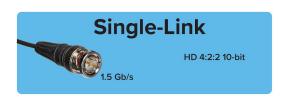# Dual-Link and 3G Overview

Introduction

There has been some confusion in the industry related to the terminology of Dual-Link and 3G. Below is an overview of the proper terminology as we use it in AJA documentation and also some examples of how these different standards are used.

At the end is a more detailed explanation of the evolution of these standards.
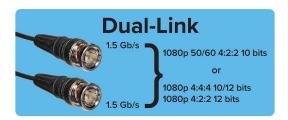
Terminology

Standard HD-SDI

Standard HD-SDI allows for a single 4:2:2 image to be carried on one cable at 1.5Gb/s.*

Dual-Link HD-SDI

Dual-Link HD-SDI is a single image signal conveyed over two standard 1.5gb HD-SDI cables. This is most often used for 1080p 50/60 video but may also be used for 1080p 24/25/30 at 4:4:4 color encoding and/or 12 bits.

For 1080p 50/60, the higher frame rate is split between the two cables. This is done in a manner that allows each link to be viewed individually as a 1.5gb HD-SDI signal.

*Technically 1.485Gb/s.

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Note: For 1080P 24/25/30 4:4:4 10-bit or 12-bit, the first cable is a valid 4:2:2 HD-SDI signal which can be viewed on a monitor, the second cable carries the additional color samples, additional LSBs, and an optional Alpha channel.

3G HD-SDI

3G HD-SDI uses the double data rate to combine the two Dual Link cables into one cable. This is done in different ways called Level A, Level B-DL and Level B-DS:

- Level A is a direct mapping of the video signal into a 3G SDI signal (similar to how 1.5gb HD-SDI is formatted.)
- Level B-DL simply multiplexes the two signals from the dual-link format, as-is, into one 3G SDI signal.
- Level B-DS multiplexes two separate 1.5gb HD-SDI signals into one 3G SDI signal.

Dual Stream HD-SDI

Dual Stream 3G is a specific variant of 3G-SDI which combines two completely separate 1.5gb HD-SDI signals into a single 3G signal. This is used to reduce the number of HD-SDI cables in facilities. This can also be used to minimize confusion in stereoscopic production by keeping left and right eye signals together. Dual Stream 3G-SDI is Level B-DS by definition.

Using 3G-SDI

Note that not all 3G HD-SDI inputs/outputs on equipment are capable of supporting both Level A and Level B. For example, if a 3G SDI input supports only Level A it will not work with Level B. On some equipment 3G SDI inputs will auto-configure for Level A or B and/or the outputs are manually configurable. When using 3G SDI one must confirm the formats in use and equipment capabilities with respect to Level A and B to insure proper operation.

Dual Stream vs 3D Muxing

It's important to note that Dual Stream 3G when used for stereoscopic is not the same as a "muxed" stereoscopic image. Stereoscopic muxing squeezes the left and right eye images into a single, standard video frame, potentially sacrificing the quality of the images. Dual Stream 3G has the bandwidth to embed two complete 1.5 Gb image streams into a single 3G signal, which can then be extracted and used without compromise.

Examples

Dual Link 4:4:4
In this example, two SDI cables are connected between the source device and the receiver. The 4:4:4 data is split between the two cables such that the first cable carries a standard 4:2:2 signal and the second cable carries the color information, additional LSB bits (for 12-bit), and an optional Alpha of Key signal.

3G 4:4:4

With 3G 4:4:4, the entire signal is carried over a single 3G cable. In order for this to work, both the source and receiving device must support 3G and also be compatible with respect to the formatting (Level A or B) which are being used.

Dual Stream 3G

In this case, two completely different 1.5gb HD-SDI signals are combined together and carried over a single 3G cable. Both the source and receiving device must not only support 3G Level B-DS, but must also be able to combine or extract the two signals properly.

How We Got Here

Initially, the standard HD-SDI signal had a data rate of 1.5Gb/s. Due to the data rate limitation this meant signals had to be at a frame rate of 24, 25 or 30 frames per second[1], a bit depth of 10 bits, and color encoding of 4:2:2.

There was a need for higher frame rates, 4:4:4 color encoding, and higher bit-depths (12 bits). This lead to the creation of the Dual-Link specification[2], which links two standard HD-SDI signals together -- essentially doubling the bandwidth. Each link carries a separate 1.5Gb/s SDI signal.

For 1080p50/60 frame rates the progressive frame is split into two pseudo "fields" similar to interlaced video, and each field is sent as a 1.5gb 1080i signal. This allows each link to be individually viewed on a monitor. The receiving equipment reconstructs the 1080p 50/60 frames.

Alternatively, for frame rates 24/25/30, the two HD-SDI links can carry a video signal with 4:4:4 color encoding and/or 12-bit. This is usually referred to as Dual-Link 4:4:4 and can be either YUV or RGB.

Soon after, the ability to handle up to 3Gb/s on a single cable was introduced.[3] This made the need for two cables obsolete, since Dual Link could now be carried on a single cable.

In addition, since 3G could carry twice the information it's also possible to combine two separate 1.5Gb/s 4:2:2 HD-SDI signals into a single 3G signal. This is referred to as "Dual Stream 3G". Dual Stream 3G is particularly useful in stereoscopic production where separate left and right eye information is being captured.

1. We are ignoring the subtleties of 23.976 and 29.97 in the interest of brevity.

2. SMPTE ST 372:2017   ("Dual Link 1.5 Gb/s Digital Interface for 1920 × 1080 and 2048 × 1080 Picture Formats").

3. SMPTE ST 424:2012 ("3 Gb/s Signal/Data Serial Interface").

Conclusion

As SDI has evolved, it is important to use the proper terminology. "Dual Link" is often used to describe both the original dual cable standard and also the 3G standard. Also, with 3G there is confusion between Levels A and B. One must be careful that everyone involved understands what is being used so interfaces between equipment work properly.

Technical Support

AJA Technical Support is free and available to help you answer questions or resolve issues with any of your AJA products.

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