External Monitors

PMUG General Meeting February, 2024

External Displays

- Why
- Computer
- Monitor
- Cable
- Connector
- Setting up
- Use

Why Add External Display

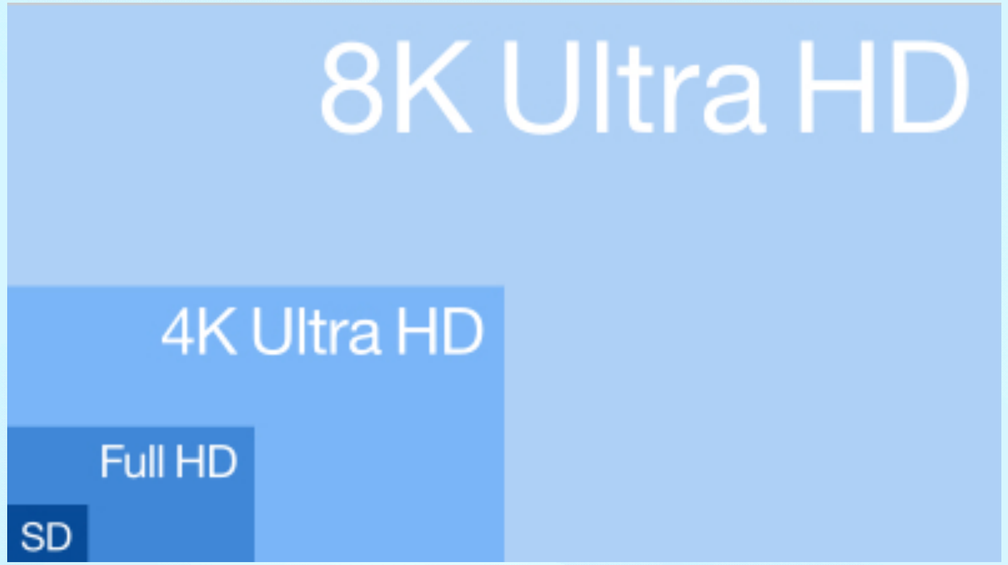
- Provide additional and larger screen on which to view things
- Example: Video editing - Video on one screen, commands on the second
- Example: Creating web sites - view the web page on one screen while editing objects on the second to insert into web page
- Gaming
- Using Windows 11 under VM on one screen and MacOS on second screen
- Comparing products, files, images, etc.
- Magazine editing using vertical (page layout) & horizontal (inputs) display

Computer Requirements

- Adding a second screen requires more RAM for the windows and Apps that will run there
- If running a second OS, add in the RAM for the 2nd OS (min 8GB per OS, 16GB per OS better)
- Graphic card/SoC powerful enough to run external monitor(s)
- All Apple M series based computers support at at least one external monitor
- Number of monitors and resolution of monitors dependent on GPU
- Port for connecting a cable to second monitor

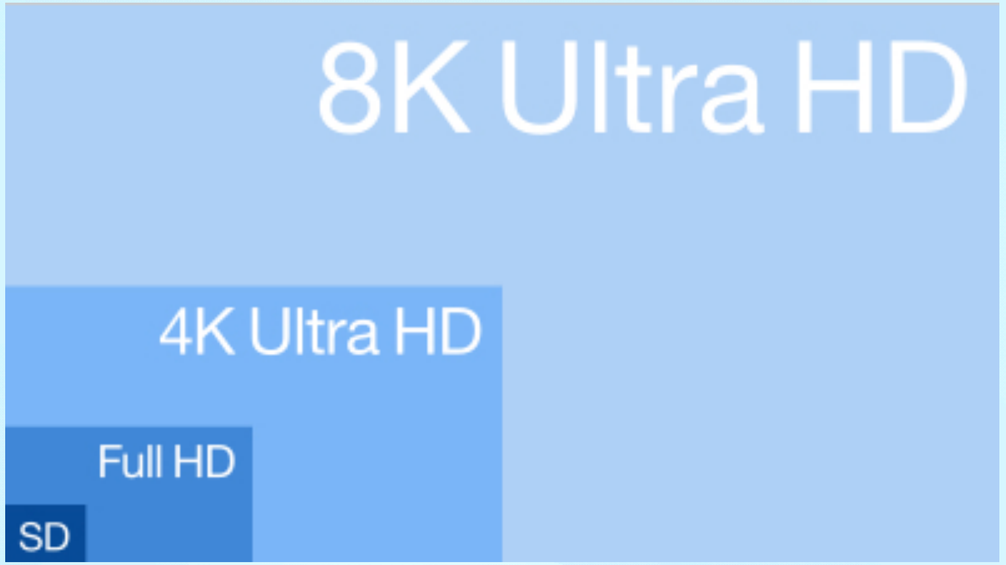
Monitor Issues

- First, EVERY manufacturer produces TV's and/or monitors with varying resolutions
- There are MANY different standards
- Created by MANY different organizations
  - Horizontal x Vertical pixels
  - Interlaced (i) vs Progressive ℗
  - Aspect ratio (4:3, 1.9:1, 16:9, 16:10, 1:1, 21:9, etc)



Note: the terms used to describe the resolution changed from vertical lines (720, 1080) to horizontal pixels (2k, 4k, 5k, 8k)

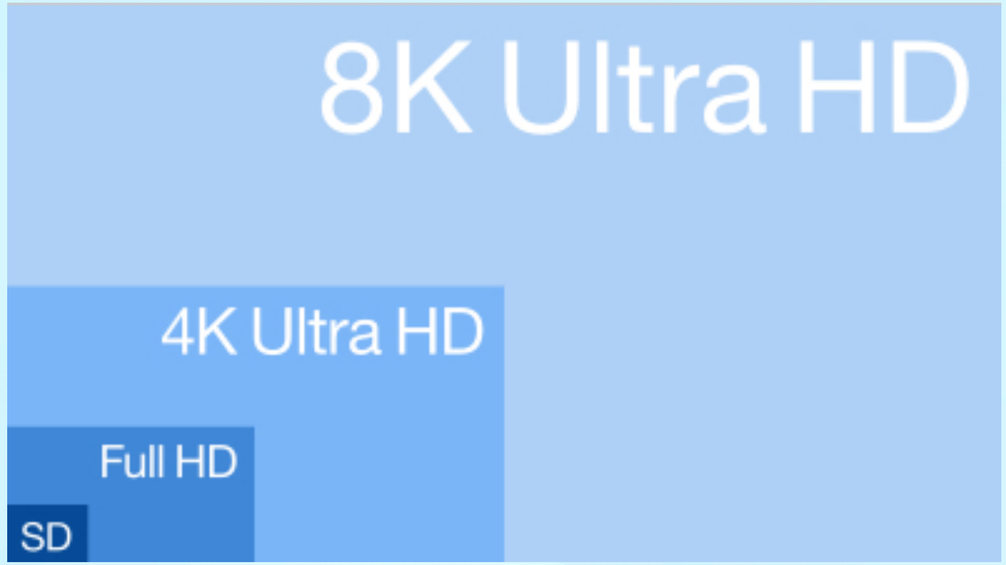
Monitor Issues



- SD - 480p is 640 x 480 or 576p is 768 x 576
- HD - 720p is 1280 x 720, 1080i or 1080p is 1920 x 1080
- Quad HD (4*720) 1440p is 2560 x 1440
- 4K Ultra HDTV-1 2160p is 3840 x 2160
- 5K 2880p is 5120 x 2880
- 8K Ultra HDTV-2 4320p is 7680 x 4320
- ALL resolutions above are subject to change!

Note: the terms used to describe the resolution changed from vertical (720, 1080) to horizontal (4k, 5k, 8k)

Monitor Issues



4K sizes

Resolution	Aspect ratio	Pixels
4096×3072	1.$\overline{33}$:1 (4:3)	12,582,912
4096×2560	1.60:1 (16:10)	10,485,760
4096×2304	1.$\overline{77}$:1 (16:9)	9,437,184
4096×2160	≈1.90:1 (256:135)	8,847,360
4096×1716	≈2.39:1 (1024:429)	7,020,544
3996×2160	1.85:1 (37:20)	8,631,360
3840×2400	1.60:1 (16:10)	9,216,000
3840×2160	1.$\overline{77}$:1 (16:9)	8,294,400
3840×1600	2.40:1 (12:5)	6,144,000
3840×1080	3.$\overline{55}$:1 (32:9)	4,147,200
2160 × 3840	9:16	8,294,400

UW sizes

common name	aspect ratio	resolution
WFHD	64:27	2560×1080
WFHD+	12:5	2880×1200
WQHD	43:18	3440×1440
WQHD+	12:5	3840×1600
UW4K	12:5	4320×1800
UW5K (WUHD)	64:27	5120×2160
UW5K+	12:5	5760×2400
UW6K	43:18	6880×2880
UW7K	12:5	7680×3200
UW8K	12:5	8640×3600
UW10K	64:27	10240×4320

8K sizes

Resolution	Aspect ratio		Total pixels
7680×2160	3.$\overline{5}$	32:9	16.59 Mpx
7680×2400	3.2	16:5	18.43 Mpx
7680×3200	2.4	12:5	24.58 Mpx
7680×3240	2.$\overline{370}$	64:27	24.88 Mpx
7680×4320	1.$\overline{7}$	16:9	33.18 Mpx
8192×4320	1.$\overline{8962}$	256:135	35.39 Mpx
8192×4608	1.$\overline{7}$	16:9	37.75 Mpx
8192×5120	1.6	8:5	41.94 Mpx
8192×8192	1	1:1	67.11 Mpx

Monitor Issues

- Physical Size - up to 49” for 5k Computer Monitor or 8K TV’s up to 85”
- What is the refresh rate of the monitor (60hz - 240hz)
- Aspect ratio - 4:3, 16:9, 21:9, 31:9 et al.
- What Ports does it support (VGA, DVI, Display Port, HDMI, Thunderbolt 1 or 2 (Mini Display port) or Thunderbolt 3, 4, or 5
- How many Ports does it have
- What is the brightness of the monitor (200-500 nits) (LCD<LED<OLED)
- Curved or flat design, horizontal or vertical

Connecting via Cable

- Cable ends most important since the each interface supports different speeds of transfer which controls the resolution of the monitor and refresh rates
- Different cables allow for different data throughput
- One way or symmetrical flow
- Thunderbolt 3 vs 4 vs 5 requires different cabling (internal wiring, but still “looks” the same) to support the transfer speeds
- Length of cable is an issue - longer the cable, the poorer the signal quality
- Gold plated contacts better than others

Ports

- VGA (Video Graphics Array), XVGA, Super VGA - IBM developed, PC industry standard, develop for Analog monitors
- DVI (Digital Visual Interface) - Industry developed in 1999, support both analog & digital displays (with the correct cable), maxed out at 2560x1600
- HDMI (High Definition Multimedia Interface) - 2003 release, included audio channel, grew from 1k support to 4K support and now 8K support using upgraded cable bandwidth - max speed 48Gb/s for 2.1 spec
- Thunderbolt - 2015 release, Started with Mac, moving to PC’s, Monitors & TVs, max speed 120Gb/s for T5 spec
- Thunderbolt delivers both DATA & POWER - HDMI is data ONLY

Connectors/Dongles

- DisplayPort - VESA standard in 2006, more common as computer monitor connector, includes Audio channel
- Thunderbolt 1&2 - Implemented in 2011, AKA Mini DisplayPort - 20 pin connector
- USB-C - Implement in 2015, supports Thunderbolt 3, Display Port and HDMI
- Thunderbolt 3 - Implemented in 2015, Superset of USB-C, 2x faster than USB-C
- Thunderbolt 4 - Implemented in 2020, support for dual 4K displays
- Thunderbolt 5 - Implemented in 2023, support for dual 8K displays, 2x faster than Thunderbolt 4

Connectors/Ports

VGA

DVI

Thunder-bolt 1&2

Thunder-bolt 3-5

Display Port

USB-C

Pay attention to the “lightning” icon!!!

USB-C ‘looks like’ Thunderbolt

Dongles, Cables, Hubs

USB-C VGA

TB2 to TB3

USB-C HDMI

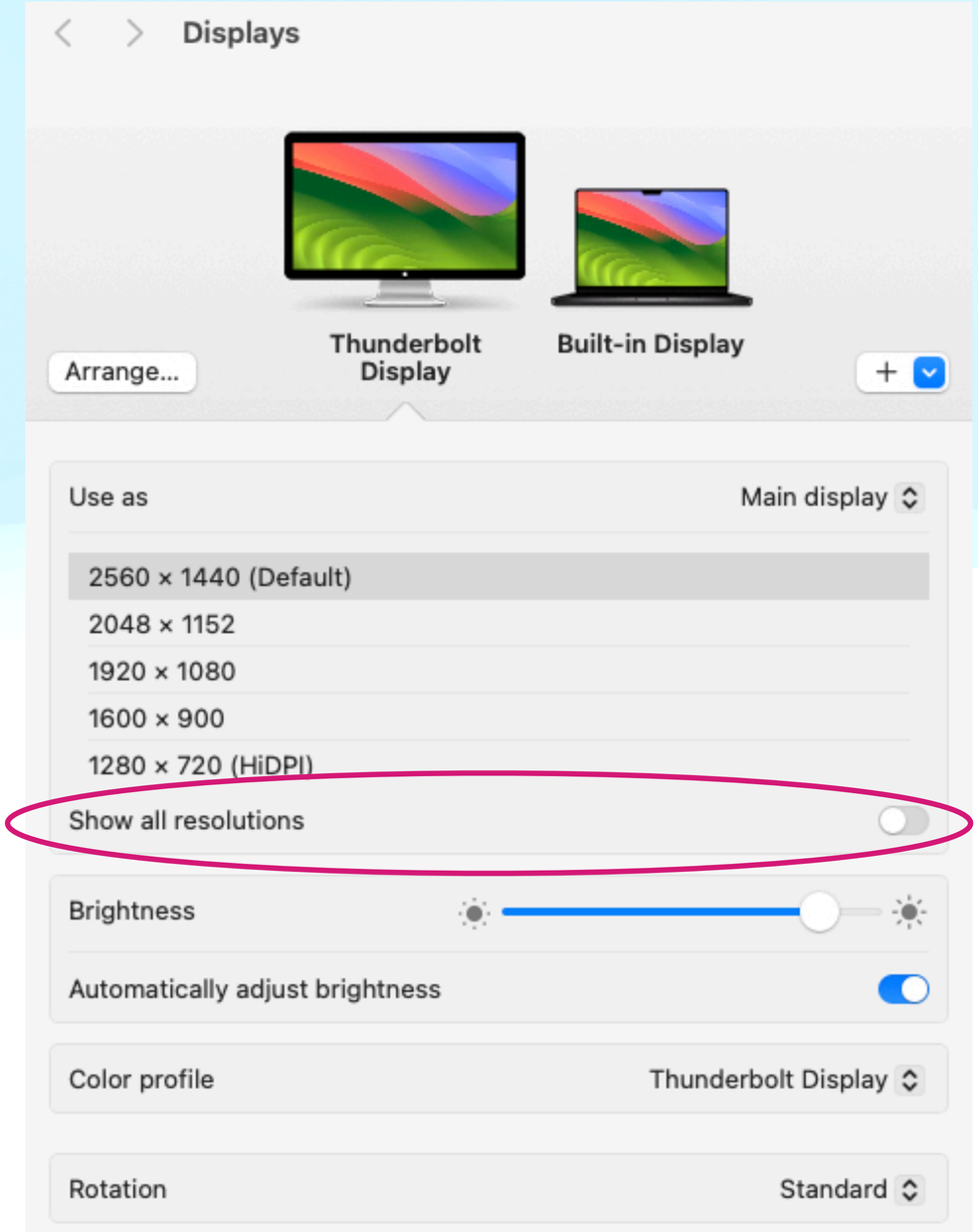
DVI to HDMI

Display Port to VGA

Display Port to HDMI

Setting Up

- Confirm your computer supports a second monitor
- Verify output port for video on your machine
- Get the right cable for your video output
- Get a monitor with the same port your computer has
- Go to System Settings>Displays>Monitor Name, then click on the desired resolution and whether it will be your main display or mirror your first display
- Arrange the displays so they match the physical layout of your monitors



Apple Studio Display

27-inch 5K Retina display. 12MP Ultra Wide camera with Center Stage. Studio-quality mics. Six-speaker sound system with Spatial Audio.

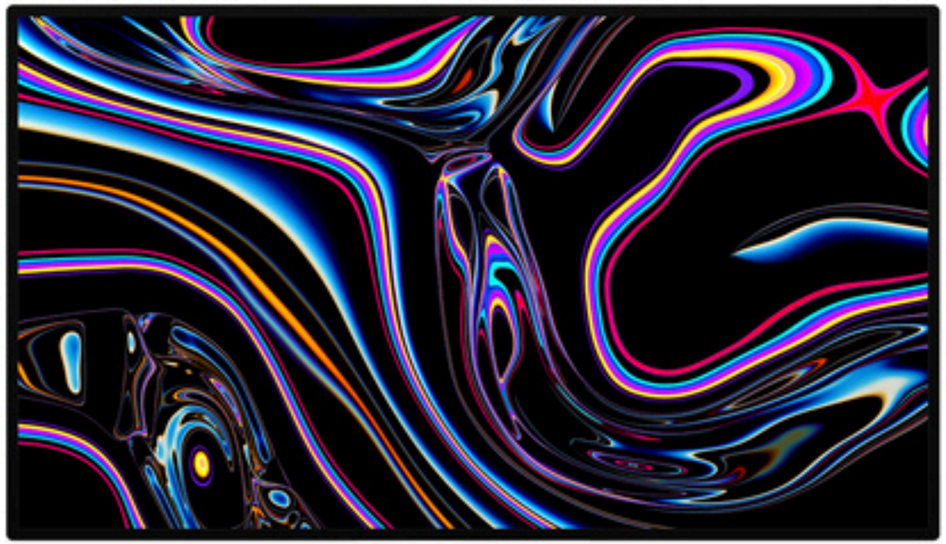
Standard glass has an industry-leading anti-reflective coating for viewing comfort and readability.

Display

Choose from two anti-reflective glass options. Standard glass is engineered for extremely low reflectivity. Nano-texture glass scatters light to further minimize glare while delivering outstanding image quality in workspaces with bright light sources.

Standard glass	From $1599 or $133.25/mo. for 12 mo.*
Nano-texture glass	From $1899 or $158.25/mo. for 12 mo.*

Apple Pro Display XDR



View gallery

Buy Pro Display XDR

Free shipping. And free returns.

Pro Display XDR

32-inch Retina 6K. Astonishing color accuracy. Superwide viewing angle. And Extreme Dynamic Range.

Display stand sold separately.

Which glass is right for you?

Standard glass	$4,999.00 or $416.58/mo. for 12 mo.*
Nano-texture glass	$5,999.00 or $499.91/mo. for 12 mo.*

MacWorld - Best Mac Monitors

- https://www.macworld.com/article/668700/best-mac-monitors-displays.html

Use iPad as Second Display

- Connect iPad with cable to Mac
- Click on System Settings>Displays>”+”>Mirror or extend to “iPad name”
- Click on Arrange to move pictures to reflect physical position of displays