



DesignNews

Getting Started in Automation with Arduino

DAY 3: Wiring and Testing Automation Controls

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Dr. Don Wilcher

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Course Kit and Materials

Arduino Opta



12VDC @ 500mA Wall Mount Power Supply



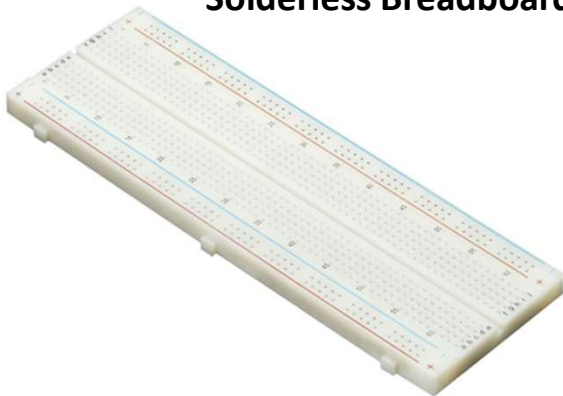
DC Motor: Medium Torque



Adafruit Parts Pal Kit



Solderless Breadboard



Jumper Wires: Male to Male



Solderless Breadboard Power Supply



Agenda:

- Basic Logic Gates
 - a) AND Gate
 - b) OR Gate
 - c) NOT(Inverter) Gate
 - d) The Importance of Knowing Them
- AI-assisted Logic Function-based automation applications for the Arduino Opta
- Wiring 2 Pushbutton Switches to the Arduino Opta
- Lab: Programming an Arduino Opta Ladder Diagram Logic Function



Seminal Research Perspective



“Programmable Logic Controller (PLC) is the most important component in industrial automation, and it has become one of the three pillars (robots, PLC, and CAD/CAM) of the modern industrial control technology”(Liao, 2007).

Basic Logic Gates

- Basic Logic Gates are at the core of industrial controllers like PLCs.
- Basic Logic Gates allow PLCs to make low-level decisions based on received electrical control signals.
- Basic Logic Gates provide the interfacing “glue” to connect real-world physical switching devices to PLCs.
- The Arduino Opta micro-PLC can be programmed to perform basic logic gate functions.
- The Basic Logic Gates that the Arduino Opta micro-PLC can perform are:
 - a) the AND Gate.
 - b) the OR Gate.
 - c) the NOT or the Inverter Gate.



Question 1

Basic Logic Gates provide the interfacing _____ to connect real-world physical switching devices to PLCs.

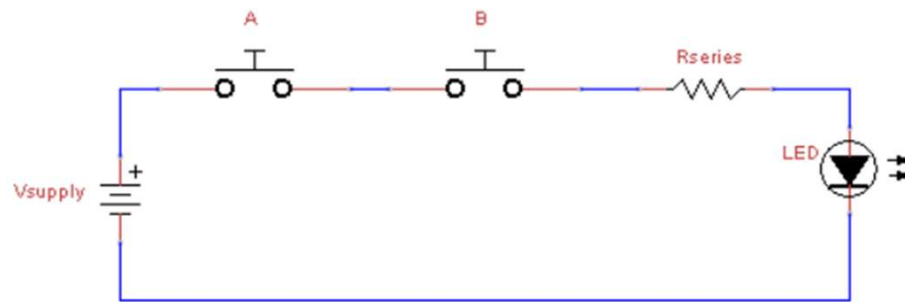
- a) adhesive**
- b) tape**
- c) glue**
- d) paper clip**



Basic Logic Gates: The AND Gate

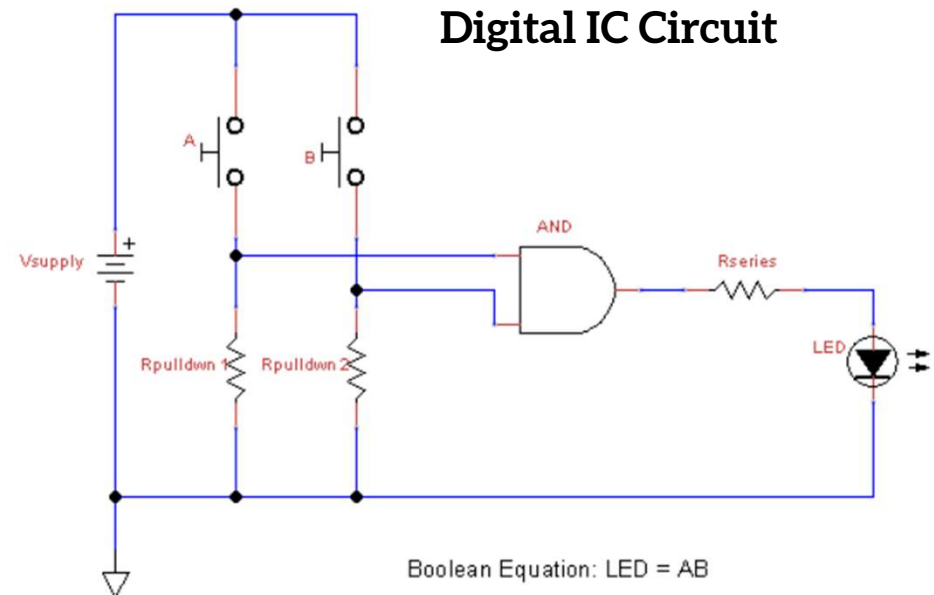


Electrical Switch Circuit



Boolean Equation: $LED = AB$

Digital IC Circuit

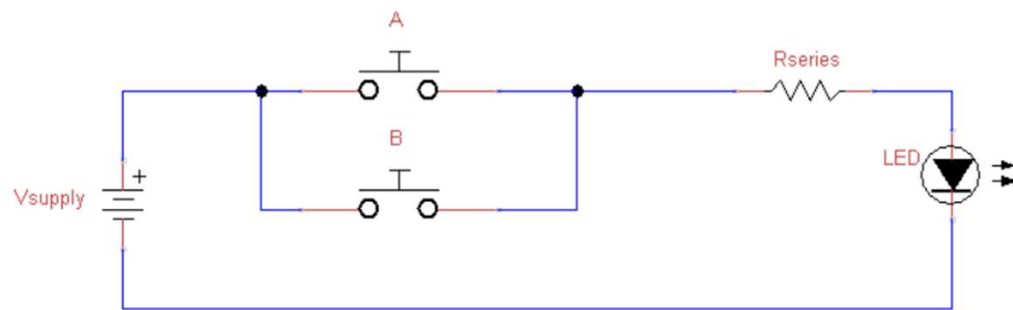


Boolean Equation: $LED = AB$

Basic Logic Gates: The OR Gate

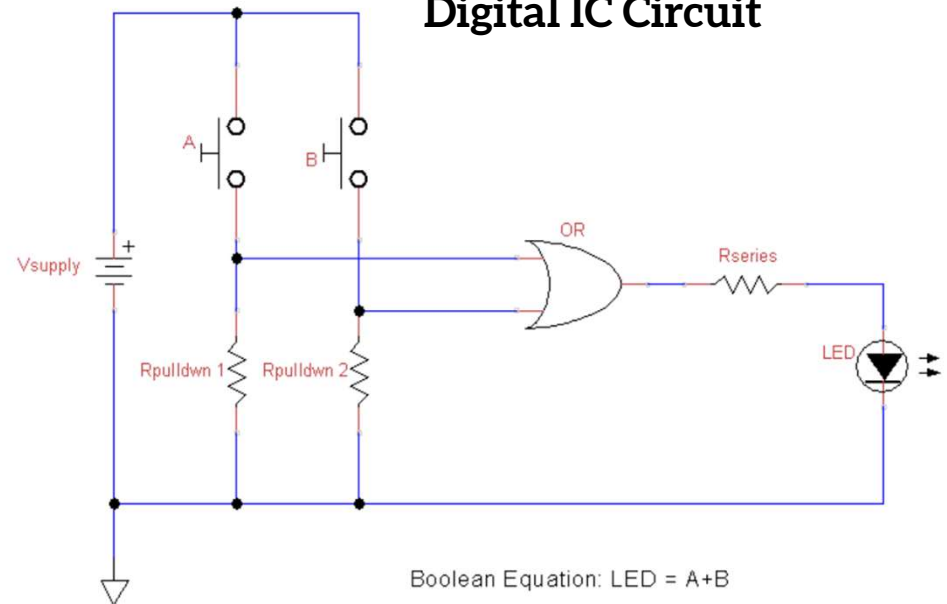


Electrical Switch Circuit



Boolean Equation: $LED = A + B$

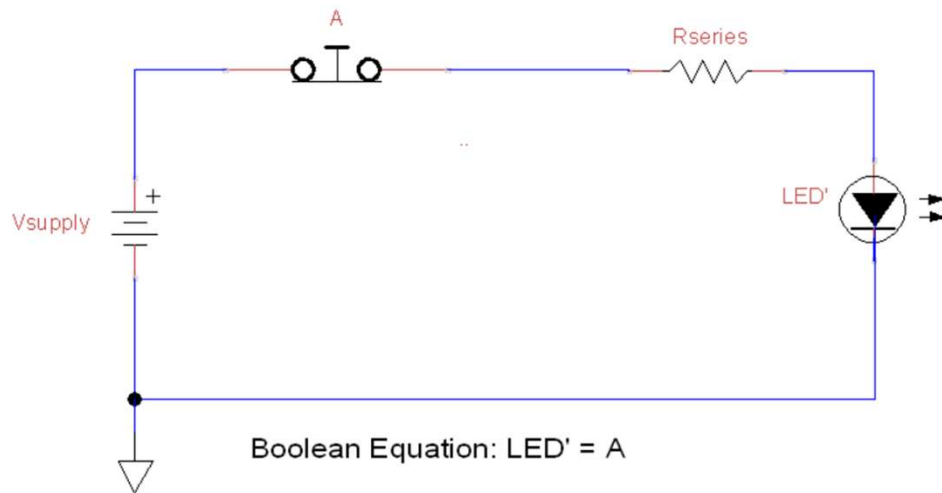
Digital IC Circuit



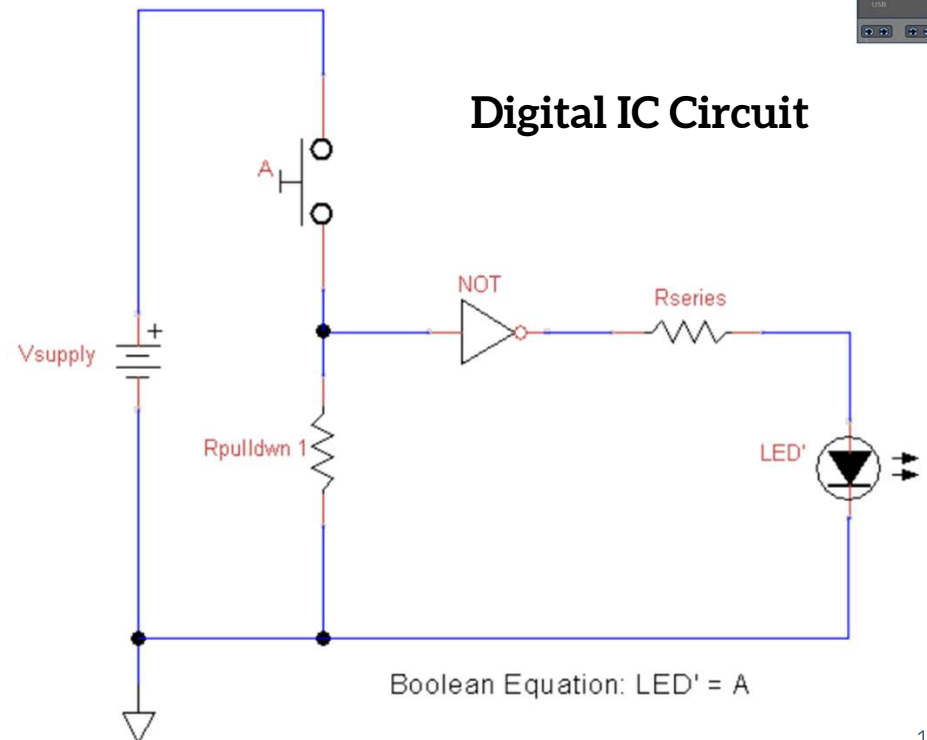
Boolean Equation: $LED = A + B$

Basic Logic Gates: The NOT (Inverter) Gate

Electrical Switch Circuit



Digital IC Circuit



Basic Logic Gates: The Importance of Knowing Them



- Having knowledge of basic logic gates allows for the implementation of their operational function in software using Ladder Diagrams (Allaboutcircuits, n.d.).
- Having knowledge of basic logic gates allows for proper planning of physical devices like digital switches and actuators to be wired appropriately to implement the Boolean functions correction (Allaboutcircuits, n.d.).
- Knowing basic logic gates allows Ladder Diagram software debugging and hardware troubleshooting with rationale on PLC-based automation systems.
- By combining basic logic gates, complex logic functions can be built for sophisticated processes.

Basic Logic Gates: The Importance of Knowing Them

Troubleshooting a NOT logic gate implemented on a PLC

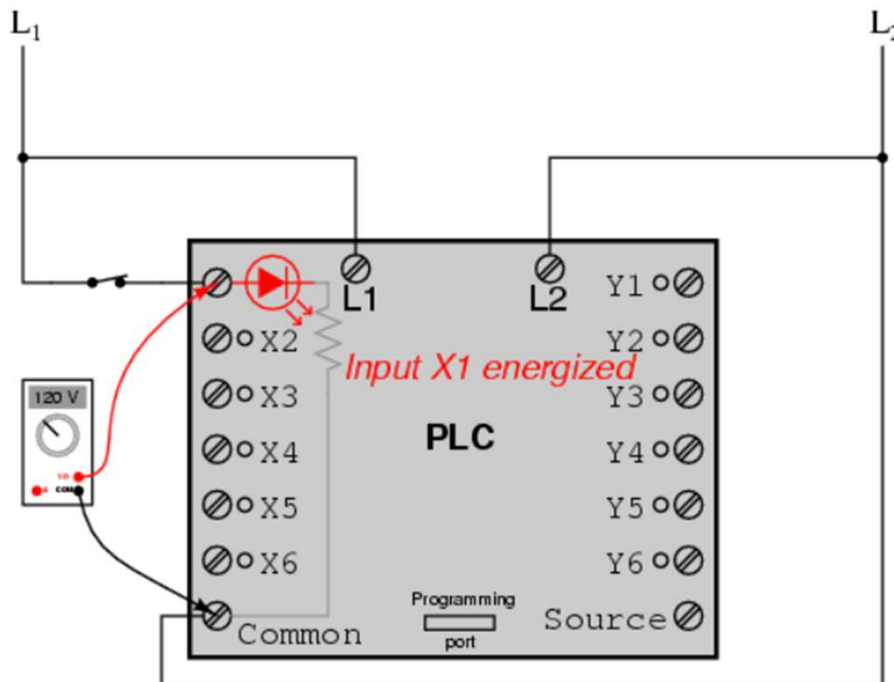


Image source:
Allaboutcircuits.com



Basic Logic Gates: The Importance of Knowing Them

Implementing a Complex logic function using basic logic gates

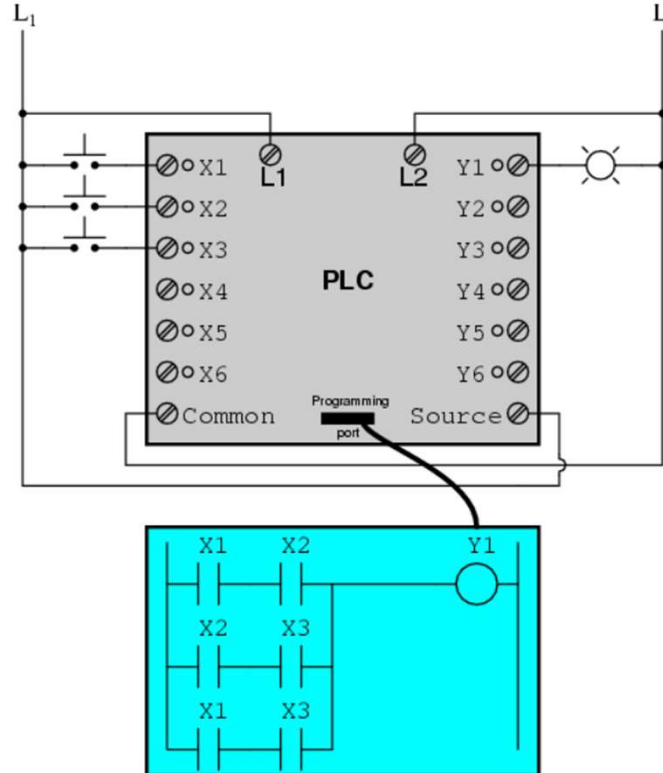


Image source:
Allaboutcircuits.com



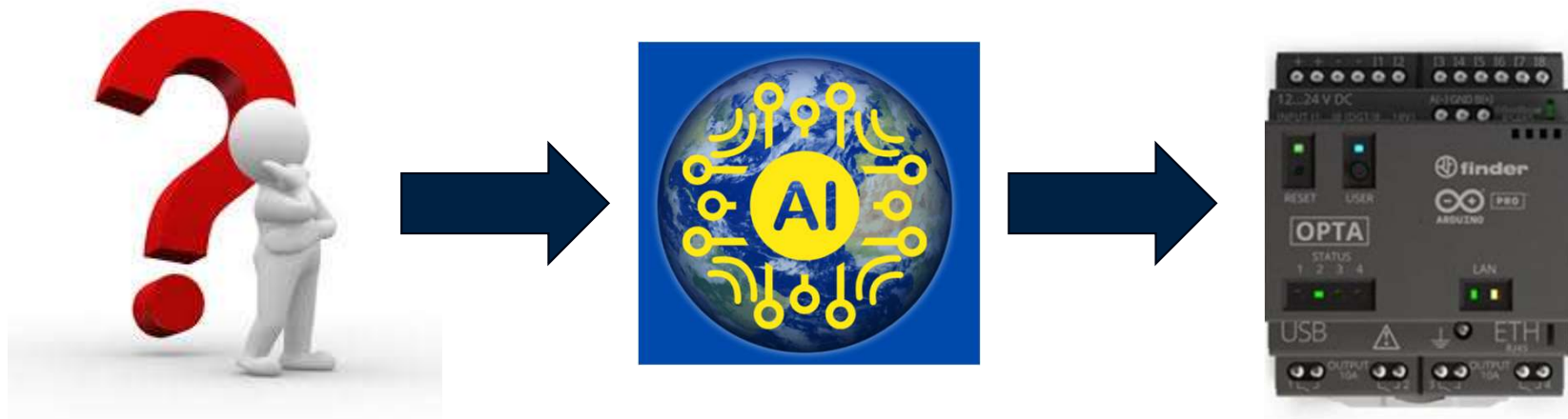
Question 2

In reviewing slide 14, what Complex logic function is implemented within the PLC?

- a) OR**
- b) AND**
- c) AND-OR**
- d) None of the above**



AI-assisted Logic Function-based Automation Applications for the Arduino Opta



What Automation concepts can be generated for the Arduino Opta using a Large Language Model?

AI-assisted Logic Function-based Automation Applications for the Arduino Opta . . .



Please describe some Automation applications implemented on an Arduino Opta using basic logic gates.



The Arduino Opta itself doesn't directly implement logic gates in hardware. It utilizes a microcontroller that can be programmed to mimic logic gate functionality. However, by using the Arduino Opta's digital pins and programming, you can create various automation applications based on basic logic gate principles (AND, OR, NOT). Here are some examples:

1. Automatic Light Control System (AND Gate):

- **Components:** Arduino Opta, Light bulb, Photoresistor (light sensor), Switch
- **Logic:** - Connect the photoresistor to an analog input pin of the Arduino Opta.
 - Connect the switch to a digital input pin.
 - Connect the light bulb to a digital output pin.

- **Programming:** - Read the value from the photoresistor (low light level = high reading).
 - Read the switch state (on/off).
 - Use an AND logic function in your code. The light turns on only if BOTH conditions are met: It's dark (sensor reading is high) AND the switch is turned on.

AI-assisted Logic Function-based Automation Applications for the Arduino Opta . . .



2. Simple Security System (OR Gate):

- **Components:** Arduino Opta, Buzzer, Two pressure mats (one for each entry point)
- **Logic:** - Connect each pressure mat to a digital input pin.
 - Connect the buzzer to a digital output pin.
- **Programming:** - Read the state of each pressure mat (pressed/not pressed).
 - Use an OR logic function in your code. The buzzer sounds if EITHER pressure mat is pressed (indicating someone entered).

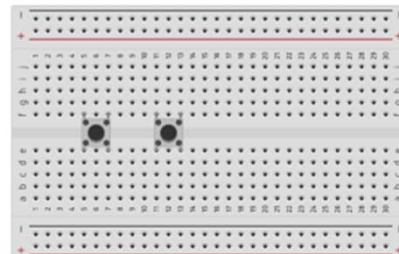
3. Automatic Watering System (NOT Gate):

- **Components:** Arduino Opta, Water pump, Soil moisture sensor
- **Logic:** - Connect the soil moisture sensor to an analog input pin.
 - Connect the water pump to a digital output pin.
- **Programming:** - Read the value from the soil moisture sensor (high reading = dry soil).
 - Use a NOT logic function in your code. The pump turns on ONLY if the soil is dry (sensor reading is high).

These are just basic examples. By combining these logic gates and adding more sensors and actuators (outputs), you can create more complex automation applications for your home or projects. Remember, the Arduino Opta provides the platform to implement these logic functions through code.

Wiring 2 Pushbutton Switches To the Arduino Opta...

2 Pushbutton Switches Simulator



Control Signals



A Prototyping
Concept for a
Digital Switch
Simulator

Wiring 2 Pushbutton Switches To the Arduino Opta: . . . A Prototyping Concept for a Digital Switch Simulator

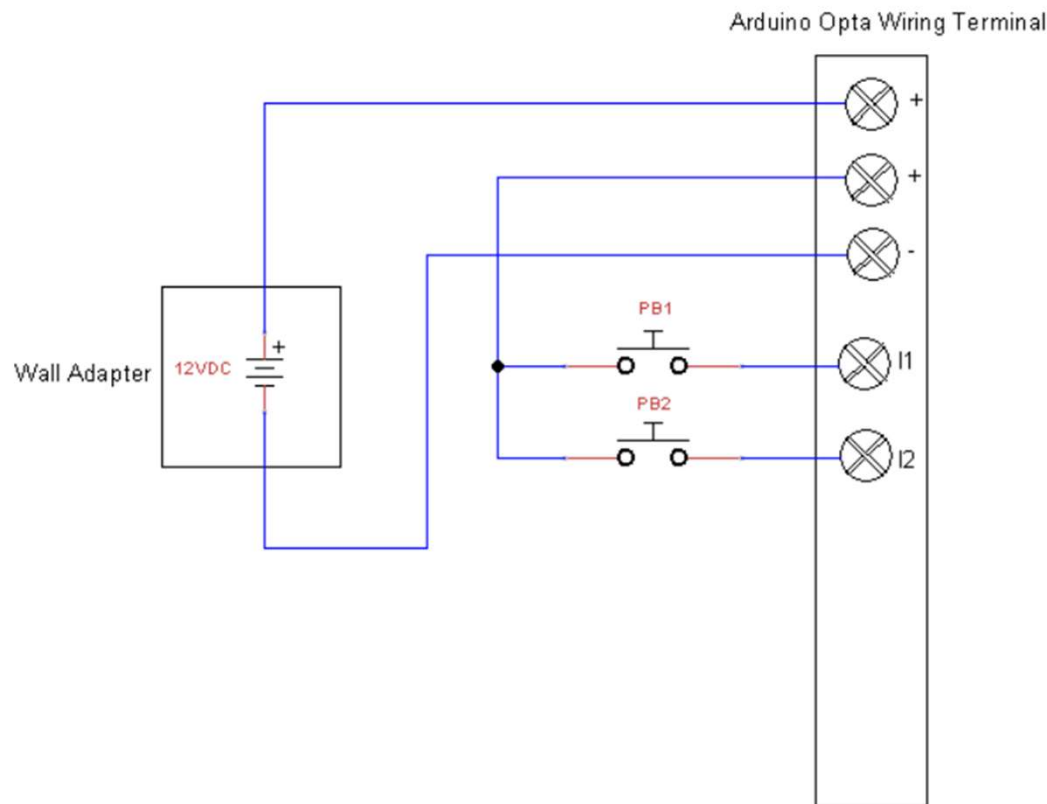


The Digital Switch Simulator provides the following benefits.

- a) Allows testing the LD logic.
- b) Allows the simulation of industrial digital switches without real devices.
- c) Allows testing the electrical interfacing connections between the industrial digital switching device and the Arduino Opta Wiring Terminal.
- d) It allows for the prototyping of complex control concepts without an expensive investment in industrial components. Saves \$\$\$

Wiring 2 Pushbutton Switches To the Arduino Opta...

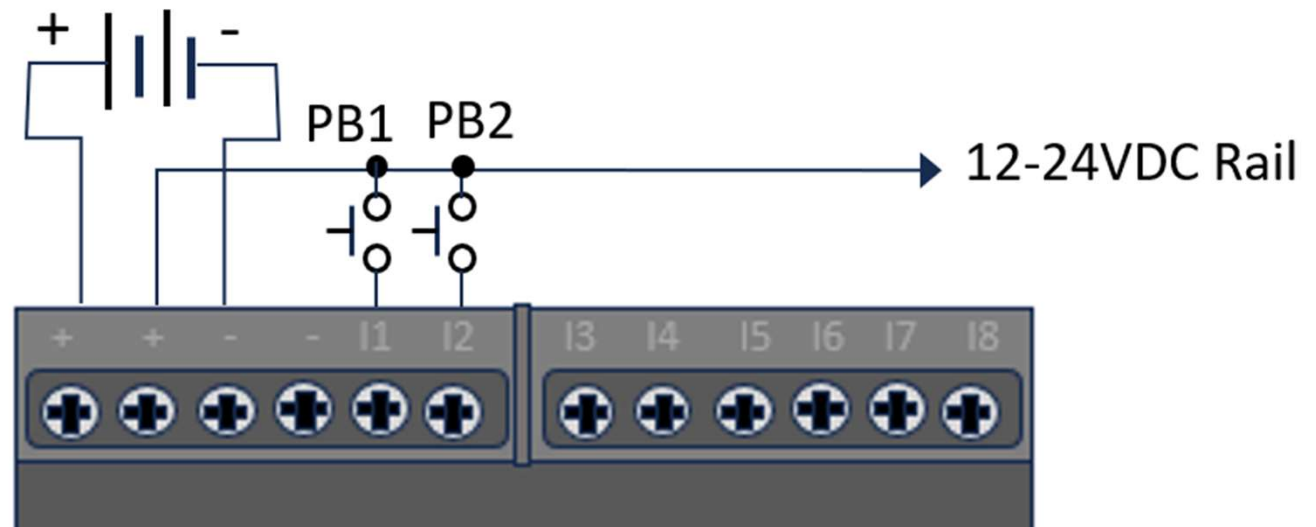
A Prototyping Concept for a Digital Switch Simulator: Input Terminal Wiring Diagram



Wiring 2 Pushbutton Switches To the Arduino Opta...

2 tactile pushbutton switches are wired to the terminal points I1 and I2 of the Arduino Opta.

12-24VDC Power Supply



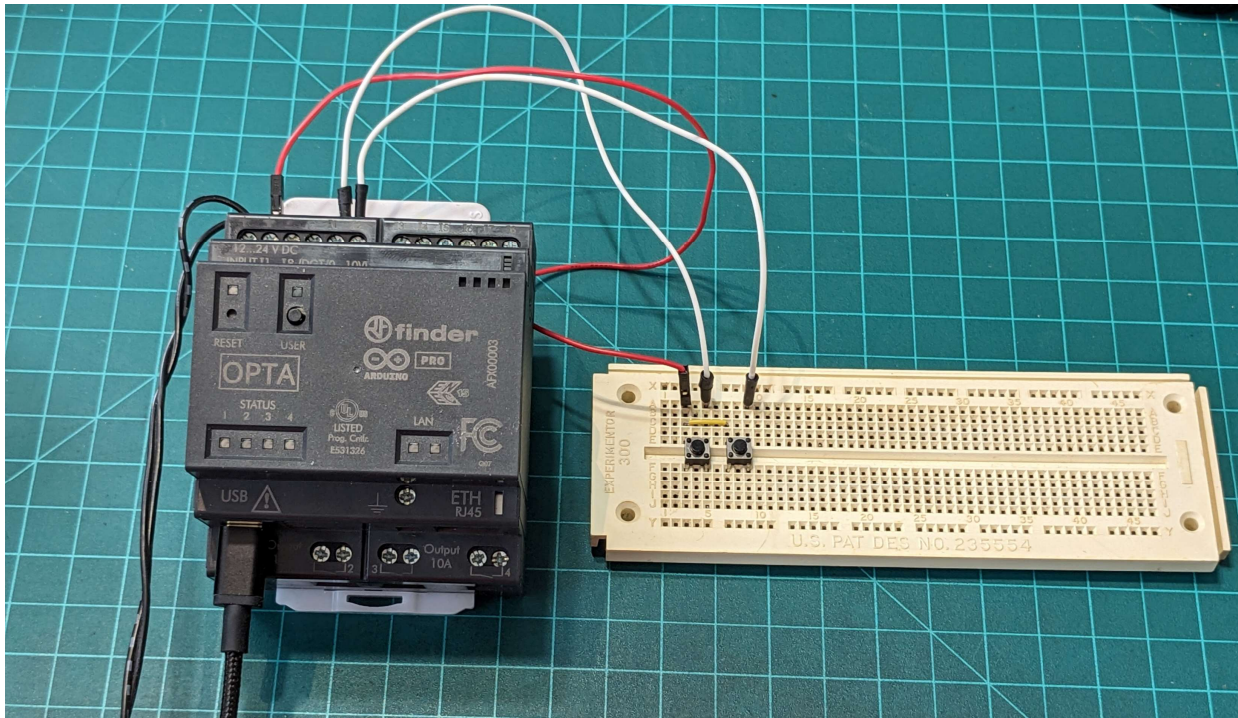
Question 3

When PB1 or PB2 are closed, what voltage is applied to I1 or I2 terminal points?

- a) +24VDC**
- b) -24VDC**
- c) +12VDC**
- d) -12VDC**



Lab: Programming an Arduino Opta Ladder Diagram Logic Function



Lab: Programming Arduino Opta Ladder Diagram Logic Functions...



Lab Objectives:

- Participants will learn to set up communications using the Arduino PLC IDE.
- Participants will learn to create a Ladder Diagram Logic Function program using the Arduino PLC IDE.
- Participants will learn to download, run, and test a Ladder Diagram Logic Function program.

Lab: Programming an Arduino Opta Ladder Diagram Logic Function. . .

The AND Gate Logic Function: Simulating An Automatic Light Control System



1. Automatic Light Control System (AND Gate):

- **Components:** Arduino Opta, Light bulb, Photoresistor (light sensor), Switch
- **Logic:** - Connect the photoresistor to an analog input pin of the Arduino Opta.
 - Connect the switch to a digital input pin.
 - Connect the light bulb to a digital output pin.
- **Programming:** - Read the value from the photoresistor (low light level = high reading).
 - Read the switch state (on/off).
 - Use an AND logic function in your code. The light turns on only if BOTH conditions are met: It's dark (sensor reading is high) AND the switch is turned on.

The AI-assisted Automation project will be implemented on an Arduino Opta. The AND Gate Logic function will be developed by.

- PB1 will simulate the light sensor
- PB2 will simulate an ordinary switch

Lab: Programming an Arduino Opta Ladder Diagram Logic Function...

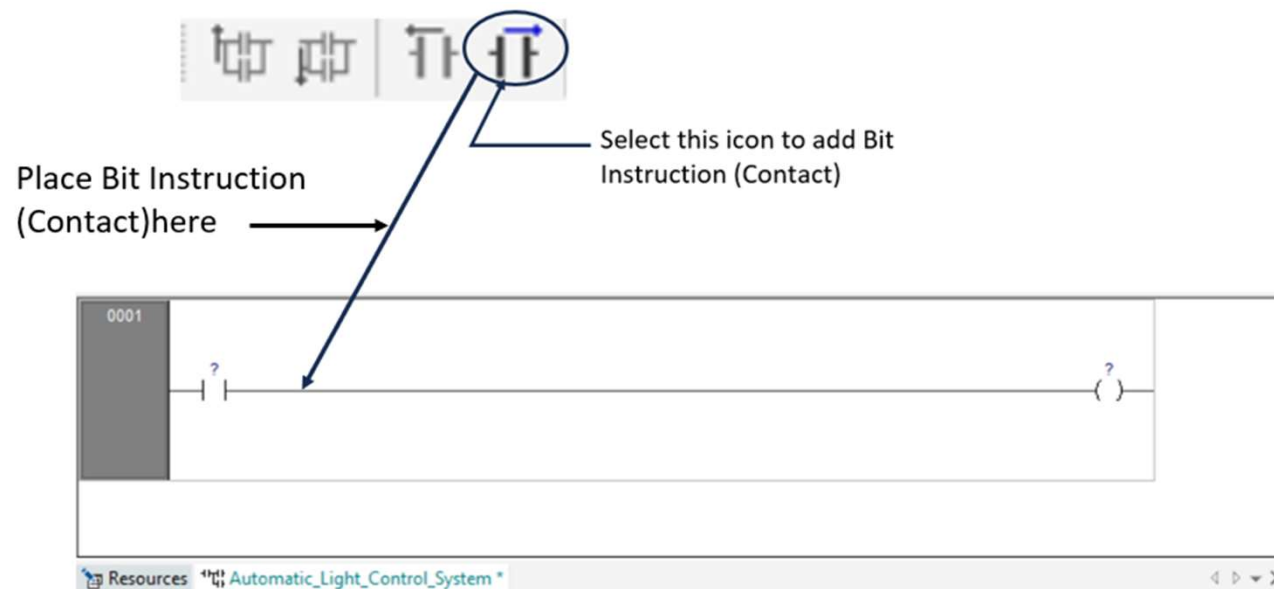
The AND Gate Logic Function: Simulating An Automatic Light Control System

To create the project and build the LD program rung. Note: Refer to Day 2 ppt/pdf and use slides 29 – 32 and 34 -35.



Lab: Programming Arduino Opta Ladder Diagram Logic Functions...

The AND Gate Logic Function: Simulating An Automatic Light Control System



Lab: Programming Arduino Opta Ladder Diagram Logic Function...

The AND Gate Logic Function: Simulating An Automatic Light Control System



Type Names (Tags) here for I1 and I2 terminals

#	Name	Variable	I/OType	Type	DataBlock	Description
1	I1	Light_Sensor	Digital	BOOL	%IW0.0	I1 programmable input
2	I2	Switch	Digital	BOOL	%IW0.1	I2 programmable input
3	I3		Digital	BOOL	%IW0.2	I3 programmable input
4	I4		Digital	BOOL	%IW0.3	I4 programmable input
5	I5		Digital	BOOL	%IW0.4	I5 programmable input

Click Here to open Programmable inputs mapping table

Question 4

What button in the Resources window allows access to the Programmable inputs mapping table?

- a) LED Outputs**
- b) Status variables**
- c) Programmable Inputs**
- d) Button Inputs**



Lab: Programming Arduino Opta Ladder Diagram Logic Function...

The AND Gate Logic Function: Simulating An Automatic Light Control System

Repeat the step for the remaining Contact and Coil (OTE Instruction). The second contact is labeled -Switch, and the OTE bit is labeled LED_Switch.

The screenshot displays the Opta Ladder Logic software interface. On the left, the Project tree shows the 'Automatic_Light_Control_System' project. The main workspace shows a ladder logic diagram with two contacts and a coil. A dialog box is open for configuring the second contact, with the name 'Light_Sensor' entered. Annotations with arrows point to specific elements: 'Click Here to Open LD program-' points to the project name in the tree; 'Double Click on Contact to open LD Properties box' points to the second contact in the diagram; and 'Type Name of Bit Instruction' points to the 'Name' field in the dialog box.

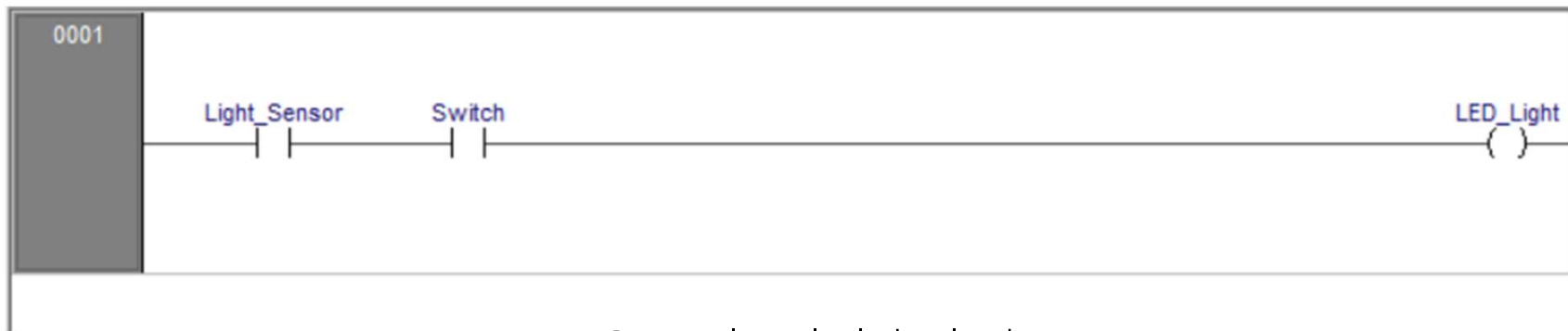
Click Here to Open LD program-

Double Click on Contact to open LD Properties box

Type Name of Bit Instruction

Lab: Programming an Arduino Opta Ladder Diagram Logic Function...

The AND Gate Logic Function: Simulating An Automatic Light Control System



Completely labeled LD Rung

Download LD program to the Arduino Opta using slides 36 and 37 from Day 2 ppt/pdf.

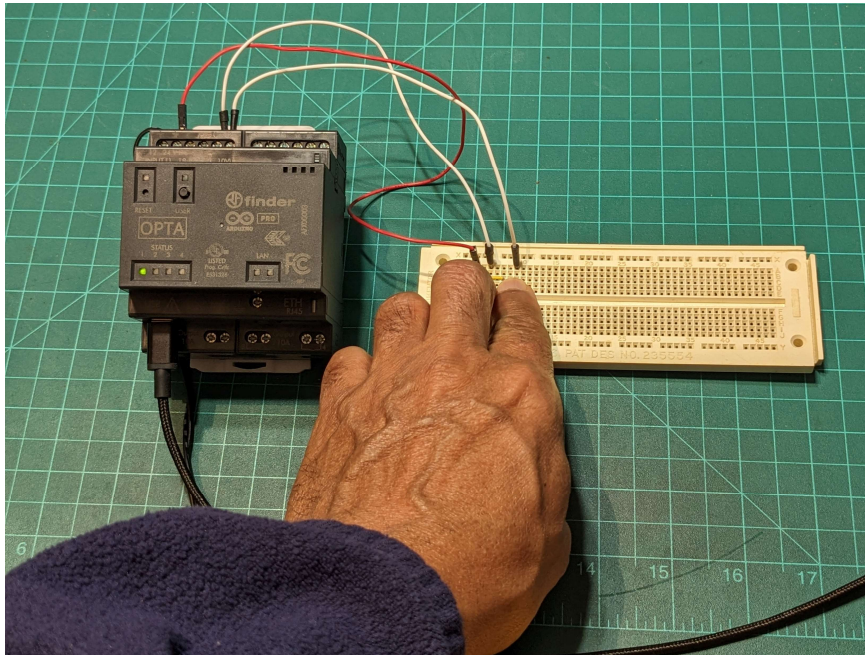
Lab: Programming an Arduino Opta Ladder Diagram Logic Function. . .

The AND Gate Logic Function: Simulating An Automatic Light Control System

Functional Automatic Light Control System – AND Gate Logic Simulator

Watch Video Clip!

<https://youtu.be/r1xgHlo0rBo>



Question 5

What box allows labels to be added to the LD rung's bit instructions?

- a) LD program**
- b) Resources window**
- c) LD Properties**
- d) Properties**



Thank you for attending

Please consider the resources below:

Bagur, J. ,& Linares, J . C. (2023, March 11). Opta user manual. <https://docs.arduino.cc/tutorials/opta/user-manual/>

Finder.(n.d.). Getting started with arduino opta. <https://opta.findernet.com/en/tutorial/getting-started>

Liao, C.C. (2007). *Programming and application of S7-200 plc* (3rd ed.). Mechanical Industry Press.

Mandal. R, Maity, T., Prasad, G.M., & Verma, R. P. (2015). Automation of underground coal mines using plc. *Journal of Mines, Metals, and Fuels*, 174 – 181.
https://www.researchgate.net/publication/317038146_Automation_of_underground_coal_mines_using_PLC#:~:text=This%20paper%20presents%20applications%20of,flammable%20gases%20exceeds%20permissible%20limit

Wilcher. D. (2024, February 21). *Turn a raspberry pi into a plc using openplc*. <https://control.com/technical-articles/turn-a-raspberry-pi-into-a-plc-using-openplc/>

Course_Lab_project_code.zip folder: Github Repository: Course_Lab_project_code.zip folder: Github Repository:
<https://github.com/DWilcher/DesignNews-WebinarCode>



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