Capturing HD

There are six ways of capturing HD:

- Component Analog
- HD-SDI
- Dual Link HD-SDI
- HDMI
- Data Transfer (USB 2.0 or FireWire)
- Solid State media card

Component Analog, HD-SDI, Dual Link HD-SDI and HDMI capture all require the addition of some third party box or card to convert the incoming signal into something that an NLE can use. For Final Cut Pro, Blackmagic Design and AJA both have a range of solutions for capture.

Direct data transfer over USB 2.0 or FireWire, or plugging in a solid-state media card directly to a computer's ExpressCard34 or PC Card slot requires no additional hardware.

Note: Sony's SxS media plugs into the more modern ExpressCard34 slot available on MacBook Pros while Panasonic's P2 media card fit the older PC Card (a.k.a. PCMCIA or Cardbus) slot. There are adapters available to convert from one to the other.

8 or 10 bits?

One thing that comes up regularly is a choice between 8- and 10-bit capture. What is being measured here is the accuracy of the analog-to-digital conversion. When a sample is taken, is it measured in 8 bits or 10 bits? The same signal can be measured in both, but the 10-bit version will more accurately represent the source. The accuracy of the sampling is unrelated to "color sampling" expressed as a ratio measuring how often the color is sampled on the screen, compared with how often the color signals are sampled on the screen. These are the common 4:2:2, 4:1:1 and 4:2:0 ratios we're all familiar with. The ratio defines how often the samples are taken, while the bit-depth defines the accuracy of each sample.

8-bit codecs can define 256 levels (per channel) between black and white. That's the limit that can be encoded in 8-bits and can lead to banding on smooth gradients. Traditionally the fix for smooth gradients and 8-bit codecs was to add a small (1-3%) of Gaussian, monochrome noise. All delivery codecs are 8-bit. Most acquisition codecs are 8-bit. The sole exceptions are those that use AVC-I (Panasonic) or capture with the AJA Ki Pro, which both capture 10 bit source.

However, a better solution is a 10-bit codec. The extra two bits gives 1024 steps between black and white in each color channel for much smoother gradients and improved accuracy in compositing because there is more "working room" during compositing.

Of course, nothing comes for nothing, and 10-bit files are about 25% bigger and therefore higher

8 bit images can cause banding on subtle gradients. 10 bit images can render smooth gradients, at the cost of larger files and higher bandwidth.

data rate throughput is required of all storage, and more storage is required. 10-bit HD is challenging to work with and definitely needs the "Rolls Royce" of storage and hardware. It is common with 10-bit 1080 to work with RAID 50 or 60 (Two RAID 5 or RAID 6 units in a RAID 0 stripe).

It's also important to note that converting down from 10-bits to 8-bits is, as they say, non-trivial to do correctly. Simply cutting off the two lest significant (over at the right) bits is only used by the most crude down-converting tools and banding is bound to occur. The better tools dither when down-converting to disguise the loss of the extra accuracy.

To work in HD at 10-bits means working in uncompressed or ProRes 422 because DVCPRO HD, XDCAM HD/EX and HDV are all 8-bit codecs.

Are ProRes 422 and DNxHD 8 or 10 bits?

Apple's ProRes 422 and ProRes 422 (HQ) are 10-bit codecs. This is explicitly stated in Apple's White Paper:

> "Normal ProRes 422 provides excellent preservation of either 8-bit or 10-bit source quality at an economical bit rate."

Avid's DNxHD family of codecs have specific 8 bit and 10 bit versions. The 10 bit version of the codec is delineated by an "X" at the end of the codec name. For example DNxHD 220 is an 8 bit codec, while DNxHD 220X is the 10 bit version.

> **Note:** The 10 bit versions of the DNxHD family use the same data rate as the 8 bit version, so the 10 bit version is very, very slightly more compressed. This is similar to what happens with the ProRes family where 8 or 10 bit source both conform to the same data rate.

Embedded Audio, AES/EBU or Analog?

You'll find that audio for HD comes into the computer in five ways:

- Analog, usually with XLR professional connectors;
- Embedded in the HD-SDI data, which has the advantage of putting audio and video on the same (single) cable;
- As AES/EBU digital audio data;
- Included in the HDMI signal; or
- As part of the digital transfer via Log and Transfer (DVCPRO HD, AVCHD), the XDCAM utility or via FireWire.

Analog

If your source is HD analog video, then it's likely your audio will be analog as well. Analog audio via XLR connectors for signal input and output is common on capture cards. Most capture cards that support analog audio also provide an unbalanced signal on RCA connectors for local monitoring.

Embedded in the HD-SDI data

The HD-SDI specification provides for 16 channels of embedded audio — on the same cable as the digital video. HD-SDI embeds up to 8 pairs of channels (16 total) but most interfaces support only 8 channels. Each channel is 48 kHz, 24-bit uncompressed audio. A dual-link interface can carry 16 channels per link for 32 channels total on one cable with the video.

AES/EBU

This digital audio standard is also called (officially) AES3, but every capture card or device refers to it as AES or AES/EBU. S/PDIF is a consumer version of AES/EBU. One of the things that makes AES/EBU audio appear complicated is that it can be carried on three different types of connectors:

- Balanced XLR connectors, the same as used by analog audio;
- Unbalanced 2 conductor, 75 Ohm coaxial cable with RCA type connectors, mostly used in consumer audio; and
- An optical fiber connector, also used in consumer applications.

AES/EBU signals are a Pulse Code Modulated (PCM) at 48 kHz or 44.1 kHz uncompressed. The AES/EBU format supports both rates by officially supporting neither. The data can be run at any rate, because the clock rate is also encoded. Clocking and re-clocking of AES/EBU signals is important.

HDMI

With a number of capture hardware supporting direct HDMI input from those cameras that provide it the HDMI audio is also captured from the uncompressed source.

Getting video into the computer world

Component Analog HD

Many decks, including the inexpensive Sony HDR-M10, provide component analog HD video. This can be fed to a capture card that converts analog HD component to digital signals for encoding to an appropriate codec (compressed or uncompressed HD), including ProRes 422.

The component HD signals are a variation on YUV signals used in Standard Definition analog video. While there are many YUV variations, you can think of HD component signals as being like an HD version of the Betacam component outputs.

HD Component signals, because they pass through an analog stage from digital and then back to digital again, do not maintain as much signal integrity as HD-SDI, but there are situations where the component analog provides a nicer looking image than direct digital transfer. Component analog form the HDR-M10 provides a useful signal path for real-time capture to codecs other than HDV although that is somewhat less necessary with Final Cut Pro 6.0.2 onward, where even a dual G5 can capture directly from HDV to ProRes 422 in software, over the FireWire cable. This is not a real-time capture on low-end systems, but rather the incoming signal is buffered so it can be converted to ProRes 422.

Component Analog HD has its uses but it is no longer a mainstream requirement.

Component Analog HD input for Final Cut Pro is available on the DeckLink HD Series from Blackmagic Design (BMD), Multibridge Pro (BMD), Kona LH series (AJA), Io HD (AJA), MXO2 (Matrox) and V4HD (MOTU).

Component Analog HD input for Media Composer is available on Nitris DX.

HD-SDI and Dual Link HD-SDI

It might look like a regular composite video cable, but it's not. HD-SDI is a high-speed serial interface between video equipment that carries digital video and multiple channels of digital audio. The video signal carried on the cable is both uncompressed and unencrypted. HD-SDI is transmitted at 1.485 Gbits/sec or, in a new standard for dual-link over a single cable, 3 Gbits/sec. HD-SDI is standardized in SMPTE 292M. The 3 Gbits/sec version supports the older standard but is designed for all 4:4:4 RGB workflows over a single connector (instead of dual-link HD-SDI) or full resolution 2K film playback at 2048 × 1556 pixels (at 24 fps).

HD-SDI is a convenient connection carrying HD video and up to 8 channels of uncompressed 48 kHz audio on one cable.

IMPORTANT: SDI cables may look like composite coax and both use a BNC connector, but the impedance of cable and connector is different for HD-SDI. Attempting to use a regular composite BNC cable A 75 Ohm Composite video cable with 75 Ohm BNC connectors will probably work over short distances (up to 6' for example) if used on HD-SDI equipment, but over longer distances the Composite cable and connectors will give failed connections, lost sync or other transfer issues.

HD-SDI is not suitable for very long distance transmission as it has been designed for short distances and the high data transmission rate would fail over extended distances. HD-SDI interfaces tend to be found in the higher end, more expensive decks, supporting "professional" formats or professional versions of decks.

HD-SDI provides a standardized, format-independent way of interconnecting HD equipment. Sony's HDV format HVR-1500 provides an HD-SDI signal that could be recorded by a Panasonic AJ-1400 DVCPRO HD deck. Both could feed into Final Cut Pro via an AJA or Blackmagic Design hardware interface and can be compressed to any format supported by Final Cut Pro in software. HD-SDI is the universal video interchange format but is not provided on inexpensive decks or cameras designed for direct FireWire connection to the computer. HD-SDI transfer maintains the highest signal integrity when copying from format to format, tape-to-tape, computer input or computer output.

See section following on Video Interface and Capture cards.

HD-SDI input for Final Cut Pro is available on the DeckLink HD Series from Blackmagic Design (BMD), Multibridge Pro (BMD), Kona LH (AJA), Io HD (AJA), Io Express (AJA), MXO2 (Matrox) and V4HD (MOTU).

HD-SDI for Media Composer is available on Mojo DX and Nitris DX.

Dual Link HD-SDI

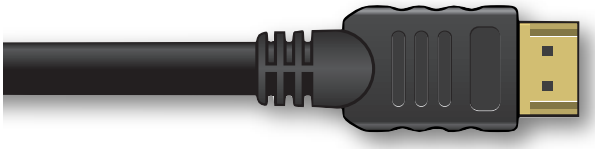
Until the advent and adoption of 3 Gbits/sec HD-SDI, two connections working in parallel were used to carry 4:4:4 RGB (full bandwidth) from XDCAM SR to a computer. A Kona 3 or Blackmagic Design Multibridge Pro/Eclipse are needed to capture Dual Link HD-SDI to Final Cut Pro.

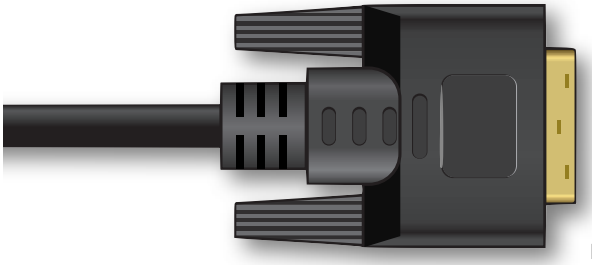
Unless you have a need to deal with 4:4:4 RGB you can ignore Dual Link HD-SDI.

Dual Link HD-SDI is available on the Decklink HD Extreme (BMD) and all Multibridge models. From AJA the Kona 3 supports Dual Link HD-SDI. There is no dual-link HD-SDI hardware for Media Composer: Avid reserves it for DS Nitris DX.

HDMI — High Definition Multimedia Interface

HDMI is an interface that anyone can license and incorporate into their products. Originally intended for high quality digital hookup between devices like HD players and Televisions, HDMI has been appearing on more and more inexpensive cameras, providing an uncompressed signal, similar in quality to HD-SDI, although on a multi-strand cable and a very small 19-pin connector.





HDMI supports standard, enhanced definition and all HD formats supported within the US ATSC broadcast system (23 or 34 formats, depending on who you ask) with up to 8 channels of audio. Audio up to 192 kHz sample rate at 24bit sample depth is supported. (Compare that with "CD quality" at 48 kHz sample rate at 16bit sample depth.)

At the time of writing, HDMI input is supported on the Blackmagic Design Intensity or Intensity Pro or AJA's Io HD. With either of these and Final Cut Pro, HDMI uncompressed output from the camera can be captured to an uncompressed file[15], ProRes 422 or other codec during capture. (With some minimum hardware requirements.)

The advantage of HDMI on cameras is that, as with those cameras with HD-SDI out, like Canon's XL-H1S and XH-G1, live video is sent out the HDMI port without being compressed first. This is perfect for a multi-camera situation using Blackmagic's On-Air software for a live studio switcher. Recorded HDV is decompressed for output through the HDMI port, but it still retains any compression artifacting caused by the compression to record. (Only live video comes out in uncompressed quality.)

HDMI was built to support content protection via HDCP (High-bandwidth Digital Content Protection). Intel developed HDCP to protect digital video and audio as it travels from player/output device to the screen. Both ends of this connection must support the same level of HDCP otherwise the output is restricted to standard definition, or blocked completely. This usually won't affect production folk unless they attempt to capture HDCP-protected content over HDMI. It won't work because HDCP is designed to prevent any further use of the protected material.

HDMI output from a camera, in combination with a capture interface card (or box) makes a very powerful capture tool (and interface to HDMI monitors as well). Intensity and Intensity Pro (BMD) supports HDMI on Intel-based Mac Pros. AJA supports HDMI input and output on the Io HD and Io Express.

There is no HDMI input on any supported Avid hardware for Media Composer.

[15] The AJA Io HD only supports ProRes 422 directly. It is possible, but not recommended because there is no benefit, to decompress the ProRes 422 to uncompressed within the computer.