Traffic Light Controller

CS4362 – Hardware Description Languages

M.D.M.D.P. Gunathilaka

180213F

CONTENT

Problem Statement

The traffic light controller is for an intersection between a Main Street and a Side Street. Both streets have a red, yellow, and green signal light. Pedestrians have the option of pressing a walk button to turn all the traffic lights red and cause a single walk light to illuminate. Lastly, there is a sensor on the Side Street which tells the controller if there are cars still on the Side Street.
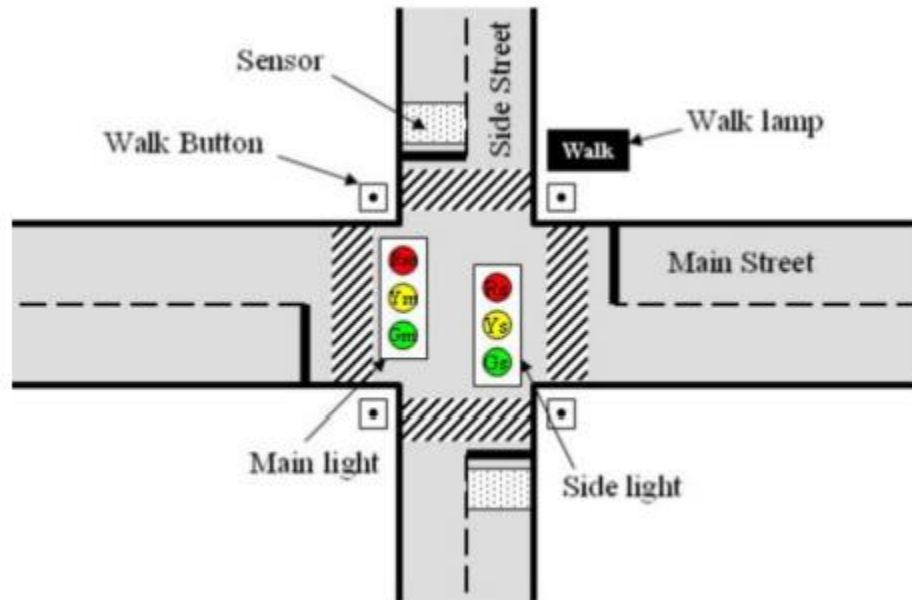
The 4 walk buttons placed at each street corner are hooked into the traffic light controller using a wired OR. Therefore the controller only needs a single input called WalkRequest. The side street sensor is placed near the intersection to tell the controller when there are cars passing over the sensor. The sensor remains constantly high if several cars pass over the sensor, rather than quick pulses, provided the cars are close enough together. This input is named Sensor. The traffic lights are timed on three parameters (in seconds): the base interval (tBASE), the extended interval (tEXT), and the yellow light interval (tYEL). The default values listed in the table below are to be loaded into the FPGA on reset and may be reprogrammed on demand using switches and buttons on your Basys3 board with the Time_Parameter_Selector, Time_Value, and Reprogram signals. Time_Parameter_Selector uses the Parameter Number code to select the interval during programming. Time_Value is a 4bit value representing the value to be programmed; therefore, it has a duration of seconds between 0 and 15. The Reprogram button tells the system to set the currently selected interval to Time_Value.

| Interval Name	Symbol	Parameter Number	Default Time (sec)	Time value
Base Interval	tBase	00	6	0110
Extended Interval	tEXT	01	3	0011
Yellow Interval	tYEL	10	2	0010

The operating sequence

- Main Street having a green light for 2 lengths of tBASE seconds.
- Main lights turn to yellow for tYEL seconds.
- Main light turns red while simultaneously turning on the Side Street green light. Hold this for tBase seconds.
- Whenever a stoplight is green or yellow, the other street's stoplight is red. This cycle repeats continuously.

There are two ways the controller can deviate from the typical loop.

1. A walk button allows pedestrians to submit a walk request. The internal Walk Register should be set on a button press and the controller should service the request after the Main Street yellow light by turning all streetlights to red and the walk light to on. After a walk of tEXT seconds, the traffic lights should return to their usual routine by turning the Side Street green. The Walk Register should be cleared at the end of a walk cycle.
2. If the traffic sensor is high at the end of the first tBASE length of the Main street green, the light should remain green only for an additional tEXT seconds, rather than the full tBASE. Additionally, if the traffic sensor is high during the end of the Side Street green, it should remain green for an additional tEXT seconds.
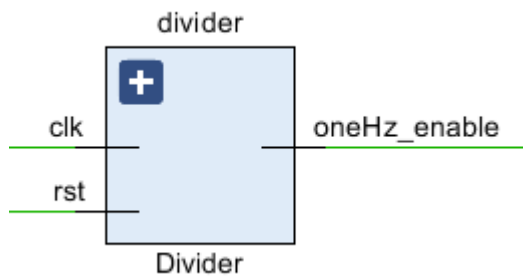
High Level Diagram
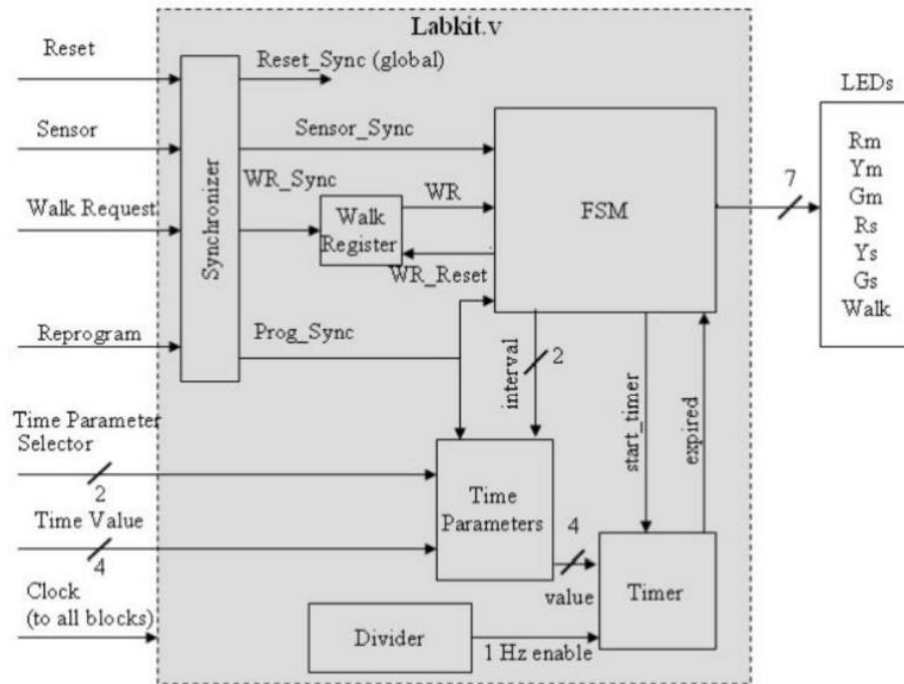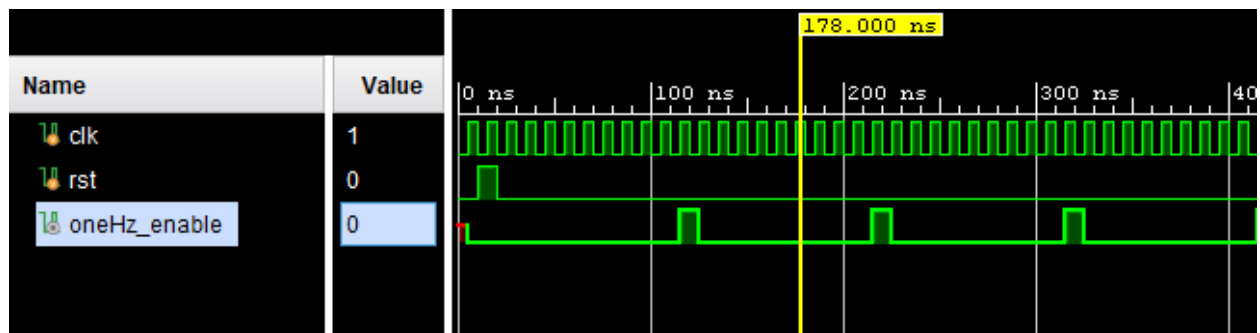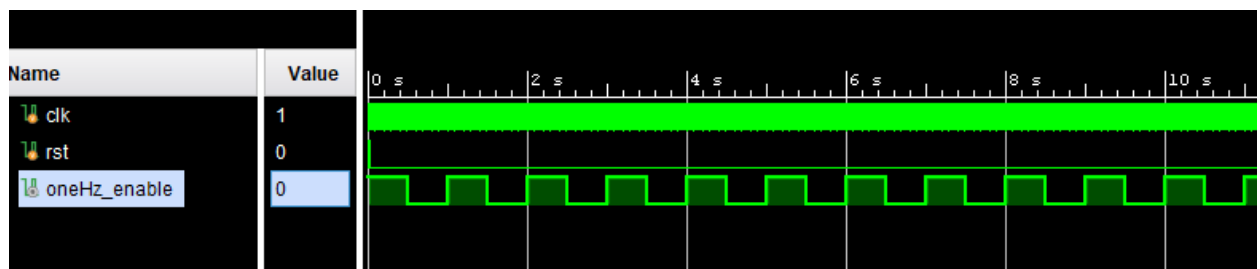

Finite State Machine (Diagram)
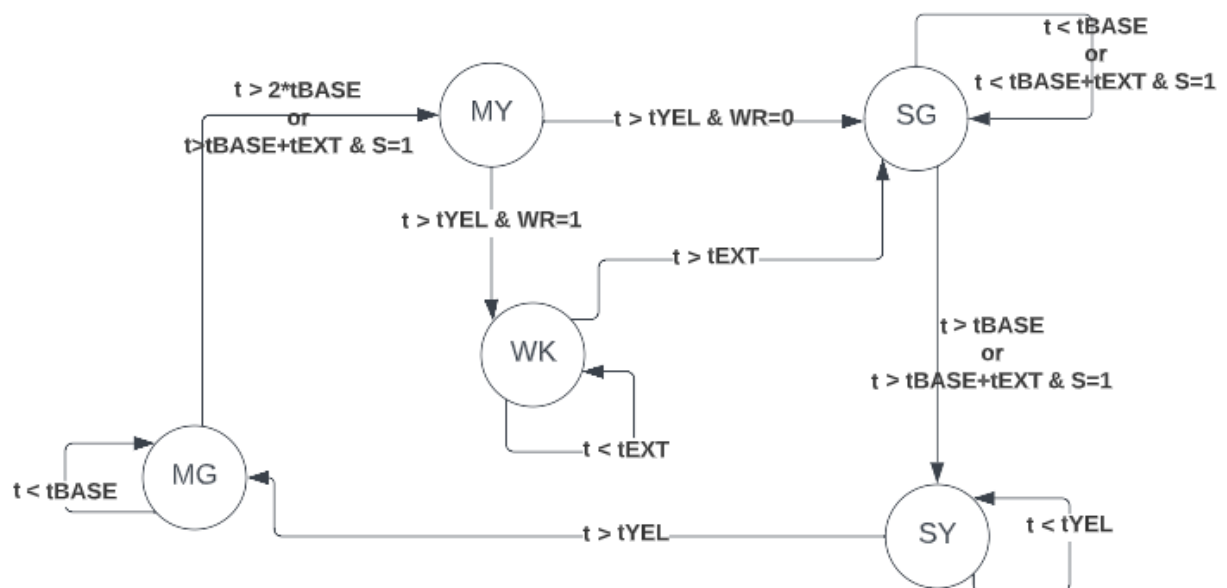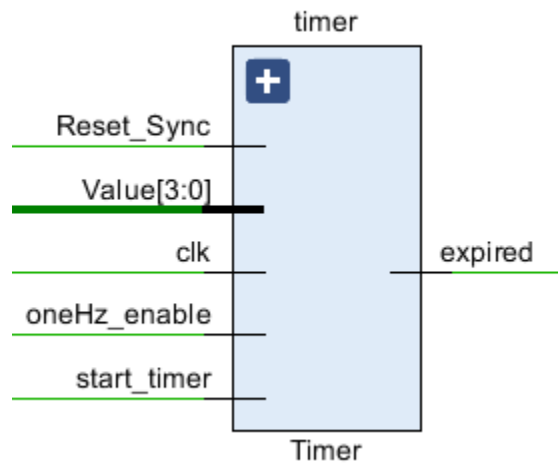
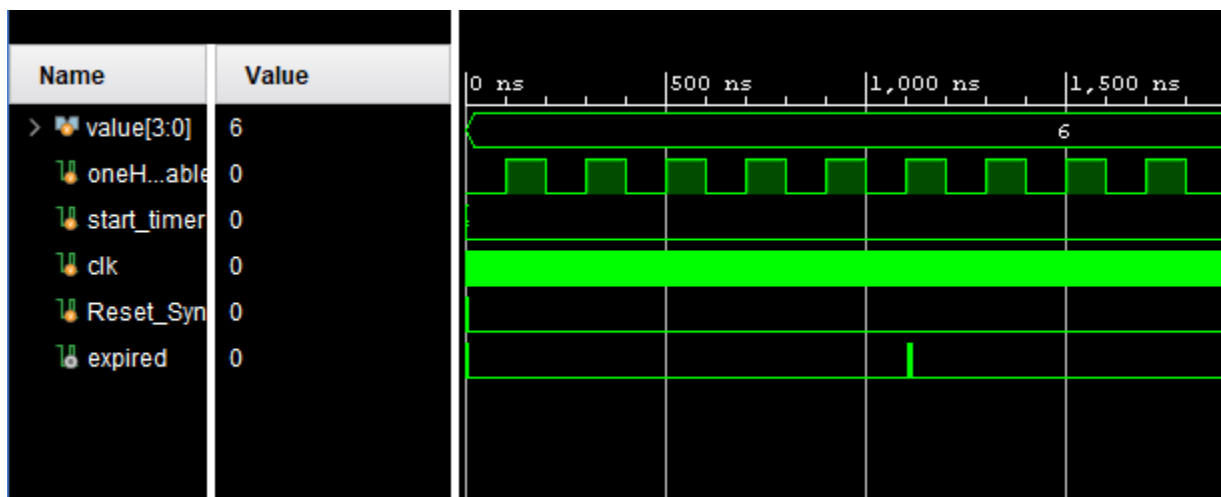# Divider.v

Divider_test.v simulation
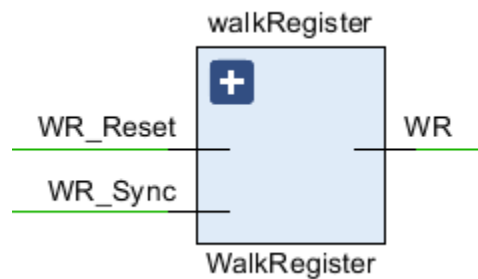
Simulation values

Real values

Timer.v

timer

Reset_Sync
Value[3:0]
clk
oneHz_enable
start_timer

expired

Timer

Timer_test.v simulation

Name	Value	0 ns	500 ns	1,000 ns	1,500 ns
value[3:0]	6			6	
oneH...able	0				
start_timer	0				
clk	0				
Reset_Syn	0				
expired	0				

WalkRegister.v

walkRegister

WR_Reset
WR_Sync

WR

WalkRegister

WalkRegister_test.v simulation

Synchronizer.v
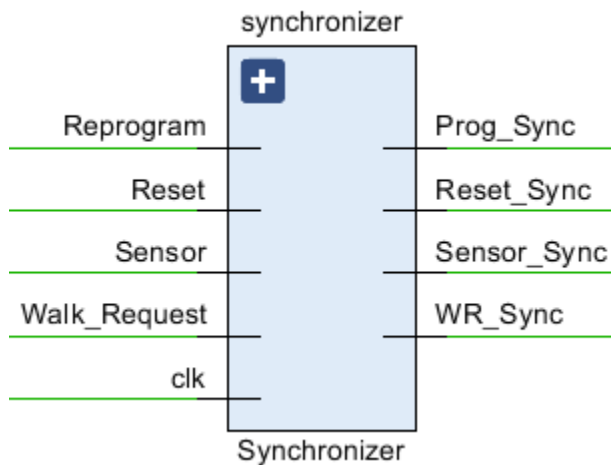
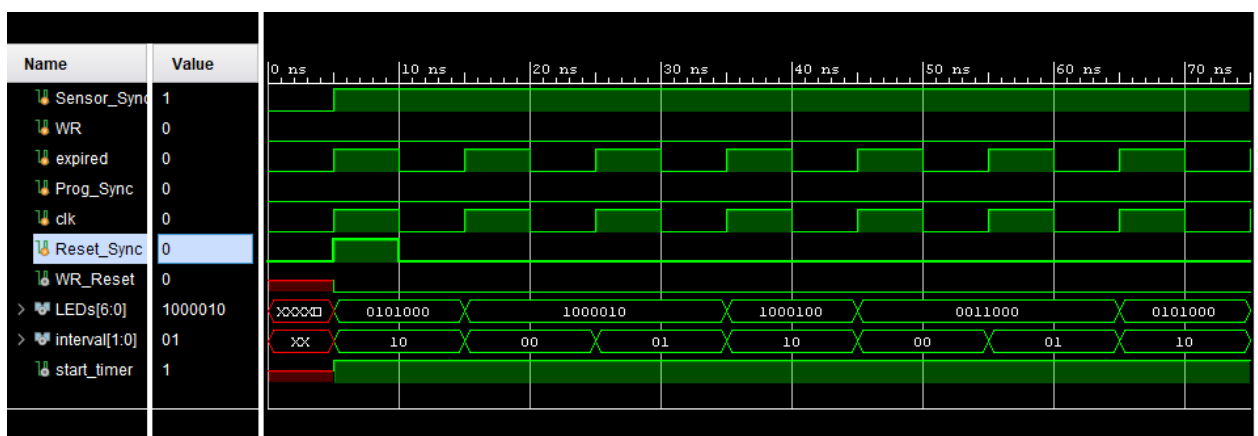## Synchronizer_test.v simulation
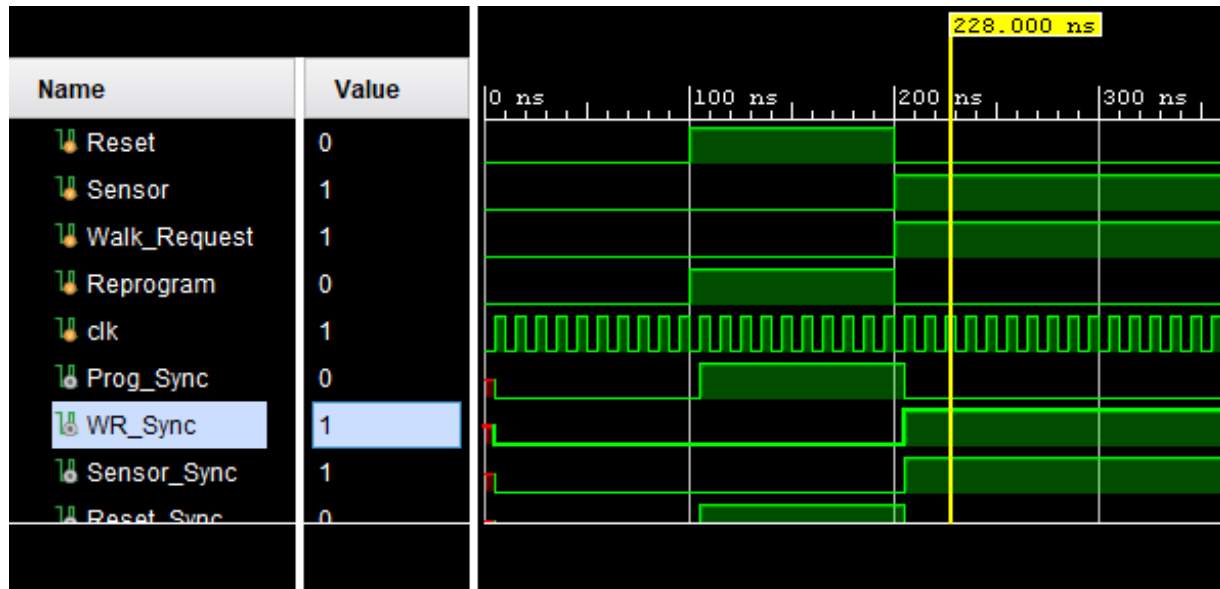
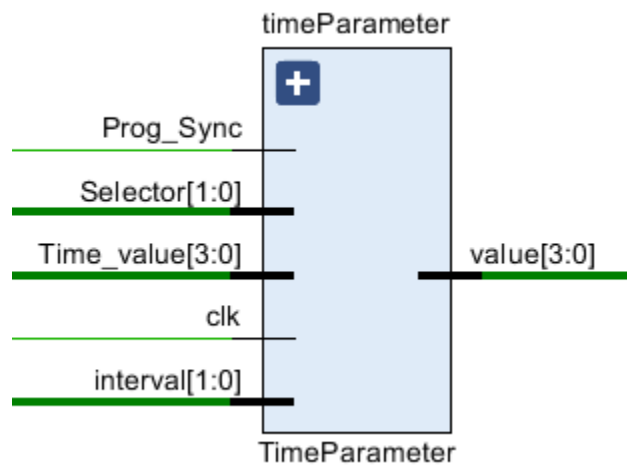

FSM.v
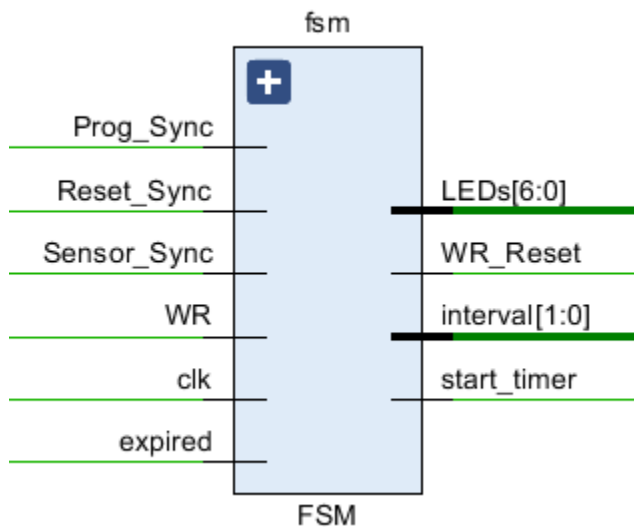
FSM_test.v simulation

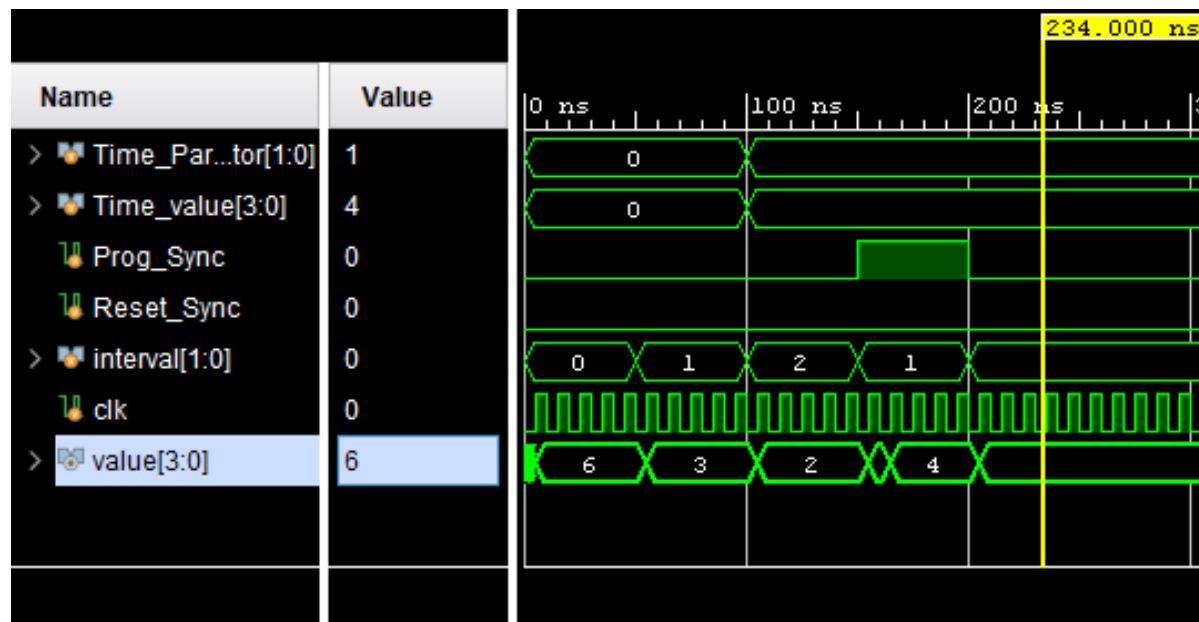## Operating cycle
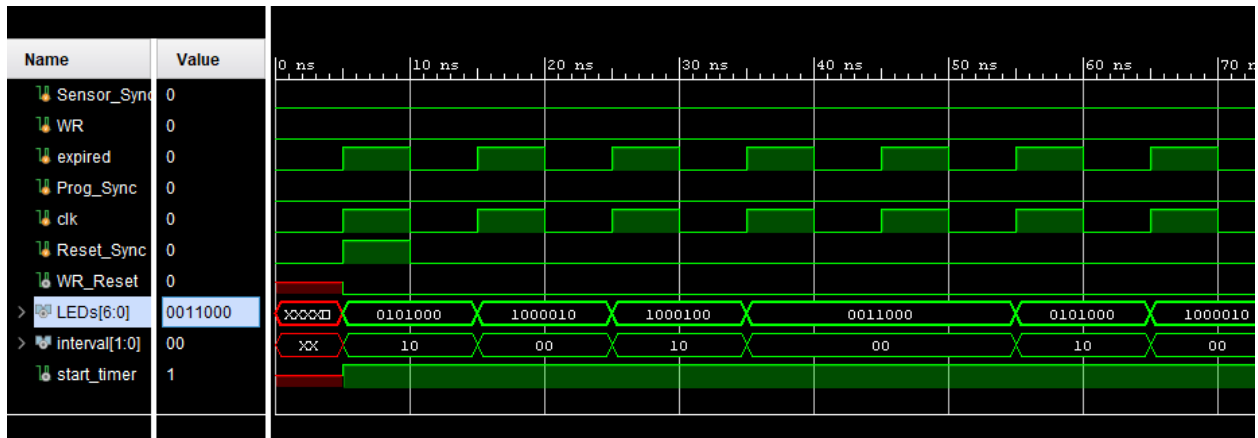
Walk Request
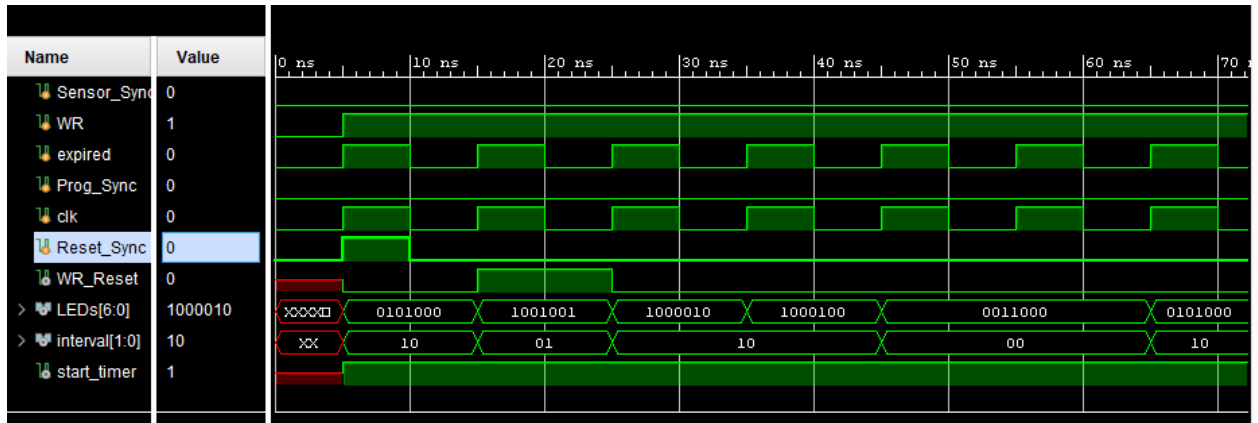
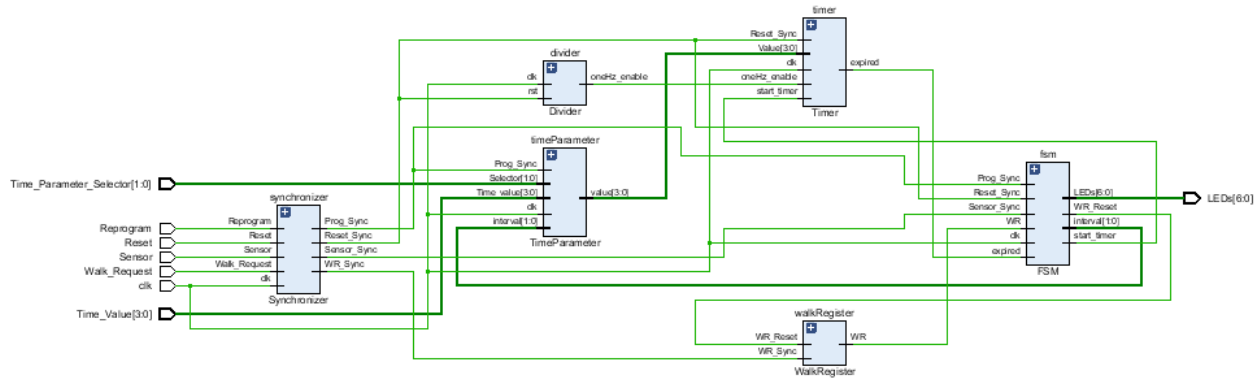

Traffic Sensor

TimeParameter.v

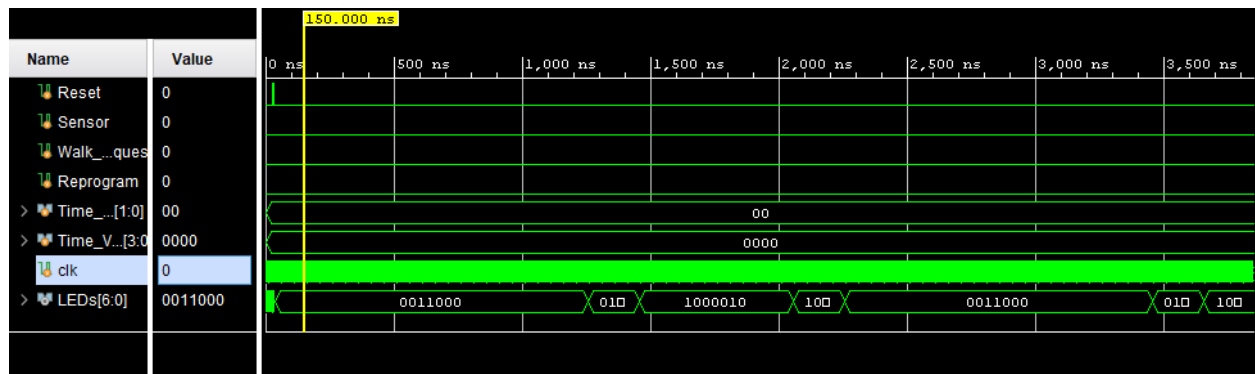## TimeParameter_test.v simulation

Labkit.v (Top Module)

This is defined as the top module which consists of all other components. Outputs a 7bit vector representing the 7 LEDs.
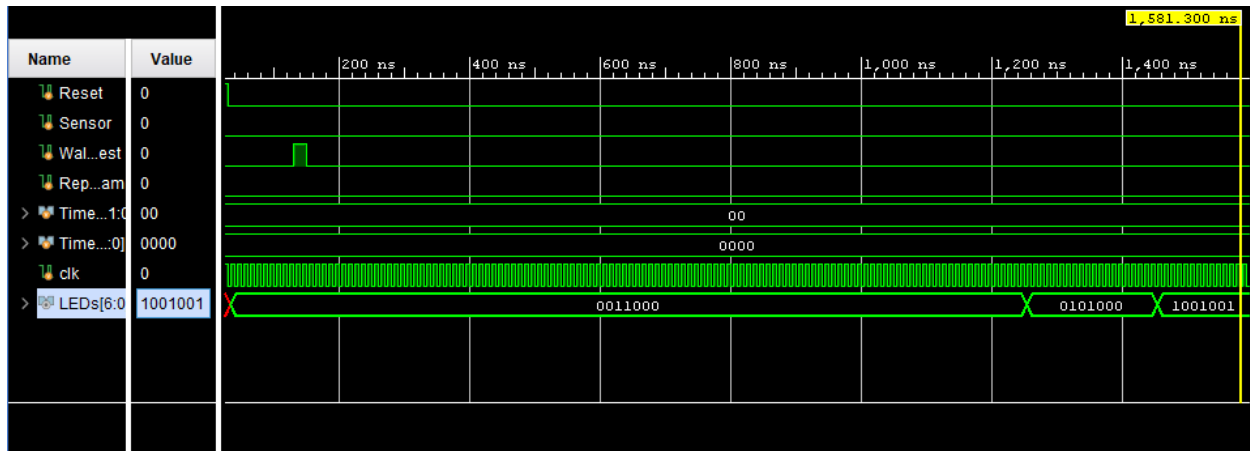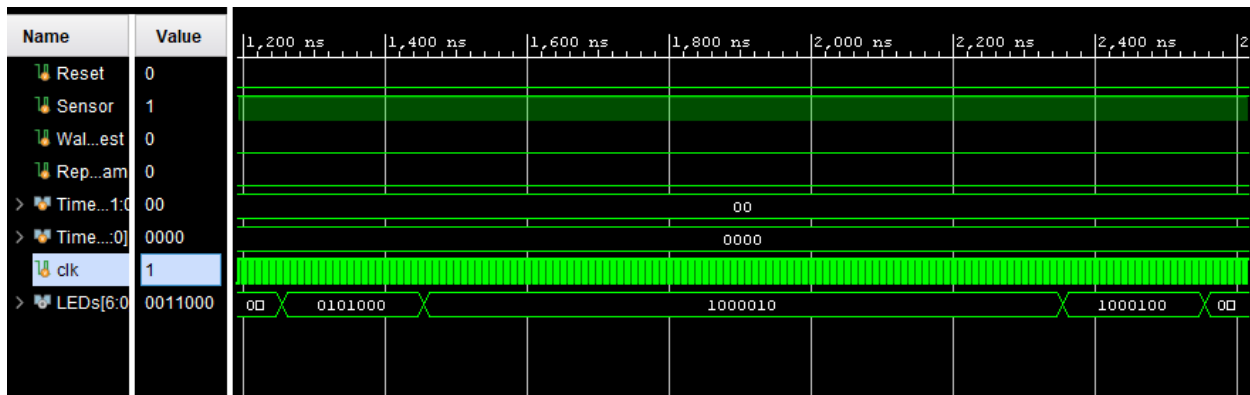

Labkit_test.v simulation

Operating Cycle

Walk Request

Traffic Sensor

Project GitHub Link: https://github.com/mdgunathilaka/TrafficLightController