Panasonic

A Guide to Panasonic's **AG-UX90** & **AG-UX180** Camcorders

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Contents

Foreword

The first book I wrote about a Panasonic camcorder was in November of 2004. That first book was called "The DVX Book", and was a comprehensive guide to Panasonic's revolutionary new (at the time) DVX100. In the intervening decade (plus one), I've written many more books on many more cameras, and we've seen several more revolutions in camera technology, including tapeless recording, HD, now 4K/UHD, and large sensors.

It's striking to see how far we've come, when I compare the new AG-UX90 and AG-UX180 against that groundbreaking DVX100. These new cameras are about the same size and same weight as the DVX100, and are designed to serve as a "Swiss Army Knife" of video cameras - able to handle just about any job that comes up.

The UX180 and UX90 are such monumental leaps forward, in comparison to that original and beloved DVX100, that it's hard to imagine that things could have changed so much in seemingly such a short time (even though it has been 12 years!) The DVX100 was such a breakthrough, and such a successful do-everything camcorder, and the UX180 really reminds me of it in many ways, and even costs less than the original DVX100 did. And the UX90 is a simply astonishing camcorder for the price, costing less than half of what a DVX100 did (when adjusted for inflation). Yet the UX180 and UX90 are Ultra High Definition/4K camcorders, so advanced that it's hard to imagine that these new UX cameras are literally making images that are 24 times the size of that original DVX100. It's like the new UX is the perfected personification of the DVX100, taken to extreme levels of performance. And that is a very good thing indeed.

This guidebook is not intended as a complete replacement for the user's manual. Rather, it is a collection of essays on the cameras, a thorough examination of their features and settings, and suggestions for how to use those settings to get the results you're after. There are also explanations on camera fundamentals and shooting fundamentals. To some readers this may be familiar material; to others, it will hopefully be an enlightening

guide that will help you understand not only this tool, but also the process of producing images with a video camera, and the ways to get the most performance from these cameras. This guidebook will occasionally refer back to the camcorder's Owner's Manual since subjects covered adequately there will not be discussed here. This guidebook will expand upon subjects that may not have been explained thoroughly enough in the manual, as well as provide techniques, tips and insight on how to best use the various features. You may find some technical jargon in these pages, but I've tried to provide plain-English explanations so that users of all experience levels will benefit.

Acknowledgements

This book has drawn heavily from my prior works, but some of it has been completely rewritten or added because of the new features and capabilities of the UX180 and UX90. I am so lucky to have benefited from the many talented, dedicated, and knowledgeable people who lent me their expertise. I'd like to take a moment to acknowledge and thank them.

First, there's Panasonic USA's **Steve Cooperman and Jim Wickizer**. They were essential in helping me to get this book made.

From Panasonic Japan, I'd like to acknowledge and thank **Ayuta Onishi**, who championed the book project from the beginning, and **Ota Yusuke**, who has been extremely helpful and instrumental in providing support and information to make sure that the information in these pages is as accurate as it can be.

Many thanks to **Victoria Hart** of Pink Kitty Creative in Las Vegas for the graphic design work.

And, of course, huge thanks to **Jarred Land** and the **membership of www.DVXUser.com**. Jarred created a one-of-a-kind community where filmmakers and shooters share information, knowledge, questions, techniques, answers, and footage. I've met some incredible people through that site, and interacting with tens of thousands of DVX, HVX, HPX, AF, HMC and AC users around the globe is what led to the creation of the original DVX Book and now to this UX180 & UX90 Book. Thanks to every one of you!


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR
15X OPTICAL ZOOM
FOCUS
PUSH AUTO
IRIS
AWB

Frequently Asked Questions

If you're a new shooter, or new to professional cameras, you may find some of the topics in this section relevant. Even some shooters with years of experience behind them, might be new to the Panasonic line of professional camcorders. There are many differences in the way a professional camcorder works, as compared to a consumer camera or DSLR. I've collected a series of frequently-asked questions here, so be sure to check these out before getting frustrated with your new camera.

What's that rattling noise?

The first question many new owners ask is "What's that click?" When a new owner picks up the camera for the first time, they will usually hear a "click" or "rattle" when tipping the camera back and forth, like there is something loose inside the camera. This is completely normal! There's nothing wrong with the camera; what you're hearing is an element of the focus group system. When the camera is powered on, the focus system is energized, and the rattle disappears. This is one of the most frequently asked questions, so if you were concerned by the "rattle," have no fear, you're in very good company! Since this is one of the first questions new users ask, it seemed only appropriate that it be the first answer in the guide.

Why Does The UX180's LCD Keep Going Black?

If there's one question that comes immediately after "What's that rattling noise?", it's got to be this: "Why does the LCD keep shutting off?" When you're new to the camera and first using it, you may notice that the LCD panel occasionally goes black. The reason is because the UX180's Electronic Viewfinder (EVF) has an automatic eye sensor, and it automatically switches from the LCD to the viewfinder any time the sensor thinks that you've put your eye near the viewfinder. Which would be great, if it only happened when your eye was actually close to the viewfinder, but the

sensor will also detect if the camera is too close to your body, or if your arm passes above the viewfinder it may trigger the sensor. In short, there's nothing wrong with your camera, it isn't broken, it's just that the eye sensor is being activated. You can adjust the eye sensor sensitivity level to make it more sensitive or less sensitive, although do be aware that the factory default is to ship it at its least-sensitive setting. I find that the easiest way to cope with the situation is to tilt the EVF to where it's pointing straight up; that provides the fewest opportunities for accidentally triggering the sensor. If you know for a fact that you will not be using the EVF, you can always select the OUTPUT SETUP->LCD/EVF OUTPUT->LCD function, which will enable only the LCD panel. A quick shortcut is to use User Button 7, which is programmed by the factory to toggle the LCD/EVF Output function. Note, this situation doesn't affect UX90 users, as the UX90 doesn't have the eye sensor for automatic switching; all switching on the UX90 is done manually using User Button 7 (or the aforementioned menu setting).

Where Did My Clips Go?

After shooting some clips and experimenting with the various recording modes, new shooters frequently toggle over to playback mode and find that many of their clips aren't shown. Where did they go? Are they lost? Did they fail to record? Is there something wrong with your SD cards?

No, none of the above, and there's no reason to panic. What's happening is a byproduct of the camera having multiple different recording modes available. When you enter the Thumbnail mode, the camera will only play back clips that were shot in the same mode as it's currently set in. What this means is, if you shoot some clips in MOV format, and some more clips in MP4 mode, and another couple of clips in AVCHD, and then you go to the thumbnail screen to play them back, the only clips you'll see will be the AVCHD clips you just shot! The MOV and MP4 clips won't even show up. Now, there's nothing wrong with the other clips, but the camera was last set in AVCHD mode, so that's the only mode of clip that's available for playback.

Resolving this is really very simple; just change the recording format to match the clips you want to play. Press the movie camera icon in the upper left of the thumbnail screen and choose MOV or MP4; then you can choose ALL to show all the clips that were recorded in that format. You can also filter them down; if you shot some clips in UHD and some others in FHD, you can choose to show just the UHD clips or just the FHD clips, if you so want.

The situation gets slightly more complex if you're using a UX180, since it has the ability to shoot in both 59.94Hz and 50Hz. If you shot some clips in 59.94Hz, and other clips in 50Hz, then when you go to the Thumbnail screen you'll see that some of the clips have a red circle/slash next to the playback button on their thumbnails. If the camera was last set in 50Hz mode, then you will be able to play back 50Hz clips but you won't be able to play back 59.94Hz clips, and if the camera was last set in 59.94Hz then you won't be able to play back 50Hz clips, until you change the camera SYSTEM FREQ. You have to go back to camera mode to change the SYSTEM FREQ to the compatible setting for the clips you want to view.

Sounds like a hassle, but in reality it's not a big deal. Usually you only change recording modes when you're experimenting, but once you settle down to shoot a particular project, you'll usually pick one recording mode for the entire project, so the mode-changing issue becomes largely irrelevant in actual practice. Just remember that if you can't see a clip's thumbnail, that just means you need to change the recording format to match that clip before being able to play the clip back.

Why Can't I Connect The Camera To My Computer?

The camera includes a USB 3.0 DEVICE port, and can be connected to any computer that has USB 3.0 (or USB 2.0) ports. The reasons for computer connectivity problems usually come down to one of these simple issues:

A) Trying to connect to a USB 1.1 port – don't do that, make sure your computer's port is USB 2.0 or USB 3.0.

B) Trying to connect through a USB hub. Don't do that, connect directly into your computer's port.

C) Trying to connect to the camera's USB HOST port. Don't do that, that's for connecting a hard drive directly, or for connecting a wireless wi-fi adapter. For connecting to a computer, use the USB Device port.

D) Trying to use a USB 2.0 cable instead of the necessary USB 3.0 cable. A USB 2.0 cable won't fit in the camera, you need to use USB 3.0. However, a USB 3.0 cable from the camera will fit and will work in a computer's USB 2.0 port.

E) Having the USB port turned off. Go into the OTHER FUNCTION menu and set USB MODE to ON, and USB MODE SELECT to DEVICE.

When you have the camera connected to the computer, it will automatically detect the attached computer and offer a menu choice of connecting to a PC or a RECORDER. Choose "PC" and you should now be able to read the camera's SD cards on your computer.

Alternatively, you don't really need to use the camera connected to the computer, you can just remove the memory card and plug it directly into an SDXC-compatible card reader. These are available at computer stores for very little money; just try to get one that is compatible with the new SDXC cards. Older readers would work only with SD cards, but not with the newer SDHC or SDXC cards. You want to make sure any reader you buy is compatible with SDXC cards in addition to SDHC cards.

There's no functional difference between reading the memory card via the camera through USB, or putting the card in a USB 3.0-compatible card reader (except that the camera treats all the memory cards as read-only; you cannot copy files to a memory card or delete files off a memory card when you're using the camera as the card reader.) Also, many modern laptop computers now include SDXC-compatible card slots, so you could put the card directly in the computer, but, again, be sure the card slot is compatible with your card (SDHC or SDXC) and not just the older SD-only card slot.

Do be aware, however, that 64GB (and larger) SDXC cards use the exFAT file system, and older versions of computer operating systems may not support exFAT. Make sure your operating system is up to date and can support exFAT, or stick to using SDHC cards that are 32GB or smaller (those use FAT32, which is widely supported by computer operating systems).

Why won't my Mac program (Final Cut Pro, Final Cut Express, or iMovie) import the footage?

Some version of Macintosh software really will only want to work with files that have been recorded in the .MOV format. If you've recorded in AVCHD or .MP4 formats, you may have to Log & Transfer the footage, converting it into Apple's ProRes codec (or Apple Intermediate Codec) before your Mac will let you work with the footage.

Additionally, be aware that at least some versions of Apple's iMovie software simply won't work with 24P footage at all, of any type. There's no easy answer for that, other than to use different software to edit your 24P footage.

Regarding 4K or UHD footage, most modern Non-Linear Editing (NLE) programs should be able to work with the footage. If you're having issues, check with the manufacturer of your software — it's possible that you may need to upgrade to the latest version to be able to work with 4K or UHD footage.

How can I view the footage on my computer?

Generally, a multi-purpose file playing program should be able to handle playing back the footage; for .MOV files you may want to use Apple's Quicktime Player; for MP4 files you may want to use something like VLC Player.

Do be aware, however, that playing 4K or UHD footage can be extremely processor-intensive, and may benefit greatly from a modern graphics card. Which means — it's possible that your computer just may not be powerful enough to properly play 4K or UHD footage. Furthermore, unless you have a very modern monitor that's capable of 4K (or UHD) resolution, you may not be able to see the full detail and quality of the footage on your computer. There's no solution for that other than to try to play the footage back on a system that's fast enough to properly display it, and on a monitor that's large-enough and high-enough resolution to properly display the footage. On smaller or lower-resolution monitors, your video playback software can be configured to "full-screen" mode, in which it will automatically re-size (or "scale") the footage to fit the resolution of your screen. That will enable you to watch the footage, but not at 100% quality.

What is the red light on the front of the camera, and why is it on? Or, why is it not on?

That's the Rec Lamp or "Tally Lamp" which lets you know if the camera is currently recording. You can turn it on or off, whichever you prefer. See Rec Lamp for more information.

Can I use this camera for live streaming (to the internet, or to a computer)?

You cannot just plug the camera into a computer via USB or connect via wi-fi and expect it to stream video. These cameras aren't webcams, by themselves. However, if you want to stream video to your computer or to the internet, it can still be done, but you'll need to buy a separate video capture device to allow that. There are many of these types of devices on the market, what you're looking for is something that will input video

(either composite video, or digital video via HDMI, or if you have a UX180, you can also use HD-SDI or 3G-SDI digital video) and convert it to digital video on your computer. Example products may include an internal capture board such as the BlackMagic Intensity Pro, or a USB-connected external device such as the Pinnacle Studio USB MovieBox. You'll also need web-streaming software, such as BroadCam Live Video Streaming Software. It's not a one-step solution like a webcam, you'll have to research the software and hardware combination to find something that does what you want, and works on the computer platform you have.

The wi-fi connectivity is not for streaming video either; it's for allowing remote control via the AG ROP app.

Why Don't Some Of The Menu Items Work?

Occasionally you'll find menu items that are grayed out — usually menu items like VFR, or PRE-REC, or VIDEO OUT OSD. And it can be frustrating to see those disabled menu items and not know why they're disabled, or how you can re-enable them. I put a section in the book specifically addressing why menu items get disabled, which ones get disabled, and what you'd have to change to re-enable them. Look up the **Disabled Menu Items** article.

Also, there are some functions that are only possible when the camera is in HD mode, and are disabled when in UHD or 4K (examples include the 5-axis image stabilizer, or variable frame rates). Again, see the "Disabled Menu Items" article for more information.

On My UX180, Why Does My SD Card Show Up In The Camera As "Incompatible Data"?

Well, assuming that there's nothing wrong with your memory card(!), it's probably down to an AVCHD formatting question. The AG-UX180 is a "world" camera; each camera has the ability to shoot either 50Hz or 59.94Hz footage. However, when recording in AVCHD, be aware that the AVCHD recording system specifies that only one type (50Hz or 59.94Hz) can be recorded on each card. A memory card formatted by a camera set to 59.94Hz cannot be used to record AVCHD clips (or play back AVCHD clips) in a camera set to 50Hz mode (and vice versa). If you're encountering a card where it's telling you it's an incompatible format, check your SYSTEM FREQ menu setting, and make sure that you're operating in the mode you should be in, for that card.

This restriction doesn't apply to .MP4 or .MOV clips; you can freely mix 50Hz and 59.94Hz MP4 and MOV clips on a memory card regardless of how that memory card was formatted. The 50Hz-only or 59.94Hz-only restrictions apply only to AVCHD clips.

Why Can't I Record Onto My Memory Card?

The camera is capable of many different bitrates, depending on the recording mode you select. Memory cards come in a variety of specifications and speeds that they can support. If your memory card is too slow — then the camera just won't be able to record your chosen recording format onto that card. To use that memory card, you may have to drop your recording format down to a lower-bitrate mode.

In general, you can use a Class 6 SD card only for recording AVCHD. You can use a Class 10 card to record AVCHD and 50-megabit FHD only. If you want to record the higher-bitrate modes (UHD on the UX90, or FHD 100M/FHD ALL-I 200M, or any version of UHD or 4K on the UX180) you're going to need a UHS-1 U3 memory card. Don't be fooled by advertising of how many kbits or megabits a card can write (such as "45MB/s" or "300x"); those specifications are not what matters to the camera. The only thing that matters is the minimum sustained write speed, which is specified by either a Class 6 or Class 10 designation, or by the Ultra High Speed (UHS) designation. UHS-1 U1 cards won't work for the highest-bitrate recording modes, you need UHS-1 U3 or MicroP2 cards for those.

Finally, if you've met the other criteria listed above, verify that your memory card works. Sometimes memory cards go bad, so you'll want to test to see if your memory card is working properly. Try putting it in another camera, or in a computer, to see if the card is recognized. On that note, always buy and use the best brand-name cards you can get; it's true that you can usually use cheaper memory cards, but the old adage "you get what you pay for" still applies, so always use the very best memory cards you can afford. And don't be ripped off by counterfeit memory cards! If you're shopping on auction sites or through less-than-reputable resellers, there is a very real prospect of receiving counterfeit ("knockoff") cards. Stick with reputable resellers who are factory-authorized dealers for the memory cards you're shopping for.

Why did the camera split my footage up into multiple clips?

If you record one long continuous recording, you may find that on the memory card there are actually multiple clips. Generally this happens most often when using SD or SDHC cards (instead of SDXC cards). The reason for this is because SD & SDHC memory cards use the FAT32 file system, and the maximum file size on an SDHC memory card is 4 gigabytes. One way to minimize this issue is to always use SDXC memory cards; they use the exFAT file system, and can record files up to 96 gigabytes in length.

On the SDHC card, FAT32 has a maximum file size of 4 gigabytes, and 4 gigabytes can accommodate about 20 minutes of AVCHD PH footage, or around 2 to 4 minutes of 4K or UHD footage. So if you're shooting UHD 24P and recording on an SDHC card for 6 minutes, what happens? Well, the camera knows to automatically split the recording into two files, close off the first file at the 4GB file limit and continue recording into the second file. So even though you only hit the record button once, the file size limitation inherent to the memory card may require the camera to make multiple files.

(When recording AVCHD, the camera will also create "pointers" for the two clips, so that each section of the clip "knows" that it is only part of a larger master clip and it will know what clip follows it, and what clip precedes it.)

For AVCHD, all of this is done automatically and seamlessly behind the scenes. When you view the AVCHD clip in-camera it will look as if there's only one clip on the card, because, essentially, there is only one clip (it just happens to be made up of several pieces, but inherently it's all intended to be treated as one continuous clip). If you use an NLE that is properly AVCHD-aware, it will know how to properly reassemble all the pieces into one contiguous clip, seamlessly and effortlessly. If your software doesn't recognize the attached nature of the clips, then you'll have to manually copy over all the pieces, and string them together end-to-end on your timeline. Note that some earlier versions of NLE software didn't know how to do this seamlessly, and would introduce small gaps between the pieces of a clip. That is a software error, not a footage problem! The camera records all the footage seamlessly. If your NLE software can't display it seamlessly, look into upgrades or fixes for your software; as of the time of this writing most if not all major NLEs can now seamlessly handle spanned AVCHD clips.

If you're recording UHD or FHD footage in MP4 or MOV file formats onto an SDHC card, you can expect that the camera will also make individual files at the 4GB limit (on SDHC cards) or at the 96GB limit (on SDXC cards). However, unlike AVCHD recordings, the camera will display each and every one of those MOV or MP4 clips with individual thumbnails, and they will import into your NLE as individual clips; you'll have to manually align them end-to-end on your NLE timeline. As a best practice, when recording MOV or MP4, it's best to stick to SDXC cards (capacity of 64 gigabytes or larger) instead of SDHC cards. SDXC cards have the much larger 96GB maximum file size and, accordingly, you'll be able to accommodate many reasonably long recordings without the camera needing to split long recordings up into multiple files. And even when it does need to split into multiple files, it should be comparatively few files, versus the many files that may be created when using an SDHC card. When recording (for example) 100 gigabytes of data, an SDXC card will do so while creating just two files (one 96GB, the other about 4GB). An SDHC card, on the other hand, will make about 25 files, all of them being 4GB in size.

As you can see, you'll have a much easier time dealing with long recordings if you use SDXC cards instead of SDHC for recording MOV or MP4 files. For AVCHD, it doesn't matter what type of card you use, it will always split files at 4GB file sizes. But, it's less of an issue for AVCHD because the bitrate is so much smaller, so you can record longer per gigabyte, and AVCHD includes file pointers that let you treat even a very long, many-part recording as one clip.

Why won't the exposure change when I adjust the iris?

Even if the camera is in manual iris mode, sometimes changing the iris won't result in the actual brightness changing. Why? Because the camera has other methods of maintaining or setting automatic exposure, and if those are active, they may cancel out your iris changing. Watch out for automatic gain control, and automatic shutter control. When the shutter is in auto, it will change on its own, without your guidance and perhaps without your approval. Look at the shutter speed display; if it says A.SHTR then the camera's automatic shutter is engaged.

To get the shutter back in manual mode, press the SHUTTER button. The "A.SHTR" display will disappear, and you will then be able to set the shutter speed manually by using the jog/dial wheel.

The other automatic exposure compensation is the automatic gain, or AGC. When the gain is in automatic mode, the display on the right will say “AGC”. To get the gain back in manual mode, ensure that the AUTO/MANU switch is in “manual”, and press the GAIN button to choose one of the manual gain settings.

For true manual exposure, you have to ensure that automatic gain and automatic shutter and automatic iris are all disabled, and that all of those functions are instead operating in manual mode.


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR
15x OPTICAL ZOOM
USER
FOCUS
PUSH AUTO
IRIS
DISP/MODE CHK
AWB
GAIN
WHITE BAL
MENU
SHUTTER

Articles

Some of the articles in this section are going to be really basic, and some will be more advanced. It's impossible to know the experience level of the reader, so I've taken the tactic of explaining things from the beginning. Even if you're an experienced shooter, you may find some nuggets of knowledge in these pages.

Understanding Exposure

Perhaps the primary ingredient in getting good-looking video is to get a proper exposure. In this section we're going to cover the ins and outs of the exposure system and talk about all the various ways that you can control the exposure in the camera, as well as attempt to define what qualifies as a "good exposure" and how you know when you've got it!

To understand exposure, we have to really narrow it down to a couple of very key concepts – we're talking about how much light falls onto the camera's sensor, and for how long. Both elements (the amount of light, and the duration) when taken together, result in the total quantity of light hitting the camera's sensor. The art of getting a proper exposure is to control that amount of light so that you don't get too much, and you don't starve the camera either, you need to get the amount of light "just right" and, when you do, the camera can work magic.

If you starve the camera of light, the results will be unpleasant. You'll get a noisy, grainy, muddy, flat, ugly mess of a picture. How do you avoid that and get beautiful results? Feed the camera enough light.

If you give it too much light, the results will also be unpleasant. You'll have harsh, blown-out, ugly images. How do you avoid that and get beautiful results? Again, the key is to control the light and make sure that the right amount gets through – not too much, and certainly not too little.

There are three primary ways we as shooters control the amount of light entering the camera. The first, and most important, is the lens aperture (or "iris"). The aperture is a variable-sized hole in the lens, which the light flows through. The bigger the hole, the more light gets let in. The smaller the hole, the less light gets through. The size of the aperture is known as its f-stop; the smaller the number (such as f/2.8) the bigger the hole and the more light comes through it; the larger the number (such as f/11) the smaller the hole and the more light it stops from coming through.

The second way we control the amount of light is through the shutter speed. The shutter speed controls the amount of time that light is allowed to enter the lens; the longer the time, the more light gets through, and the shorter the time, the less light gets through. However, while the shutter is capable of helping us control the flow of light, it's not really something you want to be using for the purpose of adjusting the exposure, because the shutter speed also affects the way motion is captured. Typically a video shooter will use the iris/aperture to control the amount of light, and they'll leave the shutter speed alone (unless the shooter has a very specific need and a thorough understanding of what the side effects of changing the shutter speed will be!)

The third way of controlling the amount of light is through Neutral Density (ND) filters. ND filters are like "sunglasses" for your camera. They darken the incoming light, with no side effects (no color shifts, no polarization, etc). ND filters are used in bright conditions (sunny day exteriors) and are usually not necessary in darker or indoor conditions. The UX cameras have three built-in ND filters, allowing the user to select from various levels of light-cutting capability. You can also get additional external ND filters that attach to the front of the lens (by screwing into the lens threads) or in an external filter holder (such as a matte box).

Automatic or Manual Exposure?

Now that you know the basics of how to control the amount of light entering the camera, the next major question is: how much is enough? What's the right amount, and how do you know?

There are primarily two ways to judge, either automatically or manually. The camera has the ability to automatically control the iris and the shutter, and it will judge how much light is necessary and open up or close down the iris to the appropriate size; it can also select a different shutter speed if it can't choose proper exposure by iris alone. The camera will also advise

you when it's reached its limits and when you should consider changing the ND filter position (i.e., if the image is too bright and the system can't compensate, it will start flashing a message such as "ND 1/4" or "ND 1/64", which is basically asking you to please adjust the ND filter switch position so that the system can more effectively control the incoming light).

You also have a couple of ways that you can influence the automatic exposure system, such as assigning SPOTLIGHT or BACKLIGHT compensation to a USER button; engaging these functions will cause the automatic exposure system to open up or close down the iris by a set amount. Or, you can get even finer control by using the AUTO IRIS LEVEL menu setting in the SCENE FILE menu.

Automatic exposure can work well in some circumstances, and it's certainly handy to be able to turn over the task of exposure to the camera so that it frees you up to concentrate on other things, but rarely does the best video come from automatic exposure. Professionals frequently (if not exclusively) rely on manual exposure control, for many reasons. Manual exposure control lets you decide what's the most important element in the scene to expose for, and it keeps the exposure from changing in the middle of a shot (something that can happen during auto-exposure).

Manual exposure is the professional way to control the camera's exposure system. The camera gives you complete control over shutter speed, iris setting, gain/ISO, and ND filtration.

How do you know how much exposure you're getting?

The key to getting proper manual exposure is to know how much light the chips are receiving, and to know if it's too little, too much, or just right. And the way you know this is by using a wide variety of monitoring tools, including:

1. the LCD monitor
2. the Zebras
3. the Marker
4. the Waveform monitor (UX180 only)
5. the Histogram (UX90 only)
6. an external monitor
7. relying on the auto-exposure system to tell you

Learning how these monitoring tools work will greatly improve the overall look and quality of the video your camera generates. Let's start with the LCD monitor.

Using the LCD Monitor to Judge Exposure

This is probably far and away the most common way that shooters, especially new shooters, use to judge exposure. It is also a terrible way to judge exposure! Seriously, it's a bad, bad idea to just look at the LCD and say "yep, hey, that looks good, let's shoot it." There are many reasons why, and I'll go into some of them, but please trust me when I say that you simply must not rely on just looking at the LCD, you have to learn how the other tools work and USE THEM.

Okay, so why is just looking at the LCD a bad idea? I mean, if it looks good there, it looks good, right? Well, not necessarily. Because the LCD monitor isn't an absolute reference point, it's subjective, and it can be influenced by a lot of things, including the lighting conditions you're in (a dark room? or broad daylight?) And the LCD is quite reflective; if you're in a bright environment the reflections can make it look washed-out, which might adversely affect your opinion of what the exposure actually is.

A second reason judging exposure off the LCD is a terrible idea is, the backlight setting on the LCD can change the brightness in the LCD by a huge amount – yet it's not changing the brightness of the video at all! So if your LCD is representing the video as brighter than it really is, you could end up underexposing your video without even realizing it. And if the LCD is representing the video too dark, you might be tempted to overexpose the video just to get it to look brighter on the LCD — when in reality, you'd be destroying the recorded footage!

So, the moral of the story is: don't rely on how the image looks in the LCD to be the deciding factor on whether you've exposed the image properly. The LCD is a relative display, and how it looks is relative to how high you have the backlight set, it's relative to what angle you're viewing the LCD at, and it's relative to the prevailing lighting conditions (meaning, if you're in a very bright environment, the LCD is going to look too dark, and if you're in a dark environment, the LCD might end up looking too bright). So, for the sake of your footage, don't rely on just looking at the LCD, and instead learn how to use the more accurate professional monitoring tools built into your camera. And if you insist on using the LCD, at least set the LCD Backlight according to the color bars, to have a prayer of it being at least in the ballpark of accurate. See LCD Set for more info.

The LCD is handy, if not terribly informative. But there are many highly accurate professional measuring tools included for exposure too.

The IRE Scale - How to Know How Bright "Bright" Is

When we talk about professional monitoring tools, we're going to be talking about devices and meters that tell us definitively, objectively, how bright the video signal is. And the scale that we use is the IRE scale (IRE being the Institute of Radio Engineers), and on that scale, video brightness is measured from 0 (pure black) to 109 (clipped white). So as we talk about video levels, just keep in mind that we're basically talking about percentages, with about 50 to 55 IRE representing a medium gray, and 0 to 5 being pretty much pitch black, and anything over about 100 being pure white.

Zebras

The first monitoring tool we're going to talk about are the zebras. Zebras are an overlay on the video monitor that show up any time an element in your image is brighter than a predetermined level (and who determines that level? You do, using the Zebra menu settings). Zebras are great because they let you know instantly, at a glance, what areas of your video might be too bright. If you set your zebras on 105, then you'd only ever see zebras on areas that are dangerously near overexposure (with 109 IRE representing a totally overexposed signal, zebras at 105 would show any portions of the screen that were at 105, 106, 107, 108, or 109 IRE). If you set your zebras to 80, then a zebra pattern would show up on the screen for any areas that were brighter than about 80% of maximum (again, on the 0-109 scale). The great thing about zebras is that they remove the subjective guesswork entirely from the equation, and they plainly and clearly tell you when something is brighter than your predetermined threshold. As a general guideline, you never want to see 105+ zebras anywhere on your screen if you can avoid it (some things, like the sun or a light bulb in the shot, might be unavoidable, but you definitely want to avoid it in the sky or on white buildings, etc). Also, when shooting a fair Caucasian face, you don't really want to see any higher than about 70 IRE showing up on the face, so if you set your zebras at 70 IRE and you set exposure on a Caucasian face, you don't want to see zebras anywhere other than maybe a little bit on the very brightest areas (typically the forehead or nose). For darker skin colors you'll need to adjust, there is no hard and fast rule for other specific skin colors because they vary in shade so widely.

Y Get Marker

The Marker goes hand-in-hand with the zebras. Where the zebras will tell you what areas of the screen are exceeding a certain brightness threshold, the marker will tell you exactly what brightness is occurring at the center of your screen. Turn on the marker and a box will show up in the center

of the screen, and a little numeric readout shows up which will tell you basically the IRE value of what's being displayed in that central box. Using the Marker you can tell exactly how bright the brightest patch of skin is, or how dark the shadowed areas are, etc.

You can also use the AREA function to choose what area of the screen you want to judge the IRE values in.

Waveform Monitor (UX180 Only)

The ultimate exposure guide for video is the Waveform monitor (WFM). This is like a million zebras and markers all combined, it's almost like a three-dimensional zebra. The waveform monitor tells you the brightness of your image not just in a 2-D scale like the zebras, but in the third dimension by showing relative brightness across the screen, and how many pixels in each column are at what brightness. Learn to read the waveform monitor and you'll be able to tell at a glance whether your image is properly exposed, underexposed, overexposed, clipping, and where any trouble spots are in the frame. Click here for a detailed introduction to the WFM.

The Histogram (UX90 Only)

The UX90 has the ability to display a histogram, which is a different type of graph. While the histogram is not as detailed or precise as the waveform monitor, it can still be effective in helping you judge proper exposure. See the Histogram article for more information.

Using an External Monitor

A properly-calibrated external production-quality monitor is a great way to judge what your image will look like. However, you do have to observe two restrictions here: 1) the monitor has to actually be a professional production monitor, and not some cheap non-professional solution, and 2) the monitor has to be properly calibrated under the prevailing lighting conditions. And an external monitor isn't really a substitute for the zebras or (especially) the waveform monitor; instead it's the "last line of defense," meaning that if you've calibrated your image properly, you're exposing properly, and everything looks good on the zebras and the scopes, then it's time to take a look at the external monitor to make sure the video looks as beautiful as it's supposed to.

A professional monitor will have controls for calibrating the monitor to color bars. The camera has the capability to output SMPTE color bars in both SD and HD standards, so if you have a professional monitor that has a blue-

only gun and chroma, brightness, contrast, and (in NTSC territories) phase controls, you can configure your monitor to very accurately display the color bars signal. When the monitor is displaying the color bars absolutely accurately, that's when you know it will also display your camera's picture accurately. And monitors need to be re-calibrated every time you set them up – every time you move them to a new location, or every time the prevailing light changes, you need to calibrate again to the color bars. If you are shooting outdoors in the sun, you'll have to calibrate the monitor. If you then put a sunshade over the monitor, you'll have to re-calibrate it. And if you go indoors, you'll have to calibrate again. Always make sure the monitor is accurately displaying the color bars before you rely on it to trust that your video signal is being displayed accurately.

Asking Autoexposure for Help

Lastly, a way to monitor the exposure might be to ask the autoexposure system what it thinks the exposure should be. You can quickly pop into autoexposure mode by pressing the Iris Button and let the system judge the exposure, then switch back to manual mode by pressing the button again. Autoexposure may not get it exactly right, but it's frequently pretty close. For example: a situation when you can use autoexposure to help you determine proper exposure could include a case of when you're shooting a wide shot of people, but you want the faces to be accurately exposed. In that scenario you might zoom all the way in on someone's face, turn on the autoexposure, and let it expose for the face. Then, lock the exposure (by going back to manual mode), zoom out, and compose your shot. Just be careful when you do so; you have to check to make sure that the rest of the shot is reasonably exposed (for example, you don't want the sky to be terribly blown out, so pop on the waveform monitor or the zebras to check the sky). If the sky is too bright, you have three choices at that point – either frame out the sky as much as you can, or stop down the iris (knowing that you'll be losing some exposure brightness off the faces too), or re-compose the shot by putting the sun at your back. With the sun at your back, the sky will be its darkest, and should be the easiest opportunity to control overexposure. Or, of course, you could always shine more light onto the faces, but that's not always an option.

Learning how to control the exposure, and framing shots so that you've included only the portions you want (at the proper exposure levels) will cause the quality of your video to skyrocket. Automatic exposure is of course the easiest way to go, but it usually results in the worst quality. If you want great quality you have to do the work yourself, but you'll be rewarded

with more professional-looking, more artistic, and better overall video. In this article I've given you the basics, but now let's go into more detail on each of the exposure systems so you have a thorough understanding of how exposure works and what your camera can do.

Aperture

As said before, the aperture is the size of the hole that light flows through, and by controlling the size of that hole, you control the amount of light that gets through. The size of the aperture is measured in "f-stops."

F-stops are basically a way to describe the amount of light the iris STOPS from getting into the lens. In simple terms of a theoretical lens, f/1 would be admitting as much light as the lens is possibly capable of (think of it as "f/1" = "f divided by one"... "f" = the maximum amount of light, so "f" divided by 1 would still be "f"). F-stops are numbered according to the following sequence: f/1, f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, and f/11. Each additional f-stop cuts in half the amount of light admitted by the previous f-stop; f/1.4 admits half as much light as f/1 does, f/2 admits half as much light as f/1.4, and so on. F-stop numbers are based off of two base numbers, f/1.0 and f/1.4. Each new f/stop number is a double of the previous number:

- 1.0 ⇢ 1.4
- 2.0 ⇢ 2.8
- 4.0 ⇢ 5.6
- 8.0 ⇢ 11 (rounded down from 11.2)

So if you remember 1.0 and 1.4, you can calculate the rest of the sequence easily. (Note that of course, the UX cameras' lens cannot open any more open than f/2.8).

You can think of the f/stop notation as a diameter formula for the lens iris. Whatever "f" stands for, when expressed in the term of "f/2.0," would mean an iris size of "f" divided by 2, which would let in 1/4 as much light as an "f" divided by 1. Remember, if you want half the light, you'd use f/1.4, so f/2 actually lets in half of half, or a total of ¼. Think in terms of a square: if you cut the length of the sides of a square in half, the new square isn't half the area, it's actually 1/4 the size of the original: a 4" x 4" square has an area of 16 sq inches, but cut those sides in half and you get a 2" x 2" square, with an area of 4 square inches, which is 1/4 the area of the 16 square inches of the 4x4 square. So to get half as much area, you don't divide by two, you need to divide by 1.4 (the square root of 2). If you take the 4" side of the

square and divide that by 1.4, you'd get a square of 2.83" x 2.83", which has an area of 8 square inches (2.83 x 2.83 = 8.0). And 8 sq. in. is 1/2 as much area as the original 4x4 square's 16 square inches. So to get half as much light coming in, you need to divide by 1.4 (which is why the first f-stop after f/1 is f/1.4.)

Therefore, the numbers you divide "f" by are: 1, 1.4, 2, 2.8, 4, 5.6, 8, 11. Each successive number lets in half as much light as the previous number. So if you want to cut in half the amount of light coming into the lens, you'd "stop down" by one f/stop. To double the amount of light flowing through the lens, you'd "open up" by one f/stop.

Shutter Speed

The shutter speed is another way to increase or decrease the amount of light entering the camera. Whereas the aperture is a hole that lets in a certain amount of light (and the bigger the hole, the more light that comes in), the shutter is more like a gate – the longer it's open, the more light gets in, and when the gate is "shut" the light stops coming in.

Because the shutter speed affects the amount of light coming in, you could use it to help control exposure. If you cut the shutter duration in half (i.e., use 1/120 instead of 1/60) then only half as much light will reach the sensor. To compensate, you will need to add twice as much light to get the same level of exposure (or, open up the aperture by one f-stop). If you double the shutter duration (i.e., 1/24 instead of 1/48) then twice as much light will get through to the camera's chip, and your image will be twice as bright. You'd need only half as much light at 1/24 for the same exposure as you would need at 1/48.

However, video shooters generally don't use the shutter speed to control exposure except in rare circumstances, because there's a great big side effect to changing the shutter speed: it affects the motion blur of your shot. Photographers use the shutter speed all the time to control exposure, but in video it's not used nearly as frequently, because changing the shutter speed will affect the motion blur of anything moving in your shot (and, because you're shooting video and not stills, that means it'll pretty much affect everything!)

In almost all normal circumstances, you'd want to use the default shutter speeds (1/60 for 59.94i or 59.94p, 1/50 for 24p, 25p, 29.97p, 50i or 50p) for normal-looking video. Small variations in shutter speed won't affect the look of your video much (i.e., 1/60 will pretty much look the same as 1/50). Film cameras use anywhere from 1/43 to 1/60 as a standard,

and it all pretty much looks like film motion, so small variations won't normally matter. However, there is one place where it matters very much: when you're shooting under fluorescent or HMI or stadium lights or other ballasted light sources! I'll explain why, but before I do, let me just say this loudly and clearly: if you're shooting under fluorescent lights or HMI lights (with a magnetic ballast) or sodium-vapor or mercury vapor lights (such as streetlights or stadium lights), or LED lights on a dimmer, DO NOT CHANGE THE SHUTTER SPEED. In the 59.94Hz mode, put the shutter speed on 1/60th and do not change it without a very, very good reason. (and yes, that does include when shooting 24p!) For 50Hz mode, put the shutter speed on 1/50th and do not change it without a very good reason. Changing the shutter speed when shooting under magnetic/ballasted light sources may cause a noticeable and annoying artifact in your video footage, where you see orange or black bands or scrolling waves cycling through your image.

You can usually totally avoid this artifact by simply leaving the shutter speed at 1/60th (in 59.94Hz territories) or 1/50th (in 50Hz territories). If you're using high-frequency electronic ballasts (such as Kino Flo™ fluorescent lights or electronic flicker-free HMI lights) then you'll have more flexibility with the shutter speed, but even so, you'd only ever want to change the shutter speed for specific looks. Do be aware that unless you specifically disable it, the camera can change the shutter speed during automatic exposure, so keep an eye out for rolling shutter artifacts when using automatic exposure.

Here are examples of the type of circumstances where you'd want to use alternate shutter speeds:

1. For a stuttery/choppy action sequence (such as the "Saving Private Ryan" or "Gladiator" effect): try a fast shutter speed such as 1/250 or 1/500. (of course, don't try this under fluorescent lights as mentioned above).

2. Overcranking for slow motion: if you're shooting variable frame rates for slow motion, you should probably change the shutter speed. Try 1/120 for 59.94p (or, for 50Hz users, 1/100 for 50p.) A film camera running at 60 frames per second would have a shutter speed of about 1/120, so if you're shooting 60fps for slow motion, you would normally want to match the shutter speed for film-style motion blur.

3. Sync'ing with monitors: use the UX180's Synchro-scan, or try 1/60 in NTSC countries or 1/50 in PAL countries, to match the camera's refresh rate with computer monitors or televisions in the shot to stop the "rolling dark band" syndrome.

4. Special blur effects: the opposite of the "Saving Private Ryan" effect. Use a slower shutter speed (like 1/24 or slower) to add smear and blur to the motion in your shot. Shutters as slow as 1/2 second can make for excellent smearing of taillights in a long-exposure freeway shot, for example.

5. Minimize strobing: If you think there's too much strobing in your 24P/25P footage, you can try a slower shutter speed to introduce a little blur into your footage, but again, watch out for fluorescent or HMI or vapor lights.

6. Extreme low light situations: when in 24P mode, using 1/36 instead of 1/50 will gain you half a stop of low-light performance on a UX180, and still look reasonably like film. Using 1/24 will gain you a whole stop of light performance, but with smearier motion.

7. If you're shooting in a different territory, such as when shooting 59.94Hz footage under 50hz lights, or 50Hz under 60hz lights, you may have to adjust the shutter speed to avoid flicker or pulsing. Set it to match the frequency of the power system where you're at, to have the best chance at minimizing any conflict with the lighting; you might have to choose 1/100 for a 59.94Hz camera in PAL territories, for example.

8. Freezing water droplets or rain: for specific instances like shooting a food commercial where someone pours champagne or squeezes a lemon and you want to show the individual droplets clearly, you might try using a very short shutter speed (like 1/2000). Typically these shots are done using strobe lights, but strobe lights generally won't work with the UX cameras (see the Partial Exposure section of the chapter on Rolling Shutter to see why). Although you probably can't use strobes with an MOS rolling-shutter camera, you may be able to get a satisfactory facsimile of the effect by using a super-fast shutter speed, as long as you aren't trying to do so under magnetic fluo/HMI lighting; you'll need high-frequency electronic ballasts to pull that off.

Be aware that when using a shutter speed slower than your frame rate, the net result will be dropping frames. You cannot have a shutter speed slower than your frame rate; trying to use 1/30th shutter in 59.94p mode will result in duplicated frames, in essence dropping your frame rate to 29.97p. Also, when using a slower shutter speed, definitely use a tripod!

Gain

Gain is an electronic amplification of the video signal. In other words, it artificially makes the picture brighter. While brightness sounds good, you have to understand that the penalty for making it brighter is that the picture generally gets "noisier." Electronic noise is a byproduct of electronic gain, and the more gain you apply, the brighter your picture will get, and the noisier your picture will get. The camera can employ sophisticated noise reduction that can help compensate, but the trade-off is that it may result in losing some of the fine detail in the picture and the colors may become flatter, softer, and more "washed out". Generally the best images come when the gain is as low as possible, or when using as little gain as possible.

Gain is measured in decibels, or dB. Zero dB means that no gain is applied, the picture is unmodified and no brightness or noise is added. Every 6 dB of gain amounts to doubling the brightness of the picture, so 6 dB of gain would make the picture twice as bright, or the equivalent of 1 f-stop brighter. 12 dB of gain would be twice as bright again (or four times as bright as zero gain), and 18db is twice as bright as that (for an image that appears to be eight times as bright as zero gain). You can also assign Super Gain to a User Button, and get as high as 36dB of gain. 36dB would result in an image 64 times as bright as 0dB, and you'd better believe there's lots of noise and grain at such a high gain setting!

Another thing to understand about Gain is that it can only amplify the signal that the camera is currently seeing; it cannot add detail that can't be currently seen. If you're shooting under low light conditions and need to employ gain to get the picture bright enough, you should understand that your video is in all likelihood underexposed, and using gain will artificially brighten up the picture, but it will not restore detail that wasn't properly captured due to the underexposure. Gain is usually used as a "last resort" – when shooting under dim conditions you should take other measures to increase the brightness of the scene first, including removing all neutral density filters, opening up the iris to its maximum opening, perhaps using a slower shutter speed, and adding light whenever possible.

Understanding White Balance

Yet another element to understand in videography is the concept of White Balance. In the simplest explanation, light is not all the same color. Even though it may look the same to the human eye, the camera sees a particular light for what it is: reddish, greenish, blueish, etc. Daylight does not give off the same color as an incandescent light bulb, for example.

Our eyes may automatically compensate, but the camera doesn't, and it needs to be told what "white" should be – which is why we have the White Balance function. Executing a proper White Balance will help the camera to record colors more accurately.

Light color is measured in degrees Kelvin, in accordance with what color a piece of platinum will glow when heated to certain temperatures. When heated to about 3200 degrees Kelvin (or 3200K), the metal will glow an orangish-red color (which is pretty much how regular household lamps work: they're small filaments of metal that are heated until they glow that orangish-red color). If the metal is heated more, the color will shift towards the blues, and at 5600K the metal will glow blue-white. These temperatures, and their corresponding colors, are referred to as "color temperature." In general there are two color temperatures you need to be aware of: 3200K and 5600K. Daylight is typically said to be around 5600K, and tungsten (or most artificial) lights burn at around 2900K to 3200K.

Proper white balance is vital to accurately record the colors in a scene. To white-balance the camera, first decide if you want to use one of the existing presets or if you want to use a manual white balance. The preset is selected by pressing the WHITE BAL button until either P3200K or P5600K is displayed, and then toggled by pressing the AWB button on the front of the camera. The presets correspond to indoor lighting (3200 Kelvin) and outdoors (5600 Kelvin). While the presets are perhaps a good starting point, there are many circumstances where a preset will not deliver the most accurate color rendition. For example, many incandescent and halogen lamps burn at color temperatures different from 3200 Kelvin; some may burn as low as 2700 K. If you're using 2700 K lamps to light your scene, and you have the white balance set to P3200K, your white walls will not look white, they'll look orange-ish. Also, daylight varies tremendously in color temperature, from around 3000 K during sunrise/sunset to over 10,000 K on an overcast, cloudy day. So the presets may make for a good starting point, and can be convenient for on-the-run shooting, but if you have the time to take a manual white balance you can get more accurate color rendition.

There are two channels of manual white balance, Ach and Bch. Both function identically. To set a white balance, you need a white card (or other white object – a sheet of paper, a T-shirt, whatever you have, although the purer the white the more accurate results you'll get; I highly recommend getting a DSC Labs CamWhite card.) Place that white card/object into the

light where you intend to be shooting. Don't just hold it up in front of the camera! You have to move the white card into the light that's hitting your desired subject. Ideally you'd have your subject hold a white card up in front of their face; you need to make sure that the light that your subject is lit by, is the same light that's lighting up the white card. Frame up that white card until it fills the screen (or as close as you can get). Now you're ready to take a white balance. Press the WHITE BAL button until it displays either Ach or Bch, and press the AWB button; the camera will let you know when the white balance has been properly set. Any time your lighting conditions change, you'll need to re-white balance if you want your colors to continue to be rendered accurately.

Another white balance option is to use Automatic Tracking White (ATW). In this mode, the camera will automatically attempt to continually monitor and change the white balance to what it thinks is correct. To enter ATW mode, set one of the WHITE BAL button options to ATW in the SW Setup menu. For example, you could configure your camera so that Ach is reserved for manual white balance, and Bch is set to ATW. Then when you press the WHITE BAL button to select "Bch", the camera will automatically start tracking white balance by itself, updating as lighting conditions change.

ATW is an automatic function, along the same lines as autofocus and auto-exposure. For professional shooting situations you may not want to use ATW very often, but for run 'n' gun type situations it may come in handy.

Note: when changing the white balance switch, it doesn't immediately force a hard image change; rather the camera smoothly transitions from the old white balance setting to the new one (this is called a "shockless" white balance transition.)

Black Balance

The camera also offers the ability to perform a Black Balance. It's really simple, and I recommend you get in the habit of doing it frequently. The black balance procedure is simpler than the white balance, because black (unlike white) isn't relative to the lighting conditions. Black is the absence of all light, so it doesn't really matter what the prevailing lighting conditions are. As such, you don't have to point the camera at something black, instead the camera takes care of it for you: when you perform a black balance, the camera shuts its iris, blocking all light from hitting the sensor. The camera then analyzes the signal coming off its sensor, and compensates for any noise issues or other situations which cause the sensor to be delivering anything other than a pure black signal. The manual recommends doing

a black balance whenever you first turn the camera on, when you change progressive-scan modes, etc. I think it's simple enough and easy enough to do that you might just want to get into the habit of it; all you have to do is hold down the AWB button a bit longer. If you release the AWB button right away, the camera will do only a white balance; if you hold the button down longer it will do a white balance followed immediately by a black balance. If you're noticing a lot of noise in your footage, that's another time to do a black balance; black balancing may have an effect on noise in the darkest regions of your image. Black Balance frequently.

Focusing

Getting precise focus is not so easy in Ultra-High Definition or 4K; certainly not as easy as it was in standard-def! In this section we'll explore focusing and explain the techniques you need to use to get razor-sharp focus.

First, understand that proper focus is absolutely critical in UHD or 4K. UHD video means a frame that has four times as many pixels as a high-def video frame, and as much as 24x as many pixels as a standard-def frame. Standard-def's low resolution could mask small focus errors; ultra high-def's sharpness will point out focus errors blatantly, each and every time. You have to get your focus right.

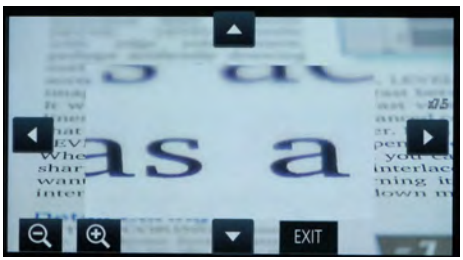
Second, it's important to acknowledge another fact: it's impossible to judge focus properly using only the on-camera LCD. The very best you can do is get in the ballpark; it's mathematically impossible to judge focus of an 8-million-pixel image on a ~1-million-pixel display device like the UX camera's LCD. No small display is going to be adequate, by itself, to show you true proper focus; it's just not possible. You simply must rely on some focusing aids.

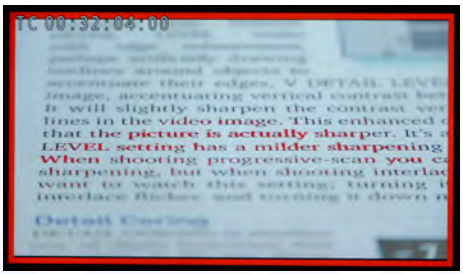
Setting focus involves finding the exact spot where the focus is pinpoint-sharp on your subject. Usually you do this by adjusting the focus ring until the subject looks as sharp as possible, and then adjusting the ring too far until it actually starts to go out of focus; then you pull back until it comes back into focus and keep adjusting until it goes out of focus again, and keep refining this process and splitting the difference until you get the absolute sharpest image. Obviously this technique relies on being able to actually see the image sharply! And with the LCD and viewfinder not having nearly enough pixels to render the image sharply, you can't truly count on this technique alone.

Fortunately, there are several focus assist methods available to assure you're getting the best focus possible. Use them all: you're going to find they all are helpful.

First, there's the EXPANDed FOCUS ASSIST which magnifies the center extraction from the frame. The magnified FOCUS ASSIST is a wonderful option and indispensable for achieving sharp critical focus. It shows you much more detail than the full frame view does.

The EXPAND FOCUS ASSIST is ideal for setting focus on your subject, but unfortunately it is not available when actually recording. The FOCUS ASSIST button does have a second option, which is colored PEAKING. This option draws an outline around objects that are in sharp focus, in the color of your choosing (in this example, it's using red peaking). The colored peaking is a great option that works even while recording. Generally I highly recommend using both the EXPAND and the PEAKING together. It gives you the most detailed, easily-focusable focusing aid when lining up your shot, and it displays the colored focus during recording.





When using the EXPAND FOCUS ASSIST, you can modify the level of magnification, and you can move the magnified box around the frame to check or set focus on different sections of the video frame. You can move it by either using the arrow buttons on the touchscreen, or by just dragging the magnified box around the touchscreen.

The caveat with the PEAKING focus system is that it only functions when it sees suitable contrast in the scene, and doesn't work on low-contrast

scenes. In bright light it's usually very easy to see, but in darker scenes on flatter subjects, it may be a struggle to see the colored PEAKING at all. You can make it bolder and more visible by adjusting the PEAKING LEVEL menu option, but that may just make the system more generous in assessing what it believes is actually in focus; taken too far, it might report that items are in focus when in fact they might be slightly out. So the colored PEAKING focus assist is a great tool, and I highly recommend its use; just be aware that there are some limitations with the system.

Another excellent focus aid is the EVF/LCD DETAIL system. This works the same as the colored PEAKING focus assist, by using the high-frequency detail in the image to draw a white outline or highlight on edges that are in focus. If you don't have EVF/LCD DETAIL on, the LCD may not look sharp enough to get accurate focus; with EVF/LCD DETAIL on you'll see when areas of the image start to "snap" into focus. Test it to familiarize yourself with the look; focus on an object and then turn EVF/LCD DETAIL on and off, and you'll quickly learn to recognize the look of it, so you'll know when your image is snapping into sharp focus. EVF/LCD DETAIL is also customizable for intensity and frequency, and it even works in some places where the colored PEAKING doesn't.

Another use of a focus assist tool would be the UX180's MF ASSIST function. When in manual focus, you can employ the MF ASSIST to "touch up" the focus once you're done manually focusing. You can use manual focus to get it as close as you possibly can, and when you stop moving the focus ring, the MF ASSIST function will engage the autofocus system briefly, in a very limited range, to see if it can optimize the focus point. It won't continually autofocus, it'll just "spot check" to see if you've gotten it as sharp as possible. It then disengages and returns to fully manual focus, until you move the focus ring again. This function is not available on the UX90.

So there are many tools provided to help you get proper focus. If you use most or all of these tools, your focus is likely going to be perfect. But there's another technique that is extremely helpful in gauging proper focus: narrowing your depth of field. When judging focus it's obviously much easier to judge what's in focus if the depth of field is extremely narrow (meaning, very little is actually in focus in the shot; when only the part you want is in focus and everything else is out of focus, it's obviously easier to know that you've properly focused your shot). To narrow the depth of field for checking focus, zoom all the way in to full telephoto mode (Z99) and open the iris all the way up (OPEN). If the image gets too bright and blown-

out to see what you're looking at clearly, use one of the neutral density filters, but the important thing is to have the iris OPEN and zoom at Z99 when setting critical focus. That will narrow the depth of field down as small as it can be, letting you choose exactly where to set your focal point. Then, before shooting, you'll zoom back out and set your iris to the proper exposure again.

As you zoom out, the depth of field becomes deeper, which brings more and more of the frame into focus. And as you stop the iris back down to the proper exposure, more and more of the frame comes into focus. So if you can nail the focus with an OPEN iris at Z99, then as you zoom out and stop down you can be assured that the focus is just getting better and better, crisper and sharper. Don't go too far though! F/8 or so is about as small an aperture as you'd ever want to use when in UHD or 4K mode; going deeper than f/8 (such as to f/10 or f/11) may make the UX90's image get somewhat softer due to the principle of diffraction. You have a little more room when shooting in HD; you can easily go to f/11 without encountering diffraction. Stick between f/2.8 and f/8.0 whenever possible (see the Recommended F-Stop Range essay for more information).

Another focus assist tool you may want to consider is auto focus; if you can't get focus any other way, you can press the "PUSH AUTO" button and the camera will attempt to quickly lock into focus; as soon as it does, the camera automatically returns to manual focus. There's no guarantee that the focus will be perfectly accurate, however; auto focus may not choose to lock onto the part of the frame that you prioritize as being most important. If you have no other way of double-checking your focus, temporary auto focus is probably better than nothing, but it certainly shouldn't be your primary focus assist tool.

Strobing

The UX90 and UX180 include several different frame rate options, ranging from 23.98 to 59.94 frames per second. 59.94 represents the traditional "video" look, but 23.98 (or 24 or 25, collectively referred to hereafter as 24P) is used for footage that looks more like the traditional "film" look. However, when new users shoot 24P for the first time, they sometimes just wave the camera around and then say "hey, wait a minute, what's all this strobing?" The motion in their shots appears very "jerky," and not smooth at all. For those unaccustomed to shooting film, the look is unfamiliar and

can be unsettling; many times they think that there may be something wrong with their camera.

There's nothing wrong with the camera. What's happening is a perceptual difference between what the shooter is familiar with (50- or 59.94-fps video) and what they're now using (24-frame or 25-frame video). There's a very different look between 24P (or 25P) and traditional video, also known as 59.94i/59.94P (or 50i/50p in PAL territories). In 24P, the camera shoots twenty-four frames every second, like a film camera does. In regular interlaced 59.94i video, the camera shoots nearly sixty "half-frames" per second. The difference is dramatic: the 24P footage looks more like a movie, and 59.94i video looks more like a news broadcast. Apart from the interlacing artifacts, 59.94p video renders motion the same as 59.94i does, and 50p renders it the same as 50i does. 59.94p/50p have just as much of a "video" look as 59.94i/50i do.

Shooting at the 24 or 25 fps frame rate can certainly impart a much more filmic motion to your image. But shooting at a slower frame rate may exhibit a side effect called "strobing." Pan the camera, or move it side-to-side too fast, and you might see choppy, stuttery movement. Strobing can be unpleasant to watch. It needs to be properly managed. Film runs at 24 frames per second, and film exhibits the same strobing issues that 24p/25p video cameras do. Fortunately for us, film cinematographers have been fighting this issue for the last 100 years, and over the years they've developed some ways to combat the strobing effect. These techniques include panning the camera slowly; following a stationary subject in the frame; using a slower shutter speed; and increasing your frame rate.

First, Pan the Camera Slowly

The chart below was inspired by the American Cinematographer's Manual, a publication of the American Society of Cinematographers. It's been adapted to reflect the focal lengths of the UX90's and UX180's lens, and shows just how slowly and deliberately you need to move the camera to execute a smooth 90-degree pan, depending on what focal length you have the lens set at. (Note, these focal lengths are approximate, depending on whether you're shooting FHD, UHD, or 4K there may be very slight field-of-view differences; also, the UX90's UHD is more telephoto and needs slower panning.)

Zoom Setting	24P Pan Speed	UX90 UHD Speed
8.8 mm	8 seconds	11 seconds
10 mm	9 seconds	13 seconds
13 mm	12 seconds	16 seconds
16 mm	15 seconds	19 seconds
21.5 mm	19 seconds	25 seconds
28 mm	25 seconds	36 seconds
35 mm	32 seconds	42 seconds
45 mm	42 seconds	55 seconds
60 mm	55 seconds	70 seconds
85 mm	70 seconds	120 seconds
132 mm	120 seconds	150 seconds
176 mm	150 seconds	N/A

To read that chart properly, if you've set the UX180 lens focal length to 16mm, and you want to pan 90 degrees with no juddering or stutter, and you're shooting 24P, you have to take 15 seconds to execute the pan. If you take the full 15 seconds, the pan will be glass smooth. If you're shooting UHD on the UX90 at 16mm, you'd have to slow down to 19 seconds to get an equally smooth pan. These panning speeds are really slow, but it's what you need to do if you want smooth motion. Any faster than that, and smoothness will suffer and strobing will begin. Those are just the rules. If these charts seem complicated, remember this general rule of thumb: make sure that an object takes about seven seconds to cross the screen. That's for shooting 24P (or 25P). You can go faster if you're shooting 29.97P – at 21.5mm, you can pan the UX180 90 degrees in 15 seconds at 29.97P and it'll still be smooth. When shooting interlaced (or 59.94P/50P), you can pan at any speed with no restrictions, but when shooting slower-frame-rate footage you have to carefully monitor how fast you pan.

The more you zoom in, the more things change; if you're at maximum telephoto, things change dramatically: you have to go much, much slower than if you were shooting at wide-angle. If you want a glass-smooth 90-degree pan at 132mm, it will take two minutes to execute that pan at 24P!

Right now you're probably thinking "that's outrageous – nobody pans that slowly!" Those are the panning rates, as established by the combined experience of the American Society of Cinematographers. Having shot film

for the last 100 years they've figured out the speeds you need to stick to if you want smooth pans. When people say "pan slower," they're not kidding! Obviously those speeds are very restrictive. If you choose to go faster, you just need to determine what level of stutter/judder is acceptable to you.

Fortunately with video you can hook up an external monitor and see exactly what it looks like (with film, they had to wait until it was developed and projected, which is why they took the effort to devise the chart in the first place). Panning quickly enough will eliminate all strobing – a "swish pan" will be strobe-free. You only really need to worry about strobing in that "dead zone" between proper panning speed (on the slow side) and swish-panning (on the fast side).

Second, Follow a Screen-Stationary Object

Another rule to minimize strobing is that you can move the camera much quicker if you put something stationary (relative to the screen) in the foreground for the eye to follow. If you're following a person or a car or some other foreground object, as long as you keep that object relatively stationary on the screen, you can basically pan as fast as you want. Having a stationary subject on the screen gives the viewer's eye something to focus on other than the strobing background. The background's strobing just as much, of course, but the viewer doesn't notice it because they're watching the subject. Once you see how this technique works, you'll start noticing it all the time in movies and film-shot television shows.

Why does the motion strobe? Usually because there's an abrupt change between the frames of the video, and this is more likely to happen the slower the frame rate you're shooting at. With high-sampling frame rates (like 59.94i or 50P) strobing is never an issue. Furthermore, when shooting for a film-like look, there's a difference in the way the shutter works. With film and 24P (and 25P), the camera's shutter is typically only open for half the time, but in 50i/59.94i (or 50P/59.94P) the shutter is usually always open. In 59.94p the camera shoots (approximately) 60 frames per second, and each frame is exposed for 1/60 of a second, so the camera's eye is basically always open, always recording motion. There's never a time when the camera is "blind" to the action. But with 24P, the camera captures 24 frames per second, and each frame is exposed for half that time, or approximately 1/48 of a second. This means that the camera's eye is 'shut' half the time. This can accentuate the abruptness of changes between frames. In 60p the shutter is always open, but in 24P it's open/closed, open/closed. So the motion "strobes" just like a strobe light. If you've had

the chance to observe motion in a room that's lit only by a strobe light, you'll recognize the choppy, stuttery movement being discussed (except obviously it's quite exaggerated in the strobe light example; however the principle remains the same.)

Film works the same way. Film cameras have a rotating disc "shutter." The shutter is an opaque disc with a wedge of it "cut out." This wedge is where the film gets exposed; on film cameras the shutter opening is usually about half the disc, or (expressed in terms of a 360-degree circle) 180 degrees.

Two examples of film shutters: 180 degrees and 90 degrees.

As film is shot, the shutter rotates, alternately covering-up or revealing the film frame. When the shutter is closed, the film advances to the next frame, and then the film gets held stationary while the shutter is open. So film works on this same principle of "open/closed." Fully half the time a film camera is running, it's "blind" to the action! That's why motion strobes in film, and why it also strobes in all 24P cameras.

So, is this strobing a good thing or a bad thing? Obviously it makes motion more choppy, but if you want your footage to look like film, it's a necessary effect. Although some people say that film doesn't strobe like 24P video does, I decided to find out. I strapped a 24P DVX100 to a 16mm camera and mounted them both on a tripod, and shot the exact same scene side-by-side. When the film footage was transferred to video, I split-screened the scenes, and was able to conclude that the 24P DVX100 renders motion exactly the same way 24fps film does. What this means for you is, if you find the strobing in your footage objectionable, the camera's not at fault, it's doing exactly what it's supposed to do. You need to adapt your techniques to follow the American Society of Cinematographer rules for shooting film: slow down your pans, and follow a subject. Disobey the rules and your footage will strobe, exactly like film does.

There's a secondary benefit to panning slower in 24P mode – it helps control the rolling shutter "skew" effect.

Using a Slower Shutter Speed

Using a longer shutter speed will induce more motion blur. Film cameras typically use shutter speeds anywhere between 1/40 to 1/60 of a second

(shutter angles of 220 to 150 degrees). Faster shutter speeds mean sharper footage and perhaps more strobing. Slower shutter speeds mean more motion blur and slightly less strobing. You can select a shutter speed as slow as 1/24 in 24P mode, or, if you have a UX180, you could go into the SYNCHRO SCAN menu and select any shutter speed between 1/24.0 and 1/249.6 (in 25P the range is 1/25.0 to 1/250.0). The slower the shutter speed, the more light the camera will let in, and also the blurrier the motion will be. Shutter speeds slower than about 1/36 will result in extreme motion blur and a loss of film-like motion rendition. To keep a realistic simulation of what film looks like (while getting a little better low-light performance and a little more motion blur) stick to a speed no slower than about 1/36.0 (240 degrees). The more motion blur, the less objectionable the strobing may be, but too much is too much: at 1/24 you get an artificial blurry-motion look that definitely doesn't resemble film motion. If you have a certain shot in mind which demands a certain panning speed, and you find the strobing unacceptable at that speed, you can consider using a slower shutter speed to get the shot while not overwhelming the viewer with strobing; the trade-off will be blurrier video, so be sure to test the technique on a television to make sure that the blur/strobe compromise will deliver the look you're after.

Increase the Frame Rate

One last technique to minimize strobing is to increase your frame rate. Shooting at 29.97P will get 25% more frames per second than 23.98P, which will mean less strobing. The faster the frame rate, the less strobing. Shooting your project in a 29.97P time base will make it look a little more like video, but still look sort of film-like. 29.97P can't be transferred to film or to European/Australian/PAL television well, but if you're bothered by the strobing in 24P you may find 29.97P more to your liking. In the 60Hz mode you can choose faster frame rates of 29.97p or 59.94p; in the 50Hz camera you can choose the faster frame rate of 50p.

Or, you can always shoot in interlaced mode at 50i/59.94i or progressive at 50P/59.94P and completely eliminate all strobing, but your shots will look completely like live video instead of film. And, the UX90 doesn't offer UHD at 50 or 59.94P, so if you want to use 50P or 59.94P on a UX90, that would limit your product to Full HD 1080p.

The choice is yours, but unfortunately you can't have it all: if you want the film look, you have to work to control the strobing, and if you shoot in interlace mode you don't have to even worry about strobing at all, but

the footage will look like video instead of film. Strobing is inherent in the slower capture rate. You can't avoid it; all you can do is intelligently manage your circumstances (and heed the wisdom of 100 years of cinematographer experience!) to control the strobing.

Recommended F-Stop Range

When cramming more pixels onto a sensor to increase resolution (such as for a UHD camera), it is necessary to make the pixels smaller in order to have them all fit. And an issue that can affect small-pixel cameras is the issue of diffraction: the propensity of light to scatter when forced through a too-small aperture, which makes it appear like the image is out of focus – an issue that especially affects ultra-high-definition cameras with small sensors. However, the UX90 and UX180 have relatively large sensors -- so is diffraction an issue?

I tested the lens for diffraction and to find the f-stop range where the lens is sharpest, and can conclude that for both cameras, in Full HD or less (1080p/1080i, 720p, and standard-def), diffraction is really a non-issue. The camera maintains full resolution across the entire f-stop range, from f/2.8 to f/11.

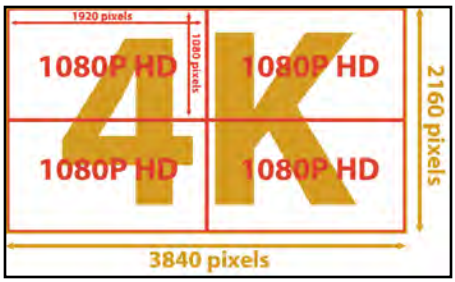
For Ultra HD (2160P) and 4K, I found a minor difference in performance. The UX180 uses larger pixels than the UX90, and is more resistant to diffraction. In fact, I found that there was practically no diffraction on the UX180 throughout the entire iris range.

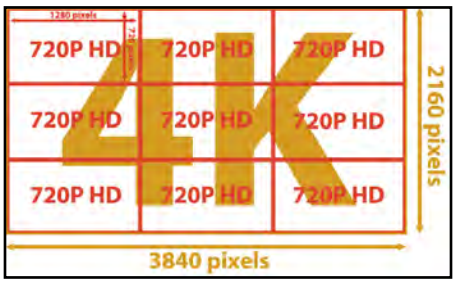
The UX90 in Ultra HD can encounter a little softening when the iris reaches double digits. From f/2.8 to about f/9.6, it's quite uniform and is not significantly affected. The very deepest f-stops (f/10 and f/11) can show some mild softening. The practical result of this is: when shooting a UX90 in Ultra HD, try to keep your iris in single digits. If you want the sharpest images, keep the iris between OPEN and f/8.0. Use the neutral density filters outdoors, so you can keep the iris more open. The softening is not significant, in fact it's quite mild, so this isn't something you have to pay much attention to, but if you're in pursuit of the very sharpest images, it's a factor you may want to keep in mind.

As a summary: in general diffraction is a non-issue on the UX180, and in HD on the UX90. It can manifest itself in UHD on the UX90, but only in the very deepest f-stops (f/10 and f/11).

Benefits Of Shooting In 4K or UHD

Originating footage in 4K/UHD brings a host of benefits to the video shooter, not the least of which is that your source footage uses four times more pixels than 1080p HD footage would, or nine times as many pixels as 720p HD footage. It's really rather remarkable; you would need to set up nine 720p HD cameras, each pointing at different sections of the scene, to capture as large an image as a single UHD camera could!





All that additional detail can be used in many different ways and provides many potential benefits to the video shooter. First and foremost, shooting in 4K (or Ultra HD / UHD) means that your footage can be displayed on larger displays or projected on larger screens without losing detail. For movie screens, digital signage, large-screen 4K televisions, or other environments where the largest displays will be used, 4K origination means the sharpest images for those displays.

But what if you're not delivering your footage in 4K (or UHD)? What if you're producing footage that's intended to be broadcast in HDTV (in 1080 or even 720 resolution) — or, perhaps, even in standard definition? What if you're delivering content for web streaming in HD (or lower) resolution? Are there still benefits from, and reasons for, shooting 4K/UHD in the first place? Most definitely!

Shooting 4K/UHD for 1080 (or 720) HD Delivery

When your final delivered footage is going to be mastered in 1080p, 1080i, or 720p, there are still substantial and significant benefits that can be derived from shooting your source footage in 4K/UHD. Some of these may or may not apply to your particular scenarios, but it's still interesting to explore the implications of all of them.

Future Proofing: How many times have you seen a good, vintage television series, and bemoaned that it looks lousy on your HDTV because it was shot and mastered in 4:3 standard-definition television? Many older television series were shot on standard-definition video cameras, but some were shot on film. Those film-shot series are sometimes "remastered" into high-definition versions — and they look so much better! When the series were produced, standard-definition television broadcast (and perhaps VHS video or maybe, at best, DVD) were the anticipated delivery mediums, so mastering the series and distributing in standard-def were practical decisions at the time. But with the advent of HDTV and Blu-ray discs and HD streaming, it opened new markets for remastered high-definition versions — which created new opportunities and new revenue streams for those producers. Unfortunately for those who shot their projects on standard-definition TV cameras, there is no higher-definition master footage to go back to. Accordingly, while you may not necessarily see a need or even an opportunity to deliver a 4K or UHD version of your projects, wouldn't it be nice to have the higher-resolution master copies of the footage to go back to in case such an opportunity were to arise?

Sharper HD Footage: When you have a much larger source image to work from, shrinking it down to HD size can make for the sharpest, clearest HD images possible. A super-sampled ultra-high-definition image, when resized down to HD frame sizes, can result in images that hold as much detail as the HD frame size is capable of retaining. This means that you will get sharper HD images from scaled-down 4K or UHD footage, by resizing the images in post, than you would get from shooting in HD in the first place.

Reduced Noise: Another benefit to downconverting 4K/UHD footage to HD in post production is that you'll see a significant reduction in visible noise in the image. When converting UHD/4K footage down into 1080p footage, each 2x2 group of UHD pixels are used to create a single pixel in HD. Combining the 2x2 group of UHD pixels can result in "averaging" the noise from each pixel together, resulting in smoothing out the noise and greatly reducing its visibility.

Increased Color Resolution and Bit Depth: One excellent benefit of downconverting UHD/4K footage to 1080 HD in post is that you can realize an increase in proportional color resolution and a notable increase in bit depth. The UX cameras record UHD footage at 8 bits

per pixel and utilize 4:2:0 color sampling. After downconversion, the resulting footage has 10 bits per pixel and 4:4:4 color sampling! Yes, you can convert 3840x2160 8-bit 4:2:0 recorded footage into 1920x1080 10-bit 4:4:4 footage in post.

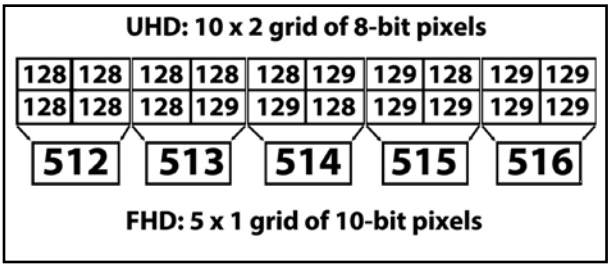
To understand the color sampling advantage, you'd have to first understand that the camera records its footage in 4:2:0 color sampling. That means (simply put) that there is one color sample for every 2x2 block of pixels. In any given 2x2 block of pixels there are four different "brightness" samples, but they all share one "color" sample. Effectively, within the 3840 x 2160 frame, there is a 1920 x 1080 matrix of color samples, one for every 2x2 block of pixels. During the downconversion to HD, each block of 2x2 brightness samples are converted into one HD pixel, creating a 1920 x 1080 matrix of brightness pixels. This 1920 x 1080 "brightness" (luminance) matrix can be effectively married to the originally-recorded 1920 x 1080 "color" matrix, resulting in one individual and unique color sample for each and every brightness pixel. The result is effectively 4:4:4 color sampling at high-definition resolution.

In terms of pixel depth, the original recorded footage is quantized and recorded at an 8-bit depth, providing for up to 256 shades per pixel. Other formats, like Panasonic's own AVC-Intra, quantizes and records at a 10-bit depth, for up to 1,024 shades per pixel. Having deeper bit depth provides the ability for finer shading and more subtle transitions, especially apparent on smooth gradients (such as in a clear blue sky). Generally 8-bit cameras perform fine for most images, but extensive image manipulation in post can reveal the limitations of 8-bit encoding and cause "banding" and "stair-stepping" from one shade to the next. 10-bit footage minimizes those effects because there are up to four shades for every one shade in 8-bit footage. When downconverting UHD/4K footage to 1080p HD, you also get some of the benefit of converting 8-bit pixel depth into 10-bit pixel depth! Since each 2x2 block of UHD/4K pixels will be summed together to create a single 1x1 pixel in 1080p HD, the individual pixel values and gradations from the source footage can be retained in the downconverted footage.

Imagine a smooth gradient of medium gray, gradually getting brighter from left to right. In 8-bit pixel data, a medium gray might be represented by a pixel value of 128, and the next brighter

shade might be 129. In 10-bit pixel data, that same medium gray (128) would be represented by a pixel value of 512 (128 x 4) and that brighter shade (129) would be represented in 10-bit by a value of 516 (129 x 4). The obvious difference here is that an 8-bit camera can't represent any difference between 128 and 129, but the 10-bit camera (looking at the exact same gradient) could represent a smoother transition between 512, to 513, 514, 515, and then finally 516. Having 10 bits of data provides for the ability to retain and discern between finer shades of gray (or color).

So what happens when we downconvert our 8-bit UHD footage to 10-bit 1080p HD footage? As each 2x2 block of pixels is summed together, to create each individual HD pixel, those subtle differences in shade are retained, and we end up being able to represent shades that the 8-bit footage couldn't have.



To reap the full benefit of converting 8-bit UHD to 10-bit FHD, you'll need to use a downconversion technique that employs bilinear or bicubic conversion; a simple "nearest neighbor" or pixel decimation (discarding every other pixel) won't result in improved gradient performance. Bicubic or bilinear conversion will significantly improve the downconversion process and deliver much higher quality end results.

Extended Zoom Range (in post): The UX180 has a 20x optical zoom, providing for the 35mm photography camera equivalent of 508mm of telephoto reach — but sometimes, you just need more. If you're delivering in 1080 HD, you can crop in post into the central 1/4 of the UHD frame and use that crop as your full 1920 x 1080 frame, effectively "zooming" in post for a total magnification equivalent to 1,016mm. If your final delivery is going to be 720p footage, you can zoom in post even further, to the central 1/9th of the screen, while still retaining full resolved detail; that would mean a total "effective" zoom equivalent of 1,524 mm.

Full optical zoom

Post crop of center of image, for 2x "post zoom"

Reframing and Post-Production Camera Moves: Sometimes when you frame up a shot, you think you've got it perfect, only to get to the editing suite and realize that there's a microphone in the shot, or something ugly in the background, or perhaps your composition wasn't quite level, or maybe you really wish that you'd zoomed in just a little tighter. When you're shooting in 4K/UHD and finishing in HD, you've got quite a bit of flexibility in resizing, trimming, cropping, rotating, or otherwise adjusting your footage in post. In fact, you can even turn a locked-down stationary tripod shot into a simulated pan, tilt, or even zoom, by cropping into the UHD frame and then moving that cropped portion across the UHD frame during the shot. You can also turn a wide shot into a close-up, perhaps giving you more editing flexibility in post.

Shot Stabilization: The UX cameras have excellent image stabilization capabilities, including the 5-axis Hybrid Optical Image Stabilization when shooting in HD. When in 4K or UHD, the camera doesn't get the benefit of the Hybrid OIS, it uses standard optical image stabilization, which — while good on its own, may not be sufficient for more extreme shooting scenarios. Maybe you decide you need more stable footage than you were able to get when using the camera handheld (or on a boat, or from a car window, or wherever you were shooting from). Most modern nonlinear editing programs include excellent image stabilization capabilities, but taking advantage of these programs usually means cropping off a notable chunk of your footage (to give the stabilizing software "room to work.") The more unstable your footage is, the more that would need to be cropped off; the remaining footage then gets magnified to fill the full frame, and that normally might lead to soft, low-res-looking footage. The nice thing about originating your footage in 4K or UHD is that you'll start with so much resolution in the image, that you could devote a large percentage to the post-production image stabilizing software and still retain plenty of resolution for the resulting stabilized image. Knowing this beforehand, and knowing that you may need to stabilize the footage in post, you would be best served to consciously shoot your footage at a wider angle than you might otherwise have done, with the express intent of allowing that wider field of view to be cropped off as the "buffer zone" that the image stabilizing software will need. The resulting footage can be substantially stabilized in post, while still retaining plenty of resolution to be suitable for use in your Full HD project. Used judiciously, this could even mean that you could occasionally leave your tripod at home and work lighter, while still being able to deliver tripod-stable shots in post.

To see examples of some of the techniques described in this article, I recommend this excellent video produced by Park Camera in the United Kingdom.

The advantages of shooting in UHD/4K are numerous, even if your final project is destined for only an HD or even standard-definition finish and delivery. The UX cameras are flexible enough to provide for the ability to record in standard definition, high definition, and ultra high definition (and the UX180 also adds Cinema 4K). Whenever possible and practical, I recommend shooting in UHD (or 4K) for the flexibility, future-proofing, and post-production advantages that UHD/4K acquisition provides. You may or may not need it, but if you ever do need to do some of the tasks outlined in this article, you'll be very glad you had that high-resolution source footage to work from.

There do remain some advantages to shooting in HD instead of 4K/UHD, and those will be covered in the Which Mode To Shoot In article.

SDHC and SDXC Card Best Practices

Recording video on an SD card will be new to many users, so it seemed like a good idea to put together a "Best Practices" guide to help new users avoid common mistakes.

1. Always format the memory card in the camera.
This is a vital first step. Even though the memory card comes pre-formatted when you buy it, it's still advisable to format it in the camera. Reports of glitches in the footage seem to be greatly reduced when cards are formatted in the camera instead of by a computer. Never format the card in a computer using your operating system's "format" command. If you must format a card in a computer, only use the SD Card Formatter software program (a free download on Panasonic's website). It is especially important to format the cards properly depending on what kind of card they are; SD and SDHC cards should be formatted as FAT32, but SDXC cards need to be formatted as exFAT. The camera will always do this properly, so it's best to format the cards in the camera.

2. Never pull the card out when it's being accessed.
This is a big one; if a card is being written to, or read from, and you eject that card, it has the potential to not only ruin the current clip, but perhaps to glitch the entire card! Always make sure a card is not being accessed before you pull it out of any device. This is one reason for the presence of the card door – closing that door will remind you to double-check that recording has

stopped. However, do be aware that the camera has hot-swap capability; you can leave the door open and eject a memory card that's not currently being accessed. This gives you the ability to perform an endless RELAY REC, where you can continually swap in new cards and record perpetually. The danger in this scenario is, of course, ejecting the card that's being currently written to. Always double-check yourself and look for the access lights to make sure you only eject that dormant card, and never the card that's currently being written to.

And when removing a card from a computer, be sure to eject the card through your desktop (on Mac, "Eject" or drag its icon to the trash, on Windows, use the green-arrow "Safely Remove Hardware" utility.)

3. Carry the cards in some sort of protective case.
SDXC and SDHC cards should be carried in a protective plastic case, or in a dedicated card holder. You really don't want to have cards roaming around loose in your pockets or at the bottom of your camera bag, where they can be crushed, be subjected to static electricity, be spilled on, or forgotten in your clothes and subsequently washed! Always put a card in a case when you're not using it.

4. Always write-protect the cards the instant they come out of the camera.
This has been a backbone of my tapeless workflow for years – the instant the card comes out of the camera, write-protect it. This does several things for you:

A. It prevents your valuable footage from being overwritten.
B. It alerts you that this particular card hasn't been offloaded to a computer yet.
C. It prevents you from getting that card mixed up and formatting it(!)

My standard workflow is to write-protect the card, and leave it write-protected until I've successfully offloaded the footage onto a computer (at least once, and maybe to two separate drives). Once I know the footage is safe, the write-protection tab gets moved to the "unprotect" position. Things can get confusing quickly in a production environment, but with this procedure I always know that my footage is safe from being lost or overwritten. Get in the habit of immediately write-protecting your cards and you'll save yourself from some grief.

5. Use the very best cards you can afford.
This one almost goes without saying, but – I'm going to say it. There are cheap cards out there, and some of them are junk, and some of them are

even counterfeit! Not all SDHC/SDXC cards are the same! Some employ technologies for protecting your footage from write errors, from power failures, from wearing out — and the cheaper ones don't. If you're buying no-name cards from third-world countries off internet auction sites, don't be surprised if they don't perform as well as a top-of-the-line Panasonic Gold or Lexar Professional or SanDisk Extreme card. In fact, don't be surprised if it's a fake/counterfeit/knockoff! There are plenty of examples on the internet of people who received fake cards; unscrupulous sellers have printed their own labels and stuck them over low-quality cards to deceive unwary buyers into thinking they've received a higher-quality, more-expensive card than they actually have.

It's not a matter of footage quality, it's a matter of data integrity. If a card works, it'll record the footage the same as any other card will. But a cheap card might not have as much reliability, it might have "bad sectors" or it might fail unexpectedly. While anything's possible, it's reasonable and practical to expect that a better-quality card will perform more reliably, and in my experience that has held to be the case. They say "you get what you pay for," and going with super-cheap cards may bring nasty surprises when it comes to reliability. Always get the best media you possibly can. And always buy your memory cards from the manufacturer's authorized resellers. You might pay an extra $10 per card, but if it helps you avoid a reshoot, it's extremely cheap insurance!

6. Test your memory cards first.
You can use the Panasonic "SD Card Formatter" software to format a memory card before its first use. The SD Card Formatter program will format a card in the same way that the camera does, but it can also be used to do a bit of error checking on the card, by choosing to do a "Full" format, and choosing the "flash erase" option. You might also consider running a program such as Flash Memory Toolkit, which will scan a card for errors. You don't want to run an error checker too many times, since all flash memory has a limited lifespan, but doing it once when you first buy the card may be a wise precaution.

Rolling Shutter MOS Sensors

The UX cameras use an MOS sensor, and like virtually all MOS and CMOS camcorders on the market, these sensors use what is known as a "rolling shutter." This is a subject you should be aware of, because rolling-shutter chips perform differently in several ways from the CCD chips of older video cameras.

First, what is meant by "rolling shutter"? Fundamentally we're talking about a difference in the way the camera exposes. On a CCD camera (or on a camera with a global shutter), the entire chip is exposed simultaneously, top to bottom, all at once. Across the entire frame, it goes from black to fully exposed, simultaneously. Click the video to the left for an example.

Video simulation of global shutter

On a rolling shutter camera, that doesn't happen – instead, exposure happens incrementally from top to bottom. As a simplified explanation, a rolling shutter camera will expose the very top line first, and then the next line, and then the next line, and on and on, until the entire frame has been exposed. Click the video above for an example.

Video simulation of rolling shutter

This differs significantly from the "global" approach of the CCD, and it can result in some image artifacts or differences in the way the camera renders images, that you need to be aware of.

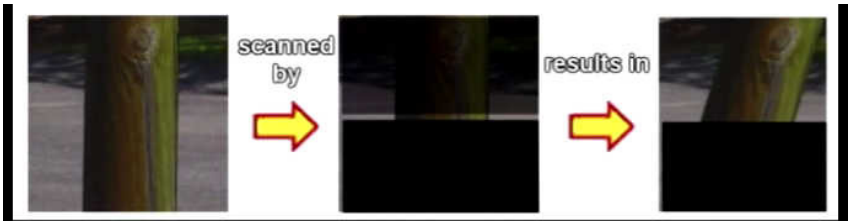
For purposes of this discussion, we're going to talk about three main image artifacts: Skew, Wobble, and Partial Exposure.

Skew

Perhaps the best-known and most-talked-about rolling shutter artifact is known as "skew." This refers to the tendency of objects to lean or tilt (or, well, "skew") when the camera pans past them. Take a rolling shutter camera, put it on full telephoto, point it at a picket fence, and rapidly pan it back and forth, and you'll see that the vertical lines start leaning depending on which way the camera is panning, and as you reverse direction they actually start to look "rubbery."

It's pretty easy to understand why this happens – again, in the prior section, we talked about how the rolling shutter works, and how it "rolls" through the frame. Well, think about panning past a tree: when you start the pan, and the first line is starting to be exposed, the tree might be on the left side of the frame. As you continue to pan, the tree is moving across the frame, but the shutter is still rolling down the screen – so as it exposes each new line, the tree has moved some. As the camera frame moves across the tree, the tree may be in a different position as each line is exposed as the shutter rolls down the frame. The resulting frame is a diagonally skewed image.

Moving Image *Rolling Shutter Scan* *Skew in Final Frame*



Frankly, that's going to happen on any image that you pan quickly past, not just vertical poles or trees or fence posts. It will happen with buildings or flagpoles or cars or signs or... well, anything, really, because that's how a rolling shutter works. And it's not just limited to panning the camera, it happens with any image motion across the sensor, whether you're moving the camera, or the image is moving relative to the camera (as in, speeding cars going by; you'll notice that the cars may be leaning, especially noticeable on big square vehicles like train cars or moving trucks.)

There are some things you can do to work with this, but let's get one thing out of the way first – changing the shutter speed will not help. The shutter speed controls how long each row gets exposed for, but it does not cause the scanning to happen any faster. The only difference the shutter speed will make is in how much blur happens in your shot, but the exact same amount of skewing will still exist.

The frame rate and recording mode does not appear to matter either in these cameras. Whether you shoot at UHD or FHD, at 59.94p or 29.97p or 23.98p, the cameras give the same amount of skew.

A major contributor to skew is the amount of relative motion. The faster you're panning, or the faster the object is moving, the more skewed it will appear. But you can change the amount of relative motion by zooming out, for example. The further you're zoomed out, the longer it will take for an

object to cross the frame, and the longer it takes, the less skewed it will be. Skew is at its strongest at telephoto focal lengths, and it's at its mildest at full wide angle.

So how do you control it?

There's nothing on the camera you can change that will affect the skew. The only thing you can do is modify your shot composition and technique.

1. Zoom out. Telephoto = more skew, wide-angle = less skew.

2. Control the relative motion. That means either slow down your pans, or slow down the object you're tracking. One way to slow down an object you're tracking is to pan with it as it goes across; the more time the object spends on the screen, the less relative motion it's exhibiting, and the less relative motion, the less skew. Or, consider re-composing your shot - do you have to be 90 degrees from the subject? If you can move the camera so that the subject crosses at a 45 degree angle, you'll greatly reduce the amount of relative motion and thus the amount of skew. Remember, it's not about the actual ultimate speed, it's about how fast the object moves across the camera's sensor.

As far as slowing down your pans, be sure to read the article on Strobing to see why you should probably be slowing your pans down anyway. If you time your pans in accordance with the guidelines for avoiding strobing, you'll find that the skewing has been overcome too.

Wobble

The second major image artifact to discuss is "wobble." Wobble gives a rubbery, gelatin-ish, bouncy/stretchy texture to the footage. Wobble happens primarily in cases of vibration, where the camera is being constantly moved up and down or side to side very rapidly. Wobble is really an extension of Skew, and happens for the same reason. If you zoom in to full telephoto and wave the camera back and forth, you'll see vertical lines get kind of "wobbly"; the same thing will happen with vibration. Another example would be if you had the camera mounted on a tripod, and somebody bumped into the tripod — during that bump, you're going to see the image get "wobbly."

How can you deal with wobble?

1. Use the Optical Image Stabilizer. It can't overcome all instances, but the OIS is really rather good at dealing with minor, momentary wobble. And

the OIS is programmable, so you can tune it to be more sensitive to high-frequency vibration where it may help avoid wobble. It's not a fix-all, but the OIS can certainly help minimize some instances of wobble. Of course, there are reasons to avoid using OIS when on a tripod, too, so you'll have to make a judgement call as to when OIS on a tripod is an appropriate choice.

2. The ultimate cure here is to avoid those scenarios! If you're going to be mounting the camera to a highly vibrationary surface (such as an ultralight airplane or a helicopter or dirt bike) you can expect wobbly footage. You have to minimize or eliminate the vibration whenever possible. The camera's internal optical stabilizer actually does help to overcome a lot of high-frequency vibration, and a vibration-absorbing mounting (such as a CineKinetic CineSaddle™) can help absorb the vibrations and eliminate or at least minimize the rubbery effect. Regardless of how you choose to approach it, recognize that if the camera is put in a vibration-prone environment or is used in a herky-jerky handheld style, you're going to see wobbling, and the only real way to prevent it is to prevent the wobbles from reaching the camera in the first place.

Partial Exposure

This artifact is also known as "flash banding." This is perhaps the most prevalent of the rolling shutter effects. What happens is that when a flash goes off, only part of the flash is recorded.

Again, think back on how that rolling shutter rolls through the frame; as it rolls from top to bottom, it exposes the frame onto its sensor. If the image is uniformly lit, you'll get a uniform image, such as the one on the left. However, what if a flash was happening in the frame when the rolling shutter starts exposing, and then halfway down the frame the flash stops? It'll record the bottom half of the frame without the flash, but the top half has already been recorded when the flash was happening! The result is you'll see a frame where only part of the frame is lit up by the flash, and the lower half is darker.

The UX cameras have a way to prevent or minimize flash banding. You can assign **Flash Band** (Flash Band Compensation) to one of your user buttons, and use it when in a scenario

where flashes are likely. There are some restrictions on its use (you can't use it with VFR, or in 24p/25p/29.97p modes, or when using Digital Zoom); this usually isn't that much of a problem because flashes are most likely to happen at a press conference or other ENG/news-style event, and in those scenarios you're probably going to be wanting the "live" look of 59.94p/59.94i or 50p/50i anyway. If you're encountering flashes during film-style shooting at 24p/25p, however, there's not really anything you can do to minimize it as far as camera settings go. You can repair those images in post, but you can't do much about them in-camera.

Flash bands are most apparent when there's a big difference in brightness between the lit and unlit portions (which seems obvious, of course) and so you can minimize the appearance and distraction of the flash bands by lighting up your scenes more. A stronger on-camera light can greatly minimize the distracting nature of the flash bands by minimizing the difference between the flash- and non-flash portions of the screen.

Perhaps the only way to fully address the flash banding is in post; overlaying a white frame or blending portions of the frame together can minimize the effect of flash banding or partial exposure. In general, the advice is to be aware that all rolling-shutter cameras exhibit this artifact, and if you are planning on shooting a red-carpet Hollywood premiere or a press conference or some other event where there are likely to be many flashes going off, you can expect that you'll have flash banding in your footage. If you're shooting 59.94P/59.94i or 50P/50i, you can minimize or eliminate the flash banding by using the Flash Band Compensation.

Another effect you need to watch out for is scrolling bars in your image, which are mainly caused by changing the shutter speed when shooting under fluorescent, sodium vapor, mercury vapor, or HMI lighting. The rolling shutter will cause brightening/darkening bands to appear (similar to when you shoot a computer monitor or television at an "off" shutter speed.) The way to minimize this is to always use a shutter speed that matches your country's power frequency (in the USA or NTSC territories, that means use 1/60th; in Europe or PAL territories, use 1/50th). There are some other shutter speeds that may prove safe in these scenarios, such as 1/25th in PAL territories, or 1/24 or 1/30 in NTSC territories, but those are only available if you're shooting in a slower frame rate anyway. In general it's easiest to remember that in NTSC territories, the way to best avoid any bars/bands in the footage is to stick to 1/60th, and in PAL territories, stick to 1/50th. Now, the UX cameras can automatically adjust

Video of "partial exposure" bands

their shutter speed, so you have to monitor that and ensure that it is in strictly manual shutter speed.

How do you know if your fluorescent/HMI lights are likely going to cause a problem? Sometimes the scrolling bands are not very apparent on slow shutter speeds (such as when shooting 24P at 1/50), but they will become glaringly apparent if you use a short shutter speed. One easy way to test for the problem is to set the shutter speed to something very fast, such as 1/250 or 1/500. If you don't see black bars or scrolling orange bars at those short shutter speeds, you're very unlikely to see them at more normal shutter speeds. But if the black bars do show up, you know that you're shooting under potentially problematical lighting. The safest course of action is to replace that lighting with your own, but if you can't re-light the scene, keep a close eye on your shutter speed and manipulate it to minimize the prospect of scrolling bars in your footage.

Note that with some LED panels, their dimmers can cause rolling bands too — and you can't eliminate that banding with the shutter speed! Some LED panels dim their lights by actually cycling the light off and on briefly, and the rates at which they do this are not easily trackable by adjusting the shutter speed. You really have to be careful when working with dimmed LED lights, and try to keep them at full brightness to avoid the rolling band syndrome.

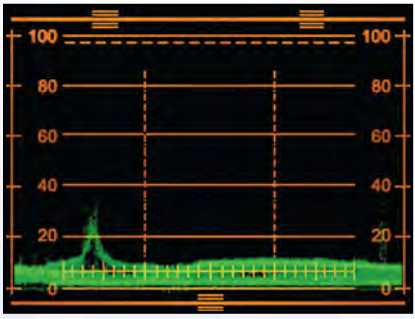
An Introduction to the Waveform Monitor and Vectorscope (UX180 Only)

The best tools for calibrating the color accuracy and exposure accuracy of your video signal are the WaveForm Monitor (WFM) and the VectorScope (VS). These tools have been a staple of professional video production for many years, and they provide a way to evaluate the actual video signal. Buying a standalone waveform monitor is an expensive proposition, but the UX180 actually offers a free, built-in waveform monitor and vectorscope!

An exhaustive look at all the possibilities afforded you by a waveform monitor and a vectorscope is far beyond the scope of this article. This section will introduce you to these tools and show you basic fundamental operations, which should allow you to evaluate and monitor your video signal more accurately than you may have experienced before.

The waveform monitor ("WFM") is the most useful tool for judging your video's exposure levels. The waveform monitor can tell you at a glance whether your footage is overexposed, underexposed, clipped, and – if any of those conditions are true, the waveform monitor will also tell you where your footage is overexposed, underexposed, or clipped. The waveform monitor is like having the ultimate light meter available to you, but it's infinitely more informative and precise than a light meter, because the waveform monitor takes into account all the signal processing the camera does – the gamma curves, the master pedestal, the effect of the knee, all of these effects can be discerned from looking at the waveform monitor, and none of these things could be known by just using a light meter. Light meters work great for lighting film, but when working with video a waveform monitor is a far more useful tool to have on hand.

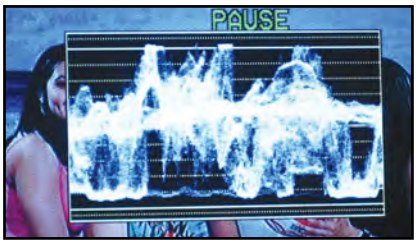
In simple terms, a waveform monitor is essentially a graph of your video signal. It draws a mathematical representation of the brightness of the image, from left to right, and it plots its pixels according to the brightness of the image: the brighter the source image, the higher up on the scale it will plot the pixels.



Here's an example of a waveform monitor screen. Vertically you can see that there are certain denominators at predetermined reference points (0, 20, 40, 60, 80, and 100 IRE; on the camera's waveform monitor the solid lines are at zero, 50, and 100, with dotted/dashed lines at 10-IRE increments). You can think of these numbers as basically telling you the overall percentage of brightness; a dark gray object might illuminate around the 10 to 20 IRE mark, and a bright white light might stretch all the way up to or even past the 100 IRE mark (up to as much as 110 IRE). The brighter the signal, the higher up the chart it will mark. In this example you can see an extremely underexposed image;

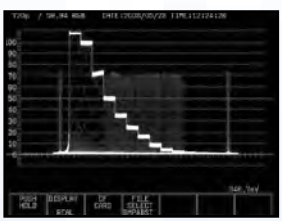
the plot of image brightness is almost entirely down at the 0 to 10 IRE level (but there's a small spike about 15% of the way across the screen, in our video image there was something a bit brighter there.) If your waveform monitor looked like this, you'd get terrible video quality: the image would be underexposed, muddy, and probably very grainy and noisy.

Ideally, for most real world scenes, you want a rich saturated image with brightness distributed across the full scale, which shows that you're taking advantage of the maximum dynamic range the camera affords. Look at this next image for an example of a fully saturated, brightly exposed scene.



In a moment I'll show you how to read the waveform monitor and fine-tune the image in order to get the best overall exposure; this example is just to show you more of what you should be aiming for in terms of a rich, saturated, full signal.

As said before, the waveform samples the brightness (luminance) of the picture and plots a graph of the image on its screen. Horizontally, the waveform monitor plots out the image just like on your video screen; if a very bright object was located in the center of your monitor, you should see a bright spike in the center of the waveform display. The next pictures show what a waveform monitor looks like when shooting a chart full of gray bars.



The brighter bars are represented on the left side, and the darker bars are on the right. The waveform monitor looks at the brightness of the image as it scans horizontally and it plots the relative brightness vertically, so white is the highest point and black is the lowest point, and the shades of gray are distributed in-between.

These waveform plots show clean lines where each bar appears on the screen. That's because the waveform will plot the entire vertical height of each vertical line of the display, and it will plot pixels on top of each other – so, the more pixels that appear at a certain brightness level, the brighter

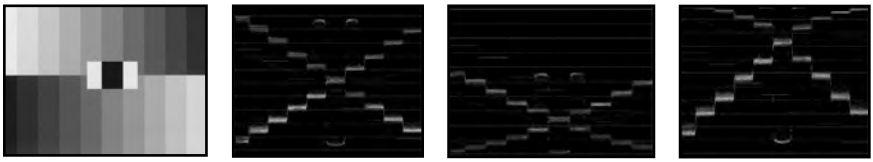
that section of the waveform monitor will be plotted. In our example there's only one level of brightness in each gray bar, so the waveform monitor plots a thin clean line. If you looked at a waveform display of a perfectly flat white sheet of paper, you'd see a razor thin line running across the waveform monitor's display. That's because, with no variation in brightness, there's no variation of where the pixels get plotted, so they all get plotted on top of each other, making that section of the waveform display brighter and brighter. If, on the other hand, we were to feed the waveform monitor a signal that had wildly varying brightness in each vertical column, you'd see a large swath of pixels plotted on the waveform display.

This is a very valuable aspect to a waveform monitor because you can use this to evaluate the relative brightness of your scene, especially when shooting something like a greenscreen. If your greenscreen lighting is perfectly flat and even, you should see a tiny thin line plotted across the waveform monitor's display. The thicker the waveform's plot, the more variation there is in your lighting (which will make it more difficult to pull the best-quality key from your footage). Also, if the line is not perfectly flat, but it dips in the corners or has peaks and valleys across the screen, that is telling you that your lighting is uneven; wherever the waveform monitor dips, that's showing you have a darker spot, and wherever there are peaks or hills on the display, that's telling you that there are hotspots on your greenscreen. The waveform monitor is the best tool for helping you light a perfectly flat, perfectly even greenscreen.

Here are three examples of lighting a greenscreen using a waveform monitor. In the first example the screen is evenly and flatly lit, so the waveform shows a tight thin horizontal line of brightness. In the second example the screen is unevenly lit, so the line on the waveform is much thicker. In the third example there's a brighter spot on the screen about 1/3 of the way across.

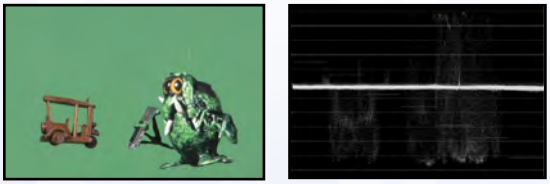
Besides telling you evenness of lighting and overall exposure levels, the waveform monitor tells you what sections of your footage might be overexposed or underexposed. If you see a big clump of bright plots down at the bottom of the waveform, you know that your exposure level is really low in that section. Conversely, if you see a flat line clipping off the top of the waveform, that alerts you that portions of your video signal are "too

hot" and are, in fact, clipping (losing all detail and becoming a big blob of overexposed white). Keep an eye on your video signal and watch for those clipping hot spots, and either lower the light level on those hotspots, or stop your iris down some to keep them from blowing out. Blown out highlights on video are ugly, ugly, ugly, and are best avoided. And if you're seeing sections of your video that are grossly underexposed, either iris up or shine some light onto that portion of the scene to prevent you from getting stuck with noisy, muddy, underexposed video.



The above examples are of a gray 10-step chart; notice how the gray bars form an "X" on the waveform. The first example is properly exposed. The second example is quite underexposed, look at all the wasted range at the top end of the waveform. And the third example is very overexposed, look at how the white bars are actually clipping off the top of the waveform.

The great thing about a waveform monitor is that it tells you absolutely what your video signal is doing. You don't have to try to trust your eyes to a perhaps - miscalibrated monitor, or strain to see where the zebras may or may not be hitting, or (worst of all) just guess. Instead, at a glance, you can see whether you're getting a full and proper exposure and whether your image is clipping or crushed.



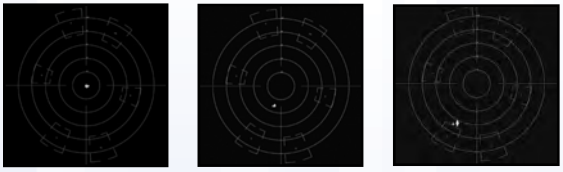
In this example, you can see that the greenscreen is evenly and flatly lit at about 57 IRE (as shown by the thin line running throughout), the wooden car is darker on the left, and the monster is both dark and light on the right (and its white teeth are coming close to clipping off the top of the waveform). Diligent use of the waveform monitor will be your best method for ensuring strong, richly exposed video.

Whereas a Waveform Monitor (and especially the waveform monitor in the UX180) is designed to monitor brightness, the Vectorscope is a tool to help

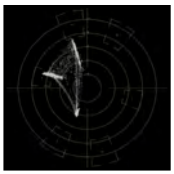
you judge the accuracy of color rendition and the level of color saturation in your image. When used with proper test charts the Vectorscope can give you an overview of your camera's color rendition at a glance, and you can also see exactly what the menu setting changes do to the way the camera manipulates the color of the images.

The vectorscope plots colors along certain vectors. The graphical overlay (or "graticule") of a vectorscope will always have some boxes to indicate where the pure color vectors should be lining up, and frequently a vectorscope's graticule will include some circular or gradated marks to show the percentage of saturation (in terms of IRE) of the color signal. The camera's vectorscope only shows the color boxes, so we'll focus on that aspect of the vectorscope.

The vectorscope features six boxes, representing (clockwise from the top, starting at about 11:00) red, magenta, blue, cyan, green, and yellow. The vectorscope analyzes the video frame and plots dots on the display according to how many pixels it finds in each particular group (or, obviously, between groups for mixed shades). When shooting a black and white picture, ideally you should see a tight bunching of pixels at the center of the vectorscope. When shooting an object of a pure color (such as a greenscreen), you should see all the plotted dots bunched tightly in one place, ideally towards the green box. The plotted dots will be closer to the center or closer to (or even beyond) the color box, depending on how saturated the color is. These next three examples are of: 1) a black and white picture, 2) a very low-saturated greenscreen, and 3) a highly saturated greenscreen.

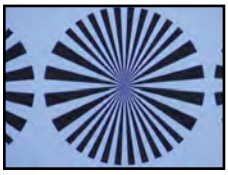


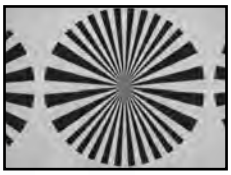
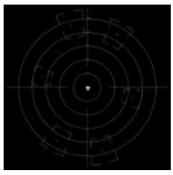
In these examples, the only color involved was green, so you only see pixels plotted on the screen either at the center (the black and white picture, no color present), or slightly towards the green box (a greenscreen picture with low color saturation), or a lot of plotted pixels closer to the green box (a highly saturated greenscreen). It's uncommon to see such simple vectorscope plots; most scenes have a lot of color in them and so the plot will be "busier."

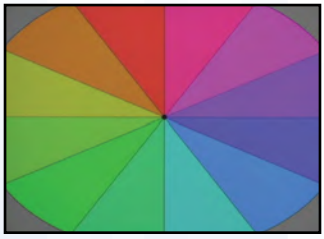
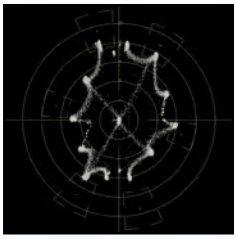
Here's an example of a red and yellow ball against a green screen. There's a good deal of color purity here with intense plots at the red, yellow, and green boxes.

In real-world monitoring, you're not likely to use the vectorscope nearly as much as you will the waveform monitor. The vectorscope is a more useful tool for setting up and evaluating camera performance, whereas a waveform monitor can (and ideally should) be used on every shot to evaluate exposure and lighting. However, a vectorscope can be useful to solve lighting problems because, like the waveform monitor, it reports exactly what's happening in the video signal – rather than trusting your eyes to a perhaps - miscalibrated production monitor. In the following example the white balance is grossly off; we white-balanced for tungsten light but the actual light was daylight, so the image is too blue. The effect of this is clearly observable at a glance in the vectorscope, as the plot is bleeding towards the blue vector instead of being a tightly-controlled pack of pixels as in the second example.



A vectorscope may be most useful with test charts, to see how the color is being rendered by the camera under controlled conditions. Here is an example of a DSC Labs CamBook™ color chart, and the vectorscope display. This is a 12-color chart so you'll see heavy plots in the six main boxes for the six specified colors (red, magenta, blue, cyan, green, and yellow) as well as heavy plots in-between those colors. The goal, for accurate color representation, is to adjust the lighting and the camera settings until the primary six colors align as best as possible with the color boxes on the vectorscope's graticule, and the intermediate colors appear halfway between the primary colors.

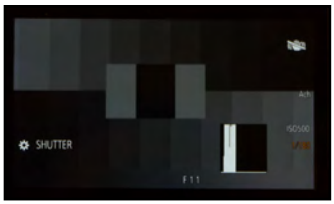



Whether you choose to use the vectorscope or not, my advice to all video shooters is to become thoroughly versed with the waveform monitor and use it on every shoot you possibly can. Proper use of the waveform monitor will help you to more accurately expose your video image, keeping you from getting noisy underexposed images or clipped/overexposed video. You'll find that the waveform monitor (especially used in tandem with a properly-calibrated production monitor) will help you in your lighting and exposure far more than any light meter would be able to. These cameras make it extremely easy to spot-check with the waveform monitor. Other options would include getting a dedicated waveform/vectorscope device, or using a production monitor with a built-in waveform monitor (such as the Panasonic BT-LH series of LCD monitors).

An Introduction To The Histogram (UX90 Only)

The Histogram is an exposure tool common in still photography, and it is a simple tool to use and to read; it's a mathematical graphing of the brightness of the image. The scale ranges from pitch-black to blown-out white horizontally, and the higher the peaks, the higher percentage of total image area conforms to that particular level of brightness. As a quick example here are three histogram displays. The picture is of a DSC Labs grayscale chart, so there should be uniform tones of gray; the histogram is the overlaid graph on the lower right.

This is a properly-exposed image of the grayscale chart. The histogram shows a nice even distribution of brightness tones throughout the image, with high peaks that indicate a lot of image data at a variety of brightness levels — exactly what you'd expect when viewing an image of distinct and varied brightness levels. You'll notice that there's not much on the very leftmost and rightmost edges of the histogram display. That tells us that very little of our image is in the "danger" zone of being too dark or too bright, and instead most of the image is nicely represented across the safe zone through the middle of the histogram. You don't typically want a lot of image detail to occupy either extreme (too dark or too bright), so balance your shot to get a nice, full histogram image whenever possible.



This shot is grossly underexposed. It's the same chart, but the exposure is so dark that all the black and dark gray bars have blended to a solid mass of black, and the white bars are now a fairly dark middle gray. So what does the histogram tell us? The histogram is entirely "bunched up" to the left. There is very little image area being represented on the graph anywhere but in the very darkest (leftmost) region, and those bars are very tall (meaning, there's a lot of image area represented there). If your histogram looks like that, your image is going to be severely underexposed. All the potential dynamic range that's represented by the right side of the graph is going completely unused. Images exposed like this are likely going to be dark, muddy, and noisy.

The overexposed shot shows that the situation is pretty much reversed. The lighter-tone chips are now all blown out to white, and the darkest chips are now middle gray. Accordingly, the histogram display shows little if anything on the left side, but there's a big huge spike on the far right (which represents the very brightest levels); meaning there's a lot of our image that's being shown in the too-brightest tones, and that's not good.

As such, the histogram is generally used as an exposure reference at a glance; you can quickly tell if the image is exposed well, or if there's too much being pushed into the shadows, or if the image is exposed too brightly.

Lastly, on the histogram, and with reference to digital photography or cinematography, you'll occasionally hear the term "expose to the right." That's referencing the practice among digital shooters to push the image as bright as they can, while avoiding overexposure. There is merit to this technique when used in digital shooting; the brighter you can make the image (without overexposing!) the cleaner the image will be. Remember, the most visible noise "lives" down in the lower/darker regions, so when you expose the image so that the overall histogram is shifted over to the right as far as it can safely go, you're usually going to end up with cleaner/better images. However, this technique presupposes that you will be doing some post-processing on your image, bringing it into an image-editing program and bringing the levels back down to pleasing levels. Overexposed footage is unpleasant to look at, and requires post-processing to put it at the proper

levels. In digital shooting it's always safe to bring levels down in post, but brightening up images tends to bring out the noise and grain, so when you can arrange it, try to practice shooting with the histogram balanced somewhat to the right while being sure to not stray into overexposing any of the image. Avoid overexposure; overexposure ruins digital video, causes color shifts, and washes out detail.

Which Mode to Shoot in?

The UX180 presents a dizzying array of formats, frame rates, frame sizes, scan speeds and recording modes to choose from. Everything from 480i, 576i, 720p, 1080i, 1080p, and 2160p, with some choices between 4:3, 16:9 and 17:9 aspect ratios, in both 50Hz and 60Hz modes at base frame rates of 23.976, 24.00, 25.00, 29.97, 50.00, and 59.94 frames per second, in various combinations of bitrates in long-GoP as well as some choices for intraframe recording, and most of that is available to be recorded in your choice of three different file formats (AVCHD, MOV, and MP4)! By my count, this camera offers at least 57 different ways to record footage! The UX90 is no slouch either; while it doesn't offer all the bitrates the UX180 has, or the international capability, it still provides for 480i, 720p, 1080i, 1080p and UHD, with some choices of 4:3 or 16:9, in AVCHD, MOV, and MP4 -- still a huge variety of modes! So which mode should you shoot in? And why would you pick one particular mode over another? Let's examine each mode and outline what it would be best for.

We'll evaluate the different choices that are available in six basic categories: aspect ratio, frame size, frame rate, scan speed, bit rate, and recording format. One constant factor is that all the recording modes, regardless of all other factors, use 8-bit quantization and 4:2:0 color sampling. It's possible to output 4:2:2 in almost all modes, even during recording, but all recordings done to the internal memory cards are done in 8-bit 4:2:0 regardless of frame size, frame rate, aspect ratio, recording format or bitrate.

Aspect Ratio - Let's start with the simplest of choices, aspect ratio. This refers to the shape of the video frame. Traditionally in video there have been two major aspect ratios, 4:3 (old-style television) and 16:9 (modern "widescreen" television). In the USA, the two can be divided largely along lines of standard definition and high definition; standard definition televisions were almost all 4:3, and high-definition TVs are pretty much exclusively 16:9. The transition to HDTV simultaneously ushered in a transition to 16:9 TV. This is not the case in other countries around the world; some countries moved to 16:9 while still airing standard-def.

In general, the UX90 and UX180 should be considered as 16:9 cameras. Nearly every recording format offered is in a 16:9 aspect ratio, but there is one exception; the UX180's 4K/2160P at 24.00 frames per second. This mode utilizes an (approximately) 17:9 aspect ratio. This mode is a Digital Cinema Initiatives standardized format, and matches the widescreen aspect ratio of digital cinema cameras and projectors (approximately 1.85:1).

All of the UHD (3840 x 2160) and FHD (1920 x 1080) and HD (1280 x 720) recording modes use a 16:9 aspect ratio.

There is also a standard-definition recording mode (AVCHD SA mode) which has a user-selectable aspect ratio. When recording SA, you can choose to record in SQUEEZE (16:9), or SIDE CROP (4:3). SA also offers a third mode, LETTERBOX, which is a 4:3 frame with a 16:9 image embedded in it with black bars at the top and bottom of the frame.

Frame Size - The next consideration is the frame size of the video you intend to produce. Depending on which camera you have, there are up to seven different options available.

The 4K/2160P choice is available only on the UX180. It delivers a 4,096 x 2,160-pixel image. This is the highest resolution that the camera offers, with the widest field of view. It's actually the same height as the UHD 24p frame, but slightly wider, with an additional 128 pixels on each side.

In Ultra High Definition (UHD) shooting modes, the frame size is always 3,840 x 2,160.

In Full High Definition (FHD), the frame size is always 1920 x 1080.

When in the AVCHD recording format, one of the 1080 modes has a different recording frame size. HE mode is recorded as 1440 x 1080, but it is intended to be up-rezzed to 1920 x 1080 for viewing. The 1440 x 1080 does not represent a different aspect ratio, instead it is a form of compressing the video footage by discarding some of the fine detail and shrinking the frame to 1440 pixels wide. It is expanded to 1920 on playback.

There is one AVCHD mode which records in 720p, the PM mode. Its frame size is 1280 x 720.

There are two options in AVCHD for standard definition, but the choice depends on whether you've set the camera in 50Hz or 59.94Hz mode; since the UX90 is a single-territory camera, it only has one choice for standard-def. The SA recording mode uses a frame size of 720 x 480 in 59.94Hz, and it uses 720 x 576 in 50Hz. Note that even though you can select between 4:3 and 16:9 aspect ratios in SA mode, the frame size doesn't change — 480i SA mode will always be 720 x 480, whether you're recording it as 16:9 or 4:3 or LETTERBOX 4:3. And 576i SA mode will always be 720 x 576, regardless of the aspect ratio. The pixels that are recorded are intended to be interpreted as rectangles, not squares; the shape of the pixel changes depending on the aspect ratio you've chosen. If you choose 16:9, the pixels that are recorded are intended to be viewed as wide rectangles; if you choose 4:3 (or LETTERBOX) the recorded pixels are intended to be viewed as skinny rectangles.

Frame Rate - There are up to eight different base frame rates to choose from, not including variable frame rates! Not all frame rates are available in all modes or cameras. For example, the UX180 has all eight available, but the UX90 will have either three (in the 50Hz camera) or four (in the 59.94Hz camera). The base frame rates are:

23.98P - This frame rate is available in UHD, FHD, and in PH AVCHD modes. Technically 23.976 fps, it is frequently rounded off to "23.98" and in common vernacular it is usually referred to as "24P". Note that the frame rate is not exactly 24.00 frames per second (as you'll see below); this frame rate is 0.1% slower. This is the standard frame rate for shooting film-looking footage for display on 59.94Hz (USA/NTSC) televisions, or for release on Blu-Ray or DVD discs. Generally if you're shooting footage that you want to have the "film look", this is the frame rate that you will normally be choosing. This frame rate is available when the camera is in 59.94Hz System Frequency; it is not available on a 50Hz UX90.

24.00P (UX180 Only) - This is only available in 4K/2160P mode. It is designed to exactly match the frame rate of a film camera, not a video camera; as such, video footage shot in this mode may not synchronize exactly with external audio recordings if the footage is edited on a conventional video 23.976 fps (or "23.98p") timeline. As such, this is somewhat of a "specialty" mode, and is not a general-purpose video mode.

25.00P - When shooting with the camera in 50Hz System Frequency, 25P is essentially the 50Hz counterpart of 23.98P. It is a "film look" mode that creates footage that is compatible for broadcast or display on 50Hz televisions. If you live in a "PAL" territory (i.e., if your country's standard-definition television was PAL), then 25P is the "film-look" frame rate that you'd want to choose to create film-looking footage. 25.00P is available in UHD and FHD modes, and is not available in AVCHD. This mode is not available in a 59.94Hz UX90.

29.97P - This is also frequently called "30P". This mode offers a faster frame rate than 24P, and is only available in the 59.94Hz System Frequency. 30P delivers sort of a hybrid between the "film look" and the "video look". The frame rate is faster than 24P/25P, resulting in smoother motion, but it's nowhere near as fast as the 50/60 fps of "live video". The result is a sort-of-film-ish, sort-of-video hybrid, which integrates nicely into a 1080/60i broadcast stream. This mode is available in FHD and UHD only, and is not available in AVCHD, nor is it available on a 50Hz UX90.

50.00i - This is the "live video" look for cameras that are set to 50Hz System Frequency, and is available in 1080i and 576i. 50i video is interlaced and would be appropriate for footage that is going to be broadcast in 1080i or standard-def. It would make for a poor choice for computer video though; 50P would be a far better choice. This rate is not available in a 59.94Hz UX90.

50.00P - This is a fully progressive version of the "live video" look. Fundamentally it delivers the same general feel as 50i video, with the benefit of more resolution because each motion sample is made from a complete frame, rather than a "half frame" field as used in 50i. 50P is only available when the camera is set to 50Hz System Frequency. It's available in UHD, FHD, and 1080P AVCHD PS and 720P AVCHD PM modes. This rate is not available in a 59.94Hz UX90.

59.94i - (aka "60i") - This is the "live video" look for cameras that are set to the 59.94Hz System Frequency; 59.94i is frequently referred to as "60i". 1080-resolution HDTV broadcasts in the USA are broadcast as 1080/59.94i; in this mode the camera would be producing footage that could be used for broadcast directly. However, it would be a poor choice for video that will be viewed on a computer, and in general 59.94p would be the better choice for any footage that will be displayed on a progressive-scan TV or computer. This rate is not available in a 50Hz UX90.

59.94P - (aka "60P") - This is a fully progressive version of the "live video" look, for cameras set to the 59.94Hz System Frequency. Just as with 50i/50p, 59.94p delivers the same general look and feel as 59.94i, but made with pure progressive frames. 59.94p footage can be easily converted to 59.94i for broadcast if necessary, and in general is a superior choice to 59.94i except for instances where the footage is going to be broadcast unedited or unconverted. 59.94P is available in UHD, FHD, and AVCHD 1080P PS and 720P PM modes. This rate is not available in a 50Hz UX90.

Bit Rates - All UX cameras record all their footage using MPEG-4; the differences generally involve the frame size (discussed earlier) and bit rates. The bit rate is how much data is involved in recording each second of video.

There are four main bitrates that the UX180 camera employs when recording footage in MP4 or MOV mode; the UX90 uses two bitrates. In AVCHD, both cameras use many more.

MP4/MOV 50 Mbps - This is available only for 1080P and 1080i Full HD footage, at all frame rates (23.98p/25p/29.97p/50i/50p/59.94i/59.94p). This is available on the UX180, and it is the only bitrate the UX90 can use to encode Full HD MOV/MP4 footage. At 50 megabits per second, the camera uses a fairly modest bitrate to encode footage, and can record approximately two minutes per gigabyte (i.e., a 64-gigabyte memory card can hold about two hours of 50 Mbps footage). The quality of the recordings is very good, although the UX180 can do even better with higher bitrates. 50 Mbps recordings offer two to three times the bandwidth that AVCHD has, and can retain more detail and show less artifacts than AVCHD footage.

MP4/MOV 100 Mbps - On the UX180, this bitrate is available in 4K/24P, UHD 23.98/25/29.97P, and in Full HD at 50P/59.94P. On the UX90, this is the only bitrate available for UHD recordings, and is only available for recording UHD. As regards the UX180's 4K and both the UX90's and UX180's UHD 23.98/25/29.97p, there's not much to say — this is the only bitrate at which those resolutions are offered, so you don't get a choice. As for the UX180's option of recording 1080 FHD at 50P/59.94P, this is the highest-quality recording format offered for FHD 50P/59.94P. It uses approximately 4x as much bandwidth as AVCHD's PS mode. The bitrate is half that of the 200 Mbps ALL-I mode discussed below, but the efficiencies gained

by the long-Group Of Pictures ("long-GoP") encoding make it able to render even higher detail than the 200 Mbps ALL-I mode. At 100 Mbps, one minute of footage takes up approximately one gigabyte of space on the memory card; a 64GB card holds approximately one hour of 100 Mbps footage.

MP4/MOV 150 Mbps - This is only available on the UX180, and only for Ultra HD at 50P/59.94P. It's the only choice offered. The additional bandwidth helps preserve the detail when encoding twice as many frames per second, as compared to the 100Mbps used when encoding 25P or 29.97P.

MP4/MOV 200 Mbps ALL-I (UX180 Only) - This is an intraframe-only codec and is offered only for Full HD in MOV and MP4 recording formats, in all the progressive-scan frame rates (23.98P/25P/29.97P/50P/59.94P). By being an intra-frame-only codec, it's possible that this choice may result in faster editing on some computers that can't handle the long-GoP nature of all the other recording formats. However, you shouldn't assume that just because this mode has the highest bitrate, that it will also result in the highest quality — that's not necessarily the case. It may, or it may not, depending on the complexity of the subject being filmed and amount of motion and color changing happening in the scene. In general, you can expect that a 100 Mbps long-GoP codec should be able to generally match or perhaps exceed the performance of a 200 Mbps intraframe codec in terms of quality. However, the 100Mbps long-GoP is only available for 50P/59.94P; if you want to record FHD at 23.98/25/29.97P, the ALL-I codec is the highest-quality recording codec choice available in the UX180.

Also, be aware that all these codecs uses variable bitrate encoding, and that means that the file size is not a constant. There is no guarantee that the system will actually take up a full 200 megabits per second. It might reach up to 200 megabits on a complex, highly-detailed scene, but on a simpler scene it might take up maybe 150 megabits, or even 100 megabits. As a variable bitrate codec, it only uses what it needs; the "200 Mbps" quoted figure isn't a guarantee of what you'll get, it's more like a maximum of what it will potentially use and, as an intraframe-only codec, it's also dependent on the frame rate you've chosen. When in the ALL-I mode, the amount of recording space allocated per frame remains relatively consistent, but with fewer frames to encode in the

slower frame rates, the overall observed bitrate per second is lower. When shooting the same complex scene I found that in 23.98P it delivered an actual observed 105 megabits per second, in 29.97P it delivered about 129 Mbps, and in 59.94P it delivered about 183 Mbps, but those numbers are subject to change based on scene complexity. When considered on a frame-by-frame basis, 23.98P appears to have used about 4.39 megabits per frame, 29.97P used about 4.31 megabits per frame, and 59.94p used about 3.83 megabits per frame. As you can see, each frame was generally recorded at about the same quality; the more frames per second, the larger the file size, up to about 200 megabits per second for 59.94P.

AVCHD 25 Mbps - This is used only to record PS mode, which is Full HD at 50P or 59.94P. PS can be thought of to mean "Progressive Scan."

AVCHD 21 Mbps - This is used only to record PH mode, which is Full HD at 23.98P, 50i, or 59.94i. PH can be thought of to mean "Progressive High Quality." PH is one of the highest-quality AVCHD recording formats (but it still trails the MP4/MOV 50Mbps and 100Mbps modes).

AVCHD 17 Mbps - This is used only to record HA mode, which is only used for interlaced 1080i at 50i or 59.94i. HA can be thought of to mean "High Advanced" quality. For interlaced footage this is a decent choice, but the PH mode is definitely higher quality, and includes higher-quality audio recording as compared to HA and HE modes.

AVCHD 5 Mbps - Yes, you read that right –5 megabits. This mode results in tiny, tiny file sizes. This is used only to record HE mode, which is 1440 x 1080 HD at 50i or 59.94i. HE can be thought of to mean "High Economy." Now, at 5 megabits, that's so low that you do have to be concerned about quality. HA mode (17 mbps) can look very good, but HE mode is less than 1/3 that bitrate. It can look surprisingly good when shooting a stationary (or largely stationary) subject, such as a talking head interview, but should only be used when tiny file sizes are the most important factor.

AVCHD 9 Mbps - This is used only to record SA mode, which is standard definition video at 576/50i or 480/59.94i.

AVCHD 8 Mbps - This is used only to record PM mode, which is 720P HD at 50P or 59.94P. That's not a lot of bitrate for encoding a whole lot of data, so you shouldn't expect PM mode to deliver the highest-quality footage; it's for when you want high-definition footage in the smallest file sizes possible, and you don't want to deal with interlaced footage (such as HE mode). This mode is sort of like the 720P equivalent of HE mode, and is the only way to record 720P on a UX camera.

Recording Formats - Finally, there's the question of what file format you want your footage recorded in. There are three choices (MP4, MOV, and AVCHD). There's no quality difference between the MP4 and the MOV; the codec is the same, the recorded footage is the same. AVCHD has its own bitrates, frame sizes, and frame rates as part of its package.

So the question really is: how are you going to edit the footage? If you're a Macintosh user, you probably want to use the MOV file format for all your HD and UHD/4K shooting. If you're a Windows user, you may prefer to use the MP4 format for your HD and UHD/4K shooting.

As for AVCHD, it's mainly used for times when you need the longest possible recording times on your memory cards. Or, potentially, if you're going to be uploading the footage to the internet, and accordingly you need the smallest file sizes possible. Or, perhaps if you're going to be turning the footage over to someone else to edit, and you don't know whether their editing system can handle the large file sizes and bitrates of the MP4/MOV modes. AVCHD is an extremely well-established file format supported by all major nonlinear editing programs, so you can be sure that just about anyone should be able to properly edit AVCHD footage.

Putting It All Together - Deciding On A Format - Now that you know what the choices are, you should feel more empowered to make the right decision on what formats and recording options best suit your projects.

There is no overall "best" choice, there's only "the best choice for the current project." If you're shooting news for a 1080i station and uploading footage from the field, it's possible that AVCHD HA mode might be the best choice for you, for that project. If you're shooting a film to enter the Sundance Festival, it's far more likely that 4K/24P or UHD/23.98P would be the right choice.

Generally when approaching this decision, I rely on a few basic factors to inform the final choice. First — what do I want this project to look like, "live video" or "filmic"? If it's a live event, news, sports, or some other project that generally benefits most from the "live video" look, I would choose 59.94p whenever possible, and 59.94i only if the client specifies and requires 59.94i. On the other hand, if producing a project that would benefit most from a cinematic look, I'll shoot 23.98p every time — unless the footage is destined for integration with other footage that's being shot at 24.00p; in that case of course I'd set the UX180 to 4K/24.00p.

(note: for users in 50Hz countries, just substitute 25P for 23.98P or 24P, and 50P/50i for 59.94P/59.94i).

As to whether to shoot MP4 or MOV, I regard that as an editing choice — if editing on Windows, choose MP4; if editing on Mac, choose MOV.

As for bitrate, I hold to the general rule that more = better. Memory cards are cheap, but recorded quality is forever -- so buy a bigger memory card if you need it, to accommodate the higher bitrate footage. 50Mbps MOV/MP4 looks better and retains better quality than 25Mbps AVCHD. On the UX180, you have even more choices; 100Mbps MOV/MP4 looks better and retains better quality than 50Mbps, etc. The only caveat, as stated before, is regarding the 200Mbps ALL-I mode in 1080p; it may or may not look as good as 100Mbps, for example.

When it comes to frame size, it's a little more complex than that. Yes, generally, bigger = better, so UHD is usually the better choice over FHD. And if your project needs to be shot in UHD or 4K, then the decision is already made for you. But what if your project is meant to be an HD delivery? As elucidated earlier, there are several considerations as to why choosing UHD may make sense even if your final project is going to be finished in FHD or SD. But it's not a hard-and-fast rule, because there are some things that FHD 1080 mode does better than UHD, and if you need those features, you may be better off shooting in FHD in the first place. Here are several examples:

Wide Angle Of View on UX90 - The widest field of view the camera can deliver (24.5mm equivalent) is found when using the 1080 FHD mode. When going to UHD, some significant cropping occurs; UHD mode has a field of view (FOV) equivalent of about 35.4mm. That's a big difference, and may make the difference between being able to get

the shot, or not. So for some situations, that field of view difference may mean it's more practical to shoot in FHD instead of UHD.

Faster Frame Rate on UX90 - The UX90 can't shoot UHD at 50P or 59.94P. On the 50Hz camera, UHD is only available at 25P, and on the 59.94Hz UX90 it's available in 23.98P and 29.97P. So what happens if you're shooting sports or live news and you really require the "live" look of 50P or 60P? The only choice would be to shoot your project in FHD instead.

Optical Image Stabilization - The cameras have very good optical image stabilization when in UHD and 4K modes. But when in FHD, it gains the benefit of Hybrid OIS. It's really rather remarkable as to how stable the camera is when the Hybrid OIS is engaged in 1080 mode. If you need the most powerful image stabilization for your particular shoot, you may find that the added benefit of the Hybrid OIS may make FHD the better choice over UHD. Then again, consider that you could always do image stabilization in post-production if you shot in UHD, and that may negate this advantage depending on how much post production you're willing to do.

Long Zooms - The UX90 has a 15x optical zoom. When used in 1080 FHD mode, you can engage the i.Zoom function, which can extend that range to effectively 25x. The UX180 has a 20x optical zoom, but when used in 1080 FHD mode you can use the i.Zoom to extend that range to effectively 30x. If you need the longest zoom function, in-camera, then this may be a factor that sways you to shooting in FHD instead of UHD. However, if you've got time in post, you can simulate this feature in post just as effectively, so the decision is really about whether you have the time to go through the post-production process to crop-in and magnify the UHD footage, similar to how the i.Zoom does.

Variable Frame Rates - The ability to shoot off-speed footage for slow-motion or fast-motion effects is only available in FHD 1080 mode. If you need to incorporate that style of footage in your project, this alone could be what makes up your mind. Do keep in mind however that if you're shooting a UHD project in 23.98P, you can gain some limited Variable Frame Rate functionality by incorporating footage shot in 29.97P, 50P, or 59.94P; when played in the timeline at the appropriate speed (29.97P @ 80%, 50P @ 48%, or 59.94P @ 40%) you'll get perfectly lovely frame-accurate slow-motion at UHD resolution.

For the UX90, this would apply only when using 29.97P footage @ 80% speed in a 23.98P timeline.

The advantages that UHD offers are generally significant enough to make it my first choice, but there are some very good reasons why the camera offers its 1080 mode, so you'll have to make that decision on a case-by-case basis on the merits of each mode and the suitability to the project at hand.

Recording Time on an SDHC/SDXC Card

How much footage can you fit on a card? That's a question that doesn't have a very simple answer, from the perspective that each shooting mode takes up a different amount of space on the card, and, furthermore, the camera uses variable bitrate recording — which means that for easy-to-encode scenes, it may take less space than you might otherwise think.

The following table should give you ballpark estimates for how much footage will fit on a card, with the understanding that these are probably worst-case estimates and real-world recordings may actually fit more footage than what is listed here — especially for the 23.98/25/29.97 frame rates in 200M ALL-I mode; you can expect that you may get more recording time in those frame rates than you'd get in 50P/59.94P versions.

Rec Format	16GB Card	32GB Card	64GB Card
4K 24P (UX180 Only)	21:00	42:00	1:24:00
UHD 59.94P/50P (UX180)	14:00	28:00	56:00
UHD 23.98/25/29.97P	21:00	42:00	1:24:00
FHD ALL-I 200M (UX180)	10:00	20:00	40:00
FHD 100M (UX180)	21:00	42:00	1:24:00
FHD 50M	42:00	1:24:00	2:48:00
AVCHD PS 1080P	1:23:00	2:46:00	5:32:00
AVCHD PH 1080i & 1080P	1:36:00	3:12:00	6:24:00
AVCHD HA 1080i	2:10:00	4:20:00	8:40:00
AVCHD HE 1080i	7:02:00	14:04:00	28:08:00
AVCHD PM 720P	4:24:00	8:48:00	17:36:00
AVCHD SA 480i & 576i	4:18:00	8:36:00	17:12:00

Optimizing for Low Video Noise

"Noise" in a video signal is a random variation in the color and intensity of each pixel. This random variation is very small compared to a strong signal (i.e., a bright part of the image), but becomes relatively more apparent as the signal level decreases (i.e., in dark parts of the image). In general, a properly-exposed image will show much less noise than an underexposed image!

Depending on the settings of the camera, noise can be minimal, or quite invasive (just try Super Gain at 36 dB for an example). A small amount of noise is usually present in all scenes, but there are steps you can take to minimize the appearance of the noise. By taking advantage of the various menu settings, as well as employing proper lighting, you can reduce the appearance of some of the image noise.

The most important determining factor for how much noise is in the image is the electronic gain level. The higher the gain, the more noise will be in the image. Now, sometimes it's easier to just crank up the gain to get a shot in challenging lighting — but just understand that doing so can raise the noise level slightly, moderately, or even outlandishly, depending on how much gain you add. If you need the picture brighter, adding light to the scene will do much more for the quality of your picture than gain ever would, because adding too much gain can cause the image to get very noisy, muddy and soft. Adding light will give you a cleaner picture and adequate light can help to suppress noise that might otherwise have been there. Underexposing video leads to increased noise in the signal; giving the camera proper exposure will clean up the signal nicely. A camera is a light-gathering device, so giving it enough light will help it perform its best. A camera feeds on light – feed it, and it will reward you with gorgeous imagery; starve it and you may not be as pleased by its results. Instead of using more gain, consider opening the iris more, disengaging any neutral-density filters, or using the slowest shutter speed that is practical. In fact, for the most noise-free image, if you have enough available light to afford it you may want to consider setting the camera to negative gain values. If you enable the EXTENDED SENSITIVITY menu option, it will allow you to lower the gain to -1, -2, or -3 dB.

If you're using a UX180, you have one other option: before reaching for the gain, consider using the HIGH SENS mode; HIGH SENS doubles the sensitivity of the image and employs significant noise reduction to cancel out the increased noise that would otherwise come with using gain. The

HIGH SENS is a simple and easy solution to double the camera's sensitivity without notably increasing the noise; in fact, HIGH SENS might actually even reduce the noise level, since it employs quite a bit of noise reduction. The potential drawback is that HIGH SENS's noise reduction might cause a loss of fine detail in the image.

Another way to really clean up the noise is to shoot in FHD (1080) instead of UHD. When in FHD mode, the camera averages multiple UHD pixels together to create each HD pixel, and the noise gets averaged out in the process. FHD mode is notably cleaner than UHD footage in terms of noise performance because of this; you can get away with about 6dB of gain in FHD and still have comparable noise performance to UHD at 0dB of gain.

As for menu settings, the most obvious one is the NR CONTROL setting. Raising the NR CONTROL setting will add more noise reduction processing to the signal, lowering the visibility of the noise. There's no free lunch however; noise reduction can have side effects, such as "ghosting" in dark shooting scenarios, or a loss of fine detail. There are good reasons why the NR CONTROL provides for lowering as well as raising the noise reduction level. But if you're seeing more noise than you like, the NR CONTROL is one simple way to address it.

DETAIL LEVEL controls can have a large impact on the perception of noise. Lowering the MASTER DETAIL LEVEL and V DETAIL LEVEL can mask the visibility of noise. It doesn't really change the presence of noise itself, but the higher detail level settings will actually accentuate the edges of the noise, and can even draw edge-enhancement outlines around the noise, making it much more noticeable. The lower you set the detail level, the less visible the noise will be (but, of course, the softer the image will look, too).

Hand in hand with the detail level controls is DETAIL CORING. Coring is designed to suppress edge enhancement on noise. What this means is, the higher you turn up DETAIL CORING, the less visible noise you'll see in your picture, but it really depends on your MASTER DETAIL and V DETAIL LEVEL settings. If the detail levels are very low, then there won't be any edge enhancement happening on the noise, so there won't be anything for DETAIL CORING to do. So when you have the MASTER DETAIL really low (say, -25 or so) then you really won't see much if any effect on noise from DETAIL CORING no matter what you set it to. But the higher you set the MASTER DETAIL, the more effect DETAIL CORING will have in suppressing the visibility of the noise. DETAIL CORING can't

tell the difference between fine high-frequency image detail and general noise though, so setting coring up to a high level may reduce the apparent sharpness of high-frequency detail too, and can cause an “oil painting” type of effect on areas where there’s not a lot of contrast, so - use DETAIL CORING judiciously.

Also, the SKIN DTL function can help smooth out a little bit of noise in skin tones. It works just like DETAIL CORING but very mildly, and only on colors that it perceives to be skin tones (the general idea being to smooth out skin blemishes.) If you’re aiming to minimize noise as much as possible, enabling SKIN DTL may help a little.

Next, take into account the gamma curve. The different gamma curves lend different looks to your footage, and they all also play a part in how perceivable noise may be in the footage. Since noise is principally found in the deeper shadow tones, it stands to reason that gamma curves that enhance or stretch the shadow tones will, in turn, enhance the visibility of image noise. If the camera’s gamma stretches up the shadows, you can expect that any noise in those shadows will be stretched up too. HD, SD, FILMLIKE 1, FILMLIKE 2, and CINELIKE-D all show noise in the shadows; CINELIKE-V and FILMLIKE 3 both suppress the shadows and can result in cleaning up the shadow noise. If it’s noise in the highlights that you’re concerned with, FILMLIKE 2 cleans up highlight noise notably. As always, you’ll have to experiment to determine what you prefer; there’s more to choosing a gamma curve than its influence on noise, but as a point of reference, the gamma curves (and specifically their treating of the shadow areas) can have an impact on where the noise sits in your images.

The MASTER PED can have an effect on noise, especially when it’s raised higher. The higher the MASTER PED, the softer the contrast, and as the shadows get flattened and raised, the noise may become more visible.. But lowering the MASTER PED a few notches can clean up the noise in the blacks and darker shadows, at the risk of making it more visible elsewhere, and taking it down too far will result in losing shadow detail and crushing down the dark tones in the picture, so don’t go overboard with lowering the MASTER PED.

In a similar vein, the BLACK GAMMA adjusts the intensity of the shadow regions, and as you raise or lower the shadows, you’ll change the visibility of noise in those shadows.

Finally, if you want to avoid noise, you should avoid the DRS function. Stretching the dynamic range of the camera can be very handy, but like gain, you should only use it when absolutely necessary. The DRS function selectively applies gain throughout the entire image, including as much as +12dB of gain to the darkest areas when used on DRS level 3. Using DRS on level 1 may add only +3dB of gain, but DRS level 3 might add as much as +12dB, and that can result in notable amounts of noise added to the picture! DRS should be used with caution and only when necessary.

Also, be sure to do an Automatic Black Balance frequently. Black Balancing may help the camcorder's sensor to sort out, minimize, and mask noise in the darker regions. To do a black balance, just hold in the white-balance button long enough to start the black balance process.

Synchronizing Timecode in a Multi-Camera Shoot (UX180 Only)

The UX180 offers the ability to synchronize timecode to another camera, or you can also sync to an external timecode generator, timecode slate, or other device that sends or receives LTC timecode.

This isn't, however, a full-fledged jam-sync capability. The UX180 doesn't have a general-purpose timecode input/output port. Instead, it has a dedicated TC PRESET IN/OUT port which can be temporarily enabled to function as a timecode output port, or as a timecode input port. The UX180 doesn't have genlock capability either, so precise perfectly-synchronized video is not possible. Instead, you can synchronize the two cameras' free-run timecode values, and then disconnect the cable. The two cameras should stay generally in sync, although there is the possibility that some sync drift may occur the longer it has been since you synchronized the devices.

The key to synchronizing timecode is to use FREE RUN timecode. For most normal recording situations, it's typical to use REC RUN. However, for synchronizing multiple cameras, FREE RUN is the only way to maintain synchronization if one of the cameras stops recording. With FREE RUN, all of the cameras should maintain sync (or extremely close to sync) no matter how many times a camera operator stops or starts recording. This can make matching up takes in the edit bay easy and effortless.

You'll designate one camera as the "master timecode" camera, and all other cameras will sync to the master camera. Make sure the cameras

(or timecode slate or decks or whatever devices you're synchronizing) are set in FREE RUN mode, they all need to be set in the same recording format and frame rate (i.e., all need to be in 1080/50p or all need to be in 720/60p or whatever format you're using). If you're using a 59.94Hz camera, ensure all the cameras are set equally to either DROP FRAME or NON DROP FRAME (not applicable to 50Hz cameras). In short, make sure that the recording modes and timecode settings are identical among all the cameras or devices.

If you're using the UX180 as the timecode source, first ensure that it is in camera mode, not playback. In the RECORDING SETUP menu, set TCG to FREE RUN and configure the TC PRESET to whatever you want it to be (typically you'd set it to match the current time of day, or you might set it to 0:00:00:00 at the start of each shoot day.) Then go to the EXT TC LINK menu option and choose MASTER. At that point, the UX180 will start broadcasting standard LTC timecode on its TC PRESET IN/OUT port. Connect the other cameras or devices to it using a double-shielded BNC cable (the manual recommends a 5C-FB cable), and synchronize their timecode to the timecode the UX180 is broadcasting. When all are synchronized, exit the menus and disconnect the cable.

If you're synchronizing the UX180 to another camera or device, configure that other camera so that it is transmitting LTC timecode through its TC OUT or TC PRESET OUT ports, and connect it to the UX180's TC PRESET IN/OUT port. Configure your UX180's SYSTEM MODE->REC FORMAT to match the master timecode source, especially in terms of frame rate. In the RECORDING SETUP menu, set TCG to FREE RUN and set the DF menu item to match the master timecode source's settings for Drop Frame or Non Drop Frame (note: when shooting 23.98p/24p, the setting will be automatically set to NDF and you cannot change that; the UX180 only operates in NDF mode when shooting 23.98/24p). Finally, go to the EXT TC LINK menu option and choose "SLAVE". (Note: you'll have to disable Variable Frame Rate and Super Slow Recording and Interval Recording, or you won't be able to choose "SLAVE".) With the master camera (or slate or other device) connected and outputting timecode, you just have to press the RESET/TC SET button (up by the LCD panel) and the UX180 will read the incoming timecode and set its TC PRESET to match. Then disconnect the cable and continue on with your shoot; the cameras should stay basically in sync although, as noted before, you may encounter some timecode drift throughout the day.

Also, be aware that it's more difficult to get an exact timecode match when shooting 24P; 24P really only sets its timecode to multiples of 0 or 4, so if you synchronize when the master camera is at a timecode of (for example) 00:00:00:24, then it may sync perfectly. But, if the master camera's last timecode digit were on neither 0 nor or 4 (for example, 00:00:00:22), then the timecode on the UX180 may be off by about 2 frames.

Absolute frame accuracy is not guaranteed when using the timecode sync method. It should be very close throughout the day, but you cannot expect it to maintain perfect frame alignment among multiple devices when all the devices are running on their own internal clocks. If you notice timecode drift happening, you can always re-sync by re-attaching the cable, configuring the cameras for master/slave, and pressing the TC SET button again.

Variable Frame Rates

The UX cameras allow variable-frame-rate shooting in 1080p MOV/MP4 mode. The variable frame rates provide you with a wide variety of creative choices.

The available frame rates change based on whether you're using the camera in 50Hz or 59.94Hz, and what the base frame rate is (i.e., whether you're recording in 23.98, 25, or 29.97 frames per second). In all cases you get a range between 2 and 50 frames per second (50Hz camera) or between 2 and 60 frames per second (59.94Hz camera), but not every frame rate is available in all modes; there's a selection of 9 or 10 frame rates to choose from depending on what your recording frame rate is set at: in 25P or 29.97P there are 9 frame rates to choose from; in 23.98P there are 10 to choose from.

In addition, if you're using a UX180, there's an additional frame rate available in each mode, called "SUPER SLOW." When recording 25P on a 50Hz camera, the SUPER SLOW frame rate is 100 frames per second; when recording 23.98P or 29.97P on a 59.94Hz camera, the SUPER SLOW frame rate is 120 frames per second.

Why so many choices, and when and why would you use them? Each is suitable for a certain specific effect (although, of course, creative users will find other ways to take advantage of the choices offered).

To start with understanding why variable frame rates even matter, let's reference back to how movie camera film gets shot. In film, slow motion is

shot by running the camera at a faster frame rate. Film normally runs at 24 frames per second (fps), but for slow motion the camera operator might shoot it at something like 48 fps. When those 48 frames are played back at the 24 fps speed, it'll take twice as long to play back, so everything will be moving at half speed, giving that superb film-style slow-motion look. Shooting at a faster frame rate is called "overcranking," because in the early days cinematographers used a hand-crank to drive the camera, and for slow-mo they would actually crank the film faster. Similarly, shooting at a slower-than-normal frame rate results in a "fast motion" effect – think of the Keystone Kops or an old Charlie Chaplin movie and you'll get the idea. If you only shoot 12 frames in a second, but you play those frames back at the 24fps speed, it'll only take 1/2 second to play back action that took a full second to record – accordingly, the motion will be twice as fast as normal. This is referred to as "undercranking."

Using actual overcranking and undercranking can yield dramatically smoother, superior off-speed effects in your productions. Prior to the introduction of genuine over/undercrank, video shooters had to try to synthesize slow motion effects in their nonlinear editors. This led to frames being blended together, footage being de-interlaced, new frames being interpolated, motion artifacts, and all sorts of other compromises that resulted in lower-quality footage and a less-than-filmlike slow motion experience. With the true overcranking and undercranking potential of these cameras you no longer have to settle for those types of compromises; now you can shoot genuine frame-accurate film-style slow motion effects (or fast-motion effects).

I will discuss some examples of what many of the frame rates might be useful for, and ways that you could use them. This is not by any means an exhaustive list, there are likely many, many more uses where each frame rate could be used, but this listing will give you a basic overview. Each of the choices listed below assumes that you're going to be playing back the footage at the film-look rate of 23.98 fps (or 25fps for the 50Hz mode).

2 fps: Extreme fast motion, also for time lapse type photography. If you wanted to record a city street at night, with cars smearing by and leaving trails of taillights, 2fps at 1/2-second shutter would be an excellent choice for that.

12 fps: Usable for fast motion, twice as fast as normal motion. In the indie hit film "El Mariachi", director Robert Rodriguez made use of 12fps for fast-motion scenes such as the hotel front desk clerk scrambling to the telephone to make a call.

20 fps: 20 fps is a fast-motion effect that's not nearly as exaggerated as 12fps is, but it's fast. If you wanted to show someone running extremely quickly, 20 fps might be a good choice for that. It starts to push the bounds of what the audience can believe is "real," but it's very fast motion without being exaggeratedly fast. The 50Hz camera equivalent would be 21 fps.

22 fps: This is a subtle fast-motion effect. 22 fps is a very popular frame rate for karate action movies – shooting at 22 fps and playing back at 24 fps makes motion look very fast but completely believable. Shooting a car chase or a fight scene at 22 fps will lend an added edge of excitement and action to your scenes. The 50Hz mode equivalent would be 23fps.

24 fps: This is the standard movie film speed. Shooting at 24 fps and playing back at 24 fps gives your footage the temporal feel of motion picture film. This is the speed you'd normally shoot all dialogue scenes and "normal action" scenes. The 50Hz mode equivalent would be 25fps.

26 fps: This frame rate can add a subtle, subliminal slow motion effect to your footage, but the effect is very mild. Things moving slower than normal can be perceived as being "larger than life" – if you want to add a bit of elegance and grandeur to your scene, but don't want it to be obvious that you've done so, 26 fps can add that additional element of drama. The 50Hz mode equivalent would be 27fps.

28 fps: This is a mild slow motion speed. It's a little subtle, but noticeable. It's the first of the "real" slow motion speeds. The 50Hz equivalent would be 30 fps.

36 fps: At 36 fps, the scene is obviously slow motion. Action takes 1.5 times as long to play out as it took to shoot it. 36 fps is as slow or slower than many movie cameras can shoot. The 50Hz mode equivalent would be 37 fps.

48 fps: Full-fledged slow motion. 48 fps makes everything take twice as long to play back as it did to shoot it. The 50Hz equivalent would be 50 fps.

60 fps: Even slower slow motion. 60 fps is suitable for shooting explosions or dramatic slow motion scenes.

120 fps SUPER SLOW: Super-ultra slow motion. In 120 fps, motion takes about five times as long to play back, as it took to shoot it (if shooting

in a base frame rate of 23.98p). Even if your main project is set to 29.97p, 120 fps footage will still be extremely slow motion, taking about 4x as long to play back as it took to shoot it. There is a compromise to achieving this frame rate though; the resolution is notably lower than it is for regular footage. The 50Hz equivalent would be 100 fps. Super Slow Rec is only available on the UX180.

Obviously, having a variety of different frame rates gives the camera operator a great degree of flexibility and creative choices. But remember that there's also an intervalometer feature. You can use that to shoot one single frame at certain specified intervals. While not quite the same thing as having more frame rates, it does give you even more options for creative interpretation in how you want to record motion.

The acquisition rate, and the playback rate, are two different things. Under normal circumstances you want them to be the same – i.e., acquire at 23.98 frames per second, play back at 23.98 frames per second, and you get real-time action. Acquire at 29.97 fps and play back at 29.97 fps, and you also get real-time action – a bit smoother than the 24fps/24fps sequence, and less film-like, but still real-time. Acquire at 59.94 frames per second and play back at 59.94 frames per second, and you also get real-time motion. 59.94fps looks nothing like film, it looks like "video," and gives the smoothest strobe-free motion possible. In the 50Hz mode, the equivalent would be to shoot 50fps and play back at 50fps for the "video" look.

But what happens if you acquire at 60 fps and play back at 29.97fps? The result is slow motion, a 2-to-1 slowdown factor. And what if you acquire at 60fps and play back at 23.98fps? It's also slow motion, but it's even slower: it's a 2.5-to-1 slowdown factor. The same frame rate, played back at different time bases, delivers different looks to the viewer.

Selecting your time base, and selecting your acquisition frame rate, are therefore interconnected when you decide what type of look you're choosing for your program. With 23.98P you'll have film-like footage, and the most wide-ranging slow-motion capabilities. With 29.97P you'll have hybrid film/video footage – it'll be smoother/less stroby than 24p, but it will still have some strobing and a somewhat film-ish look to it, and it'll still be capable of up to 2:1 slow motion.

Something else to consider: sound will not be recorded when you're filming "off-speed" footage. What that means is: when shooting 23.98P, sound will only be recorded if you set the frame rate to 24. If you shoot at slower or faster frame rates, no sound will be recorded. The same holds true for 25p at 25 fps, and 29.97p at 30 fps — sound is only recorded when the selected frame rate matches the recording frame rate. Don't worry about

remembering this though, a warning will be displayed in the LCD display to tell you when audio won't be recorded.

There are some limitations to using variable frame rates. First and foremost, this feature is only available in 1080p mode when recording 23.98, 25, or 29.97 fps, in MP4 or MOV at 50 megabits. You cannot select VFR when recording 4K, or UHD, or AVCHD, and you cannot select it when recording 1080i. On the UX180, you can't choose 100M or 200M ALL-I either; it has to be set to 50 megabit recording, at 23.98, 25, or 29.97 frames per second.

Also, when shooting SUPER SLOW (100 or 120 fps), there is a limit on the maximum possible recording time. The maximum recording time depends on your base frame rate; in 23.98p the maximum recording time is 2 hours; in 25p or 29.97p it's 2.5 hours.

As mentioned before, there is also a noticeable drop in resolution when choosing SUPER SLOW. There is no drop in resolution for the other frame rates though.

Finally, you cannot record the SUPER SLOW frame rates externally on an HDMI or SDI recorder. The SDI and HDMI outputs are capable of a maximum of 60 frames per second; if you set the camera to record 120 fps, the monitor outputs will show every other frame (thus lowering the actual output to 60p). You won't see the slow motion effect during monitoring, you can only view it properly during footage playback of the internal recordings.

HDMI vs 3G-SDI and HD-SDI (UX180 ONLY)

The UX180 offers two digital video output ports: HDMI 2.0, and 3G-SDI. What's the difference, and what is each best suited for?

First, the similarities—both HDMI and 3G-SDI will output a fully uncompressed 8-bit 4:2:2 image, suitable for using with an external monitor or recording unit. The data coming out of these ports is digital, uncompressed, full-raster high-definition footage (either 1920x1080 or 1280x720), using 8 bits of color data embedded in a 10-bit depth. Also, both HDMI and 3G-SDI can output embedded audio and timecode, and record start-stop flags. So the question of which one to use, for which purpose, isn't really about the quality of the video image, at least as far as 1080p/1080i and standard definition go.

The SDI port is a 3G-SDI port. It is fully compatible with HD-SDI, but 3G-SDI is an extension to HD-SDI that allows for transmitting full 1080/59.94p

(and 1080/50p) video. HD-SDI is limited to 1080i, but 3G-SDI offers everything HD-SDI does and extends it to include 1080p at 59.94p and 50p.

HDMI has traditionally mainly been used in consumer devices, and almost exclusively for monitoring. Consumer televisions, for example, will have HDMI input, but they won't have SDI inputs. SDI is routinely found on professional video monitors, and on professional video recording devices. SDI uses a substantially more robust connector, with a locking mechanism to keep it from becoming accidentally disconnected. For this reason, if you're recording 1080 FHD, I recommend that if you're using an external recording device (such as a Convergent Design's Odyssey 7Q+™ or Video Devices' PIX-E5™), it would be preferable to use the SDI output to connect to that recorder. Even though many of those recording units do offer HDMI input, the SDI is generally the much better choice for FHD.

The HDMI port does something the SDI port cannot do however: the HDMI port is the only way to output 4K or UHD footage. 3G-SDI is limited to 1080P and cannot output 4K or UHD. The HDMI port is fully capable of outputting every format that the camera can record, at full resolution and full frame rate, and in 4:2:2 color (4:2:0 for UHD 50p/59.94p). The HDMI connector is far from ideal for connecting to a recorder, but — if you need to monitor or record externally, the HDMI port is the only way to monitor or transmit UHD or 4K footage. If you're using the camera in UHD or 4K mode, and are monitoring through the SDI port, the camera will automatically perform a very high-quality downconversion to 1080p for SDI output.

If you must use HDMI for a recorder or connecting to a field monitor or other mission-critical purpose, consider investing in a way to hold the cable more securely. Some manufacturers offer locking clamps that will hold an HDMI cable firmly in place; an example would be the XTender for the Odyssey 7Q+.

Note that the camera's HDMI port is an HDMI 2.0 port. As of the time of this writing (December 2016) there are many monitors and recorders on the market that use HDMI 1.4 connectors. HDMI 1.4 supports 4K and UHD up to 29.97 frames per second, but cannot handle UHD at 50p or 59.94p. The camera is capable of transmitting that signal, but the recorders and monitors are incapable of receiving it. The UX180 is backwards compatible with HDMI 1.4 and will work with HDMI 1.4 monitors and recorders, but you won't be able to send UHD 50p or 59.94p to them because they are

incapable of receiving that signal. You can configure the UX180's output to limit itself to no more than 29.97p output; that will make it fully compatible with HDMI 1.4 devices.

There are a couple of limitations to the HDMI output that you need to be aware of; both are encountered when the camera is in UHD 59.94P or 50P mode. First, the camera is incapable of outputting 4:2:2 when set to UHD 59.94P or 50P; the HDMI output changes to 8-bit 4:2:0 in that case. It is always 8-bit 4:2:2 in all other recording modes (including 4K and UHD 23.98p/25p/29.97p), but specifically in UHD 59.94P and 50P, it can only output 8-bit 4:2:0.

Second, the camera cannot simultaneously record UHD 59.94P/50P and also output UHD 59.94P/50P. It can maintain a live output of UHD 59.94P/50P when in standby, but not while also recording. When you start recording, the HDMI output will be downconverted to 1080p for the duration of the recording, and automatically switch back to UHD when recording is finished.

Finally, the UX180 is capable of multiple outputs, but it can't support having the SDI and HDMI active at the same time. You have to choose which one to activate in the OUTPUT SETUP menu.

Using a Hard Disk with the Camera

The UX cameras offers a "Host Mode" that lets you plug in an external media device such as a hard disk. The camera can take control of that device and copy files to it, or play files from it. This functionality is only available in playback mode. When in camera mode, the USB port will not control a drive, but it can be used with an optional wireless network adapter, or you can use it to power a device (such as charging a phone)

As an example of how Host Mode works, the camera has the ability to power and take control of an external USB hard disk (either USB 2.0 or USB 3.0), format that disk and copy the contents of its SD cards over to the hard drive, and it can also play back clips that are on the hard drive — all without needing a computer anywhere along the way. If the drive is a portable, bus-powered drive, the camera can supply bus power to it. If the drive is a larger AC-powered type, you'll need to plug that drive's power supply in to be able to use it. The camera can only power devices that are designed to be powered through a single USB port.

There are some limitations to the hard drives you can use; they can't be smaller than 32 gigabytes, or larger than 2 terabytes. Not every drive is going to work; Panasonic recommends you go to http://pro-av.panasonic.net for more info on using external media devices. And not every device will work; for example, an Android phone will not connect as a media device for offloading, so you really do want to stick with conventional hard drives. The hard drive needs to have only one partition on it, and it has to be formatted either FAT32 or exFAT; you can't use NTFS or MacOS-formatted drives. Finally, the hard drive needs to be directly connected to the camera; don't try to connect through a USB hub as that won't work.

The best format for a hard drive to use with the UX camera would be exFAT. exFAT is compatible with both Mac and Windows systems, and it provides for large file sizes. When the camera formats a hard drive, it formats it in exFAT format. And, crucially, you can only copy SDXC cards from the camera to an exFAT drive; you can't copy those to FAT32 drives. This may not be a problem if you only use SDHC cards (which are themselves formatted FAT32), but if you're using SDXC cards, you're going to want and need exFAT.

To use a hard drive with the camera, there are two menu settings you need to set: in the OTHER FUNCTION menu, set USB MODE to ON, and set USB MODE SELECT to HOST. Then plug in your drive, turn on the camera, and press the THUMBNAIL button to go to playback mode.

There are four basic functions you can perform with an external drive: you can format it (in exFAT format), you can copy files to it, you can play back files from it, and you can eject it.

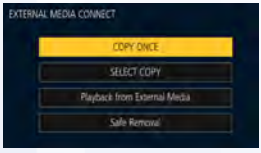
With a FAT32 drive you can copy SD or SDHC cards to the drive, and play files back from it. With an exFAT drive you can do the same, but you can also copy SDXC cards to an exFAT drive. You can't copy SDXC cards to a FAT32 drive because the file size limit on an SDXC card is much bigger than a FAT32 drive can handle, and SDXC cards are formatted as exFAT.

Copying files can be done in two ways: a "copy once", or a "select copy".

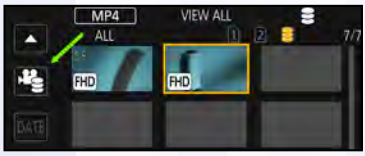
Copy Once will copy up to the entire contents of your memory card over to the drive, but it will only copy files that it hasn't previously copied. The first time you copy a card to any drive using Copy Once, it will copy the entire contents over. The next time you copy that same card to

any drive, it will only copy any clips that have not been previously copied. It is not doing a comparison; it doesn't check the drive to see if those clips already exist on that particular drive; rather it knows internally that clips have been copied to some drive before (even if they weren't copied to this particular drive!) so it won't copy them again. So with this mode, any time a clip gets copied to any hard drive anywhere, it's marked as having been copied. And Copy Once will never copy that clip again, even if you reformat the drive you copied the clip to. It doesn't check the drive, it only copies clips that have never been copied anywhere before. Now, if you only ever use the one same drive to copy to, and you never reformat that drive or delete clips off the drive, then this works just fine, and will be the fastest way to copy and keep that particular drive updated. Each time you tell it to copy it will only copy clips that are newer than the last time you copied. But, again, this workflow is only practical if you're always using the same drive, and you never delete files from that drive. Once you use a new drive, the camera will not know to copy all the previous clips over! This mode is optimized for speed, but for safety's sake I'd recommend using SELECT COPY instead.

Select Copy will copy either all the clips (or scenes), or you can pick and choose which scenes to copy over, and it can copy from memory card to memory card, or from memory card to external media (hard disk). If you choose "VIDEO & PICTURE", it will copy every video clip and JPEG photo from the memory card onto the hard disk. If you only want to copy certain clips over, choose "VIDEO" (or "PICTURE") to choose which scenes to copy. You'll have to know what recording format the particular clip was recorded in (MP4, MOV, or AVCHD) in order to find the thumbnail for that particular clip.



When the hard drive is first attached, the camera will present a menu with four choices (copy once, select copy, playback from external media, or "safe removal" to eject the drive). Once you've selected your choice, it will then take you to the thumbnail screen. If you want to return to these options, you can get there by pressing the MENU button, and choosing COPY (for copy once or select copy); you can choose to play back from the SDXC card or hard disk by choosing the movie camera or hard disk icon in the middle left side of the screen.



To eject the media or drive, press the "USB cord" button at the bottom center of the SELECT MEDIA screen. You should always safely eject the hard disk; don't just pull out the USB cable to remove the hard drive without soft-ejecting it first.

Benefits of Using an External Recorder

Internally, the UX cameras record in many different frame sizes and recording formats (MP4, MOV, and AVCHD), but all the recordings share one property: they're all 8-bit 4:2:0. And while the UX cameras can't internally record 4:2:2, they can output it through their HDMI ports (and through the UX180's SDI port), so it's available to record externally.

Why 4:2:0 8-bit Internal Recordings?

One of the primary design decisions regarding the UX cameras was to make them as affordable as possible, not only to buy, but to use. In that context it was decided that the camera should use inexpensive, non-proprietary SDXC memory cards. Further, long recording times are a priority; since the UX may be used in a wide variety of recording environments and may be used for long-duration recordings (such as for events or speeches), it was determined that lower bandwidth recording would provide the best combination of long recording times and inexpensive recording media. Keeping the bitrate to 50Mbps or lower allows for over two hours of recording on a 64GB SDXC card, while ensuring rock-solid reliability.

Understanding the limitations on bitrate, the next task was to engineer a codec that delivered good picture quality while meeting that bitrate expectation. Video compression nearly exclusively uses "lossy" technology; information is discarded to reduce the data rate, and priorities are balanced to maintain the best image quality while discarding the least-important information. 10-bit and 4:2:2 are both desirable elements to have, if all things were equal and a large bitrate were possible to suitably encode those aspects of the image. But within the context of the desire for long recording times on inexpensive media, it was determined that 8-bit 4:2:0 provides sufficient image quality for many potential uses. Professional video has used 8-bit digital encoding for decades, all DVD and Blu-Ray discs are encoded as 8-bit 4:2:0, and all HDTV broadcasts are done in 8-bit 4:2:0. 8-bit 4:2:0 can look very good. 10-bit 4:2:2 provides even more information, but

takes up substantially more space to record it, and for many recordings and many jobs, it's simply not necessary.

There are many jobs where 4:2:2, while nice, is not necessary (as evidenced by the massive body of work that's been recorded on 8-bit 4:2:0 cameras over the last twenty years). Some broadcasters and some jobs may require 4:2:2, but many don't, and for those that don't, the UX cameras provide inexpensive internal long-format record capability on commodity media cards.

4:2:2 External Output

4:2:2 recording, when given sufficient bandwidth, produces images that are more detailed, and easier to color grade, and easier to chroma key, than 4:2:0 does. 4:2:2 is superior to 4:2:0 when it can be adequately recorded (meaning, when there's enough bitrate to support properly encoding the signal, and when the recording media is fast enough to support that higher bitrate.) Recording 4K or UHD footage at 4:2:2 in high-quality intraframe encoding (such as Apple's ProRes HQ) takes up about 880 megabits per second, or around 9x as much data as the camera's internal recordings. Those recordings would be higher quality than the camera's internal codec could deliver, yes, but such recordings could never be made on an inexpensive SDXC card, and even if they could, you would only be able to record about 7 minutes of footage on a 64GB memory card.

Additionally, there are some jobs that would benefit significantly from 4:2:2 recording. Indeed, there are some broadcasters and employers that will specify 4:2:2 as a minimum requirement. For those scenarios, Panasonic has taken the approach of providing good-quality 8-bit 4:2:0 recordings internally, and 8-bit 4:2:2 output for use with external recording devices.

Renting or buying an external recorder can provide a way to deliver 4:2:2 footage for clients who require it. There are many recorders on the market; generally they support Apple ProRes and/or Avid's DNxHD codec, at 10-bit depth and 4:2:2 color sampling. While the UX cameras can't output 10-bit data, they can output an 8-bit 4:2:2 signal embedded in a 10-bit word, which means the external recorders can record their signals.

The UX180's HDMI 2.0 output provides UHD video at 50 or 59.94 progressive frames per second with full resolution and 4:2:0 color sampling. When shooting UHD at 23.98, 25 or 29.97 frames per second, the output is 8-bit 4:2:2 (on both the UX180 and UX90). The UX180's 4K/24p is also output at 8-bit 4:2:2.

Using an external recorder allows you to use solid-state disk drives or other recording media that can handle the higher bitrate of UHD 8-bit 4:2:2 data.

Additional Benefits To An External Recorder

I have had the opportunity to use a Convergent Design Odyssey 7Q+, and a Sound Devices PIX-E5H. I have found that these types of devices make fantastic companions to the UX cameras, offering benefits far beyond just the ability to record. The nature and design of the external recorder provides alternatives and workarounds to shortcomings or design compromises presented by the camera itself. Even if you weren't planning on recording externally, the benefits offered by these external recorders (and by similar non-recording monitors) may smooth over some of the limitations of the camera itself.

Note: There are several other external recorders on the market. I have not had the chance to test or experience all of them personally, so in this article I am making reference to the ones that I have direct experience with. Other products may provide similar, equal, or even better functionality than the ones I've tested. Additionally, these types of products frequently receive firmware updates, which may add additional features or improve existing features. Definitely check with the manufacturer of any recorder you may be interested in buying to see what the current state of features and firmware are.

As said before, the benefits to using one of these external recorders are numerous. First, you gain an external monitor. External recorders such as the Convergent Design Odyssey 7Q+ and Sound Devices PIX-E5H include their own monitors, which give you an additional monitor that can be used on-camera or as a director's monitor. Normally, just having a second monitor on set can be enough of a bonus to warrant its purchase, but in the case of the UX cameras it pays additional benefits; since the on-camera LCD is a touchscreen it really needs to be dedicated to the camera operator, and isn't as convenient for the director or other set personnel to use. Second, the UX cameras' LCD is really only viewable from directly behind the camera; an external monitor can be positioned for anyone to see. Third, external monitors may be bigger, even significantly bigger, than the camera's 3.5" LCD. The PIX-E5H is significantly bigger at 5" and offering much more screen area; the Odyssey 7Q+'s monitor is substantially bigger; at 7", it offers 4x the viewing area of the camera's LCD.

These external monitor/recorders usually include a wide variety of exposure tools that can be used while recording. In the case of both the Odyssey 7Q+ and the PIX-E5H, they offer waveform monitors, vectorscopes, histograms, RGB parades, and false color exposure systems. The waveform monitors and vectorscopes on these recorders far exceed the UX180's built-in monitors. Furthermore, the camera limits what can be on the display when using its built-in tools; when the waveform or vectorscope is displayed, no other camera information can be displayed. That means you can't see the iris, or shutter speed, or focus distance, or other information, when using the camera's built-in waveform or vectorscope. That restriction is lifted entirely when using the external monitor/recorder. You can have the full camera readouts on the camera's LCD, and a full-screen, highly-detailed waveform monitor on the external monitor. Additionally, both products allow you to change the magnification of the vectorscope, something that is extremely helpful when using DSC Labs' line of professional color charts. I use DSC Labs' Chroma Du Monde color charts, and they require a vectorscope set at 2x gain. The camera's internal vectorscope is fixed at 1x gain, which means the charts are less useful when relying on the camera's own vectorscope, but the external monitors provide for adjustable scope magnification, including the necessary 2x. On top of that, the vectorscope on the Odyssey 7Q+ is simply a breathtakingly gorgeous scope, extremely detailed and vastly superior to the in-camera vectorscope. The in-camera vectorscope does handle the basics, but the Odyssey's scope is simply in a different class by itself. Both recorders offer full-screen waveform monitors and full-screen vectorscopes, and the PIX-E5H also offers a 4-way display where the vectorscope, waveform monitor, histogram, and display monitor are all shown simultaneously.

Another area where the external recorder can be very helpful is in focusing, especially while recording. The UX cameras have a simply fantastic expanded focus assist tool but, unfortunately, it is not available while recording. This limitation can be easily overcome with the use of an external monitor (with or without recorder). Both the 7Q+ and PIX-E5H offer red focus peaking, and expanded focus assist, while the camera (or the external recorder) are recording. The PIX-E5H (as of the current firmware) offers a 2x or 4x magnified view, and the Odyssey offers 1:1 and 2:1 magnification of the full screen, and it can magnify a window on the screen at ratios of 4:1, 6:1, 8:1, 10:1, all the way up to 12:1. Suffice it to say, pinpoint pixel-perfect focus is easily achievable with external recorder/monitors such as these, even during recording.

Yet another way the external recorder can expand on the camera's functionality is in audio recording. The camera has an excellent audio section with two XLR inputs. The camera embeds its audio into its HDMI video feed (and on the UX180, into its SDI video feed too), and the recorders record that embedded audio. Both of the external recorders I've used feature 3.5mm stereo audio input jacks that can be used instead. Additionally, the PIX-E5H offers an additional XLR module that provides its own set of two XLR inputs.

Lastly, the external recorders may produce footage that's easier to edit on some computers. The external recorders frequently use an intraframe codec (such as Apple's ProRes or Avid's DNxHD); intraframe codecs are generally faster and easier for a computer to process than long-GoP codecs (such as the camera's internal .MP4 or .MOV or AVCHD). You may find that external recordings are easier to edit and that your computer is more responsive and able to sustain a faster frame rate of playback using the external recording, than would be possible from the camera's internal recordings. You do pay a price for this, in that the external recordings are around 9 times as large as internal recordings would have been; however, the external recorders typically use high-speed SSD (Solid State Disk) drives that can sustain the necessary data rates. Both the Odyssey 7Q+ and the PIX-E5H support removable drives that can easily be attached to a computer through a USB 3.0 connection.

Limitations On External Recordings

There are a couple of situations to be aware of when using an external recorder. In general, the benefits are substantial, but there are some things that need to be taken into account.

First, recording the UX180's UHD/59.94P and UHD/50P may not be possible, depending on the recorder's hardware. All of the recorders I've used or researched use HDMI 1.4 input ports, and HDMI 1.4 is not capable of UHD 59.94P or UHD 50P input. HDMI 2.0 is required to handle UHD footage at 50P or 59.94P. An HDMI 1.4 port is capable of handing UHD up to 29.97P, but it cannot handle 50P or 59.94P. This is a hardware limitation, and something that cannot be solved with firmware. If you need the ability to externally monitor and record UHD footage at 50P or 59.94P, you'll need to get a monitor/recorder that has an HDMI 2.0 input. If you're working with an HDMI 1.4 recorder, the UX180 has a feature that can limit the HDMI output port to keep it legal with HDMI 1.4 recorders: you can use the HDMI UHD OUTPUT LIMIT function to

restrict the HDMI output to formats that are compatible with HDMI 1.4 devices.

Second, understand that the UX180's 3G-SDI port cannot transmit UHD footage. The 3G-SDI port is capable of a maximum of 1080/59.94P. In order to handle UHD/59.94P, it would need a 12G-SDI port, and that is not what it has. So if you want to use an SDI connection to an SDI recorder, the highest-quality signal you will be able to utilize is 1080/59.94P (or 50P, of course).

Third, there are limitations when using UHD at 59.94P and 50P. The camera outputs UHD 8-bit 4:2:0 when operating at 59.94P or 50P frame rates. There is no possibility for 4:2:2 UHD at 59.94P or 50P. Again, since there are (at the time of this writing) few if any recorders that handle UHD 59.94P or 50P, that isn't currently much of a problem, but may become more of a concern when newer HDMI 2.0 recorders appear.

Configuring For External Recording

It is true that you could just plug in an external recorder to the HDMI (or UX180's SDI) port and start recording, and that would work, but there are some settings you can make that will let the camera work better with an external recorder, and other settings that may optimize the quality of your external recordings or the interaction between your camera and recorder.

First, for configuring the camera to work with an external recorder, the relevant settings are the HDMI TC OUTPUT, REMOTE REC, REMOTE REC LINK, and assigning AUTO REC to a User Button. Set REMOTE REC to ON. If you're using HDMI, you'll also need to set HDMI TC OUTPUT to ON. If you're planning on recording both internally and externally, set REMOTE REC LINK to ON. With this configuration, the camera will record to its internal memory cards and also send record signals out its HDMI (or theUX180's SDI) ports to trigger an external recorder to start (or stop) recording every time you press the red RECord buttons on the camera. Finally, if you're planning on recording only externally (with no internal recording at all), set REMOTE REC LINK to OFF, and assign AUTO REC to one of your User Buttons. In this configuration the camera's RECord buttons won't work; you trigger recording on the external recorder by pressing the AUTO REC User Button.

Disabled Menu Items and "Invalid" User Buttons

When navigating the menus, occasionally you'll come across a menu item that's grayed out and cannot be changed. When a menu item is disabled, it's letting you know that that particular function is disabled due to some other camera setting or mode. It means that you'd have to change some other menu item before the disabled menu item becomes functional again. It does not, however, mean that whatever is displayed in gray is "in effect" – rather, in fact, it means that the whole concept of that menu item is not relevant to your current shooting circumstances. As an example: in the SYSTEM MODE menu, there's a menu item called "ASPECT CONVERT". That menu item has choices of SIDE CROP, LETTERBOX, and SQUEEZE. Those choices are only valid, and only relevant, if you're shooting in the standard-definition AVCHD SA recording mode. When you have the recording format set to any high-def, UHD, or 4K mode, the "ASPECT CONVERT" menu option becomes disabled. Why? Because it's not active, and it's irrelevant – you're not currently shooting standard definition, so why would it matter what the standard-def aspect conversion factor was set to? One thing you can be certain -- in high-def or UHD, the image will always be recorded at 16:9, so even though the ASPECT CONVERT menu item might say "SIDE CROP" next to it, your footage will definitely not be cropped on the sides!

Accordingly, the menu item is disabled, and it is irrelevant to your current shooting scenario. In order to change that menu setting, you'd have to make it relevant to the current camera mode. For the ASPECT CONVERT menu setting, that means you'd first have to put the camera's REC MODE in AVCHD, and then you'd have to change the REC FORMAT to SA. Immediately you'll see that the previously-disabled ASPECT CONVERT menu item is now white, and selectable. It is now relevant to your shooting mode, so now the menu item is active and you can change its setting.

Whenever you see a disabled menu item, it means that that menu item has no bearing on the camera's current status, but could become relevant if you changed some other setting. Furthermore, disabled menu items may show a status (such as the ASPECT CONVERT menu showing SIDE CROP). That doesn't mean that you're currently using SIDE CROP – it means that when this menu becomes re-enabled, the default will be SIDE CROP.

There are two general reasons a menu item will become disabled: either (as described above) the menu item is not relevant due to other settings in the camera, or the function is not possible due to some hardware situation

such as certain switches being set a certain way, or lack of an SD card in the camera. For example, if there are no SD/SDHC/SDXC cards in the camera, then the SCENE FILE menu's LOAD/SAVE menu item will be disabled. That menu item allows you to save your scene file settings to a memory card, or to load scene file settings from a memory card, but -- if there's no memory card, you can't do any of those functions, so the menu item gets disabled. Another example: if you set the camera to automatically control the levels of Audio Channel 1, you'll find that the AUDIO ALC CH1 menu item becomes disabled. When the camera's automatically riding the levels, it will decide for you whether it will use the limiter or not, so that functionality is taken out of your hands and, accordingly, the menu item is disabled. Change the AUDIO LEVEL CH1 menu item to "MANUAL" and you'll see that the menu item for the AUDIO ALC CH1 becomes re-enabled.

Following is a description of many of the menu items that get disabled, and what you have to change in order to enable the menu item. Additionally, there are many scenarios under which a User Button function might not work (and usually results in the word "INVALID" being displayed on the screen). This section includes reasons why the User Buttons might be invalid.

Scene File Settings

Note - the entire menu becomes disabled if Freeze Frame is active.

Load/Save: the Scene File menu is disabled when there is no memory card in the camera to load from or save scene files to.

DRS and DRS EFFECT: disabled while VFR is enabled, or Super Slow recording is enabled.

System Mode Menu

Aspect Conv: This item becomes disabled when you're shooting in any recording mode or format other than AVCHD SA. It also becomes disabled during Freeze Frame.

Extended Sensitivity: Disabled when HIGH SENS MODE is set to HIGH SENS.

Flash Band Compensation: Disabled if the frame rate is anything other than 50p/50i or 59.94p/59.94i. Also disabled if using Digital Zoom, Freeze Frame, Super Slow Recording or VFR.

High Sens. Mode (UX180 Only): Disabled during VFR or Super Slow recording is enabled, or when Freeze Frame is selected. Also, if you enable EXTENDED SENSITIVITY, then High Sens. Mode will be automatically set to off.

Low Light Mode (UX90 Only): Disabled if the master Auto/Manu switch is set to Manu. This is only available when the Auto/Manu switch is set to Auto. Also disabled during Freeze Frame.
Rec Format: Disabled during Freeze Frame recording.
Rec Mode: Disabled during Freeze Frame.

User SW Menu

Area: Disabled when VFR or Super Slow Rec is enabled, or when using the wi-fi ROP remote control app. Also, Area Mode will be canceled if you press the Thumbnail button, change the Rec Format to 4K/24p (UX180 only), or change the Aspect Convert menu item.
ATW: Disabled if you've engaged the ATW Lock.
ATW Lock: Disabled when the white balance is set to anything other than ATW.
Auto Rec: Won't work if the recording format is set to standard-definition AVCHD SA mode, or when the OUTPUT SETUP->RESOLUTION is set to Down Conv.
Background (UX180 only): Disabled if 2 SLOTS FUNC is set to anything other than Background.
Backlight: Disabled during Freeze Frame.
Black Fade: Disabled during Freeze Frame, VFR, Super Slow recording, and Interval recording.
D. Zoom: Won't work during Freeze Frame, Area Mode, or during Interval Recording, and won't work when VFR or Super Slow Recording are active.
DRS: disabled while VFR is enabled, or Super Slow recording.
EVF On/Off: Won't work if the LCD/EVF Output has been set to LCD. Only works when it's been set to AUTO.
Flash Band: Disabled when the recording format is 23.98/24/25/29.97p. Only works when in 50p/50i or 59.94p/59.94i. Also disabled during Digital Zoom, Freeze Frame, or when VFR or Super Slow Rec is enabled.
Focus Assist 1: Disabled when autofocus is engaged, or when Rec Check is being performed, or when Freeze Frame is active, or when Color Bars are being displayed. Also, the EXPAND magnification portion of the Focus Assist won't work when recording (including when Pre-Rec is active), or when Digital Zoom is active, or when using Area Mode, or when VFR is enabled. It also won't magnify when you use the Auto Rec user button to trigger external recording.
Focus Assist 2: Disabled if you've set FOCUS ASSIST 1 to "BOTH". Otherwise, see the same restrictions as FOCUS ASSIST 1.

Focus Trans: Disabled when autofocus is engaged. Also disabled if you've zoomed in or out since registering your focus positions; any change in the zoom will erase any stored focus positions and the Focus Trans function will instead report "INVALID" when it is pressed; activating Infrared Recording will also erase your stored focus positions, and pressing the Thumbnail button or turning the camera off will also erase them. This function is also disabled during Freeze Frame or when VFR or Super Slow Rec is active.

Freeze Frame: Disabled when using Focus Assist, or when VFR or Super Slow Rec is enabled, or during Interval Recording, or when Color Bars are displayed.

High Gain: Disabled during Freeze Frame.

Histogram (UX90 Only): Disabled during Freeze Frame.

Infrared Rec (UX180 Only): Disabled when VFR or Super Slow Recording is enabled.

i.Zoom: Disabled when recording in UHD or 4K resolution, or when VFR or Super Slow Rec is enabled, or when Freeze Frame is active.

Last Scene Del: Won't work if the Thumbnail button has been pressed, or if the SD card has been ejected or a new one inserted, or if the Rec Format has been changed since the last recording. Also won't work if 2 SLOTS FUNC is set to Simultaneous, Dual Codec or Background. Won't work during Interval Recording.

Level Gauge: Disabled if Freeze Frame is active, or color bars are displayed.

Low Gain: Disabled during Freeze Frame.

Low Light (UX90 Only): Disabled if the Auto/Manu switch is set to Manu. Only available when it's set to Auto. Also disabled during Freeze Frame.

Mid Gain: Disabled during Freeze Frame.

Pre-Rec: Disabled during VFR or Super Slow Recording, or when 2 SLOTS FUNC has been set to Background, or during Interval Recording.

Push Auto: Disabled when the camera is set to Autofocus.

Rec Check: Won't work if the Thumbnail button has been pressed, or if the SD card has been ejected or a new one inserted, or if the Rec Format has been changed since last recording a clip. Also won't work if 2 SLOTS FUNC is set to Simultaneous or Background. Won't work during Interval Recording, Pre-Rec, or Freeze Frame.

Scene File: Disabled if you don't have any memory cards loaded.

Spotlight: Disabled during Freeze Frame.

Super Gain: Disabled when AUTO/MANU switch is in Auto, and AUTO SW->AGC is set to ON. Also disabled when HIGH SENS MODE is set to HIGH SENS.

Super Slow (UX180 Only): Disabled when recording AVCHD or UHD or 1080i; disabled on UX180 when recording FHD at 100 or 200 megabits. Only available when recording 50-megabit 1080p MOV/MP4 FHD at 23.98, 25, or 29.97 fps.

VFR: Only enabled if the recording format is MOV/MP4 FHD 1080 at 50 megabits, at either 23.98, 25, or 29.97 frames per second. Disabled in all other recording formats and also disabled in AVCHD.

WFM (UX180 Only): The waveform monitor is disabled when using the viewfinder; it's only available on the external LCD panel. It's also not available if the LCD is flipped over so it's facing the front of the camera, or during using the Focus Assist, or during Freeze Frame or when displaying Color Bars.

White Fade: Disabled during Freeze Frame, VFR, Super Slow recording, and Interval recording.

Zebra: The zebras won't be displayed during Freeze Frame or when displaying the waveform monitor or vectorscope.

SW Setup Menu

Custom O.I.S.: Disabled when the REC FORMAT is set to 4K (UX180 only).

Digital Zoom: Won't work during Freeze Frame, Area Mode, or during Interval Recording, and won't work when VFR or Super Slow Recording are active.

Focus Assist 2: Disabled if you've set FOCUS ASSIST 1 to "BOTH".

Hybrid O.I.S.: Disabled when the REC FORMAT is set to 4K or UHD, or when you turn the image stabilizer off. Also disabled when VFR or Super Slow Rec is active, or when using Freeze Frame.

i.Zoom: Disabled when recording in UHD or 4K resolution, or when VFR or Super Slow Rec is enabled, or when Freeze Frame is active.

MF Assist (UX180 Only): Disabled when auto focus is selected by the Focus Switch, or when using Area Mode, or when VFR or Super Slow Rec is enabled. It also won't work if you have an external focus controller plugged into the FOCUS/IRIS remote jack.

Super Gain: Disabled when the camera is in automatic gain (AGC), or during Freeze Frame, or when the UX180's sensitivity is set to HIGH SENS.

WFM Type: Disabled during using the Focus Assist, or during Freeze Frame or when displaying Color Bars.

Auto SW Menu

Auto Slow Shtr: Won't work during Freeze Frame

Record Setup Menu

2 Slots Func: Disabled when you don't have two memory cards installed. Relay Rec not available during VFR or Super Slow or Interval Recording; Simultaneous not available if you're using both an SDHC and an SDXC memory card (they need to be identical types); UX180's Background not available when Rec Format has been set to UHD or 4K, or when the Rec Format is set to record at more than 50 megabits. UX180's Dual Codec not available when the Recording Mode is set to 4K or UHD 50/59.94p or to any FHD 50mbps mode.

DF Mode: Disabled when the recording format is set to 23.98 or 24p, or during Interval Recording; it will also be disabled and hidden when the system frequency is set to 50Hz.

Dual Codec Rec (UX180 Only): Disabled when VFR or Super Slow Rec is active, during Interval Recording, when the Rec Mode is set to AVCHD, or when the Rec Format is set to 4K, UHD 50/60p, or FHD at 50 megabits. Only works when the main recording is UHD 23.98/25/29.97, or FHD MOV/MP4 at 100 or 200 megabits.

EXT TC Link (UX180 Only): Disabled when VFR is active, or during Interval Recording.

Focus Transition (UX180 Only): Disabled when auto focus is selected by the Focus Switch, or during Freeze Frame, or when VFR or Super Slow Rec is active.

Frame Rate: the Frame Rate is disabled for the same reasons VFR is disabled, and becomes enabled when VFR becomes enabled.

Infrared Rec: Disabled during VFR or Super Slow Recording are active.

Interval Rec: Disabled when Freeze Frame or when Pre-Rec or VFR or Super Slow Rec are active. Disabled when the recording format is set to anything other than 4K/24p, UHD 29.97/25p, or MOV/MP4 FHD 29.97p/25p at 50 megabits. When recording AVCHD, it is only available in HA mode.

Pre-Rec Mode: Won't work when VFR or Super Slow Rec is active, or during Interval Recording, or when the UX180's 2 SLOTS FUNC is set to Background.

Super Slow Rec: Disabled unless the recording format is set to MOV/MP4 at FHD 23.98p/25p/29.97p.

Time Stamp: Will not be displayed if the Rec Format is set to AVCHD SA (576i or 480i), or when Date/Time is set to OFF, or during Freeze Frame

or VFR or Super Slow Rec, or when the UX180's 2 Slots Func is set to Dual Codec. Note: even if you set Video Out OSD to OFF, the Time Stamp will still be displayed if this menu item is set to ON. Also, on the UX180, Time Stamp won't be enabled if you've set the UX180 to output to SDI and you're using a frame rate that would result in 1080PsF being output (meaning 4K/24p, or UHD or FHD at 29.97p or 25p or 23.98p.) It will never output when the camera is set to use the SDI output and the record format is 4K/24p, but you can force the system to output the Time Stamp in all other HD and UHD modes through the SDI port by setting the Output Setup menu's RESOLUTION setting to either 1080p or 1080i instead of SYSTEM.

TCG: Disabled and forced to FREE RUN when PRE-REC is enabled, or when the UX180's 2 SLOTS FUNC is set to Background Recording. Disabled and forced to REC RUN when VFR or Super Slow Rec is active, or during Interval Recording.

UB Preset: Disabled when the Rec Format is set to MP4 or MOV; it's only available in AVCHD recordings.

VFR: Disabled when shooting any AVCHD recording format, or any UHD or 4K format. Only enabled if the recording format is MOV/MP4 FHD 1080 at 50 megabits, at either 23.98, 25, or 29.97 frames per second.

Audio Setup Menu

Generally items in these menus are affected by the audio switches or other audio menu items; if you set the audio channels to automatic mode, you'll find that the limiter will be disabled; if you set the one channel to auto and the other manual, you'll find the ability to link the limiters together will be disabled. If there's something disabled in this menu, check your switch settings on the side of the camera under the flip-out audio controls door. Also, if you've enabled SUPER SLOW recording on the UX180, it will disable the entire Audio Setup menu (since no audio is recorded during Super Slow recording).

Audio ALC Link: Disabled if either Audio Level CH1 or Audio Level CH2 are set to AUTO.

Audio ALC CH1: Disabled if Audio Level CH1 is set to AUTO.

Audio ALC CH2: Disabled if Audio Level CH2 is set to AUTO.

Output Setup Menu

Down Conv: Forced to SQUEEZE when the Rec Format is set to UHD or 4K.

Output Sel (UX180 Only): Cannot be set to [AV] on the UX180 if the Rec Format is set to 4K/24P.

Resolution: Cannot be set to [Down Conv] or [1080i] or if the Rec Format or Output Format is set to 4K/24P. Also, if the Rec Format is set to AVCHD SA 576i or 480i, this menu is forced to SYSTEM. If Output Sel is set to [AV] this menu item is set automatically to [Down Conv.] Finally, this menu item can't be set when Freeze Frame is active.

SDI Audio Gain Chg (UX180 Only): Disabled when OUTPUT SEL is set to HDMI or AV. Re-enabled when Output Sel is changed to SDI.

SDI EDH (UX180 Only): Active only when SDI is outputting standard definition; it won't overlay EDH over an HD-SDI or 3G-SDI high-definition output.

Disp Setup Menu

Eye Sensor (UX180 Only): Disabled when the viewfinder is disabled, via OUTPUT SETUP->LCD/EVF OUTPUT being set to LCD.

EVF Setting: This menu item is disabled when using the LCD. Use the viewfinder to enable this menu.

Power LCD: This menu item is disabled and forced to "0" when the camera is set to USB MODE SELECT->DEVICE and connected to a computer via a USB cable. It's forced to "1" when the camera is connected to an AC power supply. It is also disabled when using the EVF.

Video Out OSD: Disabled when using a Rec Format of UHD or 4K; Video Out OSD only works when in 1080 FHD or AVCHD modes. Also, it will be disabled when the Auto Rec User Button is pressed.

Network Setup Menu

Connection History: Disabled unless you've set the USB MODE to ON, USB MODE SELECT to HOST, and plugged in a compatible wireless module to the USB Host port.


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR

Scene File Settings

The cameras offer the ability to store and recall groups of image-control settings, called "Scene Files." You can have up to six different "looks" pre-programmed into the camera at one time, and many more readily accessible on your SD memory card. The settings that make up these Scene Files are contained in the SCENE FILE menu.

The following descriptions of the scene file properties will give you a better understanding of how these settings affect the image. You may need to zoom in to some of the pictures at up to 300% to see the differences clearly.

Please note: the color photos included in this book are for convenience, but should not be taken as absolutely accurate, that would depend on the color accuracy of each computer monitor it is being viewed on. As such, the photos should be considered approximations.

Note: many of these menu items can be adjusted over a wide range (Chroma Level, for example, ranges from -70 up to +30, that's a range of 100 steps). It would be slow and tedious to use the touchscreen to navigate through 100 steps of adjustment. Consider using the menu/jog dial wheel instead, it's much easier to move through many steps of adjustment by using the wheel.

File Select

This menu item lets you choose which of the six Scene Files you want the camera to be using, and (accordingly) which one you want to be able to modify. Selecting one of the Scene Files using this menu will load it as the current Scene File, which means that it will affect all the parameters in the Scene File Menu. Any changes made to the rest of the menu items in the Scene File Menu will apply to the particular Scene File that you have selected with this File Select menu option.

Name Edit

Each of the six stored Scene Files can have their own custom name. Selecting this menu option will bring up a keyboard on the LCD screen

which will allow you to "type in" a name for the currently-selected Scene File (as determined by the aforementioned File Select menu item). Two things to note: first, the Scene File name can be up to six characters long. Second, once you've typed in the name, use the ENTER key, not the RETURN key. ENTER will assign the new name and keep it; RETURN will effectively cancel the new name and leave the old name untouched.

Load/Save

This menu item lets you save your six internal Scene Files onto an SD/SDHC/SDXC memory card, or load previously-saved Scene Files from a memory card back into the camera. Note, this function will be disabled if there's no SD card in the camera to load or save from.

An important thing to understand about this menu option is that it doesn't save an individual scene file. Instead, it saves all of the internally-stored scene files. When you choose to SAVE using this menu, it will write out the entire contents of all six Scene Files (F1 through F6) onto the memory card, as one big batch, into one of eight positions (named SCNFILE1 through SCNFILE8).

Think of it as saving (or loading) an entire package of Scene Files. Each position on the memory card (SCNFILE1 through SCNFILE8) holds a complete package of all six Scene Files, and there are eight potential packages on a memory card. A little math tells us that you can keep up to 48 individual Scene Files on your memory card (eight packages of six scene files each).

While saving always saves a complete package of six Scene Files, you have the option of loading an individual Scene File from a package, or the entire package. You can scroll through the names of the individual scene files contained in the package, or you can choose ALL. When loading ALL, all six scene files will be loaded into the camera in the order that they were saved on the memory card (so, whatever was in position F3 when you saved the file, will be loaded back into F3 when you load the package). When you choose to load an individual scene file, though, it will load into whatever position you've set the FILE SELECT to.

Let's say you have a package of six scene files, and that package contains F1: COMEDY, F2: DRAMA, F3: HLLYWD, F4: STYLIN, F5: RICH, and F6: PEOPLE. If you load "ALL", then when you choose a scene file from FILE SELECT, you'll see all those names in those particular positions. However,

you could choose to load just one of the scene files, and you can load it wherever you like. So, for example, you could set the FILE SELECT to F5. Then, you could go to LOAD/SAVE and tell it to load from your stored scene file package. You could choose one scene file from the package on the memory card (for example, F2: DRAMA). When you choose RETURN, the camera will ask you "Do you want to overwrite it?" (meaning, do you want to overwrite the current contents of scene file F5?) If you choose YES, then you'll find that now your FILE SELECT option of F5 will say F5: DRAMA.

If you want to return to the factory default scene file settings you can do that by using the OTHER FUNCTION -> INITIAL SET menu and choose the SCENE option.

Synchro Scan (UX180 Only)

The UX180 has a wide variety of preset shutter speed settings, from 1/2 second all the way up to 1/8000 of a second. But by going into the SYNCHRO SCAN menu, you can specifically dial in exactly what shutter speed you want, in increments as small as 1/1000 of a second. The SYNCHRO SCAN function is useful for getting alternate shutter speeds, but it's also useful for shooting a scene with computer monitors (or other flickering displays or lights) in it. Computer monitors sometimes have refresh rates that may not synchronize with the camera's standard shutter speed, and that can result in seeing a dark/scrolling bar on the computer monitors in your shot; with the SYNCHRO SCAN shutter speed you may be able to find a shutter speed that matches the monitor's refresh rate, and eliminate that scrolling bar (or at least minimize it).

SYNCHRO SCAN is, in effect, another shutter speed - a custom shutter speed. So to use it, you first have to set your camera to the custom shutter speed setting. Once it's there, you can then vary that custom shutter speed.

Press the SHUTTER button on the side of the camera, which should result in the gear icon in the lower left of the LCD display reading "SHUTTER". The shutter speed (displayed in the lower right of the LCD) should be highlit in orange. Now, rotate the jog/dial wheel to change the shutter

speed; the Synchro Scan speed is located between 1/8000 and 1/2. If you set the shutter speed after 1/8000 and before 1/2, you should see a decimal fractional speed, such as "1/36.3" or "1/48.0" or "1/60.0". That speed with a decimal point is the SYNCHRO SCAN speed. This is a vital and confusing step, so you have to take the time to get this right and select the SYNCHRO SCAN speed with the wheel.

You can then go into the SYNCHRO SCAN menu option and change the Synchro Scan speed, or you can press the jog/menu dial when the shutter speed is highlit in orange; when you do so, the wheel's function will change to say "SYNCHRO" and at this point you can rotate the dial to choose the exact shutter speed you want. Hint — if you hold the dial pressed in, you can rapidly scroll through the available shutter speeds by rotating the dial up or down.

If you're trying to sync with a computer monitor, point the camera at the computer monitor and then scroll through the shutter speeds until you find one that makes the monitor stop flickering. For television screens in the USA, you'll normally want to use a shutter speed of 1/60.0, and in PAL territories you may want to use 1/50.0. For computer monitors you will likely have to use the SYNCHRO SCAN menu to find a speed that stops them from flickering.

Note: please be very aware that changing the shutter speed can complicate matters when shooting under certain types of lights. See the Rolling Shutter article ***for more information.***

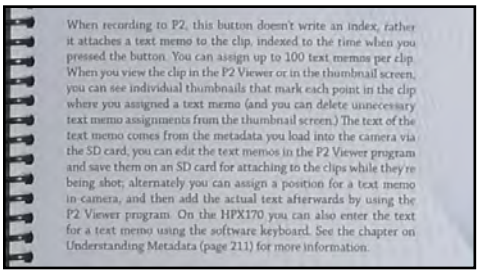
Be aware that you cannot select a Synchro Scan shutter speed that's slower than the frame rate you're shooting at. For 23.98/24p modes, the slowest shutter speed you can select is 1/24.0, for 25p it's 1/25.0, for 29.97p modes it's 1/30.0 and for 50i/50p it's 1/50.0 and for 59.94i/p it's 1/60.0.

Master Detail

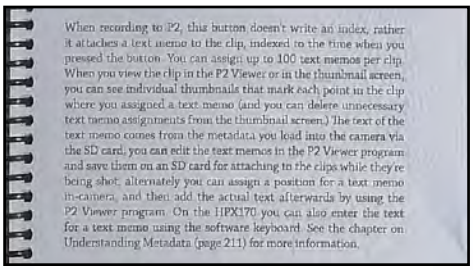
With some of these functions, it may be easier to describe what the item "does" while separately explaining what the "effect" is. MASTER DETAIL is one of those. In the simplest terms, the "effect" it provides is to make the image look sharper (or softer, depending on which way you set it). Now, that's not what it really does, but that's what it looks like it does. If you want the picture to look sharper, you can just crank up the Master Detail level to the positive values (up to +31) and the image will, upon casual inspection, indeed look quite a bit sharper. But there are side effects, and that's why it's valuable to know what the Master Detail control is actually

doing to the image. The more you know about it, the more prepared you are to use the right settings for any given circumstance.

In a nutshell, Master Detail controls edge enhancement and overall electronic sharpening of the picture. It doesn't actually make the image any higher resolution, but it makes it "look" as if it's sharper by enhancing the contrast around fine details. Video cameras use a sharpening circuit (or edge enhancement, or "detail") to artificially increase the perceived contrast of the image. It works because humans use two main criteria to judge the sharpness of an image: resolution, and contrast. The camera always delivers the same amount of resolution (within each given mode), but the MASTER DETAIL can be used to control how much additional contrast is added to the edges. With MASTER DETAIL set all the way down to –31 the image may look somewhat blurry if there's not adequate contrast in the scene already. With MASTER DETAIL set up to +31 the image will look much sharper and crisper, but a higher MASTER DETAIL level makes the edge enhancement more visible, resulting in artificial video sharpening that can look unnatural, or even coarse.


When recording to P2, this button doesn't write an index, rather it attaches a text memo to the clip, indexed to the time when you pressed the button. You can assign up to 100 text memos per clip. When you view the clip in the P2 Viewer or in the thumbnail screen, you can see individual thumbnails that mark each point in the clip where you assigned a text memo (and you can delete unnecessary text memo assignments from the thumbnail screen.) The text of the text memo comes from the metadata you load into the camera via the SD card; you can edit the text memos in the P2 Viewer program and save them on an SD card for attaching to the clips while they're being shot; alternately you can assign a position for a text memo in-camera, and then add the actual text afterwards by using the P2 Viewer program. On the HPX170 you can also enter the text for a text memo using the software keyboard. See the chapter on Understanding Metadata (page 211) for more information.

Master Detail -31 (view at 300% for best results)


When recording to P2, this button doesn't write an index, rather it attaches a text memo to the clip, indexed to the time when you pressed the button. You can assign up to 100 text memos per clip. When you view the clip in the P2 Viewer or in the thumbnail screen, you can see individual thumbnails that mark each point in the clip where you assigned a text memo (and you can delete unnecessary text memo assignments from the thumbnail screen.) The text of the text memo comes from the metadata you load into the camera via the SD card; you can edit the text memos in the P2 Viewer program and save them on an SD card for attaching to the clips while they're being shot; alternately you can assign a position for a text memo in-camera, and then add the actual text afterwards by using the P2 Viewer program. On the HPX170 you can also enter the text for a text memo using the software keyboard. See the chapter on Understanding Metadata (page 211) for more information.

Master Detail +31

Also consider that the higher the MASTER DETAIL level is set, the more noticeable overall image noise will be! The noise is a fine fluctuation in brightness levels, which looks a whole lot like "fine detail" to the sharpening circuitry in the camera — and that's why the edge enhancement process may actually sharpen the edges around the noise in the video signal. If you want to minimize the appearance of noise in your footage, lowering the MASTER DETAIL setting can go a long way towards accomplishing that. See the DETAIL CORING section for more information on controlling noise from MASTER DETAIL.

When deciding on what MASTER DETAIL value to use, first consider how large your footage will be displayed. The larger the display, the less artificial detail you normally would want to use. On a small screen a high detail setting can look fantastic, but on a movie theater screen it may look too artificial. Second, consider how much post-processing you might do to the image. If you're planning on extensive color grading or special effects work, you probably want to use as little artificial edge enhancement as possible. You can always add more sharpening in post, but you can never remove it from your footage once you've recorded it that way.

The smaller the MASTER DETAIL number, the softer and more organic the image will look. The larger the MASTER DETAIL level, the sharper (but perhaps more electronic) it'll look. For most purposes, this camera delivers enough raw resolution that you don't need to add much in the way of artificial detail; I usually use no more than about 0, ranging down to around -10. For a film transfer or projection on a movie theater screen you may want to go to as low as -31, but for normal use the camera benefits from a little dosage of detail; a small detail setting can sharpen up the image nicely without creating large objectionable "outlining" around high-contrast edges. For greenscreen work, a lower detail level (such as -31 to -10) may be preferred.

Negative levels do not actually cause the image to blur, and 0 is not the same as "detail off." -31 means that minimal to no edge enhancement is applied, and any number higher than that means that there is active edge enhancement happening. A setting of 0 means a medium level of edge enhancement is being applied. Also, note that MASTER DETAIL adds sharpening equally in both horizontal and vertical directions. If you want to enhance only on the vertical axis, see the V DETAIL LEVEL section.

Detail Coring

DETAIL CORING is another one of those functions that "appears" to do one thing, while "actually" doing something else. At its most basic level, you can think of Detail Coring as a noise control; the higher you set it, the less noise you'll likely see in your image. That's not really what it does, but it appears to mask the appearance of noise in the image. To understand the effect of DETAIL CORING, you have to understand the interaction between MASTER DETAIL and noise in the image. The MASTER DETAIL control tells the system to accentuate contrast between low-contrast elements of the picture, but MASTER DETAIL doesn't know the difference between

fine high-contrast detail, and noise in the signal. As such, a high MASTER DETAIL level makes the noise significantly more visible; MASTER DETAIL actually sharpens the edges of the noise, drawing attention to it. DETAIL CORING can help bypass that process.

DETAIL CORING can be thought of as a threshold control; the higher you set it, the wider the range of frequencies that will not be sharpened by MASTER DETAIL. The lower you set DETAIL CORING, the more frequency range will fall under the jurisdiction of the MASTER DETAIL control. The higher the DETAIL CORING setting, the more it will cause the system to ignore sharpening of high-frequency detail. This means that if you set it high enough, the noise won't become sharpened/edge enhanced, making it less visible; the trade-off is that your legitimate high-frequency detail won't receive the contrast-enhancing sharpening effect either, so your image may not look as sharp as it otherwise could. Finding that level where you minimize the noise, but retain the sharpening you want, is the key to successfully using DETAIL CORING.

Detail Coring 0 (view at 200% or higher)

Detail Coring 60

The effect of DETAIL CORING is most noticeable when MASTER DETAIL is set to a high value (because the noise will be exaggerated most when MASTER DETAIL is set to a high level; that makes the effect of DETAIL CORING easier to observe.) When set to 0 (the minimum value), DETAIL CORING has no effect on the noise. The higher you set it, the more it cleans up the image. At its maximum value of +60 it has a significant smoothing effect, and really cleans up the noise in the video signal (again, at the expense of legitimate detail). Now, please understand it's not actually removing the noise, it's removing the sharpening that accentuates the noise, which makes the noise much less visible and less objectionable.

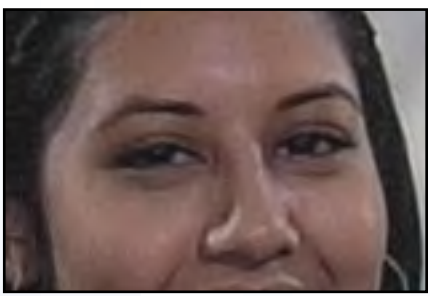
The higher the DETAIL CORING setting, the smoother the image, but too high of a level can lead to your picture looking softer and even "blotchy,"

because if too much of the contrast-enhancing effect is removed, sections of the image with fine color transitions or detailed edges can look like one big "blob." Removing all or most of the fine detail will affect surface textures and skin appearance, and not in a good way. This is especially prone to happen if you're using a lower bitrate recording mode; the lower the bitrate, the more likely the compression engine will be to lump similar-looking sections together into one big blob.

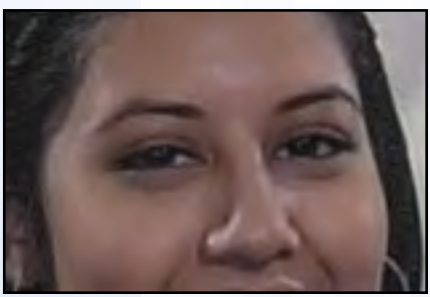
Also, the lower the MASTER DETAIL setting, the less effect DETAIL CORING will have on the image. For maximum sharpness, detail and resolution on your image you may want to set DETAIL CORING lower, but doing so may make noise more visible (noise manifests itself in a crawling texture on the surface of the video, sort of like film grain). Generally I'd advise to use as little coring as you can get away with; only set it to the point where noise is adequately under control, but no higher.

Skin Tone DTL

SKIN TONE DTL (detail) is designed to help smooth the appearance of mild imperfections on people's skin. When set to ON, it avoids sharpening anything it perceives as "skin tones," without affecting any other aspect of the picture. When set to OFF, it doesn't try to smooth skin tones. For an overview of how the SKIN TONE DTL function works, look at the description for DETAIL CORING. SKIN TONE DTL works like DETAIL CORING, except only on colors and tones that it perceives to be "skin."



Skin Tone DTL OFF



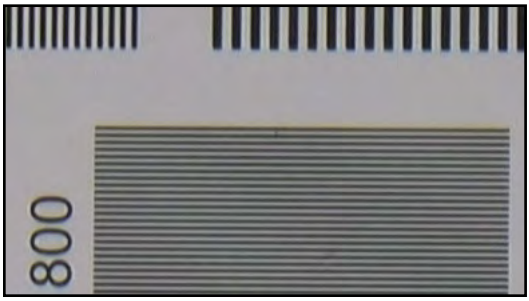
Skin Tone DTL ON

The higher you have the MASTER DETAIL set, the more noticeable the SKIN TONE DTL effect will be. However, even at the highest setting, the effect of SKIN TONE DTL is fairly mild and subtle. Sometimes it can be hard to even tell that it's working. And it may or may not succeed in identifying what a skin tone is; I've seen it smooth out detail on blonde and red hair too, and it can do so on

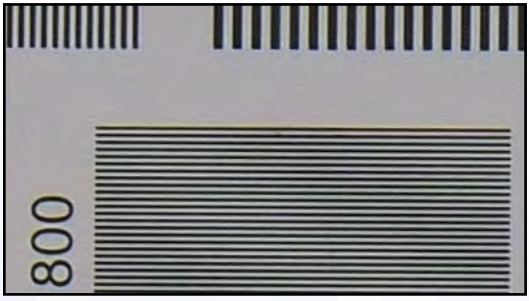
a wooden desk or, well, anything that falls in the same basic tonal range as skin tones. If you find that your subject's face is looking too flat and smooth, consider turning this function off. If your subject has acne or otherwise has "bad skin," you may find this function makes for a more flattering appearance of your subject.

V Detail Level

V DETAIL LEVEL affects perceived sharpness similar to the MASTER DETAIL control, but V DETAIL LEVEL enhances the contrast only vertically (i.e., between horizontal lines, or above and below the fine detail.) Depending on how high you set the level, it will sharpen the contrast vertically between horizontal lines in the video image. This enhanced contrast leads to the illusion that the picture is actually sharper.



V Detail Level -7 (view at 200% or higher)



V Detail Level +7

Now, V DETAIL LEVEL is a bit tricky because it works in tandem with DETAIL LEVEL - the higher the DETAIL LEVEL you set, the more effect V DETAIL LEVEL will have. If MASTER DETAIL is already enhancing the contrast between horizontal lines notably, then V DETAIL LEVEL can push that even higher. Or, it can help to pull some of that vertical enhancement out.

V DETAIL LEVEL as an independent control is probably most suited for when shooting interlaced (480i/576i or 1080i) as it gives you a bit of control over interline detail which may help reduce line twitter on an interlaced monitor or television. As the world replaces interlaced monitors with progressive monitors (such as LCD, LED or OLED) that becomes less and less of a concern.

RB Gain Control Setting

These settings allow you to "paint" the camera's image, by adjusting the level of blue and/or red saturation. You can add some red to the image to "warm it up", or turn it more blue to "cool it off". There's quite a bit of adjustment possible by using these settings, you can really push the color palette around by adjusting these two controls, and you can assign different settings to the different WHITE BAL channels (Ach or Bch).

You can add or subtract from either the red channel, or the blue channel, or both. The range is -30 to +30 for each. At mild settings, this function can help to warm up skin tones for interviews, comparable to using something like an #812 warming filter. On the other hand, aggressive use of positive values for the blue control can perhaps be useful for creating a "Day For Night" scene.

These settings can be combined with the color matrix and saturation levels, and with the various gamma options and the UX180's COLOR CORRECTION feature, to give you extensive control over the camera's color palette.

RB Gain Control at 0

RB Gain Control Red -30

RB Gain Control Red +30

RB Gain Control Blue -30

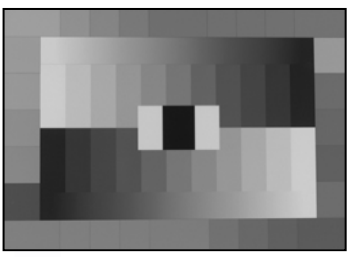
RB Gain Control Blue +30

This RB GAIN CONTROL SETTING function is only available when using the manual white balance channels A and B. If you set the camera in ATW (Automatic Tracking White) mode, the RB GAIN CONTROL SETTING will be bypassed - even if you assign ATW to be the designated function for either Ach or Bch.

In addition to the red and blue levels, there's a third option in this menu, and that's GAIN OFFSET (OFF/ON). The name of this function is not intuitive, it's not obvious as to what it does, but the general idea is that this option lets you decide whether or not your adjustments will survive the next time you do a manual white balance. You can have your custom settings applied to the new white balance (by choosing ON), or you can have the parameters reset to zero automatically the next time you manually white balance the camera (by choosing OFF). So when it's OFF, each time you take a manual white balance you get a pure and proper white balance, unadjusted by this menu (because the parameters are re-set to zero). When it's ON, the camera will take a proper white balance and then adjust it based on this menu's parameters. Again, this process is bypassed when you use the P3200 or P5600 presets, ATW, or the VAR manual white balance color selection.

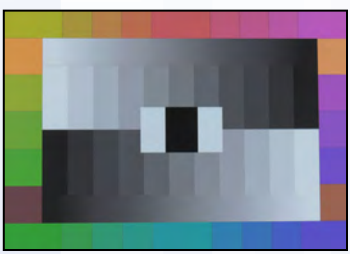
Chroma Level

CHROMA LEVEL refers to the amount of color saturation the overall picture has. The lower the CHROMA LEVEL, the more pale and muted the colors will be. The higher the CHROMA LEVEL, the more saturated the colors become. At –70 the image will be drained of all color and will be a true "black and white" grayscale image. The default setting of 0 delivers a richly saturated color palette. You can crank it up to maximum color saturation at +30, at which point he colors will be very strong and rich and vibrant.



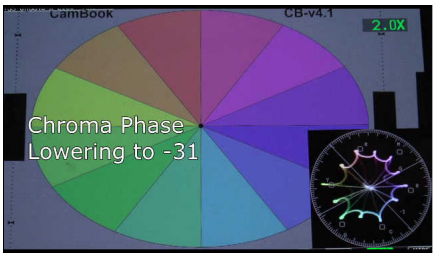
Chroma Level -70

Chroma Level 0



Chroma Level +30

Chroma Phase

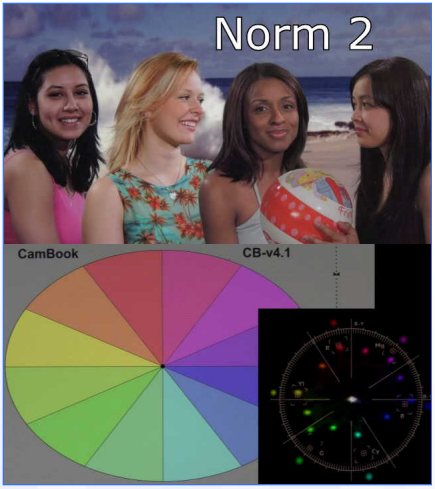


Click the video above for a demonstration

CHROMA PHASE works as a hue control. It allows you to, effectively, rotate the color wheel on your images. Setting it to negative values rotates the color plot on the vectorscope display counter-clockwise; setting it to positive values rotates the color plot on the vectorscope display clockwise. The range is +/- 31 steps, and the maximum adjustment results in approximately a 40-degree rotation of the color wheel.

Matrix

The MATRIX setting lets you choose different palettes of overall color reproduction. Using the MATRIX you have a limited amount of control over how saturated the colors are, and which colors get enhanced and which do not.



Click the video above for a demonstration

NORM1 is a mild, normal color response. In NORM1 the colors are at their most technically accurate of these five matrices. This matrix is frequently used for shooting outdoors or under halogen lighting in the studio; it is the most accurate and least "stylized" of the color matrices. Panasonic says that this color look is preferred in NTSC territories such as the USA and Japan.

NORM2 matrix brings up the brightness and saturation of the colors. In terms of color accuracy it's largely similar to NORM1, but with brighter reds, blues and purples. It also renders fair Caucasian skin a bit warmer. Panasonic says that this color look is preferred in PAL territories such as Europe.

In FLUO the colors are largely the same as in NORM2, meaning brighter and more vibrant than in NORM1, but the green, yellow and magenta

colors are more saturated in FLUO. Skin tones are slightly warmer than in NORM2, and notably warmer than in NORM1.

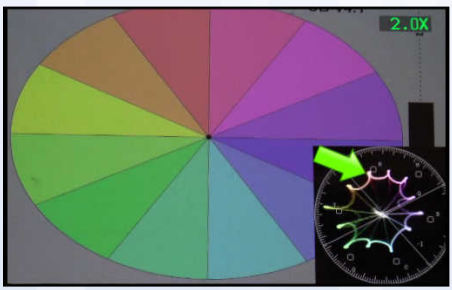
In CINE-LIKE all the colors except blue and cyan are strongly saturated, as compared to NORM1. This matrix is used to produce richer, cinema like color. The skin tones are accurate but slightly warmer than in NORM1. While you can use this matrix in any gamma, Panasonic recommends to use this matrix when using one of the CINE gammas.

The STILL matrix is designed to generally match the color reproduction of a still photography camera such as the Panasonic Lumix GH4. The color rendering in STILL is very different from the other matrices.

Color Correction Setting (UX180 Only)

The UX180 offers a 16-pole color correction matrix. You can individually control the saturation and phase of sixteen different points on the color wheel. This gives you a tremendous amount of control over how the images are rendered, as you can individually fine-tune the color axes to get exactly the look you're after.

If you're not used to working with an in-camera color correction feature, it can seem intimidating at first, but it's really quite simple. As you'll remember from the discussion on the vectorscope, there are six boxes on the vectorscope and those correspond to six colors: Red, Magenta, Blue, Cyan, Green, and Yellow. The COLOR CORRECTION SETTING gives you control over those six poles, as well as another 10 that sit in-between. Some of the poles are halfway between two colors (such as R-MG, which controls colors that are halfway between Red and Magenta). Some of the primary color axes have two colors in between them (such as between Magenta and Blue, you'll find Mg-Mg-B, which is 1/3 of the way from Magenta to Blue, and you'll also see Mg-B-B, which is 2/3 of the way from Magenta to Blue). Mg-Mg-B is like "two parts Magenta, one part Blue"; Mg-B-B is like "one part Magenta, two parts Blue."



Click the video above for a demonstration

For each of these poles, you can control the SATuration, and also

the PHASE. The SAT control acts like a CHROMA LEVEL for that individual color, allowing you to intensify it or make it more muted. The PHASE control acts like a CHROMA PHASE for that individual color pole; setting lower values will rotate that pole counterclockwise on the color wheel, and setting positive values will rotate that pole clockwise on the color wheel.

The poles don't operate in complete autonomy from each other; there is some overlap. If you increase the Green saturation substantially, you may see that its neighbors (the Cyan-Green and the Green-Green-Yellow) will probably become somewhat more saturated too. You may have to go back and forth between the controls to get exactly the painted image you're looking for.

While you can adjust the colors at any time and looking at any image, frankly I don't see how one could be successful with these image adjustments without using a professional color chart such as the DSC Labs' ChromaMatch or Chroma Du Monde. Having a professional color chart with guaranteed color accuracy assures you that your adjustments are starting from a known, solid, good starting point.

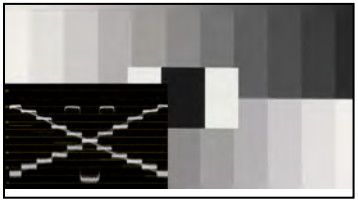
Master Pedestal

The MASTER PEDESTAL is another setting that appears to do one thing, while actually doing something else. At first glance it appears to be primarily a "contrast control", but what it actually does is quite different. It governs the overall brightness level of "black" in the picture. The lower you set the MASTER PEDESTAL, the lower, deeper, and richer the black level will be, and, correspondingly, all the rest of the levels in the picture will move darker accordingly. The lower you set it, the harder it becomes to distinguish between the darker items in the frame; at some point more dark items will all blend together into black, giving you stronger, harsher contrast and, after a certain point, a loss of detail in the shadow areas. Conversely, the higher you set the MASTER PEDESTAL, black will be rendered as a lighter and lighter shade of gray. This results in making the overall contrast look softer and flatter, but up until a certain point you may also preserve more detail in the shadows — it's easier to discern between shades of medium gray than it is to discern between shades of deep black. Put another way, a higher MASTER PEDESTAL value will preserve detail in the darker areas of the picture but make the blacks "milky"; it may also affect the appearance of noise in the image.

The MASTER PEDESTAL is not used to expand the dynamic range of the image. It doesn't stretch out the difference between black and white;

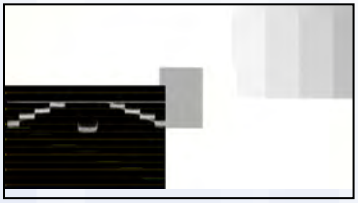
Click for a video demo of the Master Pedestal

it just changes the reference level for black. Imagine a scene where the deepest shade of black is being rendered at 7.5 IRE and the whitest whites are at 97.5 IRE. If you lower the MASTER PEDESTAL so that the blacks are now being rendered at 0 IRE, you'll find that your brightest whites have also been lowered, to 90.0 IRE. The higher brightness levels are, effectively, placed on a "pedestal" of black, and you can raise or lower the height of that pedestal, while the fundamentals of the image stay the same (meaning, the dynamic range from darkest to brightest will remain the same, but the levels of those images will be raised or lowered depending on where you've set the PEDESTAL that they all sit on).



Master Pedestal at 0

Master Pedestal at -150



Master Pedestal at +150

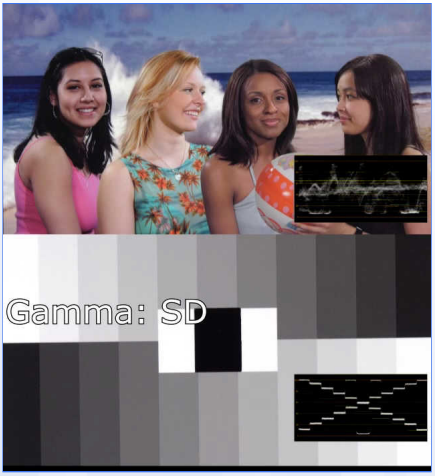
MASTER PEDESTAL doesn't increase the dynamic range, but it can certainly decrease it! If you set it too low, you'll crush the blacks down and limit the ability to discern shadow detail. Crushing down the black tones doesn't make for more room in the highlights, it just brings everything down. As an example: let's say you had a scene where the MASTER PEDESTAL was set to render black at 7.5 IRE, and the brightest portions of your scene were clipping at 109 IRE. If you set the MASTER PEDESTAL to its minimum value (-150), then you'll find that you'll have crushed the darkest third (approximately) of your image to all solid black; however, your highlights, which were clipping at 109 IRE, will now be down at about 45 IRE — and still clipped! The same highlights will still be present, and they'll still be clipping at the same relative position as they always were, but the lower PEDESTAL value will now mean that the highlights will be rendered at a maximum of 45 IRE. Lowering the MASTER PEDESTAL lowers everything that was sitting on that pedestal. It doesn't magically expand the dynamic range to higher levels.

As such, there are very practical limits as to how far you'd want to adjust the MASTER PEDESTAL. Boosting or lowering the black level is certainly a valid image control to exercise, but exercise it in moderation; boosting or lowering it significantly will cause you to lose image detail due to crushing or clipping.

Gamma

The gamma curves control how brightness information is distributed in the picture. Gamma correction can correct for the nonlinear light-output characteristics of a standard TV picture tube. Picture-tube gamma (like on a CRT television) stretches the whites and compresses the blacks. Camera gamma compresses the whites and stretches the blacks. For the technically inclined, camera gamma can be properly set by using logarithmic gray scale charts and a waveform monitor. Camera gamma must be the reciprocal of picture gamma which is 2.2, so the camera gamma is usually 0.45.

Why is this a problem? Well, back when CRT monitors were the standard, their picture tubes created nonlinear response, and the cameras had to compensate in order to make proper-looking pictures. When new monitor technologies were being introduced (such as LCD, LED, and OLED), they didn't necessarily have to be constrained by the CRT tube's restrictions, but in order to work properly with the vast library of footage that had already been created, LCD/LED/OLED monitor manufacturers have continued the trend of using CRT-style gamma reproduction. And so, cameras need gamma functions to create images that will look "correct" when broadcast or displayed on these monitors.



Click the video above for a demonstration

The UX90 and UX180 offer eight different gamma curves. The gamma curves in the camera affect how the sensor maps its tonality. If you are skilled in photo editing or video editing and post-production, you may be familiar with the concept of applying "curves" to your photos or video footage, or of manipulating the "levels". Essentially, that's what the gamma function does, in-camera. By choosing among the gamma curves you can select from

a variety of choices of how the camera maps the shadows, midtones, and highlights into displayable IRE values.


The HD gamma produces standard video-looking pictures according to the international standard Rec 709. It's basically your typical, "video"-looking picture. HD will be the base gamma curve that we compare all the others to. HD is an all-purpose gamma that can be used for many situations, but it is a particularly suitable choice for sports, news, or other footage where the immediate, "live" look is the goal.


SD is provided for times when you might want to retain compatibility with the DVX100 series of cameras' "NORM" gamma, or when you need a gamma that complies with the standard-definition recording space of Rec 601. SD handles highlights and dark tones similar to HD, with slightly lifted midtones and lower midtones. If you're shooting standard-def, or you're shooting footage that might be downconverted and mixed into a standard-def program, SD may be the right choice for that.


FILMLIKE1 is basically a reformulated version of the HD gamma, but designed to better reproduce highlights. The range from medium gray to black is handled comparably to HD, but FILMLIKE1 adds about a half an f-stop's extended range above medium gray to hold more highlights. This gamma reproduces more dynamic range than HD.


FILMLIKE2 takes the idea of FILMLIKE1 and pushes it even further. From black to medium gray it's quite comparable to FILMLIKE1, but the range from medium gray to white is slightly compressed, providing about 1/3 stop more headroom for holding a bit more highlights. As compared to HD, FILMLIKE2 provides similar tonality from black to middle gray, but compresses the region above middle gray to provide about 2/3 stop more headroom than HD gamma does.


FILMLIKE3 is very different. It doesn't just bring down the highlights, it lowers everything across the board — midtones, grays, highlights, everything is brought down, and the result is notably increased dynamic range. As an example, under proper exposure of a grayscale chart, HD gamma reproduces a certain shade of gray at about 55 IRE; in FILMLIKE3 that same medium gray is rendered at about 40 IRE. The entire curve's tonality range is compressed, which provides notably more dynamic range from deepest black to whitest white. Compared to HD gamma, with whitest whites set to 100%, changing to FILMLIKE3 renders those same whites at just about 79 IRE. You can open up the iris almost a full f-stop and still hold the highlights to 100 IRE, while letting more light fall on the shadow areas.


CINE-LIKE V is a video-appropriate gamma designed to render images appropriate for use on conventional monitors, but it's been adapted to provide a more cinematic look with higher contrast. Now, what constitutes a cinematic look is subject to interpretation; for many years it meant a rich, high-contrast look similar to reversal film or film that's received the bleach-bypass process. More modern fads have emphasized a flat look. CINE-LIKE V is more akin to the former description, although nowhere near as contrasty as reversal film! Unlike FILMLIKE3, which is a radical departure from the HD gamma look, CINE-LIKE V is about halfway inbetween. It does lower the tones below middle gray, but only about half as much as FILMLIKE3 does. And it compresses the highlights, but not nearly as much as FILMLIKE3; its exposure above middle gray is more like FILMLIKE2. As compared to HD, it's a higher-contrast look to provide richer, deeper shadows while also extending the range to hold highlights better than HD.

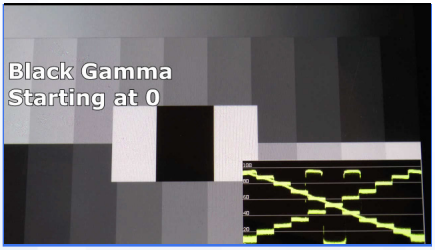

CINE-LIKE D is very different from all the prior gamma curves. It is designed to look more like the VariCam's FILM-REC gamma. It prioritizes dynamic range, and is generally the "flattest" of the gamma curves. While it can be displayed on a monitor, it has generally been used more for grading than for direct display. It provides a unique look, which may be exactly what your project is looking for, or it may be a good basis for grading your footage in post. CINELIKE-D is optimized for Dynamic Range (hence the "D" in its name).

Cinelike-D images on a television will be a little flatter because of the widened, flatter contrast.

STILL-LIKE is included specifically to provide a comparable gamma as that found in the Panasonic Lumix line of still and video hybrid cameras. Setting the matrix and the gamma to STILL may help make your UX camera footage match more closely and integrate better with cameras such as the Lumix GH4.

Black Gamma

In addition to choosing your gamma curve, you can also modify the gamma curve somewhat. The BLACK GAMMA function lets you pull the shadows down darker, or push them lighter. This function determines just how much to pull or push the dark range of the gamma curve (meaning, anything at about 30 IRE or lower). A setting of 0 is standard and leaves the gamma curve unmodified; a negative setting pulls the shadows/dark tones down (and the lower the number, the deeper the shadows are pulled); this can result in sharper and harsher contrast and, if taken too far, can result in losing detail in the shadows. With BLACK GAMMA set to positive numbers, that results in pushing the shadows up, brightening up the darkest tones in the image (from the IRE range of 0 up to about 30). This will, of course, reduce the overall contrast in the image, but it can also help preserve shadow detail that might otherwise be lost. BLACK GAMMA doesn't result in increased exposure latitude, but it does help you to discern and emphasize what latitude the camera has already captured. Do be aware that pushing the shadows brighter can result in noticeably more noise in the image; noise lives in the darker regions, so magnifying those regions may also magnify the noise that is in them.



Click the video above for a demonstration of Black Gamma

Knee Mode

The KNEE helps smooth the transition to overexposure by compressing and rolling off the intensity of the brightest parts of the picture. With the KNEE circuit engaged, the camera will detect when the highlights are getting too bright and will start attenuating the signal to bring them back lower to be within the 109-IRE limit of video brightness.

There are three settings: OFF, AUTO, and MANUAL. It seems obvious as to what they do, but even so, they merit some discussion.

OFF: Why would you want to turn the knee off? It seems like a good thing, doesn't it? It saves highlights? Well, yes, it does, but it does so by artificially compressing the bright range. The result is that the highlights may not look natural, they may lose color saturation, they may lose detail, they may even shift color somewhat. For the most natural rendering of the scene, you would perhaps want to leave the knee OFF, and control your exposure to not let anything reach into the overexposure/clipping area. This is, of course, not always possible, and it's particularly challenging when shooting in uncontrollable scenarios (such as sports or news or live events); it's more practical to turn the knee off when you're shooting in a studio and/or under controlled lighting. Never ever let your flesh tones be adjusted by the knee! For the best skin tones, keep the knee OFF, or raise it so it cannot possibly affect your skin tones.

AUTO: When set to AUTO, the camera can control the knee's MASTER POINT and MASTER SLOPE automatically. That can be a good thing, but like any auto function, it can also change at its own whim, which may or may not be what you would prefer. AUTO is best for completely uncontrollable shooting scenarios, such as outdoor sports or news coverage, where you simply may not have the time to keep track of the knee's current settings. The camera can do the job for you, but depending on changes in the scene (such as, maybe the sun comes out from behind a cloud) you may see the results of the knee changing in your footage, just like you'd see a change in auto-iris or auto-focus. So it's there to help you, you just want to be careful with it.

MANUAL: setting the knee on MANUAL gives you complete control over its behavior. This is generally best suited to when you're shooting under controllable lighting conditions, or when you know for a fact that you never want the knee to intrude lower than a certain IRE value.

Knee Master Point

This menu setting is only valid if you're using the KNEE MODE in MANUAL. This setting lets you decide at what point the knee begins working. The range is from 80.0 to 107.0, and those values are IRE values. What this means is, the knee circuit will ignore any area of the image that is less bright than the KNEE MASTER POINT. Only sections of the image that are as bright or brighter than the KNEE MASTER POINT will be modified. How much they will be modified depends on the KNEE MASTER SLOPE setting.

Click the video above for a demonstration of Knee Master Point and Knee Master Slope

The lower you set the KNEE MASTER POINT, the more of the image will be affected by the knee. Generally, you want to keep the knee away from your skin tones; knee compression on skin tones can make them look quite ugly. The lightest, fairest Caucasian skin should generally not be exposed over about 80 IRE whenever possible, and the KNEE MASTER POINT's minimum value is 80.0, so generally this works well to keep the knee away from the skin tones, but if you're exposing especially hot, it's possible that the skin tones might encounter the knee. The solution, of course, is to set the Knee Master Point higher. The default is 93.0 IRE. At that setting, it's unlikely that the knee will interfere with skin, but it's more likely that it will come into play to try to retain detail on something that's superbright, such as clouds in the sky.

Generally, set the Knee Master Point as high as you can, to keep it from interfering with image detail that has been exposed properly; you generally only want the knee working with superbright areas that are prone to overexpose.

Knee Master Slope

This menu setting is only valid if you're using the KNEE MODE in MANUAL. If the knee is set to OFF, this menu setting won't work, and if the knee is set to AUTO, the camera will dynamically and automatically determine its own KNEE MASTER SLOPE.

With the KNEE MASTER POINT you set at what IRE threshold the knee begins compressing the signal. With the KNEE MASTER SLOPE, you tell the knee how much to compress the signal. The range is between 0 and 99; at a setting of 0 there will be no compression, and at a setting of 99 the knee will extremely aggressively squash any highlights in the range at or above the KNEE MASTER POINT.

For maximum dynamic range retention you'd want to set the KNEE MASTER SLOPE as gentle (small) as possible while still holding on to the very brightest sections of the image. If you set the KNEE MASTER SLOPE too high, it's entirely possible that it will squash highlights so thoroughly that none of them ever reach the 109 IRE limit; in doing so, you wouldn't be avoiding signal clipping, you'd in fact be causing it. As an example:

imagine you had a scene with highlights as high as 109 IRE. If you set the KNEE MASTER POINT to 80.0, and set the KNEE MASTER SLOPE to its most aggressive compression of 99, the result would be that everything in your image at 80 IRE and above would be squashed down to 80 IRE — effectively forcing a hard clip. Generally, that's not the desired outcome of using the knee!

See the KNEE MASTER POINT for a video demonstration.

Consider that normally, as the intensity of light increases, so does the signal proportionally until the signal exceeds the ability of the camera to record it; any brighter and it just clips to solid white. The knee extends the dynamic range by compressing high intensity signals, somewhat like an audio limiter compresses audio signals to prevent overmodulation and distortion. But, just like an audio limiter, limited audio doesn't sound all that great, and knee-limited video doesn't look all that great. It looks better than clipped whites, but it's still something to be used sparingly if image fidelity is your principle concern.

DRS (Dynamic Range Stretching)

The DRS function is designed to extend the dynamic range of a scene, avoiding blown-out highlights and crushed shadows. To understand it, think about enabling the automatic knee, along with automatic black gamma, across your images. That gives you the general idea of how DRS works (it can compress the highlights like a knee, and it can stretch out the shadows like black gamma), but it's more complex than that, because DRS doesn't get applied globally to the entire frame; instead it gets applied section by section. It's almost like having an individual exposure level for every pixel on the screen!

It sounds great, and it can be very helpful. But, it is an automatic function, and like all automatic functions, it might act when you didn't necessarily want it to. You have to keep a careful eye on DRS, and only use it when the scenes really call for it. DRS changes dynamically, on the fly, adapting to lighting conditions or changing scene conditions, and as such, the amount of intensity it employs can change too. The result can be somewhat akin to when automatic exposure changes the exposure on you when you didn't want it to — it's nice that it can do it, but generally in professional videography you're going to be manually controlling your exposure, and you'd probably generally want to manually control your dynamic range too. That said, there are times when automatic exposure is a lifesaver, and there are times when DRS will be exactly what you need to get the shot. It's not

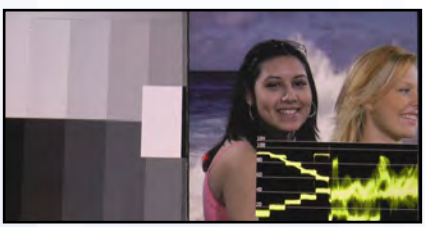
magic, and it's not a cure-all, but there are times when it may be exactly what you need.

DRS Effect

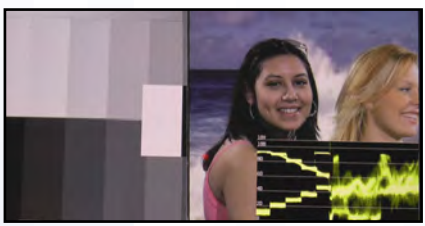
There are three levels of DRS, labeled "1", "2", and "3". They all work similarly, but the bigger the number, the more effect it can have. On level 1, there is mild compression of the highlights and mild stretching of the shadows. On level 3, there's quite a lot of compression of the highlights and quite a bit more stretching of the shadows.

How much DRS to use is a question that gets answered on a scene-to-scene basis. On some scenes there may be no need for DRS at all; in some scenes there may be no way to get the shot without employing the maximum amount of DRS. You have to evaluate the use of it based on the lighting conditions you're facing.

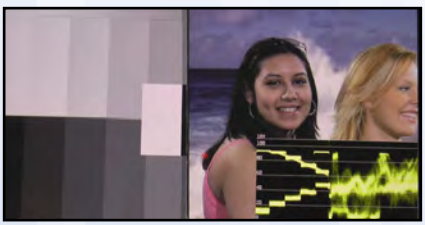
There are three general side effects to using DRS. First, there's the automatic nature of the feature, in that it can change things on you in the middle of a scene. Second, there's compression in the highlights — which can save an overexposed item, but may affect its tonality or color (see the KNEE section for more info). And third, there's the potential to add noise to the shadows. The more the shadows get lifted and stretched, the noisier they will become. On DRS 1, the stretch is very mild and the commensurate noise increase is very modest, but on DRS 3 the camera is able to really significantly stretch the shadows, and that results in quite a bit of noise being added to them.



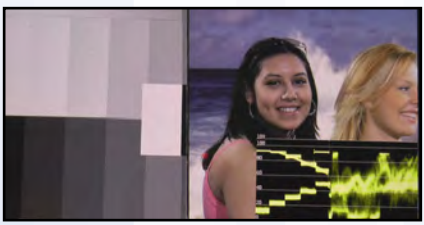
DRS: Off



DRS: Level 1



DRS: Level 2

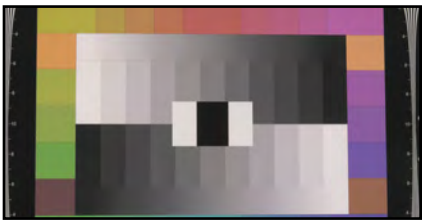


DRS: Level 3

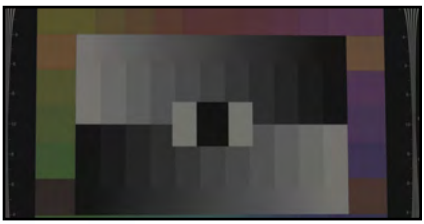
There's another side effect that may happen under certain conditions; a shadowing effect that happens when something bright meets something dark; because DRS darkens brights and lightens darks, when those two meet it might have to make some compromises. Observable compromises would include a minor ring or faint shadow of darkness around brighter objects.

Auto Iris Level and Auto Iris Level Effect

The AUTO IRIS LEVEL setting lets you instruct the automatic exposure system to bias the exposure to be darker or brighter. The AUTO IRIS LEVEL EFFECT tells the automatic exposure system just how much to adjust the exposure. The range is from -50 to +50. A setting of -50 results in the auto-iris system choosing an exposure about 2.0 stops underexposed as compared to "normal"; a setting of +50 results in it choosing an exposure about 2.25 stops overexposed as compared to "normal". Use care with the AUTO IRIS LEVEL setting, especially with + values, as you can easily overexpose your video, leading to ugly "blown out" highlights.



Auto Iris Level Effect: 0



Auto Iris Level Effect: -50

Auto Iris Level Effect: +50

Note also that while this menu item is named AUTO IRIS LEVEL, it can affect more than just the iris! The actual effect is to raise or lower the overall exposure, not just the iris, and the camera will use whatever tools are available to it to accomplish that. For example, if automatic gain is enabled, the camera may choose to add gain. If the automatic shutter is enabled, the camera may choose to adjust the exposure by using the shutter speed instead of the iris. Or, it may choose a combination of all three.

NR CONTROL

Noise Reduction is a standard feature on modern video cameras. This menu item gives the user control over how much Noise Reduction (NR) to apply.

Now, at first glance, you may think "why is this even a question? Apply as much as possible! Nobody likes noise, right?" While these may be understandable sentiments, we still have to factor in that there is no free lunch, and there are side effects to using noise reduction. Once you're aware of what it does, you'll be in a better position to evaluate just how much noise reduction is necessary for your project.

First, understand that all video signals are going to have noise in them, and noise reduction can be an extremely helpful tool in smoothing out or vacuuming up that noise.

The NR Control has a range from -7 to +7, corresponding to minimal noise reduction (-7) to maximum noise reduction (+7). The default value of 0 is a generally reasonable compromise which gives much of the beneficial effect of noise reduction, while avoiding most of the deleterious effects.

The general effect of noise reduction is to minimize the appearance of grainy noise, and the more noise reduction you apply, the more it will minimize the noise, and the more the potential side effects will be. What side effects? High levels of noise reduction typically lead to a reduced appearance of sharpness, softer contrast, flatter colors, and at excessive levels it can introduce blotchiness and ghosting on motion.

The lower you set the NR Control, the more "raw" the image will be; the contrast will be at its sharpest, and there won't be any smoothing in the fine details, and there won't be any motion artifacts (ghosting) happening on high-contrast edges. But, the video will also be its grainiest.

As you gradually increase the NR Control setting, you'll see the grain fade, but you may also notice the image getting somewhat softer overall. Noise reduction can affect the finest details and smooth them out. A little smoothing may be a small price to pay in exchange for the great job it does in eliminating the grainy crawling noise, but the further you raise the NR Control setting, the softer the image may get. In addition, the image may get flatter in contrast -- rich sharp blacks may become a more muted shade of gray, for example. As you push the NR Control up to the highest levels,

these effects will continue, and a new issue may arise: ghosting on high-contrast edges, especially noticeable in low light or underexposed scenarios. The noise reduction system can take advantage of smoothing out noise over multiple frames, which can make it more efficient and effective at reducing grain, but a side effect that may happen is that trailing edges might leave behind a "ghost" image on moving objects.

These pictures illustrate the "ghosting" that can happen when using high levels of NR Control. The camera was panned rapidly past the candle. With minimum NR Control, no ghosted image can be seen, but at maximum NR Control (+7), a trailing afterimage is detectable.

Now, none of this is inherently "bad" or "good", it's just to lay out what the system does, so you can be aware of the effects and make an informed decision as to what level of NR Control is appropriate for your footage. It may come down to which image attribute you're seeing that bothers you more: if you're distracted by crawling grain, or you're forced to use very high levels of gain in a low light situation, you may decide that the level of grain warrants setting a higher NR Control level. On the other hand, if you're seeing too many ghost-like afterimages on motion, that's probably a good sign that you've set the NR Control level too high for the current shot and reducing it some should make the overall image more appealing.

I recommend erring on the side of caution and setting the NR Control level as low as you're comfortable with. If you use too little and you're wishing that more grain had been reduced, well, noise reduction is something that can easily be added in post production. However, the opposite is not true; if you use too much noise reduction while shooting, you'll find that the smoothed-out details and ghostly after-images cannot be fixed easily in post.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System Mode

Note: the Scene File menu settings discussed in the previous chapter can be saved to the memory card in Scene Files. Loading a Scene File will only change the menu settings listed in the Scene File menu. The rest of the menu settings in the camera won't change when you change scene files; there is no way to exchange system mode or other settings between cameras.

System Freq (UX180 Only)

There are two major video systems in the world. In the days of standard definition TV, we would call these two systems "PAL" and "NTSC"; each system was designed to run at (or approximately at) the speed of the AC power system in use in their dominant territories. In PAL territories the AC power is typically running at 50Hz, in NTSC territories the power is usually at 60Hz. Even though there were other differences in the video systems besides their frequency, it has become common shorthand to refer to 50Hz video as "PAL" and 59.94Hz (aka "60Hz") video as "NTSC". There is no equivalent designation for HD and UHD and 4K. In fact, unlike PAL and NTSC, in the world of HD and UHD (and 4K) the video is much more similar from territory to territory than PAL and NTSC ever were. However, one fundamental difference remains, and that's the frame rate that they operate at. While it is probably more correct to refer to 50Hz HD or 50Hz UHD and 60Hz HD or 60Hz UHD, it's still quite common to hear 50Hz HD referred to as "PAL" and 60Hz (59.94Hz) as "NTSC". These terms are grossly inaccurate, but they're also quite common.

This menu item sets the internal clock that governs what mode the camera operates internally at. This doesn't directly dictate the recording format, but it does set the operational format. This menu item offers two timebases to choose from (59.94Hz or 50Hz). The camera also offers a third timebase, 24.00Hz, but that isn't selected from this menu. The camera automatically self-selects 24.00Hz whenever you put it into 4K/2160P 24P mode.

When you select 50Hz, you're setting the camera's internal speed such that it is now appropriate to create 25P, 50i, and 50P video. When you select 59.94Hz, the camera is now prepared to create 23.98P, 29.97P, 59.94i and 59.94P video.

The obvious benefit to being able to set the system frequency is that you are now prepared to create video in any territory in the world. If you are hired by an overseas company, for example, you can shoot video that is appropriate for editing and broadcast in their home country.

You can freely intermix 50Hz and 59.94Hz recordings on the same memory cards if you choose, with one exception: AVCHD. If you want to record in AVCHD, only one type (50Hz or 59.94Hz) can be put on any particular card. Whichever mode the camera is set to, when that memory card is formatted, will be the only type of AVCHD footage that can be recorded on that memory card. If the camera is in 50Hz mode when you format the memory card, and you later switch it to 59.94Hz, you won't be able to record any AVCHD footage on that memory card so long as the camera is in 59.94Hz mode.

One note about 24p - even though the UX180 is a world camera and can be set to either 23.98p, 24p or 25p, users who live and work in 50Hz territories (countries that used to use or still use PAL television) should think long and hard before choosing a 24p mode. Shooting footage in 23.98p or 24p that is intended for delivery on PAL or 50Hz HD systems can create some headaches for you in post production. 24p is not designed for display on PAL or 50Hz televisions. That's why 25p exists — it provides fundamentally the same filmlike look, but in a frame rate and recording format that is appropriate for use in PAL or 50Hz HD areas. 23.98P (or 24P) is appropriate for NTSC territories or for internet distribution, but if you're planning on broadcasting your footage in a PAL or 50Hz HD country, you should give careful consideration as to whether shooting in 25p just makes more sense.

Rec Mode

This menu item is where you choose what file format to record your footage into. The choices are MOV, MP4, and AVCHD. MOV and MP4 are used for recording UHD and FHD footage and, on the UX180, they are also used to record Cinema 4K footage. All this footage is recorded at either 50 or 100 megabits; on the UX180 there are also options for 150 and 200 megabits in certain modes.

The file format itself (MOV or MP4) will have no effect whatsoever on the quality of your recorded footage. Whether you choose MOV or MP4, the quality of the recorded footage will be identical; all that changes is the type of file that is actually recorded, which may have bearing on how you edit the footage. As a general rule of thumb, MOV files are more appropriate for use on Macintosh computers, and MP4 files may be more suitable for use on Windows-based computers.

AVCHD is a whole different kettle of fish. It is a recording format that is compatible with Blu-Ray players and other AVCHD camcorders. For more info on these items, see the Which Mode To Shoot In article.

Rec Format

This menu item is where you choose what recording format to record your footage into. It works hand-in-hand with the REC MODE and the UX180's SYSTEM FREQ functions; certain types of recordings may only be possible with certain REC MODEs (such as AVCHD), and certain frame rates will only be possible based on the SYSTEM FREQ settings.

The various recording formats, and how to choose among them, are covered in the Which Mode To Shoot In? article.

Also, be aware that not all functions are available in all Rec Formats. One example is when shooting VFR (Variable Frame Rates); the only recording format will be work with VFR is 50-megabit 1080p at 23.98, 25, or 29.97 frames per second. If you set your Rec Format to any other setting, then VFR will be disabled. Other examples include when using INTERVAL RECORDING or FREEZE FRAME, and some choices are limited when you set up dual codec recording in the 2 SLOTS FUNC.

For the highest quality recordings, use the highest bitrate you can; use MP4/MOV instead of AVCHD, and on the UX180 use long-GoP 100M instead of ALL-I for the FHD 1080/50p or 59.94p modes.

The owner's manual has extensive cross-reference charts that show which functions are enabled or disabled within which modes, and that data will not be repeated here. Please refer to the Operating Instructions for more information.

Aspect Convert (Standard-Def Only)

There are two aspect ratios that are common in the world of standard-definition television: traditional 4:3 televisions, and widescreen 16:9 televisions. These numbers refer to the width of the picture as compared to its height; a 4:3 television is four units wide and three units tall, whereas a 16:9 television is 16 units wide and 9 units tall (for comparison, a 4:3 television could also be expressed as a 12:9 television, which gives a better understanding of how it compares to a 16:9 television.) Displaying 4:3 video on a 16:9 television will result in video that's horizontally stretched out. Displaying 16:9 video on a 4:3 television will result in a picture that's horizontally squeezed together.

This menu item is only available if you've chosen a REC MODE of AVCHD, and set the REC FORMAT to SA.

The UX cameras are native 16:9 cameras. They are optimized to create video suitable for a 16:9 television (or widescreen DVD, etc). When you use the SQUEEZE setting you get a 16:9 picture, utilizing the entire sensor.

For standard-definition shooting you also have the choice of making 4:3 video. When you choose SIDE CROP, it generates 4:3 video, by extracting a 4:3-shaped patch out of the center of the 16:9 sensor; it uses the full height of the sensor, and crops off the extra width on the sides.

If you're shooting SD for widescreen televisions, or widescreen DVD release, you'll want to always use the 16:9/SQUEEZE mode.

If you're shooting for display on 4:3 televisions, and you want to fill the full screen, you will want to use SIDE CROP mode for a fullscreen display.

There's a third choice as well: LETTERBOX gives you video that is suitable for display on a 4:3 television, but has black bars on the top and bottom, giving the video a widescreen look (like a letterboxed movie.) If you're aiming for release on a widescreen television, use SQUEEZE mode, but if you're aiming for release on a 4:3 television, and you want the widescreen look, LETTERBOX gives you that option.

When choosing which mode to use, you should first decide what type of device your video will be played back on. If it will be played on a 4:3 television, and you want to use the full screen, you'll want to select SIDE CROP. If your video will be played on a 4:3 TV, but you like the widescreen

look, you can shoot in LETTERBOX mode. If your video will be displayed on a widescreen 16:9 television, you would want to shoot in SQUEEZE mode. But SQUEEZE mode is not suitable for display on a 4:3 television, as the image will look tall and skinny. And SIDE CROP wouldn't be suitable for display on a widescreen television, as it would look stretched-out and fat. If you're authoring your footage onto a DVD, you probably will always want to use SQUEEZE mode; DVD players have built-in aspect-ratio-conversion hardware which can automatically convert the video to properly fit whatever type of television it's attached to.

Extended Sensitivity

The camera has adjustable picture gain that ranges from 0dB up to 24dB on the UX180, or up to 30dB on the UX90 (not counting the Super Gain feature). Optionally, you can extend that gain range down to -3dB (giving a range of -3dB to 24dB on the UX180, or -3dB to 30dB on the UX90). Setting Extended Sensitivity to ON extends that range to negative gain; setting it to OFF restricts the minimum gain to 0dB.

Negative gain makes the camera less sensitive (contrary to this menu item's name); it's probably best to think of this menu item's name as shorthand for "Extended Sensitivity Range". Negative gain will also generally make the picture cleaner/less noisy. Negative gain will also let you open up the iris more under brighter light conditions. In general, I find the benefits of having access to negative gain worthwhile and keep this menu item set to ON. The only reason I find to turn it off is on the UX180 when using HIGH SENS. MODE; High Sens. Mode is incompatible with negative gain and enabling High Sens. Mode will force the Extended Sensitivity to OFF.

High Sens. Mode (UX180 Only)

The camera has two base sensitivity settings; NORMAL and HIGH SENS. When set to NORMAL, the UX180 operates at a base sensor sensitivity of approximately 500 ISO. If you're entering a darker environment and need more sensitivity, you can set this menu item to HIGH SENS. That effectively doubles the ISO (to a base of approximately 1,000 ISO) while retaining a comparable level of noise in the image to 500 ISO.

The HIGH SENS mode acts like a combination of adding 6dB of gain (or doubling the ISO), while also increasing the strength and effectiveness of the noise reduction applied to the image. Normally, adding 6dB of gain (or doubling the ISO) would result in adding quite a bit of grain to the image. HIGH SENS addresses that by using more aggressive noise reduction; the

end result is actually a picture that's slightly cleaner than NORMAL mode, while being twice as bright. (The benefit to HIGH SENS is more visible in lower gain settings; by the time you get to +18dB of gain in HIGH SENS, it looks about comparable (noise-wise) as +24dB in NORMAL would be.)

So why wouldn't you just always use HIGH SENS? Three reasons:
1) HIGH SENS works its magic through noise reduction, and noise reduction has side effects. Fine image detail may be lost, the overall image might become "smoother", colors may be a little flatter. It's really a matter of taste; you have to try it to see if you prefer it.

2) Outdoors. It seems obvious, but you would likely not want to use HIGH SENS during daylight; the base ISO of the camera is already plenty sensitive enough that you'll likely need to use 1/64 ND just to get a proper exposure; adding HIGH SENS on top of that may just end up requiring you to use a faster shutter speed to get proper exposure. Generally, during daylight, you'd be better off with NORMAL sensitivity — unless you prefer the slightly less noisy look of HIGH SENS; in that case, you may choose to add an external ND filter to the front of the lens and use HIGH SENS at all times.

3) Negative gain. The UX180 has the capability of using the EXTENDED SENSITIVITY menu item to extend its gain range down to as low as -3dB of gain, but EXTENDED SENSITIVITY is disabled when you enable HIGH SENS. MODE.

Low Light Mode (UX90 Only)

The UX90 has a one-stop "low light" mode which applies extreme measures to get the brightest possible picture in low light shooting. Enabling this menu item (or assigning it to a user button and pressing that user button) puts the camera in very aggressive settings to gather as much light as possible. It will employ the slowest shutter speed it can (1/24 in 23.98p, 1/25 in 25p, 1/30 in 29.97p) and will use exorbitant levels of gain (up to 30dB in UHD mode, or as much as 36dB in 1080, 720, or standard-def modes).

There's one other requirement for using Low Light Mode - you have to put the camera in fully automatic mode, using the AUTO/MANU switch. When Low Light Mode is activated, the camera employs automatic iris, gain, shutter, and white balance. So it will give you the brightest images possible under the circumstances, but it will do so while giving you the least manual control over the image.

I consider Low Light Mode to be somewhat of a "Hail Mary" pass -- it's something you employ when you have no other choice. If you simply cannot get enough brightness any other way, you can throw the camera in automatic and Low Light Mode and it will likely get you a visible image in even the worst lighting conditions. But, do understand it likely won't be the prettiest image -- using extensive gain (up to 36dB) will likely mean the image will be very very grainy and noisy, and using slow shutter speeds will likely mean you'll have smearier motion than you might otherwise normally prefer. As I have said in other places in this book -- adding a little bit of light will do far more for the quality of your images than any manipulation of the camera settings can compensate for. However, frankly, there's just some times where you can't add light, and you need to get an image. Low Light Mode can certainly do that.

Flash Band Compensation

This option lets you toggle on or off the Flash Band Compensation (FBC) feature. The UX cameras use MOS sensors with a rolling shutter, and all rolling shutter cameras are susceptible to the Partial Exposure situation when faced with a photography flash or strobe light going off. The Flash Band Compensation function is designed to minimize or eliminate the appearance of flash bands in your footage. There are some potential side effects when using the FBC function however; it'll cause a momentary drop in resolution on the "fixed" portions of the frame, and motion through the frame might appear frozen for a tiny fraction during the flash compensation. There may also be a thin horizontal line or two, but that's certainly better than having half the screen flashed and half dark. Don't use it all the time, either — this is something that's only for use when you know you're going to be seeing photography flashes going off. It'd be possible to fake out the system and have it trigger unnecessarily if you shot something that had a huge contrast of light and dark in the frame, such as a snap zoom-out from a brightly-exposed window, so — definitely don't leave this on all the time, use it only when necessary.

Also, FBC is not available in all modes, it only works in 50i/50p or 59.94i/59.94p, and it won't work if you've enabled Digital Zoom or Variable Frame Rates or the UX90's Low Light Mode.

When using FBC, the shutter speed will be forced to a fixed 1/60 (when shooting 59.94i/p) or 1/50 (when shooting 50i or 50p).

You can enable it here in the Scene File menu, or by assigning FLASH BAND to a USER BUTTON; either way, it works the same.

Camera Number Set

This menu item can help you keep track of footage in a multi-camera shoot. You can assign each camera an individual camera number, from 0 to 16. That camera number gets recorded in the filename for the recorded footage. When the footage is brought into post, looking at the last digit of the filename, you can determine exactly which camera the footage came from.

The camera stores its footage in subdirectories that contain information about the footage itself, and one of those pieces of information is what the CAMERA NUMBER was set at. If, for example, your camera was set to CAMERA NUMBER 3, then a recorded clip might produce a file directory called something like 122YCRH3. That seemingly random name is actually composed of specific information.

122YCRH3 breaks into certain categories: 122/Y/C/R/H/3, as follows:
122 = the sequential number of the recordings. The next directory on this memory card would start with a prefix of 123, for example.

Y = frame size. There are three possible options here; Y=FHD, R=UHD, and Q= 4K (UX180 Only).

C = frame rate. A=59.94, B=50.00, C=29.97, D=25.00, E=24.00 (UX180 Only), and F=23.976.

R = motion picture format. J=interlaced MOV, K=interlaced MP4, Q=progressive MOV, and R=progressive MP4.

H = recording settings for specifying what type of recording this was. On a UX90, this will always be "H". On a UX180, it will generally be an H, unless you were using Dual Codec Recording. If you were using Dual Codec Recording, then this will change; D = 50Mbps sub-recording of a dual-codec recording, E = 8 Mbps sub-recording of a dual-codec recording, and P = this is the main recording of a dual-codec recording.

Finally, the 3 in our example 122YCRH3 represents which camera number this particular recording was made from. This can be any number from 0 to 16, and you choose that number using this CAMERA NUMBER SET function. This number gets appended to the end of the directory name where the footage is stored; this will be either a number (0-9) or a letter (A-G, representing 10-16).

Note: this number does not get appended to the CLIPS, it gets appended to the DIRECTORY. The clips within that directory are named much more simply; they use the sequential directory number, followed by an individual clip number. As an example, in our hypothetical 122YCRH3 directory, the directory number is 122. If there were four clips in that directory, they would be named like this:
01220001.MP4
01220002.MP4
01220003.MP4
01220004.MP4

As you can see, there are two components to the file name, the first 4 digits compose the directory number, and the last four digits represent the individual clip number.

The relevant part of this discussion, however, is on knowing how you can separate and keep track of multiple cameras in a multi-camera event, using the CAMERA NUMBER SET. And that is easily accomplished by just looking at the last digit of the subdirectories. If you've properly set up each camera at the beginning of the shoot to have an individually-set CAMERA NUMBER, then you can tell at a glance which footage came from which camera by just looking at the last digit of the subdirectory name.

If you want to reset the folders to start at 0001, format your memory card, and then go to the OTHER FUNCTION -> NUMBER RESET and reset the number there. That will start your directories out at 001 and your clips at 0001.

One final note: this is all applicable only to .MOV or .MP4 recordings. The Camera Number Set is not used when recording AVCHD files. AVCHD has its own file numbering system and doesn't provide an option for encoding the camera number within its file naming/numbering. As such, you can only use Camera Number Set when recording in MOV or MP4 formats.


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR
15x OPTICAL ZOOM
FOCUS
PUSH AUTO
IRIS
AWB
GAIN
WHITE BAL
SHUTTER
MENU

USER SW - Settings for the USER Buttons

The UX90 and UX180 cameras feature nine physical buttons that can be customized to perform a number of different functions. These are called USER BUTTONS. In addition, the camera lets you program four "virtual" User Buttons, which are accessed by touching the LCD display touchscreen. In effect, this gives you 13 programmable User Buttons. Some of these buttons are pre-programmed with highly useful functions (such as User 5, which is the Zebra button, or User 6, the O.I.S. button, or User 9, the AWB button). You can change their functionality if you want, but then it would be up to you to remember that that particular button's pre-labeled function is no longer the actual function that it will perform.

The UX180 has 45 potential functions that can be assigned to any of these User Buttons (or "virtual" User Buttons), and the UX90 has 41 potential functions for these buttons. Some of these functions can be enabled either in the menus or through a User Button; an example would be Flash Band Compensation. Following is a description of each function and how it works when assigned to a User Button.

Inhibit: Assigning this function essentially disables this particular user button. If you find yourself accidentally/unintentionally pushing user buttons, you might want to "inhibit" them with this function.

Focus Assist 1 and Focus Assist 2: There's already a dedicated FOCUS ASSIST button on the camera; this choice lets you assign a user button to do the same thing. While that may seem redundant (and it is), this could let you assign Focus Assist to a virtual button on the LCD rather than a physical button on the camera body, if for some reason you needed to operate the function solely by touching the LCD rather than the camera itself.

Additionally, there are two separate functions that can be assigned to two separate buttons. The camera's main FOCUS ASSIST button can be configured to either execute a magnified focus assist (called EXPAND), or it can do a colored "peaking" function (called PEAKING), or it can do both. If you'd like to view the EXPANDed focus assist separately from the PEAKING focus assist, you could assign FOCUS ASSIST 1 to a User Button, and then assign FOCUS ASSIST 2 to a different User Button. Then, in the SW SETUP menu, you can pick which function that each Focus Assist executes (example; you could assign EXPAND to Focus Assist 1, and PEAKING to Focus Assist 2). Do be aware, however, that if you assign BOTH to Focus Assist 1, then Focus Assist 2 becomes unavailable.

Also, whatever function you assign to Focus Assist 1, is the function that will happen when you press the dedicated FOCUS ASSIST button. So, in effect, if you assign Focus Assist 1 to a physical User Button, you will have duplicated the functionality of the dedicated FOCUS ASSIST button, and therefore wasted a User Button. As such, there's not much need to assign Focus Assist 1 to a physical User Button, unless you just prefer different positioning, such as assigning it to User 8 (up by the zoom rocker) so it's accessible from the other side of the camera.

Spotlight: Pressing this button will cause the system to expose about 2 f-stops darker, as versus what it would normally auto-expose at. If the camera was set in manual iris mode, pressing SPOTLIGHT will force it to go to auto-iris mode. Note that the auto-exposure system doesn't rely solely on the auto-iris; it will also use the auto shutter speed and the automatic gain, if those are enabled.

Backlight: Pressing this button will cause the auto-exposure system to expose about 2/3 of a stop more brightly than it would otherwise have done. If the camera was set in manual iris mode, pressing BACKLIGHT will force it to go to auto-iris mode. Note that the auto-exposure system doesn't rely solely on the auto-iris; it will also use the auto shutter speed and the automatic gain, if those are enabled.

Black Fade: Pressing and holding this button will cause the picture to fade to black, and the sound to fade out to silence. The longer you hold the button, the more the picture will fade: you have to hold the button in for a while to get the picture entirely black. For the next shot, if you want to execute a fade in from black, you would need to hold the button in while

the camera is paused, until the screen is fully black. Then start recording and release the user button, and the image will automatically fade up from black. Keep in mind that the BLACK FADE (and WHITE FADE) have nothing to do with starting or stopping recording; you could do a complete fade to black and then back to picture, all while continuously recording, if you wanted to. Also, the fade functions won't work during VFR recording or while doing time-lapse INTERVAL RECORDING.

White Fade: Same as BLACK FADE, except it fades to/from white.

ATW: Enables or disables Automatic Tracking White balance: see the discussion about ATW in the SW Setup settings. Note: if you've used ATW LOCK, then this ATW button becomes disabled; you can't use the ATW function to un-lock ATW LOCK. Instead, you'd have to use the ATW LOCK again to unlock it; at that point this ATW function becomes enabled again.

ATW Lock: When using ATW, the system will constantly hunt for what it considers the optimal white balance. You can stop the camera from hunting and tell it to lock in the current white balance setting by using the ATW LOCK function. If you use ATW LOCK to lock in the white balance, and then press ATW LOCK again, it will un-lock and return to hunting in ATW mode. Note that this ATW LOCK function is only available if the current white balance mode is ATW; it won't work if the current white balance is set to a preset or to manual white balance.

D.Zoom: The camera has the ability to digitally magnify the image ("digital zoom") by a factor of 2x, 5x, or 10x. This magnification operates independently of the optical zoom, so you could (if so desired) have the lens zoomed out to wide angle, but still engage the digital zoom (although there are probably few valid reasons to actually do that.) Using D.ZOOM extracts a central portion of the image and digitally stretches it up to fill the frame, but it also causes a corresponding loss of resolution. How useful it is depends to a degree on what mode you're shooting in. A Digital Zoom of 10x is going to look extremely low-resolution, soft, and aliased if it's mixed into in the middle of a UHD production, for example, but a D.ZOOM of 2X might be okay when recording in standard-definition mode. In 720p mode, a 2X D.ZOOM will be noticeably softer than a non-zoomed image, and may or may not meet your standards of acceptability. In 1080 or UHD, I find that any usage of D.ZOOM results in a dramatic loss of resolution. In any of the modes, I think 5X and 10X are so low-resolution as to render

them of extremely limited usefulness. D.ZOOM might perhaps be most appropriate when shooting in lower light conditions where zooming in optically might result in the lens stopping down the iris, and if you're in a case where brightness is more important than sharpness you might be able to optically zoom back out and use the digital zoom (especially when in standard-def mode and using only 2X). Just be aware that there will be a loss of resolution in D.ZOOM mode; at 2X it's minimal in standard def, noticeable in 720p, and substantial in 1080p. At 5x and 10x the loss is simply massive.

D.ZOOM is not available when using the AREA MODE, FREEZE FRAME, or during VFR or INTERVAL RECording.

REC Check: This will play back the last couple of seconds of footage you shot, without having to switch the camera over to thumbnail mode. You can't use this button to actually rewind and watch the whole clip; you'd have to toggle over into playback mode to review the entire clip. Note that there are several circumstances that will make this function not work, such as turning the camera off, or changing the recording format, or ejecting the memory card. It also won't work if you've established 2-slot recording (either Simultaneous or Background), or if you're using PRE-REC or time-lapse interval recording.

Last Scene Delete: This function allows you to immediately delete the last clip you've just shot. Instead of toggling over to the playback mode and manually selecting and deleting a clip, you can instead delete the last clip with the press of a USER button (and, of course, verifying that you actually do intend to delete that clip). It's convenient, but it's not dangerous; it's difficult to accidentally delete a clip because the system asks you to confirm that you really intend to delete it. The LAST SCENE DELETE function won't work if you've changed recording formats since shooting your last clip, or if you've powered down the camera, or if you've gone into playback mode, or if you've ejected a memory card since recording the clip. It also won't work during interval recording, or if you're using the 2-slot recording functions (other than RELAY REC).

DRS: The DRS capability is discussed in the Scene File menu section. Assigning this function to a User Button lets you toggle the DRS function on or off. It's the same as if you went into the Scene File menu and manually changed the DRS menu item, but locating it here lets you toggle DRS with the push of a button instead of having to go into the menus. Note: this

doesn't allow you to set the intensity of the DRS effect; it only enables or disables DRS processing. You set the intensity of the DRS effect using the DRS EFFECT Scene File menu option.

Frz Frame: This is a stylistic effect; you can "pause" the live video feed, while still recording live audio. Live audio will be recorded underneath a still frame, of whatever was happening at the moment you pressed the User Button you'd assigned FRZ FRAME to. FRZ FRAME is not possible when you're recording VFR or time lapse/interval recording, and you can't invoke it while you're using the FOCUS ASSIST. It also won't work when you're displaying color bars, although — that's hardly a limitation, as color bars are in and of themselves a freezed frame.

Super Gain: Besides the settings you can assign to the Gain button, there's a separate user-settable maximum limit of electronic gain, called SUPER GAIN. You set the limit in the SW SETUP->SUPER GAIN menu. First, establish the amount of Super Gain you want the system to use (on the UX90, you can choose +33dB or +36dB; on the UX180 you can choose +30dB or +36dB). Then, assign SUPER GAIN to a User Button; pressing that User Button will trigger SUPER GAIN. Consider that 30dB of gain makes the image 32 times brighter than at 0dB, and 36 dB of gain makes the image a full 64 times brighter! That's a whole lot of gain, and it will bring a whole lot of noise with it. Your image quality will be seriously compromised by using such a high level of gain, but if you can't get the shot any other way, you may want to consider it. Super Gain won't work with the UX180's HIGH SENS MODE, or when the UX90 is in LOW LIGHT MODE, and it won't work if the camera's gain is in automatic mode of course.

Area: If you've ever wanted to just point to a spot on the LCD screen and tell the camera "focus here" — well, that's what the AREA function can do. You have the capability to specify what section of the frame you want the camera to prioritize when it comes to certain functions. Assigning AREA to a User Button lets you enable this "AREA" mode; you'll see a yellow crosshairs display on the screen and there'll also be an indicator saying "AREA" in the upper right of the display.

The AREA function is not just for focus; you can have the

system also prioritize exposure, or even other features, depending on how you've set up the SW SETUP->AREA MODE function.

Assigning AREA to a User Button, and pressing that button, activates the AREA mode. It will stay activated until you press that same User Button again to de-activate it. While the AREA mode is active, you can move the frame anywhere you want to, just by pointing at a spot on the LCD display, and the camera will automatically set the focus or exposure (or whatever function you've specified) in that region of the frame. You can also use the menu jog/dial wheel to change the size of the AREA frame, so you can have your chosen function take place based on a larger or smaller section of the screen. While the AREA mode is active, you can't use the touchscreen for anything else; you won't be using the touchscreen to access the menus, for example. You'd have to use the physical MENU button to be able to access the menus. This also means that the four "soft" User Buttons (#'s 10, 11, 12 and 13) won't be available while you're using Area Mode.

Also, keep in mind that the functionality of the Area Mode depends on how you have the camera configured for automatic or manual control. If you've set the camera to manual focus and manual exposure, but you configure the AREA MODE function for "FOCUS/IRIS", then the camera will briefly go into automatic focus and automatic iris when you move the AREA box on the screen. It'll return to manual focus and manual iris once it's grabbed focus/iris; it won't continually monitor focus and exposure in that case. On the other hand, if you set the camera to automatic focus and automatic iris, then yes, the camera will continually monitor and adjust focus and iris while in AREA mode.

AREA mode isn't possible when you're recording VFR, or when you're using the wireless remote control ROP application.

Histogram (UX90 Only): This function lets you bring up the Histogram exposure tool. See the article on the Histogram for an introduction on how to use this exposure tool.

Note that when using the Histogram, you can move it anywhere on the screen that you prefer. Hold your finger down on the Histogram on the LCD display for a few seconds, and you'll see that it will "detach" from the screen, and you can then drag it to a different spot on the display. Also note that the easiest way to get the histogram to disappear from your display, is to press the "HISTOGRAM" user button again.

Focus Trans (UX180 Only): The UX180 has the ability to pre-register up to three focus positions, and then seamlessly transition between them. You have to first program in your focus points using the relevant RECORD SETUP menu items; please see the discussion on FOCUS TRANSITION in the RECORD SETUP menu for details.

Once your focus points are established, just press the User Button to which you've set FOCUS TRANS. The camera will display three buttons on its LCD panel (named "1", "2", and "3"); pressing one of the buttons will cause the camera to shift focus to that pre-established position. Alternatively, you can press USER1, USER2, or USER3 physical User Buttons to trigger one of the focus positions; this might result in a little less camera shake than pressing on the LCD. Obviously this means that whatever functions you've assigned to USER1 thru USER3 won't work while the FOCUS TRANS function is active. FOCUS TRANS won't work when the camera is set to autofocus, or during FREEZE FRAME or VFR recording. Also, your pre-programmed focus positions will be lost if you turn the camera off, or go to the playback/thumbnail mode, or if you use the zoom, or if you use the UX180's Infrared Recording feature. If you press the FOCUS TRANS User Button and it says "INVALID", that probably means you haven't set any focus points yet, or you've moved the zoom since they were set. If so, you'll need to go back into the Record Setup menu and set new focus points.

Push Auto: When you're using Manual Focus, you can tell the camera to execute a quick one-touch autofocus procedure by using the PUSH AUTO function. Note that this is the exact same feature that's available by using the dedicated PUSH AUTO button, located under the Focus switch.

EVF/LCD Detail: This function lets you enable (or disable) the "peaking" feature on the Electronic ViewFinder (EVF) and LCD touchscreen panel. This can be an excellent focusing aid; I pretty much set this on and rarely ever disable it. You configure the particular settings for EVF/LCD Peaking in the DISP SETUP menu; this User Button enables or disables the function.

IR Rec (UX180 Only): This User Button enables (or disables) the Infrared Recording Mode. When you enable it, the camera removes its built-

in infrared filter, allowing it to record footage solely via infrared light. This literally lets the camera see in the dark (as long as there is some infrared light available). You generally don't use this in daylight; it's designed for low-light use. With an infrared-emitting light installed, you can film in pitch-black conditions, which may be useful for reality TV or wildlife filming, for example. There are a few caveats that come with IR REC, of course; you can't use it in VFR mode, and the focus distances reported by the camera may not be accurate when recording in IR REC. The camera also takes over full control of the iris, the gain, and the shutter speed; generally it forces the iris to maximum wide open and the shutter speed to the slowest shutter speed it can get, to let in the most light. You can also set the color of the infrared footage, to either black & white or to have that characteristic green night-vision look. Also, you'll have little to no control over the image parameters in the Scene File Menu during Infrared recording. You should consider IR REC as a fully-automatic mode, and attach an IR-emitting light for best effect in dark environments. If you want to use it during daylight, you'll need external Neutral Density filters in front of the lens to bring the light level down low enough to get a usable exposure; the camera's internal ND filters are disabled when using IR Rec.

Low Light (UX90 Only): This User Button allows you to engage or disengage the UX90's LOW LIGHT MODE at the press of a button. Note that the Low Light Mode is only available when the camera's in fully automatic exposure, with the AUTO/MANU switch set to AUTO. See the discussion on LOW LIGHT MODE in the System Mode menu for more information.

Level Gauge: The camera has a built-in two-axis level gauge that can display both horizontal skew (camera rotated as compared to the horizon), and vertical tilt (the camera being tilted up or down, and not level). This can be a great way to keep your eye on your horizons to keep them nice and flat (or you could also use the DISPLAY SETUP->GUIDE LINES function for that). It's also a great way to level the camera when setting up a tripod, especially if your tripod head doesn't have a bubble level. The level gauge works great from a tripod, but is not necessarily as useful for handheld work; it does work, but it doesn't necessarily respond instantly, so it doesn't read out its best when the camera is being actively moving. It's best for when you've steadied yourself up to take a stable handheld shot, but it's not going to be much use if you're running with the camera, for example.

Background (UX180 Only): This will start or stop BACKGROUND RECORDING on your second memory card (if, of course, you've configured

the 2 SLOTS FUNC to BACKGROUND). When recording using BACKGROUND RECORDING, the normal red REC button will start the recording on both memory cards, but it will only be able to stop the recording on the primary card; it cannot stop the card that's being used for BACKGROUND recording. You can start and stop that card's recording by using this User Button function. To start it, just press the User Button that you've assigned this function to. To stop background recording, you first have to ensure that the primary card has stopped recording; you can't stop background recording if the first card is still recording. When that first card is stopped, then you can press and hold this User Button for about five seconds, until you see and verify that background recording has also stopped.

Flash Band: This User Button enables or disables the Flash Band Compensation function. You can enable or disable this function either through the Scene File Menu, or by pressing this User Button; the functionality is the same. All the same restrictions apply though; for example, it will only work if the frame rate is 50p/50i or 59.94p/59.94i; it won't work in 23.98p or 25p or 29.97p.

PRE REC: The Recording Setup menu offers a PRE-REC menu item. Assigning this to a User Button lets you toggle PRE-REC on or off without having to go into the menus. Using this User Button won't actually start recording; instead it will start the PRE-REC buffering. You'll still have to press the regular red record button to start actual recording (including the PRE-REC buffer).

Note that PRE-REC won't work while recording VFR or when set for BACKGROUND RECORDING or time-lapse Interval Recording. PRE-REC will also time out after about three hours, at which point it'll have to turn itself off and then right back on again. This means there's a very rare instant where there might not be a PRE-REC buffered recording for a few seconds right around three hours after you've enabled it, and every three hours thereafter. And, obviously, if you start recording immediately after enabling PRE-REC, you can't expect to get the full three to four seconds of pre-record (that would only be possible if at least 4 seconds have passed between enabling PRE-REC, and starting recording).

WFM (UX180 Only): This enables (or disables) the WaveForm Monitor (WFM) or Vectorscope (or both), depending on how you've configured the SW SETUP->WFM TYPE menu item. Note that User Button 4 is

configured for the WFM by default, so assigning WFM to a different button may be redundant. One challenge may come from setting WFM to a virtual User Button (#'s 10-13); once you enable the WFM, the virtual User Buttons disappear, so you can't toggle it back off (especially if you've reassigned User Button 4 to a different function!) The way around this would be to use the MENU button to go into the SW SETUP->WFM menu item to set it to OFF.

The WFM cannot be used while you're using the FOCUS ASSIST or when using the FREEZE FRAME function, and it also won't show up in the viewfinder; the waveform is only available on the LCD display. And, when on the LCD display, it pretty much removes all other displays, so you will not be able to see the iris or shutter speed, for example.

Fast Zoom: This User Button enables or disables the Fast Zoom option. This isn't related to the variable speed of the zoom, rather it's a special higher-speed drive mode of the zoom motor, which results in somewhat faster maximum zoom speed at the trade-off of hearing more zoom motor noise during the zoom. If you want the fastest possible zooming, turn this on. If you need the quietest possible zooming, leave this set off.

EVF On/Off (UX180 Only): This lets you turn on the EVF (Electronic View Finder), or turn it off. In general you'd think this lets you swap between the EVF and the LCD, and sometimes that's the case, but sometimes it isn't. The UX180 doesn't support both the EVF and the LCD at the same time, so turning the EVF ON will always turn the LCD off; however, it's not a guarantee that the EVF will stay on (or that the LCD will stay off!) The EVF is governed by an eye sensor, and if the sensor doesn't detect something in close proximity within a few seconds, it will turn off the EVF to protect it from damage. The EVF is a sensitive OLED device and could be harmed by direct light; it's designed to be used only when your eye is up against the viewfinder (thus blocking that stray light). So you can toggle the EVF on and off using this function, but if there's no eye blocking the light from the EVF, the eye sensor will shut the EVF off, and that means the LCD will come back on. Note that if you've used the LCD/EVF OUTPUT function to specify that only the LCD should be used, then this User Button will have (of course) no effect.

A. Iris Level: This User Button enables (or disables) the AUTO IRIS LEVEL function. Assigning this function to a User Button allows you to toggle the feature on or off without having to go into the menus to change it. Note that even though it's named "AUTO IRIS LEVEL", this function

potentially affects more than just the iris; you should think of it more as an AUTO EXPOSURE LEVEL function, since the camera will use the automatic shutter (if available) or the automatic gain (if available) in addition to the automatic iris, in order to adjust the exposure level to meet the level you've requested.

Zebra: This User Button allows you to designate one of the physical or virtual User Buttons to enable and toggle through the various Zebra options. By default, User Button 5 is programmed with this function. See the section on ZEBRAS for more information.

O.I.S.: This lets you assign a User Button to toggle the Optical Image Stabilizer on/off (in UHD/4K mode) or Hybrid/Normal/Off when in FHD or AVCHD mode. By default, User Button 6 is programmed with this function. See the section on the O.I.S. Button for more information.

Scene File: This User Button duplicates the functionality of the SCENE FILE menu's LOAD/SAVE function. This allows you to save your Scene Files onto a memory card, and to load in either all six, or one individual Scene File back from the memory card.

Auto Rec: This User Button is used to control an external recorder (such as a tape deck or a hard disk or solid-state disk recorder, such as a Convergent Design Odyssey 7Q+ or a Video Devices PIX-E5H.) The camera has the capability to send a recording flag on its HDMI outputs (and on the UX180's SDI output). If you're recording internally to the camera's memory cards and simultaneously externally to an external recorder, you don't need to use this function. However, if you are not recording internally, and you only want to record externally, that's what this function is for. To have the camera control an external recorder, you'll first have to verify with the recorder's manufacturer whether or not it supports this camera. Assuming that it does, you'll need to do a little setup first. See the discussion on CONFIGURING FOR EXTERNAL RECORDING for details. The AUTO REC button can then be used to start and stop the external recorder only.

AF Area: This is another way to control what region the autofocus system uses to determine what to prioritize for focus. Unlike the AREA function, this doesn't let you move the region around the screen, but it does let you define the size of the region that the autofocus system will use to

focus on. Press the User Button you've assigned to this function, and the camera will draw a box on the LCD showing what the current autofocus region is. Then use the menu jog/dial wheel to change the size of the box; the camera will then prioritize its autofocus efforts to focus on that section of the frame. This is a temporary modification; it's in effect until you cancel it (by pressing this User Button again). If you want to adjust the size of the box while the AF AREA function is active, you can use the menu/jog dial wheel to scroll to "AF AREA", and press the wheel in like a button; it will then bring up the AF AREA box and you can adjust it as before.

This function is only possible if the camera is set in Autofocus mode, of course.

VFR: This User Button enables VFR recording if certain criteria are met (such as that the camera must be in MOV/MP4 1080P recording, and you can't have set BACKGROUND or SIMULTANEOUS recording, and all the other usual prohibitions associated with VFR.) Fundamentally, this User Button does the same thing as going into the RECORD SETUP menu and choosing VFR MODE. You can toggle the state of VFR on or off with this User Button, exactly as you can do with the RECORD SETUP Menu option. See the discussion on VFR MODE for more information.

Focus Macro: The lens generally focuses to a minimum distance of about 2.85 feet on the UX180, about 2.71 feet on the UX90. It can, however, focus much closer if you use the Focus Macro User Button. With Focus Macro enabled, the lens can focus closer; the more you zoom out, the closer it can focus, down to as close as under four inches (about 10 cm). The close focus distance depends on the zoom setting; it's about 10 cm (4 inches) from 8.8 mm up to about 56.0 mm, and then it gradually increases to about 1 foot at about 84mm, up to around 2.71 - 2.85 feet at full telephoto.

Why would you ever want to turn Focus Macro off? The main reason would be for when using automatic focus. If Focus Macro is on, it greatly increases the range that autofocus has to search, to find proper focus. Turning Focus Macro OFF reduces the range it has to search, and results in more responsive, quicker autofocus (assuming, of course, that what you're focusing on is further than about 2.85 feet from the front of the lens!)

i.Zoom: This user button enables or disables the i.Zoom function (assuming that all other conditions have been set so that i.Zoom is possible, such as setting the recording format to 1080 and turning off VFR, etc). This

functions the same as setting the SW SETUP->I.ZOOM function to ON or OFF, but lets you do so through a button press rather than having to go into the menus to do it.

USB Mode: This provides the same functionality as the OTHER FUNCTION Menu's USB MODE menu item; it basically turns the USB ports on or off. This is perhaps most useful if you're using a wireless adapter for remote control with the ROP app; it gives you a convenient one-button way to turn the adapter on or off, without having to go into the menus.

AWB: This provides the same functionality as pressing the AWB button on the front of the camera. In fact, it is the same functionality; since the AWB button is actually a reprogrammable User Button in and of itself, this AWB function is the default function assigned to it. If for some reason you decided you wanted to use the AWB button for some other purpose and programmed it to a different function, you could assign this AWB function to a different User Button so you still had access to the same functionality.

Super Slow (UX180 Only): This button toggles Super Slow Recording on/off. It provides the same functionality as the RECORD SETUP menu's SUPER SLOW REC menu item, but with the convenience of it being on a User Button. Of course, all the same restrictions about Super Slow Recording apply (for example, it won't work in AVCHD or UHD recording, etc.)

Slot Sel: This lets you change which card slot the camera will record to next. If you're recording to only one card, it will change which card slot gets recorded to; if you're recording to two cards simultaneously (such as using the UX180's BACKGROUND recording feature), it will change the assignment between cards (so Slot 1 can be the main recording and Slot 2 is background, or, after pressing this button, Slot 1 will be background recording and Slot 2 will be the main recording).

LCD/EVF Output: This User Button functions exactly the same as the OUTPUT SETUP->LCD/EVF OUTPUT menu option. On the UX90, pressing this button will toggle which is the active display device, either the LCD panel or the EVF viewfinder.

On the UX180, the functionality is a little different because of the presence of the UX180's eye sensor. Using this function you can choose to use only

the LCD, or you can choose to establish auto-switching, automatically sensing and switching between the two. If you cannot get used to the eye sensor and you want to use only the LCD, using this User Button (or its attendant menu function) is one way to do that.

Note that this function is the default program assignment of User Button 7.

Low Gain / Mid Gain / High Gain: These buttons let you switch between the pre-assigned gain values that you establish in the SW SETUP menu. By assigning a User Button to these settings, you can instantly set the camera at a fixed gain value. Normally, using the Gain button on the camera body, each press of the gain button would toggle between Low, Mid, and High. But by establishing a direct User Button, you can select specifically which gain setting you want, without toggling between the others.

Additionally, if you've modified the gain setting (using the jog/dial wheel), that will modify the current gain but it won't change the value of these User Buttons so, you can restore the gain value to a preset position even if you've modified the current gain with the wheel.

Menu: This lets you duplicate the function of the physical MENU button on another physical or virtual User Button. There's not much point in duplicating it on another physical button, but this option is used by default for the #13 virtual User Button. When you touch the touchscreen and the bottom-left option is "MENU", that's a result of this function being assigned to virtual User Button 13. You can assign this to any other virtual User Button (or, for that matter, any physical User Button) if you so choose (except there's not much point in that, seeing as there's already a physical menu button).


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SW SETUP - Button and Switch Settings

The menu items discussed in this section are found in the SW SETUP menu. “SW” is a confusing name for this menu, but what it really means is, this menu controls what the physical switches and buttons and other physical controls on the camera do. SW can be thought of as being short for “switch.” Some examples of the controls that are affected by this menu include: the Gain button, White Balance button, the Iris Ring, the zoom levers, and the Auto/Manu switch. The USER BUTTONS are not discussed in this section; they have their own menu and chapter.

Iris Ring

This menu setting controls the relationship between the direction the iris ring is turned, and the opening/closing of the iris. You can set it so that the iris opens up when the ring is rotated down, or so the iris closes down when the ring is rotated down. Broadcast cameras typically use down=open; newer users unfamiliar with broadcast gear may more intuitively feel that up should open the iris. With this setting you’re free to choose which way you prefer. Note: sometimes you can adjust the iris, and the exposure doesn’t change at all. If that happens, check to see if the camera is using either automatic shutter control, or automatic gain control. It might be canceling out the effect of your iris change by changing the shutter or gain without you realizing.

Gain Button

Before addressing what the Gain Button does, you should understand what Gain is. Please see the section on Gain in the Understanding Exposure article.

There is a physical button for the amount of electronic gain, with three positions: Low, Mid, and High. You can choose how much Gain gets assigned to each position, anywhere from 0 to 24dB (30dB on the UX90), in 1dB increments, or you can set any position to AUTO, where the camera can selectively decide to change the amount of gain to achieve suitable exposure. The AUTO position is found by setting the position one notch below 0 (put another way, the range of selections is AUTO, 0, 1, 2, 3, ... 23, 24).

Why auto? Sometimes you may want to force your iris and shutter speed to fixed values, and let the gain be used to change the exposure. Doing so carries its own drawback, of course; changing gain will change the level of noise in the image, and very high levels of gain can have a notably negative effect on image sharpness, color purity, and noise.

Note: sometimes you can change the gain and the exposure doesn't seem to change at all. Check to see if the camera is in either auto-iris or auto-shutter mode; if so, it may be adjusting the exposure on its own to cancel out the change in gain.

Super Gain

In addition to the gain choices offered by the Gain switch, you can also get up to +36 dB of Super Gain. Super Gain is only possible through the use of the User Buttons. This menu item lets you decide how much gain will be applied when you enable Super Gain through using the User Buttons. The UX90 can set +33 or +36dB; the UX180 can set +30 or +36dB. Just remember, use of Super Gain should be restricted to times when it's absolutely necessary, since the image will become much noisier and grainier under Super Gain.

O.I.S. (Optical Image Stabilizer)

This menu item engages or disables the optical image stabilization system. The camera has a User Button dedicated to this function (User Button 6); however, if you've reassigned User 6 to a different function, you can still come into the menus and use this selection to enable or disable the O.I.S. Read more about the O.I.S. in the Physical Switches, Buttons, and Jacks section.

Hybrid O.I.S.

When recording FHD or AVCHD, the camera's optical image stabilization system can work in two different modes: normal, and "hybrid". When

recording UHD or 4K, the only option is “normal”, and as such this menu option will be disabled when recording in 4K or UHD. This menu item is also disabled if the optical image stabilizer is disabled.

Normal optical image stabilization is done on two axes (pan and tilt; the yellow axes in the picture to the right). The lens elements detect motion and they are repositioned to effectively cancel out that motion. It’s effective and it works well. However, if you engage the Hybrid O.I.S., the camera adds three more axes of stabilization (sliding left/right, sliding up/down, and rotation; the blue axes in the picture above). It does this using electronic stabilization technology; scanning a further area around the sensor lets the system reposition the image to cancel out horizontal or vertical sliding motion. These types of motion are especially likely to happen when walking while carrying the camera, for example, so Hybrid O.I.S. is especially effective for handheld footage. However, if you’re doing a shot that specifically uses horizontal or vertical sliding (such as mounting the camera on a sliding dolly), you’ll probably want to disable Hybrid O.I.S.

Custom O.I.S.

You can program the optical image stabilizer to optimize it for certain different shooting scenarios. The default settings are an attempt to provide good, all-purpose stabilization, but sometimes you may want to customize the stabilizer for a particular type of shooting. As a simple example, the optical stabilization needs while running with the camera during a reality-TV shot, are probably quite different from the optical image stabilization needs when you’re mounting the camera to a car and driving on a smooth road, and both probably have very different requirements from when you may be using the camera in a high-vibration scenario (mounted to a plane, perhaps).

This menu item enables or disables your custom settings. You establish your particular custom settings in the next two menu items, BLUR AMPLITUDE and BLUR FREQUENCY.

Blur Amplitude

This is one of the parameters you can adjust for customizing the Optical Image Stabilization system. Amplitude means, simply, the size of the

movement you expect to encounter (i.e., how "Ample" the movement will be). There are two parameters you can adjust — how big the movement is expected to be, and how frequent those movements are expected to happen. If you imagine a grandfather clock's swinging pendulum, it makes big sweeping moves, but it's very slow — it has large amplitude, and low frequency. On the other hand, picture a piston in a lawn mower engine. It may only move a half an inch or so in each direction (so its range of movement is small in amplitude), but it might be doing so at 2,000 RPM — it would have low amplitude, and high frequency.

If you expect to encounter minor little bumps (such as, maybe you have to set the camera down on a vibrating piece of machinery), you can configure the image stabilizer for low amplitude (i.e., setting Blur Amplitude to 1 or 2). If you expect that the camera might be encountering much bigger movement (such as, say, the rocking of a boat) then you might want to try using a much higher Blur Amplitude setting. They do work at opposite purposes though — setting a high Blur Amplitude setting might help cancel out bigger movements, but it may make the camera more susceptible to small-movement image shake. And optimizing for removing little minor bumps may leave the image stabilizer less able to cope with bigger movements.

Blur Frequency

This setting works hand-in-hand with BLUR AMPLITUDE to complete the CUSTOM O.I.S. function. Frequency refers to how frequently an action happens; a simple definition might be that if the action happens relatively infrequently it can be said to be "lower frequency"; if it happens more frequently it would be said to be "higher frequency". This menu setting offers three choices; each choice imparts a distinct set of priorities to the camera based on the anticipated frequencies that will be encountered.

"1" is suitable for a locked-off tripod shot, where no camera motion is expected at all. In "1", the camera will actively and aggressively try to combat any shaking or vibration. It assumes that there should be no motion, so any motion is to be stabilized against. This would be a poor choice for handheld footage or for when you expect to move the camera by panning or tilting.

"2" is a general-purpose setting, most suitable for handheld use or when you expect that you will be moving the camera around.

"3" is optimized to eliminate tiny motions (like vibration or subtle shaking). It expends most of its efforts in eliminating small motions, but will also make some effort at stabilizing larger motions. This would be a good setting for a tripod shot where you do plan on panning or tilting.

ATW SET

To understand the ATW (Auto Tracking White) function, one should first understand the concept of color temperatures and white balance; please refer to the article on Understanding White Balance.

The White Balance button offers three basic modes of operation: preset, A channel, and B channel. In Preset mode, pressing the AWB button on the front of the camera will toggle between P3200K, P5600K, and VARiable settings. In A channel and B channel, you have the choice of configuring those channels for manual or automatic white balance.

White Balance Button

In manual-set mode, you point the camera at a white card in the scene, filling the screen with white, and press the AWB button in. The camera will analyze what it's looking at, and figure out how to manipulate the colors so that the object on the screen will actually look white. In automatic-tracking white (or ATW) mode, the camera continuously evaluates the scene and continuously adjusts the colors in a never-ending search for the proper white balance. See the Physical Switches, Buttons, and Jacks section for more info on the White Balance Button and its settings.

AWB Button

This ATW menu setting lets you choose which position (preset, channel 1, or channel) to assign the automatic white balance tracking to. The ATW is not assigned to the White Balance button by default; this menu item can be used to assign it to one of the positions on the White Balance switch. Normally you have two separate white balance settings you can keep in-camera (A channel and B channel), but this menu setting lets you assign ATW to "A", "B", or to the PRST (Preset) position.

If you want to use automatic white balance, you either have to assign ATW to one of the positions on the white balance switch, or assign it to a User Button. Either method results in identical operation; the difference is whether you prefer to take up one of the three positions the White Balance Button cycles through, or if you'd instead rather use up one of your User Buttons to get it.

ATW Target R and ATW Target B

These menu items work very similarly to the SCENE FILE menu's RB GAIN CONTROL SETTING menu options, but are used for adapting the ATW's color balance. Adjusting the ATW TARGET R lets you influence the automatic white balance to bias the color towards more or less red; adjusting ATW TARGET B lets you influence the ATW system to add or remove some blue. Whereas RB GAIN CONTROL SETTING can't be used during ATW operation, these menu controls give you similar power over the image specifically when using ATW. Of course, if you're not using ATW, then this menu item will have no effect on the image.

WB Preset

This lets you set what color temperature you want assigned to the PRST position of the white balance button (either 3200K, 5600K, or VARiable). Regardless of what you set it to here in the menu, you can toggle it by using the AWB button on the front of the camera under the lens. For information on how to set the VARiable color temperature, see the next menu item.

WB VAR

You can set the WB Preset value's color temperature to either a preset 3200K, or a preset 5600K, or a variable setting ranging from 2,000K all the way up to 15,000 Kelvin. This menu item lets you set the value that will be used when the White Balance button and AWB button are used to select the VAR white balance preset.

While setting the white balance manually to a specific color temperature is convenient, and popular, it may not lead to the best quality video. In many circumstances you'll get better color rendition by taking a proper manual white balance off of a white chart (like a DSC Labs CamWhite). When you set the white balance manually using the preset, it can account for variations in color temperature (on the red/blue axis) but it won't adjust for any variations in color fidelity (on the magenta/green axis). If you have low-CRI (Color Rendering Index) lights, they may be putting out a greenish cast, which will not be accounted for when using manual variable white balance; that type of color cast is only properly resolved by taking a proper manual white balance and letting the camera see the actual color the lights are casting on a white object, so the camera can adjust and balance its processing to render proper colors under that light.

MF Assist (UX180 Only)

When using manual focus, unless you're using a high-resolution monitor, it's not always easy to get pinpoint focus — and this may be especially true in a more run-and-gun environment. MF ASSIST is designed to help in these scenarios. MF ASSIST works only when the camera is set in manual focus, and it enables a little bit of autofocus at the end of the focus move. With MF ASSIST engaged, you'd focus as normal, and when you stop moving the focus ring then the camera will kick in autofocus in a very limited range right at the end to try to nail pinpoint focus. It then reverts to manual focus mode, locking in the focus position. For cinema-style shooting you'll want to leave this off, but for ENG or run 'n' gun, turning it on can make one-man-band focusing a simpler task. Now, there's no guarantee that focus will be perfect when using MF ASSIST; for one thing, it can only work within very narrow parameters, so if your manual focus is too far off the mark, then MF ASSIST won't be able to overcome that. You have to get your manual focus close enough that MF ASSIST is able to finish off the job within the limited amount of range that it's given. If it can't find proper sharp focus after a few seconds, it will abandon the attempt and return the focus position to where you had left it when you finished your manual focus. MF ASSIST is unavailable when the camera is set in autofocus, or when recording VFR.

Focus Assist 1

This menu item specifies which type of Focus Assist function you want to have occur when pressing the Focus Assist button. The choices are EXPAND, PEAKING, or BOTH. You can read more about using the Focus Assist function in the article on Focusing. Note that these settings will also apply to any User Button to which you've assigned the FOCUS ASSIST 1 function.

Focus Assist 2

You can assign the function FOCUS ASSIST 2 to a User Button. This menu item specifies whether pressing that User Button will invoke the EXPAND focus assist, or the colored PEAKING focus assist. Do be aware however that if you've configured Focus Assist 1 to show BOTH, then Focus Assist 2 will be disabled.

Peaking Color

This function works hand in hand with the FOCUS ASSIST 1 and 2 functions. If you've selected PEAKING or BOTH in the FOCUS ASSIST

1 or 2 menu options, then this menu setting lets you specify what color you want to use for the PEAKING.

Peaking Level

This menu item works hand in hand with the PEAKING COLOR and the FOCUS ASSIST 1 and 2 menu items. Assuming that you've selected PEAKING or BOTH in the FOCUS ASSIST 1 or 2 menu items, the Focus Assist function will draw colored outlines around any object that it considers to be in sharp focus. This menu item lets you determine how generous the system is in determining what it considers to be "in focus." The higher you set this (to a max of +7), the more generous the system is, and the camera may consider something "in focus" that, to your eye, may not exactly be sharp. The lower you set this (towards a minimum of -6), the more unforgiving the system is — at lower settings, it will only put red outlines around objects that it is absolutely certain are in super-sharp focus. At -7, the colored peaking will be disabled.

So where should you set this? I recommend setting it as low as you can, while still being able to see it sufficiently for it to be useful. The lower you set it, the less red peaking will show up, and the harder it will be to see where the peaking is, but — the more certain you'll be that when you DO see the peaking, it's on an object that's sharply focused. If you set it too high (such as +7), then the system is very generous in what it considers to be in sharp focus, and you may find yourself with out-of-focus shots. They may be generally reasonably in focus, but they won't necessarily be pinpoint sharp focused. Plus, the more that's considered in focus, the more red that gets drawn on the display, and when the screen is cluttered with red peaking (or whatever color you've chosen), it gets harder to make out the actual detail in the image to see if it looks to be in proper focus. My recommendation is to use the minimum level that you can, and also use the EXPANDed focus function whenever possible.

Also, keep in mind that this system is looking for sharp edges to outline. Those are much easier to see in a static (non-moving) shot. When the camera (or the subject) are moving, it's likely that any sharp edges might be blurred slightly due to motion blur, and when that happens, the focus peaking won't see sharp edges and won't be able to draw red (or other color) outlines on them.

Focus Ring Drive

The focus ring is a servo-driven ring; moving the ring signals the system to engage motors to move the focus position of the lens. How the system

responds to lens ring movement is controllable by this menu item. There are three choices:

Speed: with this choice, the lens reacts based on how fast you move the focus ring, and not necessarily on how far you move it. Quick movements result in big jumps in focus distance; slow movements allow for precision focusing. Because of this, the focus ring position is not precisely repeatable in this mode; returning the ring to the same position will not necessarily ensure that the focus will be returned to the same position (after all, you might have moved off the position very quickly, but returned to it very slowly; in SPEED the speed of movement dictates how far the focus distance moves). This is the default setting, and in general it's a great choice for many uncontrollable scenarios. If you don't need precise repeatable positioning of the focus ring, you may want to stick with the SPEED setting.

Coarse: with this choice, small movements in the focus ring can result in big distance changes in the lens' focus position. Moving from minimum distance (about 2.8 feet without macro) to infinity takes only about 3/4 of a turn of the focus ring. It's quick to make focus changes, but may not be as precise to land on the exact focus point you'd want. This choice would be more suitable for 1080 than for 4K/UHD recording, and perhaps when recording outdoors in the sun when the camera's depth of field would be deeper, which might help mask focus errors. This mode has repeatable focus points; the ring will focus at the same spot (provided you haven't turned the ring past minimum or maximum focus distances).

Fine: with this choice, the focus ring is capable of incredibly precise movement, which is fully repeatable. You can set focus marks on the lens ring, and return to them time and again, so long as you don't move the focus ring past minimum or infinity focus distances. In FINE mode, the focus ring takes about 1.5 full rotations from minimum distance (about 2.8 feet without macro) to maximum distance (infinity). This is a great choice for fine focusing, but that long travel distance might make it impractical for uncontrollable shooting scenarios (such as news and sports).

Focus Macro

Generally the lens is capable of focusing to a minimum of 2.85 feet (on the UX180) or 2.71 feet (UX90). This function enables the FOCUS MACRO, which allows the lens to focus closer (as close as 10 cm when at wide angle).

Using this menu item is fundamentally the same as assigning FOCUS MACRO to a User Button; see that discussion for more information.

Area Mode: The AREA function can be used to set which area of the screen the autofocus or exposure system prioritizes. This can come in handy if you're trying to direct the viewer's eye to a section of the screen that's not the center of the screen (normally autofocus prioritizes what's in the dead center of the screen). Or, if you've established an interview with the subject on the left side of the screen, and there's a window behind them on the right side, you might want to use the AREA function to tell the camera to prioritize exposure on the subject's face, ignoring the window. The options in this menu include:

INH: This inhibits the AREA function from working at all, even if you've pressed the User Button assigned to AREA.

Focus: This tells the system that it should direct its autofocus system to work on the area of the screen that you designate (by touching the LCD when the AREA function is active). If you're operating the camera in manual focus, it will briefly engage autofocus when you touch the LCD, grab a quick focus point, and then return to manual focus.

Iris: Choosing this option lets you direct the camera as to what area of the screen it should prioritize when determining exposure levels, when using automatic exposure. Note that even though the name of this is IRIS, the camera will not be limited to using just the iris; it may also use the automatic shutter (if enabled) and automatic gain (if enabled).

Y Get: The "marker" function normally reports the brightness value of whatever's in the center of the screen. With this function you can sample the image anywhere on the screen, and perhaps in a larger area too (if you change the size of the AREA function's sampling rectangle to a larger or smaller size, using the jog/dial wheel).

Focus/Iris: Tells the system to use the selected region for both autofocus and autoexposure purposes.

Focus/Y Get: Tells the system to use the selected region for both autofocus purposes, and to also have the "marker" system report the brightness level of the selected area.

Custom AF

The autofocus system is completely customizable. You can adjust various parameters to get it to perform ideally under a wide variety of scenarios. In order to adjust this menu item (and those associated with it) you have to first ensure that the FOCUS SWITCH is set to Auto. This menu item enables or disables the custom autofocus parameters.

AF Speed

This is one of the CUSTOM AF functions. It is only relevant if CUSTOM AF is set to ON. You can control how quickly the autofocus system responds (within the limits of the physical hardware, of course). Setting this to a higher number (like +5) will increase the speed. Faster speeds produce quicker results, obviously, but if the autofocus system has to "hunt" for focus, it might be more noticeable if it's doing it rapidly. Slower speeds will result in more gradual focus changes.

AF Sensitivity

This is one of the CUSTOM AF functions. It is only relevant if CUSTOM AF is set to ON. This parameter affects how quickly the AF system decides that it needs to refocus. Higher values make it more sensitive, lower values make it less sensitive. For immediate response, you might want to set this to the highest values. This might be useful if the camera is recording uncontrollable scenarios, such as sports; for tracking a fast-moving runner who's changing distance from the camera, a high degree of sensitivity might be the best choice. However, the chances of "focus hunting" are increased at higher levels of sensitivity. If you're in a more controlled environment (such as a sit-down interview), it might be more appropriate to choose a slower response speed, to avoid the focus system aggressively hunting for any minor change in focus. Another example given in the owner's manual is the case of someone walking in front of the subject; with high sensitivity the autofocus system would leap from your subject, to the person walking in front of your subject, and then back to your subject. On low sensitivity, the autofocus system might just remain on your subject the whole time, and ignore the person walking in front of them (depending on how quickly they walk past, of course).

AF Area Width

This is not one of the CUSTOM AF functions; it works with normal or Custom AF. Setting the width of the autofocus area can be done here, or via a User Button; either way the results are the same.

WFM (UX180 Only)

This function enables or disables the WaveForm Monitor (WFM) or Vectorscope, as defined by the WFM TYPE function. Choosing this menu item is fundamentally the same as pressing a User Button that has the WFM function assigned to it. User Button 4 is pre-assigned to WFM.

WFM Type (UX180 Only)

You can configure the behavior of the WFM function to display either the Waveform Monitor, or the Vectorscope, or to sequentially display the Waveform monitor and then the Vectorscope on successive button presses.

WFM Position (UX180 Only)

You can specify which quadrant of the screen the Waveform Monitor or Vectorscope should be displayed in. Note that you can also move the WFM or Vectorscope by pressing and holding down on the waveform (or vectorscope) display and then dragging the scope to one of the corners of the screen.

Zebra

Normally you would access the zebras by pressing the Zebra button (preprogrammed to User Button 5). But, if you've re-assigned User Button 5, or you just want to access the zebras through the menus, you can do so with this menu item. It is functionally the same as cycling through pressing the Zebra button; you can bring up Zebra 1, Zebra 2, the Marker, or turn the Zebras off. For more information on the Zebras, click here.

Zebra Mode

You can configure the zebras to be either MOMENTary, or CONTINUE (continuous). If you choose CONTINUE, the zebras will be displayed until you turn them off. If you choose MOMENTary, they will automatically turn themselves off after about five seconds.

Bars Type

The camera can display three types of industry-standard color bars. With this menu item, you can choose what type of bars to display. Type 1 is standard NTSC SMPTE color bars; Type 2 is standard EBU PAL color bars, and Type 3 is the SMPTE standard high-def color bars.

Sub Rec Button

The Sub Rec button is the record button located on top of the camera's handle, by XLR Audio Input 1 and the top zoom lever (also known as the Sub Zoom lever). This menu item lets you disable that button (which can also largely be accomplished by just closing its translucent plastic cover).

Fast Zoom

The servo zoom motor provides for a wide variety of speeds, although the fastest speed isn't enormously fast. It's tuned to keep the zoom motors quiet so they won't be picked up by the onboard microphone. If you need a somewhat faster zoom, you can enable this menu item. It results in zoom speeds that are over twice as fast with it ON than when it OFF. Set this menu item to ON when you need the fastest zooms and aren't concerned with noise; set it to OFF when you need the quietest zooms and aren't concerned with speed.

Sub Zoom

The handle zoom lever (aka the Sub Zoom) operates at a single fixed speed. This menu item lets you choose what speed you want or, alternatively, to disable the Sub Zoom lever entirely. On the slowest speed ("1"), a UX180 will take over two minutes to zoom from full wide angle to full telephoto. On the fastest speed ("7"), it takes about five seconds to zoom from full wide to full telephoto; with "Fast Zoom" enabled, it'll take only about two seconds.

Digital Zoom

This menu item lets you control the functionality of assigning D. ZOOM to a User Button. It doesn't enable digital zoom in and of itself; instead it controls what happens when you press a User Button that has been assigned to "D.ZOOM." You can have it select a direct level of digital zoom (2X, 5X, or 10X) or you can have repeated button presses toggle through the available options (including OFF). See D. ZOOM for more discussion of the Digital Zoom function.

i.Zoom

This menu item is functionally identical to assigning "i.ZOOM" to a User Button. It allows you to enable or disable the i.ZOOM function. This menu

item is not available if the camera is configured to shoot 4K or UHD, but it is available for FHD, 720P, and standard-definition modes (unless you're shooting VFR; it's disabled during VFR). The i.Zoom is a way to extend the zoom range of the camera, without compromising quality. Whereas the Digital Zoom works by digitally scaling up the existing video frame, the i.Zoom works quite differently — it crops in further and further on the sensor to create its zoom effect. Because the UX cameras are Ultra High Definition cameras, they use massive oversampling when in their HD and SD modes; that means there are more than enough pixels to produce a fully-resolved, full-detail image, even at the maximum i.Zoom setting of about 1.5x magnification (UX180) or 1.67x magnification (UX90).

The i.Zoom is integrated into the normal zoom range. If the lens is set to anything other than 100% telephoto, then all zooming will be done optically, using the optical zoom range. Once you reach 100% telephoto, that's when the i.Zoom kicks in. You'll see on the LCD display next to the zoom setting that in normal/optical zooming, the readout will show a lower-case "i" next to the zoom display, but when you exceed the maximum optical zoom, the "i" becomes inverted (black "i" on a white background), indicating that you're in the i.Zoom range.

If you were to combine the UX90's 15x optical zoom with the 1.67x i.Zoom, you'd end up with an approximately 25:1 zoom range. On the UX180, combining its 20x optical with 1.5x i.Zoom gives it a practical 30x zoom range when i.Zoom is enabled.

i.Zoom is basically a "free gift" when you choose to shoot in 1080p instead of UHD. You can't use i.Zoom in UHD (or the UX180's Cinema 4K mode), but when you're shooting in .MOV/.MP4 1080P HD (or AVCHD), you can enable the i.Zoom and get a much further practical telephoto range.

Zoom/Focus

Many functions on the camera can be controlled remotely by the AG ROP iPad application. You may want to remotely control the zoom and focus capabilities, or you may want to use the camera's own controls (its focus ring, zoom ring, iris ring, autofocus switch, push-auto button, and AUTO/MANU switch). This menu item lets you determine if those functions will be controlled on the camera, or through the wi-fi app.


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR
15X OPTICAL ZOOM
FOCUS
PUSH AUTO
IRIS
AWB

Auto SW Settings

The camera features a handy switch called "AUTO/MANU." When you slide the switch towards AUTO, the camera can override all sorts of manual settings and go into fully-auto mode: useful if you need to grab the camera and start shooting something, with no time to adjust manual settings. The "AUTO" setting might help you guarantee that you get your shot, even if it's not the absolute best video quality (which can usually only be obtained with proper tuning of manual settings.) But the AUTO/MANU switch doesn't necessarily have to mean that everything goes full-auto: you can control which functions are operated in auto mode and which ones stay in manual mode.

Note: most of these functions have no impact on the camera's operations at all if the AUTO/MANU switch is set to MANU. These only come into play when the switch is slid to AUTO. Two exceptions are AGC LIMIT and AUTO SLOW SHTR; those can affect how the camera functions even if the AUTO/MANU switch is in MANU..

A. Iris

If you set this setting to ON, then when the "AUTO/MANU" switch is slid to AUTO the camera will perform auto-iris functions, even if you previously had the camera set to manual iris. If this setting is OFF then the camera will only be able to use auto-iris if you had the camera in auto-iris mode before sliding the AUTO/MANU switch to AUTO: if you had the camera in manual iris mode, it will still be in manual iris mode after you slide the AUTO switch (when this setting is OFF.)

AGC

AGC stands for Automatic Gain Control. This is a way for the camera to control exposure through adjusting the gain, rather than through the iris or shutter. This menu item controls whether or not the camera will have permission to automatically control the gain when the AUTO/MANU switch is slid to AUTO.

AGC Limit

This switch lets you control the ceiling of how much gain the Automatic Gain Control is allowed to use; unlike most functions in this menu, this item is not limited to only when the AUTO/MANU switch is in AUTO; this limit is in effect whenever you have the camera set to use automatic gain.

You can choose to limit the AGC system to only 3 dB of gain, or give it free reign to use the maximum amount of gain, or establish a limit in-between. On the UX180, the maximum gain limit is 24 dB of gain; on the UX90 the maximum is 30 dB of gain.

The camera will decide how much gain to use, up to the maximum that you specify, when in auto gain mode. Note that the gain being discussed is only for the picture; if you want to have the camera automatically adjust the audio levels you have to do that by setting the AUDIO SETUP menu's AUDIO LEVEL CH1 (and/or CH2) settings to AUTO.

Auto Shutter

This switch controls whether or not the camera can automatically adjust the shutter speed, when the AUTO/MANU switch is set to AUTO. Note that if you set this setting to OFF, the camera is still capable of using AUTO SHUTTER when the switch is in MANU! If you want to disable the automatic shutter when in manual mode, you have to use the SHUTTER BUTTON.

Auto Slow Shtr

In darker situations, the camera might want to use a slower shutter speed to let more light in. You can allow or disallow that. If you allow it, the camera will have the ability to set the shutter to as low as 1/30 (when filming 59.94p/59.94i/29.97p), or 1/25 (when filming 50p/50i/25p), or even 1/24 (when filming 23.98p or the UX180's Cinema 4K/24.00p).

Note that this menu item is active any time the shutter is in auto; it's not limited to only when the AUTO/MANU switch is in AUTO. If you use the SHUTTER button to choose "A.SHTR", then this menu item will affect how slow of a shutter speed the auto shutter system may choose.

Slower shutter speeds will cause more blur in the image, but there's another reason to consider limiting the camera from choosing a slow shutter speed: if it chooses 1/30 when shooting 59.94p/i, or 1/25 when shooting 50p/50i,

the net result will be that your visible frame rate will drop in half. You will no longer get the smooth motion of 59.94p/i or 50p/50i; instead the camera will have to buffer the frames for the duration of the shutter speed. That means that you cannot get more than 30 distinct frames per second when using 1/30, and it's impossible to get more than 25 distinct frames per second when using 1/25. That might have a significant impact on the visual fidelity of your project, so consider how important it is (or isn't) to allow the camera to choose the slow shutter speed.

ATW

Two settings, ON or OFF, determine whether the camera will perform automatic tracking of white balance when in AUTO mode. If it's set to ON, the camera will start automatically tracking white balance when the AUTO/MANU switch is set to AUTO. If it's set to OFF, the camera will be forced to use whatever setting the WHITE BAL button has currently selected. You can always set the camera to ATW without resorting to the AUTO/MANU switch, of course.

AF

This setting determines whether the camera goes into Autofocus mode when the AUTO/MANU switch is set to AUTO. If set to ON, the camera will go into autofocus mode, regardless of whether the FOCUS switch is set to Auto, Manual, or Push Auto. None of those switches will have any effect, because the camera will run in autofocus mode. When set to OFF, the FOCUS switch controls how focus operates: if it's set to Auto, or Push Auto is held down, autofocus will continue to work; if it's set to Manual, then it'll be operating in manual focus.

When used with slow shutter speeds, Autofocus is much slower to respond. Also, when used with a slower frame rate (such as 23.98p), autofocus responds more slowly. Autofocus performs best in interlaced mode or 50p/59.94p modes, and under bright light conditions, with a 1/60 or faster shutter. Autofocus performs less efficiently in slower frame rates, under lower light conditions, or when using slow shutter speeds.


Panasonic
4K
PROFESSIONAL
UX SERIES
LEICA
DICOMAR
15X OPTICAL ZOOM
FOCUS
PUSH AUTO
IRIS
AWB

Record Setup Menu

Media Select

This menu lets you choose which card slot to record to. Note: if you've set the 2 SLOTS FUNC to "SIMULTANEOUS" then it's irrelevant which card you select to record video to, as identical video will be recorded to both cards simultaneously. However, this menu item would still be relevant for telling the camera which is the primary card to use for RELAY RECording or DUAL CODEC recording. Also, note that you can assign SLOT SEL to a User Button and change the designated recording card slot that way as well.

2 Slots Func

The camera has two memory card slots. You can configure it to work with only one at a time, or use this menu to direct the camera as to how to work with both memory cards. (Note that all the choices in this menu item are disabled unless you have two memory cards loaded in the camera.) The choices are:

Off: This tells the camera to basically ignore the second memory card slot, and to only record footage onto the current memory card (as specified by the MEDIA SELECT menu option.) When the current memory card is full, the camera will stop recording. When this item is set to OFF, the camera acts as if it doesn't know that it has a second slot.

Relay Rec: Recordings can overlap from one card to the next (this is known as creating a "spanned" recording). If you need to record long uninterrupted events or long interviews or long takes, RELAY REC may make sense. But for sheer simplicity in editing, and in making sure that the editor always has the complete footage, turning RELAY REC off will likely result in a simpler workflow in post. Spanned clips from one card to another may need to be stitched back together in the editing suite, so it may be easier and cleaner to record each clip completely on its own card. RELAY REC can record continuously from one card slot to the other, and when one

card is full, you can eject it and swap in a fresh card and the relay recording will continue. You have to be extremely careful to eject the proper card though! Ejecting the card that's being written to will cancel the recording, and may result in loss of some footage.

Be aware that RELAY REC requires two cards, and they both have to be actively recordable (so one can't be write-protected) and, if you're using AVCHD mode, they both have to be in the same format (meaning, you can't have one card for 50Hz mode and one for 60Hz mode, they both have to be formatted in the camera in the same mode, in order to be compatible).

RELAY REC is disabled if you're shooting VFR or Super Slow Recording or Interval Recording.

Simultaneous: This allows you to record two identical copies of the footage, simultaneously. This can be an excellent option for security (giving you data redundancy), and it's also a great method for being able to deliver footage that the client can take with them at the end of the shoot day, while you get to keep a backup of the footage (especially because it saves so much time in not having to make a manual backup copy.)

Ideally, you'd want to use two cards that were of comparable performance and comparable capacity. It's possible to establish SIMULTANEOUS recording with cards of different capacity, but the whole benefit of recording simultaneously will be lost when one card runs out of space. Also, both memory cards must be the same type (i.e., both SDXC, or both SDHC; you can't establish a simultaneous recording using one SDXC and one SDHC card).

Be aware that if you're recording on two different memory cards, one card may fill up before the other one does; if that happens, the camera will ignore the full card and continue recording to the one slot that does have available space — but obviously you wouldn't have a duplicate/backup of that material. And if one of your memory cards encounters a hardware failure, recording will continue on the other card — but obviously you won't have a backup of that recording (since, of course, the other memory card failed!)

Background (UX180 Only): This is an intriguing recording mode, perhaps especially suitable for live events or news shooters. With BACKGROUND recording, both cards are used to record, but they don't record identical footage. Instead, once you start recording, both cards start

recording simultaneously, but if you stop recording, only the primary card will stop recording. The second card continues recording continuously. You can start and stop the recording on the first card as many times as you want; the second card will record one continuous long recording without stopping. The idea here is that your primary card will be your "selects" reel, containing the highlights, whereas the secondary card will have the entire event recorded. If nothing unexpected or unusual happens, you can give the editor the "selects" reel to pick the highlights from, but if something were to happen while you weren't recording on the main card, you can rest assured that that event will have been captured by the "background" card.

To stop recording on the "background" card, register BACKGROUND to a User Button and press and hold that User Button until the recording stops.

There are restrictions on when you can do BACKGROUND recording; first of all, background recording is only possible when you've set your recording format to 50 megabits or less. That means no 4K, and no UHD; you can use .MOV/.MP4 FHD but only at 50mbps, and you can use AVCHD. Also, you can't establish a background recording if you've enabled VFR or Super Slow, or if you're using Interval recording. Also, selecting BACKGROUND recording will force the Timecode Generator (TCG) to FREE RUN, a necessary step so that your two memory cards' recordings will be able to be synchronized in editing.

Dual Codec (UX180 Only): this is similar to SIMULTANEOUS recording, except that you can specify different recording formats to be recorded on each of the cards. Generally this means you'll be recording a high-quality master version of your footage on one card, and a lower-resolution or lower-bitrate copy on the second card. Perhaps you're shooting in 4K or UHD for your source footage, and you want to be able to hand the editor a lower-resolution, low-bandwidth copy at the end of the day so she can cut "dailies" — in such a case, you might select a 50 Mbps dual codec recording so the editor can have good quality 1080p at 50 Mbits to work from. Or, perhaps you're working in the field on a war documentary, shooting in UHD/23.98p, and you capture some incredible footage that the world needs to see right away. If you've been recording an 8 Mbps dual codec version, you'd have a low-bandwidth version that could be uploaded relatively easily.

Dual Codec requires two memory cards, and they must both be the same type (either both SDXC, or both SDHC). You can't be using VFR or Super

Slow or Interval recording; activating any of those features will disable Dual Codec recording. Finally, the main recording must be either UHD at 23.98/25/29.97 fps, or it has to be .MOV/.MP4 FHD at 100 mbps or 200mbps.

Dual Codec Rec (UX180 Only)

This menu item is only applicable when the 2 SLOTS FUNC. menu item is set to DUAL CODEC. You establish your main recording format in the REC FORMAT menu; this menu item lets you choose the bitrate of the secondary recording; secondary recordings are always made in 1920x1080 FHD at the same frame rate as the main recording (i.e., if your main recording is UHD 23.98P, then your secondary recording will be 1080 23.98P). When recording UHD as your main codec, you can choose either 50 Mbps or 8 Mbps for your secondary recording. However, if you've chosen FHD for your main recording, this menu item will disabled and the secondary recording's bitrate will be fixed at 8 Mbps.

Note, when recording 50 Mbps secondary recordings, the secondary recording will be stored in the same file format (either MOV or MP4) as your main recording. However, when recording dual codec with an 8 Mbps secondary recording, that will always be stored as a MOV files regardless of whether your main recording is set to MOV or MP4.

Interval Rec

This option lets you perform time-lapse photography (useful for recording buildings under construction, clouds moving across the sky, or flowers opening up). When in INTERVAL REC mode, the camera will periodically capture one individual frame, at intervals that you specify (which can be as short as one frame every second, or as long as one frame every 2 minutes). Once you set up for interval recording, and establish the interval you want to use, just press the record button and the camera will commence capturing and recording individual frames at the predetermined intervals.

There are only certain recording formats that INTERVAL REC will work in. You can't establish INTERVAL REC when your recording format is UHD/23.98P, for example. And when in 1080P, the only option is the 50-megabit version of 29.97P or 25P. The available formats are:

4K (UX180):	4K 24.00P 100M	4K 24.00P 100M
UHD:	UHD 29.97P 100M	UHD 25.00P 100M
FHD:	FHD 1080/29.97P 50M	FHD 1080/25.00P 50M
AVCHD:	HA 1080/59.94i	HA 1080/50.00i

The playback rate of your footage will be partly determined by the frame rate you're recording in; 29.97P and 59.94i clips will play back faster than 50.00i, 25.00P, or 24.00P clips will. For 59.94i or 29.97P, it will take 30 frames to create one second of playback time. For 50.00i and 25.00P, it will take 25 frames to create one second of playback time. And, for 24.00P, it will require 24 frames to create one second of playback time.

30P Interval	Speed	1 Hour Becomes
1 Second	30x	120 sec. (2 minutes)
10 Seconds	300x	12 seconds
30 Seconds	900x	4 seconds
1 Minute	1800x	2 seconds
2 Minutes	3600x	1 second

25P Interval	Speed	1 Hour Becomes
1 Second	25x	144 seconds
10 Seconds	250x	14.4 seconds
30 Seconds	750x	5 seconds
1 Minute	1500x	2.4 seconds
2 Minutes	3000x	1.2 seconds

24P Interval	Speed	1 Hour Becomes
1 Second	24x	150 seconds
10 Seconds	240x	15.5 seconds
30 Seconds	720x	5.2 seconds
1 Minute	1440x	2.6 seconds
2 Minutes	2880x	1.3 seconds

If you wanted to film a 2-hour event but have it play back in its entirety in around 30 seconds, you'd use 24P mode and the 10-second interval, because each hour of realtime would result in 15.5 seconds of footage, so two hours of realtime would play back in about 31 seconds. On the other hand, if you were filming a building under construction you might want to use an interval of 2 minutes, so each hour of realtime that passes will be played back in about 1 second.

The absolute maximum recording time is 168 hours, and no audio is recorded during INTERVAL RECording. Interval Recording is not available if you're using Pre-Rec, Freeze Frame, VFR or Super Slow recording.

VFR Mode

VFR stands for Variable Frame Rates. When shooting 50-megabit FHD 1080p high definition footage in MOV or MP4 format, you have the option

of enabling or disabling variable frame rate operation. This menu item lets you choose whether to enable variable frame rates, or to prevent them. When this is set to ON, no audio will be recorded, unless the frame rate is set to the same as the recording rate, i.e. 24fps in 23.98p, 30fps in 29.97p, or 25fps in 25p. Be very careful with this setting, because you don't want to get in a scenario where you didn't end up recording any audio. The camera will warn you to this effect by disabling the audio meters.

You can enable VFR here in this menu, or you can instead assign a USER BUTTON to the VFR function and enable or disable it by pressing that User Button.

Enabling VFR also enables the ability for the menu/jog wheel on the side of the camera to select a variable frame rate.

VFR can only be selected under certain conditions. If you're recording AVCHD, or UHD, or 4K, or 1080i, then the VFR function is unavailable. It's only available in 50-megabit 1080 FHD at either 23.98p, 25p, or 29.97p frames per second. If you choose any other recording mode, VFR will be automatically disabled. And if you've set up a DUAL CODEC recording system, VFR will be disabled.

Enabling VFR Mode will also disable a number of functions, including Flash Band Compensation, Relay Recording, Background Recording, Interval Recording, PRE-REC, Area Mode, the Focus Transition feature, the TIME STAMP feature, Digital Zoom and i.Zoom, Infrared Recording mode, and the Custom AF feature.

Frame Rate

If VFR Mode is enabled, you can set your desired frame rate here, or you can set it by using the menu/jog dial. For a description of the various frame rates, see Variable Frame Rates.

The FRAME RATE cannot be changed during recording, and you can't do "speed ramping" in-camera.

Super Slow Rec (UX180 Only)

In addition to the variable frame rate capability discussed above, the UX180 also has an option for super slow frame rate recording. It provides for extreme slow motion at 100 or 120 frames per second.

It is not necessary to enable VFR MODE in order to use Super Slow Rec, but many of the same conditions for VFR MODE apply for Super Slow Rec. You must use a recording mode of .MOV/.MP4 50-megabit 1080p FHD at either 23.98, 25, or 29.97 frames per second; no other recording mode will work. And no sound will be recorded when using Super Slow Rec.

Super Slow Rec operates at 100 frames per second when your recording format is FHD 50-megabit 25p, and the result is 4x slow motion. When your recording format is FHD 50-megabit 23.98p, the Super Slow Rec operates at 120 frames per second (actually 119.88) and the result is 5x slow motion. If your recording format is FHD 50-megabit 29.97p, the Super Slow Rec is 120 frames per second (actually 119.88) and the result is 4:1 slow motion.

You can enable Super Slow Rec here in this menu, or through assigning its function to a User Button.

Enabling Super Slow Rec will also disable a number of functions, including Flash Band Compensation, Relay Recording, Background Recording, Interval Recording, PRE-REC, Area Mode, the Focus Transition feature, Digital Zoom and i.Zoom, Infrared Recording mode, and the Custom AF feature, and VFR Mode.

PRE-REC Mode

This menu item lets you enable or disable the pre-record function. When this function is enabled, the camera will continuously be buffering three to four seconds of footage. Then when you press RECORD, the camera will commit the contents of that buffer to the memory card, and also begin recording everything from that moment onward. So, in effect, PRE-REC lets you begin recording up to four seconds BEFORE you pressed the record button! This can be very handy in news, sports, and nature photography; you may never miss a shot again because the camera will be recording even before you were ready!

In MOV/MP4, the PRE-REC buffer holds about four seconds of footage. In AVCHD mode, it holds about three seconds. PRE-REC doesn't work if you've established 2-slot BACKGROUND RECORDING, or in VFR mode, or if you've already enabled INTERVAL RECording.

PRE-REC isn't active when the thumbnails are displayed or when playing back footage; it's only active when in CAMERA mode.

Infrared Rec (UX180 Only)

This menu item enables or disables INFRARED RECording. Using this menu item is fundamentally the same as assigning IR REC to a User Button and pressing that User Button. See the discussion in the User Button section for more information.

IR Rec Color (UX180 Only)

When recording using Infrared Rec, you can choose whether the resulting video will have a greenish "night vision" look, or whether it'll be strictly shades of gray.

Focus Transition (UX180 Only)

This enables the ability to execute a pre-programmed focus transition, where the camera will automatically and smoothly shift focus from one point to another. This particular menu item allows you to program in your desired focus positions; you can choose up to three focus points to program.

When you first choose SET, the camera brings up a display with three virtual buttons, corresponding to the three possible focus positions you can set. Press one of those buttons to establish a focus point; the camera then brings up a modified version of the EXPAND FOCUS ASSIST so that you can precisely establish your focus point. When you've set your focus where you want it, press the ENTER button to return to the previous screen, where you can repeat this process for the other two positions.

Once you have your focus positions programmed in, you use the FOCUS TRANSITION User Button to actually switch between the current focus point and one of your pre-programmed focus positions.

This function is only available when the AUTO/MANU switch is set to MANU. FOCUS TRANSITION can only happen when the camera is set to manual focus mode.

A few things to understand about FOCUS TRANSITION: first, when you register a focus point, that focus point is valid only so long as the camera stays exactly where it is, and the subject stays exactly where it is. If you

move the camera, or the subject moves, then obviously your focus points will be invalid.

Second, the focus points stay valid so long as the lens focal length doesn't change. If you zoom the camera, the focus points will be erased. Your focus points will also be erased if you go to the THUMBNAILs, or engage the INFRARED RECORDING mode.

Third, FOCUS TRANSITION works only when the camera has control over the focus motors. If you have plugged in an external remote focus controller, then FOCUS TRANSITION can't work, because the external remote focus will override the camera's ability to control the focus motors. Likewise, it can't work if you're using the wireless remote AG ROP application to control focus.

Finally, FOCUS TRANSITION won't work during Freeze Frame, VFR, or Super Slow Recording.

Focus Transition Time (UX180 Only)

The FOCUS TRANSITION function shifts focus from the current focus point to a preprogrammed focus point that you've established. How long it takes to make that transition is up to you; you can program the speed of the FOCUS TRANSITION using this menu item. DIRECT causes the focus transition to happen instantaneously, and also may cause a little bit of focus motor noise to be heard. FASTEST takes about a second or so to shift from one focus point to the other and, like all the other options here, is effectively silent in operation. The 2-15 SEC menu button lets you program in an exact time, between two to 15 seconds, in half-second increments.

Focus Transition Rec (UX180 Only)

This function establishes whether or not you want the camera to automatically transition to a certain focus point when you start recording. You can program the camera to know that it's supposed to go to any of the three pre-programmed focus points when the RECord button is pressed. Note that this function will take into account the Focus Transition Time, so -- if your subject is out of focus when you start recording, it will gradually transition to your chosen focus point over the course of time you've established. Also, note that this function will only work if you've activated the Focus Transition User Button before you start recording.

Focus Transition Wait (UX180 Only)

This menu item lets you delay the start of a focus transition move. This can be helpful to avoid any shaking of the camera caused by pressing the button.

Time Stamp

This menu setting controls whether the camera will "burn in" the time and/or date information into the recorded video. When set to "ON," the camera will actually print the time of day and/or date display right into your video footage, permanently (if other conditions are met, as detailed below.) Once the time stamp is added to your footage there's no way to remove it, so be very sure that you want this. An example of when you would want the time or date burned into your footage would be when using the camera for legal videography, where the court has specified that every frame of footage needs visible permanent time and date information.

This function is inherently tied to the DISP SETUP->DATE/TIME menu setting. The TIME STAMP can only burn in what information you currently have displayed, so you must configure the DATE/TIME menu item to show either the DATE, or the TIME, or BOTH. If you've set up your DISP SETUP to display the TIME, and then you come into this RECORDING SETUP menu and turn TIME STAMP to ON, then the time (and only the time) will be burned into your footage. If you change the DATE/TIME menu to show only the DATE, then only the date will be burned into your footage. If you configure the DATE/TIME menu to OFF, then no information will be burned into your footage even if TIME STAMP is set to "ON". You have to have both menu items coordinated together in order for the TIME STAMP function to have an effect. When the time stamp is actively being stamped onto/burned into your video, you'll see a small red "R" next to the date/time readout on your camera's LCD or viewfinder to alert you that the time and/or date are being burned into your footage.

Note that not only will the time stamp be burned into the footage, it will also be embedded on the video display outputs, even if you have VIDEO OUT OSD set to OFF, and even if you have used the DISP/MODE CHK button to remove the displays from the LCD/EVF. That's because the TIME STAMP is not a display, it's an integral part of your footage at that point.

There are some cases where TIME STAMP just won't work; for example, it doesn't work when recording in the AVCHD standard-def SA mode, or when the UX180 is set to record in DUAL CODEC to both memory cards,

or, of course, when the DATE/TIME function is set to OFF, or during Freeze Frame or VFR or Super Slow recording.

Also, while the TIME STAMP can output over the UX180's SDI port, it won't work if the SDI is outputting Progressive Segmented Frame (PsF). The SDI will use PsF whenever you're shooting Cinema 4K, and it may possibly happen if you're shooting either HD or UHD at 23.98, 25, or 29.97 fps. In this case you can set the OUTPUT SETUP -> RESOLUTION menu setting to "1080p" or "1080i" instead of "SYSTEM"; that will disable PsF processing and then the TIME STAMP will work in HD/UHD 23.98/25/29.97 fps.

Finally, while it's true the TIME STAMP function won't work when the camera is set to record standard-definition footage (AVCHD SA mode), you can still get the time and date stamp sent out the standard-definition AV port for connecting to a DVD recorder or other standard-definition device; if you set the OUTPUT SETUP->OUTPUT SEL to AV, and choose a recording mode of UHD, MOV/MP4 FHD or any high-definition AVCHD, the standard-definition video port will carry the TIME STAMP information. This will not work on a UX180 if the camera is recording 4K/24p.

Time Code Options

Before discussing the timecode menu settings, let's discuss timecode itself. Timecode is a system that numbers and counts every frame of video, in the format of HH:MM:SS:FF (hours:minutes:seconds:frames). An internal timecode generator (TCG) stamps an 80-bit code on every recorded frame. The playback system or NLE will use this number for individually identifying every frame. This code is recorded with the video and audio signals and is stored invisibly in the sub code area written to the memory card, and it's output over the SDI (and, optionally, over the HDMI). These 80 bits of time code contain a lot of information, such as drop frame information, frame rate information and user bit information. In NTSC/59.94Hz video, timecode can be counted in either Drop Frame (DF) or Non-Drop Frame (NDF) mode. In NDF mode, every frame gets counted and numbered sequentially. In DF mode, some timecode entries are skipped in order to make the running time of the video match the timecode display (by way of explanation, NTSC video runs at 29.97 "frames" per second, but timecode counts at 30 frames per second. Drop Frame counting was invented to resolve this .1% discrepancy, so when an hour of footage has gone by, the DF timecode will read 1:00:00:00, whereas in NDF timecode, after one hour the timecode would read 0:59:56:12.) PAL/50Hz users don't need to worry about this, since PAL televisions run

at exactly 25.000 frames per second. PAL/50Hz cameras are always in NDF mode. The 24P and 23.98P modes also use NDF only.

There are 32 User Bits in each 80-bit code; these user bits can be used to record a specific code that you can set separately for each camera. However, the User Bit data is only used when set to record AVCHD; the relevant menu item is disabled when recording MP4 or MOV footage.

DF Mode (59.94Hz Only)

This menu setting allows you to select Drop Frame (DF) or Non Drop Frame (NDF) timecode.

When in the 23.98P or 24P modes, NDF timecode is used exclusively; when you select a 23.98P or 24P recording format this menu item will be disabled. When you set the SYSTEM FREQuency to 50Hz, this menu item will disappear entirely; all 25p/50p/50i recordings are done in NDF. DF is only really relevant when shooting 29.97P, 59.94i or 59.94P. In those cases, you may want to consider setting your timecode to DF when you're planning on delivering the raw footage for broadcast; if it's for your own editing, you may prefer the frame-accurate simplicity of NDF. Then again, if you need the timecode to be time-accurate (i.e., one hour of footage shows one hour of elapsed timecode), you'd be better served with setting this menu item to DF. And, if you're using your camera in a multi-camera shoot, you're definitely going to want to verify that all the cameras are all using the same type of timecode counting, either all DF or all NDF.

TCG

TCG stands for Time Code Generator; this menu setting determines what kind of time code generator is employed: FREE RUN or REC RUN. In FREE RUN mode the timecode clock is constantly advancing whether the camera is recording or not or, for that matter, whether the camera is even powered on or if it's turned off. In REC RUN mode, the timecode clock advances only when actual recording is occurring. In FREE RUN, the timecode is derived from a continuously-running clock in the camera regardless of how many times you start or stop the recording. On the UX180, FREE RUN mode can be used to synchronize cameras in a multi-camera shoot. Note: if you're using time-lapse INTERVAL recording, or variable frame rates other than your timebase (i.e., not 24:24 or 25:25 or 30:30, but some variable frame rate) then the system will automatically force you into REC RUN mode. On the other hand, if you're using PRE-REC or BACKGROUND recording, the system will force this menu item to FREE RUN.

TC Preset

The value of the TC PRESET is the timecode that will be assigned to the next frame of video that gets recorded. When using REC RUN, this setting gets updated as the timecode runs, so the timecode on the next clip will continue where the last clip left off (i.e., it won't be reset to what this setting was first set to, it continues where it left off). Note: When recording 23.98P you must set the last digit to 0 or any other multiple of 4. If you set the TC PRESET to any other last digit, the timecode may not be recorded properly. You can also set the TC PRESET to synchronize to another camera's timecode value; see the article on Synchronizing Timecode for more details.

UB Preset (AVCHD Only)

When recording AVCHD footage (and only when recording AVCHD footage) you can set the User Bits Preset. This setting lets you specify an 8-digit sequence that gets recorded invisibly in the metadata that's recorded with AVCHD footage. Using the numbers 0-9 and the letters A-F ("hexadecimal notation"), you can write an 8-character-long message. Example messages might be the name of your company (assuming you can spell it using just the letters A,B,C,D,E, and F!) or perhaps you'd want to specify a unique identifier code for each camera in a multi-camera shoot, so in the editing bay, the editor could identify which camera shot which clip. The message that you write is set in the UB PRESET menu item.

In MOV and MP4, this User Bit info isn't used, but there is an alternative way to specify which camera shot which clip. You can establish an individual camera number in the SYSTEM MODE->CAMERA NUMBER SET menu to identify footage as having come from this particular camera.

EXT TC Link (UX180 Only)

This menu lets you start the process of synchronizing your UX180 to another camera (or to another timecode-enabled device, such as an audio recorder or a timecode slate). See the article on Synchronizing Timecode for more information.


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Audio Setup Menu

This section of the book describes the camera's audio settings, including the limiters, automatic level control, test tone volume and other audio-related settings. Note: this whole menu section becomes disabled if you're recording offspeed footage in VFR (Variable Frame Rates) or using the UX180's Super Slow Recording option. If you can't access this menu, that's probably why. Eitehr disable VFR/Super Slow, or set your frame rate to the same as your recording format (23.98p at 24 fps, 25p at 25 fps, or 29.97p at 30 fps) and that should re-enable this menu.

Audio Low Cut CH1 and CH2

You can assign a high-pass/low-cut filter to each audio channel individually. Effectively, this will cut out or de-emphasize lower frequencies, while preserving middle and higher frequency sounds. Some examples of when you might want to use this would include if there's a big truck idling outside the location you're recording in; the Low Cut might reduce that low rumbling noise and make it less intrusive on your soundtrack. Or, if you're recording in a windy outdoors environment, the Low Cut may help; when wind hits a microphone, the results are a rumbling muffling mess in your audio track. Sometimes this can ruin your recordings. The rumbling is usually quite low frequency, and establishing the AUDIO LOW CUT can knock out some of that wind rumbling and result in a less-distracting audio track.

If you need to cut out the rumbling or wind noise, consider setting the AUDIO LOW CUT feature on. However, if you don't need it, don't use it – the AUDIO LOW CUT works by chopping out some of the lower bass frequencies in your recorded audio, and that can result in your recorded audio sounding thinner. For maximum audio fidelity, you want this set to OFF. But if you're in a windy or noisy environment and relying on the onboard microphones, you might want to turn it on to minimize the rumbling wind noise, especially if you're not going to be able to apply a low cut audio filter to the footage in post.

Audio Level CH1 and CH2

You can have the camera automatically adjust the audio level of each audio channel, or you can have each audio channel level set manually using the physical AUDIO LEVEL dials.

Automatic audio level adjustment is generally frowned upon in professional productions, primarily because it can result in "pumping" of the audio. For example, when an interview subject is speaking, the audio system hears the loud volume, so the automatic level control drops the audio level down to keep the voice in a good range. But, when the interview subject stops speaking, the audio system doesn't hear anything, so the automatic level control pushes the audio level higher and higher in an attempt to capture something, anything... and the net result is that the level of background noise will rise and fall depending on whether the subject is speaking or not. And that leads to a really amateur-sounding soundtrack.

Putting these controls in manual gives you the control to set the levels at a consistent and suitable level, and can make for much easier editing in post production.

However, there are some times when you simply cannot dedicate the time to adjusting the audio levels; for example, in reality TV, you may be responding to a dangerous situation and have all your efforts concentrated on just making sure the picture is framed and in focus! At times like that, it sure would be convenient to turn the job of audio level control over to the camera and let it handle level adjustment.

As such, I've found it frequently useful to set audio channel 1 to manual, and the other to automatic; in that case, the results are usually a good solid normal audio track on channel 1, but channel 2 is available if an unpredictable scenario arises - if the audio suddenly spikes, if an ambulance drives by, or if attempting to interview someone who turns out to be unusually soft-spoken, etc; in those cases, the camera will automatically adjust and may in fact save the audio, whereas the fixed-level channel might end up clipping or being too quiet in those scenarios. In post, I can then use channel 1 for all the main audio, and dub in portions of channel 2 when channel 1's audio was rendered unusable.

Audio ALC LINK, and Audio ALC CH1/CH2

The camera provides individual control over both of its audio channels, as to whether either, neither, or both of them use the automatic limiter

capability. Note - this function is not discussing Automatic Level Control (i.e., automatically raising or lowering the volume of the audio channels); instead, this is discussing the Automatic Limiter Control. The Limiter is optional, and can help you avoid blown-out or distorted audio that gets too loud.

When the Limiter is engaged, the camera will try to "clamp down" excessive volume to prevent clipping or overdriving the audio channel. It won't modify the overall signal level (like Auto Level Control does); instead, the Limiter will just try to keep loud levels from distorting (sort of like the KNEE control for protecting against blown-out highlights due to overexposure). The ALC starts attenuating signals at approximately –6dB, and tries to limit them to a maximum of –4.5dB. It may not catch brief transitory peaks (such as clapping close to the mic may defeat the limiter and result in overmodulated sound) but in general if the overall sound level is too high for more than the briefest moment, the limiter will lower the volume to keep it below the maximum allowable threshold. When using mics directly hooked to the camera, it's usually a good idea to keep the limiter ON. When using an external mic-level mixer with its own limiter, you should set the camera's limiter OFF.

The AUDIO ALC CH1 and AUDIO ALC CH2 menu options enable or disable the limiter for each channel. Each channel can operate independently, or you can link them together by using the AUDIO ALC LINK option. If you link them together, then when either channel determines that it needs to be limited, both channels will be simultaneously lowered an equivalent amount. This may mean that a non-clipping audio channel gets its volume lowered, which may or may not be what you want; what it will mean is that both channels are kept proportional to each other. If you're using the onboard stereo mic, where both channels are recording approximately the same sound, then linking them together may be a good idea. On the other hand, if you're using a lavaliere mic on one channel and a boom mic on the other, then it's probably not a good idea to link them together. Note: you can only link the audio channels together if both are set to manual level control; if either audio channel is set to AUTO, then the AUDIO ALC LINK menu option is disabled.

If you're recording audio film-style where you run one microphone into both audio channels, and you set one channel lower than the other to prevent clipping, then you probably don't want the limiter engaged (and you certainly wouldn't want to link the channels together!) On the other

hand, if you're recording ENG or news-style, you may not have time to ride the audio levels and in such a scenario the limiter can be very useful indeed. Generally, the purest quality audio will be recorded when the limiter is off (provided, of course, that you keep an eye on the levels and don't let anything get too loud). If you can't do that, then using the limiter can at least provide some insurance from badly clipped audio.

Input1 and Input2 Line Level

You can attach microphones or line-level audio sources to the camera's XLR input ports. These menu options (LINE LEVEL and MIC LEVEL) let you specify the expected signal level of the output of whatever device you've connected to the relevant XLR port.

Generally, microphones output at MIC level, and other devices (such as mixers, audio amplifiers, or DVD players, or DJ systems etc.) output at Line level.

For line-level equipment, some signals are sent at a hotter level than others. The camera can compensate, by using this menu item. You can choose 0dBu or +4dbU. Generally professional equipment will be outputting signals at +4dBU; if your signals are mismatched and your audio input is higher or lower than what you were expecting, you may be able to adjust this menu item to compensate.

Input1 and Input2 MIC Level

Different microphones have different levels of output. If you find that the audio level coming from your microphone is too low and that you're having to crank the audio dials up high just to get a usable level, then you'd probably be better off to try changing the appropriate channel's MIC Level setting to boost the audio levels. –60dB makes the mic input louder than –50dB, and would be appropriate for use with a less-sensitive microphone. -40dB is the least-resistance setting and would be used if -50dB isn't enough.


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Output Setup Menu

This menu deals with settings related to the HDMI, 3G-SDI, and composite video and audio output jacks, as well as downconversion settings and the headphone jack.

Output Sel (UX180 Only)

This menu item determines which video output port is used to output video signals. The ports are not able to be used simultaneously; for example, when using HDMI, the SDI and composite video ports are disabled.

3G-SDI is a professional monitor connector, which supports both high-definition and standard-definition signals (when used for standard-def, it's called "SDI", when used for high-def it's called "HD-SDI"; when used for 1080/59.94P or 1080/50.00P it's referred to as 3G-SDI). I n all its modes SDI signals can embed audio and timecode along with the video. The 3G-SDI port has a maximum resolution of 1080P; it cannot be used for UHD or 4K (although when the camera is in UHD or 4K, the SDI can be used to output a downconverted 1080P or 1080i or even standard definition signal). The SDI port can also be configured to output record start/stop flags to control an external recorder.

HDMI 2.0 is a consumer-derived connector for SD, HD, and UHD/4K video. It can output the same digital video and audio signal as the 3G-SDI port, with the major difference being that HDMI also supports UHD and 4K. It also outputs audio, and can be optionally configured to output timecode and record start/stop flags to control an external recorder.

The composite video AV port can only transmit standard-definition NTSC or PAL, carrying standard-definition video and audio only.

If you are doing a lot of UHD 50p/59.94p recording, you may want to consider that the SDI output may have a tangible benefit. When recording

UHD 50p or 59.94p internally, the UX180 cannot simultaneously output a UHD signal on its HDMI port, so for the duration of internal recording the camera will instead output a downconverted 1080p signal. When recording stops, the camera will revert to outputting UHD. The thing is, HDMI monitors will generally detect the change and reconfigure themselves to display the new signal, but that change may take a few seconds, maybe up to six or seven seconds. During the changeover, the monitor will likely be blank. Since you're only going to be seeing a 1080p signal anyway during recording, you may want to consider just outputting through the SDI port instead of the HDMI; the SDI will output a 1080p signal but will do so continuously, with no regard to when recording starts or stops. If you find the monitor-switching problematic, perhaps using the SDI port would be a way to avoid that.

Resolution

The HDMI (and UX180's SDI) ports are capable of outputting a wide variety of frame sizes and frame rates, and the camera is also capable of converting its frame sizes and frame rates into other standard output formats. Using this menu item, you can configure the output ports to match whatever your monitor (or recorder) is capable of receiving.

When this menu item is set to SYSTEM it will generally try to force the video output to match whatever the recording mode is. Meaning, if you're shooting UHD or 4K, the HDMI will output that same format and frame rate. If you're shooting 1080P or 1080i, the HDMI (and UX180's 3G-SDI) ports will output those formats in their native resolution and frame rate. There are, of course, some exceptions; as an example, 3G-SDI cannot output UHD, so if you've set the UX180 in UHD 59.94P and set the OUTPUT SEL to SDI, the SDI will be outputting a downconverted 1080/59.94P. It isn't exactly the same, but it does attempt to match the output to the input whenever possible. As another example, if you set the UX180 in 1080/24P and the OUTPUT SEL to SDI and the RESOLUTION to SYSTEM, the SDI port will output 1080/24PsF.

In some cases your monitor (or recorder) may not be able to handle what the camera is sending it. As an example, the UX180 uses an HDMI 2.0 port, which is capable of transmitting UHD at 50P/59.94P. Many recorders on the market at the time of this writing use HDMI 1.4 input ports, which are capable of UHD at only up to 29.97P. As another example, the camera is capable of outputting 1080 50P/59.94P over its 3G-SDI port, but a monitor that has an HD-SDI port will be capable of receiving no more than 1080

50i/59.94i. In a case like that, you may want to use this menu setting to limit the output ports to only output signals that are within your monitor's or recorder's capabilities.

There are three options for converting the output: "1080P", "1080i" and "DOWN CONV." When using one of these settings, the camera doesn't try to match the best possible output format, it instead converts its footage to conform with the desired output. As an example, if you're recording AVCHD 720/59.94P, you can have the HDMI or SDI port output the footage as 1080/59.94P by choosing RESOLUTION->1080P. Or, you can have it output 720/59.94P to the SDI port as 1080/29.97PsF, by choosing the RESOLUTION->1080i option. Or, you can have it output it as 480i on the SDI or composite video ports using RESOLUTION->DOWN CONV.

Do be aware that some of the combinations will result in the TIME STAMP function not working. Only certain combinations of recording formats and output settings will let the TIME STAMP function work properly. If the TIME STAMP isn't working, consider changing the OUTPUT SEL and/or RESOLUTION settings, or even your recording format, to one that is compatible with the TIME STAMP. Generally, forcing the output to 1080p or 1080i will make the TIME STAMP will work; outputting at SYSTEM resolution can lead to the camera generating PsF output, which will disable the TIME STAMP. See the RECORDING SETUP->TIME STAMP function for more information.

There are extensive charts in the owner's manual that document every possible combination of recording mode and resolution setting to show what the output will be.

Note: if using a UX180 and you choose an OUTPUT SEL of "AV", this menu item will be disabled and forced to DOWN CONV.

Remote REC

The UX180 is capable of sending record start/stop flags over its SDI port and, if you've enabled timecode on the HDMI port, both the UX180 and the UX90 can send record start/stop flags over the HDMI port. This function enables those record flags.

However, even if these are turned on, record flags won't be sent over the UX180's SDI port if you're recording standard definition (AVCHD SA mode) or if you've set the SDI port to DOWN CONV.

Remote Rec Link

If you've configured the REMOTE REC function to send record signals out the SDI and/or HDMI port, this menu item lets you determine where those record flags come from. If this menu item is set to ON, then the camera will send record start/stop flags out its SDI/HDMI ports whenever the camera's record button triggers internal recording to start or stop; in other words, it "links" the internal and external recordings together. If this menu item is set to OFF, then the camera's record button will trigger internal recording but it won't trigger record start/stop flags to be sent over the HDMI or SDI ports; instead, you'll use the AUTO REC User Button to send those flags.

If you're recording to the internal memory cards and you also want to send a record flag to an external recorder, set this menu item to ON. If you're not recording to the internal memory cards, but you still want to be able to trigger an external recorder from the camera, set this to OFF and configure a User Button with AUTO REC and use that User Button to send the record flag to the external recorder.

SDI EDH (UX180 Only)

Enables or disables the output of SDI Error Detection and Handling on the SDI output jack. The camera can embed the optional error detection and error handling protocol in its output video when it's outputting standard def (but only when it's outputting standard def).

SDI Audio Gain Chg (UX180 Only)

This lets you drop the level of audio that's output from the SDI port; you can cut the volume in half (-6dB) or to 1/4 (-12dB) of what the internal recording volume is. Note that this function only works with the SDI port, so if you've set the OUTPUT SEL to HDMI or to AV, this menu item will be disabled.

Down Conv.

If you've set the RESOLUTION option to DOWN CONV, then this menu item lets you control how your 16:9 widescreen high-definition image gets downconverted to standard definition. The HD or UHD video the camera is generating will be recorded internally as 16:9, but downconverted to standard-def for video output, and you have a choice of how to deal with the widescreen aspect ratio.

There are two aspect ratios that are common in the world of television: older-style 4:3 televisions, and modern widescreen 16:9 televisions. These numbers refer to the width of the picture as compared to its height; a 4:3 television is four units wide and three units tall, whereas a 16:9 television is 16 units wide and 9 units tall (for comparison, a 4:3 television could also be expressed as a 12:9 television, which gives a better understanding of how it compares to a 16:9 television.) Displaying 4:3 video on a 16:9 television will result in video that's horizontally stretched out. Displaying 16:9 video on a 4:3 television will result in a picture that's horizontally squeezed together.

HD/UHD cameras are native 16:9 cameras. Their image sensors are shaped 16:9. This means they are optimized to create video suitable for a 16:9 television; all HD and UHD is 16:9 (and so are widescreen DVDs, Blu-Rays, etc). When recording HD/UHD the camera will always record the full 16:9 frame. This menu item lets you decide how to output a downconverted standard-definition signal for monitoring (or external recording). There are three choices:

SIDE CROP: in this setting, the camera will cut off the sides of the image, leaving a full-height central 4:3 extraction out of the widescreen 16:9 frame. This is similar to a "full screen" DVD or a "Pan & Scan" television broadcast; there won't be any black bars, but the left and right edges of the image will be cut off in order to make an image that will display properly on a 4:3 television.

LETTER BOX gives you video that is suitable for display on a 4:3 television, but has black bars on the top and bottom, giving the video a widescreen look (like a letterboxed movie.) With this setting you'll see the entire 16:9 image you're recording, but it will be formatted to properly display on a 4:3 television.

SQUEEZE will output a 16:9 anamorphic standard-def version of the full frame, and the video signal will be appropriate for viewing on a 16:9 widescreen monitor.

If you're connecting to a 16:9 monitor, use Squeeze. If you're connecting to a 4:3 monitor, use Letter Box or Side Crop.

If the camera is set to UHD, then you don't get a choice — it will always force its downconverted output to SQUEEZE. And if you're using a UX180 to record 4K/24p, you also don't get a choice, as the 4K doesn't output standard-def as an option; it can only output as SYSTEM or 1080p.

HDMI UHD Output Limit (UX180 Only)

The UX180 uses an HDMI 2.0 video port, which is capable of transmitting up to UHD 59.94P or UHD 50.00P. However, many recorders and monitors use HDMI 1.4 ports, which are capable of only up to UHD 29.97P. Using this menu item, you can constrict the HDMI port on the camera to output a maximum of 29.97 or 25.00 frames per second, making it backwards compatible with HDMI 1.4 monitors and recorders.

HDMI TC OUTPUT

This menu item lets you decide if you want to output embedded timecode on the HDMI port's output. Generally this is a pretty good idea so long as the device you're connecting to can handle it. The original HDMI specification didn't allow for timecode, but several camera manufacturers have gone ahead and implemented it anyway over the years, to the point where it's quite commonplace now. I would recommend this setting to be ON unless you're using a recorder or monitor which doesn't work properly when timecode is embedded in the HDMI. Also, if you embed TC output, it makes it possible for the HDMI to carry recording start/stop signals too; see the REMOTE REC option for more details.

AV OUT (UX90 Only)

This menu item lets you enable or disable the UX90's composite video output ports (the yellow VIDEO OUT connector and the red and white AUDIO OUT connectors). If you want to use these ports, turn this menu item to ON, and you'll also want to go into the OUTPUT SETUP->RESOLUTION menu and set that to DOWN CONV (unless you're shooting standard-def AVCHD SA mode, in which case it will be fixed at SYSTEM).

Even if you set this menu item to ON, no video will be sent over this port if you've also got an HDMI monitor connected; the HDMI monitor will take priority. And, of course, if you've told the OUTPUT SETUP->RESOLUTION to output 1080p or 1080i or SYSTEM, then the AV OUT jacks won't work. They can only work when outputting standard-def, which is why you need to set the RESOLUTION parameter to DOWN CONV.

H/PHONE MODE

This menu item lets you control the audio that gets sent through the headphone jack – either LIVE, or delayed to match the RECORDING. LIVE means that the headphone jack will output the audio directly from the audio input circuitry with no "buffering." RECORDING means the audio will be delayed to match the video output.

The video that gets output on the LCD or EVF or through the video output ports generally will lag "real time" by three or four frames. If you're hearing the audio live, but watching the video that's been delayed by three or four frames, it may actually look like the audio and video are out of sync. If you set this menu item to RECORDING, it will delay the output of the audio to match the video, and everything will look properly in-sync while monitoring. Of course, the recording will always be in sync, regardless of how this menu item is set.

However, delaying the audio can cause another potentially annoying issue -- you might hear a noticeable echo when monitoring on the headphones. If your headphones are completely noise-isolating (so that you can't hear the outside world at all), then you'll never hear an echo; on the other hand, if your headphones allow the "real world" live audio to reach your ears, then when the delayed RECORDING audio comes in three or four frames later, you'll get a significant echo which can make monitoring the audio difficult.

LIVE eliminates the echo. You'll hear and monitor the audio exactly as it's spoken. I generally find this the superior choice. Unless you have a really good reason for using RECORDING mode, I strongly recommend you put this setting in LIVE.

Volume

This allows you access to the ability to adjust the headphone volume level. It's a simple on/off menu item; if you set it to ON, then when you have headphones plugged in (and only when you have headphones plugged in) you'll have the ability to adjust the headphone volume. You use the menu jog/dial wheel to adjust the volume. Once you've pushed in the jog/dial wheel to set your chosen volume, the volume display will disappear, but as long as this menu item remains set to ON, you will see that you have a new option in the choices of what the jog/dial wheel can do; in addition to GAIN, SHUTTER, etc., you'll see VOLUME. If you press the wheel in when its display says "VOLUME", it'll bring you back to the headphone volume adjustment screen.

Test Tone

This governs whether or not a test tone is generated when the color bars are displayed. You can choose from silent, Level 1 (-12dB), or Level 2 (-20dB). The test tone that is output is a dependent on your SYSTEM FREQuency setting; when the camera is in 50.00Hz, the test tone will be 997Hz; if the

camera is in 24.00Hz or 59.94Hz, it will be at 1 kHz. Note that the test tone will be output on all the camera's outputs except for its internal speaker.

LCD/EVF Output

Both the UX90 and the UX180 have this menu item, but it behaves differently between the two cameras.

On the UX90, it's straightforward: this lets you determine whether the video signal is sent to the LCD touchscreen, or to the electronic viewfinder (EVF). Only one display can be active at a time; this menu item lets you select which one. The EVF is great for shooting outdoors, as the LCD is quite reflective and can be more difficult to see; however, operating solely on the EVF can make the camera more challenging to operate, since there are certain functions (like the AREA mode) that only work with the LCD, and the menus are quicker to access and operate when using the LCD touchscreen.

On the UX180, the choices are different: you can tell the camera to limit output to only the LCD (thus turning off the EVF entirely), or you can tell the camera to allow auto-switching. In auto switching, the viewfinder may automatically take over and disable the LCD if (and only if) the viewfinder's eye sensor detects that you've put your eye up to the viewfinder. If it doesn't detect your eye (or any other blockage, like your arm or body or whatever) then it will automatically switch back to the LCD.

If you find yourself only ever using the LCD panel, and you keep getting frustrated by the eye sensor occasionally disabling the LCD panel to turn on the EVF, then you might want to restrict the camera to only LCD output.


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Disp Setup Settings

This menu's options control the text and graphics that show up on the camera's LCD monitor and viewfinder. It also gives you control over the way the LCD panel and viewfinder are calibrated and how they operate. Note that these settings are not actually controlling the video output ports; that functionality is in the OUTPUT SETUP menu. This menu has the settings for how you personalize the information that the camera gives you, and as such it's important to understand and take advantage of the feedback the camera can give.

Zebra Detect 1 and 2

The "zebras" are an exposure guide you can use to judge the overall exposure level of your picture. When you enable the zebras, the camera will display a diagonally-striped black & white line pattern over sections of your video that exceed a specified brightness level. Using the zebra pattern will let you know what overall brightness levels your video is at, and help you to get proper exposure and work more effectively at maximizing the dynamic range of your video. The zebras can be set from 50% to 105%. While this sounds impossible (how can brightness be at 105%?) keep in mind that the percentages are just a naming convention. Video brightness is measured in IRE units, with the absolute maximum brightness registering at 110 IRE, so setting zebras at 105% means having the zebras trigger at 105 IRE.

There are two zebra settings, Zebra 1 and Zebra 2. They display different diagonal patterns on the LCD so you can tell them apart: Zebra 1 draws its lines from the upper-right to the lower left; Zebra 2 draws its lines from the upper-left to the lower right. You can't display both at the same time, you choose one or the other to be on screen. A potential way to consider setting your zebras is to set Zebra 1 at 70% and Zebra 2 to a pretty high maximum value for highlights, perhaps 100%. Then use the zebras to guide your overall exposure level. Typically when shooting faces, you'd like to see the brightest spots on a Caucasian face (usually the highlights on the

forehead and maybe the nose) just bright enough to barely trigger the 70% zebras, but nothing anywhere in the frame should be so bright as to trigger the 105% zebras (unless you have something overly bright in the scene, like a light bulb or the sun or something else that you are willing to let "blow out" in order to preserve appropriate brightness in the rest of the image). You use Zebra 1 (at 70%) to guide Caucasian facial exposure, and you use Zebra 2 (at 100%) to protect against "blowouts." Blown-out video happens when the brightness of some part of the image is too high for the sensor to resolve, so the video signal overloads the sensor and the blown-out portion turns to pure white (109 IRE), losing all detail. It looks ugly and should be avoided; the Zebras are a guide to letting you know when you are approaching blowout.

Of course, the zebra display is only drawn on the LCD and viewfinder, it doesn't get recorded in the video signal. It is also not output through the video output ports.

This Zebra Detect menu item lets you set a zebra level (or you can set Zebra 2 to OFF). You toggle between the zebras (and the MARKER) using the ZEBRA button on the camera's body (or another User Button that you've assigned ZEBRA to.) You can configure the zebras to display continuously, or to only display for about 5 seconds, using the ZEBRA MODE menu.

I highly encourage all shooters to become not only familiar with, but thoroughly well versed with, the zebras. Trying to gauge exposure by looking at the brightness of the LCD panel is a perilous process that can lead to grossly underexposed or overexposed video. The zebras bring reliable, repeatable, predictable monitoring for greatly improved exposure control. Of course, the UX180's waveform monitor is even better, but sometimes inconvenient; the zebras are sort of a handy "quick reference" for knowing that your video is being properly exposed. And I also strongly urge all shooters to avoid anything in your frame triggering 105% zebras, and for safety and color purity, you really should try to keep your exposure such that the 100% zebras are rarely (if ever) triggered. The higher up the IRE scale your video goes, the more susceptible it will be to color shifts due to chroma clipping, where one of the color channels "clips" before the others do; continuing to increase brightness beyond that point will result in color shifting (such as yellowish skin tones). Avoid too-bright exposure and you'll avoid that issue.

Marker

Another simple tool for measuring the video brightness level of different parts of your shot is the MARKER. The Marker acts something like a lightmeter's spotmeter: it tells you the brightness of whatever's in the frame within the box in the center of the screen. This menu item lets you turn the Marker ON and OFF.

To use it, press the ZEBRA button to cycle through the Zebras until the Marker box comes up. The Marker measures the video level within that box and reports it using a numerical percentage readout in the lower left of the screen. The Marker readout is specified as a percentage of brightness, with 0% representing solid black, and 99%+ representing the brightest possible luminance level. Note that these numbers are affected by the aperture and shutter speed that you currently have set: changing either the aperture or the shutter speed will affect the brightness level of the picture, and correspondingly all the Marker values will change as well. The percentages the Marker reports are relevant to the shot that it sees at the time. If you change the light level or the iris or shutter speed, then the Marker will of course report new numbers that reflect the new brightness levels the camera is seeing.

You can use the Marker to see if the camera is discerning detail in the shadow areas of the picture, or to determine brightness ratios between key and fill lights, etc. Another usage of the Marker is to check for the overall evenness of lighting of a greenscreen, for example. Using the Marker you can locate hot spots or dark areas that may not be easily discerned by eye, but will guide you towards creating a more overall evenly-lit surface, thus improving the quality of your greenscreen keys.

In most cases the UX180's waveform monitor will prove far more valuable, since it is basically a "marker" for the entire screen. However, there are some times when you want to focus in on just a small section and know exactly what's happening in your video in that portion, and those are times when the marker is the best tool for the job.

Guide Lines

This overlays a series of gridlines over the display; it can be used for checking how level your horizon is, or how "square" your frame is in relation to a vertical or horizontal surface, and some people may even find them to be useful in helping to compose their shots.

Safety Zone

The camera's LCD and Viewfinder show a full-frame image, with little (if any) "overscan." On legacy televisions you should understand that not all of the picture is typically visible; the edges may be cut off (a process called "overscanning.") On the viewfinder/LCD, the entire frame is always visible (also known as "underscanning.") In order to provide compatibility with overscanning televisions, as well as to guide composition for various aspect ratios, the camera can display a number of "safety zones," which are basically framing guidelines that indicate what parts of the image are likely to be cut off.

Options for this menu item include:

16:9 90%: You can use this as a guideline to know that your footage will show properly on an overscanning television. Keep your footage within the white outline, and you can be pretty sure it will display on all televisions.

4:3: When shooting footage where the final version might end up on a 4:3 television, this overlay lets you "protect" for 4:3; this means you'd compose your shots such that vital information is kept between the white lines, thus fitting in the 4:3 frame, in case you need to master a 4:3 version of your production. If you are outputting a standard-def version of your footage through the composite video port, the "SIDE CROP" setting should be a central extraction of the full frame that exactly matches the area within the 4:3 frame guidelines.

14:9: During the transition from the old-style 4:3 televisions to the modern 16:9 screens, producers faced the constant dilemma of how to shoot one format that will display properly on both. On some European broadcast channels they've adopted the idea of keeping all your footage within a 14:9 aspect ratio (14:9 is halfway between 16:9 and 12:9, which is also known as 4:3).

1.85:1: The standard motion picture aspect ratio has been 1.85:1 since the 1950's. Most movies are released in one of two aspect ratios, either standard (or "flat") 1.85:1, or widescreen/anamorphic 2.39:1. The 1.85:1 aspect ratio is very close to the camera's native 16:9; keep your framing within these guidelines and you can then crop to 1.85:1 in post.

17:9 (UX180 Only): This is another aspect ratio that's very very close to 1.85:1. It's actually the same aspect ratio that the 4K/2160P mode uses.

2:1: This is an aspect ratio that falls neatly between normal (aka "flat") 1.85:1 movies, and widescreen/anamorphic (aka "scope") movies.

2.35:1 and 2.39:1: The standard aspect ratio for anamorphic or widescreen movies has changed over the years, but usually has been around 2.35:1 to 2.40:1. These grid marking lets you compose your footage with the intention of cropping in post to a widescreen film aspect ratio.

Center Marker

The Center Marker is a crosshairs display in the center of the viewfinder, useful for framing and composition. This should not be confused with the MARKER exposure tool.

REC Counter

The camera offers a "COUNTER" function to keep track of the total recorded minutes & seconds. You can have the camera re-set that counter to zero for every clip you record, or you can have it show a cumulative time count since the last time you manually re-set the counter to zero. Choosing SCENE re-sets the counter to zero every time you start recording, and it also adds the abbreviation "SCN" in front of the counter display (when you use the COUNTER button to display the current clip counter, that is.) Using SCENE lets you know duration of the scene currently being recorded. Choosing TOTAL causes the counter to count up the length of all scenes you've recorded, until you manually set it back to zero; this will keep a running tally of how much footage you've shot since the last time you zeroed out the counter. Note: you access the COUNTER display by cycling through the options for timecode display by pressing the COUNTER button (located next to the LCD panel.)

Focus Display

This menu item lets you control how the camera's focus distance readout gets displayed. The camera features distance markings (in feet or meters) as well as percentage readouts, that give you feedback about the position of the lens' focus elements.

The focus ring is not a pure mechanical linkage, but it can give you direct control over the focus mechanism and repeatable focus marks when set to COARSE or FINE mode. The distance scale readout (in feet or meters) lets you know where the focus mechanism is at, and the MF00-MF99

number scale and distance readout scales provide for repeatable rack focus moves (where you shift focus from one point to another). When set to FINE mode, the focus ring will always represent an exact and repeatable spot of focus, unless you exceed infinity or minimum focus distance; in cases like that you'll have to re-calibrate your marks. Of course, if you're using a UX180, it may be a lot easier and more precise just to use the FOCUS TRANS feature to execute rack focus moves.

The focus readout can display numbers from 00 to 99, prefixed with either "AF" or "MF". "AF" means the camera is in autofocus mode, and MF means manual focus mode. MF00 means the lens is focused as close as it can possibly get; MF99 means it's focused at its furthest possible point (which is actually past infinity, as infinity focus is achieved at MF95.) While the distance readout is certainly useful, Panasonic chose to include a numerical readout as well because the numbers-to-distance relationship changes depending on whether you have any additional lenses or close-focus diopters attached. Depending on the type of lens you use (wide-angle adapter, telephoto converter, close-up diopter, etc) it may change the focus distance relationship between the lens and the scale. Normally the feet/meters readout is more precisely calibrated than the MF00-MF99, but in cases where you're using lens adapters, it can be more useful to just use the MF00-MF99 scale. Using close-focus diopter lenses also changes the focus point, and using a close-focus diopter is a way to take advantage of the lens' ability to seemingly focus past infinity: the full range up to MF99 is usable. Don't rely too heavily on the distance readouts though, they're basically accurate but are not 100% guaranteed to be absolutely accurate.

The focus ring also continues to work in autofocus mode: if the camera is set to autofocus, and you turn the focus ring, it will change the focus position of the lens (although the autofocus system will also try to compensate). This can be extremely helpful in cases where the autofocus system is struggling to find proper focus; if it gets "stuck" in a low-contrast scene and doesn't know what to do, you can spin the focus ring to get it in the ballpark and it can take over and quickly finish the focus move.

Zoom – This menu item lets you display or hide the lens's focal length readout, and choose what form those readouts will take. The camera features an exact focal length readout as well as a percentage readout; they give you feedback about the current focal length of the lens.

The zoom readout ranges from 8.8mm to 132mm on the UX90; maximum is 176mm on the UX180. Optionally you can display a percentage scale of Z00 to Z99. The mm scale is calibrated much more precisely than the Z00-Z99 scale is. Regardless of which set of numbers you choose to use, the numbers let you know approximately where you are in the zoom range, which is especially handy for establishing focus: you establish your shot composition and make a note of what Z setting you're at, then zoom in all the way (Z99) on your subject to grab critical focus, and then you can zoom back out to the same zoom setting you started at to begin filming. I generally highly recommend keeping this set on "mm" as the millimeter readings are much more finely calibrated than the 00-99 scale is.

Video Out OSD

This menu item dictates whether the text and graphics in the LCD display also get displayed on the camera's video outputs. OSD refers to On Screen Display. If you set this menu item to ON, any text or graphics (menu displays, marker settings, level meters, etc) will also be displayed on a monitor or recorder connected to the video outputs. Some items including the Zebras, EVF DTL, the UX180's waveform and vectorscope, and the Focus Assist displays are never output on the video outputs. Note that if you have the TIME STAMP function enabled and the Date/Time set to on, then the time & date will be displayed on all monitors regardless of whether you have Video Out OSD set to ON or OFF.

Video Out OSD will be disabled when the camera is set to UHD or 4K; it only works when the camera is set to 1080, 720, or standard def. Also, this menu item will be forced OFF when you're using the AUTO RECord button to send recordings to an external recorder.

Date/Time

This setting is obvious, it controls whether the date, the time, or both are displayed on the LCD and viewfinder. This menu item works in concert with the TIME STAMP function to control whether the date and/or time are displayed (or not) and whether they're recorded overlaid onto your video (or not). Turning TIME STAMP on alone is not enough to get the date and/or time recorded into your video; you'd also have to enable the display of either the date or time (or both) using this menu item.

Level Gauge

This function has nothing to do with audio levels; instead, it enables a graphic display of a level on your LCD or EVF. The level gauge lets you know

if the camera is sitting level or of it's tilted (either side-to-side, or front-to-back).

Histogram (UX90 Only)

This option enables or disables the Histogram exposure tool; essentially it works exactly as if you'd assigned HISTOGRAM to a User Button. Note: once the histogram is displayed, there are only two ways to make it go away: either come back into this menu item and set it to OFF, or press the User Button to which you've assigned the HISTOGRAM function.

Audio Level Meter

This menu setting governs whether the camera's audio meters are displayed or not. I always recommend leaving the Audio Level Meter displayed. T he audio meters show the overall strength of the audio signal. The display is a horizontal graph of white dots, one for each audio channel. The graph is interrupted by a small vertical line that marks –12dB. Each dot corresponds to about 2 dB of signal strength. Absolute peak is at 0dB and should be avoided – audio that is so loud as to "peak" will likely be distorted when recorded. The graph will show a red mark at its rightmost edge whenever the audio "peaks," avoid the red at all costs. For normal audio recording you want to have a good strong signal, with your loudest sounds filling much of the graph but not nearly all the way to the red (0dB). You should usually leave some headroom, at least three or four dots of free space, to account for unexpectedly loud sounds. Dialogue recorded on or around the -12dB mark is usually considered a good decent level. Don't set the levels too "hot" (loud) or you run the risk of overmodulation (where the volume is simply too loud, gets distorted, and the meters start showing red marks). You can use the ALC limiter to get some protection against clipping, or automatic level control for automatically boosting the audio levels during quiet portions. For manual level control of the audio levels use the two physical audio level dials.

Note: when in a very loud environment, such as a concert or other loud event, it's possible to get distorted audio even if you have the levels set lower! The microphone itself might be the source of distortion; it is quite sensitive to high Sound Pressure Levels (SPL) and in a very loud environment the microphone can be overdriven. In cases like that, use an external microphone with better loud-sound performance (such as a Dynamic microphone).

Lens Status

This menu setting determines whether the camera will display a number of pieces of information related to the current status of the lens. Many displays rely on this, as it includes information on the iris, the status of the optical image stabilizer, the state of the ND Filter wheel, the current focus distance, the gain level, the shutter speed, and whether or not the system is in auto-iris mode. You can turn all that info off and get a less cluttered display, but in general I recommend leaving this on; there's too much vital information here. You can make everything go away using the DISP/MODE CHK button, and bring it all back with another press of that button, so in general it's preferable to leave this enabled.

Card & Battery

This menu setting controls whether to display the estimated remaining recording time left on the memory cards, as well as the remaining battery life. Battery life is shown with a little graph of a battery in the upper right corner of the screen, and available recording time is shown on the upper left corner of the screen; there are two displays, one for each card, showing the approximate remaining recording time in hours and minutes. This readout is subject to change based on the recording mode you're using; different recording modes will use up the card's available space at different rates.

Other Display

The camera is capable of displaying many pieces of information in the viewfinder. Displaying all of the information can make for a quite cluttered display, but not displaying enough of it may leave you without vital information during your shot. The OTHER DISPLAY menu item lets you selectively show this additional information; this controls all the screen displays that aren't separately controlled by the previously-discussed display menu items. Regardless of how much information you choose to have active in your display, you're never more than a button press away from clearing it all away, or making it all visible. Pressing the DISP/MODE CHK button can instantly bring up all the display items, and another quick press of the button can just as instantly remove it all, leaving you with a clear and uncluttered display.

Power LCD

This menu item gives you some choices over the brightness of the LCD display. You can slightly increase the running time of your battery by choosing "-1", but that may only be practical when shooting in a reasonably

dark environment; outdoors in broad daylight you're going to want to set this to "+1" to get as much brightness as you can (understanding that you'll also be using up your battery power slightly quicker). Be very careful not to try to judge your image's exposure by using the LCD panel as a guide; always use the zebras and waveform monitor to judge exposure. As you can see, you can significantly affect the perceived brightness of the picture by changing this Power LCD setting, even though it's not really changing the brightness of your recorded image at all! Don't rely on the LCD display to judge exposure; instead use the tools that are given to you for that purpose: the zebras and the UX180's waveform monitor.

LCD Set and EVF Setting

These settings let you control the brightness, color, and contrast of the viewfinder and LCD panel. When lighting conditions change significantly your existing settings may no longer be giving you an accurate representation of the recorded image. You should use the color bars to calibrate your LCD and EVF to continue being able to rely on them to give you an accurate picture (with the caveat that you can't really judge exposure properly from the LCD or EVF alone.) Understand that no built-in LCD is going to show you the full range and full resolution of an ultra-high-definition image; only an external ultra-high-definition monitor can do that. But with proper calibration and attention to brightness and contrast, you can at least configure the LCD and EVF such that you can more accurately judge whether the shadows are crushed or the highlights are being blown out.

If you're using the LCD screen, then you'll find that the EVF SETTING menu item is disabled. Likewise, if you're using the EVF, you'll find that the LCD SET menu is disabled.

Eye Sensor (UX180 Only)

The eye sensor is used to control whether or not the OLED viewfinder is enabled. OLEDs are sensitive to light and the viewfinder could be damaged by too much light entering the magnified viewfinder lens; as such, the eye sensor is designed to protect the viewfinder by only enabling it when it detects that something (presumably your eye) is close to the viewfinder. The range is -4 to +4, with -4 being the least sensitive (meaning, at -4, you have to get really close to the viewfinder before the eye sensor will detect you're there and activate the LCD). Set this menu setting to the lower end of the scale if you find yourself constantly triggering the EVF when you didn't mean to (i.e., whenever you stand too close behind the camera, so

that your body comes within range of the eye sensor, etc). I find that the first step to take is to point the viewfinder straight up; that helps avoid "false positives" from the eye sensor. If you constantly find the LCD panel "blacking out", it's probably due to false positives by the eye sensor. Set this menu item to -4 to minimize the chance of getting a "false positive". The only way to really defeat this mechanism once and for all is to go to the OUTPUT SETUP->LCD/EVF OUTPUT menu, and force the output to always be the LCD. That will stop the viewfinder eye sensor, but it will also disable the viewfinder entirely (and, for that matter, it will disable this EYE SENSOR menu item too).

EVF Color

You can set the viewfinder (but not the flip-out LCD panel) to display in black & white or color. Setting this menu item to ON will enable color in the viewfinder; setting it to OFF will turn the viewfinder to black & white. With color disabled, some people find focusing to be a bit easier

EVF/LCD Detail

This menu item effectively does the same thing as assigning EVF/LCD DETAIL to a User Button and pressing that Button. See the User Button section for more info. I highly recommend setting this menu item to ON.

EVF/LCD Peak Level

"Peaking" is an extremely useful focus aid. For more information on peaking (also known as EVF/LCD DETAIL) see the article on Focusing.

Peaking draws white accents in the Electronic ViewFinder (EVF) and LCD panel, around the sharply-focused elements in the frame. With this menu setting you can direct how visible those peaking outlines are. The range is from -3 to +3, and it's largely a very similar effect to the MASTER DETAIL menu setting. The difference is that MASTER DETAIL is actually accentuating edges in the footage to "sharpen it up", whereas peaking does it only on the viewfinder or LCD display, and doesn't modify the footage at all. The higher you set this number, it will show progressively more and more edge detection around sharply-focused items. With it set up to +3 the peaking effect is glaringly obvious; it'd be pretty hard to miss focus with peaking level set to +3!

If you want the most natural and accurate representation of your image on the LCD and viewfinder, you'd set this menu item lower. If you instead

want to insist on pixel-perfect focus at all times, you'd set this higher. If you're of the mindset that an on-camera LCD isn't really a production monitor anyway, but rather it's a cameraperson's aid in getting the framing and focus right, you'll probably want to set this higher, but the higher you set it, the more vividly the white outlines will be drawn, and that might potentially lead to obscuring otherwise-visible fine detail on the LCD.

EVF/LCD Peak Freq

This menu item lets you control how "generous" the peaking is, with what it considers "in focus." When you set it on LOW, it will add peaking outlines around all elements in the frame that are generally in focus (or close to being in focus). But when you set it on HIGH, it will add peaking outlines only on those elements that are crisply in focus. On HIGH it's quite a bit pickier; things that are borderline of whether they're in focus or not might get outlined in LOW but won't get outlined in HIGH. Because of this, you're better off using HIGH whenever possible, especially when shooting UHD or 4K. Using LOW might be more confidence-inspiring because you will see so much more of the peaking effect, but — it may actually end up highlighting things that aren't truly sharply in focus. Using HIGH makes it harder to see the effect, but if you do see it, you can be more certain that the objects it highlights are more likely to be in sharp focus.

The rest of the settings in this menu are adequately described in the camera's manual, and will not be duplicated here.


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Other Functions Settings

Format Media

Before you can use an SD card in the camera, it has to be properly formatted. This menu item lets you do that. Understand that anything and everything that was on the card will be erased when you format it. Make sure you know that it's okay to erase the card before you choose this menu option!

Always format SD/SDHC/SDXC cards in the camera before using them. It's true that cards can be formatted on computers, but the resulting format may not be compatible with the way the camera would have formatted the card. It's better and safer to format the cards in the camera.

If you have other information on the card (such as still photos, or other computer data) saved on the card, "format" may not be the best choice for erasing your cards; you would probably be better off using the DELETE-> ALL SCENES command from the playback mode's VIDEO SETUP menu. DELETE-> ALL SCENES will save any still photographs or other information on the card; FORMAT MEDIA will erase everything. I recommend to format the card upon first use, but after that you might want to stick with DELETE->ALL SCENES just to avoid accidentally deleting photos. Be aware that after a lot of recording and deleting and re-recording, your cards will probably become "fragmented" and would benefit from the occasional fresh reformat.

This menu also lets you format an external media device such as a hard disk or the Video Devices PIX-E SpeedDrive or a Convergent Design Odyssey 7Q SSD drive, but only in Thumbnail mode. You can't access or format a drive when in camera mode, but if the USB MODE SELECT is in the HOST setting, and you have an external media drive connected, this function will let you format it. Note: something like the PIX-E SpeedDrive can be used, but because of its shape it physically doesn't seat fully in the USB port; you'd need to use a USB 3.0 extension cable to plug it (or comparable devices) into the USB 3.0 HOST port.

Media Status

This function lets you know the remaining space on your memory cards (and, in playback/thumbnail mode, it can also tell you the status of an external media drive). The display tells you the amount of remaining free space, and also what that equates to in terms of recording time (for the currently-selected recording format). External media devices are not accessible when the menu is used from camera mode; in camera mode it can only see the status of the SD/SDHC/SDXC cards.

Rec Lamp

The camera has two "tally" lights, one at the front and one located at the rear of where the LCD panel mounts to the body of the camera, near the BARS button. These tally lights can light up red whenever the camera's recording. This menu option lets you choose how those lights behave: you can have them turn on when recording, or not, or you can choose whether just the front or just the rear light will light up. If your on-camera subject gets nervous when they see the red light, you may want to turn the front light off. Another reason to disable the front light would be if you were shooting into a somewhat reflective surface and the red light is visible in the shot. Or, if you want to shoot in "stealth" mode, with nobody knowing the camera is running, you can disable both lights. Some on-camera subjects will prefer to see the red light active so they know the camera's rolling and they're being recorded.

Economy (BATT) and Economy (AC)

The camera has a power-saving mode wherein it can turn itself off after five (or fifteen) minutes of inactivity. It's an energy-saving feature, but this can be vexing when you're setting up a shot, for example: you're taking the time to frame your shot, set the lighting, and when you go to review how it looks on the monitor you find that the monitor is a black screen because the camera's turned itself off!

This menu item lets you avoid the power-off situation. I normally always set it to "OFF", especially Economy (AC), but if you forget to turn the camera off when you put it away, you might return to find the camera overheating, so you may want to consider leaving Economy (BATT) on (or, just be diligent about turning the camera off before putting it away, of course.)

Economy (BATT) will turn the camera off after five minutes of inactivity; Economy (AC) will turn it off after about 15 minutes of inactivity. The

menu items refer to whether you're powering the camera by battery, or by using the AC adapter.

Note, this menu setting will be ignored when you're using Pre-Rec or if you've connected the camera to a computer via the USB cable. In those cases the camera will always stay on (or at least until the battery runs out!)

USB Mode

This item enables or disables the USB port. This functionality is the same as if you'd assigned USB MODE to a User Button, and then pressed that User Button.

Obviously, if you want to use the USB ports on the camera, you'll have to set this menu to ON. Setting it to OFF will disable the ports, including the power output to the USB HOST port.

USB Mode Select

This menu item controls which of the USB ports are active; it has two USB 3.0 ports, and can act as either a USB Host or a USB Device.

Host: In this mode the camera can actually take control of an external USB hard disk (or flash drive) and copy the contents of its memory cards onto that device; it can also play back footage from that device. This functionality is only available in thumbnail/playback mode. More information about this process is available in the essay on Using a Hard Disk with the Camera.

The USB HOST port can be used with a wi-fi adapter for connection to the AG ROP remote-control application, or it can supply USB bus power to a connected device. You could use it to charge your phone or power other USB accessories, but there's no streaming video or other signal coming out of the USB port.

Device: When you choose this option, going into the thumbnail mode will cause the camera to appear to a computer as if it is an external removable storage device – actually, it will appear as two removable devices, one for each memory card slot. The "contents" of these drives will be whatever happens to be on the memory cards loaded in each slot. You can use this mode to copy memory cards onto a computer or play footage from the camera's memory cards on a computer. However, as a USB device,

the camera is read-only; you can't delete, format, or otherwise modify the contents of the memory cards when attached to a computer.

Initial Set

This menu setting lets you restore all the scene files, or all of the wireless network settings, or all of your camcorder's menus, back to the factory default state. If you're getting unusual behavior from your camera, or you've rented a camera and don't know what state the menus are in, you can quickly restore it to factory-original state by executing this menu command.

Number Reset

This lets you start the filenames of your recordings back to 0001. Normally every clip you record is assigned a sequentially increasing number; with this function you can reset that clip number back to zero. This isn't the same as resetting the folder name however; the folder name will still be increasing unless you format the memory card. If you want everything to start back at the beginning (such as when you're starting a new project), freshly format the memory cards and then execute this NUMBER RESET command.

Software Info

This menu item is a somewhat complicated way to be able to read the licensing information for the Open Source software used in the camera. To execute it, first disconnect any USB cables from the camera. Then set the USB MODE to ON and the USB MODE SELECT to DEVICE. Then, press the SOFTWARE INFO menu item; the camera will display a message saying "Connect this unit to PC using USB cable." At this point, plug in a USB 3.0 cable to the camera's USB DEVICE port, and into a computer. The computer will recognize the camera and mount a new drive. Open that drive, and you'll see it contains one file; LICENSE.TXT. Open that file and you can read the licensing information. Seems like a complex procedure to go through, but when you see just how long the licensing agreement is, you'll understand that there's pretty much no practical way to read it on-camera.

There are other menu items in the menus that aren't listed here, simply because the owner's manual does a perfectly adequate job of describing them.


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Network Setup

The camera has the capability to utilize an optional, separate-purchase USB network adapter to create or join a wireless network, at which point you can control the camera remotely using an Apple iPad that's running the Panasonic AG ROP app. At the time of this writing, there are three wireless adapters that have been certified as being compatible with the UX90 and UX180 cameras; I highly recommend you use one of these adapters and only one of these adapters: the Panasonic AJ-WM30, AJ-WM50, and the ASUS USB-N53 (hardware version A1). You can check on the Panasonic Pro AV website (http://pro-av.panasonic.net) to see if any other adapters have been certified for use.

Note: be careful when downloading the ROP app from the Apple App Store. There are two apps out there, one is called the P2 ROP app, and the other is the AG ROP app. The UX90 and UX180 are AG-series cameras, and therefore they require the AG ROP app. Do NOT download and run the P2 ROP app; that's for a different series of camera and won't work properly with your UX90 or UX180.

User Account

This menu lets you create several potential account names (and passwords) for various users. Each User Account can use different connection methods and other settings; you can almost think of the User Accounts as "Scene Files", but for network settings.

The User Account is used by the iPad AG ROP app to connect to the camera. There are two layers of connections; you have to connect to the camera's network by using the iPad's wi-fi settings, and then additionally you have to connect to the camera's User Account from the AG ROP app's settings. On the iPad, go to the "settings" icon, and scroll down the list on the left until you find "AG ROP" and select it. The setting options for the AG ROP app will appear in a window on the right of the screen. The two elements of interest here are the User Account and Password fields; if you've created

a User Account name using this menu option in the camera, then you can connect the app to the camera by entering the same User Account name and Password that you established in the camera, into the AG ROP app's User Account and Password fields.

For the ultimate in configuration and security, you should establish your own User Account. However, it's not necessary to establish a User Account before you can use the ROP App; the default User Account name is "guest" and the default Password is "agguest". If you have not created a User Account on the camera, set this menu item to OFF, and go to the iPad and set the AG ROP app's settings to User Account: guest and Password: agguest.

You can have up to 10 different User Accounts registered in your camera, but you can only have one AG ROP app connected to the camera at a time. Accordingly, you have to select which specific User Account the camera is using, and then make sure that you enter that User Account's name and password in the app's settings. Just because an account exists, does not mean that you can connect to that account -- you can only connect to an account if it's currently selected on the camera. The camera will only accept requests from an iPad AG ROP app if it is using the same User Account name and Password as the camera's currently using.

You create a User Account by selecting one of the 10 available positions and then pressing the "Refresh" button. That will bring up the opportunity to enter a name for the account, and a password, and to confirm that password.

You select the currently-active User Account by selecting one of the 10 available positions and pressing the "Return" button. If you don't want to or need to create an account, you can set the USER ACCOUNT menu to OFF; in that case, the camera will be using the default account name ("guest") and the default password ("agguest").

Wireless Setup

This menu item determines what kind of network the wireless adapter will create (or connect to). The choices are:

Direct: In this mode the camera will create its own new wireless network, and will broadcast its own network identification (SSID). The default name of the network it creates is either "UX180" or "UX90", depending on which camera you have. As you can imagine, that could

be quite confusing in a multi-camera scenario, so you have the ability to change the name (perhaps "UX90-1" and "UX90-2", for example). The relevant thing here is that the name that it broadcasts, is the name you have to connect to on your iPad before you launch the AG ROP app. If you change this name to "George", then in your iPad's wi-fi settings you should see a new network SSID called "George" that you can connect to. When creating a network, you also have to establish a security password. The default password is "0123456789012345678 9abcdef", but of course you can change it. When using a DIRECT network, configuration is easiest if you go to the WIRELESS LAN SETUP menu and set DHCP to "SERVER".

SSID (Select): In this mode the camera will be joining an existing wireless network. If you've established your iPad as a hotspot broadcasting its own network, or if you're using your own network router, you can connect to it using SSID (Select). The first thing you should do is go into the WIRELESS LAN SETUP menu and ensure that DHCP is set to OFF. Then, go back to the WIRELESS SETUP menu and press the SSID (Select) menu option; this will bring up a list of all the wireless networks within range of your network adapter. Look for your network, select it, and press ENTER; if your network uses a password, you'll then be given an opportunity to enter the password and join the network. The camera will then join the network. On the iPad, you'd want to go to the wi-fi settings and join the same network. Then, make sure your User Account name and Password match between the camera and the AG ROP app's settings. Also, go into the WIRELESS LAN SETUP menu and make note of the camera's IP address, and enter that exact same address into the iPad's AG ROP app's "IP Address" setting. Finally, exit the menus in the camera; you won't be able to successfully connect if the menus are still active. Exit the menus entirely, and ensure that the wi-fi icon on the camera's LCD display shows a valid connection (no "x" on the icon), and then run the iPad AG ROP app, and you should be able to connect to the camera.

SSID (Manual): This is exactly the same as SSID (Select), except that the camera won't scan for available networks. Instead, it asks you to specifically enter the name of the network you want to join. If your network's SSID is set to "hidden", then SSID (Manual) is the way to go to be able to join that network. Enter the network name manually, and then follow all the other connection instructions as outlined above for SSID (SELECT).

Connection History

If you've successfully connected to a wi-fi network with the camera, that connection information will be stored in this Connection History menu.

Select this menu and it will display a list of prior successful connections. Selecting one of them should result in a quick and easy connection to that network.

Network Initial Setting

This menu item is functionally identical to choosing OTHER FUNCTION->INITIAL SET->NETWORK. It's just more conveniently located here. Use this menu item to reset all the network settings to default. If you've been experimenting unsuccessfully with getting the camera to connect, it can certainly be helpful to re-set the settings to a known default state before trying different settings.

Network Setup Password

This menu item establishes a password for being able to change anything in the entire Network Setup menu. This password has nothing to do with connecting to a network, or to the ROP app; instead, this is to protect your settings. Once you've got your settings figured out and working properly with your iPad, you can password-protect those settings so that nobody else can come in and change anything (unless, of course, you tell them the password that you establish here).


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Maintenance Menu

Version

This menu item tells you the current version of the firmware that the camera is using. Occasionally Panasonic may issue new firmware updates for the camera; this menu item lets you see what version you already have. Check for firmware updates at eww.pass.panasonic.co.jp.

Update

If Panasonic has issued a newer firmware version for your camera, this menu item lets you install it. Download the firmware update on your computer and extract the UPDATE.HDC file to the root directory on a memory card; install that memory card in the camera and then execute this UPDATE command. Follow the on-screen instructions, and also follow any instructions included in a .PDF file that comes with the downloaded firmware file.

I also strongly recommend having a charged battery in the camera and having the camera connected by AC power too. That way it'll have access to AC power and if your power goes out, the camera can switch over to battery power to keep operating while the firmware update process is underway. Having a power failure during a firmware update could possibly render the camera unable to operate, so it's best to avoid that remote possibility by using AC power combined with a fully-charged battery whenever updating the firmware.

Hour Meter

This menu tells you the status of how many hours the camera has been powered on and used, as well as information on how many times the zoom lever has been used and how many times the zoom motor has worked, and how many times the menu jog/dial wheel has been used.


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Thumbnail Screen

When you press the THUMBNAIL button, the camera switches to playback mode. The thumbnail display appears, and there are also a number of menu commands available if you press the MENU button; those are discussed in the next section.

Working with the Thumbnail Screen

The camera's touchscreen makes playback effortless; you simply touch the picture of the clip you're interested in to play it. You can also use the camera's zoom lever to zoom in to see the details of a particular clip, or to zoom out to see more thumbnails displayed at a time; the system can display as many as 20 small thumbnails at once. If there are more clips than can be seen on the screen at one time, you can touch the UP or DOWN arrows to scroll to the next batch of thumbnails.

When a clip is playing, a control bar appears at the bottom of the screen that lets you stop, pause, play, rewind, or fast-forward through the clip (if you press fast-forward or rewind twice, it'll fast-forward or rewind twice as fast.) If you've paused a clip, then the fast-forward and rewind buttons instead become frame-advance buttons; pressing the frame-advance button causes the playback to show the very next frame, one at a time; if you hold down the frame-advance button you can get a nice smooth slow-motion playback effect. Note that if you try to do a frame-reverse, the camera doesn't go frame-by-frame in reverse, it'll jump back about 1/2 second of footage on each press. And, the "Direct Playback Bar"allows you to jump to any portion of the clip, instantly. Finally, you can remove most of the clutter from the display by just touching the touchscreen itself (i.e., not on a control or button).

When using the EVF, you can use the menu jog/dial wheel to navigate and operate through the various controls.

You can also extract a still photo of any frame while a clip is playing back; just press the image of a camera (right side of the screen, above the trash can) during playback, and the current video frame will be saved onto your memory card as a JPEG still image.

Screen shot with USB hard drive attached

On the left is a media icon which lets you choose which memory card (or attached hard drive/ media drive) you're reviewing, and whether you want to play back video clips or photos. The icon will be a picture of either a movie camera (indicating you're working with video clips) or a still photo camera (indicating you're working with still photos). The camera will have an indicator on it to indicate which media you're viewing; if it's a memory card, the number in the camera picture will be either a "1" or a "2", telling you which memory slot you're currently viewing the contents of. If it's three discs (as in the picture above), that indicates that you're viewing external media (such as an attached USB hard drive.)

Below the media icon, there's a clip-sorting button that lets you see the icons for ALL of the clips on the card in the currently-set format, or only those clips that were shot on a certain DATE. Using this function you can limit the clip display to only show clips that were shot on a certain date; this may make it a little easier to navigate a crowded thumbnail screen, if you know exactly which date a particular clip was shot in.

During clip playback, you can adjust the volume of the headphones (if attached) or on-camera speaker, by using the zoom rocker.

This brings us to perhaps the most confusing element of using the UX cameras: finding the footage you shot to play it back. The camera has a wide variety of recording formats and frame sizes, and the playback system is limited to only being able to show thumbnails that represent the current camera mode settings. This means that you may not be able to quickly find the clips on your memory cards, if you've been changing frame rate, or recording format (MP4, MOV, or AVCHD), or frame size (UHD, 4K, or

FHD). You have to know the right combination in order to get the footage to play back. Generally, it's much easier to play back clips from a computer, where you can see all the files, all the folders, and the thumbnails for all the clips simultaneously. It also is much easier to play back the clips on the camera if you haven't been changing format, system frequency, or frame size very much; the fewer options you've used, the fewer setting combinations you'll need to try to find those clips. While the camera can play back any clip it's shot, it can be challenging to find those clips; it's easier to do so from a computer. As an example, finding a clip you shot in Dual Codec can be particularly frustrating; you may be working with MP4 files, but if you shoot a 1080P clip in dual codec, the dual-codec sub-recording will be recorded in MOV format, and you'd have to specifically choose MOV file format to be able to find that clip. Again, it's much simpler to just use a computer to view and play back the clips.

When looking for clips and formats, do not be misled by the "VIEW ALL" wording displayed at the top of the screen. That does not mean that you're viewing all of the clips on the card! Instead, it means you're viewing all of the clips that were shot in this particular format, at this particular frame rate, in this particular frequency, in this particular frame size. The reason it says VIEW ALL is because the other option is to limit the thumbnail display to only showing clips from a particular date.

When changing the playback options to see different types of clips, you have to select the format (MOV, MP4, AVCHD, or JPEG) first, by pressing the corresponding buttons across the top of the frame. Then, you have to choose the frame size and frame rate in the middle of the screen (or ALL). Finally, you must press ENTER — don't press RETURN, or that's like canceling your selection. Press ENTER for your selection to be accepted and the system will then change modes and display any thumbnails that match the new settings.

Screen shot from UX180, no USB hard drive attached


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Thumbnail Screen Menu Options

In playback mode, press the MENU button to bring up the thumbnail menu display. You'll find several menus available; many of them are duplicates of menu items available in camera mode, but some are specific to the thumbnails and playback mode, including those which let you change the thumbnail display, or perform operations on the clips or cards.

Video Setup or Pict. Setup Menu

The VIDEO SETUP menu (or PICT. SETUP menu) lets you configure how the clips will play, and gives you options to protect or delete clips. If you've chosen to play back videos, the available menu will be the VIDEO SETUP menu. If instead you've chosen to play back still photos, you'll get the PICT. SETUP menu. You choose whether you want to work with pictures or video by pressing the camera icon (left side of the screen on the thumbnail display) and choosing either one of the video formats (MOV, MP4, AVCHD) or the JPEG option. Then, when you enter the thumbnail menu screen (by pressing the MENU button on the camcorder body) you'll have the choice of VIDEO SETUP or PICTURE SETUP.

Repeat Play (Video Setup Only)

Normally when the system plays back a clip, it'll finish playing the current clip and then start playing the next clip, until it's played all the clips on the card (or all the clips in the folder, depending on whether you've chosen to display ALL thumbnails or only the ones in a particular folder), and then it'll stop playing. You can instead have it perpetually play the same sequence of clips over and over until you manually stop the playback. An example of why you might want to use Repeat Play would be if you were using the camera to play a looping demo reel, perhaps at a trade show booth or in a business. With Repeat Play set to ON, it'll play all a loop of all the clips whose thumbnails are currently displayed.

Resume Play (Video Setup Only)

Normally when you go to play back a clip, the system will start the playback from the very beginning of the clip (the first frame). But if you set this menu item to "ON" the system will "remember" the last time this clip was played, and resume playing from that point. So if you're interrupted during clip playback and had to stop the playback, then the next time you go to play back this clip it'll start where you left off. A new indicator (looks like three arrows pointing right) will show up on the thumbnail icon of this particular clip, to show that it was in process of being played and will play back from where it left off the next time you play it. Note: if you've zoomed out to show 20 icons per screen, you won't see the three-arrow indicator for a resumed clip; the indicator is displayed when you have zoomed in to show either 9 thumbnails, or one thumbnail, per screen.

SCENE Protect

You can protect individual clips from being modified or deleted by using the SCENE PROTECT function. After selecting this menu item, it'll bring up a version of the thumbnail screen; just touch the thumbnail of the clips you want to protect and a "key" icon will show on clips that are protected. Protected clips cannot be deleted, either accidentally or on purpose, by using the VIDEO SETUP->DELETE command. However, they're not indestructible: you can still lose them if you choose to format the card that they're on, or if you delete them from a computer. This SCENE PROTECT function only protects you from deleting via the VIDEO SETUP->DELETE command.

To unprotect a clip, go back into the SCENE PROTECT menu and just touch its thumbnail again to make the key disappear.

Protected clips will show a "key" icon on the thumbnail screen (if you've zoomed in to show 9 thumbnails, or 1 thumbnail, per screen). No keys will be displayed if you zoom out to show 20 thumbnails, or if you zoom all the way in to one particular clip's details.

Delete

You can delete an individual scene (or a group of scenes or all scenes) off of the memory card. Deleting is immediate, and the space that the deleted scenes used to occupy will be made available for further recording. Deleting is also irreversible.

To delete all the currently-viewable scenes on the card, choose ALL SCENES. Be aware that this does not necessarily mean that you will be erasing every clip on the card – it depends on if you've configured the thumbnail mode to show ALL, or just a particular date's clips. If you've configured the system to show ALL, then when you choose to delete ALL SCENES, then yes every video scene on the card in the current format and frame rate will be erased (but JPEG still photos will not be deleted). If you've configured it to show only a particular date's clips, then all clips from that particular date will be deleted.

Instead of deleting all clips, you can choose to delete individual selected clips, either one by one or in a group. To do so, choose SINGLE or MULTI. There is no way to un-delete a deleted clip, so be sure that you have selected the proper clip to delete!

Copy Menu

This menu item lets you copy scenes or photos (or both) between memory cards, or from a memory card to an external hard disk (or other media that you've plugged into the USB HOST port, like a USB thumb drive.)

Copy Once

This menu item will only appear if you have attached a USB media drive; if there's no media drive (hard disk or USB stick) attached, or if USB MODE is set to OFF or USB MODE SELECT is set to DEVICE, this menu option won't exist and you'll only see the option for SELECT COPY.

This COPY ONCE menu item will copy certain clips from the source memory card to an external media drive. If you've never copied this memory card over to a hard disk before, then it will copy all the clips on the memory card to the hard disk. If you've previously copied this card to a hard disk, then this menu item will only copy clips that haven't been previously copied. However, there's something very important to understand about this — it doesn't go out and compare the clips on the USB drive to see whether it needs to update it by copying newer clips. Instead, the COPY ONCE process will flag any clip that has been previously copied anywhere, and will not copy it again, ever. This means that if you've used COPY ONCE to copy your memory card, all the clips on the card at that time will be flagged as "HAS BEEN COPIED" and they will not be copied again. Ever. To any other drive. The philosophy here is "once it's been copied, it's been copied." But this doesn't take into account the possible scenario of you wanting to make multiple copies. You can't do a COPY ONCE to one hard drive, eject that hard drive, plug in a different hard drive and then do another COPY

ONCE — it just won't work. The system will have flagged all your clips as having been copied, so it will not copy them again, even though the drive has changed.

In short, this COPY ONCE system can be a reasonable choice when you only ever use one media drive to copy to, but it would be a poor choice if you're using multiple drives, or if you've formatted the media drive that you'd previously copied the clips to. For those reasons, I strongly encourage you to consider using SELECT COPY instead.

Select Copy

This lets you copy all clips, or only selected clips, from one memory card to another, or from a memory card to an external hard disk or other media drive.

You have two options — you can either copy all clips (all movies and JPEGs), or you can select which individual clips to copy over. If you choose "Video&Picture", all clips will be copied from the source card to the destination, regardless of what format or frame size they were recorded in. If you instead choose either VIDEO or PICTURE, then only videos (or only pictures) will be copied over.

When choosing either VIDEO or PICTURE, you will have the option to choose whether to copy ALL clips, or SELECTed scenes. You can select up to 99 different scenes to copy. You have to select the recording format, and the frame size/frame rate, of the clips you want to copy. This means you won't see all the thumbnails of all potential clips available, you'll only be seeing (and selecting from) the thumbnails of the clips that match the format that you specify. If you know exactly which clips you want to move, this can be a quick and easy way to do it; if you don't know what the recording format for a particular clip was, well, that can be more challenging; you'll have to either look on a computer, or go through the various options until you find the clip you're looking for.

Note: if you're copying from one memory card to another, be aware that you can copy SDXC to SDXC, or SDHC to SDHC, or SDHC to SDXC, but you cannot copy from SDXC to SDHC. If you're trying to copy from an SDXC card, it can only be copied to another SDXC card, or to an external media drive that's been formatted for the ExFAT file format.

There are many other menus available too; however, their functionality is the same as when in camera mode, so please refer back to the camera menu options to learn how those functions work.


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Physical Switches, Buttons and Jacks

This section will describe some of the features of the camera and observations about how those features work and how they can be best employed. Most descriptions will be accompanied by a photo of the button or switch being described.

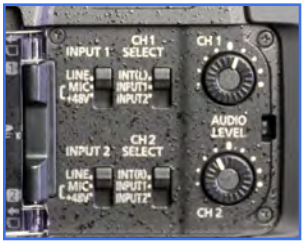
Rec Check Button: When the camera is in CAMERA mode, the REC CHECK button will play back the last two seconds of the most-recently shot clip. There are several things you can do that will make this not possible; if you change the REC FORMAT, or eject one of the memory cards, or turn the camera off or switch over to THUMBNAIL mode, it won't work. And, if you're using SIMULTANEOUS or BACKGROUND recording or PRE-REC or INTERVAL recording, it can't work. Finally, this is a user-programmable User Button (User Button 8); if you've used the USER SW menu to change the function to something other than REC CHECK, then obviously pressing this button won't perform a REC CHECK.

Zoom Rocker: The power zoom is controlled by one of the zoom rockers, either the handle zoom or the main zoom rocker. The main zoom rocker is pressure-sensitive, the harder you press it the faster it zooms. At its slowest speed it takes over two minutes to travel from wide angle to telephoto; at its fastest speed, it's about 2 seconds (with FAST ZOOM enabled). The zoom rocker can also be used to set the headphones volume when headphones are plugged in; you control that functionality with the VOLUME menu item.

The handle zoom rocker is not pressure-sensitive, you tell it what speed you want to zoom at using the SW SETUP's SUB ZOOM menu item and it will zoom at only that fixed speed. You can also disable the handle zoom by setting this menu item to OFF.

Zoom can also be controlled by using an external zoom controller connected to the CAM Remote Zoom S/S jack. Finally, you can also control the zoom remotely if you have a compatible wireless network adapter properly configured and are using the Panasonic AG ROP app on an Apple iPad.

Audio Controls: On the left of the camera under the large audio controls door are a number of switches and dials for controlling how the input ports work, by setting which input gets assigned to which channel, what the sensitivity is of each input, and whether or not phantom power is supplied. Of note: there are two inputs (XLR1 and XLR2) and there are two audio channels (frequently called L and R, but more appropriately called CH1 and CH2). XLR1 does not have to be routed to CH1, and XLR2 does not have to be routed to CH2. They can be, but it is not required. Nor do you have to use the XLR inputs at all; you can use the internal built-in microphone as your audio input source, or you can combine using the internal and an XLR input.



CH1/CH2 Line/Mic/+48V Switches: The LINE/MIC/+48V switches control the signal level sensitivity of the XLR connectors, for mating the connector to the type of component attached to it. For example, when you have a mixer attached to the camera, the mixer may be outputting a LINE level signal, so you'd want to flip the LINE/MIC/+48V switch to LINE for that channel. If instead you hooked up a microphone directly, that mic would be outputting a MIC level signal, so you'd need to flip the LINE/MIC/+48V switch to MIC to match levels to the microphone. If the microphone requires phantom power, you'd instead set the LINE/MIC/+48V switch to +48V. In essence, the three switch settings are LINE, MIC (phantom power off), and MIC (+48V phantom power on). Some types of microphones (such as Dynamic or self-powered) should not have phantom power supplied to them. Other types of mics,

such as condenser mics, require phantom power in order to function. And some types of mics (such as electret condensers) can operate as either self-powered or from phantom power; frequently those mics will perform better from phantom power. Make sure you check your microphones to verify whether they should or should not have phantom power supplied.

LINE level can be set to +4dBU or +0dBU in the AUDIO SETUP->INPUT1 (or INPUT2) LINE LEVEL menu. The MIC level can be set to -40 dB, –50 dB or –60 dB, as determined by the AUDIO SETUP->INPUT1 MIC LEVEL or INPUT2 MIC LEVEL settings. If you attach a device to the XLR input and you can't get satisfactory audio levels from it (like the audio is way too low, or too loud) then try changing the setting of the LINE/MIC switch for that audio channel to get a better level match.

Audio CH1/CH2 Select: The camera has the ability to record audio from three potential sources: the built-in microphone, XLR connector 1, or XLR connector 2. You can mix and match these inputs to suit your circumstances (i.e., connect a wireless microphone on XLR channel 1, and use the built-in microphone on audio channel 2 for ambience/backup purposes). You can also choose to have one input be recorded on both audio channels. When using the built-in stereo microphone, only the left side can be recorded on channel 1, and only the right side can be recorded on channel 2.

Audio Level Controls: There are two audio level control dials. These potentiometers control the volume assigned to channel 1 and channel 2, regardless of what source is attached. If you set the CH1 or 2 SELECT switches to INT, these dials will control the volume of audio coming from the internal microphone. If you set the CH1 or CH2 SELECT switches to INPUT 1 or INPUT 2, these dials will instead control the volume being input through the XLR connectors. It should be noted that it's possible to record the same XLR input on both CH1 and CH2; when doing so, you may find it advantageous to set one of these audio control dials to slightly lower volume; this can give you a clean track of audio that's more protected against clipping and distortion in case you need it in post; or, you may choose to have one channel set manually, and let the other channel be automatically controlled.

SD Card Access Lamps: Each card slot has a glowing LED lamp near it, and that lamp lets you know the recording or access status of the card. You never want to eject an SD/SDHC/SDXC card when it's being accessed! If the light is on next to a card, leave that card alone. These lights will light up when the card is being recorded to, when it's being played from, and when it's being copied from and copied to. If you're using BACKGROUND recording, one slot will show the red dot only during your selected recordings, the other slot will show the red dot continuously (that's the background recording slot). Perhaps most importantly, when you're doing a RELAY recording, the red light will be lit up next to the card that's currently being recorded to, and the other card's light will be off. When you want to swap cards, pay careful attention and only eject the card whose light is currently off.

Viewfinder: The viewfinder is quite versatile, and on the UX180 it features a very clear OLED display. You can configure the eyecup for left-eye or right-eye viewing. You can focus the viewfinder sharply using the diopter adjustment dial (very handy when you've forgotten your reading glasses!) The viewfinder cannot be active if the flip-out LCD panel is active; it's either one or the other. The viewfinder can also be configured to be either black and white or color. The viewfinder rotates up to facilitate low-angle shooting.

The viewfinder's display usually mirrors the LCD's display but the UX180's Waveform and the Vectorscope only show up on the flip-out LCD, not on the viewfinder.

Warning: Never leave the camera with the viewfinder pointing at the sun! The viewfinder has a magnifying element over it, and when you combine a magnifying glass with the sun, the results will be a burned viewfinder display! In order to protect the UX180's viewfinder's sensitive OLED display, the UX180 employs an eye sensor to determine if someone is currently using the viewfinder. The eye sensor detects any objects or obstructions within a certain distance of the viewfinder; you can adjust that distance in the DISP SETUP->EYE SENSOR menu. The viewfinder is usually configured to be disabled whenever the flip-out LCD is in use; if the eye sensor detects something (hopefully, your head) in range of the viewfinder, the camera will disable the LCD panel and enable the viewfinder. When

UX180 Viewfinder with eye sensor

used intentionally, it works well, but can be a little frustrating when you find yourself inadvertently blocking the eye sensor; doing so may cause the LCD panel to switch off when you didn't want it to! Generally this can be minimized by keeping the viewfinder pointing straight up when not in use. You can also use the OUTPUT SETUP->LCD/EVF OUTPUT menu item to disable the viewfinder and force the LCD to be the only output.

The primary benefit to the viewfinder over the LCD is that the LCD can be quite reflective which makes it a challenge to use in daylight; the EVF is immune to reflection when your eye is pressed up to it so it can be much more useful in daylight shooting situations. Additionally, using the viewfinder can make for more stable footage; when your eye is pressed against it, it adds a third point of contact (two hands and your skull) that can lead to more stable handheld footage. However, using only the EVF can make the camera more challenging to operate when it comes to the menus; the menus are usually easily operated by the touchscreen of the LCD, but that's not available when using the EVF. You can navigate the menus with the menu jog/dial wheel when using the EVF. The UX180's waveform and vectorscope, however, will not be available to you until you switch back to the LCD.

Focus Assist Button: Ultra High Definition video is very demanding in terms of focus. Whereas minor focus errors may be tolerable in standard-definition video, ultra high-definition video provides no leeway – shots that are out-of-focus even just a little bit will show. Accordingly, Panasonic has included a very useful magnified Focus Assist, able to be used in concert with or instead of the colored PEAKING focus assist. When set to EXPAND, the Focus Assist function pops up a window in the center of the viewfinder or LCD panel which shows a high-resolution magnified section of the image. The magnified focus assist is disabled during recording; if you need a focus assist in the middle of a shot you'll have to rely on the Focus Assist's colored PEAKING or the LCD/EVF DTL function. See the article on Focusing for more information.

Focus Switch: On the side of the lens is a switch named "FOCUS", with three possible settings: "A", "M", and "∞". This switch lets you control the autofocus or manual focus capability of the camera. When the switch is set to "A" the camera operates in full autofocus mode, automatically hunting for the best and sharpest focus; when the switch is set to "M", the camera is

set to strictly manual focus (unless the AUTO/MANU switch is set to auto; that can override the "M" setting of this switch). When the switch is pushed to "∞" the camera is instantly set to "infinity" focus, the setting where even the furthest possible objects (such as the moon) should be in sharp focus. Infinity is not really a switch setting, it's just a momentary push – when you push the switch down, the lens gets set to infinity and then the switch automatically returns to manual focus mode.

Some notes on autofocus: autofocus works better at faster frame rates; it works best in 50i/59.94i interlaced mode or 50P/59.94P mode. The autofocus system responds much more slowly when using slower frame rates (such as 24P or 29.97P) or when using slow shutter speeds (such as 1/12 or 1/8). The reasoning is simple: in interlaced mode or 50P/59.94P mode, the autofocus system gets fed sixty (or fifty in PAL/50Hz) updates per second. But in slower-frame-rate modes or slower shutter speeds, the updates come far more slowly: in 24P mode, the autofocus system only gets 24 updates per second; in 1/12 shutter speed it's only receiving 12 updates per second. With less-frequently-updated information to work from, the autofocus system cannot respond as quickly to changes in the image.

Autofocus works best under brightly lit conditions. Under low light and low contrast conditions autofocus has to work much harder, and will respond much more slowly, and will be more prone to "hunt" for proper focus. Another factor to consider in autofocus performance is that the autofocus system relies on measuring contrast to determine proper focus points. If the scene you're shooting is very low in contrast the autofocus system will have a harder time determining the proper focus point. Autofocus works quickest when it can easily discern a transition between dark and bright elements, especially vertical elements (i.e., on a black and white picket fence, the autofocus system would perform superbly. Trying to find focus on a sold white wall would be extremely challenging for it.)

When the camera is set to Manual focus mode, the focus readout in the LCD display changes from AF to MF to signify the change from Auto Focus to Manual Focus. In Manual Focus mode, the camera offers one of the most precise focus systems of any servo-focus camera. The focus ring moves with precision and accuracy; focus marks are definite and repeatable (when set to COARSE or FINE speed). You can use professional follow-focus attachments and get completely repeatable focus performance. Distance measurements show up in the viewfinder rather than on the

lens barrel (so they're more readily accessible to the camera operator), and those distance marks are delineated much more frequently than any lens barrel markings would be, which helps eliminate guesswork in judging distance. Rack focus moves are easily accomplished. The only substantial difference between how this camera's focus ring works, and how a true manual linkage works, is that this focus ring doesn't have physical hard stops at infinity and at minimum focus distance.

When the FOCUS switch is pushed towards the Infinity symbol ("∞"), the lens is set to infinity focus (MF95). However, as discussed in the section on FOCUS DISPLAY, infinity focus may not be the same depending on what accessory lenses you may have on the camera. The Push-To-Infinity button is only practical if you have no added lens adapters installed.

When in manual focus mode you can invoke the autofocus system on a temporary basis by pressing the PUSH AUTO button. If you just briefly press the PUSH AUTO button, the camera will attempt to quickly focus and then immediately return to manual focus mode. If you prefer it to go into autofocus mode for a longer period of time, you'll find that the longer you hold the button, the longer autofocus will remain active; when you release the button it reverts to manual focus mode.

Note: the focus ring is still active while the camera is autofocusing. If you encounter a scenario where the camera just can't successfully autofocus, you can kick-start it by moving the manual focus ring. Maybe you are focusing close-up on a wedding signature book, and then you tilt up to an outdoors scene, and the scene is so wildly out of focus that there's just a big blob of blur on the screen, and the camera doesn't know what to do; in that scenario you could manually focus to get the camera "into the ballpark", at which point autofocus can take over and finish the focusing job.

The UX180 also offers a manual focus assist mode, where the primary focusing is done manually and then, when you stop moving the focus ring, the camera engages a little bit of autofocus to "touch up" the manual focus. Click to read more about the MF ASSIST feature.

Iris Ring and Iris Button: There are two controls for the iris – a push-button, and an iris ring (the thinnest ring, the one closest to the camera body).

The iris ring allows you to set the f-stop manually. You can't use it when the camera's in AUTO-IRIS mode; the ring is only available when in manual iris control. A common technique is to let the auto-iris set the overall exposure level, then press the Iris Button to switch to manual control and fine-tune the exposure according to taste (or according to the zebras or referencing a production monitor or waveform monitor). The Iris Button lets you toggle between auto-iris and manual mode.

To understand how the iris ring/wheel works, you first need to understand what f-stops are. Be sure to read the article on Understanding Exposure for a discussion on what an f-stop is, and how it's numbered.

The iris display shows whole f-stop numbers, but it also shows numbers in-between. The iris is actually controllable down to 1/6-stop increments; for example, between 5.6 and 8.0 (which are both "whole" stops) you'll also find 6.0, 6.4, 6.8, 7.2, and 7.6 displayed. The iris in the camera can be adjusted in 1/6-stop increments, and the camera numbers each and every increment, so you'll always know exactly where in the exposure curve your iris is set at.

The lens is capable of opening up to f/2.8, but only at the most wide angle portion of the lens (from about 8.8mm to about 10.4mm.) At 10.4mm the maximum opening is f/3.0, and the lens continues to "ramp" this way until 86mm, where it reaches f/4.5 and stays there throughout the rest of its zoom range. Accordingly, be aware that OPEN doesn't always mean f/2.8! Instead, it means the lens is as open as it can possibly be, given the current zoom position. If you're shooting in extreme low light conditions and need the brightest picture you can get, you may want to avoid zooming in very much, as the most telephoto position of the lens is around 1 1/3 f-stops slower than the full wide angle position.

Finally, remember to keep your iris from getting too small or you run the risk of losing some sharpness. Read the article on Diffraction for more information.

ND Filter Switch: The camera includes three switchable ND filters. Neutral Density filters are used to control exposure, and ND filters act like "sunglasses" for your camera: they help cut down the amount of light passing through the lens, so in bright conditions you can engage the ND filters to lower the light level and get proper exposure. They're called

"neutral" density filters because they add no color shift to the image: they're a neutral shade of gray, so the only image effect should be to lower brightness.

The ND Filter switch has four settings:

Off: No ND filters (best used in lower light conditions);

1/4: The mildest setting of ND filtration, reducing the amount of light coming into the camera by two stops.

1/16: A medium setting of ND filtration, reducing the amount of light coming into the camera by four stops.

1/64: The strongest amount of ND filtration, reducing the amount of light coming into the camera by 6 f-stops.

ND filters are named according to how many thirds of an f-stop they reduce the incoming light, and typical ND strengths are ND .3 (three thirds, or one full f-stop), ND .6 (six thirds, or two stops) and ND .9 (three stops). An ND .3 reduces light by 3 thirds of an f-stop (or one full f-stop.) Put another way, an ND .3 reduces the amount of light coming into the camera by half. The exposure compensation of an ND .3 is the equivalent of closing down the lens by one f-stop; for example, a camera shooting at f/4 with an ND .3 filter will deliver the same exposure as a camera shooting at f/5.6 with no ND filter.

The UX180 is a light-sensitive video camera, rating at between about 500 ISO (in NORM SENS) to 1000 ISO (in HIGH SENS). The UX90 is a reasonably sensitive camera as well, rating at approximately 250 ISO. Because of this sensitivity, you need to use the ND filters to control the amount of light that enters the camera. For indoors shooting you'll usually want the ND filter off, but outdoors will almost always dictate using at least ND 1/4 and frequently ND 1/64. Follow the recommendations of the auto-iris and your zebra display and waveform monitor to determine which ND setting to use, and keep your eye on the f/stop – you don't really want to see the iris stop down into double digits (f/10 or more closed) when shooting UHD, so you may need to use the ND filters to get that iris more open.

User Buttons: The UX90 and UX180 each have nine customizable USER buttons on the camera body (and four more "virtual" buttons that can be displayed on the LCD screen.) Three of these physical User Buttons

are grouped together on the side of the camera; four more are at the back of the camera above and below the audio controls (pre-programmed for O.I.S., Zebra, and LCD/EVF; on the UX180 User Button 4 is pre-programmed for the Waveform Monitor); User Button 8 is located up by the servo zoom rocker (pre-programmed for REC CHECK), and User 9 is on the front of the camera below the lens, pre-programmed for AWB. These buttons allow you to instantly switch in certain features, such as turning on high gain, spotlight or backlight compensation, or fade to white or black, etc. Click here for more discussion of what the various USER buttons can do.

Disp/Mode Chk Button: Below the cluster of User Buttons 1-3 is a button labeled DISP/MODE CHK. This button has two functions — it cycles the display overlays on and off (when pressed and released), or, when pressed and held down it brings up the status of the physical user buttons, which scene files are loaded in the camera (by name), the gain and white balance settings, the handle zoom, and information on the video signal and outputs, and more. This is a great button — get to know and love it! When you have all the camera displays turned on, the LCD monitor can become quite cluttered — once you have the lens info and the battery display and the UX90's histogram and the gridlines and all the other info, all that information can become a bit of a hindrance to actually framing your shot. The DISP/MODE CHK switch whisks it all away at the press of a button, returning you to a clean, uncluttered viewfinder (or LCD) display. It doesn't actually take away everything, some elements (such as the safety zone or grid overlay, or the timecode counter) will still be displayed. You can make the timecode display go away by cycling through presses of the COUNTER button (up by the LCD panel).

Instantaneous access to a clean screen is a great compositional aid (and the reason the gridlines remain is because they're specifically for aiding composition). But the other nice aspect of the DISP/MODE CHK button is that when you hold it down, it brings up even more info: first it brings up the status of your nine physical user buttons, and if you press it again it'll bring up even more info. If you've forgotten which user button you assigned a particular function to, you don't have to go digging through the menus, you can just press the DISP/MODE CHK button and it'll display

what the physical user buttons are set to; if you want more info on the camera's configuration, press the button again and again.

Gain Button: The GAIN button is for controlling picture gain. Gain is an electronic amplification of the video signal, which means that by using gain you can make the picture brighter than it otherwise would look. The downside to using gain is that it introduces more noise into the picture. The more gain you use, the brighter the picture becomes, and the noisier the image gets. The button cycles between three settings: LOW, MID and HIGH. You can set three different levels of gain in the camera's menus, and swap between them quickly and easily. The factory default for LOW is 0dB, meaning that no gain is applied. The factory defaults for MID and HIGH are 6dB (twice as bright) and 12dB (four times as bright). You can change those settings in the SW SETUP menu, the UX180 lets you set up to 24dB (sixteen times as bright) and the UX90 lets you set up to 30dB (32 times as bright). There is also an option for even higher gain; you can assign a SUPER GAIN setting of up to 36dB, which would give you a picture sixty-four times as bright as with no gain (but the picture will be very noisy). You cannot assign 36dB of gain to the GAIN button; the only way to get those extreme levels is to assign SUPER GAIN to one of the USER buttons. When setting gain levels on the GAIN button, you can set them in 1dB increments (so, you could assign 4dB, or 22dB, etc) and you can also set it to AUTO, where the camera will take control of and automatically adjust the gain to what it thinks it needs to be for proper exposure.

If you'd rather the camera be less sensitive (and less noisy), you can assign negative gain to one of the SW SETUP menu options (LOW, MID, or HIGH Gain). To enable negative gain, you first have to enable EXTENDED SENSITIVITY in the SYSTEM MODE menu.

Be sure to read the article on Understanding Exposure for a more thorough discussion of Gain, how it works, when it's good and how it can harm your picture.

White Bal Button: The camera offers many options for white balance settings, including a fixed PRESET, automatic tracking white balance, and two positions of manual white balance (A and B). These various choices are selected by use of a WHITE BAL button, and an AWB button on the front of the camera.

The WHITE BAL button toggles between the fixed PRESET, A channel, and B channel. Using this button in connection with the menus and the AWB button on the front of the camera, you can choose from a wide variety of white balance possibilities: either a 3200k preset, a 5600k preset, a variable color temperature preset, up to two channels of manual white balance, or ATW, an automatically-tracking white balance mode. You choose which channel to affect by using the WHITE BAL button, and you affect that channel by using the AWB button on the front of the camera, below the lens.

As an example, let's say you wanted to set the white balance to the 5600K preset. You'd use the WHITE BAL button to cycle through the choices until it shows the PRESET white balance option (either P3200K, P5600K, or a different number followed by VAR, like 4900K VAR). Once you've chosen the white balance channel, you'd then use the AWB button to select among them; it will cycle between the P3200K, P5600K, and VAR choices.

Alternatively, you could choose to execute a manual white balance. You'd use the WHITE BAL button to choose either A channel or B channel; then you'd point the camera at a white chart or other white object in the scene and zoom in to fill the screen with white, and then you'd press the AWB button to instruct the camera to take a manual white balance reading and assign it to this channel. If you hold the AWB button down for a couple of seconds it will follow up the white balance procedure by doing an automatic black balance (ABB). You should black balance frequently.

Note that the AWB button is actually a User Button; if you've changed the functionality of the AWB button by assigning a different function to User Button 9, then it obviously won't be functioning as the AWB function anymore, so if the camera's not performing as you'd expect, you may want to check and ensure that the AWB function is assigned to User Button 9.

For a discussion on color temperatures and white balance, see the discussion under menu item ATW SET. Also, be sure to read the article on Understanding White Balance .

Menu Jog/Dial Wheel: This multi-purpose control is used to set the shutter speed, the UX180's Synchro Scan shutter speed, to navigate the menus, to set a variable white balance temperature, and can also be used to choose a variable frame rate or adjust the gain.

To use this control while in camera mode, rotate the Menu Jog/Dial Wheel to cycle through the available options, until the one you want appears in the lower left side of the display (examples include SHUTTER, GAIN, ICONS, or VFR). When you see the one you want, press the wheel in (like a button) to select it.

When you press the wheel in, the displayed word goes white, and some other section of the screen will highlight in orange (example: if you'd selected GAIN with the wheel, then the gain display would now be highlighted in orange). Rotate the wheel to change the option you have selected, and press the wheel in again (like a button) to make your selection.

You can also change the variable frame rate with this dial. If you've enabled VFR, then VFR becomes a choice as you scroll the wheel. Choose it, and then you can scroll the dial up or down to change the frame rate.

Obviously, in order to use this functionality, you need to have the displays enabled on your LCD (or EVF). If you've used DISP/MODE CHK to hide all the displays then no displays will be present, and you won't be able to adjust these functions with the wheel.

Menu Button: The wheel can also be used to navigate the menus. This is utterly vital when using the EVF (since the touchscreen is disabled when the EVF is active); just roll the wheel up and down to the menu option you want to change, and press the wheel in to make selections. The wheel is also useful in the menus even when using the LCD, because the wheel can be used to quickly navigate through some of the menu options that are tedious to adjust with the touchscreen. As an example, many of the SCENE FILE menus bring up adjustment choices that can be adjusted across a huge range; the Master Pedestal is adjustable from -150 to +150 — that would take forever to navigate with the touchscreen, one press at a time. You may find that the wheel is much more convenient and quicker to use to adjust those menus. Not only can the wheel adjust those menu items, but in many cases it can do so at an accelerated speed: press and hold in the wheel, and while holding it in, then

rotate it either up or down. For example, on the Master Pedestal setting: instead of touching the left and right arrows, you could rotate the wheel to select more quickly. But to really move along the selection, press and hold the wheel in first, and then rotate it, and you'll see that the system rapidly scrolls through the available settings.

Shutter Button: The shutter button lets you choose between automatically-controlled and user-controlled shutter speeds; it also enables the mode whereby you can choose a specific shutter speed using the menu jog/dial wheel. You can set a specific manual shutter speed, or you can instruct the camera to automatically adjust the shutter speed. If the shutter speed display shows "A.SHTR", then that means the camera is automatically adjusting the shutter! This is important to know, as shutter speeds can affect how the motion blur looks in your footage, and it can potentially affect whether or not the camera will be susceptible to certain Partial Exposure effects due to the rolling shutter nature of the sensor, when used under certain types of lights.

Generally, you want to avoid automatic shutter control whenever possible. Use the Shutter Button to make sure that a shutter speed is displayed in the lower right section of the LCD display (and that it doesn't say A.SHTR!); use the Menu Jog/Dial Wheel to adjust that shutter speed to the shutter speed you want. Obviously, this requires that the DISP SETUP->LENS STATUS menu item be set to ON; that's the menu item that controls whether or not the shutter speed will be displayed on the LCD.

If the camera is not set to "Auto Shutter" then it's able to have the shutter speed set by the user. There are stock shutter speeds (such as 1/2, 1/3, 1/6, 1/12, 1/24, 1/30, 1/60, 1/100, 1/120, 1/250, 1/500, 1/1000, 1/2000, etc) and (on the UX180 only) SYNCHRO-SCAN. You choose a shutter speed by rotating the dial, and pressing the wheel inwards like a button once it's displaying the shutter speed you want. If you want to switch to automatic shutter control, press the SHUTTER BUTTON and the shutter speed display will show "A.SHTR". Note that slow shutter speeds may not be displayed when VFR is set to ON; in VFR, the slowest shutter speed is dependent on what the frame rate is. If your frame rate is 15 frames per second, the slowest shutter speed will be 1/15; if the frame rate is 2 frames per second, the slowest shutter speed will be 1/2.

For more information on the many different ways you might want to use the different shutter speeds, please read the article on Understanding Exposure.

UX180 only: If you want to adjust the Synchro Scan speed, you'll first have to select the Synchro Scan setting as your shutter speed. Press the SHUTTER BUTTON to switch to manual shutter control.; "A.SHTR" will disappear and the shutter speed will display in orange. Rotate the Menu Jog/Dial Sel wheel until you've chosen the speed that occurs right after 1/8000; when you choose 1/8000 and then try to choose an even-faster speed, it will wrap around to the Synchro Scan speed, which will have a decimal point (such as 1/60.0); it's the only shutter speed that has a decimal point. Press the Menu Jog/Dial Sel wheel in to select that as your current shutter speed. Once you've set the Shutter to Synchro Scan, the jog wheel will then change to "SYNCHRO" and you can then use the Menu Jog/Dial wheel to choose your Synchro Scan speed.

For more information on the function of the Synchro Scan shutter speed, please see the section on Synchro Scan.

Auto/Manual Switch: These cameras have a wide variety of manual controls and capabilities. But what if you're in a situation where you just have to grab the camera and shoot something (say, a breaking news story?) For circumstances like that, where you simply don't have time to set all the manual settings in time to get the shot, you can slide the AUTO/MANUAL switch to AUTO and the camera will take over many of the functions automatically. You can configure it to switch into auto-focus, auto-exposure, auto-iris, auto-gain, and auto-white balance... or you can tell it to go into auto-mode for any combination of those settings (see the discussion on the AUTO SW menu for more information).

Another good use of the AUTO switch might be if you need to hand the camera to someone who's not skilled on it, to get a shot you need. The results will likely not be as good as if you'd manually set up the camera, but the AUTO switch may make the difference between getting a shot, and not getting it at all. Note that the AUTO switch doesn't turn on automatic level control for the audio; automatic control for the audio levels would need to be set in the AUDIO SETUP menu's AUDIO LEVEL CH1/CH2 options.

Thumbnail Button: This is one of the buttons you'll be pressing frequently. When you press it, the screen will fill with the thumbnail display of the recorded clips on the memory card. Press the THUMBNAIL button again to go back to camera mode (or, if you need to start recording immediately, just press one of the RECord buttons; the camera will automatically switch back to camera mode and start recording). Also, be aware there's a whole list of menu options available in playback mode that can only be accessed by pressing the MENU button.

Counter & Reset (UX90) or Reset/TC Set (UX180): These buttons are used to control the display of the timecode (or counter) and to set or reset the timecode preset value. Pressing the COUNTER button will cycle through the timecode/counter displays in the viewfinder/LCD; the possible counter displays include Timecode, User Bits, and Counter. Also, the only way to remove the timecode (or Counter) from the display is to use the COUNTER button; using DISP/MODE CHK won't remove the counter display. If your timecode has disappeared or you're not seeing what you expect, be sure to check this oft-forgotten button to make sure your display is giving you the info you want!

UX180 shown.

Note: the RESET button here is only for resetting the timecode counter. It isn't a general hardware "reset" button.

The RESET (on the UX90) or RESET/TC SET button (on the UX180) functions differently depending on what mode the camera is in. When entering a timecode or User Bit preset in the menus, you can zero out the preset by pressing the RESET button. This makes it simple to update the preset every time you change a card, for example – you can zero out the timecode quickly, and then just change the hour setting for each card.

The UX180's RESET/TC SET button functions differently if you're using it to sync timecode to an external device. If you've enabled EXT TC LINK, then pressing the RESET/TC SET button will read the incoming timecode and synchronize the TC PRESET to match.

Bars: The camera can display SMPTE (Society of Motion Picture and Television Engineers) color bars, suitable for use in calibrating a professional monitor. When hooking up to a professional monitor, you can calibrate the monitor to know precisely what the recorded image looks like. All too often shooters will try to judge color, contrast, saturation or other picture elements based on how the image looks on a television, or on the camera's viewfinder or LCD. Those are not accurate representations of what the recorded image really looks like. The only way to know exactly what the image looks like is to use a professional monitor, and the color bars help you calibrate that monitor properly. Once calibrated correctly, informed decisions can be made on picture adjustments and settings. You can also record the bars if desired. It can also output a 1KHz (or on 50Hz cameras, 997Hz) reference tone when the bars are displayed, at -12dB or at -20dB. This tone will not be output on the camera's speaker, but it does get recorded and will go out on any audio output jack (such as headphones or HDMI).

LCD Monitor: The LCD monitor is a 3.5" touchscreen useful for monitoring your shots and for controlling the camera's menus (as well as directing the AREA function for specifying what section of the screen you want the camera to focus or expose at). It's a sharp display but it's still not enough resolution to rely on it exclusively for focusing.

The DISP SETUP->LCD SET menu gives you some control over the LCD display, including brightness, contrast and color. While it is tempting to think that you could calibrate the LCD to the color bars to match a professional monitor, it's not really practical because a slight change in the ambient light level or changing the DISP SETUP->POWER LCD level may change how the LCD's display looks. It's much better and safer to rely on a true external production monitor to gauge color, exposure and contrast, or, if one isn't available, use the zebras and waveform and vectorscope.

The touchscreen element of the LCD may take a little getting used to. It is not an electrical capacitance touchscreen; instead, it relies on pressure. This means that you can use it while wearing gloves, for example. The touchscreen doesn't respond to the mere presence of a finger (like an electrical capacitance screen might); instead, it needs to register pressure. When using the touchscreen, it's not affected by how long you hold your

finger in place, what matters is whether you've pressed the screen in deeply enough for it to register. A little bit of practice with it should have you navigating the touchscreen efficiently in no time.

The LCD screen is also quite reflective. That reflectiveness gives it nice rich deep blacks, but it also makes it harder to see under daylight conditions. You may want to invest in an LCD hood (or use the EVF) for filming outdoors.

Zebra Button: The Zebras are discussed in the Display Setup settings section. This button is a general-purpose User Button, and you can redefine it to a different function (or, you can assign Zebra to a different User Button if you want.)

O.I.S. Button: The camera includes an Optical Image Stabilization (OIS) system, which helps smooth out shaky handheld shots. The OIS system consists of a series of moving elements in the lens that actually move and redirect the image coming into the lens, to detect motion and compensate for it. The OIS effect can be most easily seen when at full telephoto: at full telephoto it's harder to hold the camera still without some shake, as the picture is magnified and so any corresponding shake will be similarly magnified. The OIS tracks any movement of the frame and moves the prisms to track the original framing, trying to keep the frame as still as possible. There's a limited amount of compensation it can do.

In FHD recording mode, the OIS can be enhanced by the use of the Hybrid OIS, which adds electronic stabilization to the optical stabilization. The results are really very effective.

Additionally, the OIS system may help to reduce the instances of MOS-sensor "wobble" that may happen in handheld shots or in instances where a tripod-mounted camera might by lightly jostled. The OIS can perform surprisingly well at absorbing those little jolts.

The OIS system is also tunable; you can customize the OIS response to tailor it towards the type of situations you expect to encounter. See the SW SETUP->CUSTOM O.I.S. menu for more information.

While the OIS can work quite well, there are times when you will want to turn the OIS off. First, you will want to disable OIS when using the camera

on a tripod (or dolly or jib arm or a slider or any other image stabilizing device). When mounted on a tripod, the image will already be adequately stabilized, and any motion that occurs in the frame will be intentional (i.e., if you start panning the camera). But if OIS is enabled, the OIS system will see that motion and try to "compensate," actually canceling out your panning motion. The result is that the OIS will try to "stabilize" your shot, and the further you pan the further it will try to stabilize it, up until the point where it can no longer compensate (remember that the prism can only move so far before it reaches its limit). The result will then be a noticeably jerky motion in the pan. Or, another side effect may come into play when you stop panning — the OIS might cause the image to slowly drift back to a centered position (where the lens elements are all reset back to their default state). While this might be fine when handheld, it can be noticeably distracting when using a tripod. If you're using a tripod, there's not many good reasons to have two image stabilization devices trying to do the same job, so turn OIS off and you'll get cleaner, smoother pans and tilts.

The O.I.S. button is also a reprogrammable User Button.

WFM Button (UX180 Only): This button enables or disables the WaveForm Monitor (WFM) or VectorScope (VS), according to the menu setting you've assigned to the WFM button. You can display either the waveform monitor or the vectorscope, but not both simultaneously. The waveform and vectorscope show up only on the camera's external LCD, and will not be displayed in the viewfinder or on the video outputs. Nothing else can be displayed while the WFM or VS are displayed; you won't see the iris or shutter speed or any other LCD readouts while the video scopes are active.

The integration of a waveform monitor is perhaps the most valuable exposure tool. A waveform monitor is an excellent tool for analyzing the video signal and getting excellent exposure. For an introduction into how to read the waveform monitor, see this article.

The WFM button is a re-programmable User Button, and you can also access the waveform monitor or vectorscope by assigning the "WFM" function to any other User Button. On the UX90, this button is User Button 4, with no "WFM" label.

LCD/EVF Button: Both cameras have this button, which is also User Button 7. However, the functionality is a little different between the cameras. On the UX90, this button toggles between the LCD being active, and the EVF being active. On the UX180, it toggles between the LCD being the only output enabled, or it enables auto-switching where the LCD will be active when the EVF's eye sensor isn't detecting an eye pressed up to the viewfinder; it will auto-switch to the EVF if it detects an eye pressed up to the viewfinder.

CAM Remote Jacks: There are two remote-control ports labeled CAM REMOTE for attaching third-party controllers. There is a small 2.5mm mini-plug socket labeled "ZOOM S/S". This socket allows for a remote zoom controller to be used. Note: it is not a LANC-type of jack, and there is no provision for remote focus control through this socket. The only functions that can be controlled through this socket are zoom and record start/stop. There is also a 3.5mm mini-plug socket labeled "FOCUS/IRIS". This jack allows the use of a remote controller to control the focus and iris settings. Manufacturers such as Varizoom and Manfrotto and Zoe and others supply remote controllers that allow the operator to control zoom, start/stop, focus, and iris.

Note: these ports are backward-compatible with the DVX200, AF100, AC160, HVX200, HPX170, and DVX100-series remote controls (such as the Zoe™ or Varizoom™ DVX zoom controllers).

SDI/HD-SDI/3G-SDI Connector (UX180 Only): The UX180 includes an industry-standard 3G-SDI output terminal. SDI stands for Serial Digital Interface, and the SDI port lets you monitor (or even record) fully uncompressed digital high-definition video at up to 1080/59.94P in 4:2:2 color sampling. This port is a regular locking BNC connector and is capable of transmitting either standard-definition or high-definition footage. This 3G-SDI port is fully backward compatible with HD-SDI and standard-definition SDI. The OUTPUT SETUP menu settings govern what type of video signal

is sent through the SDI port, whether full-resolution, cross-converted, or downconverted video. The camera also sends embedded timecode and audio in its SDI signal, making it suitable for use with computer SDI capture cards or portable recording units. The SDI port can also optionally be configured to output SDI error detection and handling. What the SDI port cannot do, however, is output Ultra High Definition or 4K footage. 3G-SDI is capable of a maximum of 1080/59.94P; to transmit UHD or 4K footage, you have to use the HDMI connector. The SDI and HDMI connectors cannot be used at the same time; you have to select one or the other.

Video and Audio Output Connectors (UX90 Only): These connectors are not digital outputs; they're standard definition composite video and analog audio output ports. You can connect these ports to something like a DVD recorder's composite video and audio inputs, or to a standard-definition video monitor. These ports are only active if the OUTPUT SETUP->AV OUT is set to ON, and the OUTPUT SETUP->RESOLUTION is set to DOWN CONV. Even then, the video may not be output if you have an HDMI cable attached, so definitely disconnect any HDMI cable before using the yellow VIDEO OUT port.

AV OUT (UX180 Only): The UX180 has a single output jack and can use an optional breakout cable for connecting to standard-definition composite video and analog audio devices. The breakout cable uses a four-conductor mini-plug and supplies the standard yellow video connector and red and white audio connectors. Note: Don't plug your headphones into this jack! There's a separate headphones jack specifically for headphones. Headphones won't work in this jack.

To use this connector, you have to set the OUTPUT SETUP->OUTPUT SEL to "AV". This means that the HDMI and SDI ports are disabled when using the AV OUT jack. And, consequentially, the AV OUT jack is disabled if you're using either the HDMI or SDI ports. Also, this port can't be used if you're recording Cinema 4K, but it can be used if you're recording UHD. The output of this port is standard-definition video and audio, suitable for connecting to a standard-def monitor or to something like a DVD recorder. It is not a high-quality high-def or UHD signal suitable for professional monitoring when shooting HD or UHD.

TC PRESET In/Out (UX180 Only): The TC PRESET IN/OUT port is used to synchronize timecode with other cameras or timecode slates or other TC-enabled devices. This is not, however, a timecode in/out port in the traditional sense. It can be connected to traditional timecode devices, but it does not continuously send or receive timecode; it is only active when the camera is put into the EXT TC LINK mode. When that mode is enabled, this port can then receive or transmit timecode and, when set to receive, it can synchronize its internal timecode clock to match the incoming timecode. After that, however, you must break the connection by disconnecting the cable. See the article on Synchronizing Timecode for more information.

HDMI Connector: The UX180 includes an industry-standard HDMI 2.0 video output terminal, and the UX90 includes an industry-standard HDMI 1.4 video output terminal. HDMI stands for High Definition Multimedia Interface, and HDMI ports are common on HDTV sets, Blu-Ray players, game systems and other consumer electronics devices. HDMI can also be easily converted to DVI through the use of a simple adapter; using an HDMI->DVI adapter will let you use an older DVI-only computer monitor as a video monitor (which is not necessarily that good of an idea, but hey, it's an option; also, converting to DVI will mean losing the audio that is carried in the HDMI signal as DVI doesn't support embedded audio).

The HDMI port lets you monitor (or even record) fully uncompressed digital video in standard def, high definition, UHD, and 4K. This port is a standard full-size HDMI connector and uses standard HDMI cabling available at electronics stores; whenever you're using UHD (and especially in the case of the UX180, because it is compliant with HDMI 2.0), you're going to want to use quality high-speed cables. Cheaper cables might work for standard-def or maybe even high-def, but might fail when using UHD or 4K.

The camera also sends embedded audio in the HDMI signal, and can optionally send timecode as well. When configured to send timecode, the HDMI can also be used to send a RECord start/stop flag, which can be interpreted by recorders such as the Video Devices PIX-E5H or the Convergent Design Odyssey 7Q+, thus enabling one-button recording for both onboard and external recorders.

One thing for UX180 users to be aware of regarding the HDMI — the camera cannot support onboard recording simultaneous with full-bandwidth UHD 50/59.94P HDMI output. It can do so in 4K/24P or in UHD at 23.98/25/29.97P; in those modes, you can record internally and simultaneously output the full bandwidth signal. But when selecting UHD at 59.94 or 50P, the camera can either send a full-bandwidth signal out its HDMI port, or it can record that signal internally to its memory cards, but it can't do both simultaneously. Accordingly, when recording UHD 59.94 or 50P, the HDMI signal drops to 1080/59.94P or 1080/50P for the duration of the recording, and reverts to UHD when recording stops. If the changeover from UHD to 1080 is problematic for monitoring, you may want to force the HDMI output to be a constant 1080 when recording UHD 50p/59.94p.

XLR Audio Connectors: There are two XLR audio connectors for attaching microphones, wireless mic receivers, mixers, or other professional audio devices to the camera. These XLR connectors are input-only, no audio can be output from them. Also, the XLR connectors only function when in camera mode. The XLR ports can also supply phantom power. One connector is located at the front of the handle, right by the microphone holder; the other is located at the back of the camera, below the record button.

USB Device Port: The camera includes two USB 3.0 ports; the one on top of the camera is a USB Host port, and the one on the back of the camera is a USB Device port, suitable for using the camera as an SD card reader for a computer.

Only one port can be active at a time; you set which port is active with the OTHER FUNCTION->USB MODE SELECT menu item. Even so, if you haven't enabled the port, it won't work; you need to use the OTHER FUNCTION->USB MODE menu setting to turn the port ON (or, use a User Button that's been assigned the "USB" function to turn the port on or off).

When set to DEVICE, and connected via a USB cable to a computer, the camera appears as an external storage device on the desktop (actually, it shows up as two removable storage devices; one for each SD card slot). You can copy files, or play footage from the cards in the camera, but you cannot

modify the contents of the memory cards; when in DEVICE mode, the camera acts as a read-only device.

The camera should never be connected to a computer using USB 1.1; always make sure you're using a USB 3.0 port (or USB 2.0 port) to connect to the camera. Also, always connect directly to the computer, never daisy-chain through another device and don't plug in through a USB hub.

USB Host Port: On top of the camera near the viewfinder is a door that, when opened, reveals the USB 3.0 HOST port. When the OTHER FUNCTION->USB MODE SELECT menu item is set to HOST, the camera can supply bus power and can use a wireless network adapter when in camera mode; when in playback mode it can take control of a hard disk and copy files to the hard disk or play files back from that hard disk. For more information on using the USB Host port to control a hard disk, see this article.

Additionally, the USB HOST port can be used with an optional wi-fi network adapter to connect wirelessly with an Apple iPad running the Panasonic AG ROP app for wireless remote control. See the NETWORK SETUP menu for more information.

Lens Hood Release Button: The camera has a built-in lens hood to shade the front of the lens from glare. Underneath the lens hood, it has a 67mm filter ring for attaching filters or optional conversion lenses or other accessories. To remove the lens hood, press the button on the back of the lens hood at the top right;. it's located right below the microphone). Press that button in, and rotate the lens hood 1/4 turn and it will come off of its bayonet mount. To reinstall it, just line up the bayonet lugs and turn the lens hood until it snaps into position.

Lens Cap: The lens cap is integrated into the lens hood. Simply slide the switch to block the lens, or slide it again to open the lens cap. If you remove the lens hood, you'll also inherently lose your lens cap, so you may want to pick up a 67mm lens cap for times when you're using the camera without the hood.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Published by Fiercely Independent Films Inc.,
3091 College Park Dr Ste 240-6,
The Woodlands, TX USA.