



TIPA Camera Test

How we test a camera for TIPA



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1 INTRODUCTION

At Image Engineering, we have been testing digital cameras in order to provide independent test results since 1997. This document provides a brief tour through our measurement processes for TIPA.

There are four major components to the camera measurements Image Engineering performs for TIPA: image quality, speed, features, and handling. All of the tests are purely objective, with the exception of the handling assessment. Each of these four sets of tests is described in this paper.

2 TEST ENVIRONMENT

Image Engineering carries out many of its assessments in rooms tailored to testing digital cameras and lenses. In these rooms, external factors that might influence the results of tests are reduced or controlled. So, for example, the walls and ceiling are painted black (and the floor is neutral grey), in order to reduce the risk of reflected light influencing the test results. In this dark environment, the test charts or scenes are illuminated with artificial lighting. The lights used are checked every month to be sure that they are creating a consistent lighting environment.

The lab is not only dark but also temperature-controlled. All measurements are made at room temperature (23°C). This is because temperature can influence the quality of a digital image (as heat influences noise).

Test images are captured with the camera mounted on a mount or tripod, which in turns stands on strong rails on a massive concrete floor. This is to avoid interference in results due to blurring from movement, such as vibrations from the operator's hand.

And, finally, of course the subject of the photograph also has to be controlled – one wouldn't be able to fairly (or easily) compare photos of different things. Image Engineering's camera measurements are based around test charts that are produced in-house and are regularly quality-controlled.

2.1 *Sourcing the cameras*

The cameras we assess for TIPA are provided by the manufacturers as test samples. Each device is checked before testing begins. If any kind of doubt arises that the hardware or firmware is representative of the device that is available to consumers, we reject the camera for testing and ask the manufacturer for a new device.

In addition, should our test results indicate any physical damage to the camera (for example, large differences in resolution between the four corners of the image), the device is also rejected and the



manufacturer asked to provide a new camera. If the replacement device shows similar results, it is considered as "as is", testing continues and the results are provided to TIPA.

The results are sent directly to TIPA: at no point does the manufacturer have access to the results or any opportunity to comment or approve results.

2.2 Camera settings

Once a camera had arrived at the Image Engineering lab, all settings are put at "factory default". From this starting point, settings are then set for the test. The settings used are detailed in the table below.

Should the model of camera being tested have additional camera settings not included in the list below, Image Engineering selects the setting which represents that most likely to be chosen by consumers. Which setting has been chosen is recorded to ensure consistency with future tests on cameras with similar settings.

PARAMETER	SETTING	INTENTION
pixel count	sensor native	avoidance of interpolation
compression	best JPEG, RAW	best available quality of image capture
image enhancement	off (if possible)	e. g. contrast, HDR, face detection
contrast enhancement	off	e. g. D-lighting
sharpening	factory default	most customers do not change these
lens correction	on (if available)	correction in signal processing is part of the system
noise reduction	factory default	correction in signal processing is part of the system
color	factory default	most customers do not change these
color space	sRGB	
flash	off	uniform illumination needed (except flash test)
stabilization	off	not needed, and not recommended when using tripod
mode	P, M or Av	aperture is part of test definition
sensitivity	ISO100 - max	lowest native ISO speed, minimum ISO100
white balance	auto	avoid color cast
self timer	2s (or remote)	prevent vibration
autofocus	Spot-AF	AF-Spot may be set off-center to get better performance
digital zoom	off	avoidance of interpolation of pixels



2.3 Lenses used for testing

We use two different lenses to test each camera body. The same lenses are used on the various camera bodies produced by each manufacturer. Thus, each model of camera body made by Sony, for example, is tested with the same two lenses. One of these lenses represents 'best quality'. The 'best quality' lens is usually a prime lens. It is used for all measurements related to image quality and also for photographing the test scene and portrait.

The second lens is chosen for its speed and is used for timing-related measurement. The 'speed' lens is usually a standard zoom lens.

Using the same lenses for tests on different camera bodies, helps ensure comparability of the results. The test lenses are stored on site at Image Engineering and are either the property of Image Engineering or long-term rentals from manufacturers. The lens used is detailed in each report of test results.

2.4 Viewing conditions

Some aspects of image quality change depending on how a human observer sees the image. The same image may be judged differently when it is seen as a small printout or when it is projected onto a large screen. Some aspects affecting perceived quality might only be visible when observed in large scale. In order to accommodate these differences in perception, images are analyzed with the use of models that take into account the human experience of observation. We call these models viewing conditions. These models are incorporated as algorithms into the analytical software Image Engineering uses for its objective testing of cameras.

If not otherwise stated, we use the following three viewing conditions:

2.4.1 Viewing condition 1 - 100% view

This represents a 100% view on a standard PC screen at 0.5m viewing distance. As screen resolution is fixed (pixels per inch), an image with more pixels is larger. This viewing condition highlights most of the flaws in an image.

2.4.2 Viewing condition 2 - Small print / Mobile screen

This viewing condition represents the observer experience of a small printout of the image 10cm in height, viewed from a distance of 25cm. Even though specified for a print, we can use this viewing condition also to judge how the image appears on a modern smartphone display.

2.4.3 Viewing condition 3 - Large print / PC screen

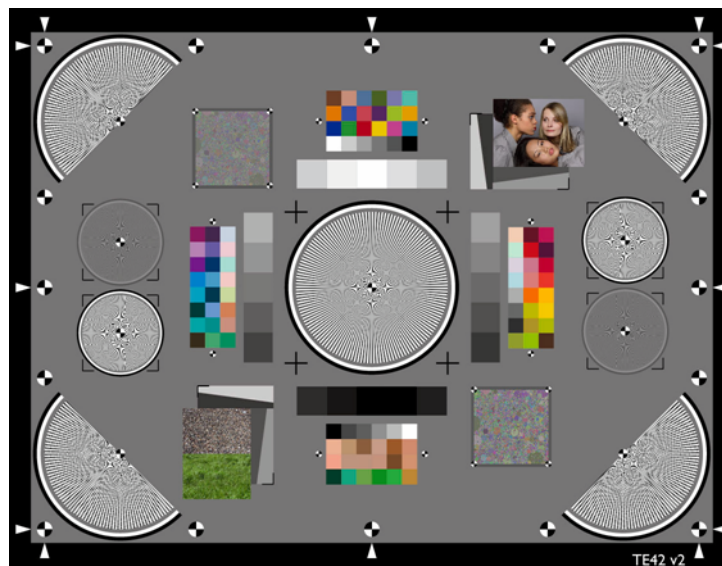
For this viewing condition, we model the human observer in front of a large print (40cm height) with a viewing distance that equals the diagonal of the image (so it depends slightly on the aspect ratio). This viewing condition also represents the observation of a full-scale image on a modern computer screen.

2.5 Measurement procedure

A multi-functional test chart (TE42) is used to objectively measure resolution, texture reproduction, acutance, dynamic range, noise, color reproduction, distortion, shading, chromatic aberration, and visual analysis. With every native ISO speed the camera offers, we capture four images of the chart using the camera being tested on a stable mount and then select the best for further analysis. "Best" is defined as highest resolution in the image center.

Exposure can influence some results, which is why tests are performed using a standard protocol which may be derived from applicable ISO standards or are defined by Image Engineering.

Cameras that also capture video, are assessed in video mode with regard to resolution, texture loss, sharpening, dynamic range, visual noise, and color reproduction. These tests are carried out on individual frames from a five-second video.



The TE42v2 test chart. Within the one chart are different elements which comprise the basis for measurement, including resolution, distortion, color, shading, texture loss, and sharpening.



3 SCORE 1: IMAGE QUALITY

Image quality is measured for both still photographs and for video. All measurements take the form of what are known as "semi-reference-methods" and based on international standards wherever possible.

A semi-reference-method compares reality and the image captured: specific aspects of the original scene photographed are compared with the image as recorded by the camera being tested. For example, noise can be assessed by examining the camera's image of a uniform grey patch. The grey patch in the test chart does not vary across its area, and so any variation in the digital values recorded in the camera's image, has been added by the camera. This is noise, and the degree of divergence from the uniform provides the measurement of the noise.

All measurements of image quality are "system tests", meaning that all parts of the camera are included and may potentially influence the results. Thus, lens, sensor, and signal processing may each have an impact and must be included in the testing. For example, the performance of the lens will not change with different light levels, but the signal will be processed differently. Thus, the resolution, due to differences in processing, will also change depending on the selected ISO speed. Therefore all measurements are performed for different ISO speed settings, as a higher ISO speed indicates less light per pixel, and this has an impact on the image quality.

3.1 Resolution

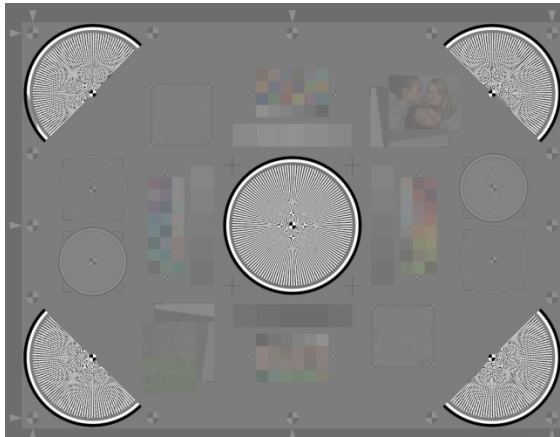
Resolution and pixel count are not the same, although inconsistency in communications may have encouraged consumers to develop an incorrect perception that they are the same. While the pixel count is simply the number of pixels found on the sensor, resolution is the level of detail a camera can reproduce. A camera with double the number of pixels in the sensor, does not necessarily have twice as much resolution.

The resolution of a digital camera was originally described by a single function, called the spatial frequency response (SFR). However, digital cameras are now designed to perform in-camera processing of images captured. The image may be subject to processes that, for example, increase contrast in areas with high level of detail (e.g. foliage) or high contrast edges (e.g. written text), but not in areas where there are few details (e.g. sky). The TE42 test chart mentioned above allows these different functions to be tested.

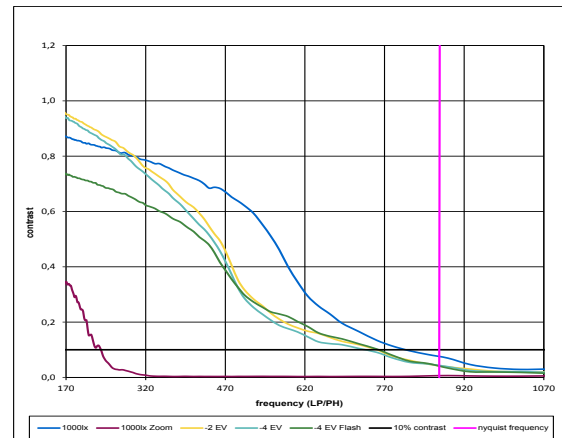
3.1.1 Measuring resolution

Resolution is measured for each camera using a complex figure called a sinusoidal Siemens star (described in the international standard ISO12233:2014). The star consists of 144 cycles between

bright and dark and is itself printed with such high resolution that we can measure all cameras that are on the market today.



The TE42v2 test chart with the sinusoidal stars highlighted



An example of MTF curves after calculation

A dedicated software program registers the center of the stars and reads the digital values over the radius. Based on this information, an SFR is generated. From the resulting SFR, a variety of numerical values are derived. The limiting resolution is defined as the highest spatial frequency the device under test can reproduce with at least 10% SFR (often called the MTF10 value). So it is the absolute limit of detail that you can see in the image.

The unit used to describe the resolution results is line pairs per picture height (LP/PH). So, if a device has a limiting resolution of 1500 LP/PH, that means that the device can differentiate and provide at least a minimal contrast for a pattern that is equivalent to 1500 black and 1500 white lines interleaved side by side within the image height.

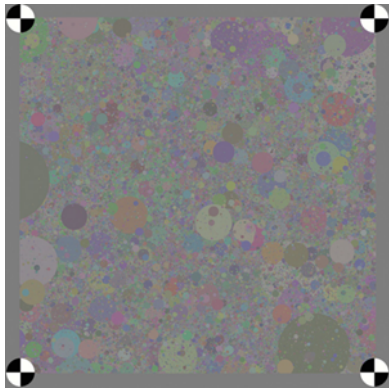
3.1.2 Texture loss

Digital cameras today apply noise reduction to improve image quality. This process involves a noise reduction algorithm detecting regions of the image that contain a lot of noise, and then smoothing that area. Unfortunately, it is possible that what is detected as noise is in fact an essential component of the image. This means that low-contrast fine detail may be automatically removed as it is classified as noise and not as important detail. This "texture loss" is not easy to measure, although it is a very important differentiator in image quality, especially in low light situations.

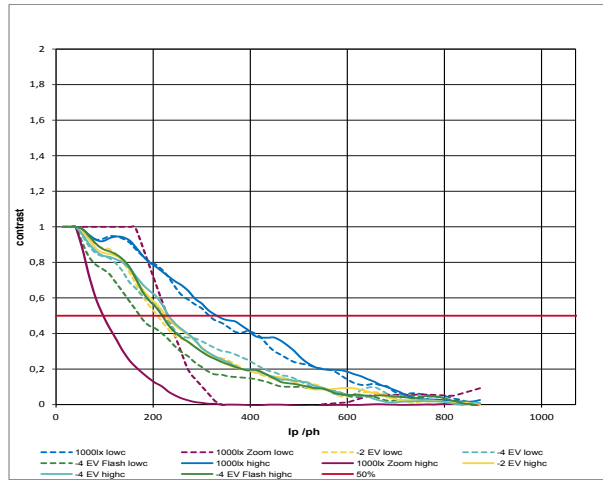
At Image Engineering, texture loss is measured using two versions of a pattern called "dead leaves" (as it looks similar to a pile of leaves on the ground). The pattern consists of thousands of circles that are stacked on top of each other. The radius, position, color and intensity of each circle is random with a known probability function. The image is then analyzed using a method called "DeadLeaves_cross",



a method which was developed by Image Engineering and currently on its way to become an ISO standard in the future.



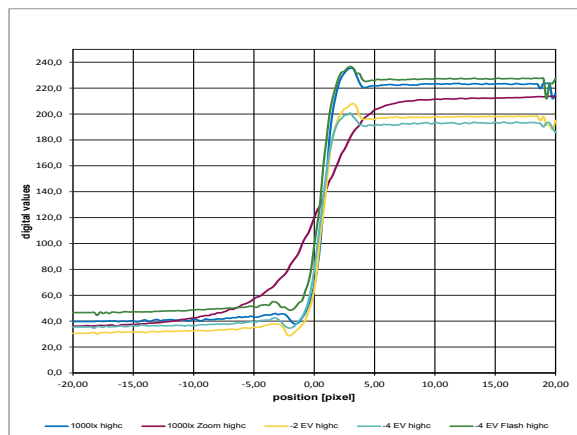
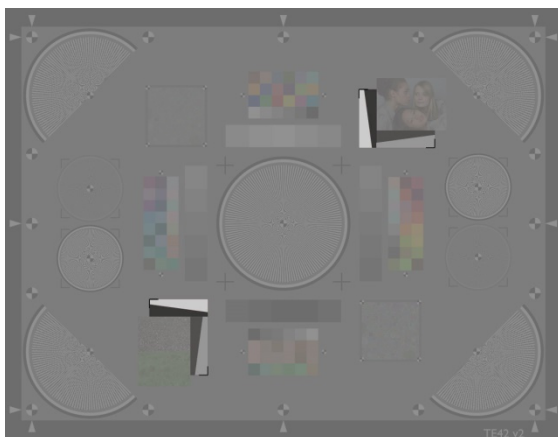
The 'dead leaves' pattern (low contrast version)



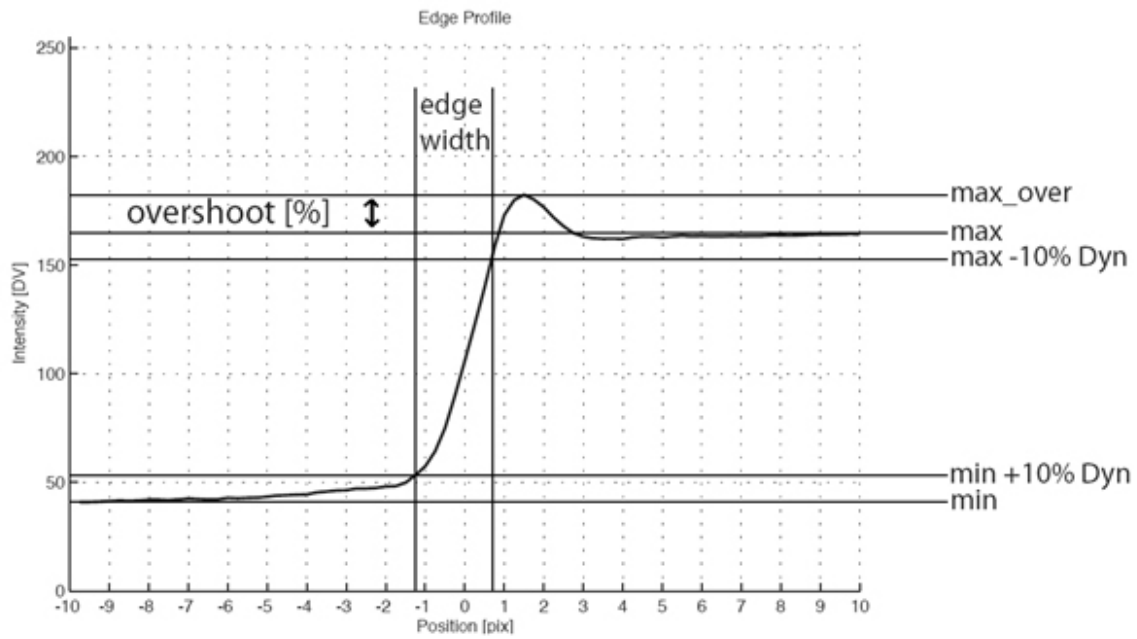
An example of the software output

3.1.3 Sharpening

Image Engineering uses the measurement of a black/white slanted edge to characterize the sharpening a camera applies to the image. Edge measurement has been used in the past to measure resolution, but that result can be flawed because of in-camera sharpening. High-contrast edges are easy for a camera to detect and enhance, so a measurement of resolution using these high-contrast edges may not reflect whether the image overall looks good. However, such a high contrast edge is useful to assess sharpening. Image Engineering uses the edges spread function (ESF) as described in ISO12232:2014, to calculate the overshoot and undershoot, a reflection of the artifacts of sharpening. In general, having no sharpening would not be beneficial as the image appears less crisp, and yet too much sharpening results in visible and disturbing artifacts.



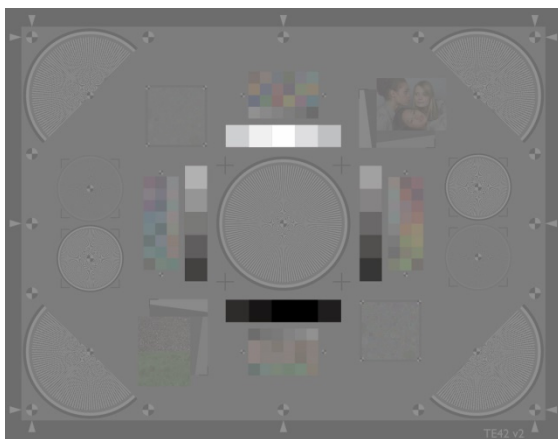
The edges used in assessing sharpening (top left), and an example of the output (right). Below is a graph demonstrating overshoot.



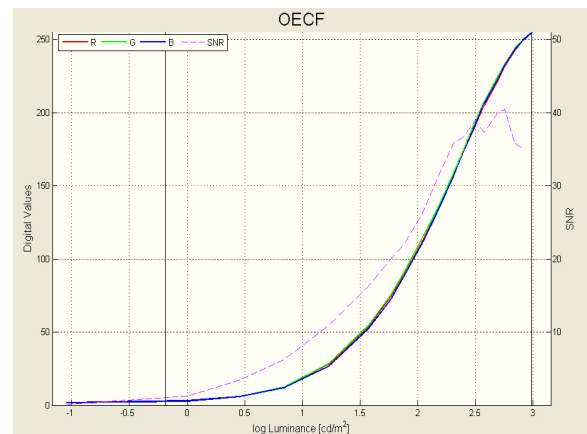
3.2 OECF and Noise

Image Engineering uses a special transparent test target to measure OECF, Noise and Dynamic Range. The chart consists of gray patches that show a well-defined and regularly re-measured luminance (in unit cd/m^2). The analysis consists of checking how the camera renders the gray patches. The measurements we perform are defined in ISO14524 and ISO15739.

OECF stands for Opto Electronic Conversion Function which describes how the camera reproduces patches with a known luminance. This function is needed for further calculation and analysis.



TE42v2 Chart with 20 gray patches



OECF and SNR curves after calculation



3.2.1 Visual Noise

The amount of noise in an image is frequently measured as the ratio of signal to noise (SNR). We also measure the SNR, but we do not use it for the assessment, as the SNR is not correlated to the human vision. Although higher SNR is technically better, it is possible to have two cameras with the same SNR that show different amounts of noise to a human observer. The problem is that SNR does not take the human observer and the viewing conditions into account.

The visual noise approach uses a model of how a normal human observer perceives spatial frequencies. With that model, the noise a camera adds to an image is weighted before the analysis. In this way, components of noise that are hardly visible to a human observer have only a small effect on the result. In contrast, components of noise that are clearly visible to humans are more heavily weighted. The visual noise metric depends on the viewing condition. Therefore, we calculate the visual noise value for the three different common viewing conditions as described earlier in this document (See [Section 2.4](#)).

3.2.2 Dynamic Range

The dynamic range of a camera is defined by the contrast between the highest luminance that can be reproduced and the lowest luminance that can be reproduced. The highest luminance that can be reproduced is limited by clipping. Thus, if a bright object is rendered to the maximum digital value (255 for an 8bit image), an even brighter object will not get a higher digital value, and the information is lost.

The lowest luminance is limited by noise. So as soon as the SNR gets too low, the information is lost and an even darker object cannot be differentiated. While the ISO standard defines the threshold based on the signal theory with $SNR=1$, we use a slightly more difficult threshold of $SNR=3$, based on Image Engineering's two decades of experience in digital photography.

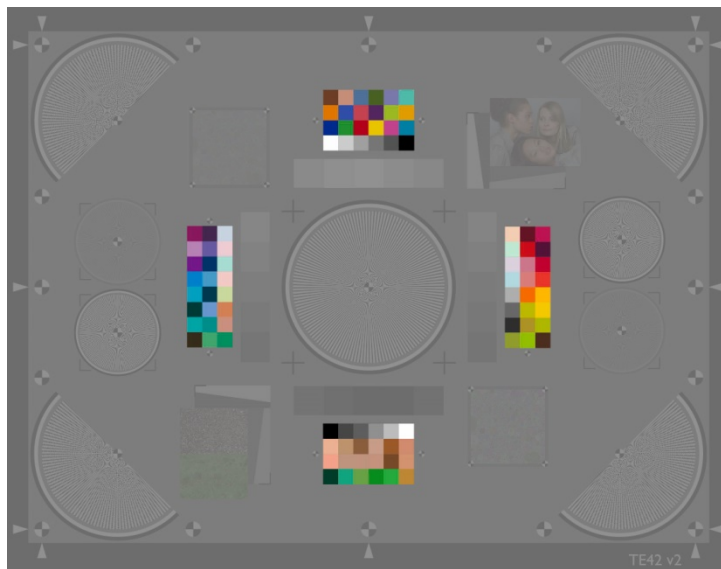
The dynamic range is a ratio which can be expressed in different units. We report the dynamic range normally in the common unit "f-stops" or "EV" (Exposure value). Every f-stop equals a doubling of the contrast. A dynamic range of 10 f-stops equals a contrast of 1000:1.

3.3 Color

Many magazines and test institutes make the mistake of measuring how well a camera reproduces colors. The problem is that a digital camera is not made to reproduce colors accurately. A digital camera is made to provide pleasing colors. This makes assessment of color reproduction very challenging.

Color itself is a subjective impression by the observer, depending on the hue and saturation itself, the environment, and personal preference. Therefore color assessment at Image Engineering focuses on revealing any significant issues with color reproduction.

To measure color reproduction, we use color patches within the TE42 test target. The colors in these patches have been selected with reference to the well-known X-Rite ColorChecker SG color target. Each of the 96 color patches is individually measured using a calibrated spectrophotometer. Reference data is provided to the analysis software along with the image being tested. With the knowledge of the RGB color space (the commonly used sRGB), we can convert the RGB data to the CIE-LAB color space. Based on the LAB color space, we calculate color error and differences in brightness, saturation and color tone.



The color patches on the TE42v2 test chart.

3.4 Video

In order to assess video quality, a five-second video recording is made of the TE42v2 test chart under bright light (8000 lux) at two ISO settings (ISO100 and ISO1600). With camera models that do not permit the user to set aperture and shutter speed manually in video mode, the videos are made in auto ISO mode, with bright light and low light. For each recording, five individual frames are 'grabbed' from the recording by the analyzing software and compared with regard to sharpness. The sharpest of each recording is used for further analysis.

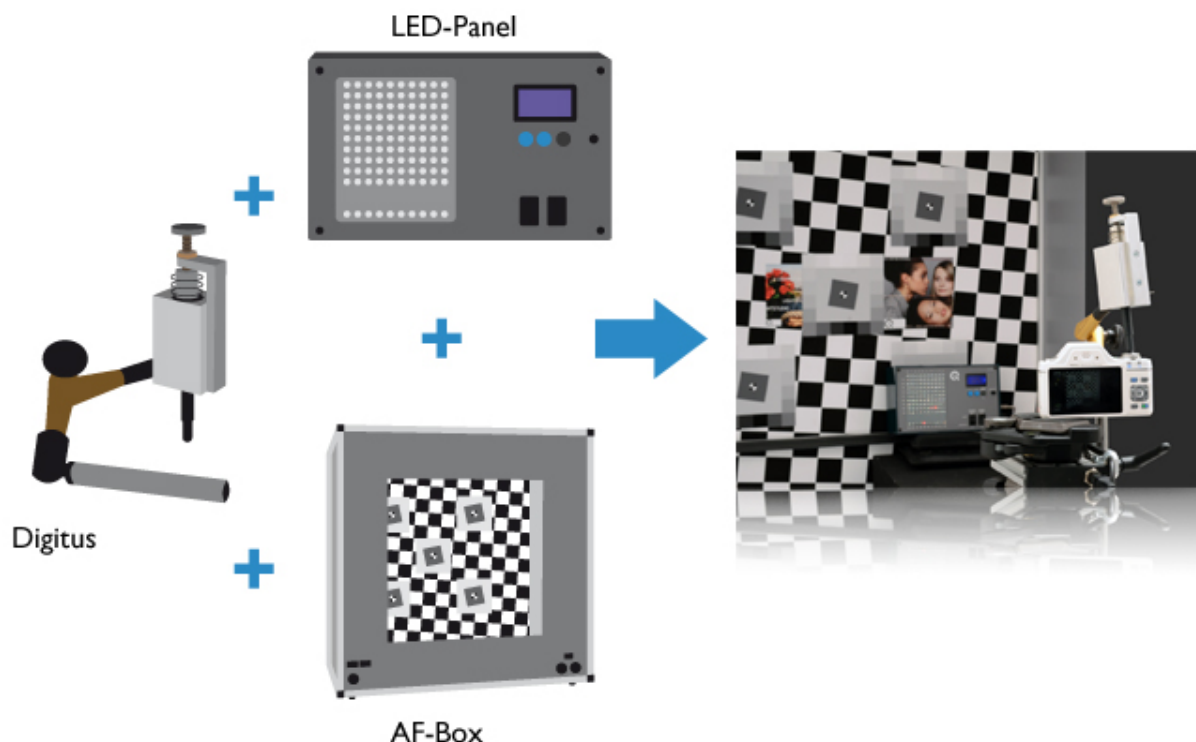
Video frames captured are assessed as described above, with regard to resolution, texture loss, sharpening, dynamic range, visual noise, and color reproduction.

4 SCORE 2: SPEED

4.1 Shooting time lag and auto-focus speed

Shooting time lag is the time (in seconds) between pressing the release button and the start of the exposure, starting with a camera that is not focused onto the target. Thus, the shooting time lag includes both the time needed to auto-focus on the target and the shutter release time lag (see next section). The release button may be a physical button on the device or a button on the user interface (touch screen).

This test is carried out in high and low light, using auto-focus with the viewfinder, auto-focus with LiveView, and also in high light conditions without auto-focus. For each of the five conditions, the measurement is carried out ten times, and the result is averaged. For each measurement, the camera being measured is focused onto an object in the far distance. For the measurement, the camera is aimed at a test chart with many different edges with different contrasts (to make sure the auto focus process can detect needed edges; see below). Also included in the test box area photographed is an LED Panel that shows sequential red lights at precise speeds. Thus, the location of the lit LED light shown in the photograph can be used to determine how much time passed between pressing the release button and the start of the exposure.



Elements used in the speed tests: shutter release, chart used for auto-focus, and LED-Panel.



4.2 Startup time

The camera's startup time is measured from turning the camera on, until the first image can be recorded. Extraneous functions, such as auto-focus and any starting image, are turned off.

4.3 Frame Rate

The number of frames in burst shooting is measured for both the largest jpeg images and also for RAW (if available). The fastest mode of burst shooting is always the mode tested. For cameras that slow down after a certain number of shots, this first set of faster frames is called `frames in a series`. The amount of time required to shoot the maximum number of frames in burst shooting, or 100 frames, whichever is smaller, is measured.

5 SCORE 3: FEATURES

The Features component of the score is calculated on the basis of a standardized checklist. This list assesses the features present in the camera model, both on the basis of the manufacturer's published specifications and on the basis of an individual check of the camera. Features assessed include sensor type and resolution, number of data cards that can be used, hardwired connections, and viewfinder and monitor type and size. Features are weighted to reflect their importance to the camera user, and each camera is assessed against the same checklist.

6 SCORE 4: HANDLING

The Handling score is derived from a subjective assessment of how the camera feels in the hand, and how accessible some features are in the reality. Some of the camera ergonomics included on the handling checklist include whether buttons can be comfortably used, or whether the size, shape, the number that must be held down at once, the robustness of dials, or other such quirk interferes with camera use. Camera robustness, whether it would fit into a trouser pocket, and whether the camera's , shape, size and weight could mean it could become a favorite travel or hiking companion, are a few of the other characteristics assessed. The handling checklist is broken down into five categories, each of which contributes 20% to the final score: buttons, ergonomics and build, viewfinder and monitor, general operations, and video.



7 GLOSSARY

Resolution	
Resolution	The level of detail a camera can reproduce. The highest possible resolution of a digital camera is limited by the pixel count, but lens and signal processing very often cause a lower resolution than possible with the pixel count . Resolution is expressed in units of LP/PH (Linepairs per Picture Height) or cy/px (Cycles per pixel).
Pixel count	The number of pixels the camera can capture, mostly reported in Megapixel. So 20 Megapixel equals 20 Million pixel. Unfortunately pixel count is very often misinterpreted as resolution . A camera with 20 Megapixels has a higher pixel count compared to a camera with 16 Megapixels, but it does not necessarily have a higher resolution.
Nyquist Frequency	The theoretical highest possible spatial frequency a camera can reproduce.
Spatial Frequency	Spatial frequency describes the number of cycles (maximum and minimum in a signal) per distance. A high spatial frequency equals very fine details, while a low spatial frequency describes changes of intensity over a larger area. Common units are LP/PH or cy/px .
SFR	Abbreviation of Spatial Frequency Response, which is a mathematical model of how a camera system can reproduce spatial frequencies. Perfect reproduction equals 100%, and a lower number represents lower contrast. (Less than 10% means a complete loss of information.) A SFR value higher than 100% cannot be reached by optical components; this strongly indicates in-camera sharpening or other optimization algorithms in the image signal processor. Single values like MTF10 , MTF50 or Acutance are calculated based on a SFR.
MTF	Abbreviation: Modulation Transfer Function. The traditional way to describe how an optical system can transmit spatial frequencies. Per definition only applicable if a harmonic pattern (sine waves) is used for the analysis. A MTF is the same as a SFR and can also be interpreted like a SFR.
MTF10	see "limiting resolution"
limiting resolution	The highest spatial frequency a camera system can reproduce, defined by the spatial frequency that leads to a SFR of 10%. The higher the number, the more details a camera can reproduce. A high limiting resolution does not necessarily mean high sharpness .



MTF50	The spatial frequency that leads to a SFR of 50%. Experience shows, that the MTF50 values correlates somehow with the human perception of sharpness . However, as it does not take the viewing condition into account, this correlation does not always hold.
Acutance	The acutance is a numerical value, calculated based on a SFR, a given viewing condition and the CSF . The acutance correlates with the human perception of sharpness. The image with a higher acutance is rated as more sharp by most observers.
Viewing condition	Different properties of a digital image vary depending on how a human observer observes the image. It is harder to see details in a small image at a larger distance than when able to observe a large image from nearby. In order to reflect these differences, some measurements, including Acutance , Visual Noise and Sharpening , are calculated for different viewing conditions.
CSF	Abbreviation: Contrast Sensitivity Function. A model of how the normal human observer can perceive spatial frequencies. The CSF is used to calculate Acutance and Visual Noise .
Texture or Texture loss	The lack of capability of a camera system to reproduce low-contrast, fine details. Because of noise reduction and data compression, these details are often lost as the optimization algorithms cannot adequately distinguish between noise and low-contrast image content. One of the biggest differentiators between a system camera with a large sensor, and mobile phone cameras or small compact cameras is the lack of texture in low light.
Siemens star	The name of a pattern used for the measurement of the SFR. It is described and defined in the standard ISO12233:2014.
Dead Leaves	A pattern used to measure texture loss . A huge number of circles with a random diameter, position and color are stacked on top of each other to build the pattern. The pattern itself has been used in camera analysis since 2008, but the appearance and contrast of the pattern and the analysis algorithms have changed.
Slanted Edge	The SFR of a digital camera is obtained from a photograph of slanted edges. The SFR is calculated from the image of the edge transitions. The results may be influenced by sharpening and other optimization algorithms, as these can easily detect and enhance edges.
Sharpening	The term Sharpening includes all algorithms and techniques that try to improve the human perception of sharpness in a digital image. In most cases, sharpening also introduces artifacts along edges, such as overshoot and undershoot. Sharpening also tends to increase the noise



	in the image. Thus, too much sharpening will have a very negative impact on the image appearance, while lack of sharpening can result in flat and unpleasant images.
Overshoot / Undershoot	Sharpening in the signal processor can create image artifacts which consist of dark and light highlights, or areas of increased contrast compared to the edge contrast. In extreme sharpening, we can observe black and white lines along edges.
OECF and Noise	
OECF	Abbreviation of Opto Electronic Conversion Function. This is a measured function that describes how a digital camera converts the luminance of an object into digital values. The raw sensor signal will most likely show a linear OECF, while a processed image will show an OECF curve. The OECF is used as a helper for other calculations (Noise, SFR, Dynamic Range, ...) as the non-linear OECF curve needs to be corrected in an analysis step called Linearization .
Noise	The fluctuation of a signal caused by random processes. In digital imaging, noise is caused by different effects in the light itself, the sensor, and the analog/digital conversion. It results in changing digital values over time (temporal noise, in several images of the same scene) and over neighboring pixel (spatial noise, for pixels that show the same object). In general, the noise increases with less light coming in to a single pixel. Small pixels are more likely to show significant noise than larger pixels.
SNR	Abbreviation of Signal to Noise ratio. This is a common measure of the noise in any kind of signal. The higher the value, the less noise is present.
Visual Noise	A metric to describe the perception of noise. In addition to the SNR , the visual noise measurement takes the human observer and the viewing condition into account.
Dynamic Range	The ratio between the brightest area and the darkest area in an image. In camera testing, the value reported is the "input referred dynamic range" (e.g. 9 f-stops) in comparison to the output referred dynamic range (e.g. 8bit or 16bit).
Luminance	The photometric measure of luminous intensity, expressed in cd/m^2 (candela per square meter). The higher the value, the brighter an area appears. It depends on the illumination and the reflection of the object.
Linearization	One of several steps in the image analysis. This will correct the non-linear OECF as many of the mathematical assumptions and calculations can only be performed on linear data.
Color	
Color Reproduction	A measurement procedure to evaluate how well the colors in an object



	have been reproduced. The ideal, for perfect reproduction is the lowest possible color error (ΔE). However, in photography, the aim is to have "nice colors", rather than "correct reproduction", so a very low color error does not always mean an improvement in image quality.
ΔE	"Delta E", the difference between two color samples in the CIE-L*a*b* color space. The E stands for the Euclidian distance and the lower the distance the closer the colors. A ΔE of 1 equals a difference between two colors that a normal, untrained observer is able to see.
ΔL	"Delta L", the difference in lightness between two color samples in the CIE-L*a*b* color space. Lightness represents how bright a color appears, so a negative ΔL means, that the color appears darker as it should.
ΔC	"Delta C", the difference in chrominance between two color samples in the CIE-L*a*b* color space. Chrominance represents how saturated a color appears, so a negative ΔC means, that the color appears less saturated as it should. Many cameras tend to increase the saturation to make the image appear more colorful.
ΔH	"Delta H", the difference in the color tone between two color samples in the CIE-L*a*b* color space. The color tone is expressed in the angle Hue. A difference in Hue represents a shift in the color itself.
CIE-L*a*b*	A color space that behaves linear to the human perception of color. This color space is widely used to describe color independent from a specific device and is also used to calculate the color error (ΔE and others) between two color samples. To convert from the camera output to CIE-L*a*b*, the color space of the camera needs to be defined (e.g. sRGB or AdobeRGB).
Timing	
Startup-Time	The standard ISO15781 defines this as the time between activation of the camera via the main switch and the camera being ready to capture an image. As the status "ready to capture an image" is not well defined, IE measures the time between activation via the main switch and the start of the exposure, so it includes the shutter release time lag .
Shutter release time lag	The time between activation of the release button and the start of the exposure. It is assumed that the camera did not have to focus onto the object, as the focus is turned off or the main object is already in focus. This reflects the situation where the photographer is waiting for the right moment, while the camera is already prepared.
Shooting time lag	This is the shutter release time lag plus the autofocus time. The device under test is de-focused and needs to focus onto the main object before the exposure starts. This reflects the situation where the photographer



	has the camera on stand-by and is targeting a new object.
Autofocus time	The time the camera needs to focus on an object. This depends on the camera and the lens. It is calculated as the difference between shutter release time lag and shooting time lag.
Shooting rate	How many images the device being tested can capture per second. It is also commonly reported in fps (frames per second). Next to this number, it is best practice to also evaluate how many images can be captured at this speed. Some devices might be able to capture a few images very fast, but then slow down significantly while writing the captured images from the internal memory onto the memory card. "Until card full" is reported if the device did not slow down until the memory card was full.

8 BIBLIOGRAPHY

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