# RGB2YCrCb & YCrCb2RGB Color Space Converter MegaCore Functions

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**Target Applications:**
Digital Signal Processing

**Family**: FLEX 10K & FLEX 8000

**Vendor**:

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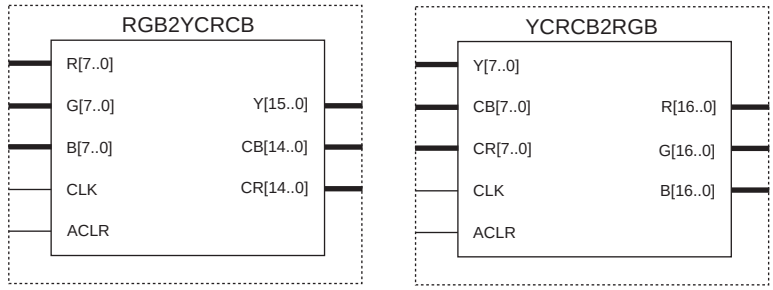
## Features

- Optimized for the Altera® FLEX® 10K and FLEX 8000 device architectures
- 24-bit RGB2YCrCb and YCrCb2RGB color space conversion
- High-speed operation (100 MHz)
- Full precision outputs: rounding and saturation can be performed with the `round` and `saturate` reference designs
- Useful for a variety of applications, including image filtering, machine vision, and digital video

## General Description

The `RGB2YCrCb` and `YCrCb2RGB` color space converter MegaCore™ functions convert digital video colors to television broadcast signal colors and vice-versa. The functions are useful for a number of image processing and filtering operations. The `RGB2YCrCb` function converts red-green-blue (RGB) color space to the YCrCb (intensity-color red-color blue) color space; the `YCrCb2RGB` function performs the inverse operation. Figure 1 shows the symbols for the `RBG2YCrCb` and `YCrCb2RGB` functions.

***Figure 1. RGB2YCrCb & YCrCb2RGB Symbols***




## Functional Description

The `RGB2YCrCb` function uses the following equations when converting gamma-corrected RGB data to YCrCb data:

$$Y' = 0.257R' + 0.504G' + 0.098B' + 16$$
$$Cr = 0.439R' - 0.368G' - 0.071B' + 128$$
$$Cb = -0.148R' - 0.291G' + 0.439B' + 128$$

The `YCrCb2RGB` function uses the following equations when converting YCrCb data to RGB data:

$$R' = 1.164(Y' - 16) + 1.596(Cr - 128)$$
$$G' = 1.164(Y' - 16) - 0.813(Cr - 128) - 0.392(Cb - 128)$$
$$B' = 1.164(Y' - 16) + 2.017(Cb - 128)$$

Because the inputs are multiplied by constant values, the look-up table (LUT) architecture of FLEX 10K and FLEX 8000 devices is ideal for efficiently performing the conversion equations.

For more information on the RGB2YCrCb and YCrCb2RGB functions, refer to the *RGB2YCrCb & YCrCb2RGB Color Space Converters Data Sheet*.

## Performance

Table 1 describes the device utilization and maximum clock frequency results for the RGB2YCrCb and YCrCb2RGB MegaCore functions.

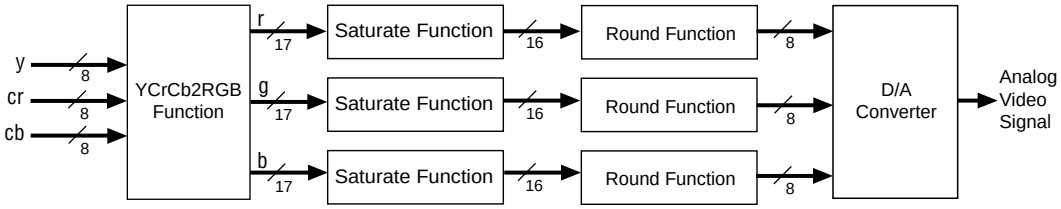
*Table 1. Typical Device Utilization for the RGB2YCrCb & YCrCb2RGB MegaCore Functions*

| Function | Clock ($f_{MAX}$) | Logic Cells |
|---|---|---|
| RGB2YCrCb | 100 MHz | 380 |
| YCrCb2RGB | 100 MHz | 247 |

## Digital Video System Application

Figure 2 shows a simplified illustration of an 8-bit color channel in a digital video system. In this example, color space conversion is performed using the YCrCb2RGB function. Depending on the input values to the YCrCb2RGB function, the multiplication used in the color conversion may result in 17-bit data words that roll over. To avoid data word roll over, the 17-bit digital video signals are fed to the saturate function, where they are saturated to 16-bit words. The signals are then fed to the round function, where they are rounded to 8-bit words. At this point, the data words are ready for conversion to an analog video signal.

*Figure 2. Digital Video Channel*




For more information on data word roll over and saturating, refer to *Functional Specification 6 (saturate Data Word Saturator)*; for more information on rounding, refer to *Functional Specification 5 (round Data Word Rounder)*.

## References

Jack, Keith. ***Video Demystified, A Handbook for the Digital Engineer***. Second Edition. Solana Beach: Hightext Publications, 1996.

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