Flanders Scientific Inc.

# XM310K Calibration Guide

**Only for use with XM310K (firmware 2.1.20 or later)**
**Last Revision: 22 March 2022**

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## Option 1: Manual Adjustment of Factory Calibration

Simple manual adjustments to the factory calibration can be made using the Luminance, RGB Gain, and RGB Bias settings on the Color Menu of the monitor. Additional manual adjustments can be made using the Chroma, Brightness, and Contrast knobs on the front of the monitor. For hard clip configurations, like PQ, please keep in mind that any RGB Gain adjustments should be used subtractively by decreasing values from default if small tweaks to white balance are desired.

## Option 2: Volumetric AutoCal with CR100

The XM310K's Dynamic Backlight operating modes require calibration of both the panel and backlight. FSI has developed a closed loop calibration process to accomplish this task. The optimal probe to use for this process is the Colorimetry Research CR100.

To start, please make sure you have an XM310K specific matrix saved to the CR100 and that it is named **XM310K**. This will be the active matrix the monitor uses when connected to the CR100. If you do not have an XM310K specific matrix you can create one with a suitable spectroradiometer using the CRI Utility or you can send your CR100 to FSI for creation of an XM310K specific matrix. From the CRI Utility also ensure that the exposure multiplier setting for the CR100 is set to the default setting of 1, higher values can cause problems during the AutoCal process.

Next, plug the CR100 into the monitor's USB port, align the CR100 with the center of the screen, and allow the monitor to warm-up for at least 30 minutes before starting calibration. The optimal warm up procedure is to display an L30 or L32 (9% to 10% of screen area) size patch of white at approximately 100 nits.

To start calibration go to the COLOR menu on the monitor, select GaiaColor AutoCal, and follow the onscreen prompts. Once calibration is complete follow the instructions to cycle the power on the monitor. This process calibrates the available selections (e.g P3-ST2084, Rec709, 2020, etc.) in the **GaiaColor Color System.**

The AutoCal process also calibrates the baseline EOTF, but not gamut, of the Dynamic Luminance Mode in the other Color System selections (e.g. User, LightSpace, CalMan). In other words, end-user 3D LUTs can also be used for calibration ahead of the Dynamic Backlight EOTF baselines for fully customizable volumetric calibration of the display using third party applications.


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# Option 3: Volumetric Calibration Using LightSpace, CalMan, or ColourSpace

## 3A: LIGHTSPACE

### Pre-Calibration Steps

#### *Monitor Settings*

Before starting calibration please set all gain, bias, and rotary knob controls back to default.
From the COLOR menu on the monitor set COLOR SYSTEM to LightSpace and set the LUT MODE to your choice of Normal or Advanced. LightSpace is compatible with both modes and will automatically detect and load the correct LUT size and format for your LUT MODE. PLEASE NOTE: Dynamic Luminance (modulated backlight) operation is ONLY supported in Normal LUT Mode. The monitor will automatically enter Normal LUT Mode if Dynamic Luminance Mode is selected. See the monitor user manual for details on Normal vs. Advanced LUT Mode operation.

Next, set the GAMUT selection on the monitor to match the color space you plan on calibrating (e.g. Rec709, P3, etc.) Then set the LUMINANCE MODE to the desired setting. Numerical selections such as 100,200,400,800,1000 are static Backlight selections. For Dynamic Backlight operation set the Luminance Mode to Dynamic. If calibrating in Dynamic Luminance Mode it is strongly suggested that you have the monitor set to Peak Optimized Modulation (Video Menu) and that test patches are set to L30, L32, or 10% window sizes.

The last monitor menu selection to consider is the RANGE selection. The RANGE setting on the monitor should be set to match the output range of your test pattern generator source. For example, if using Resolve as your test pattern generator with Resolve set to Video Range the monitor should also be set to Video Range. A mismatch between your test pattern generator output range and your monitor's RANGE setting will lead to an incorrect calibration result.

#### *Warm-up*

A warm-up period of at least 30 minutes is suggested before starting calibration. For proper warm-up please set the monitor to the LUMINANCE MODE selection you plan on using and send the monitor a test signal. L30 or L32 (9% to 10% screen area) size test patches are suggested for warm up, calibration, and QC. If using Dynamic Luminance Mode a 100 to 500nit test patch is suggested for warm up. Displaying a test patch at maximum luminance in dynamic mode (e.g. 3,000+ nits) for warmup is ill-advised as this will cause the monitor to run much warmer than would be typical in normal operation when average picture levels will be well below this maximum.

#### *Connecting the monitor to your network*

After the monitor has been turned on connect the display's ethernet port to your local network. The display will obtain an IP address via DHCP. If your display fails to obtain an IP address, please unplug the ethernet cable, reboot the monitor, and connect the ethernet cable only after the display has completed its boot cycle. The assigned IP address can be seen from the monitor's SYSTEM menu. Take note of this IP address as you will need it to connect LightSpace to the display. Alternatively, a static IP can be set on the display, see the full user manual for details.


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## General work-flow notes before you get started

LightSpace is a very flexible calibration system with a large number of potential user defined variables including, but not limited to, what test pattern generator will be used, how many test patches will be measured, what type of probe will be used, and whether the user will calibrate just the 3D LUT or if the user will calibrate using both 3D and 1D LUT positions. Sample LightSpace work-flows are described below, but there are many valid variations on these processes. Most of the variations follow the same basic steps so the work-flows described below should be useful to all users, but if you have questions specific to your work-flow please feel free to contact Support@FlandersScientific.com for further assistance.

## Sample LightSpace Work-flow (Resolve as TPG, Probe CR100, 1D+3D LUT Upload)

### *Connecting to Resolve as your test pattern generator*

Start DaVinci Resolve and create a new timeline. There must be content in your timeline before starting calibration.

Verify that the monitor is receiving a signal from Resolve then click on the Color Tab in Resolve.
Click on the Workspace menu in Resolve. Select Monitor Calibration. Select LightSpace. A pop-up dialog in Resolve will request an IP address, which can be found once you start LightSpace.

Start LightSpace and click on the network manager icon. In the Network Manager window click on enable and then take note of the IP address listed. Enter the IP address in Resolve and press Connect. Do not close the Calibration network connection window in Resolve as this will terminate your connection.

#### *Connecting your probe*

With the CR100 plugged into your computer return to LightSpace and click on the tools menu.

Select Discoverable Probes and click on Colorimetry Research CR-100 as your calibration probe. Make sure that Virtual Probe is not selected.

### *Connecting LightSpace to the XM310K*

From LightSpace click on the File menu, then select Upload. From the Upload dialog window select XM as your device type. Next type in the monitor's IP address, which can be found on the monitor's SYSTEM menu.

Next select the Color Gamut memory position where you will save your LUTs. This selection should match the GAMUT selection made on the monitor as outlined in the pre-calibration steps at the beginning of this document.

Finally, with NULL Cube checked select 1D+3D, then press upload. This will load unity LUTs to both the Front 1D LUT and 3D LUT memory positions. Next, if a static luminance mode selection (e.g. 100) is active do the same for the back 1D LUT selection, with NULL cube checked, press upload. Nulling the back 1D LUT in Dynamic Luminance mode is not necessary as only the front 1D and 3D LUTs are used, the back 1D is automatically disabled in this mode. Loading NULL LUTs clears previous LUT based calibrations allowing for a neutral starting position for display profiling.

Once NULL LUTs are loaded in all positions press Close within the upload dialog window.


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### *Profiling the XM310K*

Next select either the Calibration Interface or Display Characterization icons to begin profiling the monitor. Grey Only Large (Calibration Interface) is suggested for PQ based calibration. Grey Only (Calibration Interface) or 17x17x17 Display Characterization are suggested for SDR calibrations.

From the Display Characterization / Calibration Interface window select Options. Make sure the CR100 serial number is listed at the top of the options window. Set Extra Delay Time to 0.5 Seconds.

To Sync the CR100 set Sync Frequency to Manual and select Probe Calibration. Follow the prompt and click Ok. It may be advisable to type in a custom number here based on your source frame rate, contact FSI support if you have questions about this selection. With the monitor in Dynamic Luminance Mode using AUTO sync is advisable. Under Calibration Settings, select the correct calibration matrix that is stored on the CR100. Then press Ok.

Next place your CR100 probe at the center of the monitor and press the Measure (Display Characterization) or Profile (Calibration Interface) button. A dialog window will ask you to give your **profile a name**. Select something easily identifiable and press OK to begin the profiling process.

Once your profile completes select the Convert Colour Space icon.

In the Convert Colour Space window enter your desired LUT name in the NAME field.

From the source dialog select your target colour space from the colour space drop-down menu (e.g. Rec709). From the destination dialog select your **calibration profile**. Then click create new to generate your calibration LUT.

Once your LUT is generated select File, then Upload. From the upload dialog make sure NULL Cube is unchecked. Select 1D + 3D, verify you are saving to the correct memory position option, and then press Upload. This will save the calibration LUTs to the Front 1D and 3D LUT calibration positions. Your calibration is now complete.

### Additional Considerations

If you plan on utilizing the Back 1D LUT (static backlight selections only) for calibration please remember to calibrate for this position first, upload to the monitor, then profile with this Back 1D LUT active.

When profiling in Dynamic (modulated backlight) Luminance Mode the baseline EOTF and peak luminance behavior are determined by the monitor menu's EOTF settings. Gamma EOTF selections (e.g. 2.4) will result in a baseline gamma response and an SDR appropriate peak luminance. PQ and HLG EOTFs will have corresponding baseline PQ (hard clip) or HLG EOTFs with HDR appropriate peak luminance settings.

When profiling a display with a PQ baseline EOTF in LightSpace it may be advisable to use the patch scale functionality to only generate test patches to the hard clip value of the display. If doing so you should apply the inverse of the patch scale to the resulting 3D LUT using the Maths functionality. For example if scaling the patch set from 0 to 217 you would want to append the maths operation approximately as R = r*.85, B = b*0.85, G = g*0.85. Note, when creating a PQ-3D LUT you will also want to use the EOTF nits option in LightSpace to specify the corresponding measured peak luminance of the display (e.g. 3,000nits).


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## 3B: CALMAN

**Please note: CalMAN is currently only compatible with SDR 3D LUT based calibration. 3D LUT based HDR calibration is not currently supported in the software.**

### Pre-Calibration Steps

#### *Monitor Settings*

Before starting calibration please set all gain, bias, and rotary knob controls back to default.
From the COLOR menu on the monitor set COLOR SYSTEM to CalMAN and set the LUT MODE to your choice of Normal or Advanced. CalMAN is compatible with both modes. PLEASE NOTE: Dynamic Luminance (modulated backlight) operation is ONLY supported in Normal LUT Mode. The monitor will automatically enter Normal LUT Mode if Dynamic Luminance Mode is selected. See the monitor user manual for details on Normal vs. Advanced LUT Mode operation.

Next, set the GAMUT selection on the monitor to match the color space you plan on calibrating for (e.g. Rec709, P3, etc.). Then set the LUMINANCE MODE to the desired setting. Numerical selections such as 100,200,400,800,1000 are static Backlight selections. For Dynamic Backlight operation set the Luminance Mode to Dynamic. If calibrating in Dynamic Luminance Mode it is strongly suggested that you have the monitor set to Peak Optimized Modulation (Video Menu) and that test patches are set to L30, L32, or 10% window sizes.

The last monitor menu selection to consider is the RANGE selection. The RANGE setting on the monitor should be set to match the output range of your test pattern generator source. For example, if using Resolve as your test pattern generator with Resolve set to Video Range the monitor should also be set to Video Range. A mismatch between your test pattern generator output range and your monitor's RANGE setting will lead to an incorrect calibration result.

#### *Warm-up*

A warm-up period of 30 minutes is suggested before starting calibration. For proper warm-up please set the monitor to the LUMINANCE MODE selection you plan on using and send the monitor a test signal. L30 or L32 (9% to 10% screen area) test patches are suggested for warm up, calibration, and QC. If using Dynamic Luminance Mode a 100nit test patch is suggested for warm up.

#### *Connecting the monitor to your network*

After the monitor has been turned on connect the display's ethernet port to your local network. The display will obtain an IP address via DHCP. If your display fails to obtain an IP address, please unplug the ethernet cable, reboot the monitor, and connect the ethernet cable only after the display has completed its boot cycle. The assigned IP address can be seen from the monitor's SYSTEM menu. Take note of this IP address as you will need it to connect CalMAN to the display. Alternatively, a static IP can be set on the display, see the full user manual for details.


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***Connecting Devices in CalMAN***

Start DaVinci Resolve and create a new timeline. There must be content in your timeline before starting calibration.

Verify that the monitor is receiving a signal from Resolve then click on the Color Tab in Resolve.

Click on the Workspace menu in Resolve. Select Monitor Calibration. Select CalMAN. A pop-up dialog in Resolve will request an IP address, which can be found once you start CalMAN.

Start CalMAN and Select *Open Workflow Template -> Calibration -> 3D LUT* from the menu at top left. Once the 3D LUT workflow template opens select the *3D LUT Only* option.

Follow the prompts to connect your meter.

Next select *Find Source* and select DaVinci Resolve as your Pattern Source. Select *Connect* and take note of the IP address listed. Enter this IP address in Resolve and press Connect. Do not close the Calibration network connection window in Resolve as this will terminate your connection.

Return to CalMAN and Select *Find Display -> Flanders Scientific -> FSI XM Monitor*. Type in the IP address of your monitor as found on the monitor's System Menu, then select *Connect*.

Press NEXT to continue with the calibration process.

***Calibrating the Monitor***

In CalMAN set your Calibration Targets, for example Whitepoint: D65, ColorSpace: Rec709, EOTF: Gamma 2.4. Then select NEXT.

You can skip the Pre Cal Capture step if you like, this is optional. However, before continuing select the FSI monitor tab at top right and select Full DDC Reset. This step will load UNITY LUTs to the selected calibration position. Loading UNITY LUTs returns the monitor to its native, uncalibrated state, which is necessary before continuing with the calibration process. Please ensure you are resetting the LUT ID memory that corresponds to the memory position you are saving LUTs to on the monitor.

ID1 = BT.709 memory position on the monitor
ID2 = P3 memory position on the monitor
ID3 = BT.2020 memory position on the monitor

For example, if you have the monitor's Gamut position currently set to BT.709 memory position you will want to reset and save LUTs to ID1.

*Note: Please ensure that the File Format listed matches the LUT mode currently selected on the monitor. FSI Advanced Mode 33 is for LUT Mode: Advanced. FSI Normal Mode 17 is for LUT Mode: Normal. More details on Normal and Advanced LUT modes can be found in the XM311K user manual.*


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Once the DDC reset is complete select NEXT to continue to the 1D LUT calibration page. **If you are calibrating in Dynamic (modulated backlight) Luminance mode skip this step,** as it is only supported in static backlight modes. For Dynamic Luminance Mode ensure that your baseline EOTF settings on the monitor correspond to the color space you are targeting.

Static Luminance Modes Only: From the 1D LUT calibration page click on the AutoCal symbol and confirm that you have the LUT ID position set to the correct memory position. CalMAN will then begin the 1D LUT AutoCal process. It is normal for the screen to flash during this process as the LUTs are updated in real time. The probe will only read between flashes so any lines, flashes, etc. that occur during a LUT update will not negatively impact calibration. Once this process is complete select NEXT to continue to the 3D LUT calibration step.

All Luminance Modes: From the 3D LUT calibration page select the AutoCal symbol. Confirm your LUT settings once again to ensure that the 3D LUT will be saved to the correct memory position. We also suggest using 0.5 pattern delay.

The XM310K is a very linear device so a Lightning LUT may be more than sufficient to generate excellent calibration results. We suggest trying Lightning LUT first before trying longer calibration processes, but time based and point based selections will also work well. Once the calibration process is complete the 3D LUT will be automatically saved to the display.


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## 3C: ColourSpace

### Pre-Calibration Steps

#### *Monitor Settings*

Before starting calibration please set all gain, bias, and rotary knob controls back to default.
From the COLOR menu on the monitor set COLOR SYSTEM to LightSpace and set the LUT MODE to your choice of Normal or Advanced. ColourSpace is compatible with both modes and will automatically detect and load the correct LUT size and format for your LUT MODE. PLEASE NOTE: Dynamic Luminance (modulated backlight) operation is ONLY supported in Normal LUT Mode. The monitor will automatically enter Normal LUT Mode if Dynamic Luminance Mode is selected. See the monitor user manual for details on Normal vs. Advanced LUT Mode operation.

Next, set the GAMUT selection on the monitor to match the color space you plan on calibrating (e.g. Rec709, P3, etc.) Then set the LUMINANCE MODE to the desired setting. Numerical selections such as 100,200,400,800,1000 are static Backlight selections. For Dynamic Backlight operation set the Luminance Mode to Dynamic. If calibrating in Dynamic Luminance Mode it is strongly suggested that you have the monitor set to Peak Optimized Modulation (Video Menu) and that test patches are set to L30, L32, or 10% window sizes.

The last monitor menu selection to consider is the RANGE selection. The RANGE setting on the monitor should be set to match the output range of your test pattern generator source. For example, if using Resolve as your test pattern generator with Resolve set to Video Range the monitor should also be set to Video Range. A mismatch between your test pattern generator output range and your monitor's RANGE setting will lead to an incorrect calibration result.

#### *Warm-up*

A warm-up period of at least 30 minutes is suggested before starting calibration. For proper warm-up please set the monitor to the LUMINANCE MODE selection you plan on using and send the monitor a test signal. L30 or L32 (9% to 10% screen area) size test patches are suggested for warm up, calibration, and QC. If using Dynamic Luminance Mode a 100 to 500nit test patch is suggested for warm up. Displaying a test patch at maximum luminance in dynamic mode (e.g. 3,000+ nits) for warmup is ill-advised as this will cause the monitor to run much warmer than would be typical in normal operation when average picture levels will be well below this maximum.

#### *Connecting the monitor to your network*

After the monitor has been turned on connect the display's ethernet port to your local network. The display will obtain an IP address via DHCP. If your display fails to obtain an IP address, please unplug the ethernet cable, reboot the monitor, and connect the ethernet cable only after the display has completed its boot cycle. The assigned IP address can be seen from the monitor's SYSTEM menu. Take note of this IP address as you will need it to connect ColourSpace to the display. Alternatively, a static IP can be set on the display, see the full user manual for details.


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### General work-flow notes before you get started

ColourSpace is a very flexible calibration system with a large number of potential user defined variables including, but not limited to, what test pattern generator will be used, how many test patches will be measured, what type of probe will be used, and whether the user will calibrate just the 3D LUT or if the user will calibrate using both 3D and 1D LUT positions. Sample ColourSpace work-flows are described below, but there are many valid variations on these processes. Most of the variations follow the same basic steps so the work-flows described below should be useful to all users, but if you have questions specific to your work-flow please feel free to contact Support@FlandersScientific.com for further assistance.

### Sample ColourSpace Work-flow (Resolve as TPG, Probe CR100, 1D+3D LUT Upload)

#### *Connecting to Resolve as your test pattern generator*

Start DaVinci Resolve and create a new timeline. There must be content in your timeline before starting calibration.

Verify that the monitor is receiving a signal from Resolve then click on the Color Tab in Resolve.
Click on the Workspace menu in Resolve. Select Monitor Calibration. Select LightSpace. A pop-up dialog in Resolve will request an IP address, which can be found once you start ColourSpace.

Start ColourSpace and click on the profiling icon. From the profiling window select the Hardware Options tab. From the Hardware drop-down menu select Network Server and click connect. Take note of the IP address listed in the Network Server Options area. Enter the IP address in Resolve and press Connect. Do not close the Calibration network connection window in Resolve as this will terminate your connection.

#### *Connecting your probe*

With the CR100 plugged into your computer return to ColourSpace and in the Hardware Options window that is already open from the previous step, select the probe options tab.

From the Probes menu select Colorimetry Research CR100. Select Rescan if no active com ports are shown. Then press connect. Once connected verify you have the correct XM310K matrix active on the probe. Sync frequency can be set to Auto, set extra delay to at least 0.25 seconds.

#### *Connecting ColourSpace to the XM310K*

From ColourSpace open an additional profiling window (do not close the profiling window already open with your active probe and network connections), select hardware options, and from the hardware drop-down menu select FSI XM.  In the Network Address field type in the IP address of the monitor and then press connect.

Next select the Gamut memory position where you will save your LUTs. This selection should match the GAMUT selection made on the monitor as outlined in the pre-calibration steps at the beginning of this section.

From the Select LUT dialog select UnityBypass. Then from the Load toggle select 1D+3D, then press upload. This will load unity LUTs to both the Front 1D LUT and 3D LUT memory positions. Next, if a static luminance mode selection (e.g. 100) is active do the same for the back 1D LUT selection. Setting the back 1D LUT to Unity in Dynamic Luminance mode is not necessary as only the front 1D and 3D LUTs are used, the back 1D is automatically disabled in this mode. Loading UnityBypass LUTs clears previous LUT based calibrations allowing for a neutral starting position for display profiling.


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### *Profiling the XM310K*

Next return to the first profiling window in ColourSpace where your probe is actively connected to begin profiling the monitor. Click on the Display Characterization icon, then select a desired profiling mode. Grey Only Large is suggested for PQ based calibration. Grey Only or Cube (size 17) are suggested for SDR calibrations.

Next place your CR100 probe at the center of the monitor and press the Start button to begin profiling.

Once your profile completes click on the graph options tab, select rename to give the profile an easy to identify name, then press save to save the completed profile. Once the profile is saved open a LUT Tools window in ColourSpace. From the LUT Tools window enter your desired LUT name in the NAME field.

From the source dialog select your target colour space from the colour space drop-down menu (e.g. Rec709, Rec2020, P3-ST2084-3000, etc.). From the destination dialog select the calibration profile you just saved. Then click create new to generate your calibration LUT.

Once your LUT is generated click on the Manage LUT icon, then select save.

Next return to the Hardware Options window that is connected to the monitor and from the Select LUT dialog change from UnityBypass to the LUT you just saved. Then press Upload. The LUT will then be uploaded and saved to the gamut and “Load” positions indicated (e.g. 1D + 3D in Rec709).

### Additional Considerations

If you plan on utilizing the Back 1D LUT (static backlight selections only) for calibration please remember to calibrate for this position first, upload to the monitor, then profile with this Back 1D LUT active.

When profiling in Dynamic (modulated backlight) Luminance Mode the baseline EOTF and peak luminance behavior are determined by the monitor menu’s EOTF settings. Gamma EOTF selections (e.g. 2.4) will result in a baseline gamma response and an SDR appropriate peak luminance. PQ and HLG EOTFs will have corresponding baseline PQ (hard clip) or HLG EOTFs with HDR appropriate peak luminance settings.

When profiling a display with a PQ baseline EOTF in ColourSpace it is advisable to use the Limit Range toggle to limit test patch generation to or below the hard clip code value of the display. See ColourSpace guides for information on using Limit Range.

Note, when creating a PQ-3D LUT you will also want to use the EOTF nits option in ColourSpace to specify the corresponding target peak luminance of the display. To do this select the Space Management option, select a standard Colour Space (e.g. ST2084 P3 D65), then select Modify. In the nits field type in the corresponding target peak luminance then change the Output name accordingly (e.g. ST2084 P3 D65 3000) and press save. This will now be presented as a source target when creating your LUT. For best results this EOTF nits value and limit range expected luminance value for your chosen peak code value should be matched and should be set under the display’s true peak to provide some headroom for LUT application. Before generating your LUT make sure that the Limit Luminance Max option is clicked and that you type in the luminance value that corresponds to the target for your color space selection.

**Questions? E-mail: Support@FlandersScientific.com or Call: +1.678.835.4934**


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