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# Color Space Conversions Between RGB and $YC_BC_R$ Using IPM16

## Introduction

The IPM16 is a systolic image processing array capable of performing various operations on digital video and digital images. This application note describes how an IPM16 is capable of various color space conversions. As an example, conversions between RGB and $YC_BC_R$ using a IPM16 is described in this application note. Adjustments for alpha channel during the conversion is also discussed.

## Overview

In the input interface, an incoming 4:4:4:4 stream is preprocessed to the IPM16 internal data format for optimal implementation. Timing signals are used as internal reference and will be re-equalized with converted data at the output interface. The 4:4:4:4 RGB data is processed with a preloaded color matrix. The gain and offset for alpha channel is computed in the color space converter as well. The optimal design of the color space converter will be discussed in this application note. A conversion from RGB to $YC_BC_R$ is shown in Figure 2 on the back. The reverse process is designed in a similar method.

## Converter Efficiency

The routing in the IPM16 is designed for a high efficiency implementation of the color space conversion function. Processed data can be sent back to the processing array for further computations. As shown in Figure 2 on the back, the result Y is fed into a single arithmetic unit to obtain both $C_B$ and $C_R$.

Besides routing efficiency, the IPM16 can also process data at twice the pixel clock rate. The time-division multiplexed $C_B$ and $C_R$ data is computed on even and odd phases of a pixel clock in a single arithmetic unit. The time-division multiplexed Y and alpha is processed on even and odd phases as well.

## Gain/Offset for the Alpha Channel

The ability to adjust the gain and offset of the alpha channel is provided as an option when configuring the IPM16. These adjustments are combined with the color matrix in the processing array and will not affect the color space conversion.

## Block Diagram

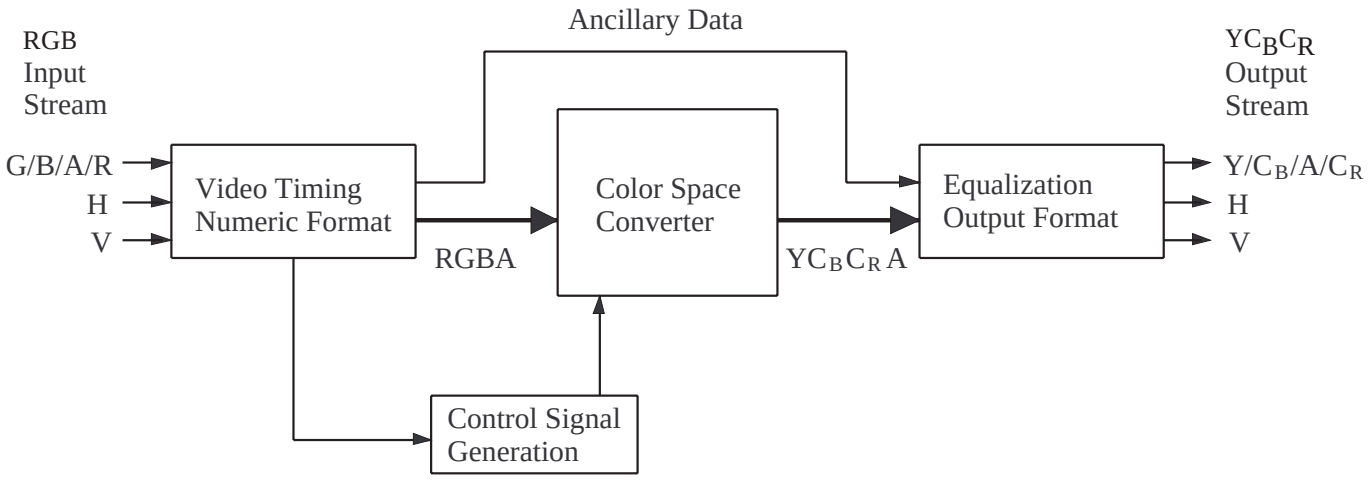


Figure 1: Block Diagram for RGB to $YC_BC_R$

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## $YC_BC_R$ to RGB Conversion

The configuration of the IPM16 for $YC_BC_R$ to RGB conversion is similar to Figure 2 to the right. The optimal design in this case also allows the alpha channel to be processed with the same efficiency. Treatment for illegal values is included in the design.

## I/O Streams

The 4:4:4:4 time-division multiplexed data arrives at the input interface every 1x pixel clock. Each component, in the order of G, B, A, and R, can be time-division multiplexed onto a single data stream. Every internal data stream carries two components alternately at either phase of a pixel clock for 2x processing. The output is a 4:4:4:4 time-division multiplexed signal from the two color converted data streams.

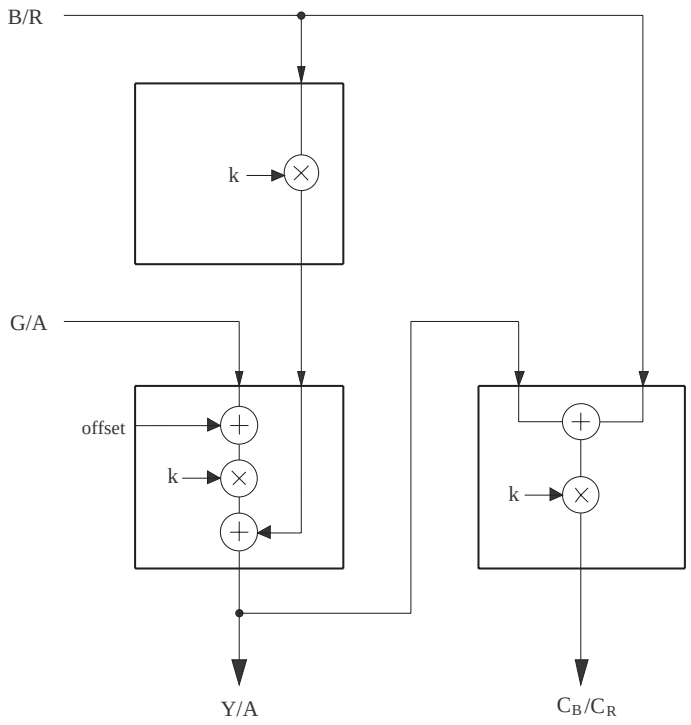


Figure 2: Color space converter – time-division multiplexed

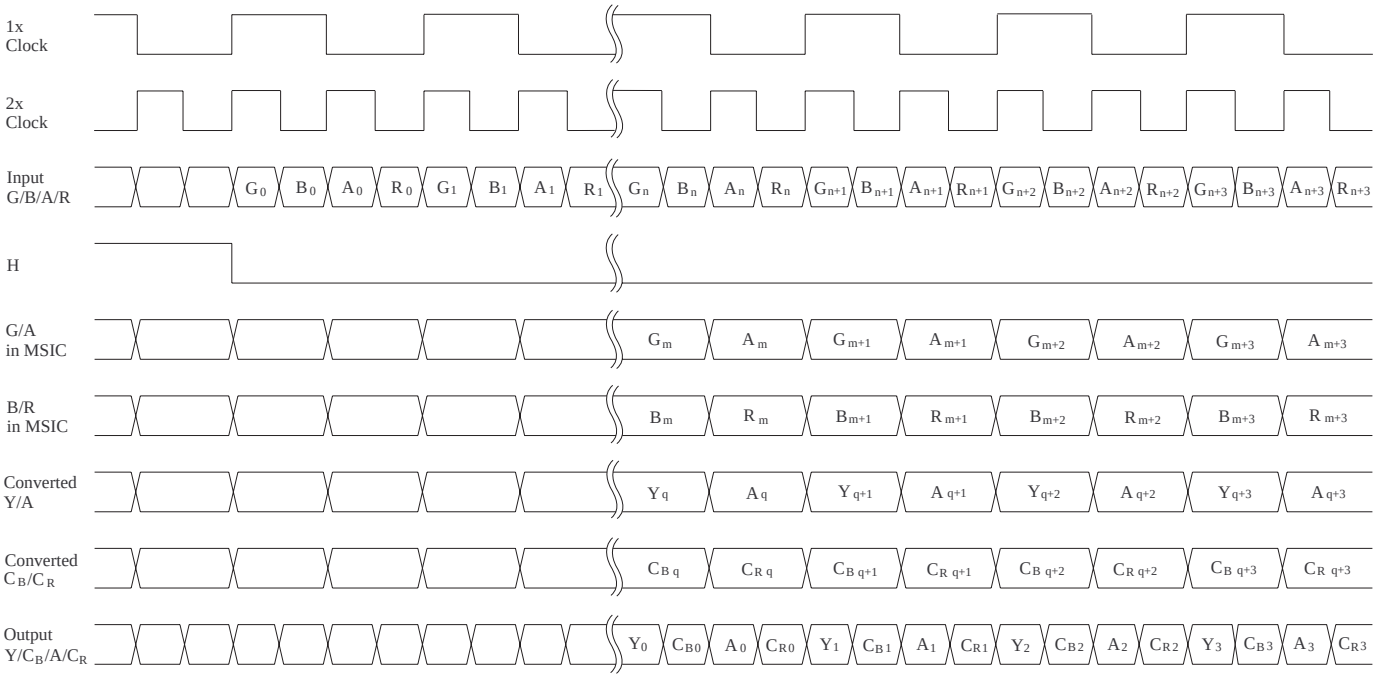


Figure 3: Data streams and control signals in the filtering process

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