

01_TG_First_Steps

Module 01 – First Steps with Arduino Opta

Estimated Duration: 1 hour

Format: Hands-on + IDE walkthrough

Prerequisites: None

Module Purpose

This module introduces the core concept of digital input-to-output control using Ladder Logic in a PLC environment. It is designed to help students understand how a basic input (a button) can be mapped and used to control an output (an LED) entirely through internal logic, without requiring external wiring.

The focus is on:

- Understanding internal I/O mapping on the Arduino Opta (e.g., BTN_USER as a digital input mapped to PC13, and LED_BUILTIN mapped to PA5)
- Writing a single-rung Ladder Logic program
- Executing control logic using the Arduino PLC IDE
- Gaining familiarity with the PLC runtime environment (e.g., bootloader flashing, switching to RUN mode)

This foundational exercise simulates how industrial PLCs process binary (on/off) signals and execute programmed responses in real time, which is essential before advancing to more complex external wiring or analog logic in later modules.

Where this is taught:

- Code logic is introduced in the Student Guide and demo .st file
 - Button/LED mapping is described in Arduino's Getting Started Guide
 - Additional clarification provided via input/output mapping diagrams and ladder screenshots in the GitHub 03_assets folder
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Learning Objectives

By the end of this module, students will be able to:

- Power and connect the Arduino Opta via USB-C for logic programming
 - Install and launch the Arduino PLC IDE
 - Upload a basic Ladder Logic program to control an onboard LED using the USER button
 - Understand basic variable mapping and runtime management
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Materials Required

- Arduino Opta WiFi (AFX00002)
 - USB-C to USB-A cable (official or equivalent)
 - Windows 10 or 11 laptop
 - Arduino PLC IDE 1.0.3 or later
- <https://www.arduino.cc/en/software#arduino-plc-ide>
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Setup Instructions

1. Connect and Power the Opta

- Connect the Opta to your computer via USB-C
- No external 24VDC is required for this module
- LED indicators will confirm board power

2. Install and Launch the Arduino PLC IDE

- Download and install the IDE
 - Open the IDE and create a new project
 - Select board target: Arduino Opta (AFX00002)
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First Program: Button-Controlled LED

Step-by-Step

1. Create a new Ladder Diagram program

Ladder Logic in IDE

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Ladder Logic in text

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2. Insert a Normally Open (NO) contact and map it to `BTN_USER`
3. Insert a Coil and map it to `LED_BUILTIN` or `PA5`
4. Link the contact and coil in a single rung

LED Mapping

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Programmable Input Mapping

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Variable Mapping

- `BTN_USER` → Internal digital input mapped to `PC13`
- `LED_BUILTIN` or `PA5` → Onboard user LED

Variable Mapping Table

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Upload and Test

- Flash bootloader via **Tools** → **Runtime** → **Flash Bootloader** (if required)
- Activate the runtime and switch to **RUN** mode
- Press the USER button — the onboard LED should illuminate

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Troubleshooting

Symptom	Cause	Solution
LED doesn't respond	Runtime is not active	Set PLC to RUN mode in IDE
BTN_USER not recognized	Variable mapping not defined	Assign PC13 to BTN_USER under Resources

Completion Checklist

- ☐ Program uploaded successfully
 - ☐ LED turns on when USER button is pressed
 - ☐ Runtime stays active
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Key Terms

- **BTN_USER** – Internal pushbutton on the Opta (PC13)
 - **LED_BUILTIN** – Internal LED on the Opta (PA5)
 - **Ladder Logic** – Graphical PLC programming language based on relay logic
 - **Runtime Mode** – Active execution mode for the PLC program
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Tools Required

- Windows laptop with Arduino PLC IDE
 - USB-C to USB-A cable
 - No external power supply or wiring required
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Resources

- Student Guide: `01_SG_First_Steps.md`
- Variable Mapping: `../03_assets/01_first_steps/01_button_mapping.png`

- Ladder Logic Example: `../03_assets/01_first_steps/01_ladder_logic.png`
- Arduino Course – Getting Started:
<https://courses.arduino.cc/explore-plc/lessons/getting-started/>

This module includes material adapted from the official Arduino Explore PLC course under the Creative Commons CC BY-SA 4.0 license. Attribution is required for reuse.

This module introduces the foundational steps for working with the Arduino Opta using safe internal components. It prepares students for future modules involving external digital inputs and outputs.