ASSIGNMENT REPORT : PULSE WIDTH MODULATION GENERATOR

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ASSIGNMENT AGENDA

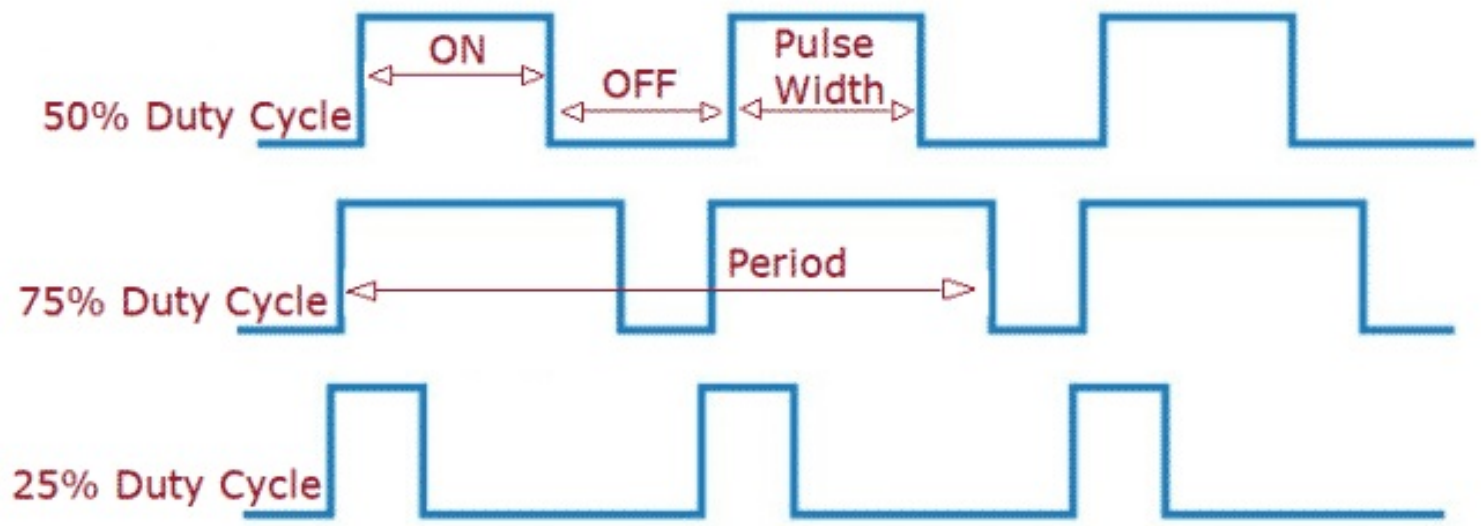
1. Definition
   - What is Pulse Width Modulation Generator¿
   - Duty cycle
   - Types of Pulse Width Modulation
2. Generation of Pulse Width Modulation Signal
3. Assignment Outcomes and its application
4. Trade off
5. Our Execution (Implementing module and launching Verilog code)

Definition of Pulse Width Modulation Generator

- Pulse modulation is a type of modulation in which the signal is transmitted in the form of pulses. It can be used to transmit analogue information. In pulse modulation, continuous signals are sampled at regular intervals.
- Pulse Width Modulation (PWM) controls analog circuits with a microprocessor's digital outputs.
- By increasing or decreasing pulse width, the energy flow to the motor shaft can be controlled

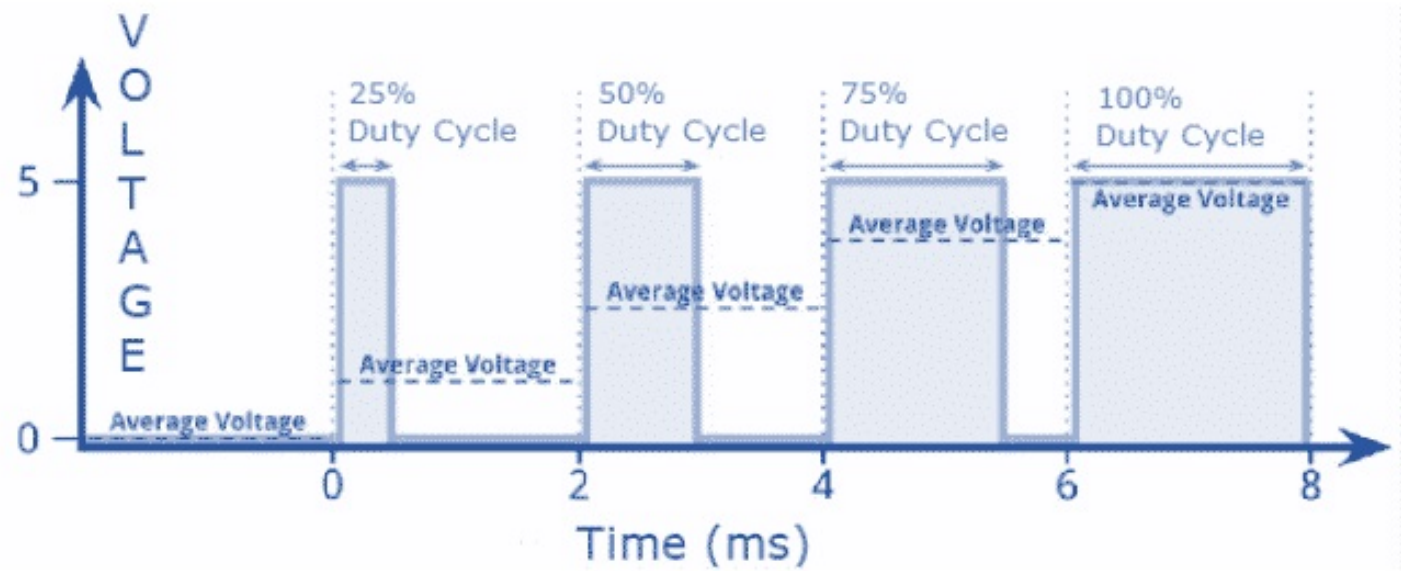
Duty Cycle

- The proportion of time that the pulse is ‘ON’ or ‘High’



Duty Cycle

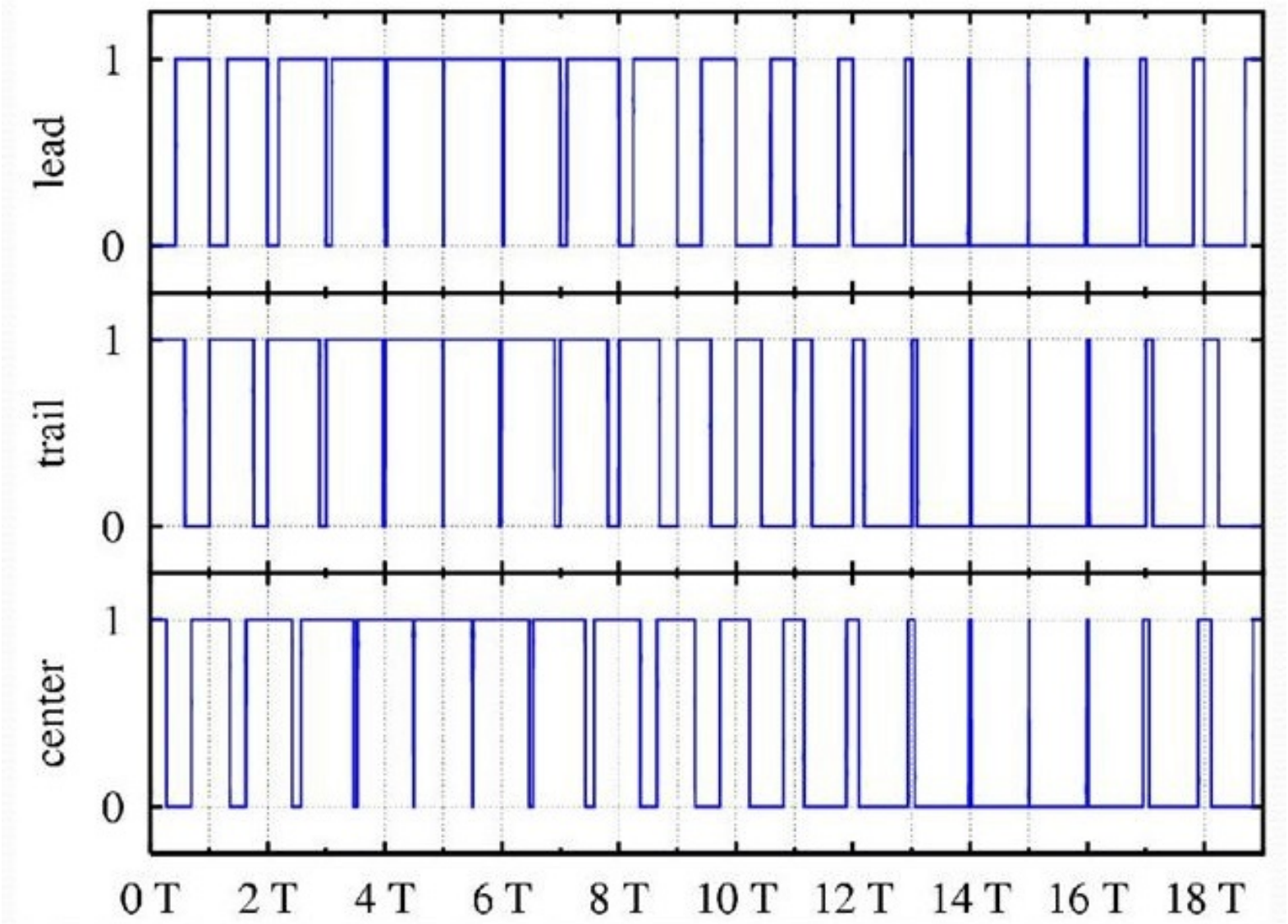
- The 'average' voltage can be controlled by varying the width of the positive pulse.
- By varying or 'modulating' the Time that the output is "ON" we can modify the average voltage.
- The average value depends on the duty cycle



Types of Pulse Width Modulation Techniques

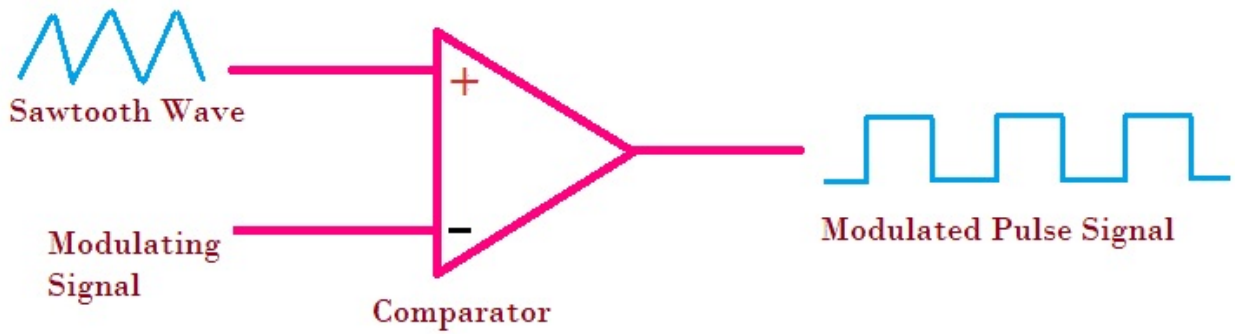
- **Lead Edge Modulation** : the lead edge of the signal is fixed and the trail edge is modulated
- **Trail Edge Modulation** : In this technique, the lead edge of the signal is modulated keeping the trail edge fixed.
- **Pulse Center Two Edge Modulation/Phase Correct PWM** : In this method, the pulse center is fixed and both edges of the pulse is modulated.

Types of Pulse Width Modulation Techniques

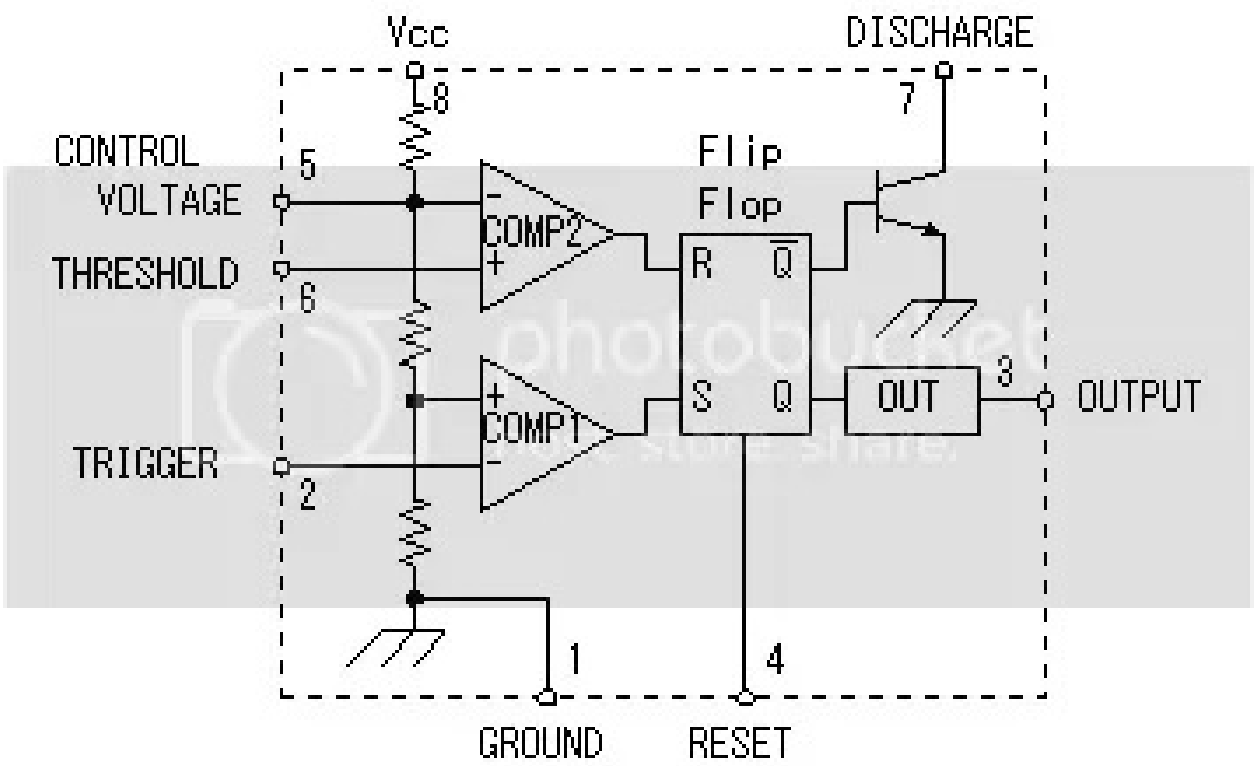


Generation of Pulse Width Modulation Signal- IC555

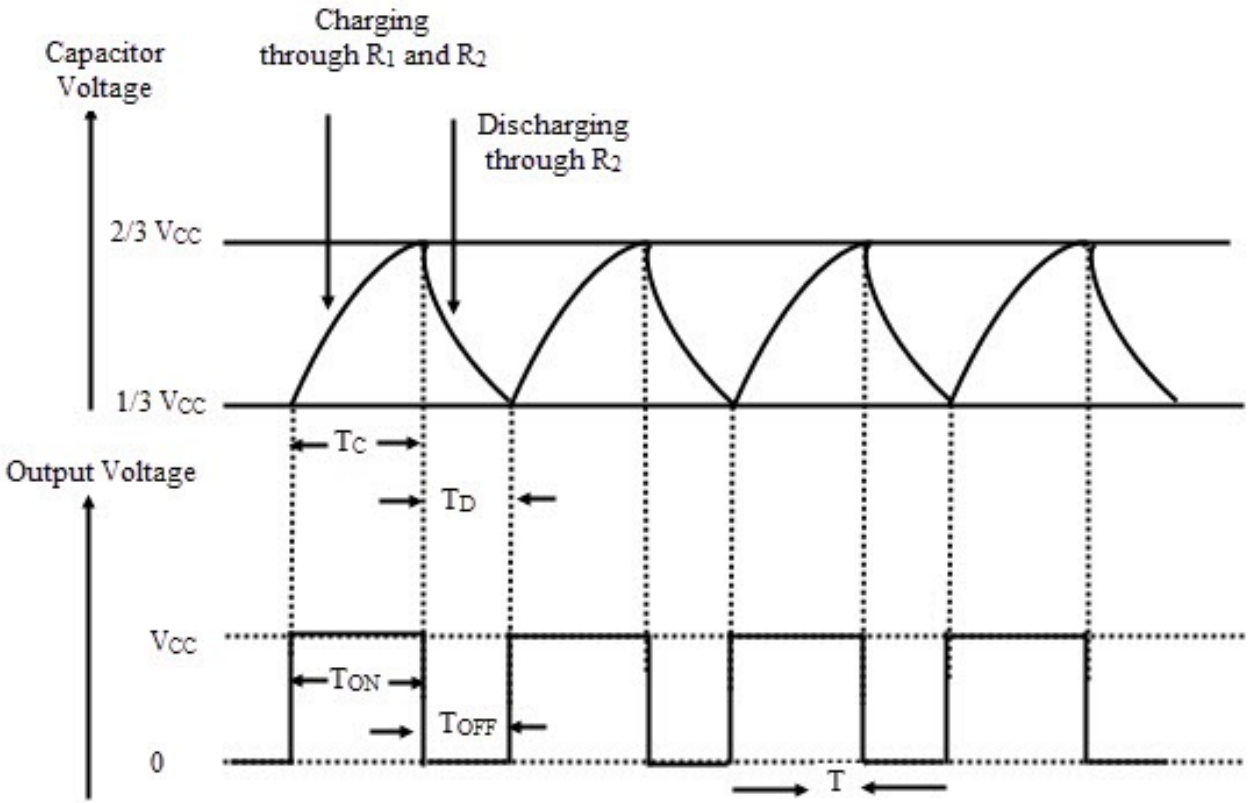
- Pulse Width Modulating signal can be generated using a Comparator
- Modulating signal forms one of the input to the Comparator and the other input is fed with a non-sinusoidal wave or sawtooth wave.
- If the value of the Sawtooth triangle signal is more than the modulation signal then the PWM output signal is at "High" else it's in "Low" state.



Generation of Pulse Width Modulation Signal- IC555



Generation of Pulse Width Modulation Signal- IC555



Assignment Outcomes and its application

- Pulse Width Modulation helps in voltage regulation and thus finds its use in controlling Brightness in Smart Lighting Systems and also controls the speed of motors.
- Computer Motherboard requires PWM Signals that controls the heat generated in the board. 4 Pin PWM header is embedded in the fan that helps to dissipate the heat from the motherboard.
- PWM Techniques are used in Telecommunications for encoding purposes.

Trade off

Advantage:

- PWM technique helps in preventing overheating of LED's while maintaining its brightness.
- provides accuracy and quick response time.
- Initial cost is low.

Disadvantage:

- As the PWM frequency is high, switching losses is considerably high
- It induces Radio Frequency Interference (RFI).

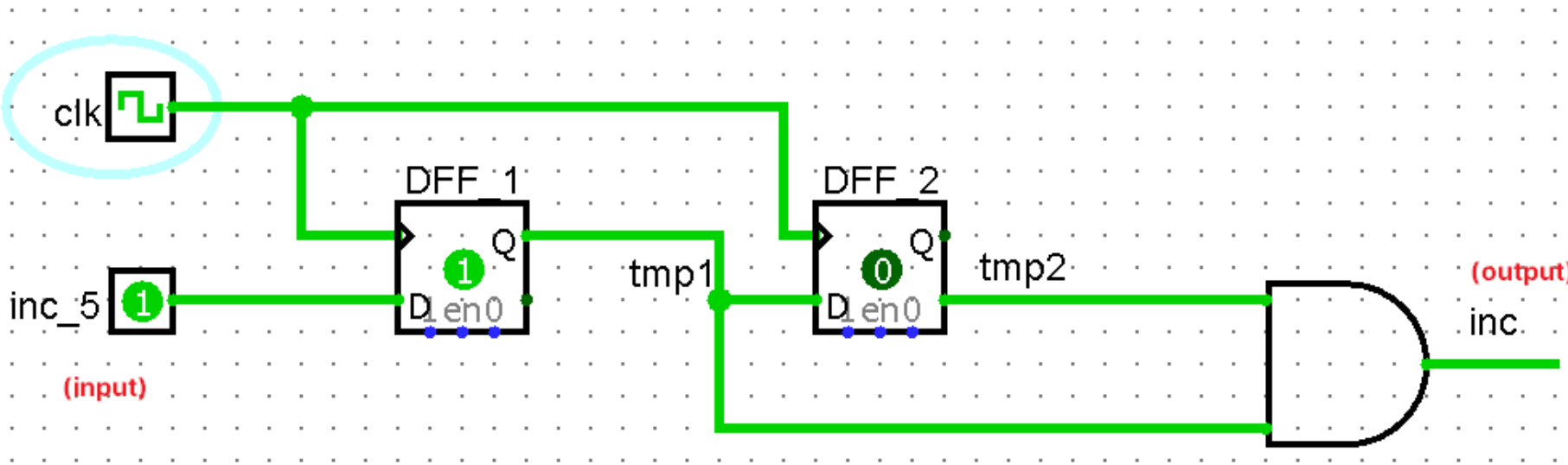
Our Execution: Input/Output

- Input:
  - clk: clock signal
  - inc_5: increase duty cycle by 5%
  - dec_5: decrease duty cycle by 5%
- Output:
  - OUT: output signal with the desired duty cycle
  - out_r (additional): output signal for the color red on RGB LED
  - out_g (additional): output signal for the color green on RGB LED
  - out_b (additional): output signal for the color blue on RGB LED

Debouncing for each button, using 2 D-Flip Flops

clk	inc_5	DFF_1	DFF_2	inc = DFF_1 & !DFF_2	
	0	0	0	0	
rising edge	1	1	0	1	press button
rising edge	1	1	1	0	
rising edge	1	1	1	0	
rising edge	0	0	1	0	release button
rising edge	0	0	0	0	

Button debouncing



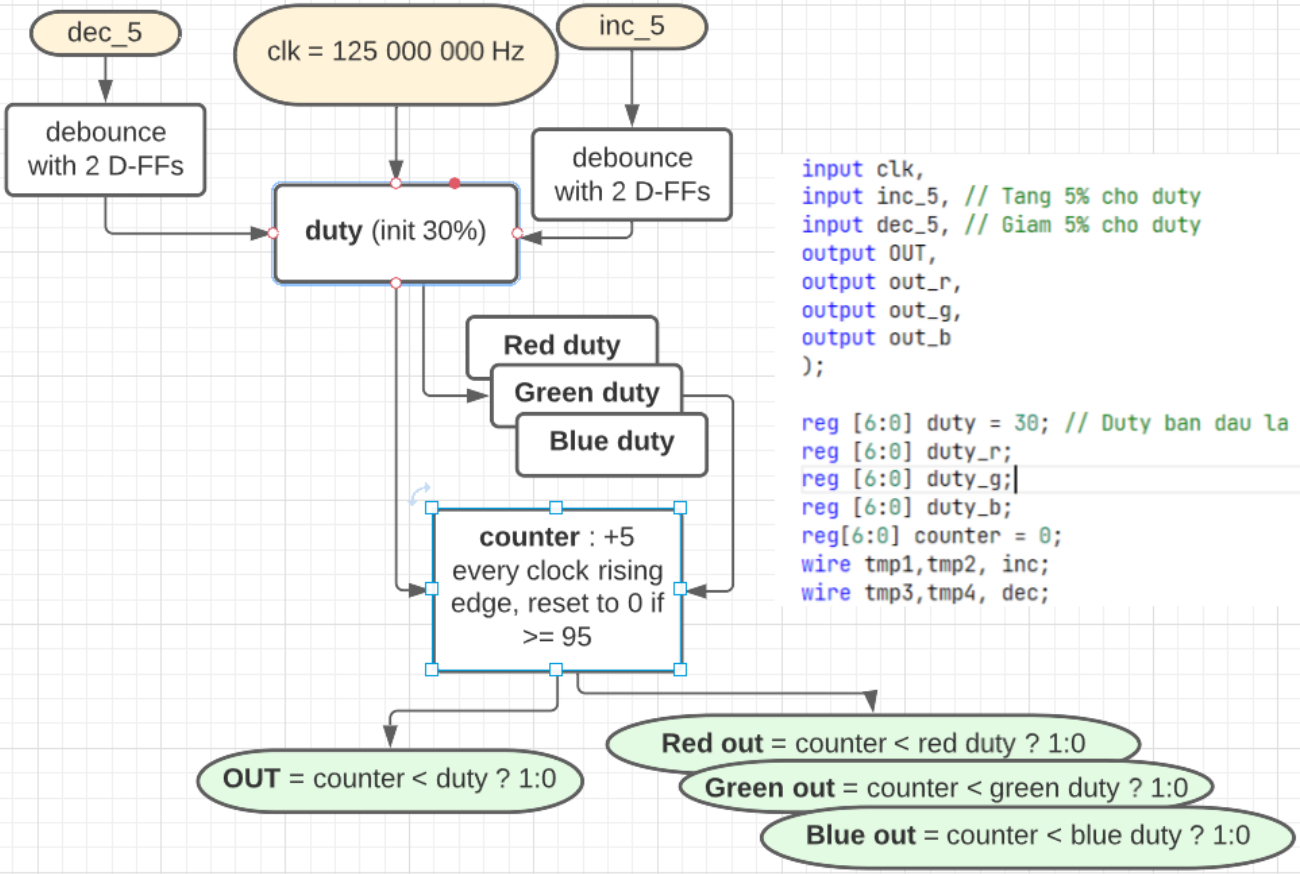
As soon as input changes to 1, output will be updated to state 1 in ONLY ONE clock cycle, then back to state 0, no matter how long the input remains 1 after the update

Our additional feature: RGB LED multi-color display

duty	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
out_r duty	0	100	100	100	100	75	40	0	0	0	0	0	0	0	40	75	100	100	100	100	100
out_g duty	0	0	40	75	100	100	100	100	100	100	100	75	40	0	0	0	0	0	0	0	100
out_b duty	0	0	0	0	0	0	0	0	40	75	100	100	100	100	100	100	100	75	40	0	100
R	0	225	225	225	225	169	90	0	0	0	0	0	0	0	90	169	225	225	225	225	225
G	0	0	90	169	225	225	225	225	225	225	225	169	90	0	0	0	0	0	0	0	225
B	0	0	0	0	0	0	0	0	90	169	225	225	225	225	225	225	225	169	90	0	225
(color)																					

- Associate each OUT signal duty cycle with an unique color

Our Execution: Main design - block diagram




```
input clk,
input inc_5, // Tang 5% cho duty
input dec_5, // Giam 5% cho duty
output OUT,
output out_r,
output out_g,
output out_b
);

reg [6:0] duty = 30; // Duty ban dau la 30%
reg [6:0] duty_r;
reg [6:0] duty_g;
reg [6:0] duty_b;
reg[6:0] counter = 0;
wire tmp1,tmp2, inc;
wire tmp3,tmp4, dec;
```