HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
FAUCULTY OF COMPUTER SCIENCE AND ENGINEERING

LSI LOGIC DESIGN

- LAB REPORT -

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Group: iGears

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1 Interface

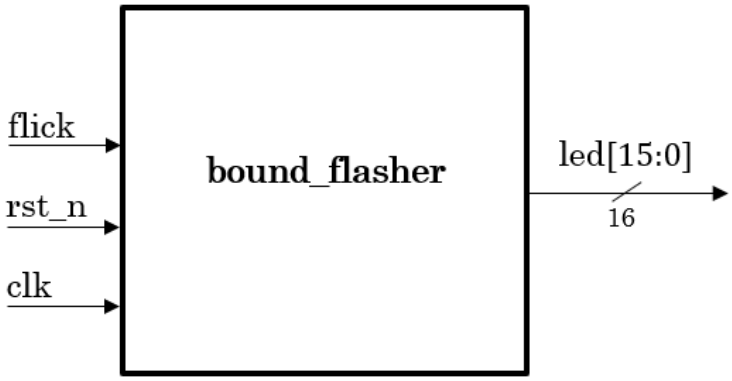

Figure 1: Bound flasher module design

Signal	Width	In/Out	Description
flick	1	In	Flick signal
clk	1	In	Clock signal
rst_n	1	In	Reset signal
led	16	Output	16 LEDs

Table 1: Description of signals involved in Bound Flasher

2 Functional implementation

– Expected outcome: A 16-bit LEDs system that functions accurately as specified below.

– System specification:

- The system operates based on three input signals and produces one output signal:
  * Input - Clock (clk): Clock signal controls the timing of the system and is used as the main synchronizing event (state transitions happen at positive / rising edge of clock signal).
  * Input - Reset (rst_n): An ACTIVE-LOW asynchronous input signal used to restart the system to the initial state.
  * Input - Flick (flick): An input signal used in controlling state transitions.
  * Output - 16-bit LEDs (led): A signal representing the state of 16 lamps of the bound flasher.
- Typical workflow: At the initial state, all lamps are OFF. If flick signal is ACTIVE (set 1), the flasher will function according to the following steps:
  1. The lamps are turned ON gradually from lamp[0] to lamp[5].
  2. The lamps are turned OFF gradually from lamp[5] (max) to lamp[0] (min).
  3. The lamps are turned ON gradually from lamp[0] to lamp[10].
  4. The lamps are turned OFF gradually from lamp[10] (max) to lamp[5] (min).
  5. The lamps are turned ON gradually from lamp[5] to lamp[15].
  6. Finally, the lamps are turned OFF gradually from lamp[15] to lamp[0], return to initial state.
- Additional condition: At each kickback point (lamp[5] and lamp[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 simplicity, kickback point is considered only when the lamps are turned ON gradually, except the first state.

– For illustrative purpose, images of typical workflow are attached below:

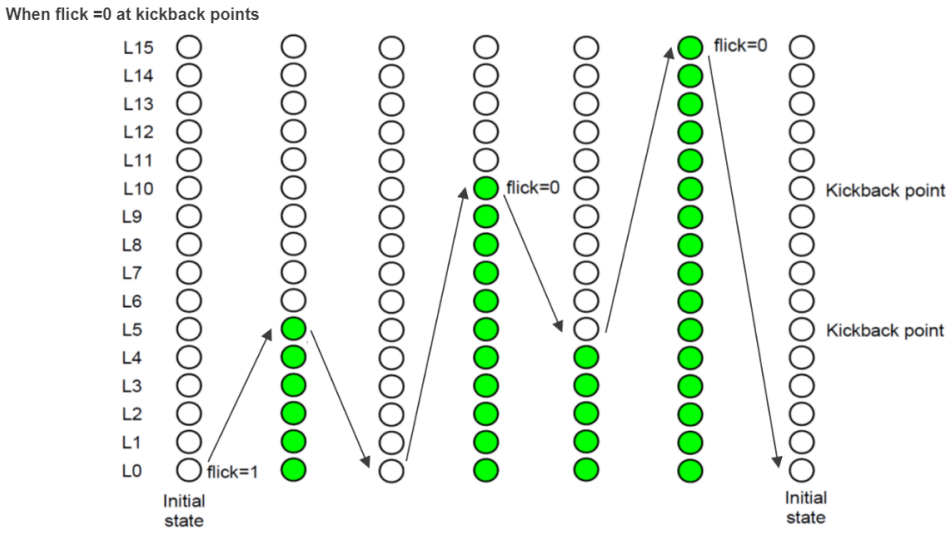

Figure 2: Workflow with no flick at kickback point involved

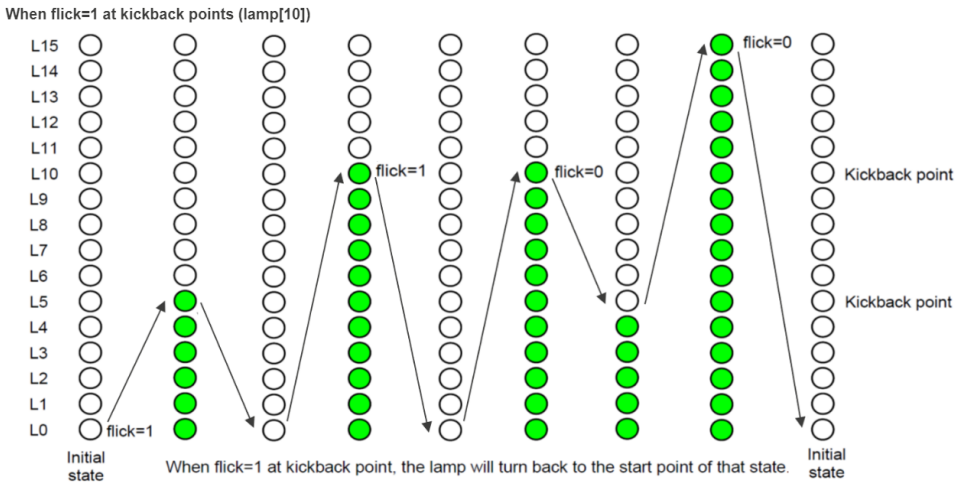

Figure 3: Workflow with flick at kickback point lamp[10]

3 Internal implementation

3.1 Overall

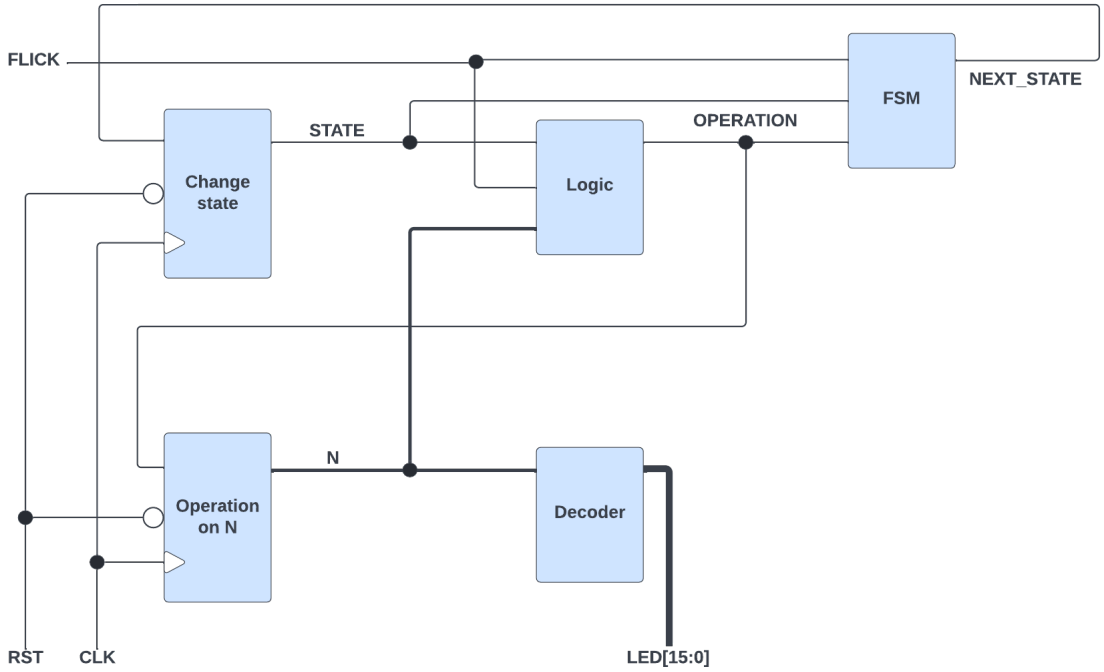

Figure 4: Bound flasher block diagram

Signal	Width	Type	Description
CLK	1	Input	Used to trigger the sequential blocks.
RST	1	Input	Used to reset the system.
FLICK	1	Input	If the signal is high when the last turned on LED is at the kick back point the module returns to it's previous state.
LED	16	Output	Output signal will be connected to LED.
STATE	3	Reg	Used to keep track of the current state of the module.
NEXT_STATE	3	Reg	Used to keep track of the next state.
N	32	Integer	Used to turn on or off LED, also involves in deciding the next state of the module.
Operation	2	Reg	Deciding whether to increment or decrement N or keep it unchanged in the next clock cycle.

Table 2: Data path of Block diagram description

Block	Description
Change_state	The block has three input signals NEXT_STATE, CLK, RST. It simply transfers the NEXT_STATE input signal to the current state when CLK goes high, If RST is low the output is assigned to INIT.
Logic	This block's output is the operation signal, which is determined by the flick signal, the current state and the value of N.
Operation on N	This block performs either increment, decrement or to keep the value of N unchanged over clock cycle based on the value of operation input signal.
FSM	This block decides the next state of the machine, it relies on three input signals such as FLICK, STATE and OPERATION to make the decision
Decoder	This block's work is to convert the value of N into appropriate output LED display

Table 3: Components of Block diagram description

3.2 State machine

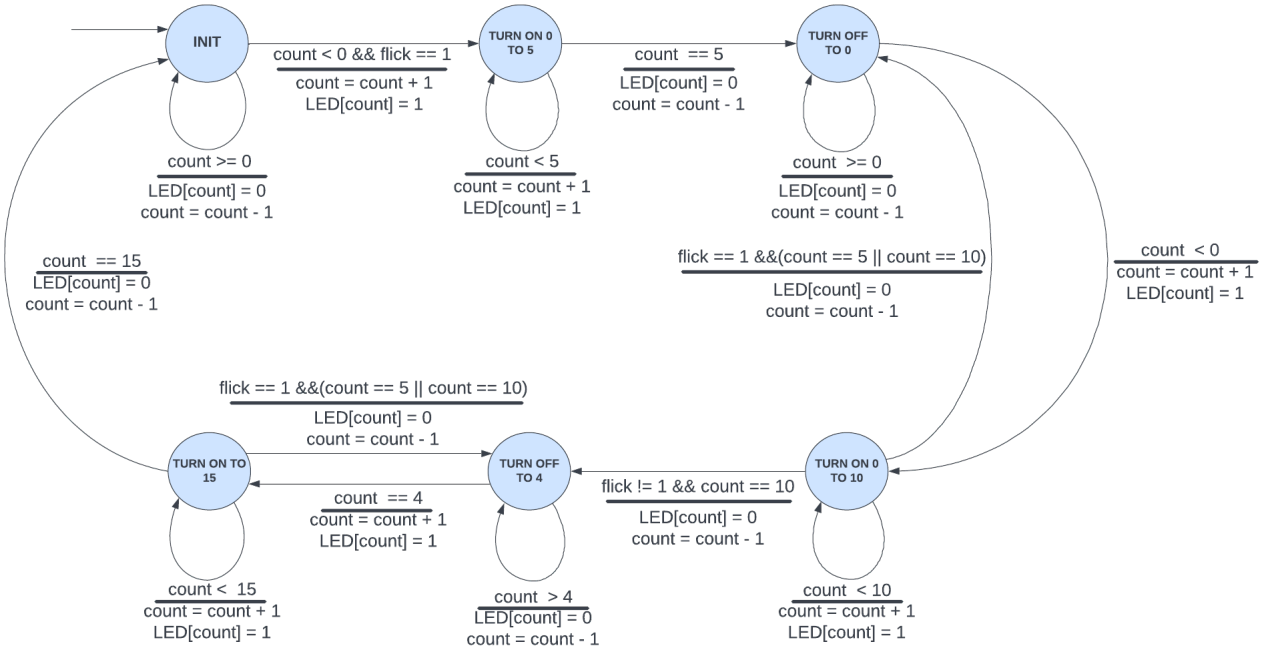

Figure 5: Bound flasher finite state machine

Variable name	Description
count	Used to keep track of the position of the latest turned on LED, also involves in deciding the transition state from one particular state.
flick	An input signal which decides the next state if the current state is either "Turn_on_to_15" or "Turn_on_to_10" and count is at "kick_back_point".
LED	The 16 bits output which is used for LED display.

Table 4: Variable name of State machine

State name	Description
INIT	The initial state, if any bit is set, reset them.
TURN_ON_0_TO_5	Gradually set all bits form 0 to 5 in this state.
TURN_OFF_TO_0	Gradually reset all bits starting from the latest turned on LED.
TURN_ON_0_TO_10	Gradually set all bits form 0 to 10 in this state.
TURN_OFF_TO_4	Gradually reset all bits larger than the fourth bit starting from the latest turned on LED.
TURN_ON_TO_15	Gradually set all bits form 5 to 15 in this state.

Table 5: Variable name of State machine

4 History

Date	Author	Modified part	Description
11/04/2022	Nguyen Le Thao Vy	- All	Re-creating the template
15/04/2022	Nguyen Le Thao Vy Vu Hoang Hai	- Interface - Functional implementation	Filling the contents
15/04/2022	Le Nguyen Tan Loc	- Internal implementation	Adding block diagram and its description
15/04/2022	Nguyen Ly Dang Khoa	- Internal implementation	Adding FSM and its description

- End of report -