RTL_EXERCISE_1 BOUND FLASHER

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Contents

1. Interface

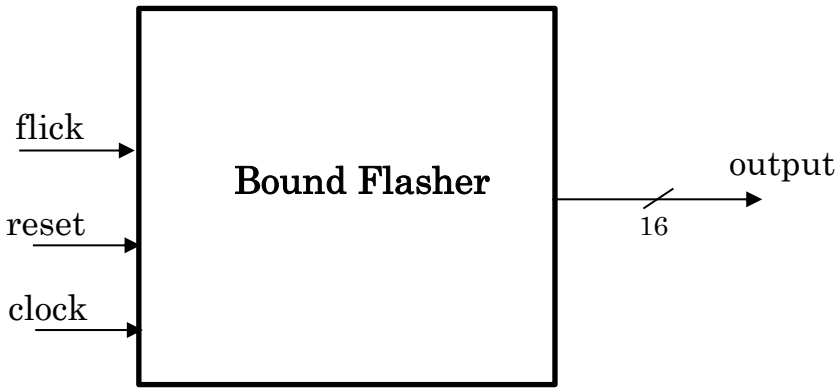


Figure 1: The figure of Bound Flasher System

Signal	Width	In/Out	Description
flick	1	In	Asynchronous input signal; when the output (led) is turned OFF gradually, at LEDs[5] or LEDs[10], if flick = 1, then the output will turn on gradually again to the max led of the previous state, except the final state.
reset	1	In	Reset signal; LOW-ACTIVE; reset = 0: system restarts to Initial State; “reset” is asynchronous signal (does not depend on “clock” signal).
clock	1	In	Clock signal; The function operates state’s transition at the rising edge of the clock signal.
output	16	Out	16-bit led from LEDs[0] to LEDs[15] ; LEDs[0] is the Least Significant Bit ; LEDs[15] is the Most Significant Bit.

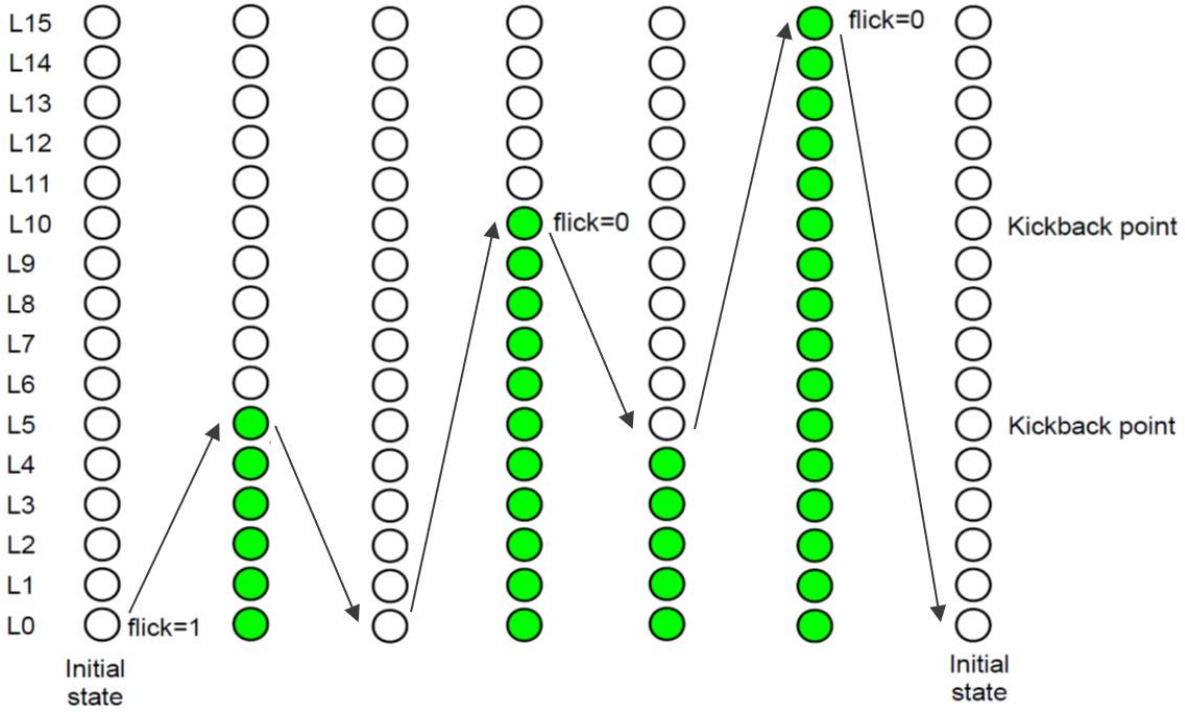
Table 1: Description of signals in Bound Flasher

2. Functional implementation.

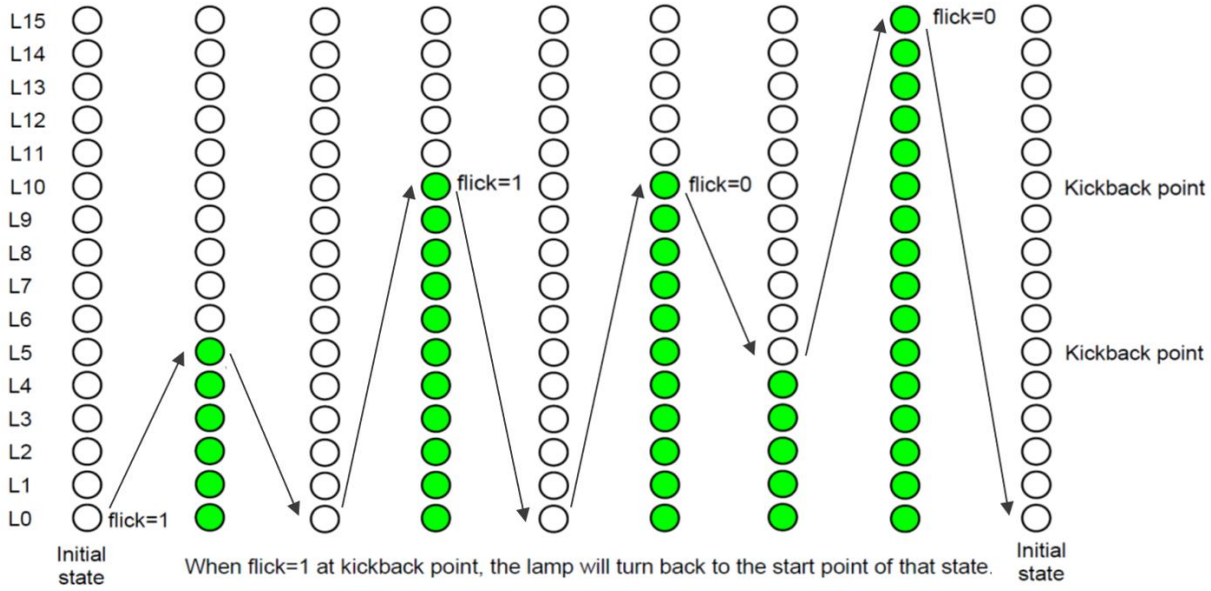
- Implement a 16-bits LEDs system
- System's Operation base on three input signals
  - Reset
  - Clock
  - Flick
- The system specification
  - Clock signal is provided for system inspire of function status. The function operates state's transition at positive edge of the clock signal.
  - Reset signal:
    - 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 starts operating:
  - The lamps are turned ON gradually from LEDs [0] to LEDs [5].
  - The LEDSs are turned OFF gradually from LEDs [5] (max) to LEDs [0] (min).
  - The LEDSs are turned ON gradually from LEDs [0] to LEDs [10].
  - The LEDSs are turned OFF gradually from LEDs [10] (max) to LEDs [5] (min).
  - The LEDSs are turned ON gradually from LEDs [5] to LEDs [15].
  - Finally, the LEDs s are turned OFF gradually from LEDSs [15] to LEDSs [0], return to initial state.
- Additional condition: At each kickback point (LEDs [5] and LEDs [10]), if flick signal is ACTIVE, the lamps will turn OFF gradually again to the **min** lamp of the previous state, then continue operation as above description. For simple, kickback point is considered only when the lamps are turned ON gradually, except the first state.

– Some insulations:

- When flick = 0 at kickback points



- When flick = 1 at kickback points (led [10])



3. Internal implementation.

3.1. Overall.

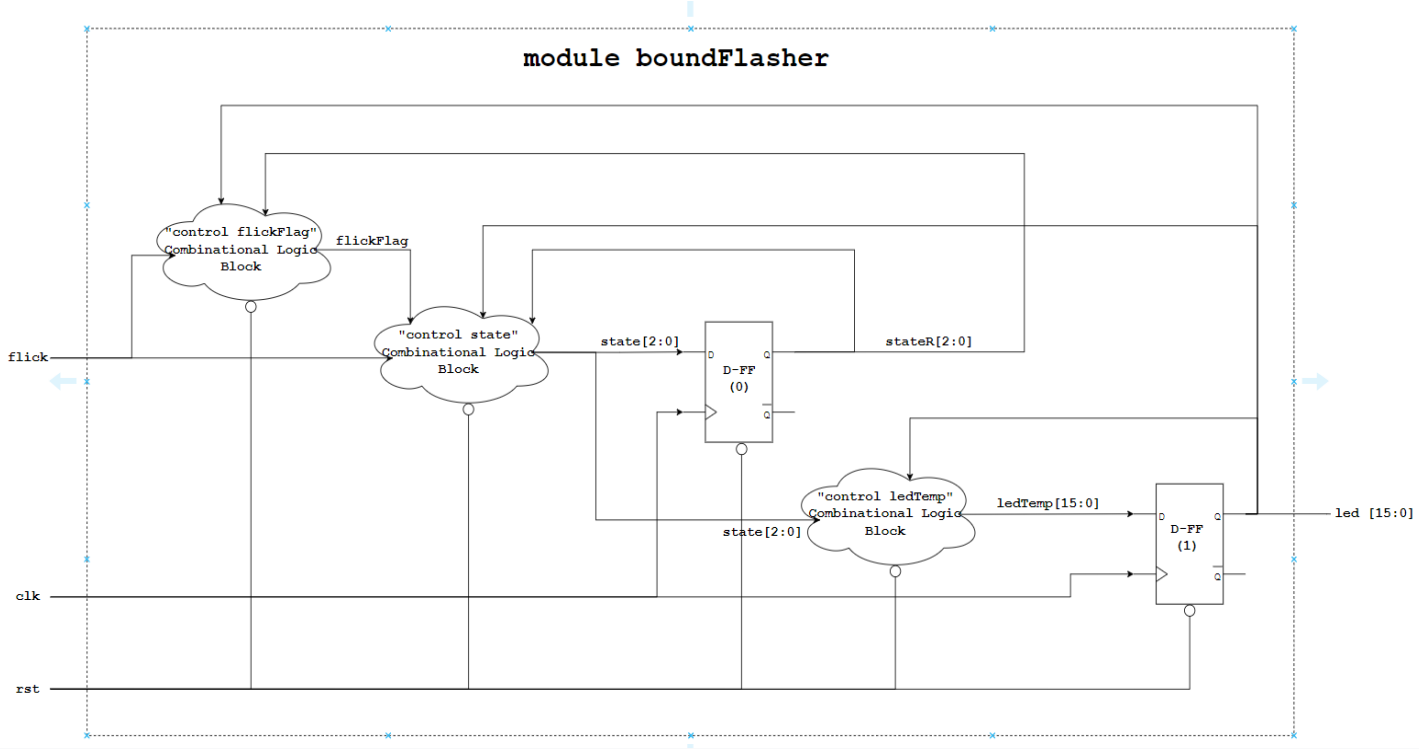


Figure 3.1: Block diagram of Bound Flasher

Block	Description
D-FF (1)	Synchronize the input signal (ledTemp[15:0]) with the rising edge clock. Using the clock signal to increase or decrease the 16-bit led. The rst (reset) signal is the low-active asynchronous signal (whenever rst == 0, all the led will be off immediately).
“Control ledTemp” Combinational Logic block	Using the input signals (state[2:0] and led[15:0]) to control the ledTemp[15:0] signal.
D-FF (0)	Synchronize the input signal (state[2:0]) with the rising edge clock. Using the clock signal to change the output signal (stateR[2:0]) (stateR means “state Real”). The rst (reset) signal is the low-active asynchronous signal

	(whenever rst == 0, then the “Real state” will be reset to Initial State immediately).
“Control state” Combinational Logic block	If “flick signal” is 1 at “kick-back points”, “state” will be changed to previous “state”; If “flick signal” is 1 at “Initial State”, “state” will be changed to “State 1”. The rst (Reset) signal is the low-active asynchronous signal (whenever rst==0, state will be reset to Initial State immediately).
“Control flickFlag” Combinational Logic block	Using a flag (called flickFlag) to check if there is a flick signal (flick == 1) at “kick-back points”. If there is a flick signal (flick == 1) at any point of the “kick-back points”, this 1-bit flag will be 1 (flickFlag = 1). The changing of “stateR” signal (state Real) and the led will help to set this flag back to 0. The rst (Reset) signal is the low-active asynchronous signal (whenever rst == 0, flickFlag = 0 immediately).

Table 3.1: Block diagram of Bound Flasher Description

3.2. State Machine

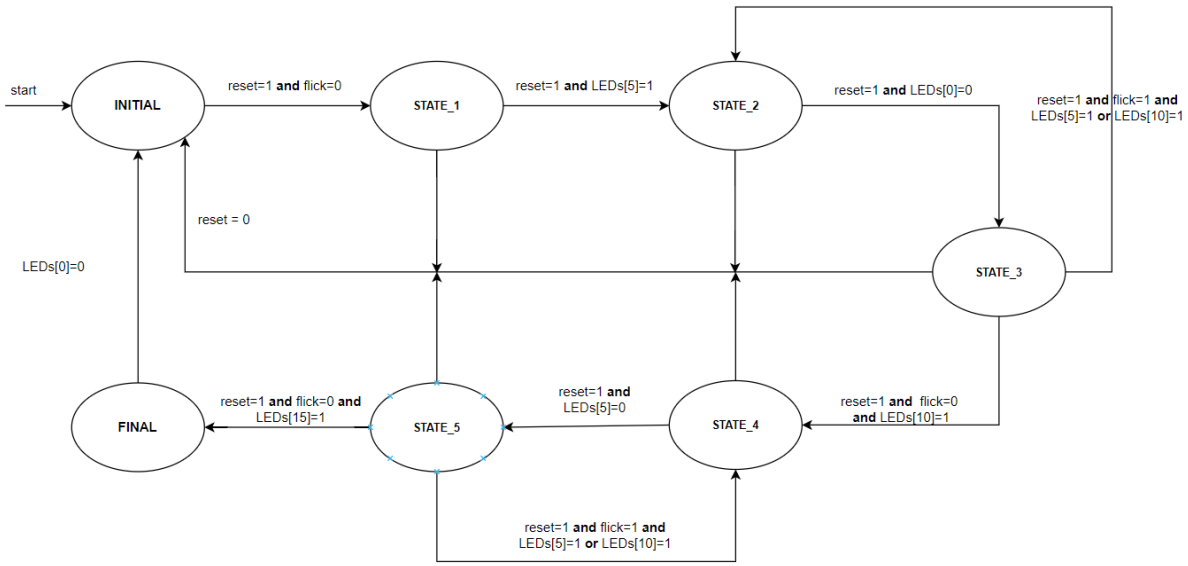


Figure 3.2: State Machine of Bound Flasher

Variable name	Description
reset	Asynchronous signal input. When reset = 0, the state will return to the initial state.
flick	When the output (led) is gradually turned OFF (=0) gradually, at LEDs[5] or LEDs[10], if flick = 1, then the lamps will turn OFF gradually again to the **min** lamp of the previous state, except the final state.
LEDs	16 bits output represents 16 lamps. LEDs[0] is the LSB and LEDs[15] is the MSB.

Table 3.2: Variable name of State machine

State Name	Description
INITIAL	All LEDs is OFF (16 bits output = LED[0:15] = 0) If flick = 1, then state will change to STATE_1.
STATE_1	The LEDs is gradually turned ON from LEDs[0] to LEDs[5], if reset = 0, the state will return to INITIAL. If LEDs[5] is ON, the state will change to STATE_2.
STATE_2	The LEDs is gradually turned OFF from LEDs[5] to LEDs[0], if reset = 0, the state will return to INITIAL. If LEDs[0] is OFF, the state will return to STATE_3.
STATE_3	The LEDs is gradually turned ON from LEDs[0] to LEDs[10], if reset = 0, the state will return to INITIAL. If (flick=1 and LEDs[5]=1 (ON)) or (flick=1 and LEDs[10]=1(ON)), all LEDs will gradually turn OFF to min lamp of the STATE_2 (LEDs[0]=0) and the state will return to STATE_2. Else, if LEDs[10] is ON, the state will change to STATE_4.
STATE_4	The LEDs is gradually turned OFF from LEDs[10] to LEDs[5], if reset = 0, the state will return to INITIAL. If LEDs[5] is OFF, the state will return to STATE_5.
STATE_5	The LEDs is gradually turned ON from LEDs[5] to LEDs[15], if reset = 0, the state will return to INITIAL. If (flick=1 and LEDs[5]=1 (ON)) or (flick=1 and LEDs[10]=1(ON)), all LEDs will gradually turn OFF to min lamp of the STATE_4 (LEDs[5]=0) and the state will return to STATE_4. Else, if LEDs[15] is ON, the state will change to FINAL.
FINAL	The LEDs is gradually turned OFF from LEDs[15] to LEDs[0]. If LEDs[0] is OFF, the state will change to INITIAL.

Table 3.3: State name of State machine

4. History

Date	Author	Modified part	Description
2022/02/25	Group 1	All	New creation
2022/03/05	Group 1	All	Update information
2022/04/07	Group 1	State diagram	Update state diagram