CALCULATING CROP FACTORS RELATIVE TO A 35mm FULL FRAME NEGATIVE

There seems to be a certain amount of confusion surrounding the crop factors of the numerous "Super 35 type" and other smaller sensors on the market. Primarily for my own benefit I've compiled the following table but others may find it useful. The main area of confusion I see is surrounding the actual crop factor of a these smaller sensors when being used in conjunction with full frame 35mm lenses who's length is usually defined in millimetres relative to a FF sensor. All crop factors of the smaller sensors are usually expressed as a fraction of that full frame 35mm still camera negative size of 36mm x 24mm that has a diagonal dimension of 43.3mm.

To be able to calculate the crop factor of any given sensor to any degree of accuracy one needs to know the diagonal dimension of a) a 35mm full frame negative and b) the diagonal dimension of the sensor who's crop factor you are trying to determine. Given that a 35mm FF neg is generally accepted as 36mm x 24mm we can calculate its diagonal dimension as 43.3mm using the following formula and state its crop factor as being 1.0 as this is going to be our 'reference sensor' for future crop factor calculations.

Working on the basis that a FF 35mm neg has a diagonal of 43.3mm we can work out the crop factor of any sensor by dividing its diagonal length into the FF diagonal length of 43.3mm.
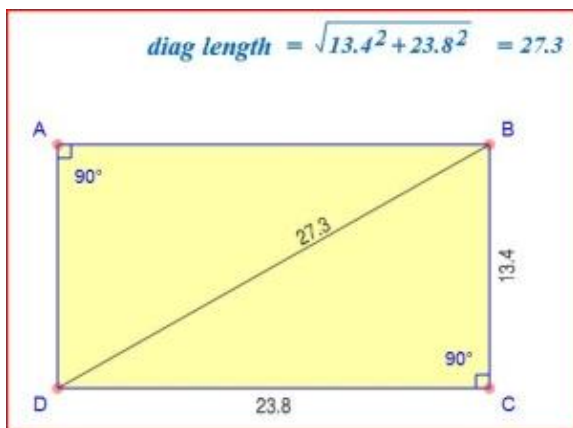
$$\text{diag length} = \sqrt{24^2 + 36^2} = 43.3$$

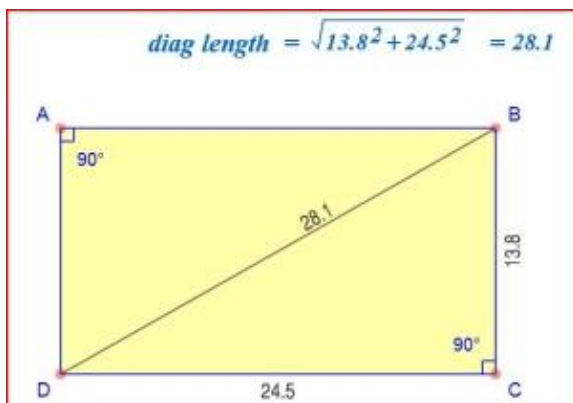Thanks to the Digital Sensor Dimensions chart put out by Abel Cine:

http://blog.abelcine.com/2010/08/18/35mm-digital-sensor-comparison-chart/

I have been able to calculate the crop factor for a number of the popular smaller sensors.

Arri Alexa. 43.3/27.3 = a CF of 1.586

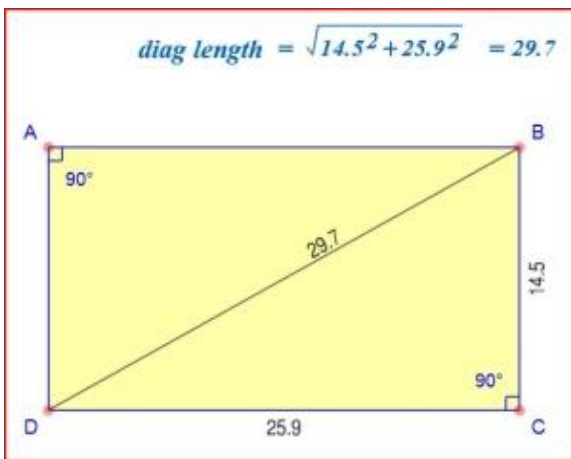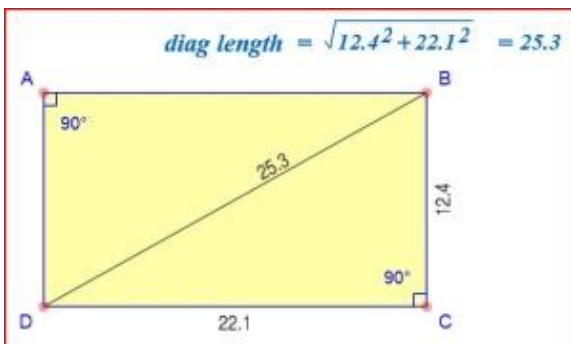$$\text{diag length} = \sqrt{13.4^2 + 23.8^2} = 27.3$$

Canon C300. 43.3/28.1 = a CF of 1.540

$$\text{diag length} = \sqrt{13.8^2 + 24.5^2} = 28.1$$

Panasonic AG-AF100. 43.3/21.6 = a CF of 2.004

$$\text{diag length} = \sqrt{10.6^2 + 18.8^2} = 21.6$$
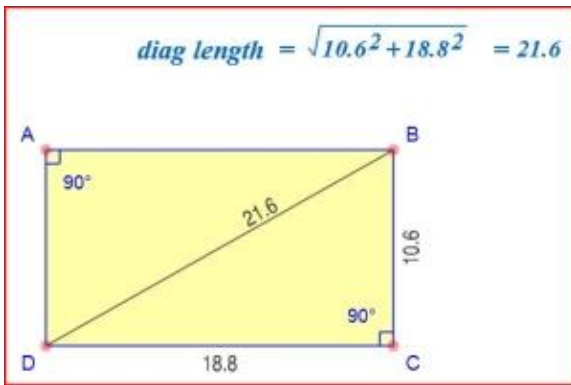
Red Epic / Scarlet. 43.3/29.7 = a CF of 1.457

$$\text{diag length} = \sqrt{14.5^2 + 25.9^2} = 29.7$$

Red One. 43.3/25.3 = a CF of 1.711

$$\text{diag length} = \sqrt{12.4^2 + 22.1^2} = 25.3$$

Sony FS700. 43.3/27.1 = a CF of 1.597

$$\text{diag length} = \sqrt{13.3^2 + 23.6^2} = 27.1$$
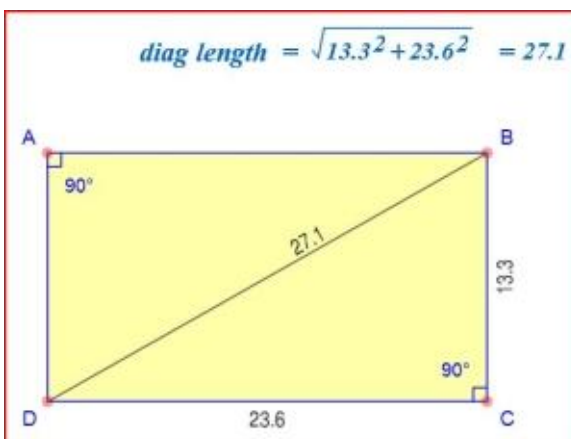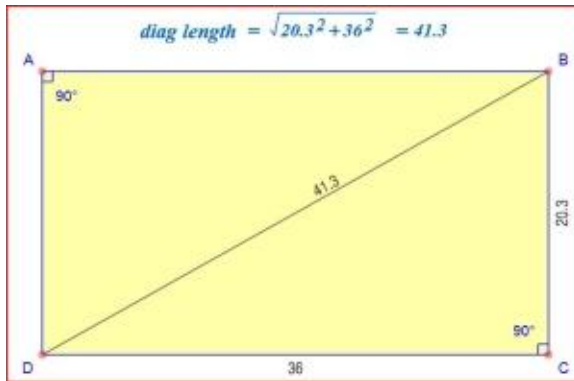
Interestingly most of us take it for granted that the sensor on the Canon 5D series is a 100% full frame. This is not strictly the case as the 5D sensor is:

Canon 5D. 43.3/41.3 = a CF of 1.048

$$diag\ length = \sqrt{20.3^2 + 36^2} = 41.3$$

Unless you are a nit-picker I think we can take the 5D sensor as being 1.0 from a practical point of view.

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