COMD 1162 Raster/Vector

Understanding Resolution
and the meaning of DPI, PPI, SPI, & LPI

Pixels per inch (**PPI**) or **pixel density** is a measurement of the resolution of devices like:

- computer displays
- image scanners
- digital camera image sensors.

Determining Resolution for Scanning
Scanners: SPI (samples per inch) or ppi (pixels per inch)

PPI (pixels per inch) works for scanner input.

Digital Cameras: Width x Height Pixels only

*A digital camera can capture data based on the mega-pixel ability of its CCD. For example, an 8 mega-pixel digital camera shoots at approximately 3264 x 2448 pixels (different brand cameras may vary in size slightly). 3264 pixels * 2448 pixels = 7,990,272 total pixels (rounded up).*

Monitors: Width x Height Pixels only

Monitor resolution is measured strictly by pixel width and height. Some common settings are 1280x1024, 1920x1080, and even 2880x1800. Different size monitors could be set to the same resolution, so there is **no** default ppi setting for monitors since ppi depends on the monitor resolution and the physical size of the monitor. For example, a 1920x1080 monitor could be 17 inches (monitor sizes are measured diagonally like TVs) or could be 22 inches, so the actual ppi would be different for each.

Image resolution for printing: ppi (pixels per inch)

Excess resolution is not used when printing the file and only does three things:
• make your files larger than necessary,
• increase the printing time, and
• it may have the effect of "softening" your images.
The best solution is to have the maximum amount of resolution REQUIRED, based on your final image size, your printing method, and line screen used.

AM (Halftone) Screening

For print, images need a minimum resolution, measured in pixels per inch or ppi (this should **not** be called "*dots per inch*"), in order to have enough detail and look natural. The amount of resolution required mostly depends on lpi.

Lines per inch (**LPI**) is a measurement of printing resolution in systems that use a halftone screen. Specifically, it is a measure of how close together the lines in a halftone grid are. Higher LPI indicates greater detail and sharpness.

Line screens, measured in lpi, have ink dots arranged in a set pattern with different inks printed at different angles; black is usually printed at 45°, . Since printers can only put down a solid dot of ink, various tones are created by different dot sizes. However, the dots, regardless of size, are always spaced out the same distance (determined by the lpi).

AM Screening Chart

Printing Method		1.5 X Method			2 X Method	
File dimensions: 8x10 in.	PPI	Size for RGB (in MB)	Size for CMYK (in MB)	PPI	Size for RGB (in MB)	Size for CMYK (in MB)
Newsprint — 100 LPI	150	5.15	6.9	200	9.16	12.2
Magazine — 133 LPI	200	9.16	12.2	266	16.2	21.6
Magazine — 150 LPI	225	11.6	15.4	300	20.6	27.5
Brochure — 175 LPI	263	15.8	21.1	350	28	37.5
Brochure — 200 LPI	300	20.6	37.5	400	36.6	48.8

FM (Stochastic) Screening

FM screening is a comparatively newer technology (AM screening has been around since the late 19th century). It uses more of a "random" pattern in "specs" of ink rather than a structured line screen, densely packing more specs in darker areas of color. The result is better quality images since there is more capability of maintaining detail, no moiré or rosette patterns, larger color gamut (range), and a more photographic look—however, there may be some noise/grain in flat-color areas. FM screening is measured by the specs or dots of ink, ranging from 10-60 microns (a micron is .001 mm or 1/25,400 of an inch)—this would be roughly equivalent to 480–120 lpi in AM screening.

FM Screening Chart

Printing Method		Resolution		
File dimensions: 8x10 in.	Micron Size (appx.)	PPI/PPMM	Size for RGB (in MB)	Size for CMYK (in MB)
Newsprint — 35 micron	1/726 in	242/95	13.4	17.9
Magazine — 25 micron	1/1016 in.	254/100	14.8	19.7
Magazine — 20 micron	1/1270 in.	317.5/125	23.1	30.8
Brochure — 15 micron	1/1693 in.	338.6/133	26.3	35
Brochure — 10 micron	1/2540 in.	423.3/166	41	54.7

As you can see from the chart above, FM screens are much smaller than AM screens. A 20 micron FM screen can print 1270 dots/specs per inch, while a 150 LPI AM screen is always the same (150 various-sized ink dots per inch on a fixed grid). Image resolution requirements are hard to pin down for FM screening, so it is best to ask your printer.

Inkjet Printing: PPI - Pixels per Inch

Inkjet printing is a type of computer printing that creates a digital image by propelling droplets of ink onto paper.

Desktop inkjet printers, as used in offices or at home, tend to use aqueous inks based on a mixture of water, glycol and dyes or pigments. These inks are inexpensive to manufacture, but are difficult to control on the surface of media, often requiring specially coated media.

Advantages -

Inkjet printers use a printing method virtually identical to FM screening, except the inkjet companies usually list the resolution of the printer in dpi (for example, the Espon Stylus Photo R3000 prints at 5760 x 1440). *For example, most Epson print drivers limit output to the printer to 360 dpi and 760 dpi. Luckily, this is usually an even division of the actual printer resolution. (When dealing with printers, just like scanners, work with the lower resolution number.)*

To determine the best ppi for images, based it on the native printer resolution—this information is usually buried deep in the user manual of the printer.

Halftone Screen Frequency: LPI (lines per inch)

Using black-only print job as an example, gray tones are mimicked by printing various sized dots of solid black ink at a set distance. A group black dots lets some of the paper show though (usually white paper), and the blackness of the dots and the white of the paper blend optically to look like a shade of gray. Depending on the size of the black dots, the gray looks darker or lighter. However, in a given print job, the spacing of the dots is the same (for AM screening). The spacing is referred to by these names: screen frequency, line screen, or more recently, lines-per-inch (lpi). The lpi is usually determined by the type of printer and by the quality of paper. Line screens are easiest to see in a newspaper since the cheap paper requires that the dots be spaced far apart due to dot gain (the ink soaking in and spreading out on the paper). The same principal applies for spot-color printing and process-color printing (CMYK).