ENGR 3410: Miniproject 2
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This project designs a digital circuit using SystemVerilog to control an RGB LED on the iceBlinkPico board. The circuit uses a 12 MHz clock, and by calculating a step interval (which is the clock frequency divided by 360), it updates the hue by one degree every 33,333 clock cycles. This means that in just one second, the LED cycles through all 360 degrees of the HSV color wheel, creating a smooth and continuous transition through the spectrum. The hue value resets to zero after reaching 359 degrees, ensuring a seamless loop without any abrupt jumps in color.

The design calculates the brightness levels for the red, green, and blue components by dividing the hue into six segments, each covering 60 degrees. For each segment, the circuit adjusts the duty cycle values that determine how long each LED is on during each PWM cycle. An 8-bit counter runs continuously to generate these PWM signals by comparing its value with the computed duty cycles, which effectively controls the brightness of each color. This counter increments on every clock cycle, ensuring that the PWM signals operate at a high enough frequency to avoid visible flickering.

To verify the design, a SystemVerilog testbench was created. The testbench generates a clock signal that mimics the 12 MHz clock and captures the behavior of the circuit over one full second, which is enough time to see a complete cycle through all hues. A waveform dump is generated so that the results can be viewed using GTKWave, confirming that the RGB values change smoothly and correctly over time. Additionally, the testbench records the transitions of the RGB signals to verify that the duty cycles update consistently as the hue progresses, ensuring accurate color blending.

The GTKWave analog step plot shown below demonstrates the smooth transition of RGB signal components over one complete color cycle (1 second). The PWM output waveforms reveal how each color channel gradually increases and decreases in intensity, forming the characteristic HSV-to-RGB transitions. The plot also highlights the correct timing of hue updates, showing that the circuit maintains a precise step interval to complete a full rotation in exactly one second. Overall, the results confirm that the circuit successfully implements smooth color cycling using a structured combination of counters, combinational logic, and PWM control.

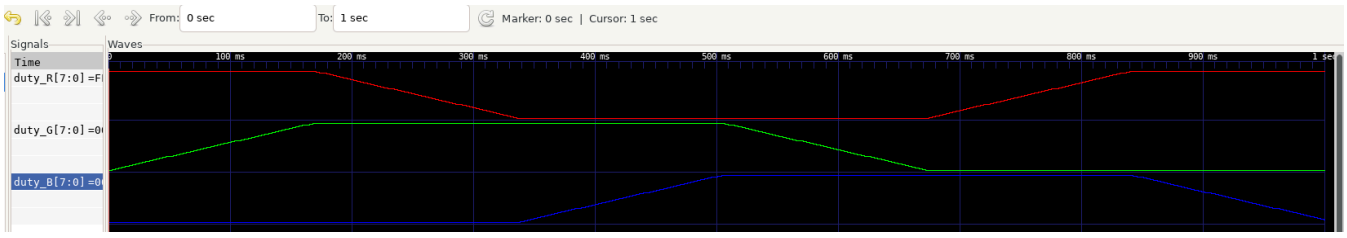

Figure 1: GTKWave screenshot displaying the simulation of Miniproject 2 RGB signal components over one full color cycle (1 second).