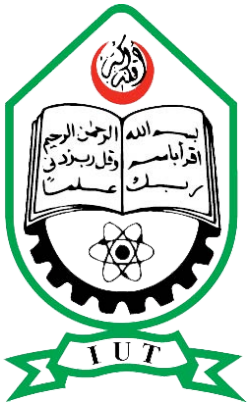

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

Project Report

CSE 4206 : Digital Logic Design Lab

Team Members

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Comic Cart

Motivation

We're a group of readers at heart - whether it's comics, novels, or graphic books, stories have always had a special place in our hearts. So when we were challenged to build a project using only digital logic components, we didn't want to create just another generic circuit. We wanted to build something that actually reflected us - something that connected our shared love for stories with our growing skills in digital logic design.

That's how the idea for *Comic Cart* was born.

Instead of a typical snack vending machine, we imagined a vending system for comics and books, one that could recommend, respond, and react - but all using only logic gates, encoders, decoders, flip-flops, adders, counters, and registers. All powered by pure digital logic.

Description

The Comic Cart is a vending machine style system designed entirely using digital logic components. It embodies the fusion of creativity and circuitry, a vending system that sells comics, responds to user input, manages inventory, tracks sales, and even recommends related comics, all powered solely by logic gates, decoders, multiplexers, counters, adders, and flip-flops.

The idea was inspired by a playful scenario from the world of Doraemon:

Nobita, an avid comic reader, is always borrowing comics from Sunio. Tired of this, Sunio decides to build a Comic Cart, a vending machine that lets Nobita and others buy comics fairly, using a system that operates purely on digital logic principles instead of futuristic gadgets.

When a user selects a comic using a 3-bit Comic ID, the system decodes the input and displays its base price, rarity level, and the genre recommendation. The Comic Cart then calculates the total price by adding a rarity-based tax using multiplexers and BCD adders. Once the comic is added to the cart, the total cost, remaining stock, and sales count update automatically through

interconnected counters and flip-flops. If the chosen comic is out of stock, the machine uses encoder-decoder logic and priority selection to suggest another comic from the same genre.

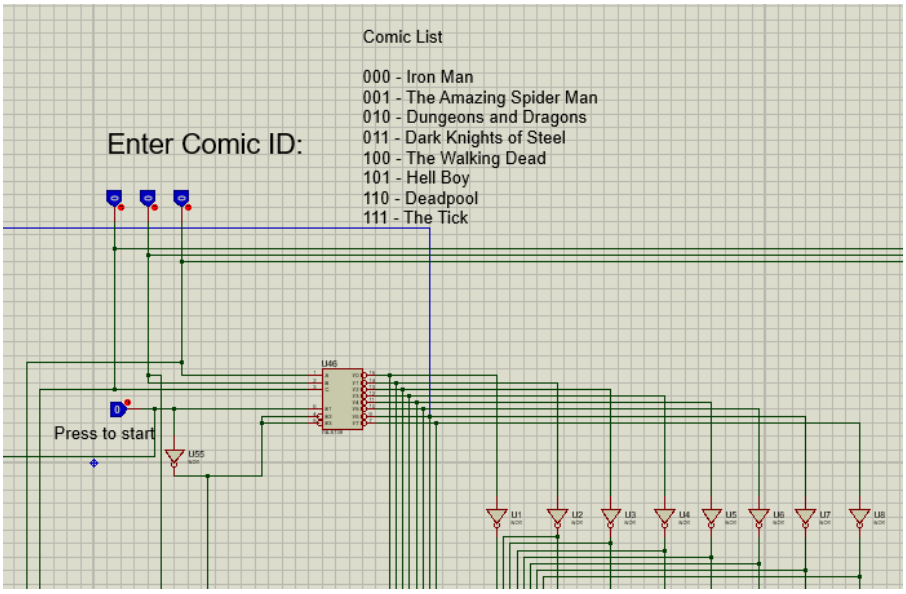
The system features multiple modules, each responsible for a distinct function such as input decoding, pricing, stock management, running total tracking, and genre-based recommendation, working in harmony through clock-controlled synchronization. From user selection to total price computation, every process is executed through logic-level design.

Ultimately, the Comic Cart demonstrates how complex decision-making and automation can be achieved purely through combinational and sequential logic. It's more than just a vending machine, it's a digital story created with logic gates and creativity.

Features and Mechanism

The Comic Cart project is a hardware vending machine style system that sells comics.
It supports:

1. Comic Selection (Input Module)



Input:

3-bit Comic ID (CID) → Selects 1 out of 8 comics

Press to start

Decoder:

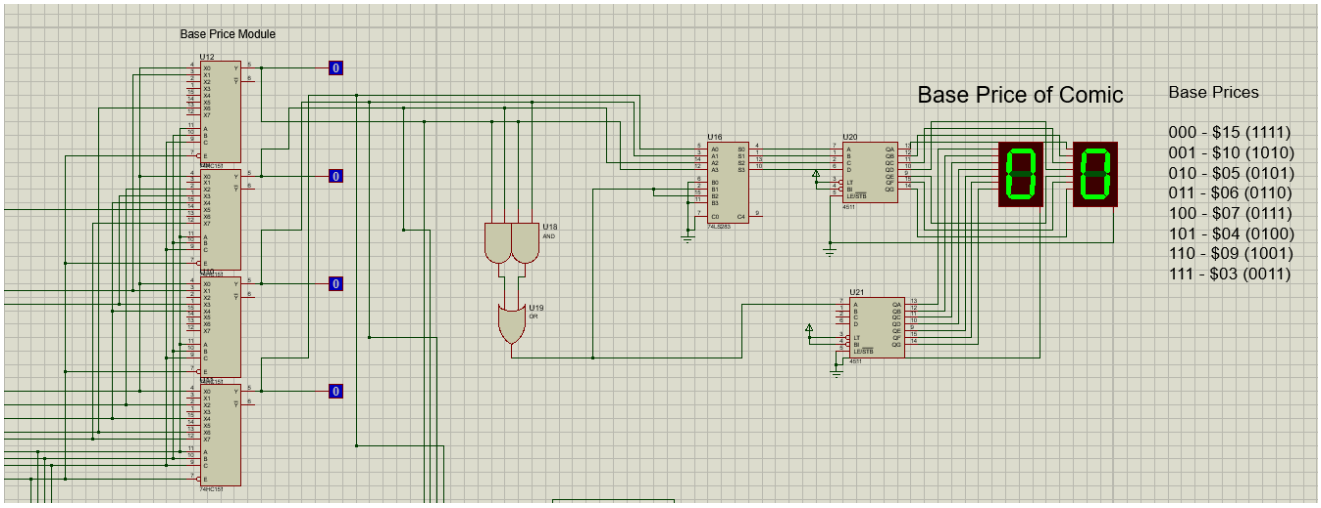
3 to 8 decoder (Active low → Inverted outputs)

Function:

Works like pressing a product button on a vending machine, to select a comic.

Using the press to start activates the whole cart and shows the base price, rarity, genre recommendation and price added with tax.

2. Base Price Module



Input:

4-bit base price, ranging from $1 – $15.

Logic:

4 multiplexers select the base price.

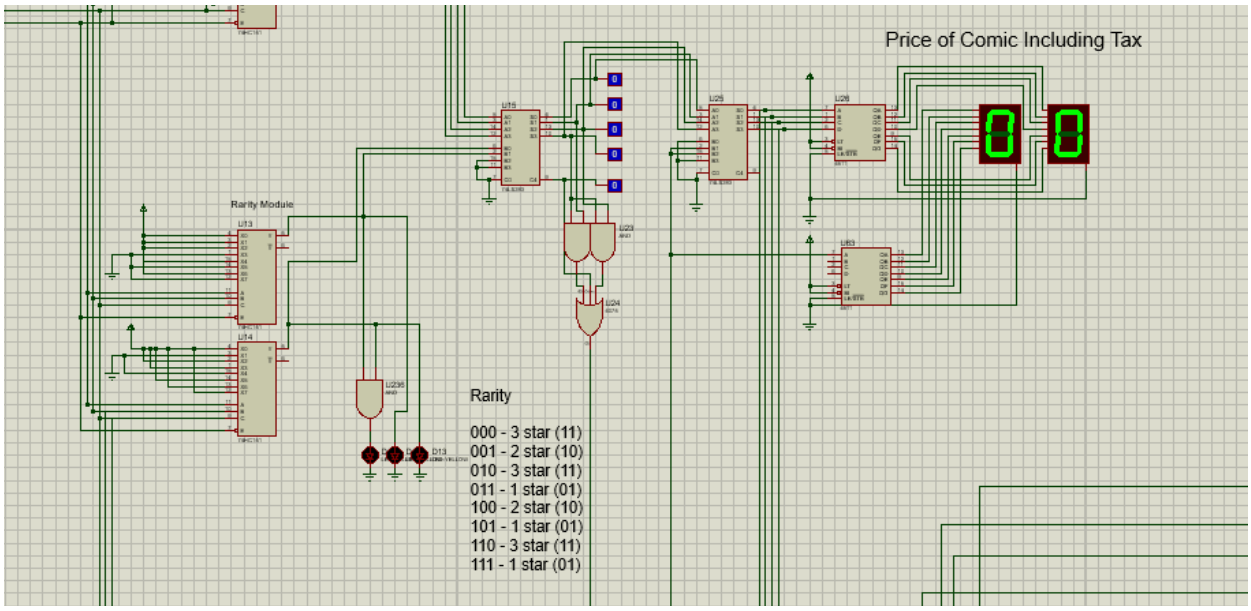
BCD Correction:

Converts binary to valid two-digit BCD.

Function:

Displays →Base price and Base price + tax on two seven-segment displays.

3. Dynamic pricing with rarity tax (Rarity Module)



Input:

2-bit rarity (1-star, 2-star, 3-star)

Logic:

Implemented using 2 multiplexers.

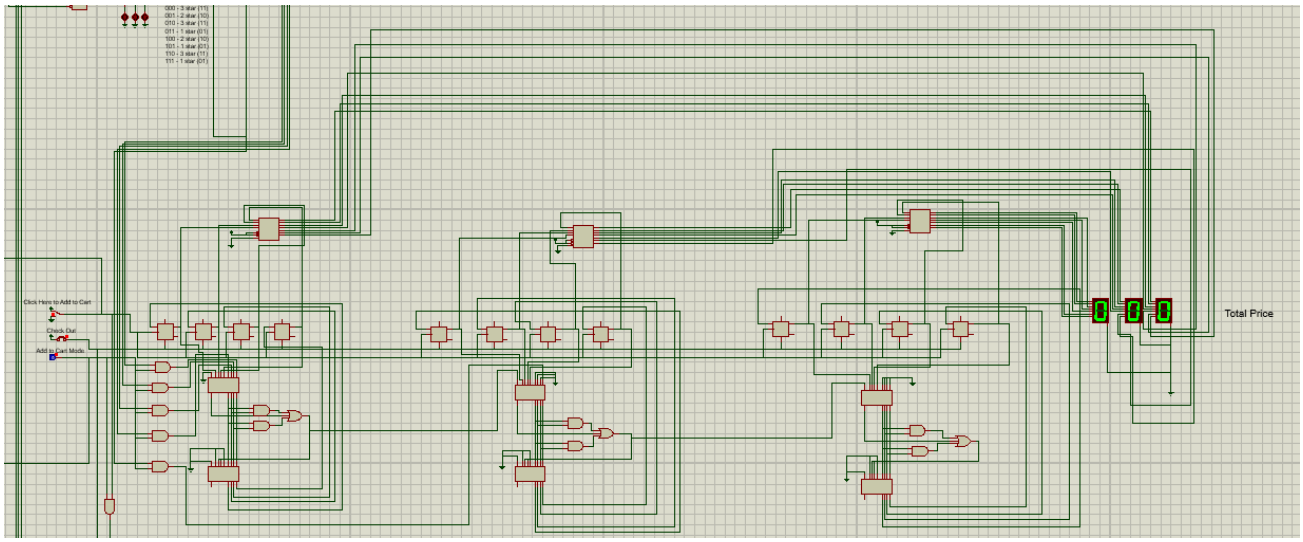
Output:

Generates tax value based on rarity and shows in LED form.

Function:

Tax + base price = Final price of the comic

4. Cart & Running Total Module



Logic Components:

- 12 D flip-flops store the total.
- 3 Adders accumulate prices.
- 3 BCD correction units maintain valid decimal digits.

Features:

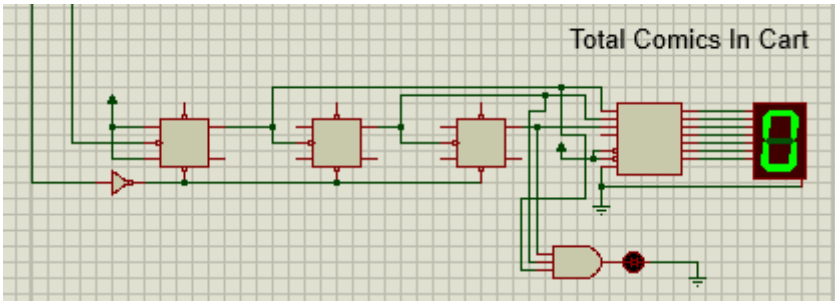
Each purchase updates:

- Total cost (3-digit display)
- Stock (–1)
- Sales counter (+1)
- Total comics in cart (+1)

Checkout Button:

Clears total cost and cart items.

5. Total Comics in Cart (Item Counter)



Logic:

Small counter increments every time “Add to Cart” is pressed. It can hold up to 7 comics.

Display:

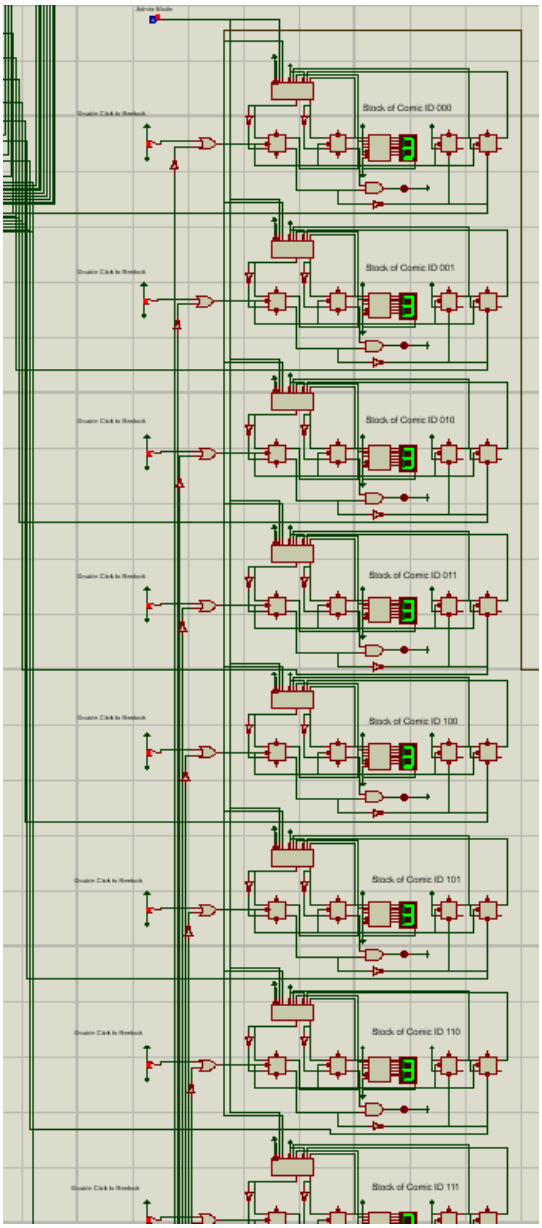
Shows the number of comics currently in the cart.

Lights up a Red LED if max comics are added to Cart.

Checkout Reset:

Counter resets to 0 when checkout is pressed.

6. Stock Management Module



Storage: 2-bit register per comic (max stock = 3).

Logic:

Dynamic PIPO register + MUX selects input:

- Hold (no change)
- Purchase (Subtract 1)
- Restock to maximum (admin)

Down Counter: Decrements automatically on purchase.

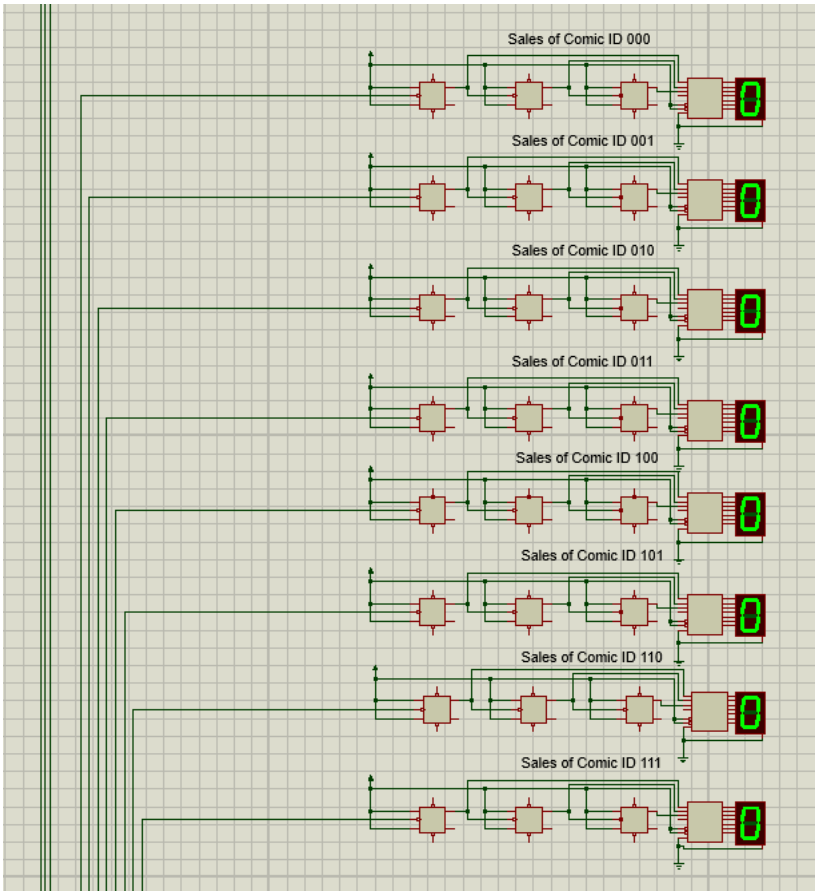
Stock Out Indication:

When stock = 0, a red LED lights up.

Admin Mode:

Allows manual restocking to max.

7. Sales Tracking Module



Implementation:

3-bit up counter per comic.

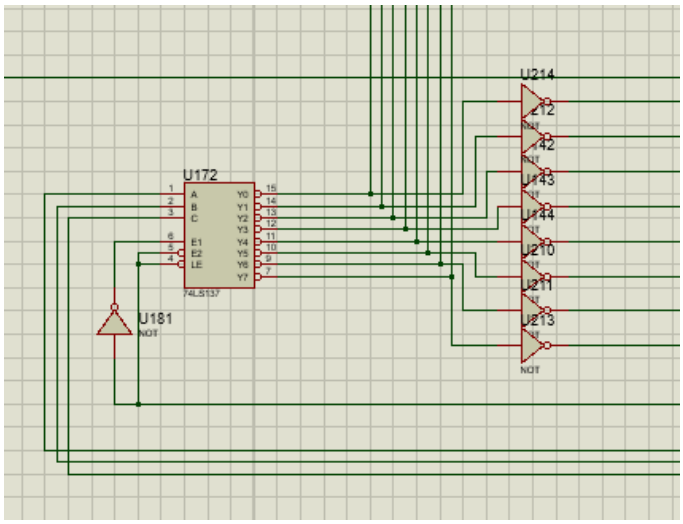
Function:

Increments each time that comic is purchased.

Use:

Tracks popularity of comics → shows which sold most.

8. Clock Control with Demux



Add to Cart Button:

Acts as the main clock pulse.

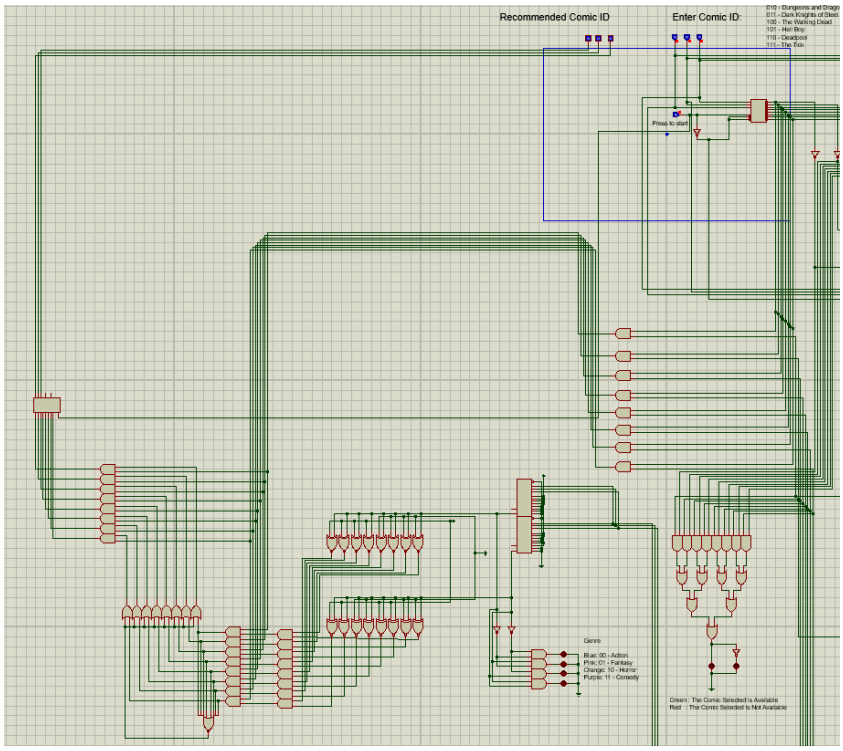
Demultiplexer:

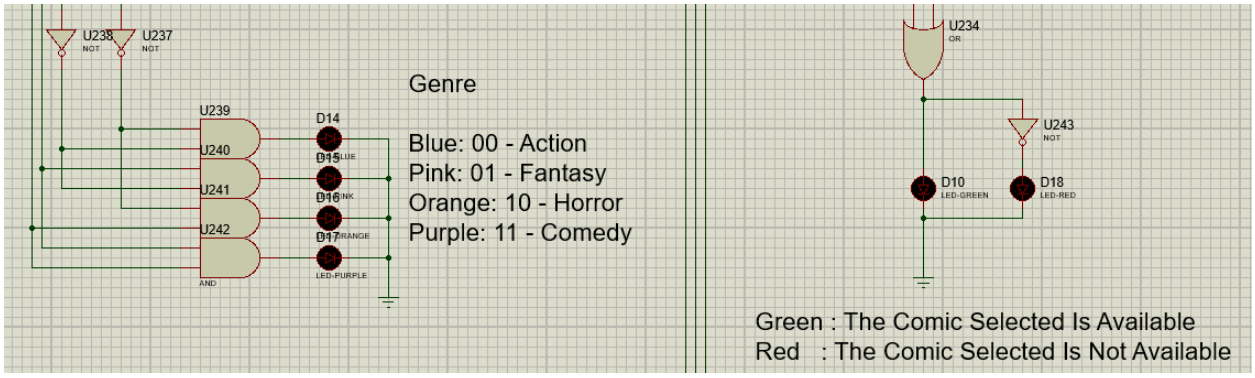
Routes clock to the selected comic's stock register and sales counter.

Selection Line:

Comes from decoder output (Comic ID).

9. Genre-Based Recommendation Module





Genre Mapping:

MUX determines the genre of selected comic.

Logic:

AND, OR, XNOR gates generate availability signals.

Priority Encoder:

Chooses the final recommended comic.

Recommendation Rules:

- If selected comic in stock → Recommend another comic from the same genre.
- If stock out → Recommend another comic from the same genre.

- If the same genre is not available → Recommend the highest priority comic.

Output:

Shows the recommended ID in logic probe

Showcases the Genre of the selected genre in LED based on the genre.

Components of the project and how they were used

Input

a) **Logic Toggle**
   - Comic ID Input (3 logic toggles)
   - Starting (1 logic toggle)
   - Admin Mode (1 logic toggle)
   - Add to Cart Mode (1 logic toggle)

b) **Push Button**
   - Check Out (1 button)

c) **Switch (SPDT)**
   - Click Here to Add (1 switch)
   - Double Click to Restore (8 switch)

Adder / Subtractor

a) **BCD Adder**
   - Total Running Price (3 Adders)
   - Base Price Display (1 Adder)
   - Price Including Tax (1 Adder)

Encoder Decoder

a) **Decoder**
   - Input Module (1 Decoder)

b) **Priority Encoder**
   - Genre Recommendation (1 Encoder)

c) **MUX**

- Base Price Module (4 MUX)
- Rarity (2 MUX)
- Genre (2 MUX)
- Stock (8 MUX)

d) DEMUX

- Clock Control (1 DEMUX)

Flip Flops

a) JK Flip Flops

- As Registers in Stock Management (2x8 = 16)
- As Counters in Stock Management (2x8 = 16)
- As Counters in Sales (3x8 = 24)
- As Counter is Total Comics in Cart (3)

b) D Flip Flops

- As Register in Running Total Price (12 Flip Flops)

Registers

a) PIPO Register

- Stock(2 Bit 8)
- Running Total Price(12 Bit 1)

Counters

a) Synchronous Down Counter

- Stock Management

b) Asynchronous Up Counter

- Sales
- Total Comics Added To Cart

Output Devices

a) Logic Probe

- Recommended Comic ID (3 probes)

- Base Price (for Simplicity 4 probes)

b) BCD Displays

- Base Price (2 Displays)
- Price Including Tax (2 Displays)
- Running Total Price (3 Displays)
- Stock Management (8 Displays)
- Sales (8 Displays)
- Total Comic In Cart (1 Display)

c) Seven Segment Display

- Base Price (2 Displays)
- Price Including Tax (2 Displays)
- Running Total Price (3 Displays)
- Stock Management (8 Displays)
- Sales (8 Displays)
- Total Comic In Cart (1 Display)

d) LEDs

- Green LED for Stock Availability (1 LED)
- Red LED for Stock Unavailability (1 LED)
- Red LED for Stock Out (8 LEDs)
- Red LED for Maximum Items Added to Cart (1 LED)
- Display Rarity Level (3 Yellow LEDs)
- Genre Indication (Blue, Pink, Orange, Purple - 4 LEDs)

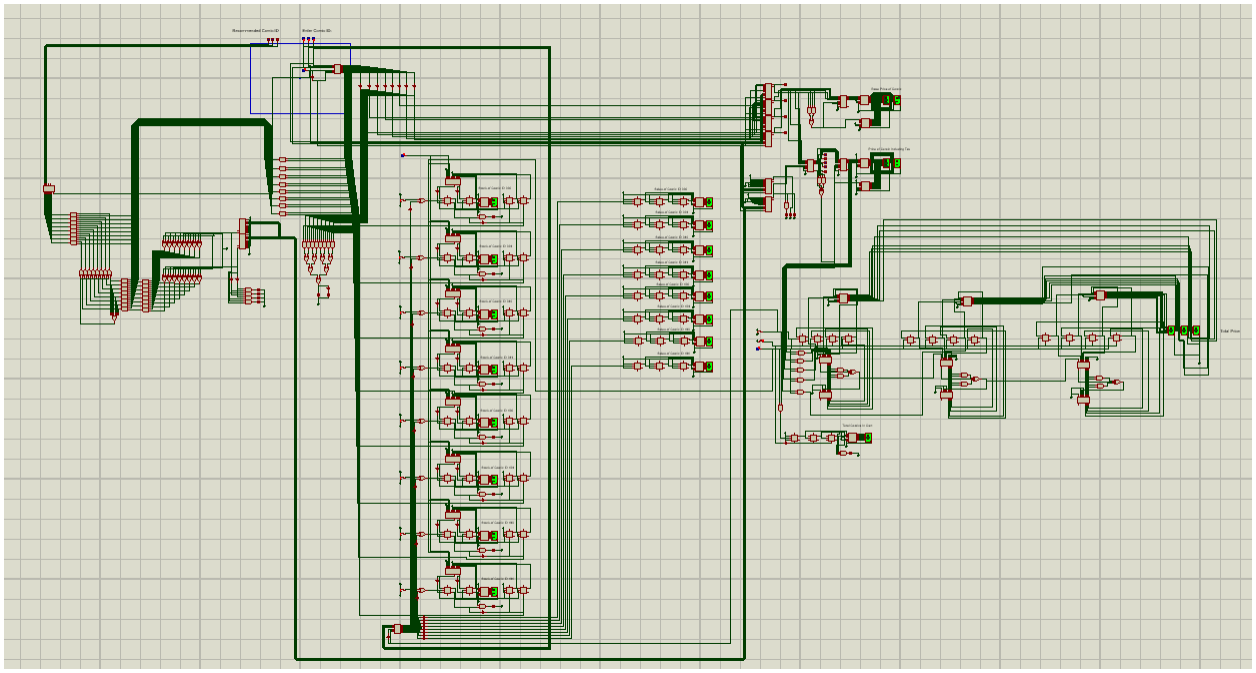
Summary Table

Serial	Component Name	Count	Use Case
1.	Logic Toggles	6	- Input - Admin Mode - Add to Cart Mode
2.	Push Button	1	- Check Out
3.	Switch (SPDT)	9	- Add to Cart - Restock

4	BCD Adder	5	- Base Price - Price including Tax - Running Total Price
5	Decoder	1	- Input
6	Priority Encoder	1	- Genre Recommendation
7	MUX	16	- Stock - Genre - Base Price - Rarity
8	DEMUX	1	- Clock Control
9	JK Flip Flop	59	- Stock - Sales - Total Comics In Cart
10	D Flip Flop	12	- Total Running Price
11	2 Bit PIPO Register	8	- Stock
12	12 Bit PIPO Register	1	- Total Running Price
13	2 Bit Synchronous Down Counter	8	- Stock
14	3 Bit Asynchronous Up Counter	9	- Sales - Total Comic In Cart
15	Logic Probe	7	- Genre Recommendation - Base Price
16	BCD Displays	24	- Base Price - Price Added with Tax - Sales

			- Stock - Total Comic Added to Cart - Total Running Price
17	7 Segment Display	24	- Base Price - Price Added with Tax - Sales - Stock - Total Comic Added to Cart - Total Running Price
18	LEDs	18	- Stock Availability - Rarity - Genre - Maximum Items Added to Cart

Project Diagram



Individual Contribution of each Team Member

ID	Name	Contribution
230042135	Khadiza Sultana	1. Input Module 2. Full Genre Recommendation 3. Added LEDs to Rarity Module 4. Project Proposal and Report
230042120	Safia Aman Anika	1. Full Stock Management 2. Clock Control With DEMUX 3. Project Proposal and Report
230042154	Aksan Anan Ria	1. Full Running Total Module 2. Add To Cart Button 3. Check out Button
230042159	Saika Sarara	1. Full Base Price Module 2. BCD Correction in Total Price Including Tax 3. Total Comics Added to Cart
230042114	Procheta Silvie	1. Full Rarity Module 2. Adding tax and base price using adder
230042161	Adiba Ahsan	1. Full Sales Tracking Module 2. Used Clock Control using DEMUX

Manual

Overview

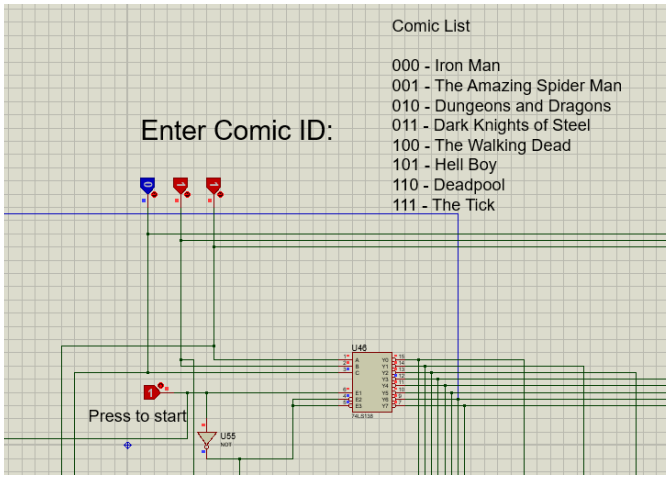
The Comic Cart is a fully digital vending system designed using fundamental logic components such as multiplexers, decoders, encoders, flip-flops, adders, counters, and registers. This manual describes how to operate the Comic Cart, the role of each control switch, and how the system responds to user interactions.

1. System Initialization

- Ensure all connections are correct and the power supply is active in Proteus.
- Set Admin Mode = OFF(0) and Add to Cart Mode = OFF(0) before beginning operation.
- Reset all modules using the Checkout Button to start with an empty cart and full stock.

2. Comic Selection

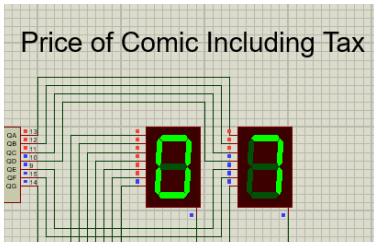
- **Input Comic ID:** Use the 3-bit Comic ID toggles to choose one of the 8 available comics.
- Once the Comic ID is set, press Start to activate the selection. (Start to activate toggle = 1)
- The 3-to-8 Decoder activates the corresponding line for the chosen comic, enabling all relevant modules (price, rarity, stock, and genre recommendation).



3. Viewing Base Price and Tax

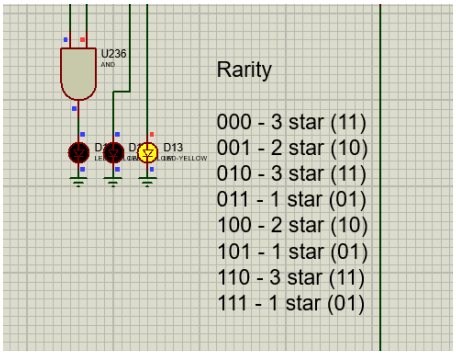
- The Base Price Module displays the original price of the selected comic on two seven-segment displays.
- The Rarity Module determines the tax amount based on the rarity level (1-star to 3-star) using 2-bit input through multiplexers.

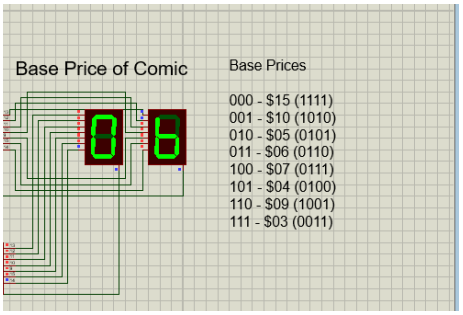
- The final price, including tax, is shown in the “Price Including Tax” display.



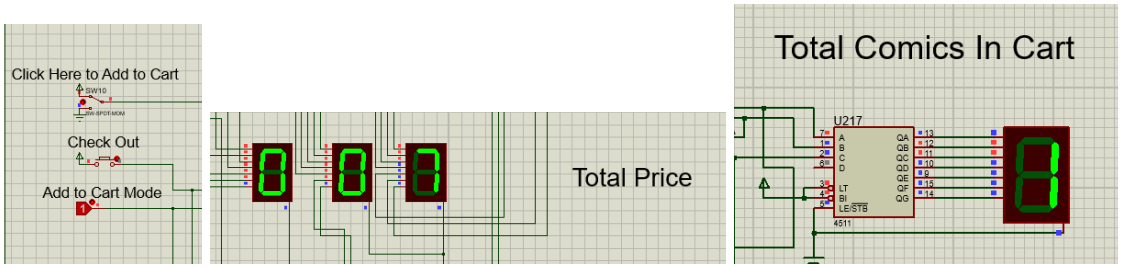
4. Adding to Cart

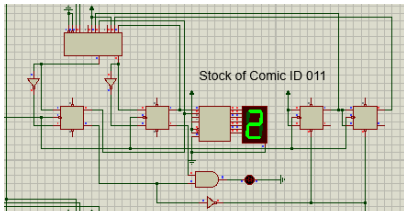
- After selecting a comic and viewing its price, set Add to Cart Mode = ON(1).
- Press the “Add to Cart” Switch (SPDT) to simulate purchasing that comic(Try to pulse it. It will require a quick clock pulse to work).
- The following updates occur automatically:
    - **Running Total**: Updated using three BCD Adders.
    - **Stock**: Decrements by 1 using a 2-bit down counter.
    - **Sales**: Increments by 1 using a 3-bit up counter.
    - **Total Comics in Cart**: Increments by 1 using an asynchronous counter.
- The DEMUX ensures the clock pulse affects only the selected comic’s stock and sales

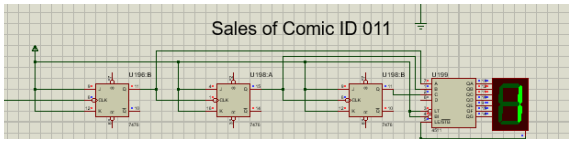




counters.

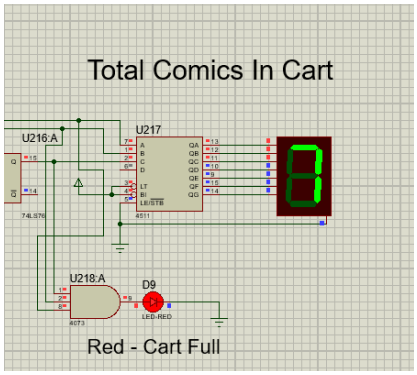


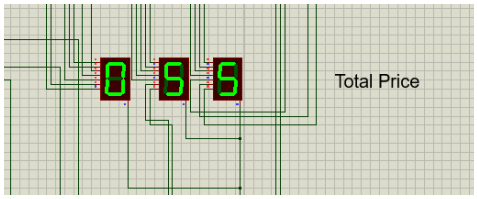




5. Checking Cart and Limits

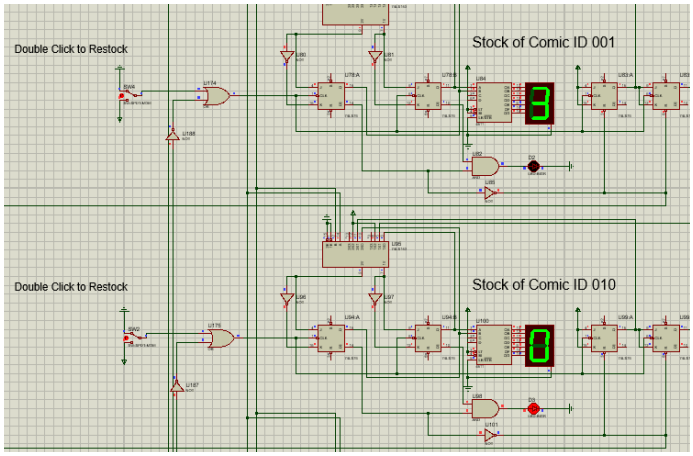
- The Running Total Display shows the accumulated cost of all comics added to the cart.
- The Total Comics Display shows how many comics are currently in the cart.
- If 7 comics have been added (maximum limit), a Red LED lights up, preventing further additions to the cart until checkout is performed.

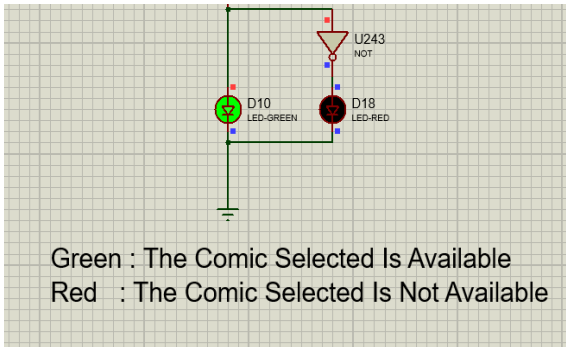




6. Checking Stock

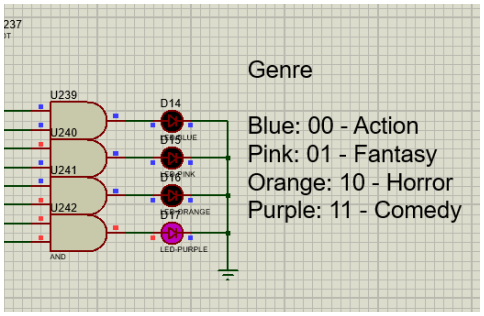
- Each comic has a 2-bit Stock Register (0–3 copies).
- If a comic is available, then a Green LED remains ON beside it, indicating that the selected comic is available.
- If a comic's stock reaches 0, then a Red LED turns ON beside it, indicating that the comic is out of stock. It's our queue to manually restock that comic.

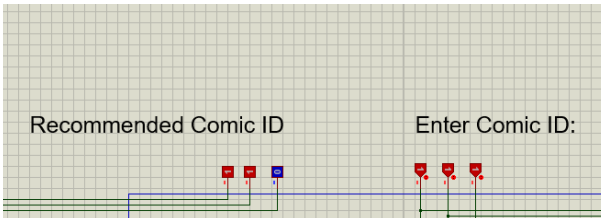




7. Genre Recommendation

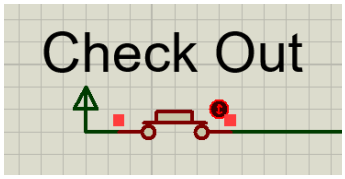
- Once a comic is selected, the Genre Recommendation Module activates.
- The genre is displayed through genre-specific LED colors:
  - Blue → Action
  - Pink → Fantasy
  - Orange → Horror
  - Purple → Comedy
- If the selected comic is unavailable (stock = 0), the Priority Encoder and MUX logic automatically recommends another comic from the same genre (or next highest priority if unavailable).
- The Recommended Comic ID is shown via Logic Probes.

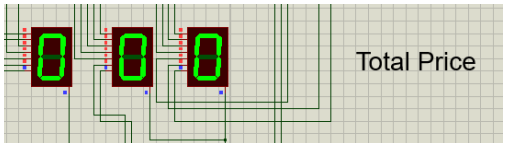


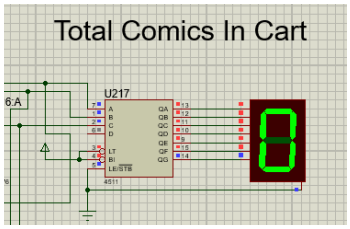


8. Checkout and Reset

- When ready to finalize the purchase, press the Checkout Button.
- This action performs:
    - Reset of Running Total
    - Reset of Total Comics in Cart
- The stock and sales counters remain unchanged (for record keeping).

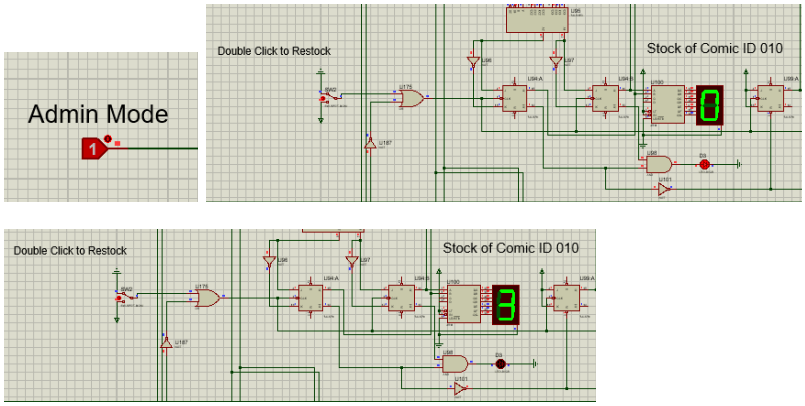






9. Admin Mode (Restocking)

- Switch Admin Mode = ON(1) to enable restocking.
- Use the “Double Click to Restore” switches (try to pulse the switch twice) to restock each comic back to its maximum inventory (3 copies).
- LEDs for out-of-stock comics will turn OFF after restocking.
- Turn Admin Mode = OFF after restocking to return to normal operation.



System Indicators Summary

Indicator Type	Description	Color/Display
Stock Available	Comic in stock	Green LED
Stock Out	Comic out of stock	Red LED
Max Cart Limit	7 comics added	Red LED
Rarity Level	1-star to 3-star	Yellow LEDs
Genre Indicator	Action / Fantasy / Horror / Comedy	Blue / Pink / Orange / Purple LEDs
Recommended Comic	Logic Probe Output	Logic Probe (CID)

Precautions

To ensure stable and accurate operation of the Comic Cart, a few precautions should be followed while testing or demonstrating the circuit:

1. **Avoid excess clock pulses:**
   Do not press the “Add to Cart” switch more than three times for the same comic. Each comic has a maximum stock of 3, and exceeding this limit (i.e., adding after it is sold out) may cause incorrect behavior in other modules such as stock management, total price calculation, or sales tracking.

2. **Proper mode switching:**
   Always make sure that Admin Mode and Add to Cart Mode are not active simultaneously, as this can interfere with the normal counting and register operations.
3. **Reset before restarting:**
   Always perform a checkout to reset the Comic Cart before beginning a new purchase cycle to clear the running total and prevent overlap from previous sessions.
4. **Safe restocking:**
   Only activate Admin Mode when restocking. Switching it on during normal operation can cause the system to overwrite stored data unexpectedly. Also do double click as doing it so the counters will also be restored and the module will be prepared perfectly for the next purchase. And restock only when stock reaches 0.

Conclusion

The Comic Cart project is a real life example of how digital logic can bring an imaginative idea to life. Built entirely with logic gates, multiplexers, decoders, counters, and flip-flops, we built a system that selects, calculates, manages stock, and even recommends comics, all without any programming.

Through this project, we discovered the real value of modularity. Each part of the system operates as an independent yet reusable block that works seamlessly with others. This approach made the design easier to test, expand, and understand.

The scope of the project reaches beyond vending comics. The same logical framework could be extended to other real-world systems like digital vending machines, automated counters, or simple recommendation tools, proving that complex projects can be built purely from logic.

Ultimately, Comic Cart became more than just a lab project—it reflected our teamwork, creativity, and understanding of how digital circuits can model real-life interactions. It stands as a reminder that even with the simplest tools of logic, meaningful systems can be designed with both structure and imagination.