Aquilon:
A Comprehensive guide to SMPTE ST 2110 configuration and operation on Analog Way Aquilon systems

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Introduction

This guide serves as an authoritative resource for the configuration and operation of the Analog Way Aquilon series' SMPTE ST 2110 input (ACC-AQL-IN-2110) and output (ACC-AQL-OUT-2110) cards. It extends beyond a simple quick-start guide to provide a detailed technical manual, with a specific focus on the complex and often overlooked network infrastructure requirements. The successful deployment of these cards hinges on three critical factors: the Aquilon system itself, a robust Layer 3 (L3) IP network with a spine-leaf topology, and a dedicated Precision Time Protocol (PTP) grandmaster clock. Manual configuration of multicast, PTP, and NMOS settings is essential, as the Aquilon unit functions as a network endpoint, not a central router. The guide provides step-by-step instructions and technical explanations to navigate these complexities, ensuring a stable, reliable, and standards-compliant ST 2110 workflow.

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1. Understanding the ST 2110 ecosystem for Aquilon

1.1. Introduction to SMPTE ST 2110

SMPTE (Society of Motion Picture and Television) ST 2110 is a suite of standards that represents a significant evolution in professional media transport by moving away from the traditional SDI interface. The standard specifies the carriage, synchronization, and description of separate "essence streams", uncompressed video (ST 2110-20), uncompressed PCM audio (ST 2110-30), and ancillary data (ST 2110-40), over a managed IP network. This separation of essence streams provides flexibility, allowing each component to be routed independently and recombined at the destination. This capability simplifies workflows for multi-language audio, captions, and time codes, enabling a whole new set of applications based on standard IT protocols and infrastructure.

1.2. Essential components of a functional ST 2110 system

A successful ST 2110 deployment with the Aquilon series requires three mandatory elements:

- ST 2110 endpoints, such as the **Aquilon device** itself with its **ST 2110 input and output cards**, serving as the primary video processing and I/O unit.
- A high-performance, Layer 3 (L3) 25GbE **managed network switch**, with specific features. Standard Layer 2 (L2) switch will fail to meet the demanding requirements of uncompressed video streams.
- An **external PTP grandmaster clock** which provides a single, highly accurate time reference (IEEE 1588 PTP) for all devices on the network, replacing traditional video synchronization methods like black burst or tri-level sync, and ensuring the precise time alignment of the separate essence streams.

A common point of misunderstanding is assuming that Aquilon ST 2110 cards simply plug into any network. The provided documentation and industry best practices make it clear that the cards are endpoints within a specialized, purpose-built network and not a general-purpose IT fabric. The architecture demands a robust, broadcast-grade 25Gb or higher bandwidth network that supports specific protocols, including IGMP, PIM, and PTP. Misconfiguration at this foundational level will lead to a system that either fails to operate or performs unreliably. Therefore, a thorough understanding and correct setup of the network infrastructure is the most critical part of the entire deployment process.

2. Analog Way's Aquilon ST 2110 I/O cards technical overview

The Analog Way Aquilon ST 2110 cards are high-performance accessories designed to seamlessly integrate the video switcher into an IP-based video production environment. The two cards, the ACC-AQL-IN-2110 input card and the ACC-AQL-OUT-2110 output card, share a number of key features and physical specifications, but differ in their stream handling capabilities.

2.1. Key features and capabilities

Both cards are field-swappable (but not hot-swappable) and require Aquilon firmware version 5.0.152 or above to function. They are equipped with four 25GbE SFP28 ports, two primaries and two secondaries, which provide up to 25 Gbps of bandwidth per port. Both cards are PTP-compliant, requiring an external grandmaster clock for synchronization, and they are compatible with NMOS IS-04 for discovery and registration and NMOS IS-05 for connection management. They support video formats up to UHD60 10-bit 4:2:2 (see Annex 1 for the detailed list of supported formats) and are HDR compliant with both HDR10 and HLG standards. Both cards also support manual configuration.

The **ACC-AQL-IN-2110** input card is designed to de-encapsulate up to 4x UHD60 or 8x FHD60 streams from an uncompressed ST 2110 IP network. It can de-embed up to eight PCM audio channels per UHD stream or four channels per FHD stream. The support of Session Description Protocol (SDP) files largely simplifies the card's configuration, allowing easy stream connection setup.

In contrast, the **ACC-AQL-OUT-2110** output card is a transmitter card that encapsulates up to 4x UHD60 (Annex 1) streams into uncompressed ST 2110-20 IP networks. It can embed up to eight PCM audio channels per video stream.

The table below provides a side-by-side comparison of the two cards.

Feature	ACC-AQL-IN-2110 (Input Card)	ACC-AQL-OUT-2110 (Output Card)
Function	SMPTE 2110-20 Receiver (De-encapsulates streams)	SMPTE 2110-20 Transmitter (Encapsulates streams)
Maximum Streams	Up to 4x UHD60 or 8x FHD60	Up to 4x UHD60
Video Formats	Up to UHD60 10-bit 4:2:2	Up to UHD60 10-bit 4:2:2
Audio Channels (PCM)	Up to 8 per UHD stream, 4 per FHD stream	Up to 8 per stream
Network Ports	4x 25GbE SFP28 (2 primary, 2 secondary)	4x 25GbE SFP28 (2 primary, 2 secondary)
Stream Redundancy	Supports ST 2022-7	Supports ST 2022-7
Synchronization	PTP (external grandmaster required)	PTP (external grandmaster required)
Control Protocols	NMOS IS-04 (Discovery) NMOS IS-05 (Connection)	NMOS IS-04 (Discovery) NMOS IS-05 (Connection)
Connection Configuration	- Easy configuration via an external NMOS controller - Or advanced connection settings based on SDP file, or manual settings	- Easy configuration via NMOS controller - Or advanced connection settings based on manual settings
Firmware Requirement	v5.0.152 or above	v5.0.152 or above
Dimensions	Width: 129.7 mm / 5.10” Height: 42.3 mm / 1.66” Depth: 147.4 mm / 5.80”	Width: 142.6 mm / 5.61” Height: 42.3 mm / 1.66” Depth: 147.4 mm / 5.80”

Table 1 - ST 2110 cards comparison table

2.2. Limitations and interoperability

The cards are designed for specific ST 2110 applications and have certain limitations. They do not support video compression or custom video formats, instead adhering to formats consistent with HD/3G/6G/12G-SDI. The maximum supported frame rate is 60Hz, and they do not support High Frame Rate (HFR) formats. Audio format support is limited to PCM, with no compatibility with compressed formats such as Dolby True HD or DTS-HD Master Audio. Furthermore, ST 2110 does not support HDCP encryption, as it is based on SDI encapsulation, which does not carry HDCP information.

A crucial architectural consideration is that the Aquilon unit itself does not provide ST 2110 routing from presets. All routing must be performed by an external NMOS controller or using SDP files or configured manually, positioning the Aquilon not as a central media router but as a high-performance source and sink endpoint within a larger, orchestrated IP system. The cards are designed for interoperability and can be used with ST 2110 products from different manufacturers, enabling the creation of a multi-vendor ecosystem. This open-standard philosophy is a significant departure from proprietary, vendor-locked systems, offering users greater flexibility and protection against vendor lock-in.

Aquilon ST 2110 cards also have a specific limitation due to their architecture. All signals within the same module (2 modules per ST 2110 card) must use the same type of bit rate (Integer or Fractional).

It is also important to understand that the ST 2110 is part of a network with specific limitations, particularly in terms of bandwidth. For example, it is impossible to receive or transmit two video signals in 3840 x 2160 10-bit 4:2:2 at 60 Hz simultaneously on the same module as the 25Gb/s bandwidth is insufficient for this type of streams.

Aquilon ST 2110 input and output cards are not designed to support the IPMX standard in the future.

The product supports Forward Error Correction (FEC) as specified in IEEE802.3 Clause 108, commonly referred to as FEC RS108 (using Reed-Solomon RS(528,514) code), and No FEC. Default FEC mode is RS 108. It is strongly recommended to leave FEC mode on RS 108.

Important Note: For certain switches or specific deployment scenarios, it may be necessary to manually force the desired FEC mode (RS108 or No FEC) for 25GbE Network on the switch port to ensure proper link establishment and stable operation.

Please note that the audio connection in ST 2110 is currently limited to NMOS control only. Manual connection of audio is not supported at the moment. This is a temporary restriction and manual audio connection capability will be implemented in a future update.

Please note also that by design of the ST 2110, a format change results in a stream being re-routed either through an NMOS controller or through the advanced connection setting.

3. Network infrastructure configuration: the critical first step

Proper network infrastructure is the most challenging and essential part of a successful ST 2110 deployment. The Analog Way Aquilon cards require a specialized network environment to function reliably.

3.1. The network switch

The choice of network switch is paramount. A simple Layer 2 (L2) switch is inadequate for ST 2110, as the large number of uncompressed multicast streams would overwhelm it, leading to a network-wide broadcast storm known as "multicast flooding". This phenomenon degrades performance and causes packet loss, making stable operation impossible. A **25GbE Layer 3 (L3) switch with Internet Group Management Protocol (IGMP)** is a mandatory requirement (such as M4350-32F8V or M4350-16V4C references from NETGEAR).

The most effective network topology for a scalable and reliable ST 2110 network is a **spine-leaf architecture**. In this design, "leaf" switches connect directly to endpoints (like the Aquilon cards), and "spine" switches interconnect all leaf switches. This topology provides a high level of redundancy and minimizes the number of hops between any two endpoints. This reduces latency and complexity, which is critical for meeting the strict timing budgets of ST 2110.

To manage multicast traffic, **IGMP snooping** must be enabled on the switch. This feature allows the switch to "snoop" on IGMP "Join" and "Leave" messages from devices, forwarding multicast streams only to the ports that have explicitly requested them. The switch must also have an active **IGMP Querier** to periodically poll devices and maintain group membership, preventing multicast groups from timing out and being dropped. For networks that span multiple subnets, a more advanced routing protocol like **Protocol Independent Multicast (PIM)** is necessary to direct multicast traffic between them.

Finally, **Quality of Service (QoS)** policies are the best practice. Using **Differentiated Services Code Point (DSCP)** and **Explicit Congestion Notification (ECN)** tagging, QoS ensures that time-sensitive media traffic is prioritized over other network activity, further guaranteeing low latency and minimal packet loss.

Additionally, it is important to perform a bandwidth calculation before your configuration to avoid sending too many flows to an endpoint and causing saturation between the switch and the endpoint.

The technology used on Aquilon ST 2110 cards has been successfully tested with a variety of switches from different manufacturers, including:

- NETGEAR
- Mellanox
- Arista
- Cisco.

3.2. Precision Time Protocol (IEEE 1588 PTP) setup

Synchronization is a key component of ST 2110. An **external PTP grandmaster clock** is required for the Aquilon ST 2110 cards to function properly. PTP provides nanosecond-level accuracy, essential for ensuring that the separated video, audio, and ancillary data streams remain perfectly aligned as they travel across the network.

To support this synchronization, PTP-aware network switches can be configured in two main modes: **Transparent Clock (TC)** and **Boundary Clock (BC)**. A TC switch measures the time a PTP packet spends within the switch and adjusts the timestamp, improving accuracy. A BC switch is more sophisticated. It acts as both a follower to the grandmaster and a master to downstream devices, creating a hierarchical clock tree that reduces the load on the grandmaster and enhances scalability. Using Boundary Clock switches is highly recommended for any multi-switch deployment.

All devices in the system, including the PTP grandmaster clock, switches, and Aquilon cards, must be configured to operate within the same **PTP domain**. They must also have consistent timing values, such as the Announce Interval and Announce Receipt Timeout, which are used by the **Best Master Clock Algorithm (BMCA)** to elect a single grandmaster clock and maintain a stable clock hierarchy.

3.3. Network Configuration

The table below provides a concise checklist of essential network configurations.

Network Component	Configuration Parameter	Recommended Setting
Network switch	Type	Managed Layer 3 (L3) switch
	Topology	Spine-Leaf (for scalability and high performances)
	IGMP Snooping	Enabled
	IGMP Querier	Enabled and configured
	Multicast Routing	PIM Sparse Mode (for L3 routing)
	QoS	Enabled, with DSCP/ECN policies for media traffic
PTP Grandmaster	PTP Domain	A consistent, user-defined domain
	Clock Type	Grandmaster Clock (with external GPS/GNSS reference)
PTP-Aware switches	Clock Mode	Transparent Clock (TC) or Boundary Clock (BC)
Aquilon ST 2110 I/O cards	PTP Domain	Must match the grandmaster's domain
	PTP Mode	Multicast or Hybrid

Table 2 - Network configuration table

4. Configuring the Aquilon ST 2110 I/O cards

Once the underlying network infrastructure is properly configured, the focus shifts to the Aquilon cards themselves. All configuration is achieved through the system's **Web Remote Control Software (Web RCS)**.

4.1. Initial access and IP configuration

To begin with, a computer must be connected to the Aquilon chassis using a standard Ethernet cable. The Aquilon unit has a default IP address of 192.168.2.140 with a subnet mask of 255.255.255.0. The computer's network adapter must be manually configured with a static IP address in the same subnet (e.g., 192.168.2.100) to establish a connection. The Web RCS can then be accessed by entering the Aquilon's IP address into a web browser.

Within the Web RCS, the IP addresses and subnet masks for the primary and secondary ST 2110 ports on the cards must be configured. This is a crucial step to ensure the cards are properly recognized on the ST 2110 network. The best practice is to use the range 239.0.0.0 to 239.255.255.255 reserved by IANA (Internet Assigned Numbers Authority, RFC-2365) for administratively scoped IP multicast purposes.

By default, the DHCP is activated by default, and it is strongly recommended to keep it this way.

To complete this section, it is necessary to ping your input or output ST 2110 cards to confirm a successful connection.

4.2. Stream and format configuration

The Web RCS provides the tools to configure the specific streams for both input and output cards.

For input cards, this involves specifying the video format (e.g., UHD60p 10-bit 4:2:2), color space (BT.709 or BT.2020), and associated audio channels. The cards support easy connection configuration via **Session Description Protocol (SDP)** files. An SDP file is a standardized text file containing all the necessary information for a receiver to "know" the details of a sender's stream, including its multicast IP address, port number, and media format. The Web RCS provides also an advanced mode that requires manual configuration of all the sender's stream information.

For output cards, all the information about the delivered streams must be configured manually to generate SDP files.

Generally, it is recommended to work in an NMOS environment (please refer to chapter Discovery, registration, and connection management with NMOS) with a dedicated controller to simplify the IP management, the only remaining parameters being the media format. SDP files and especially advanced configuration should be reserved for experienced users.

4.3.ST 2022-7 seamless redundancy

A key feature of the Aquilon ST 2110 cards is support for **SMPTE ST 2022-7 seamless protection switching**. This standard provides a mechanism for stream redundancy and requires the same media stream to be transmitted over two separate network paths simultaneously, one over the primary network and one over a secondary, redundant network.

While this feature is essential for mission-critical applications, its implementation comes with a significant increase in network complexity. It requires the deployment and maintenance of **two entirely separate and synchronized network fabrics**. This means duplicating the entire network infrastructure, switches, cables, and configurations for PTP, IGMP, and PIM, to create a parallel data path for the secondary stream. The Aquilon cards' primary ports connect to one network fabric, and their secondary ports connect to the other. This ensures that if one network path fails, the receiver can seamlessly reconstruct the stream from the redundant path without interruption. This architectural requirement is an important but often overlooked consideration that directly affects the total cost of ownership and the technical expertise necessary for a successful deployment.

5. Discovery, registration, and connection management with NMOS

SMPTE ST 2110 defines how media is transported, but it does not specify how devices discover each other or how connections are managed. This is the role of **NMOS (Networked Media Open Specifications)**, which provides the "control plane" for the ST 2110 ecosystem. NMOS is produced by the AMWA (Advanced Media Workflow Association).

5.1. The role of NMOS

NMOS is an open set of specifications that enables interoperability between different manufacturers' equipment, preventing vendor lock-in and allowing users to build a best-of-breed system. NMOS operates through several core specifications, with IS-04 and IS-05 being the most relevant to the Aquilon cards.

- **NMOS IS-04 (Discovery & Registration):** A device, or "Node," on the ST 2110 network uses IS-04 to automatically register itself and its capabilities with a central NMOS registry or controller. This includes registering its "Senders" (output streams) and "Receivers" (input ports), along with metadata about their supported formats and resolutions. The Aquilon cards, when correctly configured, will automatically appear in the NMOS controller's interface, identified by their device name and port number.
- **NMOS IS-05 (Connection Management):** An external control system uses IS-05 to manage connections between registered devices. This is how a user or an automated system can command a Aquilon input card (a Receiver) to "connect" to a specific stream from another device on the network (a Sender). The controller sends a connection command to the receiver, which then begins listening for the specified multicast stream.

5.2. Aquilon integration with NMOS

The Analog Way Aquilon is not a self-contained routing solution for ST 2110 streams. It is an NMOS-compliant endpoint. The Aquilon device as well as the ST 2110 input and output cards, don’t have a dedicated management port for NMOS; the controller must be on the same network as the ST 2110 streams. Furthermore, the Aquilon does not support ST 2110 routing from its own presets; this must be accomplished via the external NMOS controller or through manual configuration.

This architectural choice highlights a fundamental shift in system design. The routing logic is moved from the individual devices to a central, external control system. This decentralization of control allows for a flexible, scalable, and open media network where a variety of manufacturers' products can be seamlessly integrated. For a user, this means that a successful deployment depends not only on configuring the Aquilon cards and the network but also on procuring and configuring a compatible, third-party NMOS controller.

5.3. NMOS interoperability of Aquilon ST 2110 cards

Aquilon ST2110 cards are successfully interoperable with the following NMOS controllers:

- Matrox ConductIP
- Grass Valley Orbit
- Imagine Magellan
- EVS Cerebrum
- Evertz Magnum SDVN
- TSL X-Control
- Lawo VSM w/ NMOS (Ember+ also)

It is strongly recommended to use an NMOS controller rather than using advanced connection settings due to its ease of use and management of all streams grouped on a single interface.

6. Troubleshooting and best practices

The transition from a physical, baseband workflow to a logical, IP-based one introduces a new set of potential issues. Troubleshooting an ST 2110 system requires shifting the mindset from checking physical connections to diagnosing logical protocol states.

6.1. Common issues and solutions

- **PTP synchronization issues:** If streams are not decoding correctly, the first step is to verify PTP synchronization. The absence of a stable PTP clock will prevent ST 2110 devices from de-encapsulating and re-timing streams. Common causes include a misconfigured PTP domain, a lost connection to the grandmaster, or excessive network latency causing clock drift. The solution involves verifying the PTP status on all devices and ensuring the network meets the timing requirements.
- **Multicast flooding:** This is a severe network issue where unrequested multicast streams are being forwarded to all ports, causing network congestion and packet loss. The primary cause is a lack of or improperly configured IGMP snooping and/or an absent IGMP Querier on the network switch. The solution is to immediately enable and configure these features on the managed switch to ensure that streams are forwarded only to the ports that have explicitly requested them.
- **Stream connection failures:** If a stream does not appear in the NMOS controller or fails to connect, the problem may lie in several areas. Common causes include incorrect IP or UDP port assignments, a misconfigured NMOS controller, or a multicast routing (PIM) failure between subnets. A systematic approach is required, checking settings in the Web RCS, the NMOS controller, and the network switch to ensure that the stream's logical path is correctly defined and open.

6.2. Maintenance and monitoring

Due to the mission-critical nature of ST 2110 networks, continuous monitoring is highly recommended. Dedicated monitoring equipment can be used to track key performance indicators such as latency, jitter, and packet loss, providing early warnings of network degradation. It is also a best practice to regularly stress-test the network under the maximum expected load to ensure it meets performance standards and can handle the required number of streams without compromise.

A fundamental paradigm shift underpins this entire process. On an SDI network, a bad cable is the primary point of failure. In an ST 2110 system, a "lost signal" could be due to a PTP timing error, an IGMP membership that has timed out, an NMOS connection that was never made, or a QoS policy that is misconfigured. Understanding this multi-layered complexity is the key to effective troubleshooting and robust system operation.

Issue	Possible cause	Diagnostic steps	Solution
Streams Not Detected	NMOS controller is not on the same network; NMOS IS-04 is not enabled.	Verify network connectivity between the Aquilon and the NMOS controller. Check NMOS settings in Web RCS.	Ensure the NMOS controller is on the same network as the ST 2110 streams. Enable NMOS IS-04/IS-05.
Streams Not Connecting	Incorrect IP/UDP port assignment; Multicast routing (PIM) is not configured.	Verify the IP and UDP port settings in the Web RCS. Check PIM and IGMP routing tables on the L3 switch.	Correct IP/port information. Enable PIM on the switch interfaces to allow multicast traffic between subnets.
Video Glitches/ Packet Loss	Multicast flooding due to misconfigured IGMP snooping.	Monitor network traffic for excessive broadcast storms. Check IGMP snooping and Querier settings on the switch.	Enable IGMP snooping on all relevant ports. Configure a proper IGMP Querier on the L3 switch.
PTP Synchronization Loss	Grandmaster connection failure; PTP domain mismatch; excessive latency.	Check PTP status in the Web RCS. Verify BMCA election on the network switch. Monitor network latency and jitter.	Ensure all devices are in the same PTP domain. Verify grandmaster is online. Use a PTP-aware switch (TC or BC).
ST 2022-7 Failover Failure	Misconfiguration of redundant network paths.	Verify that the primary and secondary network fabrics are completely separate and identical in their configuration.	Reconfigure the secondary network to be an exact, parallel duplicate of the primary network.

Table 3 - Resolution table

7. Training

Online training courses are available free of charge on NETGEAR Academy's website (https://academy.netgear.com/):

- NETGEAR AV / AV Certification Level 1
- NETGEAR for Broadcast / Broadcast ST 2110 Certification

Conclusion

The Analog Way Aquilon ST 2110 cards are powerful and reliable components for modern, IP-based video production. However, their successful deployment requires a meticulous approach that extends far beyond the physical installation of the cards. The single most important factor is the configuration of the network infrastructure. This involves selecting a high-performance L3 switch, implementing specific protocols like IGMP and PIM for multicast management, and integrating a dedicated PTP grandmaster for precise synchronization.

The Aquilon's architecture, which relies on an external NMOS controller for routing, makes it a flexible endpoint within a larger, standards-based ecosystem. This provides significant advantages in terms of interoperability and futureproofing, but it places the responsibility for designing and managing the control plane firmly on the user. A deep understanding of these foundational principles is essential for transitioning from a traditional baseband mindset to a modern IP one. By adhering to the best practices outlined in this guide, a user can ensure a robust, reliable, and future-proof production environment capable of meeting the demands of high-quality live events.

Annex 1

Format	Rate Gb/s	Pixel Data Structure				Colorimetry
		10-bit	12-bit	4:2:2 YCbCr[a]	4:4:4 RGB or YCbCr[b]	
1280 × 720p29.97	1.5	x		x	x	BT.709 or BT.2020[c]
1280 × 720p30	1.5	x		x	x	BT.709 or BT.2020[c]
1280 × 720p50	1.5	x		x	x	BT.709 or BT.2020[c]
1280 × 720p59.94	1.5	x		x	x	BT.709 or BT.2020[c]
1280 × 720p60	1.5	x		x	x	BT.709 or BT.2020[c]
1920 × 1080p23.98	1.5	x	x	x	x	BT.709 or BT.2020[c]
1920 × 1080p24	1.5	x	x	x	x	BT.709 or BT.2020[c]
1920 × 1080p25	1.5	x	x	x	x	BT.709 or BT.2020[c]
1920 × 1080p29.97	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080p30	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080p50	3	x		x		BT.709 or BT.2020
1920 × 1080p59.94	3	x		x		BT.709 or BT.2020
1920 × 1080p60	3	x		x		BT.709 or BT.2020
1920 × 1080psf23.98	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080psf24	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080psf25	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080psf29.97	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080psf30	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080i47.95	1.5	x		x		BT.709 or BT.2020
1920 × 1080i48	1.5	x		x		BT.709 or BT.2020
1920 × 1080i50	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080i59.94	1.5	x	x	x	x	BT.709 or BT.2020
1920 × 1080i60	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p23.98	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p24	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p25	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p29.97	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p30	1.5	x	x	x	x	BT.709 or BT.2020
2048 × 1080p47.95	3	x		x		BT.709 or BT.2020
2048 × 1080p48	3	x		x		BT.709 or BT.2020
2048 × 1080p50	3	x		x		BT.709 or BT.2020
2048 × 1080p59.94	3	x		x		BT.709 or BT.2020
2048 × 1080p60	3	x		x		BT.709 or BT.2020
3840 × 2160p23.98	6	x	x	x	x	BT.709 or BT.2020
3840 × 2160p24	6	x	x	x	x	BT.709 or BT.2020
3840 × 2160p25	6	x	x	x	x	BT.709 or BT.2020
3840 × 2160p29.97	6	x	x	x	x	BT.709 or BT.2020
3840 × 2160p30	6	x	x	x	x	BT.709 or BT.2020
3840 × 2160p50	12	x		x		BT.709 or BT.2020
3840 × 2160p59.94	12	x		x		BT.709 or BT.2020
3840 × 2160p60	12	x		x		BT.709 or BT.2020

Table 4 - Supported format table

a. For 4:2:2, YCbCr 12-bit resolutions, the value shown in the **Rate** column is doubled.
b. For 4:4:4, RGB or YCbCr resolutions, the value shown in the **Rate** column is doubled.
c. BT.2020 is only available for 4:4:4, RGB or YCbCr 10-bit resolutions according to SMPTE ST 292.