BROMPTON TECHNOLOGY

# AV OVER IP ON GEN③

## SQ200 SPECIFICATIONS

| | |
|---|---|
| VIDEO THROUGHPUT | Single 8K (up to 2.4 GP/s) / Quad 4K (up to 600 MP/s) |
| STANDARD RESOLUTIONS | HD, 4K and 8K up to 8192 x 4320 |
| CUSTOM RESOLUTIONS | Up to 32K pixels wide / tall per stream |
| FRAME RATES | 23.976 to 250 fps, progressive only |
| BIT DEPTH | 8, 10, 12 bits per channel |
| COLOUR FORMAT | RGB / YCbCr |
| COLOUR ENCODING | 4:4:4 / 4:2:2 |
| EOTF | SDR, PQ HDR, HLG HDR |
| COLOUR SPACE | sRGB / Rec.709 / DCI-P3 / Rec.2020 / ACEScg / Custom |
| INPUTS | Two dedicated 100G / 25G / 10G QSFP28 ports |
| REDUNDANCY | ST 2022-7 seamless protection switching via second dedicated input port |
| VIDEO STREAM TYPE | ST 2110-20 Uncompressed Video |
| SUPPORTED SENDERS | ST 2110-21 Narrow (N) / Narrow Linear (NL) / Wide (W) / IPMX |
| IP STREAM | Unicast / multicast |
| SYNCHRONISATION | IEEE1588-2008 PTP with ST 2059 alignment / IPMX |
| MANAGEMENT | NMOS / IPMX |

*Specifications are subject to change*

# EXPLANATIONS

## VIDEO THROUGHPUT

Video throughput is the amount of video data in terms of pixels that a video interface can handle. The throughput required for a video signal varies with resolution and frame rate – so it is important to verify that there is sufficient throughput for your requirements.

The SQ200 can receive up to 2.4GP/s (Gigapixels per second), which is more than enough for a single stream of 8K DCI at 60fps. Alternatively, it can receive dual streams of up to 1.2GP/s, each of which is sufficient for 4K120, or it can receive 4 streams of up to 0.6GP/s (or 600MP/s), each of which is sufficient for 4K60, allowing for 4x4K workflows.

## STANDARD RESOLUTIONS

The SQ200 can receive all standard resolutions from 720p up to 8K DCI (8192 x 4320). There are multiple reasons why you might not be running at full 8K resolution, such as needing to receive multiple lower resolution streams, limitations of the source, or running at frame rates above 60fps. Brompton will support whatever resolution you need to work with.

## CUSTOM RESOLUTIONS

In practice it is possible to define the media stream to be any resolution up to 32K pixels wide or tall and this can be received by the SQ200 within throughput limits.

Defining a custom resolution is relatively common practice for LED video walls as they rarely match standard resolutions exactly – but it is important to confirm that both sender and receiver support non-standard resolutions. The 32K limit is a restriction of ST 2110. The SQ200 supports a canvas up to 64K wide or tall, so this would require multiple streams of ST 2110.

## FRAME RATES

It is crucial for an LED screen to be refreshing at the same frame rate (or an integer multiple) as the content to avoid stuttering or judder, so it is crucial to be able to support any possible frame rate on the video input. This is as true for AVoIP as it is for baseband video, and Brompton processing will synchronise to any incoming frame rate between 23.976 and 250fps.

As with resolution, there is no practical constraint (other than throughput) to ST 2110 running at any desired frame rate to suit your application – but it is important to verify that both sender and receiver support it. We expect to support frame rates above 250fps in future.

## BIT DEPTH

Lower bit depth means lower stream bandwidth, which can be important in terms of network capacity, especially when multiple streams are being handled from multiple sources (senders) to multiple sinks (receivers). However, it is important to select a sufficiently high bit depth to achieve the desired visual quality. In some cases (e.g. PowerPoint), an 8-bit signal will be sufficient, but typically for HDR content the minimum would be 10-bit, with 12-bit for the most demanding applications.

When considering bit depth, bear in mind that video streams are non-linearly encoded because our eyes are more sensitive to small changes in dark areas than in bright ones, and linear encoding would use far more bandwidth to achieve the same quality. But this means we need to be wary of comparing stream bit depth to the bit depth quoted for LED drivers (commonly 14 or 16 bit), as these do operate in linear light space. Brompton processing employs 27-bit and higher precision internally in linear light space to maintain maximum possible image quality. 12-bit non-linear encoding of the input already has more than sufficient precision to match the rest of our pipeline.

## COLOUR FORMAT

Every video pixel has three channels – but these can either be encoded as RGB (Red, Green, Blue) or as YCbCr (Luminance and two Chrominance). We convert to RGB for internal processing.

## COLOUR ENCODING

RGB is always 4:4:4 – which means having a distinct value for all three channels for every pixel. However, for YCbCr you always encode Y (luminance) for every pixel but can choose to include only colour data for blocks of pixels. For example, 4:2:2 means you only include colour data for pairs of adjacent pixels within a line of video, and this reduces bandwidth requirements by a third.

4:2:2 is broadcast quality, and most video content can be encoded that way with no noticeable loss of quality. However, some graphics content – small point fonts or hard vertical edges – can have noticeable artefacts and is better encoded as 4:4:4. If you are bandwidth limited, then for video content (especially HDR), it is typically preferable to use at least 10-bit with 4:2:2 encoding rather than 8-bit with 4:4:4 encoding.

There are other encodings such as 4:2:0 that have less colour data and are sometimes used with consumer video products to reduce bandwidth even further. We would not expect those to be used in a professional application and they are not supported.

## EOTF

LED is well suited to HDR, but there is lots of SDR content out there. Brompton processing supports both SDR and HDR content.

HDR content can be in PQ format (which encodes the absolute brightness in a way that is designed to avoid artefacts over a wide range of brightness levels) or HLG format (Hybrid Log Gamma, which is designed as a format that can display on either an HDR or SDR display and the brightness is not absolute). The vast majority of pre-rendered HDR content is in PQ format.

## COLOUR SPACE

To display colours accurately you need to know the colour space the signal is encoded in. Historically, SDR content used Rec.709, which is a much narrower colour gamut than most LED screens are capable of displaying. sRGB has essentially the same colour gamut as Rec.709. HDR content is typically in Rec.2020 or ACEScg. It is also possible to define a custom colour space for specialist applications. These wider colour spaces are all about maximising the colour saturation available for parts of the content that require it, while still maintaining colour accuracy throughout.

## INPUTS

The network bandwidth needs to be sufficient for the required video throughput (resolution and frame rate) at the desired bit depth and colour encoding.

An 8K60 DCI signal at 12bpc 4:4:4 requires at least 81.6Gb/s (Gigabits per second), so 100G Ethernet is required. A 4K60 DCI signal requires at least 20Gb/s at 12bpc 4:4:4, so 25G Ethernet is required. Four separate 4K streams can be carried over 100G Ethernet for 4x4K workflows.

Lower link speeds allow compatibility with other systems that are only capable of lower link speeds or when less bandwidth is required. Typically, lower link speeds will mean lower cost of network infrastructure.

The second port is either for redundancy or for receiving primary streams on two different physical networks (which can avoid creating a requirement for an upstream Ethernet switch in some cases).

## REDUNDANCY

A mechanism for seamless redundancy is defined as part of the ST 2110 standard. It requires a second Ethernet port for physical network redundancy.

To provide processor redundancy you would feed both networks (A and B) to both processors.

Duplicate incoming streams for redundancy do not count twice towards your video throughput, because only one version of the incoming video data is passed onwards through the video pipeline. The second 100G Ethernet port means you have enough network bandwidth to receive duplicate streams without reducing the available video throughput of the SQ200.

## VIDEO STREAM TYPE

ST 2110 allows for transporting video data in either an uncompressed or compressed form. Initially we are focused on supporting uncompressed video, which is most common and optimal for professional applications as it avoids any compression artefacts (which can be more visible on LED than other display technologies, due to LED's ability to precisely render the exact incoming signal, artefacts and all).

## SUPPORTED SENDERS

Within the ST 2110 standard there are three categories of sender, which differ with respect to the predictability of timing of incoming data.

A Narrow sender effectively reproduces the timing of an SDI baseband video signal, including blanking.

A Narrow Linear sender has strict uniform timing for data arriving, but without allowing for blanking.

A Wide sender has comparatively relaxed timing requirements which requires more buffering at the receiver.

In most cases, a hardware-based sender will be a Narrow or Narrow Linear type. However, a software-based sender (such as used by some media servers) will be a Wide type.

Not all receivers are capable of receiving from a Wide-type sender due to the buffering requirements. It may not always be obvious what the type of a particular sender is, or what sender types a receiver supports, so this is a potential interoperability risk. Brompton processors are compatible with all three sender types.

## IP STREAM

This concerns how packets are addressed on the network – are they addressed to a single receiver (unicast) or to a group of receivers (multicast)?

If you are setting up a sender to transmit to a single receiver and don't want to worry about complex network setups, then unicast works fine. But once you need to transmit to multiple receivers (which might include confidence monitors or multi-viewers or multiple LED processors), then multicast is normally required. However, high-bandwidth multicast also requires support and configuration within your network infrastructure.

It is important not to assume that any network infrastructure will be able to cope with high-bandwidth ST 2110. Switches that have been designed with data comms in mind may or may not be able to cope and default configurations will often block or limit exactly the types of traffic required for AVoIP. Consult a networking professional.

## SYNCHRONISATION

ST 2110 uses PTP to maintain accurate frame timing to ensure you are not doubling or dropping frames and for synchronisation across multiple systems (displays, sources or cameras). PTP synchronisation requires a PTP Grandmaster on your network, and the processor will lock to that. The need for a separate PTP Grandmaster to synchronise an ST 2110 system should not be overlooked and could be a significant complication for simple systems.

IPMX does not require PTP. It can use PTP, but when it is not present it offers an alternative synchronisation mechanism that Brompton processors also support.

## MANAGEMENT

NMOS is a management protocol that can be used to discover and manage ST 2110 devices across the network. It allows for more flexible systems and can enable capabilities such as dynamic routing of streams, similar to a matrix switcher for baseband video.

# FREQUENTLY ASKED QUESTIONS

### What is ST 2110?

ST 2110 is a suite of standards developed by SMPTE (Society of Motion Picture and Television Engineers) for transporting professional media (video, audio and ancillary data) over IP networks in real-time. It is increasingly widely used in broadcast and production environments, and has become the de facto standard for the media and entertainment industry. It has enormous potential benefits in terms of scalability, flexibility, cost-effectiveness and future-proofing – but also introduces new challenges in terms of achieving correct configuration, interoperability and network infrastructure that may not be well understood.

### What is IPMX?

IPMX is a set of standards developed by AIMS (the Alliance for IP Media Solutions) for transmitting media (audio, video and metadata) over IP networks. It is based on ST 2110, but where ST 2110 was developed for broadcast environments, IPMX has been specifically designed for the Pro AV industry. The goal of IPMX is to deliver the same type of pluggable video experience that we are all used to with HDMI or DisplayPort, which is decidedly not the case for ST 2110. The IPMX standard is still relatively new – but it is supported by Brompton Gen 3 processors.

### When should I consider using AVoIP?

AVoIP has the potential to address some of the limitations of baseband video protocols (such as SDI, HDMI and DisplayPort). You can make use of all the advances in computer networking, using Ethernet cabling that is lower cost than specialist baseband video cabling and making use of capabilities to carry multiple streams down one higher-bandwidth connection, to send data longer distances or to route data to multiple destinations cost effectively. If you are encountering these limitations of baseband video or are planning a fixed install that has to be future-proof against these issues in the long-term, then AVoIP may be the answer.

### When should I not use AVoIP?

If you are connecting sources directly to single receivers then baseband video is a well understood way of doing that and AVoIP may not add anything, but will introduce some complexities. You will need network infrastructure, which may not be cheap for a high bandwidth connection, and may need a networking professional to configure it, as off-the-shelf switches may not support (or be configured to support) this kind of high-bandwidth traffic. With ST 2110 you will also need a PTP Grandmaster on the network. As a newer technology there is more potential for interoperability issues than with familiar baseband video protocols, and fault-finding is harder when you can't plug the cable into a monitor to check it looks right.

Our advice would be not to go to AVoIP simply for the sake of it, especially in a temporary or high-pressured setup where you won't have time to fault-find. But if the benefits of AVoIP are important to you then absolutely use it – but get the right people involved (including a networking professional) to ensure a good outcome.

### What bandwidth do I need?

| FRAME RATE | 60fps | | 24fps | |
|---|---|---|---|---|
| SAMPLING | 4:4:4 12bpc | 4:2:2 10bpc | 4:4:4 12bpc | 4:2:2 10bpc |
| 8K UHD | 76.5 | 42.5 | 30.6 | 17.0 |
| 4K UHD | 19.1 | 10.6 | 7.7 | 4.3 |
| HD (1080p) | 4.9 | 2.7 | 1.9 | 1.1 |

*All bandwidths approximate and expressed in Gbps*

### Do I need a network or can I connect directly from sender to receiver?

In theory you can connect directly with either ST 2110 or IPMX. But with a pure ST 2110 system you can only achieve full synchronisation by having a separate PTP Grandmaster, which introduces a requirement for some form of network.

### Do I need a networking expert?

The traffic patterns for high bandwidth AVoIP are very different from what you see on a normal IT data network. Some switches will not be able to cope with the traffic and others may be configured by default to block it. Multicast addressing can also create complications when configuring networks, and any fault-finding is likely to involve questions about the network. It is advisable to ensure someone with appropriate expertise is responsible for designing and configuring your network.

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