



## Blackmagic DeckLink Technical Overview

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The Blackmagic DeckLink is a complete re-think in uncompressed video cards, and is priced dramatically lower than any previous product. In consideration of this low price, Blackmagic DeckLink still provides greater quality and features over any other NLE system available today.

This document is designed to help the reader understand the technical innovations contained in the Blackmagic DeckLink product, and how it functions. This will benefit the reader in system design, and understanding how modern television facilities can integrate the Blackmagic DeckLink into their workflow.

Even though this document is mostly concerned with an explanation of the technical features of Blackmagic DeckLink, it also features a QuickTime™ technology primer containing information on how it relates to high end video product systems. This explanation is at the end of this document, and is a good start for engineering staff who need to know more about QuickTime™ and what it makes possible.

Many people purchase the Blackmagic DeckLink purely based on price or video quality. Once they become familiar with the system, and start to take advantage of more than one QuickTime™ application, it becomes clear that QuickTime™ allows workflow changes that have never previously been possible. The QuickTime™ primer at the end of this white paper will help the reader discover the possibilities of QuickTime™ based systems.

## Low Cost

Blackmagic DeckLink has been designed from the ground up as a low cost but high quality uncompressed video card. Any company can just drop prices, however for this to be sustainable, low cost had to be designed into the DeckLink card right from its inception.

Low cost created many unique design challenges for the DeckLink design team. Namely how to reduce the cost without compromising video quality, reliability or features?

Lowering the cost has only been possible by carefully looking at the functions uncompressed video cards need to perform, and then tailoring engineering to remove waste and focus on including only hardware features required for multi stream uncompressed video.

This is in essence, just good engineering. Customers don't pay for things they never use.

Another area that helps reduce costs for users was to consider the entire editing system customers will build using the Blackmagic DeckLink. Many savings can be made to other parts of the system if changes are made to how the DeckLink operates.

A good example is Genlock. Other cards require genlock, however genlock has not really been used in post production since the days of linear edit bay design, where each deck needed to be "timed" into a vision mixer.

Most facilities don't use vision switchers any longer, so system timing is no longer a requirement. When connecting to broadcast tape decks, Blackmagic DeckLink will output a stable SDI sync reference to the deck to sync it. This eliminates the requirement for adding a sync generator to the edit system, and can save over US\$600 on the cost of a system by eliminating this expensive piece of equipment.

Low cost was the prime development goal along with the highest video quality possible within the bounds of the SDI 10 bit television system. At only \$995 the Blackmagic DeckLink development goals have been met.

## A New Way to Connect

Most cards have audio connections, genlock connections, SDI video connections and you need to add separate hardware for deck control with custom cables, and hard disk arrays.

Blackmagic DeckLink breaks through this mess for a simple direct-to-deck connection.

DeckLink features SDI in and out connections that link directly to any SDI digital deck. Video and all audio channels are sent through a standard BNC cable for ease of connection. DeckLink also includes a second monitoring SDI video/audio connection, and a deck control port all on the one card.

### **Sony™ Compatible RS-422 Deck Control**

Blackmagic DeckLink is the first uncompressed video card to feature a standard Sony™ compatible RS-422 serial deck control port.

No custom cables or annoying modem replacement cards are required. You don't lose a PCI expansion slot on the new mirror door Power Macintosh G4 computers, and you don't need to add modifications to the computer to add a serial port. This also eliminates the \$80 cost of a serial port modification, and won't affect the computer warranty.

The DeckLink serial deck control port is fully pin-for-pin compatible with standard Sony™ and Panasonic™ broadcast decks. Any pin for pin standard DB-9 serial cable can be used for connecting the Mac to your broadcast deck. Serial deck control is low latency, and fully frame accurate.

### **SDI Video & Audio Connections**

Blackmagic DeckLink also features two SDI serial connections for the deck. One SDI input is connected to the output of the deck, and the SDI output is connected to the SDI input of the deck.

The DeckLink card will provide stable SDI sync to the deck when in video capture mode. This means the requirement for a video black sync generator is eliminated, and no cable reconnections are required when moving from capture to output to tape.

Blackmagic DeckLink also takes advantage of the common SDI equipped decks, such as DVC Pro 25, DVC Pro 50, Digital Betacam, and many other types of decks that have SDI video connections built in. These decks have both the video and the audio channels all contained in the single BNC type cable.

Broadcast users have been taking advantage of this ability for the last few years to build large systems with only SDI video routing to save enormous costs of facility construction. No additional audio connections are required because the DeckLink uses SDI audio, so all video and audio channels are sent down the single BNC cable to the deck.

SDI audio is sometimes called embedded audio, and can allow up to 16 channels of audio, 10 bit uncompressed video and sync information to be transported down a standard BNC cable. This eliminates separate audio cabling, and allows easy interconnections, and patching between systems and decks.

This means only 3 standard off the shelf cables are required to connect to any digital broadcast deck. Blackmagic DeckLink does not require any reconnections when in use, as it automatically changes modes based on what the user is doing.

### User Monitoring

Monitoring for the user can be connected from the deck, or from additional SDI monitoring connections from the Blackmagic DeckLink card.

When monitoring from the deck, the digital or analog output connections can be used. By selecting PB/EE mode on the deck, the deck will automatically switch modes between capture and EE so you can see the output of the DeckLink card while editing.

If the deck is busy, and cannot be used for monitoring, then the Blackmagic DeckLink provides a separate SDI video/audio monitoring output. This can be connected into standard broadcast monitors, or analog converters can be used for lower cost monitoring.

AJA Video manufacturer a range of low cost SDI to video converters, and these start from as low as US\$350 for SDI to composite. Higher quality converters are also available for RGB and YUV video at higher cost. See [www.aja.com](http://www.aja.com)

For audio monitoring, Miranda make the Picolink series of low cost converters that take SDI audio and convert to stereo audio, or AES/EBU digital audio. In addition for a lower cost solution, some Macs support audio monitoring via the built in analog audio output, however this requires a change in the audio output system preferences before outputting to tape.

### Variable Quality Video

Blackmagic DeckLink offers a full range of video quality modes. Each mode has its own special benefits, and the user can choose which ever mode suits a particular task.

All Blackmagic DeckLink video modes, including 10 bit uncompressed, are fully compatible with the AJA Video Kona SD, as they use the same Blackmagic software. Uncompressed 8 bit is also compatible with the format used by the Pinnacle CineWave™ card.

The Blackmagic Software Codec can be downloaded from the Blackmagic Design web site. It allows opening and rendering to uncompressed 8 bit and 10 bit files without hardware installed. Blackmagic Software Codecs are available for Windows, Mac OS 9, and Mac OS X platforms.

### **Uncompressed 10 Bit**

Uncompressed 10 bit is the highest quality video possible because it's the same bit depth as the SDI video standard. Broadcast decks such as Sony Digital Betacam™ and Panasonic D5™ are full 10 bit recorders, and will provide the highest quality 10 bit video to the Blackmagic DeckLink card.

This format is great for heavily designed work, such as graphics and television commercials. All video captured will be played out in full 10 bit video. When rendering, the Blackmagic codec will use the 10 bit uncompressed video to provide extremely clean RGB images to application software. Even if application software is 8 bit RGB, this color space is quite different to YUV, and the color space conversion is extremely precise and clean using the extra bit depth available with uncompressed 10 bit video.

For software developers, DeckLink uncompressed 10 bit video format is based on the QuickTime™ v210 file format standard, and more information can be found on the QuickTime™ develop page at [www.apple.com](http://www.apple.com). Generally QuickTime™ APIs should be used for accessing file data, however if QuickTime is not available, then file format information can be extremely useful.

Resolution of 10 bit uncompressed is defined by the SDI video standard as 720 x 486 lower field first rendering for NTSC, and 720 x 576 upper field first rendering for PAL. Lower resolutions are supported, and in this situation video will be centered over black. Lower vertical resolution can be used for letterboxed projects as the video will center vertically over a black background automatically.

### **Uncompressed 8 Bit**

Uncompressed 8 bit video is taken from the 10 bit SDI input and rounded down to 8 bit YUV video on disk. This is similar to how almost all NLE systems handle video. By featuring uncompressed 8 bit video, the Blackmagic DeckLink saves disk space when quality requirements are not as high, and allows compatibility with other uncompressed video cards.

8 bit uncompressed is great for episodic television programming work when many hours of storage is required, however the video quality of uncompressed is critical. Uncompressed 8 bit video is compatible with the format used on the Pinnacle CineWave™ and the Kona SD card. Users can mix and match different systems, and drag and drop media between edit timelines and applications without rendering or file conversions.

DeckLink uncompressed 8 bit video format is based on the QuickTime™ 2vuy file format standard, however, even though files are identical to the 2vuy standard, they are labeled as 2Vuy for compatibility with the format used on the Pinnacle CineWave™ card. This helped create commonality amongst uncompressed file formats, and is an important requirement by customers in this industry.

If you require file format information, check the QuickTime™ file format information for the 2vuy standard, and change the format label to 2Vuy. It's worth noting that one other company also uses the 2vuy file standard, however they set the type label as 2VUY.

The reason for the non standard file type label is because QuickTime™ has a codec for 2vuy built in, however it features consumer quality color filtering. For high end use, most companies used the 2vuy standard, however changed the label to match to their own custom codec with broadcast quality color filtering. Basically, we would prefer QuickTime to not show the file at all, than use the built in 2vuy consumer grade codec. It's because QuickTime is such a modular and flexible API, that this is even possible.

Generally QuickTime API's should be used for accessing file data, however if QuickTime™ is not available, then file format information can be extremely useful.

Resolution of 8 bit uncompressed is defined by the SDI video standard and is the same as mentioned above for uncompressed 10 bit video.

### **Online JPEG**

Online JPEG is a high quality JPEG capture and playback format that's great for television programming work, when you need extremely high amount of storage, however don't have the budget for a large disk array. The Online JPEG format has very high video quality, is full SDI resolution, and is easily good enough to broadcast.

The Online JPEG data rates are quite low, and can be stored in the internal ATA disk that's used for the system boot drive. For budget conscious users, this means no disk array is required, and a lower cost system can be put together initially, then a disk array purchased when a high quality job comes along later.

The Online JPEG data rate is so low, we have captured 5 minute duration video clips onto an iPod at a quality that showed little visual difference from uncompressed video. This demonstrates the flexibility of the DeckLink Online JPEG format.

What this means for users is they can actually capture directly to a fast FireWire hard disk using a video format quality that's suitable for broadcast. This means any editor can take a capture disk home and edit on a domestic iMac out of the office. They can finish the edit, and are not limited to offline.

This is possible because FireWire hard disks are very portable, and rugged, and can be moved easily. Large projects can also take advantage of editing high quality video material on lower cost iMac computers. Compared to DV, Online JPEG is extremely good quality because it's full 4:2:2 video unlike 4:1:1 color limited video used by the DV format.

This quality is great for episodic television program production, but features the benefits of flexible storage options. Many flexible workflow options are possible when Online JPEG is used.

Online JPEG is fully compatible with the Apple QuickTime™ PhotoJPEG codec, and when rendering on systems without hardware, this codec can be used. When media storage disks or files are transported over to DeckLink systems, they can be played back direct out to hardware.

Resolution of Online JPEG is defined by the SDI video standard and is the same as mentioned above for uncompressed 10 bit video.

## DV Playback

DV support is also built into the Blackmagic DeckLink card, and allows any native DV project to be played out to SDI video in real time, without format conversions.

Generally users can capture material shot on DV or DVCam™ via the FireWire port, then using a native DV time line in Final Cut Pro™, edit and play out to the Blackmagic DeckLink as they work. This is an incredibly powerful format, because many users shoot on DV formats. Now they can capture and edit field originated footage, and then edit it down in duration to a sub master, and output this to tape. This eliminates the storage requirements for field originated footage when shoot ratios are high.

Another advantage of DV playback is integration with portable editing systems. Apple Powerbook systems running Final Cut Pro™ feature a full speed 400 Mbps FireWire port that can connect to DV cameras for capture and playback. This means a complete DV edit can be completed on a standard Powerbook G4 system.

If the Powerbook is booted with the 'T' key held down, it will start in a mode called Target Disk Mode. This means the Powerbook will emulate a FireWire hard disk, and the internal disk can be mounted on any desktop Mac system if the FireWire ports are connected.

Once the internal hard disk in the Powerbook mounts on the desktop system, it's easily possible to open the project and play the DV edit to the DeckLink SDI video output. No file copies or conversions are required. Allowing an internal Powerbook hard disk to be set as the media disk on a desktop system for real time video creates exciting workflow options.

Resolution for DV is different than the SDI standards, and is 720 x 480 for NTSC, and 720 x 576 for PAL. Field order for both formats is Lower Field First. This is different to the normal SDI video standard, and DeckLink will convert these differences in real time during playback. When working with DV, it's important to render to native DV resolutions, as Blackmagic DeckLink uses native DV standard files. This avoids creating differences in the DV standard.

## PCI Interface

Blackmagic DeckLink features a highly efficient and low cost 32 bit PCI interface that's actually faster than some 64 bit PCI cards. In addition, Blackmagic DeckLink is the first standard definition video card to feature a double speed 66 MHz PCI interface.

High speed PCI interface make Blackmagic DeckLink perfect for multi stream real time effects.

### High Efficiency PCI Interface

Blackmagic DeckLink features a highly efficient PCI interface that takes advantage of the new high speed PCI bridges in the latest Macintosh G4 computers. DeckLink PCI is designed to reduce a problem called PCI disconnects, allowing the PCI interface to transfer a dramatically higher amount of data per second.

Due to the way the PCI bus operates, data rates are highest when hardware is connected to the PCI bus and data is transferred as “bursts”. When cards disconnect because they cannot accept data fast enough from devices such as high speed SCSI cards, data rates stall until a reconnect occurs. Reconnects can take a lot of PCI bus cycles, so dramatically slow the PCI bus.

DeckLink was designed to reduce the number of disconnects, and the result is DeckLink features a less power hungry 32 bit PCI interface, but still performs better than other 64 bit PCI cards. This is smart design, and is part of the reason DeckLink only consumes a minute 5 watt’s of power even when running full 66 MHz speed PCI transfers. Lower power consumption reduces heat, which can be important on some systems with lots of cards plugged in.

### **2 x PCI, 66 MHz Speed**

The Blackmagic DeckLink features a 2 x PCI 66 MHz speed computer bus connection that’s twice the speed of all other standard definition video cards on the market. On computers such as the Apple Xserve, the DeckLink 2 x speed PCI interface will run at the full 66 MHz speed for double speed data transfer.

PCI bus speeds are normally determined by the slowest device plugged in. Other standard definition video cards will slow the fast Xserve PCI interface down to 1 x speed 33 MHz, and the speed advantage of 2 x speed PCI 66 MHz will be lost.

This is a critical problem when using newer SCSI cards such as the ATTO UL4D, and only the Blackmagic DeckLink will allow the UL4D to operate at its native 66 MHz speed. This will result in the full advantage of the speed of the SCSI array, and result in blindingly fast render times.

### **Real Time Effects**

Blackmagic DeckLink supports single stream, and multi stream real time effects. Real time effects can be uploaded at any time using a programable hardware arrangement that’s extremely flexible.

Hardware updates can be downloaded from the Blackmagic Design web site, and users will never need load risky “flash” firmware updates again.

Current single stream real time effects include image control sepia, desaturate, proc amp, tint, gamma, brightness contrast. Current dual stream real time effects include cross dissolve, non additive dissolve, additive dissolve, dip to color, fade in fade out, additive dissolve. More effects will be added as downloadable updates.

### **Video Desktop**

One of the most popular features of the DeckLink is the video desktop. The video desktop is available when application software such as Final Cut Pro™ is not running, or switched to the background.

Video Desktop is a full featured monitor, and is available in the displays control panel. Any image or window that’s dragged over to this desktop will output as full quality SDI



video. This means Adobe Photoshop™ documents can be moved to the video desktop and output as video, even though Photoshop™ was not designed for video.

Even application software such as Microsoft PowerPoint™ can output in real time to uncompressed SDI video. Video Desktop television standard can be independently set via the display settings in the system preferences.

## Blackmagic Codec

Blackmagic DeckLink uses the Blackmagic Codec which provides 16 bit per pixel or 64 bit rendering in applications that support it. This includes Adobe After Effects™, which is the worlds most popular broadcast design application.

When rendering in Adobe After Effects using 64 bit rendering, the image quality of uncompressed 10 bit video can be taken best advantage of. The quality is incredible, and independent tests confirm that the Blackmagic Codec is the best quality codec currently available on any system at any price.

## QuickTime™ Primer

Many people who have seen application software Final Cut Pro™ being used for high end video editing would have only noticed the low price of these systems.

Many other people might have noticed some of these cards do 10 bit uncompressed video and realized that this quality is higher than Avid™ or Media 100™ systems.

Many others would not believe that a low cost plug in card could beat the video quality of systems from Avid™, Discreet™, or Media 100™. Everyone in the television industry has been familiar with these systems in the past, however over the last few years things have started to change. Low cost cards that work with applications such as Apple Final Cut Pro™ and Adobe After Effects™ have started to become popular due to their low cost.

How is this high video quality at such low cost possible?

The reason for this change is linked back to a technology developed in the very early 90's at Apple Computer Inc. called QuickTime™. QuickTime™ was designed to allow software and hardware to be used together without the application writer adding special changes in their software to support a particular hardware card.

QuickTime™ keeps track of installed hardware and lets applications connect to video outputs and video inputs in a consistent way. Any QuickTime™ compatible hardware card will be noticed by the application software, and then this software can use it for video capture or playback. Video hardware can be changed based on the quality required by the user.

For example when a FireWire DV camera is plugged into a Macintosh, the operating system creates a QuickTime™ video input, and a QuickTime™ video output for the device. This means QuickTime™ software can list this input and output in the video settings, and users can choose to use the DV camera as a video capture source, or for playback to.

In many ways this is very similar to how printer drivers work. You can add printers either locally, or on the network, and then choose the printer you want to print to. As long as the application writer supports the standard print menu, then you can choose to print from any application you use. The PostScript™ printing standard helps make sure any printer can be printed to, whether it's a low cost laser printer, or a high end imagesetter.

In effect, QuickTime™ is the PostScript™ of the television industry.

Another area where QuickTime™ demonstrates its flexibility is codecs. If there is one rule in television, it's that nothing stays the same for very long, and file formats have changed dramatically over time. QuickTime™ allows for this, with plug in codecs. Codec's stand between a QuickTime™ application and the file format, and let any application open any file as long as a QuickTime™ codec has been written for this file type.

A good example is QuickTime™ does not understand the 10 bit uncompressed file format. With the Blackmagic Codec we allow QuickTime™ to handle uncompressed 10 bit video as easy as any other format. We include software codecs downloadable from the Blackmagic Design web site to let anyone open and render these files even with no hardware installed.

The format of the file is not a problem, as a QuickTime™ codec will generally exist to allow users to simply open the file with any QuickTime™ compatible software application. That means users have complete hardware and file format flexibility and can adapt to changes in their workflow or client requirements.

When building a production system based on QuickTime™, users can choose between hardware and software products based on feature and price. This creates a situation that's never existed before in the television industry, and that's true competition between vendors of system components.

All other areas of the computer industry benefit from this competition, however the television industry has been dominated by large custom based monopoly systems that have not moved ahead in features very much over the last several years. These companies also sustain themselves on heavy support costs that users have to submit to, to be eligible for system updates. Creatively, the television industry has been strangled by this in the past.

In effect, these companies use their monopoly power to keep extracting extra cash from customers. They have total control over the customer's system, and customers cannot add components to their system without being told it's "not supported". This basically scares customers into remaining compliant, and doing what the vendor tells them to do.

QuickTime™ changes everything because customers have freedom of choice.

Many products have been introduced that are QuickTime™ compatible over the last decade. In the past due to slow bus and processor speeds, data rates were too low for high quality video. Video on these older cards had to be compressed so it would fit on through the bus and not take up expensive space on disk arrays.

This is not an issue now, as system memory bus, disks, SCSI cards, and processors are now fast enough to handle uncompressed video with ease. Companies such as

Blackmagic Design have produced hardware that's both low cost, and now able to handle the highest video quality possible at 10 bit uncompressed. In addition, lower cost tape formats have become available, and now most decks have SDI digital video options.

At no other time in history has the television industry been able to choose from various hardware and software products to build a production system at a quality level that the most expensive traditional systems cannot beat.

Once a software application works with one hardware card, it generally works with all cards. This drives competition between vendors, resulting in much greater innovation and better value for money. It breaks down the monopolies that have dominated the television industry in the past.

The single biggest benefit to low cost is the workflow changes made possible. Previously, all post production was based around the edit system, however now things can be based around production requirements or people. It's now possible to easily increase production capacity and to eliminate the time consuming offline-online process.

Adding more systems is a low cost and easy thing to do. Only client systems need nice rooms, and many of the production systems can be simply desktop based allowing editors more time to experiment and develop creative ideas. There is no reason why every Mac system in a television environment should not include a Blackmagic DeckLink card so it can be involved in the creative process if required.

Application software has been improving over the last several years, and many QuickTime™ applications are now industry leading tools used by the highest end facilities. These software applications are truly professional tools that often beat the old traditional dedicated systems on features.

Editing applications include Apple Final Cut Pro™, and Adobe Premiere™. Design and effects tools include Adobe After Effects™, Apple Shake™, Discreet Combustion™, and Commotion™. Color correction and image treatment can be completed with Color Finesse™.

Other areas in production are also covered by amazing QuickTime™ software. DVD authoring can be completed with Apple DVD Studio Pro™, or for quick DVD's even iDVD™ can be used. Streaming for the web and video on demand files can be created with Discreet Media Cleaner™.

Application software is being added constantly, and with the robust API built into QuickTime™, often software applications will work first try on the Blackmagic DeckLink without us ever testing the software beforehand. Many software tools written for the DV market come alive and are tremendously powerful when used with uncompressed video captured with Blackmagic DeckLink.

This is a new era for the television industry, and before long the entire industry will be based on QuickTime or API's similar to it, as this ultimately delivers what customers need and want. That's freedom of choice.

## Summary

Blackmagic DeckLink contains features and technology that make it the leading uncompressed hardware card on the market today. Due to innovative engineering it's priced well below the cost of other products.

Many of the innovative features in the Blackmagic DeckLink card will eventually be adopted industry wide as companies offer products for this market. This is a milestone in the television industry and allows unprecedented flexibility in system design, that's never been possible before now.

Competition between vendors keeps companies thinking, and innovating. This is a new era for customers, as they develop new workflow procedures to take advantage of the flexibility and low cost of QuickTime based products such as Blackmagic DeckLink.

DeckLink is the product the people behind Blackmagic Design always wanted when working in post production, and is the product we started the company to build. When you realize why the television industry moved slowly in the past, it's easy to see why it needed the customers to create the company to make the products we always wanted.

Blackmagic DeckLink is that product. It's low cost enough for all of us to afford, but has the quality to make it a serious tool that we can actually use on the highest end jobs.

It's an exciting time to be involved in the television industry.

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