ViDi Labs HD/UHD test chart v.5.x

Product manual

Video and Digital Imaging Labs

ViDi Labs

www.vidilabs.com

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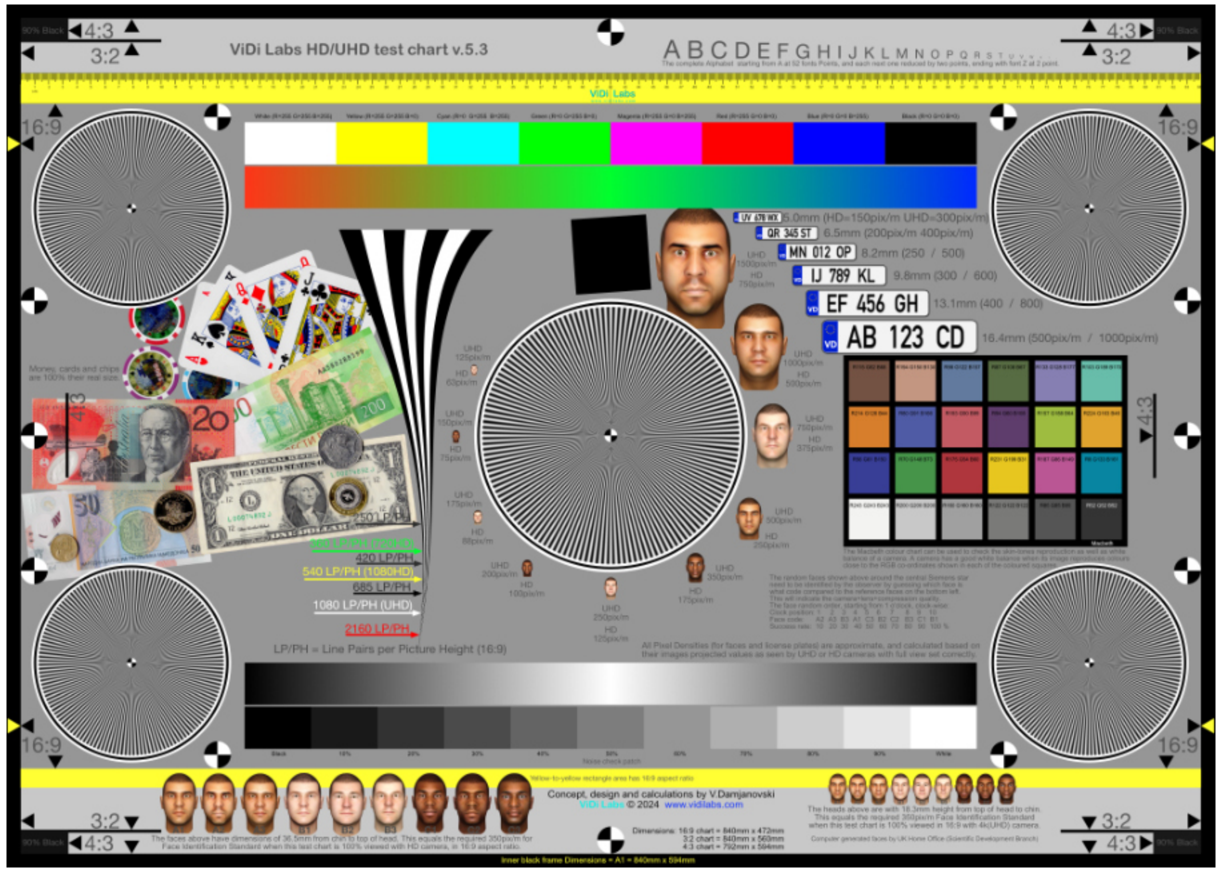

Please handle your Test Chart with care!

The ViDi Labs HD/UHD Test Charts are designed primarily for indoor use. If used outdoor, please avoid direct exposure to rain, snow, dust, or long periods of exposure to direct sunlight. Although the ViDi Labs Test Chart has been designed specifically for the CCTV industry, it can be used to verify the quality of other visual, transmission, encoding and recording systems.

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Contents

*ViDi Labs has designed this chart with the best intentions to offer an objective and independent evaluation of various video signal characteristics, and although all the details are as accurate as we can make them, **we do not take any responsibility for any damage or loss** resulting from the use of the chart.*

The standard dimensions of this test chart is A3 size (420x297mm) for convenient packaging and shipping. The same chart can also be produced in A1 size (840x594mm) if required. Please contact us for more details on costing, packaging and shipping.

The chart design is subject to change without notice due to ongoing product improvements.

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v. 01/02/2025

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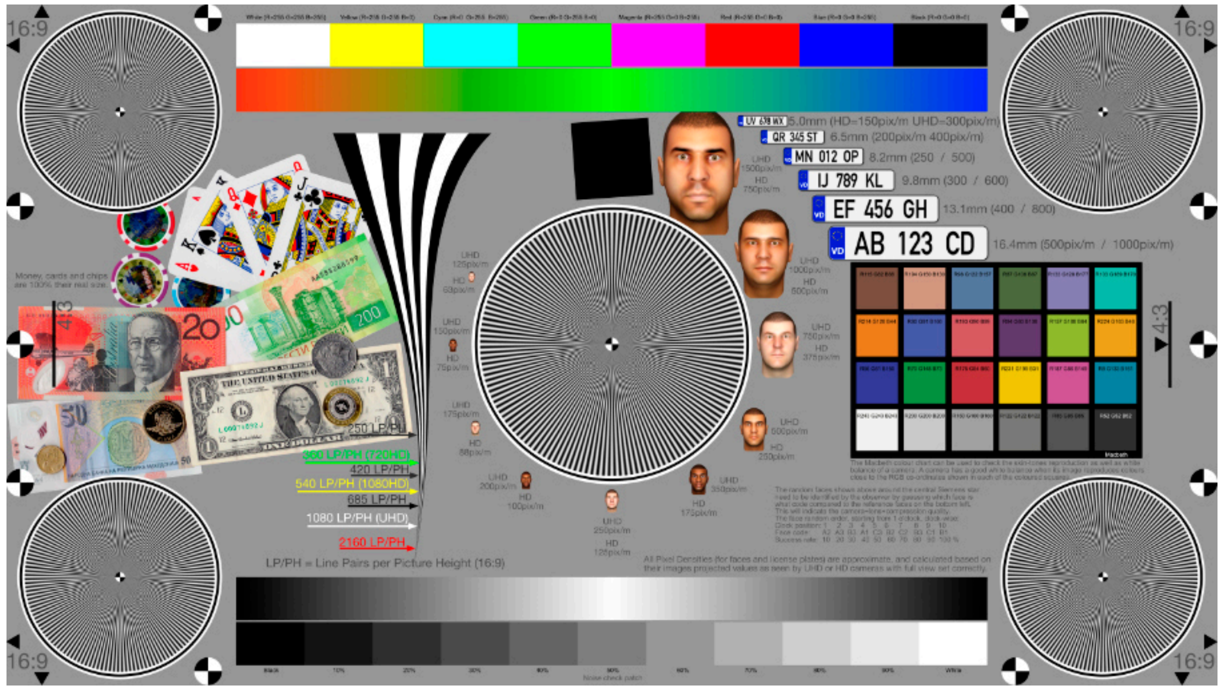


The ViDiLabs version 5.x is a **multi-format test chart**, which allows for testing of cameras with aspect ratios 4:3, 3:2 and certainly 16:9, all within the one test chart.

While the previous 4.x version was intended for SD and HD resolutions, in the new 5.x version we have gone one level higher. Now you can test and evaluate **HD (2k) and UHD (4k) cameras** up to 12MP, and all the mega-pixel sensors in between.

The ViDi Labs HD/UHD test chart v.5.x is a significant update with many new features that will easily and convincingly test various camera parameters.

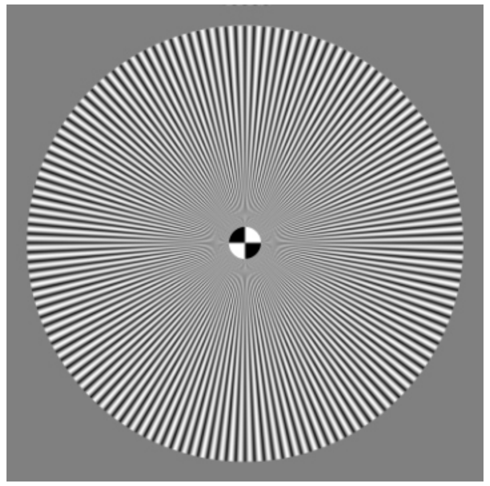
These parameters include camera ***resolution, colour quality, linearity, gamma, noise levels, dynamic range, minimum illumination and pixel densities.***

The most important advancement we have made has been the creation of dedicated software for **automated and objective testing** of some of the critical parameters listed above. This removes human error and guesstimates made by visual inspections, and most importantly, they are all **compliant with the IEC 62676-5** standards.

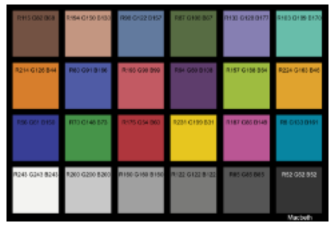
If you send us exported JPG, TIF or BMP images from your camera and we will perform a **free software analysis** for up to ten different images and send back the report to you.

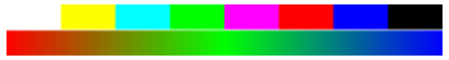
You can still perform manual inspections and evaluations, as with the previous test charts. We will explain all details of such procedures further in this manual.

The key elements of the ViDi Labs HD/UHD test chart



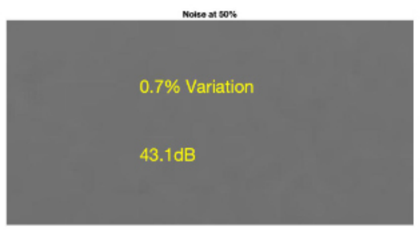
For a more objective camera resolution measurement we have now included **sine-wave Siemens stars**, as recommended by the IEC 62676-5 and referred to as **sSFR** (*Siemens star Spatial Frequency Response*). We have one larger star in the middle of the chart that can be used for focusing, as well as another four smaller sine-wave stars in the corners of the chart. These are useful for aligning the perpendicularity of the camera versus the test chart. The stars also permit checking of lens corner resolution, as well as verifying if a camera sensor is tilted relative to the optical axis. In addition to the Siemens stars, we also offer the standard visual method of merging lines, as with the previous test charts.



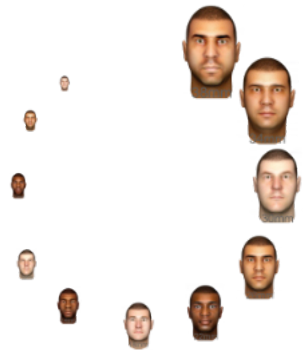


In addition to the standard television eight **colours**, which we used in the previous test charts, we have now included the **Macbeth** colour chart, familiar to many photographers and cinematographers. This colour chart is accurately reproduced with the standard 24 colours that are chosen for critical skin tone colour reproductions and at various colour light sources instead of saturated television colour bars. The continuous colour bar is still there and it has the same function as with our previous test chart v.4.x. It can be used to easily evaluate **quantisation and compression artefacts**.

We still offer evaluation of the transfer function (**linearity**) of the camera system and the **Gamma** based on the continuous black-white-black bar, and the standard 11-steps of grey bar, as with the previous version of test charts. The difference here is that we can also do this automatically with our new developed software.



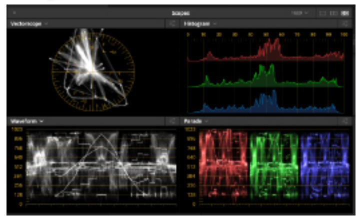
We have added one new measurement here, which can be done by our newly developed software, and that is **Signal Noise** based on the middle patch of grey in the 11-step grey scale. This is computer intensive and a very accurate calculation at pixel level. Unfortunately, it can not be done manually by visual observation. From this calculation we derive the value for S/N of the camera whose image is analysed.



In regards to the face identification measurements, we have included the **face identification** method advised by the IEC 62676-4, which is based on the UK's Home Office computer generated faces with various skin colours and facial expressions. This method is designed to offer visual evaluation of the entire system's quality based on the observer's judgement.

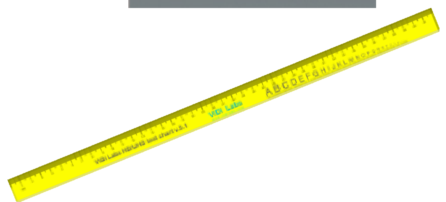
Next, we included a variety of **number-plates** positioned on the right hand side of the chart. We have reproduced plates that replicate those used in Europe (as well as other countries) with standard character sizes to cover HD and UHD resolution cameras.

To the left of the middle Siemens star, we have included **banknotes and coins, casino cards and chips**. These inclusions can be used to visually inspect the quality of a camera and lens setting for best reproduction needed in banks, casinos, or where money is exchanged.



We also advise on how to measure camera's **minimum illumination**, using a waveform monitor and as per the latest standard IEC 62676-5.

We also offer a method for evaluating your camera **dynamic range**, by use of a calibration slide.



The yellow **metric ruler** is 1:1 scale and can be used for various measurements, often needed when evaluating and testing cameras.

Last but not least, we have also developed a methodology of **rotating the test chart** which can be used for evaluating moving objects.

This chart comes in A3+ format, mounted on light but hardened board for easy transporting and mounting, together with a user's manual. On special request we can produce the chart in A1 format.

Written and illustrated by
Vlado Damjanovski
February 2025,
Eastwood, **SOUTH AUSTRALIA**

The ViDi Labs HD/UHD Test Chart v.5.x

In order to help you determine your camera resolution, as well as check other video details, ***ViDi Labs*** has designed this special test chart in A3+ format, which combines three aspect ratio charts in one, **for testing High Definition (HD) and Ultra High Definition (UHD, or 4k) cameras, with 16:9 aspect ratio, but also Mega Pixel (MP) cameras and systems with 3:2 aspect ratio, or even 4:3**.

The various working areas **dimensions** are:

16:9 chart = 420mm x 236mm
3:2 chart = 420mm x 280mm
4:3 chart = 396mm x 297mm

The A3+ format test chart shipping dimensions are **450mm x 317mm**.

For special projects, and where required, this test chart can also be ordered in A1 format size (double the dimensions shown above).

Please contact us for more information.

Using our experience and knowledge from the previously designed test charts, as well as feedback we have received from numerous users around the world, we have designed this HD/UHD test chart from ground up adding many new and useful features. We have tried to make it as accurate and informative as possible. Its primary intention is to be used in the IP CCTV industry, as an objective guide in comparing different cameras, encoders, transmission, recording and decoding systems, although it can be used with any digital camera of up to 12MP resolution.

Before you start testing

Lenses

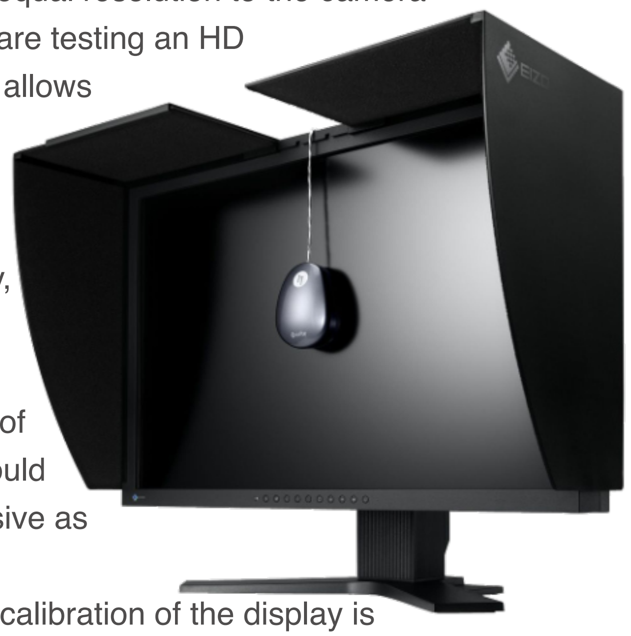
For the best picture quality you must first select a **good lens which has equal or better resolution than the camera sensor itself**. In order to minimise opto-mechanical errors, typically found in vari-focal lenses, we suggest to use good quality fixed focal length manual iris lens, or perhaps a very good manual zoom lens. The lens should be suitable to the chip size used in the camera (i.e. its projection circle should cover the imaging chip completely), in addition to offering superior resolution for the appropriate camera. Avoid vari-focal lenses, if possible. If the camera comes with a built-in lens that cannot be removed, then the image quality will be limited to the weakest component, which most often is the lens.

Shorter focal lengths, showing angles of view wider than 30°, should also be avoided if they introduce spherical image distortions (‘barrel’ distortions), unless they are a part of the camera design. Cameras with ‘barrel’ distortions can still be tested visually, but not with our software analysis tool which requires non-distorted images to work accurately.

A good choice for 1/2” sensor cameras would be an 8 mm, 12 mm, 16 mm, or 25 mm lens. For 1/3” sensor cameras, a good choice would be a 6 mm, 8 mm, 12 mm or 16 mm lens. If a camera comes with non-removable vari-focal lens, then the best results would be achieved with the focal length set to position that produces the least visible distortions, which is typically not the shortest focal length.

Displays/Monitors

Displaying the best and most accurate picture is of paramount importance for reliable testing. Since most modern CCTV cameras are network based, and decoded by software running on a computer, good computer displays should be used. For best results it is recommended that high resolution and colour calibrated displays are used. Ideally, the computer display should be of equal resolution to the camera decoded and displayed. This would mean if you are testing an HD camera with 1920x1080 pixels, and your display allows 2560x1700 pixels, then using the 1920x1080 window within the full display would produce the best quality image. There will be pixel-to-pixel reproduction, rather than up-sampling. Obviously, higher resolution displays would be acceptable, although the resolution may appear somewhat blurry, due to the up-sampling. Displays that are of lower resolution than the tested video format should be avoided. The visual results will not be conclusive as to the quality.



For best colour reproduction evaluation a colour calibration of the display is recommended. There are a number of products available on the market and one that we recommend is the *Spyder* from 'Datacolor.'

Tripods

One of the simplest and yet most time consuming procedures during camera testing is the perpendicular alignment of the test chart, relative to the optical axis of viewing. It is not only the perpendicularity that matters, but for accurate resolution measurement, the alignment of all four sides of the test chart using the eight edge triangles is very important. There are various methods used by various testers, and you may find your own best solution. Some users have found it convenient to position the test chart on the floor, and have a camera mounted on a tripod looking down on the floor. Others have used a small mirror

positioned in the middle of the test chart and then aligning the camera to see its lens in the centre of such mirror reflection. In any case, using a **good tripod is highly recommended**. Larger tripods are usually more stable and come with more degrees of freedom for better positioning. There are photographic tripods on the market which are very suitable for various mounting. Like with photography, most cameras in CCTV use the same ***1/4" UNC*** thread for mounting, and tripods come with such mounting. Ultimately, building a special guide system which would allow for positioning of any camera at any distance from the centre of the test chart might be the way to go. If you are interested in such a investment, we would be happy to help you with the design.

Lights

When the test chart is positioned for optimal viewing and testing, **controlled and uniform light is needed** to illuminating the test chart surface. Typical lab setup is with a minimum of two such lights, positioned to the left and right from the central optical axis, at such an angle as to not create reflection from the test chart surface

area. As a general rule, the area around the test chart should be of **non-reflective and darker material** so that unwanted lens flare is minimised.
Although our test charts are printed on matte paper (for the reason of minimising reflections), the light positioning should still be taken care of as suggested. In addition, the uniformity of illumination on the test chart surface is better distributed when lights of equal intensities are positioned symmetrically at an angle that is determined based on the camera's position, as shown in the drawing below.

Modern **LED lighting** equipment offers a good choice of a variety of types, angles of light dispersion, with different lumen levels, and many are equipped with dimmers for continuous reduction or increases in the light levels.
It is important to note that the spectral luminosity distribution of white LED lights (and any other type of light for that matter) is very important and needs to be **as close to the natural white light illumination as possible**. The importance of this cannot be emphasised enough, as it is important for the camera's colour vision as well as for lux level accurate measurements. Lux-meters are designed to match human 'white light' spectra sensitivity and so are colour cameras. For resolution measurements the higher the lumen levels of the lighting the better.

According to the latest standards (IEC62676-5), reflected illumination of 1000 lx is recommended for best resolution measurement. We suggest that you look for good lights in photographic or video-graphic shops. Without very strong lights - it is difficult to achieve 1000 lx levels. It might be acceptable to use lower lux levels when measuring resolution, as long as such illumination is stated with the measurements. **With equal illuminance levels, even if they might be below the recommended 1000 lx, comparing resolution between cameras is possible**.

However, below certain illumination levels, the noise starts to prevail, and such levels are not recommended for the resolution measurements, but rather only for minimum light level performance.
Different camera models have different low levels below which measuring resolution is no longer meaningful. The 62676-5 standards suggests that **resolution measurements should not be done below 100 lx of reflected illumination.**

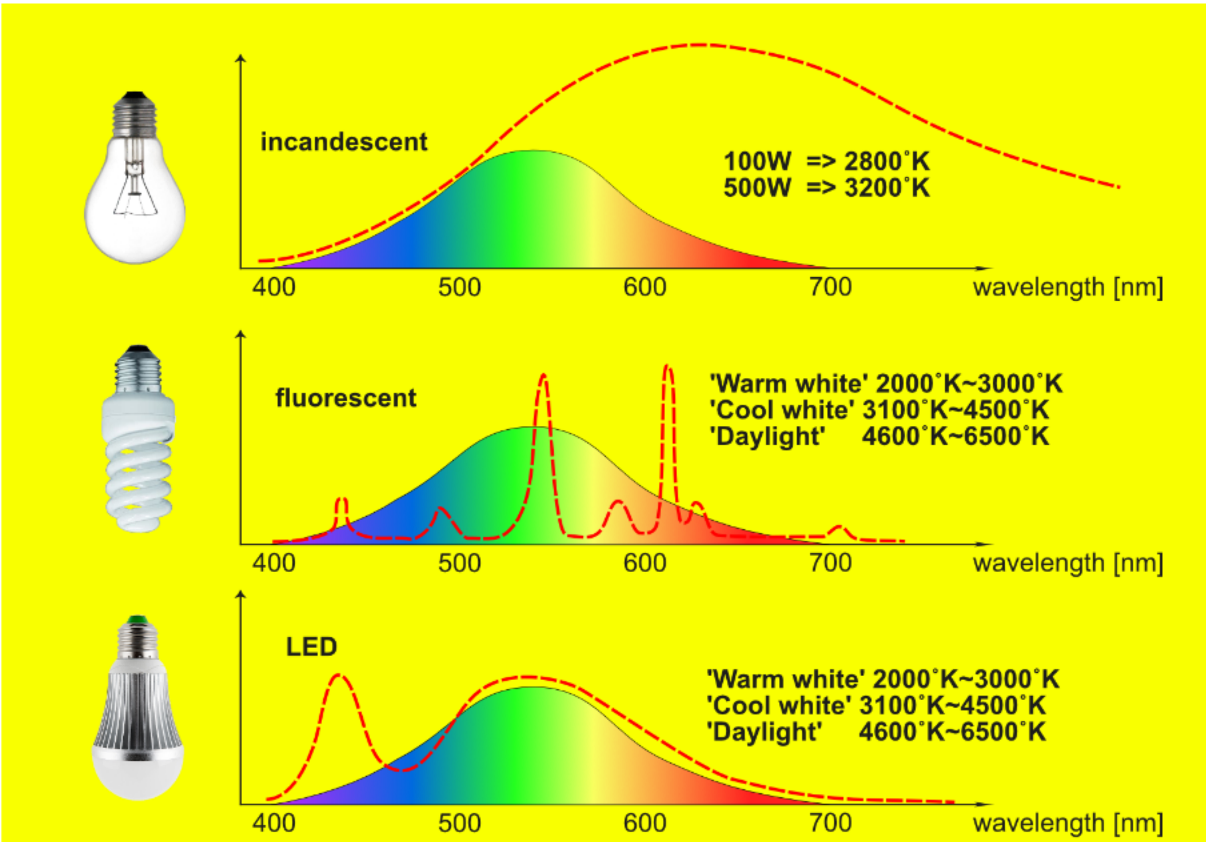
Please note, that when testing colour cameras, most of them have automatic white balance which adjusts the camera colours based on the room lights colour temperature. This means you need to make a habit of turning the camera that you are testing power on **after** you turn the lights in your test room, so that the camera white balance can adjust itself better.

It would be an advantage to have the illuminating lights controlled by a **light dimmer**, because then you could also test the camera's minimum illumination. Naturally, if this needs to be tested then this whole operation would need to be conducted in a room without any additional light. Also, if you want to check the low light level performance of your camera you would need to **obtain a professional lux-meter which can measure down to 0.1 lx levels.** Some readily available non-professional lux-meters don't measure below 1 lx and it would be difficult to evaluate camera minimum illumination with such. Position the camera on a tripod, or a fixed bracket at a distance which will allow you to see a sharp image of the full test chart. The best focus

sharpness can be achieved by viewing the central Siemens star.
If your camera lens iris can be controlled, **set the lens' iris to the middle position (F/5.6 or F/8)** as this is the best optical resolution in most lenses.

One of the difficult things to control in choosing lights for your testing is the **colour temperature of the light source**. Some light suppliers will clearly identify their light source colour temperature and spectrum, others may not. The camera under test would typically include automatic white balance circuitry and algorithms, but variations are still possible and this is what we can measure with our software.
The light source **colour temperature is very important when measuring white balance and colour reproduction** of a camera.

With our new camera software we are able to measure very accurately the **colour deviation of the camera white balance**. If you wish this done with your measurements, just export a JPG, TIF or BMP of your camera recording, send it to us, and we will provide such a report free of charge for the first 10 images.
The modern lighting industry offers a great range of good LED lights, which produce good visible spectrum radiation and consume less power. Many of you would still use



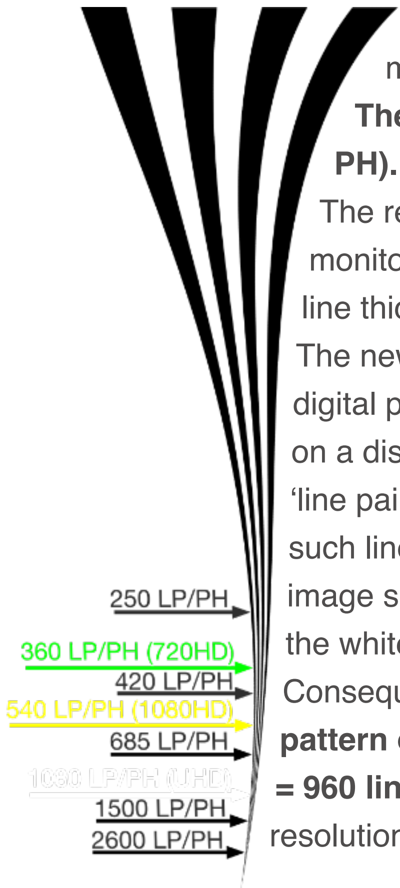
Spectral energy radiation of various light sources and their approximate colour temperature

tungsten or halogen lights, and this is still OK. Beware that tungsten light has different colour temperatures depending on the wattage and the type of light. Typically, a 100W tungsten light globe would produce approximately 1,600 lumens and its equivalent colour temperature would be 2800˚K. Professional photographic halogen lights are designed to consume 500W and produce around 4,000 lumens with a colour temperature of around 3200˚K.

In practice, some of you would probably use natural light, in which case the main consideration is to have **uniform distribution** of the light across the chart's surface. The chart is made of a matte finish in order to minimise reflections, yet care should be taken **not to expose the chart to direct sunlight for prolonged periods of time as the UV rays will change the colour pigments.**

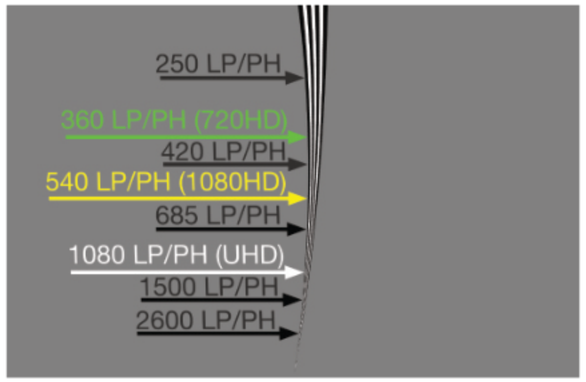
The overall reflectivity of the ViDi Labs test chart v.5.x is 60%.
This number can be used when making illumination calculations, especially at low light levels.

Resolution units as LP/PH



Based on the latest standards IEC 62676-5 resolution is no longer measured with Television Lines (TVL) like we did in the past. **The new units of measuring are Line Pairs per Picture Height (LP/PH).**
The reason for this is that we no longer use tube cameras, nor CRT monitors, which in previous times were referred to and measured with the line thickness, produced by electron beams hitting the phosphor coating. The new measuring units are in line with how resolution is measured in digital photography and cinematography. And in order to produce visible lines on a display raster, both black and white lines are needed, hence the term 'line pairs.' If we had nothing but black lines in a very fine pattern, and if all such lines were projected on the fine pixels pattern of a sensor, then the full image sensor produced would be a black image as we have not allowed for the white space between the black lines.
Consequently, **an HD (1920x1080) sensor image looking at a very fine pattern of black and white line pairs, can produce nor more than 1920/2 = 960 line pairs across the sensor width**. But in order to express the resolution relative to the picture height of the 16:9 aspect ratio sensor, (as was

the case in the analogue television days when we used the term TVL, referring to the picture height of 3/4 of the width), **we normalise the width to the height**. So instead of 960LP/PH which was for the HD sensor width, we would express **the maximum resolution of an HD sensor relative to the height of 1080 pixels, which would yield 540LP/PH.**

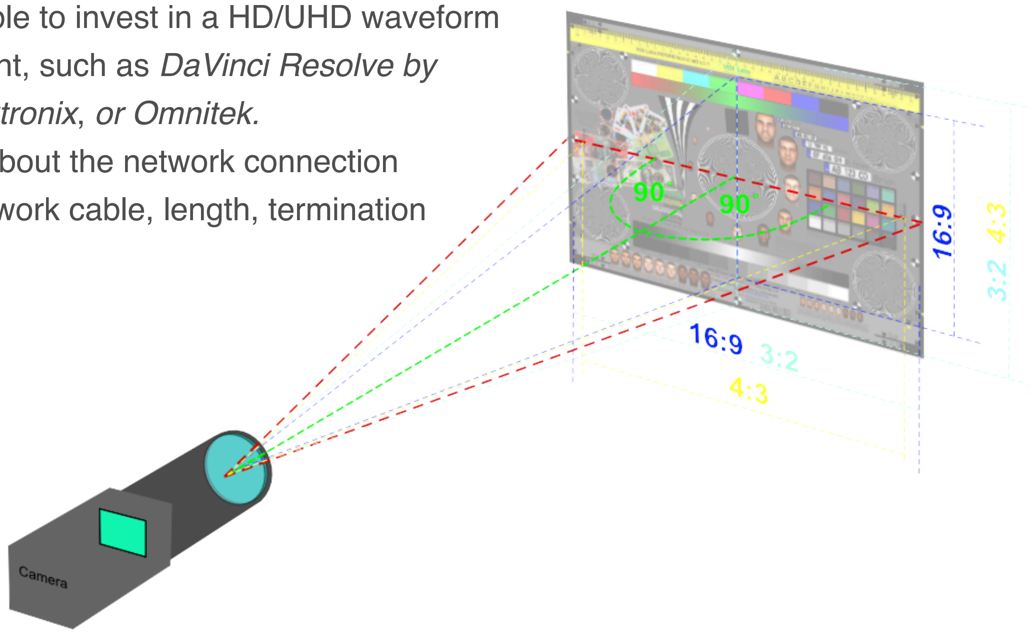


Similarly, **the best resolution an UHD (4k) camera can produce is 1080LP/PH.** Another example would be a 4:3 aspect ratio sensor of a 12MP camera (like some smart phones, with pixel counts of 4032x3024 pixels) would have a maximum resolution of 3024/2=1512LP/PH.

Setup procedure

Position the chart in front of the camera horizontally and perpendicularly to the optical axis of the lens. When testing an HD or UHD system - the camera has to see 100% of the 16:9 chart section exactly to the black triangles around the black frame. To align the HD/UHD 16:9 section better we have also added ten 'Maltese cross' circles around the perimeter.
Use the five sine-wave **Siemens stars can be used for optimal focusing**, giving preference to the middle star.

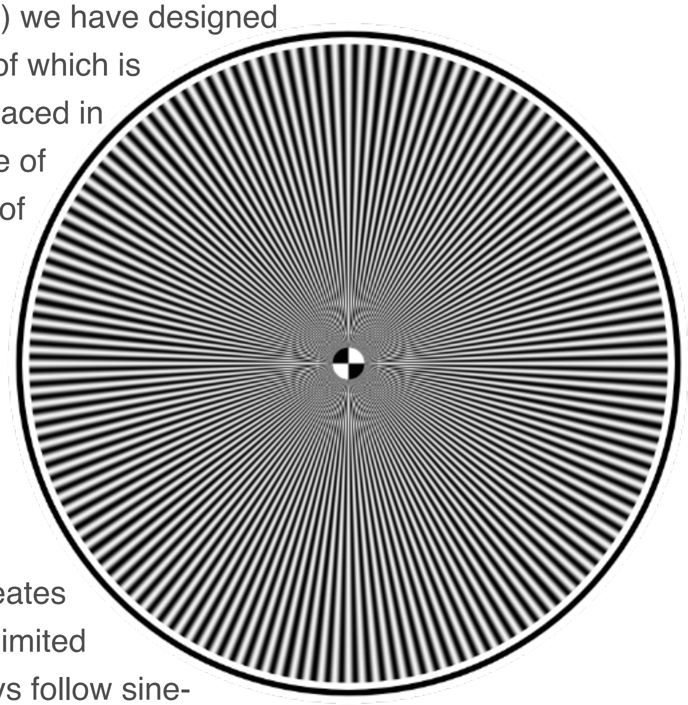
For digital, or IP cameras, good quality computers with viewing/decoding software will be needed. It is advisable to invest in a HD/UHD waveform measurement equipment, such as *DaVinci Resolve by BlackMagicDesign*, *Tektronix, or Omnitek.*
Care should be taken about the network connection quality, such as the network cable, length, termination and the network switch.



What you can test with this test chart

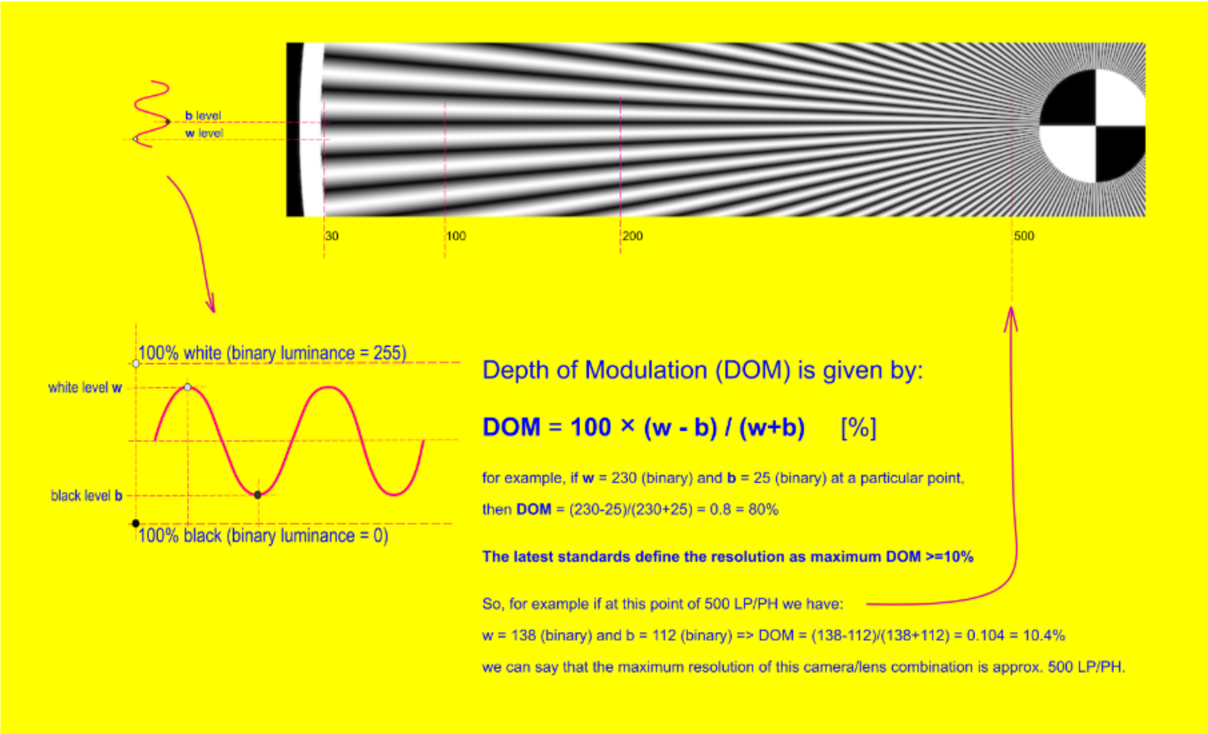
Resolution

In many projects and systems, **camera resolution is first and foremost the important specification.** As mentioned earlier, the resolution is now **measured and expressed in LP/PH.** In an ideal world, knowing the camera sensor pixel count should be sufficient if we were to find the maximum resolution. For example, one would expect that an HD sensor of 1920x1080 pixels would produce a picture with a resolution of 540LP/PH. Yet, in the real world, **this is never the case**. **Lenses are rarely perfect, and often do not produce resolution better than what the sensor can see.** Additionally, inherent thermal noise inside the camera and **noise produced when seeing scenes in lower light will further reduce the expected maximum resolution**. Furthermore, **image A/D conversion, the quantisation, compression and image processing stages reduce the expected resolution outcome even more.** Yet, another parameter may also affect resolution - and this is **vibration**. This may be in the form of tripod vibration, or even movement of the test chart, (if the location of the mounting is next to a vibrating fan of a computer or similar electric appliance.)



Based on the new standards by IEC (62676-5) we have designed five sine-wave Siemens stars, the larger one of which is placed in the middle and the remaining four placed in the corners of the chart. These stars are made of 144 black and white rays, where the intensity of black changing to white follows a sine-wave law. Instead of abrupt changing lines from black to white, we now have gradual and continuous change of black and white line-pairs. This is useful for proper and more realistic analysis of the camera image processing. When objects that a camera sees have abrupt changes from black to white it creates 'ringing' artefacts in image processing due to limited bandwidth in signal processing. When star rays follow sine-wave law, the camera processing is more efficient and produces more realistic resolution measurement.

Furthermore, the Siemens sine-wave star pattern has unique features which show the same resolution limit at various camera distances from the chart. This means, that accurate positioning when measuring resolution is not as critical as when relying on the pure black/white line wedges, which we also have included in this version.
The Siemens stars are also very useful for indicating the best setup focus.
The easiest and most objective way to evaluate resolution is by sending the best exported image (JPG, BMP or TIF) to us at ViDi Labs (*vlado@vidilabs.com*), where we'll run it through our special software and produce an MTF plot as shown here.
We are offering this free service for up to ten images for all our test chart customers.
Our software calculates the Spatial Frequency Response (**sSFR)** to the point of the **depth of modulation** (DOM) of 10%, which the resolution limit as suggested by the IEC 62676-5 standards.

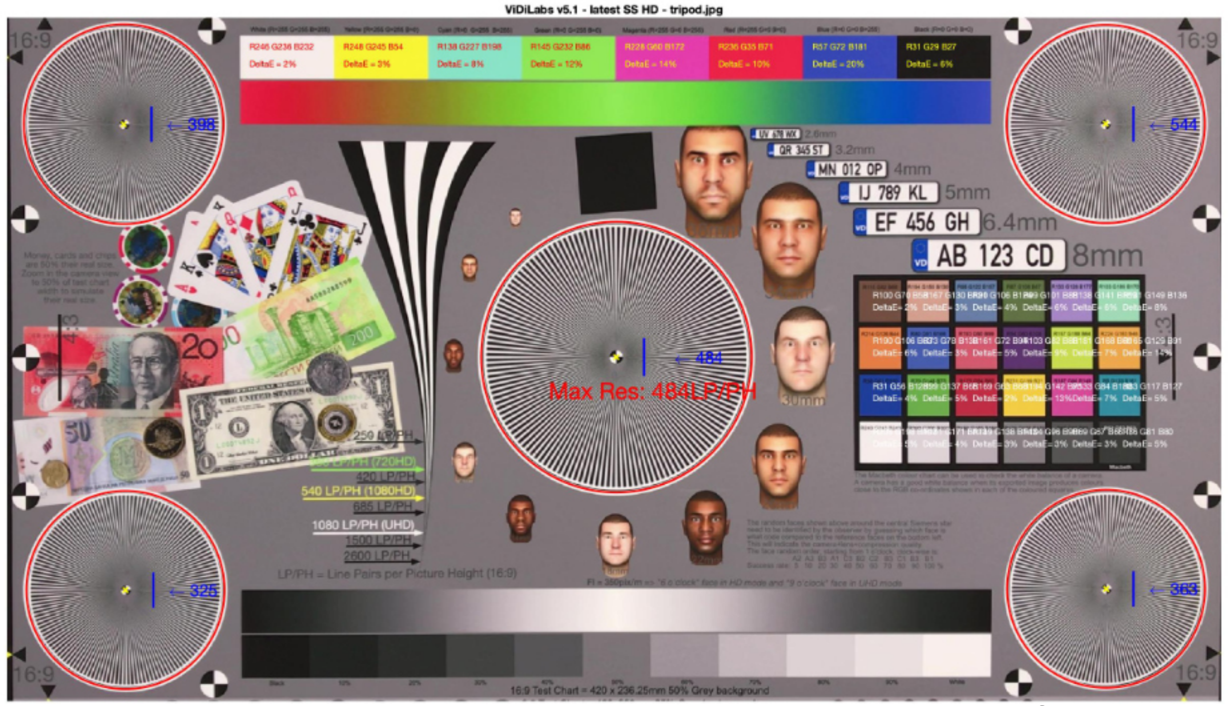


Explanation of Depth of Modulation

The depth of modulation is measured in the same way as with the analogue resolution measurement using oscilloscope, and it is expressed in percents:

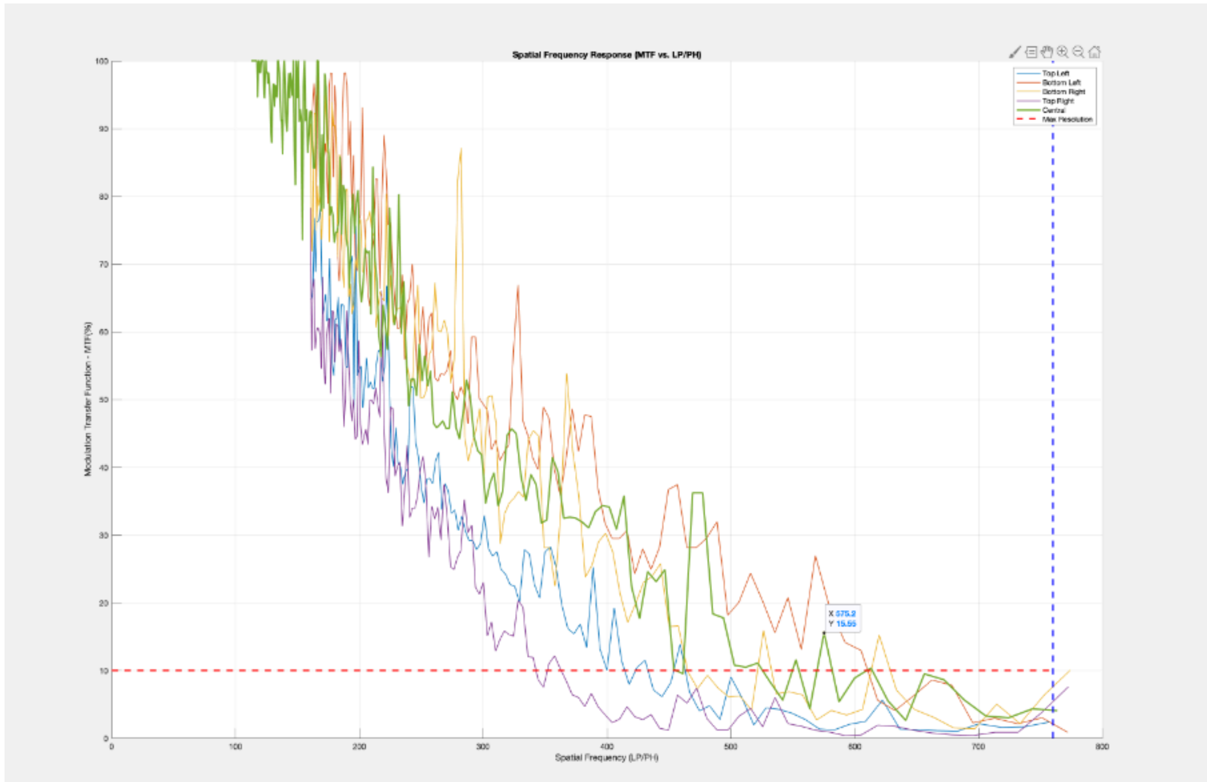
DOM = 100 x (w - b) / (w + b) [%]

where: w = white peak of the sine-wave star ray
b = black deep of the sine-wave star ray



Main evaluation screen produced by the ViDi Labs software

So the point that we refer to as **maximum resolution** is the point where DOM falls down to 10%, as illustrated in the diagram above.
Although we offer software analysis of your exported video images, the resolution based on the Siemens stars **can also be performed manually, by visual inspection.**
To do this, one needs to measure the pixel width from where the Siemens star rays



Resolution plot produced by the ViDi Labs software

merge into an indistinguishable pattern to the centre of the star, as shown in the example.

If we refer to this measurement as '**Rad**-res' **in pixels**, then the **maximum resolution** is given by the equation:

$$\textbf{Max}\text{-res} = (\mathbf{N}_{Siemens\_cycles} \times \mathbf{N}_{image\_height})/(\mathbf{2} \times \pi \times \textbf{Rad}\text{-res})$$

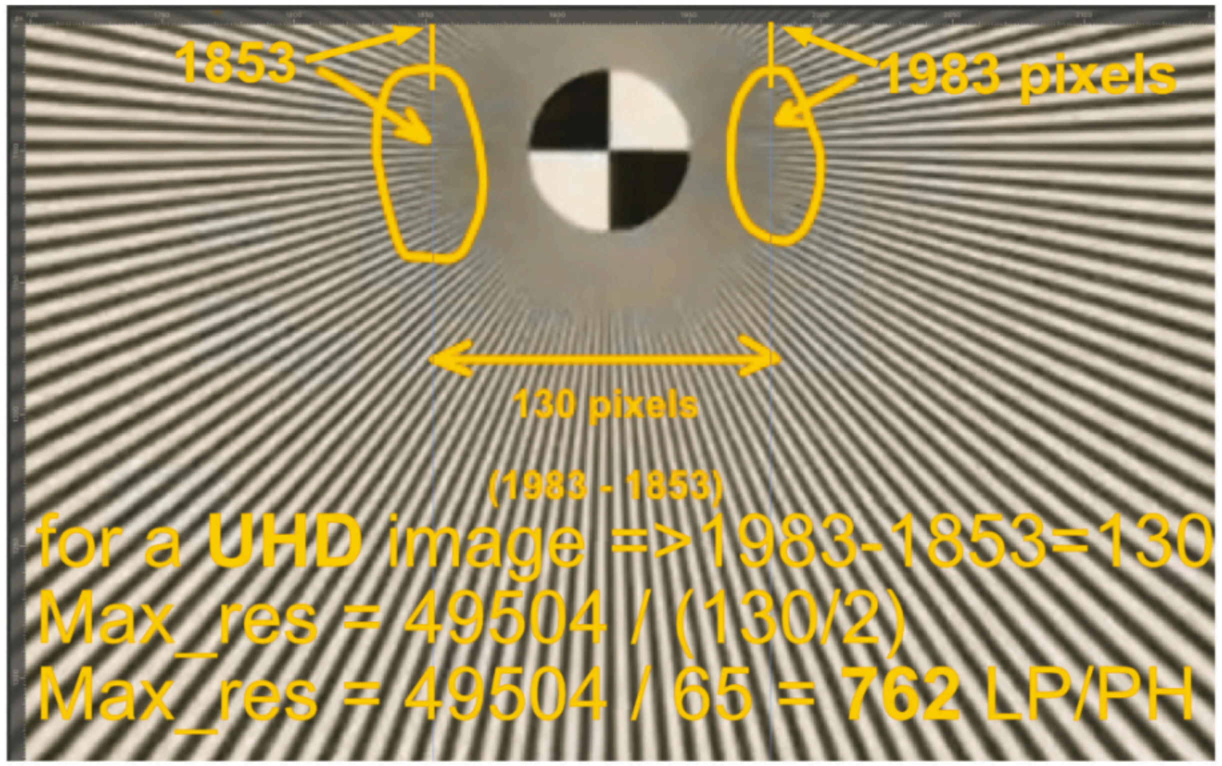
where: $\mathbf{N}_{Siemens\_cycles} = 144$
$\mathbf{N}_{image\_height} = 1080$ for HD; 2160 for UHD
$\pi = 3.14$
Rad-res = as found in the measurement

From here, one can conclude that there is a constant for HD, and another one for UHD, which needs to be divided by the pixel distance from the centre of the star to where lines merge, producing the resolution in LP/PH.
These two numbers are:

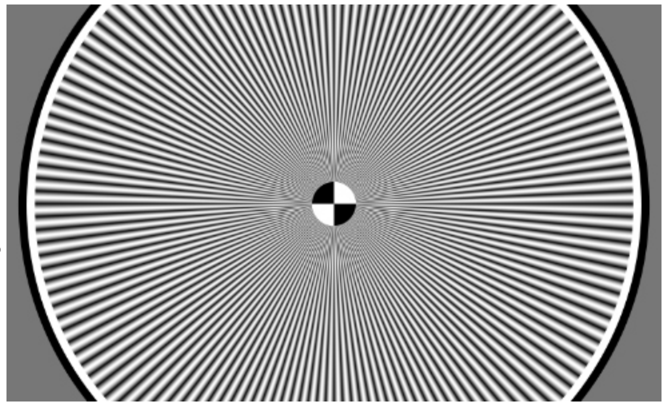
$$\textbf{HDc} = (\mathbf{144} \times \mathbf{1080})/(\mathbf{2} \times \pi) = \mathbf{24{,}752}$$

$$\textbf{UHDc} = (\mathbf{144} \times \mathbf{2160})/(\mathbf{2} \times \pi) = \mathbf{49{,}504}$$

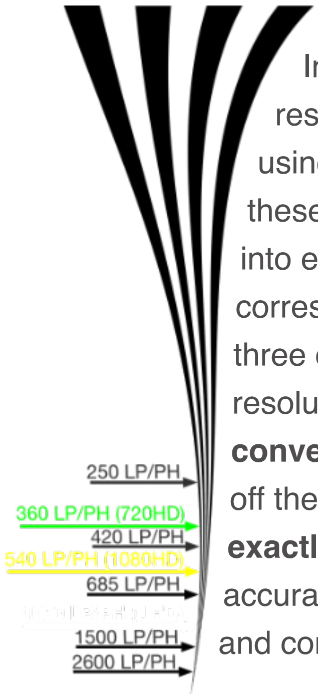
The easiest way to find **Rad**-res is by using a photo editing software where you can use a ruler in pixels, then zoom in the centre of each Siemens star for better



inspection, and determine where lines merge, like illustrated below.
One important note when doing such measurement is to **ignore, or eliminate, the aliasing** (also called 'Moire patterning') that often appears in some cameras due to lack of or poor anti-alias filtering. By definition, the HD cameras should not have resolution higher than 540LP/PH, and the UHD not higher than 1080LP/PH.
However, with cameras that do not filter alias frequencies properly, resolution higher than this maximum may appear in an image as unreal or unwanted harmonics. This could be recognised by a trained expert and it is typically found in the crossing of the aliasing frequencies of the Siemens stars, as shown in the example.

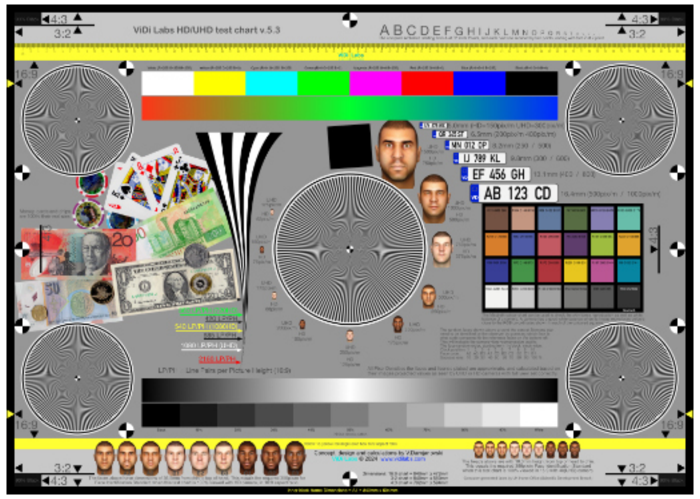


In addition to finding the resolution with the Siemens stars, it is also possible to determine the **corner resolution** which is typically slightly lower than the central star resolution. This is typical for most lenses, since optical resolution in the corners of an image is never better than the central resolution. If, however, the resolution of the corner stars is substantially lower than the central one, it may also be indicative of **sensor tilting** relative to the optical axis. This could be visible either in only two corner stars on one side, and the opposite two being much better, or when all four corner stars are completely out of focus, while the middle star appears sharp. This would indicate a tilted sensor relative to the 90˚ optical axis.



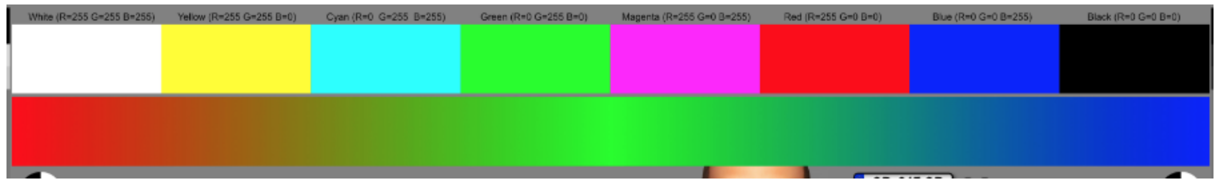
In addition to the Siemens sine-wave stars method for determining the resolution, we have also included the old '**lines-converging**' method, by using 'squiggly lines' to the left of the central Siemens star. There are four of these 'squiggly' lines which decrease in size from top to bottom and converge into each other in a non-linear fashion. There are markers at the point which correspond to the resolution as indicated by the four black lines converging to three or two, also marked in LP/PH units. To find the camera maximum resolution you have to determine the point at which **the four wedge lines converge into three or two.** The approximate resolution can be read directly off the chart. **This method is valid only when the camera view is aligned exactly to the previously discussed edge arrows.** Although this is not as accurate a method as using the Siemens stars, it is sufficient for determining and comparing cameras visually, by an experienced observer.

The Siemens star circles may also be used for checking the **display and optical/geometrical image non-linearity**. The geometrical image non-linearity was very typical in CRT monitors in the past, but modern LCD or OLED displays by design would be free of geometric distortions. However, it is possible to detect and evaluate **non-linearity due to A/D conversion, encoding or decoding.**



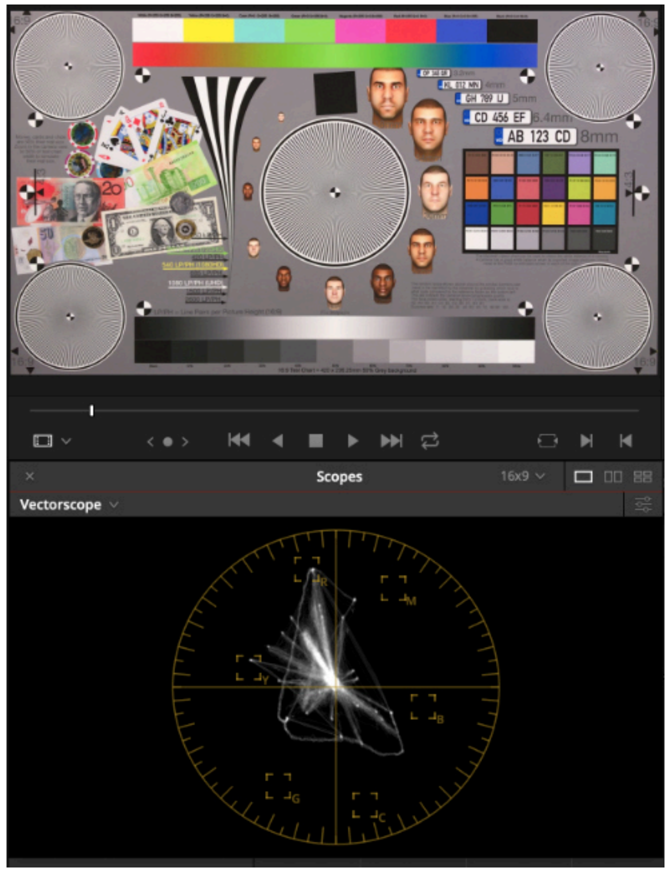
Colours

The colour strip at the top of the chart is made of eight colour patches with all combinations of the three primary (RGB) colour extremes. Since there are two possibilities in terms of saturation of each of the three primary colours (binary 0 for no colour and 255 for maximum) there are a total of $2^3 = 8$ colour patches in this colour strip. These colours are typical for colour television systems and represent the **standard broadcast television colour bars** consisting of **white, yellow, cyan, green, magenta, red, blue and black colours**, from left to right. As such, when



analysing the RGB values of the reproduced video, if the camera colour reproduction is perfect, the RGB values should be a combination of either 0 or 255 of any of the primary colours. In our free software measuring report, we also measure the RGB values and show them within each patch. We also calculate the **deviation** from the original values with **DeltaE** parameter. **DeltaE is calculated as a percentage of the standard deviation between the measured colour and a referenced one.**

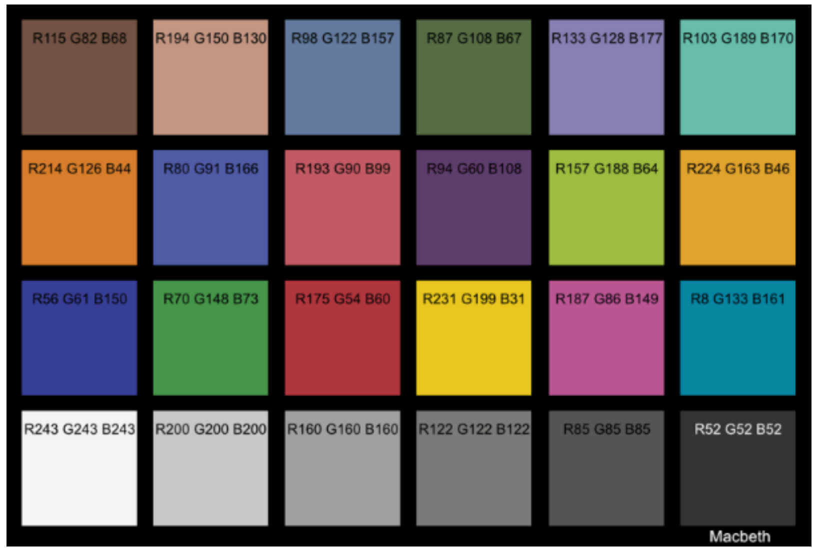
It is also possible to evaluate and visualise the deviation of the RGB values in your camera colour reproduction with a *Vectorscope*, an instrument which can be part of your software video signal evaluation, such as the *DaVinci Resolve* software *by BlackMagicDesign, Adobe Premiere, or similar.*



Our test chart ink-based colours are printed on a colour calibrated ink-jet printer and when they are picked up by the camera sensors they should be reproduced as pure saturated colours. However, they will be subject to the light colour temperature used in your testing, as well as the quality of the camera white balance. For this reason, it is suggested that for best results in colour reproduction of your camera, you choose good quality light sources, with a known colour temperature, which we discussed under the **Lights** section.

Similar to the previous ViDi Labs test charts, below the television colours strip we have also included the RGB continuous colour strip. This colour strip is made to have a gradual change of colours, from red, through green and ending with blue. We claim that such a **gradual change of colours is a very good test for showing the quality of the camera A/D encoding, the quantisation and compression levels.** At this stage, this evaluation is made only visually, by comparing the camera video or exported image of the colour strip with the test chart. If the camera you are analysing uses H.264, H.265 or JPG compression, then they are most likely based on 8-bit primary colours, which produce 256 levels per colour. The gradual change of colours is chosen so that colour artefacts can be detected easily. This, combined with the sensor noise and compression artefacts will produce very **visible discontinuities** in

the colour transition of this colour strip and by comparing two different cameras, or different settings of the same camera, it is relatively easy to make a judgement of which camera is better, or perhaps, which compression of the one camera offers better results with less colour artefacts.



Last but not least, in this colour evaluating section of the **ViDi Labs HD/UHD test chart**, we have now included the **Macbeth colour chart** on the right hand side of the central Siemens star. The *Macbeth colour chart* is composed of 24 colour patches, and it is a **known reference** in the photographic and cinematographic industry. The *Macbeth colour chart* is designed primarily for testing the **reproduction of skin colours and testing the colour balance of a camera**. These colours, are with an exactly defined combination of RGB components, which are written inside each patch. You can compare your camera colour reproduction by printing out the Macbeth section from the test image and putting it next to the test chart Macbeth section. We have made our original Macbeth chart available from the Downloads page of web site: ***https://vidilabs.com/downloads.html***. If you decide to do this, you will need a good ink-jet photo printer and matte photo paper, to match the test chart stock.

With our evaluation software we measure the RGB values of each of these colour patches and calculate the colour variation as **Delta E**, in percents.

For best results in all colour measurements, as already discussed, it is suggested that you **choose good quality light sources**, which we discussed under the **Lights** section.

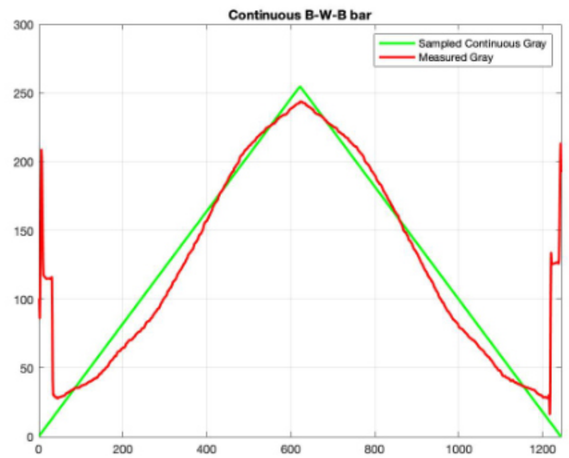
Since any pigment-based ink changes properties with time and prolonged exposure to sunlight and humidity, **it is recommended that the test chart is kept in dry areas, avoiding prolonged exposure to direct sunlight and moisture**.
Most ink manufacturers guarantee **two years of their pigment stability, after which test chart replacement is suggested**, especially if colour testing is needed for a longer period of the test chart life-time.

Linearity and Gamma

In the bottom section of the test chart, symmetrically opposite from the central Siemens star, and relative to the colour strips, we have placed two black and white strip bars.

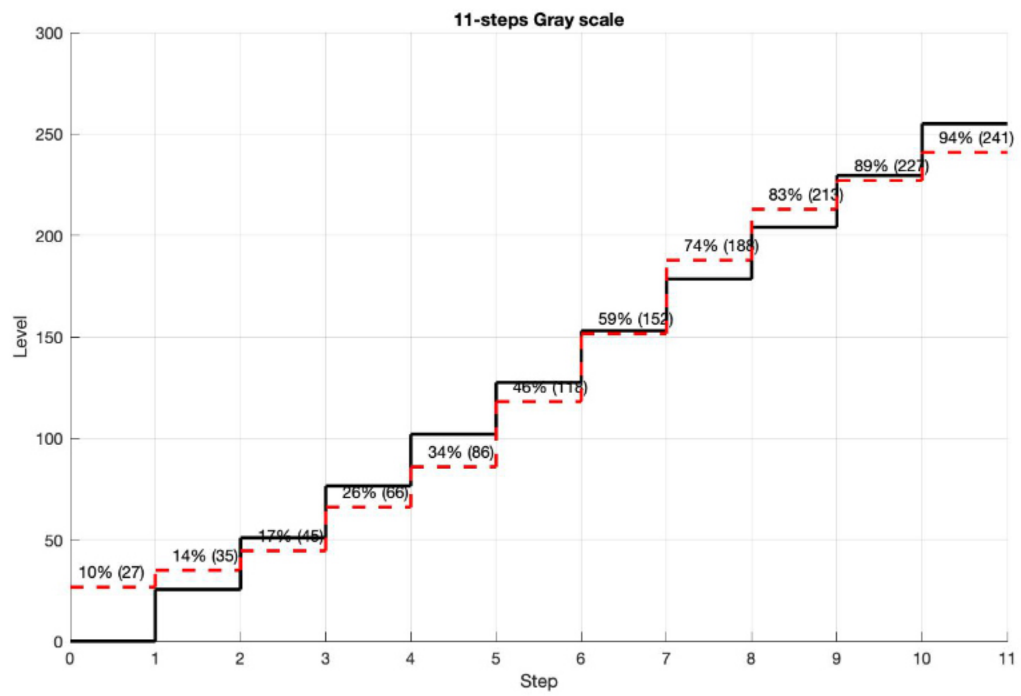
The top one is a continuous change from black to white in the middle, and black again, 'BWB' strip. Below it is the standard 11-step grey scale bar.

The **continuous changing 'BWB' strip** has two uses. The first one is similar to the continuous colour change strip, for **visually inspecting quantisation and compression artefacts**. For camera signals that are nice and clean, there should be a continuous change from black to white and back to black again. **For excessive compressions, or noisy video, there will be a lot of discontinuities in this section.**



The second usage of this BWB strip bar is by way of measuring the **linearity of the gradual change black-white-black**. The original and undistorted function for the BWB looks like a straight line raising from black to white and back to black. In reality however, many cameras use their own internal Gamma function to correct the

camera transfer curve, which may look different to the straight line. This, in fact, represents the **Gamma curve** of the camera processing. With our test chart we put together two halves of it in a pyramidal shape, and they should be symmetrical. With our evaluation software we measure the luminance levels of the BWB bar in many points and produce a plot that looks like the one shown below. The green line represents the original BWB bar, and the red one as the camera reproduces it.

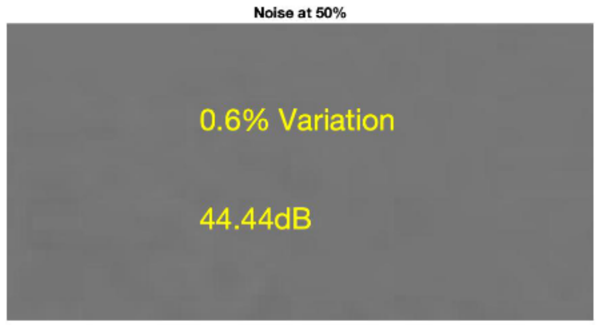


The **eleven-step grey scale** at the bottom can be used, similarly like the continuous BWB bar above, for determining the camera Gamma, just in this case shown in discrete steps. With good camera, **all eleven steps should be clearly distinguishable.** An ideal camera Gamma should be equal to one, and if this is the case, **all steps of the grey scale should be visible and equally spaced** on the reproduction. Using such reference, displays and monitors can also be adjusted by way of contrast/brightness so as to see all steps clearly.

With our evaluation software we measure the luminance component of each grey step and show it in binary levels (0 being black and 255 being white) as well as a percentage of 'whiteness' (0% being black and 100% being white).

It is possible to view and measure the grey levels using a computer based video evaluation software, such as the previously mentioned *4kScope*, *SmartScope* or any other HD or UHD video analysing software.

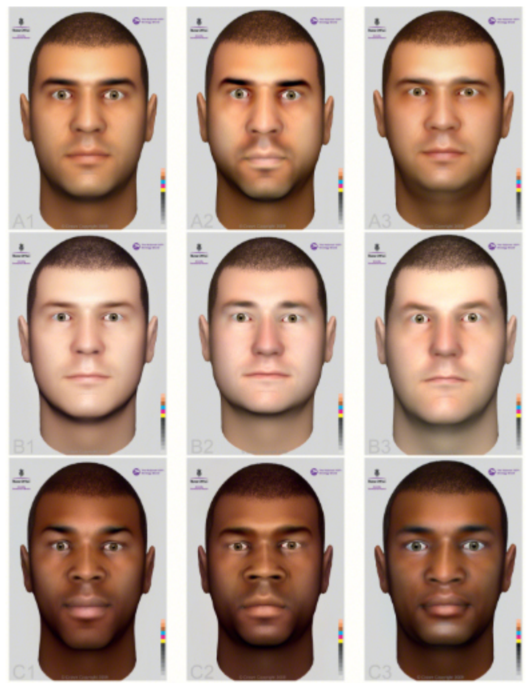
Noise



As a part of our evaluating software, we also offer detailed analysis of the **middle grey patch** in the last mentioned 11-step grey bar in terms of noise. Namely, we measure the small patch of this middle level of grey and perform a standard deviation measurement of the pixels luminance relative to the average grey value at that patch.
The result is equivalent to the **S/N ratio at the luminance level at which the camera was tested**. The noise part is composed of the sensor noise at the light levels tested, and compression artefacts produced from such noise.
Using this measurement can be very useful in determining which of two cameras has better S/N ratio, or perhaps which of the compression settings of one camera produces a less noisy signal.

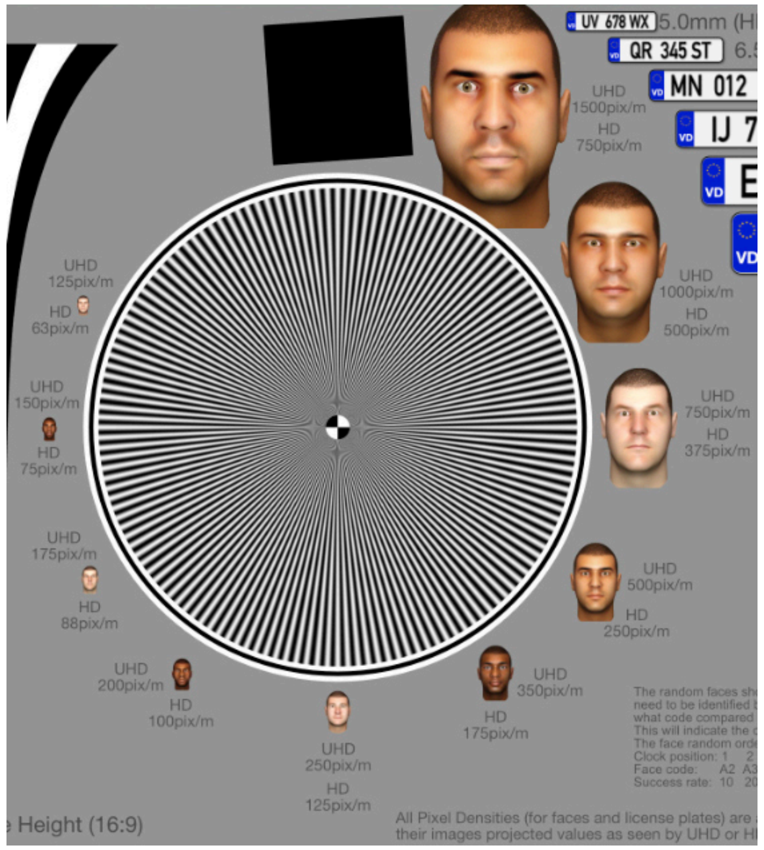
Face Identification evaluation

In the v.5.x version of the ViDi Labs test chart, we have included **faces for determining face identification ability of the camera system**, as suggested by the IEC 62676-5 standards.



There are nine computer generated faces produced by the *Scientific Development* branch of *UK Home Office*, and they are made to have different skin colours, and different face expressions with the same skin colour. They are marked with codes, such as A1, A2, A3, and so on, and the idea is to have an observer guess which particular face is shown in the camera view or recording. Because they are computer generated, they are not intruding on anybody's privacy, and can be reproduced (printed) for the purpose of finding out the quality of the system in determining its Face Identification abilities.
The nine faces are divided into **three groups**

and in each group there are **three similar but slightly different faces**, which are numbered as 1, 2, or 3. **An observer testing the system needs to guess which number of the various faces is shown**. When faces are seen directly with the high quality reproduction, such as at the back of this manual, there is little doubt in noticing the differences between the faces and identifying the correct one. However, it is more difficult when these faces are seen by an imperfect system, such as a CCTV camera for example, with an imperfect lens and image compressed with lossy compression.

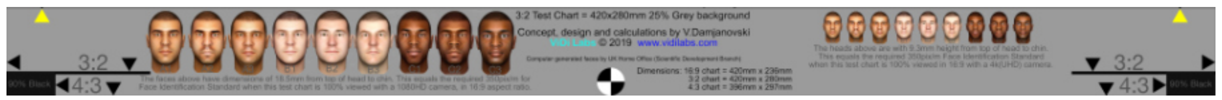


This is the basis for our evaluation method of the faces positioned around the central Siemens star. This method relies of the **visual judgement of the observer** who needs to guess which face is at question. We have positioned faces in **random order** at 10 different locations around the central Siemens star, **mimicking a clocks' hour hands**, from 1 PM to 10PM. Each of these randomly chosen faces are made to decrease in size, the largest being at 1 o'clock position and the smallest at 10 o'clock position.

We have then given a **weighing factor** for the degree-of-difficulty for identification of the faces from 1 to 10, where 1 is the lowest and 10 is the highest score.

Recognising only the 1 o'clock face will give 5% score rate of the system, the 2 o'clock face 10%, 3 o'clock 30%, and so on, the 10 o'clock face bringing 100% face identification score.

The actual reference faces are also shown at the bottom of the test chart, both for HD (on the left hand side) and for UHD video (on the right hand side), in their standard order, from A1, A2, up to C3. They are out of the 16:9 area as to not give away the random order written in the instructions text, written in grey fonts to the right



of the 5 o'clock face. The order of the random faces, when starting from 1 o'clock position up to 10 o'clock, are as follows:

A2, A3, B3, A1, C3, B2, C2, B3, C1, B1

When the test chart is viewed in full HD (or UHD) mode, the **face positioned at 4 o'clock, if recognised successfully, has equivalent pixel density of 250 pix/m for HD cameras, and the same ability with UHD cameras has the face at 6 o'clock position.**

The actual **head height in mm can be measured with a ruler**, so when the test chart is aligned for full coverage by the sensor, like when measuring resolution, the **pixel density can be recalculated for each of the various heads.**

The mathematics of how to calculate this is based on knowing the physical dimensions of the test chart. This is written at the bottom of the test chart, to the right of the 'Maltese cross' circle in the middle:

		A3 chart	**A1 chart**
Dimensions:	16:9 chart	= 420mm x 236mm	840mm x 472mm
	3:2 chart	= 420mm x 280mm	840mm x 560mm
	4:3 chart	= 396mm x 297mm	792mm x 594mm

So, if we use A3 size test chart, for example, and if we are testing faces in HD mode for example, (1920x1080), this means the 236mm test chart height is projected into 1080 pixels. If this is the case, the face at 6 o'clock position with a head size of 6.5mm (A3 test chart), is a fraction of the 236mm picture height, which is found from:

236 / 6.5 = 36 (i.e. 36 times smaller than the chart height)

From this we find that the head height of 6.5mm is equivalent to 104 pixels in HD:

6.5mm => 1080 / 36 = 30 pixels

Knowing that an average human head height, from the chin to the top, is approximately 24cm (0.24m), then

30 : 0.24 = x : 1 => x = 30/0.24 = 125pix/m

This is the required and accepted pixel density for the current **Face Recognition** standard 62676-4 (from 2014), as shown at 6 o'clock position.

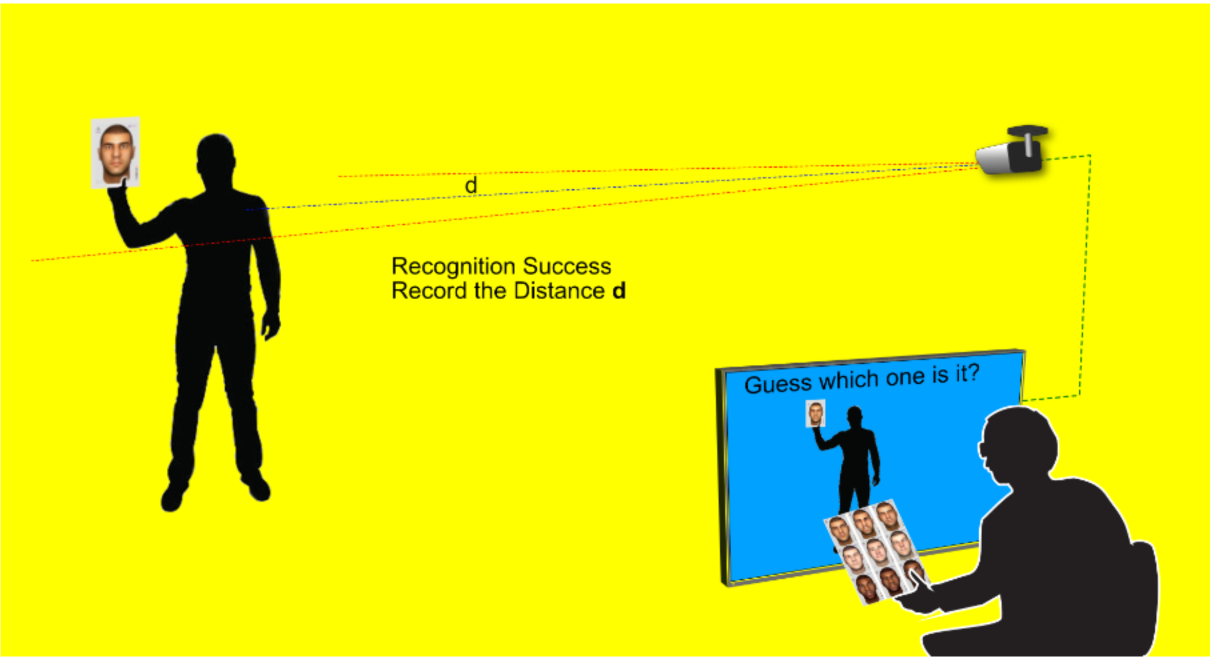
From the illustration on the left page, the **Face Identification** equivalent pixel density is the face at 4 o'clock position. This refers to a camera producing HD image of the A3 size format test chart, with pixel density as described in 62676-4 (from 2014).

Using this knowledge, one can easily find the best camera compression settings for optimum pixel density, for both live and recorded image quality.

Using analogues maths one can determine the equivalent pixel density of all other elements in the test chart, including licence plates, money and coins.

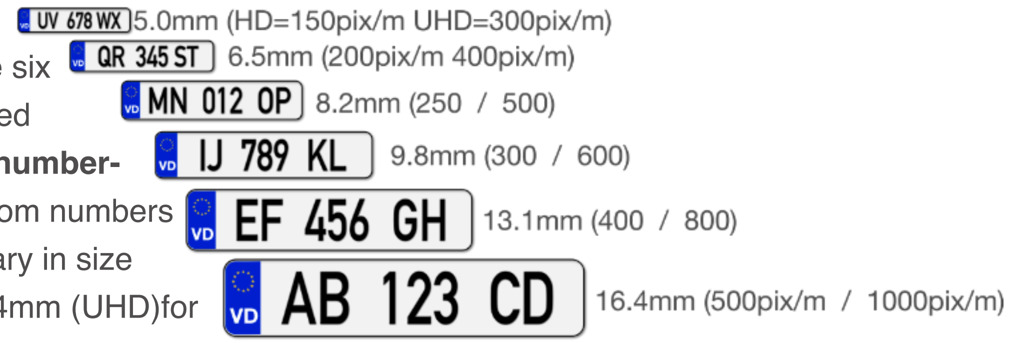
This will be shown later in the section for number-plates, as well as banknotes and coins.

While we are at the point of face identification section of this test chart, we would like to suggest yet another, the IEC 62676-5 standards method. For this purpose you wouldn't need this test chart, but rather only the printout of these computer generated faces described here. For this purpose, you can **download the high quality artwork** of these nine faces from our web site (***https://vidilabs.com/downloads.html***). They are intended to be printed on A4 format photographic paper and we suggest you print them in **matte finish** which will minimise light reflections from the surface. The A4 format paper is suggested because one real-size face can fit on this size, so practically the faces are printed at 1:1scale.
The way this is supposed to work is with the camera and system chosen for testing, one person needs to go in front of the camera with printout of all nine faces on the A4 format photo matte paper. At the back of each of the printed faces their code is written for easy identification (A1, A2, ..., C2, C3). Then, the person with the printed faces, goes in front of the camera being tested, being the closest to the camera. The distance to the camera is noted and written down. Then the person with the printed faces **randomly shuffles the photos** of the faces (without showing this to the operator) and then he picks one face and shows it to the camera. At this time, he is in communication with the operator and **the operator needs to guess which face is shown**. Hopefully, being the closest to the camera, the operator would successfully guess the shown face immediately, but a few attempts are allowed if not successful. This is noted down, both the number of attempts and the distance. Next, the person with printed faces **steps back from the camera for 1 metre**. He **repeats the same process**, shuffles the faces prints and shows randomly another one. If the operator guesses this one too, all is noted down, and the person showing the faces steps back from the camera for another 1 metre. This process is repeated until such distance



from the camera, **where the operator makes more mistakes then correct guesses, which is then taken as the distance at which, and beyond which, no more face identification can be made with such camera, lens, compression and light levels**. The last distance at which the operator successfully guessed random faces, would be taken as the **actual maximum distance for successful face identification.**
The beauty of this method is that **it does not rely on any theoretical knowledge of pixel densities, sensor sizes, compressions**, or anything else for that matter. **It only relies on an operator's ability to see details and judge the identity based on what he/she sees.**

Number-plate recognition



Above the *Macbeth colour chart*, you will see six different sizes of simulated European style **vehicle number-plates**, which have random numbers and letters, and which vary in size from 8.2mm (HD) or 16.4mm (UHD)for the characters of the largest plate, down to 2.5mm (HD) or 5.0mm (UHD) for the smallest one.
This section can be used for simple **evaluation of how small number-plates can be recognised with the camera being tested**. In order to obtain a more universal meaning of the system ability to recognise number-plates, these number-plate sizes can be **converted into pixel densities**, like we did when calculating the pixel densities for face identification. This is shown in the illustration above, in this case as printed on A1 size test chart. Using pixel densities is **more meaningful to what you would see in real life**, based on the test chart evaluation.
For example, if we setup an HD camera to see the full HD section of the A1 test chart (to the 16:9 section edges), the test chart height of 472mm will be equivalent to the camera's 1080 pixels. Let's assume with the HD camera we are testing the smallest we can recognise is the second number-plate from the top, which has 6.5mm characters height. Let's also assume that the very top number plate appears far too small and blurry on our tested camera, so much so that we cannot read the number-plate at all. So, what is the pixel density that is equivalent to recognising 6.5mm number-plate in HD view?
To find this out, we can use the same mathematics as with the face identification. First, we need to know how large are number-plate characters in real life. This may

vary from country to country, and you should use your own local data, but for the purpose of this calculation, let's assume the **common height for characters of 70mm**. If this is the case, than the 6.5mm mentioned above is seen by the camera and recognised by the viewer, as if it is a real '70mm' number-plate.

If this is the case:

70mm / 6.5 = 10.77

the real number plate is 10.77 times larger than the image of it on the test chart.

This means the test chart height of 472mm will be equivalent in real life, where the real number-plate would be positioned, to:

472 x 10.77 = 5,083.44mm = 5.1m

So, this 5.1m projected test chart height is being 'seen' by a camera with 1080 vertical pixels.

Now let's see out of this 5.1m vertical view, what fraction is the 70mm characters of the number-plate:

5,083.44 / 70 = 72.6

this means that out of the 1080 vertical pixels, the number-plate characters should occupy:

1080 / 72.6 = 14.9 pixels

Since in 1m there are:

1,000 / 70mm = 14.28 (number-plate characters fit in 1m)

it follows that the pixel density, when recognising the second number-plate from the top, is equivalent to:

14.28 x 14.9 = 213 pixels/m.

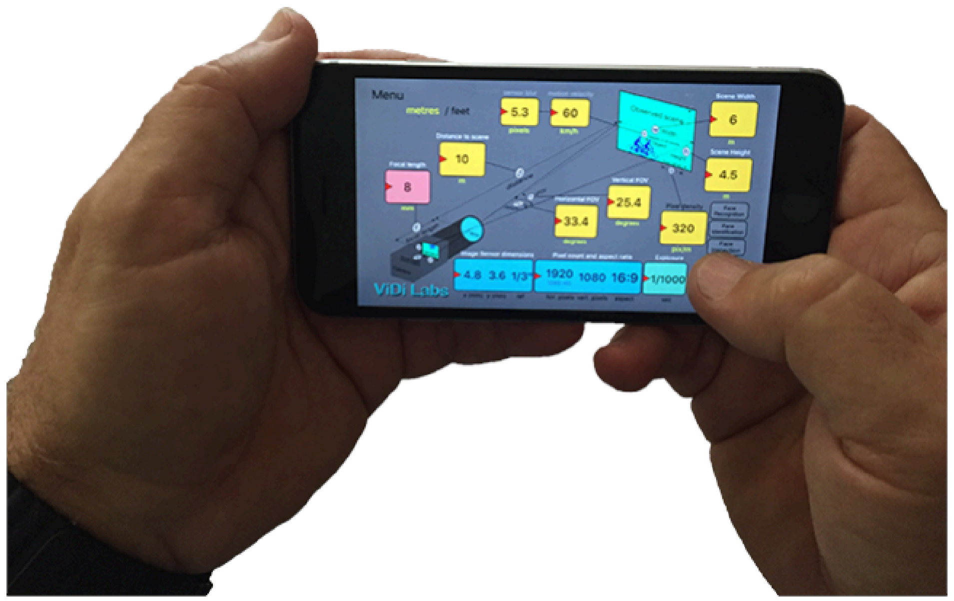
The exact same calculation can be made with any camera resolution, although this example is for an HD resolution of 1920x1080 and A1 size test chart, the same can be done for UHD (4k) camera, both on A1 and A3 size test charts.

According to the IEC Standards, and our own experiments and calculations, **approximately 300~400pix/m are needed for real life confident number-plate recognition**. In our example we have assumed that we recognised the second plate from the top on the test chart, and if this is so, we find that the equivalent pixel density will be 213 pix/m. This would mean that in our example we had a very good camera/lens/compression combination which allowed for the recognition of characters despite them being below the standard recommended minimum pixel density. In real life however, number-plates are not always clean nor perfectly aligned horizontally as in our test chart. In addition, in real life, a **moving vehicle will produce blurry characters due to vehicle movement**, which is one of the most common problems in recognising number-plates. And last but not least, in real life we would have noise especially when the number-plates are picked up in lower light. For all these practical reasons, the standards are suggesting higher pixel densities from what is possible to recognise in a static and well controlled lab environment.

ViDi Labs faces and number-pates pixel density metrics derived from the A1 and A3 size test chart v.5.3						
	Faces head size on the ViDi Labs test chart (A1/A3 size)					
Random face position clock-wise	5 o'clock	6 o'clock	7 o'clock	8 o'clock	9 o'clock	10 o'clock
Reproduced on the A1/A3 test chart with head size in mm =>	18mm / 9mm	13mm / 6.5mm	10.6mm / 5.3mm	9.2mm / 4.6mm	8mm / 4mm	6.6mm / 3.3mm
Seen by a camera with a sensor resolution as below	Equivalent pixel density when the A1/A3 size test chart is seen exactly 100% width by a camera with various sensors					
HD (1920 x 1080)	175 pix/m	125 pix/m	100 pix/m	88 pix/m	75 pix/m	63 pix/m
4MP (2688 x 1512)	245 pix/m	175 pix/m	140 pix/m	123 pix/m	105 pix/m	88 pix/m
UHD/4k (3840 x 2160)	350 pix/m	250 pix/m	200 pix/m	175 pix/m	150 pix/m	125 pix/m
	Number-plates character size on the ViDi Labs test chart (A1/A3 size)					
Various number-plates on the A1/A3 test chart with character sizes in mm =>	16.4mm / 8.2mm	13.1mm / 6.6mm	9.8mm / 4.9mm	8.2mm / 4.1mm	6.5mm / 3.3mm	5.0mm / 2.5mm
Seen by a camera with a sensor resolution as below	Equivalent pixel density when the A1/A3 test chart is seen exactly 100% width by a camera with various sensors					
HD (1920 x 1080)	500 pix/m	400 pix/m	300 pix/m	250 pix/m	200 pix/m	150 pix/m
4MP (2688 x 1512)	700 pix/m	560 pix/m	420 pix/m	350 pix/m	280 pix/m	210 pix/m
UHD/4k (3840 x 2160)	1000 pix/m	800 pix/m	600 pix/m	500 pix/m	400 pix/m	300 pix/m

For our customers that want to be able to calculate pixel density based on proven formulas which connects all the variables that define pixel density, such as camera sensor, lens and distance from objects, we would like to recommend our ***ViDi Labs calculator*** application, which is available for both iOS and Android smart devices and you can find it from the *iTunes App* store, or *Google Play* store when you search under the '**ViDiLabs calc**'.

For all of the test chart users that want to go further with testing and evaluating number-plates, we would like to refer you to the previously mentioned ***ViDi Labs calculator*** application for smart devices, where we also have an actual **calculator for determining 'amount' of motion blur due to vehicles movement at various speeds**.



Money and casino cards recognition

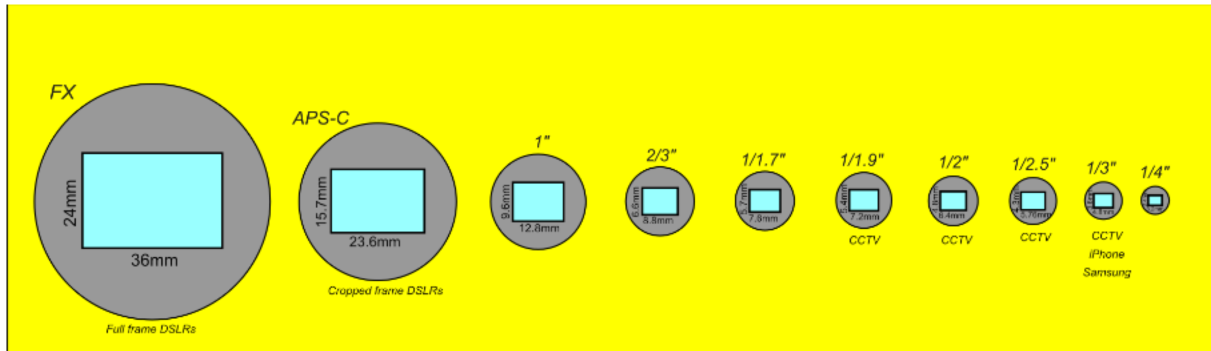
To the left of the central Siemens star, we have included a **photo reproduction of various banknotes, coins and casino cards**. On the A1 test chart size these elements are 1:1 scale, and on the A3 test chart, they are 50% of their real life size. This means, in practice, if you wish to test the quality of your camera in recognising real size money or cards, you need to adjust the viewing angle to cover 50% of the test chart width. This is easily done by **aligning the left side to the edge markers and the right hand side to the centre of the central Siemens star**. Using such alignment, you can evaluate if your camera/lens combination, with the chosen compression level, and the illumination you have, would be sufficient to recognise the money or the cards.

Using the photo reproduction of monies and cards it is also possible to **find the furthest distance your camera can have and still be able to recognise them**. This would be very useful in determining **optimal camera positions in casinos** which focus on gaming tables or in **banks and shops, where a camera is intended to look at money handling**. To do this, just start increasing the distance from the camera to the test chart until you can no longer recognise the money, or cards. Then, take **the last distance from which you could identify the details and multiply such a distance by two,** because of the real size of the money and cards have been reduced by half of their original size.

Minimum Illumination

Minimum illumination is often seen as the holy grail in CCTV. Most video recording captured during critical incidents usually occurs when illumination levels are very low. Criminals most often choose the disguise of the darkness for their illegal activities. Although infra red illumination is used for the purpose of seeing in the dark, this test chart is not designed to evaluate camera response in the IR spectrum. Using IR illumination often causes more problems. From their attraction of insects and moths,

their nuisance alarms, the internal IR dome reflection of a badly designed camera, (oscillating between IR flicking on and off due to bad feedback looping), the IR camera will need additional power to operate. In addition, the lux-meters we recommend in these test chart procedures are designed to measure visible light only, and so we cannot measure nor evaluate IR testing in this instant.



The various imaging chip sizes and their relative dimensions

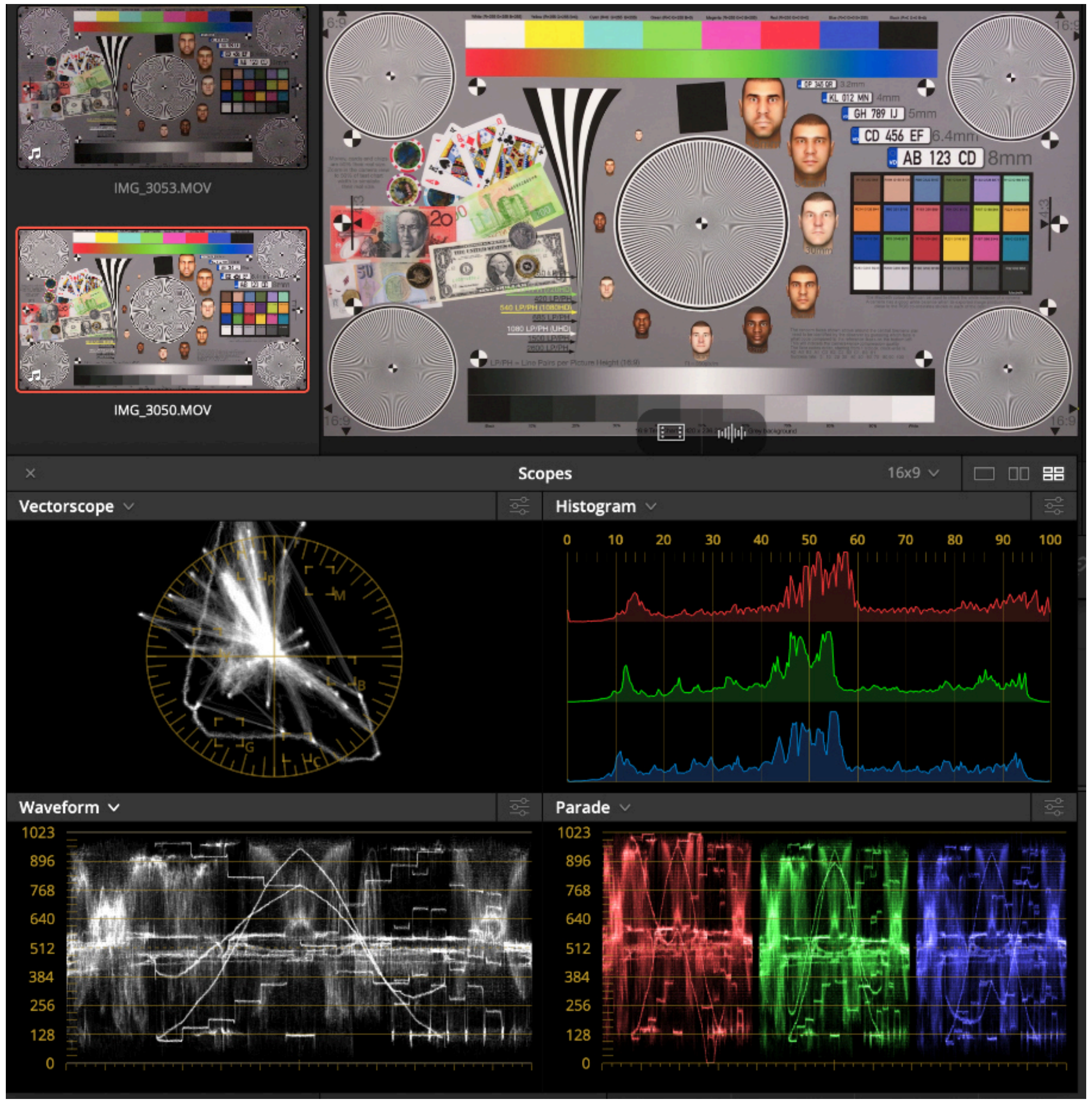
In order for a camera to perform well in low light the first and simplest precondition is for the camera to have **large pixels**. CCTV sensors have an average of 2um pixel size, or smaller, which is nowhere near the optimum pixel size for good low level video. Many professional video cameras have a pixel size of 6um. Although this appears as only three times larger than 2um, in fact it is nine times larger, as we are dealing with surface area. Larger pixels means larger sensors for resolution, and consequently more expensive cameras. Unfortunately, our industry is not keen on paying premium prices for premium cameras.

In the days of analogue cameras, when we were testing minimum illumination performance of a camera, one of the important things we considered was to turn all processing circuitry inside the camera to OFF (AGC, Noise reduction, and similar). Then, when producing a certain level of a signal, to state the level obtained, at what illumination level and at what lens F-stop setting. This was not adhered to by all manufacturers equally. Some were stating the signal levels at 50% video, others at 30% video, and some others not mentioning the level at all, but only stating a vague phrase ‘recognisable video’. Others were not even turning the electronic AGC gain off, thus making their camera appear to pick up better signal at low light, but not mentioning anything about the amplified noise which the gain increases. Regrettably, there were also manufacturers that would illegally state any minimum illumination needed in their specifications, just to win a tender.

During the testing of analogue cameras we used oscilloscopes for measuring the analogue video signal levels. This was a straight procedure of connecting the coaxial cable of a camera into a properly terminated load.

With digital and IP video cameras we have a different process. Since most video signals in CCTV are digitised and encoded by video compression, in order for us to evaluate the video signal level we need a digital waveform monitor.
This might be in the form of a hardware waveform monitor device, or easier and more affordable - in the form of software.
In our measurement and for the purpose of illustrating how to measure the minimum illumination of an IP CCTV camera, we used *DaVinci Resolve* by *BlackMagicDesign* for our Mac computers, although any other similar software will do the trick, such as *4kScope*, *Adobe Premiere*, and other.

The latest standards IEC 62676-5 suggests a simple way of measuring the low light performance of a camera **without turning off any of the video processing**. All that



is required is to produce **live stream at 25fps** (or 30fps if desired) while the video signal drops down to **30% of the signal level**. Then, **state the F-stop used** on the lens and the **lux level reflected off the tested scene would represent the Minimum Illumination level for that camera/lens combination**.

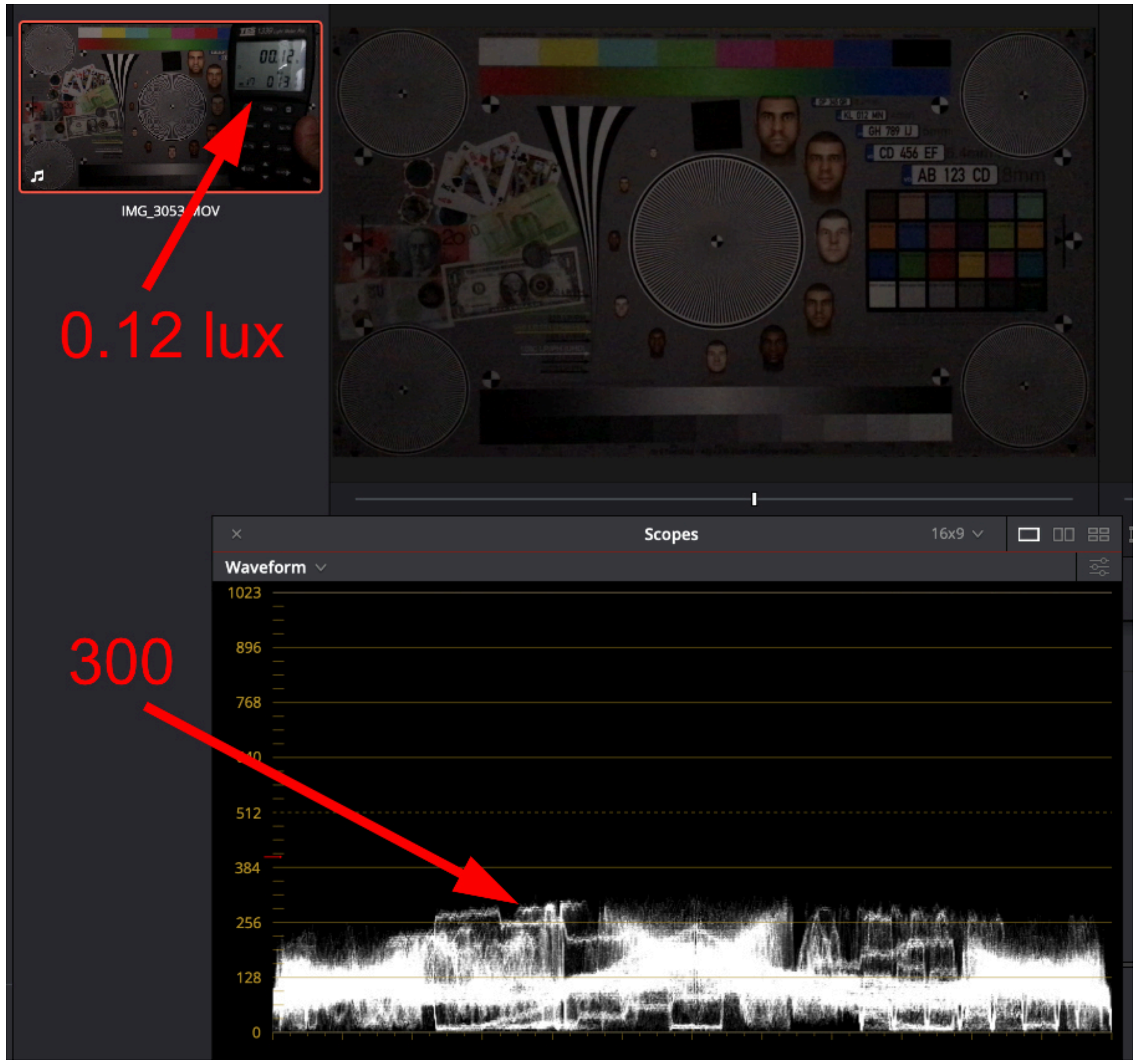
The IEC 62676-5 suggests that the 30% video level is equivalent to a binary level of 77 for the 8-bit video, and 307 for 10-bit video.

In our example, we measured approximately 0.12 lux with the 10-bit video showing around binary level of 300. We used a fixed lens of F-2.8. This would then be stated in this example as the minimum illumination for this camera.

Setup the chart in full frame view of the sensor aspect ratio (in our case 16:9), and position your dimmable LED lights at such a distance, as to produce very low illumination on the test chart, but sufficiently visible so that you can read the lux levels reflected off the test chart, from the point of the camera looking at the chart. For the purpose of measuring down to 0.1 lux a professional light meter is suggested, as described under the **Light** section. In the absence of good dimmable lights, we suggest an alternative method which we have used in the past, although it may not be as accurate but certainly it could be a good reference.

This is by using two standard candle lights illuminating the test chart from equal distance positioned at the sides.

For the purposes of having a camera that may perform at even lower light levels, the IEC 62676-5 standard recommends the use of *Neutral Density filters* with known light attenuation, which can then be used in front of the light meter to proportionally reduce the measured light.



In such cases, the **accuracy of the finding may not be very high** due to possible variations in the 'attenuation density.' Another important factor is that the **spectral characteristic of the ND filter must be flat across the visible range.**

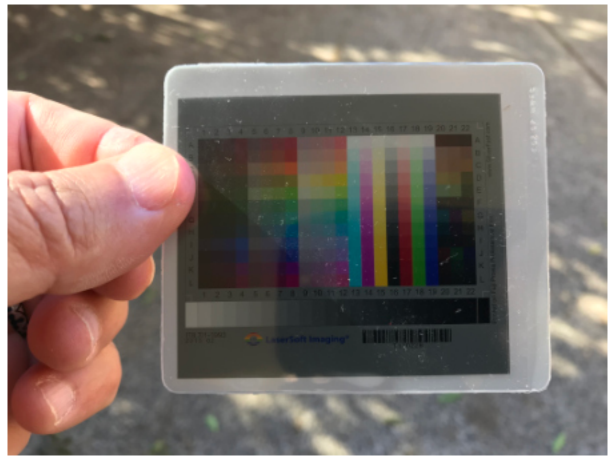
Dynamic Range

One of the most difficult tasks for any CCTV system is a scenario where the camera from inside a room looks against a bright window or glass door, and the operator wants to see clearly both - the outside area as well as the inside, when people are entering the room. To do that, a camera with **high dynamic range** is needed. **Current CCD and CMOS technology, as used in CCTV, is mostly with 2um pixel size, and thus has very limited dynamic range of no more than 3,000:1, which expressed in dB is about 70dB.** Human eyes have logarithmic sensitivity curve, and can see in one scene from illumination of around 100,000 lx down to 0.1 lx. **This makes human vision capable of seeing a ratio of 1,000,000:1, which is 120dB.**

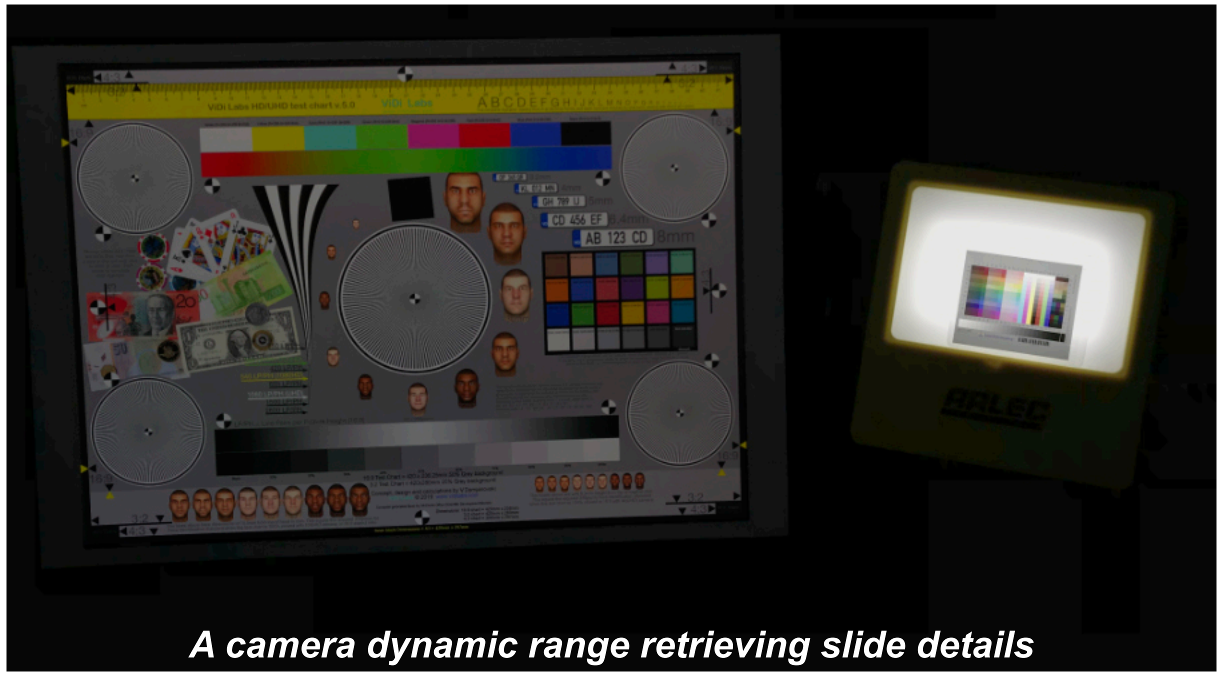
In order to achieve similar dynamic range ratio, without having larger pixels, the CCTV cameras are designed to make **two, or even three, exposures during each of the 25 frames of live streams**. By digitally overlapping these double, or triple, exposures, we get the illusion of high dynamic range in the video. Such a technology is typically referred to as **WDR (Wide Dynamic Range)**, or Ultra Wide Dynamic Range (UWDR).

To evaluate Dynamic Range of a camera a very strong light needs to be produced next to a darker area. This is **not possible using a reflective test chart**, similar to this one. The dynamic range of a test chart, being reflective surface, is not sufficient to test a camera's dynamic range.

The IEC 62676-5 recommends a procedure for measuring dynamic range by using a special transparent test chart, with 32 semi-transparent patches and a strong light behind it. Such a product would be prohibitively high for our industry, and at this stage we do not offer it.



We have however, come up with a reasonably simple and easy to reproduce procedure, which may be **sufficient for many applications**. It may not measure and evaluate the dynamic range in dB, but it will certainly give you a **good indication of the dynamic range of the tested camera**. This might be useful

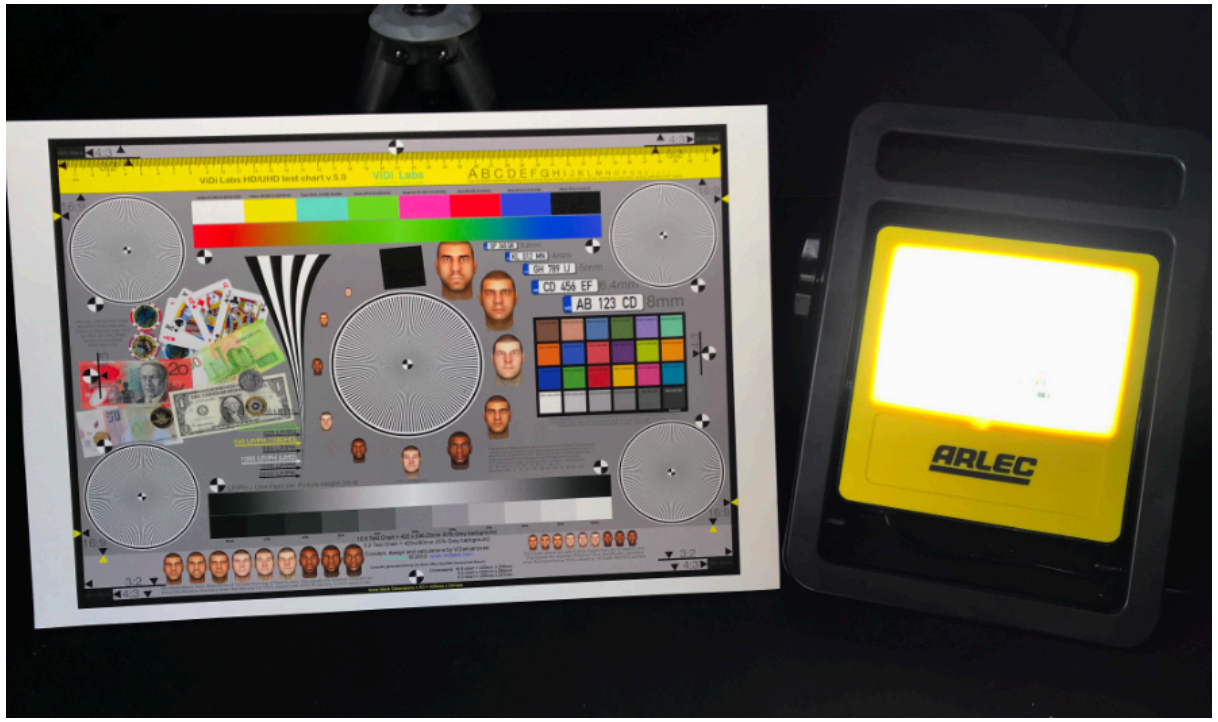


A camera dynamic range retrieving slide details

when comparing two cameras, or when adjusting various WDR parameters to find out what settings offer you the best outcome.

To do that, you need to obtain a **'Calibration slide' for film scanners**. Such a slide can be purchased from various online photographic or scanner shops, such as *LaserSoft, Epson*, *Plustek* or *Microtek.*

When you obtain such a slide, you can then use your standard LED illuminator with at



least 3000 lumens (which would be produced by approx. 30W of power) and affix the slide directly onto the LED light white diffuser. Position the LED light with the slide next to the ViDi Labs test chart and adjust the WDR until you see details of both - the slide and the test chart.

Furthermore, because the Calibration slide has patches with grey scale gradation, as well as various colours, you may even determine the fine difference between two cameras or settings with good WDR.
If you cannot set the camera to see both, it might be indicative of inferior dynamic range of your tested camera.

The yellow ruler and the fonts at the top of the chart

Lastly, the final detail on the v.5.x test chart is the **yellow ruler** located at the top of the chart. This is simply a real size (1:1) metric ruler that can be used for various calculations and measurements, as well as for pixel density calculations if needed. The ruler is positioned just outside the 16:9 area. It can also be useful when aligning the HD or UHD camera, where the yellow colour has to be just outside the view. Of course, when using it for measuring and calculating pixel densities, the camera needs to be tilted up so as to bring the ruler in the filed of view.

Within the yellow ruler we have the same **traditional fonts**, as in the previous test chart, from **the largest font 'A' at 26 font points, down to 'z' being point 1**. This too can be used to measure the camera's ability to see written text at various point sizes, providing the test chart width is covered 100%. This may be useful in determining the appropriate camera/lens combination for **recognising characters in the printing industry, ticketing counters, and anywhere else where printed text is used.**

Rotating test chart for analysing moving objects

Everything of interest in CCTV moves, people, vehicles, animals, etc...

This means that motion artefacts, such as motion blur, or compression artefacts, may affect the image clarity of the moving objects. This, indirectly, affects the pixel density required for clear recognition of such moving objects.

After many years of research and study we derived the "Motion Blur" formula, which is included in the ViDiLabs calculator application. Based on this formula, we conclude that an object moving with a speed V at 1m distance, for example, seen from the camera perspective, will produce the same pixels blur as ten times that speed (10 x V) at 10m distance, or 100 x V at 100m distance.

Using this knowledge, we have developed a new methodology, first in the world, which, by rotating the test chart, we could evaluate camera image quality of captured moving objects. By rotating the test chart, with faces and number-plates around the central Siemens star, and using various rotational speeds, **we can simulate and evaluate almost any real object movement at any distance**.

In addition, by applying controlled light, from the very low to high, we can gain better understanding of various cameras processing artefacts at various light levels.

In the drawing on the following pages, we have illustrated the methodology of calculating the tangential speed of the rotating faces and number-plates, and then

ViDi Labs A1/A3 size test chart v.5.3 rotations and derived real speeds (camera to chart = 1.2m/0.6m)						
	Faces head size on the ViDi Labs A1/A3 test chart					
Rotation speed (rev/s)	**0.25 rev/s**	**0.5 rev/s**	**1 rev/s**	**2 rev/s**	**4 rev/s**	**8 rev/s**
Faces tangential speed (m/s)	0.2m/s / 0.1m/s	0.4m/s / 0.2m/s	0.8m/s / 0.4m/s	1.6m/s / 0.8m/s	3.2m/s / 1.6m/s	6.4m/s / 3.2m/s
	Equivalent real speed (Vfr) speed, at an angle ß relative to the optical axis:					
Person walking/running or cycler riding at the below distance from the camera						
3m	3.6/sinß km/hr (A1) 1.8/sinß km/hr (A3)	7.2/sinß km/hr (A1) 3.6/sinß km/hr (A3)	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)	75.2/sinß km/hr (A1) 37.6/sinß km/hr (A3)
6m	7.2/sinß km/hr (A1) 3.6/sinß km/hr (A3)	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)	75.2/sinß km/hr (A1) 37.6/sinß km/hr (A3)	
9m	10.8/sinß km/hr (A1) 5.4/sinß km/hr (A3)	21.6/sinß km/hr (A1) 10.8/sinß km/hr (A3)	43.2/sinß km/hr (A1) 21.6/sinß km/hr (A3)	86.4/sinß km/hr (A1) 43.2/sinß km/hr (A3)		
12m	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)			
15m	18/sinß km/hr (A1) 9/sinß km/hr (A3)	36/sinß km/hr (A1) 18/sinß km/hr (A3)	72/sinß km/hr (A1) 36/sinß km/hr (A3)			
	Various size number-plates on the ViDi Labs A1/A3 test chart					
Rotation speed (rev/s)	**0.25 rev/s**	**0.5 rev/s**	**1 rev/s**	**2 rev/s**	**4 rev/s**	**8 rev/s**
Number-plates tangential speed (m/s)	0.3m/s / 0.157m/s	0.6m/s / 0.314m/s	1.26m/s / 0.63m/s	2.52m/s / 1.26m/s	5m/s / 2.52m/s	10m/s / 5m/s
	Equivalent real speed (Vcr), at an angle ß relative to the optical axis:					
A vehicle driving at the below distance from the camera						
3m	5.6/sinß km/hr (A1) 2.8/sinß km/hr (A3)	11.2/sinß km/hr (A1) 5.6/sinß km/hr (A3)	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)
6m	11.2/sinß km/hr (A1) 5.6/sinß km/hr (A3)	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)	352/sinß km/hr (A1) 176/sinß km/hr (A3)
9m	16.8/sinß km/hr (A1) 8.4/sinß km/hr (A3)	34/sinß km/hr (A1) 17/sinß km/hr (A3)	68/sinß km/hr (A1) 34/sinß km/hr (A3)	128/sinß km/hr (A1) 64/sinß km/hr (A3)	256/sinß km/hr (A1) 128/sinß km/hr (A3)	
12m	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)	352/sinß km/hr (A1) 176/sinß km/hr (A3)	
15m	27.6/sinß km/hr (A1) 13.8/sinß km/hr (A3)	55.2/sinß km/hr (A1) 27.6/sinß km/hr (A3)	110/sinß km/hr (A1) 55/sinß km/hr (A3)	220/sinß km/hr (A1) 110/sinß km/hr (A3)		

extrapolate the equivalent real object speed at various distances, which would produce the same "amount of motion" as seen from the camera perspective. This is also shown in the table on the opposite side, with some typical distances as an example. The ß is the angle that the moving object makes with the camera optical axis.

When using the A3 size of our test chart, and rotating it with, for example, one revolution per four seconds (0.25 rev/s), the resultant tangential speed of the faces is 0.1m/s (0.36km/hr) and of the number-plates 0.157m/s (0.57km/hr), on the chart itself. This can then be extrapolated as shown in the above spread-sheet.

IMPORTANT NOTE: The motors for rotating the chart are not supplied with the test chart, but they can easily be found online from any electronic shop that sells electronic components. Such motors are small and inexpensive DC stepper motors, and the ones with slow revolution speed (like 0.25, 0.5 or 1 rev/s) should be purchased. Since our A3 test chart is very light (230g) it can easily be affixed on the motor axis. For rotating the A1 test chart on aluminium frame, please consult electronic or mechanical engineer.

--- END OF PRODUCT MANUAL ---

ViDi Labs rotating test chart for analysing moving objects

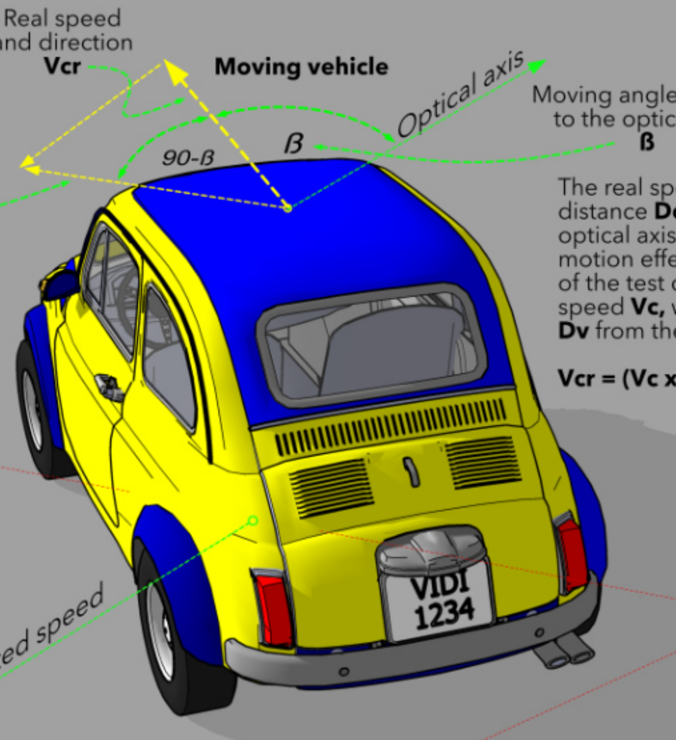
The raw electronic version of the test chart with the random faces around the clock representing various pixel densities and the various size number-plates in the top-right hand quadrant

Rotations per second **Rs** (rev/s)

Vc = 2 x π x **Rs** x **Fc =** 2 x 3.14 x **Rs** x 0.2 [m/s] (A1 test chart)
Vc = 2 x π x **Rs** x **Fc =** 2 x 3.14 x **Rs** x 0.1 [m/s] (A3 test chart)

Vf = 2 x π x **Rs** x **Ff =** 2 x 3.14 x **Rs** x 0.13 [m/s] (A1 test chart)
Vf = 2 x π x **Rs** x **Ff =** 2 x 3.14 x **Rs** x 0.065 [m/s] (A3 test chart)

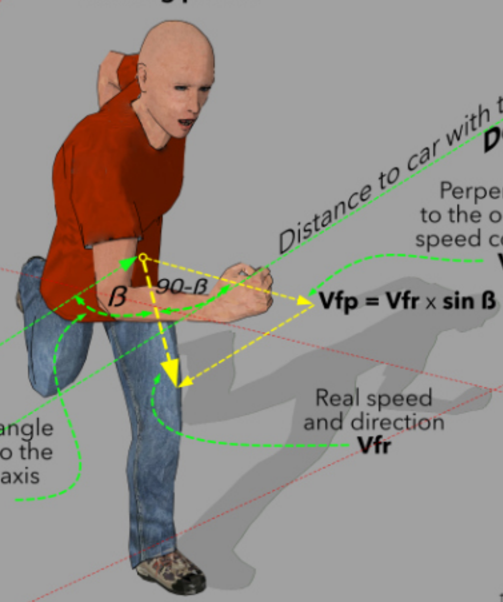
ViDi Labs faces and number-pates pixel density metrics derived from the A1 and A3 size test chart v.5.3						
	Faces head size on the ViDi Labs test chart (A1/A3 size)					
Random face position clock-wise	5 o'clock	6 o'clock	7 o'clock	8 o'clock	9 o'clock	10 o'clock
Reproduced on the A1/A3 test chart with head size in mm =>	18mm / 9mm	13mm / 6.5mm	10.6mm / 5.3mm	9.2mm / 4.6mm	8mm / 4mm	6.6mm / 3.3mm
Seen by a camera with a sensor resolution as below	Equivalent pixel density when the A1/A3 size test chart is seen exactly 100% width by a camera with various sensors					
HD (1920 x 1080)	175 pix/m	125 pix/m	100 pix/m	88 pix/m	75 pix/m	63 pix/m
4MP (2688 x 1512)	245 pix/m	175 pix/m	140 pix/m	123 pix/m	105 pix/m	88 pix/m
UHD/4k (3840 x 2160)	350 pix/m	250 pix/m	200 pix/m	175 pix/m	150 pix/m	125 pix/m
	Number-plates character size on the ViDi Labs test chart (A1/A3 size)					
Various number-plates on the A1/A3 test chart with character sizes in mm =>	16.4mm / 8.2mm	13.1mm / 6.6mm	9.8mm / 4.9mm	8.2mm / 4.1mm	6.5mm / 3.3mm	5.0mm / 2.5mm
Seen by a camera with a sensor resolution as below	Equivalent pixel density when the A1/A3 test chart is seen exactly 100% width by a camera with various sensors					
HD (1920 x 1080)	500 pix/m	400 pix/m	300 pix/m	250 pix/m	200 pix/m	150 pix/m
4MP (2688 x 1512)	700 pix/m	560 pix/m	420 pix/m	350 pix/m	280 pix/m	210 pix/m
UHD/4k (3840 x 2160)	1000 pix/m	800 pix/m	600 pix/m	500 pix/m	400 pix/m	300 pix/m



Vcp = Vcr x **sin ß**

The real speed **Vcr** of a car driving at a distance **Dc** at an angle **ß** (relative to the optical axis), which will produce the same motion effect as the rotating number-plates of the test chart, with the tangential speed **Vc,** which is positioned at a distance **Dv** from the camera, is :

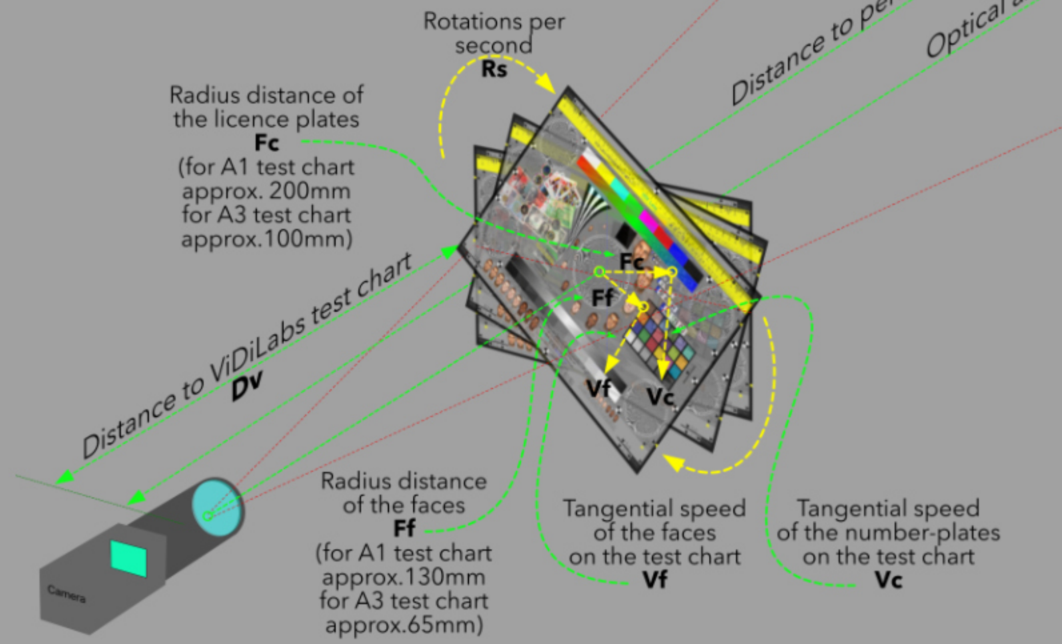
Vcr = (Vc x (Dc/Dv))/sin(ß)



Vfp = Vfr x **sin ß**

The real speed **Vfr** of a person running at a distance **Df** at an angle **ß** (relative to the optical axis), which will produce the same motion effect as the rotating faces of the test chart, with the tangential speed **Vf,** which is positioned at a distance **Dv** from the camera, is :

Vfr = (Vf x (Df/Dv))/sin(ß)

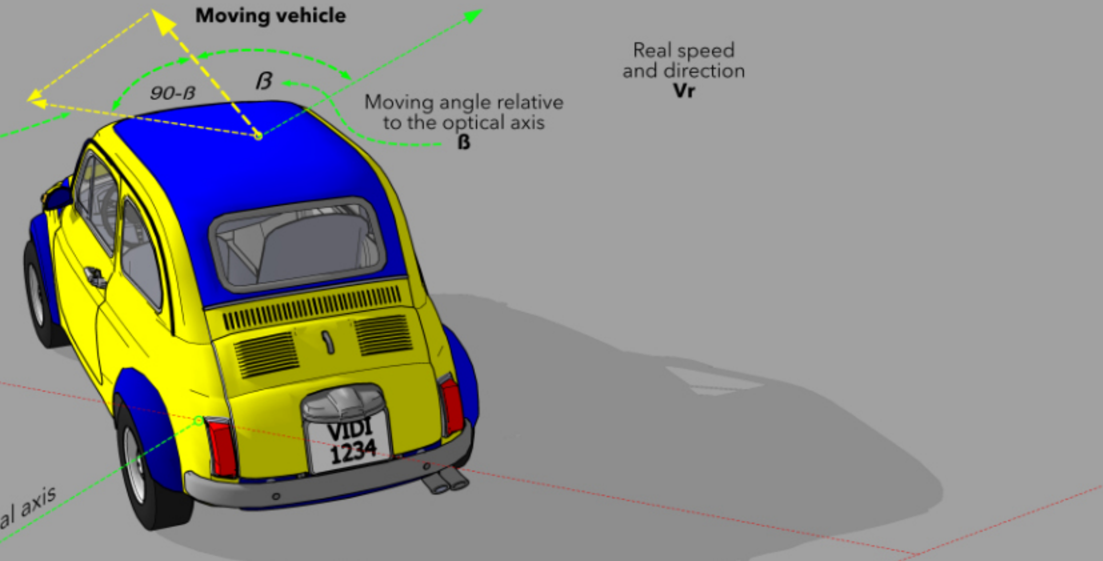


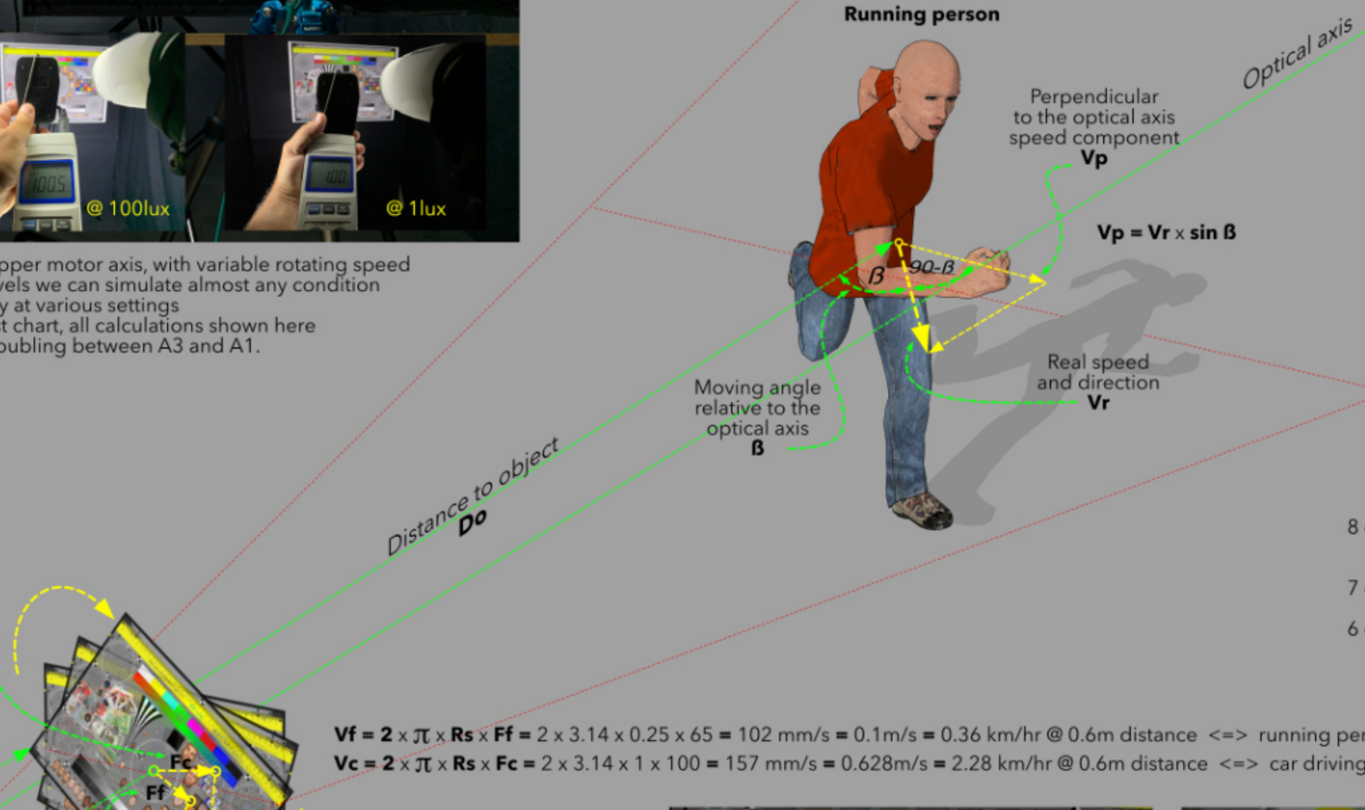
Trigonometric reference	
ß (degrees)	sin ß
10	0.17
15	0.26
20	0.34
30	0.50
45	0.71
60	0.87
90	1.00

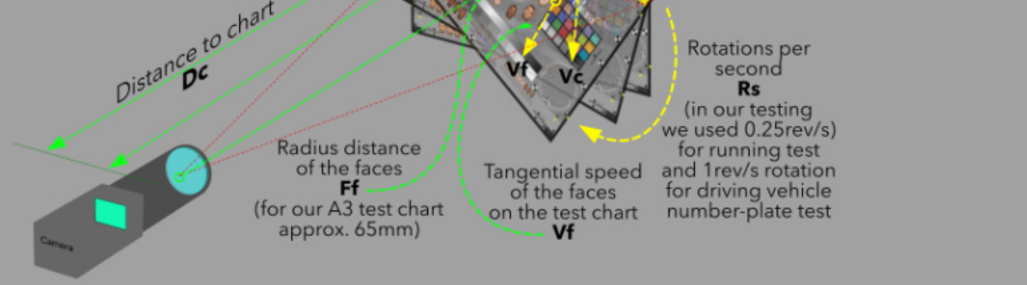
ViDi Labs A1/A3 size test chart v.5.3 rotations and derived real speeds (camera to chart = 1.2m/0.6m)						
	Faces head size on the ViDi Labs A1/A3 test chart					
Rotation speed (rev/s)	0.25 rev/s	0.5 rev/s	1 rev/s	2 rev/s	4 rev/s	8 rev/s
Faces tangential speed (m/s)	0.2m/s / 0.1m/s	0.4m/s / 0.2m/s	0.8m/s / 0.4m/s	1.6m/s / 0.8m/s	3.2m/s / 1.6m/s	6.4m/s / 3.2m/s
	Equivalent real speed (Vfr) speed, at an angle ß relative to the optical axis:					
Person walking/running or cycler riding at the below distance from the camera						
3m	3.6/sinß km/hr (A1) 1.8/sinß km/hr (A3)	7.2/sinß km/hr (A1) 3.6/sinß km/hr (A3)	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)	75.2/sinß km/hr (A1) 37.6/sinß km/hr (A3)
6m	7.2/sinß km/hr (A1) 3.6/sinß km/hr (A3)	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)	75.2/sinß km/hr (A1) 37.6/sinß km/hr (A3)	
9m	10.8/sinß km/hr (A1) 5.4/sinß km/hr (A3)	21.6/sinß km/hr (A1) 10.8/sinß km/hr (A3)	43.2/sinß km/hr (A1) 21.6/sinß km/hr (A3)	86.4/sinß km/hr (A1) 43.2/sinß km/hr (A3)		
12m	14.4/sinß km/hr (A1) 7.2/sinß km/hr (A3)	28.8/sinß km/hr (A1) 14.4/sinß km/hr (A3)	57.6/sinß km/hr (A1) 28.8/sinß km/hr (A3)			
15m	18/sinß km/hr (A1) 9/sinß km/hr (A3)	36/sinß km/hr (A1) 18/sinß km/hr (A3)	72/sinß km/hr (A1) 36/sinß km/hr (A3)			
	Various size number-plates on the ViDi Labs A1/A3 test chart					
Rotation speed (rev/s)	0.25 rev/s	0.5 rev/s	1 rev/s	2 rev/s	4 rev/s	8 rev/s
Number-plates tangential speed (m/s)	0.3m/s / 0.157m/s	0.6m/s / 0.314m/s	1.26m/s / 0.63m/s	2.52m/s / 1.26m/s	5m/s / 2.52m/s	10m/s / 5m/s
	Equivalent real speed (Vcr), at an angle ß relative to the optical axis:					
A vehicle driving at the below distance from the camera						
3m	5.6/sinß km/hr (A1) 2.8/sinß km/hr (A3)	11.2/sinß km/hr (A1) 5.6/sinß km/hr (A3)	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)
6m	11.2/sinß km/hr (A1) 5.6/sinß km/hr (A3)	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)	352/sinß km/hr (A1) 176/sinß km/hr (A3)
9m	16.8/sinß km/hr (A1) 8.4/sinß km/hr (A3)	34/sinß km/hr (A1) 17/sinß km/hr (A3)	68/sinß km/hr (A1) 34/sinß km/hr (A3)	128/sinß km/hr (A1) 64/sinß km/hr (A3)	256/sinß km/hr (A1) 128/sinß km/hr (A3)	
12m	22/sinß km/hr (A1) 11/sinß km/hr (A3)	44/sinß km/hr (A1) 22/sinß km/hr (A3)	88/sinß km/hr (A1) 44/sinß km/hr (A3)	176/sinß km/hr (A1) 88/sinß km/hr (A3)	352/sinß km/hr (A1) 176/sinß km/hr (A3)	
15m	27.6/sinß km/hr (A1) 13.8/sinß km/hr (A3)	55.2/sinß km/hr (A1) 27.6/sinß km/hr (A3)	110/sinß km/hr (A1) 55/sinß km/hr (A3)	220/sinß km/hr (A1) 110/sinß km/hr (A3)		

ViDi Labs rotating test chart jig for analysing moving objects picture quality

Our ViDi Labs A3 v.5.3 chart test jig, mounted on a stepper motor axis, with variable rotating speed
By varying the revolution speed (rev/s) and light levels we can simulate almost any condition
in order to test camera quality at various settings
NOTE: If you are using the A1 size of the test chart, all calculations shown here
will be **doubled** due to dimensions doubling between A3 and A1.

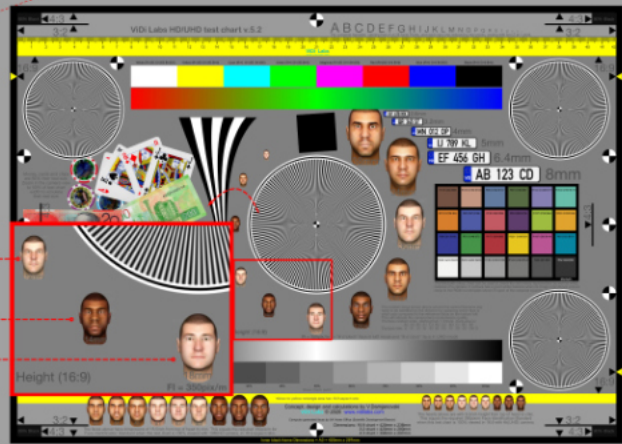






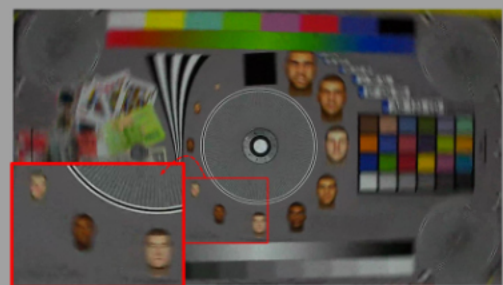
Vf = 2 x π x **Rs** x **Ff** = 2 x 3.14 x 0.25 x 65 = 102 mm/s = 0.1m/s = 0.36 km/hr @ 0.6m distance <=> running person @ 7.6km/hr @ 11m
Vc = 2 x π x **Rs** x **Fc** = 2 x 3.14 x 1 x 100 = 157 mm/s = 0.628m/s = 2.28 km/hr @ 0.6m distance <=> car driving @ 57km/hr @ 13m

The apparent pixel density for A3 test chart, and 1/3" 4MP sensor (2688x1520 pixels) is:
8 o'clock face <=> 330 pix/m
7 o'clock face <=> 380 pix/m
6 o'clock face <=> 490 pix/m



The raw electronic version of the test chart with the 6, 7 and 8 o'clock faces magnified in the red frame
(NOTE: the visible quality is limited to this PDF resolution)

Static chart, 1lux, Auto, 4MP, H265, 6Mb/s



Rotating chart, 1lux, Auto exp., 4MP, H264, 6Mb/s

Rotating chart, 1lux, Auto exp., 4MP, H265, 6Mb/s

Static chart, 100lux, Auto, 4MP, H265, 6Mb/s

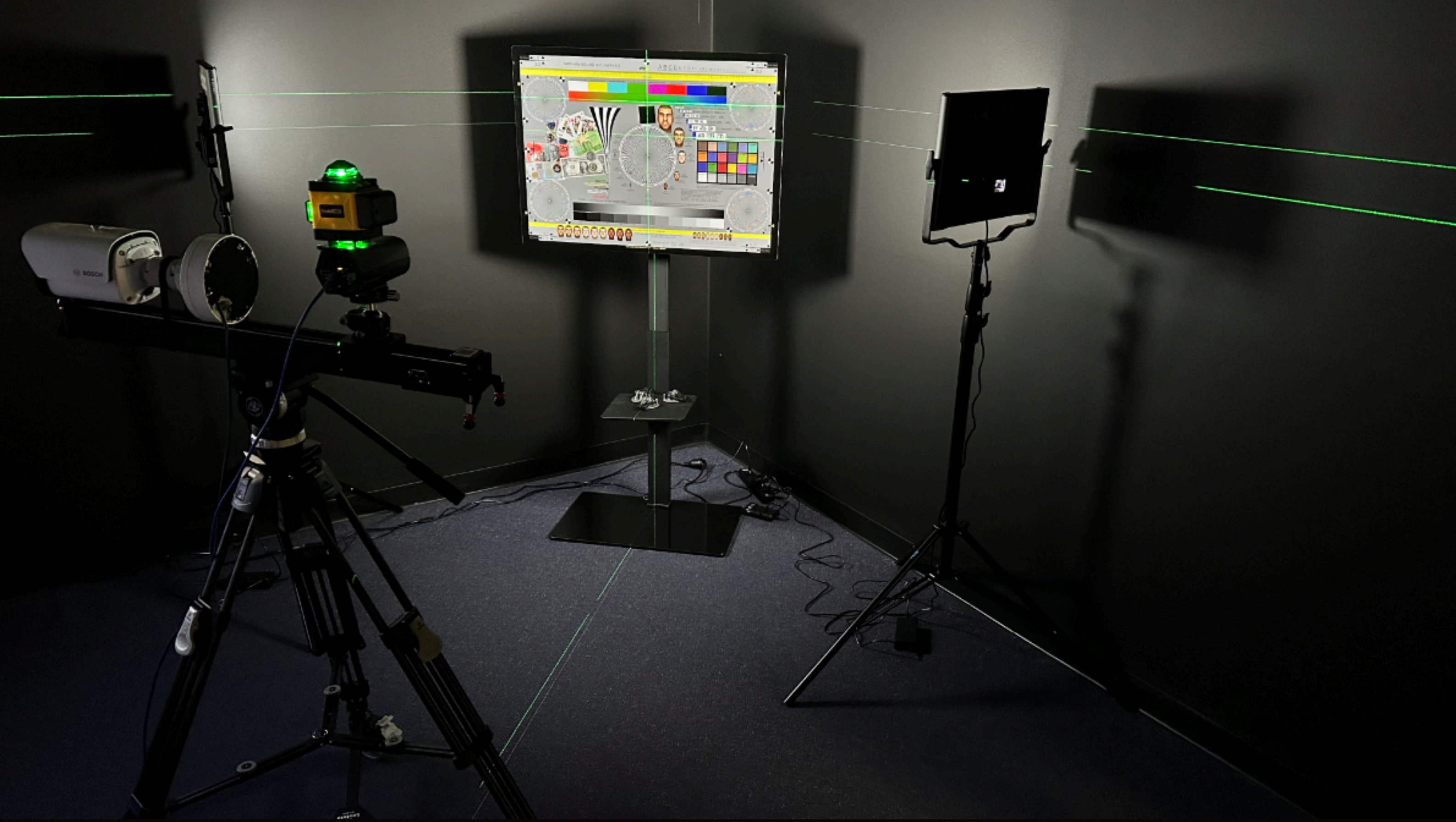
Rotating chart, 100lux, Auto exp., 4MP, H264, 6Mb/s

Rotating chart, 100lux, Auto exp., 4MP, H265, 6Mb/s

Rotating chart, 100lux, 1/500s, 4MP, H264, 6Mb/s

Rotating chart, 100lux, 1/1000s, 4MP, H264, 6Mb/s

Rotating chart, 100lux, 1/1000s, 4MP, H265, 6Mb/s



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