

Canon

WHITE PAPER

EOS C300 MARK II

ERGONOMIC AND OPERATIONAL ENHANCEMENTS TO EOS C300 MARK II



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CINEMA EOS

Ergonomic and Operational Enhancements to C300 Mark II

Abstract

The original EOS C300 digital cine camcorder made its formal debut in November 2011. It surprised many with its novel ergonomic design – which had been carefully optimized for handheld shooting. While many expressed preference for a more conventional mechanical form factor, the C300 did indeed prove to be particularly popular among the world’s documentary cinematographers whose work generally does entail a great deal of handheld shooting. From the extraordinary diversity of productions done with a large body of C300 camcorders around the globe for the ensuing four years a great deal of commentary and suggestions based upon those shooting experiences were gathered. The new EOS C300 Mark II embodies many of these suggestions while also incorporating innovative enhancements to both imaging and recording capabilities. On-set systemization has been greatly enhanced by a coordinated design with a new on-set 4K reference display.

1.0 Introduction

As shown in the two photos below – the C300 and the new C300 Mark II are physically quite similar. But, as will be outlined in this white paper and two companion papers [1] and [2] – they are radically different in their image performance and operational capabilities.

The EOS C300 was a major statement by Canon that it was formally entering the global digital cinematography marketplace while at the same time introducing a radical departure from mechanical form factors of contemporary cine cameras. Extensive consultations with a broad range of cinematographers and videographers had shaped much of the design decision making at the time. Opinions remain varied to this day – some love the form factor while others shun it.

In planning a successor to the C300 Canon again consulted a broad body of cine practitioners – both those having experience with the C300 and those who have other experiences. There remained a solid core of those who like the C300 basic mechanical form factor – but many offered both criticisms and suggestions that largely contributed to multiple changes made to the successor model C300 Mark II. This paper is intended to outline the many improvements.



Figure 1 On the left is the original EOS C300 cine camcorder and on the right is the second generation EOS C300 Mark II

2.0 ERGONOMICS

2.1 Basic Mechanical Differences between the C300 Mark II and the C300

The original EOS C300 was physically tailored to be very compact and lightweight and has a form factor optimized for handheld shooting



Figure 2 Conveying a sense of the size and form factor of the original C300 cine camcorder

As can be seen from Figure 3 the new C300 Mark II is slightly longer and higher than the original C300. The basic form factor has been retained. The change in dimensions is a consequence of a significant number of important internal additions to the C300 Mark II – that include mechanical, optical, and electronic.



Figure 3 The new C300 Mark II is slight larger than the original C300 (shown as grey foreground)

2.2 Rugged New Mechanical Design of the C300 Mark II

The C300 is one of the world's most popular cameras for documentary shooting. With the large numbers presently in use across the globe – under a vast variety of shooting conditions – it is no surprise that a multiplicity of “war stories” speak to the myriad of adventures and misadventures encountered during those countless productions. Anything that could possibly happen to lenses and cameras under all sorts of grueling conditions did indeed occur. Some of the more extreme encounters included instances of accidental lens-camera incidents that delivered traumatic violence to these systems. Canon closely followed as many of these productions as possible to learn all that could be gleaned about the ruggedness and durability (or not) of this first generation cine camcorder. From an extensive reporting – suffused with many recommendations and suggestions – we collated an impressive listing of improvements that underlay the mechanical design of the second generation C300 Mark II.

The new C300 Mark II uses a die-cast inner structure to support the core imaging system and the electronic boards. This structure is housed inside a reinforced external housing made of a magnesium alloy – Figure 4.



Figure 4 *Showing the inner die-cast superstructure that is housed within the camcorder body*

2.3 Mechanical Protection of the Imaging System

Experiences gleaned from the EOS C300 camcorder exposed the hard reality that accidental physical shocks – as incurred when lens-camera systems fall from tripods or are subject to unexpected blows – can incur expensive damage to either the lens or camera imaging system (or both). Innovative mechanical design strategies have been introduced into the EOS C300 Mark II to ameliorate the possibilities of such damage. The die-cast superstructure is made up of the three mechanical subsystems shown in Figure 5 – where the ND filter subassembly and CMOS image sensing system is mounted within the Imaging Unit. This is a floating structure that is secured to the Front Frame Unit via a Base Plate. The latter is made of a special metal material that is designed to absorb the shock of any traumatic external force – Figure 6.

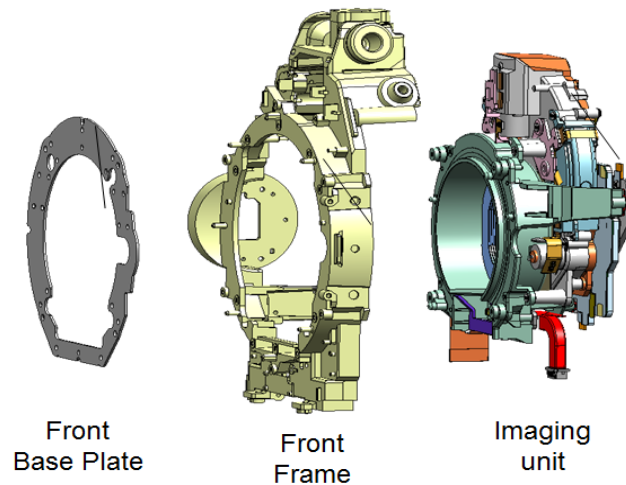


Figure 5 Showing the mechanical elements that constitute the protective floating system intended to ensure absorption of any sudden impact to the lens-camera system

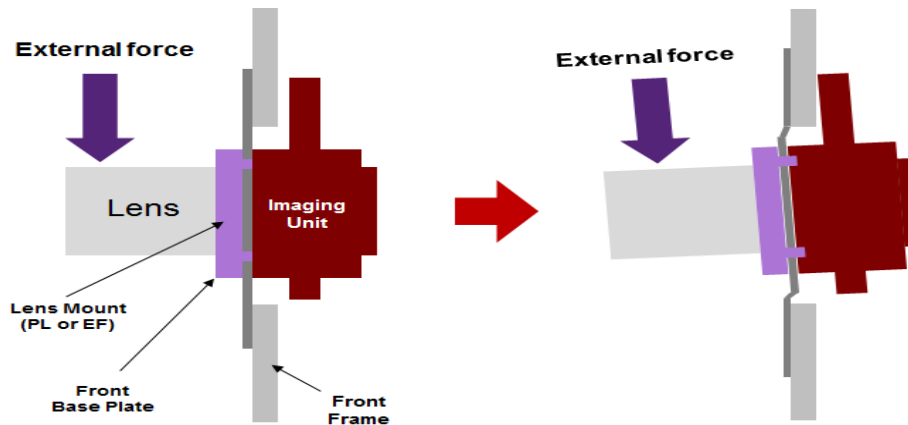


Figure 6 In the event of a sudden physical shock to the lens camera system the special material of the Front Base Plate is such that it is momentarily deformed and absorbs the impact

2.4 Choice of Lens Mount

The EOS C300 Mark II is delivered with a standard Canon EF mount. This mount can be removed (at a Canon service center) and be replaced by a choice of the standard PL mount or an alternative EF mount that has a positive locking system.



Figure 7 Showing the available choices in lens mount for the C300 Mark II

2.5 Innovative Cooling System

The broad experiences gained with the first generation C300 emphasized that these camcorders are often subject to severe environmental conditions. The C300 was unusual in its quite low overall power consumption – totaling less than 5 watts during recording – and its cooling system proved adequate. The C300 Mark II consumes more than twice the power of the C300 (because of more powerful video processing and greatly extended on-board recording capabilities), and accordingly, a more sophisticated cooling system has been incorporated. Die-cast parts increase the diffusion of heat and the forced-air cooling system has been enhanced with two fans that ensure the discharge of the hot air outside of the camcorder body – Figure 8.

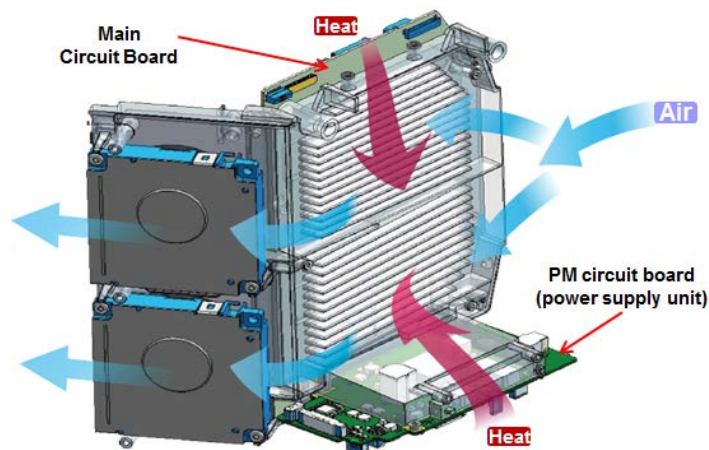


Figure 8 The main circuit board and power supply generate almost 90% of the heat and two cooling fans drive this out of the body

3.0 OPERATIONAL ENHANCEMENTS

3.1 Operational Enhancements Incorporated into the C300 Mark II

An extensive three year sustained dialog with countless end-users of the first generation EOS C300 produced a wide-ranging litany of requests and recommendations for operational enhancements in a second generation cine camcorder system. They centered about increased ruggedness, more flexible configurability, and greater flexibilities to utilize third party accessories. Based upon many recommendations the modular design has been improved.



Figure 9 The essential modular design of the C300 Mark II (top right) reflects that of the C300 (bottom left) but with numerous enhancements that aide camera operation



Figure 10 Showing on the right and left some of the options of mounting the LCD monitor, and in the center another alternative using a 3rd-party mounting arm

3.2 Dual Rotary Turret ND Control System

The original C300 deployed a four-bayonet system of ND filters as shown in Figure 11 – offering four levels of light control to the image sensor. In general these covered most real world scene illumination situations. However, there were those who produced documentaries in regions of the world where midday sunlight levels were unusually intense and required more than the maximum of 6-stops. In some other situations where shooting was in bright sunlight the desire to open the lens aperture to decrease the depth of field of a given scene also called for a higher ND level. Accordingly, a dual rotary turret system has been deployed in the new C300 Mark II as illustrated in Figure 11 which allows selection of six levels of light transmission into the image sensor.

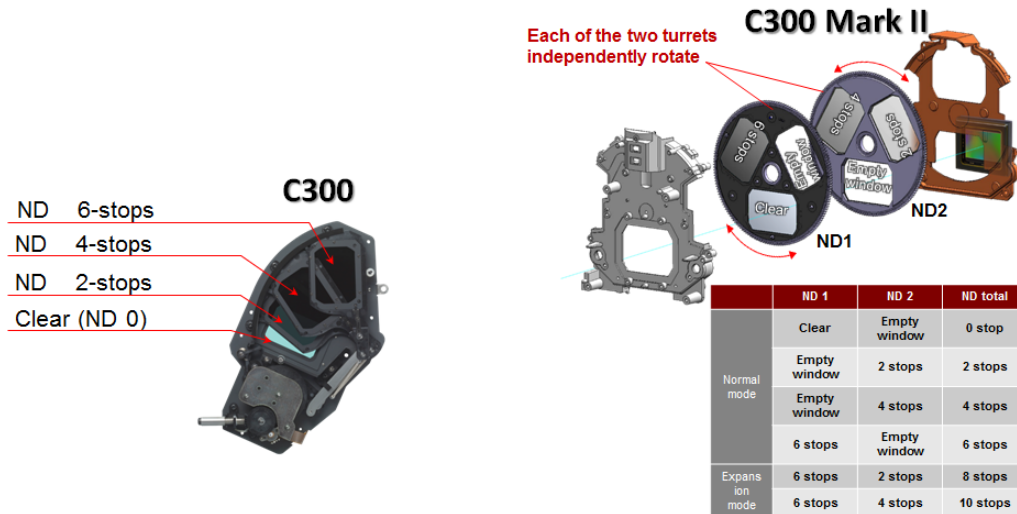


Figure 11 On the left is shown the switchable ND bayonet system of the EOS C300 and on the right the new dual rotary turret system incorporated into the EOS C300 Mark II

This very wide range of ND filters allows great latitude in setting both camera ISO and lens aperture to achieve very shallow depth of field and beautiful bokeh even in extremely bright sunlight. As shown in Table 1 a 10-stop ND, ISO set to 200, and the lens aperture set to T2.8 in extremely high scene illuminance will produce a very shallow depth of field.

TABLE 1

Depth Of Field	Scene Illuminance (Lux)	ND Filter	Lens Aperture	ISO Setting	Master Gain (dB)	Luma Level (IRE)
	2000	Clear	T-11.0	200	0	100
Very Deep	2000	Clear	T-22.0	800	+12	100
Shallow	500	Clear	T-5.6	200	0	100
	128,000	6-Stops	T-11.0	200	0	100
Very Shallow	128,000	10-Stops	T-2.8	200	0	100

3.3 Dual Pixel Focus Guide

The Super 35mm single sensor digital cine camera has brought wonderful creativity to many genres of television program production, television commercial production, and theatrical motion picture production. The cinematographer is an integral part of the creative aspirations of directors and directors of photography in their intimate tactile manual interface with the lens focus control. But, a perennial challenge underlies shooting with such cameras – namely, the singular challenge of ensuring truly sharp focus on a chosen subject within a given scene. Electronic viewfinders are still limited in their resolution (especially when shooting in 4K), and the desire for very shallow depths of field for certain scenes can compound the challenge.

In the new C300 Mark II, Canon is introducing to the industry an empowerment to the manual focus control action that offers an innovative solution to the dilemma of uncertainty in focus accuracy. The CMOS image sensor developed by Canon deploys two individual photodiodes within each and every photosite of that 4K array. The microlens centered above each photosite directs the light sample separately onto each photodiode in the manner shown in Figure 12. This provides a dual signal data output having a phase difference that is dependent upon the degree of defocusing at each photosite location. The two signals then undergo powerful arithmetic processing that ultimately produces a unique unambiguous focus guiding indicator to the camera viewfinder.

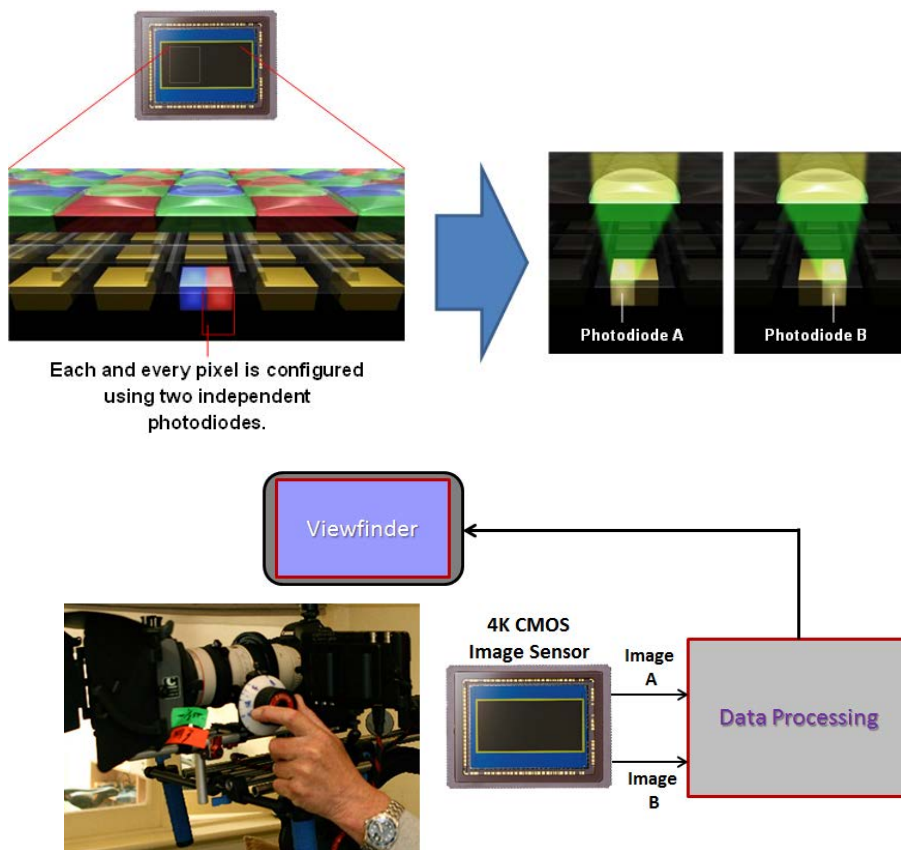


Figure 12 *Focus Guide* is a control loop that couples the manual focusing action to an indicating guide in the viewfinder – created from the Dual Pixel data from the CMOS image sensor – that unambiguously directs the cinematographer as to which direction to rotate that Focus Controller

The viewfinder guiding indicator is a white colored cursor which can be positioned anywhere within the focusing area that constitutes an 80% horizontal and 80% vertical region of the on-screen image display – as shown in Figure 13. The guide cursor is moved by the cinematographer to overlay the specific subject within the scene that is to be sharply focused. Allied with the guiding indicator are the three small arrows that lie above the cursor, and their direction is an unambiguous signal as to which direction the cinematographer should rotate the focus control. Precise focus is achieved at the point where the guide cursor snaps to a vivid green color.

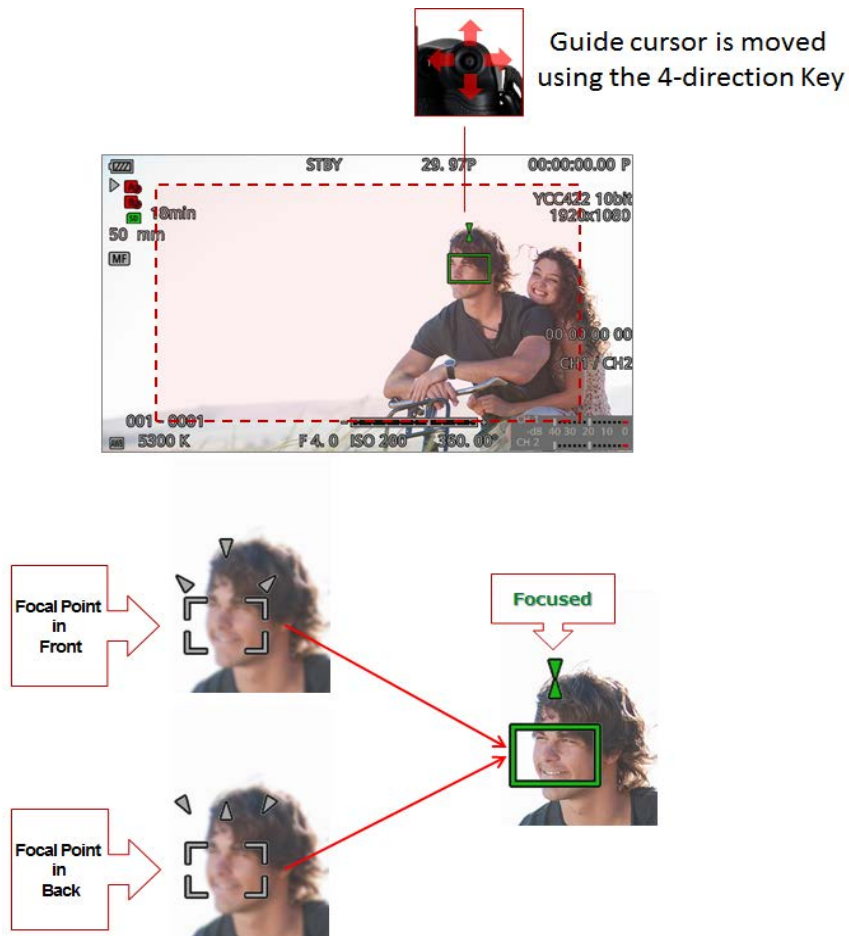


Figure 13 On top is a replication of the viewfinder display within which is a cursor that can be positioned over most of the image area (red line boundary shown). The lower illustration shows the guide cursor detail which uses three arrows to indicate the direction to rotate the focus control. At the point of precise focus on the chosen subject the cursor snaps to a green color.

Instead of struggling to identify sharp focus on a selected subject in a small viewfinder, attention is instead solely directed to the cursor overlaying that subject. The precision focus detection takes place within the CMOS image sensor photosites encompassed by that cursor thus ensuring absolute precision of focus achievement. Nothing has been taken away from the cinematographer (other than the vexation of sharpness limitations in the viewfinder). The principle of the phase detection used is very similar to that described in an earlier Canon paper on an optical embodiment within a broadcast television lens [3].

3.4 Dual Pixel CMOS Auto Focus

The Focus Guide system just described is specifically intended to totally support the long-established craftsmanship of the cinematographer whose manual control of focusing actions is an essential part of the creativity embodied in so many scenes. It is anticipated that the excellent imaging and recording capabilities of the C300 Mark II will see this camera used on many forms of high-end productions in moviemaking and in television.

Separately, the C300 Mark II is expected to also continue the legacy set by the original C300 within that quite separate production world of documentaries, news magazine productions, and a range of television run 'n gun program genres. In many of these productions achieving and sustaining accurate focus can pose inordinate challenges. An *automatic* focusing system – that can be fully relied upon – can make all the difference in achieving footage of exceptional quality. For this reason the C300 Mark II also embodies a *Dual Pixel CMOS Auto Focus (AF)* system that was first introduced more than a year ago in the C100. However, unlike that initial system which constrained a fixed cursor position in the image center, the new system allows that cursor to range across most (80% horizontal and vertical) of the image area. This supports incredibly smooth and consistent automatic rack focusing between selected subjects within the scene while also ensuring precision focus tracking if those subjects move within the scene.

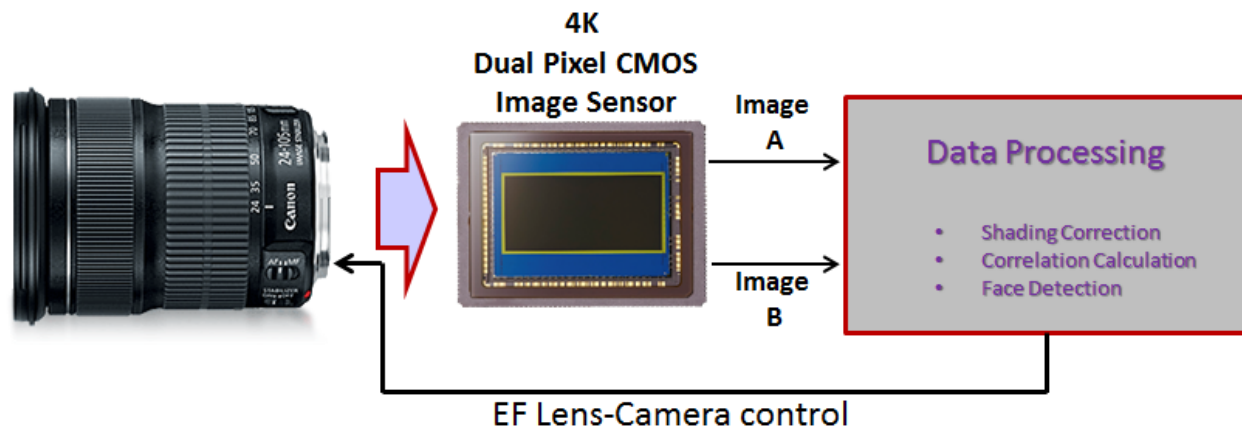


Figure 14 Simplified depiction of the Dual Pixel CMOS AF control loop operating with EF lenses. Face Detection is allied with this AF function

Dual Pixel CMOS AF is compatible with over 103 Canon EF lenses, and with these lenses Face Detection AF also becomes possible – see Figure 15. This feature, when enabled, allows for incredibly responsive and reliable contrast detection auto-focusing. Face AF is capable of tracking more than one face at a time, allowing the shooter to switch from one face in frame to another.

Based upon the experiences of those using Dual Pixel CMOS AF in the C100 Mark II there emerged diverse commentaries on the speed of the closed loop lens drive. Recognizing that this can vary for different shooting conditions a menu has been added into the C300 Mark II that allows selection of ten different speeds – a function that is applicable to those lenses having the capability of low-speed drives.



Figure 15 *Face detection in combination with Dual Pixel CMOS AF is a powerful new creative tool for certain forms of digital motion image production*

3.5 EF Lens Communication with C300 Mark II

The more than one hundred standard Canon EF lenses have a direct electronic communication with the C300 Mark II camera.



Figure 16 *The standard EF L series lenses (shown mounted on the C300 Mark II) have full electronic communication with the camera. The EF versions of the CINE-SERVO lenses (shown on the left) are also planned to communicate with the camera*

A planned firmware upgrade to the CN7x17 CINE-SERVO lens will allow many of the functions of this lens to be used by the C300 Mark II. These will include:

- Remote control (through the camera) of Zoom, Focus, and Iris
- Chromatic aberration correction (per planned future firmware update to C300 Mark II)
- Selectable T-No / F-No view availability
- Peripheral illumination correction (per planned future firmware update to C300 Mark II)
- Lens Metadata recording
- REC Start / Stop from the lens drive unit

It is also planned to have a downstream firmware upgrade for the CN20x50 CINE-SERVO lens.

3.6 Wireless Control of Focusing

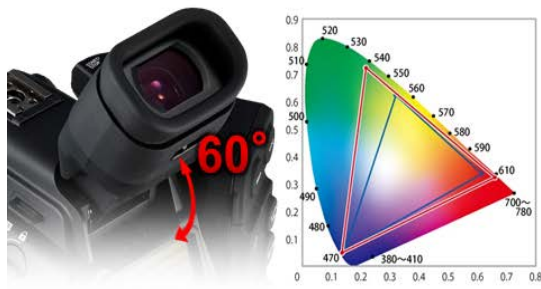
The addition of wireless file-transmitter (WFT-E6A) enables the EOS C300 Mark II to function in multiple production applications. Utilizing dual 5 GHz and 2.4 GHz frequencies, remote control of the camera via a simple browser window is now possible via a compatible smartphone, tablet, or laptop. When the C300 Mark II is imaging in a remote situation – for example, on the end of a jib arm, or aerial shooting from a drone, the Browser Remote function can carry through almost all shooting operations and settings from a tablet. Especially significant is the fact that focusing functions have been added, and the focusing area can be moved by touch – something that cannot be done using the camcorder body controls. Accurate focusing operations, which cannot be performed manually from a remote location, can now be carried out.



Figure 17 *Highly creative empowerment of remote control of the C300 Mark II is enabled with the capability of control of focusing*

3.7 Important Enhancements to the Electronic Viewfinder

Many comments and suggestions were received about the EVF of the original C300 system. The new C300 Mark II has embodied many of these recommendations. The EVF is an OLED display with a considerably higher contrast higher and wider color gamut that produces more vivid green and blue. The resolution is also modestly higher. Responding to the pleas of many DPs to “clean” the on screen display (OSD) there is a mode where lens-camera setting information can be displayed outside of the active picture area shown in Figure 18.



	Organic EL CVF C300 Mark II	LCD CVF EOS C300
Screen size	0.46inch	0.52inch
No. of dots (Resolution)	WSVGA, 1.77 million dots (1024 × RGB × 576)	QHD, 1.56 million dots (960 × RGB × 540)
Contrast	5000	270



Figure 18 Comparing the salient EVF image specifications of the C300 Mark II with that of the C300 on the left and showing an example of the noise-less OSD perimeter display on the right

3.8 Camera Assist Displays on the 3G SDI and HDMI Outputs

Many requested the capability of showing the waveform monitor and principal camera settings (presently shown only on the 4-inch LCD monitor of the C300) on an external on-set reference monitor as well as in the camera monitor. In the C300 Mark II the capability has been added to send the WFM and certain camera assist information via the MON 3G SDI interface and HDMI interface.



Figure 19 The Mon output 3G SDI interface and HDMI interface carries certain camera assist information and the WFM to the external display.

3.9 On-set Operational Systemization

It is especially noteworthy that the operational capabilities of the C300 Mark have been further enhanced with an innovative on-set systemization that encompasses the new Canon 4K Reference Display DP V2410. A single 3G SDI interface transfers the 4K RAW output of the C300 Mark II to the display DP V2410 which internally deBayers this to facilitate live-on-set viewing. That same signal can be looped through the display and sent to a video village or directly to an external RAW recorder (of which there are now many choices that handle the Canon 4K RAW signal format). This same reference display can perform on-set grading of that RAW signal within an in-built ACES color space. The grading settings are recorded as ASC CDL files on a thumbdrive plugged into the display. The C300 Mark II can also deliver a 10-bit ACESproxy output [4] via the SDI that can be an alternate for color grading within the display.

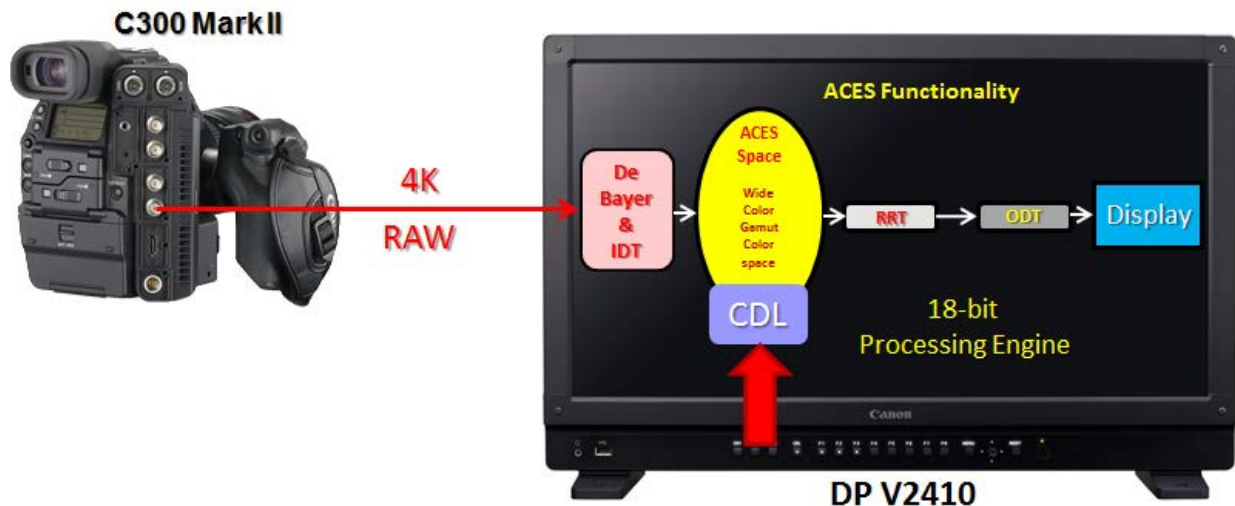


Figure 20 On-set operational creativity is greatly extended by the coordinated systemization of the new C300 Mark II and the new reference display DP V2410 that facilitates on-set grading according to the ACES 1.0 system

4.0 SUMMARY

While the original EOS C300 and the new EOS C300 Mark II bear a close physical resemblance to each other the differences between them are striking in multiple respects. A primary design goal in the new camcorder was to implement as many as possible of the wide ranging suggestions from those having experiences with the original C300 – especially those bearing upon ergonomic and operational issues. This paper is intended to provide an overview of the more prominent of these end-user urgings. But, there are many more enhancements incorporated in the C300 Mark II.

The C300 Mark II also benefits from significant technological advances in both camera image origination and video processing [1], as well as in the allied video capture [2]. These technical details are each covered in the two referenced separate white papers. The C300 Mark II is designed for serious theatrical motion picture and many forms of high-end television productions.

REFERENCES

- [1] *Canon White Paper: Image Performance Enhancements in the EOS C300 Mark II*

- [2] *Canon White Paper: Extended Recording Capabilities of the EOS C300 Mark II*

- [3] *Auto-Focus System for HDTV Field Lenses*
Laurence J. Thorpe, Yasuyuki Tomita, and Ken Ito
SMPTE Motion Imaging Journal March 2008: Pages 22 – 29

- [4] Specification S-2013-0 ACESproxy, an Integer Log Encoding of ACES Image Data
Science & Technology Council of the Academy of Motion Picture Arts and Sciences
Version 1.0 May 10, 2013