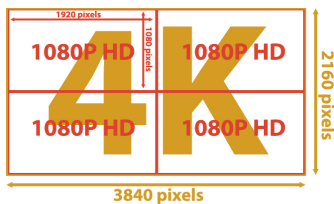


## The Panasonic AG-UX180: A Full-Featured 4K Camera For Professional Applications

Panasonic has introduced two new Ultra High Definition camcorders in 2016; the “standard” model AG-UX90, and the “premium” model AG-UX180. In a previous paper (entitled “The Panasonic AG-UX90: A Low Cost Camera For Professional Applications”) I discussed the AG-UX90 and what makes it such an outstanding value for the price, and compared the advancements it made over the previous model. The AG-UX180 is very similar in design and offers nearly every feature the AG-UX90 does, but it exceeds the AG-UX90 in many important ways.

In this paper I will explore the AG-UX180 and its new technologies and discuss the additional features that it offers over and above the AG-UX90, especially as it pertains to the camera operator's perspective.

### 4K and Ultra HD Recording



The AG-UX180 is a 4K and Ultra High Definition camcorder, capable of recording video in a frame size of 4096 x 2160 pixels (known as “Cinema 4K”) and also at 3840 x 2160 pixels (known as “UHD” or, generally, “4K”). It supports the standardized television implementation of UHD/4K at 23.98 or 29.97 progressive-scan frames per second. This frame size is literally four times as large (or provides up to four times as much detail) as a typical Full HD frame. The consumer television industry and streaming program providers such as Netflix and YouTube currently support 4K.

The UX180 adds four important advancements over the UX90 in regards to 4K imaging. First, it adds UHD at up to 59.94p frames per second. This is indispensable for covering live events, news, concerts, sports, nature cinematography or other programming where the cameraperson's goal is to deliver the “live/reality” look. Most UHD cameras support a maximum of 29.97 frames per second, which may be sufficient for a filmic or documentary look, but doesn't deliver the traditional “looking through a window” aesthetic that 59.94p does. The addition of UHD/59.94p marks the UX180 as a unique camera that can deliver the type of footage that competitor's cameras just can't do. To cope with the additional data from the faster frame rate, the UX180's codec uses wider bandwidth to encode this signal; it uses 150 megabits per second of H.264 when recording 59.94p (or 50p) UHD.

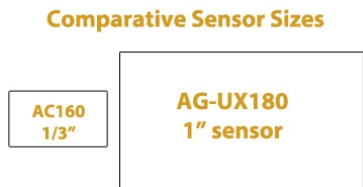
Second, the UX180 is a “world camera,” in that it supports both the 59.94Hz standard common in the USA, Canada, Japan and other areas of the world, and it also supports the 50Hz standard common in Europe, Asia, Australia and other parts of the world. The ability to deliver footage usable by any client anywhere in the world is a compelling advantage for the UX180.

Third, the UX180 retains a wider field of view in UHD, as compared to the UX90. While the UX90 offers a field of view equivalent to a 24.5mm photography lens in Full HD, that field of view shrinks to approximately 35.4mm when used in Ultra HD. The UX180 has no such restriction; whether in UHD or FHD, it retains the same 25.4mm wide angle field of view and 20x optical zoom lens. Not only does the UX180 offer the widest field of view of any fixed-lens professional camcorder anywhere near its price point, but it does so both in FHD and UHD, and is even slightly wider in 4K! If I were to point out just one feature professional cameramen have been asking for from the major manufacturers for years, it would be a wider lens; the UX180 delivers. I will discuss more about the lens in a later section, but felt it deserved special mention in this section about UHD since it is a differentiating factor between the UX90 and UX180.

Finally, the UX180 supports a wider frame, known as Cinema 4K. In Cinema 4K mode, the UX180 records at 4096 x 2160 pixels. This delivers about a 6.7% wider field of view, and a more cinema-appropriate aspect ratio of 17:9 (nearly identical to the standard movie aspect ratio of 1.85:1). Also, the Cinema 4K recording mode operates at exactly 24.00 frames per second, the traditional frame rate of cinema cameras. As such, a UX180 may be able to more easily integrate into a film production that's being shot on cinema cameras running at 24.00 frames per second.

### Large Sensor With Big Pixels

The AG-UX90 and AG-UX180 both use a 1" type sensor, which is a comparatively huge sensor for a conventional video camera. Historically, lower-cost cameras have utilized smaller sensors (typically 1/3" or 1/4"), and the large sensors have been utilized only in the more expensive models (typically using 2/3" type sensors). The AG-UX180's predecessor, the AG-AC160, used 1/3" sensors; the UX180's sensor is almost 8 times larger than the sensors in the AG-AC160! It is approximately twice as large as the 2/3" sensors used in common full-size broadcast camcorders.

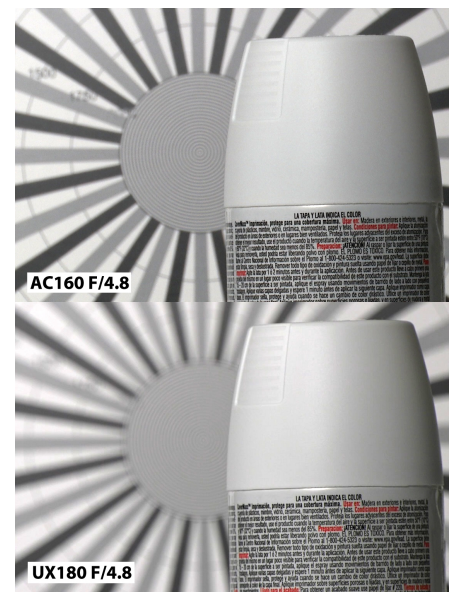


While the sensors are the same size in the UX90 and UX180, they are not the same sensor. The UX180 uses a sensor that is optimized for 4K video. The pixel density on the UX180's sensor is designed to provide native 4K resolution while maximizing the size of the pixels. By using a 9.46-megapixel sensor, the UX180 creates its 4096 x 2160 frame at an almost 1:1 ratio, without needing to resort to line-skipping or pixel binning to manage excessive sensor pixels. The result is true Ultra HD and 4K resolution (approximately 1440 lp/ph) with the biggest pixels possible.

Bigger pixels lead, generally, to more sensitivity, more dynamic range, and less noise. In direct comparison to the AG-UX90, the UX180's pixels are approximately twice as large as the UX90's. The UX180 is approximately twice as sensitive as the UX90 (about 500 ISO, vs. the UX90's ~250 ISO), and it shows noticeably less video noise. Even though the UX180 is a much higher resolution camera than its predecessor (the 1/3"-sensor AG-AC160), it is also significantly more sensitive (approximately 500 ISO, vs. the AC160's approximately 320 ISO).

Finally, another benefit of a large sensor is that it may afford somewhat more creative control to the user, in terms of the ability to isolate a subject and focus the user's eye through the use of selective focus. Put simply, when all other things are equal, the larger sensor will deliver images that have a shallower depth of field than a smaller sensor will. The implementation of a large sensor in the AG-UX180 means it is capable of delivering a more shallow depth of field look than a smaller-sensor camera could. With small-sensor cameras, the videographer or cinematographer is frequently dealing with an image where everything is in focus, from the closest subject to the furthest background. But with a large-sensor camera, it may be easier to isolate the subject, blurring the background somewhat and directing the user's eye towards the desired subject.

The improved shallow-depth-of-field capability may make the AG-UX180 more usable for more different types of jobs than were previously practical on small-sensor cameras.



Another beneficial aspect of the UX180's sensor is that it makes for excellent, crisp, alias-free Full HD 1080p. Because the sensor provides exactly four sensor pixels for every Full HD pixel, it is able to cleanly mix those pixels without resorting to line-skipping. The result is sharp, clean, moire-free HD that is easily on par with a pure-HD camera such as the AG-HPX250, and in HD mode the UX180 supports 1920 x 1080 Full HD at 23.98, 25, 29.97, 50 or 59.94 progressive-scan frames per second, in addition to the television standards of 50 or 59.94 interlaced fields per second (1080i).

### **Zoom Range**

The AG-UX180's zoom range is extremely usable. It offers the widest wide-angle zoom of any camera in its class, which is substantially wider than its predecessor (the AC160 offered a class-leading wide-angle equivalent of 28.0mm, the UX180's wide-angle equivalent is 24.0mm). While the UX90 offers a similar wide angle, the UX180 has much more telephoto; it offers a full 20x optical zoom, as compared to the UX90's 15x.

One significant differentiating factor between the UX90 and the UX180 is in terms of its wide-angle field of view when shooting UHD. While the UX90 can approximately match the UX180's wide-angle field of view (24.5mm vs. 25.4mm equivalent), it can do so only in Full HD mode; the UX90 loses quite a bit of its field of view when shooting UHD. The UX180, on the other hand, maintains its full wide-angle field of view whether in UHD or FHD. When in UHD mode, the UX90's widest equivalent field of view is 35.4mm, whereas the UX180 is at 25.4mm. This can make a valuable difference in the videographer's ability to "get the shot" when in tight quarters or small rooms.

The AG-UX180's 20x optical zoom range gives it an equivalent of 24 mm to 480 mm (in comparison to a full-frame photography camera) when in Cinema 4K HD mode. When in Full HD or UHD, the range is from 25.4 to 508mm. That's a highly useful zoom range, suitable for anything from tight-quarters work to nature videography. It is significantly wider and longer than the zoom range of competing cameras. In addition, when in Full HD mode, the user can employ the i.Zoom feature to take advantage of the high-resolution oversampling sensor to extend the zoom range to approximately 30x while generally maintaining full image quality. That results in an effective zoom range of 25.4 to 762 mm!

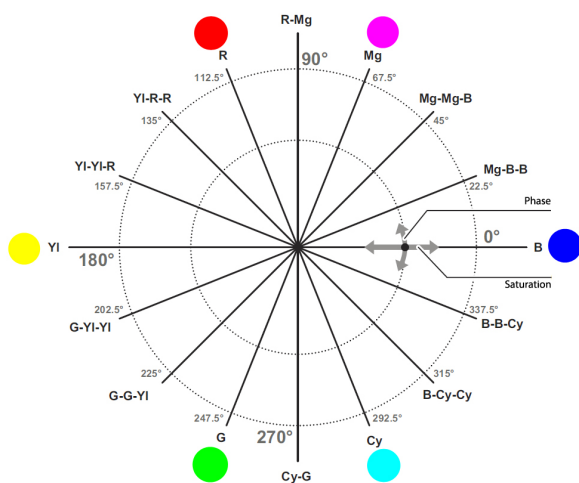


*These two pictures give an example of the UX180's incredible zoom range. The picture on the left is at full wide angle, and the arrow points at the star at the top of the tree. The picture on the right is fully zoomed in using i.Zoom; the star fills the entire frame.*

### **Image Control**

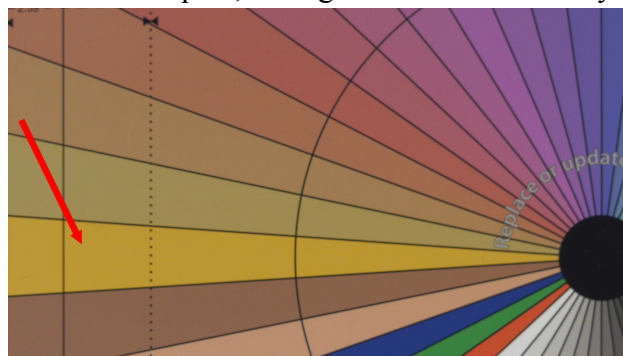
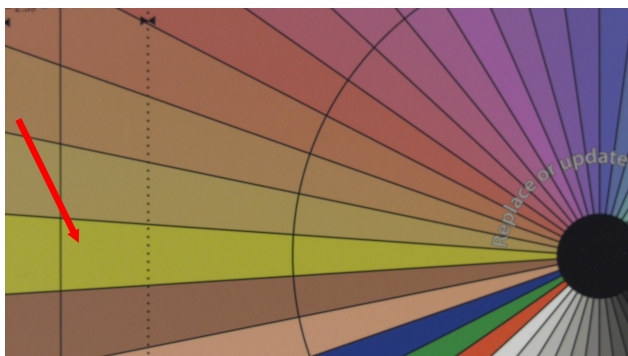
The UX180 gives the camera operator extensive control over the image. It has all the familiar settings for controlling edge enhancement/detail, gamma, color matrix, dynamic range stretching, and other image controls that have been a standard feature of Panasonic handheld professional cameras for many years, and shares those with the UX90.





However, there is one area where the UX180 is extremely advanced in its image manipulation: it features a 16-pole color matrix for extensive control over the color processing of the image. With this advanced color correction feature, a skilled operator can paint the image to their exact taste, with the ability to individually set the color saturation and chroma phase on sixteen positions around the color wheel. Armed with a color chart and a vectorscope, the operator can adjust the intensity on the six main axes (Red, Magenta, Blue, Cyan, Green, and Yellow) as well as 10 additional axes (such as R-Mg, halfway between Red and Magenta, or G-G-Yl, which is about 1/3 the way from Green to Yellow).

In practical terms, this color painting capability means that the operator can adjust and fine-tune the camera's image to provide the exact results they're looking for, or to match the color response to another camera for more seamless multi-camera shoots; such a capability is especially valuable in live-switched coverage of current events, since there is no time to provide post-processed color correction to the live feed. Even in productions that will have a post-production process, matching the cameras beforehand can save hours and hours of color-correction work in post, saving both time and money.



*An example of the UX180's Color Correction capability. The picture on the left is unmodified; the picture on the right has had extensive modification to its yellow color axis.*

## SDI Output



The UX180 includes a professional 3G-SDI digital video output port, in addition to its HDMI digital video output port. This is a notable upgrade over the UX90, which has an HDMI port but doesn't have an SDI port. SDI is the professional standard for monitoring and has been for many years. HDMI has its share of advantages (such as being able to transmit the UHD or 4K video signal), but HDMI at its core has been a consumer connector. 3G-SDI uses a locking BNC connector and provides a sure and safe connection to monitors or external video recorders.

For productions centered on 1080p or 1080i, the SDI connector is preferable to the HDMI connector in many ways, and is a standard feature of professional production video villages. The UX180's SDI connector is fully compatible with HD-SDI and 3G-SDI and is capable of up to 1080p at 59.94 frames per second.

## Timecode Sync Port



Another differentiating factor from the UX90 is the UX180's Timecode Preset In/Out Port. The standard model UX90 has no provision for receiving or transmitting a timecode signal (other than embedding timecode on its HDMI feed). Timecode synchronization is an extremely helpful capability in multi-camera productions. The UX180's timecode port is capable of transmitting or receiving an LTC timecode signal and synchronizing its free-run timecode generator to that signal. While it doesn't offer full genlock capability, the timecode synchronization port lets the UX180 integrate into productions using other professional cameras, or timecode generators, or external audio recorders that need timecode sync.

Synchronized timecode can dramatically minimize the amount of time necessary in the edit bay to edit from multiple cameras, and is vital for applications such as reality TV productions, concerts, or other multi-camera productions.

## Slow Motion and Super Slow Motion

Yet another differentiating factor for the UX180 over the standard model UX90 is in the ability to film slow motion. The UX180 has all the same variable frame rate capabilities of the UX90, but extends them in two important ways.

First, the UX180 is capable of delivering UHD-resolution slow motion for 23.98p, 25p, or 29.97p projects. The capability of filming UHD at 50 or 59.94 frames per second gives the editor the opportunity to insert that footage into a 23.98p, 25p, or 29.97p project and, after conforming the frame rate, the result is picture-perfect, frame-accurate, full-resolution slow motion even in Ultra High Definition.

Second, the UX180 goes a step further by offering Super Slow Recording at either 100 fps (when operating as a 50Hz camera) or 120 fps (when operating as a 59.94Hz camera). The Super Slow Recording delivers slow motion at a rate of 4x to 5x slower than real time, for extended slow motion sequences. Super Slow Recording is only available in 1080p and does yield softer resolution than normal 1080p mode, but there are no compromises to field of view or recording time. Whereas competing cameras sometimes limit the amount of slow motion recording you can do to just a few seconds, the UX180's Super Slow Motion can run for over two hours (which would yield 8 to 10 hours of footage upon playback).

## Dual Codec Recording

One very interesting and useful feature that the UX180 offers above and beyond what the UX90 is capable of, is Dual Codec Recording. The UX180 offers two memory card slots, and provides several ways to utilize those slots; you can, for example, simultaneously record identical footage to both card slots, or configure the camera to roll over from one card slot to the second slot when the first card is full. These features are shared with the UX90. But the UX180 takes it a step further; the more sophisticated processing engine of the UX180 provides the ability to actually record footage in two different codecs at the same time. This capability means that you could record Ultra High Definition footage on your main card, and simultaneously record a high-quality downconverted 1080p version of the footage for easier editing in an offline/online workflow. The files are recorded with the exact same filenames on both cards, utilizing identical timecode, so you can complete the edit rapidly using the 1080p version and then substitute in the UHD footage for your final delivery. Or, alternatively, perhaps your delivery requirement is for Full HD 1080p today, but you'd like to shoot UHD for

futureproofing. You could configure the camera to shoot UHD to one card, and a 50-megabit 1080p version on the second memory card. You could use that 1080p version to complete the project in 1080p today, and retain the UHD files for revisiting the project in the future when creating a UHD master makes sense.

Another way to utilize the dual codec capability would be to record high-quality, full-bandwidth 100-megabit/sec UHD or even 200-megabit/sec Full HD on the main memory card, and a low-bandwidth 8-megabit 1080p version on the second card. Recording an 8-megabit version will create comparatively tiny file sizes which would be suitable for uploading in the field to an editor who could get to work cutting the footage right away, while your full-quality 100- or 200-megabit master footage (which would perhaps be impractical or uneconomical to upload) could be express-shipped when convenient, or brought back with you at the end of the shooting assignment. The editor can then just substitute the full-quality footage and have an instant high-quality edit ready to go.

### **Summary**

The UX90 offers a lot of camera for the money. The UX180 delivers significant upgrades in terms of imaging, sensitivity, connectivity, operability, and especially when operating as a UHD camera. For professionals who need the best performance and control and the ability to work in a multi-camera environment, the UX180 offers the needed tools and power at a very reasonable price.