Megapixel Equivalent of Film

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We should not ask, "What is the megapixel equivalent of film?" That question is too simple.

There is no single value that expresses the megapixel equivalent of film. It depends on the resolution of the film combined with the resolution of either the enlarger lens or a scanner.

We should instead ask, "If we use the same 24x36mm format and the same lens for both digital and film and if we assume a particular film and enlarger lens or scanner, how any digital megapixels would it take to match the system resolution of the film version." That is a much more complicated question and the answer will take some analysis.

Photographic System Resolution looked at how the lens+sensor, lens+film+enlarger and lens+film+scanner can be combined into a system resolution. The formulas can be expressed as:

$$1/Rs^2 = 1/Rl^2 + 1/Rd^2$$
$$1/Rs^2 = 1/Rl^2 + 1/Rf^2 + 1/Re^2$$

where all of the terms are in lp/mm:

- Rs is the system resolution
- Rl is the lens resolution
- Rd is the resolution of the digital sensor
- Rf is the film resolution
- Re is the resolution of either the enlarger lens or the scanner

If we rearrange the terms in each equation:

$$1/Rs^2 - 1/Rl^2 = 1/Rd^2$$
$$1/Rs^2 - 1/Rl^2 = 1/Rf^2 + 1/Re^2$$

If we assume that the system and lens resolution are the same we can eliminate those two terms and:

$$1/Rd^2 = 1/Rf^2 + 1/Re^2$$

We can now solve for Rd using the combined resolution of only the film and enlarger lens or scanner.

Here are some typical resolutions for 35mm film according to the manufacturer:

Film	**lp/mm**	**Source**
Tmax 100	125	Kodak
Tmax 400	100	Kodak
Fuji Velvia 50	80	Fuji
Fuji Neopan Acros	100	Fuji

A full frame enlarger lens (for the 24x36mm format) might resolve 60 lp/mm.

Scanner resolutions according to ScanDig:

Scanner	**Pixels/inch***	**lp/mm**
Epson V750	2300	45.28
Nikon Coolscan 9000	4000	78.74
Hasselblad Flextight	6300	124.02

Combining the resolution values of the film and either the enlarger or a scanner:

	Enlarger	V750	Coolscan	Flextight
Tmax 100 @ 125 lp/mm	*54.09*	*42.57*	*66.62*	*88.04*
LW/PH	*2596*	*2043*	*3198*	*4226*
Pixel rows needed*	*5193*	*4087*	*6396*	*8452*
The equivalent digital MP	*40.4*	*25*	*61.3*	*107.1*
Tmax 400, Acros @ 100 lp/mm	*51.45*	*41.25*	*61.86*	*77.85*
LW/PH	*2470*	*1980*	*2969*	*3737*
Pixel rows needed*	*4939*	*3960*	*5939*	*7473*
The equivalent digital MP	*36.6*	*23.5*	*52.9*	*83.7*
Velvia 50 @ 80 lp/mm	*48.00*	*39.40*	*56.12*	*67.23*
LW/PH	*2304*	*1891*	*2694*	*3227*
Pixel rows needed*	*4608*	*3783*	*5387*	*6454*
The equivalent digital MP	*31.8*	*21.5*	*43.5*	*62.4*

* 2 pixels rows are needed to clearly resolve each line with a Bayer array