EOS HD (DSLR)
White Paper

Canon EOS and
Apple® Final Cut Pro®
Workflow
INTRODUCTION

Canon continues to be at the forefront of digital photographic technology. The Canon EOS series HD-DLSRs (including the 1D Mark IV, 5D Mark II, 7D, 60D, Rebel T2i and Rebel T1i) shifts the paradigm in modern digital photography by effectively combining two highly versatile cameras in a single package. These cameras allow experienced photographers and photojournalists to now shoot HD video with the same refined image quality, advanced workflow, customizable control and incredible responsiveness that they have come to expect from their Canon DSLR in stills.

In conjunction with high quality Canon EF lenses, high-sensitivity Canon CMOS sensors, and the advanced capabilities of Canon’s proprietary DIGIC 4 image processors, every HD video-capable EOS camera gives seasoned videographers new tools to create the kind of rich and dramatic imagery needed for any job. Photographers and videographers can capture HD video with a level of image quality and creative control found only in professional video models, using a broad selection of interchangeable EF lenses, including specialized optics such as fisheye, ultra-wide, super-telephoto, macro, tilt-shift, high-speed and image stabilized lenses.

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 EOS series HD-DLSRs in conjunction with Apple Final Cut Pro.
INSIDE CANON TECHNOLOGY

Canon EOS series cameras are able to produce superb quality high definition video using several key Canon technologies. Images are first captured through a Canon EF or EF-S lens, for maximum optical performance. The optical image data is then converted into electrical signals by a Canon CMOS sensor, which are then converted to usable image data with Canon’s patented DIGIC 4 processors and recorded to Compact Flash (CF) or Secure Digital (SD) memory cards depending on the camera model.

Canon 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.

CMOS has marked advantages for both still and video image capture when compared to traditional CCD (charged coupled device) sensors. CMOS enables multi-channel readouts at the pixel level resulting in much faster processing of high definition data, as well as enabling the incorporation of on-chip noise reduction and pixel amplification. In addition, CMOS sensors consume much less power than CCD sensors of equal size, contributing to reduced heat and extended battery life.

There are three sizes of CMOS sensors in use with current EOS series cameras: Full Frame, APS-H, and APS-C.
The size differences between the sensors are designed with the user in mind, balancing affordability with quality, and creating cameras that fit the particular jobs that photographers and videographers will face in the field.

**EOS 5D MKII - Full-Frame** 21.1-megapixel CMOS sensor with single DIGIC 4 Image Processor

**EOS-1D MKIV - APS-H** sized 16.1 Megapixel CMOS Sensor, Dual DIGIC 4 Image Processors

**EOS 7D - APS-C** 18.0 Megapixel CMOS sensor, Dual DIGIC 4 Image Processors

**EOS 60D - APS-C** 18.0 Megapixel CMOS sensor, single DIGIC 4 Image Processor

**EOS Rebel T2i - APS-C** 18.0 Megapixel CMOS sensor, single DIGIC 4 Image Processor

**EOS Rebel T1i – APS-C** 15.1 Megapixel CMOS sensor, single DIGIC 4 Image Processor

**Full-Frame sensors** (24mm x 36mm) are found in the EOS 5D Mark II and are the largest of the three sensor sizes, with an effective diagonal measurement of 43.3mm. This sensor size is the closest to actual 35mm film for still cameras and produces shallower depth of field than smaller formats when aperture values and angles of view are equalized. The 5D Mark II sensor can capture up to 21.1 million effective pixels (5616 x 7344 pixels). The larger sensor allows for the use of bigger pixels (6.4 microns), which in turn increases the camera’s light sensitivity. This means less noise in the image, especially at higher ISO settings (greater than 800), and greater performance in low-light situations. These are important considerations for both still photography and HD video.

**APS-H sensors** (18.6mm x 27.9mm) in the Canon EOS-1D Mark IV model have an effective diagonal measurement of 33.5mm, resulting in a focal length conversion factor of approximately 1.3x compared to full-frame. This places the APS-H sensor midway between the full frame sensor of the 5D Mark II and the APS-C sensor of the 7D, and is similar in size to Super 35mm motion picture film. Despite its 5.7 micron pixel size, which is slightly smaller than that of the 5D Mark II, the EOS-1D Mark IV with its Dual DIGIC 4 image processors produces the lowest noise levels of any EOS model released to date, and it also has the widest range of sensitivity settings from ISO 100 to 102,400 for HD video.
**APS-C sensors** (14.9mm x 22.3mm), used in the Canon EOS 7D, EOS 60D, Rebel T2i and Rebel T1i models, are the smallest CMOS sensors used in current EOS cameras with a diagonal measurement of 26.8mm. This image sensor size results in a focal length conversion factor of 1.6x compared to full-frame, making it easier to reduce the overall size, weight and cost of APS-C cameras compared to larger format models while providing exceptional noise reduction and low light sensitivity. Even though the APS-C sensor is the smallest sensor in the EOS HD-DSLRs, it is approximately the same size as a 35mm motion picture film frame and the sensors in high-end digital motion picture cameras used in Hollywood productions. As a result the APS-C sensor provides similar lens characteristics to equivalent focal lengths used in current 35mm film production.

**DIGIC 4 IMAGE PROCESSORS**

Canon’s powerful DIGIC 4 image processors dramatically improve the signal processing speed and image quality of Canon’s HD-capable EOS DSLRs. This latest DIGIC (Digital Imaging Integrated Circuit) unit supports full HD video output from CMOS sensors with high pixel density, providing crisper image quality in video and still images. Here is a list of relevant improvements:

- Low noise image development, allowing for better noise reduction at all ISOs and 2 stops higher normal ISO speed compared to DIGIC III.
- Higher speed image processing (1.3x faster than on the DIGIC III). This results in improved highlight and shadow details, extended dynamic range, and more accurate, saturated colors that maintain fine details.
- Improved high ISO Noise Reduction, corresponding to higher image quality and allowing the cameras to maintain their fast maximum shooting speeds and burst rates with two out of three noise reduction settings.
- Face Detection and optimized metering of up to 35 faces are enabled in Live Face Detection AF shooting mode.
Add high speed UDMA Mode 6 (CF card) read and writing speed compatibility.

Enables 1080p Full HD video recording mode with sound, standard definition (SD) video recording with sound, and video playback with sound.

Controls LCD brightness as well as white balance adjustments during video recording.

KNOWING YOUR FOOTAGE

Since the High Definition video-capable family of Canon EOS series cameras shoots at a variety of frame rates, 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 (Non Linear Editing) system. This section will cover the following key concepts:

- Digital Resolution
- Frame Rates and Scan Modes
- Data Compression
- Codecs and File Formats

DIGITAL RESOLUTION & ASPECT RATIOS

Any video recording format that is of higher resolution than standard-definition or SD video is called high-definition or HD video. Digital video resolution is measured in pixel density. 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, which is universal for high-definition television (HDTV). Standard definition 4:3 video formats are commonly 720 x 480 or 640 x 480 pixels (NTSC) or 720 x 576 pixels (PAL). High definition 16:9 video formats are commonly 1920 x 1080 pixels (Full HD) or 1280 x 720 pixels (HD).
Generally speaking, the higher the digital resolution, the clearer the picture when all else is equal. For example, Full HD video at 1920 x 1080 resolution contains approximately 2 million pixels per frame. Standard HD video at 1280 x 720 resolution contains approximately 920,000 pixels per frame, and Standard Definition SD video at 720 x 480 or 640 x 480 resolution contains approximately 345,000 pixels or 307,000 pixels per frame respectively.

The number of pixels within an HD frame can differ as long as it is characterized by a 16:9 aspect ratio.
EOS HD VIDEO FRAME RATES AND SCAN MODES

Video frame rate refers to the number of frames being recorded over time, and is usually measured as frames per second or FPS. Scan modes can be defined as either progressive or interlaced and are usually designated by the letter p or i respectively. All video-capable EOS models capture video in progressive mode only.

<table>
<thead>
<tr>
<th>EOS Model</th>
<th>1080p 24/25/30 fps</th>
<th>720p 50/60 fps</th>
<th>480p 50/60 fps</th>
<th>480p 25/30 fps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1D Mark IV</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5D Mark II</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>7D</td>
<td>X</td>
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<td>60D</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>Rebel T2i</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rebel T1i</td>
<td>X (20 fps)</td>
<td>X (30 fps)</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1. Canon EOS series cameras capture video at a variety of progressive frame rates.

**Progressive** framing rates (24p, 25p, 30p, 50p, 60p) scan and record the entire image as one complete frame. This is often seen as being more ‘film like’ because it more closely mimics the shutter behavior of traditional film cameras in that each frame of video or film is recorded as a single unique image.

**Interlaced** framing rates (not offered with EOS cameras) record images as odd and even numbered horizontal lines that are combined together to form a single frame. This has been the most common broadcasting mode for most television sets, and despite the advent of newer progressive scan displays, continues to be the standard format for most of the television industry. (The mini-HDMI port built into HD-capable EOS DSLRs provides interlaced output for compatibility with HDTV displays, but the videos themselves are progressive, not interlaced.) To determine which frame rate 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 frame rate is typically best for shooting cinematic projects because it is the same frame rate as motion picture film (24fps). It therefore tends to look visually more filmic, and can be transferred to actual film via scan recording for final projection.

25p: This frame rate is best for direct distribution in international video formats such as PAL and SECAM.

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

50p and 60p: High frame rates such as these allow for crisper detail when capturing fast action subjects, such as sports. The 50p and 60p modes provide smooth slow motion video when conformed to 30 fps, 25 fps or 24fps, which is a fairly common practice.

DATA COMPRESSION

Compression reduces the amount of digital data used to produce a video or graphic 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.
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, 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, EOS series cameras acquire video footage and encode them to recording media using an H.264 codec. The encoded images can be converted to an intermediary codec compatible with individual editing systems. If a final product is designated for a transmission medium such as the internet, it will be exported to yet another codec, such as MPEG-2 or WMV, optimized for that form of transmission.

**H.264 codec**

H.264 is an industry standard for video compression and it builds on the concepts of earlier standards such as MPEG-2 and MPEG-4 Visual, offering the potential for better compression efficiency and greater flexibility in compressing, transmitting and storing video. The H.264 standard, implemented in the Canon EOS series as a Quicktime Movie (.mov) using MPEG-4 compression, is capable of providing excellent video quality at substantially lower bit rates than previous standards without increasing the complexity of design. An additional goal was to provide enough flexibility to allow the standard to be applied to a wide variety of applications on a wide variety of networks and systems.
**File format** typically refers to how information is stored on disks, and is often erroneously confused with codecs. Popular video file formats include AVI (Audio-Visual Interleave), MOV (Quicktime), and MXF (Material eXchange Format). A file format does not necessarily mean anything in regard 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.

**RECORDING MEDIA**

Flash memory has become a dominant force in the photo and video industry due to its fast read access times, low power requirements, and extreme durability. Of the many types of flash memory media that have surfaced over the years, Compact Flash and Secure Digital are two of the most successful memory card formats, and they continue to be popular choices for digital videographers.

Both CF and SD cards are considered sufficiently durable and rugged for field use, gaining high marks in reliability and data writing endurance. They also have higher storage capacities than most other flash memory cards. Due to file system restrictions, continuous movie shooting with current EOS cameras is restricted to a 4GB file size or 29 min. and 59 sec., whichever comes first. In low resolution standard definition video modes, the shooting will stop when 29 min. 59 sec. is reached, even if the file size is less than 4GB. Approximate recording times are listed in the table below using a 4GB file size as a basis.

<table>
<thead>
<tr>
<th>Movie-recording Size</th>
<th>Frame rate</th>
<th>Total Recording Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920 x 1080</td>
<td>30 fps</td>
<td>Approx. 12 min.</td>
</tr>
<tr>
<td></td>
<td>25 fps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 fps</td>
<td></td>
</tr>
<tr>
<td>1280 x 720</td>
<td>60 fps</td>
<td>Approx. 12 min.</td>
</tr>
<tr>
<td></td>
<td>50 fps</td>
<td></td>
</tr>
<tr>
<td>640 x 480</td>
<td>60 fps</td>
<td>Approx. 24 min.</td>
</tr>
<tr>
<td></td>
<td>50 fps</td>
<td></td>
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</tbody>
</table>
For CF card-compatible models such as the EOS-1D Mark IV, 5D Mark II and 7D, Canon recommends a Type 1 Compact Flash card that is rated UDMA Mode 4* or higher, and at least 30MB/s or faster for recording 1080 HD Video. For SD card-compatible models such as the EOS 60D and Rebel T2i, Canon recommends SDHC** Class 6 or faster, or better yet SDXC*** memory cards.

*UDMA stands for Ultra Dynamic Memory Access.
**SDHC stands for Secure Digital High Capacity.
***SDXC stands for Secure Digital Extended Capacity.

PORTS AND TERMINALS

Every current video-capable camera in the Canon EOS series is equipped with a CF or SD memory card port as well as a Hi-Speed USB 2.0 terminal for basic input-output data operations.

Each Canon EOS HD-capable DSLR also has a HDMI mini OUT terminal for high-definition video playback on an HDMI-compatible external display, as well as selectable NTSC/PAL audio video output for video playback on standard definition televisions.

Additionally, all current Canon EOS HD-capable DSLRs except the Rebel T1i have a terminal for stereo audio input from external microphones.
CONNECTING DEVICE

Once your memory card is placed into a reader connected to your computer, follow the steps below to import footage using EOS Movie Plugin-E1:

1) Memory card mounts to OS X desktop as EOS_DIGITAL.

a) Keep in mind any clips on the memory card will use the card readers name as the default reel ID. For example if left alone the clips will import with the resulting reel ID: EOS_DIGITAL. For the purposes of archiving compact flash cards it is recommended to change EOS_DIGITAL to a unique name such as 001, 002, 003 etc.
2) **Launch Final Cut Pro.**

   a) Choose FINAL CUT PRO from the menu bar > System Settings (SHIFT+ Q).

   ![System Settings Menu](image)

   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 & Transfer Window
EOS MOVIE PLUGIN-E1 KEY FEATURES:

a) Time Code is added to each clip (based on the camera’s date/time stamp), as well as user-given reel names embedded in the ProRes files, which can then be viewed from FCP throughout the editing process.
b) Automatic transcoding of clips from H.264 to various Apple codecs. For example: ProRes 422, which combines superb imaging with no perceptible degradation from the original H.264 files. Selectable formats include:

**Final Cut Pro 7:**

- ProRes 4444
- ProRes 422 (HQ)
- ProRes 422
- ProRes 422 (LT)
- ProRes 422 (Proxy)
- Apple Intermediate Codec

**Final Cut Pro 6:**

- ProRes 422 (HQ)
- ProRes 422

c) Transcoding time may be up to 3x faster than previously possible with EOS movie files using Compressor, or similar (performance tested on a 2.8GHz Quad-Core Mac Pro).

d) With the Log and Transfer function, users can set in and out points to transcode and import only the portion of the clip needed for the project, greatly improving speed and productivity.
e) 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 memory 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.
Select from the Action pop-up menu (the gear-shaped icon near the top of the window) to set import preference.

4) Select from the Action pop-up menu (the gear-shaped icon near the top of the window) to set import preference.

a) In the Import Preferences window, select 'Canon DSLR' as your Source Format, and then select the Transcode Format to select the transcoding codec of your choice (such as ProRes 422).

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.

Media from the Transfer Queue is transcoded, and placed into your Project Browser.
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.
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.