

An initiative of the



Photoindustrie-
Verband e.V.

D I G I T A L
Q U A L I T Y

Tool for
Digital Image
Quality



In the “Digital Imaging Control Tool” initiative, the German Photographic Industry Association (Photoindustrie-Verband e.V.) brought manufacturers of photographic products and providers of digital imaging services together to simplify the production of digital prints in photographic laboratories.

The purpose of the tool is to help users obtain a more uniform print quality. This is achieved by adjusting the monitor to match the reference print.

Everything you will need is included in this set:

1. the **contrast file** for coarse setting of monitor brightness and contrast (Contrast.tif)
2. the **reference image file** for fine adjustment of the monitor (Monitor.bmp)
3. the **reference print** from a particular processing laboratory, which is indicated on the print and serving as a specific reference for their kind of output.

The reference image file "Monitor.bmp" is used only for matching the monitor image to the reference print; it is **not a print file**.

The enclosed *reference print* is the print from your laboratory; it is characterized by device-specific properties that are reflected its colors, lightness and contrast.

Digital Imaging Control Tool provides...

- ...a simple, fast way of achieving a more uniform print quality.
- ...the possibility of matching your monitor settings to your photographic laboratory's photo printer.
- ...a tool that can be used independently of software in every image processing program.
- ...a tool that functions independently of device manufacturer and operating system.

Before you start...

- ...to optimize your monitor settings with the DQ reference images, please make sure the color temperature, contrast and brightness are set correctly. This is essential so that you can assess the images properly. Detailed information is given on the following pages.

Please note...

- ...that the DQ reference file for the monitor and the DQ reference print for the output are not a substitute for professional calibration using device profiles.
- ...that the DQ reference images cannot be used for checking color management software.
- ...that we are unable to deal here with device-specific questions. If you have problems, please get in touch with your hardware or software manufacturer.
- ...that the enclosed reference print was produced by the laboratory used by your photo retailer. Prints from other laboratories can differ in color, contrast and lightness, depending on the technology used.




Instructions for use

1. To activate highlighted words and this  sign, double-click on them with the left mouse button.

The text field that appears contains additional information.

To make the text field disappear, click on the gray square in the top left corner.

2. When you see this  pictogram, you are on the page containing hidden interactive elements that you can activate with the mouse. For example, when you move the mouse pointer over pictures, its appearance will change. If nothing else changes, you can obtain further information by clicking with the left mouse button.

Settings

The aim is to match the monitor image as exactly as possible to the enclosed print.

When you edit images on the computer, the monitor is the most important assessment criterion. This means that certain basic settings must be made and adhered to:

- The graphics card must be set to a **color depth** of at least 24 bit (16.7 million colors = true color); smaller color depths are unsuitable for image editing.
- If your monitor and graphics card menu permit, set the **color temperature** of the monitor to 6,000 K. With some monitors it is not possible to select color temperature.

Now please make the settings described below to

1. the **monitor** (basic settings) and
2. the **graphics card**.

Fine adjustment is then performed by

3. **matching the monitor to the reference file**.

Now please make the settings described below to the **monitor** (basic settings) and the **graphics card**.

Fine adjustment is then performed by coarse **matching the monitor to the reference print**.

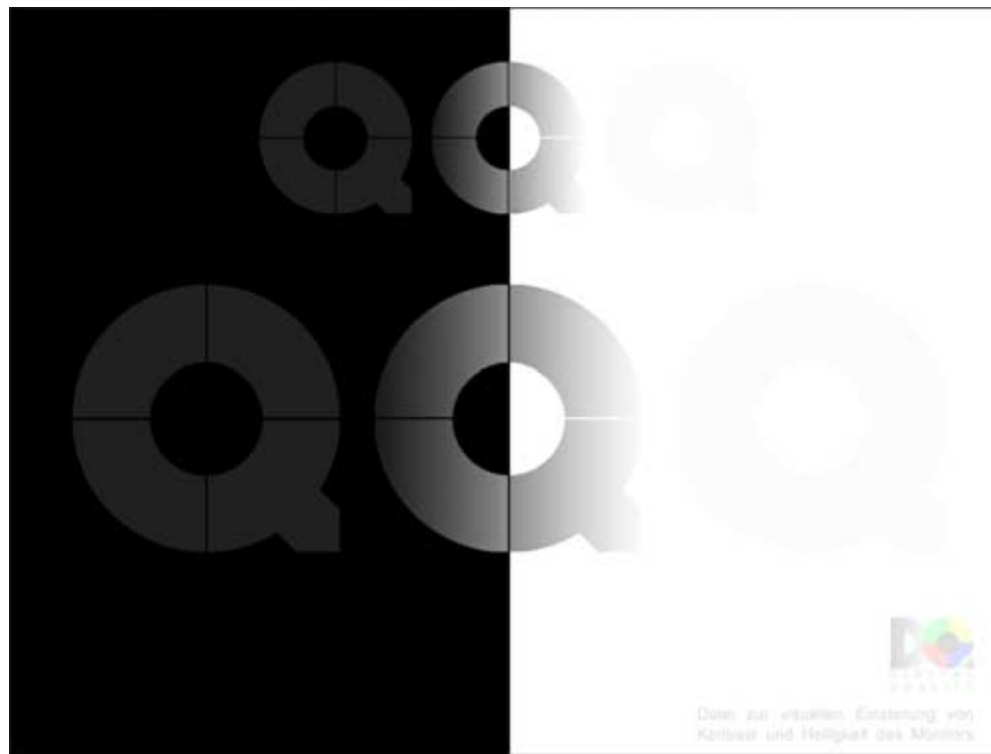
To ensure a good print quality, it is finally necessary to match your monitor to the printer used by your print service.

1. Monitor

Part 1

You can perform the coarse adjustment of the contrast and brightness of your monitor with the file "Contrast.bmp" on this CD.

As the reproduction of images in your image editing software can differ from that in Acrobat Reader, it is important that you open "Contrast.bmp" (download Contrast.jpg) with your image editing program.




reduced image of Contrast.bmp

1. Monitor

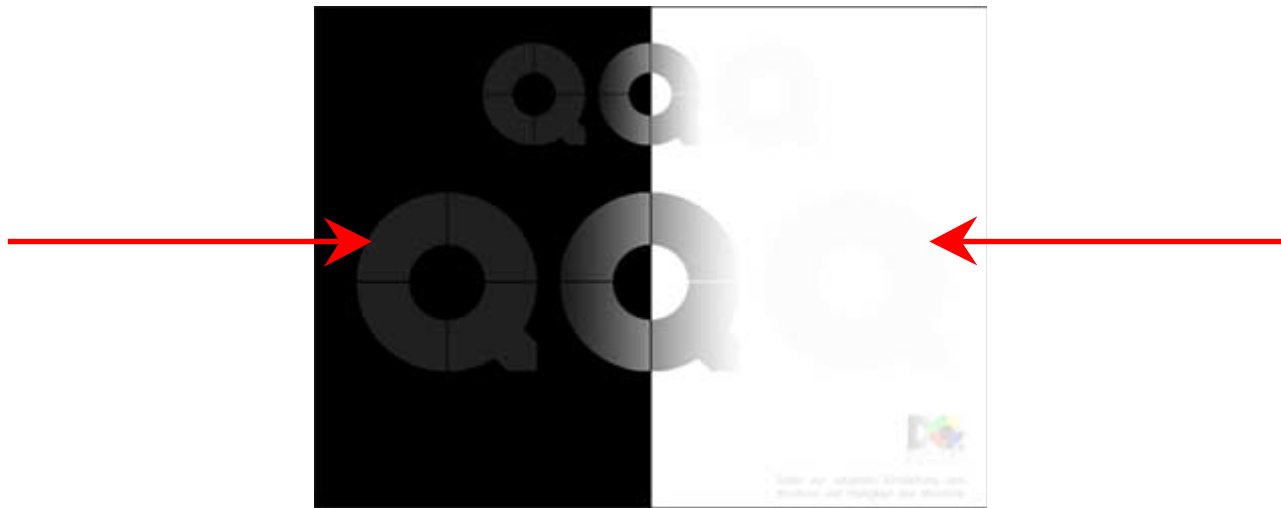
Part 2

Open "Contrast.tif" with your preferred image editing software and select "Full Screen" or similar as the view option.

[File → Open →  CD - ROM drive → English → Contrast.bmp]

Your monitor should have means of setting that are independent from the computer. On nearly every monitor there are knobs and/or buttons for setting color temperature, contrast and brightness.

1. If possible, please set the color temperature to 6,000 K.
2. Set the contrast to the maximum value.
3. Now set the brightness so that the dark Q is just visible.



reduced image of Contrast.bmp

The basic settings for contrast and brightness are now complete.

1. Monitor

Contrast

Contrast describes the relationship between the different tonal values of an image.

If the image contains a lot of black and white but only a small amount of gray, it will have a hard appearance and a high contrast. If, however, the black and white tones are absent and the gray tones are predominant, the image will have a soft appearance and a low contrast.

Images in which black, white and gray are present in well-balanced proportions have a medium contrast.

If the contrast is too high, the monitor will not reproduce all the tonal values present in the image, and if the contrast is too low, the monitor will not show any fully black or white regions.

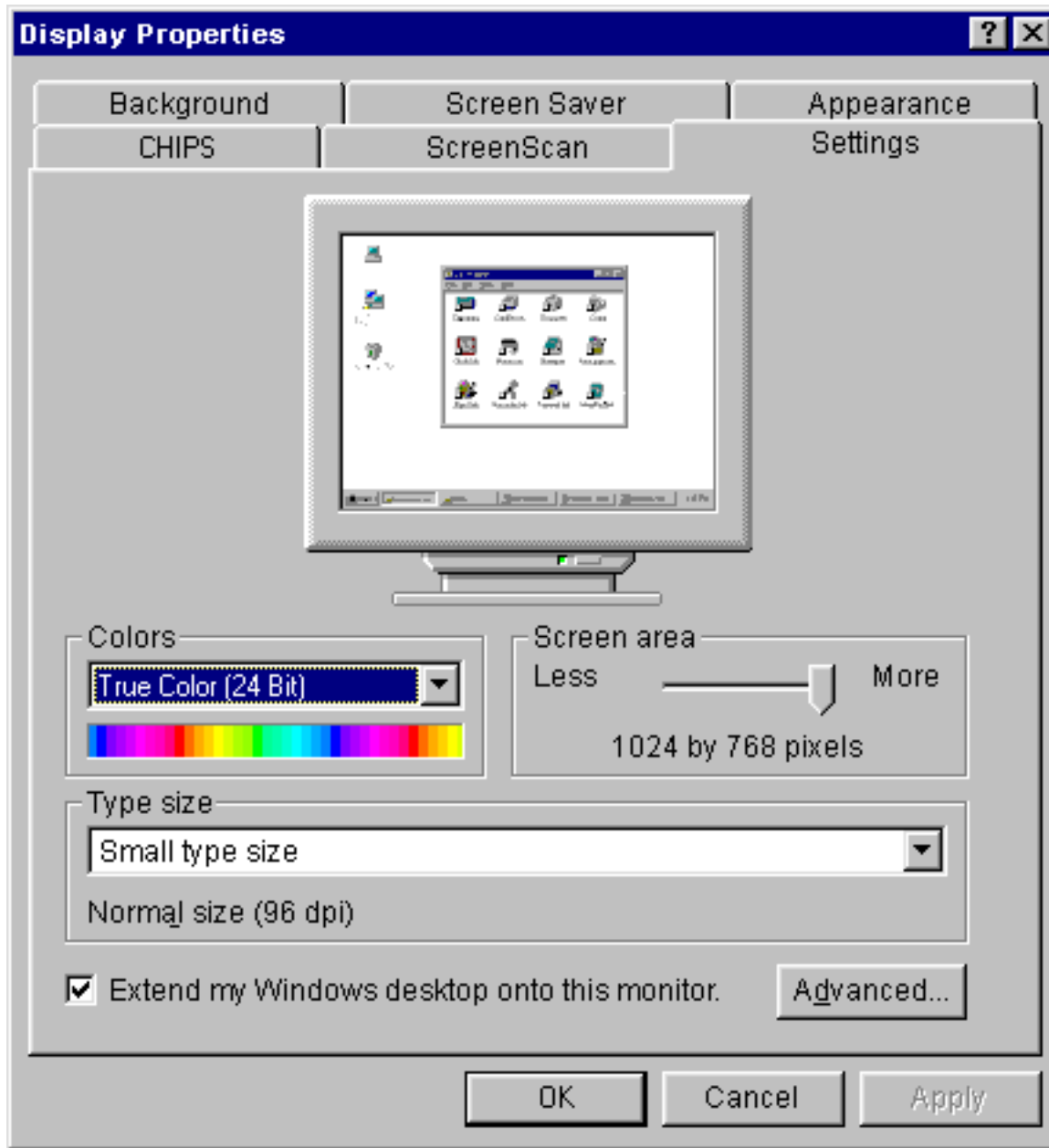


Brightness

Brightness describes the intensity of the light.

If the brightness setting of the monitor is too high, black will be reproduced as dark gray. If the brightness setting is not high enough, bright white cannot be shown.


2. Graphics card



Via:

-  Start
- SETTINGS
- CONTROL PANEL
- DISPLAY

you can open a settings menu for the graphics card, in which you can set the monitor resolution and color depth.

Or: 

Click with the right mouse button on the desktop to open a pop-up menu, then select

- PROPERTIES
- SETTINGS

to reach the settings menu.

Set the **color pallet** to "True Color (24 Bit)" and select a **resolution** appropriate to the size of your monitor.

In a 15" monitor, this is 800 x 600, in a 17" monitor, 1024 x 768.

3. Matching your monitor to the reference file

Part 1

To match the image reproduction of your monitor as exactly as possible to the enclosed print, please start your image editing program.

Matching and assessment can be performed by the following steps:

- a) Opening Monitor.bmp
- b) Comparing the images
- c) Gray-scale bar
- d) Color bar




Please do not print this file; it should be used only for assessing the image reproduction of the monitor.

reduced image of Monitor.bmp

3. Matching your monitor to the reference file

a) Opening Monitor.bmp

Open the file "Monitor.bmp" on this CD (download Monitor.jpg) in your image editing program and select the full-screen view.

[File → Open →  CD - ROM drive → English → Monitor.bmp]



reduced image of Monitor.bmp

This reduced image is not suitable for assessing the image reproduction of your monitor.

The picture provides you with various possibilities for matching the image reproduction of your monitor to the reference print. You can use the four photos or the gray-scale and color bars, depending on which you find most visually appealing.

3. Matching your monitor to the reference file

b) Comparing the images

Each image emphasizes a different feature:

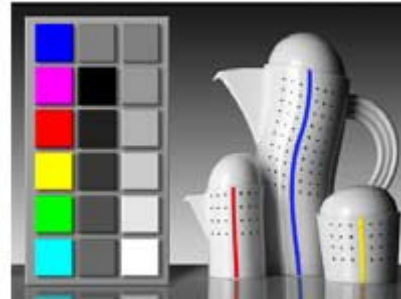


In the **landscape image**, the emphasis is on the realism of the image,



in the **portrait**, it is on natural flesh tones and gray balance,

in the **paper windmill**, the emphasis is on the reproduction of details in bold colors,



in the **porcelain arrangement**, it is on the gray tones.

Now look at the image which comes closest to the main subjects of your photographs. Alternatively, you can consider the overall impression of the four images. Or, if you wish, you can use two of the images. Whatever you decide, you should adjust the color reproduction of your monitor until the you achieve maximum agreement with the reference prints.

To do this, you should use the adjustment facilities on the monitor. Only if these facilities are inadequate should you use the graphics card menu.

If you have any queries regarding the graphics card menu, please get in touch with the manufacturer.

Please note: You should never edit the image file. Doing so will make the results of the adjustment invalid.



AGFA 

 FUJIFILM

 Kodak

 Konica





AGFA 

 FUJIFILM

 Kodak

 Konica





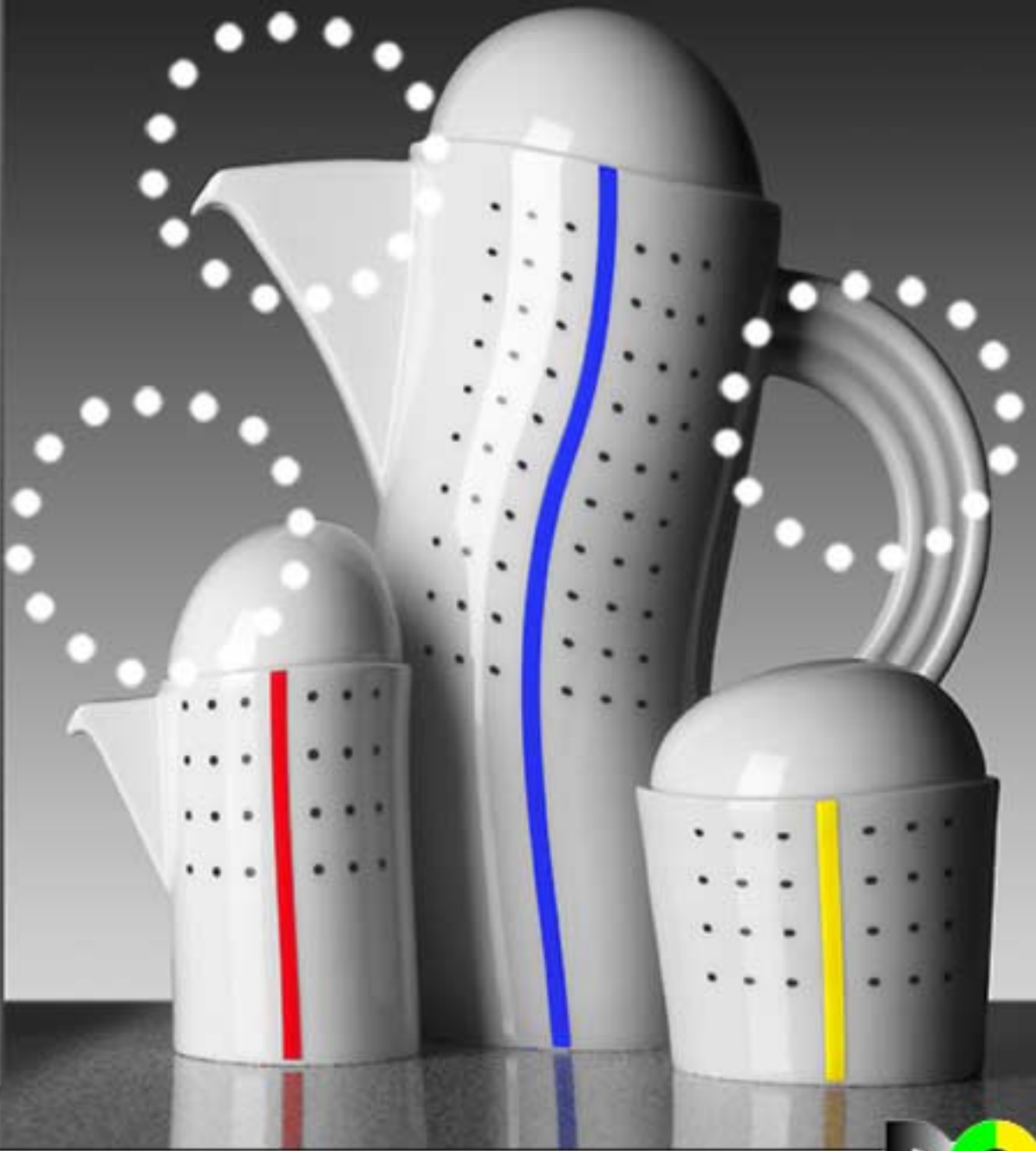
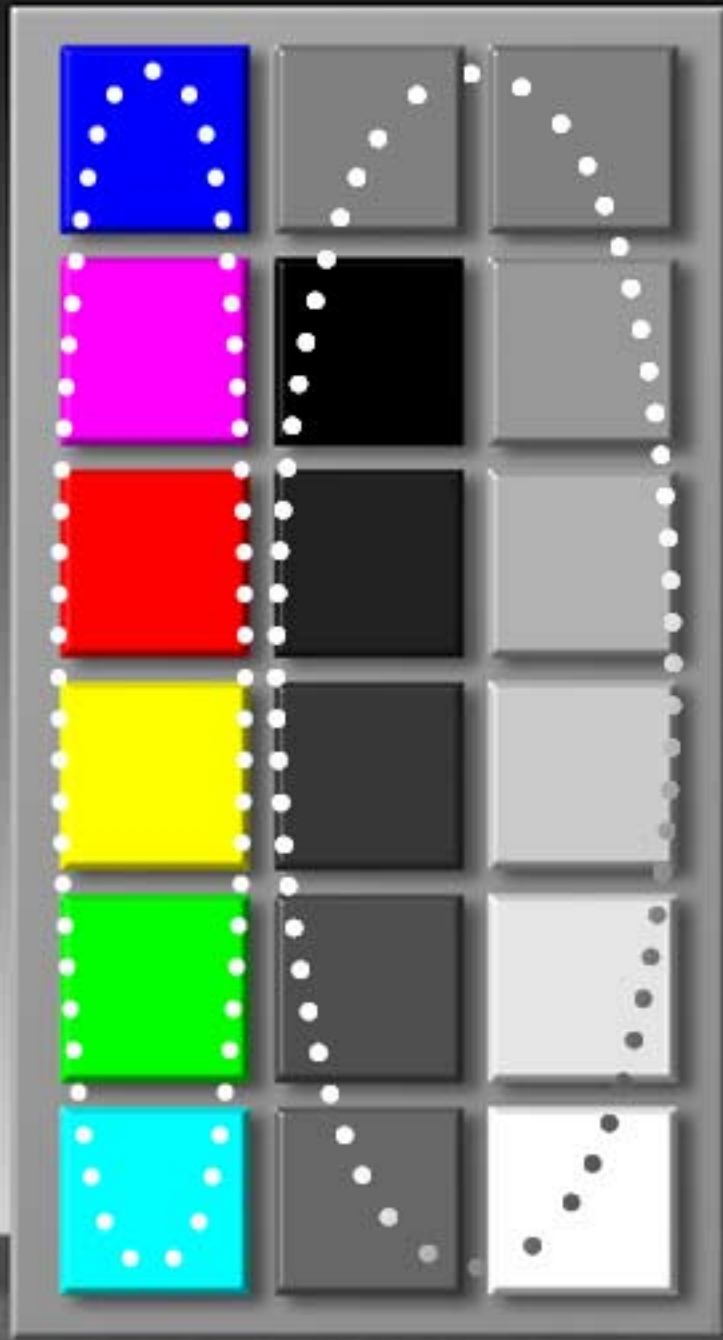
AGFA 

 FUJIFILM

 Kodak

 Konica





3. Matching your monitor to the reference file

Part 4

c) Gray-scale bar

The gray scale on the left of the image is particularly suited for assessing the maximum density range. It allows a good assessment of the progression from white to black and the variations in gray values. With optimum reproduction, the array should be neutral in color:

White comprises 100% red (R), 100% green (G) and 100% blue (B),
Grey tones comprise equal proportions of R, G and B,
Black is 0% RGB.

Some image editing programs provide the possibility of reading out these values. The values should not, however, be used as a basis for assessment, as they are independent of the image reproduction of the monitor and will not change as you adjust the monitor.

The only thing that matters is your visual impression of the image as compared with the reference print.

If there are any discrepancies, you should generally be able to make the necessary adjustments with the pop-up menu of your monitor. Only if the monitor adjustment facilities are inadequate should you use the graphics card menu.

If you have any queries regarding the graphics card menu, please consult the manual or get in touch with the manufacturer.

Please note: You should never edit the image file. Doing so will make the results of the adjustment invalid.

3. Matching your monitor to the reference file

d) Color bar

The color bar shows the possible color nuances. The gray points indicate (from top to bottom) the colors magenta, red, yellow, green, cyan and blue, each with maximum saturation. A saturated color does not contain any gray; it has the highest color purity and will generally be displayed more vividly on a monitor than in a photograph.

Colors too can be indicated with numerical values, and some image processing programs can display these values, which are comprised as follows:

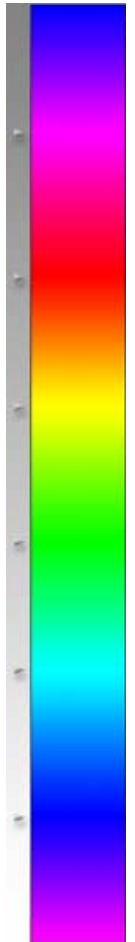
pure yellow:	R	255	pure red:	R	255
	G	255		G	0
	B	0		B	0
pure magenta:	R	255	pure green:	R	0
	G	0		G	255
	B	255		B	0
pure cyan:	R	0	pure blue:	R	0
	G	255		G	0
	B	255		B	255

This same applies here as for the gray-scale bar: The values are fixed and will not be affected by your monitor settings.

The only thing that matters is your visual impression of the image as compared with the reference print.

If there are any discrepancies, you should be able to make the necessary adjustments with the pop-up menu of your monitor. Only if the monitor adjustment facilities are inadequate you should use the graphics card menu.

Please note: You should never edit the image file. Doing so will make the results of the adjustment invalid.

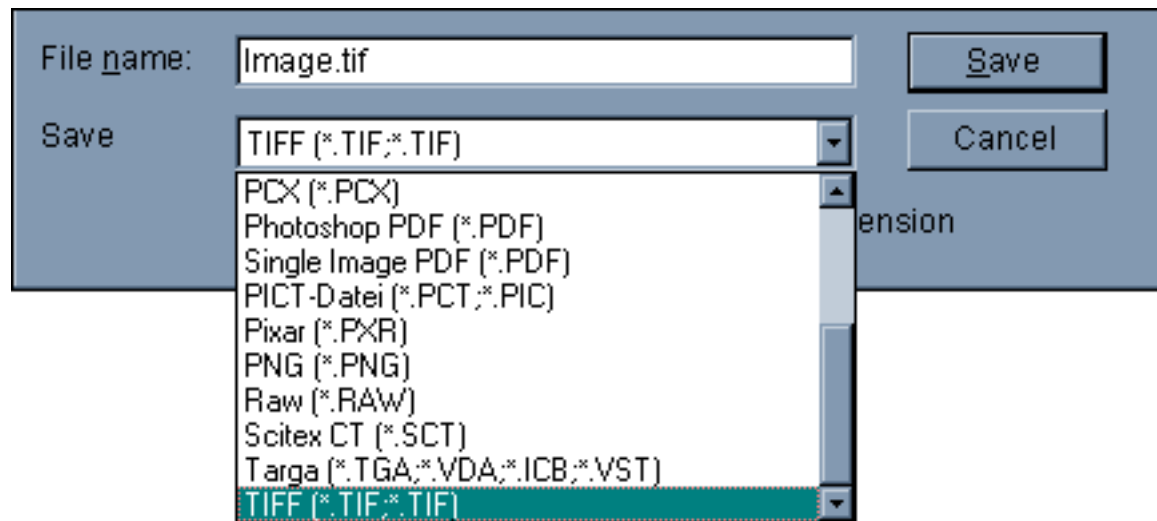


How should digital photos be prepared?

Part 1

Once you have optimized your monitor settings with the two reference files, you can edit your digital photos as you wish. Then you should save your files.

This can be done in several ways:



The two most commonly used file formats in digital photography are *.jpg and *.tif.

How should digital photos be prepared?

*.jpg

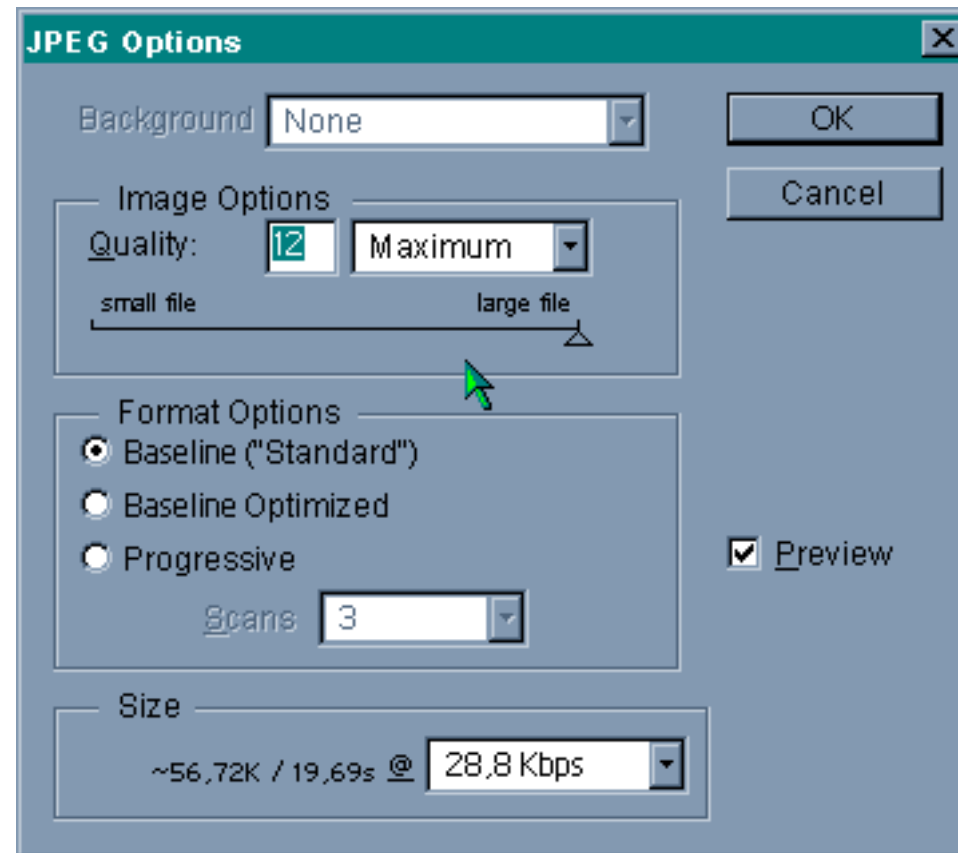
Saving as *.jpg always results in data losses due to compression. Saving once in the highest quality will not cause any problems. If you wish to edit and save a file a number of times, however, you should choose a different format, as each save in *.jpg will result in a further loss in quality. Such quality losses will be seen as "staircasing" and a disjointed quality in color transitions and areas of homogeneous color.

JPEG provides various image and format options:

Image options:

Select high quality and "large file".

Only in this way will you achieve optimum picture quality.



Format-Optionen: *(if possible)*

Select "Baseline ('Standard')"

How should digital photos be prepared?

*.tif

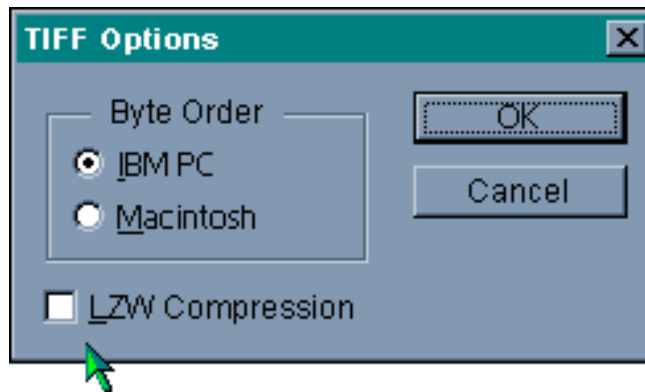
Saving as *.tif will not result in any losses. No matter how many times you edit and save a file, the quality will not be impaired. Your PC will probably display a request similar to the one shown here:

You should select "IBM PC"

Make sure the option

"LZW Compression" is not selected.

(i.e. no tick in the white field)



„Alpha Channels“, „Non-Image Data“ and „Flatten Image“ should not be saved; please select the appropriate functions for this.



Photo printers cannot process such information!

How do digital photos get to the laboratory?

Part 1

You have edited your digital images, and now all you need is the prints. But how do you get from photos to prints? It is quick and simple to have your pictures printed onto real photographic paper.

- **At your photo retailer**

You can read out the data directly from the memory card of your camera. If you wish to edit the pictures before printing, you should save them on diskette, CD-R or Zip once you have edited them. The most common file formats are *.jpg and *.tif. The table below shows the most widely used camera resolutions and the print formats that can be obtained with them:

Category	Width x Height (W x H)	Print format *	
		optimum quality (W x H)	acceptable quality (W x H)
VGA	480 x 640 Pixel	4 x 6 cm	13 x 18 cm
XGA	768 x 1024 Pixel	7 x 9 cm	18 x 24 cm
1,2 MegaPixel	960 x 1280 Pixel	9 x 13 cm	20 x 30 cm
2,0 MegaPixel	1200 x 1600 Pixel	10 x 15 cm	30 x 40 cm
3,0 MegaPixel	1536 x 2048 Pixel	13 x 18 cm	40 x 50 cm
4,0 MegaPixel	1800 x 2400 Pixel	15 x 20 cm	50 x 60 cm

* Conversion not exact; figures based on standard print formats

Many photo retailers have digital terminals with which the image data can be read from the above-mentioned storage media and from the most common memory cards. The data are transmitted to the photographic laboratory, printed on photographic paper and sent back to the retailer by post or courier. Shops with their own digital mini labs can make prints themselves. A few days later, your pictures will be ready – just as with conventional photographs.



How do digital photos get to the laboratory?

Part 2

- **By internet**

Another possibility is data transfer by internet. Many companies offer the possibility of uploading the image data directly to the laboratory via their home page. The prints are then sent to the photo retailer of your choice, or posted to your home address.

Is that complicated, and does it take long?

Not at all, as the following example will show:

A 56 K modem has a theoretical transfer rate of 7 kilobyte/s (KB/s). 

In practice, there will be a difference between downloading files from the internet and uploading your own files.

During a download, the transfer speed with a 56 K modem will be about 5 KB/s; during an upload, it will be about 3 KB/s.

Exact figures cannot be given, as the transfer rate will be dependent on a number of factors, for example the provider and the load on the network.

A 2.2 megapixel image file with normal *.jpg compression will have a size of 500 - 700 KB.

A 600 KB image can be transferred in about 3 minutes. 

Impressem

The programs and files are protected by copyright. All rights reserved, in particular those relating to reproduction (photocopying), translation, editing and distribution.

The programs and files have been carefully tested. However, given the current state of technology, software errors, and in particular problems relating to interoperability with unknown programs of other origin, cannot be fully excluded. We can therefore accept no liability for data loss or other damage arising from use of the programs and files.

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Basic knowledge

Additive color mixing

This color system is based on additive combination of red, green and blue. The set of all the colors resulting can be represented graphically in three dimensions; this representation is referred to as the *RGB color space*. If the three primary colors each have the same intensity, gray tones will result; if the intensity of each is 100%, the result will be white. Additive color mixing is used in monitors to simulate human perception of color. Additive color recognition is used in digital cameras and scanners to record image data.

Red, green and blue cannot, however, be used for print colors.

Aliasing

Aliasing errors ("staircasing") are digitization errors. They occur in the reproduction of non-vertical and non-horizontal lines and in brightness transitions. The causes are physical. In digital photography, this problem occurs less and less frequently as the number of pixels in the sensor are increased.

Analogue-digital

In conventional and digital photography, the picture information is recorded in an analogue manner in accordance with the light exposure. With a conventional film, the subsequent processing does not involve any fundamental changes to this information. When the signal is processed in a digital camera, however, the picture information is digitized. The picture is broken down and stored digitally; as a result, the picture can only be processed on a computing device. Analogue signals are continuous, i.e. they are infinitely variable; digital signals are discrete, i.e. they can only have certain discrete fixed values.



Bit

A bit, **B**inary **U**nit, is the smallest unit of information in computer engineering and all digital systems. A bit can have the values 1 and 0, which correspond to the electrical states "On" and "Off" respectively. 8 bits form 1 *byte*.

Bitmap

Every digital photograph comprises a grid of individual *picture elements*. This form of image is called a bitmap. The color of each picture element is defined by a certain number of *bits*. At proper magnifications, the individual picture elements or pixels cannot be seen. However, at high magnifications, individual pixels can be seen. All the important *file formats* in digital photography, such as *.tif, *.jpg or *.bmp, are based on this type of image representation. In Windows systems, bitmap (*.bmp) is also the image data format used at system level.

Blooming

This is an image error in digital photographs that manifests itself as a glare or halo around light areas of the image. It is caused by overexposure.

BMP

This image file format belongs to the Windows operating system and supports 24-*bit* color depth. It is the simplest of the pixel-oriented graphic formats. Each *picture element* is described by its horizontal and vertical position and a color value. BMP file is a non compressed file format.

Brightness

Brightness describes the intensity of the light.



Byte

8 bits together form a byte, the standard unit of *file size*. A byte can be thought of as a digital word, and a *bit* as a digital letter.

8 bits can represent 256 different permutations of "0" and "1", which in the decimal system take values from 0 to 255.

8 bits = 1 byte

1 kilobyte (KB) = 1,024 bytes

1 megabyte (MB) = 1,024 KB = 1,048,576 bytes

1 gigabyte (GB) = 1,024 MB = 1,048,576 KB = 1,07 billion bytes

CCD chip

Another name for the *CCD sensor*.

CCD sensor

The sensor that detects the optical image in a digital camera is nearly always a CCD chip. CCD stands for **C**harge **C**oupled **D**evice. A CCD chip is a light-sensitive semiconductor component that emits an analogue signal proportional to the intensity of the incident light

The CCD sensor forms the heart of most digital cameras. The individual CCD elements are arranged on the CCD sensor in a matrix.

CCD element

An individual light-sensitive semiconductor element of a *CCD sensor*.



CF card

Compact Flash cards are memory cards for photographs taken with digital cameras (used instead of films) and have a memory capacity of up to 2 GB. They can also be connected to notebooks and stationary computers with a special PC card adapter. Data transfer can thus take place independently of the camera.

CMYK color space

The graphical representation of a limited space encompassing all the print colors that can be reproduced by *subtractive color mixing* of **C**yan, **M**agenta, **Y**ellow and **K**ey (black). The CMYK color space is smaller than the *RGB color space*; for this reason there are colors that can be reproduced in digital photos and on monitors but not with a printer. Consequently, color shifts are unavoidable in reproduction on printers.

Color management

The task of a color management systems is to guarantee color fidelity and predictability when different devices are used. To this purpose, the color management system corrects the color deviations caused by the various devices (e.g. digital camera, monitor, printer) to ensure uniformity of the color reproduction.

A color management system must be set up before use, as its operation will always be device-dependent. A profile is produced for the input and output devices, which contains information on the color characteristics of the individual devices and compensates for these characteristics in the course of the work flow (e.g. scanning, editing on the monitor, and printing).



Color depth

The color depth refers to the number of colors and gray-scale values that a *pixel* can reproduce; it is given in *bits*.

A picture with a color depth of 1 bit has only black and white *picture elements*; a picture with a color depth of 4 bits can represent 16 gray-scale values or colors.

An 8-bit color depth corresponds to 256 colors, a 24-bit color depth corresponds to 16.7 million colors.

As the *CCD elements* of digital cameras are coated with red, green and blue filters, 256 values of each of the colors red, green and blue can be represented, i.e. 8 bits per primary color:

$256 \times 256 \times 256 = 16.7 \text{ million.}; 3 \text{ (RGB)} \times 8 \text{ bits} = 24 \text{ bits.}$

This representation with a color depth of 24 bit is also referred to as *true color*.

Color space

A color space is a model for illustrating a color system. It contains all the colors that can be mixed in the color system. Color spaces can be represented graphically by limited areas within a coordinate system and can be compared in terms of various parameters such as size and color. A comparison of the gamut of additive colour spaces with that of subtractive shows the subtractive to have a lower gamut. Thus some colour are physically impossible to reproduce subtractively.

Color temperature

The color temperature characterizes the light color of a light source. It is measured in Kelvin [K]. A monitor is a light source – although not used to illuminate a room, it does radiate light. A color temperature of 5,500 K or 6,000 K, which is similar to that of daylight, is recommended for the monitor setting. A higher color temperature corresponds to a bluish picture and a lower color temperature to a reddish picture.



Compression

In digital photography and digital image processing, compression is the reduction of the file size relative to the size based on the pixel resolution. Depending on the *file format*, compression may or may not involve a loss of information: With *JPEG*, information will be lost. LZW compression, for example with the *TIFF* format, does not involve any loss of information

Contrast

Contrast describes the relationship between the different tonal values of an image. If the image contains a lot of black and white but only a small amount of gray, it will have a hard appearance and a high contrast. If, however, the black and white tones are absent, the image will have a soft appearance and a low contrast.

If all the tonal values are present in well-balanced proportions, the image will have a medium contrast.

CRT monitor

A CRT monitor (**C**athode **R**ay **T**ube) functions in the same way as a classical television picture tube. It is the commonest type of monitor and it uses – like digital cameras – the additive color system. This common feature permits quite an accurate reproduction of digital photographs.

Monitors do, however, have to be adjusted before the first digital image is edited. The monitor itself will have adjustment facilities, although experienced users can fine tune the system using the graphics card driver. The most important settings are *resolution*, *color depth*, *contrast*, *brightness* and color saturation; even relatively old monitors have facilities for adjusting them.

Data carrier

Data carrier is a term used to refer to all media on which data of any kind can be stored. A few examples of data carriers are musicassettes, audio CDs, videotapes, digital camera memory cards, diskettes and CD-Rs.

Data transfer rate

This is the theoretical data quantity that can be transmitted per second during data transfer. It is given in K (kilobit) – for example in the data transfer rate of a modem: 56 K. This means that the modem is technically capable of transmitting data at a rate of 56 kilobits per second. In practice, this value will never be achieved, because of limitations of the network and/or of the provider, for example.

Digital-analogue

→ see *Analogue-digital*

Digitization

Digitization is the conversion of analogue information to digital information for further processing in the computer. In digital cameras, the *CCD sensor* converts picture element information into electrical signals proportional to the intensity of the incident light. These signals are then coded as digital information in the subsequent A/D conversion.

Digitization error

There are essentially two digitization errors: *noise* and *aliasing*.



DPI

Dots per Inch describes – contrarily to *PPI* – the number of individual print dots that are output on 1 inch (2.54 cm). A printer with 1440 dpi prints 1440 dots every 2.54 cm (= 1 inch). To reproduce half tones, i.e. colors that are not pure cyan, magenta or yellow, an ink-jet printer forms a grid cell of approximately 4 x 4 dots. Mixed (secondary) colors are formed by means of various arrangements, distributions and opacities. In the case in question, the dpi figure must therefore be divided by 4 to give the actual picture element resolution of 360 ppi, which can then be used in for calculating the print size.

DPOF

Digital Print Order Format, which is not a *file format* in the normal sense, was developed specially for digital cameras. You can select the photos from which you wish to have prints made, before you download them from the camera. As well as individual prints, an index print can be made; this is a single print depicting all the images ordered. Most customer terminals, at which you can usually order prints of digital photos from virtually any type of data carrier, support DPOF. If you are not sure whether a particular terminal supports DPOF, please ask your photo retailer.

File format

File formats specify the manner in which data for text, graphics, digital photographs etc. are stored. The file format is indicated by three letters separated from the file name by a dot.

The most important formats for digital photography are *JPEG*, *TIFF* and *BMP*. Most digital photos are stored in the JPEG format. The abbreviations are the names of the file formats; the three-digit file name extensions *.jpg, *.tif and *.bmp are the Windows-specific identifications codes for the file formats.



File size

The file size of a digital photo is determined by the resolution and the *color depth*.

Example:

Pixel resolution: 1600 x 1200

Color depth: 24 bit

24 bit = 8 bits (1 byte) per color channel (R, G, B)
= 3 bytes per pixel

File size: 1600 x 1200 x 3 = 5,760,000 bytes

5,760,000 bytes = 5,625 kilobytes

= 5.49 megabytes (MB)

This calculation DOES NOT take into account any *compression*.

The file size is essentially dependent on the following factors:

- the sensor resolution
- the color depth
- the image file format (*TIFF, JPEG*)
- the compression factor

As a guide: 1 million pixels as a high-quality JPEG file require approximately 0.5 MB of memory.

GIF

In GIF, **G**raphics **I**nterchange **F**ormat, the image is analyzed line by line and identical or very similar pixels are grouped together in 256 colors. The result is a drastic reduction in file size. The GIF format was developed specially for use with the internet, where small, quickly loading files are a necessity. GIFs are best suited for images with large areas of one color and without gradual color transitions, and for so-called "animated gifs". GIF does not provide photo-quality images.

Graphics card

Together with the monitor (hardware), the graphics card is the determining factor for reproduction quality and picture characteristics of the monitor. From all the digital data that are to be represented on the monitor, the graphics card calculates a picture signal which, after D/A conversion, is sent as an analogue signal sequence to the CRT. The graphics card can be set directly via the driver menu. This should, however, be the last stage in setting the monitor, the fine tuning, as it were. Depending on the manufacturer and quality, adjustments can be more or less difficult to make. If in doubt, one should keep to the standard settings.

Interpolation

Interpolation is a process for image file enlargement and reduction in which, by means of a sequence of mathematical operations (algorithms), intermediate values are added or eliminated. Interpolation is part of various image-processing programs.

Caution should be exercised, however. There is no point in enlarging a small image by increasing the resolution setting. No original image information can be created that was not there in the first place. Interpolation will increase the size of the image, but may not make it necessarily better than the original file.

JPEG

JPEG is the abbreviation for **J**oint **P**hotographic **E**xperts **G**roup, the name of the committee that developed the format. The image is divided up into areas of 8 x 8 pixels and a check is made for similarities, which are then grouped together. The JPEG *file format* thus involves an inherent loss of information. Although the user can select the degree of *compression* to be applied, there will always be a certain amount of compression. If the storage process is repeated a number of times, the information loss will eventually become visible, since compression takes place each time. The advantages of JPEG are a small *file size* and platform independence, in other words *.jpg files can be processed by any computer. Before editing, files in this format should be stored as a copy in a loss-free format, for example *TIFF* (*.tif).

Kilobyte

→ see *Byte*

LC display

These are monitors that, in contrast to *CRT monitors*, use the properties of liquid crystals for image reproduction. For this reason, and because the picture varies with the viewing angle, LCDs, **L**iquid **C**ristal **D**isplays, are not ideal for digital image editing.

Megabyte

→ see *Byte*



Moiré

Moiré is an interference pattern that is produced by overlapping of regular dot or line rasters. Such moiré effects occur in digital photos of, for example, fine patterns and are reminiscent of the way fine-checked jackets can appear to flicker in television pictures.

Monitor

- see *CRT monitor*
- see *LC display*

Noise

Noise in digital photographs can be compared to the graininess in conventional photos. It results from the properties of the light-sensitive silicon, the main component of a *CCD sensor*, and unfortunately cannot be avoided. It is most noticeable in photographs taken under poor lighting conditions and in images containing large expanses of uniform tones.

The ideal output size in this case is a 10 x 13 cm print.

The calculations for ink-jet and laser printers are slightly different!!!

With such printers, the DPI value of the printer should not be used. Instead, you should use the number of printable picture elements per inch.

The table below shows the relationship between output resolution (print), print format, *file size* and capture resolution (camera, scanner):

Resolution of the print	Print format H x W for output 1:1 = optimum quality	Print format H x W for output 3:1 = acceptable quality	File size (uncompressed)	File size * (compressed: JPEG 1:10)	Number of pixels of camera
300 Pixel / Inch	4 x 6 [cm]	13 x 18 [cm]	0.9 MByte	92.2 KByte	0.3 MegaPixel
300 Pixel / Inch	7 x 9 [cm]	18 x 24 [cm]	2.3 MByte	235.9 KByte	0.8 MegaPixel
300 Pixel / Inch	9 x 13 [cm]	20 x 30 [cm]	3.5 MByte	368.6 KByte	1.2 MegaPixel
300 Pixel / Inch	10 x 15 [cm]	30 x 40 [cm]	5.5 MByte	576.0 KByte	1.9 MegaPixel
300 Pixel / Inch	13 x 18 [cm]	40 x 50 [cm]	9.0 MByte	943.7 KByte	3.1 MegaPixel
300 Pixel / Inch	15 x 20 [cm]	50 x 60 [cm]	12.4 MByte	1296.0 KByte	4.3 MegaPixel

* Data compression reduces the memory requirement as well as transmission times over the internet. With high compression, data is lost, which impairs the picture quality.

Parallel interface

The parallel interface on a PC transmits data on 8 lines simultaneously; in other words, several signals, which together form one *byte*, are transmitted in parallel. For this reason, the data transfer rate is higher than for a *serial interface*.

PCMCIA card

A memory card, whose name comes from the abbreviation for **P**ersonal **C**omputer **M**emory **C**ard **I**nformation **A**ssociation. The term PCMCIA has now become an interface standard. Cards for this interface are today referred to as PC cards.

Picture element

A picture element is an element of a digital image. In digital cameras and monitors, a picture element is the same as a *pixel*, in printers, each picture element comprises several print dots

Pixel

Pixel is a made-up word, derived from **p**icture **e**lement. It denotes the smallest element of a digital image.

PPI

Pixel **p**er **I**nch – contrarily to *DPI* – indicates the number of individual *picture elements* that can be recorded or represented per inch (2.54 cm). Each pixel contains the complete color and brightness information, e.g. *true color* 24 bit.



Print size

→ see *Output size*

Printing to photographic paper

To transfer digital image data to photographic paper, a light source is controlled in accordance with the pixel brightness and color. Conventional photographic paper is exposed to the light and subsequently developed. The light source can be e.g. a *CRT monitor* or a laser beam.

Rasterization

Ink-jet printers must rasterize the image. So, as to be able to print it by using only four or six colors. Rasterization is the process of breaking down an image into dots. Associated with each dot are fixed values relating to its color, size and position in the image. With traditional color paper, the pixels are printed without any rasterization.

Rechargeable battery

When a rechargeable battery is charged using a charger, it stores electrical energy. This energy can be used by devices that require an electric current, such as digital cameras; the battery then discharges.



Resolution

The number of *picture elements* in the horizontal and vertical directions, e.g. 1,600 x 1,200, and the total number of picture elements that can be reproduced, e.g. 1.9 million pixels, are standard information for indicating the image resolution of a digital camera.

Resolution (W x H)	Number of pixels	MegaPixel	Category
480 x 640	307,000	0.3	VGA
768 x 1,024	786,432	0.8	XGA
960 x 1,280	1,228,800	1.2	1.2 MegaPixel
1,200 x 1,600	1,920,000	1.9	2.0 MegaPixel
1,536 x 2,048	3,145,728	3.1	3.0 MegaPixel
1,800 x 2,400	4,320,000	4.3	4.0 MegaPixel

RGB color space

The graphical representation of a limited space encompassing all the colors that can be reproduced by additive mixing of **R**ed, **G**reen and **B**lue. The RGB color space is larger than the *CMYK color space*. For this reason, there are colors in digital photos and on monitors that cannot be reproduced accurately with a printer. The RGB color space is the color space of all primary light sources and photo printers.

SCSI

The **S**mall **C**omputer **S**tandard **I**nterface is a fast data bus for internal and external connection of peripheral devices to a computer. The SCSI interface is equally uncommon in MAC computers and Windows PCs.

Serial interface

The serial interface is used for connection, to a computer, of peripheral devices (e.g. mouse, modem) that do not require high data transfer rates. In PCs, the serial interface conforms to the RS-232 standard. The serial interface is also used for communication with digital cameras.

SmartMedia card

These rewritable memory cards are used mainly for storing image data in digital cameras. The card can be taken out of the camera and read with a card reader on a PC. The data transfer can thus be performed independently of the camera.

sRGB

This color space (**s**tandard, **R**ed, **G**reen, **B**lue) is supported by numerous hardware and software manufacturers and has become the standard for various scanners, color printers and software applications.

In contrast to the *RGB color space*, which is based on pure spectral colors, the sRGB color space is smaller and comprises the technically reproducible colors.



Subtractive color mixing

This color system is based on the subtractive combination of the surface colors cyan, magenta and yellow. The *CMYK color space* of subtractive color mixing is smaller than the *RGB color space* of additive color mixing. For this reason, it is not possible to convert directly between the two color systems.

TIFF

TIFF, **T**agged **I**mage **F**ile **F**ormat, is indicated by the file name extension *.tif. This *file format* permits storage of images with more than a 24-bit *color depth* and, if required, loss-free *compression*. TIFF is used platform-independently by many image editing programs and is thus an ideal storage format for exchanging files.

Note: LZW compression of the TIFF format should never be used with digital photos that are to be printed on photographic paper!

True color

True color refers to image reproduction with 16.7 million colors or a 24-bit *color depth*. Correct assessment of color nuances on a monitor is really only possible if true color is used. True color is thus a basic requirement for digital image editing on a computer.

Thumbnail

A thumbnail is a reduced picture of a digital image on a computer monitor or camera display.



USB

USB, **U**niversal **S**erial **B**us, is an interface for connection of external devices (e.g. printers, scanners, digital cameras) to a PC. The data transfer takes place serially at a high speed, and the devices can be connected while the system is running (hot plug).

ZIP

1. ZIP drive with exchangeable media that can have a storage capacity of 100 MB or 250 MB. The drive can be connected internally or externally via SCSI, USB or *parallel interface*.
2. *File format* (*.zip) for a widely used compression standard that reduces *file size* independently of the file type concerned.