XF300/305
White Paper

Canon XF and
Apple® Final Cut Pro®
Workflow
INTRODUCTION

In April 2010, Canon redefined the professional handheld video camera market with the launch of the XF300 and XF305 – two revolutionary, file-based video cameras; the first models to use the new Full HD (high definition) Canon XF recording codec.

Designed to offer exceptional image quality and seamless workflow compatibility for a wide range of professional uses, these new XF models feature technology unrivaled in their class.

The XF300 and XF305 camera system is comprised of a Canon L-series HD Video Lens, patented 3 CMOS (Complementary Metal Oxide Semiconductor) sensor system and a highly advanced DIGIC DV III Image Processor. MPEG-2, Full HD (4:2:2) video is recorded to Compact Flash cards, using data recording rates of up to 50Mbps.

This white paper will be divided into two main parts. The first part will explain concepts and terms that are important for users deliberating on an appropriate post-production process. The second part will detail a general workflow for use with Canon XF300 and XF305 cameras in conjunction with Apple Final Cut Pro.

INSIDE CANON TECHNOLOGY

Canon XF300 and XF305 video cameras are able to produce superb quality high definition video using several key Canon technologies. Images are first captured through a Canon L-series HD video lens, designed to prevent chromatic aberration and achieve ultra-high resolution. The optical image data is then converted into electrical signals by three Canon CMOS Image Sensors. The signals are then converted to usable image data with Canon’s patented DIGIC DV III Image Processors and recorded to Compact Flash (CF) cards.
CMOS Sensors

Canon possesses unrivaled expertise in the design and manufacture of CMOS imaging sensors. Canon introduced the world’s first CMOS sensor for digital SLRs in 2000 with the EOS D30. With the introduction of the EOS 5D Mark II in 2008, Canon was also first to market with Full HD (1080p) video recording in a digital SLR. Canon not only designs, develops and manufactures its own CMOS sensors, it designs, develops and manufactures the steppers that manufacture the sensors.

For Canon XF300 and XF305, a new 1/3-inch type 3CMOS image sensor system was created, with three native 1920 x 1080 CMOS image sensors. By using each CMOS sensor to capture one of three primary colors, the camera provides outstanding color accuracy, wide dynamic range and low noise. Each sensor features 2.07 effective megapixels through which to capture Full HD video. The 1/3 inch sensors enable a compact lens and body design, for greater mobility and quick shooting.

DIGIC DV III

Canon’s latest processing innovation for video, DIGIC DV III, dramatically improves the signal processing speed of the XF300 and XF305. This new DIGIC (Digital Imaging Integrated Circuit) unit supports Full HD signals from CMOS sensors with high pixel density, providing crisper image quality in video and still images.

The DIGIC DV III also allows for enhanced shading, lifelike tonal gradations, new custom picture settings, lower power consumption, and powers Genuine Canon Face Detection technology, with operations such as face tracking a single subject through a crowd of people.
KNOWING YOUR FOOTAGE

Because the XF300 and XF305 shoot in a variety of HD formats, it is important to understand how the settings in the camera can directly affect the workflow that will be used for ingest and editing in an NLE system. This section will cover the following key concepts:

- Digital Resolution
- Frame Rates and Shooting Modes
- Compression
- Codecs and File Formats

DIGITAL RESOLUTION AND ASPECT RATIOS

High-definition video or HD video is any format that is of higher resolution than standard-definition or SD video. The aspect ratio of an image is the ratio of the width of the image to its height, expressed as two numbers separated by a colon.

Two common video aspect ratios are 4:3 which is universal for standard-definition video formats, and 16:9, universal to high-definition television and European digital television. These numbers represent the ratio of the pixels present in each dimension (width and height) of the image. High definition video formats use 16:9 pixel dimensions of 1920 x 1080 or 1280 x 720. Standard definition video formats use 4:3 pixel dimensions of 720 x 486 (NTSC) and 720 x 576 (PAL).
Generally, the higher number of pixels present within a frame, the higher the digital resolution. For example, a Full HD 1920 x 1080 has a higher pixel density than HD 1280 x 720, and both contain much more resolution than a standard definition frame at 720 x 486.

**FRAME RATES AND SHOOTING MODES**

Canon XF300 and XF305 cameras shoot in a variety of frame rates and scan modes:

- **1920x1080**: 60i, 50i, 30p, 25p, 24p
- **1280x720**: 60p, 50p, 30p, 25p, 24p
- **1440x1080**: 60i, 50i, 30p, 25p, 24p

(50i, 50p and 25p optional upgrade available through Canon Factory Service Center)

**Frame rate** refers to the number of frames being recorded by a camera over time, and is usually measured as frames per second or FPS. Scan modes can be defined as either interlaced or progressive and are usually designated by the letter i or p respectively.

**Interlaced** shooting modes (50i and 60i) use techniques developed for CRT-based monitors, that are typically made up of 576 horizontal scan lines. Interlacing records images as odd and even numbered horizontal lines that are alternately displayed to form a single frame. The interplay between these odd and even scan lines has commonly been described as a type of “tearing” effect, a visual characteristic of interlaced video.

**Progressive** shooting modes (24p, 25p, 30p, 60p) scan and record the entire image line by line as one complete frame. Progressive images are not split into separate fields like interlaced images do, and are often seen as visually more ‘film like’, as it closely mimics the shutter behavior of traditional film cameras. By recording every frame of HD video as a solid image, a proper progressive monitor can display this shooting mode with no “tearing” effect.
To determine which shooting mode is best to shoot with, it is critical to understand what type of medium, or destination format, the final product will be broadcasted to.

24p: This shooting mode is typically best for shooting cinematic projects as this frame rate is the same as motion picture film (24fps) and therefore tends to look visually more like footage shot on a film camera, and can be transferred to actual film via scan recording for final projection.

25p and 50i: These shooting modes capture in PAL and SECAM formats to provide for potential international distribution.

30p: This frame rate records more frames per second than 24p allowing motion to appear smoother especially when aggressive camera movements are used. The 30p format would be ideal for newsgathering, as the progressive frames can be used for print applications or transmission via television or the internet.

60p: High frame rate shooting modes such as these allow for greater, crisper detail for fast action subjects, such as sports photography. The 60p mode displays high speed progressive imagery for some broadcast formats, as well as providing smooth slow motion video when conformed to 24fps, which is a fairly common practice.

60i: Provides the benefits of 30 fps shooting for fast action subjects as well as providing a path to broadcast interlaced formats. Canon has minimized the visible skew that can occur in other CMOS camcorders when shooting fast moving subjects in this mode.
Slow and Fast Motion Recording: The XF300 and XF305 also allows you to shoot in slow and fast motion modes, providing a myriad of frame rates to choose from. Shooting in a mode greater than your destination frame rate or “overcranking” will produce smooth slow motion footage, while shooting a lesser frame rate or “undercranking” will create fast motion footage.

Interval Recording: With this feature, users can program the camera to record a specified number of frames at specified intervals. The technique can be used to observe natural phenomena over extended periods, making it ideal for time-lapse applications. The interval can be set in 25 levels ranging from 1 second to 10 minutes.
60i/30p: Selectable between 1, 3, 6 and 9 frames  
24p/60p: Selectable between 2, 6 and 12 frames

Frame Recording: This setting allows a specified number of frames to be recorded – ideal for projects such as stop motion animation.
60i/30p: Selectable between 1, 3, 6 and 9 frames  
24p/60p: Selectable between 2, 6 and 12 frames

COMPRESSION

Compression reduces the amount of digital data used to record a video image, thus taking up less media card or hard drive storage space than an uncompressed file as well as lowering the bandwidth needed for transmission. Different compression techniques result in varying levels of actual or perceived quality.

Bit Rate
One method that is used to reduce the amount of digital data in a video image is thru the moderation of the bit rate of the signal. Bit rate refers to the number of bits used per unit of playback time. Shooting at a lower bit rate will record a more compressed image
requiring less bandwidth, and will allow for longer recording times on less storage space. Conversely, shooting at a higher bit rate will record a much more pristine image, due to less compression, but will increase bandwidth and storage needs. As the bit rate and bandwidth needs increase, the recordable media (such as CF cards) being used needs to be faster and larger to transfer and accommodate the larger amount of data generated.

Canon XF300 and XF305 cameras can record using several bit rates, which are expressed in Mbps (Megabits per second). Megabits should not be confused with megabytes. A megabyte (MB) is 8 times the size of a megabit (Mb), so if you have a data rate of 8MB/s, that translates to 64Mbps (8 x 8Mbps). Also, bandwidth and transfer speeds are often referred to in megabits, whereas the sizes of files themselves are often referred to in megabytes. For example, a 16 second file recorded on the Canon XF305 at a data rate of 50Mbps takes up approximately 100MB of disk space. (50 / 8 x16)

**CBR**, or constant bit rate compression, is used to describe an encoding method whereby imagery is captured at a constant maximum bit rate.

**VBR**, or variable bit rate compression is an encoding method whereby the bit rate varies based on the complexity of the material. Simple images use lower bit rates and more complex images use higher bit rates, allowing for the possibility of better quality in these segments while maximizing compression in areas that will show little visual loss due to compression.
CODECS AND FILE FORMATS

An image is compressed for recording/storage and decompressed for display. This process is also referred to as “encoding” and “decoding”. Codec is an abbreviation that stands for Compressor/Decompressor or Coder/Decoder, meaning it can both encode and decode something, in this case video.

Codecs are usually designed for specific purposes. Some codecs are designed for acquisition, others are meant specifically for editing, and then some codecs are intended primarily for transmission. For example, XF series cameras acquire video footage and encode them to recording media using the Canon XF MPEG-2 4:2:2 codec. This codec has been optimized to edit natively on most non-linear editing (NLE) systems and can be used as an editing codec without the need for transcoding. If a final product is designated for a transmission medium such as broadcast, DVD or Blu-Ray disk or the internet, it will be exported to the codec appropriate for that distribution medium.

MPEG-2, 4:2:2, 50Mbps codec
MPEG-2 is a professional compression format widely supported by hardware and software manufacturers. It is also less hardware-intensive than other available compression formats.

MPEG-2 compression takes advantage of the redundancy between successive frames of video, which often contain similar picture information, even when the image has moved slightly from one frame to the next.

Because the human visual system is less sensitive to the position and motion of color than luminance, storing more luminance detail than color detail can optimize bandwidth. This process is known as chroma subsampling and is represented by a three-part ratio separated by colons. The first number refers to the width of a conceptual region of luminance, with the following two numbers indicating the number of chrominance samples. For example the 4:2:2 scheme requires two-thirds the bandwidth of 4:4:4 while resulting in almost no visual difference as perceived by the viewer.
4:2:2 color sampling at up to 50Mbps provides ultra-fine graduations in tone and color and retains the highest quality image for use in post production processes such as chroma keying, color grading, advanced compositing and effects.

**File format** typically refers to how information is stored on disks, and is often erroneously interchanged with codecs. File formats include things like Audio Video Interleave (.AVI) or Quicktime. A format does not necessarily mean anything in regards to video quality; it only dictates the underlying structure of a file. Formats like AVI and Quicktime have little to do with the underlying codec, except that the limitations of a format must be adhered to in the codec. What a format is unable to handle, any codec within it will also have that limitation.

**Material eXchange Format (MXF)**
The Canon XF305 and XF300 record industry standard Material eXchange Format (MXF) files, an open-source file format compatible with major file-based workflow systems used by professionals today.

Canon has adopted MXF as a “wrapper” for MPEG-2 4:2:2 (and 4:2:0, depending on record settings) encoded video stream and linear PCM audio captured by the XF305 and XF300. While Adobe Premiere CS5 and Grass Valley Edius offer native support for this new MXF format, software plug-ins have been developed (Canon XF Plug-in for Final Cut Pro and Canon XF Plug-in for Avid Media Access) to ensure optimal compatibility.
RECORDING MEDIA

Flash memory has become a dominant force in the photo and video industry due to its fast read/write access times, low power requirements, and extreme durability. Of the many types of flash memory media that have surfaced over the years, Compact Flash cards are one of the most successful memory card formats, and continues to be the best data recording option for digital videographers.

CF cards are considered more durable and rugged for field use, gaining high marks in reliability and data writing endurance. They also have higher storage capacities than most other memory cards.

<table>
<thead>
<tr>
<th>CF Card Capacity</th>
<th>50 Mbps</th>
<th>35 Mbps</th>
<th>25 Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>2GB</td>
<td>5 minutes</td>
<td>5 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>4GB</td>
<td>10 minutes</td>
<td>10 minutes</td>
<td>20 minutes</td>
</tr>
<tr>
<td>8GB</td>
<td>20 minutes</td>
<td>25 minutes</td>
<td>40 minutes</td>
</tr>
<tr>
<td>16GB</td>
<td>40 minutes</td>
<td>55 minutes</td>
<td>80 minutes</td>
</tr>
<tr>
<td>32GB</td>
<td>80 minutes</td>
<td>110 minutes</td>
<td>155 minutes</td>
</tr>
<tr>
<td>64GB</td>
<td>160 minutes</td>
<td>225 minutes</td>
<td>310 minutes</td>
</tr>
</tbody>
</table>

File based on recording facilitates workflow by reducing transfer times when moving video to non-linear editing (NLE) systems. Additionally, metadata can be input at image acquisition and imagery may be reviewed immediately after recording to insure every shot is captured and logged correctly.

Canon recommends a Type 1 Compact Flash card that is classified as UDMA Mode 4 or higher. Due to the high requirements of the new XF305 and XF300, some existing Compact Flash (CF) cards may exhibit unexpected behavior when used with the camcorders. Canon is actively testing CF cards and working with manufacturers to ensure compatibility.
As of October 2010 only the following Compact Flash (CF) cards have been tested to work with the XF300 and XF305 cameras (please check the Canon USA website for current information as these specifications are subject to change).

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Name</th>
<th>Capacity</th>
<th>Nominal Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sandisk</strong>*</td>
<td>Extreme Pro</td>
<td>64GB</td>
<td>x600(90MB/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extreme</td>
<td>32GB</td>
<td>x400(60MB/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8GB</td>
<td></td>
</tr>
<tr>
<td><strong>Lexar</strong></td>
<td>Professional x300</td>
<td>16GB</td>
<td>x300(45MB/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional x600</td>
<td>16GB</td>
<td>x600(90MB/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8GB</td>
<td></td>
</tr>
<tr>
<td><strong>Delkin Devices</strong></td>
<td>CombatFlash</td>
<td>32GB</td>
<td>91MB/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16GB</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>8GB</td>
<td></td>
</tr>
<tr>
<td><strong>Trancend</strong></td>
<td>600X</td>
<td>32GB</td>
<td>x600(90MB/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16GB</td>
<td></td>
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</tbody>
</table>

*Fully operational in all modes
**Not operational when using slow motion modes

Canon INC has released the results from a CF card compatibility test for the XF series cameras. After all the major cards in the US were tested, “Delkin” and “Transcend” CF cards are now listed as compatible except in slow motion conditions. To date, “SanDisk Extreme” is the only card which is fully compatible with XF300/300/105/100 in the US.

**PORTS AND TERMINALS**

The XF300 and XF305 are both equipped with dual CF memory card slots as well as a standard USB 2.0 terminal for basic input-output data operations. An SD (Secure Digital) card port is also provided for storing still images and camera settings.
CONNECTING DEVICE

Once your CF memory card is placed into a reader connected to your computer or Canon XF300 or 305 camera is connected via USB, follow the steps below to import footage using Final Cut Pro’s Log & Transfer:

1) Compact Flash card mounts to OS X desktop as CANON XF.
2) Launch Final Cut Pro.
   a) Choose FINAL CUT PRO from the menu bar > System Settings (SHIFT+Q).
Set Scratch Disks for placement of clips on computer directory.

b) Choose File from the menu bar > navigate to Save Project as... 
SHIFT+ COMMAND + S

Give project a name.
3) Choose File from the menu bar > navigate to Log & Transfer... (SHIFT+COMMAND+8).
LOG AND TRANSFER KEY FEATURES:

a) **Time Code** is added to each clip, as well as user-given reel names embedded in the subsequent files, which can then be viewed from FCP throughout the editing process.

b) **Automatic Transcoding** of clips from native file format to various Apple codecs. Selectable formats include:

FINAL CUT PRO 7:

- ProRes 422 (HQ)
- ProRes 422
- ProRes 422 (LT)
- ProRes 422 (Proxy)
- Native

c) With the **Log and Transfer** function, users can set in and out points to transcode and import only the portion of the clip

d) Create a **Disk Image** (DMG file) of the memory card that may be mounted and used for Log and Transfer operations in place of the physical card – archiving all your footage, and freeing up your CF cards for immediate re-use.
Right-click over the mounted card and select “Archive to Disk Image”.

Name, and save the Disk Image to a hard drive.
4) Select from the Action pop-up menu (the gear-shaped icon near the top of the window) to set import preferences.
a) In the Import Preferences window, select ‘Canon XF PLUGIN’ as your Source Format, and then select the Transcode Format to select the transcoding codec of your choice (such as ProRes 422).

![Import Preferences window]

b) Once your preference is selected, click OK to go back to the Log and Transfer Window.

c) Select the thumbnails to view clip(s) in the right-hand preview window and set in and out points, as needed.
d) Add reel names/numbers, scene data, and other notes in the Logging Area, as needed.

e) Drag-and-drop the clip(s), or press the Add Selection to Queue button or the Add Clip to Queue button (below the preview window) to move your media to the Transfer Queue area at the bottom-left.
f) From the Transfer Queue, all media is automatically imported and transcoded. The transcoded files will appear in the browser area of your project window, ready to go directly into the timeline.

5) To create a disk image (DMG file) of the memory card right-click on volume.

a) Make sure **Hierarchical List view** is selected.

b) Select **Archive to Disc Image**.

c) Name and Save the Disc Image to a hard drive.
6) To add clips to Final Cut Pro Sequence:

a) Select clips from Browser.

b) Drag clips to the Insert section of the Edit Overlay.
c) Final Cut Pro will prompt with a warning to change sequence settings to match the clip setting. Select yes.