Calibrate MacBook M1 Pro or M1 Max with built-in XDR Display

The new Apple MacBooks Pro 2021 handle color on the built-in XDR display completely differently than before and differently from connected external monitors.

In principle, an XDR display can be "adjusted" for different applications using the built-in tools. If the screen is to be calibrated individually, further steps are required. In order to achieve optimal results, a good measuring device is required, which is properly calibrated and whose correction matrix - in the case of colorimeters - is correctly selected (RG Phosphor or GBr in the case of XDR displays).

MYIRO-1

Even if (still) few of you own this instrument, here is a hint for use with the new MacBooks M1: The MYIRO-1 is often not recognized correctly on these computers when connected to a USB-C adapter (even the original from Apple).

The solution: Use a USB2 hub to connect the meter.

Here are the necessary steps to adjust, calibrate, profile, validate and if necessary optimize the display.

To do this, first leave the computer display screen on for at least 10 minutes to warm up, place the measuring device on the monitor. This allows the monitor and measuring device to reach operating temperature. If the temperature were to change during the measurement, this may falsify the measurement results.

1. Start the "ColorSync Utility" program from Applications¬Utilities

Under "Devices" select any profile as your "Current profile" (e.g. AdobeRGB), but not the factory (LCD-xxx). This cannot be overwritten by basICColor display 6, selecting the factory default option would generate an error message.

• • •	Devices
	Profile First Aid Profiles Devices Filters Calculator
	Default Display "Color LCD"
> Scanners > Cameras	ID: 37D8832A-2D66-02CA-B9F7-8F30A301B230
✓ Displays	Scope: Any user of current computer
Color LCD	
> Printers	Mode "Color LCD" Factory Profile: Name: Color LCD Path: /Library/ColorSync/Profiles/Displays/Color LCD-37D8832A-2D66-02CA- Open B9F7-8F30A301B230.icc Current Profile: v
	Name: Adobe RGB (1998)
	Path: /Users/karlkoch/Library/ColorSync/Profiles/AdobeRGB1998.icc Open

You can leave the ColorSync utility open and see basICColor display 6 replace the selected profile with the newly created one.

2. Open System Preferences and select "Desktop & Screensavers" Remove the checkmark from "Show screensaver after" You can reset this setting later.



3. Select "Battery" in System Preferences



First make sure that

• Both under "Battery and under "Power supply unit" "Switch off monitor after:" is set to "Never" or at least 1 hour (you can also reset these options later)

• "Slightly dim the monitor while on battery power" must not be checked . If you want to work with correct colors when using battery power, you should not change this setting later.

••• < >	iiii Battery	Q Search
	Turn display off after: 1 min 15 min Put hard disks to sleep when possi lightly dim the display while on ba	
basICColor display 6	Built-in Retina XDR	Page 2 of 12

4. Open "Displays" in System Preferences



Switch off

"Automatically adjust brightness" and "True Tone".

	Resolution: Oefault for Display Scaled
	Here's Larger Text
MacBook Pro Built-in Liquid Retina XDR Display	Using a scaled resolution may affect performance. Brightness: Automatically adjust brightness Tue Tone
	dutomatically adapt display to make colors appear consistent in different ambient

Do not change the Brightness slider!

5. Choose a Preset and create a new one

Choose a preset, it doesn't matter which one, as we customize the parameters. This works with any of these presets (also called reference modes in Apple's documentation). We use the preset "Apple Display (P3-500 nits)" here as an example (nits is the American term for cd/m2).

After this is selected, you need to click on this preset again and select "Customize Presets..." from the drop-down menu that opens up.

 Apple Display (P3-500 nits) HDR Video (P3-ST 2084) HDTV Video (BT.709-BT.1886) NTSC Video (BT.601 SMPTE-C) PAL & SECAM Video (BT.601 EBU) Digital Cinema (P3-DCI) Digital Cinema (P3-D65) Design & Print (P3-D50) 		Apple XDR Display (P3-1600 nits)
HDTV Video (BT.709-BT.1886) NTSC Video (BT.601 SMPTE-C) PAL & SECAM Video (BT.601 EBU) Digital Cinema (P3-DCI) Digital Cinema (P3-D65)	1	Apple Display (P3-500 nits)
NTSC Video (BT.601 SMPTE-C) PAL & SECAM Video (BT.601 EBU) Digital Cinema (P3-DCI) Digital Cinema (P3-D65)		HDR Video (P3-ST 2084)
PAL & SECAM Video (BT.601 EBU) Digital Cinema (P3-DCI) Digital Cinema (P3-D65)		HDTV Video (BT.709-BT.1886)
Digital Cinema (P3-DCI) Digital Cinema (P3-D65)		NTSC Video (BT.601 SMPTE-C)
Digital Cinema (P3-D65)		PAL & SECAM Video (BT.601 EBU)
		Digital Cinema (P3-DCI)
Design & Print (P3-D50)		Digital Cinema (P3-D65)
Design a rink (ro Doo)		Design & Print (P3-D50)
Photography (P3-D65)		Photography (P3-D65)
Internet & Web (sRGB)		Internet & Web (sRGB)
		Customize Presets
Customize Presets		Fine-Tune Calibration

The predefined presets cannot be edited. Create a copy of the selected setting by clicking on the "+" sign.

Checked presets will appear as options in the Display Menu of Control Center.

Preset	Show in Menu
Apple XDR Display (P3-1600 nits)	
Apple Display (P3-500 nits)	
HDR Video (P3-ST 2084)	
HDTV Video (BT.709-BT.1886)	
NTSC Video (BT.601 SMPTE-C)	
PAL & SECAM Video (BT.601 EBU)	
Digital Cinema (P3-DCI)	
Digital Cinema (P3-D65)	
Desian & Print (P3-D50)	
$+$ $ $ $+$ $ $ \otimes \sim	

Name the new preset as you wish, in our example it is "Prepress".

6. Now it's time to set the desired "calibration parameters"

_	Preset Name:	Prepress	
	Description:	Configures the display for general use in office and home environments. This mode is based on the wide color P3 color primaries and supports a brightness range of up to 500 nits typical of Apple built-in displays.	the first conception in the first conception is the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first point first conception of the first conception of the first conception of the first point first conception of the first concepti
	Color Gamut:	P3 🗘	
Built-ii	White Point:	D50 📀 x: 0,3457 y: 0,3585	
	SDR Transfer Function:	sRGB ICC V2	
		Apply System Gamma Boost 1,00 Enable HDR Content	colors nt
	Maximum Luminance:	HDR 160 SDR 160	0
		Limit Luminance to Full Screen Capability	0
Add Dis	?	Cancel Save Preset	t

• Leave the "Color Gamut" at "P3" for all color managed programs. This is the native color space of the XDR Display.

You should only chose a different setting here if you are working with programs that require a certain (smaller) color space in order to display colors correctly (e.g. some video editing programs that do not use color management).

 You can set the white point to D50, D65 or DCI (the latter for video), or determine it individually by entering xy values. This assumes that you know these values. • Here are the values for a few common illuminants:

Color Temperature	Illuminant	Da	aylight	Blac	k Body
or CCT		x	у	x	у
2856	Α			0,4476	0,4075
4000		0,3823	0,3836	0,3804	0,3767
4500		0,3620	0,3707	0,3607	0,3635
5000		0,3456	0,3585	0,3451	0,3516
5002,70	D50	0,3456	0,3584	0,3450	0,3515
5250		0,3387	0,3528	0,3384	0,3461
5500		0,3324	0,3474	0,3324	0,3410
5502,97	D55	0,3324	0,3474	0,3323	0,3409
5750		0,3268	0,3424	0,3270	0,3362
6000		0,3216	0,3376	0,3220	0,3317
6250		0,3170	0,3332	0,3176	0,3275
6500		0,3127	0,3290	0,3135	0,3236
6503,51	D65	0,3127	0,3290	0,3134	0,3235
6750		0,3088	0,3251	0,3098	0,3199
7000		0,3053	0,3215	0,3063	0,3165
7500		0,2990	0,3148	0,3003	0,3102
7504,05	D75	0,2990	0,3148	0,3002	0,3102
8000		0,2937	0,3090	0,2951	0,3047
8500		0,2891	0,3039	0,2907	0,2999
9000		0,2852	0,2994	0,2869	0,2955
9305,02	D93	0,2830	0,2969	0,2848	0,2931
9500		0,2817	0,2954	0,2835	0,2917
10000		0,2787	0,2918	0,2806	0,2882

Tabelle 1

- The SDR transfer function (tone curve) can be selected from any gamma value between 1.6 and 2.6 (referred to here as "Pure Power"), the sRGB curve or BT 1886 (again only suitable for video). Select Gamma 2.2 if you have selected AdobeRGB as your working space or "sRGB ICC V2" if sRGB is your working color space or if you are aiming for an L* calibration, as this best reflects the human perception of tonal gradations. The sRGB curve is closest to L*, which unfortunately is not available for selection here.
- Leave both "Apply system gamma boost" and "Enable HDR content" turned off.

• Under "Maximum luminance", you set the desired luminance of your monitor at SDR. Select a value here that is approx. 10% above the desired luminance of the calibrated screen, since the video LUTs may reduce the brightness somewhat in order to achieve the exact color temperature for the white point.

IMPORTANT!

Switch "Limit Luminance to Full Screen Capability" on, otherwise no "Fine-Tune Calibration..." can be done.

7. Save Preset

After completing and saving the settings, the brightness can no longer be changed with the keyboard or the system settings.

The white point can also only be changed within narrow limits - and rather awkwardly - during "Fine-Tune Calibration...".

_	Preset Name:	Prepress	
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	Color Gamut:	P3 🖸	
Built-ii	White Point:	D50 📀 x: 0,3457 y: 0,3585	
	SDR Transfer Function:	sRGB ICC V2	
		Apply System Gamma Boost 1,00	colors
		Enable HDR Content	nt
	Maximum Luminance:	HDR 160 SDR 160	:
		Limit Luminance to Full Screen Capability	

If the desired parameters such as luminance or color temperature cannot be edited in "Fine-Tune Calibration…", you must start the entire process from the beginning and select a lower or higher luminance or other xy values.



8. Now open basICColor display 6



...and switch to EDITOR

Select a WORKFLOW by clicking on the icon. Mouse-over to highlight the edit menu and click the pencil icon.



9. EDIT the WORKFLOW

Set the following parameters:

Calibration mode:	"Automatic"
White Point:	Exactly the white point chosen for the active preset (D50 in our example)
Tone curve:	The gamma or sRGB you selected in the preferences under SDR transfer function (sRGB in our example)
White Luminance:	The nits value you set in the preferences under Maximum Luminosity, SDR (160 in our example)
Black Luminance:	Minimum (recommended)

In our example it looks like this:

WORKFLOW EDITOR		Prepress - Edit WORKFLOW
Calibrate 🔒 En	nulate 🖁 Profile	子 Validate 😣 Evaluate 😣 Light
Calibration Mode 🕑		White Point 🕑
Automatic	:	D50 ÷ A A
sRGB	:	160 ÷ 🚔 🚔
		Min Native
+ BACK		SAVE WORKFLOW →

10. Save the WORKFLOW ...

... unter a name of your choice, e.g. Prepress

11. Switch back to WORKFLOW

Select the newly created WORKFLOW Start the calibration and profiling process.

NOTE: We strongly recommend to upgrade to Monterey \geq 12.5 before calibration.

Instrument Info

• If you use an i1 Display Pro (color checker Display/Pro/Plus) as your instrument, make sure you select "PFS Phosphor" as your correction matrix.

This calibration setting is available in version 6.6.0 build 4230 and up only, please install this version!



 for spectrophotometers (i1 Pro, MYIRO-1) you don't have to select anything – it's always "Spectral".



12. Save the report

After completing Calibrate, Profile and Validate, save the report in order to record the values achieved. You may need this later for "Fine-Tune Calibration…".



If the validation passes, the process is successful and you do not need to do anything else.

If the validation is unsuccessful, you may be able to correct the values with the calibration fine adjustment in System Settings Displays. However, this is only possible within very narrow limits.

13. White Point Edit (basICColor display 6 Pro)

If you use basICColor display 6 Pro you can edit the white point if it is visually a bit off. Click on the rightmost dot below the graphics window.

Note: This only works correctly from Monterey 12.3, before that the video LUTs are swapped.

This is much easier than Apple's "Fine-Tune Calibration…" or even having to repeat the whole process from the beginning if the tolerances for "Fine-Tune Calibration…" were exceeded.

	•—	-0		-•		-•		-•		-0					DONE		
		P	rofile x: 0.3	343, y: 0.3	356, Com	ection x: (0.000, y:	0.000		White Po	oint Edit			Reset (orrection		
														Save C	prrection		
														Reset			
													_				
												► VALID	ATE				
												► PROF		coponoc.			
													Black I		Min Native		
												<u> </u>	White I	Point: D50 Luminance:			
												▼ CALIE		tion Mode:	Automatic		
												Prep					
9	T	Built	-in Reti	1d	•			7	9		RG Phosp	nor Ţ		UV VIV	Viewing Light	Report	
		Dealle	in Dati						-	- IR	DO DL			UV	Manda a Dalah		
WO	RKFLOW	EDIT	DR								M	easurement P	age				

But you can also use the "Correction" values for "Fine-Tune Calibration...".