Quato Intelli Proof 262/240 excellence

The visual contract proofer´s White Paper on wide color gamut technology

Since the beginning of hardware calibration, the display calibration technology made a great leap forward. Today, standard gamut hardware calibrated TFTs are a common tool for all graphic and photographic professionals. But with the more demanding printing technologies like Multicoloror printing and the high end digital backs, the display technology needs new answers to the basic problem of the match between additive and additive/subtractive color.

The Intelli Proof excellence and the incorporated Gamut Plus Technology are Quato´s answer to this technological challenge. For the first time, a display tries to cover the majority of the ECI-RGB working space that is regulated as the ISO standard working space for all graphic arts, prepress and photographic environments: plus it covers Adobe-RGB.

But using the right gamut shape and size is only a small part of the work that has to be done to create one of the most powerful visual systems in the world. This whitepaper would like to give a short look behind the scenes and offers some ground braking news for all color power users: the visual contract proofing is possible. At Quato, we take the challenge to develop the most sophisticated hard- and software solution by combining powerful

Science and Simplicity

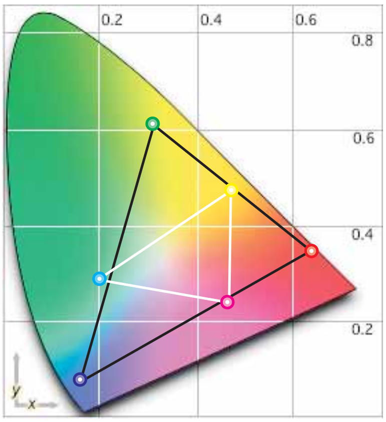
Quato´s Gamut Plus Technology

The Backlight

Today´s display technologies make - in most cases - use of a CCFL-backlight (Cold Cathode Fluerescent Light) that illuminates the TFT-screen. The CCFL-tubes contain special types of phospors to create a white light.

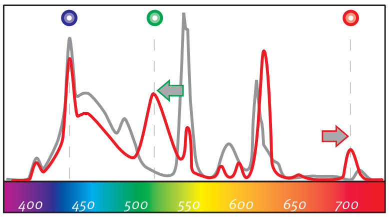
The majority of the TFTs can show up to 75% of the NTSC color space. While this color space is large enough from its volume to include the printing standards, its size and position is not suited to reproduce all colors of the print on the screen.

That´s because, we have different color models [additive color (RGB) and subtractive color (CMY)] and a geographically suboptimal position. To include the printing standards, the gamut of the RGB-device has to be increased a lot.

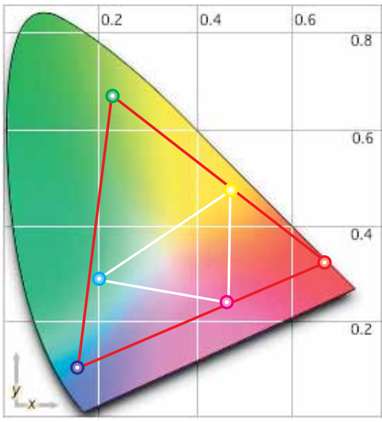


Expanding the Gamut

The best way to expand the gamut size is by changing the spectra of the backlight. By combining color science and chemical science, it´s possible to create a phosphor set that has a different spectra and a better representation of the red and green areas.

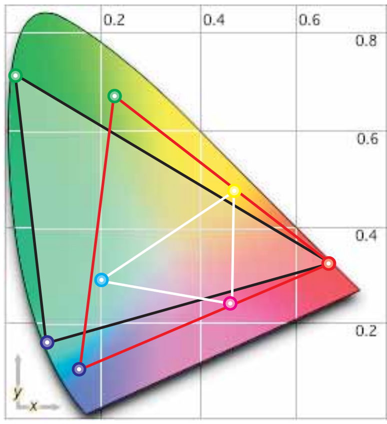


In the chromatic and spectral diagram, the difference is clear to be seen: red and green have moved in the spectra and thus, the gamut size increased. The result is a much higher brillance of red and green.



Optimizing the Gamut

Increasing the gamut may not help to increase the coverage of an subtractive output device. The match between the display´s gamut and the output device´s gamut is the main goal. The volume of the



black outlined monitor [illustration] gamut is bigger than the red outlined monitor gamut. However, the coverage of the red one, in respect to the output device´s gamut, is much better. Therefore, one has to differ between the gamut quantity (raw volume) and the gamut quality (the real congruency to an output device).

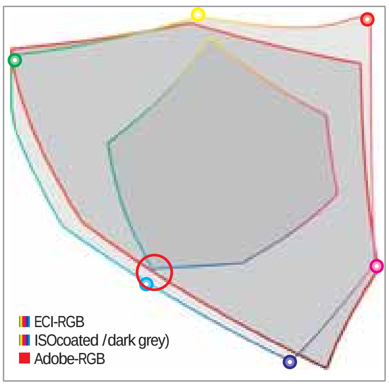
This means that a display with a smaller but optimized gamut might be better suited for softproofing than a display with a larger but suboptimal shaped gamut.

ECI-RGB vs. Adobe-RGB optimizing

The working space discussion

In today´s workflows, there are two working space RGBs very much common: Adobe-RGB and ECI-RGB.

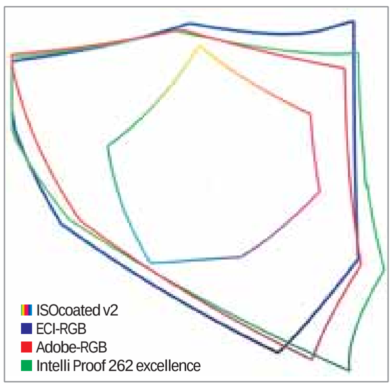
Adobe RGB is refered to be a good solution for overall work, but it´s not optimized for reproducing printed colors or softproofing. That´s because it uses 6.500K for the Whitepoint and a Gamma of 2.2. The standard of color management is D50 (5.000K) and the dot gain curve of a standard offset print does not match gamma 2.2. Once more, the shape of the gamut shows that Adobe-RGB nearly cuts off the cyan of the standard offset printing. ECI-RGB is more and more accepted to be the standard RGB working space and is submitted as ISO standard. It was built to include all printing technology standards and to exclude colors that cannot be reproduced even in RGB. Additionally, it uses a whitepoint of D50 and a Gamma of 1.8 (v1) or L* (v2), so it better matches the printing technologies with the standardized dot gain curves and the regulation for environmental light.



▲ The gamut shape differs between Adobe-RGB (red oulined) and ECI-RGB - especially in the red/orange and blue/green area. Plus, Adobe-RGB cuts off the printer´s cyan.

The right way to go

As ECI-RGB allows to reproduce the printing standards and includes the majority of the RGB-devices, it is a good solution for a media-independent workflow. Thus, a display, that covers both, Adobe-RGB and ECI-RGB would be the best solution. The Intelli Proof excellence was designed with this in mind.



The Intelli Proof 240 and 262 excellence Gamut

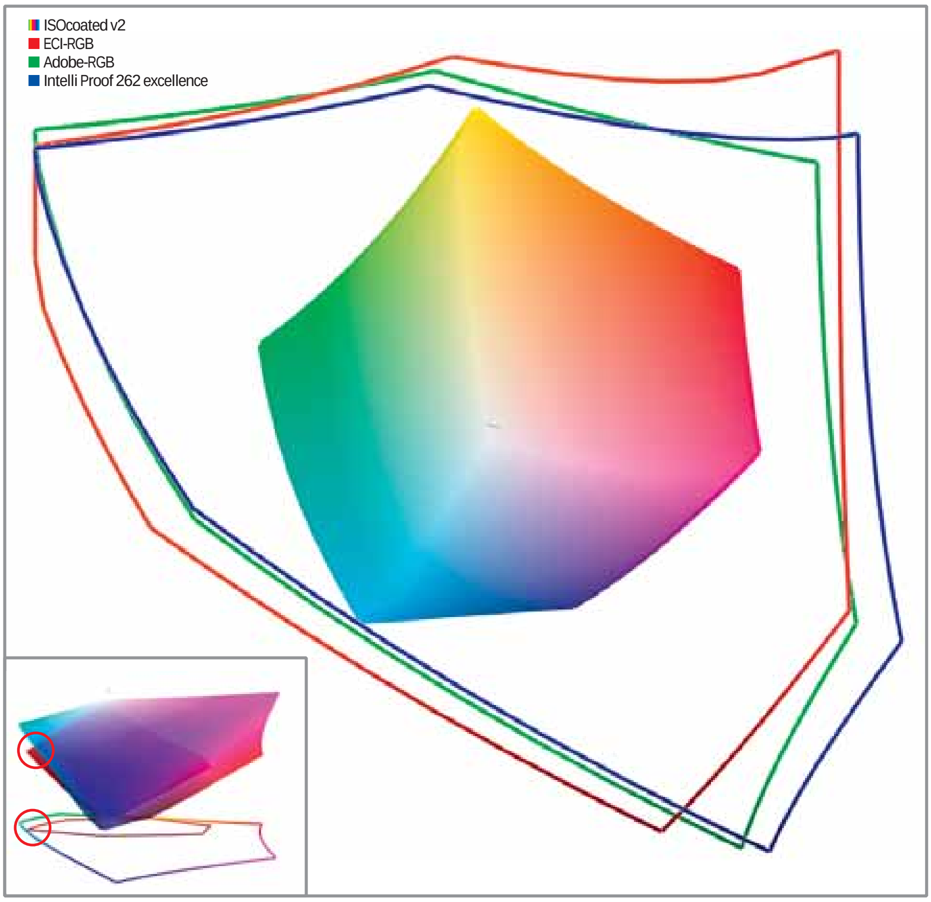
The Backlight development

The backlight development in the past 3 years has made a great leap forwards. From edge-lighting to direct-lighting, from 72% NTSC to more than 100% now, the CCFL-techology today offers what was imagined only with a LED-backlight in the past.

Quato´s first Wide Gamut TFT, the Intelli Proof 230 excellence was a well balanced ECI-RGB and Adobe-RGB optimized. This offered a quite good match to both color spaces, but showed a less than optimal sRGB coeverage.

The successor, the Intelli Proof 260 excellence was a compromise between sRGB, Adobe-RGB and ECI-RGB. Due to the limited gamut size of 92%, the 260 excellence wasn´t able to match ECI-RGB as good as the original 230 excellence. On the other hand, the Intelli Proof 213 excellence was purely optimized for Adobe-RGB and sRGB to offer especially photographers a perfect color correction display.

With the new Intelli Proof 240 and 262 excellence, the gamut volume increased to 103%. This extended wide gamut gives the real chance to get an even better color matching to the three common color spaces. Both new units offer therefore a nearby 100% Adobe-RGB match and the ECI-RGB match is high enough to pass the UGRA recommendation of 90%.



▲ Gamut projection of the new IP 262 excel and 3D snapshot

Gamut mythology Part 1: match vs. volume

The discrepancy between gamut volume (quantity) and the real match (quality) is because it´s very hard to reach the same primary colors as NTSC/ECI with today´s technology - might it be CCFL or LED. Therefore the volume that is expressed in marketing material does not really tell anything, because it´s very likely that only the raw volume is mentioned. Only the match or gamut quality really counts. In the table on the right, one can see that the Intelli Proof 262 excellence, for example, has a large gamut volume of 103% NTSC, but the real match to NTSC (ECI uses the same primary colors) is 94% only. Thus, following the standard procedure, we can claim that the display has 100% ECI and 100% Adobe-RGB gamut. But, in reality it´s only 94% for ECI and 99% for Adobe-RGB, respectivly.

Gamut mythology Part 2: 1931 vs. 1976

The standard gamut volume is correlated to the CIE1931 formula. Sometimes, competitors now use the CIE1976 formula to express the gamut volume and claim to have a larger gamut size than competitors. It´s good to be seen on the right, that with CIE1976, the gamut size increases a lot and makes it hard to compare units to each other. The mentioned 103% of the Intelli Proof 262 excellence increases - thanks to CIE1976 - to nearby 120%. But, that´s basically the same trick that is used in some monitor calibration software, where DeltaE 94 instead of DeltaE 76 is used to make the calibration look more precisely than it really is.

Gamut mythology Part 3: Projection vs. 3D or slicing

A gamut projection always shows the largest dimensions of a gamut, no matter the absolute L*a*b* luminance of the colors. But, what looks like a 100% match, can be a noticeable deviation. Thus, only a Gamut slicing or a 3D model can really show how good two devices or reference working space and device match to each other. It´s hard to get an idea of the 3D-Gamut on printed paper - thus, the projection is a compromise.

▼ Gamut quantity versus Gamut quality

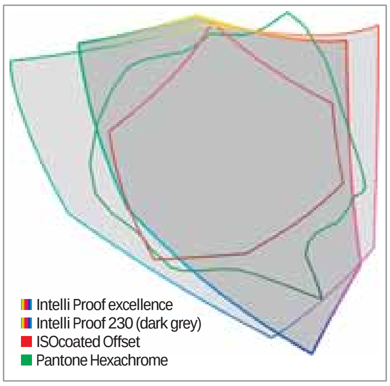
Display	Gamut quantity CIE1931 (volume)			Gamut quantity CIE1976 (volume)			Gamut quality (real match)			
	ECI	Adobe	sRGB	ECI	Adobe	sRGB	ECI	Adobe	sRGB	ISOcoated v2
IP 213 excel	89%	93%	125%	99%	97%	113%	85%	91%	100%	88%
IP 230 excel	92%	95%	129%	90%	89%	103%	91%	91%	94%	100%
IP 260 excel	93%	97%	131%	106%	105%	122%	88%	93%	99%	99%
IP 240 excel	102%	107%	144%	119%	117%	137%	93%	98%	100%	100%
IP 262 excel	102%	108%	145%	119%	117%	136%	94%	98%	100%	100%

Looking at PrePress

Using a wide gamut display has some advantages for prepress, graphic design and printing. Only a wide gamut display reaches a level of color reproduction and precision that can be compared to contract proofing (based on standard offset printing).

A standard gamut unit reaches, for example, for subtractive Cyan a deltaE value of 15, while an Intelli Proof excellence can reduce this error to about 5. This is also a big advantage for Remote Proofing applications that need to have the best possible color reproduction.

When looking at non standardized printing technologies like HighBody (printing with higher densities) or Multicolor printing (more than 4



colors), a wide gamut display will have an even higher benefit. Compared to a standard Intelli Proof display, the gamut of the wide gamut unit is big enough to include the majority of Pantone Hexachrome.

The same applies to HighBody printing, where the gamut increases up to 20% and therefore exceeds the abilities of a standard gamut display by far.

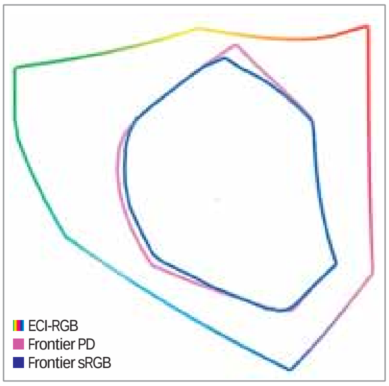
Especially when using spot colors in packaging, a wide gamut unit can help to improve the output

simulation quality. A Pantone Rubin Red coated has only barely visible 5.5 deltaE on a wide gamut unit compared to eye-tracking 13.0 deltaE on a standard gamut unit.

Looking at Photography

While not suited for printing and prepress, most photographers rely on Adobe-RGB, because it´s the standard working space of all professional D-SLR cameras and comes preinstalled with the number one image editor: Adobe Photoshop.

Another reason for the use of Adobe-RGB or sRGB is the output on digital labs that internally use sRGB for the image development. But, the gamut of the mini labs is much smaller than sRGB or Adobe-RGB. So it makes no difference if one uses ECI-RGB instead.

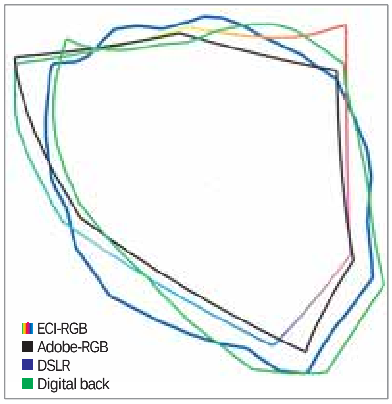


Additionally, the standard communication whitepoint for the ICC color management is D50. Soft box lighting and flashes generally also use 5.000K. Even more, the photo is only one part of the workflow and at the end of this workflow is the printed image. This print matches Gamma 1.8 - 5.000K much better. Using a corresponding RGB working space enables the user to get the most out of the workflow and to avoid problems from image converting.

The high-end photography has already moved on that path as digital backs and their software widely support ECI-RGB as the RGB working space. The image from the camera comes without a specific profile (but sometimes with an embedded camera profile) and the RGB-working space can be applied during the development of the image in the camera software. This gives full control over the colors and the results.

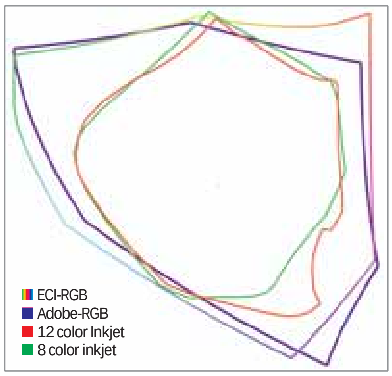
But also for DSLR users, it´s not a problem to change from the camera´s embedded Adobe or sRGB to ECI-RGB. The major Raw-converter softwares support the setup of an individual RGB working space in the

The CCDs and color algorithms in digital cameras have quite different color gamuts. Interestingly, Adobe RGB is not able to reproduce the camera´s gamut - especially in the red area. ECI-RGB´s overall match to the camera´s color abilities is much better.



But Adobe-RGB is not only used in conjunction to a camera. It´s also used in conjunction to photographic inkjet printers. Interestingly, no inkjet printer - even the 12 color ones not - can reproduce the Adobe-RGB gamut. Furthermore, Adobe-RGB cuts off the Cyan of the printer´s gamut. ECI-RGB offers - once again - a better coverage of the color gamut.

The conclusion is to think about the workflow and to use ECI-RGB plus an ECI-RGB optimized wide gamut display like the Intelli Proof excellence.



Calibration Technologies

There are many different ways to calibrate and profile a display. If one can adjust the monitor's hardware automatically we can call it hardware-calibration. If no adjustments are possible or only the luminance and the whitepoint can be controlled we will call it software-calibration. The gamut is only slightly affected by this type of calibration, even if some people argue this way. But, the more precise the calibration and the profiling process are, the better the color performance and the simulation of in-gamut and out of gamut colors will be. If the color profile on the other hand has to balance the monitor's drawbacks too much, then the overall quality will decrease.

Visual calibration

Without the assistance of a measuring device, a monitor can only be adjusted by using the human eye. Apple´s Colorsync and Adobe´s Gamma allow the user to adjust based on visual test patterns. So this is fairly precise. The whitepoint can also be adjusted, but the software never knows the state of the monitor.

Software calibration

A monitor without adjustments can set the luminance in most cases, but doesn't have any control over its internal RGB-values. In this case, the profile has to do a lot of math and every deviation from the reference has to be corrected by the ICC-profile. Such a display for example has about 7.000 Kelvin and a gamma of 2.2. For prepress appliances the profile has to reduce whitepoint by up to 2.000 K and gamma by 0.4. This leads into a loss of about 20 shades per channel. This loss is visually recognizeable and the usage for softproofing and color critical applications is not recommended

Hardware-assisted OSD-calibration ①

Some TFTs allow to adjust RGB- and luminance. Depending on the monitor's type and manufacturer more or less 100 steps are available to tweak the colors. With 100 steps it's impossible to reach exactly the calibration target. The remaining deviations will be corrected by the profile with only a little loss. But don't forget the gamma. On such a display one will lose around 19 shades per channel by doing the gamma-math. This loss can be avoided with a display that supports gamma-adjustments, but the gamma in only valid for the 50% gray.

The Quato Intelli Color series allows users to setup the whitepoint based on Gamma 1.8, 2.2 and L*. The resulting deviations still have to be adapted by the profile in the end and slight deviations will show some effect on graybalance and fidelity.

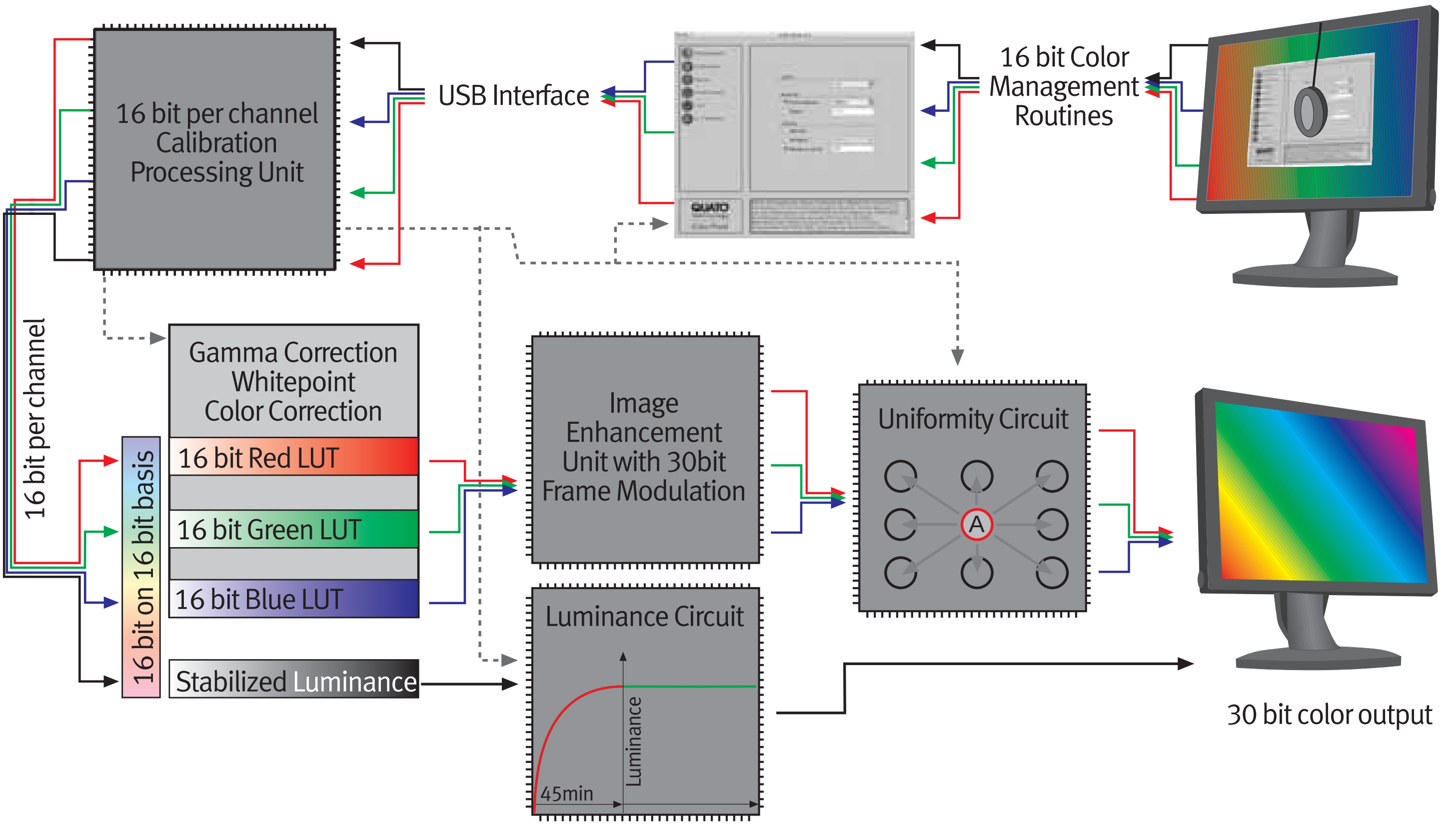
Factory-based hardware-calibration

In this case, the display has a precise factory calibration LUT and a user calibration LUT. If the user calibrates to values near the factory LUT, then a calibration process doesn't have to tweak the user LUT too much. But there is always a difference between a factory and a user calibration due to the measurement devices used. The more the user differs from the factory calibration, the more the precision decreases, as the calibration data is calculated and not measured. This ensures basic color performance and is not suited for highend work.

Individual hardware-calibration ②

In this case the gamma and white point will be adjusted individually and with up 14 bit precision inside the monitor's LUT. The hardware-calibration sets up the complete range of tonal values in hardware based on actual measurements. So there is no adjustment on the graphic card's LUT, keeping the full dynamics. This kind of individual calibration takes longer than the Factory-based hardware-calibration but is much more precise.

Intelli Proof 262/240 excellence calibration technology in depth

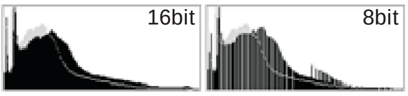


The Intelli Proof display in depth

The Intelli Proof / iColor Display calibration technology is based on the individual calibration of the monitor's LUT with up to 42 bit precision and the exact control of the backlight to ensure a stable luminance.

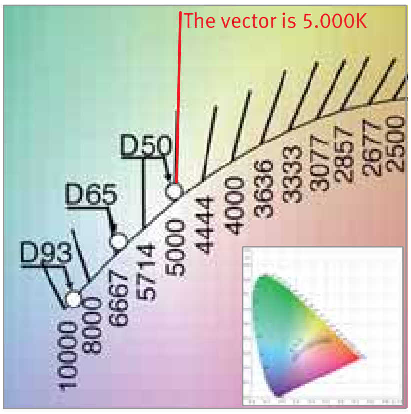
Instead of a manual adjustment with its sub optimal precision of only up to 256 steps, the iColor Display software controls the Intelli Proof's internal Calibration Processing Unit (CPU) and the internal LUT (Color Correction Table) with up to 16 bit resolution by a dedicated USB-connection. To increase the precision even more, the software computes all values with an absolut precision of 16 bit (65.536 steps).

This can be compared to what was done during high quality drum scanning. The reprograph scanned the image in 16 bit resolution and made all corrections with 16 bit resolution. Later, a perfect 8 bit image was created. Using an 8 bit image and doing all the correction would result in a big loss and visible effects. Therefore the Intelli Proof uses a scale down from 16 bit software precision to 14 bit calibration and 10 bit output.



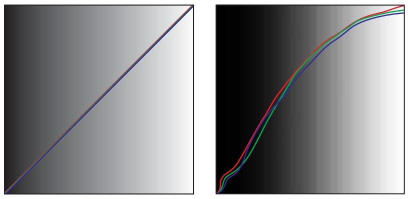
▲ Changing the levels on the 16bit image shows no deviations, while changes on the 8bit image show a lot of gaps in the histogram. The gaps will result in visible loss of detail and color fidelity.

This highest precision approach eliminates the differences between the monitor's calibration and the calibration target. The whitepoint reaches a precision of less than 0.5 deltaE from target to reference. Reaching a whitepoint of 5.000K for



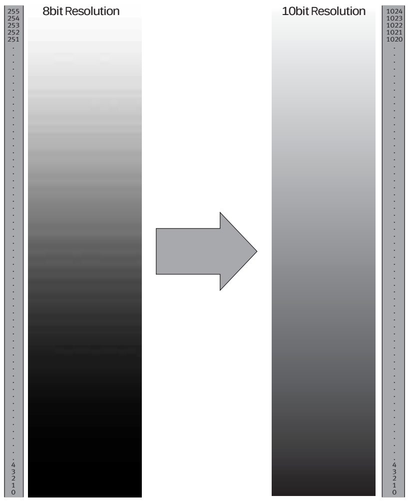
example, is not the same as matching the black body curve (the real target), as the whitepoint is only correctly matched, if it matches the black body curve and not the 5.000K vector.

Other than with a software calibrated display, the gradation (Gamma, L*) and the whitepoint are exactly matched for the whole dynamic range from L=0 to L=100. This ensures that colors and grays can be reproduced at any level without visual deviations from the target. The graybalance shows only an average deviation of less than 1 deltaE - that´s far below the human eye´s recognition.



▲ The linear curve on the left side shows the perfect match of the Intelli Proof to the target gradation. The left shows a software calibration.

The display's image processing unit (IPU) converts any 8 bit signal from the digital graphics card to 10 bit. As the human eye needs more than 256 shades of gray to have the perception of a smooth blending from one color to the other, this 10bit output is needed to reproduce ultra smooth gradiants and high dynamic images without loosing detail.



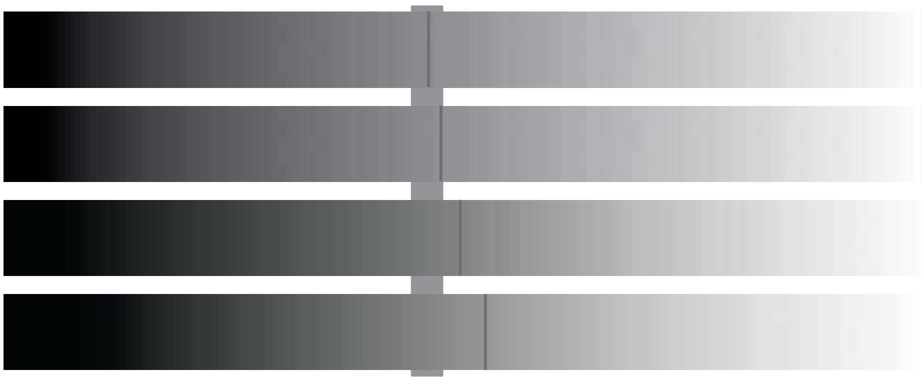
Gradations (tonal response)

In the past, Gamma 1.8 was referred to be the Macintosh Gamma and Gamma 2.2 was refered to be the standard PC Gamma. The Gamma is not related to a specific platform but to a specific workflow and working space.

Gamma 1.8 for example is mostly used in the printing and graphic arts, as it matches the ISO compliant dot gain curve very well, while Gamma 2.2 has a different balance between black and white and therefore a shifted mid gray.

A color mode change from 1.8 Gamma RGB to CMYK (ISOcoated) will result in no visible loss of the gradation. Doing this with a Gamma 2.2 RGB will result in a visible loss.

If one decides to use ECI-RGB as the working space, one has to calibrate the monitor with the same setup. A mismatch between working space and monitor profile results always in a



▲ The gradiants shows the balance between black and white and where the mid gray is located. From top to bottom: ISOcoated, Gamma 1.8, L* and Gamma 2.2. It´s good to be seen, that Gamma 1.8 matches the mid gray much better than L* or Gamma 2.2. That´s why the Gamma 1.8 based ECI-RGB is prefered.

visible loss. For example: if the monitor is calibrated with Gamma 1.8 and 5.000 K and Adobe-RGB is used as a working space, the shown image will have a loss of about 40 shades per channel. That´s a definitive visual loss and can best be traced by using a uniform graybalance from black to white.

However, it´s not possible to generalize the use of ECI-RGB for every working environment. It´s the individual workflow that rules. But following a media neutral path with an RGB working space that includes all possible output devices is a clever choice to avoid the most common problems.

The Intelli Proof display´s uniformity

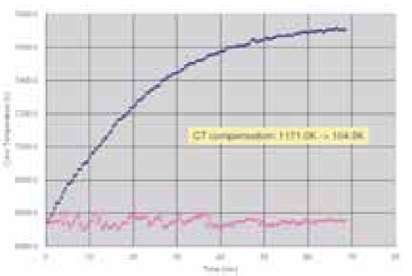
Today´s displays suffer from several non-uniformity issues. While a luminance change from the center to the corners might be acceptable, a color shift from left to right is most likely to be unacceptable.

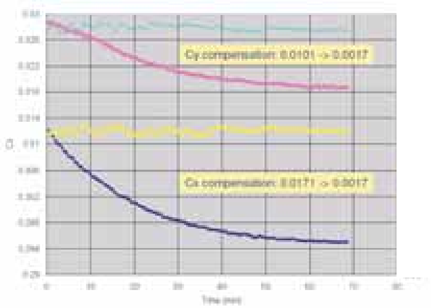
While direct backlight sources - instead of edge-lighting - can significantly reduce the luminance non-uniformity, the color shift can not be compensated. Due to this limitation of backlight technology, Quato has developed the ADC-circuit (Area Dimming Control) that separates the display into 25 independent areas and individually corrects the deviations of every single display.

The sophisticated ADC-circuit´s correction LUT uses a factory based measurement and smoothes automatically every of the 25 areas to its neighbouring area to avoid the occurance of a checkerboard phenomenon.

Additionally, the sensors in the back of the display track temperature, luminance and whitepoint and keep the display adjusted to the calibration parameters and give a real-time feedback to the ADC-controller to keep the uniformity.

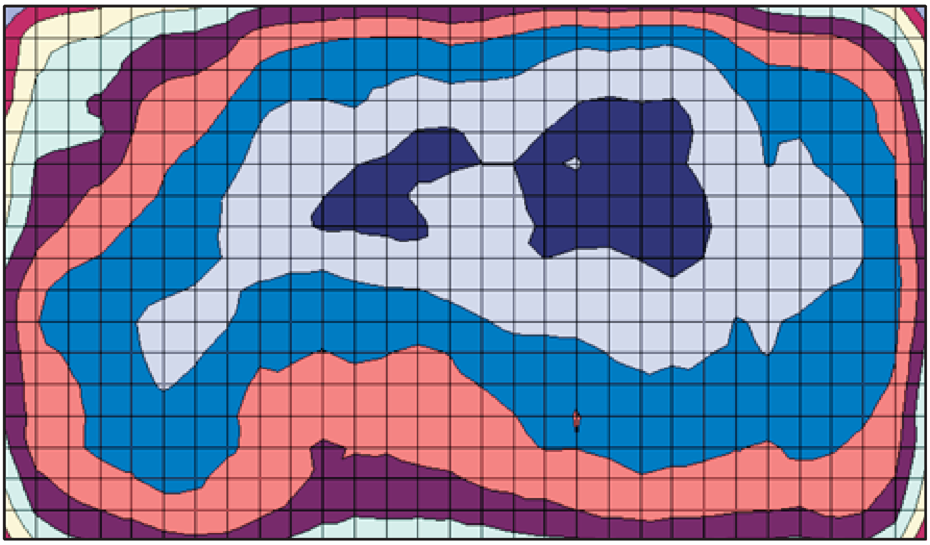
▼ Whitepoint stability improvement





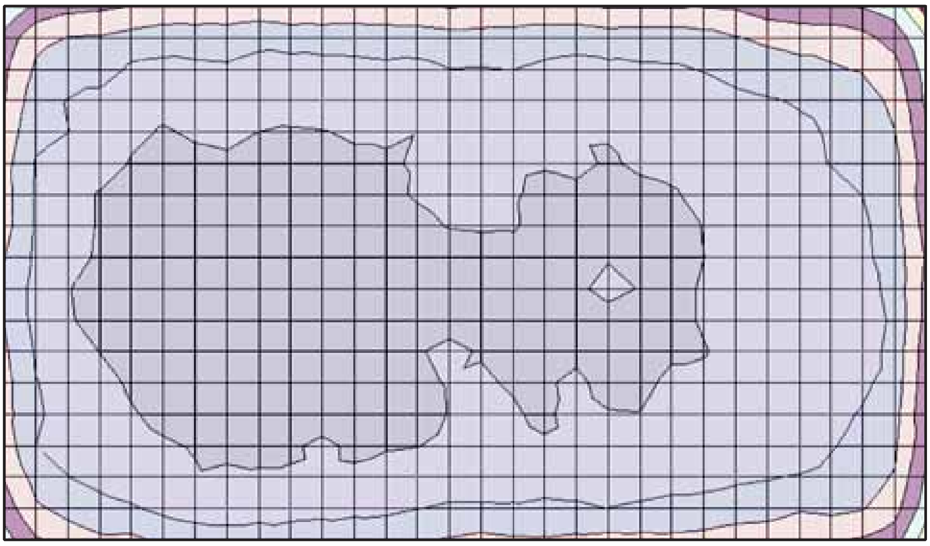
▲ Color stability improvement

As a result, the display easily reaches the uniformity requirements of ISO12646-2008. Additionally, the whitepoint is stabilized and the optical drift is reduced. However, slight clouds of non uniformity (called mura) cannot be fully avoided. But, the difference to CRT and standard TFT displays is visually striking and makes the Intelli Proof excellence 240/262 a perfect solution for high end work.

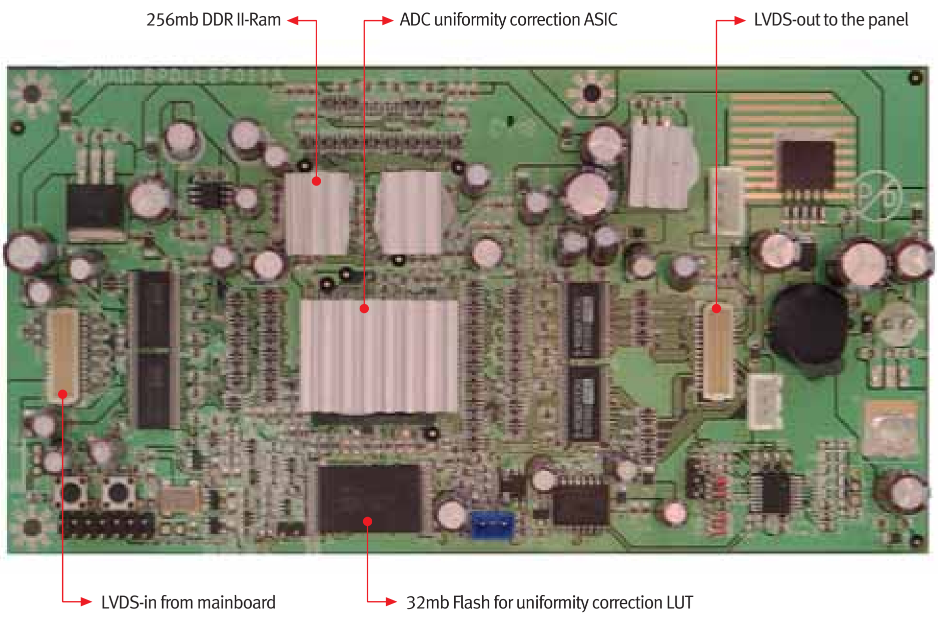


▲ Before uniformity compensation

▼ After uniformity compensation



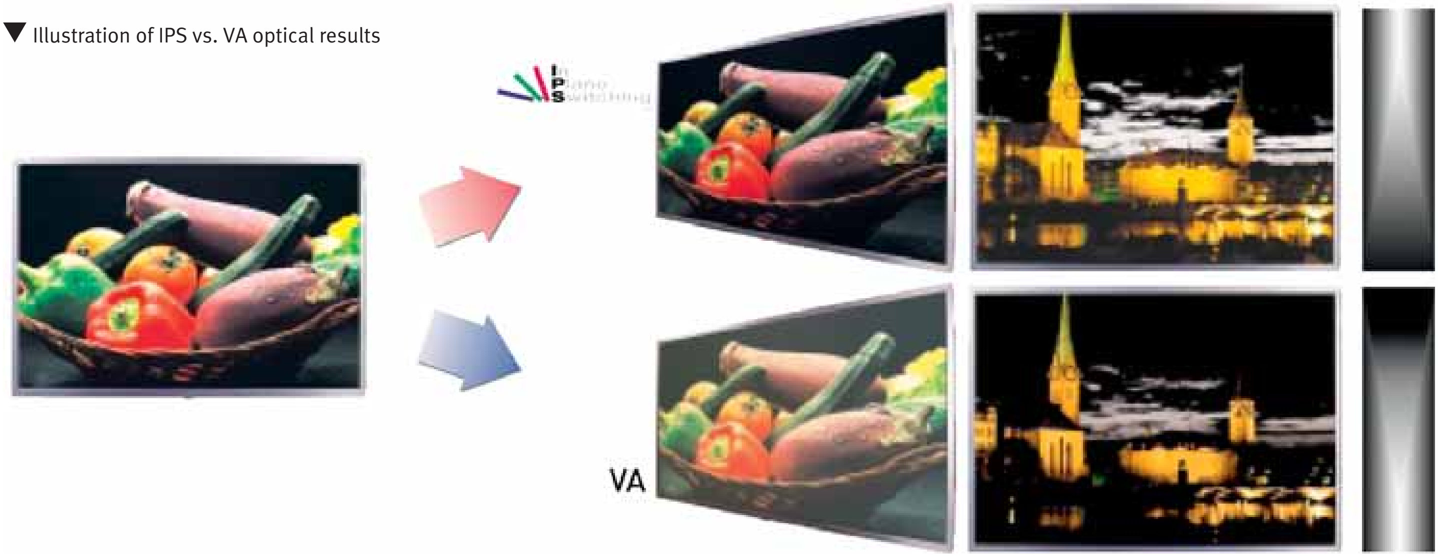
▼ The Quato ADC Circuit Board



Panel Technology

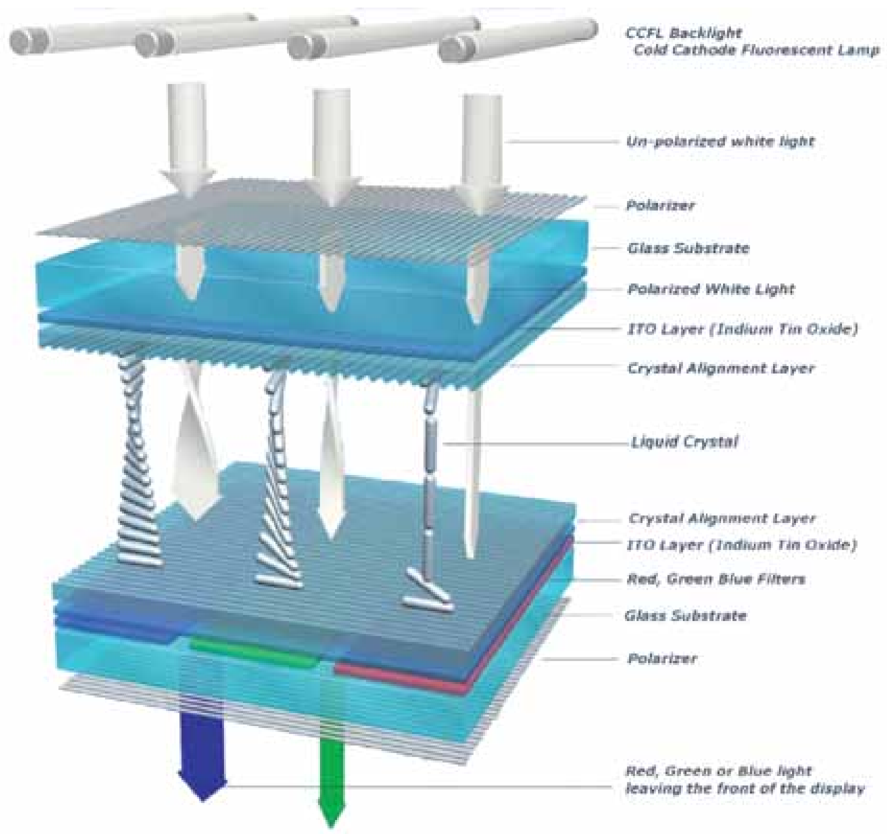
The panel technology is another key for a perfect color representation. The Intelli Proof excellence is based on advanced S-IPS panel technology that offers much more stable viewing conditions than competing unit based on S-PVA panels. IPS is the only available panel technology on the market that offers a wide viewing angle without visible hue shifts. While the luminance of a color drops, the hue basically stays the same. With S-PVA or A-MVA panels, the luminance will stay more or less the same while the hue changes heavily. A white image for example, will look simply darker when viewed from the side with S-IPS, while a S-PVA will get a color change to yellow.

▼ Illustration of IPS vs. VA optical results



Panel Technology - a look behind the scenes

An LCD panel is made of different parts. Between the polarizer on the back and the polarizer on the front, there is the glass substrate covering the liquid crystal cells and the RGB color filter to the front. The polarizer in the back has the same orientation than the back part of liquid crystal while the front polarizer is aligned to the front part of the liquid crystal. The polarized light will be bent by the liquid crystals and passed through the cell. The result is that the light passes the crystal and leaves the cell at the opposite side. The liquid crystal looks bright. Depending on the intensity of the light that passes the Red, Green and Blue filters with their correlated liquid crystal package on the back (the sub-pixel), the different colors occur in an additive way (Red + Green + Blue result in white).



A word about Contrast and Brightness (Lumiance)

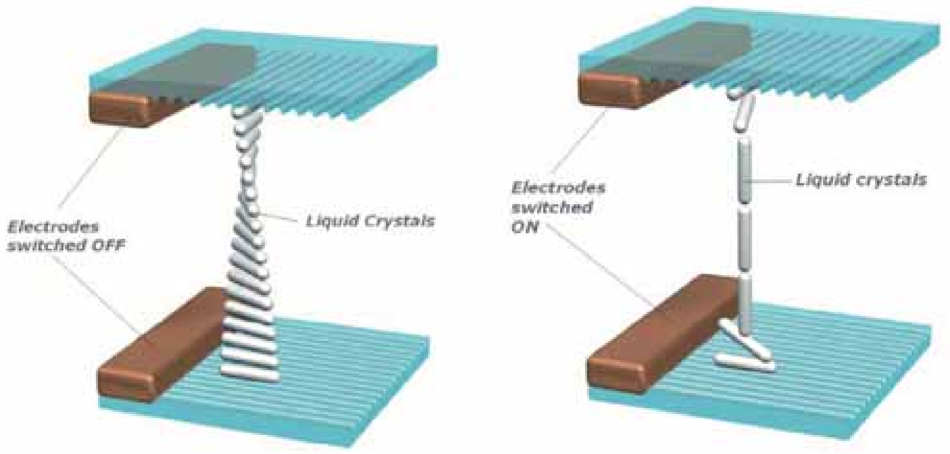
The contrast and luminance values on a data sheet do not tell anything real. For example a 1000:1 contrast is not used in any real world application. If the monitor is calibrated to the ISO12646 recommendation of 160cd/m^2 and has a blackpoint of 0.5cd/m^2, a contrast ratio of 1:320 is achieved (160/0.5=320). This is the real net or working contrast - no matter what values are printed on the data sheet. In addition, a viewing angle of 178° only tells that the contrast does not go lower than 1:10 when the image is observed at 89° from the side. But this does not tell anything about how the colors change. And the color change is what really counts. The specifications of a S-IPS panel for example show the same 178° viewing angle like a A-MVA or S-PVA panel. But the color - or better: hue - change is obvious. The color difference between 0° and 30° for a pure red is DeltaE 4 for the S-IPS and DeltaE 8 for the S-PVA. Given that the human eye can distinguish from DeltaE 3-5 on, a visible difference.

Panel Technology - the different panel types

TN Technology

TN is the oldest and still most widely used LCD technology. Thanks to its rather simple structure and ease of manufacturing, it is the cheapest LCD technology available today and is widely used for home and office computer applications. TN cells have the ability to quickly switch from dark to bright and vice versa. They also have some drawbacks. As can be observed, the crystals at the edge will not fully transition into a vertical state when an electric signal is applied. In addition, the optical properties of the TN liquid crystals vary greatly relative to the viewing angle under which an observer looks at the screen. Heavy color and hue shifts and a poor contrast are the result.

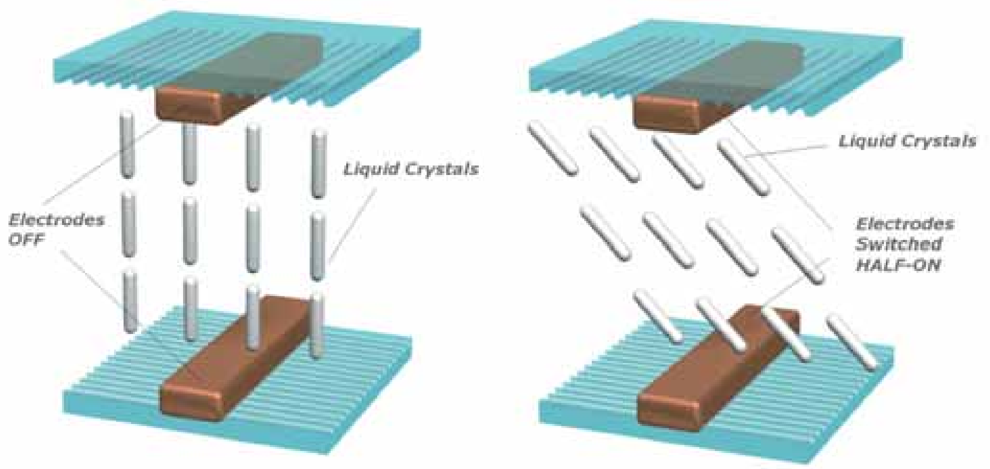
▼ TN-Technology



VA Technology (A-MVA/S-PVA)

Multidomain Vertical Alignment and Patterned Vertical Alignment are acompromise between TN and IPS technology as the technology resulted in fast response times, relatively good viewing angles. When one observes from the top to a cell that is switched half on, the crystals are oriented at 45 degrees and the cell will look gray. On the other hand, observed from the left, with a parallel viewing angle to the crystals, the cell will look dark. The cell is split into 2 halves (domains) in which the crystals are oriented slightly differently, in such a way that for an observer the two halves work complementary. If one looks at the screen from a different angle, one domain will look dimmer but this will be compensated with the second domain that looks equally brighter.That´s the reason why VA-panels show a much higher color shift at different viewing angles than IPS-panels, but offer high contrast ratios.

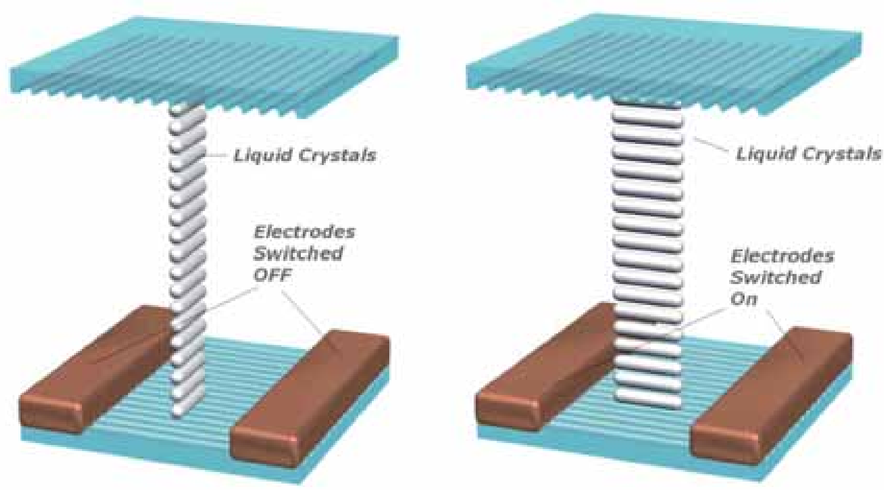
▼ VA-Technology



IPS Technology (AS-IPS/S-IPS)

In an IPS LCD display, the long axis of the crystals is always oriented parallel to the glass panels. When an electrical signal is applied, the crystals rotate horizontally, i.e. in the same plane. The IPS panel needs 2 electrodes to create the proper electrical field so that the liquid crystals can rotate in a horizontal plane. As an immediate result, the aperture of each cell becomes smaller as each electrode blocks some of the light coming from the backlight. A small aperture means that less polarized light can pass from the back to the front of the

▼ IPS-Technology



Panel Technology - the different panel types

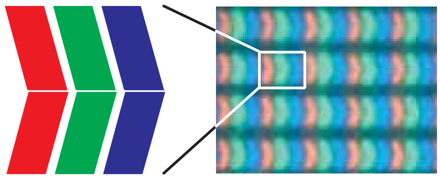
display. This drawback becomes more significant with increasing resolution (smaller cells) as the relative size of the two electrodes will block a relatively larger part of the light. A display using an IPS panel will therefore have a lower brightness than a TN panel when using the same backlight. As the electrodes also reflect some of the light, also the contrast ratio of IPS panels will be somewhat lower. The major advantage of IPS technology is the ability to preserve high contrast and color values under different viewing angles. For image editing, contrast preservation is a must as there is a need to distinguish subtle differences from a broad viewing angle. And as color becomes more and more important, accurate and repeatable color reproduction under different viewing angles also becomes mandatory.

The new Intelli Proof 262 and 240 excellence use an advanced S-IPS panel that incorporates some advantages of the hightest end medical IPS-Pro development to offer high contrasts with low color shifting and even exceeds TN/VA in respect of luminance. Thanks to the increased transmittance of the new subpixel structure, the new direct backlight offers a high maximum luminance of 400 cd/m^2 and reduces the overall power consumption. It has therefore enough headroom for brightness aging over the time when using the ISO 12646 luminance recommendation.

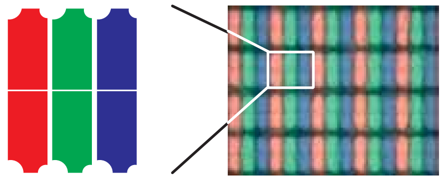
When comparing the new advanced S-IPS panel with a comparable 24" hardware calibrated wide gamut S-PVA unit, the known limitations of S-PVA are easy to observe. While both displays look quite good from the front, the side view shows the heavy color shift of S-PVA. White or neutral gray areas get a reddish-yellowish cast, while the S-IPS panel simply gets darker without showing a severe color shift. This can be seen on both images, the color and the black and white one on the right.

On the color image, especially the gray and color balance strip on the right shows a severe color shift to yellow while the image shows an overall visible shift to yellow.

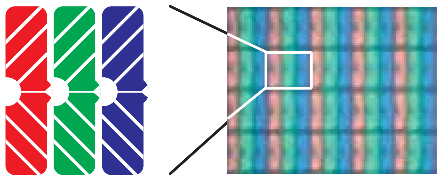
On the grayscale image, the gray balance strip on the right shows the same severe yellow tint while the main image has an even more visible yellow cast.



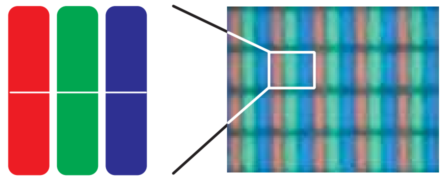
▲ S-IPS pixel-structure



▲ advanced S-IPS pixel-structure (derived from IPS-Pro)



▲ S-PVA / A-MVA pixel-structure



▲ TN pixel-structure

▼ Direct color comparison between Quato IP 240 excel and 24" S-PVA based display

iColor Display software in depth

IColor Display establishes a complete new way ro calibrate a display. Its straight forward and intuitive user interface makes the calibration process a snip; even for beginners and semi trained personal. When starting up iColor Display, the user can decide how the calibration should be performed: from automatic hardware calibration for Intelli Proof Displays to simple profiling for notebook displays.

Base calibration

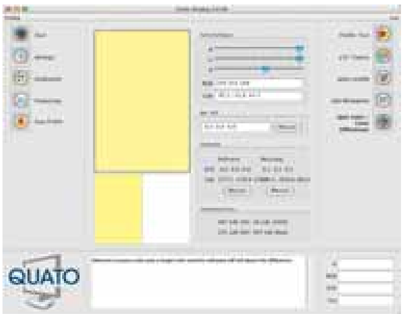
After the user sets the values for white point, gamma and luminance, the necessary calibration procedures are automatic without any interaction from the user. After the calibration, the user saves the profile and the complete process is completed.

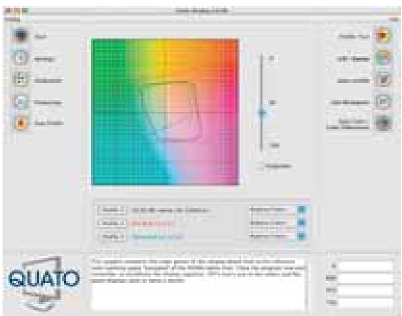
iColor Display supports Gamma, L* and a real sRGB mode. The whitepoint can be defined in Kelvin and x/y or XYZ. Furthermore a measured D50 L*a*b* paper white can also be used for the whitepoint setup to match the screen to a printng paper without active softproofing.

The human eye recognizes colors not always the same way colorimeters or spectrometers do. Due to that, iColor Display allows the user to adjust the whitepoint to match two displays to each other or to match a screen´s whitepoint to the reflective paper in a D50 viewing booth.

As the world's first dedicated display calibration software, iColor Display allows you to save the profile in three different ways without the need of a recalibration. One can choose between a RGB-optimized or a perceptivly optimized matrix- and a LUT-profile. As only Adobe Photoshop iCS3 and 4 are able to work correctly with LUT-profiles it's not recommended to use this kind of profile with older applications. Instead a matrix-profile will do the job. Additionally, five chromatic adaptions are available to adapt the tonal response to the human eye with whitepoints other than D50.

The results and settings of an already made calibration can be easily transferred back into the display to switch between two environments without a complete recalibration.





Testing and evaluation

A set of testing- and evaluation-functions are available to ensure the best results. The primaries (Red/Green/Blue) and secondaries (Cyan/Magenta/Yellow) are used to show the precision inside the display's gamut in deltaE. A grey-ramp is also included. For more experienced users, the basic values are also available as XYZ-values. The deviation calculation method uses deltaE 76 and 94.

The ugra Display Analysis and Certification Tool is built into the iColor Display software and certifies a monitor for proofing with different printing environments.

After all optimizing and evaluation, an a/b-diagram shows the gamut of the display in projection or slicing view in comparison to two additional profiles. Possible deviations can be seen before anything gets wrong.

TFTs do not require a calibration once a week, a monthly recalibration is enough. This means the smallest possible interuption of the working process.

As a novelty, the iColor Display software includes a site-license. Even non Quato monitors can be calibrated with the same allgorithm as the Intelli Proof series. This ensures a highly predictable color workflow for all types of displays. To perform a calibration or profiling of third party display, simply choose the appropriate calibration task.

iColor Display 3 supports a variety of colorimeters and spectrometers:

- Eye-one pro / photo / publish
- Eye-One display 1 / 2
- Datacolor Spyder 2 / 3
- X-Rite DTP94 / Monaco Optix XR

For the specific tasks of a wide gamut unit calibration, only the Eye-One spectrophotometer from Rev. D on and the Quato branded DTP 94 should be used. Keeping in mind, that Eye-One spectrophotometers are not perfectly suited for TFTs as they cannot measure dark emmissive shades with high accurancy, a colorimeter is still better suited to produce perfect results.

iColor supports Windows XP 32 / Vista 32/64 and X 10.2 or later (except LE series: 10.5.2 minumum).

Calibration results and built-in certification

Aside from the precision of a calibration, the gamut is also a key feature for excellent soft proofing results. The Intelli Proof's wide color gamut advanced S-IPS panel covers the ISOcoated reference offset printing gamut at around 100% according to the ugra Display And Certification Analysis. The slight absolute difference to ISO12647 standard offset print makes the monitor a perfect companion for remote proof solution and for high quality soft proofing of standard Offset and higher Gamut printing technologies.

But there is always one problem with calibrated monitors: Is the display really color-correct? Does it reproduce colors correctly? How precise will a softproof be? In order to give some help through these daily problems, the Quato iColor Display software includes the certification routines of both, SWOP® and ugra/fogra for full color control.

The ugra Display Analysis And Certification Tool (ugra-DACT) is based on the color patches of the widely accepted ugra/fogra Media Wedge. In addition to the 48 Media Wedge patches, the ugra-DACT will also measure the calibration and the gray balance precision. Based on the gamut size, the software will use categories like Multicolor, coated, uncoated and newspaper printing to evaluate the display´s performance. Therefore this approach does not only measure and certify the results, it also gives recommendations for a reasonable use of that specific display. That´s a complete new approach and separates the UDACT idea from other certification tasks.

The in-line SWOP® certification, together with the integrated spot color measurement helps to check the complete workflow. To certify the calibration, the Quato SWOP® wedge will be opened in Adobe Photoshop® with its embedded profile. iColor then assists the user to measure all the patches in Adobe Photoshop® and check if the color setup and the calibration match. So the SWOP® certification does not only certify the calibration, it certifies the color workflow.

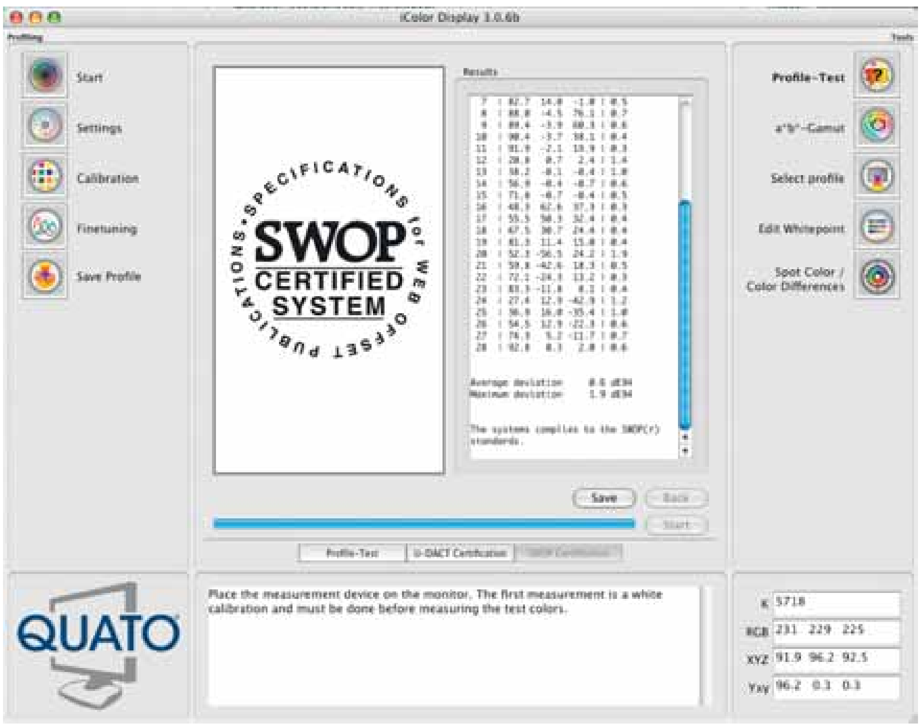
The Intelli Proof displays can be actively certified all around the world. And if other standards should be applied, it´s no problem to extend the certification approach.

▲ ugra UDACT certification

▼ ugra/fogra Mediawedge

▲ The Quato SWOP wedge

▼ SWOP certification



Sample certification results

UGRA
Display Analysis & Certification Tool Report

Basics

Date:	2008-10-9 11:06:24
Report-Version:	v1.3.1
Monitor-Name:	QUATO240Excel
EDID-Name:	QUATO240Excel
EDID-Serial:	DTCI36D0004
Profile:	/Library/ColorSync/Profiles/09.10.08-5800K-18-120cd-trc.icc
Created:	2008-10-9 11:03
Measurement device:	eye-one pro

Summary

The monitor has passed the certification according to the UGRA DACT specifications.

Calibration

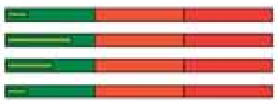
White Point	yes
Gray balance	yes
Profile quality	yes

Softproofing

MultiColor, HighBody	yes
Offset/Gravure Paper Type 1/2	yes
Offset on uncoated paper	yes
Newspaper Printing	yes
sRGB	yes
AdobeRGB	yes
ECI-RGB	yes

Diagram

WhitePoint
Gray Balance
Profile Quality
Softproof Quality



Whitepoint

The whitepoint should be as close as possible to the black body curve and the calibration target. The maximum allowed distance to the target whitepoint is DeltaE 2.0.

XYZ:	117.26 123.14 120.70
XYZ (normalized):	95.23 100.00 98.02
Luminance:	123.1 Cd/m2
Next Temperature:	5847 Kelvin
Assumed Target Whitepoint:	5800 Kelvin
Distance to assumed Target Whitepoint:	0.5 deltaE

Blackpoint

The blackpoint is not defined in ISO 12646. Therefore UDACT does only measure but not assess it.

Luminance:	0.1 Cd/m2
Chromaticity:	2.3 Chroma (Lab)

Gray balance

Average and maximum calculation will respect measurements with 1% minimum luminance only. The maximum allowed deviations to comply with this test are an average of DeltaC 1.0 and a range of DeltaC 2.0.

%	Kelvin	Cd/m2	L	Chroma	Gamma
0	0	0.12	0.87	2.32	
5	7336	0.68	4.97	1.70	1.82
10	5885	2.16	14.16	0.12	1.79
15	5887	4.22	21.67	0.14	1.80
20	5821	7.04	28.68	0.12	1.79
25	5827	10.23	34.61	0.39	1.81
30	5841	14.05	40.27	0.18	1.81
35	5865	18.65	45.83	0.50	1.81
40	5840	23.52	50.80	0.11	1.81
45	5793	28.80	55.47	0.49	1.82
50	5825	34.95	60.23	0.21	1.82
55	5818	41.08	64.45	0.97	1.83
60	5840	48.80	69.21	0.09	1.82
65	5846	56.14	73.28	0.34	1.82
70	5832	64.05	77.29	0.18	1.84
75	5815	72.77	81.34	0.43	1.84
80	5838	81.51	85.09	0.15	1.85
85	5858	90.04	88.50	0.19	1.93
90	5859	100.32	92.34	0.16	1.95
95	5843	110.82	95.99	0.10	2.05
100	5847	123.14	100.00	0.00	
Average	5842			0.27	1.84
Range				1.47	
Max				0.97	

Tone values = 100.0%

Through the calibration of a display tone values can be lost. A display for the printing industry should show at least 95% of the incoming tone values.

Gamut-Volume

These measurements are only informative.

Gamut-Volume	
ISO	100 %
sRGB	100 %
AdobeRGB	98 %
ECI-RGB v1.0	92 %

Profile Quality

This test displays and measures RGB values and compares them with the transformation of the profile. The maximum allowed deviations to comply with this test are an average of DeltaE 3.0 and a maximum of DeltaE 6.0.

The assumed chromatic adaptation is: Bradford

RGB	Lab	deltaLab	deltaE
0 0 0	0.9 -0.4 -2.3	-0.9 0.4 2.3	2.5
0 0 128	13.1 49.4 -75.9	-0.4 1.5 -1.2	2.0
0 0 255	27.7 77.2 -116.9	-0.3 -0.3 0.2	0.4
0 128 0	50.7 -87.6 50.9	0.4 -1.6 1.9	2.5
0 128 128	52.6 -58.8 -13.3	0.2 -0.7 0.3	0.8
0 170 255	67.6 -43.1 -51.9	0.0 -0.9 0.8	1.2
0 255 0	85.5 -134.4 79.5	-0.1 -0.5 0.4	0.7
0 255 170	86.9 -110.9 15.7	-0.2 -0.0 -0.5	0.6
0 255 255	88.3 -89.7 -19.9	-0.2 -0.3 0.2	0.4
85 85 85	44.3 -0.1 0.1	-0.3 0.1 -0.1	0.4
128 0 0	34.0 67.0 49.8	0.0 0.8 3.0	3.1
128 0 128	37.0 75.3 -35.8	0.1 0.3 -0.1	0.3
128 128 0	59.0 -10.5 63.9	0.3 -0.7 0.6	1.0
128 128 128	60.7 0.3 -0.1	-0.0 -0.3 0.1	0.3
128 128 255	63.9 22.7 -57.0	-0.1 -0.5 0.6	0.7
128 255 128	90.2 -75.4 39.9	-0.1 0.3 0.0	0.3
170 0 255	50.2 98.4 -78.4	0.0 -0.5 0.6	0.8
170 170 170	75.0 0.6 -0.4	-0.0 -0.6 0.4	0.7
170 255 0	91.9 -61.3 89.3	-0.0 0.0 -0.2	0.3
170 255 255	94.3 -36.8 -9.8	-0.1 0.2 0.1	0.2
255 0 0	60.1 103.2 86.1	-0.4 -0.6 -2.6	2.7
255 0 170	62.2 109.2 -17.0	-0.3 -0.7 -0.4	0.9
255 0 255	64.5 115.2 -54.4	-0.3 -0.9 0.1	1.0
255 128 128	75.4 39.2 24.5	-0.1 -0.7 -0.8	1.1
255 170 0	81.7 30.8 89.3	0.2 -0.8 -0.9	1.2
255 170 255	84.6 46.3 -23.0	0.0 -0.2 0.3	0.4
255 255 0	97.9 -16.7 98.6	0.0 -0.3 -0.9	1.0
255 255 170	99.1 -8.5 35.1	-0.1 -0.0 -0.2	0.2
255 255 255	100.0 0.0 -0.0	0.0 0.0 0.0	0.0
170 85 85	55.5 45.7 19.2	-0.1 0.4 -0.5	0.6
85 170 85	67.2 -58.6 31.0	-0.0 -0.5 0.5	0.7
85 85 170	46.8 17.6 -44.3	-0.3 -0.0 -0.2	0.4
85 170 170	68.5 -42.6 -11.0	-0.0 -0.4 0.3	0.5
170 85 170	57.4 54.0 -26.5	-0.1 0.4 0.1	0.4
170 170 85	73.8 -8.8 42.1	-0.0 -0.5 -0.2	0.5
Average			0.9
Maximum			3.1

ISO-Gamut

This test displays and measures Lab values and compares them with the reference. The maximum allowed deviations to comply with this test are an average of DeltaE 4.0 and a minimum Gamut volume of 90% for ISOcoated.

Reference	Lab	deltaLab
55.0 -37.0 -50.0	53.3 -31.9 -49.2	5.2
66.9 -24.7 -37.1	66.9 -24.5 -36.9	0.2
79.7 -12.5 -21.8	79.5 -11.6 -22.0	1.0
48.0 74.0 -3.0	48.4 73.7 -2.3	0.9
60.8 50.6 -6.7	60.8 50.6 -6.5	0.3
76.4 25.8 -6.9	76.4 25.4 -6.5	0.6
89.0 -5.0 93.0	88.5 -4.1 91.2	2.1
90.3 -4.7 62.6	89.9 -4.3 63.1	0.8
92.2 -3.5 31.1	91.9 -3.2 31.0	0.4
53.1 37.7 28.9	53.1 37.2 29.9	1.1
41.5 22.7 16.8	41.6 22.3 16.2	0.7
31.9 40.0 24.0	32.2 39.2 23.8	0.8
32.5 44.5 -1.8	33.2 43.7 -1.1	1.2
51.3 1.3 44.5	51.3 2.1 44.4	0.8
34.6 -36.4 13.9	34.7 -35.1 12.7	1.8
36.0 -26.2 -20.9	36.3 -25.4 -21.0	0.9
20.9 9.6 -23.6	22.0 8.3 -22.0	2.3
89.0 0.0 -1.9	88.6 -0.2 -1.9	0.4
82.8 0.0 -1.7	82.6 0.4 -1.9	0.5
69.5 0.0 -1.4	69.3 -0.0 -1.2	0.1
54.1 0.0 -1.0	54.1 0.8 -1.1	0.8
36.6 0.0 -0.5	36.8 0.7 -0.8	0.8
16.0 0.0 0.0	17.2 0.4 -0.2	1.3
24.0 22.0 -46.0	24.7 21.4 -45.4	1.1
40.9 17.9 -36.6	41.1 18.4 -36.1	0.7
63.7 10.3 -23.8	63.4 11.2 -24.2	1.1
47.0 68.0 48.0	47.3 67.6 48.2	0.5
58.5 47.1 37.9	58.6 47.4 38.5	0.7
74.2 22.9 21.4	74.1 22.8 21.8	0.4
50.0 -65.0 27.0	49.9 -63.4 26.2	1.8
62.1 -39.8 21.0	61.9 -39.1 20.8	0.8
77.0 -19.1 11.0	76.9 -18.8 10.6	0.5
71.2 18.9 17.2	71.0 19.0 17.5	0.4
71.2 22.1 73.1	70.7 23.2 73.3	1.2
47.7 71.2 16.2	48.1 70.8 17.2	1.1
38.0 55.4 -20.9	38.4 54.4 -20.1	1.4
73.7 -22.8 67.6	73.5 -22.7 67.6	0.1
[illegible]	52.3 -51.6 -20.4	0.8
43.5 -17.0 -48.6	43.5 -15.9 -48.9	1.2
95.0 0.0 -2.0	94.7 0.5 -2.2	0.6
88.5 -0.4 -3.1	88.3 -0.5 -3.0	0.3
82.0 -0.9 -4.1	81.7 -0.5 -4.0	0.5
67.7 -2.0 -4.4	67.5 -1.9 -4.5	0.2
52.8 -2.5 -3.5	52.4 -2.7 -3.2	0.4
37.5 -3.9 -3.1	37.8 -3.8 -3.4	0.4
26.3 -6.8 -3.4	27.0 -7.2 -3.4	0.8
Average		0.9
Gamut-Volume		100 %

Uniformity

The uniformity test shows the luminance (in %) and the color deviation (in Delta C*) from the centre to the 8 measuring points around it. The maximum deviation for the luminance may be 10%. The average value and the chroma deviations are only informative. This test is not taken in consideration for the UDACT certification.

Summary:

	Average	Max
Luminance Deviation	1%	3%
Chroma Deviation	1	1

▲ The results of the UGRA Display Analysis and Certification Tool show that the Intelli Proof excellence reaches both, a very neutral gray balance and a very high profile quality. Additionally, the unit nearly reaches an exact match to the black body curve with only 0.5 deltaE and a very dark black point of 0.2 nits. Further more, the display reaches a Softproof quality that is nearby equal to what you get out of contract proofer and can therefore be called a “visual contract proofing system”.

A few steps to the perfect image

Color management is not new. In fact it's as old the human being realised the colors of nature and tried to reproduce them. The human eye is the basis of all our colored emotions and the computer display is the centre of all decision regarding color. Due to the extension of the display's gamut the display will step by step be an add-on to the classic hardcopy proof – a soft proof will be the future way to judge color reproduction.

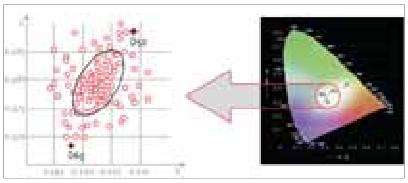
Keeping that in mind, one can wonder why so many workstation use old and blurred CRTs that have never been calibrated. Of course, the monitor is only one piece in the color management puzzle, but it's the most important visual one.

Before any discussion about and decision for new hardware, one should double check the working environment since color is not color. The human eye only allows us a relative and subjective recognition of colors. Every human being has a different sense of a specific color. Just think about tomato red – does your neighbour also have the same color in mind. Definitely not. But it's not only our eye and brain that influences color recognition. It's also the environment. The wrong surrounding light makes the definition of color pretty much impossible. Thanks to the ISO 3664 regulation one might know the right lighting conditions: a proofing and imaging workstation must uses D50 lighting. It's quite easy to achieve D50 light in every bureau by using GTI or JUST daylight fluorescent tubes. With only a few steps one can have perfect lighting conditions if one can keep direct sunlight out of the office. For example the Pantone Color 169 CVC viewed under D50 standard light has no visible difference to the reference. The same color viewed with the normal office lighting of about 2.800 Kelvin differs up to 12.4 deltaE. Keep in mind that – generally speaking – above 3 deltaE the human eye recognizes differences between two colors. With greys is even lower from 0.5 deltaE on.
To make it a bit more complicated, the gamut of one device and another device is also not the same. Displays, cameras and scanners are working with the additive RGB color space. Printers usually work with the subtractive CMYK color space.

No device reproduces colors correctly out of the box. So this is absolutely necessary to perfrom a calibration to have a valid color reproduction. To make the conversion from RGB to CMYK easier, the color management is based on the device independent L*a*b* color space. This kind of conversion ensures the best matching of colors that share the source and the target color space. Colors that do not match have to be converted into a shade that is inside the gamut (color space) and looks near the original. Color management could not be loss-free by definition, but it warrants a clear definition of what will happen with the colors during the conversion from one color space to another.

Unfortunately a monitor looks different at 5.000K than a viewing booth that uses D50 lights according to the ISO12647 and ISO 3664 standards. Extensive tests at the RIT lead into the result, that if a monitor should match a D50 viewing booth, it needs to be calibrated to a more colder (blueish) whitepoint and the viweing box has to be dimmed down to the luminance of the screen. Basically, the booth´s luminance in Lux has to be divided by Pi to get the equivalent in candela per squaremeter. Thus, for 150 cd/m^2, the box has to be reduced to 450 Lux.

The native corresponding whitepoint for paper type 1 at D50 for the human eye on a transmissive device like a



▲ The native whitepoint

TFT is between 5.600k to 6.000k.

As D50 is the standard of color communication that all ICC aware applications use, the display´s higher whitepoint has to be downscaled to the D50 basis. This is called the chromatic adaption. A linear downscale does not match the human eye´s tonal response curves, so a different model has bo be taken into account. That´s where chromatic

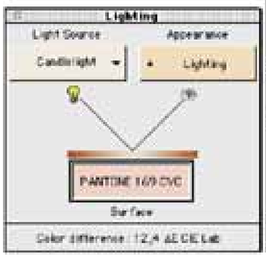
▲ Notice the difference

adaptions like Bradford or vonKries step in. Quato offers the user five different chromatic adaption methods to optimise the display´s color performance to the color recognition of the human eye when using non D50 lighting and display whitepoint. Especially iColor display´s reference technology - that calibrates all monitors to one, user defined setup - helps to integrate Intelli Proof displays into remote proof and special proof enviroments.

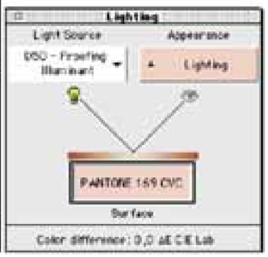
With the integrated UGRA and SWOP display certification, iColor display additionally helps to ensure a perfect colormanagement workflow. For the first time ver, users can certify if the display is recommended for soft proofing and remote proofing.

For a perfect workflow it's not only necessary to use well balanced equipment but also all software application have to speak the same language. Combined with individually profiled and calibrated input and output devices this ensures a trouble free color managed workflow which is the only way to reach a perfect color reproduction.

▼ Color deviation
with standard lighting



Color deviation with ▼
D50 lighting



Some background and calibration recommendations

The process stability of every digital or analogue tool highly depends on the ability to finally trace the results as beeing inside the specifications.

As a result, almost everything in the digital workflow is standardized, except the display. There is a ISO regulation for environmental lighting conditions that defines D50 as the standard for proofing and comparisons between colors and prints. The ISO 12647 defines the printing technologies and the allowed deviations from the specifications to print in an acceptable way.

Of course, there are some regulations like ISO 13406 (display technology) and ISO 12646 (requirements for soft proofing displays). The first is only accepted regarding the pixel error class. The latter is for manufacturers only. So both don´t have a real impact on today´s work.

Regarding the pixel error class, Quato decided not to follow the ISO 13406-2, because a 21.3" display with 1.92 million pixels can have more than 10 defective pixels and this is nothing one would accept. Therefore Quato Intelli Proof Displays use selected panels and offer a much higher level of quality. Intelli Proof 240/262 displays are granted not to have any defective pixels in the center area of the screen. In the outer parts of the screen, a maximum of two defective pixels is allowed.

The viewing angle dependencies, specified in ISO 13406, do not really meet the user´s demand. A viewing angle of 178° only specifies, that the contrast is not fallen below 1:10 when looking from this position on the screen. It does not tell anything about the color stablility. For example, the Intelli Proof´s panel has a shift in the luminance instead a shift in the color when looking at higher viewing angles on the screen. The white image still appears to be white and colors only decrease in luminance. That matches the human eye, as this is more critical on chromatic shifts than on luminance shifts. In deltaE, the Intelli Proof has a deviation of deltaE 2 at 20°, while some other hardware calibrated TFTs reach deviations of up to deltaE 12 at the same viewing angle.

The contrast ratio is also irritating as the real world contrast is much lower than factory measurement maximum contrast ratios like 1000:1. When using a the recommendations for calibration a display may has a white luminance of 150 cd/m^2 and a black luminance of 0.5 cd/m^2. This results in a contrast ration of 300:1. The difference between realworld and factory is obvious and shows that only the net contrast rules.

The ISO 12646 does not only cover the minimum requirements for softproofing displays, it also covers the viewing conditions according to ISO 3664. In contrast to UDACT and SWOP, the ISO 12646 cannot be certified at the user side - this has to be done in a laboratory and is valid for a series of monitors and not for the individual one.

The ugra/fogra Display Analysis and Certification Tool implements some of the elements of this upcoming regulation and establishes them on the desktop. Todays color judgement is focussed on primaries, but there are discussions in almost every normative institute to extend the focus also to the graybalance. The reason is obvious, as it is possible to have good primaries and a bad gray balance. Is the gray balance acceptable, than the primaries are in most cases also acceptable. This focus shift is the reason why iColor Display is performing an extensive iterative gray balance calibration.

▼ gray balance dependencies

But the certification does not help to setup the display´s calibration preference in the right way. If one takes the final process into account (almost every image is a least printed) and selects the recommended ECI-RGB working space, then gamma 1.8 makes much more sense as the image does not know on which system it runs, so harmonizing the setup is a good thing, too.

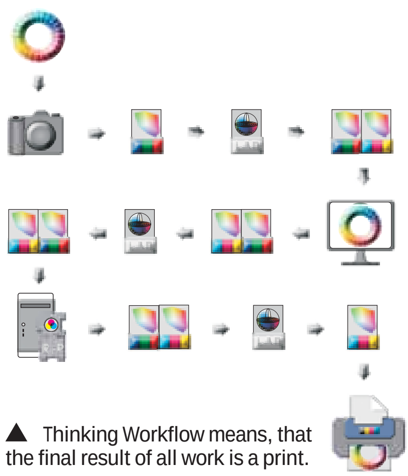
The next thing to define is the luminance. ISO 3664 defines at least 1800 Lux as the environmental light intensity. A display´s luminance is defined in candela per squaremeter (cd/m·). To get LUX into a relation with candela, it must be devided by Pi. So 1800 Lux is around 600 cd/m2. No proofing display can support this high luminance and so most of the viewing booth include an electronic dimmer to set the viewing booth down to around 450 cd/m^2. Additionally, ISO 3664 defines 32 Lux for the softproofing and comparison to a printed image. 32 Lux is only given in a very dark room. In most environments, it´s impossible to reduce the external lights to such a value.

The ISO 12646 draft defines a minimum luminance of 120 cd/m^2. The right luminance depends on the environmental lighting conditions. The brighter the light, the higher the luminance. Changing the luminance regularly due to changes in the lighting conditions is not suited.

Stable and defined lighting is a must for a softproof workflow.

To summarize of all the three mentioned basics for calibration, one should use a Gamma of 1.8 for ECI 1.0 or L* for ECI 2.0. The Whitepoint should be around 5.800 K when comparing printed images with the softproof under D50 light and the luminance should be at least 120 cd/m2.

Gamma:	1.8 or L*
Whitepoint:	5.800 k
Luminance:	at least 120 cd/m^2



▲ Thinking Workflow means, that the final result of all work is a print.

▲ The colormanagement dialogue from Adobe Photoshop® that shows the recommended setup for the use of Intelli Proof displays.

QUATO®

Quatographic Technology GmbH
Hansestrasse 47b

38112 Braunschweig
Germany

fon: +49-(0)531-281381
fax: +49-(0)531-2813898

url: www.quato.de
mail: info@quato.de