ARRIRAW
Frequently Asked Questions

F A Q

Date, 9th December 2014

Introduction

This is a collection of frequently asked questions (FAQ) about the ARRIRAW format. This FAQ pertains to all ALEXA and ALEXA XT cameras. This FAQ supersedes any earlier versions.

Questions regarding ALEXA/ALEXA XT cameras or the XR module are answered in the respective FAQs. Information contained in the manual will not be duplicated here.

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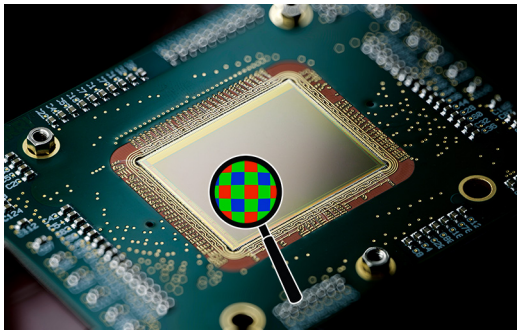
File Format

1. **What is ARRIRAW?**

The ALEXA uses a single chip CMOS sensor to capture images. The single chip can only differentiate luminance levels, so its output is essentially a black and white image. To allow the separation of colors, the sensor is covered with a red, green and blue mosaic color filter pattern (Bayer pattern). The Bayer pattern filters the light hitting the sensor so that 50% of the sensors photosites are used to represent green, 25% of the photosites represent red and the remaining 25% represent blue.



The sensor readout of this raw Bayer frame is provided as uncompressed, 12 bit log ARRIRAW data. To turn ARRIRAW data into RGB images, the raw data needs to be processed (de-bayering and color processing).

2. **What is the resolution of ARRIRAW?**

An ALEXA can be set to capture ARRIRAW in a 16:9 or 4:3 aspect ratio.

- A 16:9 ARRIRAW frame is 2880 x 1620 pixels.
- A 4:3 ARRIRAW frame is 2880 x 2160 pixels.
- A 4:3 cropped ARRIRAW frame is 2578 x 2160 pixels.
- An Open Gate ARRIRAW frame is 3414x2198 pixels.

The 16:9 aspect ratio is the standard mode for shoots with spherical lenses. 4:3 is commonly used for anamorphic shoots and visual effect shots, which require the extra frame height.

3. **What about Open Gate ARRIRAW?**

The sensor grade and processing power of the ALEXA XT makes it possible to capture a frame that is considerably larger than the standard 2.8K ARRIRAW format. The active frame size of this format is approximately 3.4K in a 1.55:1 aspect ratio. The frame includes, and actually extends beyond, the surround view area. We therefore call this mode Open Gate.

ALEXA XT SUP 9.0 will make ALEXA XT cameras ready for the Open Gate sensor mode. To enable this mode, an ALEXA XT camera needs to be upgraded/re-calibrated at an ARRI service center. After the release of Open Gate mode, all new ALEXA XT cameras will ship with Open Gate mode enabled.

Open Gate mode will first be available on the ALEXA XT, ALEXA XT Plus or ALEXA XT Studio. We plan to also enable the mode for the ALEXA XT M. An ALEXA with the XR upgrade cannot capture the Open Gate format, because its sensor and image processing does not meet the technical requirements.

An Open Gate ARRIRAW frame is approximately 11.30 MB.
At 24 fps, this results in a bit rate of 2.16 Gbit/s and a data rate of 270 MB/s or 972,5 GB/h.

4. **What is the bit rate of ARRIRAW?**

- 16:9 ARRIRAW has a bit rate of 1.34 Gigabit per second at 24 fps.
- 4:3 ARRIRAW has a bit rate of 1.79 Gbit/s at 24 fps.
- 4:3 Cropped ARRIRAW has a bit rate of 1.60 Gbit/s at 24 fps.
- Open Gate ARRIRAW hat a bit rate of 2.16 Gbit/s at 24 fps.

5. **What is the data rate of ARRIRAW?**

- 16:9 ARRIRAW is 7 Megabytes per frame. At 24 fps, this results in 168 Megabytes of data per second or 605 Gigabytes per hour.
- 4:3 ARRIRAW is 9.33 MB/frame; 224 MB/s and 806 GB/h at 24 fps.
- 4:3 Cropped ARRIRAW is 8,35 MB/frame and 722 GB/h at 24 fps.

- Open Gate ARRIRAW is 11,26 MB/frame and 972,5 GB/h.

Shooting ARRIRAW

6. What cameras can record ARRIRAW and what recorders can record ARRIRAW?

ALEXA XT models and ALEXA Classic cameras with an XR module upgrade can record ARRIRAW footage internally onto XR Capture Drives, without the need for an external recorder. ARRIRAW Open Gate and 4:3 cropped is only available on ALEXA XT cameras. ALEXA Classic cameras (with the SxS module) cannot record ARRIRAW internally, but use a special protocol called T-Link, to output ARRIRAW via HD-SDI. ARRIRAW T-Link output requires an onboard recorder that was certified for ALEXA ARRIRAW (T-Link) recording:

- Codex Digital Onboard M and S
- S.Two OB-1
- Astrodesign HD-7502-A
- Convergent Design Gemini
- cineFlow cine Take

7. What is T-Link?

The ARRIRAW T-Link (Transport Link) has been developed to utilize a standardized HD-SDI interface for sending raw data from the camera to an external recorder. The camera packs the ARRIRAW data into a 12 bit log encoded RGBA HD video stream, which is sent over a standard SMPTE 424M or SMPTE 372M dual link HD-SDI connection. Since the recorder then has to recreate the individual raw frames from the stream, only certified recording equipment can be used.

8. What is the advantage of ALEXA XTs over ALEXA classic?

- Integrated recording of ARRIRAW data.
- Faster and easier setup. Less time until the camera is ready to shoot.
- ARRIRAW recording at up to 120 fps (with SUP 9.0 also for ProRes 4444).
- All models offer 4:3 sensor mode, LDS mount, anamorphic and high speed licenses.
- Open Gate mode.
- Built-in (ND) filter option for shooting in bright light.
- CDL server support for tweaking looks as you shoot.
- Improved EVF mounting bracket.

9. When shooting raw, what are my options for live viewing?

The camera always outputs an HD monitoring image with optional surround view (see what is around the frame), status information and configurable frame markers.

10. Does ARRIRAW have an HDR feature?

The ALEXA does not offer an HDR mode. The camera's sensor provides an unrivalled 14+ stops of exposure latitude (measured with the ARRI Dynamic Range Test Chart) without any special capture mode.

11. What is the dynamic range of an ARRIRAW file and how does it compare to ProRes?

An ALEXA offers 14+ stops of dynamic range over its entire exposure range, with a base sensitivity of EI 800. This dynamic range is available in both ARRIRAW and Log C encoded ProRes footage. Due to the image compression used in ProRes, however, ProRes footage can start to exhibit encoding artifacts when the material is excessively pushed in grading, whereas ARRIRAW footage will remain clean.

12. What is the maximum frame rate when shooting ARRIRAW?

The ALEXA XT can record ARRIRAW at up to 120 fps in 16:9, up to 90 fps in 4:3, up to 96 fps in 4:3 cropped and up to 75 fps in Open Gate sensor mode.
A classic ALEXA can output ARRIRAW at up to 60 fps in 16:9 and up to 48 fps in 4:3 sensor mode.

Data Management

13. **How much footage does fit on a mag?**

One XR Capture Drive holds 35 minutes of 24fps, 2.8K ARRIRAW footage in 4:3 aspect ratio or 47 minutes in 16:9. For ARRIRAW 4:3 cropped a magazine holds 39 minutes, where as in Open Gate mode 29 minutes are available.

When shooting with a classic ALEXA and an external recorder, the recording time varies depending on the mag size, but in typical configuration, it's about the same.

14. **How much storage space should I calculate per hour of footage?**

At 24 fps, 16:9 ARRIRAW footage requires about 605 Gigabyte per hour. In addition to the ARRIRAW data, you also need to factor in the derivatives that will be created from the raw data, such as:

- VFX sequences
  - 9.4 MB per frame at 2K and 18.7 MB at native 2.8K in 10bit log dpx.
  - 14.2 MB per frame at 2K and 28 MB at native 2.8K in 16 bit tiff or uncompressed OpenEXR.
- 2K ProRes 422 (HQ) dailies at about 98 GB/h
- DNxHD36 clips for editing at about 17 GB/h
- iPad rushes at about 1 GB/h

The number of VFX shots has a big impact on the amount of required space. Without the VFX account, one hour of footage causes between 620 and 720 GB of data, depending on the shooting ratio (percentage of selects/circle takes). For an anamorphic production, shooting in 4:3 sensor mode, you need to add about 33% of storage space.

15. **Is ARRIRAW an open format?**

Yes, it is. We've successfully submitted two SMPTE Registered Disclosure Documents (RDDs) on ARRIRAW:

- RDD 30:2014: ARRIRAW Image File Structure and Interpretation Supporting Deferred Demosaicing to a Logarithmic Encoding
- RDD 31:2014: Deferred Demosaicing of an ARRIRAW Image File to a Wide-Gamut Logarithmic Encoding

These documents are available from the Society of Motion Picture & Television Engineers (SMPTE)'s website at https://www.smpte.org/

16. **How do I QC ARRIRAW?**

ARRIRAW playback at 24 fps requires a computer setup with a steady data throughput of about 230 MB/s and a beefy GPU with OpenCL or Cuda support. ARRI offers the free ARRIRAW Converter, which can be used for ARRIRAW playback. If you have access to a Codex Vault, you should consider the Codex review player. This is a hardware module for the vault that has been designed for live playback and quality control of raw footage.

17. **How can I create a verified copy of ARRIRAW data?**

Since ARRIRAW footage is a straight forward file sequence, most software that allows creating verified copies from ALEXA ProRes clips can also handle ARRIRAW data. One example would be Pomfort Silverstack. If you recorded to XR capture drives, the Codex Platform also offers verified data copies through the Offloader option.

18. **What transfer speeds can be obtained using the different docking stations for the codex mag?**

The USB 3.0 Single Dock can transfer a full XR Capture Drive in about 49 minutes at approx. 160 MB/s.

The SAS Dual Dock is slightly faster with 40 minutes and approx. 190 MB/s, but in addition can clone the data directly to e.g. a Codex Transfer Drive.

The Codex Vault will transfer an entire drive in just about 11 minutes at about 730 MB/s.

19. **What metadata is recorded along the image in an ARRIRAW file?**

ARRIRAW files contain a large set information that can be extracted by ARRI Meta Extract (AME) or the ARRIRAW Converter (ARC). The metadata contains all camera settings, production notes, optionally scene

and take information, camera tilt and roll and lens metadata (if an LDS lens/camera was used). Tilt, roll and lens information is recorded for each frame individually, so it is possible to track the exact timing, e.g. when the focus pulls away from one actor to an object in the back.

20. How do I handle ARRIRAW files for VFX work?

A good selection of VFX tools have built-in support for ARRIRAW processing. Click here to see the full list of tools that can process ARRIRAW footage. For applications without ARRIRAW support, the footage can be processed to e.g. 10 bit log dpx or 16 bit tiff files. Processing the files in native resolution usually provides a better basis for VFX work. Once the material has been composited, it can be scaled down to the target format.

21. Is it safe to archive ARRIRAW footage, or should the footage be processed into images first?

We strive to make the ARRIRAW format accessible to anyone. With our recent effort, to have the format specification published as SMPTE RDD (Registered Disclosure Document), we want to make sure that anyone who needs to process ARRIRAW archives in the future can rest assured that the instructions, how to do it, will be there.

22. Can I edit ARRIRAW directly?

Provided your system can deliver the data at a sufficient speed (approx 230 MB/s at 24 fps), ARRIRAW can be edited in the latest versions of Adobe Premiere (CS6 and CC 2013 or later), Autodesk Smoke. Glue Tools offers an ARRIRAW Tookit, which enables QuickTime-based applications to work with ARRIRAW footage directly.

ARRIRAW Processing

23. What is the de-bayer process?

The sensor in the ALEXA is covered with a mosaic RGB filter pattern, called the Bayer pattern. When an exposed frame is sampled by the sensor, it is captured as a one channel image (as opposed to a regular RGB channel color image). The de-bayer process calculates the missing color components for each pixel, based on the type and position on the Bayer pattern. This color reconstruction is also called de-bayering.

With a Bayer pattern sensor, 50% of the sensors photosites are used to represent green, 25% of the photosites represent red and the remaining 25% represent blue. For more information, please click here.

24. What kind of post-production software can read ARRIRAW?

Almost all major post production tools can read and process the ALEXA ARRIRAW format. You can find a choice for generating dailies deliverables, editing, compositing, color grading and mastering. For a full list of hardware and software supporting ARRIRAW, please click here.

ARRIRAW support is also available in a number of major post production tools, which may be usable for QC purposes. For a full list of hardware and software supporting ARRIRAW, please click here.

25. What options do I have when processing ARRIRAW?

ARRI offers a software development kit (SDK) for ARRIRAW processing that software vendors can incorporate into their application. ARRI also supports vendors who wish to implement the ARRIRAW processing procedure on their own. Depending on the implementation, the following processing settings can be adjusted:

- Exposure Index (ASA rating).
- white balance.
- tint (green-magenta shift).
- current or legacy de-bayering mode.
- output color space for HDTV, digital cinema (P3), ACES and Log C wide gamut.
- different standard aspect ratios.
- output resolution.
- sharpening of the image output.

With the ARRIRAW SDK, you can also apply a custom ARRI Look File, which offers primary adjustments through printer lights, saturation and additionally lift/gamma/gain (or slope/offset/power).

26. **What is difference between the de-bayer modes and processing versions in the ARRIRAW SDK?**

The different ARRI De-Bayer Algorithms (ADA) control how the color channels are reconstructed.

- ADA-5 HW is the lastest de-bayer algorithm used in the ALEXA cameras starting with SUP 11.0. It offers improvements for bluescreen vfx shoots and reduces noise as well as aliasing.
- ADA-5 SW is an enhanced software de-bayering algorithm based on ADA-5 HW
- ADA-3 HW is the camera hardware de-bayer algorithm used in ALEXA cameras in SUP 7.0 up to SUP 10.0.
- ADA-3 SW is an enhanced software de-bayering algorithm based on ADA-3 HW. Depending on the scene content, it can deliver more image detail than ADA-3 HW.
- ADA-2 SW is a legacy software de-bayer algorithm.
- ADA-1 HW is a legacy camera hardware de-bayer algorithm, that was used before SUP 7.0.

The processing version controls which color transformations are applied to the de-bayered data. Version 4.0 represents the latest status of in-camera color processing. Previous versions are available to allow matching an output with previously processed footage. ADA-3 HW/SW is only available in combination with processing version 4.0.

27. **Does ARRI offer any tools for handling ARRIRAW files?**

To cater to different needs, we provide our reference ARRIRAW processing chain though the free ARRIRAW Converter (ARC) application and through a free command line tool for different operating systems.

28. **How do I upres ARRIRAW footage for a 4k DCP?**

The ARRIRAW SDK/ARRIRAW Converter can process a high quality 4K output from a 2.8K ARRIRAW or Open Gate ARRIRAW input. Delivering 4K to grading, however, requires a lot of disk space and a high performance grading system. A more economic option is to color grade all ARRIRAW footage in the native sensor image size and then upres the output to 4K for the deliverables using e.g. a Mitchell or Lanczos resize filter.

Color Processing

29. **Why is ARRIRAW data output as Log C for grading?**

Images with Log C encoding in the ALEXA-specific wide gamut color space provide the camera's full latitude in an unconfined color space. Log C grading is very similar to grading of scanned film negative. It is very efficient and feels familiar to any colorist who is used to grading film.

30. **Do I loose any information going to Log C?**

No. ARRIRAW data already is stored using 12 bit log encoding. Going from ARRIRAW to 12 bit Log C encoded files means no information loss.

31. **Why do I need LUTs when grading ARRIRAW footage?**

When viewed directly, Log C footage looks flat with desaturated colors. To get an image with a grayscale characteristic and color reproduction that is visually correct, the Log C footage has to be tone-mapped and transformed into the target color space. This conversion can be applied with a 3D Look Up Table (LUT), which can be created using the ARRI LUT Generator. A one-dimensional LUT can take care of the tone-mapping, so the resulting image will at least have a grayscale characteristic suitable for display. The transform into the target color space, however, requires a 3D LUT. This type of LUT contains both, the grayscale and the color transformation.

In the grading application, the LUT is applied for the viewing/output path. The color correction is applied on the Log C image and the result of this operation is then converted into the target color space with the LUT.

32. **Can I use ARRIRAW for an ACES pipeline?**

Yes you can. The ARRIRAW SDK and ARC can output Open EXR files with ACES color space. ARRI provided all partner companies with IDTs, so the ALEXA profiles are already available in most tools that support ARRIRAW data and the ACES color pipeline.

33. **Do you get more information from a Lin ACES file than a Log C file after de-bayer?**

ACES allows negative color values. It can therefore store colors outside additive gamuts, such as the ALEXA Wide Gamut, which is typically used for Alexa Log C encoded images. However, the difference will rarely be visible and only in highly saturated colors.