Circuit-Level Design of a Touch Controlled Smart Switching IoT Node using Digital Logic in eSim.

Theory:

The proposed circuit demonstrates a touch controlled smart switching system designed using digital logic in eSim. The main objective of the circuit is to detect a touch input signal and control the ON/OFF state of a load such as an LED or any electrical appliance.

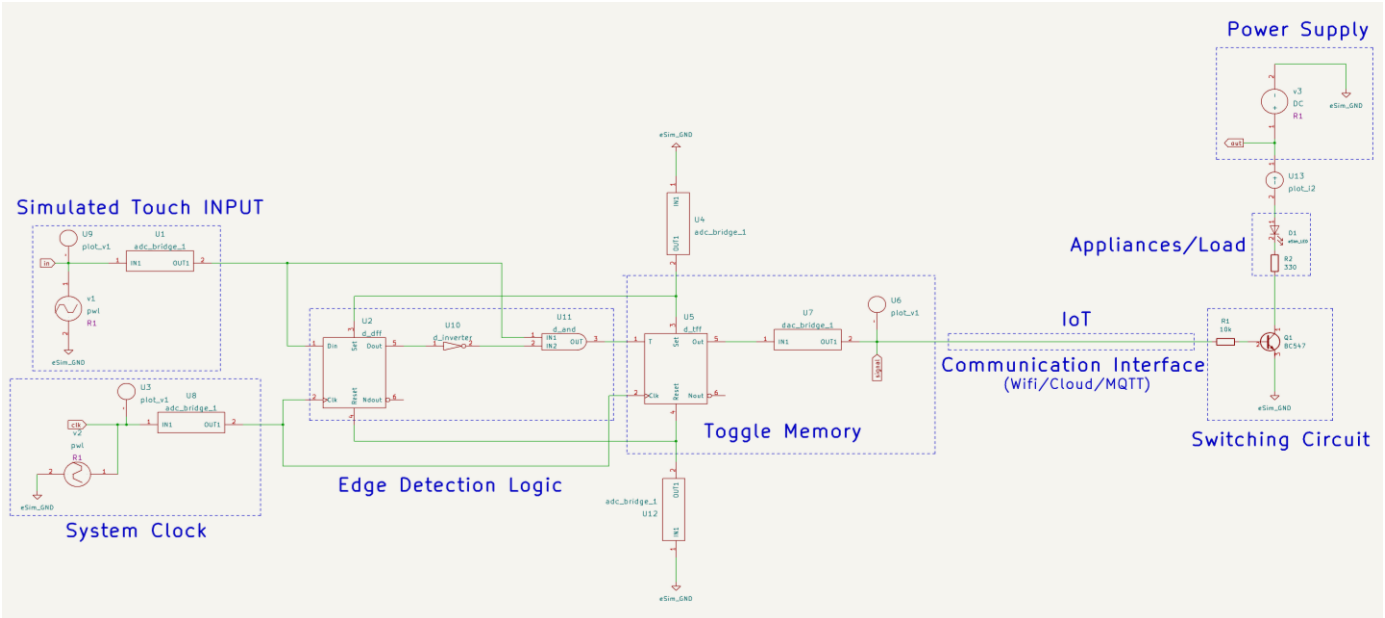
The touch input is simulated using a pulse voltage source which behaves similar to a real touch sensor. Whenever the touch signal changes its state, the edge detection circuit detects the change in the signal. The output of the edge detector is then given to a flip-flop based memory block which stores the switching state of the system.

The flip-flop acts like a small memory unit that stores either 0 or 1. Whenever a valid trigger pulse is received, the output of the flip-flop changes its state from LOW to HIGH or HIGH to LOW. This output is passed through a communication interface block which represents the IoT communication path.

In the final stage, a transistor is used as a switching device to control the load current. When the logic output is HIGH, the transistor turns ON and current flows through the load. When the logic output is LOW, the transistor turns OFF and the load stops operating.

This circuit shows how digital logic can be used to create smart switching systems at hardware level. The communication path between logic circuit and switching circuit represents how the system can be connected to IoT modules such as ESP8266, ESP32 or cloud communication platforms.

Schematic Diagram:



The circuit schematic is designed using eSim tool. The circuit consists of:

- **Simulated Touch Input**
  Generates pulse signal representing touch action.
- **System Clock**
  Provides timing signal required for flip-flop operation.
- **Edge Detection Logic**
  Detects change in input signal and produces trigger pulse.
- **Toggle Memory**
  Stores ON/OFF state of the system using flip-flop.
- **IoT Communication Interface (WiFi/Cloud/MQTT)**
  Represents communication path between logic circuit and IoT system.
- **Switching Circuit**
  Controls current flow through the load using transistor.
- **Load (LED)**
  Represents device being controlled.
- **Power Supply**
  Provides required DC voltage for circuit operation.

The signal flow of the circuit is:

Input Touch Signal → Edge Detection → Memory Block → Communication Interface → Transistor Switch → Load

Simulation Results:

The circuit is simulated using the Ngspice simulation engine in eSim. The obtained plots show the behaviour of the input signal, clock signal, output signal and load current. The waveforms confirm that the digital logic circuit responds correctly to the touch input signal and produces the expected switching output. The current waveform verifies proper operation of the switching circuit..

Figure 1: Input touch signal waveform (random pulse signal of different pulse width).

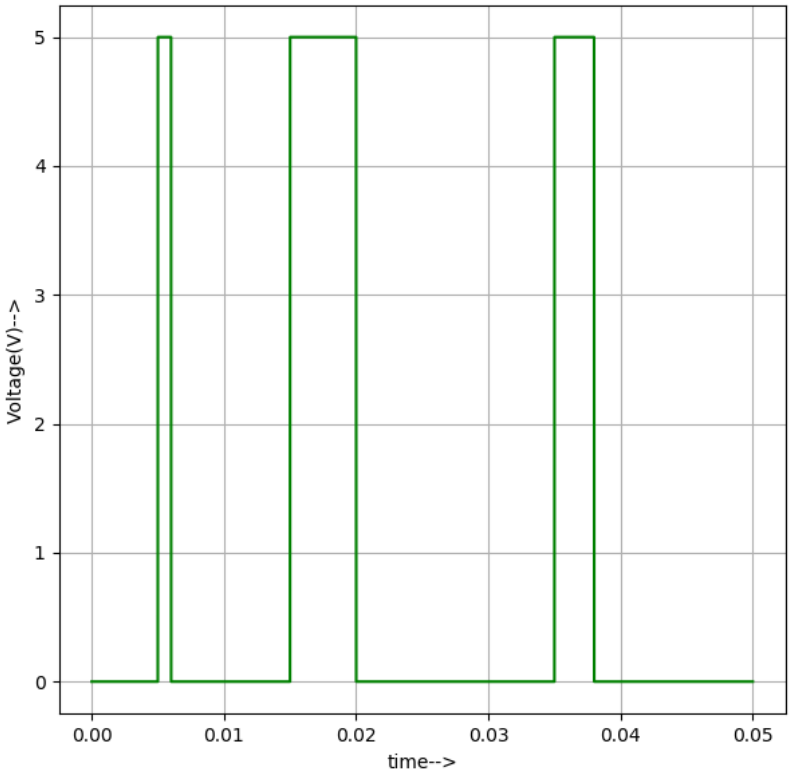


Figure 2: Clock signal waveform.

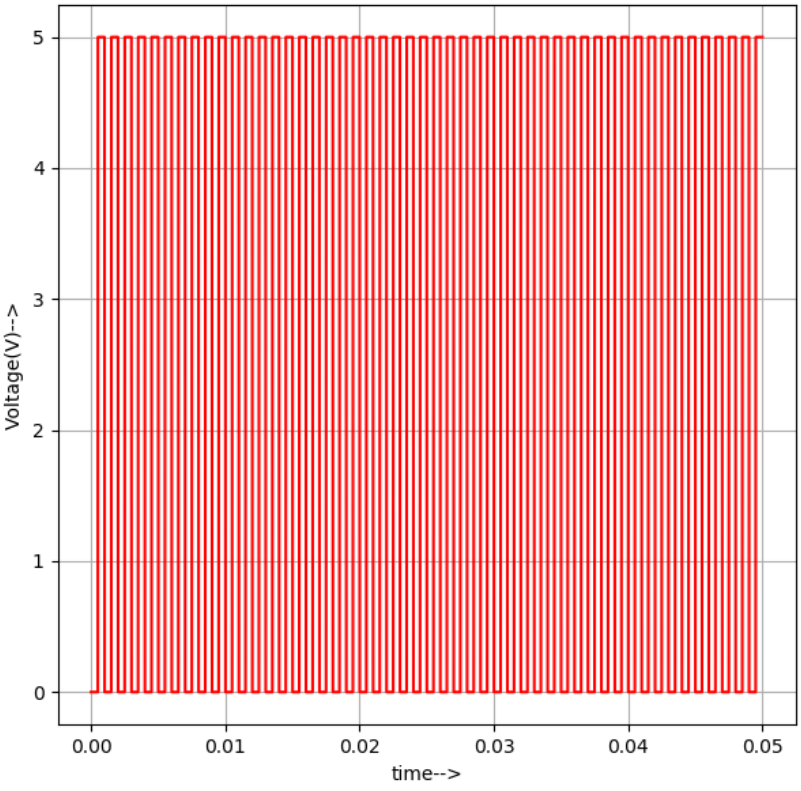


Figure 3: Output signal waveform.

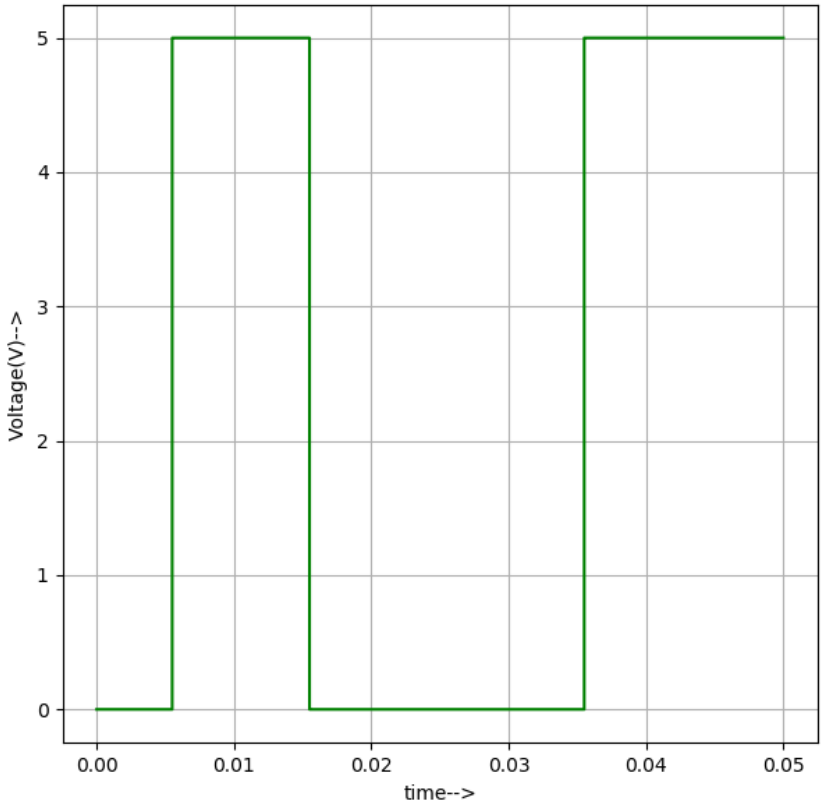
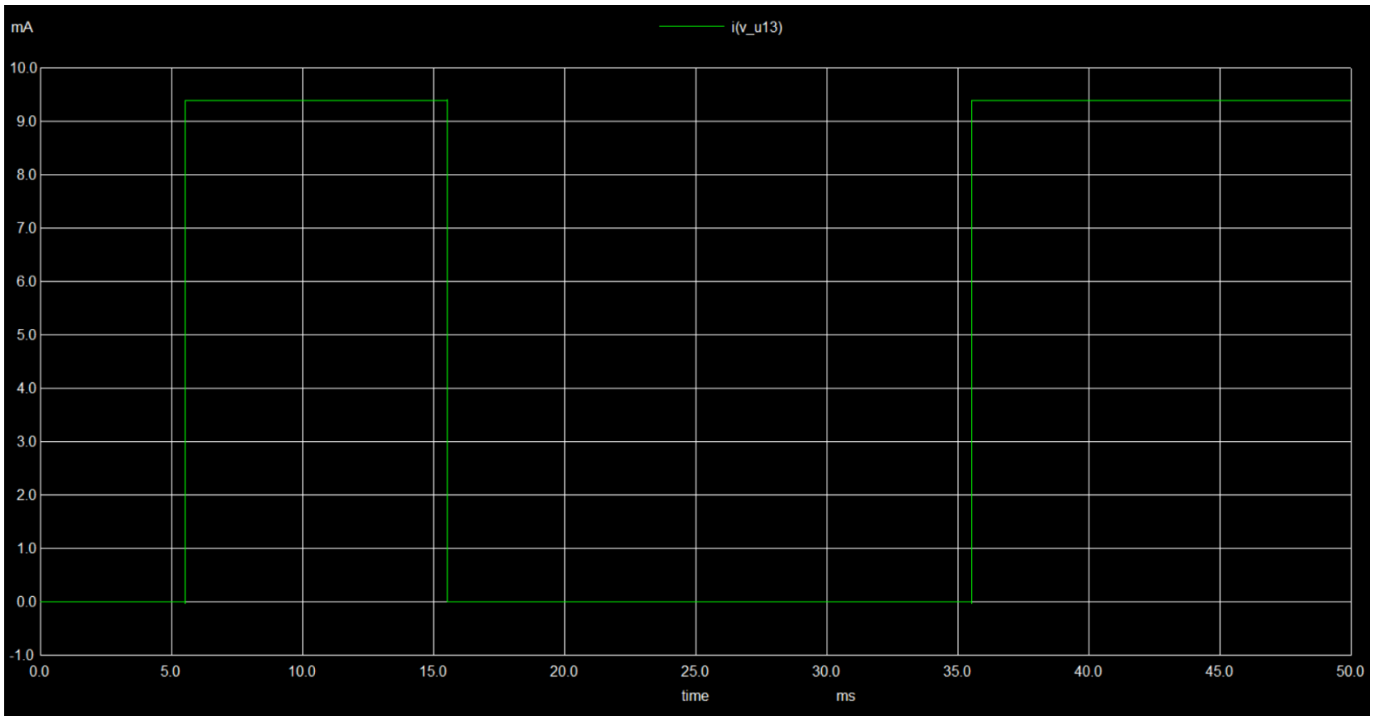


Figure 4: Load current waveform.



Results:

The touch controlled switching circuit works as expected. When the touch input is applied for the first time, the edge detector generates a trigger pulse which changes the state of the flip-flop memory from LOW to HIGH. Due to this, the transistor turns ON and current flows through the load, turning the LED ON.

When the touch input is applied again, the flip-flop changes its state from HIGH to LOW. This turns the transistor OFF and stops the current flow, turning the LED OFF.

Therefore, each touch changes the state of the system. The first touch turns the system ON and the next touch turns the system OFF. The obtained waveforms confirm proper toggling behaviour of the digital logic circuit and correct operation of the switching circuit.

The circuit successfully demonstrates touch based smart switching behaviour which can be used in IoT based control applications.

Conclusion:

A touch controlled smart switching circuit using digital logic is successfully designed and simulated using eSim. The circuit demonstrates the use of digital logic, flip-flop memory and transistor switching for smart control applications.

The project shows how circuit-level design can be used as a foundation for IoT based smart switching systems.

References:

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   https://www.electronics-tutorials.ws/transistor/tran_4.html