02_TG_Binary_Input_Counter

Instructor Notes: Module 02 – Binary Input Counter (DIN Simul8)

Module Purpose

This module introduces students to the concept of digital input reading and binary counting using Structured Text (ST). Students learn how to monitor the state of physical switches via the DIN Simul8 module and represent those states as a single binary number. This forms the basis for more complex control systems where multiple inputs determine system behavior. Instructors should focus on explaining how digital inputs are mapped, how binary numbers represent switch states, and how to use bitwise logic (AND) to manipulate outputs based on the input count. Instructors should emphasize how structured logic maps cleanly to visual input states and reinforce this with live input toggling and LED changes during the lab session.

Reference material: Arduino Explore PLC – DIN Simul8 Digital Inputs

---

Pre-Lab Setup

This module uses **pre-wired hardware only**. Students do not connect any physical inputs or outputs.

Required Hardware

- Arduino Opta WiFi (AFX00002)
- DIN Simul8 Module
- 24V DC Power Supply (barrel jack)
- USB-C to USB-A cable
- Jumper wires (20–22 AWG, pre-cut)
- Laptop with Arduino PLC IDE v1.0.3 or newer

Wiring Instructions

Wiring Length Reference

From (DIN Simul8)	To (Opta Input)	Recommended Length	Notes
X0	I1	12 cm	Route cleanly along edge of DIN rail
X1	I2	13 cm	Crosses one signal wire; avoid overlap
X2	I3	14 cm	Allow slight slack to accommodate bend radius
X3	I4	15 cm	Can be bundled with X2 → I3
X4	I5	16 cm	Route under power leads if possible
X5	I6	17 cm	Avoid routing near 24V barrel connector
X6	I7	18 cm	Use shortest path across board to reduce clutter
X7	I8	19 cm	End of array; route behind others if needed
GND	Opta GND	10 cm	Common GND; keep away from input bundle

Additional Notes

- Use 20-22 AWG stranded wire.
- Color coding:
  - Red for +24V
  - Black for GND
  - White, Blue or Green for signal (X0 - X7)

Power

- Connect 24V DC power to both:
  - Opta VIN terminals (+24V and GND)
  - DIN Simul8 +24V and GND terminals

Signal

- Connect DIN Simul8 outputs to Opta inputs:
  - X0 → I1
  - X1 → I2
  - ...
  - X7 → I8

> Ensure **shared GND** between all devices.
> Test continuity between each X# → I# pair before powering the system.

“../../03_assets/02_Binary_Input_Counter/02_wiring.png” could not be found.

Pre-Test Program

Use this logic to validate LED output before class:

```
VAR
  switchCount : INT := 0;
END_VAR

switchCount := 0;

IF Input_1 THEN switchCount := switchCount + 1; END_IF;
... (repeat for Input_2 through Input_8)

LED_4 := (switchCount AND 1) <> 0;
LED_3 := (switchCount AND 2) <> 0;
LED_2 := (switchCount AND 4) <> 0;
LED_1 := (switchCount AND 8) <> 0;
```

Structured Text Code

“../../02_code_samples/02_Binary_Input_Counter.st” could not be found.

LED Output Map

“../../03_assets/02_Binary_Input_Counter/02_led_output_mapping.png” could not be found.

Variable Mapping Diagram

“../../03_assets/02_Binary_Input_Counter/02_programmable_inputs_mapping.png” could not be found.

Learning Outcomes to Assess

Students should:

- Correctly describe how switch states convert to binary
- Understand `switchCount` logic and the use of AND masks
- Successfully upload and run their code on the Opta
- Explain which LEDs should be active for a given input count

---

Suggested Reflection Questions

- Why is a counter variable used instead of just checking each switch directly?
- How does bitwise logic allow you to control multiple LEDs from one value?
- What real-world systems use similar logic for input counting?
- How could incorrect wiring or GND errors affect binary counting?

Common Student Issues

Symptom	Fix
No LEDs at all	Runtime not in RUN mode
Upload fails	Bootloader not flashed
Wrong LEDs lighting	Simul8 wired incorrectly
Inputs appear stuck	GND not properly shared

Suggested Instructor Folder Structure

```
/Instructor/
├── Module_02_Instructor_Notes.md
```

```
├── Simul8_Wiring_Diagram.png
├── Pre-Test_Code.st
└── Module_02_Presentation.pptx
```

Instructor Checklist

- [ ] System powered and confirmed operational
- [ ] All 8 Simul8 inputs tested
- [ ] LED binary output verified
- [ ] IDE configured and Opta connected
- [ ] Student environment ready (no exposed wiring)

Images and structure adapted from the official Arduino Explore PLC course under CC BY-SA 4.0 license. Attribution is required for reuse.