

2

CODEX[®]

TECHNICAL BULLETIN

WORKING WITH CODEX MEDIA

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Contents

Introduction	1
CODEX Device Manager	1
File System Types	1
Universal Disk Format (UDF)	1
CODEX FS (CFS)	2
Media and Media Stations	2
Virtual File System (VFS)	3
Identifying a VFS volume	3
VFS Information File.....	4
VFS Log Files.....	4
High Density Encoding (HDE)	5
HDE Extended Attributes.....	6
Volume Names	6
Folder and File structures	6

Introduction

This document is intended to help users and developers understand how to work with CODEX media and readers. The information is focused on the latest CODEX media and readers, and the features and behaviour of CODEX Device Manager 5.1 software for macOS 10.13 and higher.

CODEX Device Manager

CODEX Device Manager is a set of drivers and utilities required to support CODEX media stations on macOS. The latest version is available to download from [CODEX Software Downloads](#)

Device Manager provides the following features:

- Control of CODEX reader hardware peripherals (e.g. Load, Eject).
- Ability to Format and Erase filesystems on CODEX media.
- Access to recorded data on Capture Drives ([CODEX FS](#)) via a [Virtual File System](#)
- [High Density Encoding](#) workflows for ARRIRAW on all CODEX media.

File System Types

CODEX media can be formatted as UDF or CODEX FS depending on the camera/workflow being used, as summarised in Table 1.

Universal Disk Format (UDF)

UDF is used by ARRI ALEXA cameras on Compact Drive and Capture Drive:

- On ALEXA Mini LF with Compact Drive, UDF is used for both MXF/ARRIRAW and MXF/Apple ProRes recording.
- On ALEXA LF and ALEXA SXT with Capture Drive, UDF is used for Apple ProRes recording (in Quicktime MOV container).

UDF volumes behave as read-only external drives, and do not require any special handling by file copier applications.

CODEX FS (CFS)

ARRI ALEXA LF and SXT cameras support ARRIRAW recording to Capture Drives using the CODEX File System (CODEX FS). The same Capture Drives are also used for recording Canon Cinema RAW on the CODEX / Canon C700 Recorder, and Panasonic VRAW on the CODEX / Panasonic VRAW Recorder and VariCam Pure.

CODEX FS is a proprietary object store designed for high performance and reliability. When CODEX FS volumes are loaded on a macOS system, their content is presented via a software layer called the Virtual File System (VFS).

VFS volumes have some special features and properties that are detailed in the next section.

Media and Media Stations

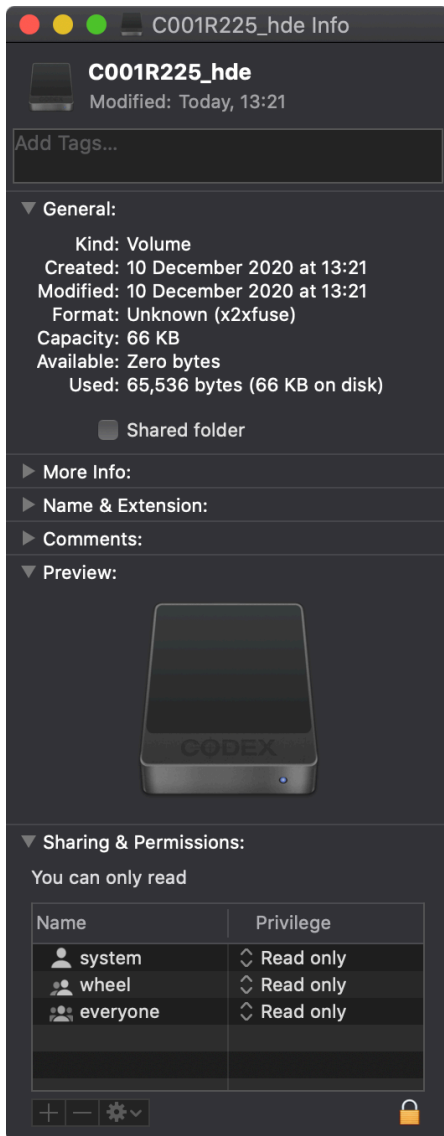
Table 1: Media and Media Stations

Media Type (Model No.)	Camera/Recorder	File System	File Format	Media Station (Model No.)
Compact Drive (CX.0001002)	ALEXA Mini LF	UDF	MXF/ARRIRAW MXF/Apple ProRes	Compact Drive Reader (CX.0001005) Compact Drive Dock (CX.0001007)
Capture Drive (CDX-37018, CDX-37019, CDX-37020, CDX-37021)	ALEXA LF, ALEXA SXT, Canon C700, Panasonic VariCam Pure	CODEX FS or UDF	ALEXA: ARRIRAW (on CODEX FS), MOV Apple ProRes (on UDF) C700: Canon Cinema RAW VariCam: Panasonic VRAW	Capture Drive Dock (CDX-75013-1) Capture+Transfer Drive Dock (CDX-62102-3)

NOTE: Legacy media such as CDX-3730 Capture Drive for ALEXA XT also uses CODEX FS for ARRIRAW capture and UDF for MOV Apple ProRes capture.

Virtual File System (VFS)

VFS volumes are dynamic - when the media is loaded it takes a short amount of time for the file system to build. This time will depend on the performance of the host machine and how much content is on the media.



Identifying a VFS volume

VFS volumes appear with a black disk icon that is marked with the CODEX logo text.

X2XFUSE is the software component used to create each VFS volume. If the properties of a VFS volume are checked using Finder > File > Get Info (Cmd-I) the Format is listed as 'x2xfuse'.

As VFS volumes are dynamic and virtual they have some other special properties - the Capacity will reflect the total size of all files presented on the VFS, and in the case of a HDE volume this may be very small.

The Available space is given as Zero bytes due to the volume being read-only.

VFS Information File

A hidden JSON document named '.codexvfs' can be found at the root of each VFS volume. It contains static information that may be useful to a file copier application, e.g.

```
{
  "volume_label": "A001R0Z3",
  "vfs_type": "device",
  "media_id": "286088E6040000F6",
  "log_file": "/Library/Logs/Codex/vfs/20200131_104035_A001R0Z3.log"
}
```

- The Modification Time of the .codexvfs file is repeatedly updated while the file system is built (as new files are exposed via the VFS). For applications indexing a VFS volume it is recommended to compare the Modification Time pre and post index, to check whether the contents has changed during the indexing process. Checks separated by 2 seconds or more will detect any changes to the Modification Time. When the Modification Time stops updating, the file system has finished building. The command 'stat -x .codexvfs' can be used to check the Modification Time.
- The .codexvfs file contains the following useful information in JSON format:
 - Volume label and Media ID - can be used for tracking.
 - Log File - path to the log file that contains details of mount/unmount times and any checksum errors during the VFS session for this media.

It is optional whether to copy the '.codexvfs' file during the backup process.

VFS Log Files

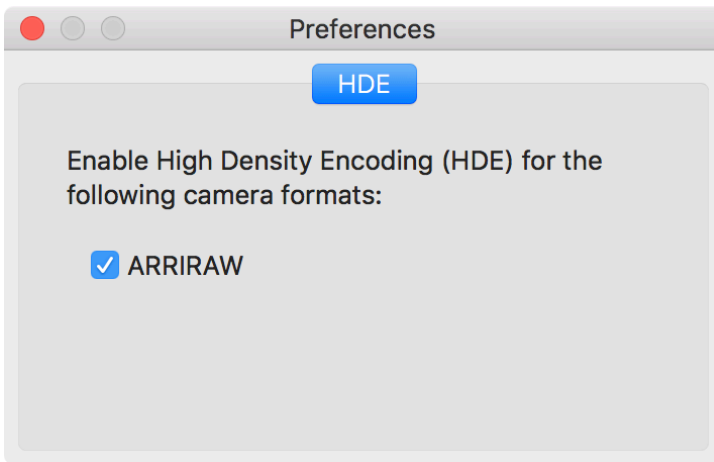
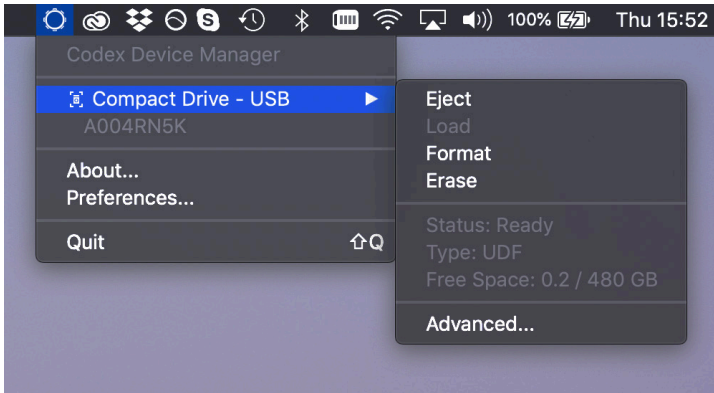
Device Manager creates a log file for each VFS session (from the time a VFS volume gets mounted to the time it gets unmounted). These log files are stored under /Library/Logs/Codex/vfs/. These files record the mount and unmount time of the volume, and any checksum errors that occur:

```
31 Jan 2020 11:50:11am mounted A001R0Z3
CRC ERROR: A001R0Z3/A001R0Z3/A001C001_140711_R0Z3/A001C001_140711_R0Z3.0027301.ari
CRC ERROR: A001R0Z3/A001R0Z3/A001C001_140711_R0Z3/A001C001_140711_R0Z3.0027311.ari
31 Jan 2020 11:52:51am unmounted
```

High Density Encoding (HDE)

[HDE](#) is a technology from CODEX which can be used to losslessly reduce the size of ARRIRAW material. HDE is not applied in-camera at the point of recording, but applied during the initial backup process from CODEX media.

In the CODEX Device Manager software there is a Preferences option to enable HDE for ARRIRAW.



When HDE mode is enabled:

- For ARRIRAW on Codex FS - the files shown are .arx instead of .ari.
- For MXF/ARRIRAW on UDF - a new volume with '_hde' name suffix is shown that contains .arx files. The original volume containing the .mxf files will also remain mounted.

The HDE algorithm is variable bit rate - the size reduction is dependent on the image content, and varies frame by frame (though is typically around 40%). Because the HDE algorithm is applied during the backup the size of the .arx files cannot be pre-determined. Therefore the .arx files are presented with a size of 0 bytes and copy applications should read the data stream from the file until the end is reached.

Note: Finder does not handle copying of 0 byte files. An error will occur if a Finder copy is attempted

Examples of copy applications that work with 0 bytes .arx files are Hedge, ShotPut Pro, Silverstack, and YoYotta. The Terminal command 'cp <filename>.arx <destination>' can also be used.

HDE Extended Attributes

HDE (.arx) files have 2 extended attributes that can be used to calculate space requirements when performing a backup:

- `codex.decodedSize`: this attribute gives the full file size for a decoded .ari version of the file.
- `codex.estimatedHDESize`: this attribute gives a conservative estimate of the .arx file size, based on 75% of the original size.

Note: HDE typically results in a file that is around 60% of the original size, but some headroom is given due to HDE being variable bit rate. For example, images with lots of high frequency detail (sharpness) will not reduce as much as images in soft focus, and could even exceed the 75% conservative estimate.

The command `'xattr -l <filename>'` can be used to check the extended attributes of a file.

Volume Names

Volume names for Compact Drive and Capture Drive are set by the ALEXA camera when the media is formatted. The volume name is built using these camera settings:

- Camera Id - e.g. A, B, C, etc.
- Reel Number - e.g. 001, 002, 003, etc.
- Camera Serial - e.g. R0Z3, U8W4.

These settings are combined into the 8 character volume name:

{CameraId}{ReelNumber}{CameraSerial}, e.g. A001R0Z3.

When HDE mode is used with a Compact Drive a new volume is shown with a '_hde' suffix.

Folder and File structures

The presentation of folders and files on the volume will depend on the recording format, and whether HDE mode is enabled:

Table 2: Folder and file structure

Media / Format	File and Folder Structure
Compact Drive (ARRI UDF format)	
ARRIRAW or Apple ProRes (unmodified layout)	▽ Reel folder MXF files ALE file BIN file

Media / Format	File and Folder Structure
Compact Drive (ARRI UDF format)	
HDE Enabled ARRIRAW (MXF/ARRIRAW files are replaced by ARX file sequences)	<ul style="list-style-type: none"> ▽ Reel folder <ul style="list-style-type: none"> ▽ Clip folders <ul style="list-style-type: none"> ARX files WAV files ALE file BIN file
HDE Enabled ARRIRAW and Apple ProRes (MXF/ARRIRAW files are replaced by ARX file sequences, while MXF/ProRes files are left as-is)	<ul style="list-style-type: none"> ▽ Reel folder <ul style="list-style-type: none"> ▽ Clip folders <ul style="list-style-type: none"> ARX files (ARRIRAW) WAV files MXF files (Apple ProRes) ALE file BIN file
Capture Drive (Codex FS format)	
ARRIRAW	<ul style="list-style-type: none"> ▽ Reel folder <ul style="list-style-type: none"> ▽ Clip folders <ul style="list-style-type: none"> ARI files WAV files Codex Shot XML file
HDE Enabled ARRIRAW	<ul style="list-style-type: none"> ▽ Reel folder <ul style="list-style-type: none"> ▽ Clip folders <ul style="list-style-type: none"> ARX files WAV files Codex Shot XML file
Apple ProRes	<ul style="list-style-type: none"> ▽ Reel folder <ul style="list-style-type: none"> MOV files (Apple ProRes) ALE file BIN file