EOS HD (DSLR) White Paper

Canon EOS and Avid® Media Composer 5® 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 Avid Media Composer 5.
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.

<table>
<thead>
<tr>
<th>Sensor Size</th>
<th>Image Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>35mm full frame sensor</td>
<td>approx. 37 x 24mm</td>
</tr>
<tr>
<td>APS H size sensor</td>
<td>approx. 29 x 19mm</td>
</tr>
<tr>
<td>APS C size sensor</td>
<td>approx. 22.5 x 15mm</td>
</tr>
</tbody>
</table>
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.
 Adds 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></td>
<td></td>
</tr>
<tr>
<td>5D Mark II</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7D</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>60D</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rebel T2i</td>
<td>X (20 fps)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Rebel T1i</td>
<td></td>
<td>X (30 fps)</td>
<td></td>
<td></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.
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.

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

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.

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

Canon EOS video clips are recorded directly into digital files stored onto cost effective and readily available Compact Flash (CF) or Secure Digital (SD) cards, depending on the camera model. To edit the clips, they must be moved from the memory cards onto a computer equipped with Avid Media Composer 5. The memory cards can be connected to any MAC or PC using a standard card reader via USB.

Move the contents folder to the desired destination on the computer storage drive.
INGESTING FOOTAGE

1) Launch Avid Media Composer 5

   a) Select Project dialogue window will appear.

   b) Create new project or open existing project from list.

   c) Create a new project select New Project.
d) Give the desired Project Name, Format, Color Space, Raster Dimension.
The Avid Media Access (AMA) Workflow

Avid Media Access (AMA) is a plug-in architecture that lets you link directly to clips from a third-party volume (for example, a P2, XDCAM or GFCAM device) or to a file based media clip (for example, QuickTime or MXF) into a bin without storing the media directly on your system. AMA lets you be more productive by browsing and editing directly from the device or volume.

The bin lets you log, browse, and view these clips in the usual way. Once the third-party device is disconnected, the bin still exists with the clips, although the media displays as offline. When you reconnect the device, the media appears online. The system automatically displays the media; you do not need to mount the drives.

The AMA method also allows for more metadata to be brought into the bin which gives you more information about the media. For example, essence marks (or locators) associated with the clip are automatically brought into your bin.

To display metadata information in your bin, see “Adding a Metadata Bin Column Heading,” in the Avid editing Help.

The following considerations and limitations apply:

- When the AMA setting is activated, the non-AMA method does not appear in the File menu. Deactivate the AMA setting to display the File > Import P2 (and Import XDCAM Proxy) option. The AMA setting is on by default.

- All file based media, which can be connected via AMA, will have a downloadable plug-in available at www.avid.com/ama. You must have a third-party plug-in installed on your system for the option to display.
Windows UNC (Universal Naming Convention) paths are not supported with AMA media. To link AMA media, map it to the drive.

When you render an audio effect on an AMA media clip, all audio media files are written as PCM (MXF), regardless of what you set for the audio file format.

The Dynamic Relink option is not supported with AMA clips. Avid does not support MultiCamera editing with AMA clips.

SELECTING THE AMA SETTINGS

You can set options in the AMA Settings dialog box to turn AMA on or off (on by default), to automatically mount your volumes, and to customize your bin.

To check for and download additional or updated AMA plug-ins, click the link to www.avid.com/ama.
To set up AMA:

1) In the Project window, click the Settings tab.

2) Double-click AMA. The AMA Settings dialog box appears.

3) Click the Volume Mounting tab.

4) Select “Enable AMA Volume Management.”

By default, this option is selected. If you deselect the option and then reselect it, you must quit and restart your Avid editing application. When this option is selected, the File > Import menu item is no longer available.
5) If you want the system to automatically scan drives (volumes) every time, select the option “When mounting previously mounted volumes, do not check for modifications to the volume.” This option is off by default.

6) If you remount a volume, deselect the option “When mounting previously mounted volumes, do not check for modifications to the volume,” and the system checks the modification date of the device or drive against the last time the clips were linked. If the date is the same, the clips come back online. If the date is different, the system links the clips again, and links any new clips added to the volume. This option is off by default.

If you restart your Avid editing application, the system automatically rescans the drives regardless of the options you’ve selected.

7) To customize your bin, click the Bins tab. By default, the system links your clips into a new bin using the same name as your project name. If you want to change the bin name or want to use an already existing bin, you can make these changes in the Bins tab.

Depending on your AMA Settings, every time you insert a card into a reader or connect a device, the system creates a new bin whether the same card or device has been previously inserted or not.

8) Click OK.

UNDERSTANDING LINKING WITH AMA

Linking lets you point to media on a device or point to the media directly on your system. The media physically resides on your system or it can reside on an external device. The device can be a camera, a card reader, an optical disk, a virtual volume on your desktop or on a server. The media points to the most recent source. For example, if you link the clips to a virtual volume on your desktop, the drive column displays the desktop as the location where the clips are linked to. If you then insert a card into a reader with the same media, the clips point to the media on the card. If you remove the card, the clips point to the media on the card and the clips appear offline, the card being the most recent source. Once the card is reinserted, the clips in the bin appear online.