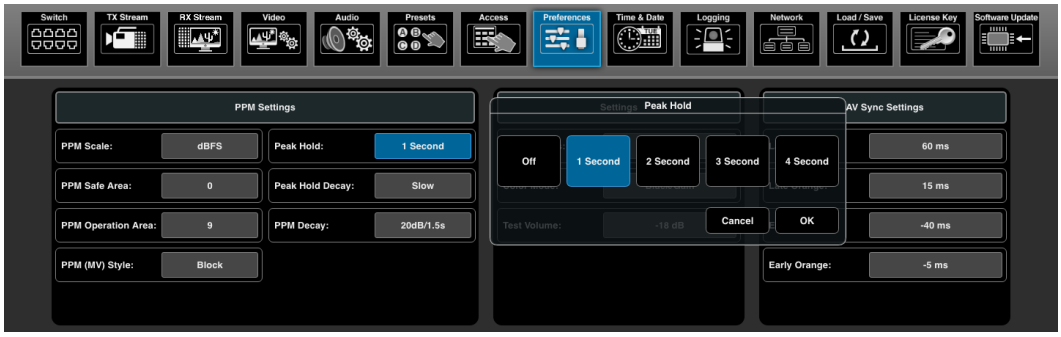


Figure 223

- `Peak Hold Decay` - this option determines how quickly the peak hold indicators are cleared:

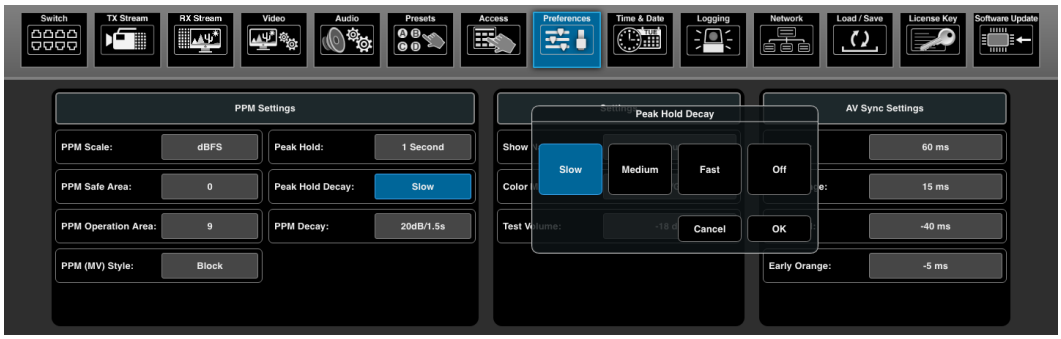


Figure 224

- `PPM Decay` - this option determines the ballistics of the PPM meter:

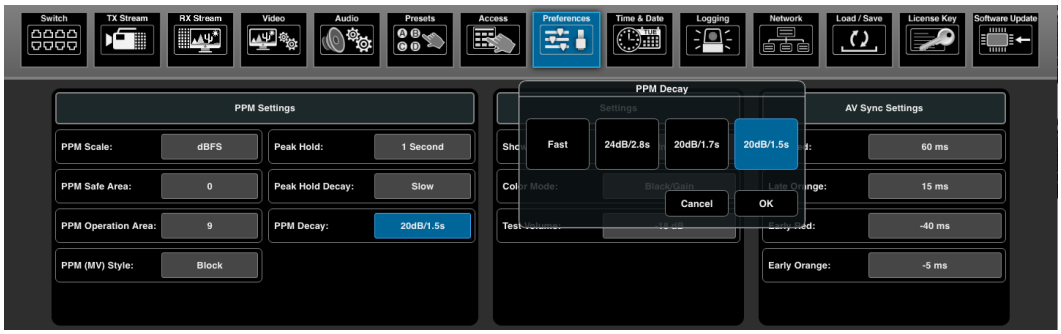


Figure 225

General Settings

Names

The names displayed for **signal routing** assignments can be set by an external control system (via the Ember+ protocol), or adjusted using the `Show Names` option:

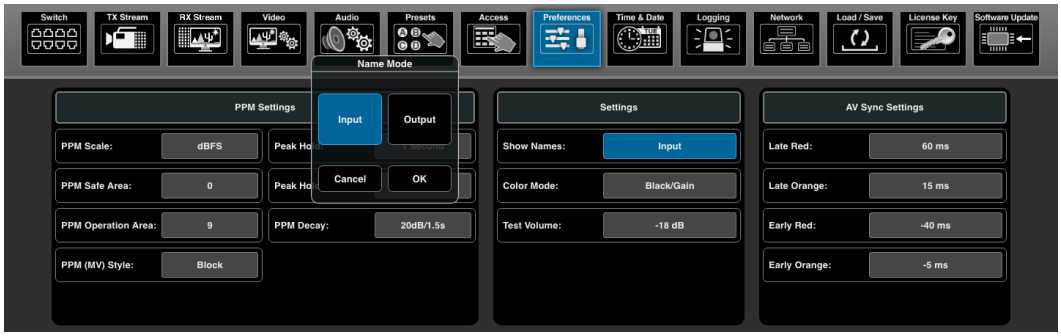


Figure 226

- `Input` - output channel assignments display only the Input name:

Figure 227

- `Output` - output channel assignments display both the Input and Output names:

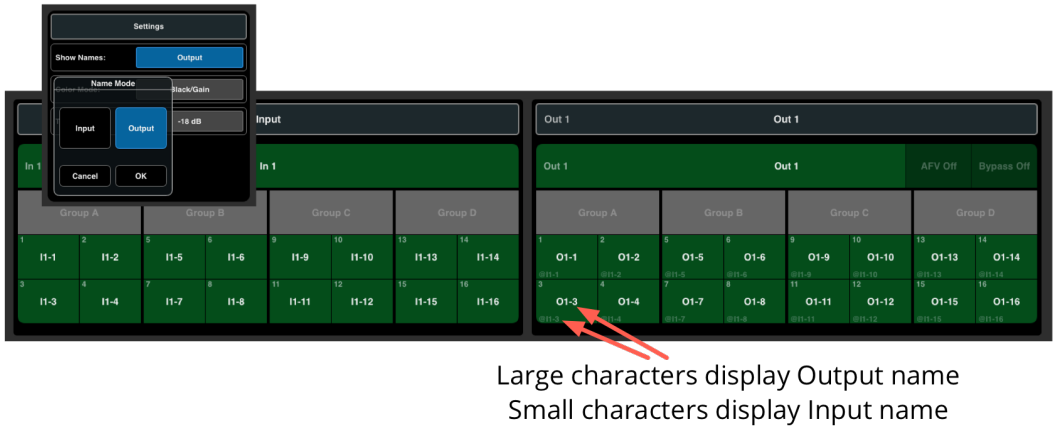


Figure 228

- J2K instances: According to installed number of J2K instance licenses configure the allocation to encoders / decoders.
- Thumbnails & WFM / VS: switch off / on thumbnail and WFM / VS. Help saving control traffic bandwidth in tight networks.

Settings -> Time & Date

Use this submenu to enter the system date and time, or synchronise to an external SNTP server.

To manually update the system time and date:

1. Click on the current `Date` field to open the pop-up selector:

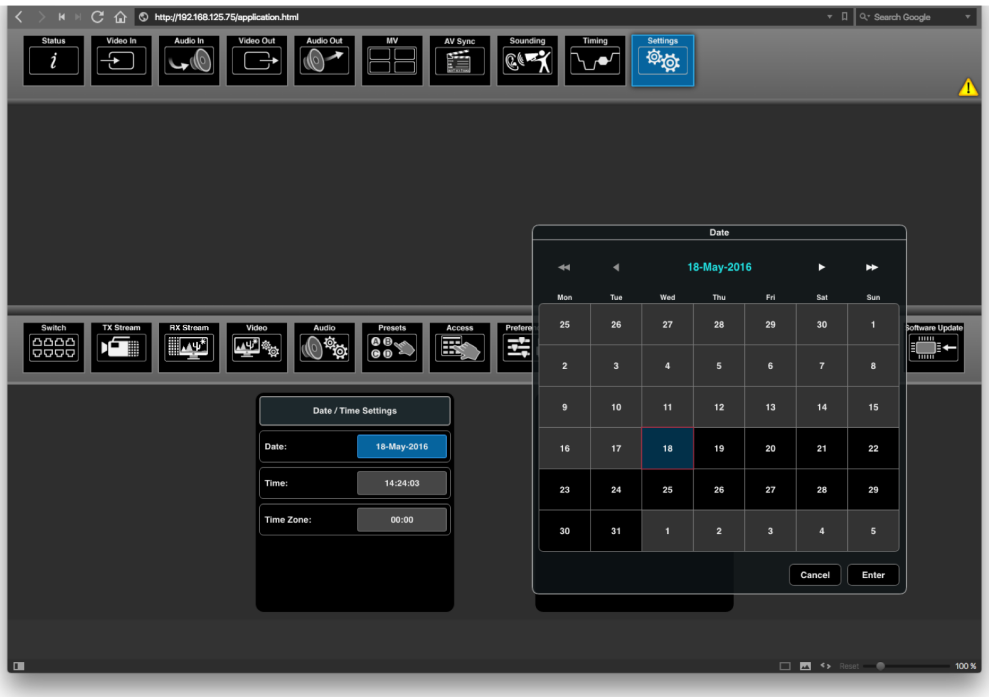


Figure 229

2. Use the `double arrow` buttons (at the top) to select the Month and `single arrow` buttons to select the Day. Confirm by clicking `Enter`.

3. Click on the current `Time` field to open the numeric keypad:

Figure 230

4. Use the keypad to enter a value and click `Enter`.

5. The `Time Zone` field can be used to enter a time zone offset in a similar manner:

Figure 231

To synchronise the system time and date to an external SNTP Server:

1. Click on the `SNTP IP Addr` field, and use the numeric keypad to enter the IP address of the server:

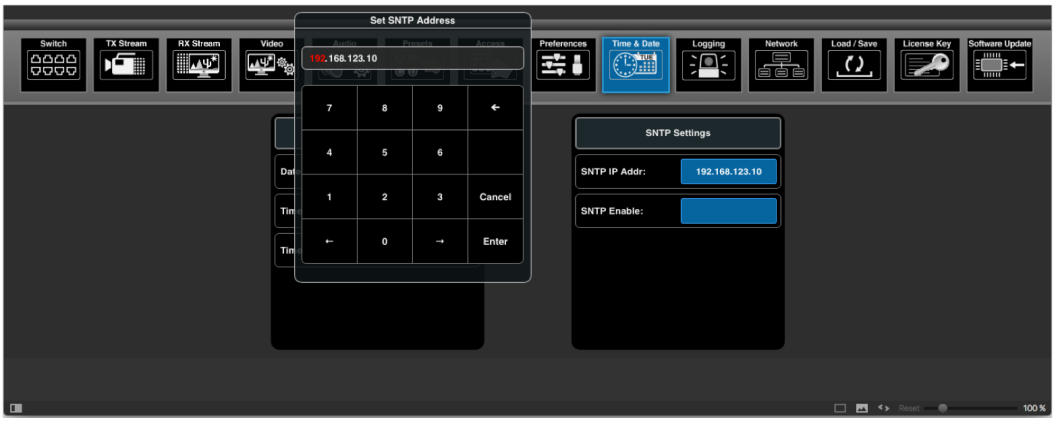


Figure 232

2. Then click on the `SNTP Enable` button to enable synchronization (green = enabled).

Settings -> Logging

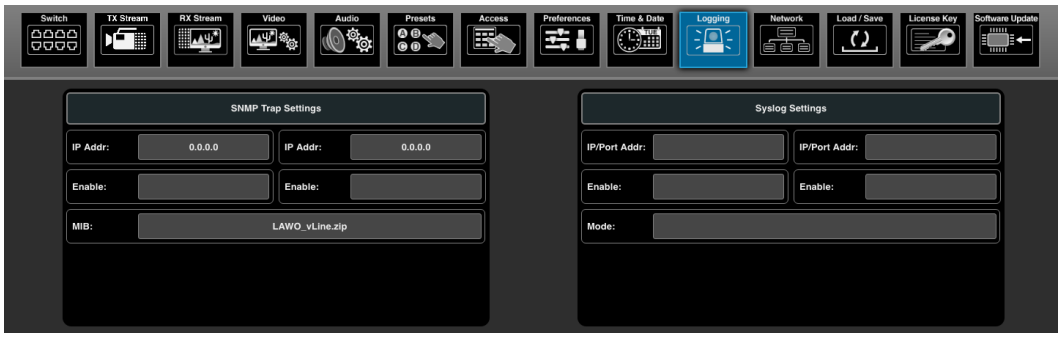


Figure 233

SNMP

The SNMP protocol (Simple Network Management Protocol) can be used to remotely monitor alarm conditions such as power supply failures, fan status and temperature.

1. Click in the `SNMP IP Addr:` field to enter the IP address of the receiving SNMP workstation:

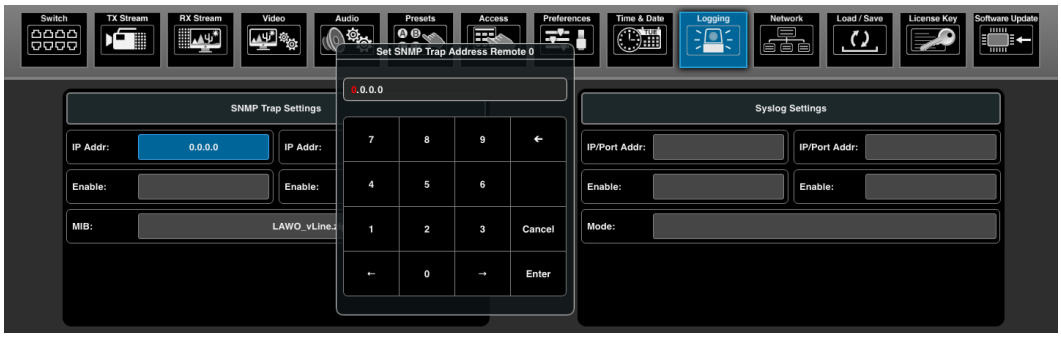


Figure 234

2. Click on the `Enable` field to enable the protocol on the network port (connected to the SNMP workstation):

Syslog

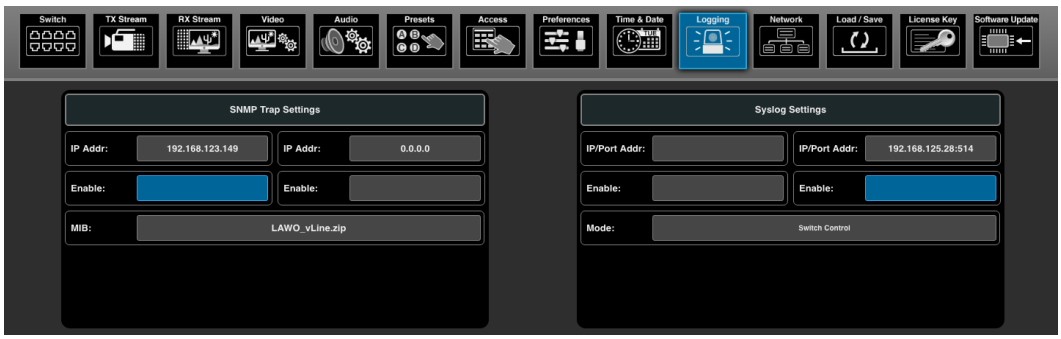


Figure 235

Two independent syslog servers can be adressed for external logging. Syslog is the mean for monitoring / logging of events including internal debug events of system. Click on `Mode` to define logging filters.

> You can download the MIB log file by clicking on the MIB button.

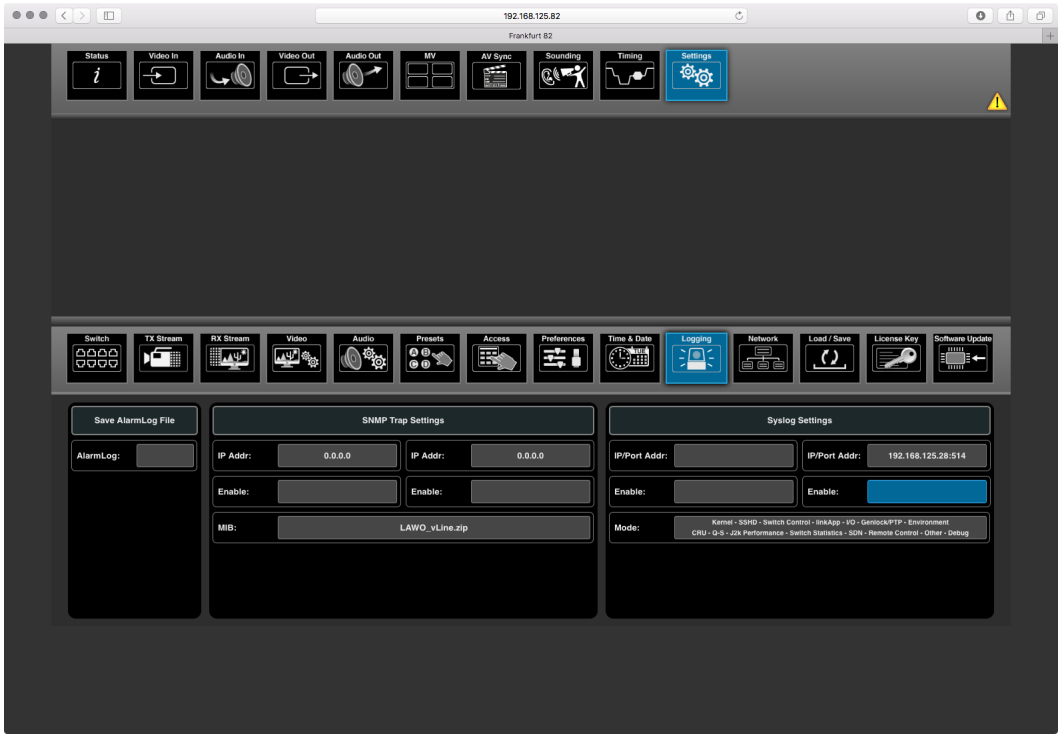

192.168.125.82
Frankfurt 82
Status
Video In
Audio In
Video Out
Audio Out
MV
AV Sync
Sounding
Timing
Settings
Switch
TX Stream
RX Stream
Video
Audio
Presets
Access
Preferences
Time & Date
Logging
Network
Load / Save
License Key
Software Update
Save AlarmLog File
AlarmLog:
SNMP Trap Settings
IP Addr:
0.0.0.0
IP Addr:
0.0.0.0
Enable:
Enable:
MIB:
LAWO_vLine.zip
Syslog Settings
IP/Port Addr:
IP/Port Addr:
192.168.125.28:514
Enable:
Enable:
Mode:
Kernel - SSHD - Switch Control - linkApp - I/O - Genlock/PTP - Environment
CRU - Q-S - J2k Performance - Switch Statistics - SDN - Remote Control - Other - Debug

Figure 236

Settings -> Network

This submenu is used to edit the TCP/IP settings and check the Mac Address for the network ports. You can also edit the V__link4 / V__remote4's device name on the network.

The MAC Address field is for display purposes and cannot be altered.

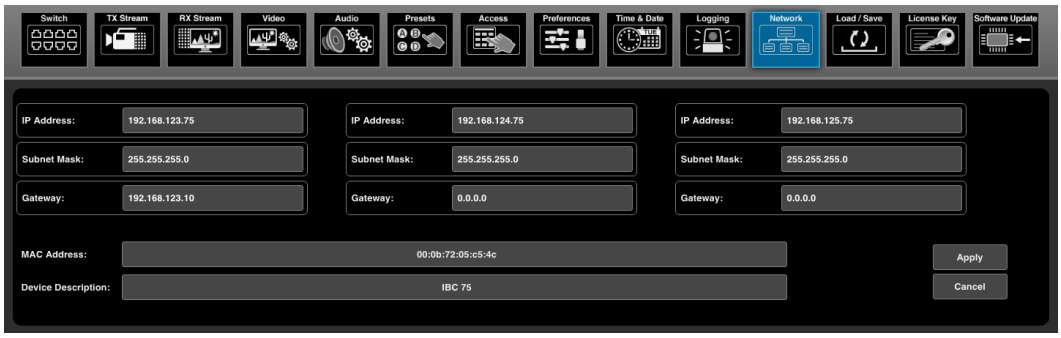


Figure 237

To change the IP settings of a network port:

1. Click on the current `IP Address` to open the pop-up selector. Click on the right arrow button to highlight the correct set of digits; use the numeric keypad to enter a new value and click `Enter`.

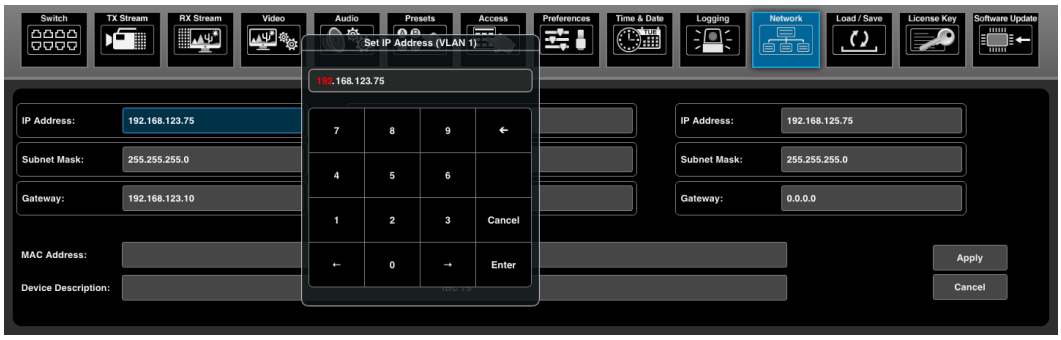


Figure 238

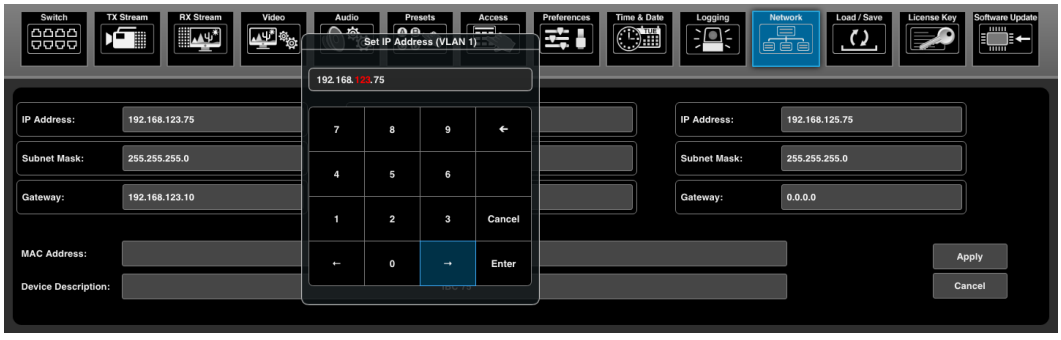


Figure 239

The `IP Address` field updates.

2. Click on the current `Subnet Mask` to open the pop-up selector. Click on the `up` or `down arrow` buttons to adjust the subnet mask and click Enter.

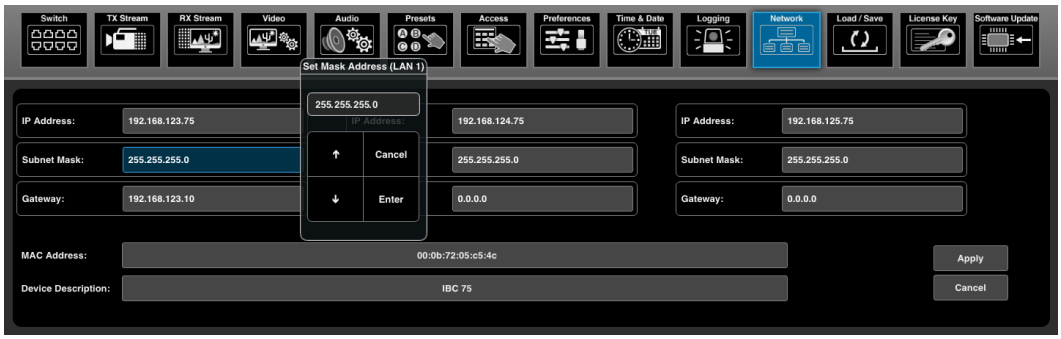


Figure 240

The Subnet Mask field updates.

3. Click on the current `Gateway` to open the pop-up selector. Click on the right arrow button to highlight the correct set of digits; use the numeric keypad to enter a new value and click `Enter`.

The Gateway is used to connect to a node on the network that serves as an entrance to another network.

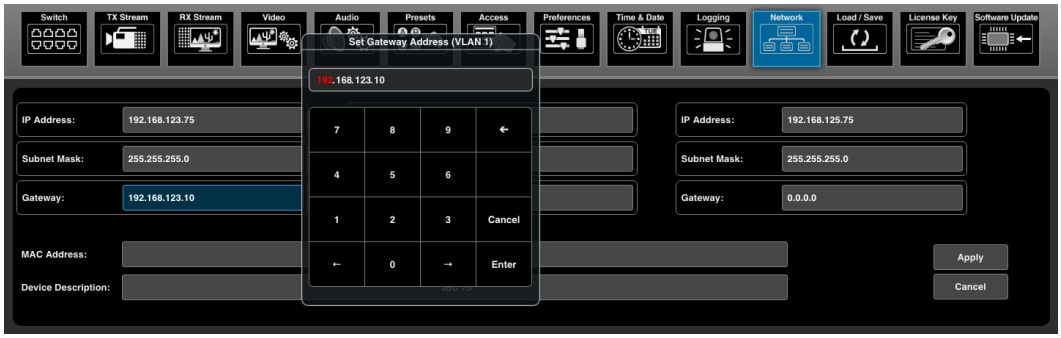


Figure 241

4. When you are happy with the new IP settings, click on `Apply`.

The network port settings are reset. Providing your computer's Network Interface Card is within the same IP range, the browser automatically reconnects, and you are returned to the **login screen**.

> All network ports will be disconnected for a short time, after changes to the Network settings are applied.

To edit the V__link4 / V__remote4's Device Name:

The `Device Description` field is used to give the V__link4 / V__remote4 a name on the network.

1. Click on the current `Device Description` to open the pop-up QWERTY keyboard:

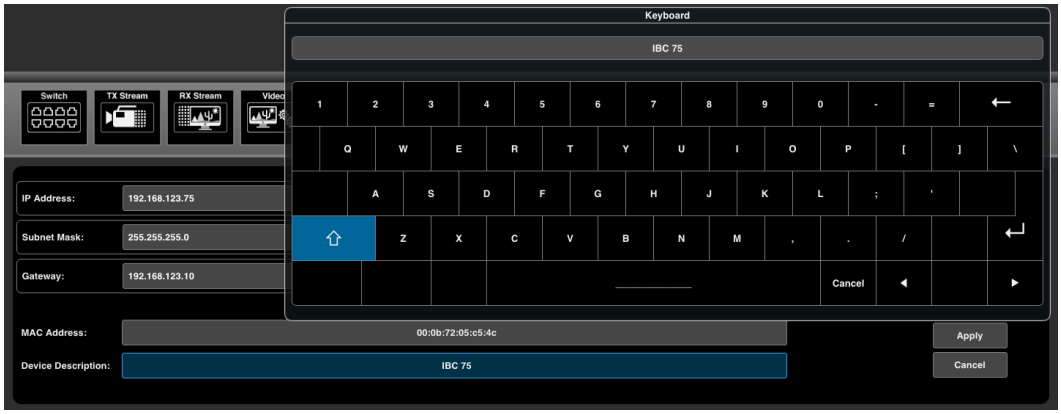


Figure 242

2. Type in a new name.
3. When you are happy with the name, click on `Enter`.

Settings -> Load/Save

This submenu is used to:

- Save and load V__link4 / V__remote4 settings to and from a computer via your web browser application.
- Clear settings - use this option to reset the unit (excluding IP addresses) to the factory defaults.

Note that all settings, except **Network** and **Time & Date**, are saved as an **.xml** file.

The default file name, storing the unit's latest settings, is "**settings.V__link4 / V__remote4**".

The `Load/Save` menu uses the upload/download functionality of your web browser (requiring a HTML5-based application). Therefore, the default storage location can be changed by modifying the downloads location in your browser:

- **Google Chrome**: `Advanced Settings` -> `Download`
- **Mozilla Firefox**: `Firefox` -> `Preferences` -> `Downloads`

Load/Save to Your Computer

To save settings to your computer:

1. Select `Local` as your Storage Device followed by the `Save Setting` field:

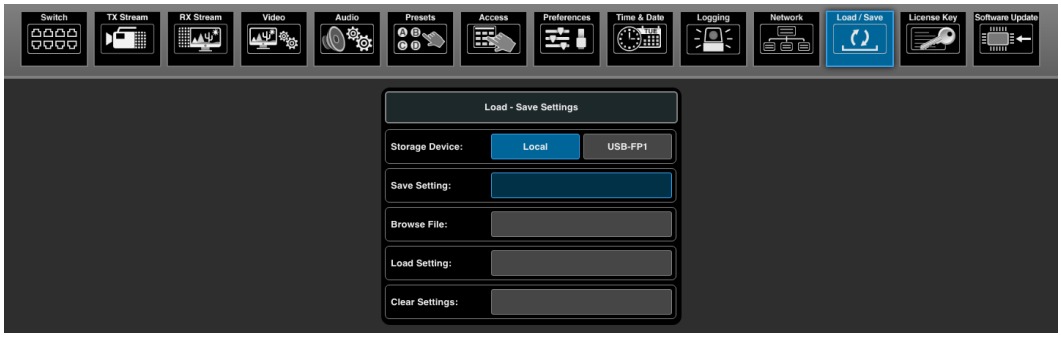


Figure 243

A “Save As” dialogue box appears:

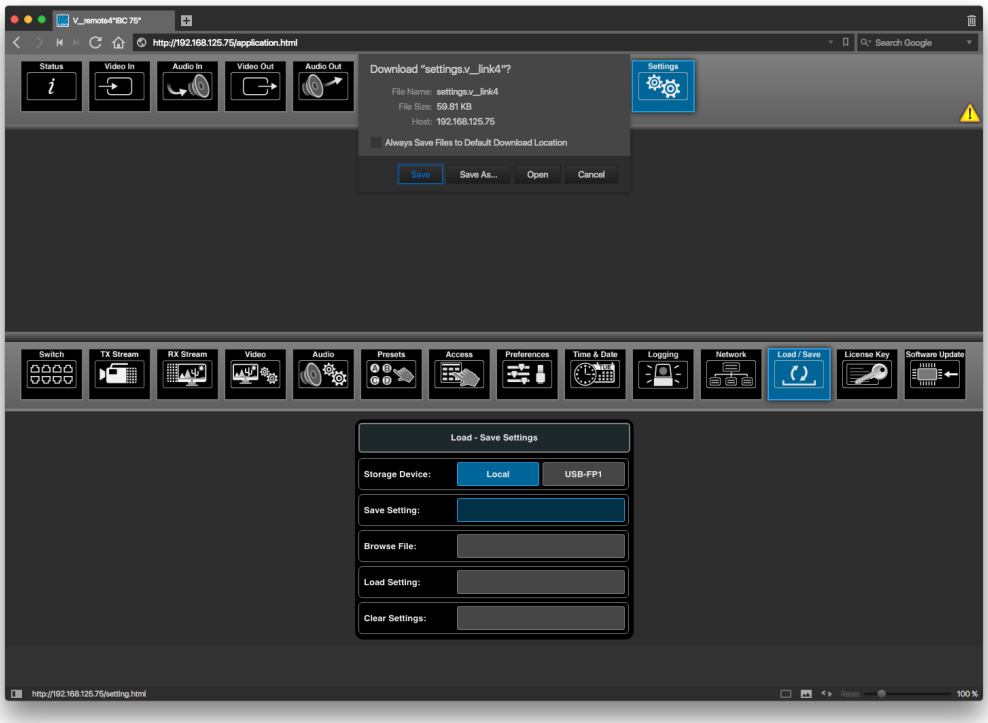


Figure 244

2. Type in a suitable file name and choose a storage location.
3. Select `Save`.

Settings are downloaded from the V__link4 / V__remote4 to your computer and stored in the designated .xml file.

To load settings from your computer:

1. Select `Local` as your Storage Device followed by the `Browse File` field:

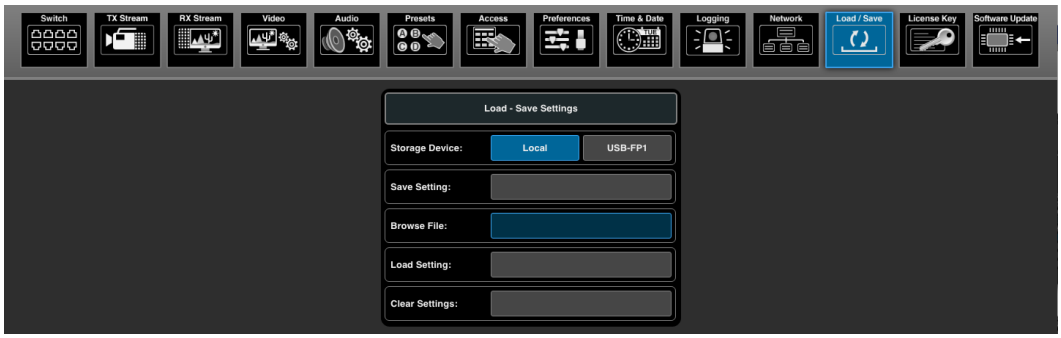


Figure 245

A “file selection” dialogue box appears:

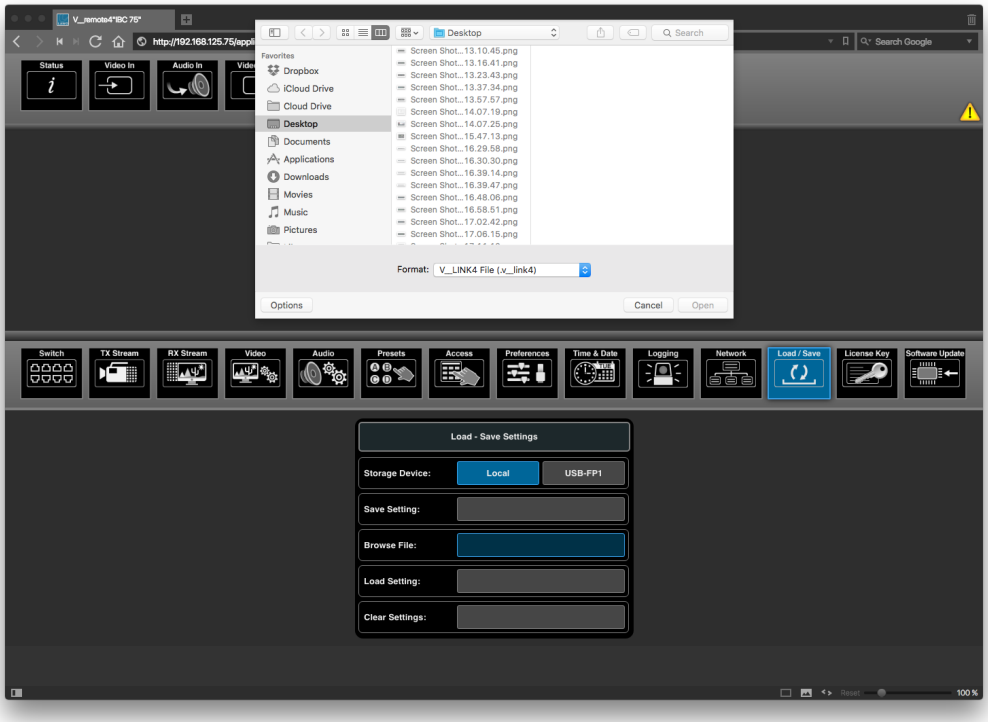


Figure 246

2. Select the file you wish to load and click `Open`.

The file is uploaded from your computer to the V__link4 / V__remote4; the `Browse File` *field shows the file name and a green* `Load Settings` *button appears:*

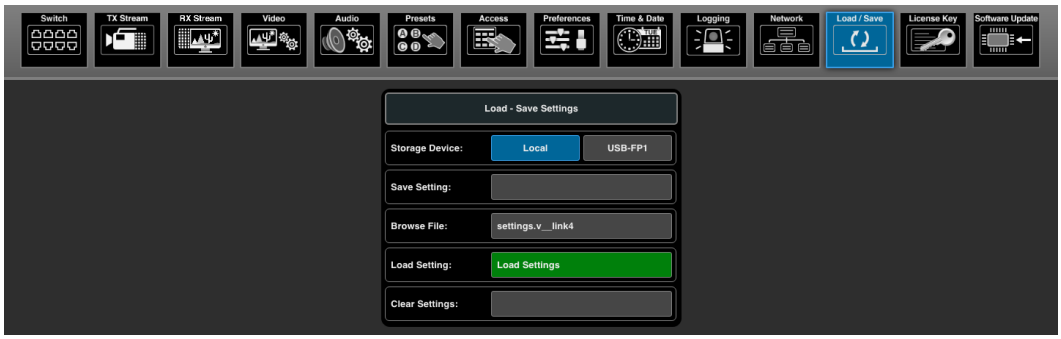


Figure 247

3. Click on `Load Settings` to load settings from the file.

Following a successful load, a popup appears.

Clear Settings (Reset)

This option resets the unit back to the factory default settings (excluding IP addresses).

1. Click on the `Clear Settings` field:

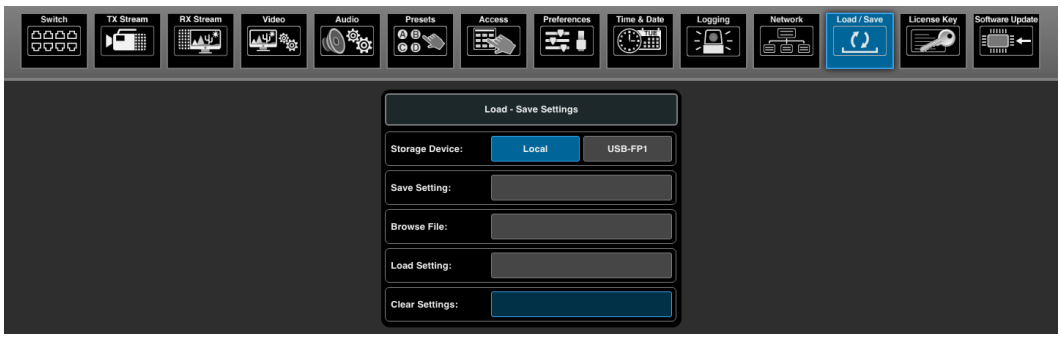


Figure 248

2. Select `Clear` to confirm:

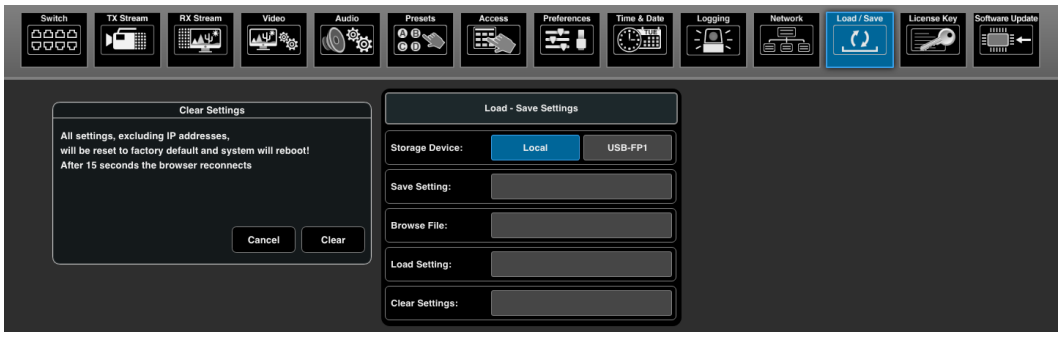


Figure 249

The V__link4 / V__remote4 reboots - during that time, you will see a countdown:

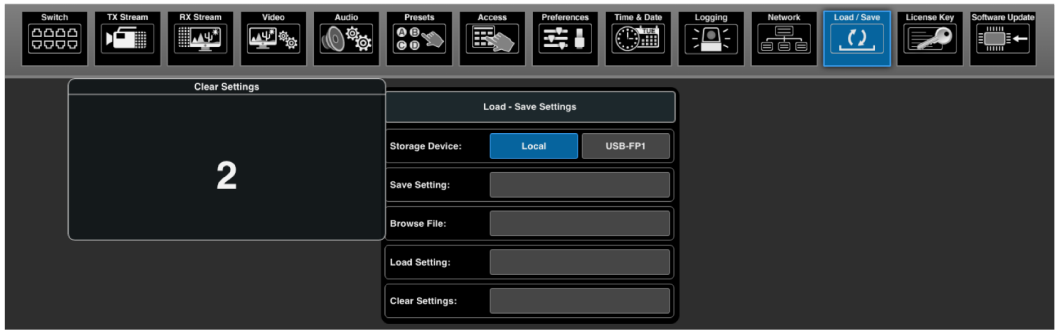


Figure 250

*At the end of the reboot, the web browser automatically reconnects and you are returned to the **login screen**.*

Settings -> License Key

This submenu is used to install a new license key file (to upgrade your V__link4 / V__remote4). See **Software Options & Licensing** for more details on the options available.

> The UUID of the V__link4 / V__remote4 device MUST match the UUID in the license key file.
>
> A single license key file contains all the purchased license information relevant to your device.
>
> For temporary licenses, an expiry warning is issued before the license is due to expire. License expiry is only checked after a reboot or power on (expired licenses remain active as long as the system is up and running).

> We recommend that you save and archive the V__link4 / V__remote4 license key file. The current license information can be verified in the **Status -> Frame** menu.

To install a new license key file:

1. Click on the `Browse File` field and select the V__link4 / V__remote4 license key file.

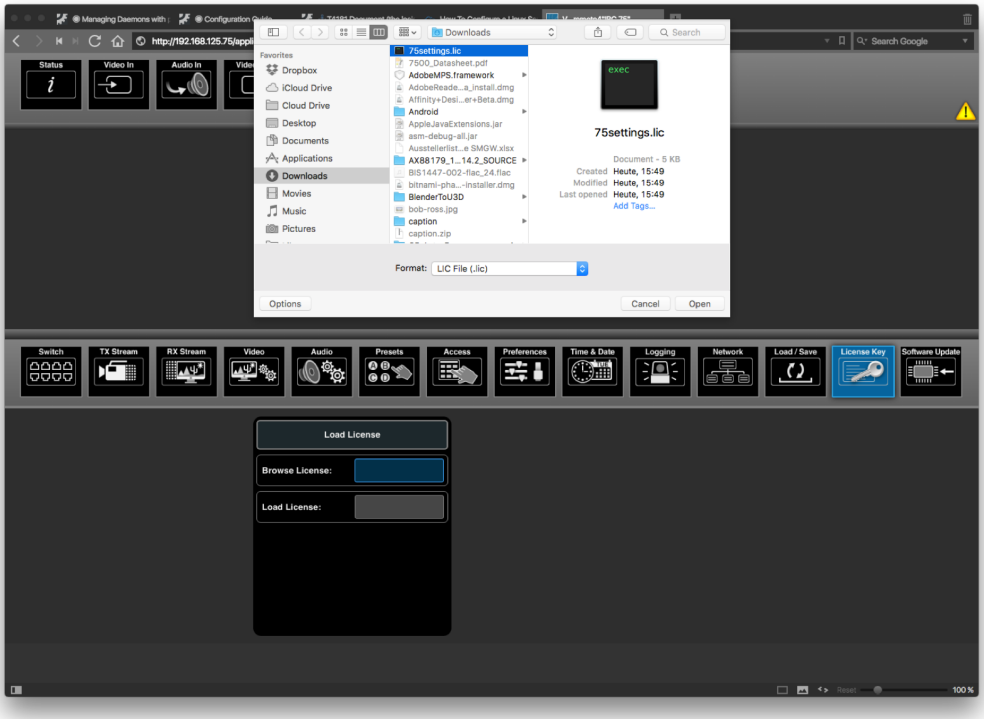


Figure 251 V__remote4 license key

The `Load License` *button turns green*

2. Click `Load License` to install and activate the licenses:

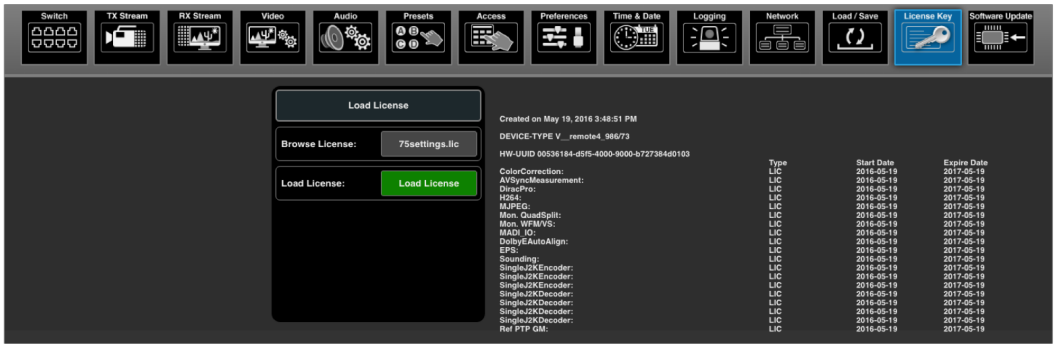


Figure 252

3. Select the `Status` -> `System` menu to verify that all licenses are correctly displayed.

Figure 253

If you have any problems with the license key file, please contact your local Lawo representative or email **service@lawo.com**.

Settings -> Software Update

This submenu is used to check or update the V__link4 / V__remote4 software.

The system includes three flash data partitions. Partition 0 is factory-installed and is not accessible to the user. Partitions 1 and 2 may be installed with different software so that you may boot from either version.

When you open the `Software Update` menu, you will see the current versions installed on each partition. The active partition is shown in green - for example, **Partition 1**:

Figure 254

To boot from the alternate partition:

1. Click in the inactive `Software Version` field:

Figure 255

2. Select `Activate` to confirm the reboot. While the system reboots, you will see a count down:

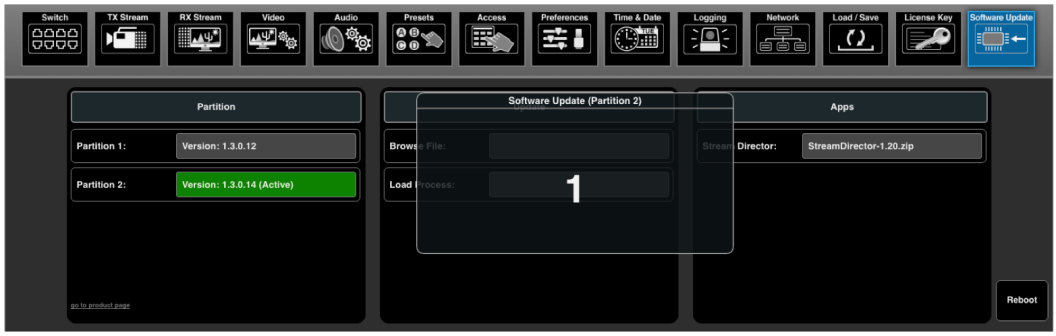


Figure 256

At the end of the reboot, the web browser automatically reconnects and you are returned to the **login screen**.

To install and boot a new version of software:

> After rebooting from new software the V__link4 / V__remote4 resets to the factory default. Therefore, please **save** your settings BEFORE performing a software update. Audio is muted during the installation process.

1. First download or copy the new software file onto your computer. Do not unzip the file. The latest V__link4 / V__remote4 software release is available from the **Download-Center** at **www.lawo.com** (after **Login**).
2. Save your settings using the **Load/Save** submenu.
3. Click on the `Browse File` button to open a file browser window. Select the software file (.zip) and click on `Open`:

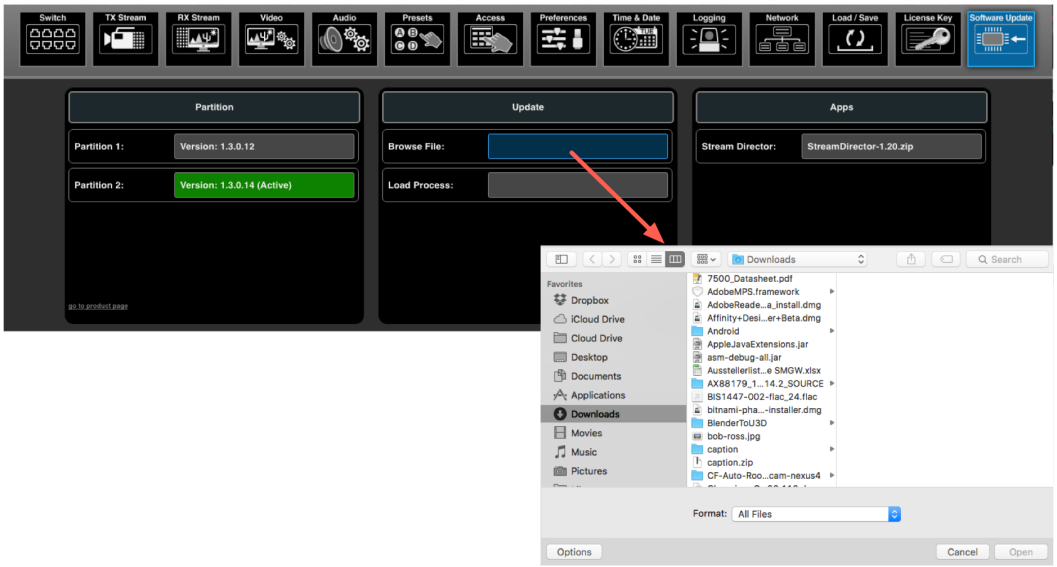


Figure 257

The `Browse File` field shows the file name and a green `Load Software` button appears:

Figure 258

4. Click on `Load Software` and then `Load` again to start the file transfer to the system - the progress is displayed in the pop-up window:

Figure 259

Figure 260

At the end of the file transfer, an Info box listing the new features and changes appears:

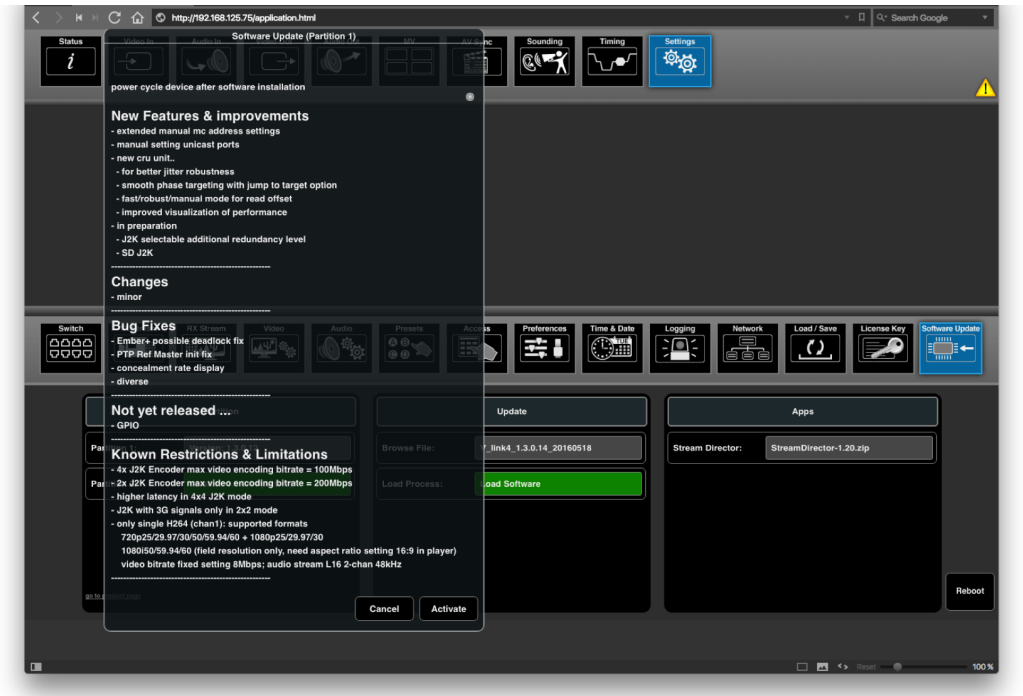


Figure 261

5. Click on `Activate` to start the update - the progress is displayed in the pop-up window:

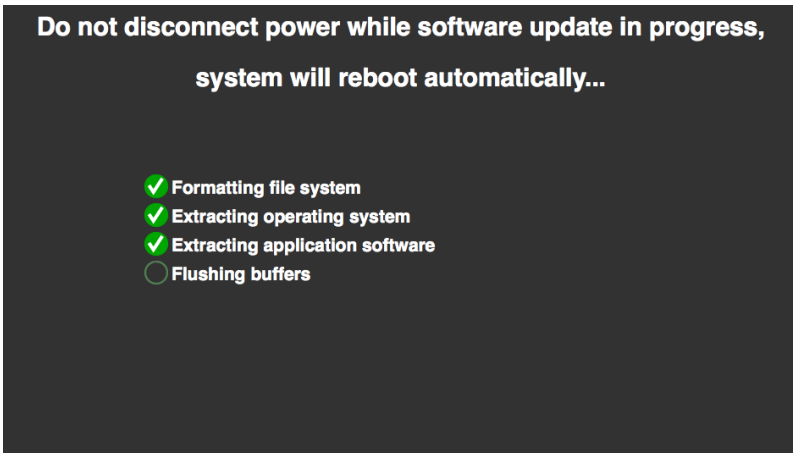


Figure 262

6. At the end of the installation, the unit reboots automatically from the new software.

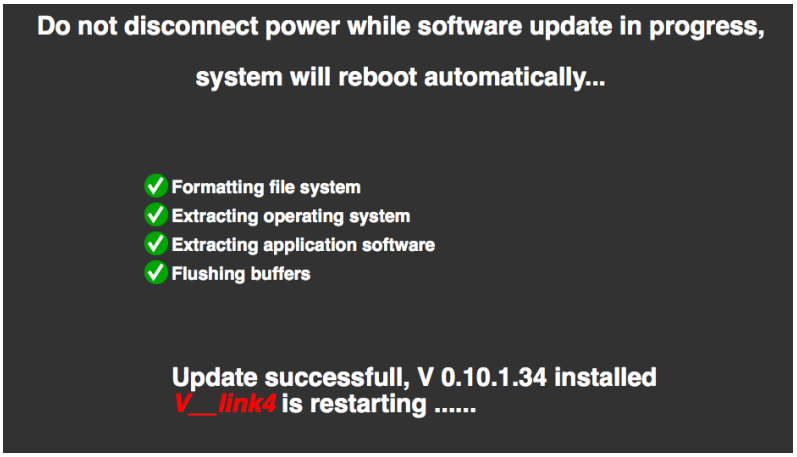


Figure 263

While the system reboots, dots appear behind the text "**V__link4 / V__remote4 is restarting**".

At the end of the reboot, the web browser automatically reconnects and you are returned to the **login screen**.

7. To recover your previous settings, load the settings saved earlier from the `Load/Save` submenu.

Update Factory Partition

Usually users cannot update the factory software partition. Factory software partition ensures in case of crashes, partition corruption etc. that unit is booting up and software can be re-installed. In most cases the software of factory partition is outdated and therefore will switch back to factory default settings which will result in uncontinuous operation in most cases. To avoid uncontinuous operation, especially for mission critical events or applications, you need to update factory partition with the same software or at least a state compatible software version. For this purpose we do have dedicated software versions which can only be installed on the factory partition. Available in download center as well. After updating the factory partition, don't forget to switch back / activate one of the user partitions again.

If you have any problems with the software installation, please contact your local Lawo representative or email **service@lawo.com**.

Color Mode

The V__link4 / V__remote4's Color Correction (**YUV** and **RBG**) can be used in one of two modes: `Black/Gain` (default) or `Brightness/Contrast`:

Figure 264

The following examples explain the difference between the two options.

Figure 1 shows the **WaveForm Monitor** (in Y view) and video preview of a grey scale ranging from black to white in 21 steps. Each step increases the luminance by 5% . Each individual bar is shown as one line in the WaveForm Monitor. Color Correction is switched off.

Figure 265 Figure 1

Figure 2 shows the same grey scale but this time with the Color Mode set to **Brightness/Contrast**, and the Brightness adjusted to +25%. The disadvantage of **Brightness/Contrast** mode is that brightening the image also effects the black level, such that black becomes grey:

Figure 266 Figure 2

By using the **Color Mode** in **Black/Gain** (the default mode), the Black and Gain video level can be changed independently without effecting each other.

In Figure 3, only the Gain Level (Luminance) is changed to -25%. The Black level remains at 0%:

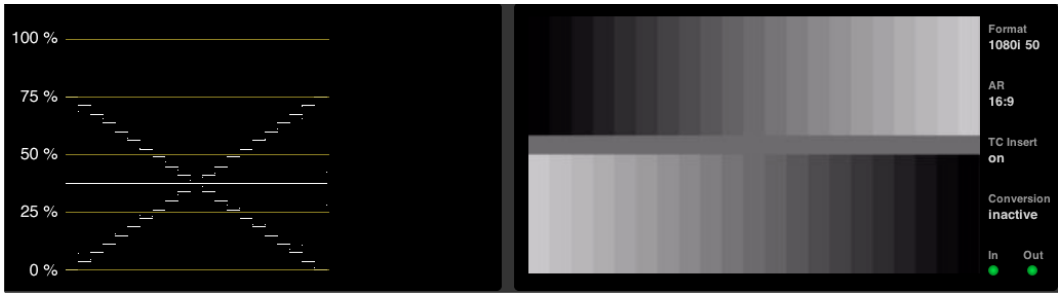


Figure 267 Figure 3

In Figure 4, the Black level is changed to +25%, and Gain level (Luminance) remains at 100%:

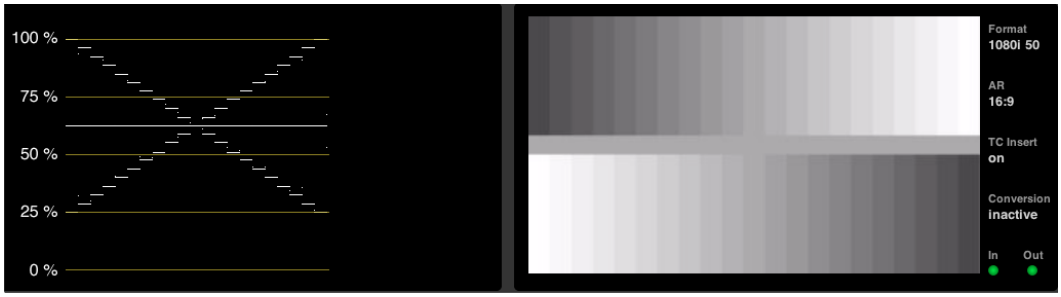


Figure 268 Figure 4

Test Volume

This option determines the audio level of the **test tone** available in `Video Out` -> `Channel ID & Pattern` menu. The level can be set to either **-18dB** or **-20dB**:

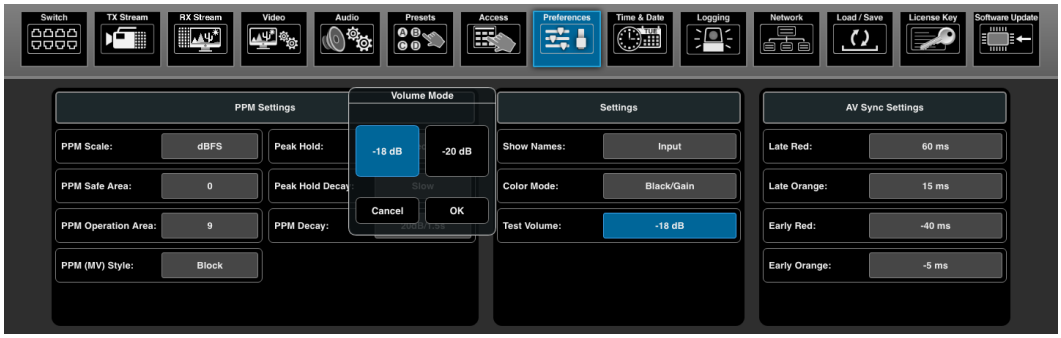


Figure 269

J2K Configuration

According to total number of J2K instances define split between number of encoders and number of decoders.

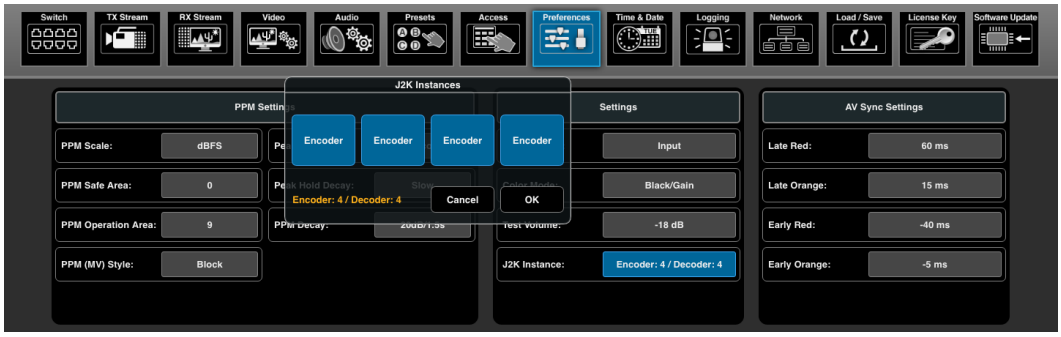


Figure 270

AV Sync Settings

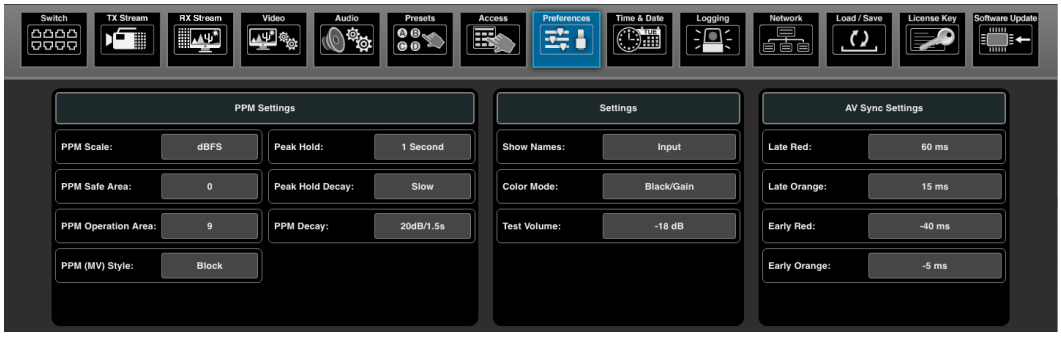


Figure 271

The **AV Sync Settings** define the green and orange ranges used in the **AV Sync menu**. The default ranges are in accordance with the EBU Technical Recommendation R37.

Click in each of the fields (`Late Red` , `Late Orange` , etc.) to adjust the numerical value:

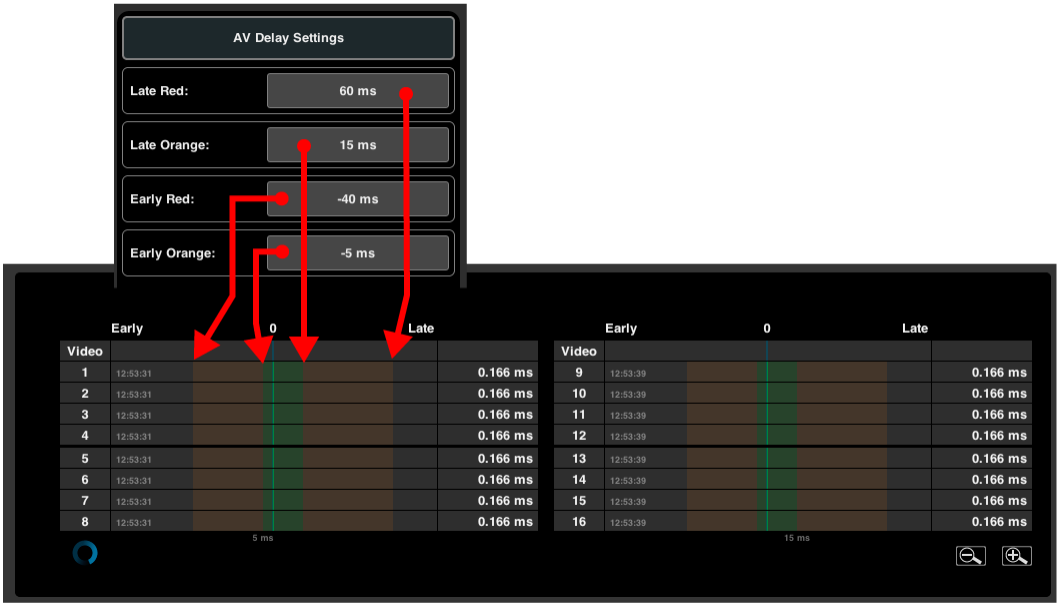

AV Delay Settings
Late Red:
60 ms
Late Orange:
15 ms
Early Red:
-40 ms
Early Orange:
-5 ms
Early
0
Late
Video
0.166 ms
5 ms
15 ms

Figure 272

V__line Redundancy Modes

Streaming

- No Redundancy
- Seamless Protection Switching
- Enhanced Protection Switching

PTP Grandmaster

- No Redundancy
- Main / Backup Grandmaster dual-path

Streaming

No Redundancy

Description

The simplest way to connect two V__lines is a single network connection. This can either be a 1Gb Ethernet connection or a 10Gb Ethernet connection, depending on the bandwidth needed. This can be a direct connection or a connection via one of the supported Ethernet switches. Using a switch is necessary if you intend to route data between more than 2 V__lines.

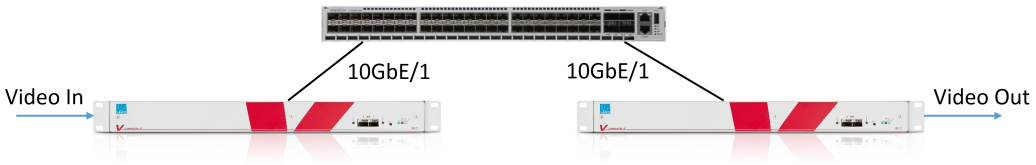


Figure 273

If one of the network connections fails or the switch fails the video signal at the output of the destination V__line is interrupted.

The maximum transport capacity over the 10Gb Ethernet out of one V__line device is:

- 4x HD video at 1.5Gb/s
- 3x 3G video at 2.97Gb/s
- 1x 4k video as 4 x 2.97Gb/s compressed with VC-2

Settings

This setup requires no special settings in the V__line and works with all IP timing modes (TxPTP, RxPTP, CRU).

Seamless Protection Switching (SPS)

Description

Seamless protection switching is also known as hitless merge and is standardized by SMPTE as SMPTE-2022-7. To achieve redundancy a second Ethernet switch is added and all V__lines involved are connected to both switches.

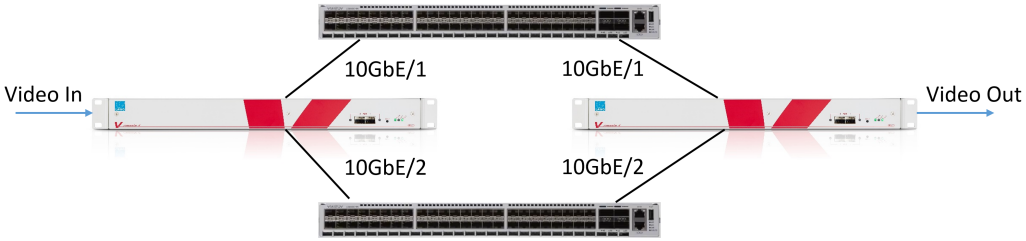


Figure 274

This setup provides network path redundancy. One switch or one network connection can fail without any interruption of the video at the output of the destination V__line. This mode does not protect you from the failure of a V__line. But you can add as many V_lines in parallel as wanted.

In this setup the same data from same origin is sent via the two paths using the same multicast address, the same sender IP address and the same RTP sequence numbers. At the receiving end both streams are received and the receiving V__line discards duplicate packets and re-orders packets that arrive out of order.

The maximum transport capacity over the redundant 10Gb Ethernet is:

- 4x HD video at 1.5Gb/s
- 3x 3G video at 2.97Gb/s
- 1x 4k video as 4 x 2.97Gb/s compressed with VC-2

Settings

The recommended setup is as-follows:

On sending and receiving V__line assign the 10GbE ports to separate VLANs (`Settings` -> `Switch` -> `RSTP`)

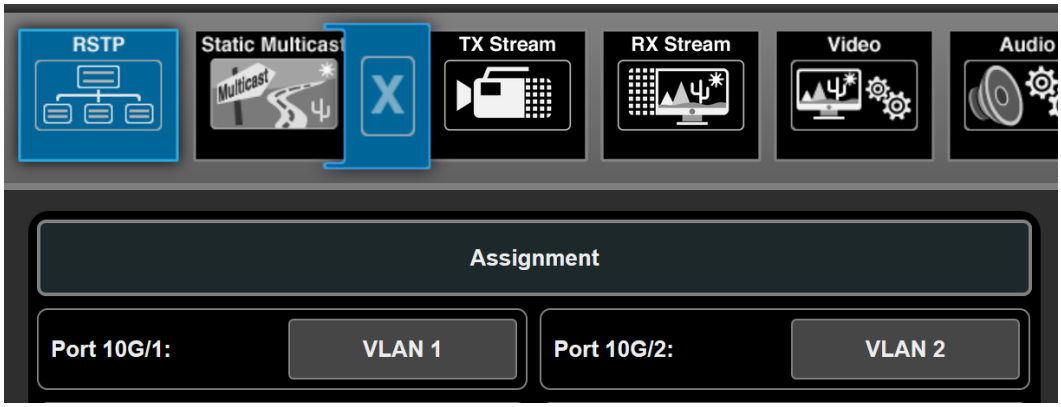


Figure 275

On sending and receiving V__line set the port classification to Managed Switch for both 10GbE ports (`Settings` -> `Switch` -> `IGMP`)

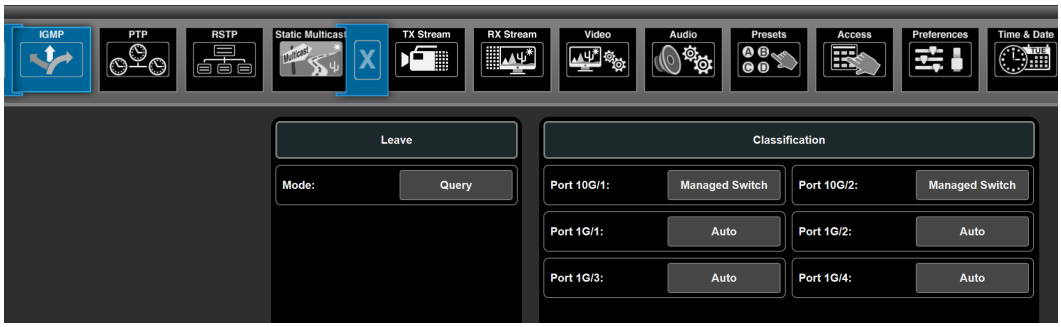


Figure 276

Enable the streams on the sending V__line (`Settings` -> `TX Stream` -> `Tx Enable`)

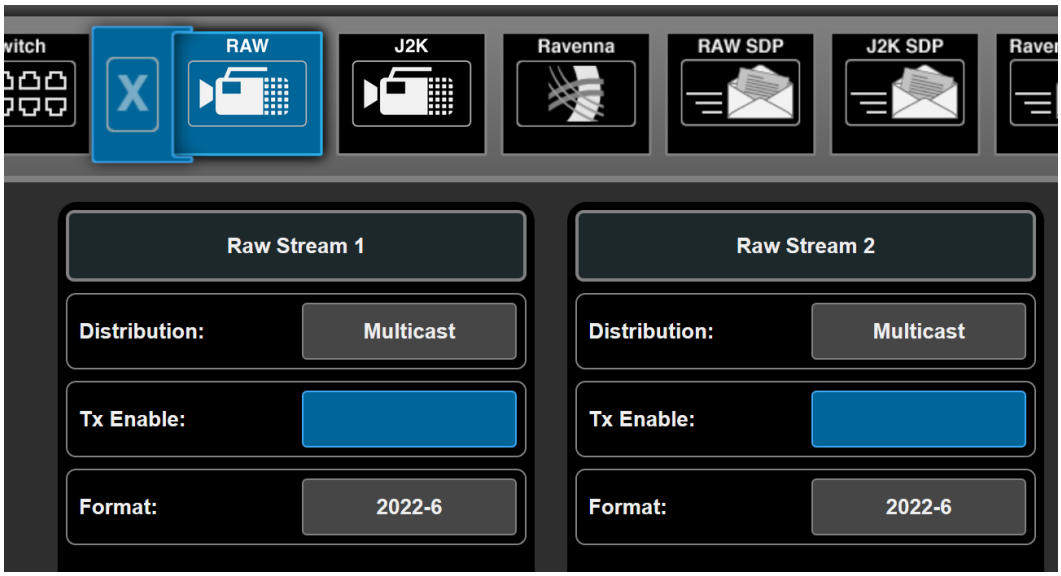


Figure 277

On the sending V__line assign the stream to both 10GbE ports (`Settings` -> `TX Stream` -> `RAW SDP`)

Figure 278

On the receiving V__line configure the Stream according to your network environment, default is “robust” to scope with higher packet delay variation values. (`Settings` -> `RX Stream` -> `Video CRU&TH`)

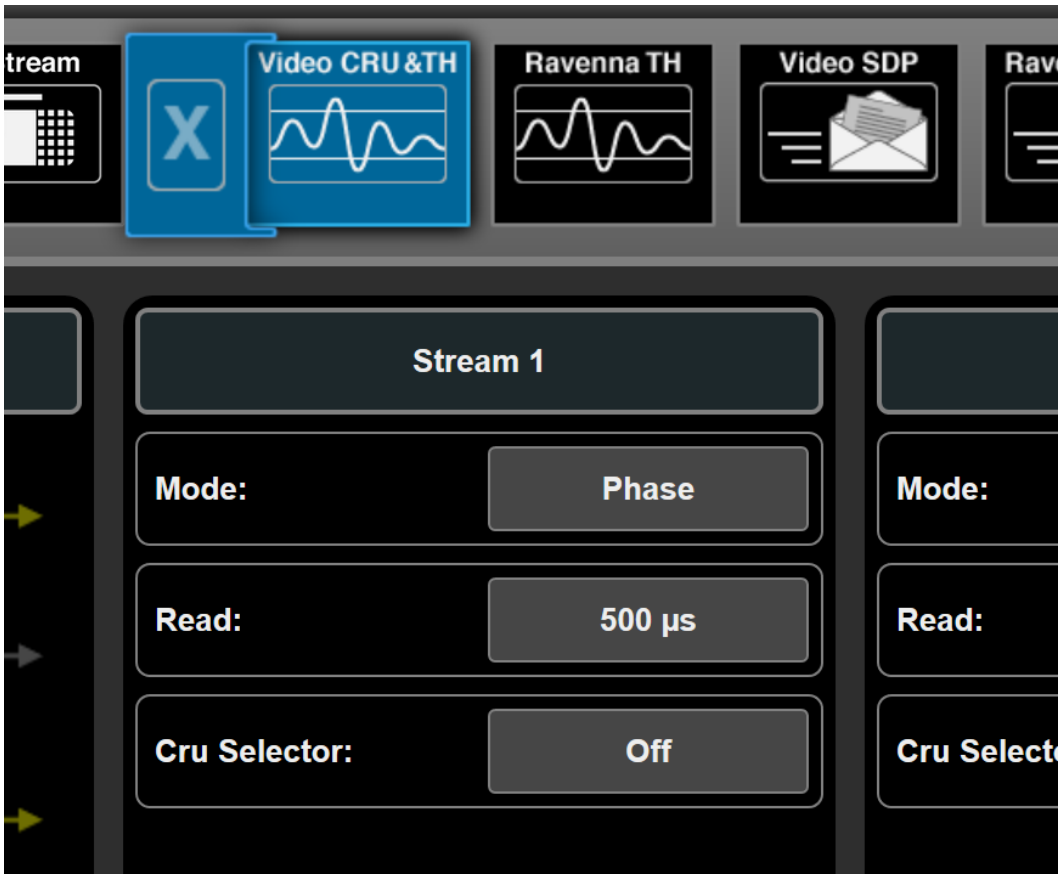


Figure 279

On the receiving V__line activate the stream receiver on both VLANs and choose TxPTP mode or RxPTP mode or CRU mode. (`Settings` -> `RX Stream` -> `Video SDP`)

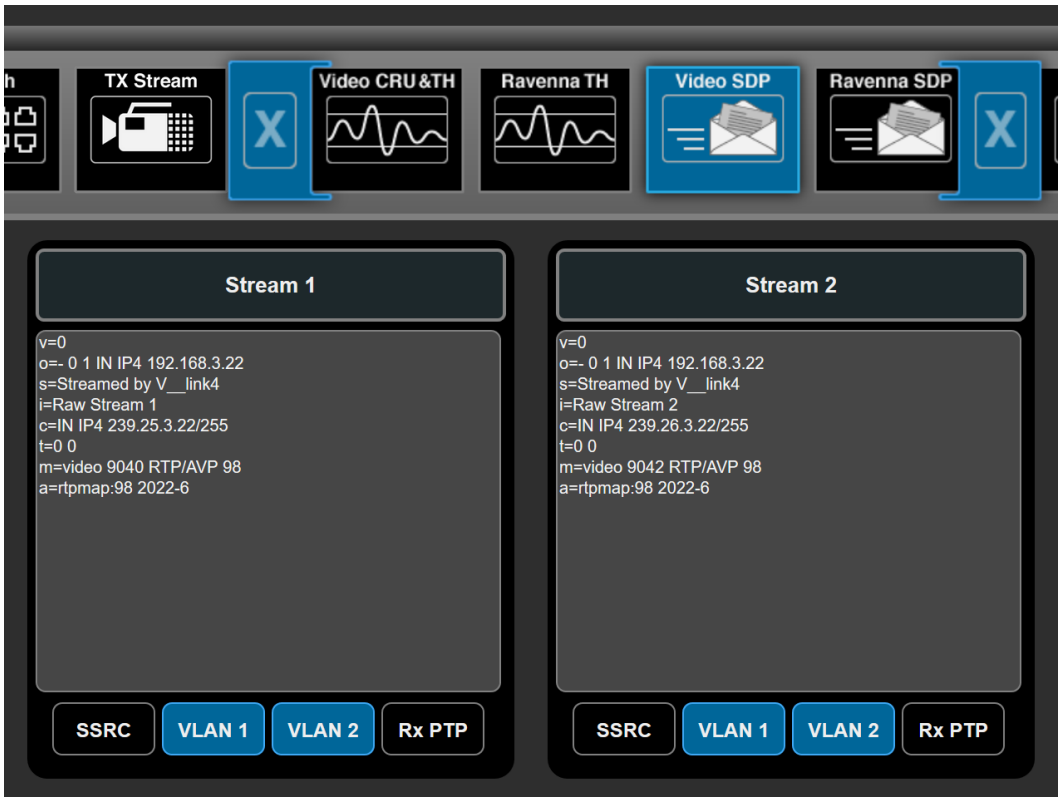


Figure 280

Copy the SDP information from the sending V__line, enter them into the receiving V_line and click `Take` to activate (From `Settings` -> `TX Stream` -> `RAW SDP` -> RAW Stream x to `Settings` -> `RX Stream` -> `Video SDP` -> Stream x)

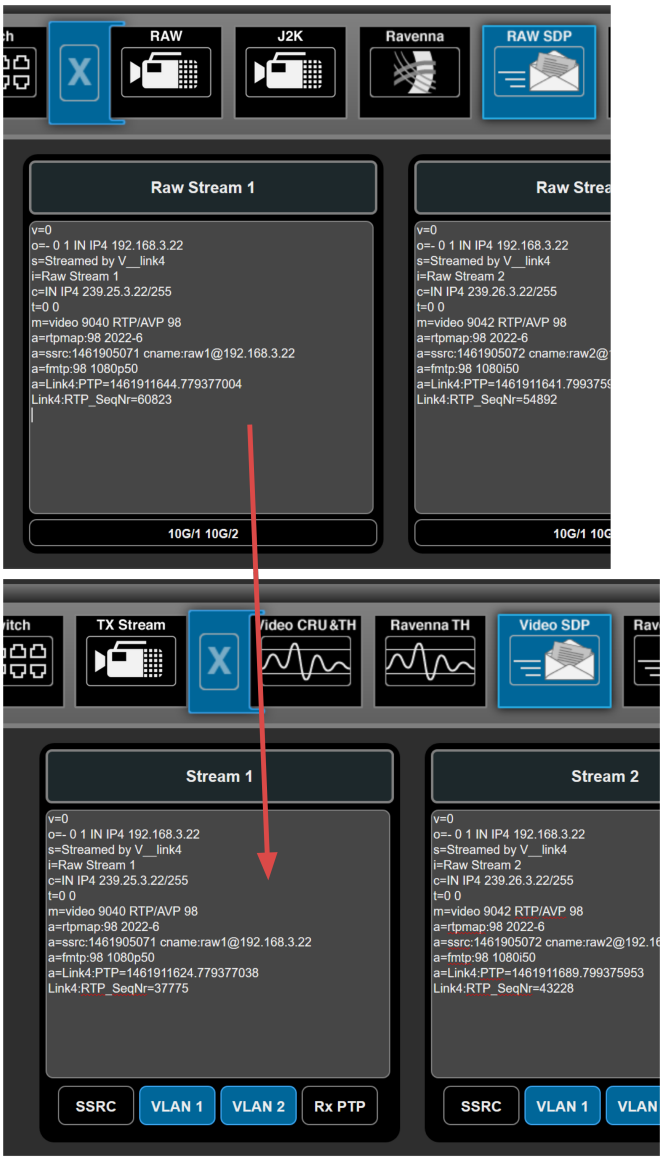

RAW
J2K
Ravenna
RAW SDP
Raw Stream 1
v=0
o=- 0 1 IN IP4 192.168.3.22
s=Streamed by V__link4
i=Raw Stream 1
c=IN IP4 239.25.3.22/255
t=0 0
m=video 9040 RTP/AVP 98
a=rtpmap:98 2022-6
a=ssrc:1461905071 cname:raw1@192.168.3.22
a=fmtp:98 1080p50
a=Link4:PTP=1461911644.779377004
Link4:RTP_SeqNr=60823
10G/1 10G/2
Raw Strea
v=0
o=- 0 1 IN IP4 192.168.3.22
s=Streamed by V__link4
i=Raw Stream 2
c=IN IP4 239.26.3.22/255
t=0 0
m=video 9042 RTP/AVP 98
a=rtpmap:98 2022-6
a=ssrc:1461905072 cname:raw2@
a=fmtp:98 1080i50
a=Link4:PTP=1461911641.799375
Link4:RTP_SeqNr=54892
10G/1 10G
TX Stream
Ravenna TH
Video SDP
Stream 1
v=0
o=- 0 1 IN IP4 192.168.3.22
s=Streamed by V__link4
i=Raw Stream 1
c=IN IP4 239.25.3.22/255
t=0 0
m=video 9040 RTP/AVP 98
a=rtpmap:98 2022-6
a=ssrc:1461905071 cname:raw1@192.168.3.22
a=fmtp:98 1080p50
a=Link4:PTP=1461911624.779377038
Link4:RTP_SeqNr=37775
SSRC
VLAN 1
VLAN 2
Rx PTP
Stream 2
v=0
o=- 0 1 IN IP4 192.168.3.22
s=Streamed by V__link4
i=Raw Stream 2
c=IN IP4 239.26.3.22/255
t=0 0
m=video 9042 RTP/AVP 98
a=rtpmap:98 2022-6
a=ssrc:1461905072 cname:raw2@192.16
a=fmtp:98 1080i50
a=Link4:PTP=1461911689.799375953
Link4:RTP_SeqNr=43228
SSRC
VLAN 1
VLAN

Figure 281

PTP Grandmaster

PTP Grandmaster redundancy schemes

Path redundancy

Setup one V__link4 / V__remote4 as PTP Grandmaster “Master only” and enable port based VLAN1 and VLAN2 and make appropriate port assignments e.g. 10GE port 1 mapped to VLAN1, 10GE port 2 mapped to VLAN2. PTP messages are send out on both VLANs thus enabling path redundant cabling to all other V__link4 / V__remote4s independent of their role as sender, receiver or both.

Hardware redundancy

Setup two V__link4 / V__remote4s as potential PTP Grandmaster “Master Slave” mode, configure main PTP GM by given this unit a higher priority. Enable redundancy mode. In case of main PTP GM fails, backup PTP GM takes over, if main PTP GM comes back it gets the lowest priority assigned dynamically and enters state “recovery”. In Recovery state it synchronizes its clock to the actual master and by means of pressing resume button or sending resume command via Ember+ the Main PTP GM takes over again seamlessly. Alternatively both units can be configured as 2master only“, in that case the rebooted former PTP GM comes back dynamically as slave in recovery state and can take over via resume trigger.

Path and hardware redundancy schemes can be combined.

In case of Analog Ref Master functionality and hardware redundancy both PTP GMs need to get the same, identical analog video reference input!

Use Cases

PTP based Video Referencing in non-PTP aware Networking

In non PTP aware networks, which have at least certain deterministic character e.g. principly symmetric behaviour like fiber cable, Rx and Tx have similar latency, packet delay variation which may be significant but not to big and not to random.

Local side: Configure one of your V_link4/remote4 machines as the PTP Grandmaster, analog ref master makes sense to adapt to local video reference. Redundant scheme with main and backup grandmaster and additional path redundancy is also possible.

Remote side: Set Timing Precision to Custom. Set Max Offset to 10.000nsec. Enable PTP, goto to Status Switch PTP and monitor variances. Lying within probability window, enough headroom to boundaries? Alternatively you may use the sounding feature to measure packet delay variation (jitter) on the network. E.g. measured PDV is average 10µsec, then try setting max offset to 20µsec and check if slave is calibrating. If needed increase max offset to higher value.

If calibrating is successful, monitor for quite some time the variances. If it stays within boundaries you may enable locking mode for the slaves and masters as well (always assuming constant continous stable analog reference input without!).

You may now also set all video receiver engines stream1 to stream4 to RXPTP mode which better compensates then for individual stream jitter.

Seamless Protection Switching

V__link4 / V__remote4

Streams are generated from one single edge device and send through to different pathes to receiver machine. Same multicast address, same sender address, same RTP sequence numbers, same stream. Receiver machine are receiving streams simultanously and storing the RTP packets into the receive/merge buffer. Second same/redundant RTP packet are discarded. Out of order packets are re-ordered.

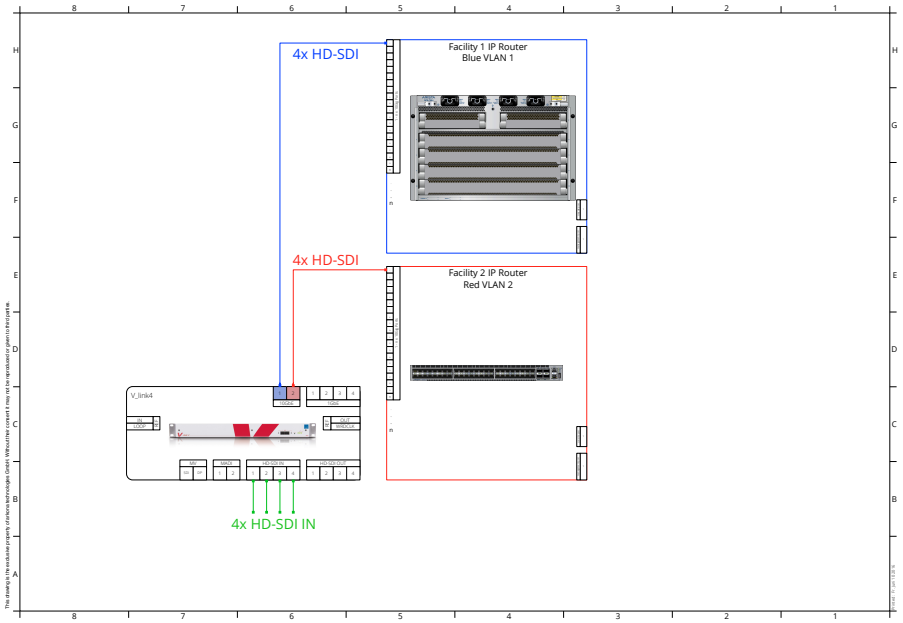


Figure 282 Single sender configuration

- Single machine getting 4x HD-SDI in and sending out 4x HD-SDI via 10GbE port 1 and 10GbE port 2 simultaneously.
- In addition Ravenna or AES67 audio streams may be sent out simultaneously as well.
- In addition J2K encoded streams may be send out simultaneously.
- In addition MJPEG monitoring streams may be sent out as single streams as well.

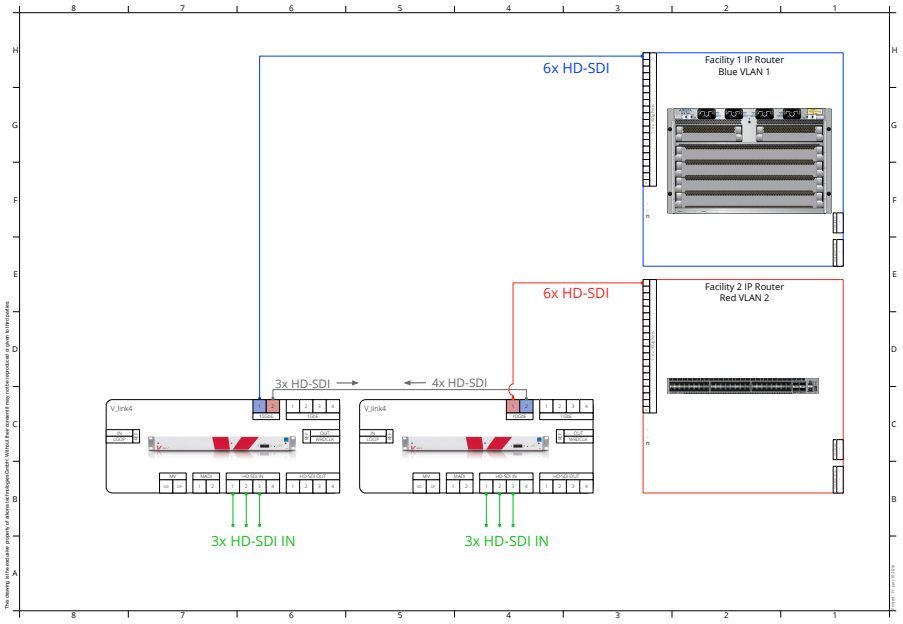


Figure 283 Dual sender configuration

Dual sender configuration can be used for loading each redundant 10GE line with 6x HD-SDI. Each unit is getting 3x HD-SDI and statically forwarding it's own 3 streams to the neighbourhood machine. Neighbourhood machine doing same vice versa, leading to configuration where each 10GE line out of left and right machine is carrying 6xHD-SDI on it. Configuration for static routing incl. VLAN bridging in Settings Switch Static Multicast.

Dual sender configuration avoids need for additional local aggregation switches.

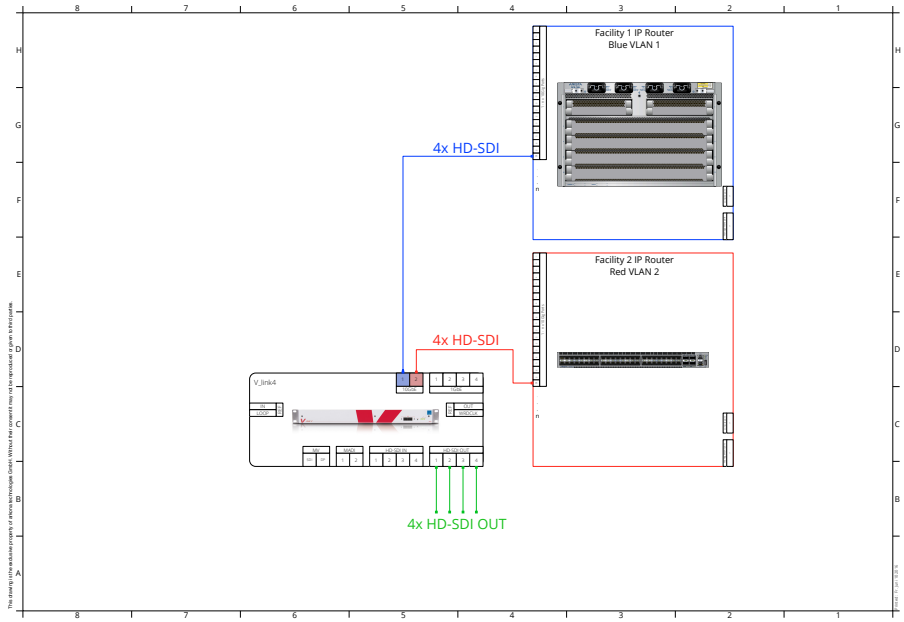


Figure 284 Receiver configuration

Additional redundant receivers possible.

Sender

In “half IGMP” mode, sender streams are statically assigned/routed to specific ports. Ports are mapped into different port-based VLANs, e.g. 10GE port 1 in VLAN1, 10GE port 2 in VLAN2. 10GE ports are wired to different switches ensuring path redundancy. Streams are enabled.

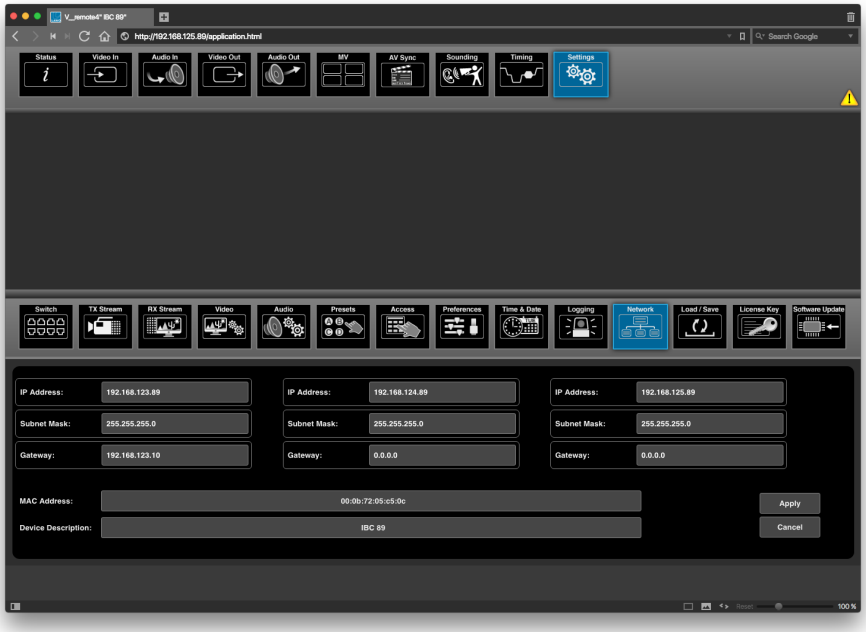


Figure 285

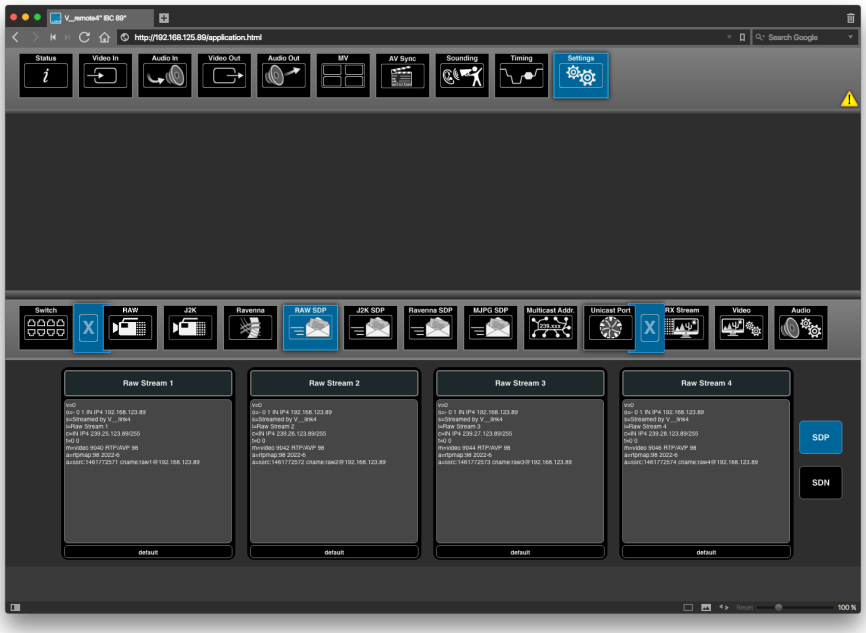


Figure 286

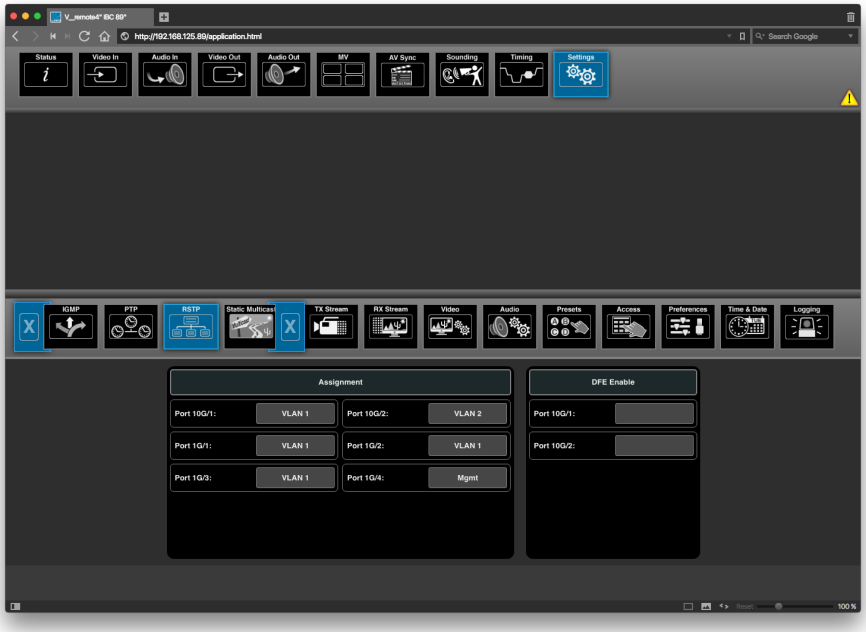

Status
Video In
Audio In
Video Out
Audio Out
MV
AV Sync
Sounding
Timing
Settings
IGMP
PTP
RSTP
Static Multicast
TX Stream
RX Stream
Video
Audio
Presets
Access
Preferences
Time & Date
Logging
Assignment
Port 10G/1:
VLAN 1
Port 10G/2:
VLAN 2
Port 1G/1:
VLAN 1
Port 1G/2:
VLAN 1
Port 1G/3:
VLAN 1
Port 1G/4:
Mgmt
DFE Enable
Port 10G/1:
Port 10G/2:

Figure 287

Receiver

Define read offset mode or value for video, define read offset value for audio.

Video SDP setting: enable VLAN1 and enable VLAN2. Define CRU vs. RxPTP vs. TxPTP mode. Input SDP data set into Video SDP stream receiver area and double-clicking in area will trigger IGMP join. Access layer switch should operate in report flooding mode or similar or alternatively port where V__link4 / V__remote4 is connected to should be disabled as MRouter port to avoid flooding.

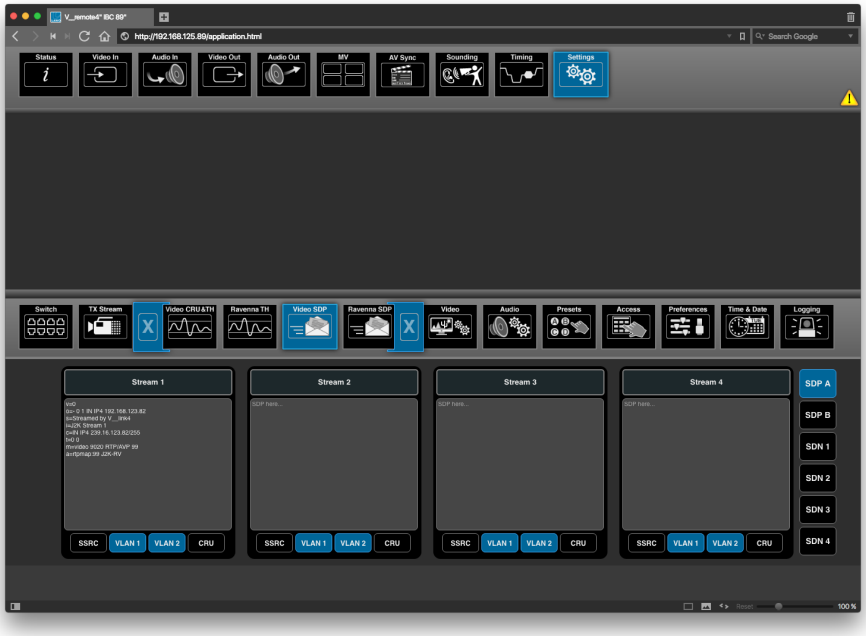


Figure 288

Switch port settings IGMP in sender and receiver should be set to “managed switch”.

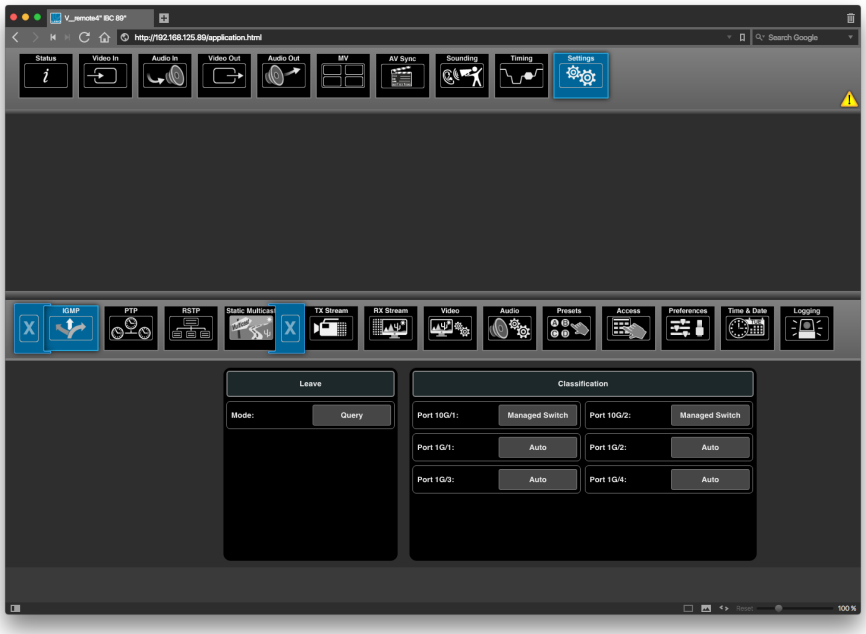


Figure 289

In Free Run mode receiver will work in cru mode, means clock recovery on incoming streams is active. CRU will lock to incoming streams. Depending on path delay offset read offset value should be set to half buffer size e.g. 15msec for max tolerance. With current max. buffer of nearly 60msec currently with 2022-6 1080i50 max path offset + jitter headroom is about 15msec. Remark : Current development of more jitter tolerant CRU will also perform averaging/smooth transition in case of seamless protection switching mode.

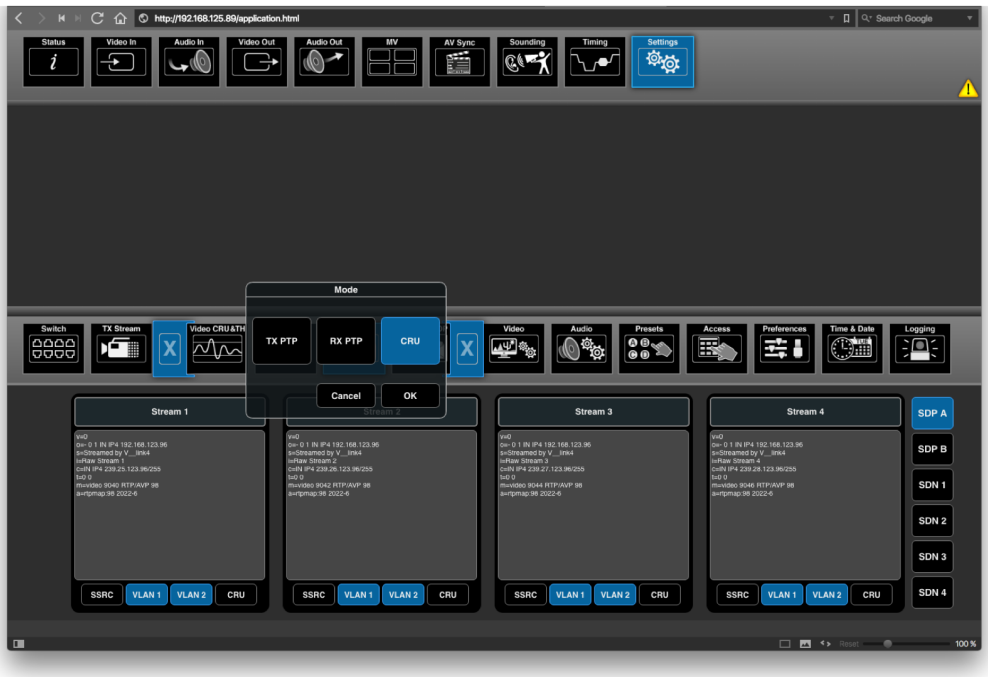


Figure 290

In PTP synced mode ... receiver can work based on absolute timing = TxPTP or relative timing = RxPTP mode. In TxPTP mode read offset value = max path delay + jitter headroom. In RxPTP mode read offset = max buffer / 2, similar to CRU mode.

PTP / PTP clk mode: a way to establish precise synchronized clocks in (distributed) IT infrastructure and derive video reference from it.

SSRC = synchronization source identifier: used in enhanced protection switching mode to disable receiver for the sending streams which has changed its SSRC.


http://192.168.125.89/application.html
Search Google
Status
Video In
Audio In
Video Out
Audio Out
MV
AV Sync
Sounding
Timing
Settings
Out 1
Out 2
Out 3
Out 4
Out 5
Out 6
Out 7
Out 8
In 1
In 2
In 3
In 4
In 5
In 6
In 7
In 8
Stream Statistics: Video In 5 (Raw)
Total
past second
Read
269815
Read Missing
0
0
Write Request
539628
Write Duplicate
2632960260
269814
Write Early
59112
0
Write Late
21023
0
Write Invalid
0
0
Distance Min
4093
Distance Max
4094
Video In
Audio In
System
RX Stream
Packet rate
Error rate
Error total
Video In 5 (Raw) 539628/s 0/s 0
Video In 6 (Raw) 539628/s 0/s 1294 15 ms 15 ms -0.0 ppm
Video In 7 (Raw) 269815/s 0/s 712 30 ms 30 ms +0.0 ppm
Video In 8 (Raw) 269816/s 0/s 2161 30 ms 30 ms +0.0 ppm
Rav Audio 1 6000/s 0/s 0 N/A N/A N/A
Rav Audio 2 6000/s 0/s 0 N/A N/A N/A
Rav Audio 3 5998/s 0/s 0 N/A N/A N/A
Rav Audio 4 6000/s 0/s 0 N/A N/A N/A
Rav Audio 5 6000/s 0/s 0 N/A N/A N/A
Rav Audio 6 6000/s 0/s 0 N/A N/A N/A
15.182 ms
20 ms
15.181 ms
15.180 ms
10 ms
15.179 ms
15.178 ms
15.177 ms
+0.2 ppm
+0.1 ppm
+0.0 ppm
-0.1 ppm
-0.2 ppm
-12 s
-8 s
-4 s
100 %

Figure 291

Enhanced Protection Switching

Streams are generated from same video input signal in different edge device A and B and send through to different paths to receiver machine. E.g. same video signal taken from two parallel camera outputs or two parallel server outputs etc. Different multicast addresses, different RTP streams with different sequence numbering, different streams generated in different edge device going different pathes, streams having unique SSRC-Ids.

Precondition is PTP based operation and if embedded audio should be used, then synchronous operation as well. EPS setup can be managed manually by copying SDP A and SDP B data or via control system VSM. SDP data contains relation of sequence numbers for matching streams from A and B based on PTP.

Receiver machine are receiving streams simultaneously and storing the RTP packets into the receive/merge buffer with rtp sequnce number offset matching. Second redundant RTP packet are discarded. Out of order packets are re-ordered.

Single Sender configuration A and B:

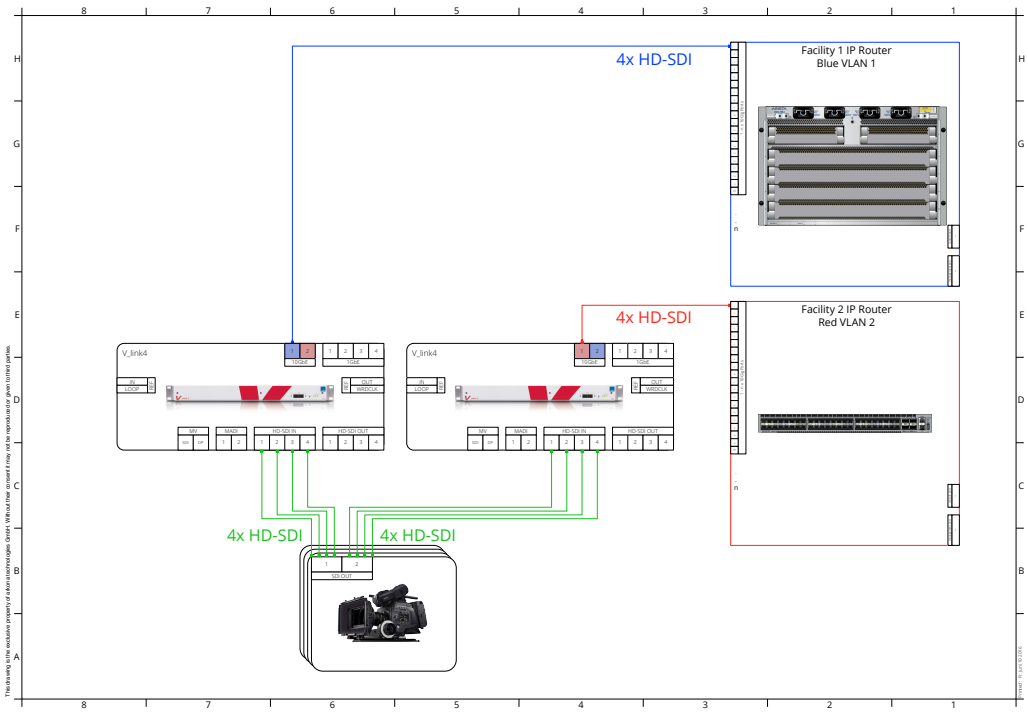


Figure 292

Triple-sender configuration A and B:

> The configurations for A (blue facility 1) and B (red facility 2) are identical.

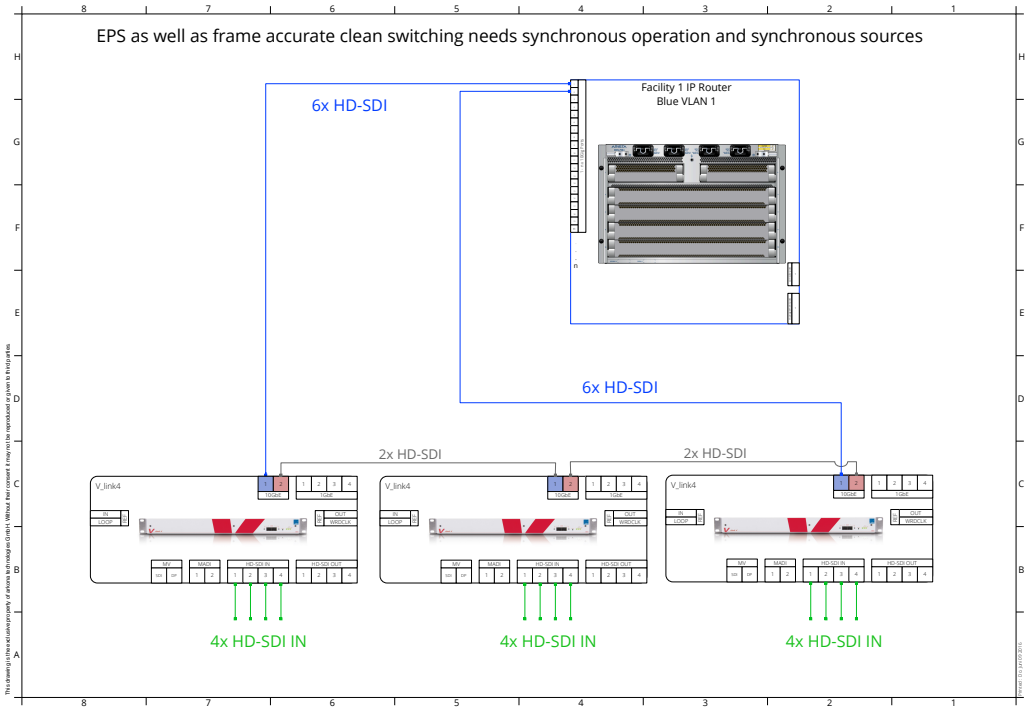


Figure 293

Triple sender confiurations serves to load 10GbE lines with 6x HD-SDI signals in balanced ways.

Receiver configuration:

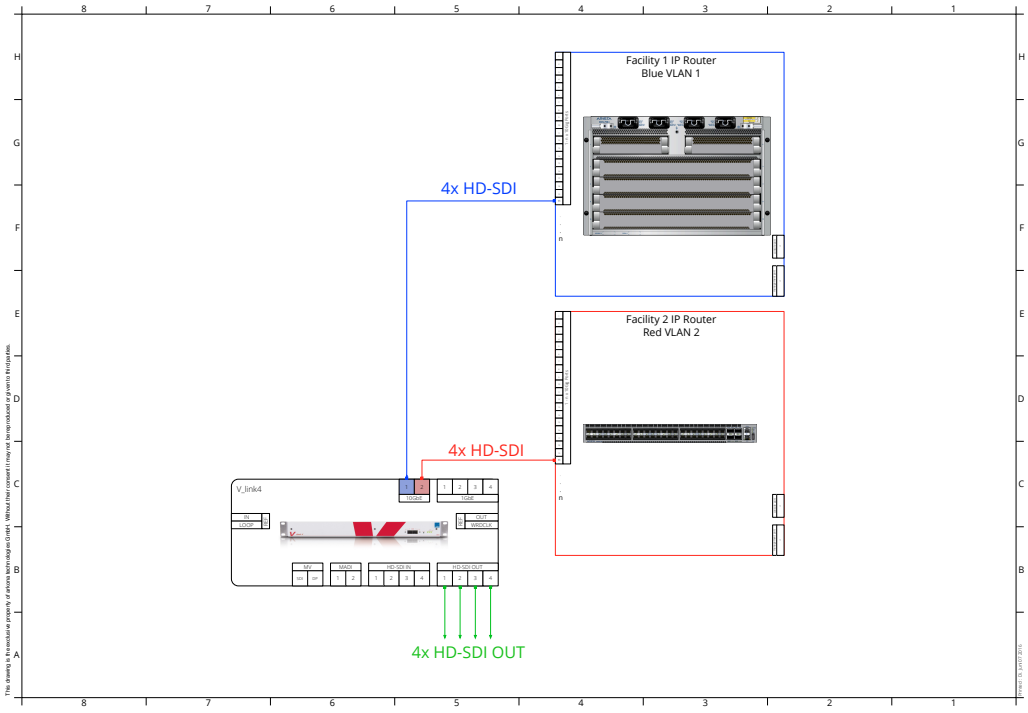


Figure 294

As many redundant receivers possible as wanted.

Sender

In “half IGMP” mode, sender A and sender B streams are statically assigned/routed to specific ports. Ports are mapped into different port-based VLANs, e.g. 10GE port 1 in VLAN1, 10GE port 2 in VLAN2 for sender A and vice versa for sender B. Static MC routing are needed for dual or triple sender configurations. 10GE port of each sender are wired to different switches ensuring edge, device, path and switch redundancy.

Streams are enabled. If embedded audio is used from 2022-6 transport streams, then bypass needs to be activated for respective input.

Figure 295

In triple sender configuration, the 4 streams generated by the middle machine are sent to each neighbourhood machine by static multicast routing - 2 streams to the left, 2 streams to the right.

For Enhanced Protection Switching, all machines must run in PTP Clk mode. In Settings `TX Stream` -> `RAW SDP` submenu you can view the corresponding SDP data which contains information regarding PTP time and respective RTP sequence numbering. SSRC as unique identifier for continuous stream is also contained.

Example SDP data

v=0 o=- 0 1 IN IP4 192.168.123.77 s=Streamed by V__link4 i=Raw Stream 1 c=IN IP4 239.25.123.77/255 t=0 0 m=video 9040 RTP/AVP 98 a=rtpmap:98 2022-6 a=ssrc:1465312484 cname:raw1@192.168.123.77 a=fmtp:98 1080i50 a=Link4:PTP=1465560541.680215203 Link4:RTP_SeqNr=166

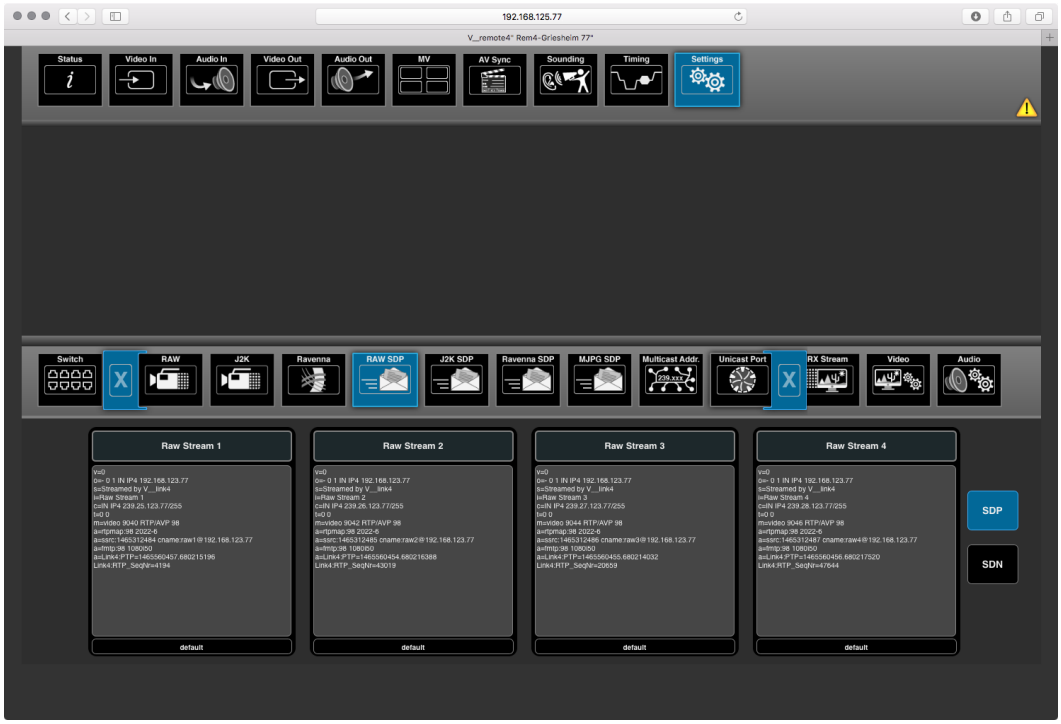

192.168.125.77
V_remote4° Rem4-Griesheim 77°
Status
Video In
Audio In
Video Out
Audio Out
MV
AV Sync
Sounding
Timing
Settings
Switch
RAW
J2K
Ravenna
RAW SDP
J2K SDP
Ravenna SDP
MJPG SDP
Multicast Addr.
Unicast Port
RX Stream
Video
Audio
Raw Stream 1
Raw Stream 2
Raw Stream 3
Raw Stream 4
default
default
default
default
SDP
SDN

Figure 296

Receiver

Define read offset mode or value. Video SDP setting: Enable respective VLAN1 or VLAN2 for Rx SDP A and SDP B. Select TxPTP mode. Input SDP data set A into Video SDP A stream receiver area and SDP data set B into Video SDP B stream receiver area. Click Take to activate each SDP. SSRC filtering should be enabled.

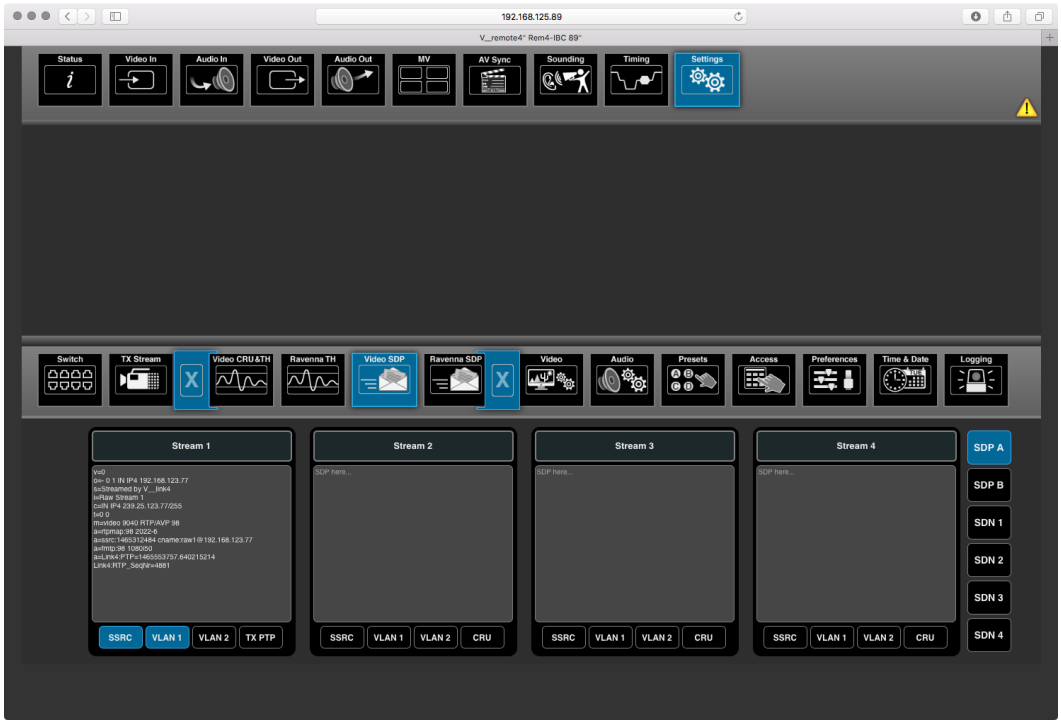


Figure 297

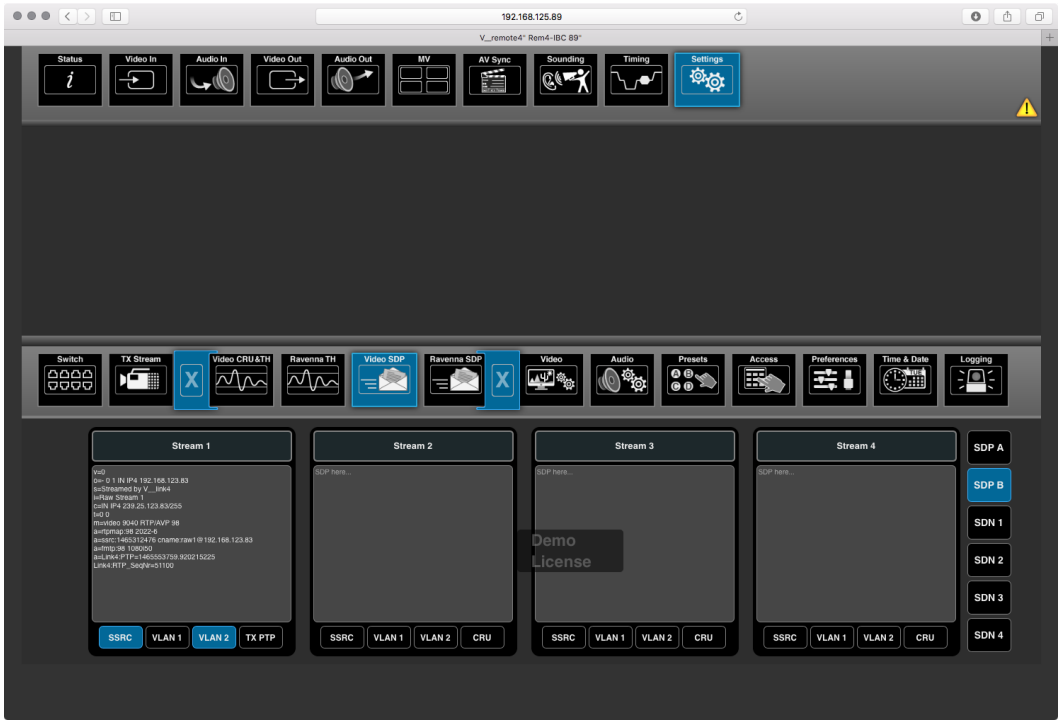


Figure 298

Switch port stettings IGMP in sender and receiver should be set to “managed switch”.

For Enhanced Protection Switching as well as Source-Timed Frame Accurate Clean Switching. CRU need to work in TxPTP mode.

SSRC = synchronization source identifier: used in enhanced protection switching mode to disable receiver for the sending streams which has changed its SSRC. Change of SSRC, means new SSRC, happens after disabling/enabling streams, reboot of machine. This indicates that the stream sender has set up a new RTP stream which has not the same correlation of RTP sequence numbers as the previous one. With SSRC filtering on and changed SSRC the FPGA based merge handler will disable the stream with unmatched SSRC and machine reports this to GUI and external control system. Re-inserting/updating the SDP data for the new stream will repair that and enable enhanced protection switching continuity. display statistic data regarding stream receiver e.g. packet duplicates and buffer usage Dist Min / Dist Max. Write early, write late counters are showing if stream input data are running out of buffer window.

Figure 299

Figure 300

SW Defined Networking & Source Timed Frame Accurate Clean Switching SMPTE2022-6

Each source edge device V__link4 / V__remote4 “A” and “B” is capable of sending multicast streams with two selectable different source port addresses or another mean to distinguish a single sender stream. The switch is able to handle port-specific flow rules via OpenFlow or another mean to be able to handle flow rules port-specfic and define routes. All edge devices are PTP synchronized, the control system has proper PTP information. The switch should be a PTP aware switch or simply fast enough. The switch has no need to know anything about video timing. The interactive VSM/SDN IP and Studio Control system is setting up the switch-internal flow tables in a way that multicast streams are available at the destination edge device. In the SDN controlled IP video network, video stream routes are directly set within the flow table of a switch.

Switching One Source to One Output

In this example, a stream from source V__link4 / V__remote4 “A” to destination V__link4 / V__remote4 “C” should be replaced by a stream from source V__link4 / V__remote4 “B”. Initially, one single flow rule is active. It specifies a stream flow from source V__link4 / V__remote4 “A” 239.25.123.53:9040 to destination V__link4 / V__remote4 “C”.

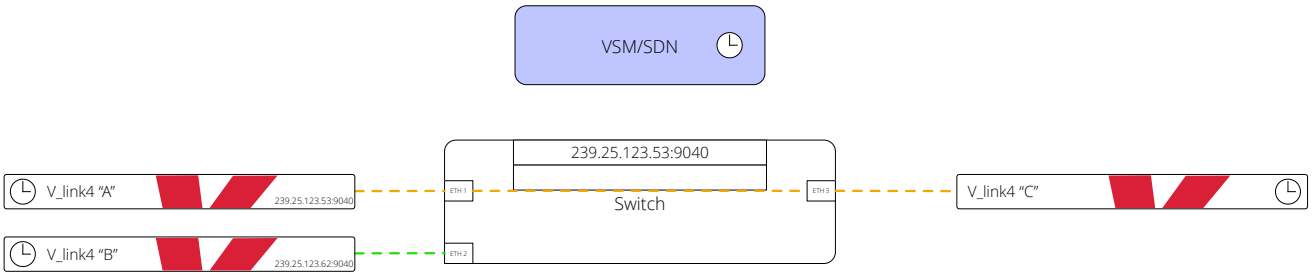


Figure 301

To prepare the switching, the SDN selects the next source port identifier (1040) and adds a new flow rule from V__link4 / V__remote4 “B” (239.25.123.62:1040) in the flow table. If the stream from source “A” is used with other destinations, the associated switch flow rules with next source port identifier must be added by the SDN for these destinations to. The SDN controller also tells Source “B” to prepare a timed switch over using next port identifier 1040 and tells Source “A” to prepare the exact same timed switch over using next port identifier 1040.

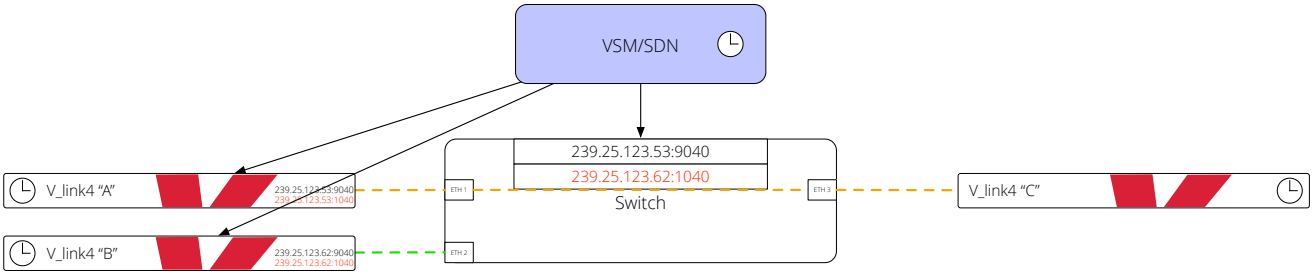


Figure 302

Source-timed switch over takes place at defined time.

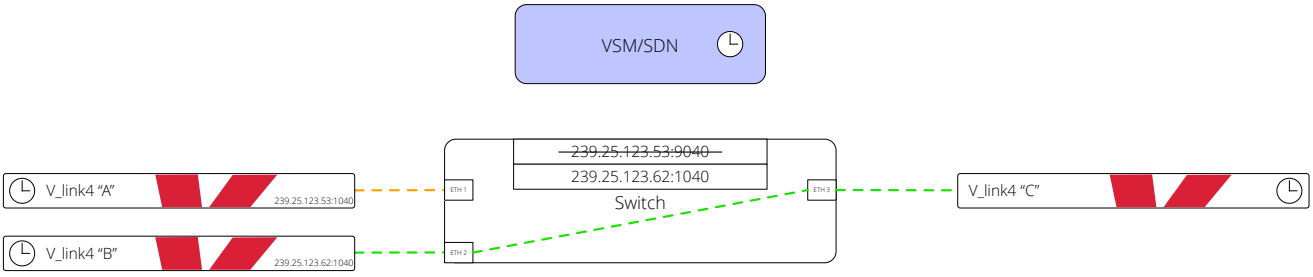


Figure 303

When the timed clean switch was executed and acknowledged the SDN controller clears the switch flow tables accordingly.

For better and balanced control efficiency the control system should always keep two flows in the switch flow table per destination device with identical IP address and the two alternate sender attributes.

How to setup and control source-timed Clean Frame Accurate Switching SMPTE 2022-6

- Source-timed switching executed in V_line edge devices, no time critical control/execution in Ethernet switch, no time critical control execution in control/management system
- All V_line edge devices are controlled via Ember+
- Each sender can user source port A or source port B as source port id for sending multicast streams; receiver has two entry SDP fields for receiving single streams
- (Open flow or by other means) controlled ethernet switch has always two flow rules active for one single destination
- Per default both flow table entries are set to sender multicast address with source port A for one entry and source port B for second entry

```
SDN_Init()
{
    //on sender and receiver
    SDN->RawMng->ConnectedPort = 0;//0- 10G port1 eth, 1- 10G port 2 eth
    //on sender
    SDN->RawS0->ActivateSDN = true;
    SDN->RawS1->ActivateSDN = true;
    SDN->RawS2->ActivateSDN = true;
    SDN->RawS3->ActivateSDN = true;
  // on receiver
    SDN->RawR0->useSDN = true;
    SDN->RawR1->useSDN = true;
    SDN->RawR2->useSDN = true;
    SDN->RawR3->useSDN = true;
}

SDN_Switch(currentSender,currentSenderStreamID, NewSender, NewSenderStreamID, Receiver,
ReceiverStreamID, EthernetSwitch)
{
    //Copy SDP
   //Receiver->SDN->RawR[ReceiverStreamID]->activeSDN shows currently used SDN SLOT; by default=
nonExisting value, need to select a slot initially
   freeSDNSLOT = not (Receiver->SDN->RawR[ReceiverStreamID]->activeSDN);
   Receiver->SDN->RawR[ReceiverStreamID]->sdpSDN[freeSDNSLOT] = NewSender->SDN->
   RawS[NewSenderStreamID]->sdp;

  //configure ethernet switch (Arista for example with openFlow)
    EthernetSwitch->setSecondRoutingTableEntry(Receiver->portAfterSwitch =
    NewSender->portAfterSwitch)

   //activate switching execution for current and new sender
    currentSender->SDN->RawS[currentSenderStreamID]->switchBit = true;
    newSender->SDN->RawS[newSenderStreamID]->switchBit = true;
```

```
   //define PTP time to switch: calculation of switch point in future, absolute PTP timing,
   switch point approx. in the middle of a video frame
    switch_PTP_time = get_Current_PTP_time() + timeOffset (e.g. 3 frames = 120msec/50Hz);
    // trigger switch execution... switch execution will be activated at absolute PTP time latched
with next StartOfFrame in each machine
    currentSender->SDN->RawMng->switchTime = switch_PTP_time;
    newSender->SDN->RawMng->switchTime = switch_PTP_time;
    Receiver->SDN->RawMng->switchTime = switch_PTP_time;

   // wait until active source port has changed for current and new sender
    wait_until_source_ports_changed();

   //reset ethernet switch second routing table entry
    EthernetSwitch->resetSecondRoutingTableEntry(currentSender->portBeforeSwitch to
    Receiver->portBeforeSwitch);

}
```

Setting up your IT Environment

COTS Switch Configuration

Remarks:

1. For proper igmp based plug'n play operation COTS switch(es) should have "report flooding" or similar feature. For switches which do not offer this functionality there's the need to configure V__link4 / V__remote4's with static multicast streaming and disable auto-detection / dynamically setting ports to Multicast-Router ports within the switch or disable IGMP querier function inside V__link4 / V__remote4 built-in switch fabric.
2. If you are not easing a V__link4 / V__remote4 only network, fast leave or immediate leave modes should be switched off as there's no common standard for that.

Arista

console / terminal port: 9600 baud, no flow control, 1 stop bit, no parity, 8 data bits

SW Version: 4.4.16M

Arista DCS-7150S-24

Remarks:

- ports where V_link4's are connected need to operate in "report flooding mode"
- ports where other equipment e.g. PC's are connected should not operate in report flooding mode
- igmp immediate leave feature need to be disabled
- Arista switch should operate as igmp querier –> need to have "lowest" querier ip-address then
- ...

connect via console cable and Putty or equivalent to console port

```
<cret>
user admin
localhost>zerotouch cancel              /restarting system
localhost>enable
localhost#configure terminal
localhost(config)#username admin secret <admin>           /password=admin
localhost(config)#interface management 1
localhost(config-if-Ma0)#ip address <192.168.124.89> 255.255.255.0
localhost(config-if-ma0)#end
localhost(config)#management ssh
localhost(config)#interface Vlan 1
localhost(config-if-Vlan1)#ip address <192.168.123.19> 255.255.255.0
localhost(config)#end

switch(config)#hostname <name>
//switch(config)#ptp source ip <192.168.123.19>
//switch(config)#ptp mode e2etransparent
```

```
switch(config)#spanning-tree mode mstp
switch(config)#exit
localhost#copy running-config startup-config
```

connect via ethernet

```
ssh admin@<192.168.123.19>
user admin
switch>enable
switch#configure terminal
switch(config)#ip igmp snooping
switch(config)#ip igmp snooping vlan 1
switch(config)#no ip igmp snooping vlan 1 immediate-leave
switch(config)#ip igmp snooping report-flooding
switch(config)#ip igmp snooping vlan 1 report-flooding
switch(config)#ip igmp snooping report-flooding switch-port ethernet 1-16
switch(config)#ip igmp snooping report-flooding switch-port ethernet 21-24
switch(config)#ip igmp snooping querier
switch(config)#ip igmp snooping vlan 1 querier
switch(config)#ip igmp snooping querier address <192.168.123.19>
switch(config)#ip igmp snooping vlan 1 querier address <192.168.123.19>
switch#copy running-config startup-config
switch#
```

Cisco

as according to our knowledge Cisco switches are not supporting report flooding option or similar feature, you need to statically disable dynamic multicast router port detection and work with V__link4 / V__remote4's like hosts.

From Cisco feature description...

Multicast Router Discovery and Static Configuration

IGMP snooping discovers mrouter ports dynamically. You can also explicitly configure a port as an mrouter port.

- Discovery—IGMP snooping identifies upstream mrouter ports in the bridge domain by snooping IGMP query messages and Protocol Independent Multicast Version 2 (PIMv2) hello messages. Snooping PIMv2 hello messages identifies IGMP nonqueriers in the bridge domain.
- Static configuration—You can statically configure a port as an mrouter port with the mrouter command in a profile attached to the port. Static configuration can help in situations when incompatibilities with non-Cisco equipment prevent dynamic discovery. The router-guard command prevents a port from becoming a dynamically discovered mrouter port by filtering out multicast router messages, including IGMP queries and PIM messages. You can configure a port with the router-guard command and then configure it as a static mrouter. See the Router Guard and Static Mrouter, on page 15 for more information about configuring router-guard and mrouter commands on the same port.

Alternatively switch off IGMP Querier mode of V__link4 / V__remote4.

Understanding Port Fast

If working with V__link4 V__remote4 edge devices with our built-in switch fabric, make sure you do not have “Port Fast” feature enabled in Cisco switches as this risks creating spanning-tree loop.

Setting Up External Syslog Servers

If you want to receive syslog data on your PC, do the following steps to receive syslog data that is delivered on port 514 (udp) by default.

Make sure that your firewall allows incoming messages on that port.

Linux

> The following steps describe the configuration of Linux Mint 17+ or Ubuntu 14+ OS's. If you have another distribution, please check for differences e.g. if your system uses rsyslog or syslog-ng.

1. Open a terminal window.
2. Enter `sudo nano /etc/rsyslog.conf`. It should now look like this:

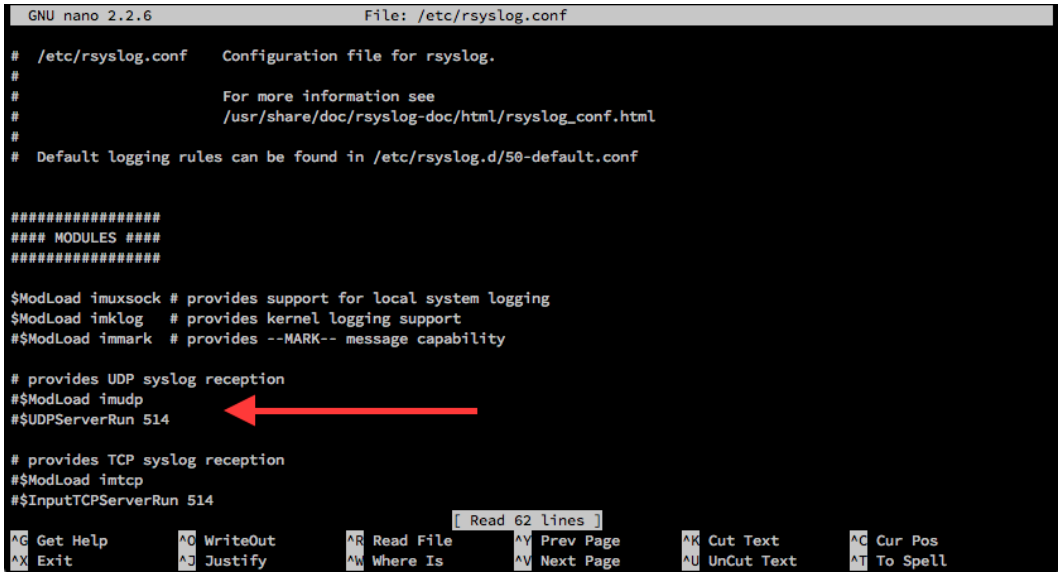


Figure 304

3. Now remove the hashtags of the lines `ModLoad imudp` and `UDPServerRun 514` like in the image below:

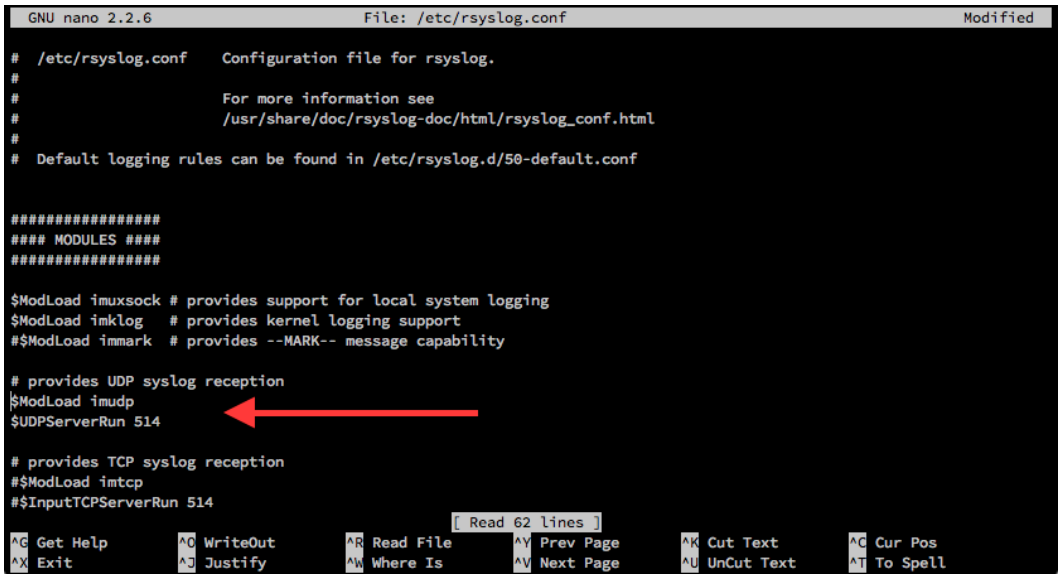


Figure 305

4. Save the changes and restart your PC to take effect.
5. You can now either open your syslog tool or open a terminal and enter the tail and grep command. For example if you want syslog messages containing the temperature, write:

Figure 306

The option `-f` tells the tail command to “follow” your syslog data, so it will be updated when new messages arrive and `-i` tells the grep command to be case insensitive.

Mac

Due to SIP changes in 2015, you are not allowed to change the syslogd configuration to receive messages.

If you want to receive messages anyway, follow the solution described on the **Apple Discussion page.**.

Windows

For Windows, you can install one of the many syslog server programs. For an overview of programs, please go to **alternativeto.net**. Some free solutions are the “Kiwi Syslog Server Free Edition”, “Paessler PRTG Syslog”, “The Dude” and others. Please look if you can work with the given limitations of the free softwares.

Technical Data

Video Interfaces

Video Signal Input/Output	4x 3G/HD/SD-SDI inputs via BNC connector 4x 3G/HD/SD-SDI outputs via BNC connector 1x 3G/1080i QS output via BNC DisplayPort for local QS monitoring
Video Reference Signal input/Output	BB/Tri-level, WordCLK input via BNC connectors Loop thru, WordCLK, BB/Tri-Level output via BNC connectors
Video Standards	
2,97Gbps Video Standards (1080p)	1080p 60Hz SMPTE-424M, 425M Level A & Level B 1080p 59.94Hz SMPTE-424M, 425M Level A & Level B 1080p 50Hz SMPTE-424M, 425M Level A & Level B 1080i 60Hz SMPTE-274M(4),-292M(D) 1080i 59.94Hz SMPTE-274M(5),-292M(E) 1080i 50Hz SMPTE-274M(6),-292M(F) 1080p 30/29.97/25/24/23.976sf 1080p 30Hz SMPTE-274M(7)-292M(G)
1,485Gbps Video Standards (HD)	1080p 29.97Hz SMPTE-274M(8)-292M(H) 1080p 25Hz SMPTE-274M(9)-292M(I) 1080p 24Hz SMPTE-274M(10)-292M(J) 1080p 23.976Hz SMPTE-274M(11)-292M(K) 720p 60Hz SMPTE-296M(1),-292M(L) 720p 59.94Hz SMPTE-296M(2),-292M(M) 720p 50Hz SMPTE-296M(2),-292M(M)
270Mbps Video Standards (SD)	576i 16:9 and 4:3 SMPTE-259M(C) 480i 16:9 and 4:3 SMPTE-259M(C)
Video Reference	Analog Genlock High definition tri-level sync SMPTE-274M/296M Analog Genlock SD 1V BB SMPTE-170M/318M SDI, IP-VidStream, IEEE1588 PTPv2+VidRef (RV or SMPTE2059*)
Return loss	SD: > 15dB HD: > 15dB 3G-HD: >15dB 5MHZ-1.485GHz, >10dB 1.485GHz-2.97GHz
Cable length	SD: >350m (using Belden1694A) HD: >180m (using Belden 1694A) 3G-HD: >120m (using Belden1694A)

Audio Interfaces

Audio Signal Input/output	2x MADI/AES10 optical in/out via LC connector front (redundant mode selectable) SDI embedded Audio via BNC connector
Audio Reference Signal Input/Output	BB/Tri-Level, WordCLK input via BNC connectors WordCLK output via BNC connectors
Audio Standards	SMPTE 299 / 48 MADI / AES10 Ravenna / AES67

Metadata

ATC (LTC, VITC1, VITC2)	SMPTE12M-2
Binary group data	SMPTE309
AFD	SMPTE2016
Audio Meta Data	SMPTE2020
Closed-Caption	SMPTE334
VBI data services /DTV descr.	SMPTE334
ANSI/SCTE104	SMPTE2010
DVB/SCTE VBI	SMPTE2031
Teletext	OP-47
Source-ID	OBS-special
User App Id	DID C1/C4 (Sony HDC cam)

IP Interfaces, Switch

Gigabit Ethernet	4x RJ45 100/1000Base-T, 2x POE
10GE Ethernet	2x SFP+, redundant operation selectable*
Protocols	IPv4/UDP/TCP/RTP/RTCP, ARP, RSTP, LLDP, IGMPv2, Diffserv/TOS, IEEE1588 PTPv2 (transparent clock)
Switching capacity	max. 40Gbps, video&audio content streaming max. 10Gbps

Processing

Video resolution	10 bit 4:2:2
Audio resolution	24 bit, 48kHz
Video encapsulation (10 bit 4:2:2)	Raw/Uncompressed or VC-2 compressed encoding and decoding (SMPTE2022-6 vs. RV) JPEG2000 encoding and ecoding (VSF-TR01 vs. RV)
Forward Error Correction (FEC)	not (yet) planned
Seamless protection switching (Hitless Merge)	compliant with SMPTE2022-7
Raw encoding & decoding	4x
Video only encoding bitrates	2.5Gbps, 1.25Gbps, ...
Latency	< 1 line

Processing contd.

VC-2 (DiracPro) encoding & decoding	4x for 3G-SDI
Video encoding ratio	2.5:1
Video encoding bitrate	1.5Gbps
Latency	< 40 lines
JPEG2000 encoding & decoding	4x with HD/SD-SDI, 2x with 3G-SDI
Video encoding ratio	typ. 10:1
Video only encoding bitrates	up to 250Mbps 2x single mode, upt ot 100Mbps in 2x dual mode
Latency	1-2 frames at encoding, 0.5-1 frame at decoding single mode, +2 frames in dual mode
MJPEG monitoring encoding (8 bit 4:2:2)	4x (with stereo audio)
Video encoding bitrates	no constant bitrate, constant quality level
Latency	< 2 frames
H264 monitoring encoding (8 bit 4:2:0)	1x(2x*) (with stereo audio)
Encoding bitrates	1.5Mbps - 12Mbps
Latency	< 20 frames
Thumbnailing&PPM	input/output JPEG thumbnails and PPM data
Audio encapsulation	AES67/RAVENNA audio streams (encoding AM824, decoding L16, L24, AM824)
Encoding bitrates	stream dependant
Latency	synchronous operation < 2msec
AV-Sync (Audio/Video)	synchronous operation, SRC disabled < 2msec
Video/Audio output synchronization	Genlocked to external clock reference, genlocked to IP PTP master clock based reference or SDI/IP input
Video latency	
processing	< 100 pixels
Quad-Split	1 frame

Video Features

variable delay	1-8 frames per channel in steps of 1 frame
frame sync	per input
frame phaser	per output
auto phaser	per output, 2 line phaser window
RGB & YUV color correction	per output
3G conversion A->B-DL, B-DL->A, A or B-DL -> 1080i	per output
test pattern generator/inserter	100% color bar / V-line AV sync pattern, TC/time of day/date/sourcename/text-insertion
TC generator/inserter	Free run, SDI, NTP, analog VITC
master sync generator	ref out with variable shift
waveform monitor	Vectorscope / WFM YRGB / WFM Y Cb Cr / WFM Y
video matrix	8x8
timing monitor	simultaneous timing overview of 8 signals, shows offset in pixel / usec
Quad Split Multiviewer	shows input and output signals with identification, tally and audio metering

Audio Features

de-embedding	16 channels from each SDI input
sample rate converter (SRC)	for every de-embedded channel
embedding	of up to 16 cahnnels selectable from any de-embedded channel or MADI input
variable delay	up to 320msec per audio channel in steps of 1msec
level adjustment	+12dB - ∞
stereo down-mix engines	2 per output
test tone generator	1kHz/400kHz (-18dB or -20dB)
Dolby-E aligner	align automatically to optimal guard band position
audio matrix	384x384
A/V sync measurement	resolution 1 sample, accuracy +/- 2 samples

Management and Monitoring

Protocols	HTTP, SNMPv1, Ember+
User Interface	Embedded HTML5 user interface
StreamDirector	JAVA application
3rd party NMS	in preparation

Environmental Specifications

Operating temperature	0oC - +40oC / +32oF - + 104oF
Storage temperature	-20oC - +70oC
Relative humidity	< 90% non-condensing
Altitude	tbd
Electromagnetic environment	E2 (EN55103-1,-2)

Power

Connector	2x IEC redundant
Consumption	< 130W incl. 30W (PoE)

Input Voltage

AC input voltage	
Nominal	100- 240 VAC +/- 10%
Frequency	50/60Hz +/- 5%

Frame Mechanics

Width	480.3mm(19")
Depth	457.5mm
Height	1RU
Weight	5.1kg

* future SW release

Alarm & Alert Thresholds

Temp monitoring / alerts:

Red:

- T1 >= **90°C**
- P0V85_1A >= **120°C**
- P0V85_1B >= **120°C**
- FPGA1 >= **98°C**
- T2 >= **90°C**
- P0V85_2A >= **120°C**
- P0V85_2B >= **120°C**
- FPGA2 >= **98°C**
- T3 >= **80°C**
- P1V5 >= **120°C**
- P1V8_P2V5 >= **120°C**
- P3V3_P5V0 >= **120°C**
- Front >= **70°C**
- Rear >= **70°C**
- FPGA3 >= **82°C**

Yellow: * Red values -10°C

Audio Silence detection:

< -60dB for 100 frames continously

Appendices

This section includes the following Appendices:

- V__link4 / V__remote4 Video Synchronization / Phasing Modes
- Video Switching Terms and Definitions
- PTP Architecture

V__link4 / V__remote4 Video Synchronization / Phasing Modes

A) AutoPhaser = Line Phaser = Line Synchronizer = Line Sync (H)

Implicit buffering of up to x of lines (usually x=1) to correct timing differences within x lines for input signal related to V__link4 / V__remote4 Genlock/output position.

-> Overall delay ~min - max~: proc latency[1] – x[3] lines

Mode to achieve minimum delay/latency through V__link4 / V__remote4, V__link4 / V__remote4 output signals always line (horizontally) aligned/synchronized. Use this mode to achieve minimum latency with correctly timed input signals and timing/phase stays within phaser range[3].

B) FramePhaser = Frame Synchronizer w/o extra frame buffering = Line Sync (V)

Implicit buffering of x lines, x depending on timing difference between input signal and **V__link4 / V__remote4** Genlock/output position, number of lines can make up a full frame.

-> Overall delay ~min - max~: proc latency[2] - 1 frame

Mode to achieve always frame aligned/synchronized V__link4 / V__remote4 output signals without additional frame delay. Use this mode if input signal timing/phase may vary in wider range.

C) Frame Synchronizer with extra frame buffering = Frame Sync (FSY)

Always buffering one extra frame (for panic freeze) + implicit buffering of x lines, x depending on timing difference between input signal and V__link4 / V__remote4 on/off in the SDI Out -> Timing sub menu.

- FSY = on: Frame Synchronizer always active for all outputs where this input signal is routed.
- FSY = off, Auto Phaser off: Frame Phaser active for this output.
- FSY = off, Auto Phaser on: Auto Phaser active for this output.

[1] < 100 pixels

[2] < 5 lines

[3] 2 lines

Video Switching Terms and Definitions

Patching

Signal routing from A to B by means equivalent to manual patching on patch panel.

Switching

Switch from signal A to signal B for destination C.

Dirty switching

Switch from signal A to signal B for destination C in either asynchronous environment or by mean of not synced switch-over command resulting in dirty = not clean switching from A to B on C.

Clean frame accurate switching

Switch from signal A to signal B for destination C in synchronous environment by mean of switch-over command resulting in clean switching from A to B on C.

Seamless switching[1]

Multi-format, multi-standard seamless switching including automatic format conversion and frame rate conversion to target format&framerate.

Clean frame accurate deterministic switching

Switch from signal A to signal B for destination C in synchronous environment by mean of synced switch-over command and deterministic switch time resulting in clean switching from A to B on C in defined time delta .

Clean frame accurate deterministic absolute switching

Switch from signal A to signal B for destination C in synchronous environment by mean of synced switch-over command and deterministic absolut switch time resulting in clean switching from A to B on C at defined time .

Source-timed clean frame accurate (deterministic) switching

Clean frame accurate (deterministic) switching or clean frame accurate deterministic absolute switching by means of PTP timed source-timed UDP/RTP attribute changes to accomodate switch over by using double flow rule entries in switch(es) without bandwidth changes.

Switch-timed clean frame accurate (deterministic) switching

Clean frame accurate (deterministic) switching or clean frame accurate deterministic absolute switching by means of synchronised switch over within switch(es) without bandwidth changes.

Destination-timed clean frame accurate switching

Clean frame accurate switching by means of sending both streams to destination and (a) destination device performs clean switch by “Make before break” = double bandwidth required or (b= not a real clean switch) stop sending stream A and start sending stream B to destination device and destination device do freeze frame after loosing stream A and do unfreeze if stream B is received. Usually not deterministic due to IGMP based methods. Switchover time can be optimized by using fast leave / immediate leave methods.

[1]Don’t mix up with “seamless protection switching” = path redundancy, something completely different

PTP Architecture

> Why PTP: Derive (video/audio) reference via Network-based Precision Time Protocol. Delivers precision time to many slaves, spans hundred of years, sub-nanosecond granularity with hardware timestamping, delivered over IP network, can be globally locked, can co-exist with other traffic.

The IEEE 1588 standards describe a hierarchical master-slave architecture for clock distribution. Under this architecture, a time distribution system consists of one or more communication media (network segments), and one or more clocks. An ordinary clock is a device with a single network connection and is either the source of (master) or destination for (slave) a synchronization reference. A boundary clock has multiple network connections and can accurately synchronize one network segment to another. A synchronization master is selected for each of the network segments in the system. The root timing reference is called the grandmaster. The grandmaster transmits synchronization information to the clocks residing on its network segment. The boundary clocks with a presence on that segment then relay accurate time to the other segments to which they are also connected.

A simplified PTP system frequently consists of ordinary clocks connected to a single network, and no boundary clocks are used. A grandmaster is elected and all other clocks synchronize directly to it.

IEEE 1588-2008 introduces a clock associated with network equipment used to convey PTP messages. The transparent clock modifies PTP messages as they pass through the device. Timestamps in the messages are corrected for time spent traversing the network equipment. This scheme improves distribution accuracy by compensating for delivery variability across the network.

PTP typically uses the same epoch as Unix time (Midnight, 1 January 1970). While the Unix time is based on Coordinated Universal Time (UTC) and is subject to leap seconds, PTP is based on International Atomic Time (TAI). The PTP grandmaster communicates the current offset between UTC and TAI, so that UTC can be computed from the received PTP time.

Best master clock algorithm

IEEE 1588-2008 uses a hierarchical selection algorithm based on the following properties, in the indicated order:

- Priority 1: the user can assign a specific static-designed priority to each clock, preemptively defining a priority among them.
- Class: each clock is a member of a given class, each class getting its own priority.
- Accuracy: precision between clock and UTC, in nanoseconds (ns)
- Variance: variability of the clock
- Priority 2: final-defined priority, defining backup order in case the other criteria were not sufficient.
- Unique identifier (tie breaker): MAC address-based selection

Synchronization

Through use of the BestMasterClock algorithm, PTP selects a master source of time for an IEEE 1588 domain and for each network segment in the domain.

Clocks determine the offset between themselves and their master. Let the variable **t** represent physical time. For a given slave device, the offset **o(t)** at time **t** is defined by:

$o(t) = s(t) - m(t)$

where **s(t)** represents the time measured by the slave clock at physical time **t**, and **m(t)** represents the time measured by the master clock at physical time **t**.

The master periodically broadcasts the current time as a message to the other clocks. Under IEEE 1588-2002 broadcasts are up to once per second. Under IEEE 1588-2008, up to 10 per second are permitted.

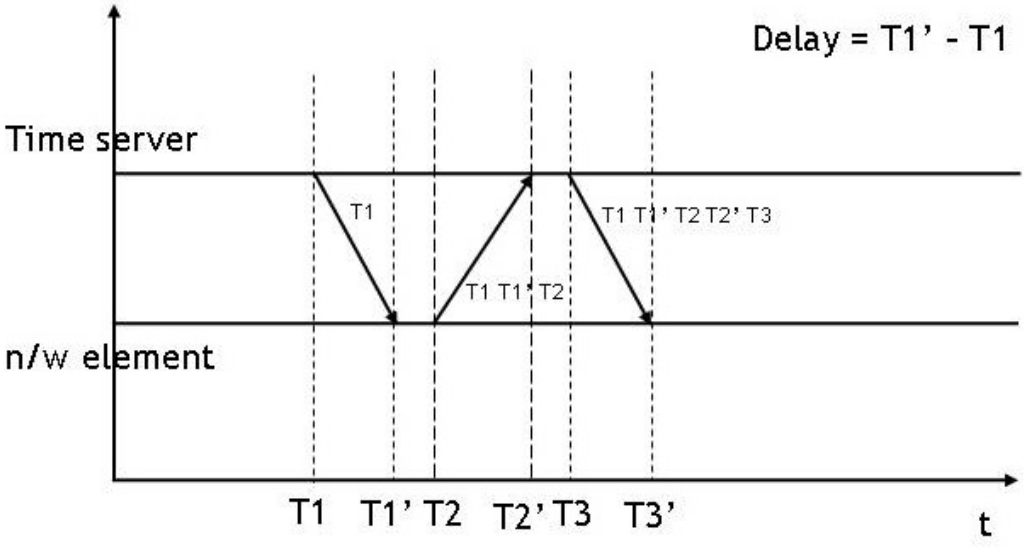


Figure 307

Each broadcast begins at time **T1** with a Sync message sent by the master to all the clocks in the domain. A clock receiving this message takes note of the local time **T1'** when this message is received.

The master may subsequently send a multicast Follow_Up with accurate **T1** timestamp. Not all masters have ability to present an accurate timestamp in the Sync message. It is only after the transmission is complete that they are able to retrieve an accurate timestamp for the Sync transmission from their network hardware. Masters with this limitation use the Follow_Up message to convey **T1**. Masters with PTP capabilities built into their network hardware are able to present an accurate timestamp in the Sync message and do not need to send Follow_Up messages (two-way vs. one-way).

In order to accurately synchronize to their master, clocks must individually determine the network transit time of the Sync messages. The transit time is determined indirectly by measuring round-trip time from each clock to its master. The clocks initiate an exchange with their master designed to measure the transit time d. The exchange begins with a clock sending a Delay_Req message at time **T2** to the master. The master receives and timestamps the Delay_Req at time **T2'** and responds with a Delay_Resp message. The master includes the timestamp **T2'** in the Delay_Resp message.

Through these exchanges a clock learns **T1**, **T1'**, **T2** and **T2'**.

If **d** is the transit time for the Sync message, and **Õ** is the constant offset between master and slave clocks, then

T1' - T1 = Õ + d and T2' - T2 = - Õ + d

Combining the above two equations, we find that **Õ**

Õ = (T1'-T1-T2'+T2)/2

The clock now knows the offset **Õ** during this transaction and can correct itself by this amount to bring it into agreement with their master.

One assumption is that this exchange of messages happens over a period of time so small that this offset can safely be considered constant over that period. Another assumption is that the transit time of a message going from the master to a slave is equal to the transit time of a message going from the slave to the master. Finally, it is assumed that both the master and slave can accurately measure the time they send or receive a message. The degree to which these assumptions hold true determines the accuracy of the clock at the slave device.

Source https://en.wikipedia.org/wiki/Precision_Time_Protocol

Glossary

3G
3G is a HD-SDI format which operates at 2,97Gbit/s. This is a higher data rate than used by 1,485Gbit/s HD-SDI. There are two versions of the 3G- SDI format - Level A, used for 1080p high data rate signals, and Level B, used to carry two 1,485Gbit/s HD-SDI signals down a single wire.

1080i
Used to describe a picture resolution of 1920 x 1080 pixels, which uses interlaced (i) scanning. See Frame.

1080p
Used to describe a picture resolution of 1920 x 1080 pixels, which uses progressive (p) scanning. See Frame.

720p
As for 1080p, but the picture resolution is 1280 x 720 pixels.

16:9
Describes the picture's aspect ratio (Width : Height) used in cinema screen and widescreen digital TV. The ratio is used in all High Definition, and some Standard Definition TV.

4:3
Describes the picture's aspect ratio (Width : Height) used in PAL or NTSC TV.

48kHz or 44.1kHz
See Sample Rate.

AFD
Active Format Description

A code number which is embedded in digital video signals, to control the way in which a 16:9 image is adapted for a 4:3 display. The AFD code describes the portion of the 16:9 image which is important and should therefore be presented to the 4:3 viewer. The AFD code can be changed on a programme by programme basis, so that a consumer set top box can react to programme material from different productions and eras.

Anamorphic
Video which is squeezed or stretched to fit a particular screen size.

Aspect Ratio
Width versus Height of the video screen. Common aspect ratios are 16:9 (widescreen TV) and 4:3.

Bargraph
An optical display instrument in the shape of a LED bar for displaying audio signal level.

Chrominance
Chroma or C for short.

Chrominance is used in video systems to convey the color information of the picture, and is paired with Luminance (Y) which represents the brightness of the image.

Chroma is usually represented as two color-difference components: U = Blue - Luma, and V = Red - Luma. The U and V components are also known as Cb (Chroma blue) and Cr (Chroma red).

RGB sources, such as the output of a camera, are usually converted into YUV so that video systems can process the brightness (Y) and color information (U and V) separately. This is useful as the human eye is more sensitive to luminance (Y), than to changes in chrominance (UV).

CRU Clock Recovery Unit

dB deciBel

A unit of transmission giving the ratio of two powers. Used in audio to represent changes in signal level.

The number of bels is the logarithm to the base 10 of the ratio of the two powers. One decibel equals one tenth of a bel.

dBu dBu is used to describe audio signal levels within the analogue domain, and is a measure of absolute voltage level based on 0dBu = 0.775 Volts (RMS). dBu is often used to indicate nominal broadcast operating levels. For example, in the EBU normal broadcasting level = +6dBu.

dBFS dB Full Scale

dBFS is used to describe audio signal levels within the digital domain. 0dBFS describes the system's internal clipping point; this is the maximum level which may be handled by the system without signal distortion. For example, your system may be set for +18dBu = 0dBFS. If your normal broadcast level is +6dBu then this leaves an operating headroom of 12dB.

Frame A video frame consists of all the information required to reproduce a still picture image. Each frame is made up of several horizontal picture elements known as lines. To form a moving picture, several frames are scanned per second, creating a frame rate.

Interlaced scanning systems (i) capture every odd line, and then every even line on alternate scans of the picture frame; this creates two fields per video frame. Progressive scanning (p) is smoother than interlaced scanning, as all lines are captured on every scan of the picture frame.

Common frame rates used in television standards include 25 frames per second (fps) and 29.97 fps. In NTSC television, 525 interlaced horizontal lines are scanned at 29.97 frames per second. In the PAL system, 625 interlaced horizontal lines are scanned at 25 frames per second.

When you apply a video delay of one frame, you delay the picture by a single, still image. The time this represents, in milliseconds, depends on the frame rate.

Frame Synchroniser A device used to match the timing of an incoming video source to the timing of a reference signal. The frame synchroniser essentially takes a picture of each frame of incoming video and then immediately outputs it with the correct synchronization to match that of the reference signal. The result is to align the incoming video signal and create a stable image. An unsynchronised signal can produce picture flicker.

Gain Adjusting the gain of a signal results in a change in the perceived level or amplitude. An increase in gain (positive values) results in amplification and a reduction in gain (negative values) in attenuation.

HD High Definition.

This terms refers to video signals of a higher resolution than Standard Definition (SD). HD video may be transmitted in various standards including 1080p, 1080i and 720p,

	where “p” and “i” stand for progressive and interlaced scan. Please see Technical Data for supported video standards.
IGMP	Internet Group Management Protocol
Interlaced Scan	See Frame.
IP	Internet Protocol
Luminance	Luma or Y for short. Luminance (Y) is used in video systems to convey the brightness, or black and white component, of the picture. It is paired with Chrominance (C) which is usually represented as two color-difference components: U = Blue - Luma, and V = Red - Luma. RGB sources, such as the output of a camera, are usually converted into YUV so that video systems can process the brightness (Y) and color information (U and V) separately. This is useful as the human eye is more sensitive to luminance (Y), than to changes in chrominance (UV).
MADI	Multichannel Audio Digital Interface MADI, or AES10, is an industry-standard interface that carries multiple channels of digital audio. It supports serial digital transmission over coaxial cable or fibre-optic lines of 28, 56, or 64 channels; and sampling rates of up to 96 kHz with resolution of up to 24 bits per channel.
ms	milliseconds Unit of time measurement
Nova73	A stand-alone audio routing matrix with networking capabilities; this is a large matrix related to the mc2 series of Lawo consoles.
Overload	Occurs when the signal level is too large for the system, resulting in signal distortion.
ProcAmp	Video Processing Amplifier. A device that stablises the composite video signal, regenerates the synchronising pulses and can make other adjustments to the video signal.
Progressive Scan	See Frame.
PTP	Precision Time Protocol
Routing	Signal Routing Term used to describe the connection made between an input and output.
RSTP	Rapid Spanning Tree Protocol
RTP	Real-time Transport Protocol
Sample Rate	The speed at which the internal processing of the system takes samples respective to values from a continuous, analogue audio signal to make a discrete, digital one. For

example, when running at 48kHz, incoming analogue audio is sampled at a rate of 48000 values per second.

SD Standard Definition

This term refers to video signals that are not considered to be High Definition (HD). The two most common SD signal types are 576i and 480i, which use 576 and 480 interlaced lines per video frame. SD video may use an aspect ratio of 4:3 or 16:9. Please see Technical Data for supported video standards.

SDI Serial Digital Interface

TCP Transmission Control Protocol

UDP User Datagram Protocol

VANC Vertical Ancillary Data

Non-video information (such as metadata) embedded within the SDI signal.

Vectorscope A vectorscope is a special type of oscilloscope used in both audio and video applications to display an X-Y plot of two signals. The aim is to reveal details about the relationship between the signals.

The V__link4 / V__remote4 provides a Vectorscope, within its graphical user interface, to measure the relationship between the different color components of the video signal.

Waveform Monitor A waveform monitor (WFM) is a special type of oscilloscope used in video applications to measure and display the level, or voltage, of a video signal with respect to time.

The V__link4 / V__remote4 provides two types of waveform monitor within its graphical user interface:

YRGB which monitors Luminance (Y) plus the individual Red (R), Green (G) and Blue (B) color components.

YCbCr (or YUV) which monitors Luminance (Y) plus the two color difference components: Chroma blue (Cb or U) and Chroma red (Cr or V).

V__line Network facts

Figure 308

__Network facts for

- Video over IP solutions for contribution & distribution
- Integrated IP based infrastructure & processing & production solutions__
- Network Classification and Categorization
- Switch Performance & Topologies
- Control & monitoring

This document outlines various aspects of networking in respect to transporting real-time video and audio streams over standard IP networks and touches topologies, redundancy schemes, distributed processing aspects.

Network Overview

General Overview

Network performance is defined by the following criteria:

- Bandwidth
- Latency
- Packet Delay Variation
- Error rate

Bandwidth

The bandwidth describes the amount of data that can be transported over the network per time unit. The usual unit is Mbit/s or Gbit/s.

When bandwidth is specified it is not always clear whether the bandwidth given is the net bitrate or the gross bitrate, but for Ethernet the data rates given are the net bitrates. For example, 100BaseT Ethernet provides 100Mbit/s usable data rate, while the amount of data on the physical connection is 125Mbit/s including the coding necessary to transport the data safely.

The bandwidth for a given technology is fixed. There is no way of increasing the bandwidth of e.g. 100Mbit/s Ethernet, except by changing to another technology such as 1000Mbit/s Ethernet (you can combine multiple links of a given technology to increase the available bandwidth, but that comes with other drawbacks).

For networks dedicated to media transport the bandwidth is determined by the bandwidth each media stream has and the amount of media stream that need to be transported over a single link. E.g. if you need to transport 3 HD video signals with 1.485GBit/s (net video) each, the link needs to support at least 4.455GBit/s + headroom for packetization which is format dependent. The choice in this case would be a 10GBit/s Ethernet connection.

Latency

Latency describes the time that the information needs to travel from source to destination.

The most basic foundation is the speed of light (roughly 300’000’000 meters / second in vacuum); no information can travel faster. Depending on the medium used to transport the information, the time is bigger. E.g. in optical fibers the index of refraction is 1.5, meaning that the light travels 1.5 times slower than in a vacuum. That results in approximately 5µs of latency for every kilometer of fiber.

Of course latency is added for other elements in the data’s path as well: conversion between optical and electrical, encoding of data, buffers in active network elements, etc.

For networks dedicated to media transport you want to minimise latency as latency ultimately translates into delay between the actual event and the representation of the event on screens or speakers. Since the distance between source and destination is usually fixed, only the processing on the path can be influenced, e.g. by limiting the amount of active network elements in the data path and limiting the processing in source and destination.

Network Parameters

Packet Delay Variation

Packet delay variation (or PDV in short) is a measurement for the difference of the one-way, end-to-end delay of packets. Sometimes this is also referred to as network “jitter”.

In an ideal network all packets would take the same time to travel from the source to the destination, but in real networks various factors cause this time to vary. When the packets are handled by an active network element such as a switch, the processing of the packets depends on the processing load of that switch. The load is mainly related to the amount of concurrent packets to process and the complexity of the processing. Due to the “bursty” nature of data transport in Ethernet networks, the load varies quickly and thus influences the packet delay variation.

Packet delay variation can only be counteracted by adding buffers at the receiving end. The incoming data is first written to a buffer. Once the buffer is filled with an amount of data which can compensate the longest packet delay variation that you expect on the network (plus a little safety), the receiving device can start reading data from the buffer using a constant rate.

For networks dedicated to media transport you want to minimize packet delay variation, because the buffers you need to add in order to compensate for the packet delay variation add to the unwanted latency in the signal path. This is usually done by limiting the amount of active network elements in the data path and using techniques like Quality of Service (QoS) to prioritize the processing of data packets carrying real time media over other traffic.

Error rate

The error rate describes the amount of data that has been altered on the path from source to destination. In data networks this is usually related to corrupted packets (bit errors) or lost packets. Reordering of packets and duplication of packets in networks are also critical factors to take into account.

Bit errors are usually compensated by adding some redundancy to the data being transported, often in the form of error correction data transported on the physical transport layer in addition to the actual data. Only errors that cannot be corrected will be noticeable to the user of the network and will need to be handled by higher protocol layers.

Since bit errors happen randomly, the error rate describes a probability in the form of percentage of packets likely to be affected by errors.

Lost packets are usually caused by overloading one or multiple network elements in the data path. E.g. if two sources try to send 1GBit/s each to a destination connected to the network with a 1GBit/s connection only half of the packets can actually be forwarded, the rest of them needs to be dropped.

For networks dedicated to real time media transport you want low error rates. Bit errors can be compensated by higher protocol layers, e.g. by adding redundancy to the data transported which allows reconstructing the original data, even if some packets are corrupted or lost on the transport.

Lost packets caused by overloaded paths in the network can only be handled by careful network design and management, including but not limited to correct choice of bandwidth and prioritization of traffic using Quality-of-Service.

Anther method of dealing with lost packets for real time video streams is concealment which means the missing data is usually filled up with data from previous frame or previous resolution level in case of compression. Lost sync frame information can be compensated by flywheel design.

Multicast

Overview

The vast majority of communication in traditional IT networks runs as unicast, meaning that messages are always sent from a single source to a single destination. While this method is perfectly sufficient to transport video and audio signals between two devices it would mean double the amount of data being sent if one source were to send the same video to two destinations; so this method does not scale if applied to a traditional broadcast infrastructure where a router is able to distribute a single source to as many outputs as the router is equipped with.

To alleviate this limitation data transmission with a multicast addressing scheme is used, which allows sending data to a group of destinations without the need for the source to send the data multiple times. The actual distribution of data to the destinations is handled by the network elements (switches and routers) connecting the source with the destinations: the source sends the data once and the switch will duplicate the packet for each destination.

If the switch does not know which destination is interested in which source, it needs to duplicate the source packets on every port, thereby turning the multicast into a broadcast. This is very inefficient in terms of bandwidth usage and does not scale well.

To orchestrate multicast in a more efficient way, the Internet Group Management Protocol (IGMP) is used. A destination interested in a certain stream will send a “Join” message. Switches can listen to IGMP communication (“IGMP snooping”) and use this information to selectively duplicate the data stream to the port on which the destination is attached. The destination becomes a “member” in the requested “multicast group”. The switch keeps track of all members of a multicast group and sends periodic queries (“membership queries”) whether they are still interested – the switch acts as an “IGMP Querier”. If a destination does not reply, the switch assumes that the destination is no longer interested and stops duplicating the packets. In more recent versions of IGMP, the destinations can also send “leave” messages, actively informing the switch about not wanting the multicast data anymore. This feature of “fast leave” or “immediate leave” is important in order to not keep bandwidth allocated for a multicast stream until the membership has timed out. Unfortunately there’s no standard or RFC yet to make that feature usable outside of single vendor network.

IGMP Snooping and IGMP Querier are features not found on all switches, but are needed for a correct and performant network function in the realm of audio / video networking for plug’n play like use cases. Other more controlled SDN based applications will use dedicated control system(s) to setup flows in switches to ensure proper video and audio stream distribution. This even includes frame accurate and deterministic clean switches on IP.

Multicast uses a reserved range of IP addresses to identify a multicast group (224.0.0.0 to 239.255.255.255 for IPv4). Some of them are reserved for specific protocols or purposes (e.g. 224.0.0.1 for all systems on this subnet or 224.0.0.22 for IGMP), others can be freely used.

When referring to multicast people usually talk about the layer 2 Ethernet multicast, limiting the data distribution to a single subnet. There are however protocols that can be used to route multicast traffic into different subnets such as Protocol Independent Multicast (PIM).

Report Flooding

Network elements differentiate between ports to which hosts are attached and port to which other multicast-aware network elements are attached; the latter are referred to as “router ports”.

There are two ways network elements can handle these router ports: the router can send membership reports only or the router can send membership reports and the data belonging to all active multicast groups.

When sending both reports and data the link between the routers is easily saturated if the multicast data streams are high bitrate as is the case with audio and video streams. In many cases this behavior is transitory until the routers have successfully established all group membership information, but the immediate sending of data (without a destination actively requesting that data) can easily cause overloading of the link between the network elements.

This behavior should be turned off. In many switches this option is referred to as “report flooding” (as opposed to report and data flooding). Usually you can also statically configure ports to not dynamically get the MRouter status for static routing applications.

Querier Election

Usually there will be only one querier (one device managing multicast group information) per subnet. This querier is elected between all the devices capable of fulfilling this task.

When such a device starts it multicasts a general query to all other systems using the 224.0.0.1 address using their own (unicast) IP address as source address. When a device receives such a query it compares the source IP from the message with its own IP address. The device with the lowest IP address is elected querier.

All other devices start an internal timer which is reset every time they receive a general query from the querier. If those messages cease, a new querier election takes place.

PTP

Overview

Precision Time Protocol (PTP) is a way of synchronizing clocks within a computer network. It achieves a clock accuracy in the sub-microsecond range and is suitable to synchronize media streams. Version 2 is applicable today and has been standardized as IEEE1588-2008.

PTP time uses the same epoch Unix time uses (00:00 on 1970-01-01), but is based on International Atomic Time which is not adjusted for leap seconds.

PTP uses a master-slave approach in which all master-capable devices elect the best master, called the grandmaster, following a common algorithm. To ensure accurate time at the client, the delay caused by the time it takes the packets to travel between master and slave is measured and compensated for in a constant adjustment process.

PTP usually uses multicast to distribute time information, even though version 2 of the standard extended the protocol by an option for unicast transmission.

In addition to the PTP masters and slaves network switches often support PTP in order to increase clock accuracy. They can work in one of three modes: ignore/forward, transparent and boundary clock.

The switches running in “ignore / forward” mode treat PTP as a regular multicast. This allows PTP to function but decreases the clock accuracy since the switch itself introduces variable delays in packet processing which are not accounted for and substantially decrease the time accuracy. Using switches without support for PTP should be avoided.

The switches running in transparent PTP mode measure the time the PTP packets spend travelling through the switch and modify the timestamps of the packets to account for that time. This increases the accuracy of PTP time and is the mode of choice for smaller (local) networks.

In boundary clock mode the switch participates in the master election process and presents itself as PTP master on any switch port that does not have “better” master attached to it. This mode alleviates some of the processing load from the grandmaster and thus allows for bigger networks with more PTP clients.

PTP will be used as a complement or replacement of video reference and word clock signals. The accuracy that can be achieved with a well-tuned system is perfectly sufficient for audio and video applications.

QoS

By default, all packets are treated as equal in a switch: whichever packet comes first is processed first. However, when it comes to requirements of audio / video networking, not all packets are equal. Packets transporting e.g. PTP time information are very sensitive to latency, so they should be transported with the minimum amount of latency possible.

The ability to treat packets identified by certain criteria differently is referred to as Quality of Service. It allows a switch to decide to process packets with e.g. PTP information before processing packets with e.g. FTP data.

In order for the switch to process packets with different priorities, a switch has queues on the output ports which are sorted by priority. Many switches have a total of 8 different queues per port with queue 7 being the highest and queue 0 being the lowest priority. These queues can either be served strictly by priority (process all packets from queue 7 first, then process packets from queue 6, etc.) which might lead to “starving” of the lower priority queues. Or the switch can assign a “weight” to the queues (e.g. 25% to queue 7, 15% to queue 6 and 10% for each of the lower queues) which makes sure that higher priority queues are served with preference, but lower priority queues don’t starve.

It is good practice to leave the highest priority queue for essential network traffic which is needed for the network itself to function and distribute the traffic that needs priority to the queues below. Any traffic assigned to the lowest priority queue is transported as “best effort”.

It is important to understand that the whole concept of QoS is no remedy for too little bandwidth on a link: If you try to transport 2GB of data through a 1GB link, packets will be dropped, irrespective of QoS. QoS will just help the switch to decide which packets to drop in case of bandwidth contention.

In common IT applications QoS is used to prioritize VoIP telephony data over the other data transported on the same network since VoIP data is very sensitive to latency and packet loss.

The same applies to audio and video data in networks: it is sensitive to latency and packet loss and – in the case of video – often very bandwidth intensive.

In order for the switch to sort the packets into the different queues, the switch must know the intended priority for each packet. This is achieved by marking the packets and evaluating these marks to decide on the correct queue (“mapping”). One way to perform the marking is called Differentiated Services or DiffServ for short.

DiffServ

With DiffServ packets can be marked with a value for packet classification. This value is called the Differentiated Services Code Point (DSCP). It allows for 64 different values and is assigned to the IP packets. As a rough approximation you can say that the higher the value, the more important the packets is. However, in standard practice only a few of the available 64 values are actually used.

An important thing to understand is that these values, if they are set by the device sending the data, are often considered a “wish” concerning the processing priority and can be redefined on the network path to the destination; that means that setting a specific DSCP value does not mean that the packets are treated preferentially along the complete network path.

A switch evaluates the DSCP values in the IP packets and uses those to map them to its internal queues. This mapping process can be configured in the switch. In order for the complete path to provide the same (preferential) handling of packets, the complete path needs to be under control.

Lawo devices use 2 DSCP values to identify packets needing special handling:

- All packets containing audio / video data are marked as “EF” (Expedited Forwarding; decimal DSCP value = 46)
- All PTP packets are marked with “CS7” (decimal DSCP value = 56)

The switches processing these packets should be setup to handle the packets according to those priorities and treat the remaining traffic as “best effort” (DSCP value = 0).

When leasing network lines on which you have no direct influence on the DSCP evaluation and processing, talk to the provider to ensure correct processing. And if possible perform checking of the lines to verify the correct configuration and processing.

LAN characteristic

Local Area Networks

For LANs we do differentiate between

- multicast-capable network or just
- unicast-capable networks

For multicast cast capable networks we differentiate between “enhanced multicast capable” networks and standard multicast capable networks. Enhanced multicast networks offers “report flooding” feature or something similar, which disables data traffic flooding to multicast routers. See description before.

Another differentiation factor is

- PTP aware network and
- non-PTP aware network.

BER, PDV, Packet Loss Rate

For LANs we do expect a packet loss rate which is close to zero and bit error rates which are well below 10exp-10 (standard for Ethernet is 10exp-8, for optical systems 10exp-12). Values differ related to physical infrastructure, 1GE copper based vs. 10GE fiber based. Packet Delay Variation (PDV) also depending on 1GE network vs. 10GE network. As 10GE network for LAN based infrastructure solution is standard, PDV should be well below < 10µsec.

Path redundancy between edge devices (Senders and receivers) with “seamless protection switching according to 2022-7”. Hardware redundancy with “enhanced seamless protection switching” mode. Requires synchronous environment and some more control/monitoring.

> V_line devices can use and run PTP clocking/referencing in non-PTP aware networks. Related to switch’s PTP implementation ... switching off PTP in switch(es) sometimes gives even better results than running switches PTP aware. Always depends on model, mode, type of implementation.

V_line Timing Precision Categories:

- High: green +/- 100nsec accuracy window; yellow
- Low: green +/- 400nsec accuracy window; yellow +/- 2µsec; following SMPTE 2059-2
- Custom: custom defined ... max 100µsec —> green: +/- 20µsec, yellow +/- 100µsec

PTP client implementation offers dynamic vs. locking mode for PTP timing. In locking mode on and with PTP outliers outside yellow area PTP clock goes into holdover, with locking mode off starts re-calibration.

WAN characteristic

Wide Area Networks

Within WANs we do expect certain degree of packet delay variation (PDV=Jitter) and certain level of bit errors (bit error rate BER) and/or packet loss rate.

Usually we can handle PDV values up to 8msec, in certain cases even more...

Bit Errors leading finally to packet losses and general packet losses are compensated per design in the following way:

- sync frame detection: fly wheel approach compensates usually for 2 sub-sequent sync packet losses
- video data raw (2022-6, RV): packet losses are compensated by filling in black as pixel data —> fractions of black lines appears on screen
- audio data raw (2022-6 embedded or discrete): missing samples
- video data J2K (RV): packets only contains certain video resolution levels, packet loss impact depending on resolution level and usually can lead to more blurry picture; basically error concealment is covering that in addition and replacing with neighbour hood data in time and/or spatial-wise
- audio data J2K (RV): missing samples or with certain level of inherent redundancy
- simply double sending audio packets and merge on the receiver side
- add certain level of redundancy in video related to resolution levels and merge on the receiver side

The stream inherent redundancy levels can ensure good acceptable video quality for packet loss rates of 10exp-3. Even 10exp-2 can be survived.

... use path redundancy “seamless protection switching according to 2022-7” and merge on the receiver side... works for RAW as well as for J2K streams and for Ravenna / AES67 streams as well.

> Custom settings for PTP client tolerance windows enables running PTP even in ok WAN networks, depending on characteristics e.g. should behave symmetric, PDV not exceeding max. 60µsec.

Switch Performance

Switches

Requirements

Bandwidth

The switch needs to support the bandwidth needed for the respective application. Lawo recommends

- 1GB Ethernet for pure audio applications
- 1GB Ethernet for J2K based video applications and audio applications
- 10GB Ethernet for video applications and mixed audio / video applications including 4K VC-2 compressed
- 10GB/40GB Ethernet for 4k video applications with the V__matrix

QoS

The switch must support DiffServ (RFC2474) and traffic prioritization according to IEEE802.1p. **Alternatively**: the switch is simply fast enough.

Spanning tree

The switch must support Rapid Spanning Tree (RSTP) or Multiple Spanning Tree (MSTP) as defined in IEEE802.1w or IEEE802.1s respectively.

PTP

The switch must support PTP as defined in IEEE1588-2008 with at least E2E Transparent Mode, preferably also Boundary Clock mode.

The switch shall also support settings all necessary PTP parameters to comply with the AES-R16-2016 profiles and SMPTE 2059-2 profiles.

Alternatively: In non-cascaded applications the switch is simply fast enough.

Multicast

The switch must support multicast traffic.

The switch must support multicast forwarding.

The switch must support IGMPv2 (RFC2236).

The switch must support IGMP snooping (RFC4541). And should offer support for report flooding which means no data flooding to MRouters.

Alternatively: configure and run edge devices in “half” igmp mode or use unicast-transport mechanism.

Performance

The switch must meet the following performance characteristics:

- Non-blocking: The switch must use a non-blocking architecture, meaning that the switch internal forwarding capacity is equal to the capacity of a single port times the number of ports (e.g. a 48 port 10GbE switch needs 48*10Gb*2 (full duplex) = 960Gb/s switching capacity)
- Support for enough multicast groups: The switch must support many thousands of multicast groups (value depends on usage of various formats e.g. upcoming formats TR03 are using many more multicast addresses for individual essences).
- IGMP processing time: the switch must be able to process many IGMP requests in less than 80msec time and not “forget” requests.
- Port to port latency: usually 10GE switch should not have more latency than 5µsec.
- PTP accuracy: in PTP aware mode switch should have accuracy less than 1µsec.

Reality Check

Even if the network / switches in many cases does not comply with listed requirements ...

...depending on application the network may still be adequate and be used as underlying infrastructure if switches are simply fast enough, using our V_link4/remote4 V_matrix systems to take over PTP Grandmaster function, filter out and minimise impact of PDV out of scope, run our systems in “half” igmp or even fully static mode...

Settings

These settings should be applied to switches in order to make them work correctly:

- **Multicast / IGMP**
- Enable IGMP Snooping
- Disable IGMP Fast Leave (aka Immediate Leave)
- Enable IGMP Querier and set IGMP Querier version to 2
- Set the querier IP address to the IP of the switch (if needed)
- Enable auto-learning of router ports or manually define them
- Filter all unregistered / unknown multicast traffic
- **QoS**
- Enable accepting (“trusting”) DSCP values on the ingress interfaces
- Enable correct mapping of DSCP values to internal (IEE802.1p) CoS queues
- Change queues used for PTP and audio / video data to “strict priority”
- **Misc**
- Disable power management on all ports (Green Ethernet, EEE)
- Disable Jumbo Frames
- **PTP**
- Enable PTP
- Set PTP to Boundary Clock mode (if available and proven to work correctly) or E2E Transparent mode as a fall-back
- **Spanning Tree**
- Enable Rapid Spanning Tree
- Set all ports that are connected to hosts/devices without built-in switch functionality (as opposed to other switches or edge devices with built-in switch functionality) to “Portfast” with BPDU (bridge protocol data unit) Guard enabled

Some of these settings might need to be applied to individual ports or VLANs. Consult your switch manual for details.

Network topologies

Star Topology

Network topologies obviously depends on applications.

Large football tournament with many stadiums and with centralized “IBC” (International Broadcast Center) usually designed as star topology between stadiums and IBC with full redundant paths and full redundant switch hardware centralized in IBC. Access layer switches on remote sites.

Works even IGMP based, works SDN based, simple and easy structure for setup, maintenance, operation.

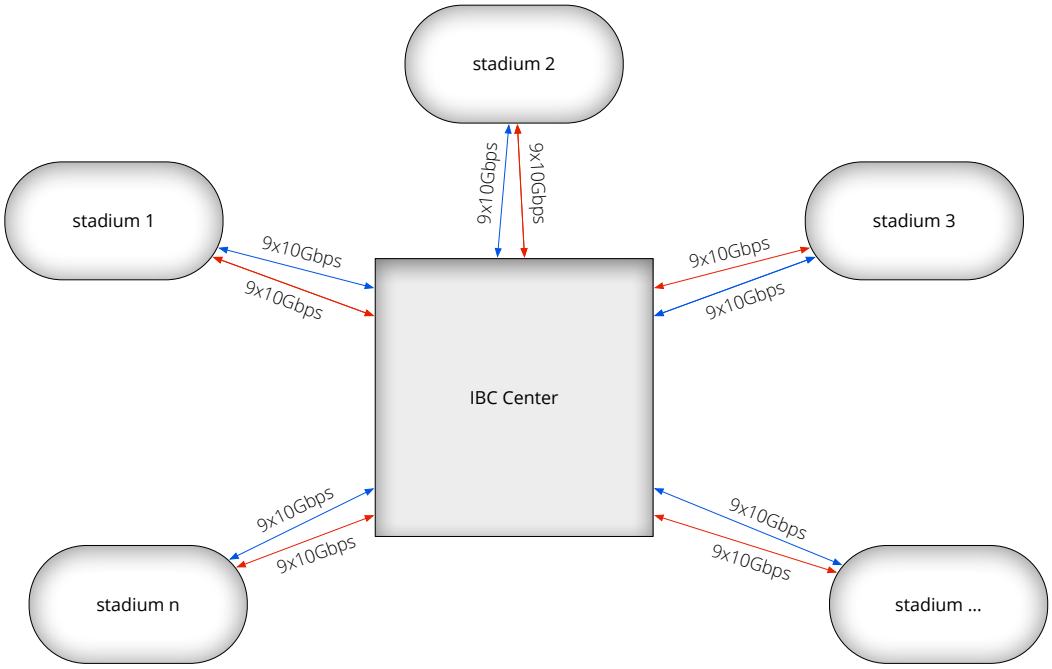


Figure 309

Centralized Star Topology

Centralized star topology with redundant paths and central switches and access layer switches.

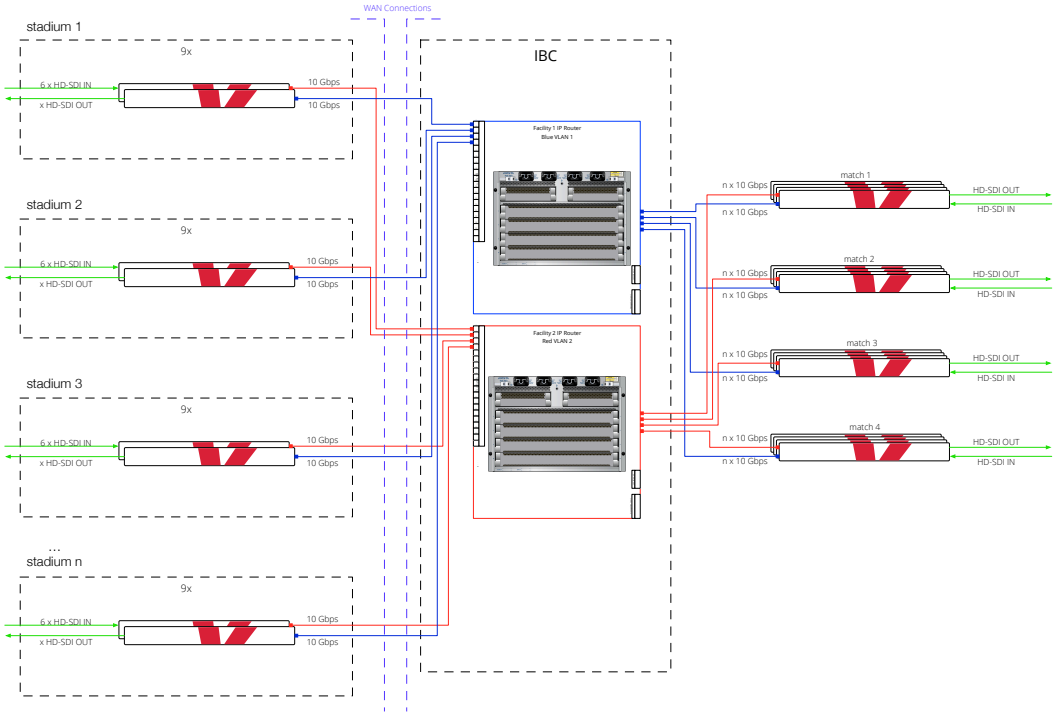


Figure 310

Ring Topology

Ring topology for small football tournament event. Max traffic obviously restricted by parallel load per ring. Therefore limited capacity depending on used transport format.

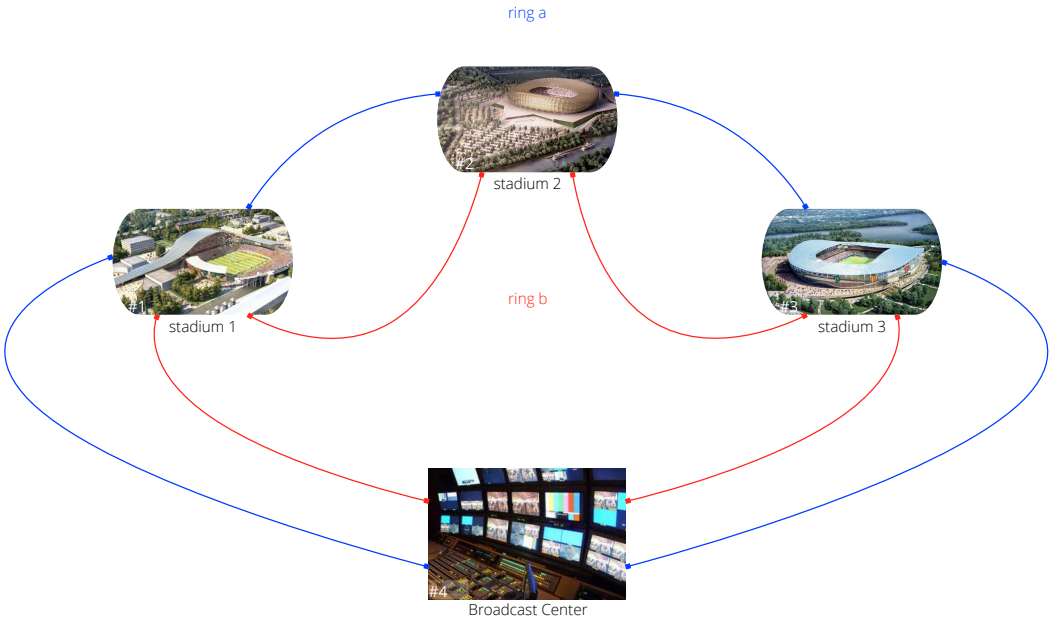


Figure 311

Ring topology for small football tournament event.

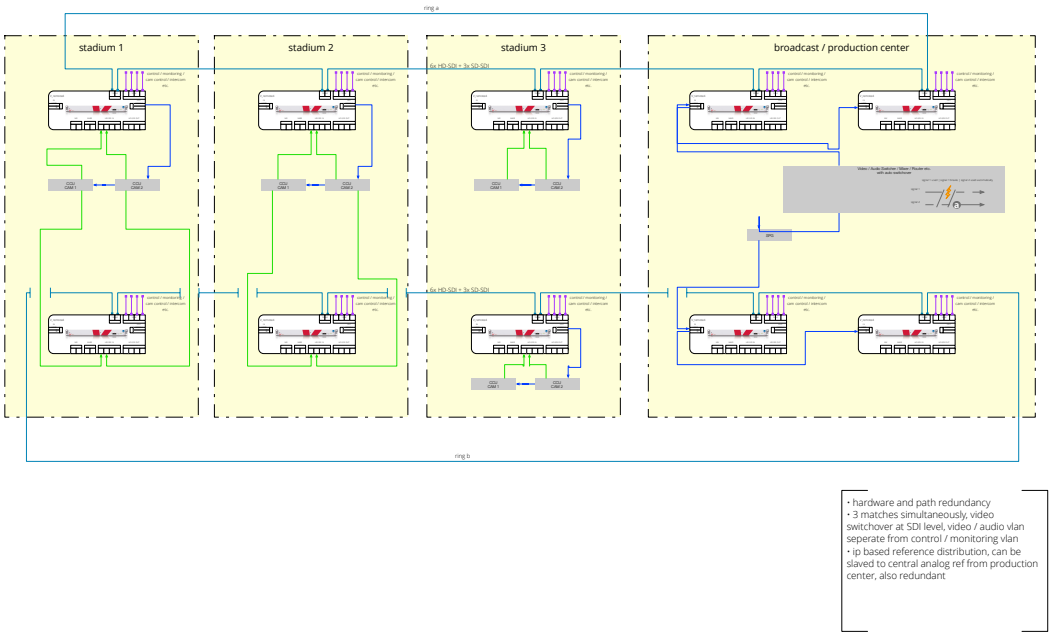


Figure 312

Leased Data Connections Checklist

Leased data connections checklist

First, determine how much traffic you will need to transport at peak times, e.g. 4 J2K compressed video streams with a data rate of 100Mbit/s each, equaling a total net data rate of 400Mbit/s. And don't forget to count for packetization overhead and possibly for inband control and monitoring. Thumbnail monitoring can be switched off for bandwidth saving in V_link4/remote4 edge devices.

Data streams originating from the V__line are marked "Expedite Forwarding" (EF; see above). Ask your provider how much "EF" traffic he can guarantee on the line (e.g. 60% of a 1GBit/s line). The remaining traffic is handled as "best effort" and comes with no guarantees in regards to latency, packet delay variation and packet loss.

Choose the bandwidth of the connection based on the comparison of the needed bandwidth and the bandwidth guarantee of the provider.

Also query the packet delay variation (aka "jitter") and the packet loss rate for the "EF" traffic on the line. The lower these values are the better.

Control and Monitoring

Control can be established via Open Source Ember+ remote control protocol. This includes all monitoring capabilities as well.

Control can be simply triggering connection establishment features of the v_link4/remote4 or V_matrix edge devices. And controlling all internal processing features and offering workflow semi-automation features. Control can be also true full Software Defined Networking control application including frame accurate deterministic and clean switching of SMPTE 2022-6 signals.

Alternative monitoring solutions / possibilities are

a. SNMP, SNMP trap server(s)
b. Syslog Server(s)

Syslog Server(s) are also used for V_link4/remote4 and V_matrix internal logging events.