BN880 Series Interfaces

Thank you for purchasing this Bluebell Opticom professional broadcast video product. The BN880 Series of interfaces requires configuration, and this User Guide should provide sufficient information to get you up and running in the vast majority of cases.

User Guide

Ref: BN880 Series QSG v1.3_11/25

Safety Warning – Important Precautions

To reduce the risk of fire or electric shock, do not expose this equipment to rain, moisture, or wet conditions.
General Safety Guidelines

- Always **disconnect the entire system from the AC mains** before cleaning or servicing.
- The following product frames – **BC100, BC100i, BC160, BC160i, BC101, BC102, BC120** – must be connected using a **three-conductor AC mains power cord with an earth ground**. All three conductors must be used at all times to prevent electric shock.
- Do **not** bypass or disable any fuse.
- Only replace fuses with those of the **specified type and rating**.
- Do **not** use flammable or combustible chemicals for cleaning.
- Do **not** pour or spill liquids directly onto the unit.
- Do **not** allow any liquid to enter the unit or wet the internal components.
- Do **not** operate the unit with any cover or panel removed.
- Do **not** obstruct the ventilation slots, **adequate airflow must be maintained**.
- Do **not** operate the unit in environments with **extreme temperatures**.
- Do **not** use or store the unit in **explosive atmospheres**.
- Do **not** attempt to repair the unit yourself. If servicing is required, please contact your local **Bluebell Opticom** distributor.

Product Warranty

- **Bluebell Opticom Ltd** provides warranty coverage as detailed in our general terms and conditions.
  Please note that warranty support is only valid **if product serial numbers remain intact and legible**. Tampering with or removing serial numbers may void your warranty.

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1. Overview

The Bluebell BN880 range of ST 2110 gateways provide multi-channel conversion between SDI and ST2110 IP. Available in 2 channel 12G-SDI and 4 channel 3G-SDI variants, each channel processes one video, four audio and one ANC data flow. Each audio flow can contain up to 16 audio channels which can be freely re-mapped. All models feature dual 10 GbE or 25 GbE (SFP28) IP media ports with full support of ST 2022-7 hitless redundancy.

The device is configured and controlled through either BluebellConnect, NMOS or Ember+ protocols, MNSet software, or through a published RESTful API to facilitate its integration into third party control systems.

There are two versions, BC880 and BN880, which consists of nine variants mentioned below. The BC880 occupies two slots in the BC100i (3RU) or BC160i (1RU) frame which can have network monitoring through a webpage/SNMP via a BM102i monitoring card. For standalone applications, the BN880 version can be used as an individual rugged enclosure.

This User Guide will be focusing on the BN880 version.

This Quick Start Guide covers nine variants comprising the range:

- BN880/2T/12G – Dual 12G-SDI Encapsulator
- BN880/2R/12G – Dual 12G-SDI Decapsulator
- BN880/1T/1R/12G – 1x 12G-SDI Encapsulator + 1x 12G-SDI Decapsulator
- BN880/4T/3G – Quad 3G-SDI Encapsulator
- BN880/4R/3G – Quad 3G-SDI Decapsulator
- BN880/2T/2R/3G – 2x 3G-SDI Encapsulator + 2x 3G-SDI Decapsulator using 25 GbE media ports
- BN880/2T/2R/3G/10G – 2x 3G-SDI Encapsulator + 2x 3G-SDI Decapsulator using 10 GbE media ports
- BN880/2T/JPEGXS – JPEG-XS Compression for up to two 12G-SDI to 10 GbE media ports
- BN880/2R/JPEGXS – JPEG-XS Compression for up to two 12G-SDI to 10 GbE media ports

Optional extras:

- /OOB – 1 GbE Out-of-Band Management Control
- /GL – PTP Synchronised Genlock Output
- /CS – Clean & Quiet Switching (bandwidth limitations apply)
- /EP – Ember+ instead of the default NMOS

The nine variants are of identical construction, except for the two channel variants having two BNC connectors and four channel variants having four BNC connectors. The outward appearance differ only in the silk-screened labelling on the interface.

1.1. Block Diagram

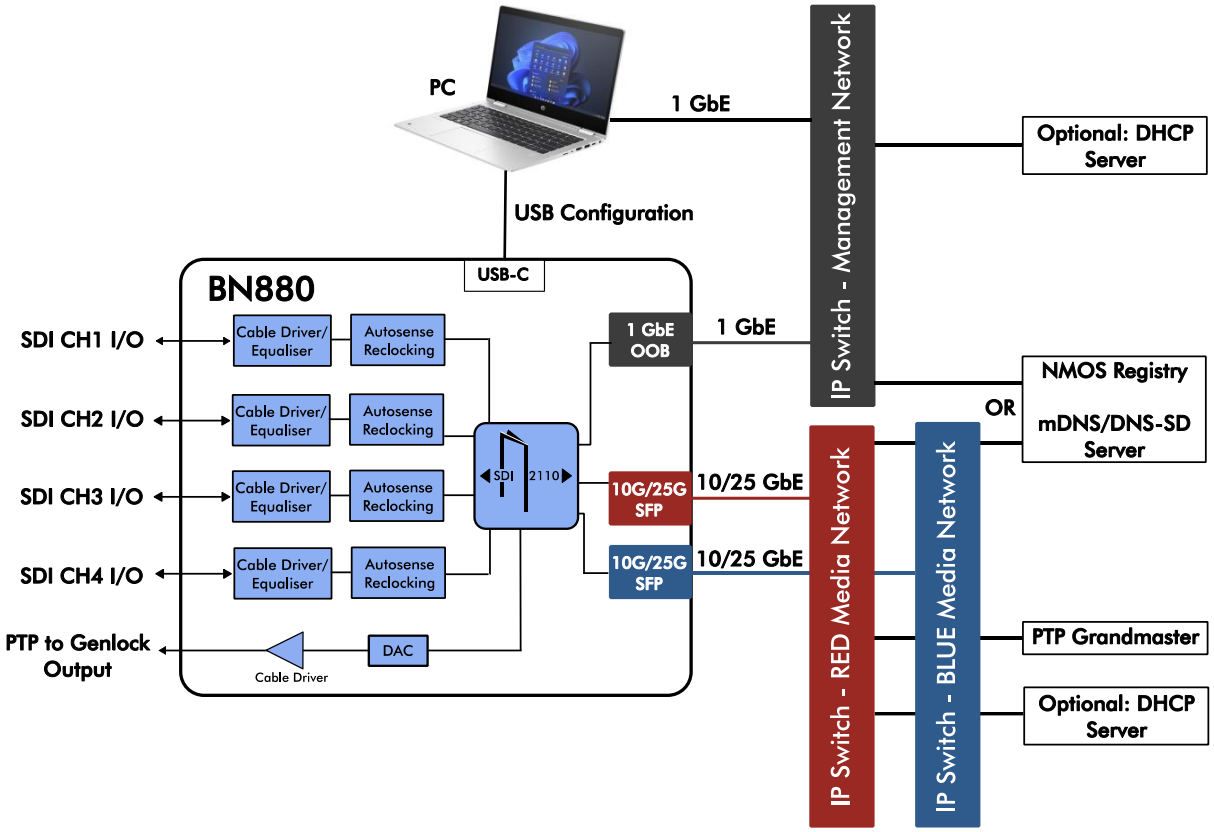


Figure 1: BN880 overview

NOTE:

- The NMOS Registry can be on either the Management Network or on the Media Network(s)
- SFP data rate 10/25 GbE depends on the BN880 version. See *Optical* for details
- 1 GbE Out-of-Band management requires an add-on licence
- PTP to Genlock output requires an add-on licence

The blocks below are repeated for each Encapsulator/Decapsulator channel.

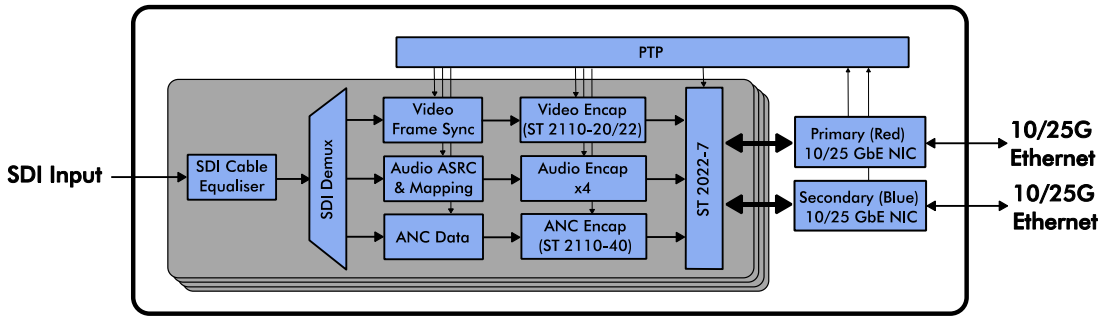


Figure 2: Encapsulator overview (per SDI channel)

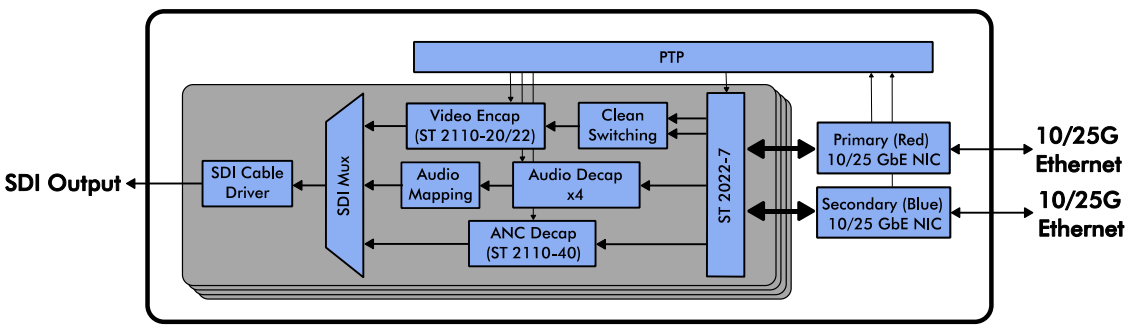


Figure 3: Decapsulator overview (per SDI channel)

1.2. BN880 - 25 GbE Variants

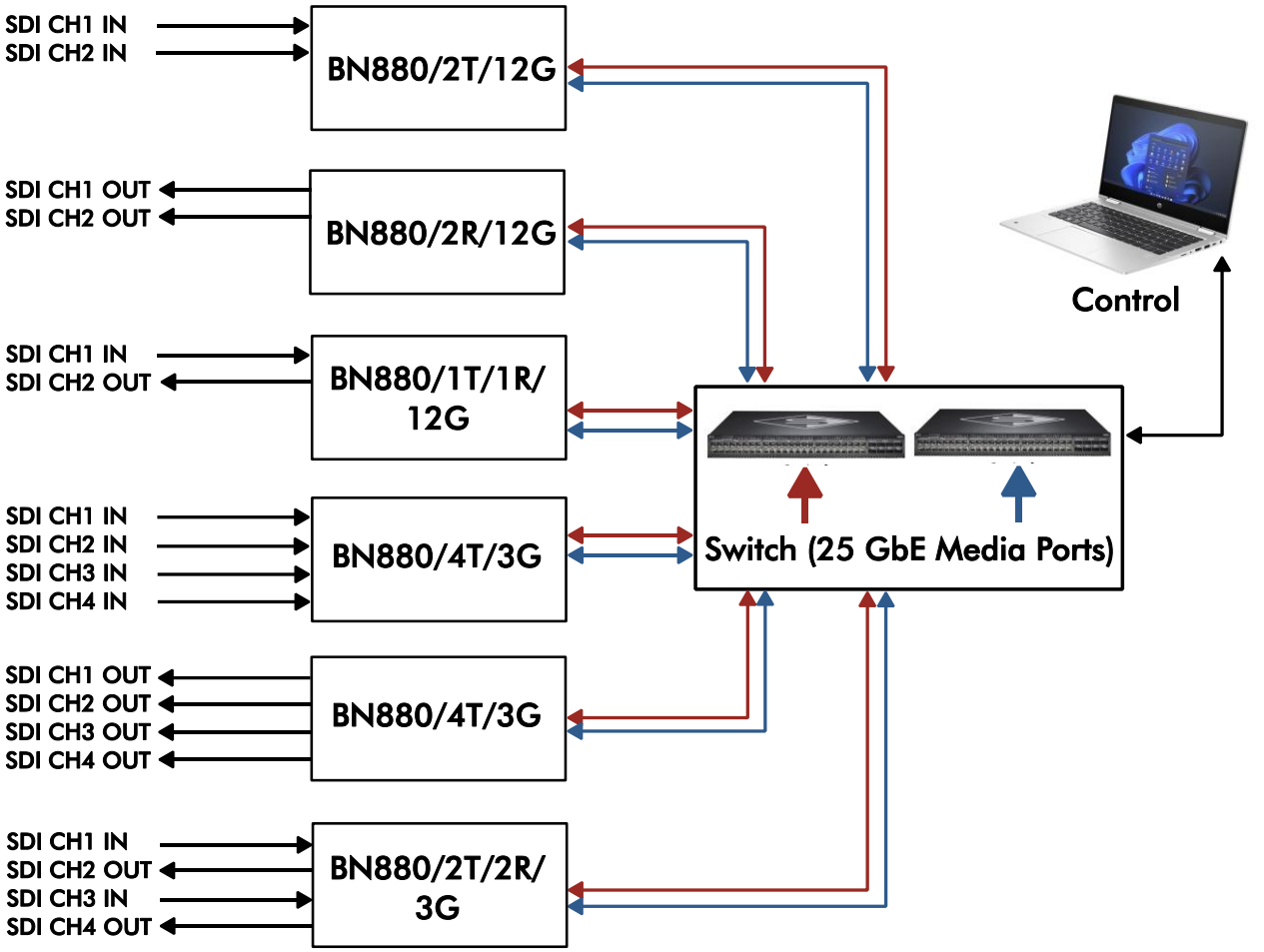


Figure 4: BN880 units compatible with 25 GbE media ports

1.3. BN880 - 10 GbE Variants

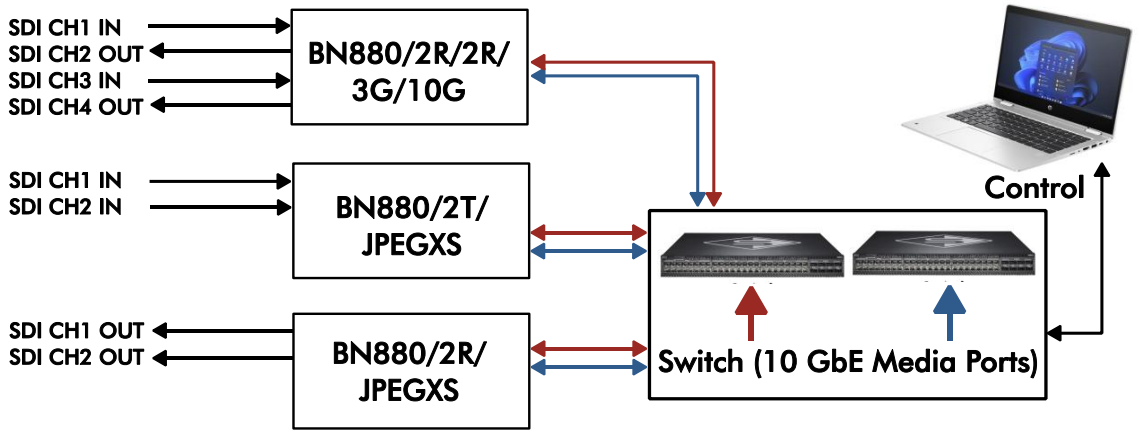


Figure 5: BN880 units compatible with 10 GbE media ports

Normally, BN880 units will be used in a network and will have the video/audio flows configured using a computer. The software used to configure/monitor the flows are managed by the customer, whether it's through NMOS, Ember+, REST API, MN Set, or customer specific software.

2. Configure and Control

The following software can be used to configure and control the BN880. Bluebell Opticom is only suggesting the use of any of the third-party software listed below; all support for third-party software is provided by the software creator.

Software	Description	Download Link
Bluebell-Connect	Bluebell's desktop GUI allows users to configure Bluebell devices via USB	https://bluebell.tv/bluebellconnect
MN Set	MN SET allows users to configure the BN880 unit via the 1 GbE Management port and 10/25 GbE media ports.	https://www.embrionix.com/product/MN%20SET
Ember+ Viewer*	An Ember+ client that allows you to use Ember+ protocol to configure and control your device's APP.	https://github.com/Lawo/ember-plus/releases
NMOS registry such as Sony nmos-cpp	An NMOS registry is required to use NMOS protocol to control the routing of media streams through your device's APP (as a registration server and connection manager). For APPs that support NMOS only. Another NMOS registry can equally be used	https://github.com/sony/nmos-cpp
Insomnia	REST client for APP configuration. Another REST client can equally be used.	https://insomnia.rest/
iReasoning MIB browser	A MIB browser used to view the contents of an SNMP server. Another MIB browser client can equally be used.	https://www.ireasoning.com/mibbrowser.shtml

* Ember+ support is not a default feature of the BN880, but can be used instead of NMOS, see

3. Power

BN880 requires an external power supply voltage of 8 - 17V DC. A Bluebell Model PS12 PSU (12V) will be packed with the BN880 interfaces if one is ordered. The power supply connector is a Neutrik® XLR4M, and a locking mating connector is pre-fitted to the PS12 DC cable.

Pin	
1	0 V
2	n/c
3	n/c
4	+V DC

If using an alternative PSU,
wire the connector as above.

Model	Typical Power Consumption
BN880/2T/12G	11.0 W (2ch variants)
BN880/2R/12G	
BN880/1T/1R/12G	
BN880/2T/JPEGXS	
BN880/2R/JPEGXS	
BN880/4T/3G	12.0 W (4ch variants)
BN880/4R/3G	
BN880/2T/2R/3G	
BN880/2T/2R/3G/10G	

The power consumption of the 2ch and 4ch BN880 variants.
2ch variants are measured with 2x12G SDI signals.
4ch variants are measured with 4x3G SDI signals.

4. Connections and Indicators

4.1. BN880 Front Panel

On all models, bi-colour LEDs are located adjacent to each BNC connector. These illuminate green to indicate a valid and locked SDI signal (HD/3G/6G/12G), or red to indicate either the absence of a signal or an invalid input.

For Encapsulator channels, the LEDs monitor the incoming SDI video signal. For Decapsulator channels, they confirm the reception of a valid ST2110 IP video stream.

The LEDs located beneath the SFP cages indicate the link status between the BN880 and the connected network switch. Ensure that the correct SFP modules are installed and that the switch ports are configured appropriately. For example, set to 10 GbE or 25 GbE as required, with FEC (Forward Error Correction) enabled or disabled according to system requirements.

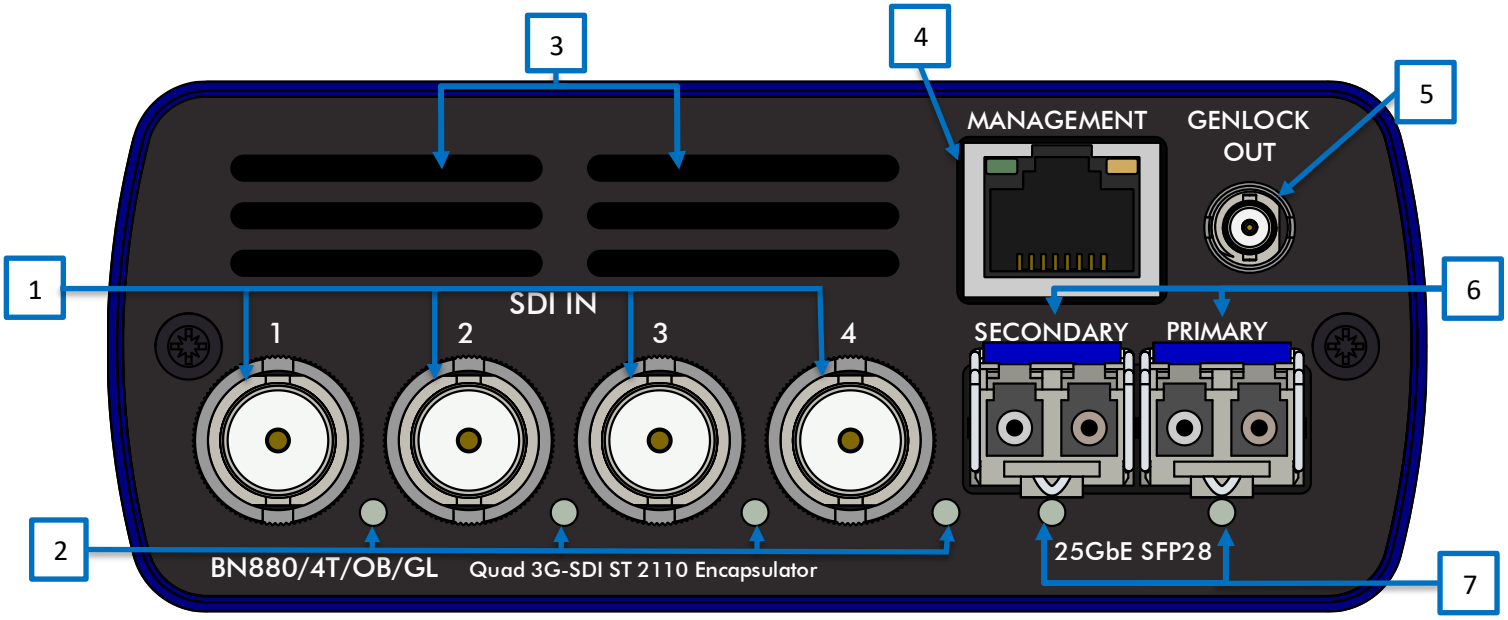


Figure 6: Connections and indicators - Front panel view

1. **SDI Input/Output** – 75Ω BNC connectors for SDI input/output on Channels 1–4. Each channel operates as an **SDI input** when configured as an *Encapsulator* and as an **SDI output** when configured as a *Decapsulator*.
2. **S/L Channel Status** – Bi-colour LEDs (one per channel) indicating SDI signal lock status for Channels 1–4. *Green* indicates signal lock; *red* indicates no lock.
3. **Air Vents** – Exhaust vents for unit airflow. Ensure adequate clearance around the vents and **do not obstruct** to maintain proper cooling.
4. **1 GbE Management Port** – RJ45 connector providing 1 GbE out-of-band management access. *(Optional)*
5. **Genlock Output** – HD-BNC connector providing a PTP-synchronised Genlock output. *(Optional)*
6. **10/25 GbE Media Ports** – SFP cages supporting MSA-compliant 10 GbE or 25 GbE data SFP modules (depending on model). These ports provide the primary and secondary Ethernet connections to the network switch.
7. **Media Port Link Status** – Bi-colour LEDs indicating the link status of each media interface between the BN880 and the connected switch. *Green* indicates link-up; *red* indicates link-down.

NOTE: Two channel cards have a similar layout but do not include BNC and indicators for channel 3 and channel 4.

4.2. BN880 Rear Panel

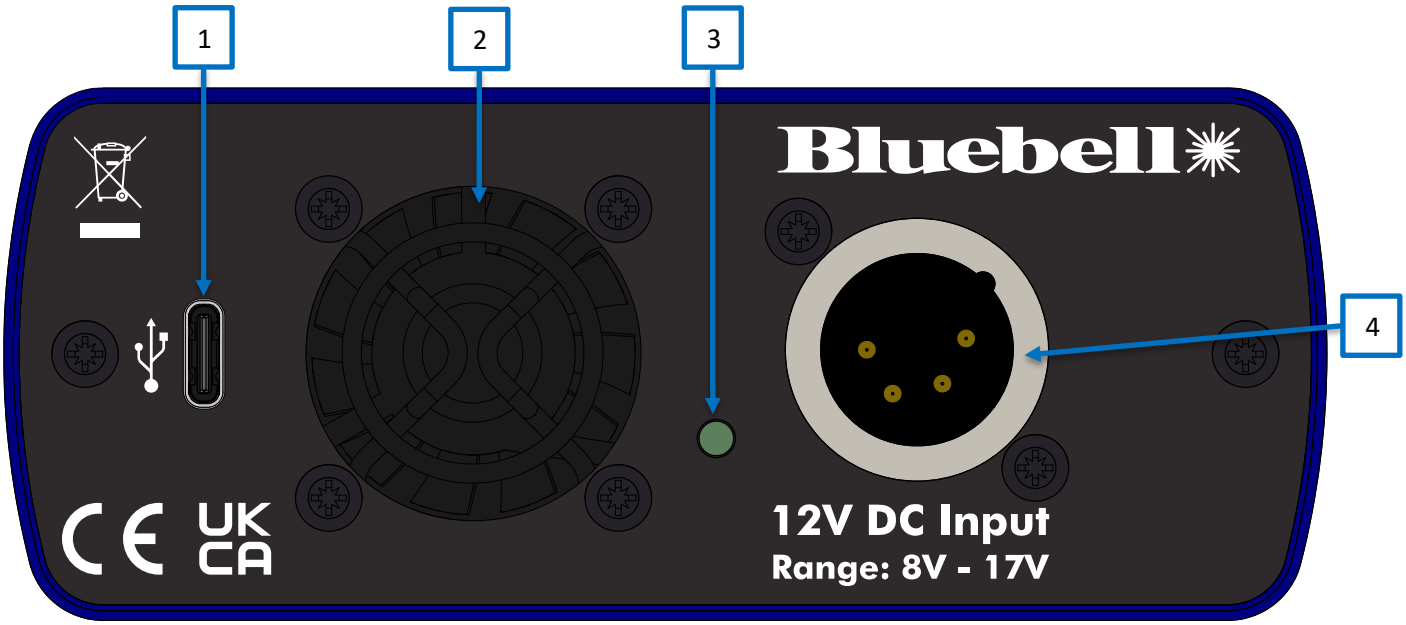


Figure 7: Connections and indicators - Rear panel view

1. **USB-C Out-of-Band configuration** – USB-C port for configuring the BN880 using Bluebell's dedicated control software, BluebellConnect. See
2. *BluebellConnect – Configure your Bluebell Device via* USB for further information.
3. **Fan** – Air intake vent for cooling. Ensure adequate clearance around this area and do not obstruct airflow to maintain optimal operating temperature.
4. **Power Status LED** – LED indicator showing the unit's power state. *Green* indicates the unit is powered; *off* indicates no power is present.
5. **Power** – 4-pin XLR power connector requiring an external 8–17 V DC power supply.

5. Inputs and Outputs

5.1. SDI Video

BN880 interfaces can be used with serial digital video signals having data rates up to 12 Gb/s. Standards supported are:

- HD-SDI: SMPTE ST292 compliant
- 3G-SDI: SMPTE ST424 compliant
- 6G-SDI: SMPTE ST2081 compliant
- 12G-SDI: SMPTE ST2082 compliant

Video inputs and outputs are on 75-ohm BNC sockets. All variants have the following SDI input/output connections on each BNC:

Model	BNC 1	BNC 2	BNC 3	BNC 4
BN880/2T/12G	I/P	I/P	-	-
BN880/2R/12G	O/P	O/P	-	-
BN880/1T/1R/12G	I/P	O/P	-	-
BN880/4T/3G	I/P	I/P	I/P	I/P
BN880/4R/3G	O/P	O/P	O/P	O/P
BN880/2T/2R/3G	I/P	I/P	O/P	O/P
BN880/2T/2R/3G/10G	I/P	I/P	O/P	O/P
BN880/2T/JPEGXS	I/P	I/P	-	-
BN880/2R/JPEGXS	O/P	O/P	-	-

5.2. Optical

Two SFP cages fitted with a dual LC optical module is standard; the module must be a 10 or 25 GbE (dependent on version), MSA standard, transceiver.

Model	Primary SFP	Secondary SFP
BN880/2T/12G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/2R/12G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/1T/1R/12G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/4T/3G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/4R/3G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/2T/2R/3G	25 GbE (SFP28)	25 GbE (SFP28)
BN880/2T/2R/3G/10G	10 GbE (SFP+)	10 GbE (SFP+)
BN880/2T/JPEGXS	10 GbE (SFP+)	10 GbE (SFP+)
BN880/2R/JPEGXS	10 GbE (SFP+)	10 GbE (SFP+)

5.3. USB-C Port

The intended use of the USB configuration is not to configure the device during live production, but to help set-up and pre-configure the device before connecting to a network.

BluebellConnect is a dedicated software to configure the BN880 units via the USB-C port. See

BluebellConnect – Configure your Bluebell Device via USB for further information.

5.4. 1 GbE Out-of-Band Management Port (optional)

A 1 GbE RJ45 port with Out-of-Band (OOB) management uses an IP network that is separate from the media network for device configuration and control. The OOB feature can be configured through the unit's REST API, BluebellConnect or MN SET. See *Out-of-Band 1 GbE Management (optional)*.

5.5. Genlock Output (optional)

HD-BNC output locked to the Grandmaster PTP clock of the network. See *PTP-Synchronised Genlock Output (optional)* for more information.

6. Media Link and Port Bandwidth Requirements

It is essential to assess the bandwidth requirements of your network to ensure it is specified correctly. If a network interface does not have sufficient capacity, the resulting symptoms may include picture blocking, dropped frames, loss of video, audio interruptions, and missing ANC data.

Please note that SMPTE ST 2022-7 protection does not increase the total available network bandwidth. If the network becomes overloaded, both the primary (red) and secondary (blue) paths will experience congestion simultaneously.

6.1. SMPTE ST 2110-20 - 25 GbE Gateways

The following table provides indicative bandwidth requirements for a range of operating scenarios. Any value shown in red indicates that the configuration is not supported.

For a Decapsulator, when the make-before-break clean-switching mode is enabled on a channel, the bandwidth demand for that channel will double during the switching period, which is approximately 300 milliseconds.

10/25 GbE Media Gateway	Use Cases	Encapsulator Bandwidth (Gb/s)	Decapsulator	
			Clean Switch (MBB)	Bandwidth (Gb/s)[1]
25 GbE	4 x 1.5G	4 x 1.3 = 5.2	Disabled	4 x 1.3 = 5.2
			Enabled	(4 x 1.3) + 1.3 = 6.5
25 GbE	4 x 3G	4 x 2.6 = 10.4	Disabled	4 x 2.6 = 10.4
			Enabled	(4 x 2.6) + 2.6 = 13.0
25 GbE	2 x 6G	2 x 5.2 = 10.4	Disabled	2 x 5.2 = 10.4
			Enabled	(2 x 5.2) + 5.2 = 15.6
25 GbE	2 x 12G	2 x 10.4 = 20.8	Disabled	2 x 10.4 = 20.8
			Enabled	(2 x 10.4) + 10.4 = 31.2
25 GbE	1 x 6G + 1 x 12G	10.4 + 5.2 = 15.6	Disabled	10.4 + 5.2 = 15.6
			Enabled	(10.4 + 5.2) + 10.4 = 26.0 (10.4 + 5.2) + 5.2 = 20.8
10 GbE	2 x 1.5G (2T2R)	2 x 1.3 = 2.6	Disabled	2 x 1.3 = 2.6
			Enabled	(2 x 1.3) + 1.3 = 3.9
10 GbE	2 x 3G (2T2R)	4 x 2.6 = 10.4	Disabled	2 x 2.6 = 5.2
			Enabled	(2 x 2.6) + 2.6 = 7.8

NOTE: [1] – This example assumes that only one channel is switched at a time. If multiple channels are switched simultaneously, the additional bandwidth for each channel must also be taken into consideration.

7. Clean Switch Switching Modes

This section describes how video and audio streams can be switched from one source to another at the IP receiver. Switching behaviour is highly configurable, and the selected mode affects the quality and smoothness of the transition. The following switching modes are available:

- **Default switching mode**
  This is the standard mode and is available without a Clean Switch licence.
- **Break-before-Make clean-switch mode** *(licensed option)*
  The current source is released before the new source is selected.
- **Make-before-Break clean-switch mode** *(licensed option)*
  The new source is acquired before the current source is released, providing the smoothest transition.

In default mode, switching may cause visible or audible disturbance. Clean switching maintains continuity and avoids video glitches or audio pops

7.1. Default Switching Mode

When operating in the default switching mode, the switching sequence behaves as follows:

1. The routing system assigns a new source (new IGMP group) to the receiver flow.
2. The device immediately leaves the previous source and joins the new one.
   - IGMP group membership is updated.
   - Video output switches straight to the new source, and a visual disturbance may occur during the transition, such as dropped frames or a black or blue screen.
     The behaviour depends on the **loss_of_input** configuration in the REST API:
     `{ManagementIPaddress}/emsfp/node/v1/flows/sdi_output/{sdiOutputId}/input_signal_output_mode`
     If **loss_of_input** is set to *freeze*, a black image will be shown during the switch because freezing cannot be applied unless clean switching is enabled.
   - An audible pop or brief silence may also occur during the transition.
3. The new source is displayed.

7.2. Clean Switching Mode Requirements (optional)

Clean switching requires an optional licence.

It may be applied to video only, or to all essences (video, audio, and ancillary data).

Clean switching is supported in the following scenarios:

- Switching between SMPTE ST 2110-20 video essences
- Switching between SMPTE ST 2110-22 video essences (if JPEG-XS variant)
- Switching between video streams that have an identical video format for ST 2110-20 and ST 2110-22 flows
- Switching between audio streams that have the same number of audio channels and identical packet time for ST 2110-30 flows

7.2.1. Break-before-Make Clean Switching Mode

The following procedure uses PUT commands issued through the device's REST API.

1. **Enable clean switching on the required essence** - If clean switching is not enabled, the default switch mode will be used.

   Issue a PUT command to the `/clean_switch/<id>/mode` field using one of the following

values:

- `enabled` — applies clean switching to both video and audio.
  When a new route is set, the switch is staged. The actual switch occurs when `now` is issued.
- `video_only` — applies clean switching to video only.
  This option uses less peak bandwidth during switchover. The switch is performed automatically when the new route is ready.

2. **Select the clean-switch mode** - Issue the following to set break-before-make clean switching:
   PUT `bbm` into `/clean_switch/<id>/type`

3. **Route a new source** (new IGMP group) to the receiver - This may be done using:

   - REST API endpoints:
     `{Management IP address}/emsfp/node/v1/flows`
     `{Management IP address}/emsfp/node/v1/sdp`
   - A suitable control system.

   The device keeps the existing source active while preparing for the clean switch to the new source.

4. **Trigger the clean switch** - Issue the following request:

   PUT `now` into `/clean_switch/<id>/switch_time`

   NOTE: This step is performed automatically if the `video_only` mode is selected.

5. **Switch execution** - The device immediately leaves the previous source and joins the new one.

   - IGMP group membership is updated
   - Video output is frozen during the transition
   - When the enabled option is active, a V-fade process is applied to audio to avoid audible artefacts. The V-fade gently reduces the current audio to mute, then smoothly brings up the audio from the new source.

6. **The new source is displayed**

7.2.2. Make-before-Break Clean Switching Mode

You can further refine the switching behaviour by enabling make-before-break clean switching. In this mode, both the current and new video sources are buffered during the transition to ensure a completely clean changeover. The following procedure is performed through the REST API.

1. **Enable clean switching** - If clean switching is not enabled, the default switch mode will be applied.

   PUT `enabled` into `/clean_switch/<id>/mode`

2. **Select the make-before-break mode**

   PUT `mbb` into `/clean_switch/<id>/type`

3. **Adjust buffering time if required** - You can configure the buffering period used to compensate for network delay.

   The `igmp_setup_delay` parameter specifies the time the network and devices in the signal path are given to route the new traffic.

   - If set too low, there may be missing frames during the transition.
   - If set too high, the device may experience increased network load during the switch.

   PUT `<delay_in_milliseconds>` into `/clean_switch/<id>/igmp_setup_delay`

   NOTE: A delay of '`0`' delay for `igmp_setup_delay` will result in an infinite timeout (packet

needs to be received in order to switch). A `0` delay can only be used when `timeout_option` is NOT `revert`.

4. **Configure timeout behaviour (optional)** - If no packets are received after a switch request, you may choose to revert to the previous source rather than switching to an empty flow. When `igmp_setup_delay` is not 0, configure:

   - PUT `switch` in `/clean_switch/<id>timeout_option`: Perform the switch anyway.
   - PUT `revert` in `/clean_switch/<id>timeout_option`: Remain on the current flows, and will change the flow's configuration to reflect a revert.

5. **Route the new source** (new IGMP group) - This may be done via:
   `{Management IP address}/emsfp/node/v1/flows`
   `{Management IP address}/emsfp/node/v1/sdp`

or via a control system.

The device remains locked to the current source while preparing to acquire the new one.

6. **Initiate the clean switch**

   PUT `now` into `/clean_switch/<id>/switch_time`

   The device joins the new source and buffers it while still maintaining the previous source. IGMP membership is updated accordingly.

   This step is automatic when mode is `video_only`.

7. **Switch to the new source** - Once the new stream is received and validated, the device transitions to it and leaves the previous source.

   - Video output transitions cleanly to the new stream
   - When audio clean switching is enabled, a **V-fade** is applied to avoid audible artefacts (audio is smoothly faded down and then up during the changeover)
   - IGMP membership is updated to leave the old stream

8. **The new source is now active**

This mode requires additional bandwidth for a short time, as both the current and new flows are received simultaneously. For example, it is not possible to perform a make-before-break switch between two UHD flows, as the temporary combined bandwidth requirement is approximately 24 Gb/s.

8. LLDP

Devices support the LLDP (IEEE 802.1AB) protocol, which allows high-level information about the physical configuration of devices to be exchanged between neighbouring network equipment. This is useful for establishing the network topology and locating physical devices easily.

BN880 units publish the following information to the IP switch:
- Chassis ID (MAC address)
- Management IP address (IP address of the interface that sent the LLDP information)
- System name (hostname)
- System description (running application and version, hardware and platform)

From the LLDP information received from the IP switch, BN880 units extract and display:
- Chassis ID
- Port number

9. Forward Error Correction (FEC) - Reed Solomon

To preserve signal integrity when the host IP media interface operates at a 25G data rate, Forward Error Correction (FEC) may be enabled on both the sender and receiver links. RS-FEC improves signal integrity over 25GbE links, particularly for longer fibre runs or marginal optical conditions.

When FEC is used, the corresponding 25G switch ports connected to the sender and receiver must also have FEC enabled in their port configuration.

This parameter can be controlled through the REST API at the following path:

```
{Management IP address}/emsfp/node/v1/self/phy
```

OR,

Via BluebellConnect

The SMPTE ST 2110 application operating at 25-gigabit Ethernet (25 GbE) can enable or disable RS-FEC depending on the network switch configuration. This requires a fixed configuration on both the device and the switch, as RS-FEC auto-negotiation is not supported.

By default, RS-FEC is disabled on the APP when operating at 25 GbE.

NOTE: A system reset disables RS-FEC on the device. If RS-FEC was enabled before the reset, you must configure the switch port to disable RS-FEC in order to restore network connectivity with the device.

Reconfiguration is performed in two stages:

1. **Modify the FEC setting**
   - Change the FEC scheme on the device interface. Each Primary (RED) and Secondary (BLUE) network interface can be configured independently.
   - Apply the same FEC setting on the corresponding switch port.
   - Ensure both settings match exactly.

2. **Verify connectivity**
   - Confirm that the link comes up and that the device is reachable.
   - If successful, **commit** the configuration to make it persistent.
   - If unsuccessful (link down or device unreachable):
     - **Power-cycle the device** to revert to the previous configuration
     - Restore the switch port to its previous FEC setting to re-establish connectivity

10. Supported Formats / Resolution

10.1. Supported Formats

SD-SDI: SD formats are not supported.

The following single-link resolutions are supported.

Format	Rate Gb/s	Pixel Data Structure				Colourimetry
		10-bit	12-bit	4:2:2	4:4:4	
				YCbCr (1)	RGB or YCbCrb (2)	
1280 × 720p23.98	1.5	•		•	•	BT.709
1280 × 720p24	1.5	•		•	•	BT.709
1280 × 720p25	1.5	•		•	•	BT.709
1280 × 720p29.97	1.5	•		•	•	BT.709
1280 × 720p30	1.5	•		•	•	BT.709
1280 × 720p50	1.5	•		•	•	BT.709
1280 × 720p59.94	1.5	•		•	•	BT.709
1280 × 720p60	1.5	•		•	•	BT.709
1920 × 1080p23.98	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080p24	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080p25	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080p29.97	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080p30	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080p50	3	•		•		BT.709 or BT.2020
1920 × 1080p59.94	3	•		•		BT.709 or BT.2020
1920 × 1080p60	3	•		•		BT.709 or BT.2020
1920 × 1080psf23.98	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080psf24	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080psf25	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080psf29.97	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080psf30	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080i47.95	1.5	•		•		BT.709 or BT.2020
1920 × 1080i48	1.5	•		•		BT.709 or BT.2020
1920 × 1080i50	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080i59.94	1.5	•	•	•	•	BT.709 or BT.2020
1920 × 1080i60	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p23.98	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p24	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p25	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p29.97	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p30	1.5	•	•	•	•	BT.709 or BT.2020
2048 × 1080p47.95	3	•		•		BT.709 or BT.2020
2048 × 1080p48	3	•		•		BT.709 or BT.2020
2048 × 1080p50	3	•		•		BT.709 or BT.2020
2048 × 1080p59.94	3	•		•		BT.709 or BT.2020
2048 × 1080p60	3	•		•		BT.709 or BT.2020

Below formats are not supported on 3G-SDI variants						
3840 × 2160p23.98	6	•	•	•	•	BT.709 or BT.2020
3840 × 2160p24	6	•	•	•	•	BT.709 or BT.2020
3840 × 2160p25	6	•	•	•	•	BT.709 or BT.2020
3840 × 2160p29.97	6	•	•	•	•	BT.709 or BT.2020
3840 × 2160p30	6	•	•	•	•	BT.709 or BT.2020
3840 × 2160p50	12	•		•		BT.709 or BT.2020
3840 × 2160p59.94	12	•		•		BT.709 or BT.2020
3840 × 2160p60	12	•		•		BT.709 or BT.2020
4096 × 2160p23.98	6	•	•	•	•	BT.709 or BT.2020
4096 × 2160p24	6	•	•	•	•	BT.709 or BT.2020
4096 × 2160p25	6	•	•	•	•	BT.709 or BT.2020
4096 × 2160p29.97	6	•	• (3)		• (3)	BT.709 or BT.2020
4096 × 2160p30	6	•	• (3)	•	• (3)	BT.709 or BT.2020
4096 × 2160p47.95	12	•		•		BT.709 or BT.2020
4096 × 2160p48	12	•		•		BT.709 or BT.2020
4096 × 2160p50	12	•		•		BT.709 or BT.2020
4096 × 2160p59.97 (3)	12	•		•		BT.709 or BT.2020
4096 × 2160p60 (3)	12	•		•		BT.709 or BT.2020

NOTES: (1) – For 4:2:2, YCbCr 12-bit resolutions, the value shown in the Rate column is doubled.
(2) – For 4:4:4, RGB or YCbCr resolutions, the value shown in the Rate column is doubled.
(3) – See 4K DCI resolution limitations below

10.2. Video-Format Structure Support

The following video-format structures at the SDI input are supported.

Note that these video-format structures are showing what is called an Alpha component in the SDI stream ("+A" or "+D"). Alpha component is not defined as part of the SMPTE ST 2110-20 video stream. That is, when receiving an SDI signal to be encapsulated as an SMPTE ST 2110-20 RTP stream, if that SDI signal is constructed as one of the listed format structures, the Alpha component will simply be dropped and not transmitted over IP. Rest API and SDP will also show the signal as not containing any Alpha component (which in any case, is not specified in the SMPTE ST 2110- 20 standard). SDI video-format structures are converted as shown in the table below.

Input SDI Video-Format Structure	Encapsulated SMPTE ST 2110-20 Video Stream Format
12-bit 4:2:2:4 YCbCr+A	12-bit 4:2:2 YCbCr
12-bit 4:2:2:4 YCbCr+D	12-bit 4:2:2 YCbCr
12-bit 4:2:2:4 YCbCr	12-bit 4:2:2 YCbCr
10-bit 4:4:4:4 YCbCr+A	10-bit 4:4:4 YCbCr
10-bit 4:4:4:4 YCbCr+D	10-bit 4:4:4 YCbCr
10-bit 4:4:4:4 YCbCr	10-bit 4:4:4 YCbCr
10-bit 4:4:4:4 RGB+A	10-bit 4:4:4 RGB
10-bit 4:4:4:4 RGB+D	10-bit 4:4:4 RGB
10-bit 4:4:4:4 RGB	10-bit 4:4:4 RGB

10.3. 4K DCI Resolution Limitation

When using the following resolutions, a single channel only can be used on either the Encapsulator or the Decapsulator.

- 4096 × 2160p 29.97Hz (12-bit, 4:2:2, YCbCr)
- 4096 × 2160p 30Hz (12-bit, 4:2:2, YCbCr)
- 4096 × 2160p 59.94Hz (10-bit, 4:2:2, YCbCr)
- 4096 × 2160p 60Hz (10-bit, 4:2:2, YCbCr)
- 4096 × 2160p 29.97Hz (10 / 12-bit, 4:4:4, RGB / YCbCr)
- 4096 × 2160p 30Hz (10 / 12-bit, 4:4:4, RGB / YCbCr)

4:4:4 pixel data structure, RGB or YCbCr resolutions use double the bitrate compared to the same signal format in 4:2:2 YCbCr 10-bit resolution.

4:2:2 pixel data structure, YCbCr 12-bit resolutions use double the bitrate compared to the same signal format in 4:2:2 YCbCr 10-bit resolution.

10.4. JPEG-XS TR 08 Support

The JPEG XS application supports SMPTE ST 2110-22 (TR 08) with the following constraints:

- SD formats are not supported
- Pixel format: only 10-bit YCbCr 4:2:2 is supported
- Minimum compression ratio: 5:1 (equivalent to 1.5 bits per pixel)
- Maximum compression ratio: 13:1 (equivalent to 4.0 bits per pixel).
  The compression level is set indirectly by configuring the target compressed JPEG XS codestream bitrate. When this value is entered, it may be rounded to the nearest supported rate.
- If *SDP overwrite* (`sdp_overwrite`) is enabled, the *Applied bitrate* (`operating_bit_rate`) must be set.
- Although TR 08 expresses compression as bits per pixel, the REST API, SDP files, and NMOS specify the compressed codestream bitrate to represent the compression level.

Format	Colorimetry	Single/ Multi-link	Standards	Min Bitrate Compression 5:1 (mbps)	Max Bitrate Compression 13:1 (mbps)
1280 × 720p23.98	BT709	Single-link	(HD) ST292, ST296	90,878	34,257
1280 × 720p24	BT709	Single-link	(HD) ST292, ST296	90,969	34,291
1280 × 720p25	BT709	Single-link	(HD) ST292, ST296	94,760	35,720
1280 × 720p29.97	BT709	Single-link	(HD) ST292, ST296	113,598	42,821
1280 × 720p30	BT709	Single-link	(HD) ST292, ST296	113,712	42,864
1280 × 720p50	BT709	Single-link	(HD) ST292, ST296	189,519	71,439
1280 × 720p59.94	BT709	Single-link	(HD) ST292, ST296	227,195	85,641
1280 × 720p60	BT709	Single-link	(HD) ST292, ST296	227,423	85,727
1920 × 1080p23.98	BT709, BT2020	Single-link	(HD) ST292, ST274	204,971	77,006
1920 × 1080p24	BT709, BT2020	Single-link	(HD) ST292, ST274	205,176	77,083
1920 × 1080p25	BT709, BT2020	Single-link	(HD) ST292, ST274	213,725	80,295
1920 × 1080p29.97	BT709, BT2020	Single-link	(HD) ST292, ST274	256,214	96,258
1920 × 1080p30	BT709, BT2020	Single-link	(HD) ST292, ST274	256,470	96,354
1920 × 1080p50	BT709, BT2020	Single-link	(3G) ST425-1, ST274	427,450	160,589
1920 × 1080p59.94	BT709, BT2020	Single-link	(3G) ST425-1, ST274	512,428	192,515
1920 × 1080p60	BT709, BT2020	Single-link	(3G) ST425-1, ST274	512,940	192,707
1920 × 1080psf23.98	BT709, BT2020	Single-link	(HD) ST292, ST274	204,971	77,006
1920 × 1080psf24	BT709, BT2020	Single-link	(HD) ST292, ST274	205,176	77,083

1920 × 1080psf25	BT709, BT2020	Single-link	(HD) ST292, ST274	213,725	80,295
1920 × 1080psf29.97	BT709, BT2020	Single-link	(HD) ST292, ST274	256,214	96,258
1920 × 1080psf30	BT709, BT2020	Single-link	(HD) ST292, ST274	256,470	96,354
1920 × 1080i47.95	BT709, BT2020	Single-link	N/A	204,971	77,006
1920 × 1080i48	BT709, BT2020	Single-link	N/A	205,176	77,083
1920 × 1080i50	BT709, BT2020	Single-link	(HD) ST292, ST274	213,725	80,295
1920 × 1080i59.94	BT709, BT2020	Single-link	(HD) ST292, ST274	256,214	96,258
1920 × 1080i60	BT709, BT2020	Single-link	(HD) ST292, ST274	256,470	96,354
2048 × 1080p23.98	BT709, BT2020	Single-link	(HD) ST292, ST2048-2	218,561	82,102
2048 × 1080p24	BT709, BT2020	Single-link	(HD) ST292, ST2048-2	218,779	82,184
2048 × 1080p25	BT709, BT2020	Single-link	(HD) ST292, ST2048-2	227,895	85,608
2048 × 1080p29.97	BT709, BT2020	Single-link	(HD) ST292, ST2048-2	273,201	102,627
2048 × 1080p30	BT709, BT2020	Single-link	(HD) ST292, ST2048-2	273,474	102,730
2048 × 1080p50	BT709, BT2020	Single-link	(3G) ST425-1, ST2048-2	445,789	171,216
2048 × 1080p59.94	BT709, BT2020	Single-link	(3G) ST425-1, ST2048-2	546,401	205,254
2048 × 1080p60	BT709, BT2020	Single-link	(3G) ST425-1, ST2048-2	546,947	205,460
3840 × 2160p23.98	BT709, BT2020	Single-link	(6G) ST2081-1, ST2036-1	819,884	307,740
3840 × 2160p24	BT709, BT2020	Single-link	(6G) ST2081-1, ST2036-1	820,704	308,048
3840 × 2160p25	BT709, BT2020	Single-link	(6G) ST2081-1, ST2036-1	854,900	320,883
3840 × 2160p29.97	BT709, BT2020	Single-link	(6G) ST2081-1, ST2036-1	1024,855	384,675
3840 × 2160p30	BT709, BT2020	Single-link	(6G) ST2081-1, ST2036-1	1025,880	385,059
3840 × 2160p50	BT709, BT2020	Single-link	(12G) ST2021-1, ST2036-1	1709,799	641,765
3840 × 2160p59.94	BT709, BT2020	Single-link	(12G) ST2021-1, ST2036-1	2049,709	769,349
3840 × 2160p60	BT709, BT2020	Single-link	(12G) ST2021-1, ST2036-1	2051,759	770,118
4096 × 2160p23.98	BT709, BT2020	Single-link	(6G) ST2081-1, ST2048-1	874,524	328,124
4096 × 2160p24	BT709, BT2020	Single-link	(6G) ST2081-1, ST2048-1	875,398	328,452
4096 × 2160p25	BT709, BT2020	Single-link	(6G) ST2081-1, ST2048-1	911,873	342,137
4096 × 2160p29.97	BT709, BT2020	Single-link	(6G) ST2081-1, ST2048-1	1093,155	410,155
4096 × 2160p30	BT709, BT2020	Single-link	(6G) ST2081-1, ST2048-1	1094,248	410,565
4096 × 2160p50	BT709, BT2020	Single-link	(12G) ST2082-1, ST2048-1	1823,746	684,274
4096 × 2160p59.94	BT709, BT2020	Single-link	(12G) ST2082-1, ST2048-1	2186,309	820,309
4096 × 2160p60	BT709, BT2020	Single-link	(12G) ST2082-1, ST2048-1	2188,495	821,129
3840 × 2160p50	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2036-1	1709,799	641,765
3840 × 2160p59.94	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2036-1	2049,709	769,349
3840 × 2160p60	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2036-1	2051,759	770,118
4096 × 2160p50	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2048-1	1823,746	684,274
4096 × 2160p59.94	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2048-1	2186,309	820,309
4096 × 2160p60	BT709, BT2020	Quad-link	(12G -4x3G) ST425-5, ST2048-1	2188,495	821,129

The bitrate parameter can be set through the REST API by issuing a `PUT` command to define the target compressed JPEG XS codestream bitrate:

```
{ManagementIPaddress}/emsfp/node/v1/flows/{encflowId}/video_encoding/requested_bitrate
```

The value entered for `requested_bitrate` will be automatically rounded to the nearest supported bitrate.

The actual operating bitrate can be confirmed with a GET request at:

```
{ManagementIPaddress}/emsfp/node/v1/flows/{encflowId}/video_encoding/applied_
bitrate
```

If a value outside the supported range is applied, a telemetry warning will be generated, and the stream will be disabled until a valid compression setting is configured.

A valid setting is one that results in a JPEG XS codestream bitrate corresponding to a compression ratio between 5:1 and 13:1, as noted in the section above.

11. PTP

The BN880 supports PTP protocol as specified by IEEE 1588-2008 while supporting SMPTE ST 2059-2 and AES-R16-2016 profiles.

All Encapsulator and Decapsulator products are PTP Time Receiver only and provide this functionality on both networks for redundancy purposes, when SMPTE ST 2022-7 hitless redundancy is used. It does not operate as a PTP Grandmaster.

11.1. Configuring the PTP Time Receiver Engine

The BN880 supports two independent PTP Time Transmitter sources, which may operate within the same PTP domain.

Selection of the active Time Transmitter source can be made automatically using the PTP Best Time Transmitter Clock Algorithm (BTCA), or manually via BluebellConnect or the REST API.

Follow the steps below to configure the PTP Time Receiver Engine.

1. **Configure the PTP Domain Number**

   Each PTP Time Transmitter source requires a domain number. This can be configured:
   - BluebellConnect: via the PTP selection tab
   - REST API: Using the endpoint `<ipaddr>/emsfp/node/v1/refclk/<uuid>` url. The UUIDs of the available PTP Time Transmitter sources are listed on the `/refclk` API page.

   Both PTP Time Transmitter sources use the same domain number, which is set to the latest configured value from either source `<uuid>`.

   Acceptable values are between 0 and 127, with a default value of 0.

2. **Configure the VLAN Tag Identifier**

   Specify the VLAN tag identifier used for PTP messages exchange.
   - The default VLAN tag is 0, meaning PTP messages are transmitted and received untagged.
   - The two PTP Time Transmitter sources may use the same or different VLAN tags.

3. **Detect the PTP Time Transmitter Sources**

   Once configured, active PTP Time Transmitter will be automatically detected if present. Each detected source displays its identifier in the `<clock_id>` field along with the PTP Grandmaster identifier.

4. **Adjust the PTP Mode (if required)**

   Set the PTP Mode to match the Grandmaster's transmission mode.
   - Multicast: All PTP messages are exchanged via multicast between the device and the Grandmaster.
   - Hybrid: The device sends message to the Grandmaster using Unicast, while the Grandmaster publishes message via Multicast.

5. **Verify PTP Locking Status**

   The locking process occurs in two stages: a coarse lock step, and a fine lock step.
   - Advanced PTP diagnostics can also be found in the <diag> section.
     - PTP messages counters for all message types
     - Offset to Grandmaster
     - Mean delay value
     - Lock/unlock events

A correctly locked device will display a stable fine-lock status, with the offset-to-Time Transmitter delay as close to zero as possible.

11.2. Locking to the PTP Clock

Under normal network and PTP operating conditions, with announce messages at 1 Hz, sync messages at 8 Hz, and delay request messages at 8 Hz, and with a mean path delay of less than 1 microsecond and clock accuracy better than 50 nanoseconds, all receivers achieve PTP lock within 30 seconds of connecting to the network.

If the PTP reference source experiences a momentary loss or is unavailable for a short period, the receiver will gracefully realign with the recovered clock once the reference returns, without introducing any visible or audible artefacts in the output.

For example, the device can operate in a PTP "free run" state for up to two minutes without any visible degradation in the video output.

11.3. PTP Parameter Configuration

The PTP implementation follows the default values proposed in the AES-R16-2016 profile, as described in the report *"AES Project Report: PTP Parameters for AES67 and SMPTE ST 2059-2 Interoperability."*

Parameter	Minimum	Maximum	Typical	Configurable
domainNumber	0	127	0	✓
logAnnounceInterval	0	1	0	
announceReceiptTimeout	2	10	3	✓
logSyncInterval	-4	-1	-3	
logMinDelayReqInterval	-3	1	-3	✓

The values shown in the table define the time interval between two consecutive PTP messages of the corresponding message type. The unit of measure is 2^n seconds, meaning the value represents a power of two.

For example:

- A value of –3 corresponds to eight messages per second.
- A value of 3 corresponds to one message every eight seconds.

NOTE: The logMinDelayReqInterval parameter is limited to a maximum value of 1, as shown in the table above. This differs from the AES-R16-2016 specification, which allows a potential maximum of 4. Setting the delay request interval above the supported maximum value of 1 will cause very long lock times and may, in some cases, prevent the PTP engine from locking entirely.

12. PTP-Synchronised Genlock Output (optional)

The BN880 includes an optional PTP-synchronised SD-SDI Black Burst genlock output derived from the PTP reference. The reference signal is available on the HD-BNC connector located on the front panel. The PTP timing information is received through the dual network interfaces and used to generate a black video SD-SDI signal.

Feature characteristics:

- Can be enabled or disabled via the REST API
- Provides a single output
- The signal contains video only (no audio or time code)
- Depending on the configured SDI bitrate (fractional or integer), the generated SD-SDI signal conforms to either NTSC (525i59.94) or PAL (625i50) standards

The genlock output feature requires an add-on licence and can be configured through the device's REST API.

13. Out-of-Band 1 GbE Management (optional)

The 1 GbE Out-of-Band (OOB) feature requires an add-on licence and can be configured and controlled through the REST API.

13.1. Enable/Disable Out-of-Band Management

To enable / disable Out-of-Band Management, see *flex_port_mode* in:
{Management IP address}/emsfp/node/v1/self/system

NOTE: Changing the flex_port_mode value can only be done through a media interface connection. Changing the value of this setting triggers a reboot.

13.2. Enable/Disable Control on Media Interfaces

The ability to configure and control a device on its media interfaces can be enabled or disabled with the *media/device_management* switch. When this switch is set to:

· **True:** The device can be controlled through any available Ethernet interface: both media and Out-of-Band.

· **False:** The device can be controlled only through the Out-of-Band Ethernet interface.

See *access_control/media/device_management* in:
{Management IP address}/emsfp/node/v1/self/system

NOTE: Changing the *media/device_management* value from true to false or false to true can only be done through the Out-of-Band Ethernet interface.

13.3. Out-of-Band Parameters and NMOS Control

To set the Out-of-Band Management interface networking parameters, see *OOB* in:
{Management IP address}/emsfp/node/v1/self/interfaces

To configure the preferred network interface to use to communicate with the device using NMOS, see *control_network* in:
{Management IP address}/emsfp/node/v1/self/diag/nmos

14. Ember+ API Protocol

All versions can either support NMOS protocol or Ember+. By default, NMOS protocol is loaded on all versions, unless the /EP has been specified when ordering.

14.1. Bess Protocol

The Gateway APPs implement the Ember+ Bess protocol that has been specified to configure IP products in order to establish routes between a sender and a receiver using an SDP file. For more details, see:
https://github.com/Lawo/bess/blob/master/BESS%20(Basic%20Ember%2B%20Stream%20Switching).pdf

See also SDP file location on *SDP File Location*.

To ensure that Ember+ controller can reach the BN880, make sure to set the Ember port according to the Ember+ server settings and that there's an IP route available.

This Ember server port number can be controlled through the REST API at the following path:
{Management IP address}/emsfp/node/v1/self/protocols,"ember_server_port"

15. NMOS Protocol

All versions can either support NMOS protocol or Ember+. By default, NMOS protocol is loaded on all versions, unless the /EP has been specified when ordering.

15.1. Supported Versions

- IS-04 (Discovery) v1.2
- IS-05 (Routing) v1.0
- IS-08 (Audio Mapping) v1.0
- IS-09 (System) - client only
- AMWA BCP-002-01 (Essence Grouping)
- TR-1001 Recommendation: System Environment and device behaviours

15.2. REST API Control Path

The device can be configured to automatically query the DNS servers to obtain the registry address, or the registry's address must be manually set with the `registry_mode` option through the REST API at the following path:

`{Management IP address}/emsfp/node/v1/self/system/diag/nmos`

Up to two Registry addresses can be manually configured. The `current_registry` option shows the registry currently in use. The `dns_server_addresses` shows a list of DNS server addresses known to the device; these DNS servers are used to get the NMOS registry address when necessary for example.

15.3. Setting up DNS-SD to Support NMOS

The device is set to work in DNS-SD mode by default. Below are the steps to correctly configure the NMOS DNS server through the REST API.

1. Configure the DNS server address. This can be done either:
   - Through DHCP. To allow DHCP, the `manual_dns_server_address` and `Manual_dns_server_address_2` to `_4` fields must all be set to `0.0.0.0`.
     Or
   - Using the `manual_dns_server_address` and `Manual_dns_server_address_2` to `_4` fields, through the REST API at the following path:
     `{Management IP address}/emsfp/node/v1/self/system/diag/nmos`
2. The found DNS server address will then appear in the `dns_server_addresses` field.
3. Make sure the domain name ("domain_name" field) is the right one.
   - If not, manually modify it.
4. At this point, the device should be fetching the NMOS registry from the DNS server.
   - Validate the targeted registry is the right one in the "registry_address" field.
5. The "status" field will display the current connection state:
   - "discovering": not yet reached the NMOS registry
   - "connecting": NMOS registry reached and currently pushing device's resources
   - "connected": NMOS registry connected, and all resources pushed

The AMWA IS-09 system discovery will always use automatic DNS resolution even when `registry_mode` is set to either manual or auto in `/emsfp/node/v1/self/diag/nmos/`.

```
{
    "status": "connected",
    "registry_address": "10.26.135.132:8010",
    "uptime": 40,
    "connection_count": 5,
    "registry_mode": "manual",
```

```
    "dns_registry_service": "_nmos-register._tcp.dns.nmos.tv",
    "mdns_mode": false,
    "dns_server_address": "10.26.135.195",
    "manual_dns_server_address": "0.0.0.0",
    "domain_name": "dns.nmos.tv."
}
```

16. SDP File

The Session Description Protocol (SDP), as defined in RFC 8866, can be used to route signals between Encapsulators and Decapsulators.

This section outlines the expected fields within a standard SMPTE ST 2110 essence SDP file.

When an SDP file is applied, the most recent configuration change takes precedence. For example, parameters defined in an SDP file will override any equivalent settings previously configured by other means at the time the SDP is received. Likewise, any subsequent updates made through a configuration interface will override the SDP parameters.

16.1. SDP File Location

The URL reported in *`sdp_file_url`* uses a dynamic host address. The host address will match the IP address of the device interface from which the REST API request has been received, which can be the IP address of the primary media interface, secondary media interface, or Out-of-Band Management interface.

The SDP file can be accessed through the device's REST API at the following paths by issuing a GET at:

- *`{Management IP address}/emsfp/node/v1/senders_sdp/{sdpId}`*
- *`{Management IP address}/emsfp/node/v1/receivers_sdp/{sdpId}`*

16.2. Essence Routing Using SDP

The following example shows a basic SDP file for a video flow, followed by a description of each expected parameter.

```
v=0
o=- 1443716955 1443716955 IN IP4 10.26.128.38
s=emsfp-a0-94-f6_0-0-0
t=0 0
m=video 20000 RTP/AVP 96
c=IN IP4 239.0.1.2/64
a=source-filter: incl IN IP4 239.0.1.2 192.168.0.1
a=rtpmap:96 raw/90000
a=fmtp:96 sampling=YCbCr-4:2:2; width=1920; height=1080;
    exactframerate=30000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110TPM;
    SSN=ST2110-20:2017; TP=2110TPN; TROFF=652; interlace;
a=mediaclk:direct=0
a=ts-refclk:ptp=IEEE1588-2008:08-00-11-FF-FE-22-91-BB:0
a=inactive
```

- v, o, s, and t: These parameters are set by implementation and are not configurable.
- m=`<type> <dst udp port>` RTP/AVP `<rtp pt>`
  - `<type>`: indicates which type of essence this is:
    - video (for video and ancillary essence)
    - audio
  - `<dst udp port>`: destination port. *Configurable*
  - `<rpt pt>`: RTP payload type. *Configurable*
- c=IN IP4 `<dst ip address>/<ip ttl>`
  - `<dst ip address>`: IP stream destination IPv4 address. *configurable*
  - `<ip ttl>`: IP stream TTL (time to live). *Configurable*

- a=source-filter: incl IN IP4 <dst ip address> <src ip address>
  - <a=source-filter> (*Optional)*: Source-filter inclusion list. *Configurable*
  - <dst ip address>: IP stream destination IPv4 address. *Configurable*
  - <src ip address>: IP stream source IPv4 address. *Configurable*

- a=rtpmap:<rtp pt> <format>
  - <rpt pt>: RTP payload type. *Configurable*
  - <format>:
    - If video essence: "raw/90000"
    - if audio essence: <type>/<freq>/<nb channel>
      - <type>: *configurable*
        - 24: 24-bit PCM audio samples.
        - AM824: 32-bit AES3 audio frames.
      - <freq>: Audio frequency, usually 48000 or 96000.
      - <nb channel>: Number of audio channels in IP stream. *Configurable*
    - If ancillary essence: "smpte291/90000"

- a=mediaclk:direct=0: This parameter is set by implementation and is not configurable.

- a=ts-refclk:ptp=<type>:<type format>
  - <type>:
    - IEEE1588-2008: When PTP locked.
    - localmac: When not PTP locked.
  - <type format>:
    - If type is IEEE1588-2008: <gm>:<domain number>
      - <gm>: PTP Grandmaster MAC
      - <domain number>: PTP domain number
    - If type is localmac: <mac>
      - <mac>: device MAC address

Video-specific parameters:
- a=fmtp:<rtp pt> <format>
  - <rpt pt>: RTP payload type (shall be the same as for the <a=rtpmap> parameter). Configurable
  - <format>: refer to "SMPTE ST 2110-20" for complete details. For information about Packet Mode, see Traffic Shaping (SMPTE ST 2110-21) on page 64.
    For an Encapsulator: The format is auto-filled from the decoded SDI stream input.
    For a Decapsulator: The format is configurable to program receiving Decapsulator engine.

NOTE: Slog3 is an invalid TCS as per SMPTE ST 2110-20. Therefore UNSPECIFIED is used in its place.

Audio-specific parameters:
- a=framecount: <number of samples per frame>
  - <number of samples per frame>: Calculated using ptime.
- a=ptime: <ptime>
  - <ptime>: The packet period time. *configurable*
    1: every milli-second
    0.125: every 125us
    0.25: every 250us
    0.333: every 333us
    0.5: every 500us

Ancillary-specific parameters:
- a=fmtp:<rtp pt> VPID_Code=<vpid code>;
  - <rpt_pt>: RTP payload type (shall be the same as for the <a=rtpmap> parameter). *Configurable*
  - <vpid_code>: This is the VPID code for the ancillary data.
    129: SD signal

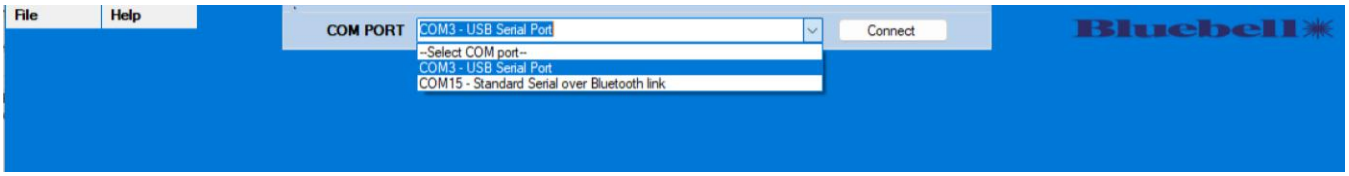
132: ST292 for 720p signal
133: ST292 for 1080p signal
137: ST425 for 1080p signal
192: ST2081 for 2160p signal
206: ST2082 for 2160p signal

17. BluebellConnect – Configure your Bluebell Device via USB

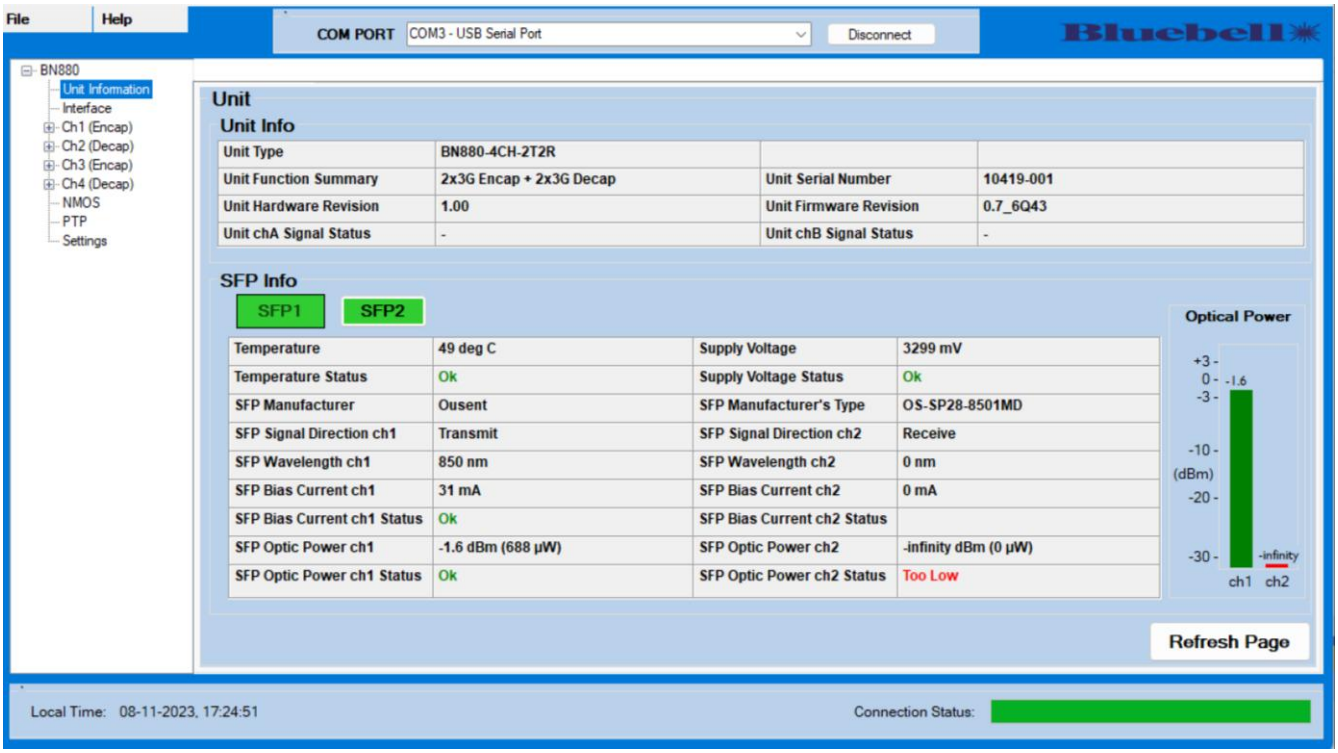
Before connecting the BN880 to the network, the user can configure the unit's network parameters to work within the network rather than altering the network itself. The intended use of BluebellConnect is not to configure the device during live production, but to help set-up and pre-configure the device before connecting to a network. *Visit* https://bluebell.tv/bluebellconnect.

To connect a unit to BluebellConnect, simply:

1. Power the Unit
2. Connect a USB from the type-C connector at the rear of the unit to a PC.
3. Open BluebellConnect.exe
4. Once the BN880's LEDs have stopped toggling green/red, it is ready for a connection.
5. Select the correct COM port for your device, and click "Connect"



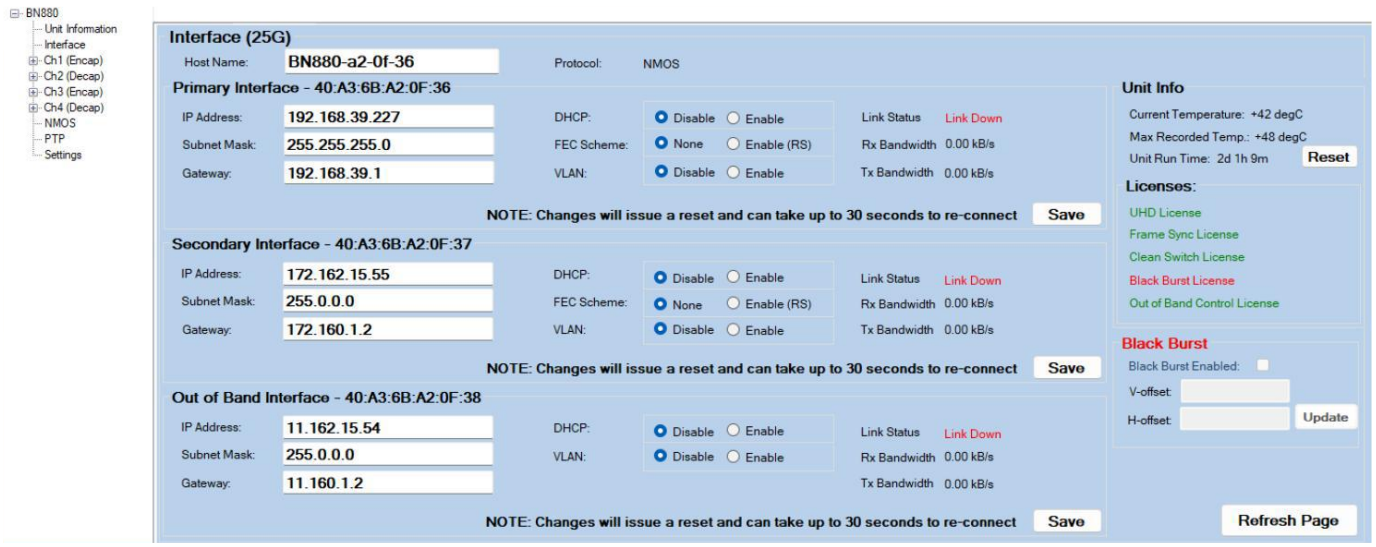
6. Once the unit is detected, the connection status bar at the bottom will turn green and the following will appear.



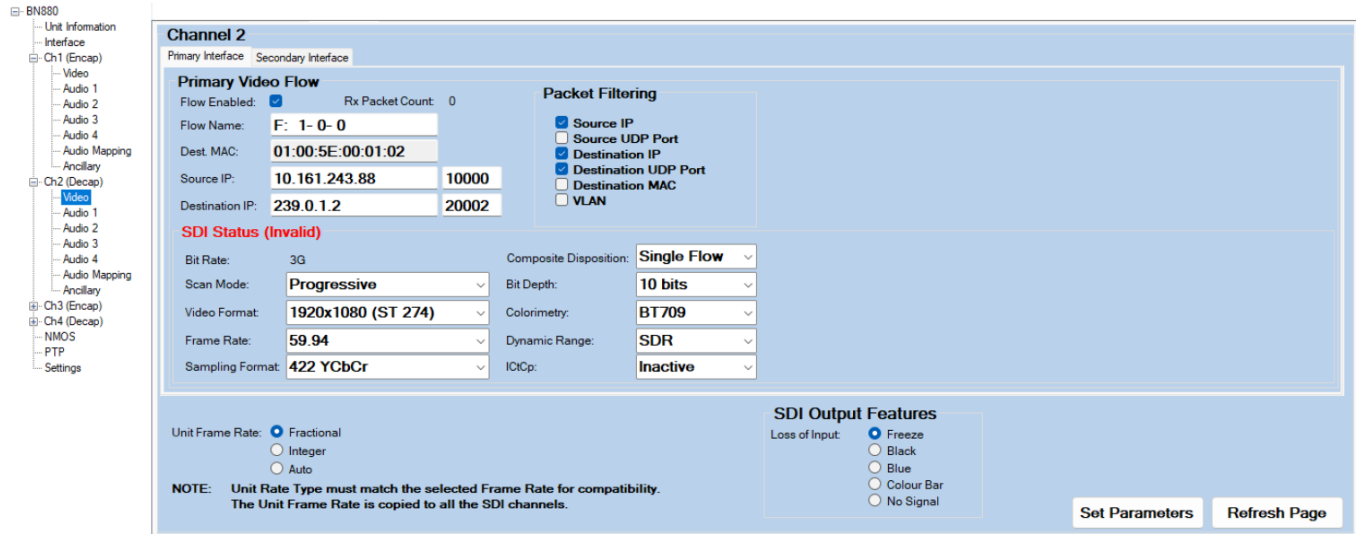
7. The units can be configured as the user desires. Simply make the changes and click "Save Changes" to trigger the change or click "Get Parameters" to refresh all the parameters on the page.

8. Click on Channels, NMOS or PTP settings for further configuration.

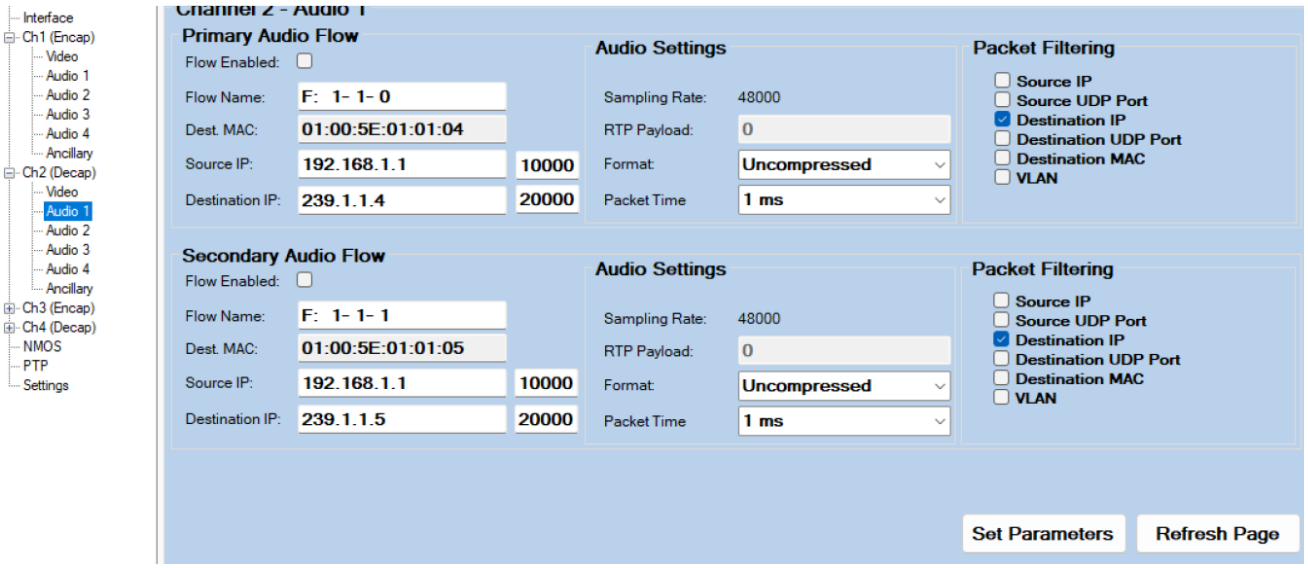
Interface Configuration:



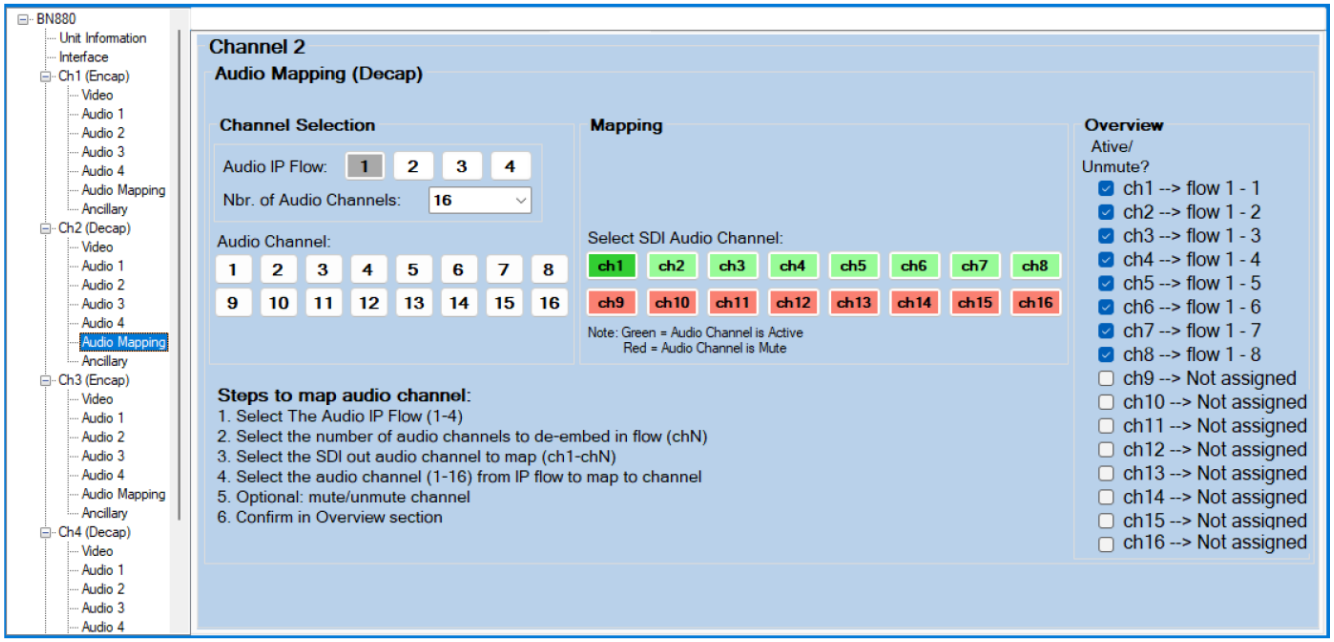
Video Flow Configuration:



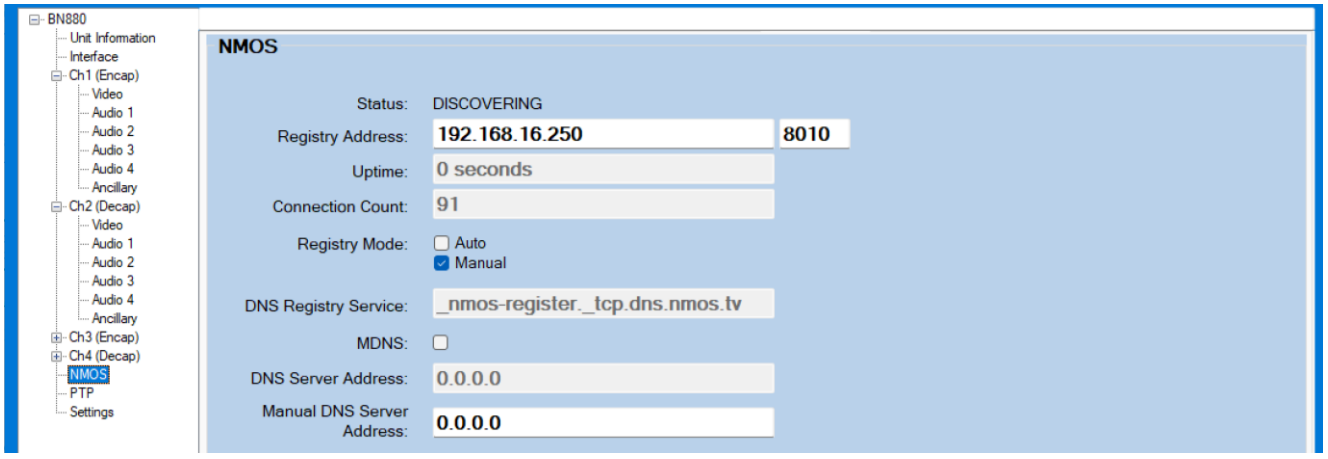
Audio Flow Configuration:



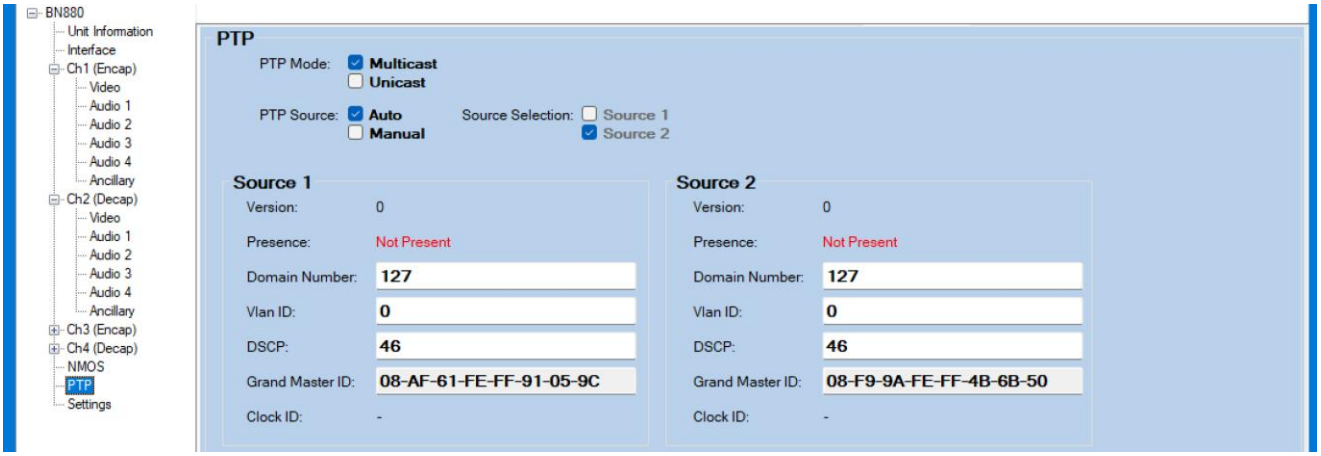
Audio Mapping:



NMOS Configuration:



PTP Configuration:



NOTE: The BluebellConnect software may change over time. Please refer to the BluebellConnect documentation for up-to-date user guides and versions.

18. Specifications

IP Media Ports	2 x 10 GbE Transceiver SFP+. OR 2 x 25 GbE Transceiver SFP28.
Hitless Redundancy Support (SMPTE ST 2022-7)	Full Support through dual media links - both Primary (Red) and Secondary (Blue) networks. SMPTE ST 2022-7 applies to receiver and sender streams. Class D and A.
Number of Encoding/Decoding Channels	Up to 4 channels are available. See *Overview* for all available variants.
FEC	Reed Solomon (25 GbE variants only)
Encapsulator Input/Output	Input: 1 x SDI Output: 1 x SMPTE ST 2110-20 1 x SMPTE ST 2110-22* 4 x SMPTE ST 2110-30 1 x SMPTE ST 2110-40 *Only available on JPEG-XS variant.
Decapsulator Input/Outputs	Input: 1 x SMPTE ST 2110-20 1 x SMPTE ST 2110-22* 4 x SMPTE ST 2110-30 1 x SMPTE ST 2110-40 Output: 1 x SDI *Only available on JPEG-XS variant.
Clean Switching	Available as add-on licence
Supported Formats	HD-SDI, 3G-SDI, 6G-SDI*, 12G-SDI* *Not available on 3G variants
PTP Support	SMPTE ST 2110-10 (AES-R16-2016)
Traffic Shaping	SMPTE ST 2110-21 Senders: Narrow Gapped Receivers: Narrow Gapped, Narrow Linear and Wide
Compressed Audio	SMPTE ST 2110-31
Processing Delay	Encapsulation: - Video without frame-sync = less than 1 line - Video with frame-sync = maximum 1 frame - Audio = depends on configured packet time - Ancillary = depends on sender profile Decapsulation: - Minimum_delay mode = minimum 2 lines, maximum almost 1 frame (depends on the output offset configuration) - Normal mode(frame buffer active) = 1 frame of delay up to almost 2 frame (depends on the output offset configuration) - Audio/ancillary = aligned to video offset. Clean switch: - Maximum 2 frames of delay for the make-before-break to finish.
Audio Packet Time	A/B/C all packet times, with up to 16 channels per flow
Audio PCM Sample Rate(s)	48 kHz
HDR Metadata	HDR metadata are integrally passed through
Management	IPv4, Out-of-Band (1 GbE RJ45) or In-Band (10/25 GbE Media ports)
DHCP Support	RFC-2131 Specification

LLDP	IEEE-802.1AB
IGMP	V2 and V3 (RFC-2236 and RFC-3376)
Multicast Streams	RTP – RFC-5771
Unicast Streams	RTP
NMOS	IS-04 (Discovery) v1.2. IS-05 (Routing) v1.0. IS-08 (Audio Mapping) v1.0. IS-09 (System) - client only. AMWA BCP-002-01 (Essence Grouping). TR-1001 Recommendation: System environment and device behaviours.
Ember+	Bess protocol support
RESTful API	Documentation available on request
Boot up time	Approximately 40 seconds
Live update	Yes

19. Factory Defaults

There are a few factory default settings customers must be aware of when first setting up a BN880 to their network.

Host name – Host name is BN880-xx-yy-zz, where xx-yy-zz is the last three bytes of the device MAC address.

Management IP Address – The management IP address will be in the 10.x.y.z range, which are reserved for private IP addresses. The x.y.z values are derived from the device's MAC address. To determine the management IP address, take the last three bytes of the MAC (e.g. A1:B2:C3) and convert each Hexa-decimal (HEX) to Decimal (DEC). In this case, A1:B2:C3 will convert to 161.178.195, therefore the management IP address would be 10.161.178.195.

NOTE: *The MAC address is factory assigned and cannot be changed.*
If the last byte of the MAC is 0, this field will be changed to a 1 to ensure a valid IP address. For example, if the MAC address is 40:A3:6B:A1:B1:00, the device's IP address will be 10.161.178.1.

Subnet Mask – Subnet mask by default is 255.0.0.0.

Gateway – Gateway by default is xx.160.1.2, where xx is the first value of the IP address, e.g., 10.

DHCP – DHCP is disabled.

FEC – FEC is turned off by default, but the device can support Reed Solomon FEC if needed. Please configure the device using Bluebell Opticom's BluebellConnect if you require a BN880 board with RS-FEC enabled. The device will not communicate with the network interface if FEC settings differ. Ensure the network port's FEC matches the unit's FEC configuration.

SFP data rate – Ensure the networks port can handle 10/25 GbE data transfer depending on the version of BN880 used. See section *Optical* for further of SFP data rates needed.

Frame rate – The frame rate is set to fractional. Changes can be implemented on BluebellConnect, or if using MN SET to configure the device, go to ***Device -> Ports***. Some other third-party software may change this automatically according to input/output signal.

NOTE: For any technical issues not covered in this Quick Start Guide, please contact Bluebell Opticom.

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE

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