Workflow Guidelines

Recommended Practice for Shooting with the ARRIFLEX D-21

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This document is intended to help defining a camera output format and suitable workflow for a given production by introducing a few aspects that can be used for characterization. As there always are exceptions, some productions will benefit more from a workflow that differs from the standard scenarios. Depending on the individual project, it may thus be advisable or necessary to deviate from the recommendations given herein.

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1. Introduction

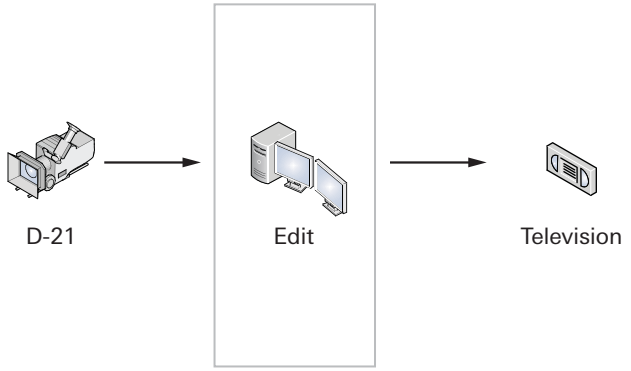
The ARRIFLEX D-21 offers different output formats, which make it a versatile camera for use in all kinds of productions. This versatility sometimes makes it hard to decide which output format would be the best for a certain project. This document is intended to help with the decision by linking a few typical production types to a suitable output format.

Different Productions Require Different Formats

This overview represents the list of output formats that are available on the D-21 and introduces what types of production scenarios they are recommended to be used for. The elements used to characterize a scenario are covered in the next section.

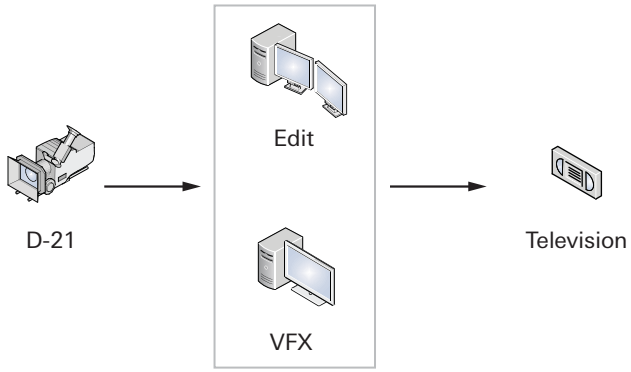
2. HD 4:2:2 Video

(HD) television productions without the need for complex postproduction are recommended to utilize the HD 4:2:2 video workflow, as described in chapter 2.



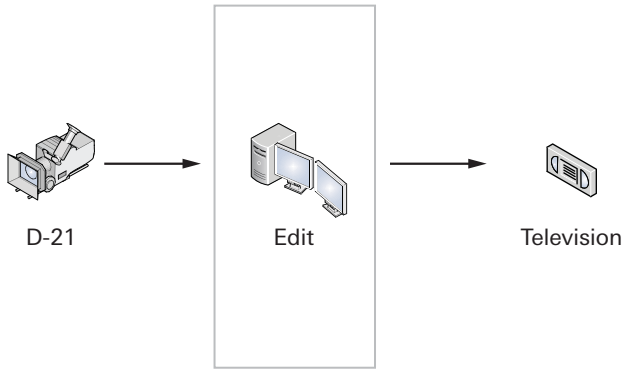
3. HD 4:4:4 Video

(HD) television productions that require that a lot of visual effects work and/or dramatic color timing are recommended to utilize the HD 4:4:4 video workflow, as described in chapter 3.



4. Mscope HD 4:2:2 Video

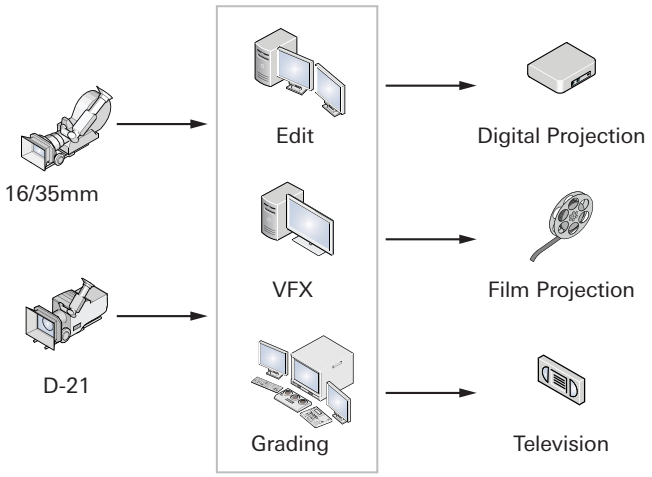
Anamorphic format (2x horizontal squeeze, 2.39:1) (HD) television productions without the need for complex postproduction are recommended to utilize the Mscope HD 4:2:2 video workflow, as described in chapter 4.



Note:
The term video describes a "What You See Is What You Get" chacacteristic curve (opto-electronic transfer curve) based on HD standard ITU-R BT.709.

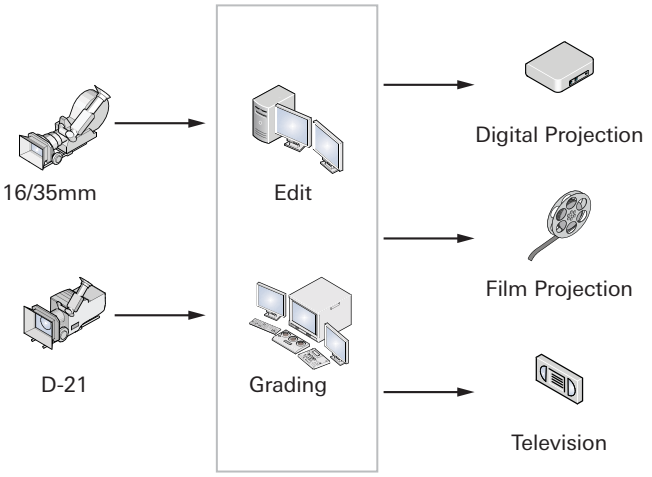
5. HD 4:4:4 log

Productions for cinema (digital or film projection), (HD) television or productions that will use material shot on film along with digitally shot material should take advantage of the possibilities offered in DI/log postproduction.
These productions are recommended to utilize the HD 4:4:4 log workflow, as describes in chapter 5.



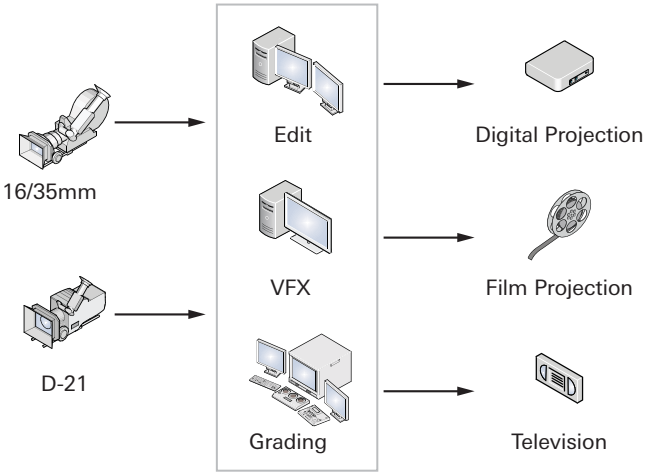
6. Mscope HD 4:2:2 log

Anamorphic format (2x horizontal squeeze, 2.39:1) productions for cinema (digital or film projection) or (HD) television without the need for complex postproduction, as well as productions that will use material shot on film along with digitally shot material should take advantage of the possibilities available in DI/log postproduction.
These productions are recommended to utilize the Mscope HD 4:2:2 log workflow, as described in chapter 6.



7. ARRIRAW

Feature productions that need to meet the highest demands are recommended to utilize the ARRI-RAW workflow, as described in chapter 7.
The ARRIRAW format allows native 2K finishing, shooting with anamorphic lenses, it can be easily combined with material shot on film and allows taking advantage of the possibilities in DI/log postproduction.



Note:
This document intentionally does not cover all the technical details or handling of the equipment, as this should be taken from the documents mentioned in the appendix and respective instruction manuals.

Finding the Right Format

One way to figure out how a project should be shot is to go backwards from presentation to creation. Through answering a few questions the best option can quickly be determined. The decision tree shows how these questions relate to each other and which format can be suggested based on the answers.

- Will your production be released in the cinema or on television?

  If a production is not intended to be screened in a cinema, there is no reason to shoot in raw camera data instead of HD video, which is easier to handle.

- What is the desired aspect ratio?

  Productions in the common aspect ratios of 16:9 (1.78:1) and standard US widescreen (1.85:1) are generally shot using standard (spherical) camera lenses. While productions in CinemaScope (2.39:1) can also be shot using spherical lenses, the D-21 uniquely also offers to shoot this format using anamorphic lenses just like a 35 mm film camera.

- Is the material required in native 2K resolution?

  One of the requirements in the current current digital cinema standard is that material needs to be available in a resolution of 4096 x 2160 or 2048 x 1080 pixels. Material of smaller dimensions is acceptable as long as the horizontal or vertical dimension of these so-called container sizes is filled (e.g. 2048 x 800 or 1920 x 1080 for the 2K raster). While it is possible to desqueeze and reformat Mscope material to fit a 2K digital cinema raster, superior image quality is achieved by using native 2K images, originating from ARRIRAW data.

- Will the production also use material shot on film?

  When film negative is scanned, it is typically available as so-called log data. The D-21 can be set to deliver its output in the log format so both film scans and D-21 output can be worked on together in the same color grading setup.

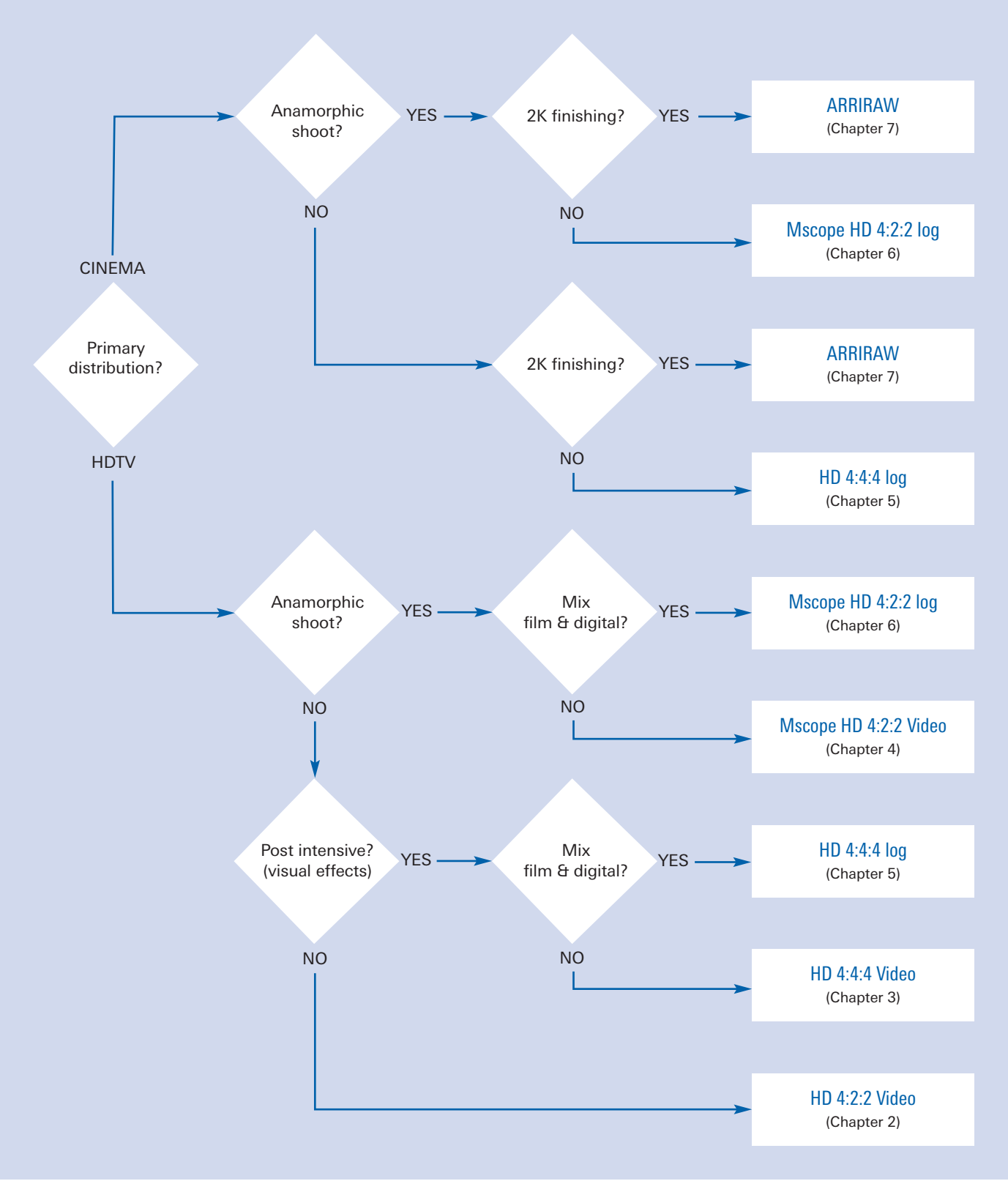
- Does the production involve a lot of visual/special effects?

  If it's a straight forward production for (HD) TV without too much need for image tweaking, the best option is to go for the format that will give you the least amount of trouble.

Decision Tree

Important Ground Rules

Whichever seems to be the format of choice – always discuss the workflow with your post house! Always shoot a test and run the output through the entire intended workflow. Everybody who needs to understand the workflow in production should also participate in the tests.



2. HD 4:2:2 Video

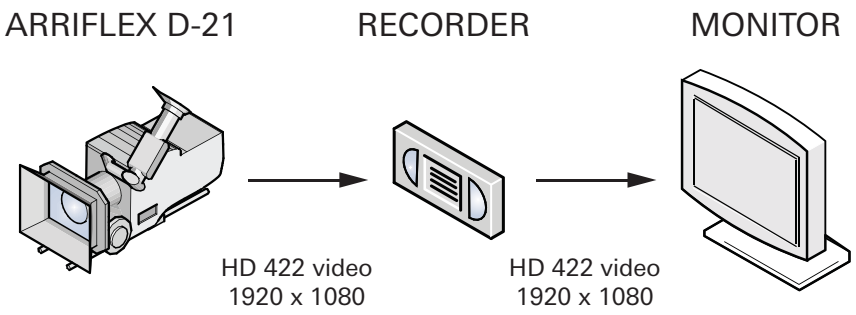
Using HD 4:2:2 video as the chosen production format enables quick and efficient production and therefore represents the ideal option for productions with distribution on (HD) television that do not require very complex postproduction.

Common Criteria

- Intended distribution is HDTV/TV
- Color grading using an HD monitor
- Regular color timing or image tweaking
- No subtle color keying

Image Characteristics

- Fully HDTV broadcast compliant
- 1920 x 1080 Full HD resolution
- 1 – 30 fps, 1 – 60 fps using High Speed Setup
- 4:2:2 chroma sub-sampling
- YCbCr (YUV) color space
- 10 bit standard HD quantization
- Video image characteristics
- Normal (broadcast legal) video level range



Pros

- Common signal format.
- Material immediately available in online/production quality.
- Simple single link HD-SDI connection to the recorder.
- Use of standard HDTV equipment.
- Option for tape or file based recording and postproduction.
- Material can be processed by any professional post facility offering HD postproduction.
- Material directly usable without the need for conversion (preview, copies for post).
- Fast turnaround.
- Allows the creation of slow-motion material when used in High Speed setup.

Cons

- Reduced spatial resolution in the color channels.

Camera Setup

Ground Glass/Glow Mask Options

- Digital 1.33 + 1.78
- Digital 1.78
- Digital 1.78 + 1.85 (centric)
- Digital 1.75 + 2.39 (centric)

Lens Options

- Spherical 35 mm PL mount lenses

Output Configuration

Framerate: 23.976 – 30
HD-SDI Mode: HD422
Output Range: Normal Range
Contrast Char.: EI 100 – 800

Cable Connections

- Connect camera HD-SDI 1 or 2, link A or B to recording HD-SDI IN.
- Connect recording HD-SDI OUT/MONITOR OUT to control monitor HD-SDI IN.

The camera's base sensitivity is 200 ASA. The contrast characteristic is chosen depending on the lighting situation in the scene. All EI characteristics directly deliver a visually correct HD image and thus are referred to as "video".

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

Recording

The camera delivers its output signal over a single link HD-SDI connection, which provides a wide range of compatible recording systems. Some solutions are very attractive due to small size, low weight and/or low power consumption while others stand out due to uncompressed recording by relaying on widely adopted standards. Recording frame rates other than those in the HD standard (23.976, 24, 25, 29.97, 30 fps) requires a recorder supporting variframe input. In any case, it is recommended to involve postproduction when selecting a recording system, as this has a great impact on the efficiency of the overall workflow.

Compatible Recording Systems

Model	Type	Media/Capacity @ 24 fps	Data Rate/Compression	Variable fps	High Speed
Sony SRW-1/SRPC-1 (Note 1, 2)	field recorder	HDCAM SR (tape size S) approx. 50 min	440 Mbit/s, approx. 2.7:1 MPEG-4 Studio Profile	yes	yes
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID mag) approx. 70 min	uncompressed	yes	yes
S.two OB-1	on-board recorder	FlashMag (flash memory mag) approx. 30 min	uncompressed	yes	yes
Codex Recorder	field recorder	Diskpack (RAID mag) approx. 160 min	uncompressed	yes	yes
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) over 5hrs (4:1) 2) Portable Rugged Diskpack (RAID mag) approx. 100 min (4:1) 3) Portable Flash Diskpack (flash memory mag) approx. 180 min (4:1)	4:1 to 16:1 JPEG2000	yes	yes
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) approx. 130 min 2) Flash pack (flash memory mag) approx. 26 min	uncompressed	yes	yes
ARRI Flash Mag/Thomson Grass Valley Venom FlashPak	on-board recorder	internal flash memory approx. 15 min	uncompressed	no	no
Panasonic AG-HPG20 (Note 3)	on-board recorder	P2 memory cards approx. 32 min	100 Mbit/s, approx. 16:1, H.264/AVC Intra	no	no
AJA KiPro	field/ on-board recorder	1) HDD Storage Module (SATA HDD mag) approx. 4 hrs 2) SSD Storage Module (SSD mag) approx. 2 hrs	220 Mbit/s, approx. 8:1 VBR, ProRes 422 HQ	no	no

(1) SRW-1/SRPC-1: Recording variable frame rates up to 59.94 fps requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.
(2) SRW-1/SRPC-1: Recording fixed frame rates at 48, 50, or 59.94 fps is also possible using dual camera mode (422x2) as described below.
(3) AG-HPG20: Only records at 25 PsF (50i) and 29.97 PsF (59.94i).

Note: *This list is not complete as there are many more recorders in existence while new ones are continuously being introduced to the market.*

HD 4:2:2 High Speed Setup

With 4:2:2 output, the ARRIFLEX D-21 can run up to 60 fps in order to create fluid slow-motion material.

Technical Info

At frame rates above 30 fps, the camera sends the HD 4:2:2 output through two HD-SDI connections (dual stream) whereas each one transports half of the captured frames to the recorder. At e.g. 50 fps, both camera output boards transmit a synchronized HD video signal with 25 fps (one containing only even, the other only odd numbered frames, composing the 50 fps signal). Any recorder supporting HD 4:2:2 dual stream/dual camera input can record these signals which are commonly used for stereoscopic capture with two camera heads.

Cable Connections and Recording

In this particular setup, the cables need to be run from camera HD-SDI 1 link A to recording HD-SDI IN A and camera HD-SDI 2 link A to recording HD-SDI IN B. Recording time, of course, shortens because of the increased fps. The last column in the table above shows which of the mentioned recorders can be used. If the recording system does not provide file based access, the material can simply be played back at standard (e.g. 25fps) speeds and thus handles no differently from regular 4:2:2 material.

Postproduction

Post houses offering a regular HDTV post workflow should be able to process the material without any difficulty.
As the recorded material is fully HDTV standard compliant, no particular setup is required.

Note:
It is recommended to verify that the recorded material lies within normal/legal/safe signal range. If the camera was accidently set to output extended range signals, this may have gone unnoted during recording. If the material is using extended range video levels, the signal needs to be compressed (not clipped) to legal range levels before it is handed to the customer.

Television Mastering

The finished material only needs to be adapted to the desired (HD)TV standard.

3. HD 4:4:4 Video

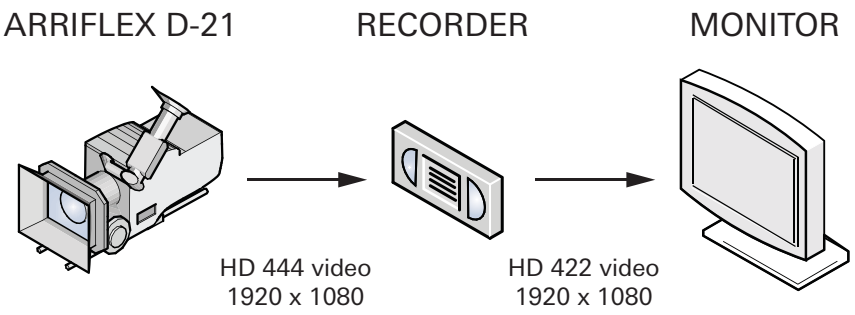
HD 4:4:4 video is recommended for productions that involve a lot of post production/special effects work with primary distribution on (HD) television. It provides images with full color resolution that are ideal for extensive postproduction work, such as subtle color/chroma keying for visual effects work and/or dramatic color timing.

Common Criteria

- Intended distribution is HDTV/TV
- Color grading using an HD monitor
- Requires very fine tonal and color separation
- Involves delicate compositing or color keying
- May use extreme color timing
- Special effects elements for digitally shot productions

Image Characteristics

- 1920 x 1080 Full HD resolution
- 1 – 30 fps
- 4:4:4 full chroma sampling
- RGB color space
- 10 bit standard HD quantization
- Video image characteristics
- Extended (non broadcast legal) video level range



Pros

- Material immediately available in online/production quality.
- Option for tape or file based recording and postproduction.
- Material can be processed by any professional post facilities offering 4:4:4 HD postproduction.
- Material directly usable without the need for time-consuming conversion (preview, copies for post).
- Provides best color resolution and tonal separation available for the HD output for superior color/chroma keying and color alteration possibilities.
- Fast turnaround.

Cons

- Frame rate limited to 30 fps.

Camera Setup

Ground Glass/Glow Mask Options

- Digital 1.33 + 1.78
- Digital 1.78
- Digital 1.78 + 1.85 (centric)
- Digital 1.75 + 2.39 (centric)

Lens Options

- Spherical 35 mm PL mount lenses

Output Configuration

Framerate:	23.976 – 30
HD-SDI Mode:	444
Output Range:	Extended Range
Contrast Char.:	EI 100 – 800

Cable Connections

- Connect camera HD-SDI 1 or 2, link A to recording HD-SDI IN A.
- Connect link B of the same output to recording HD-SDI IN B.
- Connect recording MONITOR OUT (4:2:2) to control monitor input HD-SDI IN.

The camera's base sensitivity is 200 ASA. The contrast characteristic is chosen depending on the lighting situation in the scene. All EI characteristics directly deliver a visually correct HD image and thus are referred to as "video".

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

Technical Info

About Extended Range Video

Extended range signals use a greater signal level range, i.e. -7 – 109% compared to 0 – 100% for normal range. Both normal and extended range describe the same overall luminance-range in a scene. Therefore, the selection of normal or extended range has no influence on the dynamic range of a camera. Extended range merely offers more signal range, i.e. more code values between black and white and thus delivers a finer tonal gradation of the overall luminance-range of the scene.

On most monitors, signals at/below 0% are shown as black and signals at/above 100% are shown as full white. Unless a monitor has been adapted to extended range signals, some of the detail in the blacks and in the highlights are simply not displayed. This, however, does not affect the recorded signal, which is easily verified with a waveform monitor. Alternatively, the on-set monitors can also be supplied with a normal range signal while an extended range signal is recorded. This can be done using the D-21's second output board or by using a limiter (extended to normal range converter) between the recorder's monitoring output and the connected displays.

Recording

The camera delivers its output over a dual link HD-SDI connection and can be recorded with any system supporting 4:4:4 dual link HD-SDI input. As the decision to shoot in HD 4:4:4 usually results from a desire to have extended options for post production, selecting a recording system that makes use of no or very low image compression is higly recommended. Recording frame rates other than those in the HD standard (23.976, 24, 25, 29.97, 30 fps) requires a recorder supporting variframe input. In any case, it is recommended to involve postproduction when selecting a recording system, as this has great impact on the efficiency of the overall workflow.

Compatible Recording Systems

Model	Type	Media/Capacity @ 24 fps	Data Rate/Compression	Variable fps
Sony SRW-1/SRPC-1 (Note 1)	field recorder	HDCAM SR (tape size S) approx. 50 min	440 Mbit/s, approx. 4.2:1 MPEG-4 Studio Profile, 880 Mbit/s, approx. 2.1:1 (HQ Mode)	yes
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID mag) approx. 70 min	uncompressed	yes
S.two OB-1	on-board recorder	FlashMag (flash memory mag) approx. 30 min	uncompressed	yes
Codex Recorder	field recorder	Diskpack (RAID mag) approx. 160 min	uncompressed	yes
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) over 5hrs (4:1) 2) Portable Rugged Diskpack (RAID mag) approx. 100 min (4:1) 3) Portable Flash Diskpack (flash memory mag) approx. 180 min (4:1)	4:1 to 16:1 JPEG2000	yes
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) approx. 130 min 2) Flash pack (flash memory mag) approx. 26 min	uncompressed	yes
ARRI Flash Mag/Thomson Grass Valley Venom FlashPak	on-board recorder	internal flash memory approx. 10 min	uncompressed	no

(1) SRW-1/SRPC-1: Recording variable frame rates requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.

***Note**: This list is not complete.*

Postproduction

Post houses offering a 4:4:4 HDTV post pipeline should be able to process the material without any difficulty. The full potential of 4:4:4 RGB images can only be used if postproduction is able to maintain these signals throughout the entire processing chain. As the recorded material is HD standard compliant, no particular settings are required.

Note:

Extended range signals usually do not pose a problem. However, if equipment does not support extended range signals or if it is not correctly configured, it may cause clipped off highlights and blacks or cause gamma shifts.

Television Mastering

The finished material needs to be converted to 4:2:2 YCbCr with broadcast legal signal range and adapted to the desired (HD)TV standard.

4. Mscope HD 4:2:2 Video

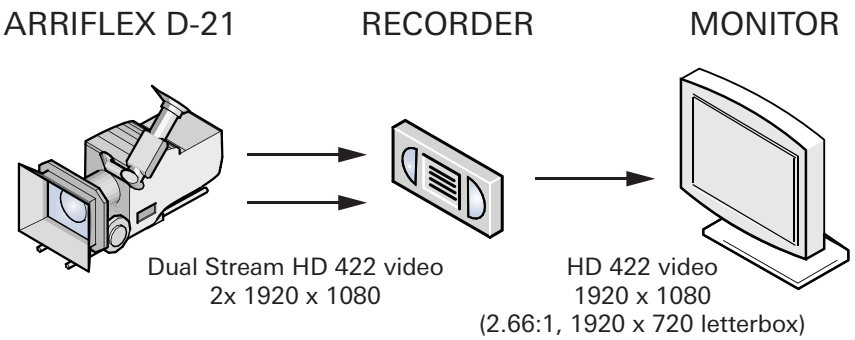
Mscope is a unique feature of the ARRIFLEX D-21 that combines the cinematic aesthetic of anamorphic cinematography with the economy of HD acquisition. Similar to the HD 4:2:2 video format, Mscope HD 4:2:2 video represents the best option for productions that want the real anamorphic widescreen look for distribution on (HD) television, but which do not require complex postproduction.

Common Criteria

- Intended distribution is HDTV/TV
- Widescreen format with anamorphic lens characteristics
- Color grading using an HD monitor
- Regular color timing or image tweaking
- No subtle color keying

Camera Output

- 1920 x 1440 HD Oversize resolution
- 1 – 25 fps
- 4:2:2 chroma sub-sampling
- YCbCr (YUV) color space
- 10 bit standard HD quantization
- Video image characteristics
- Normal (broadcast legal) video level range



Pros

- Real anamorphic capture for a unique widescreen look.
- Fully processed, de-squeezed live HD image for preview and editorial.
- Editorial/offline edit using standard HDTV equipment.
- Significantly higher line resolution than equivalent widescreen images derived from 16:9 HD material shot with a spherical lens.
- Option for tape or file based recording.

Cons

- Frame rate limited to 25 fps.
- Reduced spatial resolution in the color channels.
- The material chosen for the final product (online) needs extra processing step (unless material was recorded with Codex recorder).

Camera Setup

Ground Glass/Glow Mask Options

- Digital 2.39 + 1.78 (x2) anamorphic

Lens Options

- Standard 2:1 squeeze anamorphic 35 mm PL mount lenses

Output Configuration

Framerate:	23.976 – 25
HD-SDI Mode:	Mscope HD422
Output Range:	Normal Range
Contrast Char.:	EI 100 – 800

Cable Connections

- Connect camera HD-SDI 1 or 2, link A to recording HD-SDI IN A.
- Connect link B of the same output to recording HD-SDI IN B.
- Connect recording MONITOR OUT to control monitor HD-SDI IN.

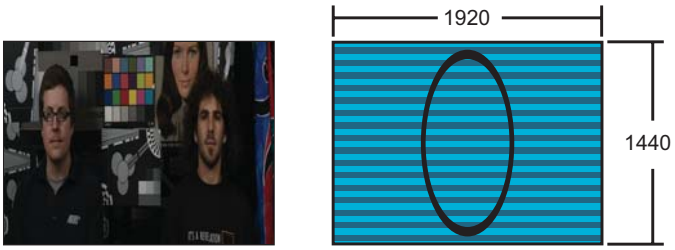
The camera's base sensitivity is 200 ASA. The contrast characteristic is chosen depending on the lighting situation in the scene. All EI characteristics directly deliver a visually correct HD image and thus are referred to as "video".

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

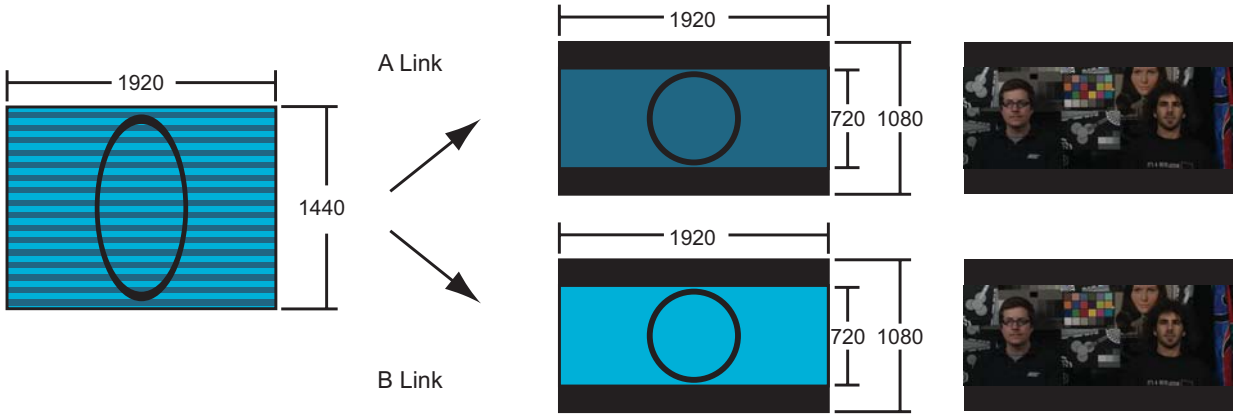
Technical Info

About Mscope

Mscope output uses the camera sensor's full Super 35-sized 4:3 aperture. Next to standard spherical lenses, the D-21 can thus be used with anamorphic camera lenses that project an optically, 2x horizontally squeezed widescreen image onto the 4:3 (1.33:1) imaging area, just as on 35 mm motion picture film cameras. The result is an oversized 1920 x 1440 HD image with approximately 80% more scanning lines than an equivalent widescreen images derived (cropped) from 16:9 HD material shot with a spherical lens.



To output this oversized image it is split into two HD 4:2:2 streams. Each HD stream contains a 1920 x 720 letterbox image in 2.66:1 aspect ratio (180 blank lines on top and bottom). Stream A contains all odd lines (line count starts from 1), stream B all even lines of the original image.



Recording

The camera delivers its output over two parallel HD-SDI connections (dual stream). Thus, recording Mscope signals requires a system that is compatible with HD 4:2:2 dual stream/dual camera input. In order to keep all image manipulation options for postproduction, it is advisable to select a recording system that makes use of no or very low image compression. Recording frame rates other than those in the HD standard (23.976, 24, 25 fps) requires a recorder supporting variframe input. In any case, it is recommended to involve postproduction when selecting a recording system, as this has great impact on the efficiency of the overall workflow.

Compatible Recording Systems

Model	Type	Media/Capacity @ 24 fps	Data Rate/Compression	Variable fps
Sony SRW-1/SRPC-1 (Note 1)	field recorder	HDCAM SR (tape size S) 25 min	880 Mbit/s, approx. 2.1:1 (Dual Cam Mode)	yes
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID mag) approx. 34 min	uncompressed	yes
Codex Recorder	field recorder	Diskpack (RAID mag) approx. 80 min	uncompressed	yes
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) approx. 150 min (4:1) 2) Portable Rugged Diskpack (RAID mag) approx. 50 min (4:1) 3) Portable Flash Diskpack (flash memory mag) approx. 88 min (4:1)	4:1 to 16:1 JPEG2000	yes
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) approx. 64 min 2) Flash pack (flash memory mag) approx. 12 min	uncompressed	yes

(1) SRW-1/SRPC-1: Recording variable frame rates requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.

Note: *This list is not complete.*

Postproduction

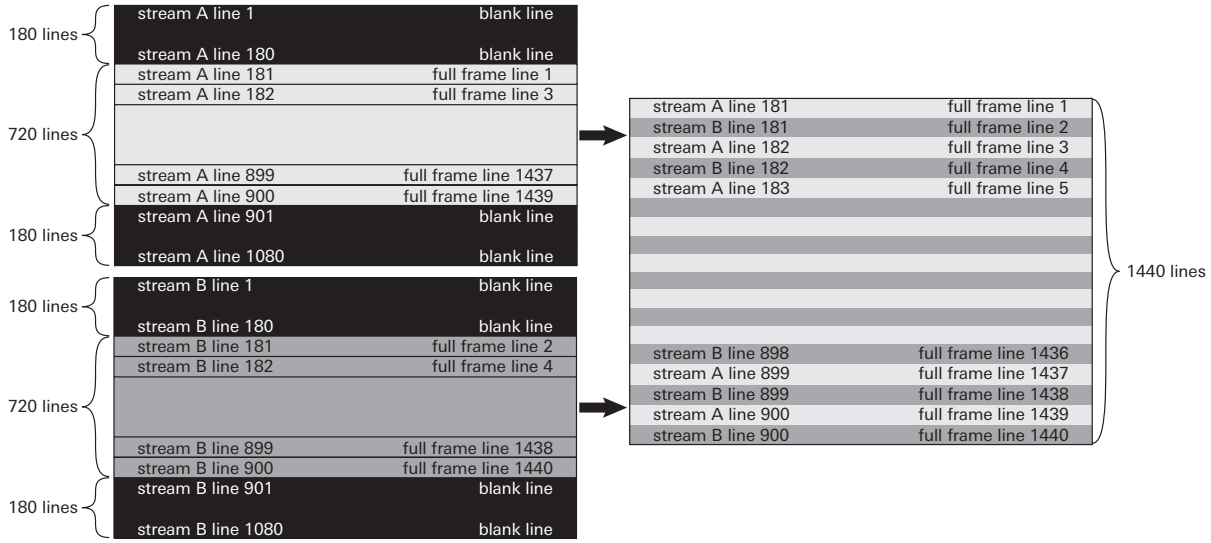
Post houses offering a file-based post pipeline should be able to process the material without any difficulty. As both streams contain a de-squeezed image, either one can directly be used for editorial/ offline without the need for recombining. After the offline-edit, only the material required for further post production and finishing needs to be re-combined to save processing time.

Note:
It is recommended to verify that the recorded material lies within normal/legal/safe signal range. If the camera was accidently set to output extended range signals, this may have gone unnoted during recording. If the material is using extended range video levels, the signal needs to be compressed (not clipped) to legal range levels before it is handed to the customer.

Working with Mscope

Re-combining both Mscope streams requires two image operations:

- Crop top and bottom 180 blank lines from both streams
- Interleave (de-interlace) both cropped streams beginning with stream A line 1, stream B line 1, A2, B2, A3, and so on, to re-create the original 1920 x 1440 image.



Note:
When recording on a Codex system, both Mscope streams are automatically recombined at the time of recording. The recorded material and automatically generated editing/viewing proxies can be directly accessed as files.

An Mscope image has a de-squeezed aspect ratio of 2.66:1, which is a little wider than the regular Cinemascope format of 2.39:1 (2.39:1 officially replaced 2.35:1 in 1970). Thus, it needs to be cropped on the sides to deliver the desired output aspect ratio. As the full frame image size (1920 x 1440) is larger than a standard HD image (1920 x 1080), 2K or resolution independent editing tools are required. There are different tools that allow recombining Mscope material as part of their feature set. Which of them is most suitable will depend on the existing infrastructure of the post facility.

- Quantel eQ
- IRIDAS FrameCycler and SpeedGrade
- Apple Shake (discontinued)
- Open Source Software ImageMagick

Note: *This list is not complete.*

Television Mastering

Anamorphically captured material needs to be finished as de-squeezed picture and adapted to the desired (HD)TV standard.

5. HD 4:4:4 log

Using HD 4:4:4 log as a production format provides images with full color resolution and logarithmic contrast characteristics that are suitable for different kinds of purposes:

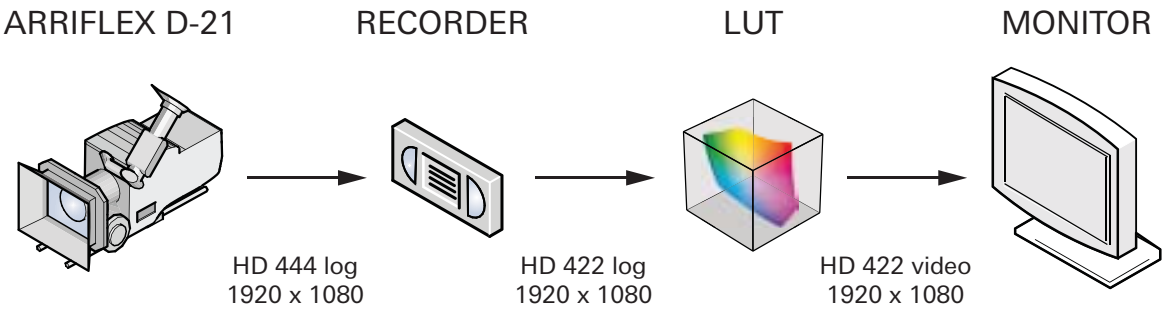
- Cinema productions (film or digital projection) where the HD resolution is considered sufficient.
- (HD) television productions where application of the extended possibilities of DI/log workflows is required.
- Productions shot on film that contain digitally captured special effects elements.
- Productions making use of both film and digital acquisition to use each system's advantages.

Common Criteria

- Special effects elements for film based productions
- Color grading using a DI/log grading suite
- Requires very fine tonal and color separation
- Involves delicate compositing or color keying
- May use extreme color timing
- Mixing of scanned footage and digital material

Image Characteristics

- 1920 x 1080 Full HD resolution
- 4:4:4 full chroma sampling
- RGB color space
- 10 bit standard HD quantization
- Logarithmic image characteristics
- Extended (non broadcast legal) video level range



Pros

- Material immediately available in online/production quality.
- Option for tape or file based recording.
- Log C material handles in the same familiar way as scanned film footage.
- Application of well-established file or tape based DI-workflows.
- Provides best color resolution and tonal separation available for the HD output for superior color/chroma keying and color alteration possibilities.
- Allows simulating a print look by using a 3D LUT in a digital projection.

Cons

- Frame rate limited to 30 fps.
- Increased production complexity as each D-21 ASA rating requires a different conversion LUT for monitoring.

Camera Setup

Ground Glass/Glow Mask Options

- Digital 1.33 + 1.78
- Digital 1.78
- Digital 1.78 + 1.85 (centric)
- Digital 1.75 + 2.39 (centric)

Lens Options

- Spherical 35 mm PL mount lenses

Output Configuration

Framerate:	23.976 – 30
HD-SDI Mode:	444
Output Range:	Extended Range
Contrast Char.:	Log C
Color Matrix:	Log

Cable Connections

- Connect camera HD-SDI 1 or 2, link A to recording input HD-SDI IN A.
- Connect link B of the same output to recording input HD-SDI IN B.
- Connect recording MONITOR OUT (4:2:2) to control monitor HD-SDI IN.

The Log C characteristic delivers an output according to Cineon format specifications at 200 ASA base sensitivity. Log to video conversion for visually correct monitoring, as well as sensitivity adjustment for other ASA ratings available through provided preview LUTs.

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

Technical Info

About Log C

Log C material is a digital positive representation of a film negative. Since the idea of log C encoding was introduced by Kodak in the 1980s, it has been the basis of the majority of visual effects and Digital Intermediates. Nearly all postproduction houses in the world that offer DI are primarily relying on log C material for projects that will be mastered to film. Just like a film negative, log C material is not intended to be judged by the human eye. The images look “flat”, the blacks seem lifted and highlights too low. The big advantage is the ability to hold all color information of a film negative in a rather small image file.

How to grade Log C - Preview LUTs
A film scanner will normally output log C files, which are graded using a preview LUT (see below). With this preview LUT, the images are displayed as they would appear on a print film, once they were recorded to negative and copied to print film in the lab (Hence, you could also call it a print simulation LUT). Preview LUTs are only applied to the image for displaying purposes during grading. After grading is finished the images are rendered to Log C files, which do not include the preview LUT. These Log C files can be recorded back to film with out the need for any conversion in modern film recorders such as the ARRILASER.

Shooting Log C - Conversion LUTs
The D-21 can output log C encoded material just like a film scanner. These images can be graded the same way (using a preview LUT in the grading process) as scanned material. It is also very easy to combine log C encoded scanned material with D-21 images. As mentioned before, the log C encoding/characteristic is not intended for viewing material. To get a visually correct representation on a video monitor on location or in editing, the log C material needs to be converted using appropriate conversion LUTs. Other than the preview LUT, the conversion LUT will only show a visually correct image rather than what a 35 mm print will look like after the material has been graded. A conversion LUT could be applied:

- at the monitoring output of a recorder (e.g. Codex, S.two or Keisoku Giken) or
- in a box sitting in between recorder and monitor (e.g. Cinetal, Thomson or Kodak) or
- in the monitor itself (e.g. Cinetal or Eizo).

ARRI offers a set of conversion LUTs for a different production equipment and software tools for download at www.arridigital.com.

Extended Range Log C
The log C extended range output of the D-21 delivers a signal range of approximately 6 to 94% when exposed at the camera's base sensitivity of 200 ASA. As the camera offers no sensitivity adjustment when outputting log C, exposing the camera at a higher exposure rating causes an underexposed output (lower max signal level). This underexposure can be corrected in grading, but also for monitoring by using an appropriate conversion LUT (severall LUTs available, based on Exposure Index 100 to 800).

Recording

The camera delivers its output over a dual link HD-SDI connection and can be recorded with any system supporting 4:4:4 dual link HD-SDI input. As the decision to shoot in HD 4:4:4 usually results from a desire to have extended options for post production, selecting a recording system that makes use of no or very low image compression is higly recommended. Recording frame rates other than those in the HD standard (23.976, 24, 25, 29.97, 30 fps) requires a recorder supporting variframe input. In any case, it is recommended to involve postproduction when selecting a recording system, as this has great impact on the efficiency of the overall workflow.

Compatible Recording Systems

Model	Type	Media/Capacity @ 24 fps	Data Rate/Compression	Variable fps	LUT Support
Sony SRW-1/SRPC-1 (Note 1)	field recorder	HDCAM SR (tape size S) approx. 50 min	440 Mbit/s, 4.2:1 MPEG-4 Studio Profile, 880 Mbit/s, 2.1:1 (HQ Mode)	yes	1D, 4 slots (only in 4:4:4 mode)
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID mag) approx. 70 min	uncompressed	yes	1D, 50+ slots
S.two OB-1	on-board recorder	FlashMag (flash memory mag) Capacity @ 24 fps: approx. 30 min Compression: uncompressed	uncompressed	yes	1D, 50+ slots
Codex Recorder	field recorder	Diskpack (RAID mag) Capacity @ 24 fps: approx. 160 min Compression: uncompressed	uncompressed	yes	1D, 50+ slots
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) over 5hrs (4:1) 2) Portable Rugged Diskpack (RAID mag) approx. 100 min (4:1) 3) Portable Flash Diskpack (flash memory mag) approx. 180 min (4:1)	4:1 to 16:1 JPEG2000	yes	1D, 50+ slots
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) approx. 130 min 2) Flash pack (flash memory mag) approx. 26 min	uncompressed	yes	1D, 15 slots
ARRI Flash Mag/ Thomson Grass Valley Venom FlashPak	on-board recorder	internal flash memory approx. 10 min	uncompressed	no	no

(1) SRW-1/SRPC-1: Recording variable frame rates requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.

Note: *This list is not complete.*

Postproduction

Post houses offering a 4:4:4 HDTV post pipeline should be able to process the material without any difficulty. The full potential of 4:4:4 RGB images can only be used if post-production is able to maintain these signals throughout the entire processing chain. Material for editorial/offline editing has to be processed with preview LUTs corresponding to the sensitivity each shot was exposed for. This information has to be carried through to post production as metadata or in shot reports.

Note:
Extended range signals usually do not pose a problem. However, if equipment does not support extended range signals or if it is not correctly configured, it may cause clipped off highlights, and blacks or cause gamma shifts.

Film Mastering

Printing the finished material to film (e.g. using an ARRILASER) does not require special conversion steps of the image parameters.

Digital Cinema Mastering

Producing a Digital Cinema Package from the finished material requires a conversion to the digital cinema color space and quantization depth and a frame rate of 24 fps.

Television Mastering

The finished material needs to be converted from log to video characteristics using 4:2:2 YCbCr color space with broadcast legal signal range and adapted to the desired (HD)TV standard.

6. Mscope HD 4:2:2 log

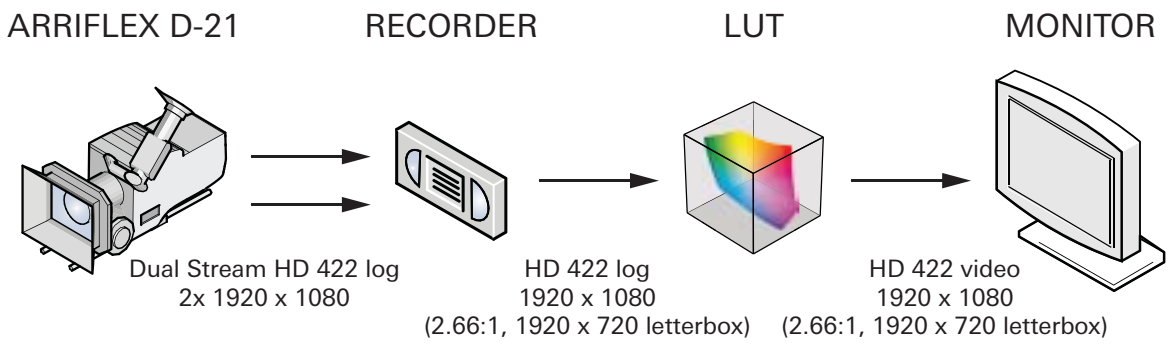
Mscope is a unique feature of the ARRIFLEX D-21 that combines the cinematic aesthetic of anamorphic cinematography with the economy of HD acquisition. Mscope HD 4:2:2 log represents a good option for productions that want the real anamorphic widescreen look for release on the big screen, but that do not plan on complex postproduction.

Common Criteria

- Widescreen format with anamorphic lens characteristics
- Intended distribution is HDTV/TV
- Color grading using a DI/log grading suite
- Color grading using an HD monitor
- Regular color timing or image tweaking
- No subtle color keying
- Mixing of scanned footage and digital material

Image Characteristics

- 1920 x 1440 HD Oversize resolution
- 1 – 25 fps
- 4:2:2 chroma sub-sampling
- YCbCr (YUV) color space
- 10 bit standard HD quantization
- Logarithmic image characteristics
- Extended (non broadcast legal) video level range



Pros

- Real anamorphic capture for a unique widescreen look.
- Log C material handles in the same familiar way as scanned film footage.
- Application of well-established file or tape based DI-workflows.
- Fully processed, de-squeezed live HD image for preview and editorial.
- Editorial/offline edit using standard HDTV equipment.
- Significantly higher line resolution than equivalent widescreen images derived from 16:9 HD material shot with a spherical lens.
- Option for tape or file based recording.
- Allows simulating a print look by using a 3D LUT in a digital projection.

Cons

- Frame rate limited to 25 fps.
- Offers a reduced spatial resolution in the color channels.
- The material chosen for the final product (online) needs extra processing step (unless material was recorded with Codex recorder).
- Increased production complexity as each D-21 ASA rating requires a different conversion LUT for monitoring.

Camera Setup

Ground Glass/Glow Mask Options

- Digital 2.39 + 1.78 (x2) anamorphic

Lens Options

- Standard 2:1 squeeze anamorphic 35 mm PL mount lenses

Output Configuration

Framerate:	23.976 – 25
HD-SDI Mode:	Mscope 422
Output Range:	Extended Range
Contrast Char.:	Log C
Color Matrix:	Log

Cable Connections

- Connect camera HD-SDI 1 or 2, link A to recording HD-SDI IN A.
- Connect link B of the same output to recording HD-SDI IN B.
- Connect recording MONITOR OUT to control monitor HD-SDI IN.

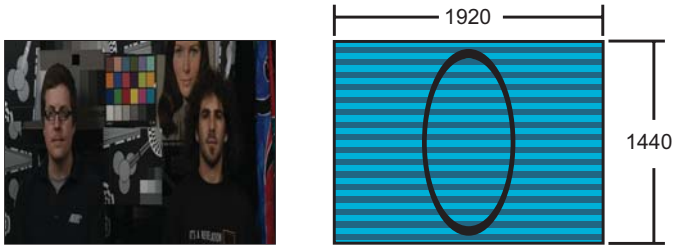
The Log C characteristic delivers an output according to Cineon format specifications at 200 ASA base sensitivity. Log to video conversion for visually correct monitoring, as well as sensitivity adjustment for other ASA ratings available through provided preview LUTs.

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

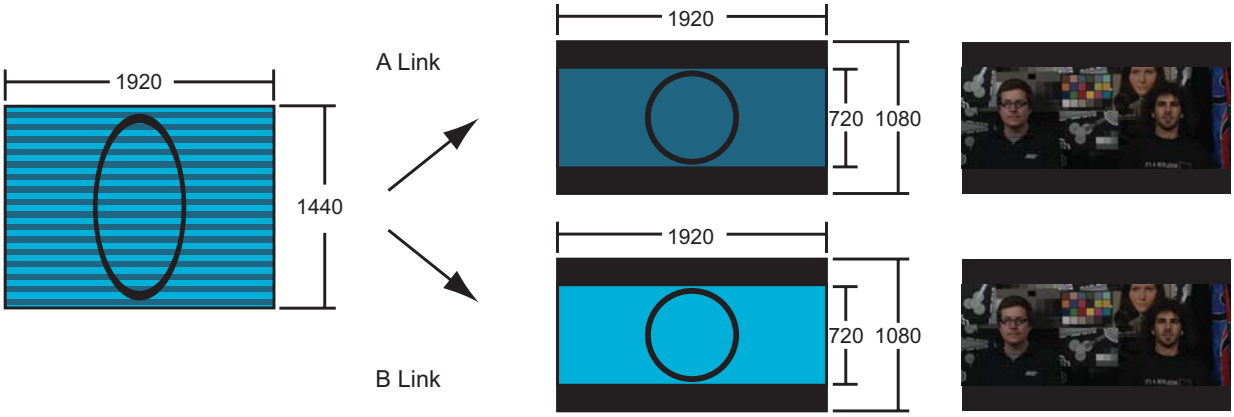
Technical Info

About Mscope

Mscope output uses the camera sensor's full Super 35-sized 4:3 aperture. Next to standard spherical lenses, the D-21 can thus be used with anamorphic camera lenses that project an optically, 2x horizontally squeezed widescreen image onto the 4:3 (1.33:1) imaging area, just as on 35 mm motion picture film cameras. The result is an oversized 1920 x 1440 HD image with approximately 80% more scanning lines than an equivalent widescreen images derived (cropped) from 16:9 HD material shot with a spherical lens.



To output this oversized image it is split into two HD 4:2:2 streams. Each HD stream contains a 1920 x 720 letterbox image in 2.66:1 aspect ratio (180 blank lines on top and bottom). Stream A contains all odd lines (line count starts from 1), stream B all even lines of the original image.



About Log C

Log C material is a digital positive representation of a film negative. Since the idea of log C encoding was introduced by Kodak in the 1980s, it has been the basis of the majority of visual effects and Digital Intermediates. Nearly all postpro-duction houses in the world that offer DI are primarily relying on log C material for projects that will be mastered to film. Just like a film negative, log C material is not intended to be judged by the human eye. The images look "flat", the blacks seem lifted and highlights too low. The big advantage is the ability to hold all color information of a film negative in a rather small image file.

How to grade Log C - Preview LUTs
A film scanner will normally output log C files, which are graded using a preview LUT (see below). With this preview LUT, the images are displayed as they would appear on a print film, once they were recorded to negative and copied to print film in the lab (Hence, you could also call it a print simulation LUT). Preview LUTs are only applied to the image for displaying purposes during grading. After grading is finished the images are rendered to Log C files, which do not include the preview LUT. These Log C files can be recorded back to film with out the need for any conversion in modern film recorders such as the ARRILASER.

Shooting Log C - Conversion LUTs
The D-21 can output log C encoded material just like a film scanner. These images can be graded the same way (using a preview LUT in the grading process) as scanned material. It is also very easy to combine log C encoded scanned material with D-21 images. As mentioned before, the log C encoding/characteristic is not intended for viewing material. To get a visually correct representation on a video monitor on location or in editing, the log C material needs to be converted using appropriate conversion LUTs. Other than the preview LUT, the conversion LUT will only show a visually correct image rather than what a 35 mm print will look like after the material has been graded. A conversion LUT could be applied:

- at the monitoring output of a recorder (e.g. Codex, S.two or Keisoku Giken) or
- in a box sitting in between recorder and monitor (e.g. Cinetal, Thomson or Kodak) or
- in the monitor itself (e.g. Cinetal or Eizo).

ARRI offers a set of conversion LUTs for a different production equipment and software tools for download at www.arridigital.com.

Extended Range Log C
The log C extended range output of the D-21 delivers a signal range of approximately 6 to 94% when exposed at the camera's base sensitivity of 200 ASA. As the camera offers no sensitivity adjustment when outputting log C, exposing the camera at a higher exposure rating causes an underexposed output (lower max signal level). This underexposure can be corrected in grading, but also for monitoring by using an appropriate conversion LUT (severall LUTs available, based on Exposure Index 100 to 800).

Recording

The camera delivers its output over two parallel HD-SDI connections (dual stream). Thus, recording Mscope signals requires a system that is compatible with HD 4:2:2 dual stream/dual camera input. In order to keep all image manipulation options for postproduction, it is advisable to select a recording system that makes use of no or very low image compression. Recording frame rates other than those in the HD standard (23.976, 24, 25 fps) requires a recorder supporting variframe input. In any case, it is recommended to involve postproduction when selecting a recording system, as this has great impact on the efficiency of the overall workflow.

Compatible Recording Systems

Model	Type	Media/Capacity @ 24 fps	Data Rate/Compression	Variable fps	LUT Support
Sony SRW-1/SRPC-1 (Note 1)	field recorder	HDCAM SR (tape size S) 25 min	880 Mbit/s, approx. 2.1:1 (Dual Cam Mode)	yes	no (only in 4:4:4 mode)
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID mag) approx. 34 min	uncompressed	yes	1D, 50+ slots
Codex Recorder	field recorder	Diskpack (RAID mag) approx. 80 min	uncompressed	yes	1D, 50+ slots
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) approx. 150 min (4:1) 2) Portable Rugged Diskpack (RAID mag) approx. 50 min (4:1) 3) Portable Flash Diskpack (flash memory mag) approx. 88 min (4:1)	4:1 to 16:1 JPEG2000	yes	1D, 50+ slots
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) approx. 64 min 2) Flash pack (flash memory mag) approx. 12 min	uncompressed	yes	1D, 15 slots

(1) SRW-1/SRPC-1: Recording variable frame rates requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.

Note: *This list is not complete.*

Postproduction

Post houses offering a file-based post pipeline should be able to process the material without any difficulty. As both streams contain a de-squeezed image, either one can directly be used for editorial/ offline without the need for recombining. Material for editorial/offline editing has to be output with preview LUTs corresponding to the sensitivity each shot was exposed for. This information has to be carried through to post production as metadata or in shot reports. After the offline-edit, only the material required for further post production and finishing needs to be re-combined to save processing time.

Note:

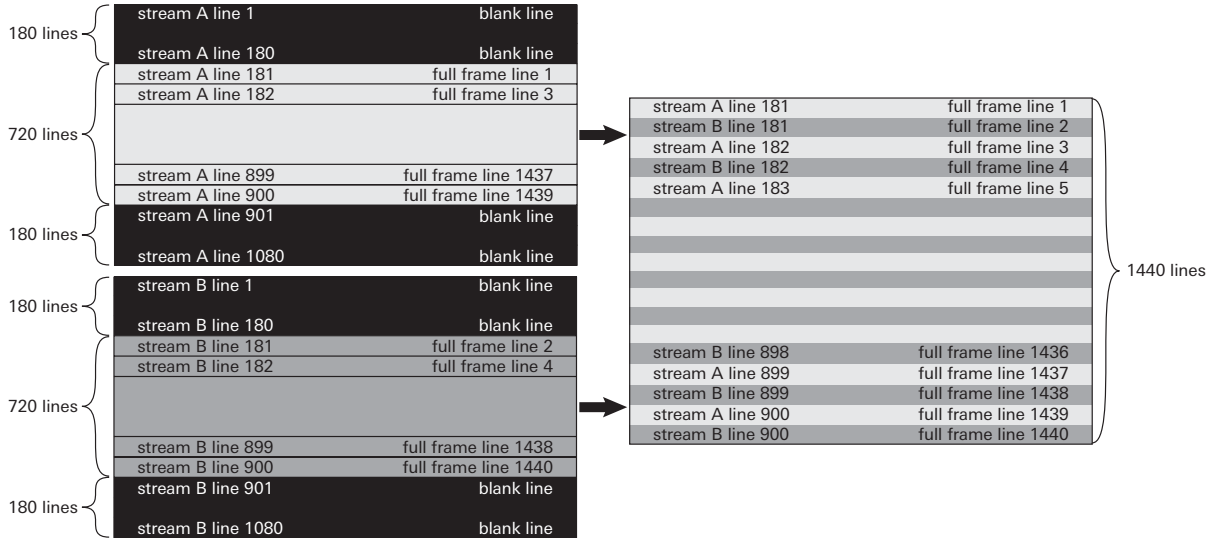
Extended range signals usually do not pose a problem. However, if equipment does not support extended range signals or if it is not correctly configured, it may cause clipped off highlights, and blacks or cause gamma shifts.

Working with Mscope

Re-combining both Mscope streams requires two image operations:

- Crop top and bottom 180 blank lines from both streams.
- Interleave (de-interlace) both cropped streams beginning with stream A line 1, stream B line 1, A2, B2, A3, and so on, to re-create the original 1920 x 1440 image.

Note:
When recording on a Codex system, both Mscope streams are automatically recombined at the time of recording. The recorded material and automatically generated editing/viewing proxies can be directly accessed as files.



An Mscope image has a de-squeezed aspect ratio of 2.66:1, which is a little wider than the regular Cinemascope format of 2.39:1 (2.39:1 officially replaced 2.35:1 in 1970). Thus, it needs to be cropped on the sides to deliver the desired output aspect ratio.

As the full frame image size (1920 x 1440) is larger than a standard HD image (1920 x 1080), 2K or resolution independent editing tools are required. There are different tools that allow recombining Mscope material as part of their feature set. Which of them is most suitable will depend on the existing infrastructure of the post facility.

- Quantel eQ
- IRIDAS FrameCycler and SpeedGrade
- Apple Shake (discontinued)
- Open Source Software ImageMagick

Note: *This list is not complete.*

Film Mastering

Printing the finished material to film (e.g. using an ARRILASER) does not require special conversion steps of the image parameters.

Digital Cinema Mastering

Producing a Digital Cinema Package from the finished material requires a conversion to the digital cinema color space and quantization depth and a frame rate of 24 fps.

Television Mastering

Anamorphically captured material needs to be finished as de-squeezed picture, converted from log to video characteristics using 4:2:2 YCbCr color space with broadcast legal signal range and adapted to the desired (HD)TV standard.

7. ARRIRAW

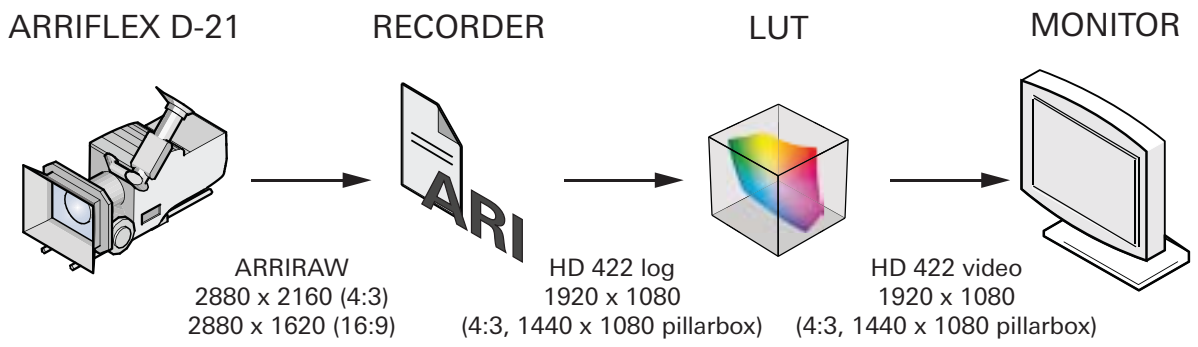
Using ARRIRAW is recommended for productions that are primarily intended to be screened in cinemas or for example used as an art installation. ARRIRAW provides 2K images of maximum quality in any aspect ration from 1.33:1 to anamorphic 2.39:1.

Common Criteria

- Special effects elements for film based productions
- Color grading using a DI/log grading suite
- Requires extremely fine tonal and color separation
- Involves delicate compositing or color keying
- May use extreme color timing
- Mixing of scanned footage and digital material

Image Characteristics

- 2880 x 2160 native (4:3) aperture (up to 25 fps), 2880 x 1620 cropped (16:9) aperture (up to 30fps)
- Super-sharp, alias-free 2K output.
- Color filter array (CFA) RGB color space
- Full 12 bit quantization
- Logarithmic or video image characteristics
- Full data value range, not bound to video standards



Pros

- Best quality for 2K mastering.
- Best overall image quality due to extended set of processing options outside the camera using ARRI reference processing software or third party tools.
- Provides the maximum color information and the largest set of tonal steps for brilliant color reproduction for superior color/chroma keying and maximum freedom in color grading.
- Log C output handles in the same familiar way as scanned film footage.
- Application of well-established file based DI workflows.
- Allows simulating a print look by using a 3D LUT in a digital projection.
- Free choice of output aspect ratio when shooting 4:3 (1.33:1) "open gate" including real Cinemascope when using anamorphic lenses.
- Live HD preview of captured material (delivered from certified ARRIRAW T-Link recorders or from 2nd camera output).

Cons

- ARRIRAW data needs to be processed for finishing.
- Frame rate limited to 25 fps for aspect ratios taller than 1.78:1, as well as anamorphic 2.39:1; limited to 30 fps for aspect ratios 1.78:1 and 1.85:1.
- Increased production complexity as each D-21 ASA rating requires a different conversion LUT for monitoring.
- Increased storage requirements.

Camera Setup

Ground Glass/Glow Mask Options

- Digital 1.33 + 1.78
- Digital 1.78
- Digital 1.78 + 1.85 (centric)
- Digital 1.75 + 2.39 (centric)
- Digital 2.39 + 1.78 (x2) anamorphic

Lens Options

- Spherical 35 mm PL mount lenses
- Standard 2:1 squeeze anamorphic 35 mm PL mount lenses

Camera Output Configuration

Framerate: 23.976 – 25 (native 4:3)
29.97, 30 (native 16:9)

HD-SDI Mode: ARRIRAW

Cable connections:

- Connect camera HD-SDI 1 or 2, link A to data recording input A.
- Connect link B of the same output to data recording input B.
- Connect PREVIEW/MONITOR OUT to control monitor HD-SDI IN.

The preview output from the recorder provides a Log C signal. The Log C characteristic delivers an output according to Cineon format specifications at 200 ASA base sensitivity. Log to video conversion for visually correct monitoring, as well as sensitivity adjustment for other ASA ratings available through provided preview LUTs.

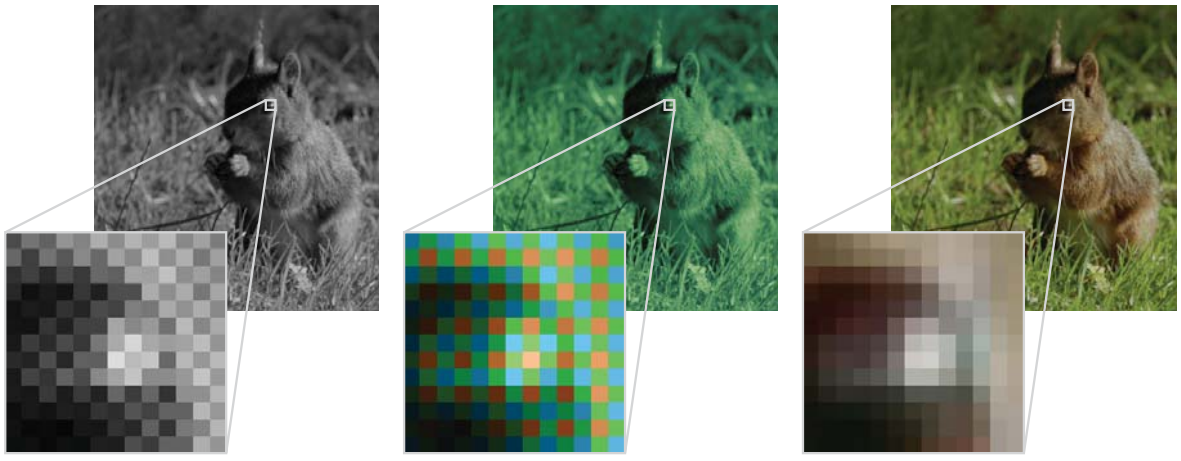
Note:
Output Range, Contrast Char. and Color Matrix are applied in processing.

Note:
The camera shutter angle also needs to be set depending on the supply frequency and/or desired exposure effects.

Technical Info

About ARRIRAW

Next to the different variants of HD and Mscope video signals, the D-21 offers the output of ARRIRAW material. ARRIRAW is uncompressed, 12 bit raw Bayer data, which is delivered from the sensor in full native resolution of 2880 x 2160 (1.33:1 aspect ratio) up to 25 fps or with reduced height at 2880 x 1620 (1.78:1 aspect ratio) up to 30 fps. Next to standard spherical lenses, the D-21 can thus be used with anamorphic camera lenses that project an optically, 2x horizontally squeezed widescreen image onto the full 4:3 (1.33:1) imaging area, just as on 35 mm motion picture film cameras.



ARRIRAW can be described as a digital camera negative, which requires processing so it can be viewed as an image. The raw Bayer data basically contains a black and white image. Every pixel in this b/w image contains the luminance information for only one of the R, G and B color components. To derive a full color image, the missing two color components need to be interpolated from the surrounding pixels. This process is called de-bayering or color reconstruction. When the camera outputs a live video signal, all image processing steps including color reconstruction happen inside the camera. When the camera is set to output ARRIRAW, the raw sensor data is output with merely white balance correction applied, so all processing needs to be done "offline" or outside the camera.

Depending on the task at hand, a processed image may be required with minumum delay or with highest quality. Thus, different tools can be used during the different stages of production:

- During recording (and playback), the recorder takes over de-bayering and image processing to create a live HD preview for on-set monitoring. Sensitivity adjustment is applied through a preview LUT.
- Quality control and editorial can use the HD preview output from the recorder, a compatible playback system or the processed output from software/hardware tools offering native ARRIRAW support (see ARRIRAW Toolkit) to receive visually correct images with video characteristics.
- Hi-res postproduction demands the highest image quality which can be achieved by working with software/hardware tools offering native ARRIRAW support or by using the image file output from ARRIRAW processing tools (see ARRIRAW Toolkit). ARRIRAW data is commonly processed using log C characteristics to enable the use of DI workflow tools.

About Log C

Log C material is a digital positive representation of a film negative. Since the idea of log C encoding was introduced by Kodak in the 1980s, it has been the basis of the majority of visual effects and Digital Intermediates. Nearly all post-production houses in the world that offer DI are primarily relying on log C material for projects that will be mastered to film. Just like a film negative, log C material is not intended to be judged by the human eye. The images look “flat”, the blacks seem lifted and highlights too low. The big advantage is the ability to hold all color information of a film negative in a rather small image file.

How to grade Log C - Preview LUTs
A film scanner will normally output log C files, which are graded using a preview LUT (see below). With this preview LUT, the images are displayed as they would appear on a print film, once they were recorded to negative and copied to print film in the lab (Hence, you could also call it a print simulation LUT). Preview LUTs are only applied to the image for displaying purposes during grading. After grading is finished the images are rendered to Log C files, which do not include the preview LUT. These Log C files can be recorded back to film with out the need for any conversion in modern film recorders such as the ARRILASER.

Shooting Log C - Conversion LUTs
The D-21 can output log C encoded material just like a film scanner. These images can be graded the same way (using a preview LUT in the grading process) as scanned material. It is also very easy to combine log C encoded scanned material with D-21 images. As mentioned before, the log C encoding/characteristic is not intended for viewing material. To get a visually correct representation on a video monitor on location or in editing, the log C material needs to be converted using appropriate conversion LUTs. Other than the preview LUT, the conversion LUT will only show a visually correct image rather than what a 35 mm print will look like after the material has been graded. A conversion LUT could be applied:

- at the monitoring output of a recorder (e.g. Codex, S.two or Keisoku Giken) or
- in a box sitting in between recorder and monitor (e.g. Cinetal, Thomson or Kodak) or
- in the monitor itself (e.g. Cinetal or Eizo).

ARRI offers a set of conversion LUTs for a different production equipment and software tools for download at www.arridigital.com.

Extended Range Log C
The log C extended range output of the D-21 delivers a signal range of approximately 6 to 94% when exposed at the camera's base sensitivity of 200 ASA. As the camera offers no sensitivity adjustment when outputting log C, exposing the camera at a higher exposure rating causes an underexposed output (lower max signal level). This underexposure can be corrected in grading, but also for monitoring by using an appropriate conversion LUT (severall LUTs available, based on Exposure Index 100 to 800).

Recording

The camera delivers its output over a dual link HD-SDI connection using a special transport method called ARRIRAW T-Link (Transport Link). While any recorder that is capable of recording a SMPTE 372M compliant RGBA signal and playing it back without compression or further encoding can record this signal, ARRI introduced the ARRIRAW T-Link certification program to ensure a minimum level of on-set practicability. Certified recorders can generate a live HD preview from the original ARRIRAW material. If anamorphic lenses are used, the preview can also be de-squeezed for the live output.

While the application of 1D or 3D LUTs is not part of this certificate, this function is available on most recorders.

Compatible Recording Systems

Model	Type	Media/Capacity	Data Rate/Compression	Variable fps	LUT Support
S.two DFR2K/DFR2K AR	field recorder	D.MAG4 (RAID magazine) approx. 70 min	uncompressed	yes	1D, 50+ slots
S.two OB-1 **Note: ARRIRAW certification in progress**	on-board recorder	FlashMag (flash memory magazine) approx. 30 min	uncompressed	yes	1D, 50+ slots
Codex Recorder	field recorder	Diskpack (RAID mag) approx. 80 mi	uncompressed	yes	1D, 50+ slots
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID magazine) approx. 130 min 2) Flash pack (flash memory mag) approx. 26 min	uncompressed	yes	1D, 15 slots

***Note**: This list is not complete as new recorders are continuously being introduced to the market.*

Postproduction

Post houses offering a file-based 2K post pipeline should be able to process the material. However, performing a test run involving the entire postproduction chain is highly recommended to ensure a smooth production workflow.

Reviewing and Editing ARRIRAW

All certified recorders and corresponding playback systems offer a live-processed HD preview output when playing back ARRIRAW material. This output can be captured into an HD editing system to obtain the material for quality control, offline editing and dailies creation. Most recorders automatically generate a shot list of the recorded material and can be remotely controlled to facilitate batch capturing. The preview output delivers a standard 1920 x 1080 4:2:2 YCbCr HD signal via HD-SDI. Material captured in 4:3 (up to 25fps) is shown as a 1440 x 1080 pillarbox image. Using this method requires the material to be played back from the original recording media/magazines (or a clone copy).

The material for quality control, offline editing and dailies creation can also be obtained from the original ARRIRAW material after it is transferred to the postproduction storage. There are various tools providing native ARRIRAW support. Which tool will be considered to be most suitable depends on the existing infrastructure of the post facility. For a complete listing of these tools, please refer to the ARRIRAW Toolkit section below.

Another convenient option is offered by the Codex recorder. This machine allows automated background proxy processing to different image file and movie clip formats in adjustable output resolution. The proxy material is then available for transfer next to the original material.

In any case, the preview LUTs need to be applied corresponding to the sensitivity each shot was exposed for.
This information has to be carried through to post production as metadata or in shot reports.

High Resolution Editing

As for the initial steps in post production there are also tools offering native ARRIRAW support for the high resolution editing phase including effects work, compositing, color grading, conform and finishing. If the tools used for these steps do not offer native ARRIRAW support, the material can also be processed to RGB image files using a tool such as the ARRIRAW converter. ARRIRAW material is typically processed to dpx sequences in 2K log, which provides the best option for application of DI postproduction.

The following list contains common settings for native ARRIRAW editing or processing tools in a typical DI workflow:

- Sensitivity/LUT file – exposure rating for each shot, e.g. 200 ASA.
- RAW/color matrix – color space used in the workflow, e.g. HD, Log/FilmLog, XYZ. A common practice would be processing to Log colorspace with 75% saturation combined with a saturation accentuation in color grading.
- Output Range – output code value range. As HD video signal restrictions do not apply for the DI workflow, this should be set to full scale output (ARRIRAW Converter: RGB Full Range).
- Aspect ratio and cropping – output image aspect. Images usually are not cropped until the conform to facilitate re-positioning.
- Anamorphic – de-squeezed output of anamorphic material. Depending on the intended distribution, material can be de-squeezed (digital projection) or kept in anamorphic aspect (film out).
- Downscaling – image resolution. Typically, material will be output in 2K resolution. While it is possible to output ARRIRAW material at its native resolution of 2.9K, it has to be noted that the processed output from CFA/Bayer pattern imagers delivers an effective output resolution that is lower than the photocell count on the sensor. This effect is compensated by oversampling. Thus, the D-21 sensor has a 2880 x 2160 photocell raster in order to obtain an alias-free 2K processed output.

ARRIRAW Toolkit

Product	Product Description	Playback	Editing	Color Correction	Proxy Processing	Online Processing	Conform
ARRI ARRIRAW Converter	ARRIRAW batch processing					√	
Avid DS	High resolution conform, compositing and graphics solution	√	√	√	√	√	√
Digital Vision Film Master	Color grading, conform and finishing solution	√	√	√	√	√	√
DVS Clipster	Turnkey conform and finishing solution	√	√	√	√	√	√
FilmLight Baselight	Color grading, conform and finishing solution	√		√	√	√	√
GlueTools ARRIRAW Toolkit	ARRIRAW importer to Final Cut and applications using QuickTime	√			√	√	
IRIDAS FrameCycler PRO	Flipbook/review tool	√*					
IRIDAS FrameCycler DDS	Conform, review and approval tool	√			√	√	√
IRIDAS FrameCycler DI	Conform, review, approval and basic color correction tool	√		√*	√	√	√
IRIDAS SpeedGrade OnSet	Previsualization and look design tool	√*		√*			
IRIRDAS SpeedGrade XR, DI	Color grading and, conform and finishing solution	√		√	√	√	√
IRIDAS MetaRender	Rendering and transcoding client				√	√	
MTI Film Control Dailies DA	Complete dailies solution	√		√	√	√	
Pomfort SilverStack	Preview, rendering and sequence management tool	√*			√		

* limited capability

Note: *This list is not complete, as we are continually adding further tools to the ARRIRAW toolkit.*

Film Mastering

For printing/recording to film (e.g. using an ARRILASER), the material should be finished as 2K log dpx sequence.

Digital Cinema Mastering

For digital cinema release, the material needs to be delivered or converted to XYZ color space with 10 or 12 bit quantization depth, typically at 24 fps.

Television Mastering

For release on (HD) television, the material needs to be converted to 4:2:2 YCbCr with HD color space using broadcast legal signal range and adapted to the desired (HD)TV standard.

Note:
Cinemascope (anamorphic) material additionally needs to be de-squeezed.

8. Recorder Overview

Model	Type	Media	Compression	Variframe	LUT Support	Recording Time (approximately)				
						HD 4:2:2 @ 24 fps	**HD 4:2:2 @ 50 fps**	**HD 4:4:4 @ 24 fps**	**Mscope HD @ 24 fps**	**ARRIRAW @ 24 fps**
S.two DFR2K/ DFR2K AR	field recorder	D.MAG4 (RAID mag)	no	yes	1D, 50+ slots	70 min	33 min	70 min	34 min	70 min
Codex Recorder	field recorder	Diskpack (RAID mag)	no	yes	1D, 50+ slots	160 min	77 min	160 min	80 min	160 min
Keisoku Giken UDR100	on-board recorder	1) HDD pack (RAID mag) 2) Flash pack (flash memory mag)	no	yes	1D, 15 slots	1) 130 min 2) 26 min	1) 62 min 2) 12 min	1) 130 min 2) 26 min	1) 64 min 2) 12 min	1) 130 min 2) 26 min
S.two OB-1 (Note 1)	on-board recorder	FlashMag (flash memory mag)	no	yes	1D, 50+ slots	30 min	14 min	30 min	14 min	30 min
Codex Portable	on-board recorder	1) Portable High Capacity Diskpack (RAID mag) 2) Portable Rugged Diskpack (RAID mag) 3) Portable Flash Diskpack (flash memory mag)	JPEG2000: 4:1 to 16:1	yes	1D, 50+ slots	1) >5hrs 2) 100 min 3) 180 min	1) 144 min 2) 48 min 3) 85 min	1) >5hrs 2) 100 min 3) 180 min	1) 150 min 2) 50 min 3) 88 min	
Sony SRW-1/ SRPC-1 (Note 2, 3)	field recorder	HDCAM SR (tape size S)	MPEG-4 Studio Profile: 2.1:1 to 4.2:1	yes	1D, 4 slots (only 4:4:4)	50 min	25 min	50 min	25 min	
ARRI Flash Mag/ Thomson Grass Valley Venom FlashPak	on-board recorder	internal flash memory	no	no	no	15 min		10 min		
Panasonic AG-HPG20 (Note 4)	on-board recorder	P2 memory cards	H.264/AVC Intra: ~16:1	no	no	32 min				
AJA KiPro	field/ on-board recorder	1) HDD Storage Module (SATA HDD mag) 2) SSD Storage Module (SSD mag)	ProRes 422 HQ: ~8:1 VBR	no	no	1) 4 hrs 2) 2 hrs				

(1) S.two OB-1: ARRIRAW certification in progress.
(2) SRW-1/SRPC-1: Recording variable frame rates up to 59.94 fps requires Sony fiber interface HKSR101 and cache board HKSR102 on the recorder as well as a Fiber Link Unit (FLU-1) on the D-21.
(3) SRW-1/SRPC-1: Recording fixed frame rates at 48, 50, or 59.94 fps is also possible using dual camera mode (422x2) as described below.
(4) AG-HPG20: Only records at 25 PsF (50i) and 29.97 PsF (59.94i).

Note: *This list is not complete.*

Workflow Guidelines

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