Avid DNxHD Technology

High definition without the high overhead. Revolutionary Avid DNxHD® encoding.

Avid

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Introduction

Gorgeous quality. Amazing efficiency. Technology that challenges old perceptions and opens up new possibilities. That's the thinking behind Avid DNxHD encoding. It's a solution that puts HD within easy reach of postproduction professionals who already work in standard definition (SD) video – and who stake their reputations on uncompromising quality. A solution engineered to withstand the rigors of multi-generational processing and leverage today's collaborative, networked environments. A solution with nearly 20 years of industry leadership behind it. A solution that's revolutionizing HD postproduction.

The benefits of Avid DNxHD encoding

Sub-sampled HD camera compression formats are efficient, but simply aren't engineered to maintain quality during complex postproduction effects processing. Uncompressed HD delivers superior image quality, but data rates and file sizes can stop a workflow dead in its tracks. Avid DNxHD delivers both efficiency and quality without compromises. Avid DNxHD is a revolutionary 10- and 8-bit HD encoding technology that significantly reduces storage and bandwidth requirements while providing mastering-quality HD media. Avid DNxHD encoding is available in four families of resolutions depending on data rate:

- Avid DNxHD 220x: For highest quality image and color space for 10-bit sources. Data rate is dependent on frame rate. For example, 220Mbps is the data rate for 1920 x 1080 30fps interlace sources (60 fields) while progressive sources at 24fps will be 175Mbps.
- Avid DNxHD 220: For highest quality image when using 8-bit color sources. Data rates based on frame rates are the same as for Avid DNxHD 220x.
- Avid DNxHD 145: For high-quality mastering when using 8-bit lower data rate sources such as HDCAM and DVCPRO. 145Mbps is the data rate for 1920 x 1080 30fps interlace sources (60 fields). Progressive sources at 24fps will be 115Mbps and at 25fps will be 120Mbps.
- Avid DNxHD 36: High-quality offline editing of HD progressive sources only. Designed for projects using an offline/online workflow due to large quantities of source media and/or needing more real-time preview streams for craft editorial or multicamera editing.

Advantages of Avid DNxHD encoding:

- Avid DNxHD 145 8-bit media delivers very high HD image quality while requiring approximately 20% less storage capacity than 8-bit uncompressed ITU-R BT.601 standard definition media.
- The reduced bandwidth of Avid DNxHD encoding allows single editing systems to work in full HD with a simple 4- or 8-way drive stripe set, or Avid DNxHD 36 on a single drive.
- The first truly collaborative real-time HD workflow is now possible with Avid DNxHD media over Avid Unity™ MediaNetwork or Avid Unity ISIS™.
- Avid DNxHD encoding supports Avid's Emmy® award-winning real-time multicamera functionality with up to four real-time streams of Avid DNxHD 145.
- With support for every popular resolution and frame rate at a choice of data rates, Avid systems can handle all sources and delivery requirements.

Avid DNxHD encoding quality

Avid DNxHD encoding is specifically designed for nonlinear editing and complex multi-generation compositing common in today's collaborative post production and broadcast news environments. It offers a choice of 8- or 10-bit sampling, four user-selectable bit rates, and the ability to maintain high image quality more effectively than native camera codecs. The chart below compares Avid DNxHD encoded media to other popular HD formats:

Format	Avid DNxHD 36	Avid DNxHD 145	Avid DNxHD 220	DVCPRO HD	HDCAM	HDCAM SR
Bit Depth	8-bit	8-bit	8- and 10-bit	8-bit	8-bit	10-bit
Sampling	4:2:2	4:2:2	4:2:2	1280 Y samples 4:2:2	1440 Y samples 3:1:1	4:2:2
Bandwidth	36 Mb/sec	145 Mb/sec	220 Mb/sec	100 Mb/sec	135 Mb/sec	440 Mb/sec

Most popular compressed HD formats do not natively support the full HD raster. Horizontal raster downsampling makes HD images easier to compress, but significantly reduces high frequency detail information in the image. As a result, downsampling makes HD images look softer by degrading horizontal resolution in the process. The camera original HD raster's 1920 pixel horizontal resolution has 33% more resolution than a 1440 pixel downsampled image and 50% more than a 1280 pixel downsampled image. Over multiple generations of postproduction processing, raster downsampling can severely degrade images, increasing unwanted visible artifacts that can render an image unacceptable. Unlike other compressed HD formats such as HDCAM and DVCPRO HD,

Avid DNxHD encoding maintains the full original raster of the active video, sampling every available pixel within the image. The table below (Fig. 2) shows the reduction in image size that is a characteristic of raster downsampling used by other HD compression schemes:

FORMAT	RESOLUTION / FRAME RATE	Luminance, Y		Chrominance, CrCb	
		FROM	TO	FROM	TO
HDCAM	1080i/59.94	1920	1440	960	480
DVCPRO HD	1080i/59.94	1920	1280	960	640
DVCPRO HD	1080i/50	1920	1440	960	720
DVCPRO HD	720p/59.94	1280	960	640	480
DVCPRO HD	720p/23.976	1280	960	640	480

Avid DNxHD encoding is open

Avid applications store Avid DNxHD material natively inside industry-standard MXF files, ensuring open accessibility by other MXF-aware applications. In addition, the source code for Avid DNxHD is licensable free of charge, and is available through the Avid Website as a download to any end user who wants to compile it on any platform. For QuickTime-aware applications such as Adobe AfterEffects, Avid distributes QuickTime-wrapped versions of the Avid DNxHD codec family compiled for Windows XP, Windows Vista, and Mac OS X.

Avid submitted the Avid DNxHD codec to SMPTE (Society of Motion Picture and Television Engineers) as the foundation format for their VC-3 standard. After two years of rigid SMPTE Standards efforts, four VC-3-related documents are now publicly available (store.smpte.org/). The Avid DNxHD codec is compliant to SMPTE VC-3. The SMPTE documents are:

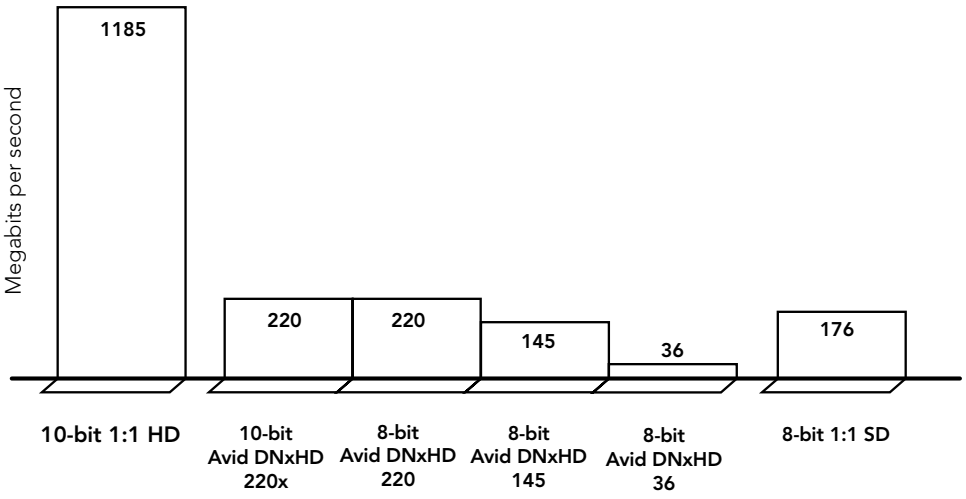
- SMPTE 2019-1 VC-3 Picture Compression And Data Stream Format
- SMPTE RP 2019-2 VC-3 Decoder and Bitstream Conformance
- SMPTE 2019-3 VC-3 Type Data Stream Mapping over SDTI
- SMPTE 2019-4 Mapping VC-3 Coding Units into the MXF Generic Container

This commitment to openness means users can confidently embrace the Avid DNxHD format, safe in the knowledge that their valuable content will always be accessible – with or without Avid equipment.

Avid DNxHD encoding: what is "high efficiency?"

Uncompressed high-definition (HD) media can require nearly seven times more bandwidth and storage resources than uncompressed standard-definition (SD) media. Avid® DS, Avid Symphony™ Nitris DX, Avid Media Composer® Nitris DX, and Avid Media Composer Mojo DX systems have the power to capture uncompressed HD files, but with high storage costs. And if you want to go beyond standalone HD editing, the high data rates of uncompressed HD media make it difficult to implement an efficient, collaborative, and profitable workflow using multiple systems connected to a shared storage network. Avid gives you the choice without compromising the quality.

Avid DNxHD encoding offers mastering-quality HD media with dramatically reduced file sizes, shattering the barriers to real-time HD productivity, whether using standalone local storage or working in real-time collaborative HD workflows over Avid Unity MediaNetwork. In fact, the efficiency of Avid DNxHD encoding makes it easy to work with mastering-quality HD media directly on notebook systems.



Sample media and bit depths

For maximum efficiency, users can pick the Avid DNxHD bit depths and data rates that most closely match those of the source media. Or they can choose to encode 8-bit HD media as 10-bit Avid DNxHD media to maintain pristine image quality over multiple generations of postproduction effects processing. The increased bit depth provides the additional dynamic range necessary for precise color correction adjustments without introducing signal clipping and rounding-error artifacts. Once postproduction is completed, the media, via HD-SDI, can be output to the same format as the source media, or in other HD formats supported by the HD VTR or encoded directly to the output format such as MPEG for broadcast and DVD delivery.

Avid DNxHD: what is “mastering quality?”

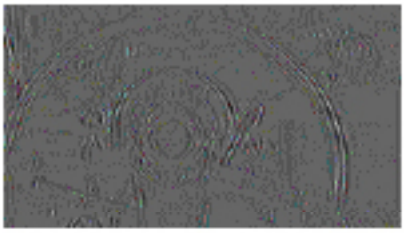
Unlike Avid DNxHD encoding, most camera acquisition formats are only 8-bits deep and reduce the image resolution through horizontal down-sampling – discarding detailed pixel information and high-frequency color information in the process. This results in the image becoming softer during multi-generation postproduction processing:

This example image represents what the camera lens actually sees in the 1920x1080 full high definition raster.

This is the same image after its raster has been horizontally sub-sampled down to 1440 pixels and recorded to videotape.

The same image returned to its normal raster. Sharpness deteriorates after multiple generations of sub-sampling in post production.

This is an A and -B mix of the original image and a negative of the subsampled image. The horizontal sub-sampling losses quickly become obvious.



This is an A and -B mix of the original image and a negative of the Avid DNxHD image. The image details are maintained with very high accuracy.

You can perform the A and –B mix test on any NLE or switcher to test for quality losses through any digital process. When you establish a 50/50 mix of any original digital signal with a negative image of the same signal after passing though the encoding process to be tested, the resulting visual differences are the errors generated by the encoding. A blank image with no notable visual differences indicates a very high degree of quality and accuracy in the process.

Avid DNxHD encoding solves the deterioration problems associated with multigenerational sub-sampling. When used to post HDCAM or DVCPRO HD source material, Avid DNxHD offers significant advantages:

- Avid DNxHD encoding preserves the full raster of the original HD frame with no reduction in the horizontal luminance and chroma samples.
- Pixels are properly aligned so that downstream processes such as MPEG2 encoding can be better optimized resulting in a higher quality image for broadcast.

Avid DNxHD delivers more precise color correction, graphics, effects, and compositing over multiple generations of postproduction processing. The result is image quality that is virtually indistinguishable from the original image, even compared to uncompressed HD in postproduction – regardless of source material. Quality is consistently higher than is possible when working within an 8-bit space, or when beginning with a sub-sampled, poorly encoded, or resized image.

> Recently a test was done to compare uncompressed HD to [Avid] DNxHD 220 for a film out. To get uncompressed HD; film was scanned at 2K then rendered as uncompressed HD, and then [Avid] DNxHD 220. The two HD elements were edited together with a diagonal wipe between the two formats. The resulting sequence was exported as DPX files for a film out. The 35mm film was projected, as well as the digital files in a calibrated screening room and no one was able to pick where the split was done, nor which part of the image was Avid DNxHD.
>
> -PostWorks, New York

Avid DNxHD in a workgroup environment

Efficiency has even more meaning in a workgroup, where benefits like mastering quality HD and low storage requirements are magnified by the power of teamwork. Better quality results, faster turnaround times, and improved productivity are all benefits of simultaneous editing processes within a workgroup. With Avid DNxHD all this HD value is possible on networks built for SD.

Using Avid Unity MediaNetwork v5.0 or later, up to 19 dual-stream clients can work in a workgroup environment using Avid DNxHD145 or DVCPRO HD. Workgroups can even mix resolutions based on the user's needs and configurations.

Avid provides flexibility and scalability for all HD workgroup types and configurations – from small Avid Unity MediaNetwork workgroups of just a few clients to large enterprise Avid Unity ISIS configurations with up to 330 clients.

Avid DNxHD family of mastering resolutions

Avid DNxHD is available in multiple HD encoding choices per resolution/frame rate combination, each identified by bandwidth (megabits/second) and bit depth, as shown below.

Project Format	Resolution	Frame Size	Bits	FPS		min/GB
1080i/59.94	Avid DNxHD 220x	1920 x 1080	10	29.97	220	0.651
1080i/59.94	Avid DNxHD 220	1920 x 1080	8	29.97	220	0.651
1080i/59.94	Avid DNxHD 145	1920 x 1080	8	29.97	145	0.985
1080i/50	Avid DNxHD 185x	1920 x 1080	10	25	184	0.780
1080i/50	Avid DNxHD 185	1920 x 1080	8	25	184	0.780
1080i/50	Avid DNxHD 120	1920 x 1080	8	25	121	1.181
1080p/25	Avid DNxHD 185x	1920 x 1080	10	25	184	0.780
1080p/25	Avid DNxHD 185	1920 x 1080	8	25	184	0.780
1080p/25	Avid DNxHD 120	1920 x 1080	8	25	121	1.181
1080p/25	Avid DNxHD 36	1920 x 1080	8	25	36	3.98
1080p/24	Avid DNxHD 175x	1920 x 1080	10	24	176	0.814
1080p/24	Avid DNxHD 175	1920 x 1080	8	24	176	0.814
1080p/24	Avid DNxHD 115	1920 x 1080	8	24	116	1.231
1080p/24	Avid DNxHD 36	1920 x 1080	8	24	36	3.98
1080p/23.976	Avid DNxHD 175x	1920 x 1080	10	23.976	176	0.814
1080p/23.976	Avid DNxHD 175	1920 x 1080	8	23.976	176	0.814
1080p/23.976	Avid DNxHD 115	1920 x 1080	8	23.976	116	1.231
1080p/23.976	Avid DNxHD 36	1920 x 1080	8	23.976	36	3.98
1080p/29.97	Avid DNxHD 220x	1920 x 1080	10	29.97	220	0.651
1080p/29.97	Avid DNxHD 220	1920 x 1080	8	29.97	220	0.651
1080p/29.97	Avid DNxHD 145	1920 x 1080	8	29.97	145	0.985
1080p/29.97	Avid DNxHD 45	1920 x 1080	8	29.97	45	3.18
720p/59.94	Avid DNxHD 220x	1280 x 720	10	59.94	220	0.651
720p/59.94	Avid DNxHD 220	1280 x 720	8	59.94	220	0.651
720p/59.94	Avid DNxHD 145	1280 x 720	8	59.94	145	0.985
720p/50	Avid DNxHD 175x	1280 x 720	10	50	175	.818
720p/50	Avid DNxHD 175	1280 x 720	8	50	175	.818
720p/50	Avid DNxHD 115	1280 x 720	8	50	175	1.244
720p/29.97	Avid DNxHD 110x	1280 x 720	10	29.97	110	1.30
720p/29.97	Avid DNxHD 110	1280 x 720	8	29.97	110	1.30
720p/29.97	Avid DNxHD 75	1280 x 720	8	29.97	72	2.05
720p/25	Avid DNxHD 90x	1280 x 720	10	25	92	1.59
720p/25	Avid DNxHD 90	1280 x 720	8	25	92	1.59
720p/25	Avid DNxHD 60	1280 x 720	8	25	60	2.39
720p/23.976	Avid DNxHD 90x	1280 x 720	10	23.976	88	1.566
720p/23.976	Avid DNxHD 90	1280 x 720	8	23.976	88	1.566
720p/23.976	Avid DNxHD 60	1280 x 720	8	23.976	58	2.381

Avid DNxHD mixed in the timeline

Avid editing systems are designed for flexibility. They can handle HD, HDV, SD, and DV media at the same frame rate in the same timeline, all playable in real time. If a project requires file footage from SD sources, native DVCPRO HD, DV material, and HDCAM footage captured as Avid DNxHD, Avid systems can handle all these types in their native format. Just drop the media right in the same timeline, even add effects and compositing. Avid DNxHD combined with native HDV, is the best of both worlds for low-cost HD production, combining the native efficiency of HDV with the quality of Avid DNxHD for graphics, compositing and effects.

Offline HD

The Avid DNxHD 36 resolution is targeted specifically at the creative editorial workflow. Avid DNxHD 36 is a high-quality offline resolution supporting full 16x9 aspect ratio and is available for 1080p/23.976, 1080p/24, 1080p/25, and 1080p/29.97 projects. Native HD offline editing adds several benefits to the overall workflow, such as: perfect conform of all effects (compared to working with standard definition 16:9 anamorphic), removes timecode conversions between standard definition frames rates of 30fs and 25fps, tracking of pulldown cadence when in NTSC, single pass capture of picture and sound, and high enough quality to screen directly without the additional cost and time of a conform step.

The Avid DNxHD 36 data rate is only 50% more than standard definition DV25 allowing for massive amounts of dailies to be captured. For example, 100,000 feet of 35mm, 4 perf film (~18.5 hours) when captured at Avid DNxHD 36 will only require 279GB of storage.

Avid DNxHD and future potential

Avid DNxHD encoding is a scaleable solution that will allow Avid to add different formats, resolutions, and data rates as required by the marketplace. As the demands move to higher and lower bit rates, there will be an Avid DNxHD solution to meet those needs.

Avid High-Definition Products that support Avid DNxHD

No matter what HD format you shoot, Avid's got you covered: all the way from native HDV to uncompressed HD. And with breakthrough Avid DNxHD encoding technology revolutionizing HD postproduction, Avid HD solutions give you everything you need to deliver "Beauty without the Bandwidth":

Avid DS Nitris
Industry-leading uncompressed HD, HD-RGB, Avid DNxHD, and 2K/4K performance

Avid Symphony Nitris DX
An HD conform and finishing powerhouse for uncompressed HD and Avid DNxHD

Avid NewsCutter® Nitris DX
Designed for high-efficiency HD broadcast workflows

Avid Interplay™
Complete media production management powered by the world's first nonlinear workflow engine

Avid Media Composer Mojo SDI and Avid Media Composer Nitris DX
Real-time Avid DNxHD editing delivers unsurpassed creative editorial

Avid Media Composer (software-only)
Powerful editorial tools with playback and edit capabilities for HD. Maximizes the portability and collaborative benefits of Avid DNxHD

Avid Unity ISIS
Engineered to deliver Avid DNxHD performance up to 220 Mb/sec, high availability, and massive scalability to large, enterprise-level customers

Avid Unity MediaNetwork
High-bandwidth shared storage network with real-time support for DV, SD and HD media

Register now to receive more information on Avid DNxHD encoding. You can also access our downloadable codec source code anytime for free just by visiting our website at: http://www.avid.com/forms/DNxHDinfo.asp

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