RTL_EXERCISE_1 BOUND FLASHER

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Date	2024/03/26
Version	1.1

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RTL_Exercise1 Bound Flasher

Contents

1. Interface

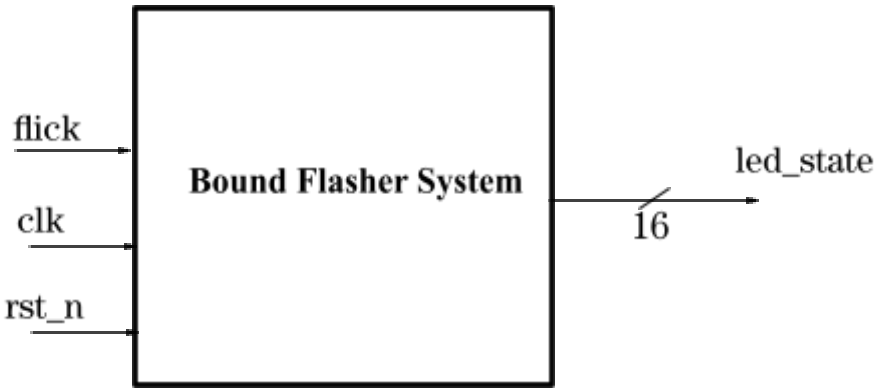


Figure 1: the figure of Bound Flasher System

Signal	Width	In/Out	Description
flick	1	In	Compare signal
clk	1	In	Clock of system
rst_n	1	In	Negative reset of system
led_state	16	Out	16bit LED’s state

Table 1: Description of signals in Bound Flasher

2. Functional implementation.

- Implement a 16-bits LEDs system

- System's Operation base on three input signal

    - Reset
    - Clock
    - Flick

- The system specification

    - Clock signal is provided for system inspire of function status. The function operate state's transition at positive edge of the clock signal.
    - Reset signal:
        - LOW-ACTIVE Reset = 0: System is restarted to Initial State.
        - HIGH-ACTIVE Reset = 1: System is started with initial state.

- Flick signal: special input for controlling state transfer.

- At the initial state, all lamps are OFF. If flick signal is ACTIVE, the flasher start operating:

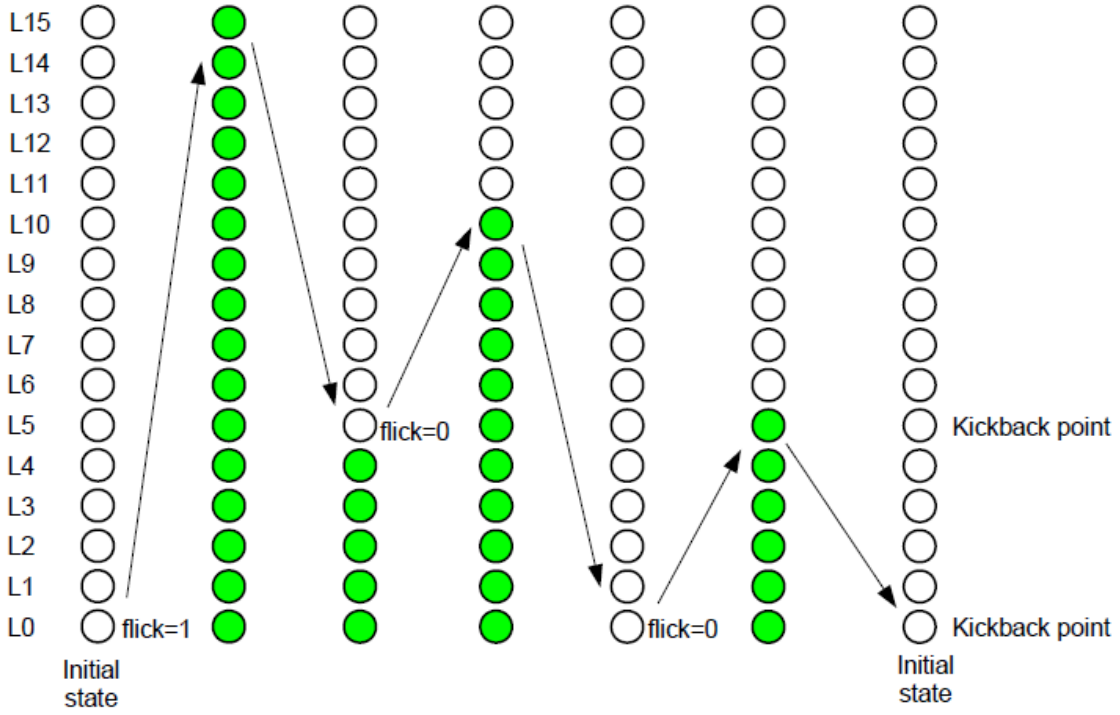
    - The lamps are turned ON gradually from LEDs [0] to LEDs [15].
    - The LEDSs are turned OFF gradually from LEDs [15] to LEDs [5].
    - The LEDSs are turned ON gradually from LEDs [5] to LEDs [10].
    - The LEDSs are turned OFF gradually from LEDs [10] to LEDs [0].
    - The LEDSs are turned ON gradually from LEDs [0] to LEDs [5].
    - Finally, the LEDs s are turned OFF gradually from LEDSs [5] to LEDSs [0], return to initial state.

- Additional condition: At each kickback point (LEDs [5] and LEDs [0]), if flick signal is

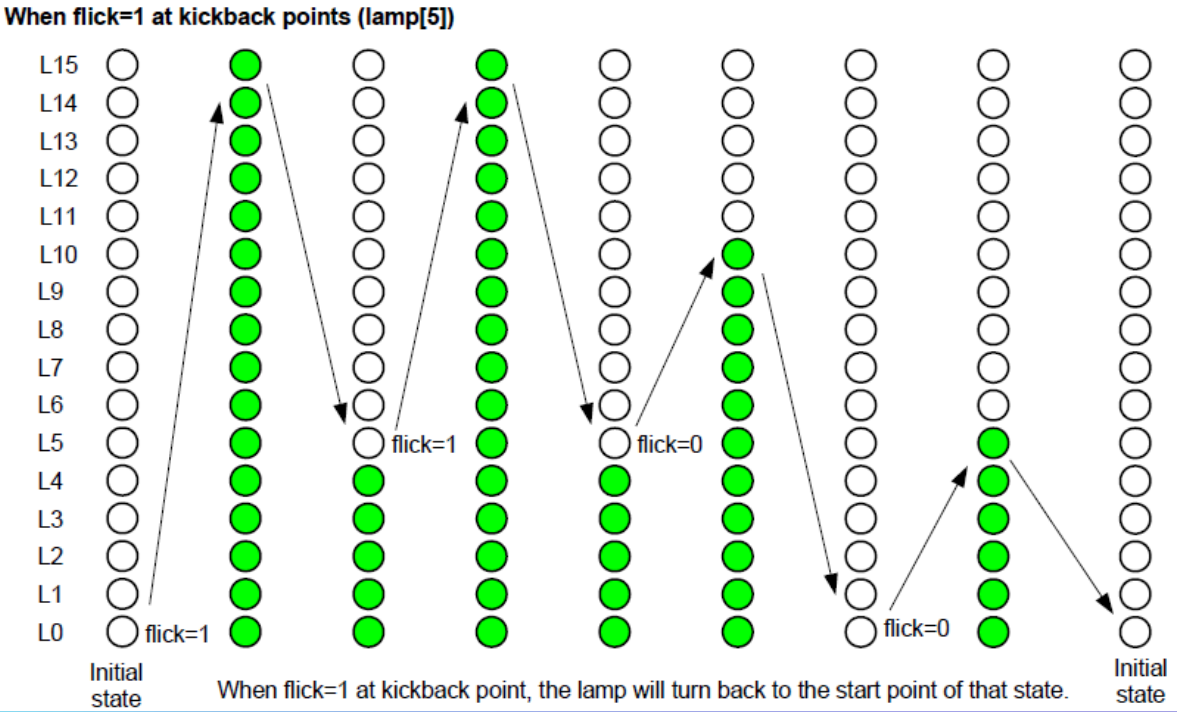
  ACTIVE, the LEDs will go back and repeat that STATE. For simple, kickback point is considered only when the LEDs s are turned OFF gradually, except final state.

- Some insulations:

  - When flick = 0 at kickback points



  - When flick = 1 at kickback points (lamp[5])



3. Internal implementation.

3.1. Overall.

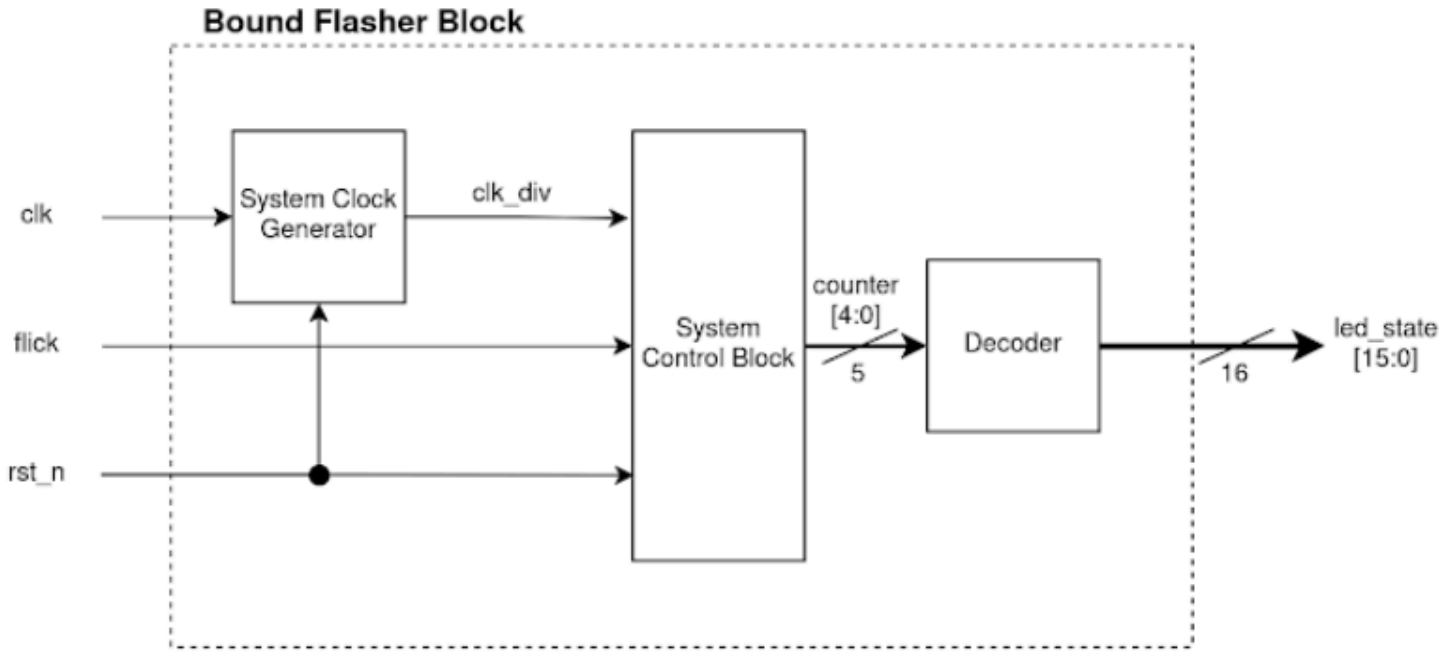


Figure 3.1.1:General block diagram of Bound Flasher

Name	Width	Type	Description
clk	1	Input	System Clock Source
rst_n	1	Input	System Negative Reset
flick	1	Input	Compare Signal
led_state	16	Output	16 LED's state
clk_div	1	Wire	Divided Clock
counter	5	Wire	The counter for the remaining 16-bit LED.
System Clock Generator	0	Module	Generate clock for system
System Control Block	0	Module	Generates control signals and contains state machine of system
Decoder	0	Module	Decode 5-bit counter to 16-bit LEDs

Table 3.1.1: Block diagram of Bound Flasher Description

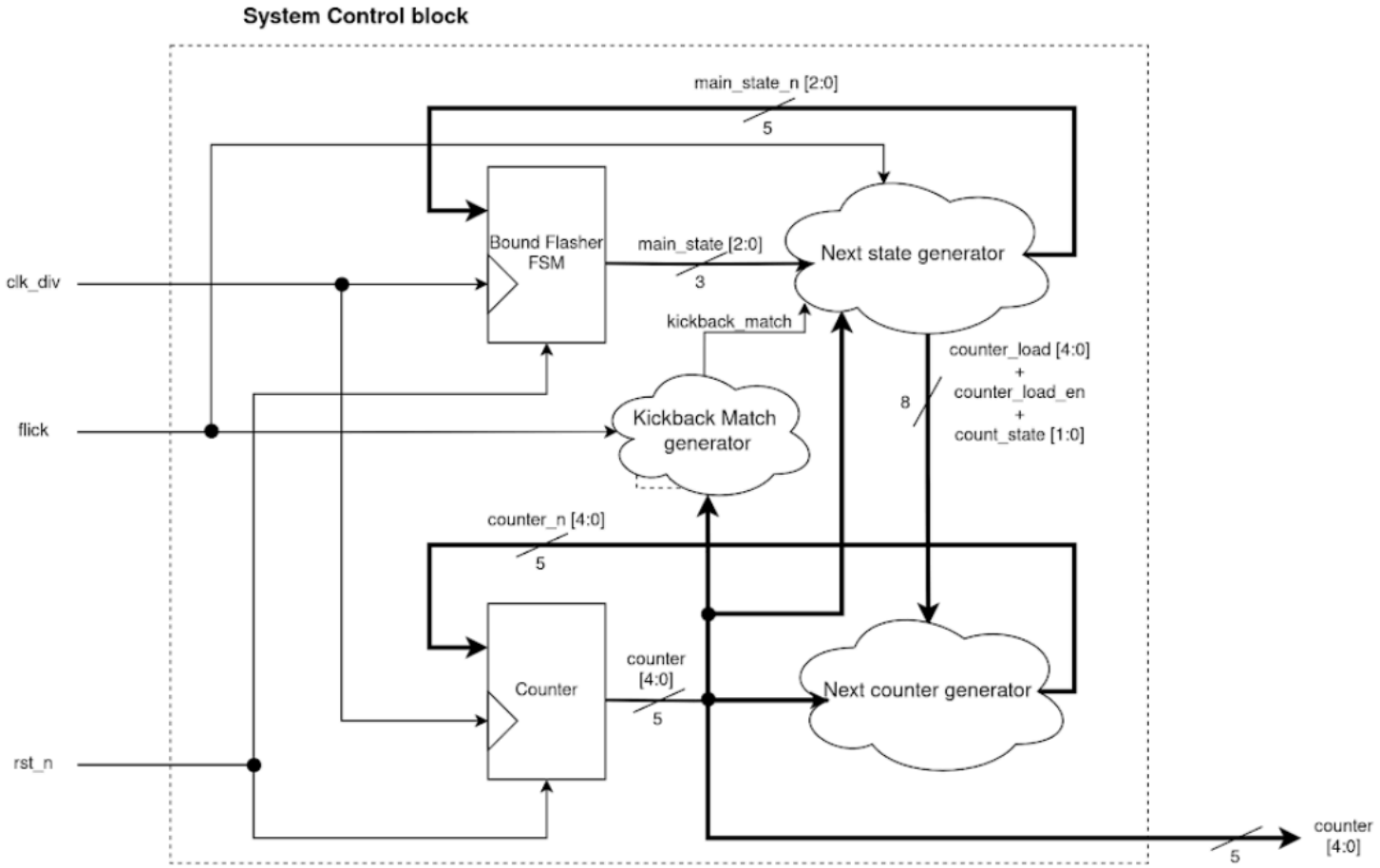


Figure 3.1.2: System Control Block diagram

Signal	Width	Type	Description
clk_div	1	Input	Divided Clock
rst_n	1	Input	System Negative Reset
flick	1	Input	Compare Signal
counter	16	Output	The counter for the remaining 16-bit LED.
main_state	3	Wire	Current main state
main_state_n	3	Wire	Next main state
kickback_match	1	Wire	Kickback matching
count_state	2	Wire	Current counter's state (Disable/Up/Down)
counter_n	5	Wire	Next counter for 16bit LED
counter_load	5	Wire	Load next state of counter (special case)
counter_load_en	1	Wire	Enable Load next state of counter (special state)

Bound Flasher FSM	0	Sequential Module	Contains main state register
Counter	0	Sequential Module	Contains counter register
Next state generator	0	Combination Module	Generate next main state and control signal of counter
Next counter generator	0	Combination Module	Generate next counter
Kickback match generator	0	Combination Module	Kickback detector

Table 3.1.2: System Control Block Description

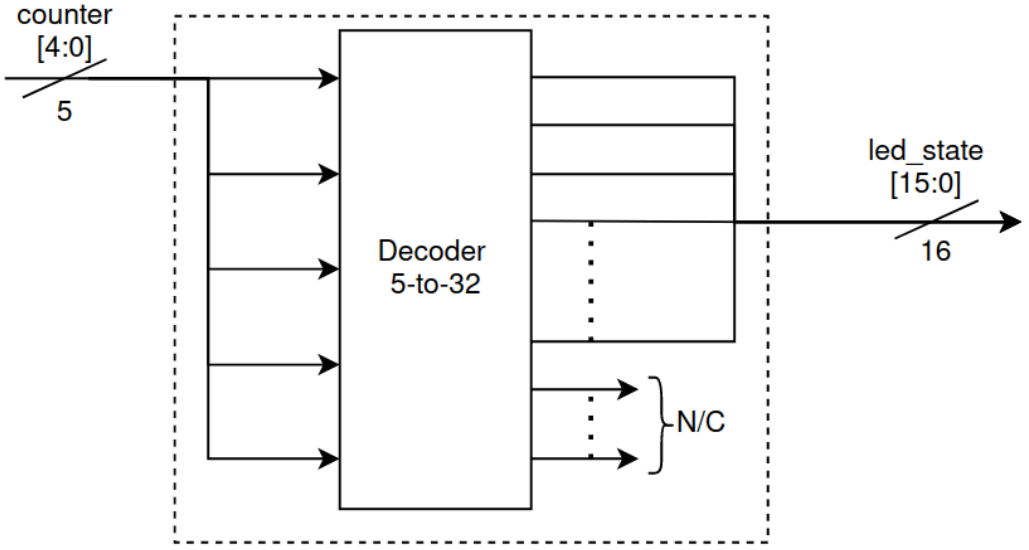


Figure 3.1.3: Decoder diagram

Signal	Width	Type	Description
counter	5	Input	The counter for the remaining 16-bit LED.
led_state	16	Output	16 LED's state
Decoder 5-to-32	0	Combination Module	Decode 5 to 32

Table 3.1.2: Decoder block Description

3.2. State Machine

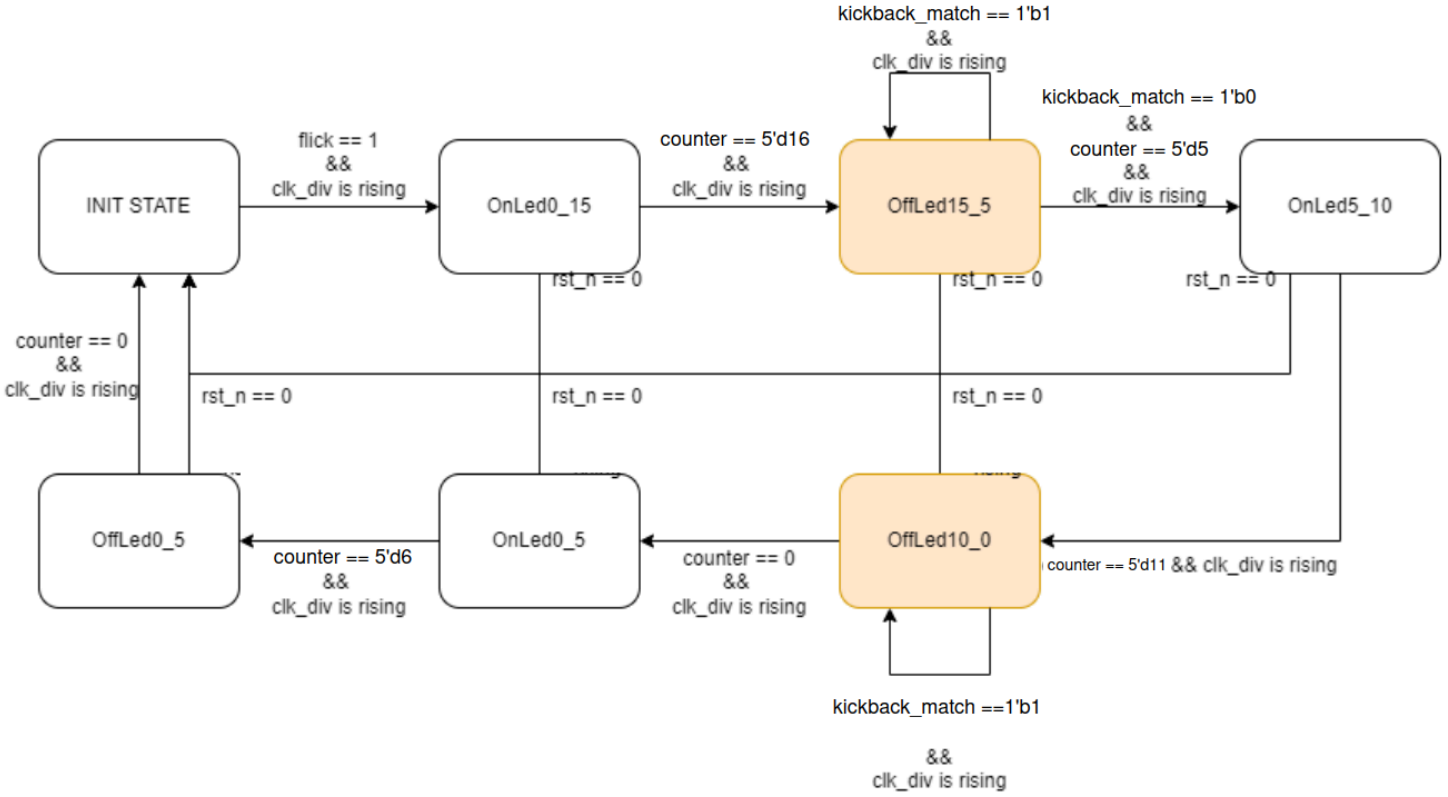


Figure 3.2: State Machine of Bound Flasher

Variable Name	Width	Description
flick	1	Compare signal
counter	5	The counter for the remaining 16-bit LED.
rst_n	1	System negative reset
clk_div	1	Divided clock of system
kickback_match	1	Kickback matching

Table 3.2: variable name of State machine

State Name	Description
INIT	Clear all parameters (counter <= 5'd0), wait for asserting **flick** signal to change state
OnLed0_15	Gradually turn on the lights from 0 to 15. When counter equals 5, the main_state is turn into OffLed15_5
OffLed15_5	Gradually turn off the lights from 15 to 5. When counter equals 5, the main_state is turn into OnLed5_10. If **kickback** is matched, the system will set counter to 16
OnLed5_10	Gradually turn on the lights from 5 to 10. When counter equals 10, the main_state is turn into OffLed10_0
OffLed10_0	Gradually turn off the lights from 10 to 0. When counter equals 0, the main_state is turn into OnLed0_5. If **kickback** is matched the system will set counter to 11
OnLed0_5	Gradually turn on the lights from 0 to 5. When counter equals 5, the main_state is turn into OffLed5_0
OffLed5_0	Gradually turn off the lights from 5 to 0. When counter equals 0, the main_state is turn into INIT state

Table 3.3: state name of State machine

4. History

Date	Author	Modified part	Description
2024/02/27		All	New creation
2024/03/27		System diagram	Adjust system diagram