Notes on imaging sensor and image display formats

1. Introduction

Although almost all of the information presented here is available from a variety of sources, it was felt useful to place all 2D 'size' information about imagers and displays in one document.

2. Television display formats

There is a vast array of display formats, with ever-increasing resolutions, driven by both the consumer TV market and by the computer monitor industry. Television displays are listed below; these use both interlaced and progressive scanning.

Standard-definition television		
480i	NTSC analog system	Two interlaced fields of 262.5 lines
576i	PAL analog system 720 × 576	Two interlaced fields of 288 lines
Enhanced-definition television		
480p	720 × 480	Progressive scan
576p	720 × 576	Progressive scan
High-definition television		
720p	1280 × 720	Progressive scan
1080i	1920 × 1080	Two interlaced fields of 540 lines
1080p	1920 × 1080	Progressive scan
Ultra-high-definition television		
2160p	3840 × 2160	Progressive scan
4320p	7680 × 4320	Progressive scan
8640p	15360 x 8640	Progressive scan

3. Complete list of display formats

A more complete list of display formats is shown below, with the most popular displays shown in bold.

Video Graphics Array	*Resolution*	*Aspect ratio*	*Diagonal*	*Quad Extended Graphics Array*	*Resolution*	*Aspect ratio*	*Diagonal*
QQVGA	160 × 120	4:3	5	**QWXGA**	2048 × 1152	16:9	18.36
HQVGA	240 × 160	3:2	3.606	QXGA	2048 × 1536	4:3	5
QVGA	320 × 240	4:3	5	**WQXGA**	2560 × 1600	16:10	18.36
WQVGA	400 × 240	16:10	18.87	QSXGA	2560 × 2048	5:4	6.4
HVGA	480 × 320	3:2	3.606	WQSXGA	3200 × 2048	25:16	29.68
VGA	640 × 480	4:3	5	QUXGA	3200 × 2400	4:3	5
WVGA	800 × 480	5:3	5.831	WQUXGA	3840 × 2400	16:10	18.36
FWVGA	854 × 480	16:9					
Video Graphics Array	*Resolution*	*Aspect ratio*	*Diagonal*	*Hyper Extended Graphics Array*	*Resolution*	*Aspect ratio*	*Diagonal*
				HXGA	4096 × 3072	4:3	5
SVGA	800 × 600	4:3	5	WHXGA	5120 × 3200	16:10	18.87
DVGA	960 × 640	3:2	3.606	HSXGA	5120 × 4096	5:4	6.4
WSVGA(1)	1024 × 576	16:9	18.36	WHSXGA	6400 × 4096	25:16	29.68
WSVGA(2)	1024 × 600	17:10	19.72	HUXGA	6400 × 4800	4:3	5
UVGA	1280 x 960	4:3	5	WHUXGA	7680 × 4800	16:10	18.87
Extended Graphics Array	*Resolution*	*Aspect ratio*	*Diagonal*	*High-Definition*	*Resolution*	*Aspect ratio*	*Diagonal*
XGA	1024 × 768	4:3	5	nHD	640 × 360	16:9	18.36
WXGA	1280 x 768	16:9	18.36	qHD	960 × 540	16:9	18.36
WXGA (2)	1280 x 800	16:10	18.87	HD	1280 × 720	16:9	18.36
WXGA (3) (HD)	1280 x 720	16:9	18.36	HD (2)	1360 x 768	~16:9	~18.36
XGA+	1152 × 864	4:3	5	HD (3)	1366 x 768	~16:9	~18.36
WXGA+	1440 × 900	5:3	5.831	HD+	1600 x 900	16:9	18.36
SXGA	1280 × 1024	5:4	6.4	**FHD**	1920 × 1080	16:9	18.36
SXGA+	1400 × 1050	4:3	5	**WQHD**	2560 × 1440	16:9	18.36
WSXGA+	1680 × 1050	16:10	18.87	4K UHD	3840×2160	16:9	18.36
UXGA	1600 × 1200	4:3	5	8K UHD	7680×4320	16:9	18.36
WUXGA	1920 × 1200	16:10	18.87				

3. Imaging sensors

Imaging sensor formats are often expressed in the confusing and non-standardized "inch" system: this “inch” measurement refers to approximately 1.5 times the diagonal length of the sensor. The reason for the confusion is that early scanning electron beam imaging sensors (e.g. vidicons, orthicons etc.) operated in a vacuum; these typically used an image scanning area of 16 mm diagonal, the maximum possible in an 18 mm internal diameter glass tube, which had an outside diameter of 1” (25.4 mm). Therefore (!!) a “1-inch” CCD has a diagonal of 16 mm and sensor dimensions of 12.8 x 9.6 mm. It is unfortunate that this confusing nomenclature has persisted, often used to refer to CCD “type” rather than size, and even includes sensors classified by a combination of fractional and decimal terms (e.g. 1/1.8” CCD. Due to inch-based sensor formats being not standardized, their exact dimensions may vary, but those listed below are typical, though probably incomplete. It is noted that a given inch dimension of sensor can occupy different aspect ratios and thus different areas.

Format name	**X x Y dimensions**	**Format diagonal**	**Aspect ratio**	**Format area**
Phase One P 65+, IQ160, IQ180	53.90 x 40.40 mm	67.40 mm	4:3 nominal	2178 mm^2
Leaf AFi 10	56 x 36 mm	66.57 mm	14:9 exact	2016 mm^2
Kodak KAF 39000 CCD	49 x 36.80 mm	61.30 mm	4:3 nominal	1803 mm^2
Pentax 645D	44 x 33 mm	55 mm	1.5:1 exact	1452 mm^2
Leica S	45 x 30 mm	54 mm	1.5:1 exact	1350 mm^2
35mm Full-frame, (Nikon FX, Sony α, Canon)	36 x 23.9 -24.3 mm	43.2-43.3 mm	1.5:1 nominal	860-864 mm^2
Medium format	50.7 x 39 mm	63.96 mm	1.3:1	1977 mm^2
APS-H (Canon)	28.7 x 19 mm	33.50 mm	3:2 nominal	548 mm^2
APS-C (Nikon, Pentax, Sony)	23.6-23.7 x 15.7 mm	28.2-28.4 mm	3:2 nominal	370 mm^2
APS-C (Canon)	22.2 x 14.8 mm	26.7 mm	3:2 exact	329 mm^2
Foveon (Sigma)	20.7 x 13.8 mm	24.9 mm	3:2 exact	286 mm^2
1.5"	18.70 x14.00 mm	23.36 mm	4:3 nominal	262 mm^2
4/3”	17.3 x 13 mm	21.6mm	4:3 nominal	225 mm^2
1”	12.80 x 9.60 mm	16.00 mm	4:3 exact	123 mm^2
Nikon 1/CX	13.2 x 8.8 mm	15.86 mm	3:2 exact	116 mm^2
1/1.2" (Nokia 808 PureView)	10.67 x 8.00 mm	13.33 mm	4:3 nominal	85.33 mm^2
Nikon CX and Sony RX100	13.20 x 8.80	15.86 mm	3:2 exact	116 mm^2
Super 16mm	12.52 x 7.41 mm	14.54 mm	15.2:9	92.80 mm^2
2/3”	8.8 x 6.6 mm	11 mm	4:3 exact	58.10 mm^2
1/1.6”	8.08 x 6.01 mm	10.07 mm	4.3 nominal	48.56 mm^2
1/1.7”	7.6 x 5.7 mm	9.50 mm	4:3 exact	43 mm^2
1/1.8”	7.18 x 5.32 mm	8.93 mm	4:3 nominal	38 mm^2
1/2” 5:4	6.66 x 5.32 mm	8.53 mm	5:4 nominal	35.43 mm^2
1/2”	6.4 x 4.8 mm	8.00 mm	4:3 exact	30.7 mm^2
1/2.3” (Pentax Q)	6.17 x 4.55 mm	7.66 mm	4.:3 nominal	28.50 mm^2
1/2.5”	5.76 x 4.29 mm	7.18 mm	4.:3 nominal	24.70 mm^2
1/2.7”	5.37 x 4.04 mm	6.72 mm	4:3 nominal	21.70 mm^2
1/3"	4.80 x 3.60 mm	6.00 mm	4:3 exact	17.30 mm^2
1/3.2"	4.54 x 3.42 mm	5.68 mm	4:3 nominal	15.50 mm^2
1/3.6"	4.00 x 3.00 mm	5.00 mm	4:3 exact	12.0 mm^2
1/4"	3.20 X 2.4 mm	4.00 mm	4:3 exact	7.68 mm^2
1/6"	2.40 X 1.8 mm	3.00 mm	4:3 exact	4.32 mm^2
1/8"	1.60 X 1.2 mm	2.00 mm	4:3 exact	1.92 mm^2
1/10"	1.28 X 0.96 mm	1.60 mm	4:3 exact	1.23 mm^2

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