codex

USER GUIDE

ACTION CAM
PROCESSING GUIDE

VERSION 2014.11.25

Disclaimer

Codex products are continually developed to remain at the forefront of the industry, and as such the information in this guide is subject to change without notice. Whilst Codex endeavour to ensure that all documentation provided is correct at the time of writing, this document is not guaranteed to be error-free.

Codex does not assume responsibility for issues or losses due to misinterpretation of the information in this document, errors in this document, or incorrect configuration or installation of the equipment described herein.

Please report any errors found in this document to **support@codexdigital.com**

Support and Servicing

For assistance with your Action Cam please contact **support@codexdigital.com**

Contents

1. Introduction

Welcome to this guide for processing material from Codex Action Cam.

Codex Action Cam itself is a tiny remote head camera for shooting at up to 60fps. The output is 1920x1080 12-bit RAW for exceptional quality.

The Action Cam records to Codex Capture Drives and these can be loaded into a Codex Capture Drive Dock or Codex Vault. Using these systems the Action Cam recordings can be processed into a range of file formats for post production: editorial, visual effects, colour grading, and archival.

2. Action Cam Recording Format

The Action Cam recordings are stored as 1920x1080 12-bit RAW Bayer format. This data represents the RAW output of the camera with no processing occuring before it is recorded.

There are several advantages to storing the RAW data in this way. Firstly, image processing is separate to recording and can therefore be performed using the best quality methods and fastest computers available at the time, rather than being limited by in camera hardware and processing.

Nothing is 'baked in' to the image - settings such as White Balance (WB) and Exposure Index (EI) are stored as metadata alongside the RAW image data. This metadata affects how the RAW data is *processed*, but not how it is *stored*. Therefore, if necessary, the values for WB and EI can be changed even after shooting has finished. As long as the RAW data is preserved it is always possible to re-process the data with different settings as required.

For archiving the RAW files also present advantages. The file size is optimal (and without compression) because it represents the original recorded sensor data exactly, compared to other formats used in post production such as 10-bit RGB DPX which require that the original sensor data is processed with a debayering step resulting in a larger file size. Also, if the RAW sensor data has been archived it can be processed at a later date, for example when re-mastering, and take advantage of the most up to date image processing techniques.

3. Action Cam Log Encoding

The Action Cam sensor outputs 14-bit linear values which are log encoded to 12-bit for transmission to the Action Cam recorder. The 12-bit conversion means the light hitting each pixel is represented by a value from 0 (total black) to 4095 (maximum white). A maximum white (clipping) level gives a value of 4095, half this amount of light (one stop less) gives 2048, and half this amount of light (one stop less again) gives a value of 1024.

Therefore, if the 14-bit to 12-bit conversion was linear a high proportion of the values would be used for highlights (half of all the values for only the top one stop!), leaving very few values available to capture the detail of mid-tones and shadows. To ensure this is not the case the log encoding to 12-bit is applied to sensor data in a similar manner to cameras such as the ARRI ALEXA. The log encoding means that across the majority of the exposure range there are an equal number of values available for each stop of light level.

This allows details to be preserved in the shadows, with a lossless translation of sensor data into recorded 12-bit values. The scheme is altered towards the extreme highlights where the number of values per stop is reduced. This region contains largely unused information, so the number of values is marginally reduced in comparison to the rest of the exposure range.

Because of the fidelity maintained in the shadows and mid tones, the 12-bit RAW data can be converted to 10-bit RGB for delivery into post with a very high degree of accuracy across the exposure range.

4. File Formats for Post Production

The different stages of post-production demand a range of file formats suited to their specific requirements. An Editor may need to view everything that has been captured, and therefore files for this purpose are generally optimized for size rather than quality. A Visual Effects Artist at the other extreme will require only a selection of material but with maximum detail, and therefore the files should be of the highest quality regardless of the size.

Codex software allows Action Cam footage to be processed to cater for all requirements of post production. Some examples of common file formats that Codex can deliver for post production are:

4.1 CDX

The CDX file format represents the original recorded data (or 'digital camera negative'). There is no compression of the data or increase in file size due to debayering (as is the case with RGB DPX files) and therefore this file type is the most efficient method of storing all the captured data.

The CDX files can be used in other software provided the file format is supported, and are the default format for archiving on the Vault. After archiving, the CDX files can be imported using Codex software, and can then be transcoded to other file formats as required.

The CDX file format is described technically in the 'Action Cam CDX File Format Guide' so that other software vendors may implement support for the files directly.

There is only one format of CDX, and the details of file size and data rate are:

Format	File Size Per Frame	60 Minutes Of Footage (24fps)
CDX (12-bit RAW)	3.1MB	268GB

4.2 DPX

Digital Picture eXchange files, or DPX, are long established for use in post production. They are typically used for visual effects and in the later stages of post production such as conforming and colour grading.

The 10-bit RGB DPX format is widely accepted and compatible with the vast majority of post production software. When Action Cam footage is delivered as 10-bit the results are very impressive due to the "super-sampling" effect of the 12-bit original data being converted into 10-bit that maintains precise shadow details.

The 12-bit RGB DPX format is less compatible due to how the file specification has been interpreted by different software vendors. 12-bit RGB DPX files from Codex software are compatible with Filmlight Baselight, DVS Clipster, and Quantel Pablo software.

The 16-bit RGB DPX format is compatible with a wide variety of post production software. When Action Cam material is delivered in this format there is no loss in quality - the 12-bits of original data is padded to make the 16-bit file.

The file sizes for these formats are as follows:

Format	File Size Per Frame	60 Minutes Of Footage (24fps)
10-bit RGB DPX	8.3MB	717GB
12-bit RGB DPX	9.3MB	803GB
16-bit RGB DPX	12.4MB	1.07TB

4.3 ProRes, DNxHD, and H264

The Codex software can transcode from Action Cam 12-bit RAW to a selection of commonly used file types for editorial and dailies.

ProRes, DNxHD, and H264 can be produced with the following codecs and data rates (1920x1080 unless noted):

| Format	Data Rate Per Second	60 Minutes Of Footage (24fps)
ProRes 4444 XQ	400Mbps	180GB
ProRes 4444	264Mbps	119GB
ProRes 422 HQ	176Mbps	79GB
ProRes 422	117Mbps	53GB
ProRes 422 LT	82Mbps	37GB
ProRes 422 Proxy	36Mbps	16GB
Avid DNxHD 444	440Mbps	198GB
Avid DNxHD 185	185Mbps	83GB
Avid DNxHD 175	175Mbps	79GB
Avid DNxHD 145	145Mbps	65GB
Avid DNxHD 120	120Mbps	54GB
Avid DNxHD 115	115Mbps	51GB
Avid DNxHD 36	36Mbps	16GB
H264 (1080p)	9Mbps (max)	4GB
H264 (720p)*	2.5Mbps (max)	1GB

*1280x720p resolution

5. Vault and Mac Settings

Codex Vault can be used to back up the CDX files using the Archive task, or to transcode to other file formats such as 10-bit RGB DPX or ProRes using the Generate Task.

Go to Work Templates, then select a Work Template and click Edit.

Add or select a Generate Task in the template and the click Settings:
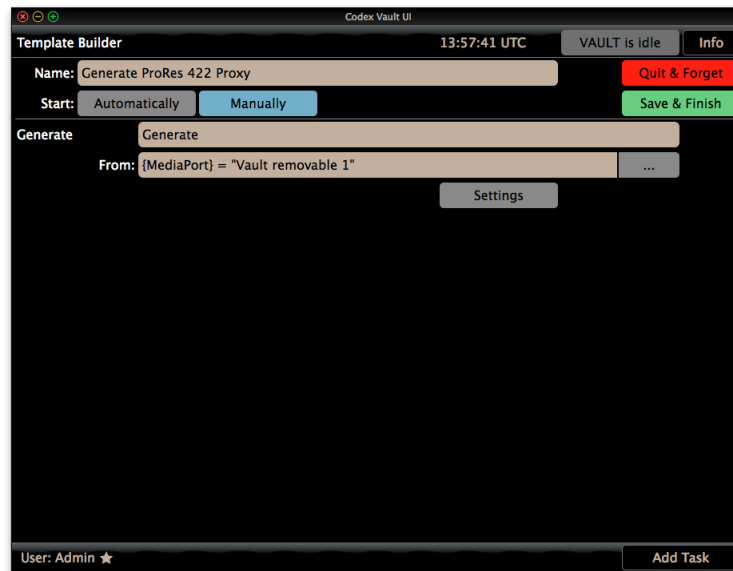
Set the required file type and other settings as detailed in the table at the end of this section:

On Mac the Codex VFS can be used to provide the CDX files and 10-bit RGB DPX files by default, or setup by the user to transcode to other file formats such as ProRes.

Open the Codex UI and go to SETUP->VFS. Click the Configuration drop down list and two Action Cam presets are available:
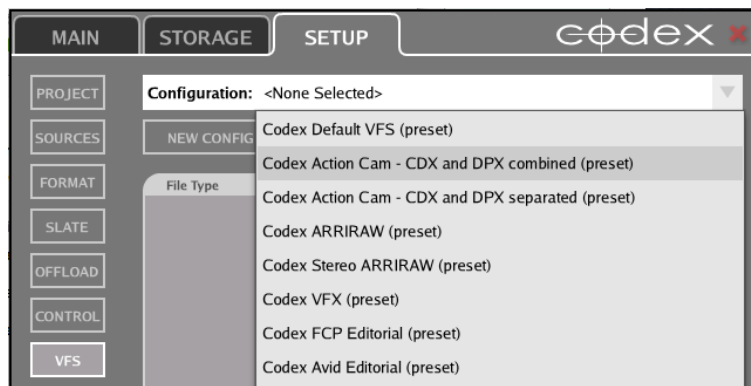

The two presets are:

- **Codex Action Cam - CDX and DPX combined (preset)** - contains both CDX and 10-bit RGB DPX files inside the same top level Roll folder, for if you want to easily back up both of these file types. Metadata XML and audio BWF files are also included.
- **Codex Action Cam - CDX and DPX separated (preset)** - contains both CDX and 10-bit RGB DPX files in separate top level folders, for if you want to back up one or the other of these file types (or back up both file types but in separate folders). Metadata XML and audio BWF files are also included.

Both presets are designed to handle both single camera and dual camera Action Cam recordings.

To transcode to a different file type click NEW CONFIG, enter a name (e.g. Action Cam Proxy) and then ADD/EDIT a file type to access the settings:
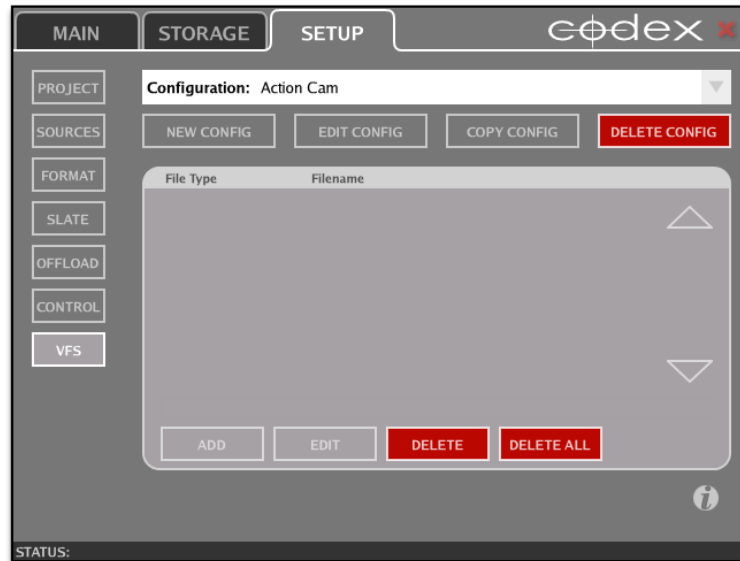
Set the required file type and other settings as detailed in the table at the end of this section:
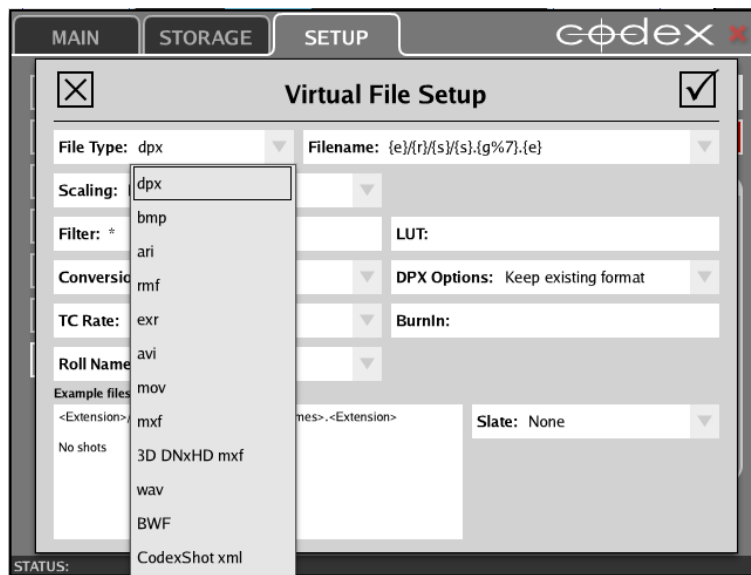
In the settings the following options can be chosen:

Output File Type	Codex Software Settings				
	File Type	**DPX Options**	**Compression**	**Comp. Quality**	**Profile**
CDX	cdx	NA	NA	NA	NA
10-bit RGB DPX	dpx	Convert to 10-bit RGB	NA	NA	NA
12-bit RGB DPX	dpx	Convert to 12-bit RGB	NA	NA	NA
16-bit RGB DPX	dpx	Convert to 16-bit RGB	NA	NA	NA
ProRes 4444 XQ	mov	NA	ProRes4444	High	NA
ProRes 4444	mov	NA	ProRes4444	Medium	NA
ProRes 422 HQ	mov	NA	ProRes422	High	NA
ProRes 422	mov	NA	ProRes422	Medium*	NA
ProRes 422 LT	mov	NA	ProRes422	Medium	NA
ProRes 422 Proxy	mov	NA	ProRes422	Low	NA
Avid DNxHD 444	mxf	NA	DNxHD444	High	NA
Avid DNxHD 220	mxf	NA	DNxHD	High**	NA
Avid DNxHD 185	mxf	NA	DNxHD	High	NA
Avid DNxHD 175	mxf	NA	DNxHD	High	NA
Avid DNxHD 145	mxf	NA	DNxHD	Medium***	NA
Avid DNxHD 120	mxf	NA	DNxHD	Medium	NA
Avid DNxHD 115	mxf	NA	DNxHD	Medium	NA
Avid DNxHD 36	mxf	NA	DNxHD	Low	NA
H264 (1080p)	H264****	NA	NA	NA	1080p
H264 (720p)	H264	NA	NA	NA	720p

*ProRes 422 is not enabled by default on the Medium setting. Contact Codex to enable this setting.
**High Compression Quality transcodes to DNx220 @ 30fps, DNx185 @ 25fps, and DNx175 @ 24fps.
***Medium Compression Quality transcodes DNx145 @ 30fps, DNx120 @ 25fps, and DNx115 @ 24fps.
****H264 transcodes available on Vault platform only.

6. Colour Management

6.1 Video Code Value Distribution Chart

The following table details how the Action Cam Log Curve distributes 10-bit SMPTE video code values across the available latitude in Stops from the camera.

Stop	10-bit SMPTE video code (v)	Codes / half stop
2.0 (800 ASA clip point)	1016 (MAX)	50
1.5	966	50
1.0 (400 ASA clip point)	916	50
0.5	866	50
0.0 (200 ASA clip point)	816	50
-0.5	766	50
-1.0	716	50
-1.5	666	49
-2.0	617	49
-2.5	568	48
-3.0	520	48
-3.5	472	46
-4.0	426	46
-4.5	380	43
-5.0	337	42
-5.5	295	38
-6.0	257	35
-6.5	222	32
-7.0	190	27
-7.5	163	23
-8.0	140	18
-8.5	122	15
-9.0	107	11
-9.5	96	9
-10.0	87	6
-10.5	81	5
-11.0	76	3
-11.5	73	3
-12.0	70	2
-12.5	68	1
-13.0	67	1

6.2 "Cineon" Equivalence

The Action Cam log encoding is based on classic Cineon, but with different parameters:

Parameter	Cineon Log Value	Action Cam Log Value
Black	95	64
White	685	560
FilmNegGamma	0.6	0.667443421

6.3 Special Values

The following values are provided as common reference points:

10-bit SMPTE code value	Linear value, t (to six decimal places)
4	-0.011437
64	0.000000
560	1.000000
940	14.192376
1016	24.000000

Linear value, t	10-bit SMPTE code value	Waveform %
0.00	64	0
0.18	332	31
0.90	545	55
1.00	560	57
6.00	816	86
12.00	916	97
24.00	1016	109

Notes