codex

TECHNICAL USER MANUAL v1.0

CODEX SYSTEMS TECHNICAL ASPECTS

27.12.2010

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Introduction

This manual is intended to provide help and information in various more-technical aspects of Codex systems, such as networking, naming-conventions, LUTs, the Virtual File System, Offloading to LTO or RAID systems, and software installation. It can be found at http://www.codexdigital.com/techdocs

Software updates and installation instructions can be found at http://www.codexdigital.com/software

1 Using Linux on the Codex

Codex machines run a customized version of Linux, which is always present and available behind the normal Codex User Interface (Codex UI). Many of the setup and installation procedures require direct access to Linux. In order to do this, you will first need to connect a keyboard, which may be plugged into either USB port on the machine.

To switch to the Linux screen: press **Ctrl/Alt/F1**

To switch back to the Codex UI: press **Ctrl/Alt/F7** (**Ctrl/Alt/F3** on the Codex Portable)

If your system does not have a Touchscreen, or if you do not have a screen connected, the Linux command line can be accessed from a remote computer – see the section **Connecting to the Codex to access the Linux command line**.

1.1 Logging on to Linux

The Linux screen will initially be full of some of the startup logging information, which you can usually ignore. You need to enter a *username* and *password*, which by default are both simply **codex**. They can be changed if necessary, but this should only be done with the help of someone familiar with Linux, since you could easily lose all access if mistakes were made.

To log-on, press `<enter>` then type:

```
codex <enter>
```

You will now see a prompt, which will look like this:

```
[codex@codex11020 codex]$
```

The digits are based on the serial number of the machine and will therefore vary. This logon allows you to do various basic things on the machine, but in order to make serious adjustments or install new software you have to upgrade your status to that of *Superuser.*

Type:

```
su <enter>
```

When prompted for a password type:

```
codex <enter>
```

You are now logged in as *root,* the Linux name for the chief user. This is the equivalent of the Administrator on a Windows systems.

The root user on Linux can execute any command – including the deletion of vital system files – so caution and certainty is necessary before performing any tasks.

1.2 Restarting the Codex software without rebooting

Note: Eject Datapacks before doing this.

Logged in as root, type:

```
telinit 3 <enter>
```

Wait for the Linux prompt to re-appear. If it does not, press CTRL-ALT-F1. Then type:

```
telinit 5 <enter>
```

1.3 Exiting Linux

Logged in as root, type:

`exit <enter>` to leave the root user, then

`logout <enter>` to exit the Linux prompt.

1.4 System shutdown from the Linux prompt

Logged in as root, type:

```
shutdown -h 0 <enter>
```

1.5 Filesystem consistency (after sudden closedown)

Under rare circumstances following a power loss, the filesystem checker may detect that changes need to be made to the filesystem to make it consistent again. This is quite rare as it is a journaling filesystem that normally recovers automatically. If this happens, the next time the machine it is started up, it will not load the Codex UI screen but will instead go directly to the Linux screen.

You will be prompted to type the root password (codex by default) and then you are dropped directly to a prompt that says:

recover filesystem # (or something similar – there are variations).

To recover filesystem consistency, you now need to type the command:

`fsck <enter>` and answer `yes` to anything it asks you.

When the filesystem checker has completed, you should type:

```
reboot <enter>
```

This restarts the system, which should now start normally.

1.6 Remote access to the Codex system disk

Commonly, you may need to access (*share)* the Codex system disk from another computer, in order to copy programs or other files to and from it. You must, of course, be connected already: if not, first refer to *Connecting to Codex over a network.*

You will be connecting as user ***root***, with password ***codex*** – this gives you full access to the machine.

Be extremely careful not to move or delete any files when connected in this way!

Details of how to set up access to a disk depend on your computer and operating system – below are the most common examples.

Note: You can only have a single logon at a time from any given computer. Therefore, if you are already connected to the Virtual File System (VFS) you must disconnect this first.

The direction of slashes in filenames depends, regrettably, on the operating system. Linux and Apple OS use forward slashes (/). Windows (usually) uses backward slashes (\). It is important to get this right.

1.6.1 Remote access on Windows

This can be done from the Command Line window or from Windows Explorer:

1.6.1.1 Command Line

First determine the IP address of the Codex (if necessary, see **Configuring network settings manually – INSERT HYPERLINK**). For this example let's say the IP address is **192.168.1.120**

Access the command prompt by selecting ***start*** and then **Run...** Type *cmd* in the box which appears and click *OK*. At the prompt, type:

```
net use * \\192.168.1.120\root codex /user:root <enter>
```

Be careful to observe the spaces and the direction of the backslashes.

This command line specifies:

the *requested disk-letter* that the Codex drive will be assigned (* means next available);

the Codex *address* and *directory* to connect to;

the *password* and;

the Codex *user* to connect as.

It will connect the Codex root as the next available disk drive-letter (which will be reported), and you can now use it as if it was a local disk on your machine. If you want to specify the drive-letter yourself, replace the * with the letter plus colon that you want (e.g. *Z:*)

1.6.1.2 Windows Explorer

Right-click the 'My Computer' icon on the Desktop and select 'Map Network Drive'. A box will appear with the next free drive letter allocated, though this can be changed if you wish. Using the same IP address from the previous example, in the 'Folder' field type:

\\192.168.1.120\root

Press the 'Finish' button or <enter>. In the box which appears enter the username *root* and the password *codex*. You will now be connected to the root directory of the Codex system.

1.6.2 Remote access on Macintosh

Bring up Finder and then the *Connect To Server* dialog box either by pressing `Apple-K` or selecting **Go** and **Connect to Server** from the menu.

Enter `smb://192.168.1.120/root` (whatever IP address the Codex is set to) into the server address box and press **Connect**. You should see a *Connecting to server* window appear.

When the *SMB/CIFS File System Authentication* dialog appears, enter `root` in the Name box and in Password type `codex` (by default). Press **OK**.
A new Finder window will now open showing the files on the Codex system.

1.7 Some Basic Linux commands

This section is for anyone who needs to make any technical adjustments but is unfamiliar with command-lines. There are thousands of Linux commands, but here are a few of the basic ones that will help you perform the Codex housekeeping tasks.

Please keep in mind that the huge number of powerful commands means that it is quite easy to change the system unintentionally, which is likely to stop it working in ways that can be difficult to diagnose. Therefore, treat the Linux command line with care and avoid typing more than the minimum necessary to do the work.

The *prompt* always shows you which directory you are in (except on the Codex Portable). When you first log in and become *Superuser*, you are in the *root* directory and the prompt will be something like:

```
[codex@codex11020 codex]$
```

depending on your serial number. Whenever you see this prompt followed by nothing else, the system is ready for a command. If there is anything else on the line, you can remove it at any time by pressing CTRL-C. All commands are *case-sensitive* - `hello` is *not* the same as `HELLO` or `Hello` - and are completed by `<enter>`.

All these commands have many options, which are usually not needed but can be found by typing `man <command>`. Alternatively, add `--help` to the command (e.g. `ls --help <enter>`).

To **print** (display) the directory you are in use the `pwd` command:

```
pwd <enter>
```

To **list** the contents of a directory, use the `ls` command:

```
ls <enter>
```

To **change directory**, use the `cd` command, e.g.:

```
cd /home/codex <enter>
```

The root directory has the name / (forward slash). The directory is a tree, so if you are on one branch and want to move to another, you have to start again at the root, using the slash - as in the example above. Linux helps you with this navigation by providing *name-completion* on directories and filenames – if you start a path

and then press **Tab** it will complete the name. In the example above, you could type:

```
cd /h<tab>/c<tab> <enter>
```

Note that this only works if there are no other choices left after the letters you have typed – if pressing **Tab** doesn't complete anything there are other directories which match, and you will have to type more letters to disambiguate them. Repeatedly pressing **Tab** will make the system display all the options which match what has been typed so far.

To **make a new directory** use the `mkdir` command. For example:

```
mkdir /tmp/import <enter>
```

This will create a directory called `import` in the pre-existing `tmp` directory. New directories should only be created in `/tmp`, `/root`, or `/home/codex`.

Note: the /tmp directory on the Codex Portable is stored on the system RAM, i.e. anything in /tmp will be lost when the machine is switched off.

To **connect an external device** (such as a CDROM, hard-drive or USB memory stick) use the `mount` command:

```
mount /mnt/cdrom <enter>
```

The device can only be omitted from a mount command if the mount point is specified in `/etc/fstab`. For USB sticks/drives the device must also be specified in order for the mount command to work. With no Datapacks loaded a connected USB device will be assigned the device name `sdb1` by the system (this will be `sda1` on a Codex Portable). To mount it use the command:

```
mount /dev/sdb1 /mnt/usb <enter>
```

Note: Linux is not very good at dealing with external devices automatically in the way that Windows or OSX are. Instead, you must mount the device as a named directory.

To **disconnect** the device, use the `umount` command:

```
umount /dev/sdb1 /mnt/usb <enter>
```

This is must be done before removing a device, and is akin to the 'Safely Remove Hardware' option on Windows. Unlike Windows or OSX, Linux is unlikely to recognize that a device has gone, and **bad things can happen if this is not done**.

To **copy a file** use the `cp` command:

```
cp <sourcefile> <destination> <enter>
```

For example, here's how you copy a new LUT file from a USB stick (assuming the file is in the top-level directory of the USB stick and you have already mounted it):

```
cp /mnt/usb/<lutfilename> /etc/codex/luts <enter>
```

To **edit text files:**

Certain system configuration files may sometimes need to be edited: most commonly, the files that control the network settings. These files can be edited from another computer connected to the Codex, but it may be necessary or easier to do it directly on the machine itself.

The standard text-editor in Linux is called by the command `vi`, and is a throwback to the early days of computing. Though it is powerful, it is also very unintuitive. Here are the very few commands you need to use it for this purpose:

To edit a file	`vi <filename> <enter>`
To move the cursor	arrow keys

You are initially in *command mode* which allows movement around the file but not editing.

To change to insert mode (for editing)	i

Then type whatever you need to change. The Backspace and Delete keys work as expected.

To 'comment out' (make inactive) a line	add a `#` to the beginning
Similarly, to 'comment in' (make active) a line	remove the `#` from the beginning
To return to command mode	Esc
To exit and save changes	`:wq! <enter>`

(*notice the colon : which is part of the command)*

To exit without saving changes `:q! <enter>`

If you insist, more commands can be found at http://www.ss64.com/bashsyntax/vi.html

To **view the contents of a file:**

less <filename>

1.8 File locations

The Codex files are in several directories on the system, depending on whether they are program files, logfiles, configuration files or LUTs. The logfiles are very useful for troubleshooting and you may need to read them or send them to Codex for diagnosis.

The configuration files store basic setup and project settings, and other items such as the filecard layouts: you can replace them with your own variations if desired.

The LUT files are applied for viewing and the generation of VFS files. The system is shipped with several standard ones, but you can add your own.

Programs:
`/home/codex` contains the executables on Studio systems. `/usr/local/codex/bin` contains the executables on Codex Portables. There are two main programs, the *server* and the *user-interface*. The server does the actual work of recording, transcoding etc, and the user-interface allows you to control it. This architecture allows the same user-interface program to be used on remote computers as well as the Codex itself.

`drserver`	- the server
`drui`	- the user-interface

Logfiles:

`/var/log/` contains all logfiles (general system logs as well as Codex-specific ones). The Codex logfiles are:

`drserver.0.log`	- the latest log file generated by the server
`localdb`	- this database file can become corrupted by a power cut, but can be safely deleted

Note: The Portable does not store logfiles after a shutdown, so if a logfile is required is must be retrieved after the occurrence of a problem but before shutdown.

Configuration files:

`/etc/codex` contains all configuration files. These are:

`filecard.xml`	- the configuration file for the shot-metadata filecards.
`sysconfig`	
`config.xml`	- server configuration file, DO NOT EDIT
`druiconfig.xml`	- user-interface configuration file, DO NOT EDIT

LUTs:

`/etc/codex/luts` contains all LUT files.

There are no other locations used directly by the Codex software.

Be very careful not to delete or move any program or configuration files.

2 Mounting an external drive/USB key

Note: There is no direct UI support for this, and USB on Linux is not perfectly developed. For non-technical users, transferring files between a USB device and the Codex is more easily accomplished by networking a laptop to the Codex and plugging the USB device into that.

This method allows simple drag-and-drop copying.

Log on as *root* (see *Logging-on to Linux).* Plug the device into either USB port. Wait a while until it gets mapped to a SCSI drive. You might see messages come up during this process. If not, type:

```
dmesg | tail <enter>
```

This should show the device being recognised and mapped to `/dev/sd<n>`.
You can also type:

```
cat /proc/partitions <enter>
```

to see which one it might be – there should be a partition sdb1 assuming the device is formatted. Then type:

```
mount -o umask=0 /dev/sdb1 /mnt/usb <enter>
```

The drive is then mounted in `/mnt/usb`. The `umask=0` ensures all users can write to a FAT32 filesystem. You can then export to it or import from it in the UI, or just use `cp` to copy directly from the VFS. When finished, remember to type:

`umount /mnt/usb` before unplugging the device.

3 Working with Codex over a network

In normal operation, Codex makes use of the network for two independent purposes:

1) To be controlled from a remote computer
2) Acting as a server for providing files to other computers

This requires certain network settings on the Codex for each purpose, along with settings on the remote machines connected to it.

3.1 Network settings on the Codex machines

All Codex machines are shipped with a standard *fixed IP address* and *Netmask*. This is based on the following range:

192.168.1.xxx	(*IP address*)
255.255.255.0	(*netmask*)

xxx is the unique address of each Codex and, as shipped, is the *last two digits of the serial number + 100*. So machine number 20 has the address **192.168.1.120**.

There are two Ethernet ports on the machine: either can be used, but as delivered all connections are normally expected to be on **Port 1** (which is known in Linux terminology as *eth0*). You can use both ports simultaneously on two networks but *not* on the same network – the netmask dictates that the first three numbers of the IP address are the same for all machines on the network. A different network would have an alternative set of three numbers at the start of the IP address, followed by the individual unique addresses for machines on that network.

Management of the network settings on Codex is currently done directly from the Linux command line. In order to be able to do this you need to log on to Linux. If you want to change anything, you will also have to give yourself *Superuser* status. If necessary, see *Using Linux on the Codex*.

For details of how to change the IP settings for a Codex machine see the next section.

3.2 Configuring network setting Manually

3.2.1 Check Codex's IP address and make sure it's configured correctly

1. Connect to the Linux command line of the Codex system. On systems with a Touchscreen, connect a keyboard to the front of the Codex system using either of the USB ports.
2. Press **Ctrl/Alt/F1** to bring up the Linux virtual console screen (to return to the Codex UI screen at any time press **Ctrl/Alt/F7** on Studio systems or **Ctrl/Alt/F3** on a Portable)
3. For systems without a Touchscreen see Connecting to a Codex system to access the Linux command line.
4. Login as `codex`, with default password `codex`
5. Type `su` to switch user to root – the default password is `codex`

6. Type `ifconfig`. A list will be generated that looks somewhat like this:

```
eth0   Link encap:Ethernet  HWaddr 00:30:48:20:DE:D8
       inet addr:192.168.2.3  Bcast:192.168.2.255  Mask:255.255.255.0
       inet6 addr: fe80::230:48ff:fe20:ded8/64 Scope:Link
       UP BROADCAST MULTICAST  MTU:1500  Metric:1
       RX packets:0 errors:0 dropped:0 overruns:0 frame:0
       TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
       collisions:0 txqueuelen:1000
       RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
       Base address:0x2000 Memory:d4400000-d4420000
```

There are variations, and there may be much more text than this, but you are interested only in blocks beginning `eth0` or `eth1`, and lines that begin with `inet addr`. These lines show the system's current IP address(es) and netmask(s).

There are two network ports: eth0 is port #1 on the back panel, and eth1 is port #2 – the ports only appear in the output of ifconfig if they are enabled and running. New machines have Port 1 (eth0) configured with a manual IP address, and Port 2 as a dynamic DHCP port.

The original IP address for the machine would be set to 192.168.1.1xx (where the xx are the last digits of the system's serial number.) You can tell what the serial number is by looking at the Linux prompt – if it says `Codex11012` then it is machine number 12 and the IP address would have been set to 192.168.1.112.

Note: You can use both ports, but don't connect both to the same LAN!

3.2.2 Edit the system's IP address

To change the IP address and netmask, most usually to adapt the Codex to an existing network, the Linux network configuration file has to be edited. This can be done on the machine itself or from any computer networked to the Codex using the standard `vi` editor. To configure port 1, type:

```
vi /etc/sysconfig/network-scripts/ifcfg-eth0 <enter>
```

To configure port 2, type:

```
vi /etc/sysconfig/network-scripts/ifcfg-eth1 <enter>
```

You are now in the vi editor, which should be showing the contents of the file somewhat like this:

```
DEVICE=eth0
ONBOOT=yes
IPADDR=192.168.1.101
NETMASK=255.255.255.0
GATEWAY=192.168.1.1
```

Type `i` to enter *insert-editing* mode and change what you need to:

```
ONBOOT=yes
IPADDR=(whatever the IP address is to be set to!)
NETMASK=(the correct netmask)
GATEWAY=(the appropriate gateway)
```

Once you've finished editing, press **Esc** to exit editing mode. Finally, type `:wq!`(to **w**rite changes and **q**uit). You then need to refresh the Ethernet changes (see below).

Note: if you want to quit without writing any changes, type `:q!` Instead.

The GATEWAY entry is used to connect to other networks. By default eth0 is used for this purpose, and both

network connections cannot be used in this way simultaneously.

3.2.3 Refresh the Ethernet changes

If using port 1, type:

```
ifdown eth0 <enter>
ifup eth0 <enter>
```

If using port 2, type:

```
ifdown eth1 <enter>
ifup eth1 <enter>
```

If you are connected via ssh from a networked computer, typing ifdown will break the connection. In this case, type:

```
ifdown eth0
ifup eth0 <enter>
```

This will reset the network port and you can then connect using the new network settings on the Codex.

Finally, type:

`exit <enter>` to leave the root user and then:

`logout <enter>` to exit the Linux prompt.

3.2.4 Using dynamic IP addresses (DHCP)

We do not normally recommend this. If you feel that you must, contact Codex support.

3.3 Network setting for other computers connected to the Codex

Each computer connected to the Codex must have a compatible IP address and netmask. The details of this will depend on the particular computer and network, but if the Codex defaults are used you would set each machine as follows:

192.168.1.xxx (*IP address*)
255.255.255.0 (*netmask*)

xxx is the specific address of each computer: they can be within the range 2-254 (1 is not recommended as this is often the address of the network router), but must of course all be different from each other and the Codex.

Once these settings have been made, it should be possible to communicate with the Codex. You can quickly check whether this is successful by opening a command-line box on your computer and typing:

`ping 192.168.1.120 <enter>` (or whatever the address of the Codex is)

(Use ***start*** / Run... | **cmd <OK>** on Windows or the **Terminal** application on Mac.)

If you are connected properly this program will report something like this:

```
Pinging 192.168.1.65 with 32 bytes of data:

Reply from 192.168.1.65: bytes=32 time<1ms TTL=128
Reply from 192.168.1.65: bytes=32 time<1ms TTL=128
Reply from 192.168.1.65: bytes=32 time<1ms TTL=128
```

```
Reply from 192.168.1.65: bytes=32 time<1ms TTL=128
```

Note: Most computers have a firewall to protect from malicious attacks. It is likely that this firewall will at first prevent a proper connection to the Codex, and this has proved to be the most common reason for problems.

We recommend disabling the firewall while trying to connect for the first time: once the settings have been shown to work the firewall can be switched back on. If this breaks the connection, it will be possible to configure options in the firewall to allow the Codex connection – details of this depend on the individual firewall, but we should be able to help if necessary.

3.4 Connecting to the Codex

Once the network settings are correct, you can connect the computer to the Codex machine and work with it either to control it directly, or to copy files from the Virtual File System (VFS).

3.4.1 Controlling the Codex from a remote computer to run the UI

The same user-interface that runs on the Codex itself can be run unchanged on any other computer, whether a Windows PC or a Macintosh. The program packages to do this can be found along with installation instructions at:

http://www.codexdigital.com/software/

Note that there are usually several versions of these on the website: you must choose the one that matches the software version on your Codex (which can be quickly found by pressing the ***i*** button on the **Setup tab**).

3.4.1.1 Windows UI package

The package will have a name such as *codexui-win-1.2.2j.zip.* The programs are installed by simply extracting all the files in the package into one directory and then running the program *drui.exe*.

You may wish to create a shortcut to drui.exe on your desktop.

Note: the PC versions also require Intel's IPP run-time library to be installed. If this is not done, the program will report failure to find modules such as 'ippcore.dll'. The library is named ipp-runtime.zip, is a normal Windows installation package, and is found on the same page as the Codex software. This installation will only need to be done once even if you install newer UI packages.

3.4.1.2 Macintosh UI package

The package will have a name such as *codexui-osx-1.2.2j.dmg.* Open the *.dmg* file and drag the Codex UI application package into Applications. The application is a universal binary and so will run on PowerPC and Intel Macs

3.4.2 Connecting to the Codex to access the Linux command line

3.4.2.1 From a Windows machine

Download the free ssh client program **putty** from http://www.putty.org

Ensure that the Windows machine and the Codex are connected over a network. Open the putty application and enter the IP address of the Codex in the 'Host Name (or IP address)' field. You will then need to log onto the Codex using the user `codex` and password `codex`. For certain operations you may need to upgrade to a *Superuser* by typing `su` and the password `codex`.

3.4.2.2 From a Macintosh machine

Open the **Terminal** application. Type:

```
ssh codex@192.168.1.120
```

You will then have to enter the password which is `codex`.

Then upgrade you status to Superuser as per the instructions in the previous section if required.

3.4.3 Connecting to the Virtual File System (VFS)

The VFS presents the shots, as files of different types, to computers connected on the network. The top-level directory of the VFS always has the name `codexvfs`, and the shots appear in this directory and sub-directories below it - the exact layout depends on how the system has been configured (see *Setting-up the VFS)*.

In order to connect to the VFS, you must establish a connection to the Codex machine's `codexvfs` directory. Details of how you do this depend on your operating system, and there are usually several choices – here are some common examples.

Note: you cannot connect to the Codex system as more than one user at a time, i.e. if you have already connected to the `root` directory as a root user you will have to disconnect before being able to connect to the `codexvfs` directory as a normal codex user. Alternatively you could navigate to the `codexvfs` directory which is located in `/mnt`.

However, you should not remain connected as a root user longer than necessary to minimise the chance of accidental dragging and dropping of files.

3.4.3.1 Connecting Windows machines to the VFS

This can be done from a command-line window or from Windows Explorer:

Command Line:

First determine the IP address of the Codex. For this example let's say it is **192.168.1.120**
At the prompt, type:

```
net use * \\192.168.1.120\codexvfs <enter>
```

You will be asked for a username, type:

```
codex <enter>
```

and then a password, again type:

```
codex <enter>
```

Be careful to observe the spaces and the direction of the backslashes.

This command will connect the Codex `codexvfs` directory as the next available disk drive-letter (which will be reported). You can now use it as if it was a local disk on your machine. If you want to specify the drive-letter yourself, replace the * with the letter you want plus a colon (e.g. *Z*:)

Windows Explorer:

Right-click the 'My Computer' icon on the Desktop and select 'Map Network Drive'. A box will appear with the next free drive letter allocated, though this can be changed if you wish. Using the same IP address from the previous example, in the 'Folder' field type:

```
\\192.168.1.120\codexvfs
```

Press the 'Finish' button or <enter>. In the box which appears enter the username *codex* and the password *codex*. You will now be connected to the `codexvfs` directory.

3.4.3.2 Connecting Macintosh machines to the VFS

Bring up Finder and then the *Connect To Server* dialog box either by pressing `Apple-K` or selecting **Go** and **Connect to Server** from the menu.

Enter `smb://192.168.1.120/codexvfs` (whatever IP address the Codex is set to) into the server address box and press **Connect**. You should see a *Connecting to server* window appear.

When the *SMB/CIFS File System Authentication* dialog appears, enter *codex* in the Name box and in Password type *codex* (by default). Press **OK**.

A new Finder window will now open showing the VFS files on the Codex system.

3.4.4 File and directory structure on the VFS

The *codexvfs* directory you are now connected to is the root of a directory tree which presents the shots on the Codex as files of different types. None of these files actually exist until they are asked for – only their names, sizes and so on are presented: this is why the system is called *Virtual*.

The **layout and names** of these directories and their contents is entirely configurable to suit the user. Therefore, what you see once you have logged onto the VFS may be very variable, depending on what shots are on the Codex and how the VFS is configured. Indeed, you may initially see nothing.

3.4.5 If the VFS appears to be empty

There are three possibilities: either there are no shots (nothing recorded or no Datapacks loaded), there is no VFS configuration loaded, or there are filters set up in the VFS and no shots satisfy the filter conditions..

If the Codex UI shows that there are shots loaded, check the VFS configurations on the **SETUP tab|VFS screen**. Full details of the VFS and how to load or change the configurations may be found in the section *Setting up the Virtual File System.*

4 Filecard structure

The structure of the shot filecards (that is, the description of all the fields of metadata that can be entered – but *not* the metadata itself) is kept in the file *filecard.xml*. This is a human-readable text file conforming to normal XML structures.

You can change the labels of the fields in the filecard, and even the overall structure and layout, by editing this file to suit your production (we recommend consulting Codex if you want to make major changes).

The Codex database makes no restrictions whatsoever on the types of metadata that can be stored. The standard filecard structure covers the basic items that productions need, but you can remove them or add others.

4.1 Different Filecards for different users

If you want to control the Codex from a remote computer, it needs its own copy of *filecard.xml* installed along with the UI program (see *Installing the UI on remote computers)*. Commonly, all the computers on a project would have the same file, but this is not mandatory: for example, you could leave out some of the fields – or make entirely new versions – to control access to the metadata by different classes of user. Fields can also be set to be *non-editable*, which allows users to see those fields without being able to modify them.

4.2 The configuration of the Filecard: filecard.xml

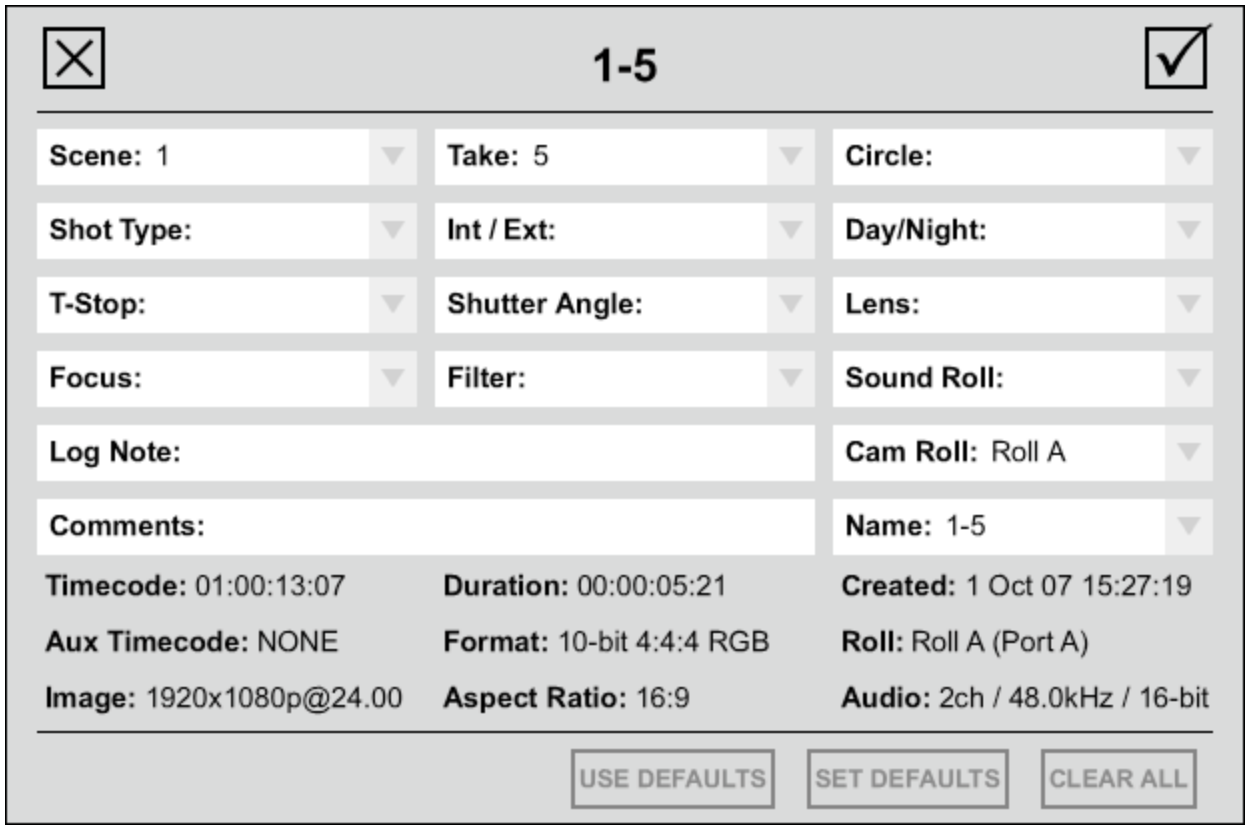
4.2.1 The standard filecard.xml

Here is the standard filecard description:

```
<?xml version="1.0" encoding="UTF-8"?>
<filecardlayout>
  <tab name="Main">
    <entry x="0" y="0" prop="Scene"/>
    <entry x="1" y="0" prop="Take"/>
    <entry x="2" y="0" prop="CircleTake" label="Circle">
      <choice>Yes</choice>
      <choice>No</choice>
    </entry>
    <entry x="0" y="1" prop="ShotType"/>
    <entry x="1" y="1" prop="IntExt" label="Int / Ext">
      <choice>Interior</choice>
      <choice>Exterior</choice>
    </entry>
    <entry x="2" y="1" prop="DayNight">
      <choice>Day</choice>
      <choice>Night</choice>
    </entry>
    <entry x="0" y="2" prop="TStop"/>
    <entry x="1" y="2" prop="Focus"/>
    <entry x="2" y="2" prop="Lens"/>
    <entry x="0" y="3" prop="Filter"/>
    <entry x="1" y="3" prop="ShutterAngle">
      <default>180.00</default>
    </entry>
    <entry x="2" y="3" prop="SourceDevice">
    </entry>
    <entry x="0" y="4" w="2" h="2" prop="Comments" text="y"/>
```

```
      <entry x="2" y="4" prop="ProductionName"/>
      <entry x="2" y="5" prop="ShotName"/>
    </tab>
  </filecardlayout>
```

This configuration file describes a Filecard that looks like the following:



The grey area of the card is fixed, and contains information that is not to be changed by the user. The white fields are configurable.

Here is a complete XML *element* on the filecard, describing the field name `Circle`:

```
<entry x="2" y="0" prop="CircleTake" label="Circle">
   <choice>Yes</choice>
   <choice>No</choice>
</entry>
```

Each element is defined by a *start tag*, then some *properties*, then an *end tag*. Notice that XML allows you to embed properties within a tag, and also that there are *nested* elements – the field has some *choices* predefined. In fact, you can see that the entire file is actually a single set of nested elements starting with the tag `<filecardlayout>`.

In more detail:

`<`	all tags begin with an angle bracket
`entry`	the start tag
`x="2" y="0"`	the position of the field (x = "0", y = "0" is top left)
`prop="CircleTake"`	the name of this metadata as stored in the database
`label="Circle"`	the label of the field on the card (optional)
`>`	all tags finish with an angle bracket

Notice that all values are surrounded by "quotes": this is because the tag for the element and some of its properties have been written in short form within the angle brackets – this is one of the styles that XML allows.

The *choices* list has been written slightly differently, in the style where each property has its own start and end tags:

```
<choice>Yes</choice>
<choice>No</choice>
```

Because each property has its own tags, there is no need for quotes in this case. The choices list is *nested* within this entry element, so we also need to finish with an end-tag for the whole element:

```
</entry>
```
Notice the forward slash / denoting that this is an *end* tag.

The predefined choices for fields are actually stored in filecard.xml. However, you can change these choices directly from the UI, so there is no need to edit the file just for this purpose. If you enter a new choice, simply open the drop-down menu for the field and select the green tick next to your new choice to save it as an option which can be selected for subsequent shots. Pre-set choices may also be removed by selecting the red cross from the drop down box.

4.2.2 Editing filecard.xml

The file can be edited in any text editor, but you must take care to stick to the basic XML rules. There are specialist programs for this, or WordPad in Windows and TextEdit in OSX are both suitable as long as the XML rules are adhered to – they provide no indication of mistakes.

If you change the location or size of a field, you must also change the others to compensate, or the filecard will become unreadable. Similarly, the filecard will be unreadable if all the space is not accounted for – the easiest way to avoid this is by setting any unwanted prop and label names blank (e.g. `prop=""`) but maintaining their co-ordinate values. Therefore, if you would like filecards that are very different from the standard, we suggest you contact Codex for advice, or to do it for you.

Here are a couple of examples of simple changes you might make yourself:

To change the name of a field: select the <entry... > line for the field you want to change. Change the word in quotes after prop= - don't forget to keep the quotes.

To make a field non-editable: select the <entry... > line. Just before the closing /> add a **space** then this: `editable="No"`

Note that metadata property names (`prop=""`) must themselves be valid XML tag names, i.e. contain no spaces or other illegal characters. The label attribute can contain any character. For example, the line:

```
<entry x="2" y="1" prop="DayNight" label = "Day/Night">
```

defines a property in the database named DayNight, but the field on the filecard is labeled Day/Night.

Note: all of the standard metadata fields (properties) have English labels pre-defined in the software, so it isn't necessary to specify these in filecard.xml – they are used anyway.

4.2.3 Making your own labels or fields

You can override the built-in labels with your own, or add entirely new fields. If you want alternative labels, or to define new fields, you will need to specify the labels. For example, if you wanted the ***Circle*** field to be called ***Print*** instead, you would change the entry to:

```
<entry x="2" y="0" prop="CircleTake" label="Print">
```

5 Naming conventions for shots and VFS files

The Shot Naming Rule is defined on the **SETUP tab | SLATE screen**. Shot names within the Codex itself, and the filenames given to shots within the Virtual File System (VFS) are generated automatically from the shot metadata (you can of course also override any shotname manually). The rules for automatic generation can be specified in as much detail as necessary using the Codex *scripting* conventions.

The key to the scripting of shot and file names is the use of *Tokens*, which are symbols or words that represent items of metadata for shots, such as Scene, Take or Width. These tokens are then replaced by the actual values for the particular shot.

The filenames in the VFS are based on the shotnames, but do not have to be the same – indeed, it is usually desirable to add different elements to the filename according to the type and usage of the file.

There are standard predefined rules for all of this, available from drop-down lists in the Codex UI, but if you want to define your own rules, or more complex variants, the next sections describe how Tokens are defined and how to use them.

5.1 Tokens

The name of any metadata field (such as *Roll, Scene, Take* or any other field found on the Filecard or **SETUP tab** screens) can be turned into a *token* by using the name of the field enclosed in {braces} – for example {Scene}.

When the shot is named, these tokens are then replaced by the current value of that field. For example, if you describe the rule for shotnames as follows:

Test {Scene}-{Take}

then for each shot the words in braces will be replaced by the current Scene and Take value, and the rest used as written. If the Scene is **14** and the Take is **5**, the shotname would become:

Test 14-5

The values don't have to be numbers, of course. Scene **Freddy** and Take **t99B** becomes:

Test Freddy-t99B

5.2 Rules for Token-Names

All of the metadata is described by *internal fieldnames*, which are the ones used in the XML structures of the configuration files and within the database. These names are ultimately what the token-replacement system uses: the built-in ones are listed below and have to be *case-sensitive* and *without spaces,* in order to conform to XML rules. Examples are `ProductionName` and `CircleTake`.

However, the user doesn't normally see these fieldnames, but the friendly *labels* or *usernames* on the Filecard and **SETUP tab** screens. All the common fieldnames can be described by these usernames, such as `Production` and `Circle`. These names are *not* case-sensitive and may contain spaces.

Note: if you invent new fieldnames in your filecard.xml they will not have friendly labels to match – you will have to assign a label as well.

There are also a number of *single-letter tokens*. Some of these are conveniences - for example `{r}` is the same as `{OriginalRoll}` – but they are mainly for special purposes within the setup of the VFS. For example, if you are generating dpx files - which are one-per-frame - `{f}` can be used to put the frame-number in each filename. This is discussed further in the VFS section and there are full lists of all legal token-names in an Appendix.

Note: the rules for tokens in shot names and VFS names are slightly different. Generally speaking:

Labels (user friendly names) should be used as tokens in the Shot Naming Rule and Roll Naming Rule

Metadata property names should be used as tokens in the VFS setup

Some single-letter tokens, such as {f}, only work in the VFS, as they have no meaning in the context of shot naming. For a list of metadata labels and single letter tokens see the Appendix.

5.3 Naming Shots

The shotname conventions are defined from the **SETUP tab|SLATE screen**. The most common conventions are built-in: you can modify them or type-in entirely new ones. In the drop-down list there are convenient buttons to remove existing choices (a red cross) or add new ones (a green tick): the choices are stored in the file *druiconfig.xml*.

Examples:

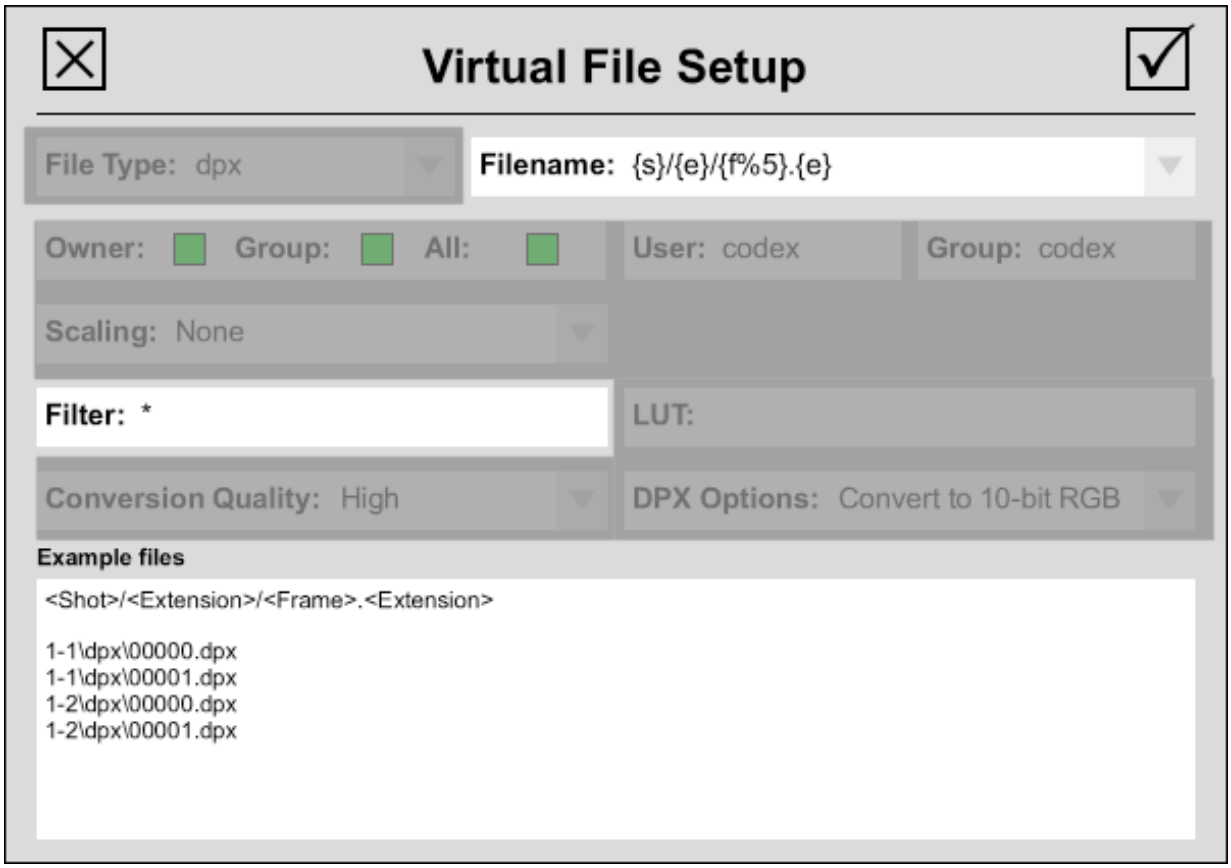
{Scene}-{Take}	expands to 10-2
{Director} Test {Scene}	expands to Altman Test 19 (note the spaces)

As you type the shotname specification, you are shown an example of what you will get. If the example is empty, or it doesn't make sense, something is wrong – check that you have a meaningful token and that there are proper {braces} around the tokens, not (brackets), and that they match properly.

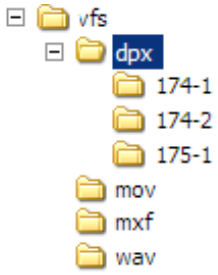
You will also be warned if your rule will produce duplicate shotnames. Try very hard to avoid rules which produce duplicate shotnames. The system continues to work because every shot has a Universally Unique Identifier (UUID) separate from the shotname: but everyone you give the shots to will become very, very confused.

5.4 Naming VFS files

The VFS filenames are set up in the **SETUP tab|VFS screen**, from the Virtual File Setup card that pops up when you press **Add** or **Edit**. There are a number of fields on this card, of which the filename is only a part – the complete process is described in detail in the next section, *Setting-up the VFS*.



The VFS scripting allows you to set up not only filenames, but separate named sub-directories and even entire trees. This is very useful for presenting the same shots in different forms for different uses. Here's a simple example:



In this case, all the shots appear together in various directories as Avid MXF files, Quicktime files, and so on. But the shots also appear as DPX files in their own individual sub-directories. The reason for this is that there is one DPX file for every frame, and shots need to be kept separate.

As with shot-naming, there are preset choices for the VFS filenames, tailored to the file type in question, and you can also construct your own.

Special mention should be made for Avid MXF files – although not mandatory, is is strongly recommended to use the following Filename structure in the VFS to prevent filenames exceeding 31 characters, which can lead to problems in Avid editing systems:

{r}{c}{d}_{t}.{e}

The bottom of the Virtual File Setup card shows you examples of the filenames you will get, including the full directory-path if specified.

In the example above, the Filetype is *dpx* and the Filename string is:

{s}/{e}{f%5}.{e} which expands to:

<Shot>/<Type>/<Frame>.<Type>

Notice the %5 in {f%5}. This defines the number of digits in the framenumber – in this case 5, padded with zeroes as necessary. Similarly, {f-5} limits this number to a maximum of 5 digits, while {f+1000} would add 1000 to any frame number. All these different options can be used at once to modify numeric values if required.

Another useful token is {g} which will insert a number value for frames-since-midnight. This can be useful for creating sequences of files which are numerically continuous, which is required by most DI and VFX systems. A common option to use is {g%8}, giving a frames-since-midnight value of 8 digits for all files.

The first example shot is named *1_1*. The result is a directory named *1_1*, with a sub-directory named dpx, containing one file per frame, each named with a 5-digit framenumber and dpx. So:

1_1/dpx/00000.dpx
1_1/dpx/00001.dpx
and so on...

Here are some more filename examples, ranging from very simple to more complex:

{s}.{e} expands to <Shotname>.<Extension> (all shots in the codexvfs root directory, e.g. *freddy.avi*)

{r}/{s}.{e} expands to <Roll>/<Shotname>.<Extension> (separate sub-directory for each Roll, e.g. *test/freddy.avi*)

{e}/{r}/{s}{f%5}.dpx expands to <Extension>/<Roll>/<Shotname><'5-digit frame-number'> (sub-directory named dpx, Roll directory, one dpx file per shot, e.g. *dpx/100/freddy00012.dpx*)

As with the shotnames, if it looks wrong, it is wrong: check the tokens and the braces. With the VFS, there is one further thing to look out for: if the specification is incomplete, you may produce *duplicate* filenames, which have *major* impacts on the performance and should be carefully avoided. For example, this specification:

{r}.{e}

This expands to <Roll>.<Extension> - for example *test.avi* - and if you used it, *every single* shot with the same Roll would get the same filename. The system will give each file a number – *test.avi (2)* etc - to avoid clashes, but this will affect the speed at which the VFS creates the list of files.

In the cases where there is one file-per-frame it is *especially* important to include something to define a different filename for each frame, such as the frame-number in the examples above, or timecode. Otherwise there would potentially be thousands of files all with the same name.

The system warns you if there may be duplicate filenames – do not ignore this warning.

A full listing of token letters, names and user-friendly labels, along with where to use them, is contained in an **Appendix**.

6 Setting up the Virtual File System (VFS)

The VFS allows shots to be seen on a network as *files* of different types. It is called *Virtual* because these files can be seen by the client computers as entries in directories, but the actual contents are not created until a client asks for a file to be copied or viewed across the network.

This allows very easy and efficient access to the shots. Most files can be generated very quickly – often streamed in real-time or better – though of course the throughput depends on how many clients need simultaneous access.

The Codex can have multiple VFS Configurations, and each Configuration can have multiple directories of the same or different file-types. Shots can appear in multiple directories, so that the same shot can be made available in different simultaneous formats, for different purposes.

All VFS setup is done form the **SETUP tab|VFS screen**.

6.1 Setting-up VFS Configurations

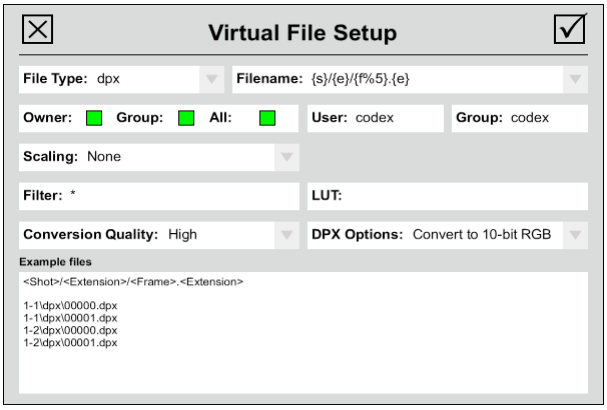
The NEW CONFIG button creates a new VFS configuration, which will initially be empty. When creating a new VFS Configuration there are several global properties which can be set to ensure compatibility with the system which will be using the files. These are:

Filename case: Either **Upper and lower** or **Lower only** as required
Illegal chars: Either \/:<>*|? or \/:<>*|?'"&#@;,^&<sp> as required
Replace with: Either _ or – as required

The EDIT CONFIG button allows you to edit the global properties of an existing configuration.

6.2 Adding or editing VFS entries

Each entry in the configuration defines a rule for the VFS to present files. Press the ADD or EDIT button. This pops up a form:



This form fully defines the file type, directory and name, scaling, compression, etc. Most of this is fairly straightforward. Here are brief notes on some fields:

6.2.1 Filename

The string in this field defines the way in which the VFS shows the shot filenames and directory structure. There is a drop-down list of common formats, which changes for each filetype, or you can construct your own. This is discussed in detail in the previous section, **Naming Conventions**.

The common formats are different for different filetypes because some filetypes cover entire shots (e.g. avi) while others produce one file per frame (e.g. dpx). In the latter case, you would usually want separate directories for each shot to avoid confusion.

The Example Files field shows results for a couple of shots, and warns if there will be any duplicate filenames: avoid letting this happen!

6.2.2 Owner/User/Group

These fields control the Linux file permissions. Unless you understand how file permissions work, it is best to leave these at their defaults.

6.2.3 Scaling

This controls the size of the output if it is to be different from the original. It may be **Relative**, in which case you are given a list of standard scales such as ½ or ¼, or **Fixed**, in which case you specify the exact size yourself.

6.2.4 Conversion Quality

This controls whether conversions (if any) are optimised for speed (**Low**) or quality (**High**). If you want to stream a shot in real-time over the network you need to choose **Low**. For the best possible converted bitmap, choose **High**. **Medium** is usually a good choice. This option mainly impacts upon the quality of Scaling.

6.2.5 Compression

Some filetypes allow compression: currently, JPEG is supported for avi files, while DnxHD and JPEG can be used for Avid MXF and mov files. Again, if you want clients to be able to play shots in real-time over the network, or the files are intended for offline editing, choose compression. If they simply want the best possible picture for online editing or a local copy, don't.

Uncompressed mov or avi files are not recommended due to their very large size. If you want to work with uncompressed material, dpx files are the best option.

6.2.6 LUT

This field controls whether a LUT is applied to the file. Typically, you would apply a LUT to filetypes used for viewing and offline editing (such as compressed mov files) but *not* to files used for VFX or DI processes (such as uncompressed dpx files). A pop-up card shows you the available LUTs – choose from the list. You can also build new LUTs or import external ones – this is described in the section **LUTs**.

Note: Remember to check that the LUT is the correct type – e.g. 8-bit for AVI, not 10-bit, to ensure optimum quality and speed. See the section ***LUT file formats.***

Any type of LUT applied through the VFS will affect RGB values. As such, any YCbCr material to which a LUT is being applied for output will be converted into RGB for the LUT processing and then output as RGB or converted back to YCbCr depending upon the output settings. The number of conversions and LUTs being processed will have an impact on the speed of file generation through the VFS.

6.2.7 CDL

This field allows you to select from **No**, **Yes**, or **+ Post LUT**. Codex systems can record CDL metadata from DP Lights, FilmLight, and Digital Vision colour correction and on-set colour grading systems. Once this metadata has been recorded with a shot it is always carried through the post-production chain.

Selecting **Yes** means this metadata will be used to burn-in a shot specific look for material output through the VFS. **Post LUTs** can be stored on the machine and applied at this stage also, but on a per VFS File Type basis. CDL Data and Post LUTs might be applied to dailies and offline editing files.

6.2.8 DPX Options

This controls whether the files are output in their existing format or converted to 10-bit RGB dpx files. This decision is dependent on various factors, such as the post-production workflow requirements. While 10-bit RGB dpx files are a very common path for post-production, there are several reasons why you may want to keep the files in their existing format:

1. material recorded from a camera outputting data is recorded in Bayer pattern format. While Codex systems can perform de-Bayering for monitoring and the output of dpx files as RGB, there are also several camera specific software programs available for performing de-Bayering which produce better results.
2. wavelet compressed material (recorded on a Portable) outputted in it's existing format (i.e. original Storage Format and compression Quality) will result in smaller files for archival. For example, a 10-bit YCbCr uncompressed dpx file is 5.27MB whereas a 10-bit YCbCr dpx file output with 4:1 wavelet compression is around 1.3MB. This may be advantageous to maximise storage capacity, but be aware that any compressed dpx files are not viewable by other systems (due to there being no standardization for wavelet compression) and need to be run through a Codex system in order to be decompressed.
3. The Convert to 10-bit RGB option will uncompress any wavelet material.
4. the size of uncompressed material outputted as dpx files will differ when using the Keep Existing Format option depending on the Storage Format used during recording, as follows:
    - 8-bit YCbCr 3.95MB
    - 10-bit YCbCr 5.27MB
    - 8-bit RGB 5.93MB
    - 10-bit RGB 7.91MB

Once again, this may be advantageous for storage reasons, but ensure that the files will satisfy all the post production demands.

6.3 Filter: controlling contents of VFS Directories

All shots can appear in more than one directory of the VFS. The most usual reason for this is to present them in various formats – the shot will appear in an AVI directory, a DPX directory, different resolutions and so on. But shots can also appear in multiple directories of exactly the same type. The reason why this is useful is that all directories can be *filtered* to contain only shots which have certain values for their metadata. For example, you can have directories of only *Circle Takes,* or from a particular *Roll* or *Source* – or any combinations of these.

All the metadata fields can be used, whether from the shot's Filecard or from the settings in the **SETUP tab** , such as **PROJECT** and **SOURCE** settings. However:

Note: Filter strings are Case Sensitive and use Internal Metadata and Single Letter Token Names (e.g. {r}, {s}, etc.), as per the rest of the VFS.

Apply filters by typing strings into the **Filter** field. An empty field or asterisk (*) means 'everything', which is set by default. The table below contains some example filters.

Filter	Directories will contain:
{CircleTake}="Yes"	*only shots whose Filecard shows* **Yes** *in the Circle Field*
{OriginalRoll}="Test 2"	*only shots with Test 2 as their Roll (on Filecard)*
{SourceId}="B"	*only shots recorded with Source ID set to B*

Note that the metadata tokens must be in {braces} and token values must be in "quotes".

You can also combine these expressions into complex statements. Operators include:

=, != (*means not-equal*)**, and, or, not**

and may be surrounded by brackets. For example:

```
{CircleTake}="Yes" and ({w}=4096 or {w}=1920)
```

i.e. only shots which have **Yes** in the Circle Field and whose width is 4096 or 1920.

If you need any help in constructing complex filters please contact Codex.

Note: the values for {w}= are not in quotes. This is because they are not strings like all the typed-in values, but are numeric values (in this case the Width of the picture).

6.4 Limitations of the VFS

It is possible to overload the VFS, particularly if you have a large amount of material loaded (for example, in a Lab or Portable Transfer Station with Datapacks and Internal Storage).

The limitation is the sheer number of files the VFS contains, and can be reached if large numbers of shots are set to be presented as individual dpx files – the approximate number of files which can create problems is around 1.5 million. When this threshold is exceeded it will be indicated by instability, crashes, or OOM (out of memory) messages on a Linux screen.

There are three central recommendations in order to avoid this:

1. Do not load multiple Datapacks and the Internal Datapack unnecessarily
2. Use Filters on the VFS, such as filtering the loaded material by Roll in order that the VFS presents only files from the Roll you require
3. Keep VFS Configurations to the minimum required for a task, i.e. do not have several different types of dpx file within the VFS at one time unless it is necessary – you can always switch between different VFS configurations for access to different file types

Additionally, it is not recommended to have large amounts of different filetypes in one VFS configuration. It is better to have the filetypes divided between configurations where possible – you can then switch configurations for different purposes and the VFS will rebuild the list of available files

Note: Codex is currently working to improve VFS performance in relation to these limitations.

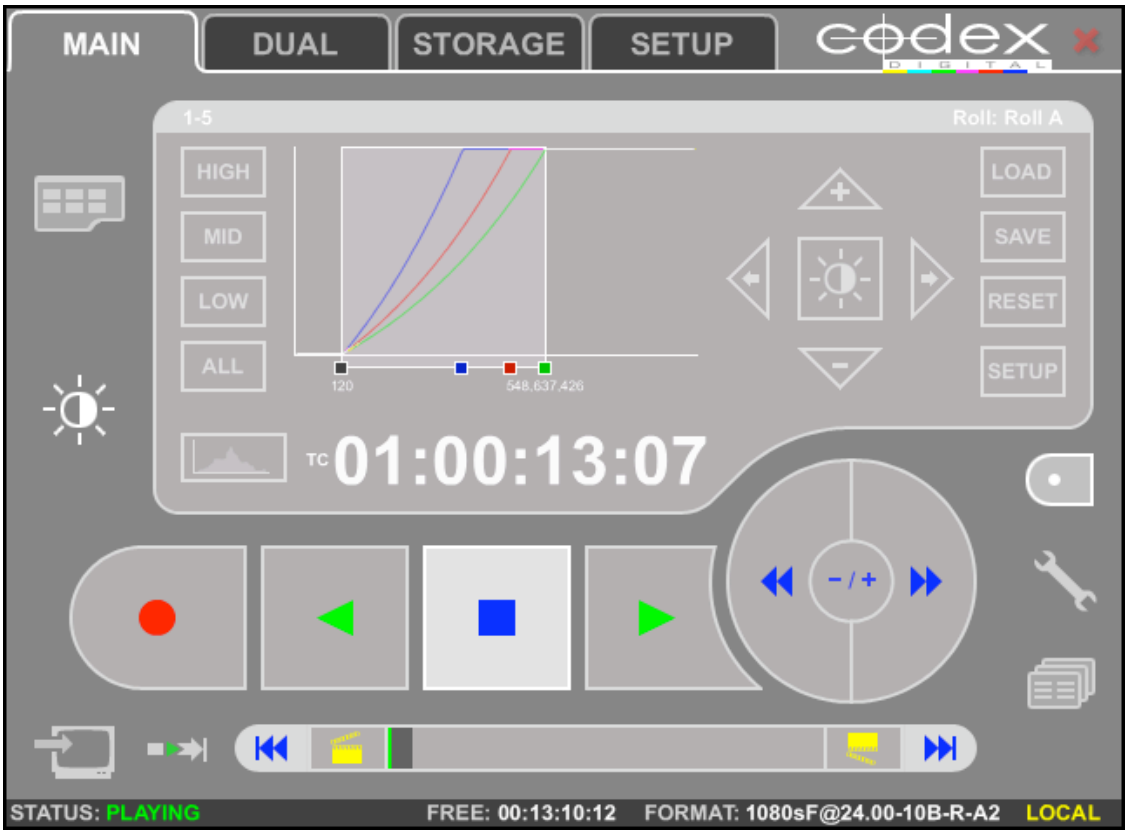
7 Using LUTs

This section describes details of how to manage Look-Up Tables (LUTs). Codex uses LUTs purely for output purposes (viewing and export), and for import of existing files - source material is always recorded and stored entirely unmodified, for maximum quality.

At present, LUTs are simple one-dimensional tables. All LUTs are RGB and will operate fully on RGB signals. For YCbCr material any LUT applied will only affect the luma (brightness) of the shot.

7.1 LUTs for Monitoring

This LUT is 10-bit to 10-bit, and modifies the HD (and DVI) outputs during record, monitoring and playback. The monitoring LUT can be selected from the **LUT** button on the **MAIN tab** or **DUAL tab**. LUTs can be applied in several ways:



7.1.1 Using a preset LUT, or creating a new one.

Both of these are done by using the **SETUP** button on the **LUT** screen. This pops up a form in which parameters, based on source material type and monitor, may be set directly.

Several standard *presets* are included for various cameras: these are selected from the *Quick Select* field. You can then, if you wish, modify the parameters on the form and save them for later use. The example above is a LUT for the Viper camera, and corrects its green cast.

When using these *preset* LUTs or your own parameters, the *adjustment arrow* buttons are active. These effectively change the *contrast* and *brightness* of the image by moving the black and white points. The LUT graph shows the effect of these controls on the LUT, and the shaded rectangle shows the pixel value range of the source material that is being shown on the monitor.

By changing to the *Histogram view* you can see how this compares to the range of pixel values present in the source.

There are also special one-touch **HIGH, MID, LOW** and **ALL** buttons. These provide an instant way of studying various parts of the image dynamic range.

The **RESET** button restores the LUT to the parameters last chosen on the **Lookup Table Setup** page, undoing any adjustments and removing any LUT loaded from a file.

The **SAVE** button saves the current LUT, with any adjustments, to a file. A new or existing filename can be used.

7.1.2 Loading an existing LUT from a file

LUTs that have been saved to a file can be reloaded later using the **LOAD** button on the **LUT** screen.

*Note: for loaded LUTs the adjustment controls are not currently available. In this case, the **RESET** button unloads the LUT, restores the parameters specified on the **Lookup Table Setup** page, and re-activates the adjustment controls.*

7.1.3 LUTs for Data-mode material

Certain cameras produce material as *data*, instead of (or as well as) video. For monitoring data sources an internal conversion is made from the linear Bayer pattern source material to 10-bit HD 1920x1080 RGB. A Cineon log curve is used to compress the 14-bit linear dynamic range to 10-bits. The monitoring LUT is applied *after* this conversion, and converts from the log space to display-gamma space. The **Quick Select** can form the basis of a suitable LUT, or one can be loaded from a file.

Note: the histogram is also shown in 10-bit log space, and hence matches up with the selected 10-bit log black and white points.

During the conversion from the linear sensor data to RGB, a white balance vector and a Rec. 709 conversion matrix are applied.

7.2 LUTs for Import / Export

LUTs can be applied when exporting or importing shots using the EXPORT and IMPORT pages. The LUT is loaded from a file and applied (only) during the import or export process.

Most standard LUT files should work. However, for best results the size of the LUT should match the source shot/file and the range of the LUT should match the *destination* shot/file. If the supplied LUT doesn't match, it will be scaled and converted to suit: this will however have some impact on the speed of the process.

For instance, when exporting a 10-bit RGB shot to a BMP file (which is 8-bit RGB), an ideal LUT would consist of 3 channels, each containing 1024 entries (2^10) with values ranging from 0-255 (2^8).

7.3 LUTs for the VFS

Each file type specified in the VFS can optionally have a separate LUT applied to it, in order to optimise the quality for that type of file. The rules for these LUTs are the same as described above.

The LUT is chosen by clicking on the LUT field in the Virtual File Setup page – a pop-up appears with the available choices.

Notes:

1. For best performance and results, it is important that the structure of the LUT should match the source shot and file type as described in the section above. There can be a severe performance hit if the LUT is the wrong number of bits, so it is strongly recommended to get this right. This will normally be very straightforward and will usually only need to be done when changing camera types.
2. In the unusual case where it is necessary to mix different types of material on a single system (e.g. if different cameras/settings are used to record RGB and Bayer material), managing VFS LUTs becomes more complex. Here, we advise making certain the Source Name is different for shots made with the different cameras. The shots can then be put into different VFS directories by filtering of the Source Name, with the correct LUT being used or each source. VFS filtering is described in the VFS section.
3. VFS LUTs are cached for best performance, so if a LUT file is replaced with another of the same name, the system will need to be restarted for the new values to take effect. Therefore, if experimenting with VFS LUTs, it is best to use a different filename for each variant.

7.4 Local LUTs

When the Codex UI is controlled from remote computers on a network, each computer can also have its own variant LUTs which can be quickly used by - or permanently uploaded to - the Codex. In this way, different operators can monitor the shots in a form that suits their needs.

When the UI is run remotely, the LUT pop-ups have two extra buttons: **Local/Server** and **Transfer**. The **Local/Server** button toggles between viewing the LUTs available on the Codex, and viewing any extra LUTs available on the remote machine. The **Transfer** button may be used to copy the highlighted LUT to/from the Codex and the remote machine running the UI.

Note: Local LUTs are only for monitoring – they are not available for the VFS outputs: these use only the central LUTs on the Codex. However, you may of course import as many LUTs onto the Codex as you need: once they have been imported, they can be applied in the VFS.

Therefore, if different VFS users need different LUTs you can set up different directories which use the various LUTs. Then, each user can simply look in the appropriate directory.
An example of an external LUT is included in the current software releases. It is named ***loglut*** *and converts log material to 8-bit gamma.*

7.5 LUT file formats

The file is in ASCII text. The start will be like this:

LUT to convert 10-bit log to 8-bit gamma.

Input black: 64

Input white R: 800

Input white G: 800

Input white B: 800

Input max: 1023

Output black: 0

Output white R: 255

Output white G: 255

Output white B: 255

Output max: 255

Output gamma: 2.200000

LUT: 3 1024

0

0

.....

All lines prefixed by # are comments and ignored *except* that the comment line containing the source and destination bit depth (the first line here) is used by the system (it looks for the -bit suffixes and uses the numbers after them).

This format is preferred and should be straightforward to provide. However, in order to make it even easier to import LUTs from elsewhere, if the destination bit depth is not specified it will be deduced from the maximum value present in the LUT itself.

There is only one *header* line, starting with *LUT* and followed by two numbers:
The first number specifies the number of channels (3 for RGB, 1 for a single channel). The second number is the number of entries per channel *<e>* (which should be equal to 2 to the power of the source bit-depth – in this case 2^10, 1024).

Following that are *<e>* lines containing the entries for the first channel of the LUT, followed by another *<e>* lines for the second channel, etc.

7.6 To use an external LUT directly on the Codex

You can use the Codex UI running on a remote computer to import the LUT, as described above. Or, you can simply copy the LUT directly into the Codex using one of the methods for getting files onto the machine. The LUT should be placed in:

```
/etc/codex/luts
```

Once this is done you can LOAD the LUT from the LUT screen.

Note: LUTs for monitoring should match the source format (usually 10-bit) and the video output (always 10-bit).

7.7 CDL LUTs

All Codex recording systems can record CDL Data which is then carried with the files into post production. Studio systems can apply CDL Data to files which are output through the VFS. The colour correction systems currently supported by Codex systems are produced by Filmlight, DP Lights, and Digital Vision.

In order for CDL Data to be recorded a configuration file in the Codex filesystem has to have the correct option enabled (depending on which colour correction system is being used). Additionally the Filecard (filecard.xml) has to have a 'CDL Data' field added. The next sections explain how to make these changes:

7.7.1 Enabling the Codex machine for CDL Data recording

A file named sysconfig.conf controls various appended system features such as CDL support. This file may, therefore, not exist on older machines – if you need a copy of this file contact Codex support.

To enable this file for CDL support, access the Linux command line and promote yourself to a Superuser as described previously. Unload any Datapacks and stop the Codex software by typing:

```
telinit 3 <enter>
```

Now type:

```
vi /etc/codex/sysconfig.conf <enter>
```

To edit the file press 'i' to enter Insert mode. Find the line in the file which refers to the colour correction system being used and delete the # symbol at the beginning – this will enable the line. For example, a standard sysconfig.conf file will contain the line:

```
#DigitalVisionCDLEnabled
```

Which should be changed to:

```
DigitalVisionCDLEnabled
```

Only one of the lines referring to colour correction systems can be enabled at a time.
Press ESC to exit Insert mode and type:

```
:wq! <enter>
```

This will exit and save the changes. Now restart the Codex software by typing:

```
telinit 5 <enter>
```

7.7.2 Adding the 'CDL Data' field to the Filecard

A field named **CDL Data** must be added to the Filecard for the recording of CDL Data. Please refer to the Filecard section of this manual for information about changing the Filecard (filecard.xml) on Codex systems.

7.7.3 Recording CDL Data

To record CDL Data you must have one of the supported colour correction systems networked to the Codex machine. Once this is done, on the CONTROL screen specify the IP address of the colour correction system in the CDL Server field.

When you put the Codex machine into record mode it will gather the CDL settings from the CDL Server. If there is an error this will be reported on the Status Bar. Otherwise, when the Filecard is viewed after a recording has completed you will see the recorded CDL values displayed in the CDL Data field of the shot Filecard.

8 Offloading files from Codex systems

8.1 Introduction to Offloading

There are two principle types of storage medium which have been extensively tested for the offloading of material from Codex systems: hard disk (either singly or configured as a RAID), and LTO4 magnetic data storage tape. These two mediums require significantly different approaches, and as such will be dealt with separately.

The Codex software has an Offloader utility built into the Codex User Interface (Codex UI) which, when correctly configured, can connect to hard disk systems, the optional LTO4 drives in the Codex Lab and Portable Transfer Station, and LTO Autoloaders[1]. The purpose of the Offloader is to automate the process of archival as much as possible by using the Virtual File System (VFS) to generate file types in a structure which is specific to the requirements of a production. The Offloader copies these files automatically to either hard disk or LTO tape.

The Offload screen of the Codex UI is divided into two halves – the top half controls the Disk Offloader which interfaces with hard disk systems, and the bottom half controls the Tape Offloader which interfaces with LTO drives. The Disk and Tape Offloaders are driven by different parts of the Codex software and, due to the nature of hard disk (non-linear) and LTO tape (linear), the two parts of the Offloader operate in a slightly different way – this will be covered in the sections which follow.

Both hard disk and LTO4 tape have advantages, and productions will often be required to keep an LTO4 archive for insurance purposes. Data stored on LTO tape is stable for many years, and the initial outlay for individual tapes is relatively low. However, the data does need to be unarchived before it is usable. In comparison a hard disk allows fast access to material, but maintaining the data on hard disks over an extended period can be more costly. On balance there are good reasons for both options to be used, and the requirements and restrictions of each production will determine whether one or both of these archival methods provide the best solution.

When a Datapack is loaded the VFS will take a short time to compile, and for this reason it is advised to view the contents of the VFS via a networked computer with Explorer or Finder before commencing an offload. This also enables you to confirm that the contents of the VFS for offloading matches your expectation.

8.2 Transfer Rates

Transfer rates for offloading to LTO4 tape are generally limited by the write speed of the tapes – around 100MB/s would normally be expected.

Transfer rates for offloading to hard disk are dependent upon such a wide variety of factors that it is difficult to cover every possible scenario. The type of connection, operating system, file system, storage medium, and many more things can all have an impact. Each system needs to be dealt with on a case-by-case basis, but

[1]Codex has tested a range of Autoloaders and can provide a list of recommended makes and models.

through our own testing Codex is able to give an indication of the transfer rates possible when utilising certain hardware and software combinations. Please contact Codex if you want to discuss your requirements.

8.3 Offloading to a hard disk

8.3.1 Outline of compatible drive types, connections, and offload methods

Codex systems can offload to a range of drive types using different configurations and methods.

Device:	Connection:
USB hard drive	Locally attached via USB ports on Codex front panel
Network server	Networked via built in Gigabit Ethernet or optional 10-Gigabit Ethernet
Fibre Channel RAID	Locally attached via optional Fibre Channel card

Once the device is connected and the Codex system has been configured, offloading will normally be done using the Offloader utility from the Codex UI. Files can be copied from the VFS directory to an attached device using the Linux command line – this is no less efficient (in some cases it is more efficient), but does require more advanced knowledge of the Linux operating system and commands. Codex can provide advice on this.

An alternative option for copying files to a USB drive is to connect it to a computer which is networked to the Codex system. The codexvfs directory will be visible from the networked computer and files can be copied to the USB drive using a drag-and-drop method. While this is convenient, due to the transfer speed it is unpractical for significant amounts of full-resolution uncompressed files. Similarly, the drag-and-drop method may not be optimal for high performance RAID systems, which have a write-speed exceeding the possible transfer speeds of this connection.

8.3.2 File systems and interoperability

The table below identifies the supported file systems of the three main operating systems users will have to consider when dealing with offloads to hard disk.

Operating System	Fully supported file systems
Windows XP/Vista	FAT, FAT16, FAT32
Linux	FAT32, Ext2, Ext3, XFS
Mac	FAT32, HFS+

The suggested options, along with their limiting factors, are:

4.

5. **FAT32** if the drive is to be accessed in Windows and on a Mac. This has a 4GB file size limit which may prevent it's use if high quality proxies are required of lengthy shots (for example, a DNxHD185 Avid MXF file would exceed this size if longer than 173 seconds). Also if this filesystem is created in Windows there is a 32GB partition limit - but you can create larger partitions under Linux that are still accessible in Windows.
6. **XFS** if the drive is only to be accessed by Linux machines. This filesystem is faster to read/write than FAT32 and does not suffer from fragmentation issues. **Ext3** can also be used in this context, except on a high-performance RAID system.
7. **HFS+** if just for Mac.

N.B. NTFS formatted drives cannot be offloaded to directly as this filesystem is not fully supported under Linux. However, you can copy to an NTFS volume on another computer from over a network using the drag-and-drop method described above.

Additionally, the limiting bandwidth when offloading to a USB hard drives will almost definitely be the USB speed (unless its a very complex file type - e.g. lots of compression, colour conversion, scaling etc.) which is around 30MB/s, absolute maximum.

8.3.3 Determining the drive name (for formatting and/or mounting of a USB device)

Power up Codex system, do not load any Datapacks, and connect the USB drive. Typically with no other drives attached the USB drive will be assigned the drive name /dev/sdb1, but if you have other drives connected here is how to determine the drive name. Login as root and type:

```
fdisk -l <enter>
```

You will see all the drives and their partitions listed. One drive will be your USB drive.

```
Disk /dev/sda: 81.9 GB, 81964302336 bytes
255 heads, 63 sectors/track, 9964 cylinders
```

```
Units = cylinders of 16065 * 512 = 8225280 bytes

Device Boot      Start         End      Blocks   Id  System
/dev/sda1            1        1993    16008741   83  Linux
/dev/sda2         1994        2243     2008125   82  Linux swap / Solaris
/dev/sda3         2244        9964    62018932+  83  Linux

Disk /dev/sdb: 1010 MB, 1010826752 bytes
255 heads, 63 sectors/track, 122 cylinders
Units = cylinders of 16065 * 512 = 8225280 bytes

Device Boot      Start         End      Blocks   Id  System
/dev/sdb1            1         123      987104+  b  W95 FAT32
```

Here you can see that a 1GB drive is attached as sdb with partition sdb1 formatted to FAT32. If there is any confusion when using the above method then type

```
dmesg | tail <enter>
```

This lists the most recent system messages, including devices which have been attached – look for something like:

```
sdb: assuming drive cache: write through
sdb: sdb1
sd 4:0:0:0: Attached scsi removable disk sdb
```

This indicates that a drive has just been attached and that it is sdb1 - i.e. accessible as /dev/sdb1

8.3.4 Formatting a hard drive using Linux

USB hard drives will often come pre-formatted with a particular filesystem. If the filesystem is not suitable for your purposes the Codex system can be used to create a new partition and/or delete the existing partition.

During this process, the first thing to ensure is that there are no Datapacks loaded in the Codex system. This being the case, when a USB drive is connected it will be assigned the device name /dev/sdb (the Codex system drive is sda), and any existing partitions will be /dev/sdb1, /dev/sdb2, etc.

Logged into the Codex system as root, once you are absolutely sure of the drive name type:

```
fdisk /dev/sdb1 <enter>
```

To create a new partition type:

```
n <enter> and then
p <enter>
```

Using all the disk (cylinder 1 to max size - beware there may be limitation in disk size if it is a very large disk), then set the filesystem by typing:

```
t <enter> and then
83 <enter> for Ext3, or
b <enter> for FAT32, or
af <enter> for HFS+, and then
w <enter> to write this to the partition table on the disk.
```

You can delete and and/or reset the type of existing partitions. Once the partition has been created it needs to be formatted with the desired filesystem. To do this type:

```
mkfs.ext3 /dev/sdb1 <enter> for an Ext3 partition, or
mkfs.vfat -F32 /dev/sdb1 <enter> for a FAT32 partition, or
mkfs.hfsplus /dev/sdb1 <enter> for an HFS+ partition
```

N.B. It may be necessary to create an HFS+ filesystem partition on a Mac as mkfs.hfsplus is not available as a formatting option on older Codex system disks.

Linux RAID systems may be formatted with an XFS filesystem which is efficient for offloading – this procedure requires advanced knowledge depending on the RAID in question, and will therefore not be covered here.

The Codex Portable can be used to format USB drives to FAT32 and Ext3 file systems only. Additionally, if a USB drive is connected to a Portable without a Datapack loaded, the USB drive name will be /dev/sda1

8.3.5 Mounting/unmounting a USB device for offloading

Use the method described previously to determine the drive letter for the USB device. If the drive name was /dev/sdb1 then to mount the USB device, type:

```
mount /dev/sdb1 /mnt/usb <enter>
```

This mounts the USB device to the directory /mnt/usb which has been specified as the offload target by making the changes detailed in the previous section.

To unmount the USB device when you have finished offloading type:

```
umount /dev/sdb1 <enter>
```

8.3.6 Setting up the Codex to interface with a USB device

The Disk Offloader is configured as standard to interface with a Fibre Channel RAID. Follow these steps to reconfigure it for a USB device. Logged in as root, from the command line type:

```
vi /etc/codex/offloader.conf <enter>
```

Press 'I' to enter Insert mode and add the lines:

```
disable_mount
mount_point_dir /mnt/usb
```

Press 'ESC' and then type:

`:wq! <enter>` to write changes and quit.

8.3.7 Setting up the Codex to interface with a Fibre Channel RAID

The primary recommended storage when using the Disk Offloader is a Fibre Channel RAID, which will result in the most efficient file transfers. The Disk Offloader within the software is optimised to interface with a Fibre Channel RAID, and Codex can supply a Fibre Channel card which has been thoroughly tested with the system.

Note: the instructions below are only for configuring the Codex for use with a Celerity Fibre Channel card, which is the aforementioned tested card.

Within the Codex file-system there is a configuration file which must be set to contain the correct SCSI bus numbers for the Fibre Channel card. With a Fibre Channel card fitted follow the steps below to determine the correct SCSI bus numbers and edit the configuration file:

1. Access the Linux command prompt and log in using the instructions above.
2. Enter the following:
3. ls -l /proc/scsi/celerityfc
4. This will show the contents of the `celerityfc` directory, which will contain two other directories called, for example, 3 and 4. These are the SCSI bus numbers for the Fibre Channel RAID.
5. To view the configuration file enter:
6. vi /etc/codex/offloader.conf
7. This will bring up the configuration file which looks like this:

```
# Codex Offloader SAS configuration file
target          localhost
port            26000
vfs             /mnt/codexvfs
mount_point_dir /mnt/offload
first_scsi_bus 3
```

```
num_scsi_buses 2

xfer_chunk_size 1048576
```

8. The num_scsi_buses line should be set to 2 if you want to offload to two drives at once (mirrored), or disabled by adding a # at the beginning of the line if only the first bus is to be used. If the configuration needs editing press 'I' to enter Insert mode and then edit as required.
9. Press 'ESC' to exit Insert mode and type:

   :wq! <enter> to write the changes and quit

A Fibre Channel RAID can be hot-mounted and unmounted using the MOUNT/UNMOUNT button on the OFFLOAD screen.

8.3.8 Setting up the Codex to interface with a network server via Gigabit/10-Gigabit Ethernet

In addition to Fibre Channel RAID systems the Codex can also offload to networked systems connected via Ethernet – either Gigabit (Gig-E) or 10-Gigabit (10-Gig). Gig-E comes as standard on Codex machines, and a 10-Gig card is an optional extra. There are certain 10-Gig cards which Codex recommend and have been tested thoroughly with the system.
In comparison to the direct SCSI attached USB drive or Fibre Channel RAID, this type of connection uses one of several network protocols for data transfer. These various protocols, combined with the different hardware options available, can provide significantly different transfer rates – contact Codex if you need advice.

The Disk Offloader can be used to transfer files to a network server, but this method is not optimal and therefore is recommended for when material can be drip-fed across to the RAID throughout the day with the Disk Offloader in **Automatic** mode. To improve transfer speeds over a network the use of open source network protocol rsync is recommended – the set up of this is covered in Setting up rsync to copy files from the VFS to a networked RAID system.

First, the network server must be on the same network as the Codex. For information on networking to a Codex machine please see Working with Codex over a network.

Create an appropriate directory within /mnt to mount the network server to – as root, type:

```
mkdir /mnt/network-server <enter>
```

Then, to mount the network share of the RAID from the command line, type:

```
mount -t cifs //<ip address of RAID>/<shared drive> /mnt/network-raid
user=<username>,password=<password> 0 0 <enter>
```

The RAID system should now be mounted on the /mnt/network-raid directory. Now the offloader configuration file needs to be edited appropriately. Type:

```
vi /etc/codex/offloader.conf <enter>
```

Press 'I' to enter Insert mode and add the lines:

```
disable_mount
mount_point_dir /mnt/network-raid
```

Press 'ESC' and type:

:wq! <enter> to write changes and quit

To unmount the networked RAID after offloading type:

```
umount /mnt/network-raid <enter>
```

8.3.9 The hard disk offload process

The Disk Offloader is designed to synchronize the contents of everything in a certain part of the VFS onto removable storage. It can run automatically or manually (set the mode on the **SETUP / OFFLOAD** page). In **Manual** mode it performs back up only when you're on the **SETUP / OFFLOAD** page; in **Automatic** mode it runs in the background continuously, although priority is always given to recording.

The **Operation** field should normally be set to **Backup**. It can be made to **Verify** as well.
You should set the VFS Directory field to the sub-directory on the VFS that you want to back up.

Assuming you want to back up dpx files for each shot, in the VFS Configuration add a dpx **File Type** with a **Filename** something like this:

```
offload/{r}/{s}/{s}_{g%8}.dpx
```

Set **VFS Directory** field on the **OFFLOAD** page to 'offload' in this case. Anything in your VFS under the directory 'offload' will be backed up, so you can add mov files or other file types. On your external disk the top

level directory will be the roll name, {r}.

It is crucial to ALWAYS have the roll name as the top-level directory on the target drive as shown in this example. This allows multiple rolls to be backed up onto a single external target without conflict, and is important for the correct operation of automatic mode.

WARNING: If you attempt to back up a directory with a name which already exists on the target disk the Offloader will overwrite the pre-existing directory. If you incorrectly specify the VFS Directory field the Offloader can delete whole directory trees or the entire contents of the target disk. The best way to avoid this is to set up a share point on the network server so the Offloader only connects to the relevant part of the server, thereby minimising the potential for damage caused by misconfiguration.

The network server should have been prepared with a compatible file system and the Codex system configured to mount the device using the information in the previous sections. Once this has been done and the VFS is setup:

1. Go to the SETUP tab / OFFLOAD screen
2. Press the MOUNT button
3. In the Devices: field will appear either '/mnt/offload/0' (for Fibre Channel) or '/mnt/usb' (for USB attached devices) or '/mnt/network-raid' (for a networked RAID system)
4. Set the Offloader operation mode to Automatic or Manual as required
5. If not already done, load your Datapack(s) and give the VFS a minute to build the list of files for offloading
6. Before beginning the offload it is generally advised to browse the contents of the VFS directory you are about to offload using a networked computer. This is to confirm that the contents of the VFS matches your expectation (there are settings within the VFS which can effect this, such as Filters, for example)
7. Once the contents of the VFS has been checked press START. In Manual mode the operation will stop when you leave the OFFLOAD screen. In Automatic mode it continues until everything is up to date. Any shots already on the VFS will immediately be backed up. When synchronizing the contents of the target drive to the VFS, the logic of the offloader disregards any top-level directories which do not match the top-level directory specified in the VFS. This allows for previous offloads to be maintained, but does mean that if there is a matching top-level directory already on the external array that is no longer on the Datapack then it will be replaced. If the top-level directory does match, then any directories within it which do not match those in the VFS will be deleted. In Automatic mode, if you modify metadata for any shot already backed up, it will be replaced on the external drive with the new version. Any new recordings will start being backed up as soon as the recording finishes. The status display on the OFFLOAD screen tells you (roughly) how long it will take to finish.
8. Before switching off or disconnecting the drive, make sure the Offloader has finished or use STOP to stop it. Then unmount the drive – either from the command line if it is a USB drive or networked server, or using the UNMOUNT button if it is a Fibre Channel RAID.

8.3.10 Setting up rsync to copy files from the VFS to a networked RAID system

Codex machines have rsync installed as standard, but in order for this protocol to work an rsync server will need to be set up on the RAID. To download rsync for a Linux/Unix machine visit http://www.samba.org/rsync/. There is a Windows version of rsync, but it is not recommended due to it's poor performance.

The VFS should be used when copying files with rsync. For ease of use this should be arranged with a configuration where all files required are contained within sub-directories of a top level directory whose name is generated from the material Roll name.

The Codex machine running the rsync server will have a configuration file which specifies a destination path. This is the mount point for for the transfer. This configuration file can be found at `/etc/rsyncd.conf` and should be edited to look something like this:

```
[backup]
    path = /mnt/network-server
    read only = false
```

where raid is a short and memorable path to specify for the transfer.

The network server will need to be mounted internally to the appropriate directory using the command:

```
mount /dev/<RAID drives> /<path specified in rsyncd.conf>
```

Which in this case would be:

```
mount /dev/sdb /mnt/network-server
```

Note: for proper security on the network there are additional commands, but that is outside the scope of these instructions.

8.3.11 Offloading to a network server with rsync

Newer Codex machines have an rsync server configured from the factory. If you have an older machine and want to run rsync please contact Codex Digital for information. The configuration file for rsync is located in /etc/rsyncd.conf

From the Codex, access the Linux command prompt. Locate the directory that you wish to copy from the VFS – this will usually be the <rollname> directory which will contain sub directories (for audio, metadata, low-res proxies, etc.), but rsync will copy everything within the directory that is specified.

Once the rsync server is running on the network server and the machines are networked together, from the command line on the Codex type the following to begin copying files:

```
rsync -rptWv --size-only /mnt/codexvfs/<Roll for offload>  rsync://<destination>
```

The `destination` requires the IP address of the network server and the directory which the files will be copied to – this is determined by the destination path in `rsyncd.conf` (rsync can also create additional sub-directories as part of this process if required). Using the settings specified above, if the IP address of the network server was 192.168.1.150 then the whole command would be:

```
rsync -rptWv --size-only /mnt/codexvfs/101    rsync://192.168.1.150/backup
```

This would result in the entire contents of the top level directory being copied. This can be repeated at the end of every day as a standard back up procedure.

The rsync process can be stopped at any time from the command line by pressing CTRL-C. It can then be re-started when required, and won't re-copy things that have already been done.

8.4 Offloading to LTO tape

There are many LTO machines on the market, as well as the option to have LTO drives fitted in a Codex Portable Transfer Station or Lab. Depending on the set up being used by a production, the configuration file for the Tape Offloader will need to be edited accordingly – this is covered in the sections below.

8.4.1 Setting up the Codex to interface with an external LTO drive or Autoloader

The tape offloader configuration file needs to be edited depending on whether an external machine is being used for a single or a duplicate tape archive. By default the configuration file is set for duplicate archiving. To edit the configuration file, from the command prompt enter:

```
vi /etc/codex/tape_offloader.conf
```

The `active_drive_mask` line dictates how many devices will be used and, therefore, whether a single or duplicate archive will be created. This is a binary mask, indicated in the configuration file by the line above `active_drive_mask` which is commented out with a `#`. To change this for creating a single archive press 'I' to enter 'Insert' mode, and edit the line to read:

```
active_drive_mask 1
```

Press 'Esc' to exit 'Insert' mode and type:

`:wq! <enter>` to write changes and exit.

Third party LTO drives and Autoloaders can be connected to a Codex via parallel SCSI, which necessitates the installation of an optional parallel SCSI card in the Codex machine. The optional SCSI card has two ports, and when connecting to external dual drive LTO machines the specific details of which port is connected to which external device (LTO drive) does matter.

The process to ensure that the drives are connected correctly is as follows:

1. Connect the machines and switch on the LTO machine first. Wait until it has finished initialising before switching on the Codex. This may take several minutes. When the display on the LTO machine reports that it is 'ready' then switch on the Codex.
2. From the command prompt on the Codex type `mtx status` (`mtx` commands act on the robot which moves tapes within an LTO machine, as opposed to `mt` commands which act on the drives in the machine). This will report whether the various drives and slots have any tapes loaded.
3. If the first drive does not already contain a tape then load one. This can be done from a front slot on some LTO machines using the machine's menu options. Alternatively, after running the `mtx status` command you will know which slots contain tapes and can run a `mtx load <source> <destination>` command. For example, if slot 6 contained a tape you would type `mtx load 6 0` to load the tape from slot 6 into the first drive.
4. If the second drive is not empty you will need to eject the loaded tape. Again, you may be able to do this from the machine's menu. If not, type `mtx unload <destination> <source>`.
5. Now that the status of the drives has been confirmed, to make sure the drives within the LTO machine are mapped correctly to the SCSI card in the Codex, type `mt -f /dev/nst0` which will display the status of the drive which is mapped to the first SCSI port on the Codex. This should now contain a tape.
6. To double check that the second drive is mapped correctly type `mt -f /dev/nst1`. This drive should be empty.

7. If the drives are mapped the wrong way round then swap the cables within the Codex.

Additionally, there are certain settings which should be changed on an external tape drive or Autoloader to guarantee maximum integrity for offloading.

With the Codex and LTO machines connected, powered up, and the Codex connected to the internet enter:

```
yum install sg3_utils
```

Then enter:

```
sg_wr_mode --contents=18,06,06,00,00,00,00,00 -d -p18      /dev/nst0
```

This will reset the TLR bit for the first tape drive. If two drives are being used then repeat this command, but change the end of the command to read `nst1`.

8.4.2 Setting up in-built LTO drives in the Portable Transfer Station or Lab

The Portable Transfer Station can be purchased with one or two optional in-built LTO drives. If these are purchased then the machine will be configured to recognise these drives automatically. Machines fitted with two LTO drives will be set for duplicate backups – if you want to do a single backup follow the instructions at the beginning of the previous section on how to edit the configuration file.

For start-up it is imperative that the lower half of the Portable Transfer Station is powered and switched on before the top half. As the Codex software starts it will scan for the LTO drives and initialise them as they are recognised.

8.4.3 General Information and Important Checks for LTO offloads

It is highly recommended to use LTO tapes with barcode labels – Codex can supply these for a competitive price. While the LTO drives in the Portable Transfer Station cannot read barcode labels, the majority of LTO autoloaders can and using labelled tapes will simplify the offload process and the cataloguing and organisation of a tape archive. The following information should be fully read to understand the LTO offload process, the checks required, and the limitations.

1. Check the VFS before starting an offload

The tape offloader operates on the VFS, not at a per Datapack level. When you load a Datapack the shots are built into files on the VFS according to your VFS setup. The directory structure may be influenced by metadata in the shots, including Scene, Take, Roll etc.

One common situation is having more than one Roll on a single Datapack, for instance when working in parallel with video tapes having a lower capacity. This would not be obvious other than by looking at the VFS (the Roll display on the STORAGE tab indicates the most recent roll setting).

When you start an offload, you may well be restricting the offload to a particular subdirectory in the VFS, often a top level directory named after the Roll. In this case, only shots with that Roll identifier will form part of the archive. If for any reason there are shots on the Datapack with another Roll, either intentionally or by accident, you may incorrectly assume the entire Datapack has been archived when in fact only a part of it has.

The only way to guard against this kind of error is to visually check the VFS against your expected shot list, before starting the offload.

In any event, this is a good opportunity to run through the metadata for each shot to check it is all correct and that you have all the shots you expect.

2. Recommended configuration

To be more explicit about the issues mentioned above: the easiest way to use the Tape Offloader is to offload a Datapack at a time, with each Datapack containing a single Roll perhaps representing a days work. With a VFS set-up with the Roll as the top level directory and with each file format in a separate subdirectory under which there is a per-shot folder which also includes a unique id (which all shots are allocated) to prevent accidental clashes due to duplicate names, Rolls or timecodes.

For instance from the VFS sub-page off the control page:

```
dpx          {r}/{e}/{r}_{s}_{u}/{r}_{s}_{g}.{e}
wav    {r}/{e}/{r}_{s}_{u}/{r}_{s}_{c}.{e}
xml          {r}/{e}/{r}_{s}_{u}/{r}_{s}_{g}.{e}
```

where:

```
{r}    rollname
{e}    extension
{s}    shotname
{u}    unique id
{g}    frames since midnight
{c}    channel id
```

This ensures a uniform structure to archives and that, because the filepath is stored in the archive, there is enough information in the archive to search for frames and shots matching on shot, roll or timecode.

3. Verification

When in Backup+Verify mode, a tape verification pass is performed which doubles the overall time required for backups. This verification checks what is read back from the tape against a precalculated checksum for each filemark. So verify confirms that what was originally written to the tape is what is on the tape, and that the tape is physically readable. It does NOT and cannot check that what is on the tape is what you expected! Hence the importance of performing additional checks as part of your archive routine.

4. Do not change anything during a tape offload

Please do not load or unload any Datapacks, or change any shot metadata (using a remote UI for instance) during an offload.
If any of these things occur during the offload, then you will be warned, and asked if you want to restart from the beginning with the new VFS setup, continue with the original list of files to offload or abort.

5. How to tell which tapes have been used

At the end of the offload you will be told which tapes have been used during the offload.

The file /etc/codex/tape-offloads/tape_list.log contains a complete list of all tapes successfully written to, when and what was archived to them. It also lists tapes that couldn't be used (due to write protected or read/write errors etc.). The Tape Offloader will not re-use any tapes in this list.

This file can also be edited - e.g. if you remove write protect on a tape that couldn't be used and want to re-use it, just remove it from the file).
The TOC files for each archive also contain the tape numbers and more (see below for more information).

6. Checks to perform when the offload is complete

As an additional safety check, we recommend you compare the TOC files for each archive against your original shot list, BEFORE re-using the Codex Datapack.

By networking to the Codex you can access the TOC files on the Codex system drive. When connected to the codex as 'root' please take extra care not to accidentally drag-and-drop any directories!

Each tape archive is recorded in a directory /etc/codex/tape-offloads/tape-archive-<nn> where <nn> increments for each new archive.
Inside that directory are subdirectories for each tape drive used in the archive (nst0, nst1 etc)
In those directories there are files called <tapebarcode>.TOC

The TOC for each tape in the archive contains the file listing for all the tapes.

If you load the TOC for the last tape into a text editor (Wordpad in Windows or Textedit in OSX) and skip to each Filemark entry (there are ~100+ per LTO3 tape) you can see which shots were included.

7. Additional QA checks

The checks in (6) are the bare minimum - another highly recommended step is to look at some of the archived material, just as you would do as a matter of course with video tape or film.

This is especially important if you are not keeping any other online disk copy of the material.

A random unarchive of a few tar files each day and a quick scan through the frames would provide confidence that everything is still set up correctly.

For the purposes of unarchiving material there are several scripts which are installed as standard on Codex machines. These scripts are written for material archived with a particular directory structure. If your production's archive directory structure differs from that mentioned in section **2. Recommended configuration** then these scripts will need alteration to work correctly. Details of the scripts and how they can be used are in the later section Unarchiving material from LTO tapes archived on Codex.

8. Cleaning up

If you run a lot of Datapacks through a system, you may end up with a lot of cached shot metadata on your system drive (known as 'offline shots'). Eventually this can cause the system to become sluggish. You should periodically 'delete all offline shots' using the user interface function on the management page. Note this only deletes the cached metadata, it doesn't delete any actual material.

In the current offloader build 0.99g, a lot of files are left in /etc/codex/tape-offloads/tape-archive-<nn> directories. This includes the .TOC (table of contents) files for the tapes which you might want to preserve – although these are also written to the tapes, they are easier to access while on the Codex, and the post house dealing with the tapes will appreciate these being delivered on a separate hard drive along with the tapes. These can easily be copied across from the Codex using Windows Explorer or Mac Finder if they are required.

The other information will need to be periodically tidied up. This can be done from the Codex command line if you know basic Linux commands, or through Samba connected to the Codex filesystem (carefully).

9. Some known bugs

These apply to 0.99g:

- Time remaining display can be inaccurate - particularly if lots of small files and/or not a DPX file based offload.
- There is no easy way to offload multiple rolls each onto their own set of tapes. At the moment each roll must be done as a separate offload, or set the VFS base directory to offload everything onto one set of tapes.
- Using the getframes.sh script to unarchive frames to disk from a tape offload can unarchive twice as much of the material as you asked for.

Although not a bug, another thing which may affect LTO backups is discontinuous or repeating timecodes within a shot. These may result in small numbers of frames being archived into a Filemark on the tape, which will slow down both the archiving and unarchiving of this material.

10. Tape drive connection

At the moment we only support an auto tape changer with a common set of tapes that one or two tape drives can access OR one or two single tape drives (with manually inserted tapes).

If using two tape drives, then 2 complete offload copies will be produced - one per drive. A single offload cannot be performed across two tape drives.

When connecting a multi-drive tape autoloader, please ensure that the 'first' drive (check your autoloader manual) is connected to the first SCSI bus and the second drive to the second SCSI bus. If they are daisy-chained onto a single SCSI bus, ensure the first drive has the lower SCSI ID.

11. Drive faults / cleaning

You should see an average of at least 50-60MB/s on LTO3 and 80-90MB/s on LTO4 for both writing and reading.

If your offloads are taking substantially longer than this (taking into account the verification pass), the drive may be getting worn or require cleaning.

If you experience any tape failures you should also clean the drive, as normally recommended by the tape drive manufacturer. Tape failures should be very rare, if you have a lot of them then it probably indicates a faulty tape drive.

Codex can perform low-level drive performance tests and advise if you are experiencing performance problems.

12. Offloader configuration

As previously mentioned, there is a configuration file /etc/codex/tape_offloader.conf with various setup options. These control things like the number of drives to use (which equates to the number of copies made), how to deduce tape type if not obvious from the barcodes, and the number of files in each tar archive on tape. We can provide assistance in initially setting up this file for your hardware configuration.

8.4.4 The LTO Offload process

With all of the above considered, the process of archiving to tape is relatively simple. With all devices configured and connected correctly, on the **OFFLOAD** screen press **MOUNT**. The **Tape** field will report either **nst0** or **nst0 and nst1** depending on if there are one or two LTO tape drives connected. Specify the **VFS Directory** for the offload and press **START**. If you are using a Portable Transfer Station with in-built LTO drives you will be required to enter the barcodes for the LTO tapes as they are loaded. If the offload will require more than one tape for each copy then you will need to be present to load subsequent tapes during the process.

If you have loaded sufficient tapes into an autoloader which reads barcodes then the process can be started and left to complete.

8.4.5 Format of tape offloads

Format of table of contents (toc) files written to tape:

The toc files (table of contents) are written as the first file on each tape of an offload. They are also stored on the system drive of the machine doing the offload under /var/log, in a unique directory of the format tape-archive-nn (where nn is a unique number) under which there is one or more subfolders for each drive an offload was made to (e.g. for a single tape archive there might be just an nst0 folder, but for 2 copies of an offload there would be a nst0 and nst1 folder) on the machine that the tape offload was created on.

It is strongly advised to copy these TOC files from the Codex system drive to another storage location after each offload (they can be dragged and dropped onto the hard drive of another computer if it is networked to the Codex). They will be required for the location of material within your tape archive and, although they can be unarchived from the tapes themselves (a slow process), having them in two easily accessible locations gives security in case there is a problem with the Codex system drive, and if a separate system is being used for unarchival then having these files is essential.

These TOC files list the Filemarks on the tape and the files contained within these (commonly dpx frames, but perhaps also mov files or other low res proxies). They also include the other tapes used in that offload if it spans over more than 1 tape - and also indicate which tape this is the table of contents for (so this should

match the barcode on the tape).

Everything written to tape is done wrapped in a tar file. Some files, e.g. dpx's, are bundled together into larger tar files in order to keep the tape running as near its maximum speed as possible - otherwise the offload would take a huge amount of time to complete. Currently the best settings for writing tapes we have found is to switch compression on (e.g. mt -f /dev/nst0 compression 1), set variable block size in hardware (e.g. mt -f /dev/nst0 setblk 0) and read/write with tar using a 64k block size.

As things are tarred up, after each Filemark (i.e. files on tape) there is a list of files in that tar, divided by a dash. For dpx's there may be say 500 source dpx's in one file.

When the files are archived to the tape, we include the path they were copied from, e.g.

055/dpx/055_128_524_1_ce830679-2108-4a51-88da-8da12c631479/055_128_524_1_1213915.dpx

The file path should be based on the following format

<rollname>/<filetype>/<rollname>_<shotname>_<unique-shot-id>/<rollname>_<shotname>_<frames since midnight>.<extension>

So that:

1. if we search all of the tapes table of contents files, we can find where all files for a particular roll or shot are,
2. when unarchived, with the unique shot id, you can't overwrite a shot accidentally given the same name/have a filename clash
frames since midnight and rollname mean you can search for timecodes (converting from frames since midnight at the correct frames per second) and rolls.

8.5 Unarchiving material from LTO tapes archived on Codex

Note: to allow maximum interoperability with the tape offloads, the tar files are created with a block size of 64k - when you unarchive be sure to use the b 128 option which specifies this.

Codex provide some useful Linux scripts for the unarchiving of material from LTO tape – these can be found in the /home/codex directory of the Codex.

tapearchive.sh - is called by the Tape Offloader to performing copying and tar'ing from disk to tape.

tapeverify.sh - is called by Tape Offloader to verify the files on tape by comparing the md5 checksum generated by reading them again with the md5 checksum created when they were written.

findtape.sh - used on command line in Linux to find which tape a shot/roll/timecode is on

getframes.sh - used on command line in Linux to load tape and copy files from it.

These scripts could also work on a machine say in the post-house accessing the frames - however in order to work there, ALL of the table of contents files from the tape-archive-nn subdirectories in /etc/codex would have to be copied into /etc/codex on that machine too.

Additionally Codex recommend that the same Linux distribution is used on this machine to remove the likelihood of problems due to compatibility.

By running findtape.sh (which uses toc.awk) you find on which tape(s) and where on that tape a shot/roll/timecode section is, e.g.: at the command line (either open a virtual terminal on the machine itself by typing, say, ALT-CTRL-F1 and logging on as user root, password codex OR connect with a putty ssh session as user root, password codex):

```
cd /home/codex
./findtape.sh -v shotname="128_488_1"
```

Might display:

```
Results
Nov 7 10:44 (./tape-archive-98/nst0/KAM104L4.toc)
Tape: KAM104L4 marks: 1-4 201 235
Nov 7 10:40 (./tape-archive-98/nst1/KAM105L4.toc)
Tape: KAM105L4 marks: 1-4 201 235
```

This means the shot is on two tapes (2 backups) and there is data related to that shot in file 1, 2, 3 and 4 and file 201 and file 235. In this case files 1-4 contain the dpxs and file 201 has the audio data and 235 contains the xml data. So you could load, say, tape KAM104L4 into the tape changer, and then use getframes.sh to get all the frames from that shot, e.g:

```
./getframes.sh KAM104L4 1 4
./getframes.sh KAM104L4 201
./getframes.sh KAM104L4 235
```

This will then search for the tape in the tape loader and if present extract all the dpx frames and place them in a directory structure underneath /home/codex - e.g. /home/codex/052/dpx/052_128_488_1_eabc0a03-f589-425f-8112-e13e7bd2a28c. You can then view them using a dpx viewer, or copy them to where ever.

N.B. There is limited space on the system disk of the Codex (which is where the dpx's are unarchived to) so you may need to copy them off bit by by.

You can also search for rolls, e.g:

./findtape.sh -v rollname="22"

or timecodes:

./findtape.sh -v rollname="22" -v timecode1="14:17:15:09" -v fps=25

or sections of timecodes:

./findtape.sh -v rollname="22" -v timecode1="14:00:00:00" -v timecode1="15:00:00:00" -v fps=25

Note that with timecode searching you need to specify frames per second, unless its 24fps which is the default.

The other script, getframes.sh, is used to load tapes and untar files into the current directory. Just pass in tape name and start (and optional end) filemark and it will search for the tape, load it, and shuttle to the correct place and copy files off tape onto harddrive (under the directory you run it from).

If you are running getframes.sh on a Codex Recorder or Transfer Station then material unarchived from LTO will be stored on the system hard drive. There is a partition on the system drive which is recommended for this purpose, and will allow for the storage of approximately 10 minutes of dpx files (an additional 1TB drive can be fitted for this purpose – contact Codex for further details) . Follow these steps to mount the partition:

mount /dev/sda3 /mnt/material

Then go to the mounted directory:

cd /mnt/material

And run the getframes.sh script in order to unarchive material:

/home/codex/getframes.sh <tape name> <start filemark> <optional end filemark>

Once you have finished with the material it can be deleted from /mnt/material using the dpxdelete.sh script.

8.6 Installing/updating the Offloader and Tape Offloader software

The latest software packages for the Disk Offloader and Tape Offloader can be downloaded from www.codexdigital.com/software under the heading **Other Codex Software**.

Once you have downloaded the file use Explorer or Finder to access the Codex file system and copy the package to the /tmp directory. As an example, let's say you have downloaded the offloader-0.99g-sas.tgz package. Once it has been copied into /tmp access the Linux command prompt. Login as root and enter:

cd /home/codex

Then enter:

tar zxf offloader-0.99g-sas.tgz

This will unpack the file within the directory. Then enter:

cd offloader-0.99g-sas

You will now be in the directory for installation, from where you enter:

./install

The new offloader software will now be installed. As a matter of course, once the software is updated you should delete any unnecessary files from the install process. To do this, enter:

rm -f offloader-0.99g-sas.tgz

And:

rm -f offloader-0.99g-sas

9 Setting up a ssh reverse tunnel

For problem solving in unusual circumstances it can be useful for a Codex engineer to connect to the system over the internet – a reverse tunnel facilitates this. A script is installed on Codex systems to assist in setting up a reverse tunnel.

First, make sure the Codex system is on a network which can access the internet. Logon to the Linux command line and promote yourself to *root*. Then type:

```
cd /home/codex <enter>
```

Followed by:

```
./codex_help.sh -port 2222 <enter>
```

You will be asked for a password – contact Codex for this.

If a problem occurs with any of these steps then contact Codex support for advice.

10 Appendices

10.1 Metadata Property Names and Labels

User-Friendly Label	Metadata Property Name	Synonym	Usage
Production	ProductionName		Setup / Project
Production Company	ProductionCompany		Setup / Project
Unit	ProductionUnit		Setup / Project
Director	Director		Setup / Project
DoP	DirectorOfPhotography		Setup / Project
Camera Assistant	CameraAssistant		Setup / Project
Codex Operator	CodexOperator		Setup / Project
Sound Recordist	SoundRecordist		None by default
Name	ShotName	{s}	Filecard, Setup / Slate Naming Rule
Roll	OriginalRoll	{r}	Storage, Filecard
Scene	Scene		Filecard
Take	Take		Filecard, auto incremented
Shot	Shot		None by default
Slate	Slate		None by default
Circle Take	CircleTake		Filecard
Shot Type	ShotType		Filecard
Interior/Exterior	IntExt		Filecard
Day/Night	DayNight		Filecard
Comments	Comments		Filecard
T-Stop	Tstop		Filecard
Focus	Focus		Filecard
Lens	LensType		Filecard
Filter	Filter		Filecard
Source Type	SourceType		Setup / Sources
Source ID	SourceId		Setup / Sources
Source Name	SourceDevice		Setup / Sources, Filecard
Serial No	SourceSerial		Setup / Sources
Shutter Angle	ShutterAngle		Filecard
Snapshot	Snapshot		Set to "Yes" by snapshot record function

10.2 Single-letter tokens applicable to VFS only

{s} Synonym for {ShotName}
{d} Date shot was recorded
{D} Date and time shot was recorded
{f} Frame number
{e} Extension (file type)
{c} Channel number (Video and Audio)
{t} Timecode (as hhmmssff string)
{T} Start timecode of shot

{g} Timecode (as framecount from midnight)
{G} Start timecode (as framecount from midnight}
{n} Total number of frames in the shot
{b} Userbit per frame
{B} Start userbit for shot

10.3 Single-letter tokens applicable to both VFS and Shot naming rule

{w} Width (VFS: after any scaling)
{h} Height (VFS: after any scaling)
{u} Uuid (128-bit unique identifier of every shot – xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx)
{r} Synonym for {OriginalRoll}

Tokens can optionally have a minimum and/or maximum width specified for the expansion. This is most commonly used with tokens that produce numbers, but work with any single-letter token.

To specify a *minimum* width n add %n after the token.
To specify a *maximum* width n, add -n after the token

Examples:

{f} Frame number 0-99999
{f%5} Frame number 00000 – 99999
{r} Roll (“A long name”)
{r-8} Roll (“A long n”)

10.4 The {Datapack} token for Roll Naming Rule

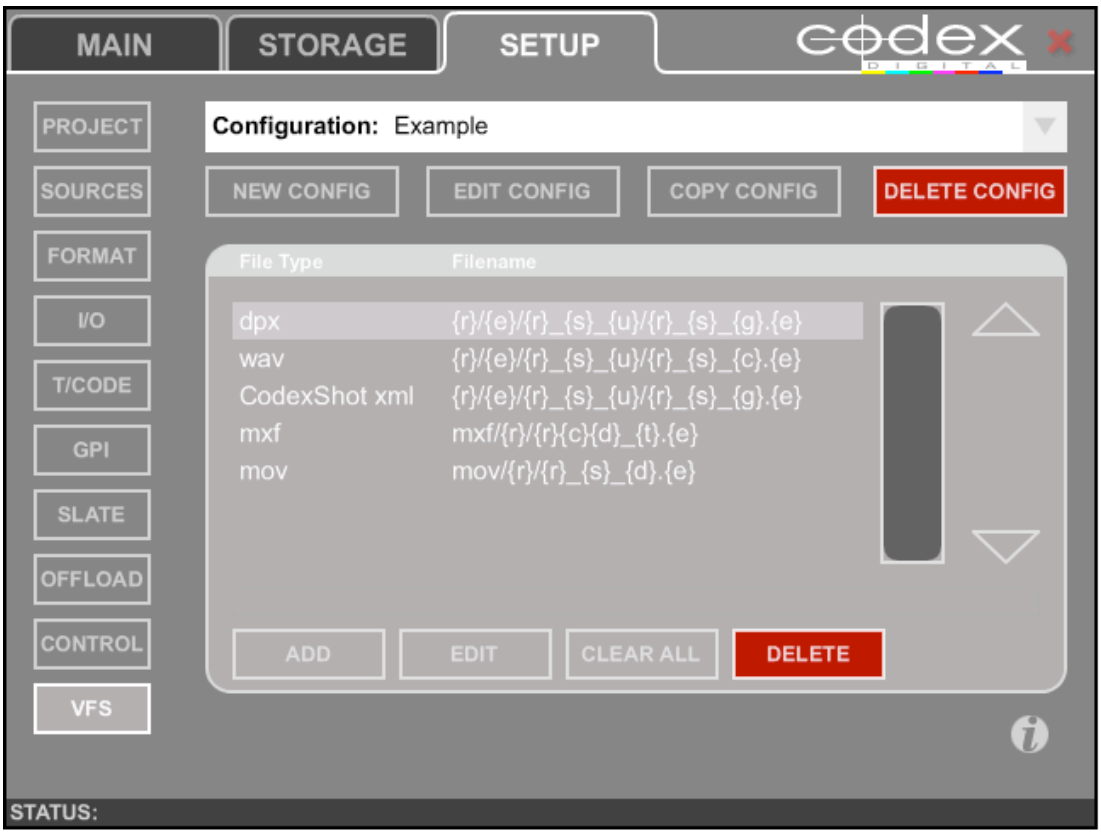
The {Datapack} token can be used only for the Roll Naming Rule. It refers to the Roll name on the STORAGE tab. When shooting multiple sources on a single Datapack (using a Codex Portable) the Roll Naming Rule can be set to {Datapack}{Source ID} which ensures that shots will have unique Rolls – a requirement for some editing systems, particularly when working with stereoscopic material.

10.5 VFS Case Study

The VFS configuration can initially seem quite confusing. As such, the following example and explanation is provided. The following example VFS configuration was designed in communication with the various end users of the files to maximise clarity for the users and minimise problems downstream when using the files in a variety of well known software. It was designed for a specific production workflow, so will not be appropriate for all scenarios, but should provide a good example of the way in which the VFS can be used and some important things to consider when configuring the VFS for use with your production.

In this example, the Shot Naming Rule is set to {Scene}-{Take}. There are 2 Rolls named 101 and 102. Each Roll contains several Scenes and Takes.

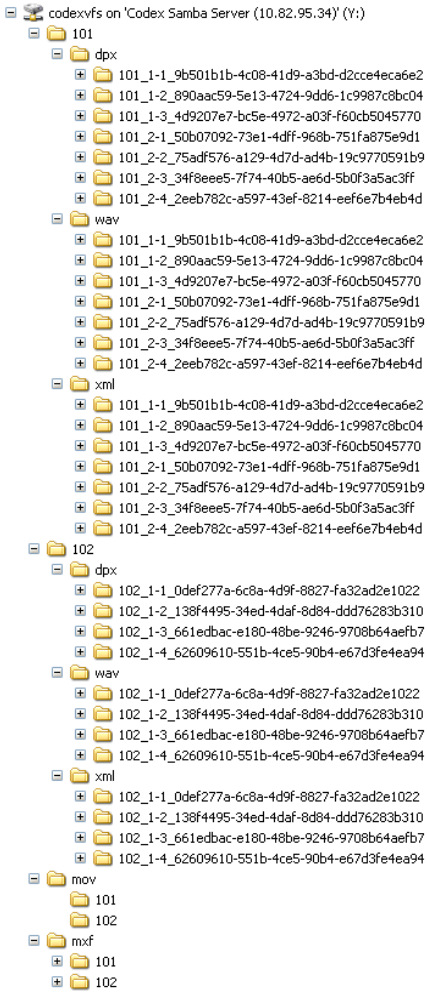
Below is the VFS configuration as viewed from the Codex UI:



This configuration is designed to make the following operations easy:

- the backing-up of material (as dpx frames, associated wav files, and xml files containing additional metadata) to either a RAID Array or LTO Tape Machine using the OFFLOAD screen.
- the copying of Avid MXF files to a USB/Firewire hard drive via a laptop, for delivery to the offline editor.
- the copying of mov files to USB/Firewire hard drive, which provides an easy access reference library of what has been shot for the Director or Cinematographer.

The configuration above would result in the following directory structure:



As can be seen, the first level of the directory tree consists of directories named 101, 102, mov, and mxf. In this first level, the directories named after Rolls contain directories of dpx, wav, and xml files for individual shots[2]. This is designed to make backing-up simple using the OFFLOAD page. It means that when offloading to either a RAID Array or Tape Machine, the Roll name can be entered into the VFS Directory field of the OFFLOAD page and the entire contents of that directory will be backed-up. In this case, that would be all full resolution dpx frames, associated wav files, and xml files containing additional metadata which will be unarchived[3] when the time comes to do the conform and online edit.

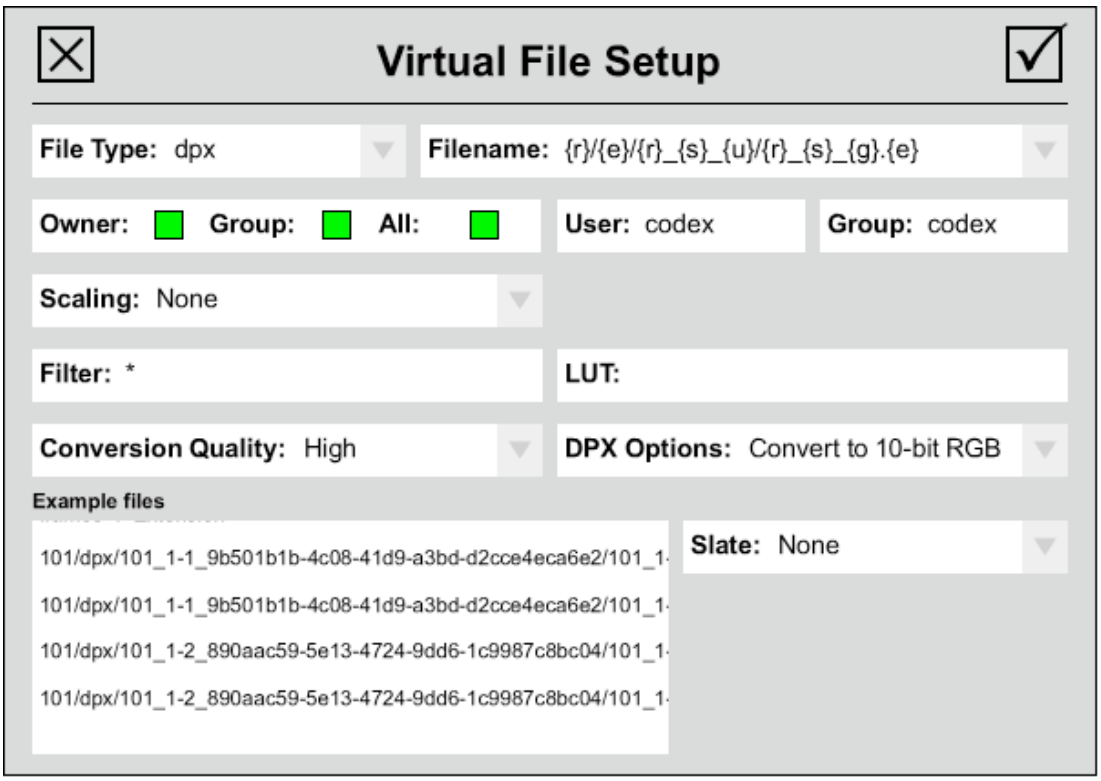
In terms of the day-to-day production process, the morning's shots can be copied across to separate hard drives as Avid MXF and mov files at lunch time, and the afternoon's shots immediately after shooting has finished for the day. The drive containing Avid MXF files can then be sent to the offline editor. Once this has been completed then the RAID/Tape archive process can be started, and left to run overnight.

It is not advised to try and create the mov/Avid MXF files and the dpx/wav/xml files simultaneously as this will place great demand on the processors in the Codex and drastically slow the whole process down!

10.5.1 DPX Virtual File Setup

The Virtual File Setup for dpx files is as follows:

[2]The long series of numbers and letters is generated by the {u} in the VFS Filename settings for each file type. It is a unique shot identifier which is not compulsory and most of the time will be ignored, but rules out the possibility of having duplicate shot names within the VFS.
[3]Please refer to the document 'Offloading Files from Codex' which can be downloaded from http://www.codexdigital.com/techdocs for comprehensive information on this subject.



The first thing to note with this Virtual File Setup is the Filename. The last Token, {g}, gives the frames since midnight. This creates dpx files which are sequential, as opposed to using {t} which gives the SMPTE timecode at the end of the file name, which is non-sequential. SMPTE timecode should not be used because there are two major problems with using non-sequential filenames for dpx files:

- when loading files, most editing systems require sequences of frames to be consecutively numbered. If SMPTE timecode is used, the sequence will break every 24 (or 25, or 30) frames, meaning you will either have to load 1 seconds worth of frames at a time, or re-name all the files – both bad options.
- when archiving to tapes, a non-continuous sequence will cause the tape drive to pause at every break, vastly increasing the time it takes to write the tape.

Conversion Quality should always be set to High if the files created are to be used for the final online edit. The DPX Options should be set to Convert to 10-bit RGB if the final edit will be in 1920x1080HD. If source image output is a higher resolution than this (e.g. Arri D-21 in ARRI-RAW 12-bit data mode [2880x2160]) then this option should be set to Keep Existing Format. This means the dpx files will be left in their original Bayer pattern format, which after unarchiving will normally be de-Bayered by specific software before being edited[4].

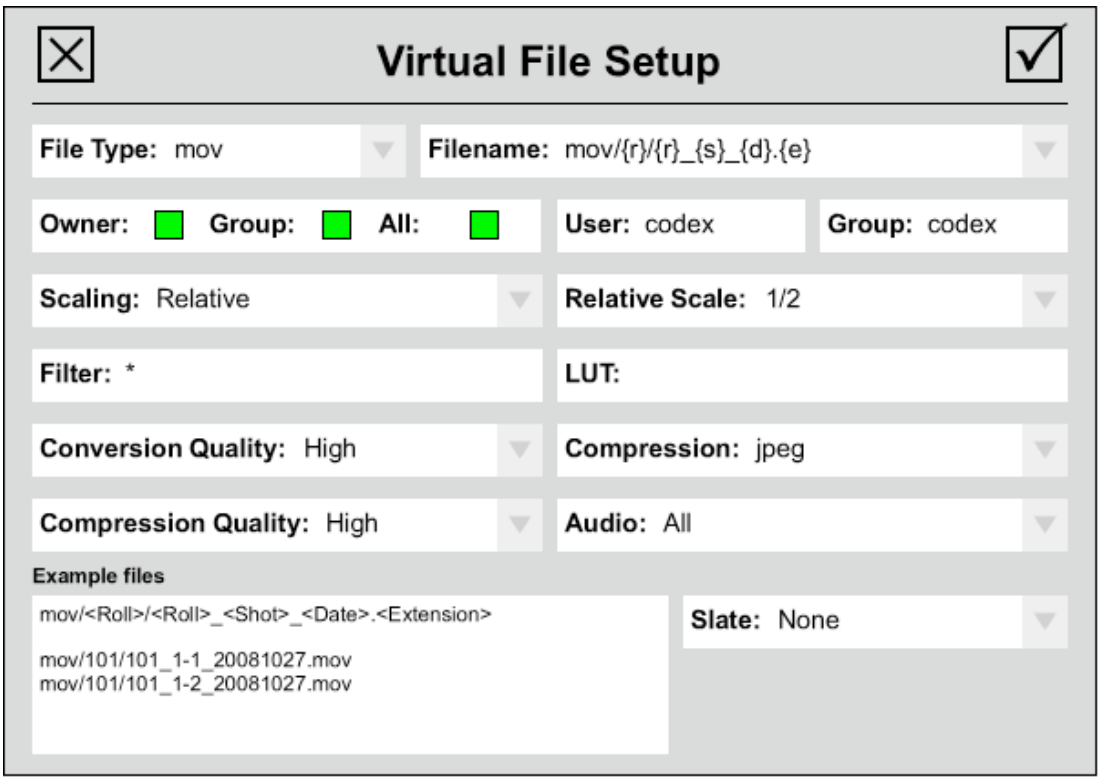
10.5.2 WAV Virtual File Setup

The main option to be concerned with is Audio, and whether this has been set to Mono or Stereo. The number of files presented by the VFS will depend on the settings of this option, and how many audio channels have been recorded. For example, if you have recorded 6 channels of audio, and the VFS is set to present the wav files in Stereo, then for each shot there will be 3 corresponding stereo audio files.

10.5.3 MOV Virtual File Setup

The directory named mov contains sub-directories for each Roll, which in turn contain individual Quicktime movie files of each shot on that Roll. These Roll directories can be copied across to a local hard drive at the end of a day's shooting and can be very useful for the purposes of the Director/DoP. For example, if the Director wants to review a shot from the previous week they can do it extremely quickly and easily from their laptop[5]. The settings for the mov files are as follows:

[4]The Codex does perform real time 'quick' de-Bayering for monitoring of such material, but we recommend using dedicated software for a full quality de-Bayer before post-production/editing.
[5]The alternative would be to copy the material back from a RAID Array which may not be conveniently situated, or to unarchive the shot from tape, which is a considerably longer process.



The Filename for the mov files is designed to allow for the easy location of a shot. For example, if the Director wishes to review a shot they can consult the Script Supervisor's notes and locate the Shot they wish see based on the Roll, Scene, Take, and Date (in this case remembering that the Shot, or {s}, in the Filename consists of the Scene and Take numbers).

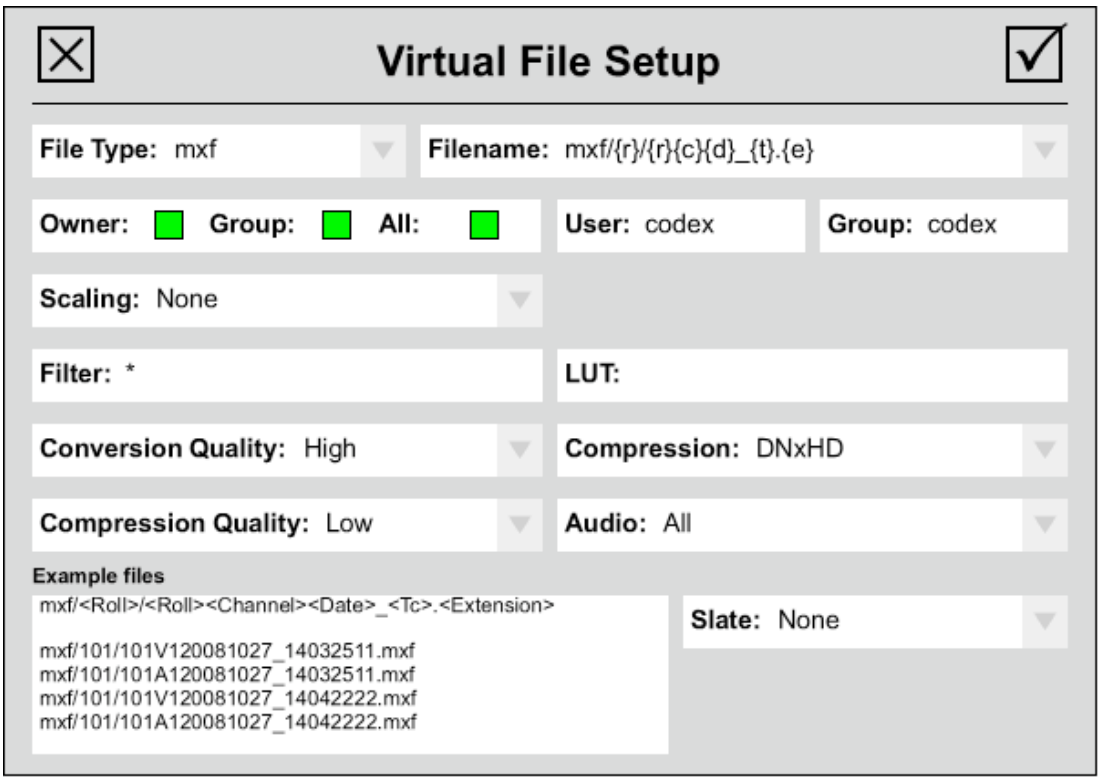
Scaling is set to Relative and ½ size. This is because most computers will struggle to play full scale mov files, whereas ½ scale is generally manageable and of a size which is useful for review purposes.

Compression is set to jpeg to reduce the mov file size, and unless the laptop being used for viewing has an HD screen then the difference will not be noticeable, provided the Compression Quality is set to High. If Compression Quality is set to Medium or Low this will create considerably smaller files (approximately ½ or 1/3 the size), but you will notice some slight blurring on edges.

10.5.4 MXF Virtual File Setup

Similar to the mov directory, the mxf directory contains sub-directories for each Roll which in turn contain Avid MXF files for each shot (separate video and audio files). These Roll directories would be copied across to a USB/Firewire hard drive via a laptop to be delivered to the offline editor at the end of a days shooting.

The Virtual File Setup for Avid MXF files is as follows:



The Filename is the most important thing to note in this case. It is modelled on the mxf file names created by Avid, and ensures that the names of the individual mxf files will never exceed 31 characters: a threshold which if exceeded is prone to causing trouble if the files are used in Avid editing systems.

The DnxHD Compression setting creates files of a small and manageable size, whilst retaining sufficient quality for the offline edit. The Compression Quality setting changes the bit-rate (and, hence, size) of the file. When set to Low the VFS will create DNxHD36 (36Mb/s) files, on High it will create DnxHD185 files.

If you require more information or advice on setting up the VFS please contact Codex Digital using the details at the end of the manual.

10.6 Loading an ALE/EDL from a USB stick or over a network

Follow these steps to load an ALE/EDL from a USB stick:

1. Copy the ALE/EDL to the top level of a USB stick using a computer (i.e. Not within a folder).
2. Insert the USB stick into one of the USB ports on the front panel of the Base Unit.
3. Plug a USB keyboard into the other USB port on the Base Unit.
4. Press CTRL-ALT-F1 to access the Linux screen (if the machine does not have a touchscreen there is a free program called putty which allows you to access the Linux screen of the Base Unit from a networked computer).
5. Enter the username root and password codex
6. The USB stick will automatically be assigned with a drive letter. This will depend on how many and which types of Datapack are loaded into the system. For example, a Rugged Datapack containing 3 hard drives would be assigned letters 'a', 'b', and 'c', and the USB stick would therefore be assigned letter 'd'. To determine which letter has been assigned to the USB stick type the command fdisk -l. This will present a list of the loaded devices (/dev/sda1, /dev/sdb1, etc.), of which the USB stick will be the device with the lowest number of Blocks. Note which device is the USB stick.
7. If, for example, the USB stick is /dev/sdd1 then type

   mount /dev/sdd1 /mnt/usb
8. Press CTRL-ALT-F7 to return to the Codex UI screen (unless it is already running over a network)
9. If using the CONFORM feature, for example, press the button and when asked to specify the Filepath enter /mnt/usb/<filename>.edl
10. Once you have finished using the USB stick return to the Linux screen and type umount /dev/sdd1 /mnt/usb to unmount the USB stick before removing it.

Follow these instructions to load an ALE/EDL over a network:

1. As standard, the IP address of the first network port on the system will be related to it's serial number, which is located on the rear of the machine. For example, if the machine serial number is 11009 then the IP will be 192.168.1.109, if the serial is 11010 then the IP will be 192.168.1.110, etc. The IP address may have been changed to fit in with a pre-existing structure, in which case it should be known already.
2. With a computer networked to the system, connect to the root directory (e.g. 192.168.1.110). The username is root and the password is codex. Then copy your ALE/EDL to the tmp directory. If your file is called test.edl then in the Filepath box which appears when you select CONFORM, for example, you would enter /tmp/test.edl
3. Once you have finished with the ALE/EDL you should delete it from the tmp directory to preserve system memory space.

10.7 Updating Datapack firmware

In the unusual occurrence of a Datapack developing a fault, it should be returned to Codex for repair. Alternatively Codex can dispatch a replacement hard drive with the appropriate firmware. In the rare event that a hard drive has been sourced from elsewhere the firmware will have to be set, and the following information is provided for this circumstance only. Additional, it is only applicable for Seagate Savvio 146GB drives.

Ensure no other Datapacks are loaded. With the hard drive fitted and the Datapack loaded:

- First, you must determine the drive letter of the replacement drive. With the Datapack loaded and the Codex software running go to the **STORAGE tab** and press the **Spanner** on the bottom left of the Datapack graphic. The drives will be numbered: make a note of the number for the new drive which will be marked as Free.
- The number will match to a device name in Linux. On a Studio machine the system drive is sda and the first drive in the Datapack is sdb, the second sdc, etc. The Portable has no system drive so the first drive in the Datapack is sda, the second sdb, etc.
- Go to the Linux command screen and type (substituting sda in this example with whatever the relevant device name is):

```
sdparm -clear WCE -save /dev/sda <enter>

sdparm -vendor=sea -clear=JIT0,JIT1,JIT3 -save /dev/sda <enter>
```

10.8 Removing a Codex Studio system from it's flightcase rack

Codex Studio systems may come supplied in a flightcase rack. Please note that, although the Codex Studio systems are constructed from either two or three parts, the units are supported by each other and so should only be removed in sequence from the top down.

First, turn off the system and remove all video cables, network cables, and power cords from the rear of the system.

Then, remove any hatches from the rear panels my unwinding the screws. Disconnect any cables connecting the different sections of the machine together.

It is now safe to undo the screws from the corners of the section front panels, and remove the sections from the flightcase, starting at the top!

When re-installing the system in a new location be sure that the cables are all reconnected correctly before powering the system. For details of the connections refer to the Codex Studio systems manual.

10.9 Cleaning air filters in Codex systems

Codex systems require occasional cleaning of the intake fan air filters to ensure that the internal temperature is being properly controlled and, therefore, that the system is working efficiently. The following sections explain how to clean the air filters for different Codex products:

10.9.1 Cleaning the Base Unit air filters

1. If mounted within one, remove the unit from it's flightcase rack.
2. Version 1 Base Units have 26 screws holding the lid in place. These all need to be removed with a 2mm hex-key and the lid can then be lifted off.
3. Locate the two fan units, situated on the left and right-hand side of the system, just behind the front panel. Each fan is covered with a foam air filter, inside a plastic surround. Unclip each plastic cover to remove the foam filters and give each one a thorough vacuum-clean to clear any dust or dirt which may have clogged the filter.
4. While the lid is removed it is also advised to spray compressed air around the inside of the unit to dislodge any dust which has made it's way past the filters.

5. Then, replace the filters securely back onto the fans and replace the unit's lid.
6. Version 2 Base Units have 3 rows of 3 screws holding the lid in place. These are coloured black to distinguish them from the other screws in the lid. These need to be removed with a 2mm hex-key and the lid can then be slid backwards using the recessed black plastic handle and removed.
7. Locate the two fan units, situated on the left and right-hand side of the system, just behind the front panel. Direct compressed air through the fans from the inside to expel any dust caught by the air filters.
8. Replace the unit's lid.

10.9.2 Cleaning the Portable Disk Bay air filters

1. If mounted within one, remove the unit from it's flightcase rack.
2. Remove black screws from the rear and sides of the lid. The lid can now be removed by lifting it from the rear and pulling it diagonally rearwards and upwards.
3. Direct compressed air through the fan on the front panel of the unit from the inside to expel any dust caught by the air filter.
4. While the lid is removed it is also advised to spray compressed air around the inside of the unit to dislodge any dust which has made it's way past the filters.
5. Replace the lid.
6. Finally, use a vacuum to remove any dust caught by the filters on the narrow air inlets next to the Disk Ports.

10.9.3 Cleaning Recorder Datapack air filters

Although there are no air filters in a Recorder Disk Bay there are individual air filters in each Datapack. To expose the Datapack air filters, simply turn the Datapack over and slide back the metal cover using your fingertips. This cover is spring-loaded, so will have to be held open whilst vacuum-cleaning the foam air filters!

10.10 Replacing a hard drive in a Recorder Datapack

1. First, remove the four screws holding the handle assembly in place, using a 2.5mm hex key. It's usually easier to stand the Datapack on its end whilst doing this.
2. Next, carefully lift the front handle assembly, noting the cable connections inside.
3. Before removing any of the cables from the lid, make sure to remove jumper J7, located near the battery. Now put it somewhere safe, as it's important...
4. *Remember to replace this after all the cables have been reconnected - in step 11 on page 3 - as the last step before screwing the lid back on.*
5. Undo the 'bullet connector' in the earth cable. This will probably require both hands, so it's actually easier to turn the handle assembly through 90° and rest it back on the Datapack body whilst doing this (as shown). Then, remove the wide ribbon cable from inside the handle assembly itself - the connector should just slide off - and the two thinner ribbon cables. With these last two, there is no need to note which cable is connected to which connector as they're interchangeable.
6. Lift out the metal reinforcement plate. Again, there's no need to make a note of the orientation of this plate as it's symmetrical and doesn't have a particular front, back, top or bottom.
7. Next, pull out the rubber shockmount. This is a very tight fit, but can be manhandled fairly roughly to remove it! It's usually easiest to slip two fingers underneath (as illustrated) and pull it out one corner at a time. Try not to snag the dangling disk cables when removing this piece. You may at this point be thinking "there's no way that's going back in there"... but it will.
8. Once the rubber shockmount has been removed, it should be possible to slide the diskcage out of the Datapack body. Carefully place the diskcage down flat on the table, bearing in mind that the disks are now unprotected from shock and vibration! The individual disks (1-10) are numbered, for easy identification.
9. To replace an individual disk, remove the 4 crosshead screws holding it in the cage (two on each side) and slide the disk out of the cage using your thumb and forefinger (as shown). If the disk refuses to move, try slackening the screws on the adjacent drives each side of it (remembering to tighten them back up later!)
10. Once the disk drive has been replaced in the diskcage (and all the screws tightened up) slide the diskcage back into the Datapack body (noting which side of the diskcage is marked "TOP") until it seats correctly in the lower shockmounting. At this point, it may be easier to tilt the Datapack and manoeuvre the zif connector (shown left) into position with your fingers, through the hole at the rear of the Datapack.
11. Next, replace the rubber shockmounting – breathe deeply and stay calm as there is a knack to this.... First, with the Datapack standing on end with the top surface facing away from you, place the right-hand edge of the rubber mount into the right-hand side of the Datapack opening (as illustrated) - noting the word "TOP" embossed on the rubber shockmount, indicating its orientation - then thread the three ribbon cables and the single earthing cable through the centre hole in the shockmount. Then, being careful not to trap any of the cables underneath, reach through the opening in the shockmount and use two fingers to push the diskcage slightly to the left - you can use the vertical metal bar on the top of the diskcage to do this. By nudging the diskcage to the left, you should now be able to snap the right-hand side of the rubber shockmount into place.

12. Next, repeat the same operation to snap the left hand side of the rubber shockmount into position. Use your fingers to push the diskcage slightly to the right and the bottom left-hand corner of the shockmount should eventually snap into place... and yes, it does have to fit that tightly... One thing to look out for here is the top left-hand corner of the rubber shockmount getting caught against the white slide rail pillar inside the Datapack body. With careful manoeuvring the shockmount will snap perfectly into place, but this procedure is worth practicing a few times until you get the hang of it!

13. Now, replace the metal reinforcing plate and reconnect the three ribbon cables and single earthing cable to the handle assembly (remembering that the two thin ribbon cables are actually interchangeable). The picture on the left shows the correct orientation for the ribbon cable connectors (though they will only actually fit one way round). After connecting these cables, remember to replace jumper J7, removed in step 3. You haven't lost it, have you?! Finally, replace the whole handle assembly and screw the whole thing back together with the four 2.5mm hex-headed screws to complete!

14. **Please ensure never to leave the handle assembly clipped onto the Datapack but not screwed on, as it's all too easy to accidentally pick the Datapack up by the unsecured handle which would have disastrous consequences!**

11 Latest Codex releases

The Codex Software and User Manuals are constantly being updated as the latest features are implemented into the system. For the latest software updates and installation instructions please visit www.codexdigital.com/software or contact Codex Digital.

The Codex Technical Manual provides information on the more-technical aspects of Codex systems such as networking, LUTs, using the Virtual File System, Offloading to RAID systems or LTO tape, and maintenance. To download this document please visit www.codexdigital.com/techdocs

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