ICC Rendering Intents

The International Color Consortium (ICC) has defined four different values called rendering intents. These represent four different approaches to creating a color rendering. These four intents, and the constants used to refer to them in code are as follows.

The ICC Profile Format Specification Version 3.4, which describes these intents, can be downloaded from the following Internet address:

[http://www.color.org](http://www.color.org/)

Picture Intent

Called perceptual intent in the ICC specification clause 4.9, a Picture intent causes the full [gamut](http://msdn.microsoft.com/en-us/library/dd316909(VS.85).aspx#_color_wcs_1.0_glossary_gamut_gloss) of the image to be compressed or expanded to fill the gamut of the destination device, so that gray balance is preserved but colorimetric accuracy may not be preserved.

In other words, if certain colors in an image fall outside of the range of colors that the output device can render, the picture intent will cause all the colors in the image to be adjusted so that the every color in the image falls within the range that can be rendered and so that the relationship between colors is preserved as much as possible.

This intent is most suitable for display of photographs and images, and is generally the default intent.

Graphic Intent

The ICC specification clause 4.12 calls the Graphic intent a [saturation](http://msdn.microsoft.com/en-us/library/dd372186(VS.85).aspx#_color_wcs_1.0_glossary_saturation_gloss) intent. It preserves the chroma of colors in the image at the possible expense of [hue](http://msdn.microsoft.com/en-us/library/dd372096(VS.85).aspx#_color_wcs_1.0_glossary_hue_gloss) and [lightness](http://msdn.microsoft.com/en-us/library/dd372163(VS.85).aspx#_color_wcs_1.0_glossary_lightness_gloss).

Implementation of this intent remains somewhat problematic, and the ICC is still working on methods to achieve the desired effects.

This intent is most suitable for business graphics such as charts, where it is more important that the colors be vivid and contrast well with each other rather than a specific color.

Proof Intent

The Proof intent, called the colorimetric intent in the ICC specification, is defined such that any colors that fall outside the range that the output device can render are adjusted to the closest color that can be rendered, while all other colors are left unchanged.

Proof intent does not preserve the [white point](http://msdn.microsoft.com/en-us/library/dd372233(VS.85).aspx#_color_wcs_1.0_glossary_white_point_gloss).

For example, the whitest white of a paper is more yellow than the whitest white of a computer monitor. An image converted into the gamut of the printer using relative colorimetric intent would result in all colors becoming more yellow. The white point of the image is moved to match the white point of the printer. All other colors in the image keep their position relative to the white point. This produces an image that more accurately reflects what the printed image will look like. However, the user may find it visually disconcerting.

Match Intent

In a Match intent, any colors that fall outside the range that the output device can render are adjusted to the closest color that can be rendered, while all other colors are left unchanged. The ICC specification calls the match intent absolute colorimetric intent.

Match intent preserves the white point.

For example, the whitest white of a paper is more yellow than the whitest white of a computer monitor. An image converted into the [gamut](http://msdn.microsoft.com/en-us/library/dd316909(VS.85).aspx#_color_wcs_1.0_glossary_gamut_gloss) of the printer using match intent would result in all colors being converted and matched into the gamut of the printer. The white point of the image is not moved to match the white point of the printer. Therefore, the distance of the colors to the white point may change. This produces an image that is less visually disconcerting to the user, but is also a less accurate rendition of printer output.

Device profiles provide color management systems with the information necessary to convert color data between native device color spaces and device independent color spaces. The specification divides color devices into three broad classifications: input devices, display devices and output devices. For each device class, a series of base algorithmic models are described which perform the transformation between color spaces. These models provide a range of color quality and performance results which provide different trade-offs in memory footprint, performance and image quality.

The device profiles obtain their openness by using a well-defined reference colour space and by being capable of being interpreted by any ICC operating system or application that is compliant with the specification. In combination with profiles for other devices colour transformations may be determined that enable colours captured on one device to be reproduced satisfactorily on many others. The information required in the profile is adequate to ensure the level of color fidelity selected by the user and for the design of a default color management module (CMM) to transform color information between native device color spaces. Such CMMs are found in many operating systems and applications

In addition to providing a cross-platform standard for the actual profile format, the specification also describes the convention for embedding these profiles within graphics documents and images. Embedded profiles allow users to transparently move color data between different computers, networks and even operating systems without having to worry if the necessary profiles are present on the destination systems. The intention of embedded profiles is to allow the interpretation of the associated color data.

The International Color Consortium Profile Format supports a variety of device-dependent and device-independent color spaces divided into three basic families: 1) CIEXYZ based, 2) RGB based, and 3) CMY based (including CMYK). A subset of the CIEXYZ based spaces are also defined as connection spaces.

2. Profile connection space (PCS)

A key component of the specification is a well-defined profile connection space. This standard color space is the interface which provides an unambiguous connection between the input and output profiles as illustrated in the diagram below. It allows the profile transforms for input, display, and output devices to be decoupled so that they can be produced independently. A well-defined PCS provides the common interface for the individual device profiles. It is the virtual destination for input transforms and the virtual source for output transforms. If the input and output transforms are based on the same PCS definition, even though they are created independently, they can be paired arbitrarily at run time by the color-management engine (CMM) and will yield consistent and predictable results when applied to color values.

The profile connection space is based on the CIE 1931 standard colorimetric observer. This experimentally derived standard observer provides a very good representation of the human visual system color matching capabilities. Unlike device dependent color spaces, if two colors have the same CIE colorimetry they will match if viewed under the same conditions as those defined for the colorimetry.

Because images are typically produced for a wide variety of viewing environments, it is necessary to go beyond simple application of the CIE system. The profile connection space is defined as the CIE colorimetry which, in the case of the perceptual rendering intent (defined later), will produce the desired color appearance if rendered on a reference imaging media and viewed in a reference viewing environment. This reference corresponds to an ideal reflection print viewed in a standard viewing booth conforming to ISO standard viewing conditions.

The default measurement parameters for the profile connection space and all other color spaces defined in this specification are based on the ISO 13655 standard, "Graphic technology - Spectral measurement and colorimetric computation for graphic arts images." Essentially this defines a standard illuminant of D50, the 1931 CIE standard colorimetric observer, and 0 /45 or 45 /0 measurement geometry measured with a black backing behind the print for the reflectance measurements. The reference viewing condition is that defined in ISO 3664 as viewing condition P2 using the recommended 20% surround reflectance. This is a graphics arts and photography print viewing environment with a D50 illumination level of 500 lux.

One of the first steps in profile building involves measuring a set of colors from some imaging media or display. If the imaging media or viewing environment differ from the reference, it will be necessary to adapt the colorimetric data to that appropriate for the profile connection space. These adaptations account for such differences as white point chromaticity and luminance relative to an ideal reflector, maximum density, viewing surround, viewing illuminant, and flare. Currently, it is the responsibility of the profile builder to do this adaptation. However, the possibility of allowing a variable illuminant in the PCS is under active consideration by the International Color Consortium.

3. Rendering intents

In general, actual device color gamuts (the range of all possible colors which can be represented or produced on the device) will not be large enough to reproduce the desired color appearances communicated by the PCS values. Four rendering intents (gamut mapping styles) are defined by the ICC in order to address this problem. Each one represents a different compromise. The colorimetric rendering intents enable within gamut colors to be reproduced accurately (though possibly with compensation for the whiteness of the media) at the expense of out-of?gamut colors. Compensation can be made for chromatic adaptation when the viewing condition assumed is different to the reference viewing environment. The other rendering intents modify the colorimetric values as-needed to account for any differences between devices, media, and viewing conditions.

3.1 Colorimetric Intents

As stated earlier, the colorimetric intents preserve the relationships between in-gamut colors at the expense of out-of-gamut colors. Mapping of out-of-gamut colors is not specified but should be consistent with the intended use of the transform.

It should be noted that in transforms for the media-relative and ICC-absolute colorimetric intents, the PCS values may represent a preferred color rendering of the actual original captured for input profiles rather than a faithful reproduction. Likewise for output profiles, the PCS values may be color rendered by the output device to the actual medium. However, wherever ICC profiles are used, the PCS values resulting from such transforms are interpreted as the colorimetry of the original and reproduction, regardless of whether such colorimetry is the actual colorimetry.

3.1.1 Media-Relative Colorimetric Intent

This intent rescales the in-gamut, chromatically adapted tristimulus values, such that the white point of the actual medium is mapped to the white point of the reference medium (for either input or output). It is useful for colors that have already been mapped to a medium with a smaller gamut than the reference medium (and therefore need no further compression). In transforms for the media-relative colorimetric intent the PCS values represent media-relative measurements of the captured original (for input profiles), or media-relative color reproductions produced by the output device (for output profiles).

3.1.2 ICC-Absolute Colorimetric Intent

For this intent, the chromatically adapted tristimulus values of the in-gamut colors are unchanged. It is useful for spot colors and when simulating one medium on another (proofing). In transforms for the ICC-absolute colorimetric intent the PCS values represent measurements of the captured original relative to a hypothetical perfectly reflecting diffuser (for input profiles), or color reproductions produced by the output device relative to a hypothetical perfectly reflecting diffuser (for output profiles).

Note that this definition of ICC-absolute colorimetry is actually called "relative colorimetry" in CIE terminology, since the data has been normalized relative to the illuminant.

3.1.3 Saturation Intent

The exact gamut mapping of the saturation intent is vendor specific and involves compromises such as trading off preservation of hue in order to perserve the vividness of pure colors. It is useful for images which contain objects such as charts or diagrams.

3.1.4 Perceptual Intent

The exact gamut mapping of the perceptual intent is vendor specific and involves compromises such as trading off preservation of contrast in order to preserve detail throughout the tonal range. It is useful for general reproduction of images, particularly pictorial or photographic-type images.

A profile that enables perceptual rendering and transcends the actual device needs to represent the desired appearance. It is difficult to know how to generate such a profile. It is helpful to conceptualize a "reference medium" which is a hypothetical medium on which the colors are being rendered. It has a large gamut and dynamic range which approximate the limits of current reflection-print technology. It is described using "realworld" specifications so that even though the medium is not real, it can be treated as if it were real. It is also necessary to define a "reference viewing environment" which is the environment in which the reference medium is to be viewed. This environment is used to determine the observer's adaptation state and establishes the connection between color stimulus and color appearance.

The concept of a reference medium viewed in the reference viewing environment helps the profile designer to understand how to produce "desired appearance" in the PCS. At the same time, it preserves the goal of decoupling the characteristics of actual media through a virtual intermediate reproduction description.

So, in perceptual transforms the PCS values represent hypothetical measurements of a color reproduction on a reference medium. It is defined as a hypothetical print on a substrate having a neutral reflectance of 89%. The darkest printable color on this medium shall have a neutral reflectance of 0,30911%, which is 0,34731% of the substrate reflectance. These are the white point and black point of the reference medium. The reference medium therefore has a linear dynamic range of 287,9:1 and a density range of 2,4593. By extension, for the perceptual intent, the PCS represents the appearance of that reproduction when viewed in the reference viewing environment by a human observer adapted to that environment. If the actual viewing environment differs from the reference viewing environment perceptual transforms need to include a compensation for the differences in viewing environments. Note: It is important to remember that the reference viewing condition and reference medium only apply to the perceptual transform.

Because perceptual renderings are vendor specific it is unlikely that profiles produced by different vendors will produce the same result. Users need to be aware of this and ensure that their workflows enable consistency when it is required (such as in distributed printing) by, for example, transmitting output profiles along with their images. There is currently no agreed ICC specification for this procedure and the onus is on the user. However, ICC are reviewing the needs of such workflows in conjunction with various standards groups.

Absolute color space

From Wikipedia, the free encyclopedia

Jump to: [navigation](http://en.wikipedia.org/wiki/Absolute_color_space#column-one), [search](http://en.wikipedia.org/wiki/Absolute_color_space#searchInput)

In [color science](http://en.wikipedia.org/wiki/Color_science), there are two meanings of the term absolute color space:

A [color space](http://en.wikipedia.org/wiki/Color_space) in which the perceptual difference between colors is directly related to [distances between colors](http://en.wikipedia.org/wiki/Color_difference) as represented by points in the color space.[[1]](http://en.wikipedia.org/wiki/Absolute_color_space" \l "cite_note-0)[[2]](http://en.wikipedia.org/wiki/Absolute_color_space#cite_note-1)

A [color space](http://en.wikipedia.org/wiki/Color_space) in which colors are unambiguous, that is, where the interpretations of colors in the space are colorimetrically defined without reference to external factors.[[3]](http://en.wikipedia.org/wiki/Absolute_color_space" \l "cite_note-2)[[4]](http://en.wikipedia.org/wiki/Absolute_color_space#cite_note-3)

In this article, we concentrate on the second definition.

[CIEXYZ](http://en.wikipedia.org/wiki/CIE_1931_color_space) and [sRGB](http://en.wikipedia.org/wiki/SRGB) are examples of absolute color spaces, as opposed to a generic [RGB color space](http://en.wikipedia.org/wiki/RGB_color_space).

A non-absolute color space can be made absolute by defining its relationship to absolute colorimetric quantities. For instance, if the red, green, and blue colors in a monitor are measured exactly, together with other properties of the monitor, then RGB values on that monitor can be considered as absolute. The [L\*a\*b\*](http://en.wikipedia.org/wiki/Lab_color_space) is sometimes referred to as absolute, though it also needs a [white point](http://en.wikipedia.org/wiki/White_point) specification to make it so.[[5]](http://en.wikipedia.org/wiki/Absolute_color_space#cite_note-4)

A popular way to make a color space like RGB into an absolute color is to define an [ICC](http://en.wikipedia.org/wiki/International_Color_Consortium) profile, which contains the attributes of the RGB. This is not the only way to express an absolute color, but it is the standard in many industries. RGB colors defined by widely accepted profiles include [sRGB](http://en.wikipedia.org/wiki/SRGB_color_space) and [Adobe RGB](http://en.wikipedia.org/wiki/Adobe_RGB_color_space). The process of adding an [ICC profile](http://en.wikipedia.org/wiki/ICC_profile) to a graphic or document is sometimes called tagging or embedding; tagging therefore marks the absolute meaning of colors in that graphic or document.

[[edit](http://en.wikipedia.org/w/index.php?title=Absolute_color_space&action=edit&section=1)] Conversion

Main article: [Color translation](http://en.wikipedia.org/wiki/Color_translation)

A color in one absolute color space can be converted into another absolute color space, and back again, in general; however, some color spaces may have [gamut](http://en.wikipedia.org/wiki/Gamut) limitations, and converting colors that lie outside that gamut will not produce correct results. There are also likely to be rounding errors, especially if the popular range of only 256 distinct values per component ([8-bit color](http://en.wikipedia.org/wiki/8-bit_color)) is used.

One part of the definition of an absolute color space is the viewing conditions. The same color, viewed under different natural or artificial lighting conditions, will look different. Those involved professionally with color matching may use viewing rooms, lit by standardized lighting.

Occasionally, there are precise rules for converting between non-absolute color spaces. For example [HSL and HSV](http://en.wikipedia.org/wiki/HSL_and_HSV) spaces are defined as mappings of RGB. Both are non-absolute, but the conversion between them should maintain the same color. However, in general, converting between two non-absolute color spaces (for example, RGB to [CMYK](http://en.wikipedia.org/wiki/CMYK_color_model)) or between absolute and non-absolute color spaces (for example, RGB to L\*a\*b\*) is almost a meaningless concept.

Other absolute color spaces

A different method of defining absolute color spaces is familiar to many consumers as the swatch card, used to select paint, fabrics, and the like. This is a way of agreeing a color between two parties. A more standardized method of defining absolute colors is the [Pantone Matching System](http://en.wikipedia.org/wiki/Pantone), a proprietary system that includes swatch cards and recipes that commercial printers can use to make inks that are a particular color.

References

[^](http://en.wikipedia.org/wiki/Absolute_color_space#cite_ref-0) Hans G. Völz (2001). [Industrial Color Testing: Fundamentals and Techniques](http://books.google.com/books?id=-0jl6ai59MMC&pg=PA40&ots=tteI6jgqEu&dq=%22absolute+color+space%22&sig=903V904NfSz1UkWeirnsgm6wbNU). Wiley-VCH. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [3527304363](http://en.wikipedia.org/wiki/Special:BookSources/3527304363). <http://books.google.com/books?id=-0jl6ai59MMC&pg=PA40&ots=tteI6jgqEu&dq=%22absolute+color+space%22&sig=903V904NfSz1UkWeirnsgm6wbNU>.

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[^](http://en.wikipedia.org/wiki/Absolute_color_space#cite_ref-2) Jonathan B. Knudsen (1999). [Java 2D Graphics](http://books.google.com/books?id=2avW9QCkSj0C&pg=PA172&ots=ANiaf8T3rt&dq=%22absolute+color+space%22&sig=p5-RDEsWwKaMGAhkuPxr23d5wkg). O'Reilly. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [1565924843](http://en.wikipedia.org/wiki/Special:BookSources/1565924843). <http://books.google.com/books?id=2avW9QCkSj0C&pg=PA172&ots=ANiaf8T3rt&dq=%22absolute+color+space%22&sig=p5-RDEsWwKaMGAhkuPxr23d5wkg>.

[^](http://en.wikipedia.org/wiki/Absolute_color_space#cite_ref-3) Bernice Ellen Rogowitz, Thrasyvoulos N Pappas and Scott J Daly (2007). [Human Vision and Electronic Imaging XII](http://books.google.com/books?id=Ne9RAAAAMAAJ&q=%22absolute+color+space%22&dq=%22absolute+color+space%22&ei=_jWYR-bFDpOMtAOr59XHCA&pgis=1). SPIE. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [0819466050](http://en.wikipedia.org/wiki/Special:BookSources/0819466050). <http://books.google.com/books?id=Ne9RAAAAMAAJ&q=%22absolute+color+space%22&dq=%22absolute+color+space%22&ei=_jWYR-bFDpOMtAOr59XHCA&pgis=1>.

[^](http://en.wikipedia.org/wiki/Absolute_color_space#cite_ref-4) Yud-Ren Chen, George E. Meyer, and Shu-I. Tu (2005). [Optical Sensors and Sensing Systems for Natural Resources and Food Safety and Quality](http://books.google.com/books?id=7IxTAAAAMAAJ&q=%22absolute+color+space%22+l-a-b&dq=%22absolute+color+space%22+l-a-b&ei=hzeYR6XQEKeGtgP8mtHHCA&pgis=1). SPIE. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [0819460206](http://en.wikipedia.org/wiki/Special:BookSources/0819460206). <http://books.google.com/books?id=7IxTAAAAMAAJ&q=%22absolute+color+space%22+l-a-b&dq=%22absolute+color+space%22+l-a-b&ei=hzeYR6XQEKeGtgP8mtHHCA&pgis=1>.

YCbCr or Y'CbCr is a family of [color spaces](http://en.wikipedia.org/wiki/Color_space) used as a part of the [color image pipeline](http://en.wikipedia.org/wiki/Color_image_pipeline) in [video](http://en.wikipedia.org/wiki/Video) and [digital photography](http://en.wikipedia.org/wiki/Digital_photography) systems. Y' is the [luma](http://en.wikipedia.org/wiki/Luma_(video)) component and Cb and Cr are the blue-difference and red-difference [chroma](http://en.wikipedia.org/wiki/Chrominance) components. The prime (') on the Y is to distinguish the luma from [luminance](http://en.wikipedia.org/wiki/Luminance_(relative)), meaning that light intensity is non-linearly encoded using [gamma](http://en.wikipedia.org/wiki/Gamma_correction).

Y'CbCr is not an [absolute color space](http://en.wikipedia.org/wiki/Absolute_color_space), it is a way of encoding [RGB](http://en.wikipedia.org/wiki/RGB) information. The actual color displayed depends on the actual RGB [colorants](http://en.wikipedia.org/wiki/Colorant) used to display the signal. Therefore a value expressed as Y'CbCr is only predictable if standard RGB colorants or an [ICC profile](http://en.wikipedia.org/wiki/ICC_Profile) are used.

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| Contents  [[hide](javascript:toggleToc())]  [1 Rationale](http://en.wikipedia.org/wiki/YCbCr#Rationale)  [2 Name](http://en.wikipedia.org/wiki/YCbCr#Name)  [3 Technical details](http://en.wikipedia.org/wiki/YCbCr#Technical_details)  [4 References](http://en.wikipedia.org/wiki/YCbCr#References)  [5 External links](http://en.wikipedia.org/wiki/YCbCr#External_links) |

Rationale

[Cathode ray tube](http://en.wikipedia.org/wiki/Cathode_ray_tube) displays are driven by red, green, and blue voltage signals, but these [RGB](http://en.wikipedia.org/wiki/RGB_color_space) signals are not efficient as a representation for storage and transmission, since they have a lot of [mutual](http://en.wikipedia.org/wiki/Mutual_information) [redundancy](http://en.wikipedia.org/wiki/Redundancy_(information_theory)).

YCbCr and Y'CbCr are a practical approximation to color processing and perceptual uniformity, where the [primary colours](http://en.wikipedia.org/wiki/Primary_colour) corresponding roughly to Red, Green and Blue are processed into perceptually meaningful information. By doing this, subsequent image/video processing, transmission and storage can do operations and introduce errors in perceptually meaningful ways. Y'CbCr is used to separate out a luma signal (Y') that can be stored with high resolution or transmitted at high bandwidth, and two chroma components (Cb and Cr) that can be bandwidth-reduced, subsampled, compressed, or otherwise treated separately for improved system efficiency.

One practical example would be decreasing the bandwidth or resolution allocated to "color" compared to "black and white", since humans are more sensitive to the black-and-white information (see image example to the right).

Name

YCbCr is sometimes abbreviated to YCC. Y'CbCr is often called [YPbPr](http://en.wikipedia.org/wiki/YPbPr) when used for [analog](http://en.wikipedia.org/wiki/Analog_video) component video, although the term Y'CbCr is commonly used for both systems, with or without the prime.

Y'CbCr is often confused with the [YUV](http://en.wikipedia.org/wiki/YUV) color space, and typically the terms YCbCr and YUV are used interchangeably, leading to some confusion; when referring to signals in video or digital form, the term "YUV" mostly means "Y'CbCr".

Technical details

Y'CbCr signals (prior to scaling and offsets to place the signals into digital form) are called [YPbPr](http://en.wikipedia.org/wiki/YPbPr), and are created from the corresponding gamma-adjusted [RGB](http://en.wikipedia.org/wiki/RGB) (red, green and blue) source using two defined constants Kb and Kr as follows:

Y' = Kr \cdot R' + (1 - Kr - Kb) \cdot G' + Kb \cdot B' \,

Pb =\frac12 \cdot \frac{B' - Y'}{1 - Kb}

Pr =\frac12 \cdot \frac{R' - Y'}{1 - Kr}

where Kb and Kr are ordinarily derived from the definition of the corresponding RGB space. (The equivalent [matrix](http://en.wikipedia.org/wiki/Matrix_(mathematics)) manipulation is often referred to as the "color matrix.")

Here, the prime (') symbols mean [gamma correction](http://en.wikipedia.org/wiki/Gamma_correction) is being used; thus R', G' and B' and to nominally range from 0 to 1, with 0 representing the minimum intensity (e.g., for display of the color [black](http://en.wikipedia.org/wiki/Black)) and 1 the maximum (e.g., for display of the color [white](http://en.wikipedia.org/wiki/White)). The resulting luma (Y) value will then have a nominal range from 0 to 1, and the chroma (Cb and Cr) values will have a nominal range from -0.5 to +0.5. The reverse conversion process can be readily derived by inverting the above equations.

When representing the signals in digital form, the results are scaled and rounded, and offsets are typically added. For example, the scaling and offset applied to the Y' component per specification (e.g. [MPEG-2](http://en.wikipedia.org/wiki/MPEG-2)[[1]](http://en.wikipedia.org/wiki/YCbCr#cite_note-0)) results in the value of 16 for black and the value of 235 for white when using an 8-bit representation. The standard has 8-bit digitized versions of Cb and Cr scaled to a different range of 16 to 240. Consequently, rescaling by the fraction (235-16)/(240-16) = 219/224 is sometimes required when doing color matrixing or processing in YCbCr space, resulting in quantization distortions when the subsequent processing is not performed using higher bit depths.

The scaling that results in the use of a smaller range of digital values than what might appear to be desirable for representation of the nominal range of the input data allows for some "overshoot" and "undershoot" during processing without necessitating undesirable [clipping](http://en.wikipedia.org/wiki/Clipping_(signal_processing)). This "head-room" and "toe-room" can also be used for extension of the nominal color [gamut](http://en.wikipedia.org/wiki/Gamut), as specified by [xvYCC](http://en.wikipedia.org/wiki/XvYCC).

The form of Y'CbCr that was defined for [standard-definition television](http://en.wikipedia.org/wiki/Standard-definition_television) use in the [ITU-R](http://en.wikipedia.org/wiki/ITU-R) BT.601 (formerly [CCIR 601](http://en.wikipedia.org/wiki/CCIR_601)) standard for use with digital [component video](http://en.wikipedia.org/wiki/Component_video) is derived from the corresponding RGB space as follows:

Kb = 0.114

Kr = 0.299

From the above constants and formulas, the following can be derived for ITU-R BT.601. Analog YPbPr from analog R'G'B' is derived as follows:

Y' =0.299 \cdot R' + 0.587 \cdot G' + 0.114 \cdot B'

Pb =- 0.168736 \cdot R' - 0.331264 \cdot G' + 0.5 \cdot B'

Pr =0.5 \cdot R' - 0.418688 \cdot G' - 0.081312 \cdot B'

Digital Y'CbCr (8 bits per sample) is derived from analog R'G'B' as follows:

Y' = 16 + ( 65.481 \cdot R' + 128.553 \cdot G' + 24.966 \cdot B')

Cb = 128 + (-37.797 \cdot R' - 74.203 \cdot G' + 112.0 \cdot B')

Cr = 128 + (112.0 \cdot R' - 93.786 \cdot G' - 18.214 \cdot B')

Note that the resultant signals range from 16 to 235; the values from 0 to 15 are called footroom, while the values from 236 to 255 are called headroom.

Alternatively, digital Y'CbCr is derived from digital R'dG'dB'd (8 bits per sample) according to the following equations:

Y' = 16 + 1/256 \cdot ( 65.738 \cdot R'd + 129.057 \cdot G'd + 25.064 \cdot B'd)

Cb = 128 + 1/256 \cdot (- 37.945 \cdot R'd - 74.494 \cdot G'd + 112.439 \cdot B'd)

Cr = 128 + 1/256 \cdot ( 112.439 \cdot R'd - 94.154 \cdot G'd - 18.285 \cdot B'd)

The inverse transform is:

R'd = ( 298.082 \cdot Y' + 408.583 \cdot Cr ) / 256 - 222.921

G'd = ( 298.082 \cdot Y' - 100.291 \cdot Cb - 208.120 \cdot Cr ) / 256 + 135.576

B'd = ( 298.082 \cdot Y' + 516.412 \cdot Cb ) / 256 - 276.836

This form of Y'CbCr is used primarily for older [standard-definition television](http://en.wikipedia.org/wiki/Standard-definition_television) systems, as it uses an RGB model that fits the phosphor emission characteristics of older [CRTs](http://en.wikipedia.org/wiki/Cathode_ray_tube).

A different form of Y'CbCr is specified in the [ITU-R BT.709](http://en.wikipedia.org/wiki/Rec._709) standard, primarily for [HDTV](http://en.wikipedia.org/wiki/High-definition_television) use. The newer form is also used in some computer-display oriented applications. In this case, the values of Kb and Kr differ, but the formulas for using them are the same. For ITU-R BT.709, the constants are:

Kb = 0.0722

Kr = 0.2126

This form of Y'CbCr is based on an RGB model that more closely fits the phosphor emission characteristics of newer CRTs and other modern display equipment.

Although the above two forms of Y'CbCr are the dominant ones, some other variants exist. For example, the [SMPTE](http://en.wikipedia.org/wiki/SMPTE) 240M standard specifies YCbCr using Kb = 0.087 and Kr = 0.212.

Note that the definitions of the R', G', and B' signals also differ between BT.709 and BT.601, and differ within BT.601 depending on the type of TV system in use (625-line as in [PAL](http://en.wikipedia.org/wiki/PAL) and [SECAM](http://en.wikipedia.org/wiki/SECAM) or 525-line as in [NTSC](http://en.wikipedia.org/wiki/NTSC)), and differ further in other specifications. In different designs there are differences in the definitions of the R, G, and B chromaticity coordinates, the reference white point, the supported gamut range, the exact gamma pre-compensation functions for deriving R', G' and B' from R, G, and B, and in the scaling and offsets to be applied during conversion from R'G'B' to Y'CbCr. So proper conversion of Y'CbCr from one form to the other is not just a matter of inverting one matrix and applying the other. In fact, when Y'CbCr is designed ideally, the values of Kb and Kr are derived from the precise specification of the RGB color primary signals, so that the luma (Y') signal corresponds as closely as possible to a [gamma-adjusted](http://en.wikipedia.org/wiki/Gamma_correction) measurement of [luminance](http://en.wikipedia.org/wiki/Luminance) (typically based on the [CIE](http://en.wikipedia.org/wiki/International_Commission_on_Illumination) 1931 measurements of the response of the human visual system to color stimuli).[[2]](http://en.wikipedia.org/wiki/YCbCr#cite_note-1)

Since the equations defining YCbCr are formed in a way that rotates the entire nominal RGB color cube and scales it to fit within a (larger) YCbCr color cube, there are some points within the YCbCr color cube that cannot be represented in the corresponding RGB domain (at least not within the nominal RGB range). This causes some difficulty in determining how to correctly interpret and display some YCbCr signals. These out-of-range YCbCr values are used by [xvYCC](http://en.wikipedia.org/wiki/XvYCC) to encode colours outside the BT.709 gamut.

[JFIF](http://en.wikipedia.org/wiki/JFIF) usage of [JPEG](http://en.wikipedia.org/wiki/JPEG) allows Y'CbCr where Y', Cb and Cr have the full 8-bit range of 0-255:[[3]](http://en.wikipedia.org/wiki/YCbCr" \l "cite_note-2)

Y' = + 0.299 \cdot R'd + 0.587 \cdot G'd + 0.114 \cdot B'd

Cb = 128 - 0.168736 \cdot R'd - 0.331264 \cdot G'd + 0.5 \cdot B'd

Cr = 128 + 0.5 \cdot R'd - 0.418688 \cdot G'd - 0.081312 \cdot B'd

References

[^](http://en.wikipedia.org/wiki/YCbCr#cite_ref-0) e.g. the [MPEG-2](http://en.wikipedia.org/wiki/MPEG-2) specification, ITU [H.262](http://en.wikipedia.org/wiki/H.262) 2000 E pg. 44

[^](http://en.wikipedia.org/wiki/YCbCr#cite_ref-1) Charles Poynton, Digital Video and HDTV, Chapter 24, pp. 291–292, [Morgan Kaufmann](http://en.wikipedia.org/wiki/Morgan_Kaufmann), 2003.

[^](http://en.wikipedia.org/wiki/YCbCr#cite_ref-2) [JPEG File Interchange Format Version 1.02](http://www.jpeg.org/public/jfif.pdf)

] External links

[Charles Poynton — Color FAQ](http://www.poynton.com/ColorFAQ.html)

[Charles Poynton - Video engineering](http://www.poynton.com/Poynton-video-eng.html)

[YCrCb to RGB converter](http://www.dvd-replica.com/DVD/colorrgb2.php)

[Color Space Visualization](http://www.couleur.org/index.php?page=transformations#YCbCr)

[PC Magazine Encyclopedia: YCbCr](http://www.pcmag.com/encyclopedia_term/0,2542,t=YCbCr&i=55147,00.asp)

[Color formats](http://www.equasys.de/colorformat.html) for image and video processing - [Color conversion](http://www.equasys.de/colorconversion.html) between RGB, YUV, YCbCr and YPbPr.