Fujifilm Raw File Converters

This document reviews the following raw file converters for Fujifilm cameras:

FreeRaw 0.4.9.5	Freeware command-line utility
RawGem 0.91	Freeware command-line utility
DCRaw 7.30	Freeware command-line utility
Fujifilm Raw File Converter LE 1.1	Supplied with Fujifilm cameras
S7Raw 0.4.0c	Freeware Windows application
Adobe Camera Raw 3.1	Comes with Photoshop CS2 / Elements 3.0
LaserSoft SilverFast DC-VLT 6.4.2r5a	Standalone image processing application

Comparisons also included a Fine 12M JPEG processed by the camera.

Testing was confined to images from the FinePix F810. As far as I know, the above converters are all those that support this camera. Paint Shop Pro 9 supports the S7000 camera, but did not recognise the raw files from the F810. IrfanView and FastStone 2.25 open F810 raw files only at 6 megapixels, apparently using DCRaw.

Introduction

The purpose of saving and converting raw files is to take over the processing of the sensor data that is usually performed in the camera. This is basically as follows:

1. **Demosaicing** Creates a complete RGB value for each pixel from the single color value (Red, Green or Blue) recorded by each photodiode.
2. **Image Adjustments** This includes setting the white balance, contrast curve and color; it may also include noise reduction and lens correction.
3. **Sharpening** Some degree of this is usually desirable to compensate for the image softness resulting from demosaicing.
4. **Saving** The processed image is usually saved as a compressed JPEG file.

Note that 'raw' is not an acronym - it simply refers to data that has not been cooked.

Some advantages of saving camera raw files and processing on a computer are:

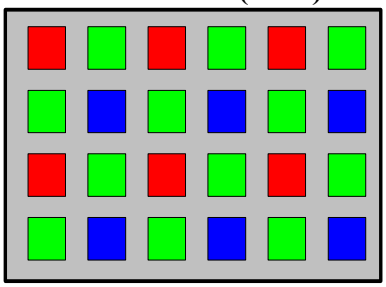
- **No Data Loss** The raw file contains all data captured by the sensor, and is thus the true digital equivalent of the film negative. Image files of various types may be created from the raw file, but not vice versa.
- **Customized Processing** In-camera processing is often unsatisfactory; for example, too high a contrast can lead to blown highlights, and excessive sharpening may give an unnatural presentation and artifacts.
- **No JPEG Artifacts** The image can be converted to a lossless format (e.g. TIFF) to avoid artifact accumulation from post processing as JPEG.
- **Compactness** Although much larger than a cmpressed JPEG image, the raw file preserves all data at typically about 1/3 the size of an 8-bit TIFF (which still loses information). A 16-bit TIFF (or other 48-bit color format capable of preserving all the sensor data) is twice as large again.
- **Highest Potential Quality** Since there are more resources available on a computer than in-camera (processing speed, memory and acceptable time limit), it is possible to use more sophisticated algorithms. This, together with the ability to control processing, should lead to higher quality results.

However, as this review shows, the quality of raw file conversion should not be taken for granted.

Demosaicing

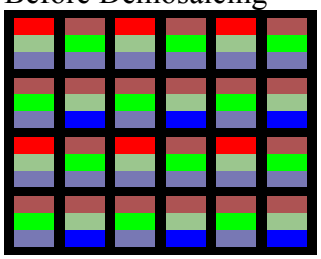
Each pixel is represented in the sensor by a photodiode that can measure only the amount of light at that location, not its composition. To provide color, the sensor is overlaid by a color filter array, so that each pixel measures only one of the primary colors Red, Green or Blue (sometimes Yellow, Cyan and Magenta are used instead). The following Bayer arrangement is adopted by the majority of manufacturers:

Standard Sensor (6 x 4)

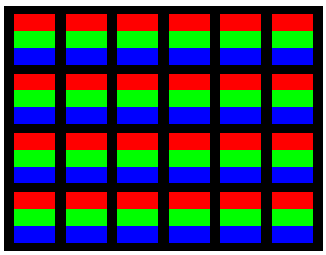


Output Image (6 x 4)

Before Demosaicing



Full Color Result



This shows a 24 pixel sensor array with 6 columns and 4 rows. The arrangement uses twice as many green pixels as red or blue ones. This is more efficient than an equal assignment, because most of the luminance information perceived by the human eye lies in the green region.

Although only one color is actually measured per pixel, each pixel in the output image must contain all three of the Red, Green and Blue channels to give proper color. This means that two of the R/G/B channels must be estimated for each pixel. The second of the above three diagrams shows the R/G/B channel in each pixel that is actually measured as bright, and the two that must be estimated as dull.

The estimation is based on interpolating values from the nearest neighbors of the color to be calculated; certain correlations between colors may also be taken into account. This process is called demosaicing, and the nature of the demosaicing algorithm fundamentally affects the quality of the resultant image.

Note that the number of bits recorded by each photodiode is usually 12 (sometimes 14), and this measures only a single color. However, the number of bits available for each RGB channel in the output image is usually only 8 (for a total of 24 bits per pixel). The conversion of these values is thus likely to lose some information, leading to loss of dynamic range and/or coarser graduations.

As a result, it is better to keep the image in raw format for processing, particularly when manipulating the contrast curve to deal with highlights and shadows. Once this has been completed, the image can be saved to a 24-bit color format such as a JPEG file. The processed file should then preserve all the important information. Alternatively, the converter may have an option to save to a 48-bit color (16 bits per RGB channel) format, thus preserving the full sensor data for post processing using a package like Photoshop or Paint Shop Pro.

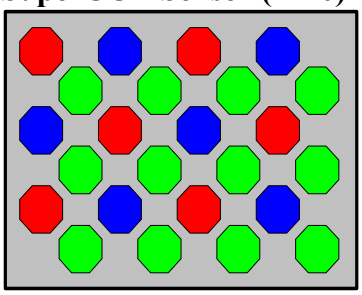
The markedly different results from the programs indicated the use of different demosaicing algorithms. None offered a choice of algorithms - it might be useful to be able to select from a number of algorithms to give the best results for the type of image to be converted.

SuperCCD

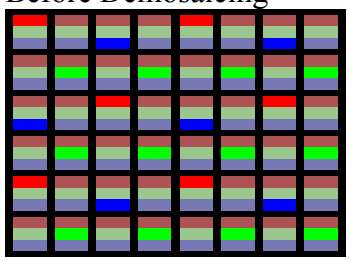
This is a type of Bayer sensor unique to Fujifilm. The pixels are octagonal (not rectangular) and are arranged diagonally (not rectilinearly).

The following illustrates a SuperCCD sensor, also with 24 pixels:

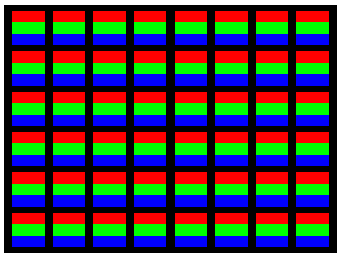
SuperCCD Sensor (4 x 6) **Output Image (8 x 6)**



Before Demosaicing



Full Color Result



This has some advantages over the standard arrangement, including higher effective resolution. The conventional sensor provides maximum resolution along diagonal lines, and minimum resolution along horizontal and vertical lines. This is shown by drawing horizontal/vertical and diagonal lines through the centers of the pixels in the illustration of the Standard Sensor; the diagonal lines are closer together.

This situation is reversed in the SuperCCD, where separation is at a minimum for horizontal and vertical lines. This is desirable since vertical and horizontal lines are prevalent in nature, whilst diagonal lines are relatively uncommon. This greater level of horizontal and vertical detail means that in practice more information is captured with the SuperCCD, even though its theoretical resolution is no better.

The downside is that processing SuperCCD data is more involved than for a standard Bayer, as interpolation is needed to produce a standard rectilinear pixel arrangement (as in all image file formats) from the diagonal pixel arrangement of the CCD.

For each row, intermediate values are calculated, producing an image file with double the number of columns of the sensor array. Thus the 24 pixels in the above example would produce an image with 8 columns and 6 rows. This results in an image that appears soft when displayed on-screen at its normal size, as the information density is lower than that from a standard sensor.

The SuperCCD HR sensor in the Fujifilm F810 camera used for this review (and also in the S7000 and E550) captures 14 bits per pixel. It has photodiodes arranged as 3080 rows of 2048 pixels each (giving 6,307,840 active pixels). This would be expected to yield an image file with 4096 columns and 3080 rows.

Most of the raw file converters did give an image of about the expected size, but with Fujifilm LE and Adobe Camera Raw (and also the JPEG), it was restricted to 4048 by 3040. For some reason, pixels in the outermost 24 columns and 40 rows were not used, with a resultant slight reduction in the angle of view. There was no sign of any problems with these unused pixels, and I think it is better (at least for raw file conversion) to use all the data captured by the sensor, and let the user crop the image as required.

Method

The testing was conducted in two stages. Firstly, a resolution chart was used to assess resolution and freedom from artifacts. Secondly, further testing including color was carried out on the three converters considered worthy of further examination.

The camera used was the Fujifilm FinePix F810. All photographs were taken using flash with the aperture close to its maximum, the focal length at around the midpoint of the zoom range, and using sensitivity of ISO 80. The test subjects were placed well inside the field of view. This should ensure the best possible image quality. Computer resources included Windows XP Professional, 3.2GHz Pentium 4 and 1GB memory.

The first target was an ISO-12233 resolution chart, printed at A3 size. The view was framed so that the chart covered about 1/12 of the total field of view. The resolution chart was in the frame center where lens performance should be at its best. The aim generally was to capture the highest resolution of which the camera is capable. Note that lens diffraction may limit the ultimate resolution - the same image of the resolution chart taken at f/8 showed no discernable detail beyond the 5 mark.

The other targets were a double page tabloid newspaper with color that occupied about half the field of view, some glossy book covers with sharp text and images, an Ordnance Survey 1:25000 map, and a real-life garden scene. These subjects made identification of inaccuracies easy, and also proved quite revealing.

Where different output size options were available, the standard 12 megapixel size was specified. Output images were saved as 8-bit TIFF in all cases except for RawGem, where a Windows bitmap file was used. Output of 16 bits per color would have been possible with all but LE, but would be unlikely to materially affect the results. The sRGB color space was used throughout

Assessing raw converters is much more difficult than assessing the processed image quality as done in camera reviews. The latter is usually considered the end result, and is hence assessed as it is. However, the user of a raw converter should be prepared to spend some time processing. Therefore the criterion is not what appears by default, but the best quality that can be achieved. This clearly requires some experimentation.

In each case the settings were adjusted to provide the best or most accurate result possible. The contrast and brightness in particular were made as consistent as possible to enable fair comparison. The JPEG images and the TIFF converted by LE (which does not allow any options to be specified) were almost identical; they were taken as a yardstick in assessing the best result. However, the LE images tended to be over-contrasty, leading to loss of dynamic range - the other converters allowed this to be customized. Conversion options were used as far as possible, with post-processing in Photoshop done where necessary. The aim was to establish what defects remained that could not be remedied this way.

The images have been examined in minute detail, mainly on the screen. It is possible that some artifacts (especially sharpening halos) that appear poor at this scale improve the subjective image quality at a smaller scale; although the prints I have seen have not convinced me that this is the case here. However, a lot of these assessments are indeed subjective, and not the last word on the subject. Your mileage may vary.

Initial Examination

This examines the features of each converter, and the image quality as assessed on the resolution test target. Note the product version number given in each heading. A useful page on raw converters and other tools is: http://byfai.com/fujitools.php

Options available for each converter are given; those specified for the resolution testing are indicated by **bold underlined** text. These were arrived at after much experimentation with other settings and options.

See the Initial Test Results section for images from these converters.

FreeRaw 0.4.9.5

http://gundam.srd.it/PhotoPages/software/freerawRelease.zip
This is a simple command-line utility, but there is also a basic Windows user interface available (not tested). It offers the following options:

White Balance	1=daylight (default), 2= shadow/cloudy, 3=afternoon/sunset, 4=tungsten, 5=fluorescent, **6=flash**
Saturation	User-specified saturation boost (default 1.0), 1.0 to 1.6
Gamma	Gamma correction (default 2.2)
Red	Sets red multiplier (0.9 to 1.5)
Blue	Sets blue multiplier (0.9 to 1.5)
Contrast	Contrast curve setting: 0 (no boost), 1-4 (mild-strong boost) (a moderate boost of **2** was used for testing)
Recursive	Use recursive raw filter to smooth hot pixels (noise)
Noise Reduction	Post processing for further noise reduction (useful values 2 to 8; higher=less noise)
Sharpening	Sharpening factor (default 2.0) (**40.0** used for testing)

Output format options are PPM (24-bit and 48-bit), TIFF (24-bit), and PSD (48-bit). Conversion to TIFF took about 25 seconds.

The EXIF header information is present, and correctly gives the camera model; however all the camera settings were completely wrong.

Numerous converter contrast curve and sharpening factor values were tried, without any significant difference or improvement being found over those used. Since the result was still too soft, brightness was increased +12 and contrast +24 in Paint Shop Pro. Further sharpening in Paint Shop Pro and Photoshop only caused more artifacts.

The final image had a moderate magenta cast with the appropriate flash white balance setting. Results also tended to suffer from pronounced moire.

Extinction occurred around the 5 mark in all the vertical and horizontal tests, and details were quite indistinct well before this point. Strangely, the 45 degree diagonals of test 1f gave better results in terms of resolution, more similar to those from LE and S7Raw, but with very bad moire.

Artifacts and sharpening halos (using the original converted images) were both low, but this was not surprising in view of the soft and low resolution results.

In resolution terms, the generated image appeared to be little or no better than the 6M JPEG and fell well short of the 12M normal JPEG, although cleaner than either. Post sharpening introduced artifacts without improving this to any degree.

Overall, the results were in my opinion too soft, too lacking in detail, and too prone to moire to make this converter worthy of further testing.

RawGem 0.91

http://www3.sympatico.ca/pierre.labreche/RawGemPage/RawGem.htm
This is also a simple command-line utility with a basic Windows user interface available (not tested). It offers the following options:

White balance	Daylight (default) or Auto being the only options listed
Gamma	Default 2.22
Color	B&W, Normal, Chrome
Contrast	Sets curve from 0.0 (normal) to 1.0 (high contrast) (**0.8** used for testing)
Tone Curve	Sets expansion value (a positive number)
Brightness	Sets brightness (default 1, **3** used for testing)
Red	Sets red multiplier (default 1.0) (custom white balance)
Blue	Sets blue multiplier (default 1) (custom white balance)
File Size	Sets size in megapixels (default 6) (**12** used for testing)
Noise Reduction	Enables/Disables (default) extra noise reduction
B&W Point	Black and White point distribution (0=none to 1=100%)
Mosaic	Optionally leave the RGB mosaic tiles intact
No chromatic aberration	Presumably attempts to correct chromatic aberration??
Use camera raw colors	Used to give the most accurate colors (still green)
Sharpen	Examples given are: 0 (none), 1 (100%), 3.5 (350%) (**2** used for testing)

Output format options are 24-bit Windows bitmap (BMP) and Photoshop PSD (24-bit, 48-bit and 45 degree 48-bit) - there is no TIFF option. The default output size of 6 megapixels and 45 degree output were also tried, with similar results.

No EXIF header information was present, so conversion loses camera settings.

The default options gave a plain white background, with all black details having a strong magenta cast. Specifying the option to use camera raw colors gave a dark result with a strong cyan cast, but increasing brightness yielded a much more acceptable result than from the default options. The end result image still had a strong cyan-green cast. However, this should not affect analysis of the results, and the color scheme (with the magenta cast of FreeRaw) at least assists in identification!

This was the slowest of all the converters, taking about a minute (during which a lot of rather uninteresting details were spewed to the console). However, it would be well worth the wait if the results were good enough.

Better sharpness was achieved than with FreeRaw (sharpness factors of 1 and 3.5 were also tried) but with many more artifacts. Especially as the sharpness factor increased, the artifacts worsened, but they were still very noticeable using a factor of 1 (which gave somewhat soft results). There were numerous fuzzy edges. Both extremes of the B&W point setting were tried, without alleviation of these artifacts.

Although RawGem gave sharper results than FreeRaw, resolution was no better, with complete extinction at around the 5 mark on both horizontal and vertical lines. Horizontal and near-horizontal lines in particular were riddled with artifacts, with results being indistinct at the 3 mark and pockmarking occurring from the top. This defect (white pits in black areas) also occurred in other places. The diagonal lines of test 1f suffered from similar step effects to those using S7Raw.

The option to save to a 45 degree Photoshop image was also tried - it gave a 74MB file, but the image quality as viewed in Photoshop was no better.

It has to be said that the 6M JPEG image had both better resolution and fewer artifacts (except perhaps for more pronounced sharpening halos in the JPEG) than the best 12M bitmap image that I could generate with RawGem, so unfortunately this program seems to have little to recommend it. No further testing was appropriate.

DCRaw 7.30

http://www.cybercom.net/~dcoffin/dcraw/

This is another command-line utility, which has similarities to both FreeRaw and RawGem; it appears that at least FreeRaw is based on this program. It offers the following conversion options:

White balance	Automatic, or **camera**
Red	Sets red multiplier (default 1.0)
Blue	Sets blue multiplier (default 1.0)
Brightness	Sets brightness (default 1.0)
Color Clipping	Don't clip colors
RGB conversion	Don’t convert RGB to sRGB
Document mode	No color or interpolation
Quick	Quick low-quality color interpolation
Half size	Half-size color image for faster conversion
Four color RGGB	Interpolate RGGB as four colors
45 degree output	**Show SuperCCD images tilted 45 degrees**
Secondary pixels	Show SuperCCD SR secondary pixels
Flip image	0 = none, 3 = 180, 5 = 90CCW, 6 = 90CW

Output may be 8-bit PPM with gamma 0.45, 16-bit linear PSD or 16-bit linear PPM.

Image file was 6 megapixels using the default options. In order to get the best quality, the option to output at 45 degrees was used, which gave a 73MB image file. This was then upsampled 200%, rotated 45 degrees, cropped then downsized to 4096x3080.

Conversion took about 12 seconds. No EXIF header information was present, so camera settings are lost on conversion.

Results in many respects were somewhere in between those from FreeRaw and RawGem. There were similar moire problems to those in FreeRaw, but without the softness. There were some of the artifacts of RawGem, although these were mainly more moderate.

Nonetheless, the overall results were rather better than from either of these converters, due partly to signs of significantly improved resolution (especially horizontal). However this was marred by the pronounced moire. There are some areas of improvement over the JPEG, especially in the lack of pockmarking and sharpening effects associated with solid areas. Nonetheless, the significant artifacts in lines together with the pronounced moire indicate that this is not worth testing further.

Fuji Raw File Converter LE 1.1 and EX 3.0.21.0

The LE version of this utility has no options whatever; one drags one or more raw file icons to the left column and clicks "Convert All" to convert them to 8-bit TIFF. The conversion appears to honor the camera settings - for this test, the relevant ones (sharpness, color and white balance) all had their default Normal or Auto settings. The simplicity did at least eliminate the time-consuming experimentation involved in checking out the options of other converters. Conversion took about 20 seconds.

The converted TIFF file is 4048x3040. It retains full EXIF header information (including all settings in the camera), and also contains a 160x120 thumbnail image.

Overall, results from the TIFF file (without any post processing) looked fine. The contrast and white color balance appeared to be accurate (and very similar to the saved JPEG files). However, there were one or two reservations:

- Pronounced sharpening halos (the camera sharpening setting was Normal). These may look fine at a smaller scale, but are intrusive at sizes viewed; viewing at 50% still showed a less clean result as a consequence of these halos than from S7Raw
- Some significant artifacts were present - these appeared to some extent to be related to the sharpening. There were many patches of pure white in between black regions (when the background was in fact light gray). These may give a sharper appearance, but are clearly inaccuracies. These and the black areas close to them were often riddled with artifacts (for example lines and zipper effects appearing between the set of near-vertical lines near the bottom of the chart), although these were not too serious.

Bearing in mind the aggressive sharpening with the Normal setting, the Soft setting was also tried (by changing the setting in the camera). This appeared to differ from the Normal setting only in the amount of contrast increase (corresponding to the Strength parameter in Paint Shop Pro). So although testing was done using the Normal setting, it is clear that results would not be materially affected by using the Soft setting. In any case, most people would use the default Normal setting.

Resolution appeared to extend well beyond that of the two command-line utilities, with clear detail being seen some way beyond the 5 point, both horizontally and vertically (lines were essentially extinguished at 5¼).

Comparison with the JPEG images showed that the LE image was clearly superior to the 6M JPEG, but appeared little or no better than the 12M normal JPEG. And after spending some time comparing the LE image with the 12M fine JPEG, I could not find any really significant improvement with LE. Strangely the 45 degree ascending lines of test 1f were resolved distinctly throughout in the JPEG image, but not in that created by LE!

Otherwise the two images correspond very closely, although the small black squares in the checkerboard (test 1n) are more accurately rendered in the LE image (these are squashed in the JPEG image). There is some pockmarking in some of the black lines in both images, although this is not as severe as that in the RawGem image. Again, the LE image is rather better in this respect than the JPEG.

Overall, both resolution and level of artifacts are very similar in the LE image and 12M JPEG images. This tends to confirm one reviewer's comment that the raw option offers no quality improvement. Certainly, any improvement is small. The converter unfortunately appears to do nothing more than standard in-camera processing without the JPEG compression. Even on this basis, the benefit is questionable with the lack of apparent quality improvement.

There is also an EX version of this product, although this appears to be intended only for use with the S series of cameras. Nonetheless, the version tested (3.0.21.0) worked with F810 raw files. It supports output to both 8-bit and 16-bit TIFF, as well as JPEG with three quality options. Output image size may be 4048x3040, 4000x3000, 2848x2136, 2016x1512, 1600x1200 or 640x480.

Again, input file selection can only be done by dropping a raw file icon on the window, which adds a file to a list. It is not possible to select an item in this list, and it seems that only the last image added may be viewed.
In my opinion the user interface is pretty poor. The preview image may be zoomed or scrolled, but operation is sluggish at best and there are often considerable delays updating the display. There are also problems with window painting, and my general impression is that development of this software was less than competent. However, the version tested was dated 2003.

One can use the camera settings or specify "Custom" settings. The main feature here is a customizable contrast curve, in addition to standard, hard and original settings. White balance may be set from a preset, a tooltip, or by color temperature. The few other options simply replicate settings in the camera: Sharpness may be soft, normal or hard (it cannot be disabled); Color may be standard, high, original or B&W; Sensitization may be specified from -1EV to +2EV in intervals of 1/6 EV. It is possible to save and subsequently reload conversion settings.

Testing on the resolution chart and other targets gave exactly the same results as those from LE, but without the aggressive detail sharpening. This was not an issue on the resolution chart, but removed some of the ill effects of LE in subsequent tests (especially the white flowers and other subtle details in Subject 5). However, there were still noticeable sharpening halos, even using the soft setting.

S7Raw 0.4.0c

http://www.geocities.co.jp/SiliconValley-PaloAlto/9919/s7raw.html
This converter offers a plethora of options; even so it is Freeware (donations are welcome). It has a full Windows-based user interface, comprising a user-sizeable main window on which the preview image is displayed, with menu bar, toolbar and pushbuttons, plus a number of dockable dialog windows. There is no main help, but a status line displays a useful dynamic context-sensitive help message.
At the time of writing, the application is in continuous development, with recent major enhancements including customizable contrast tone curves.

Images may be saved as Photoshop PSD files (8-bit and 16-bit), TIFF (8-bit and 16-bit) or JPEG (quality from 1 to 100 with Progressive option). The output size may also be specified as 4096x3080, 3072x2310, 2048x1540 or 512x384.

The conversion options are arranged into 6 pages, each selectable from a set of tabs. All parameters in these pages may be saved and subsequently reloaded - four (*or five*) file types are used. These settings can also be used to process images in batches.
A pushbutton at the foot of each page allows all details in that parameter set to be reset to defaults. Two checkboxes at the foot of each page allow the preview screen and/or the magnifier to be automatically updated with changes.

Parameter Set 1

Adjust 1: Rotation, White Balance and Sensitization	
Contains pushbuttons allowing parameters from this and the following two pages (Adjust 2, Detail) to be saved in a S7Raw Parameters file (.S7R) and then reloaded.	
Rotation	Left, Right, None (default None)
White Balance	Includes a drop-down with a dozen or so settings (default 0 - as shot), a color temperature slider (2500K to 9500K in 100K intervals), and the ability to fine tune RGB levels separately. *It also appears that the WB settings can be saved to a separate file, but the save pushbutton was not normally enabled.*
Sensitization	from -3EV to +3EV in intervals of 1/5EV (default 0)
Vivid	chrome color (can be checked, unchecked, or gray checked)
Green	enhances greens (above three settings, **gray checked** used)
Adjust 2: Basic Contrast, Brightness and Color parameters	
Gamma/Log	user selectable Gamma/Log adjustment (from 0 to 12; 32 settings) (default Log 1.8)
Contrast	from -100 to +100, in unit intervals (default 0)
Brightness	from -100 to +100, in unit intervals (default 0)
Saturation	from -100 to +300, in unit intervals (default 15, **30** used)
Hue	from -100 to +100, in unit intervals (default 0)
Detail: Controls rendering of fine details	
Sharpness	selectable as Hard (0, 20), Normal (0, 5), Soft (20, 0) or Custom; the last of which enables the two scales: Soften: from 0 to 100 in unit intervals Sharpen: from 0 to 100 in unit intervals (**40** for resolution tests)
Moire Cancel	provides an unnamed top scale (from 0 to 5 in unit intervals) and a Threshold scale (from 0 to 100 in unit intervals) (**4, 30**)

Parameter Set 2

Curve: Customizable Contrast Tone Curve	
Contains pushbuttons allowing a contrast curve specified in this page to be saved in a S7Raw Tone Curve parameters file (.S7T) and subsequently reloaded.	
Free Tone Curve	If checked, a graph is displayed that allows a tone curve to be specified. Clicking on the line adds a new point to it, which may then be dragged into position. The coordinates of all points in the curve are listed to the right, and above the list the coordinate of the current position is given. If unchecked, the graph and list are hidden and the default tone curve used.
Dropdown list	Allows the tone curve to be applied to all RGB channels, or one of R, G, B individually. Separate curves can be specified for each of R, G, B and all combined. Any combination of curves may be used in the contrast adjustment.
Linear	If checked the points are joined by straight lines, otherwise (default) by spline interpolation.
Reset All	Retains the tone curve display whilst resetting all values

Parameter Set 3

Lens: Lens Correction Parameters	
Contains pushbuttons allowing a contrast curve specified in this page to be saved in a S7Raw Lens Correction parameters file (.S7L) and subsequently reloaded.	
Lens Correction	This checkbox applies or undoes any settings made in the following controls. If checked, any updates are immediately applied. Unchecking it resets the image updates (although not the control settings) and disables any updating.
Distortion	Allows barrel and pincushion distortion to be corrected. Adjustable from -500 to +500 in unit intervals. Negative values are used to correct pincushion distortion, positive values to correct barrel distortion.
Chromatic Aberration	Contains two sliders - one for Red and one for Blue, each adjustable from -100 to +100 in unit intervals. Also contains an Auto pushbutton that attempts to automatically detect and remove chromatic aberration.
Vignetting	Contains two sliders - Amount and Midpoint, each adjustable from -100 to +100 in unit intervals.
Correction Property	Contains three sliders - X, Y (each adjustable from -100 to +100 in unit intervals) and Coefficient (adjustable from 100 to 400 in intervals of 2 units - default 200). This function appears to shift the geometry slightly, but its purpose is unknown.

Parameter Set 4

Color: Selective Color Correction Parameters	
Contains pushbuttons allowing color corrections specified in this page to be saved in a S7Raw Selective Colors Adjustment parameters file (.S7C) and reloaded.	
Selective Colors	This checkbox applies or undoes any settings made in the following controls.
Droplist	Enables selection of one of the following color groups: **Reds**, **Yellows**, Greens, Cyans, Blues, Magentas, Whites, Grays, Blacks. Settings for any of the following four components may be applied to any combination of these color groups.
Red	Slider from -100 to +100 in units (**Red +6**)
Green	Slider from -100 to +100 in units (**Yellow +16, Green +24**)
Blue	Slider from -100 to +100 in units (**Red +16**)
Black	Slider from -100 to +100 in units (**Red + 12, Yellow -6**)

The main window (which is sizeable) displays the entire image. Dockable dialog windows are as follows:

- Parameters - divided into 6 pages as described above
- Magnifier - shows an enlarged view of the area clicked on; magnification may be changed from 1 to 5 in unit intervals; may be 256x256 or 512x512
- Histogram - may be applied to the image preview, the magnifier or a selection; Red, Green, Blue and Luminosity values may be individually selected
- Parameters curve - displays Red, Green, Blue and White contrast curves; reflects the settings made in the Curve parameters page
- Exif info - displays EXIF header information; an All option allows full details to be displayed

A menu option allows blown highlights and black shadows to be indicated in red. It is also possible to overlay the image display with one of several sizes of grid.

Opening a raw file and generating the preview image took about 5 seconds. Saving the image to an 8-bit TIFF typically took about 25 seconds, but varied significantly with the raw file being processed. Application start up was very fast.
The preview appears to be based on the 2 megapixel JPEG saved with the raw image, but the magnified area is clearly as computed by the demosaicing algorithm.

The saved 8-bit TIFF file contained full EXIF header information. A 16-bit TIFF was also created, which as expected looked identical to the 8-bit TIFF.
Basic color spaces are sRGB, AdobeRGB, FinePixRGB and WideGamutRGB; further, a ColorProfile file may be loaded to use a custom color space.

The default settings gave rather soft results with one or two small patches of moderate moire coloration. The white color balance was accurate, but subsequent close examination of other targets showed too much warmth in magentas and yellows.
The settings above remedied these inaccuracies, and gave fine results on all targets.

The end result had very similar color, brightness, contrast and sharpness to that of the JPEG and LE images, but was otherwise clearly quite different. This was partly due to the obvious use of Unsharp Mask in the Fujifilm-originated images (even with the Soft setting), which is clearly not the same type of sharpening as that done by S7Raw.

For these resolution tests, a high sharpness of 40 was specified without any post processing - this gave excellent solid results without any sharpening halos. However, in certain situations this causes significant graininess, and here it is better to use the default sharpening of 5 and post process if necessary with Unsharp Mask. This was tried with the test target using a radius of 1.30, strength of 150% and clipping of 7; the results had the same overall quality and resolution, but sacrificed some solidness in dark areas for a smoother background.
But with S7Raw, one has the flexibility to choose neither, either, or both of these sharpening techniques rather than having one imposed. One can also soften the image.

It was soon apparent that this application yields a significant improvement in both horizontal and vertical resolution compared to any of the other converters. Detail is relatively strong and artifact-free at 5, and complete extinction does not occur until close to the 6 mark. Tests 1c, 1e, 1j, 1l and 1m show quite clearly that S7Raw resolved detail that the other converters could not touch.

Overall, artifacts were low by comparison with either LE or RawGem. For example, Test 1k shows far cleaner results than those generated by LE. The checkerboard (Test 1n) is also accurately reproduced.
However, one or two isolated patches in thin lines have greater artifacts than in the LE image, although the general result is significantly cleaner. Particularly pleasing is the lack of sharpening halos which I find detrimental to the quality even when viewed at 50% normal size or printed at a similar scale. Nonetheless, the sharpness appears just as good. Edges are generally cleaner, and there is none of the pockmarking that occurs in both the LE and RawGem images.

The Achilles Heel of S7Raw in these resolution tests is its rendering of ascending 45 degree diagonal lines (test 1f). This gave noticeable step effects very similar to those from RawGem. The solid area underneath these diagonal lines showed this effect on both ascending and descending 45 degree angle edges. However, further testing showed that the issue is only really a significant problem with angles from about 35 to 55 degrees. It can also be tamed to some degree by using some image softening.

The only other possible issue I have with S7Raw is that it gave a more blotchy background to the test chart than LE (it was similar here to FreeRaw). But I suspect that in this case it is a price to pay for the more punchy presentation, as it appears to be a result of increasing the contrast and sharpness above the default. And with the settings used, S7Raw showed much less noise in the dark areas. However, S7Raw does give you great flexibility in adjusting the image for the optimum result.

Adobe Camera Raw 3.1

http://www.adobe.com/products/photoshop/cameraraw.html
What appears to be the same converter is supplied with both Photoshop CS2, and the much less expensive Photoshop Elements 3.0; however fewer options are available with the latter. In both versions, the converted file can be opened into the Photoshop workspace. The CS2 version also allows saving immediately to TIFF, Digital Negative, JPEG or Photoshop format.

Both versions allow images to be processed at size 4048x3040; as with LE, this is unfortunately smaller than the expected size, with loss of field of view. Conversion may be done with either 8 or 16 bits per channel using the sRGB color space.
The CS2 version supports three further color spaces (Adobe RGB, ColorMatch RGB and ProPhoto RGB) plus five additional image sizes (1364x1024, 2024x1520, 2848x2139, 5120x3845 and 6144x4614). Saving as 6144x4614 was tried, but as expected did not increase quality, and although exactly 3/2 times 4096x3076 (the expected size minus 4 rows) did not increase field of view either.

In CS2 the conversion parameters are arranged into 5 pages as follows:

Adjust	
White Balance	**As shot**, Auto, Daylight, Cloudy, Shade, Tungsten, Fluorescent, Flash, Custom. Selecting an option sets the Temperature and Tint controls accordingly. Changing either of these two controls selects Custom in this dropdown. There is also a white balance eye dropper tool to adjust according to a specific point.
Temperature	Allows color temperature to be adjusted from 2,000 to 50,000
Tint	Changes tint from -150 (green) to +150 (red/blue)
Exposure	From -4EV to +4EV, with an Auto checkbox (**0**)
Shadows	Controls lightness in shadows from 0 (maximum lightness) to 100 (darkest shadows), with an Auto checkbox (**5** used)
Brightness	From 0 to 150, with an Auto checkbox (**25** used)
Contrast	From -50 to +100, with an Auto checkbox (**0** used)
Saturation	From -100 to +100 (**0** used)

Detail	
Sharpness	From 0 to 100, default 25 (**40** resolution charts, **5** elsewhere)
Luminance Smoothing	Smoothes grayscales; this proved useful in reducing graininess in some solid areas (from 0 to 100) (**0** used)
Color Noise Reduction	Averages out color boundaries with the effect of diluting color details (from 0 to 100, note that the default of 25 compromises color details) (**0** used)

Lens	
Chromatic aberration	Two sliders - fix red/cyan fringe and fix blue/yellow fringe (from -100 to +100)
Vignetting	Two sliders - Amount (from -100 to +100) and Midpoint (from 0 to 100)

Curve	
Tone Curve	Contains Linear, Medium contrast, Strong contrast and Custom settings. Changing this setting updates the graph below.
Graph	Allows the tone curve to be manipulated.

Calibrate	
Camera Profile	Only ACR 2.4 can be selected, as tested.
Shadow Tint	Slider from -100 (green) to +100 (red).
Color Controls	Six sliders to control Hue and Saturation for each of the Red, Green and Blue channels (-100 to +100).

Elements 3.0 has only the ***Adjust*** and ***Detail*** options on a single page.

A Preview checkbox selects whether the preview is to be updated with changes made to the settings. Shadows and Highlights checkboxes enable black shadows or blown highlights to be displayed in red. The image may also be rotated. The preview is of fixed size, but may be zoomed up to 400% and tools used to navigate it.

Using Photoshop CS2, opening a raw file and generating the preview took about 5 seconds. Saving the image to a TIFF file took about 12 seconds - faster than the other converters. Further, processing of multiple raw files can be done in the background, giving still better perceived performance.
The saved 8-bit TIFF file contained EXIF header information with camera settings. A 16-bit TIFF was also created, which as expected looked identical to the 8-bit TIFF.

Some color discrepancies were observed - for example reds and blues were too light, whilst yellows were too warm. Attempts to correct this with the Color Controls in the Calibrate page of ACR on CS2 could not remedy this effectively, so instead selective color adjustments (available in both CS2 and Elements 3.0) were made as follows:

Color	**Hue**	**Saturation**	**Lightness**
Reds	-5	+10	-15
Yellows	+5	0	+10
Blues	0	0	-15

The results on the resolution chart compared well with those from S7Raw, although resolution was on a par with that from LE and therefore significantly lower. However, artifacts were consistently low, and generally there was little negative to say.

Interestingly, the diagonal line artifacts shown with RawGem and S7Raw are present, but significantly moderated. It appears that the same basic algorithm has been applied here, but with some smoothing to ameliorate the results. Where converters generally produced artifacts, they tended to be much less pronounced with ACR.

Results overall were not quite as punchy as those from S7Raw, but anyway this depended on a high sharpness setting in the latter.

Overall ACR compares well with S7Raw. The latter has the better resolution and possibly also better noise and contrast, but ACR may more than make up for this with its consistently low artifacts.

LaserSoft SilverFast DC-VLT 6.4.2r5a

http://www.silverfast.com/show/silverfast-dcvlt/en.html
This is an image processing application that supports raw format from a number of cameras. It may be run in demonstration mode (saved images are then marked with the LaserSoft logo).

The user interface is best described as challenging. Opening a raw file presented a plethora of confusing options, few of which seemed relevant to raw file conversion. On the main dialog, one could set the imaging mode to color (the number of bits used was not clear) or grayscale, one of a number of filters may be selected, and there are some perplexing sizing/scaling parameters.

A separate Picture Settings dialog is divided into three pages. The first (Standard) contains sliders for Exposure and Color Temperature (the latter defaults to 0 and ranges from -2000 to +4000!). The second (Advanced) contains sliders for Brightness, Contrast and Saturation (these don't seem that advanced to me). The third (Navigator) provides a thumbnail of the image on which an area may be selected for viewing in the preview window.

An Options pushbutton opened up a dialog in four pages with numerous other options, which appeared to have little use (at least in this context). Despite all these options, it did not seem to be possible to convert using 16 bits per RGB channel.
Images may be saved as TIFF, JPEG or EPSF. The saved image size is 4092x3078 (marginally smaller than expected). Saving as an 8-bit TIFF took about 10 seconds. No EXIF header information is present, so all camera settings are lost on conversion.

Various options were tried, including quality settings and an Interpolation (SilverFast Standard or Antialiased) setting, but none would yield satisfactory results. There was evidence of good resolution vertically (i.e. on horizontal lines) - on a par with LE. Nonetheless, these lines were riddled with artifacts, including some not present with any of the other converters.
On the other hand, horizontal resolution (with vertical lines) was abysmal. Worse still, this low resolution was associated with very pronounced color fringing on either side of lines. This can clearly be seen as magenta and green on the black lines of the chart. It seems clear that the generic algorithm does not handle the SuperCCD column interpolation properly.

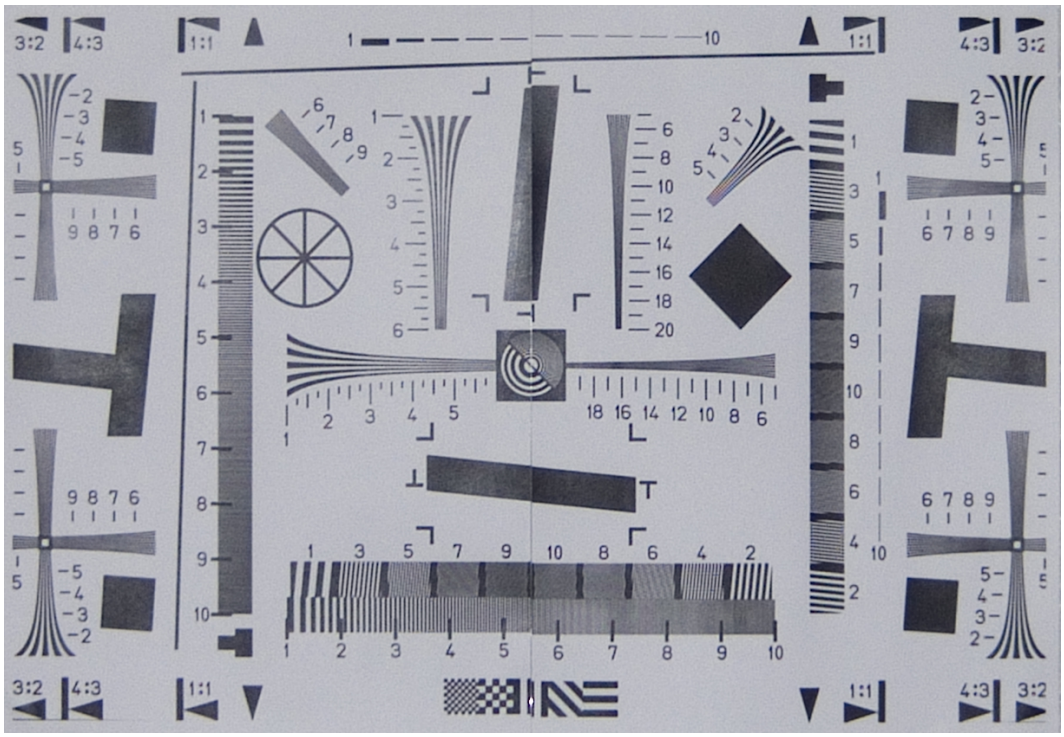
The diagonal lines in test 1f had similar artifacts and moire as those from FreeRaw, but the end result was substantially worse due to these other problems.

There were also problems obtaining a correct white balance on the resolution chart, (there was a pronounced blue cast). Strangely this did not occur with the color images tried, but these also showed the problems exhibited in the resolution chart. Color seemed reasonable, but this could hardly atone for the other problems.

The very poor results from this converter clearly preclude further testing.
Stop Press: The developer informed me that the F810 is not yet supported, and sent an updated version 6a. This remedied the horizontal resolution and color fringing issues, but is still in development. The results are therefore for version 5a.

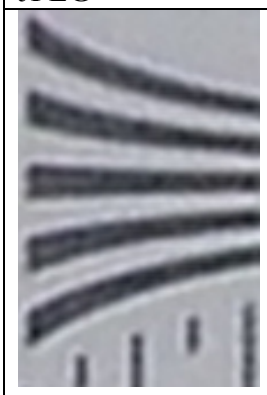
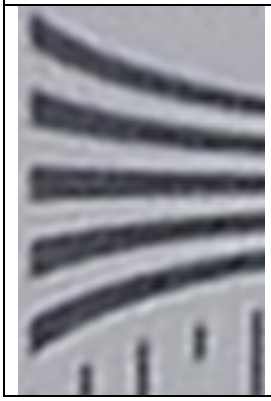
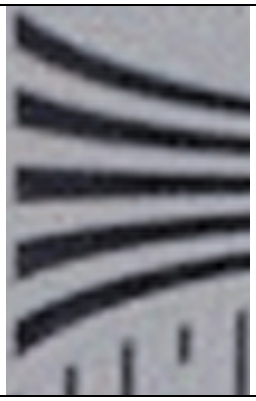
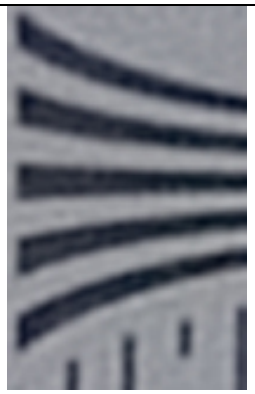
Initial Test Results

Subject 1 - Resolution Chart (1218x840, f=10.5, a=f/3.2, s=1/60)

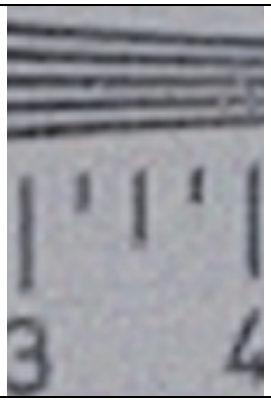


The crops from this chart have all been bicubically upsampled to 200% original size.

Test 1a (105x168) - Horizontal Lines (coarse)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	**S7Raw**	**ACR**	**DC-VLT**
			

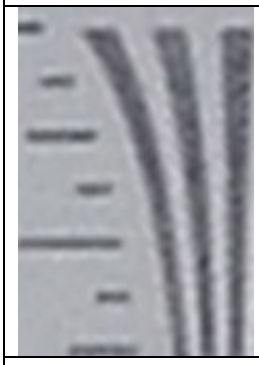
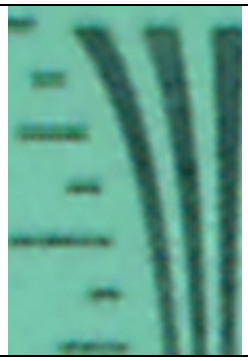
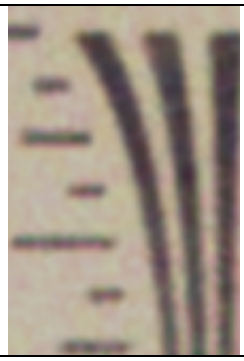
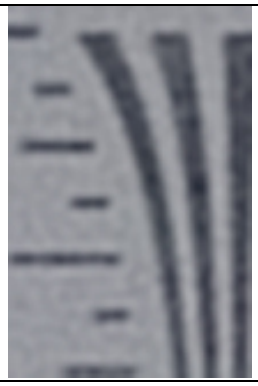
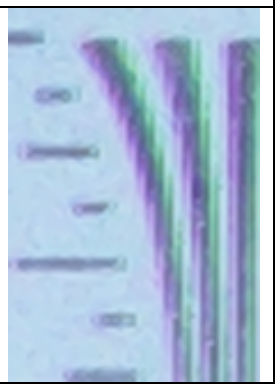
Test 1b (109x175) - Horizontal Lines (medium)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

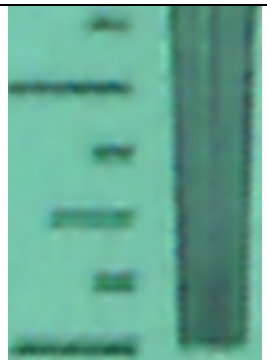
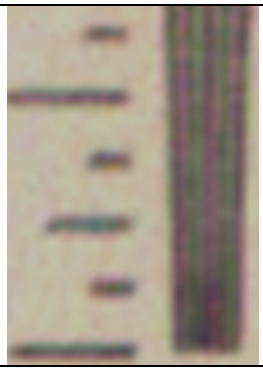
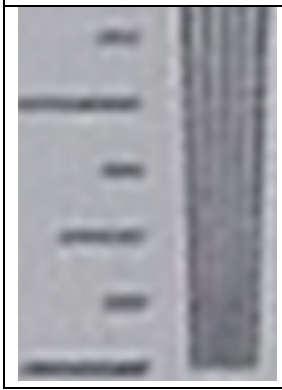
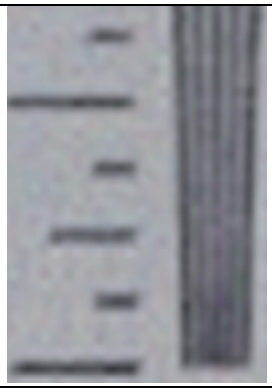
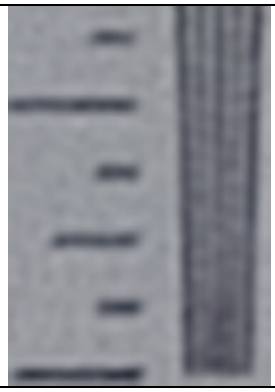
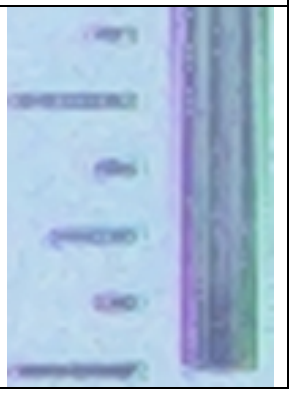
Test 1c (104x163) - Horizontal Lines (fine)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

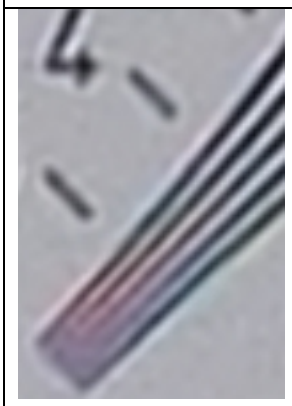
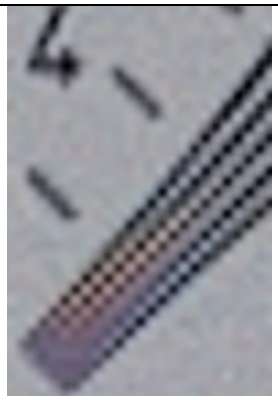
Test 1d (109x162) - Vertical Lines (coarse)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

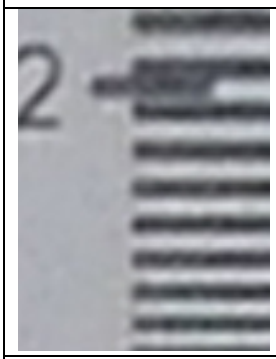
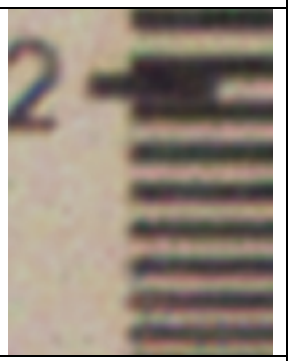
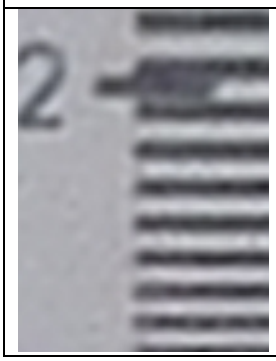
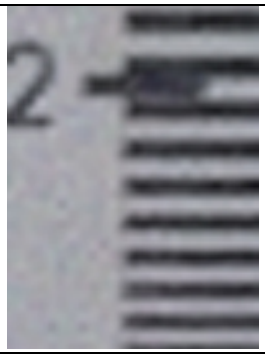
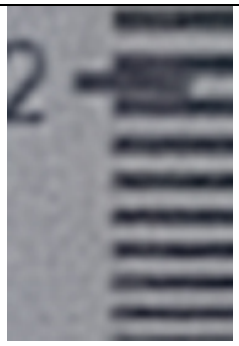
Test 1e (99x140) - Vertical Lines (fine)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

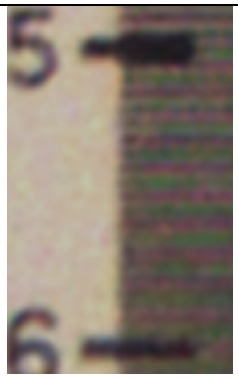
Test 1f (98x146) - Diagonal Lines (fine)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

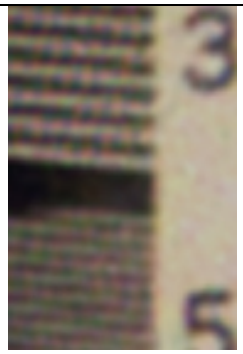
Test 1g (99x135) - Block of Horizontal Lines (coarse)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Test 1h (102x156) - Block of Horizontal Lines (fine)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

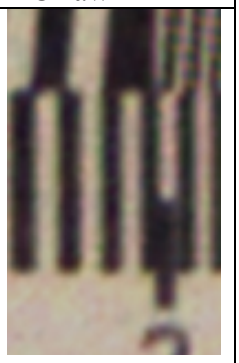
Test 1i (102x140) - Near-horizontal Lines (blocks 3 and 5)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Test 1j (97x147) - Near-horizontal Lines (blocks 4 and 6)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

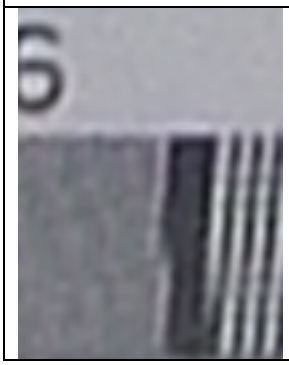
Test 1k (99x160) - Block of Vertical/near-vertical Lines (coarse)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

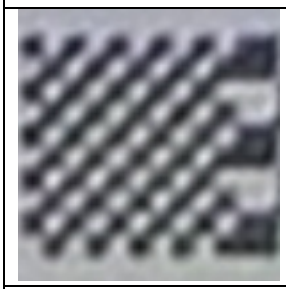
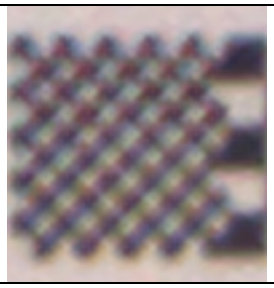
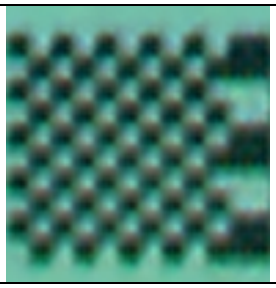
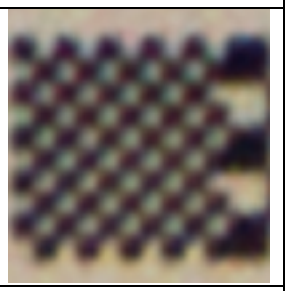
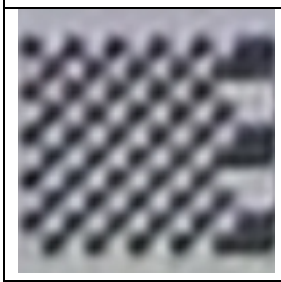
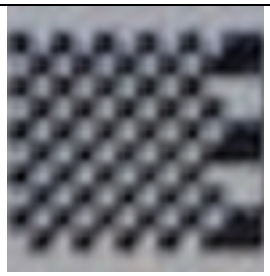
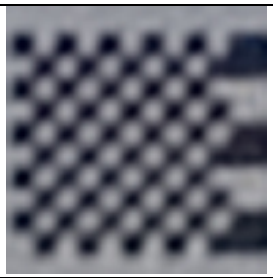
Test 1l (103x133) - Block of Vertical Lines (fine)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Test 1m (99x131) - Near-vertical Lines (blocks 4 and 6)

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Test 1n (98x102) - Checkerboard

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Test 1o (105x137) - Cartwheel

JPEG	FreeRaw	RawGem	DCRaw
			
LE	S7Raw	ACR	DC-VLT
			

Initial Comparison

The following table gives overall ratings on a scale from * to ***** on three criteria:

	Resolution	Artifacts	Other+	Total
DC-VLT	*	*	*	3
FreeRaw	**	***	**	7
RawGem	**	**	***	7
DCRaw	***	***	**	8
JPEG	****	***	***	10
LE	****	***	***	10
S7Raw	*****	***	*****	13
ACR	****	*****	****	13

+ Includes contrast, sharpness, graininess and overall presentation.

The following converters were excluded from further testing, as they gave results that were clearly inferior to the 12M JPEG produced by the camera:
LaserSoft SilverFast DC-VLT did not handle columns properly at all, and otherwise had high artifacts. *Column handling fixed in development version 6a*.
FreeRaw gave very soft and low resolution results with pronounced moire.
RawGem had poor resolution combined with high artifacts.
DCRaw showed signs of better resolution but had high moire and artifacts.

The following converter gave results very similar to the JPEG produced by the camera, and was included in further testing as a useful comparison:
Fujifilm Raw File Converter LE had good resolution, but had significant artifacts. These included pockmarking in dark areas, roughness in light areas (possibly from sharpening) and some zipper effects. There were also pronounced sharpening halos. The similarity of the results with the JPEG (confirmed on other images) indicates that LE simply replicates the processing done in the camera.
The EX version is the same, but without the aggressive sharpening of high-contrast details. Apart from this issue, results from LE in the next section also apply to EX. However, its high purchase price, together with the poor user interface and limited options do not in my opinion make EX a good candidate. LE is considered instead to enable the user to better assess what improvement can be gained by shooting raw.

The following converters gave results that were clearly better than the JPEG:
S7Raw produced the best resolution and generally good solid results, but was let down by the pronounced problems with diagonal lines. There were also one or two other artifacts that were present in other converters but were more noticeable with S7Raw. There was some grain in the background, although this tended to reflect the increase in sharpness and high contrast; the overall results were very solid and clean.
Adobe Camera Raw gave resolution that was on a par with that from LE, but fell short of that from S7Raw, particularly with horizontal resolution (on vertical lines). However, it was very low overall in artifacts. It did exhibit the same zipper/step effects on the diagonal lines test as S7Raw and RawGem, but this appears to have been smoothed out. There was also some grain in the background with rather lower contrast than from S7Raw, but appearance was very good nonetheless.

Further Test Results

The remainder of this review deals only with the converters that performed best on the resolution chart - LE, S7Raw and ACR. More aspects of these three converters are explored in the further tests, in particular their rendition of color.

It is probable that some of those converters not included for further testing would have given better overall results than LE, given its color smearing and sharpening issues (not apparent on the resolution chart). However, since the LE and 12M JPEG images are so similar, the LE results provide a useful reference. Thus the reader can judge the degree of improvement over in-camera JPEGs that can be achieved by raw conversion using what are probably the best two converters - S7Raw and ACR.

Test Summary

Testing used crops from four images:

- a double page tabloid newspaper occupying about half the field of view
- the glossy covers of three books with a smooth texture and simple images
- an Ordnance Survey 1:25000 series map
- a real-life garden scene

The LE images were processed with Normal sharpness (as set in the camera). The settings for S7Raw and ACR were carefully adjusted to give an image that was as similar as possible to the LE one in brightness, contrast and saturation.

Color and other adjustments were made for both S7Raw and ACR as described in their descriptions above. For ACR, color adjustments required post processing in Photoshop. There were still a few color discrepancies between the converters, but overall color accuracy was felt to be accurate.

All three images (LE, S7Raw and ACR) were in some cases processed with Auto Contrast in Photoshop to get the most comparable results.
Low sharpening was specified for both S7Raw and ACR (5 in each case). To get images that compared better with those from LE, Unsharp Mask processing was carried out on all images from both S7Raw and ACR. The unsharp mask parameters used throughout were: Amount 150%, Radius 1.30, Threshold 7 - these values are somewhat arbitrary but provided good results for all of the images.

The Soft setting in the camera could have been used to reduce the sharpening generated with LE, but as mentioned this seems to only reduce the strength of the sharpening somewhat. There is no way to completely disable sharpening and other rather aggressive processing done by LE.

As with the resolution test results, these images are presented at a far larger scale than it would be reasonable to view or print them at, to enable the smallest defects to be seen. However, as they say, the devil is in the detail.

In addition to close on-screen examination of the images, prints of them were assessed; these were equivalent to about A3 size for the full image, but still smaller scale than as viewed on the screen.

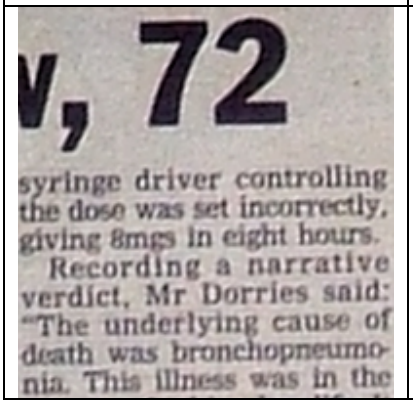
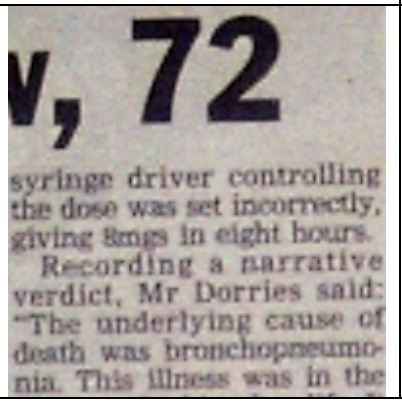
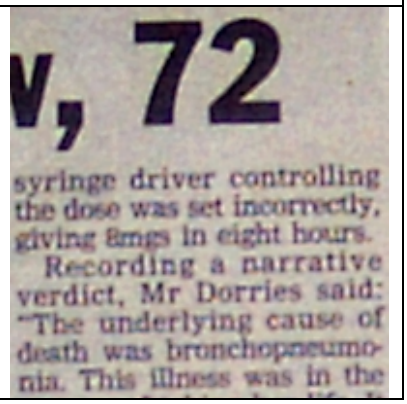
Subject 2 - Tabloid Newspaper (2900x1820, f=16.8, a=f/4.2, s=1/60)

Test 2a (136x209)

LE	S7Raw	ACR
		

The LE image has significant bleed-through here, both yellow in the dark blue text, and pink in the white text. The results from S7Raw and ACR are similar; both have only a little of this problem in the blue text, plus some unevenness in the white text (but little red). Very close examination shows slightly cleaner results from ACR.
The LE image also suffers fringing of color boundaries (for example blue/yellow near the top and yellow/red in the middle). The S7Raw and ACR images are again much cleaner here.
The yellow area in the S7Raw and ACR images is somewhat grainier than that from LE, but the LE image seems to have too much white in the blue area at the left.

Test 2b (194x200)

LE	S7Raw	ACR
		

The LE text appears rather cleaner than the other two, due partly to greater contrast from sharpening. The S7Raw and ACR images compare closely in quality, with ACR having slightly better formed letters but showing some coloration effects.

Test 2c (152x301)

LE	S7Raw	ACR
		

This test shows noticeable smearing of several color boundaries in LE (the bands should be distinct). The small segment at the very top is actually unprinted (white) paper, but LE shows this as pink. The very light pink band near the top is again too pink with LE. There are also thin dark lines either side of this band in LE that should not be there (perhaps inappropriate sharpening). There are several instances of pink fringing around bands with LE.
The results from S7Raw and ACR are clean and very similar, but with a very faint pink fringe over the blue band with S7Raw (you have to look closely to see it).

Test 2d (165x169)

LE	S7Raw	ACR
		

Again, LE renders the fine black/white details more cleanly than S7Raw and ACR. There is an artifact in the double 'l' with S7Raw, which again has slightly less accurate letters, whilst ACR shows some coloration.

But the yellow on red text is cleaner with S7Raw than LE, and possibly better still with ACR (but perhaps this is due to a color inconsistency).

Test 2e (157x260)

LE	S7Raw	ACR
		

Close examination of the foliage at the top shows some details rendered by S7Raw and ACR, but not by LE. However, there are one or two small artifacts with S7Raw.

The text appears to have become somewhat diluted with LE; this applies both to the yellow on green, and the black text on the light background which is less solid than that on a white background.
However, the background with LE appears to be rather smoother than that with S7Raw or ACR.

Test 2f (134x180)

LE	S7Raw	ACR
		

The text here rendered by LE contains some significant artifacts. For example there are spurious horizontal lines linking parts of the text; this problem is evident in both the large white text, and the dark blue text on a yellow background. The red text on this yellow background is also much cleaner with S7Raw and ACR. The yellow in the small text between the white text lines is hardly apparent at all with LE.

The S7Raw and ACR images are comparable, but ACR has the edge, with both less color bleeding into the small white text, and rather fewer text artifacts generally. However, there is a minor problem with ACR - there is a spurious red edge around the yellow area where it meets the pink.

Test 2g (124x110)

LE	S7Raw	ACR
		

This again shows color fringing in LE - for example inside the edge of the white bubble.

Both the yellow text on magenta background and red text on yellow background are more cleanly rendered with S7Raw and ACR. These areas are also quite obviously affected by the color fringing problem in LE. There is the same red edge problem on yellow/pink boundaries with ACR, but otherwise little to choose between the two.

Test 2h (125x170)

LE	S7Raw	ACR
		

The LE image clearly shows a lot of pink in the red letters where it should be gray. The S7Raw image is much better, although not quite perfect in this respect. The ACR image is better still, especially between the black area and the red letters.
The overall color of the letters also appears to tend rather to the magenta with LE (although this may be a product of the fringing).

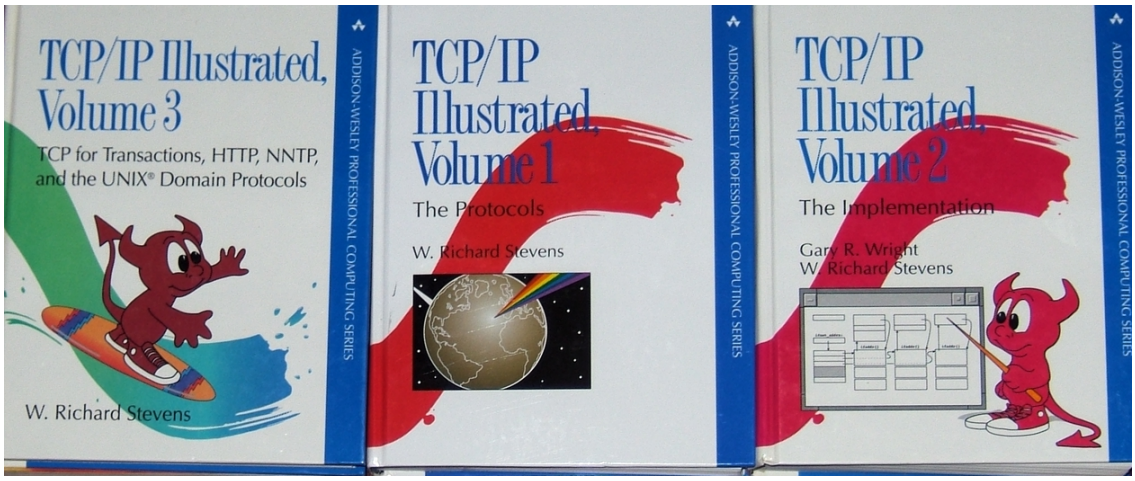
The large black on white text has some artifacts in both LE and S7Raw - the ACR image is better in this respect. However, with ACR there are some coloration problems with the text - most noticeably in the white on black text at the top.

Test 2i (125x114)

LE	S7Raw	ACR
		

The LE image shows higher contrast black and white details, but smeared colors. Both S7Raw and ACR show much clearer color details, but the yellow of ACR is perhaps rather too bright here (it is actually a subdued gold-type color). ACR shows somewhat better formed letters (the 'D' and 'R' in the S7Raw image contain some artifacts).

Subject 3 - Glossy Book Covers (2508x1048, f=11.9, a=f/3.4, s=1/60)

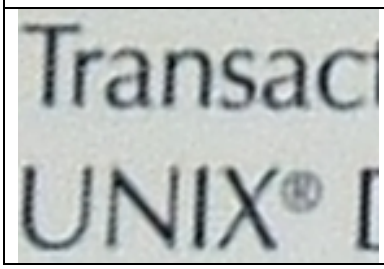
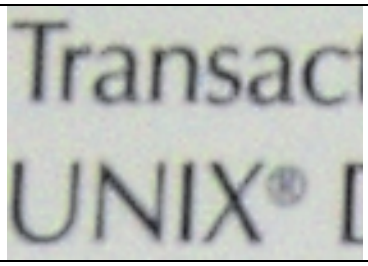
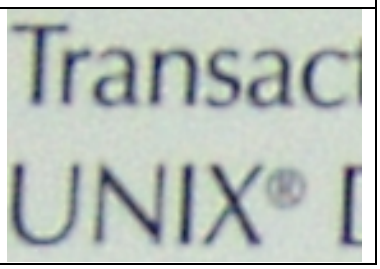


Test 3a (160x215)

LE	S7Raw	ACR
		

This and the following test show some zipper artifacts in thin vertical and horizontal lines with LE, which also has a rather grainy background. The blue color in S7Raw appears to be the most accurate here.

Test 3b (138x100)

LE	S7Raw	ACR
		

Test 3c (203x270)

LE	S7Raw	ACR
		

The grey line and three colored bands on the skateboard are rendered accurately in S7Raw and even more so in ACR, but are smudged in LE which also has a spurious line in the white foot on the skateboard. S7Raw has some artifacts in the white areas at the bottom right of the image, and there is also a trace of the diagonal line artifact in the three bands on the skateboard.

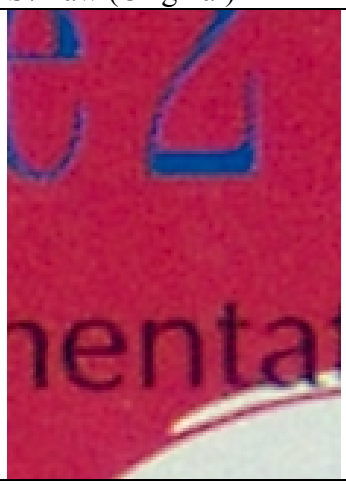
The brown areas in ACR and S7Raw are rather grainy; this is particularly the case with ACR which has quite pronounced light colored blotches.

Test 3d (115x149)

LE	S7Raw	ACR
		

All three converters have problems with blue and black text on this red background.
The black letters are softened - this is worst with LE whilst S7Raw has only soft patches but with some holes.
The edges of the blue letters are also have artifacts in all three cases; the results with ACR are probably cleanest with S7Raw being rather poorer here.
S7Raw and ACR have grainy red areas, blotchy with ACR, irregular with S7Raw.

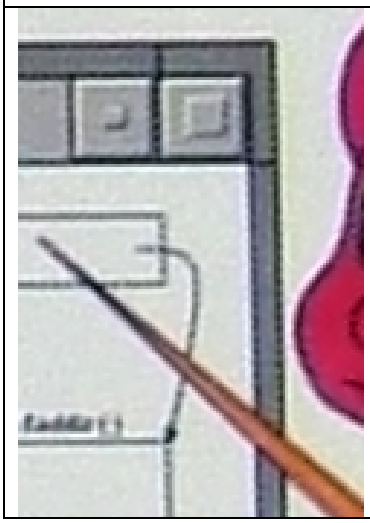
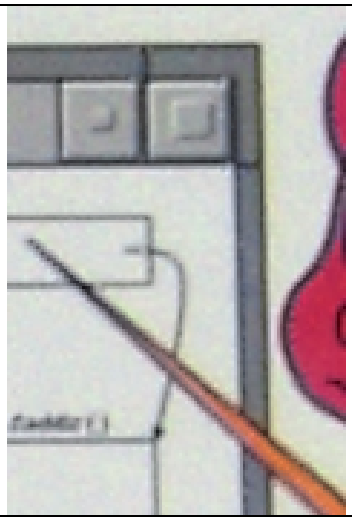
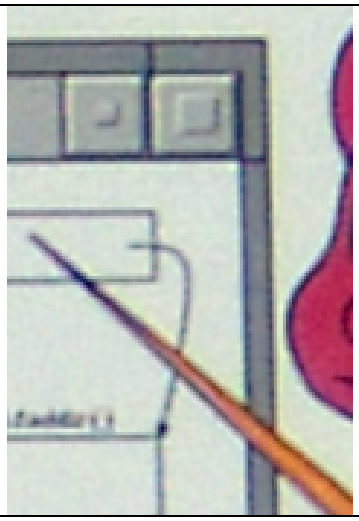
Test 3e (115x163)

LE (Normal Sharpness)	S7Raw (Sharpened)	S7Raw (Original)
		

This shows further problems with blue text on a magenta background. LE exhibits softening and bleed-through, with S7Raw the results are solid but have artifacts. ACR is best, with mild bleed-through and softening.
With LE, the black letters are soft and have artifacts, with S7Raw solid but with a few artifacts, and with ACR rather soft but with few artifacts.

There is also a noticeable zipper artifact on the thin line with LE, and again both S7Raw and ACR have rather grainy magenta backgrounds.

Test 3f (119x177)

LE	S7Raw	ACR
		

The thin black lines are less clean in the LE image, having zipper effects in both vertical and horizontal lines. The LE image also has a noticeable pinkish sharpening halo round the magenta area.

The S7Raw and ACR images are both rendered cleanly, although the S7Raw image has a trace of step/zipper artifacts in the diagonal stick and some grain in the magenta, whilst ACR has a touch of coloration in the black details.

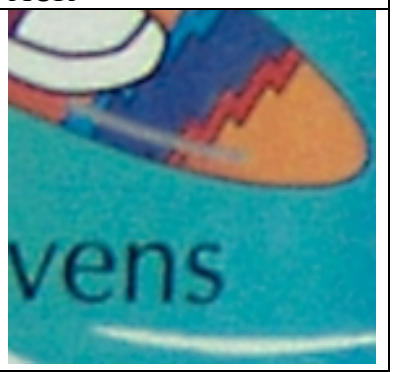
Test 3g (154x133)

LE	S7Raw	ACR
		

The LE image shows some of the now-familiar pink fringing on the globe by the rainbow, and there is faint multi-colored fringing at top of the rainbow where it meets the white (this applies to the green, blue and violet as well as the colors shown).
The LE image also has an ill-defined boundary between the green segment in the rainbow and the yellow, with some unevenness in the latter. The rainbow colors below yellow are rather grainy.

The S7Raw and ACR images have fewer defects, but ACR is significantly better here. S7Raw has some of the diagonal line artifact visible towards the point of the rainbow. It also has less clean rendition of the color bands in the rainbow - these appear to be affected by the diagonal line artifact. There is minor fringing around the red area in the top left hand corner. The ACR image is essentially defect-free.

Test 3h (141x135)

LE	S7Raw	ACR
		

The LE image shows rough edges around and smearing into the white area at the bottom, and considerable color smearing in the skateboard. Both the S7Raw and ACR images have much better color definition, with ACR being rather better.
S7Raw shows the diagonal line artifact here, both in the skateboard and in the letters. The background color also appears to be somewhat lacking in green.
The ACR image shows some small white blotches around the text, but generally gives the cleanest rendition.

Subject 4 - OS 1:25000 Map (2384x1284, f=15.1, a=f/3.9, s=1/60)

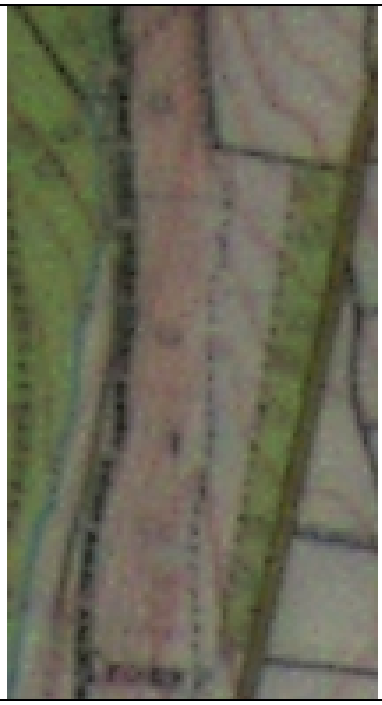
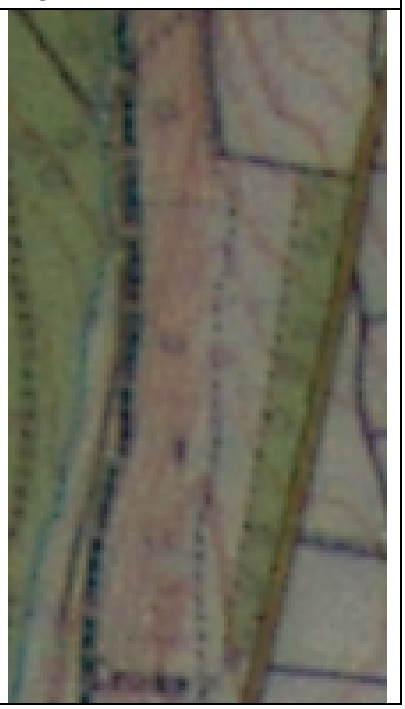
This Ordnance Survey map contains many fine color details that provide a good test of resolution involving color. The bright areas are due to the map being laminated and photographed with flash.

Test 4a (156x204)

LE	S7Raw	ACR
		

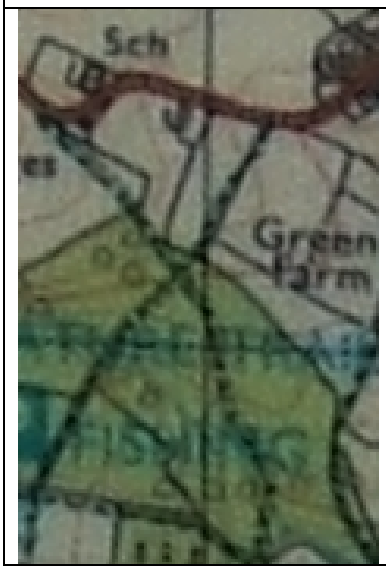
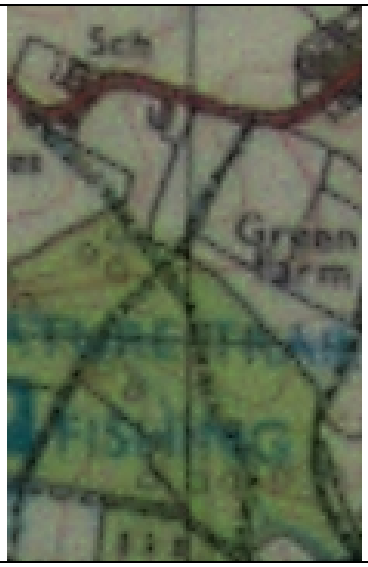
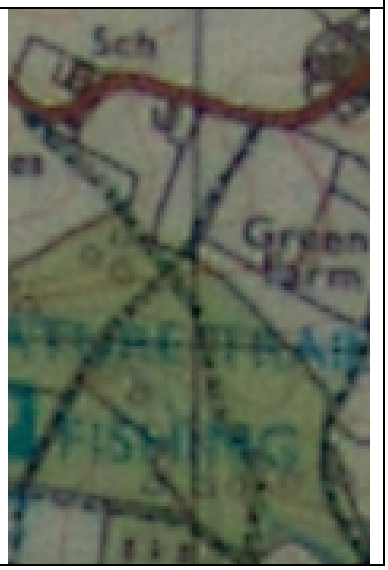
The LE image looks sharper, but close examination shows that it contains no more detail. Indeed, the dots show greater resolution with S7Raw and possibly also with ACR.
The LE image however shows significant color smearing, both in the blue letters and with the magenta road where there is loss of saturation. The S7Raw and ACR images are both much better in this respect and overall very similar, with ACR perhaps having the edge. The color of the contours is also probably more accurate with ACR.

Test 4b (105x198)

LE	S7Raw	ACR
		

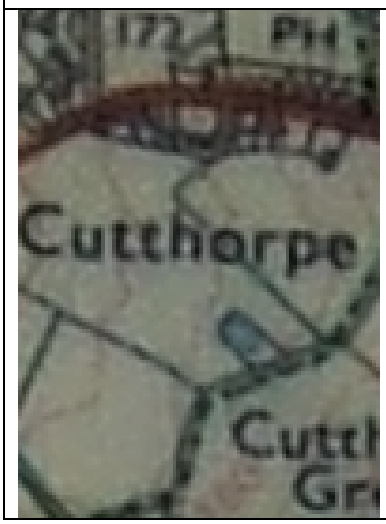
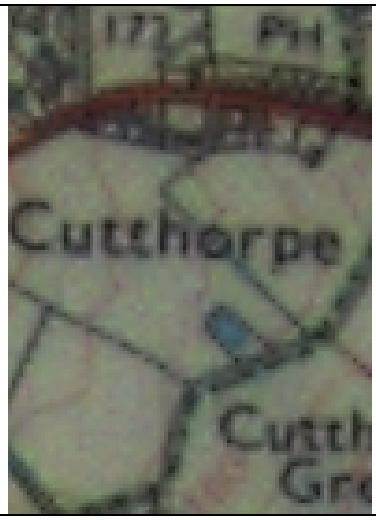
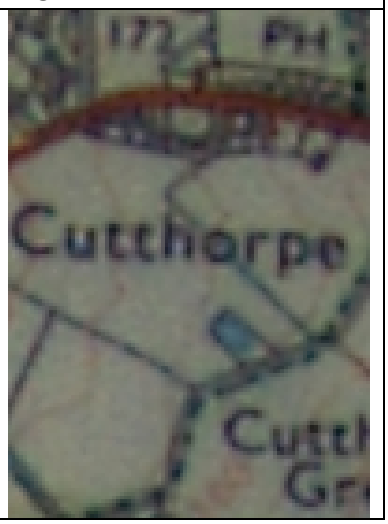
Color smearing makes the river undiscernable near the top of the LE image, and the yellow road is also lacking color. Again, both S7Raw and ACR images are far better.

Test 4c (115x178)

LE	S7Raw	ACR
		

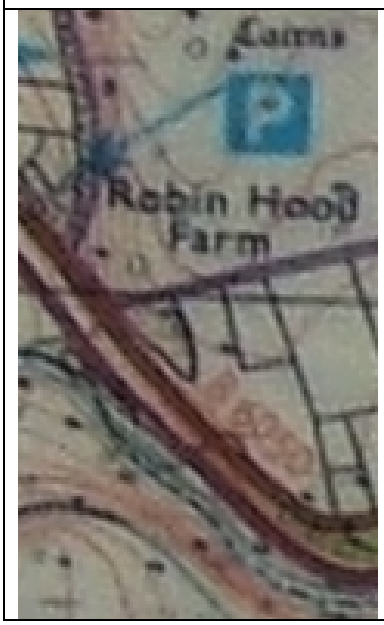
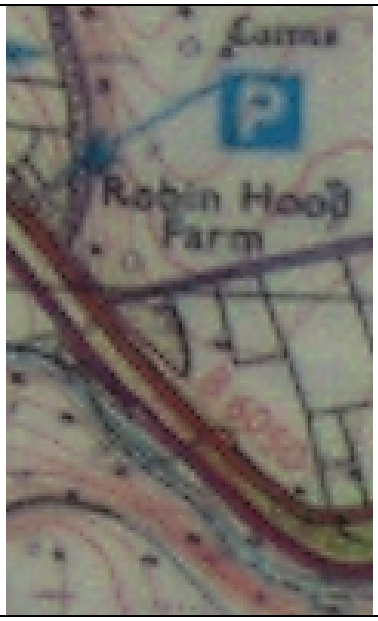
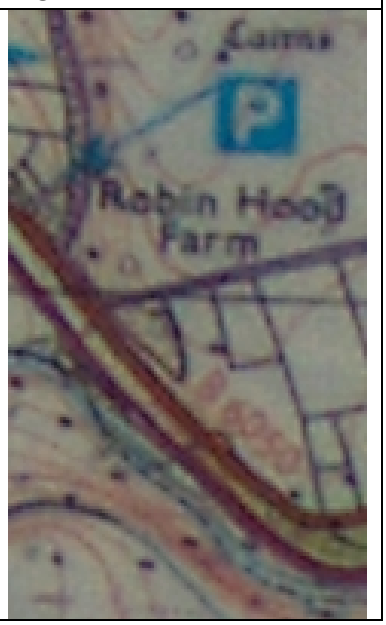
The LE image has the sharpest appearance, but the color smearing of the blue text and brown road is noticeable. The S7Raw and ACR images are similar but details tend to be better formed with ACR. For example, at the top left, the 'h' in 'Sch' and the rectangle to the left of the building next to it are rather smeared with S7Raw.

Test 4d (98x136)

LE	S7Raw	ACR
		

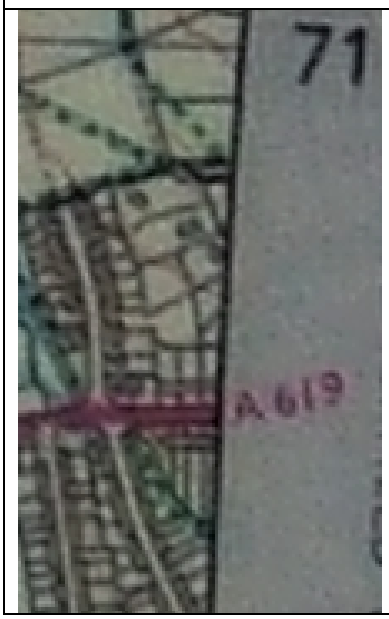
This shows again sharp black details but diluted color ones in the LE image. These details are just as clean with ACR, but do not have such sharp contrast. With S7Raw they are slightly smudged.

Test 4e (118x198)

LE	S7Raw	ACR
		

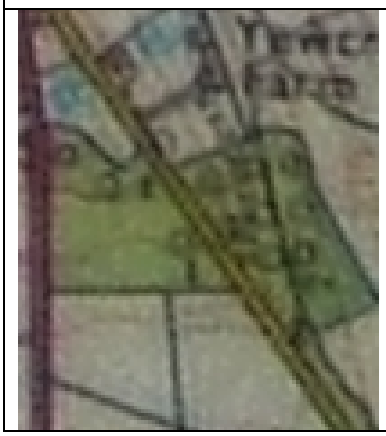
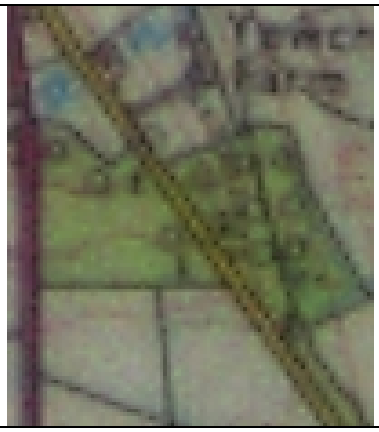
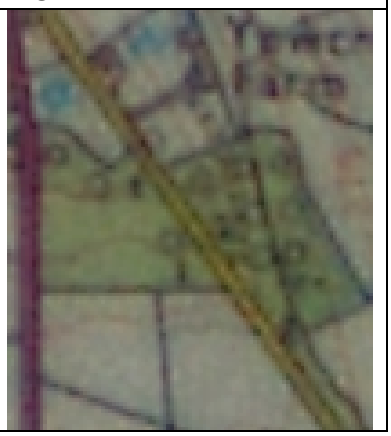
The LE image has the usual sharp black details with color smearing and dilution. The diagonal line artifact is apparent in the S7Raw image on both the roads and the field boundaries. There is no major problem here with ACR, which also has rather more solid color details.

Test 4f (110x181)

LE	S7Raw	ACR
		

This image contains house details that are beyond the resolution of the sensor. LE produces black details that are not present with S7Raw or ACR, but many of these are spurious. There is noticeable pink fringing with LE and a little with S7Raw, but none with ACR. There is rather thicker grain in the grey area with the S7Raw and ACR images than with LE, although not serious in any case. Overall, the ACR image is the cleanest and most reliable one.

Test 4g (101x116)

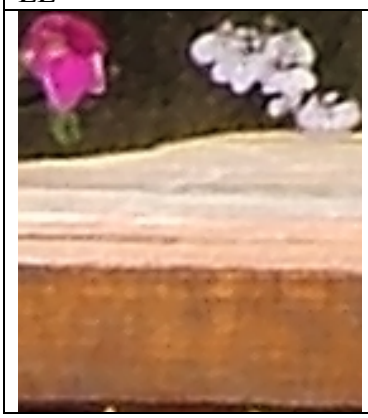
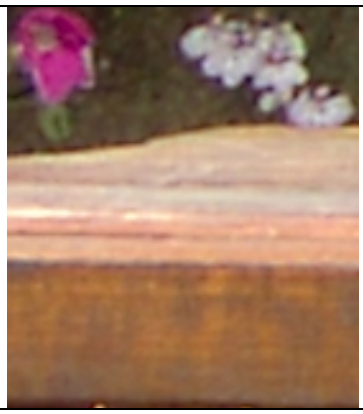
LE	S7Raw	ACR
		

This shows the color fringing problem on the magenta road in LE, and the diagonal line artifact on the yellow road in S7Raw. ACR does not exhibit either of these problems to any significant degree, and is generally rather cleaner.

Subject 5 - Garden Scene (2248x1372, f=16.8, a=f/5.6, s=1/85)

Unlike other images, dynamic range is an issue here; however blown highlights only occur in test 5f. Every effort has been made to adjust the contrast curve for S7Raw and ACR to that of LE, to avoid spurious comparisons based on dynamic range.

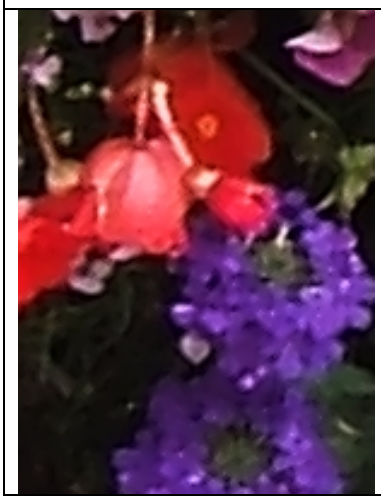
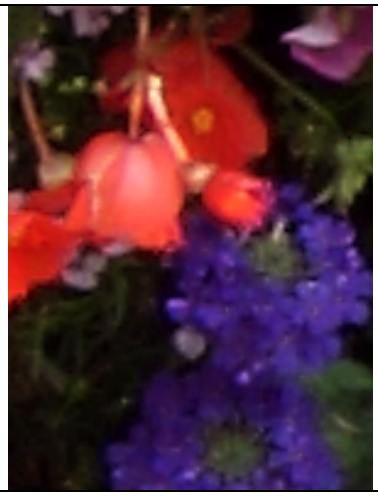
Test 5a (138x158)

LE	S7Raw	ACR
		

The edge of the trestle table illustrates significant color detailing problems in LE; the wood grain is hardly discernable. Even more striking is the smearing and dilution of the gray patches, despite the general over sharpening. The center of the pink flower also demonstrates the color smearing problem. The S7Raw and ACR images are fairly similar, but the pink flower in the S7Raw image has a few problems with its edges.

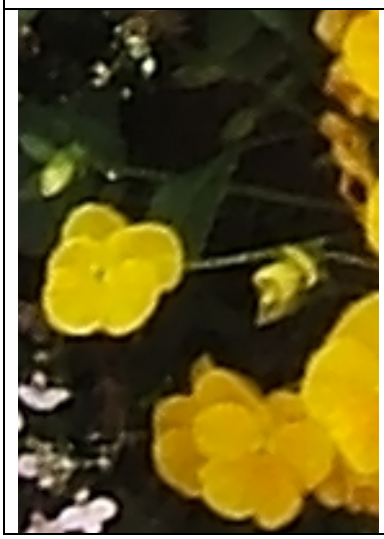
LE appears to have blown highlights in the white flowers - however these are actually well within the color gamut, and a lot less bright than other areas in the image. Close examination shows that this is actually the effect of heavy sharpening and not a dynamic range (contrast) issue. S7Raw and ACR images have been post sharpened with unsharp mask, but this is clearly a lot more moderate than that of LE.

Test 5b (150x200)

LE	S7Raw	ACR
		

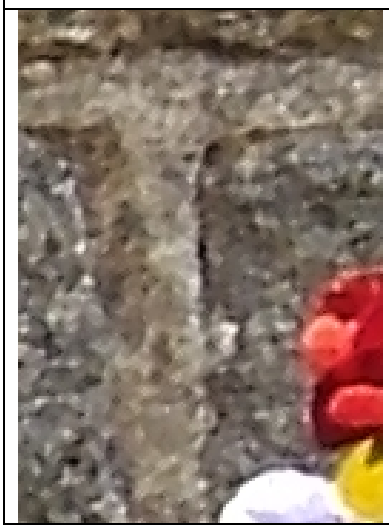
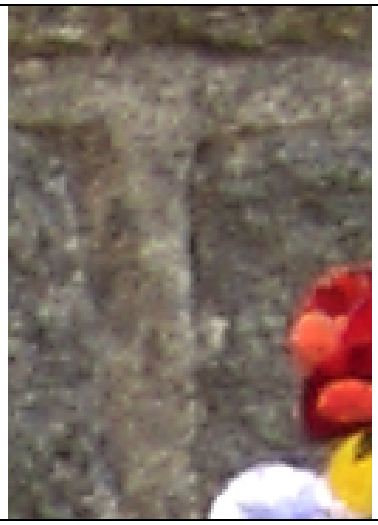
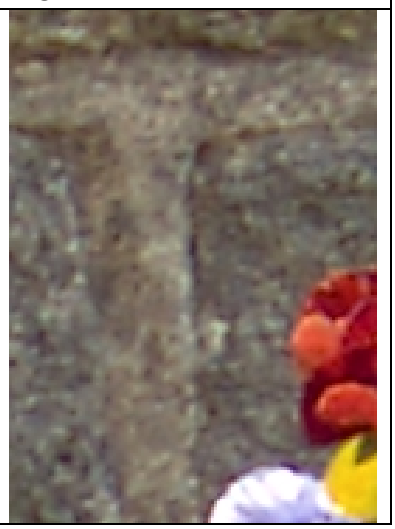
Both blue and red flowers tend noticeably towards magenta with LE. There are also artifacts in the vertical red flower stems. The color smearing of LE is evident in the center of the red flower, which is rendered clean yellow by S7Raw and ACR.
It appears that the sharpening done by LE has made some details too bright - for example some parts of the blue flowers are unnaturally white, as are some small details in the dark areas.
The diagonal artifact of S7Raw shows slightly in the green stem near the top, otherwise it compares favorably with the ACR image although having slightly darker low-level details in the foliage.

Test 5c (141x204)

LE	S7Raw	ACR
		

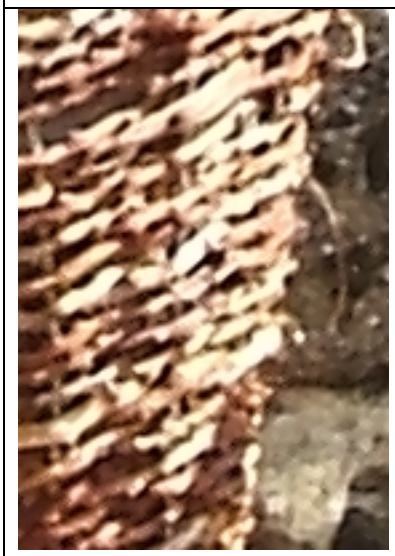
The LE image shows artifacts in the horizontal flower stem. The white flowers are clearly unsubtle through sharpening, as are the bright details towards the top. Again, S7Raw and ACR are fairly similar, although the small yellow flower to the right of the center of the image is rather more smoothly rendered by ACR.

Test 5d (130x182)

LE	S7Raw	ACR
		

The dark spots in the wall jump out quite unnaturally with the LE image; this high contrast detail sharpening that gives impressive results with black text is obviously quite inappropriate here.

Test 5e (142x205)

LE	S7Raw	ACR
		

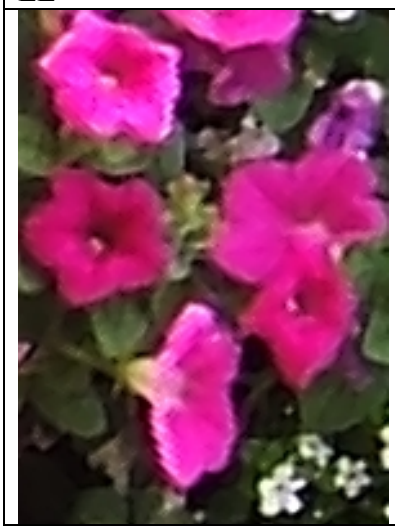
Only ACR produces a natural result with this wicker basket. The LE image is over-sharpened with unduly high detail contrast. The rougher appearance of the S7Raw image is probably mainly due to edge artifacts on diagonals, but it also shows some less subtle color graduations. Again, sharpening and artifacts appear to be the issues here, not dynamic range limitations.

Test 5f (110x192)

LE	S7Raw	ACR
		

LE suffers from noticeable artifacts, especially in the vertical lines, and renders the star indistinctly and gray. S7Raw has minor unevenness in the curved outline. ACR is free of significant artifacts, and also renders the star most accurately.
The highlights to the right are similarly blown in all three images.

Test 5g (145x202)

LE	S7Raw	ACR
		

ACR renders these flowers most naturally, although there is strangely a noticeable blue fringe to the right of the lowest and topmost flowers not present in the other two images. This may simply be due to lack of the edge artifacts in the other two images. Both LE and S7Raw images show pronounced red fringing going into the dark area at the left of some flowers, particularly the lowest one. This problem is worst with LE, which also has nasty white lines here.

Subject 6 - High Contrast (4048x3040, f=13.5, a=f/3.6, s=1/180)

This photograph contains a wide dynamic range, from very deep shadows inside the tunnel, to highlights in the sun. The dark tunnel entrance in the center has resulted in everything else being significantly over-exposed. This image provides a test of what detail can be extracted, in both highlights and shadows.

One of the advantages of shooting raw is that it should be better able to cope with this situation. This is because it usually both:

a) avoids the often over-contrasty curve set by the camera processing, instead enabling the contrast to be set by the user
b) allows 16 bits per RGB channel to be saved, thus preserving sensor data for any subsequent processing

Dynamic range has not been under consideration up to this point because the above would enable the full dynamic range to be manipulated by the user as required. However, the LE converter offers neither of these advantages, and so yields the same range-limited results that are created in the camera.

The following images show the difference this makes in handling of highlights. For each crop and converter there are two images. The first is that produced by default (with LE there is no option; with ACR the Auto settings are accepted). The second is after adjusting the image to easily reveal all highlight detail - for both LE and ACR the brightness was reduced by 80 and the contrast increased by 40 in Photoshop.

The ACR image was saved to a 16-bit TIFF; only 8-bit output is available from LE. Although only ACR was used, it can be assumed that essentially the same results can be achieved from S7Raw by appropriate user adjustment. However, the Auto settings in ACR allow good results to be achieved in most cases with ease.

Note that similar tests were also done on the shadow areas. With both LE and ACR images, it was possible to reveal details well inside the tunnel (and perhaps more than could be seen by eye). However, there was found to be little or no difference between the two in their ability to resolve these low-level details. Highlights are another story.

Test 6a (160x175)

LE (default)	ACR (auto)
	
LE (adjusted)	ACR (adjusted)
	

Significant improvement is available from LE with adjustment, but there are some problems. The text is generally thinner than it should be, with some missing segments (to some extent perhaps due to the artifacts noted previously). Some detail has been recovered in the pink flowers, but much has been lost. The color in these flowers is virtually non-existent.

The ACR image shows a high degree of recovery from the over-exposure; the flowers are detailed and preserve their color. The text is solid but is affected somewhat by chromatic aberration (LE clearly does some processing to reduce this).

Test 6b (176x178)

LE (default)	ACR (auto)
	
LE (adjusted)	ACR (adjusted)
	

The adjustment in LE reveals significantly more detail, but the red of the sign in particular is noticeably washed out. The same processing on the ACR image reveals the full red of the sign, and much more solid and detailed results generally.

These limitations in LE were frequently found in other situations. For example sky containing blue patches is rendered as such with the Auto settings of ACR, but often as plain white with LE. Only partial recovery of this is possible with LE, and then only by adversely affecting the general image quality.

Conclusion

The considerable differences between the images generated by the seven converters under test demonstrate the importance of the demosaicing and other conversion processing. This section discusses only those tested further: LE, S7Raw and ACR.

The "Official" raw file converter (LE) might be expected to give the best results, but its image quality was found to have the following significant shortcomings:

- Color smearing: in these tests especially with reds, but also occurring with other colors. There were frequent color fringing and bleed-through effects, causing dirtying of the image (all color tests)
- Probably from color noise reduction, fine details involving color tended to be soft and lacking in saturation compared to S7Raw and ACR, even though black/white details tended to be sharper (2e, 2f, 2g, 3g, 4b, 4c, 4d, 4e, 4g)
- Aggressive sharpening is imposed that results in pronounced halos and other effects around contrasting areas; they could only be reduced somewhat using the Soft camera setting (1a-1o, 2b, 2h, 3c, 3d, 3e, 3f)
- Also probably from sharpening, results tended to appear unnatural, frequently being grainy or lacking in natural graduations, resulting in lack of subtlety and smoothness (1a, 1d, 1k, 2a, 2b, 2f, 4a-4g, 5a-5e, 5g)
- Zipper effects in some vertical/horizontal lines (1b, 1o, 3a, 3b, 3e, 3f, 5b, 5c)
- Although black details are sharp on a light background, there was considerable softness in dark areas on some medium color backgrounds (3d, 3e, 5a)
- Color discrepancies: for example plain red tended to be rendered with some magenta, and blues were not always accurate (2h, 3a, 3d, 5b)
- The ISO test chart showed that linear vertical and horizontal resolution from LE was 5%-10% lower than that from S7Raw (1a, 1e, 1h, 1j, 1l, 1m)
- For no apparent reason, the output image was 4048x3040 not 4096x3080, thus not using all effective sensor pixels and giving a slightly smaller field of view
- Highlights were often blown due to a high contrast curve together with lack of ability to adjust this (6a, 6b)

The same comments apply to EX version 3.0.21.0, except that sharpening of subtle details was more moderate, and that contrast could be controlled.

S7Raw also has some significant shortcomings, namely:

- Small high contrast details (for example black/white text) tended to be rendered more softly and with some fuzziness compared to LE. Post sharpening could not quite achieve the crisp LE quality (2b, 2d, 2f, 4a-4g)
- Graininess on certain areas of solid color, exacerbated by increasing the S7Raw sharpness setting. This appeared to be associated with a change of hue of some colors (3c, 3d, 3e)
- Serious step and other artifacts on diagonal lines; although this problem did not show up too much in most real life situations, it could sometimes cause significant ill effects (1f, 1o, 3d, 3f, 3g, 3h, 4e, 4g, 5e)
- Some other artifacts and inaccuracies that were not present with LE/ACR or were worse with S7Raw (1b, 1j, 1m, 2d, 2i, 3d)
- Even though I felt that the colors after correction were more accurate overall than from LE (and possibly ACR after making adjustments to the Color settings), there were still some color discrepancies (3c, 3h)

ACR also has a few shortcomings:

- The ISO test chart showed that linear vertical and horizontal resolution from LE was 5%-10% lower than that from S7Raw (1a, 1e, 1h, 1j, 1l, 1m)
- Small high contrast details were somewhat better formed than with S7Raw but not as crisp as from LE and sometimes had coloration (2b, 2d, 2h, 3f, 4a-4g)
- Mottling on certain areas of solid color; although this can be moderated by increasing the Luminance Smoothing (3c, 3d, 3e)
- Minor step artifacts on diagonal lines, although these hardly manifested themselves other than on the resolution chart (1f)
- Colors after adjustment were questionable in some instances, although generally accurate and can be further adjusted in Photoshop
- As with LE, the output image was only 4048x3040, thus wasting 154,880 sensor pixels without apparent reason

LE does tend to render fine high contrast (black/white) details more distinctly than S7Raw or ACR. It seems likely that this results from the demosaicing algorithm of LE, which appears to do less interpolation with high contrast boundaries. I could not exactly replicate the fine detail sharpness from LE in S7Raw or ACR using unsharp mask, so LE does have a potential advantage here.

But probably the same processing that achieves this sharpness in high contrast details also spoils the quality of real life scenes. This is shown in the unnaturally light and dark details in Subject 5. The former look like blown highlights, but the sharpening effects (a thick black border around plain white) can be seen clearly on close inspection. This may also be responsible for general loss of low-level dark details.

The sharpening halos that LE imposes are clearly nothing to do with the demosaicing. It should be possible to disable this sharpening to allow the user to post process the image as required. Any sharpening of this type is best done as a final touch, on the basis of personal preference and how the image is to be used.

Although LE has the edge (pun intended) with black on white details, S7Raw and especially ACR nonetheless give results that generally compare well after careful sharpening. Where the results are slightly fuzzier, this does not normally result in lost detail. In fact S7Raw clearly has higher basic resolution, at least on horizontal and vertical details, although ACR renders details rather more accurately.

I found the overall presentation with S7Raw and ACR to be much more natural; in my opinion LE places too much emphasis on superficial sharpness. Just like excessive contrast and over-saturated colors, this is no doubt done to impress the market for which the camera is intended. It is interesting that the EX converter intended for the S series cameras carried out much more conservative sharpening; clearly Fujifilm sees this as a different market that would be aware of its detrimental effects.

Another major issue with the LE converter is that it tends to blow highlights. This is essentially due to its lack of function - a rather hard contrast curve is imposed, with no provision to change it. The lack of 16-bit output also makes it less likely to be able to remedy this by post processing. S7Raw, ACR and EX allow the contrast curve to be adjusted manually. ACR also provides automatic contrast adjustment that appears to give very good results with ease.

LE has some very significant shortcomings in color rendition. There was frequent smearing that affected all colors, but particularly red and blue. Here, stray patches of color appear well away from where the color should be.
There was also dilution of color details; further real life subjects frequently showed loss of color saturation and resolution in fine color details. This is probably the result of heavy-handed color noise reduction that is quite unnecessary in most situations.
Another problem is the considerable softness and sometimes virtual obliteration of detail in dark areas within areas of certain mid-shade colors, perhaps also due to color noise reduction.
These color problems are pervasive, and will significantly compromise the quality of many real life scenes. Also color accuracy was not as good as expected.

Both S7Raw and LE displayed some moderate artifacts that did not appear to be related to sharpening, such as zipper and step effects, and spurious additional lines. These artifacts mainly occurred in quite different places, but overall were comparable in nature and degree. Artifacts tended to appear on horizontal and vertical details with LE, and on diagonal details with S7Raw. The S7Raw rendering of the diagonal lines in test 1f looks bad, but this appears to be an extreme case. Overall, although there are certainly situations in which S7Raw can give worse artifacts than LE, in practice the two were comparable, and real life situations will probably favor S7Raw.

However, these artifacts were essentially absent with ACR; even though test 1f shows some of the same diagonal line problem as S7Raw, it hardly intruded in practice. This is probably largely responsible for the results generally favoring ACR over S7Raw. Both these converters were essentially free of the color and sharpening problems with LE, although S7Raw did occasionally show some color smearing.

Feature-wise, there is no comparison between LE and the other two converters. LE is a bare bones converter that processes with fixed options based on the camera settings. EX version 3.0.21.0 does offer more output options and the ability to customize the contrast curve, but other settings only reflect those in the camera. It does not come close to the functionality of either S7Raw or ACR, and is slow and awkward to use.
It should be noted here that LE (and possibly EX) appear to do some lens correction (for barrel/pincushion distortion and chromatic aberration). This might explain the smaller image size, although this margin does not appear to be used for that purpose.

Quality-wise, S7Raw and ACR compare closely, whilst LE trails some way behind. In my opinion, its combination of lack of processing options, lack of 16-bit output, and JPEG image quality make LE a complete waste of time. It would have been better for Fujifilm not to supply a converter at all. If the EX converter had been supplied instead, then this would be worthwhile, but still not do justice to the captured data.

It might well be said that Fujifilm has failed to capitalize on the advantages of its SuperCCD - the over-sharpening and color bleeding produced by its processing have been criticized in numerous reviews. After the Fujifilm processing in the camera and by LE, results from both S7Raw and ACR are revelatory.
S7Raw is excellent for a Freeware program, both in output quality and in features. However, despite having somewhat lower resolution than S7Raw, the lower artifacts of ACR probably make it the better converter overall. But either of these converters, unlike LE, will make user raw processing worthwhile.

Appendix - Raw Conversion Hints

The Fujifilm raw processing (LE/JPEG) includes a number of adjustments and corrections in addition to setting the white balance, brightness, contrast, and color saturation. For optimum quality, the following must be considered when processing with another converter such as S7Raw or ACR:

- Noise reduction
- Sharpening
- Color adjustments
- Correction of lens distortion
- Correction of chromatic aberration and color fringing

However, significant gains in image quality are possible by their better application.

Noise Reduction

There are two controls to apply this in ACR - Luminance Smoothing and Color Noise Reduction. Noise reduction is probably best applied before any other processing. The version of S7Raw tested does not offers moire cancelation, so only the noise reduction in ACR has been tried. *Version 0.4.2 of S7Raw does include noise reduction.*

Luminance Smoothing can be increased from its default of 0 as necessary to deal with grainy areas; the demosaicing appears to typically create a mottled appearance in the presence of noise. The equivalent of this also appears to be applied in LE/JPEG, but only at higher ISOs.

The Fujifilm processing appears to always do color noise reduction, and this results in the dilution of fine color details already noted. The default setting in ACR of 25 gives similar results; it is therefore recommended that for most purposes this should be reset to zero, and increased only when it is found to be necessary.

Sharpening

As the review indicates, this seriously compromises the quality with LE/JPEG. Sharpening is provided with both ACR and S7Raw, and appears to be somewhat different to the commonly-applied unsharp mask processsing. The results in this review have been obtained by using moderate sharpening as part of the conversion, followed by unsharp mask. However, this is clearly a matter for experimentation.

The type and degree of sharpening appropriate will depend on:

- the nature of the image (harder sharpening is appropriate for subjects with sharp outlines such as text, but not portraits)
- the medium on which the image is to be displayed (sharpening that looks good when printed may not on the screen, and vice versa)
- the size at which the image is to be displayed (if displayed at a small size, halos and other artifacts may give impressive sharpness without being visible in themselves)
- personal preferences (some people will prefer a sharper looking result, others will be sensitive to the artifacts introduced)

Color Adjustments

Neither S7Raw nor ACR gave accurate color without certain corrections. The adjustments applied are documented with the descriptions of those converters.

Lens Distortion Compensation

This primarily refers to geometric distortion, which is of two types:

- barrel distortion occurs at wide angles, and results in straight lines near the edge bowing outwards towards the middle (concave)
- pincushion distortion occurs at the telephoto end of the zoom range, and results in straight lines near the edge bending inwards (convex)

Even though LE/JPEG processing includes correction, reviews indicate that there is still about 1% barrel distortion at wide angle. The implication is quite clear - that actual optical performance is significantly worse than reviews indicate. So geometric distortion is likely to be a real issue with ACR and S7Raw if no correction is applied.

However, both Photoshop CS2 and S7Raw provide controls for this. They are part of the Lens page of S7Raw; with Photoshop, use Filter > Distort > Lens Correction. At the widest angle setting on the F810, a value of +80 in S7Raw and +6.00 in Photoshop appears to give the best results

Both ACR and S7Raw also offer correction for vignetting (darkening towards the corners); this affects the S5100/S5500 but is rarely an issue otherwise.

Another problem that may be corrected in the Lens adjustment page in both ACR and S7Raw is chromatic aberration. With the F810, this is mainly moderate, and of the blue/yellow variety. Chromatic aberration is worst in the F810 at the macro setting towards the edges of the field (where it is also accompanied by softening). It is characterised by both blue and yellow/orange fringes either side of a high-contrast feature, especially noticeable with black and white details.
Note that this is a quite separate issue from the purple/blue fringing due to sensor saturation described in the next section.

Purple/Blue Fringing (Sensor Saturation) Correction

Although this is only a real problem on a small percentage of photographs, when it does occur it can be quite pronounced. It is perhaps the biggest shortcoming of the F810 and similar cameras. The good news is that by careful post processing, it can be virtually eliminated with an excellent end result.

Note that this is NOT chromatic aberration, and should not be treated as such. It is characterized by an infusion of color into existing details, without a corresponding yellow/orange fringe. It is a result of over-exposure, and can be seen next to blown highlights such as sky that border darker areas. The fringing is deep blue on my F810 but purple on many other cameras, and is often 4 or 5 pixels wide.

Often chromatic aberration will also be present - in this case, chromatic aberration should be corrected first, checking only for yellow fringes.

Color fringing should be dealt with by selective color replacement. The following steps enable this to be done very effectively using Photoshop.
Although the problem usually results in purple or blue fringes, white or light colored haze can also occur round bright objects against a less bright background. This can be dealt with in the same way.

Fixing Color Fringing in Photoshop

Various methods have been suggested for this, including using a chromatic aberration tool (inappropriate) or blanket reduction of magenta/blue saturation (crude).
There appears to be a useful tool for this purpose in the latest version of Paint Shop Pro. Alternatively, the following Photoshop technique, although taking a few minutes, yields excellent results without much difficulty.

1. Initialise:
Open the image to be processed, and zoom to at least 100% to enable accurate treatment of the fringing. Open the Tools and Color dialogs (Window > Tools and Window > Color).

2. Create a new layer for the corrections: Layer > New > Layer…
On the New Layer dialog, set the Mode to Color and leave Opacity at 100. OK the dialog.

3. Select the color range to be replaced: Select > Color Range…
On the color range dialog, one can either choose Sampled Colors or a particular color group. Selecting the color group of Magentas or Blues will often remove the worst of the fringing, but for the best results, Sampled Colors should be used. The range can be selected by clicking on two fringed areas of the image. The Fuzziness slider should be adjusted as appropriate to vary the scope of the range. OK the dialog.

4. Select the replacement color:
Open the Color Picker tool by clicking on the foreground/background color icon. in the Color dialog. Selection of the replacement color can be done by clicking on an appropriate untainted point in the image. OK the dialog.

5. Replace the color:
Use a brush or similar tool to wipe over the points selected in the image where the color is to be replaced.

6. Deselect the areas: Select > Deselect

7. Flatten the layers: Layer > Flatten Image.

Steps 4 and 5 can be repeated for each replacement color required for a particular color range. Typically, a single replacement color for all selected areas will be fine; it will usually be a dark gray with perhaps some color such as green for foliage.

Steps 3 to 6 should be repeated until all fringed areas have been dealt with. Typically three or four iterations should give excellent results and take less than five minutes.

This technique gives maximum flexibility, both in enabling a number of ranges of colors to be specified, and for each range a number of replacement colors (which are applied only to those areas selected for that color range). Its careful use will virtually eliminate the consequences of color fringing, whilst leaving underlying details intact.