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DesignNews

Getting Started in Automation with Arduino

DAY 2: Understanding the Arduino Opta

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Webinar Logistics

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- Participate in ‘Attendee Chat’ by maximizing the chat widget in your dock.

Dr. Don Wilcher

Visit ‘Lecturer Profile’ in your console for more details.

Course Kit and Materials

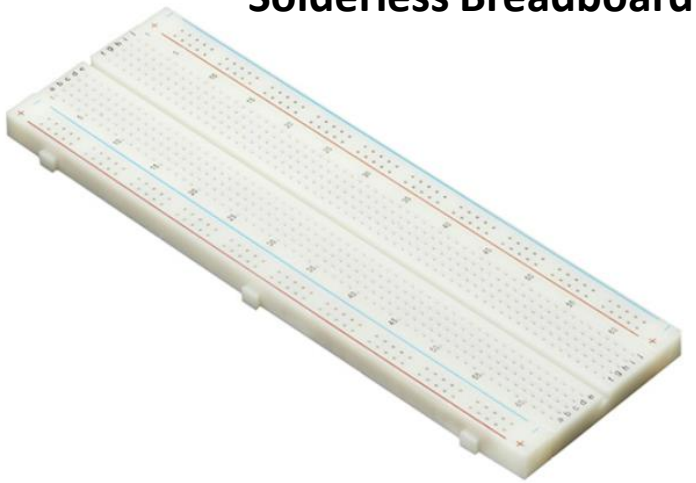
Arduino Opta

12VDC @ 500mA Wall Mount Power Supply

DC Motor: Medium Torque

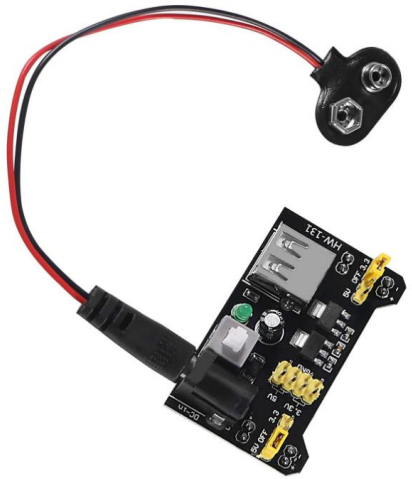
Adafruit Parts Pal Kit

Solderless Breadboard



Jumper Wires: Male to Male

Solderless Breadboard Power Supply



Agenda:

- Arduino Opta System Structure
- Input/Output (I/O) wiring structure
- An Introduction to Ladder Diagram Programming Concepts
- Lab: Hello World Ladder Diagram Program

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).

Arduino Opta System Structure

- The Arduino Opta Micro-Programmable Logic Controller (MPLC) provides a unique entry point into the automation field.
- The Arduino Opta, with its small size of 88.8 mm x 70mm x 56.8mm, makes it convenient to fit inside industrial control panels.
- The Arduino Opta uses an ST STM32H747XI processor.
- The STM32H747XI dual-core processor allows fast computation speeds for industrial or process control applications.
- The Opta has 2MB of flash memory and 1MB of programmable memory RAM.
- The MPLC has eight analog/digital inputs and four electromechanical relays (EMRs).
- Lastly, the power supply voltage has a range of 12-24VDC.

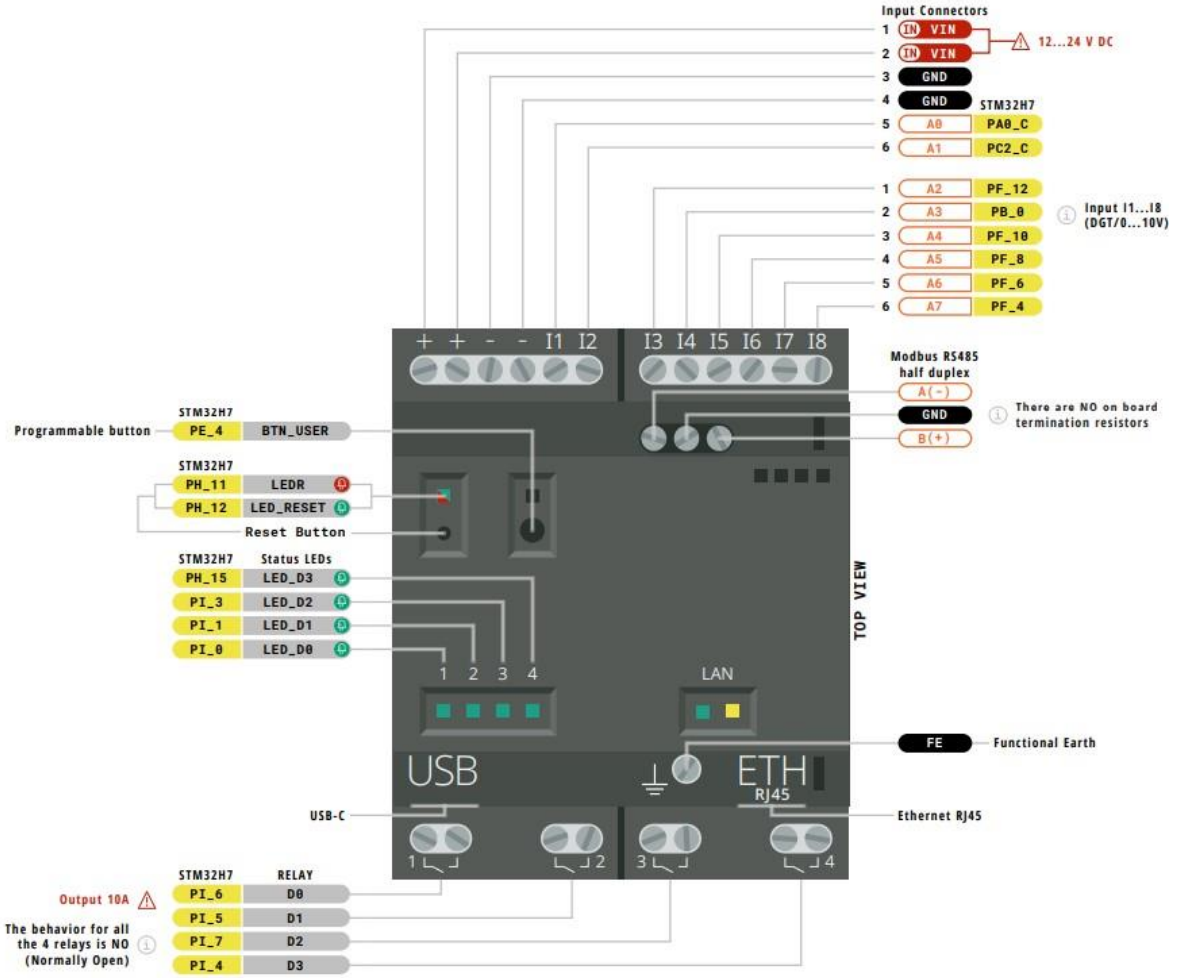
Question 1

What processor is used with the Arduino Opta?

a) STM32H747X1
b) STM32H747X2
c) STM32H747XI
d) None of the above

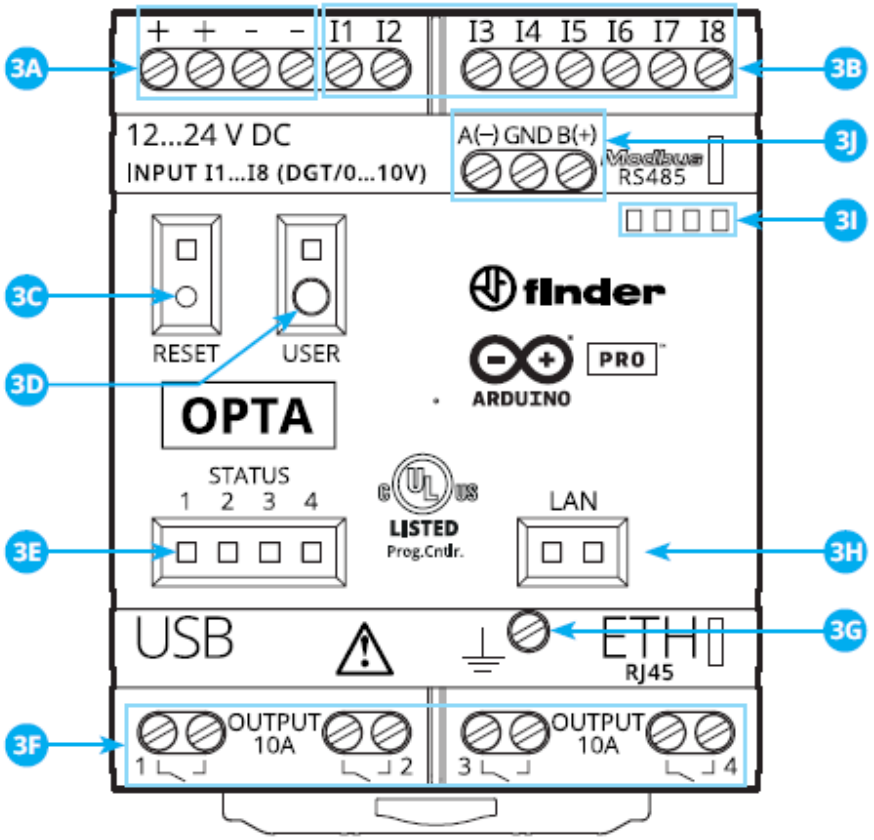
Arduino Opta System Structure. . .

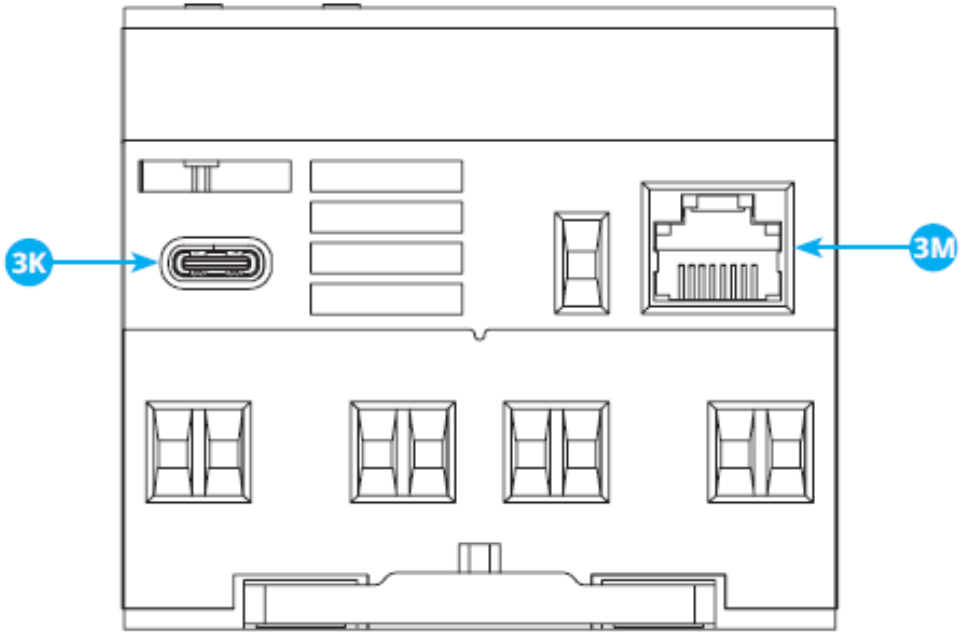
Pinout/System Structure



Arduino Opta System Structure. . .

Physical System Structure: Product View





Arduino Opta System Structure. . .

Item	Feature	Item	Feature
3A	Power Supply Terminals 12...24 VDC	3H	Ethernet Port Status LEDs
3B	I1...I8 digital/analog input terminals (0-10V) configurable via IDE	3I	Label Holder
3C	Reset Button	3J	RS-485 terminal block (for Modbus RTU or proprietary communication)
3D	User Programmable button	3K	USB-C® for programming and data logging
3E	Status LEDs 1...4 (User Programmable)	3M	Ethernet port
3F	Relay Output Terminals 1...4, NO contact (SPST) 10A 250 VAC	3N	Port for communication and connection of auxiliary modules
3G	Functional Earth		

Product View Table

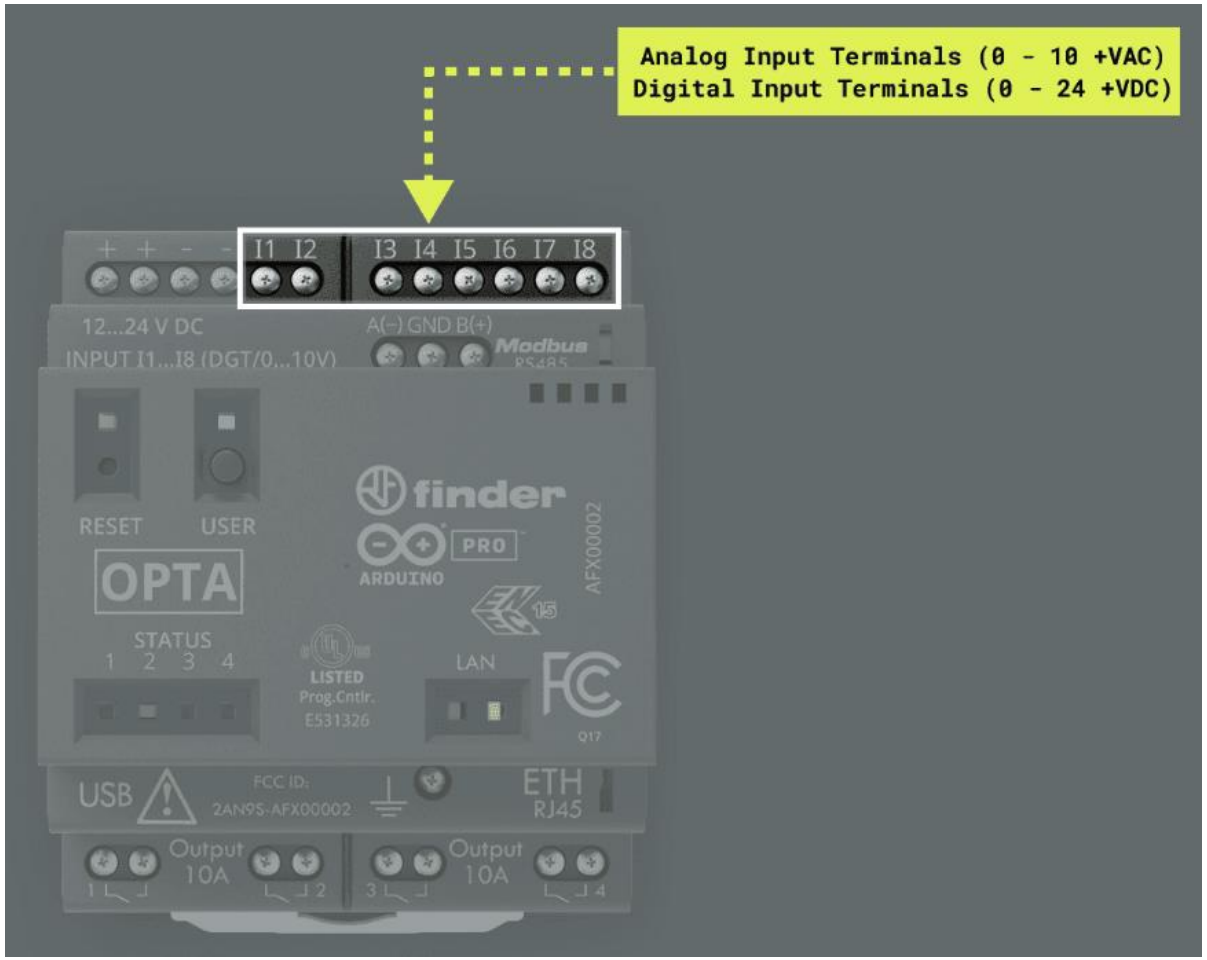
Arduino Opta System Structure. . .

STM32H747XI processor Block Diagram. Image courtesy of ST

Input-Output Wiring Structure

Input-Wiring Terminal Points

Physical terminal	Definition in core	Alias
I1	A0	PIN_A0
I2	A1	PIN_A1
I3	A2	PIN_A2
I4	A3	PIN_A3
I5	A4	PIN_A4
I6	A5	PIN_A5
I7	A6	PIN_A6
I8	A7	PIN_A7



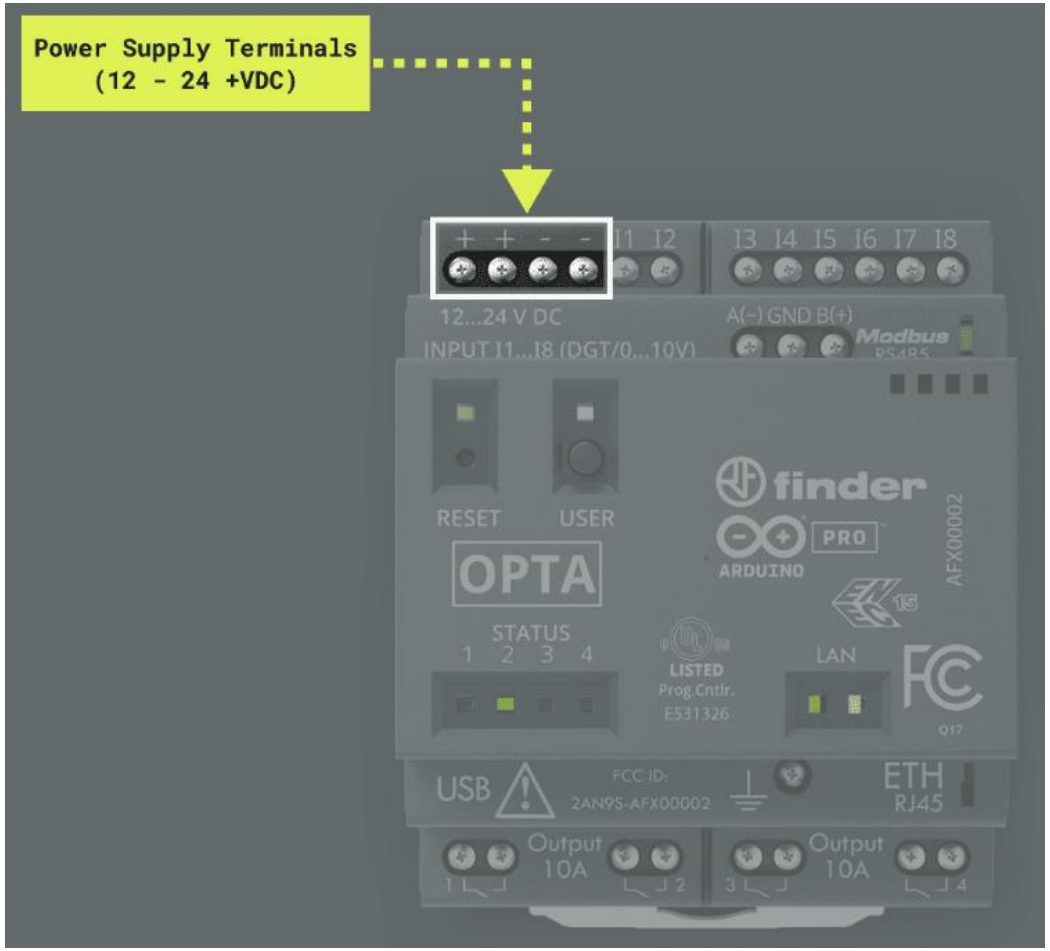
Question 2

In reviewing slide 13, what is the alias for physical terminal I8?

a) PIN_A5.
b) PIN_A2.
c) PIN_A7
d) None of the above

Input-Output Wiring Structure. . .

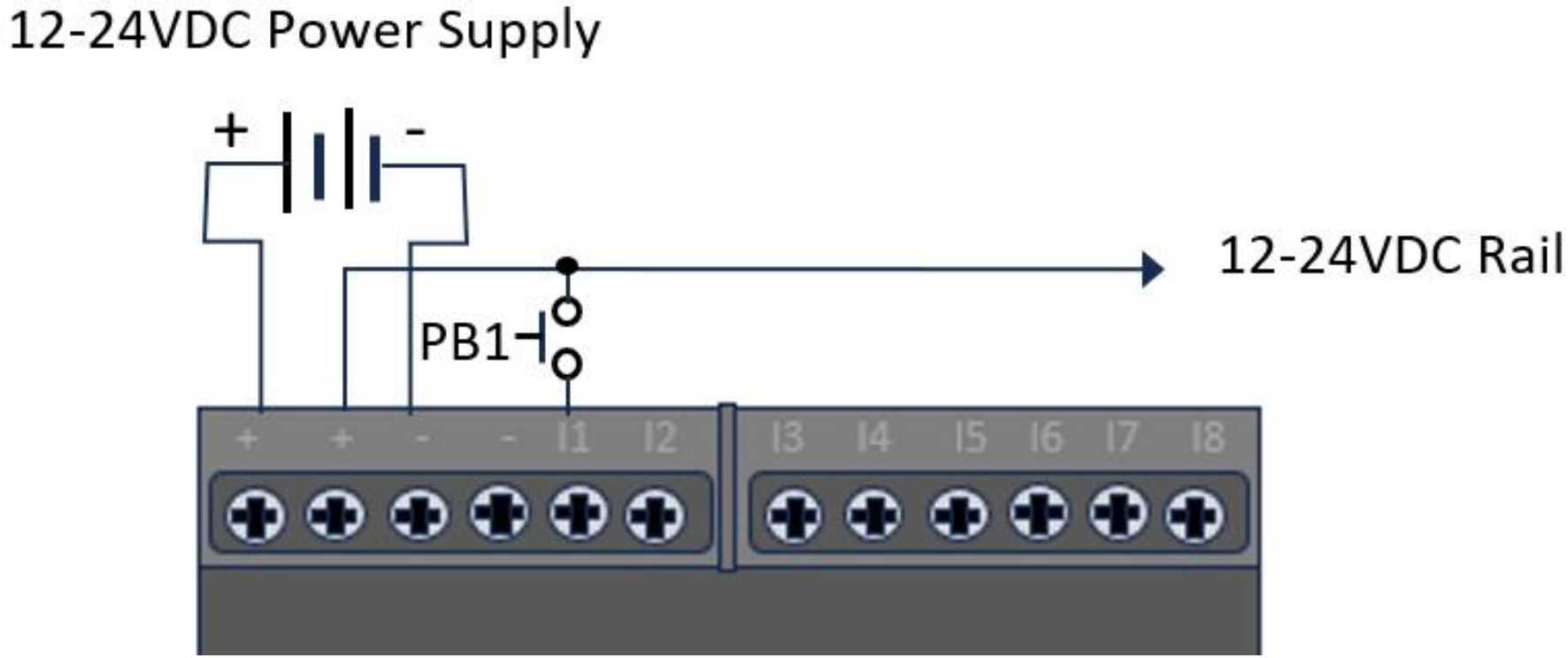
Power Supply Connection Points



Input-Output Wiring Structure. . .

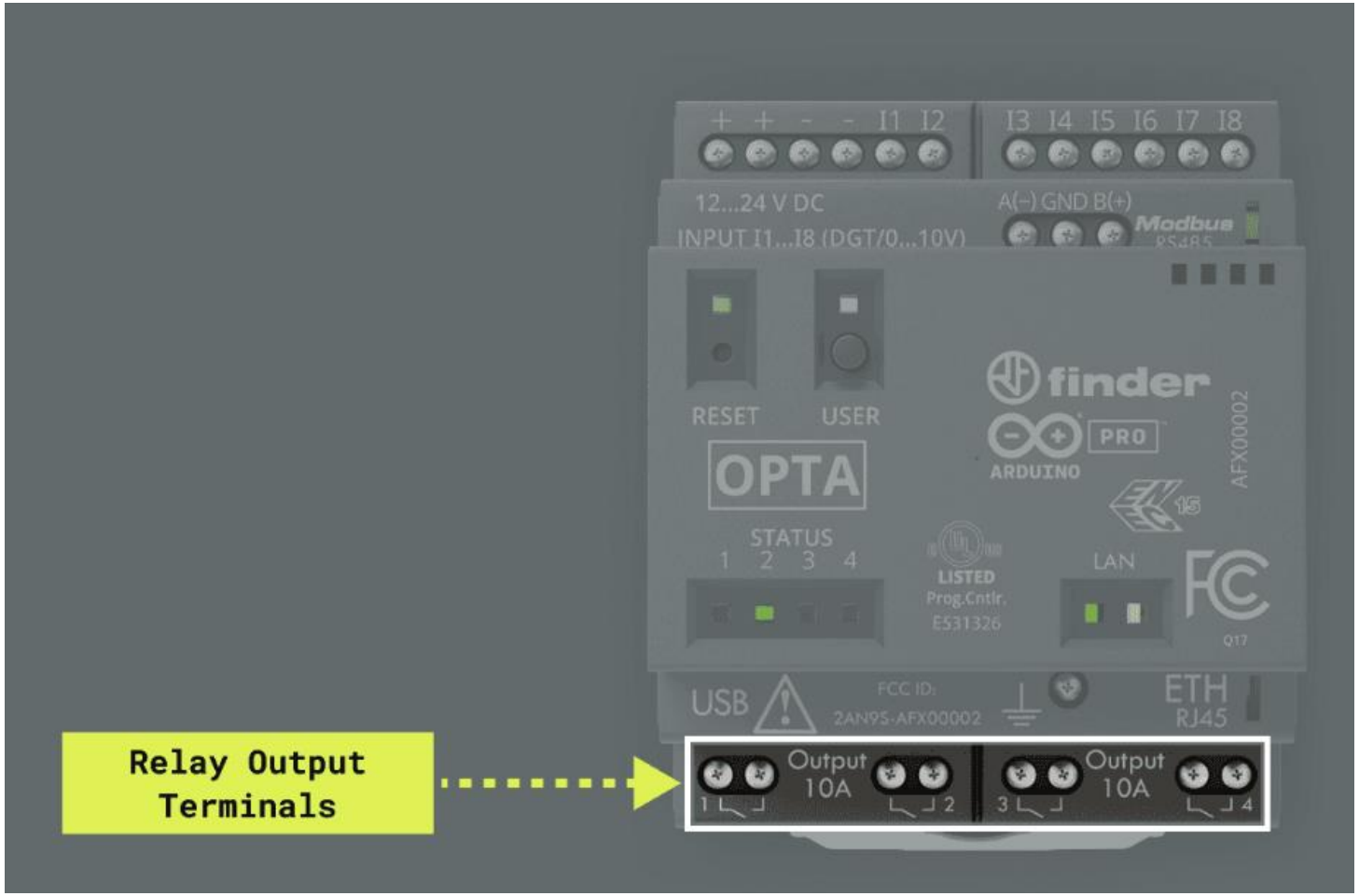
Input-Wiring Terminal Points

Example:
Electrical Wiring Diagram of DC Power Supply and Pushbutton (PB1) switch to the Arduino Opta



Input-Output Wiring Structure. . .

Output-Wiring Terminal Points



Input-Output Wiring Structure. . .

Output-Wiring Terminal Points

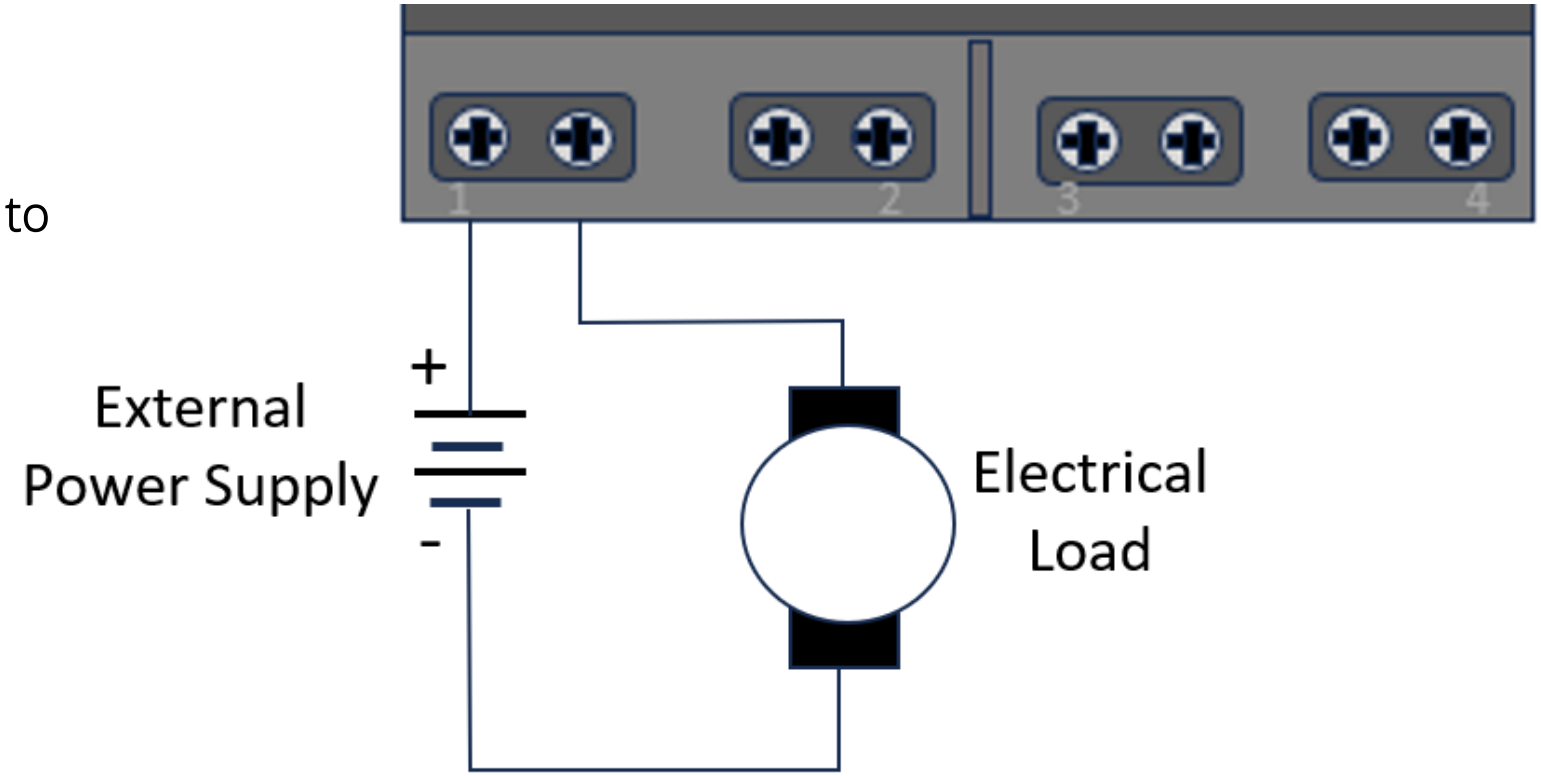
Output	Pin	Alias
OUTPUT 1	D0	RELAY1
OUTPUT 2	D1	RELAY2
OUTPUT 3	D2	RELAY3
OUTPUT 4	D3	RELAY4

Relays are Normally Open (N.O.) devices

Input-Output Wiring Structure. . .

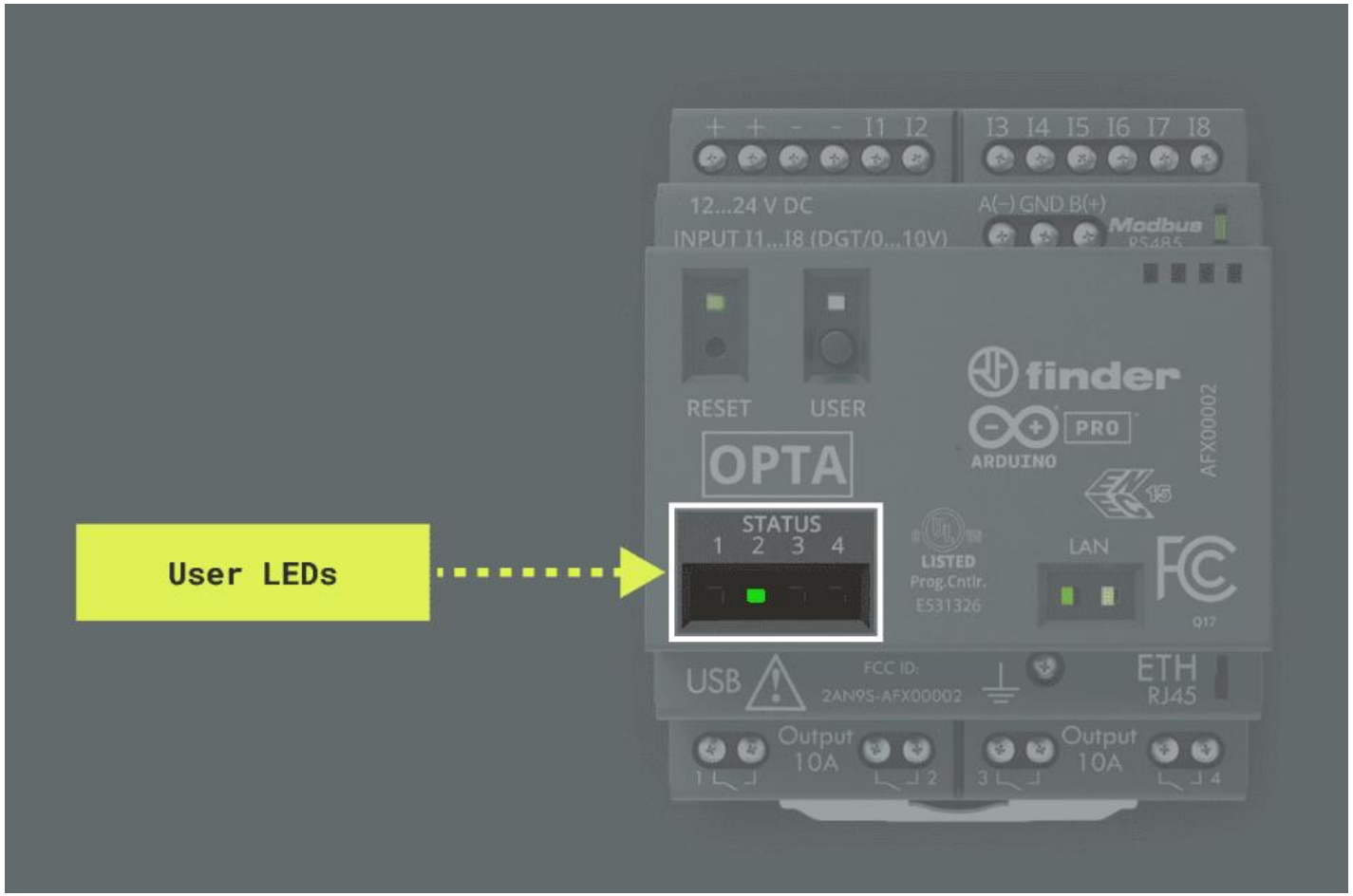
Output-Wiring Terminal Points

Example:
Electrical Wiring Diagram of DC Power Supply and DC Motor to the Arduino Opta



Input-Output Wiring Structure. . .

User LEDs



Input-Output Wiring Structure. . .

User LEDs

Opta™ User LED	Arduino Pin Mapping
STATUS 1	LED_D0 / LED_RELAY1
STATUS 2	LED_D1 / LED_RELAY2
STATUS 3	LED_D2 / LED_RELAY3
STATUS 4	LED_D3 / LED_RELAY4
USER (WiFi variant only)	LED_USER / LEDB
RESET (Green color)	LED_BUILTIN / LEDG
RESET (Red color)	LEDR

Question 3

The Arduino Pin LED_D2/LED_Relay3 is mapped to what USER LED?

a) STATUS 1
b) STATUS 2
c) STATUS 3
d) STATUS 4

An Introduction to Ladder Diagram Programming Basics

A LD program enables the programmable controller to test and modify data. The data characteristics are listed below.

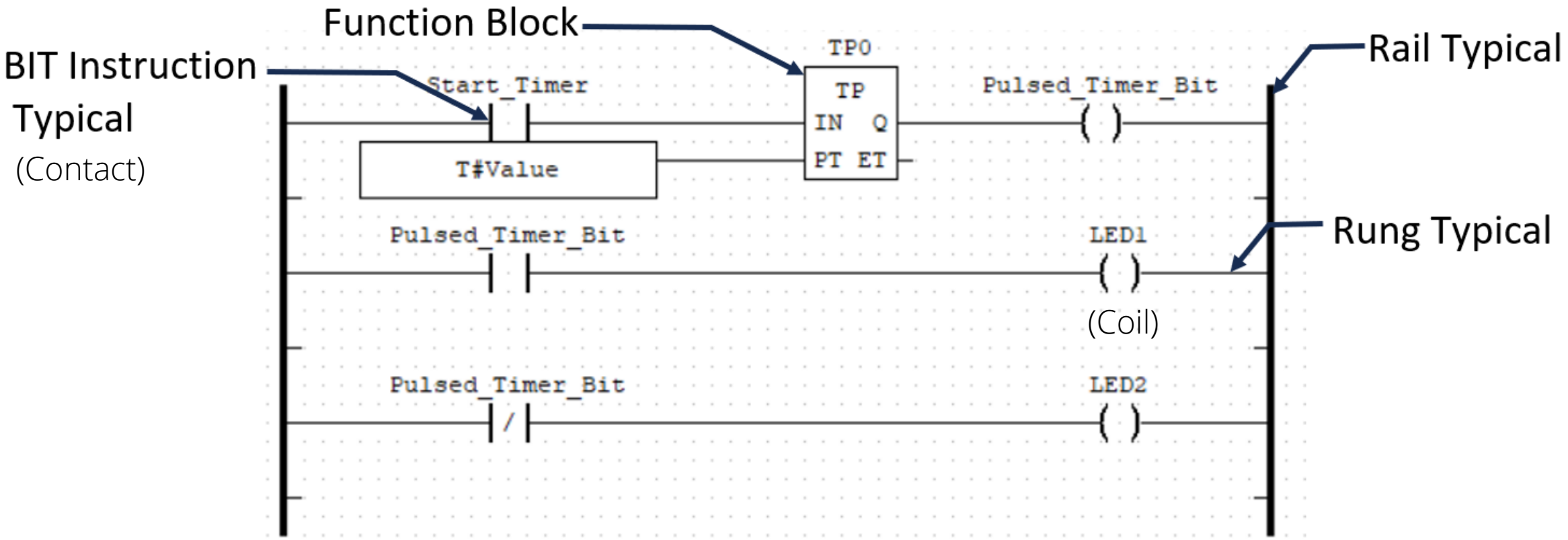
a) Standardized Symbols
b) Standardized Symbols are the programmable elements in a network.
c) The network is arranged like a rung of a relay ladder logic diagram.
d) The networks are bounded on the left and right by power rails.

An Introduction to Ladder Diagram Programming Basics. . .

- A contact is an element that imports a state to the horizontal link on its right side, equal to the Boolean function of the state of the horizontal link on its left side.
    a) The right and left sides of the horizontal link are the power rail.
    b) The horizontal link is the ladder diagram rung.
- A coil copies the state of the link on its left to the link on its right without modification. It stores an appropriate function of the state or transition of the left link into the associated Boolean variables (IEC 61131-3, p.142, 2003).

An Introduction to Ladder Diagram Programming Basics. . .

Anatomy of a Ladder Diagram



An Introduction to Ladder Diagram Programming Basics. . .

Identification of the coil on an LD.

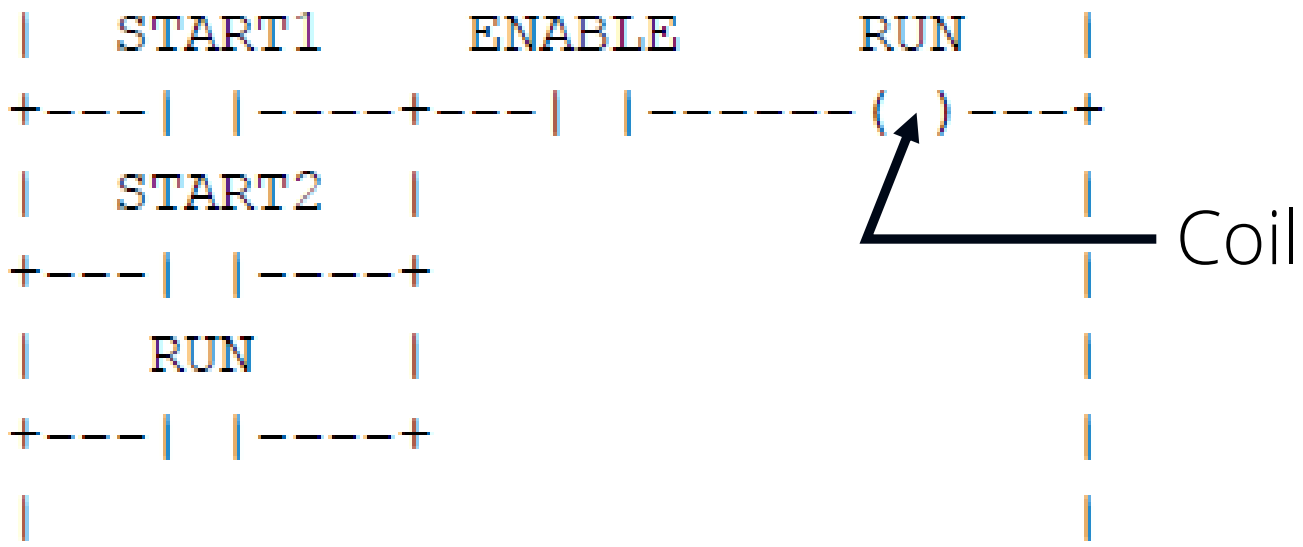
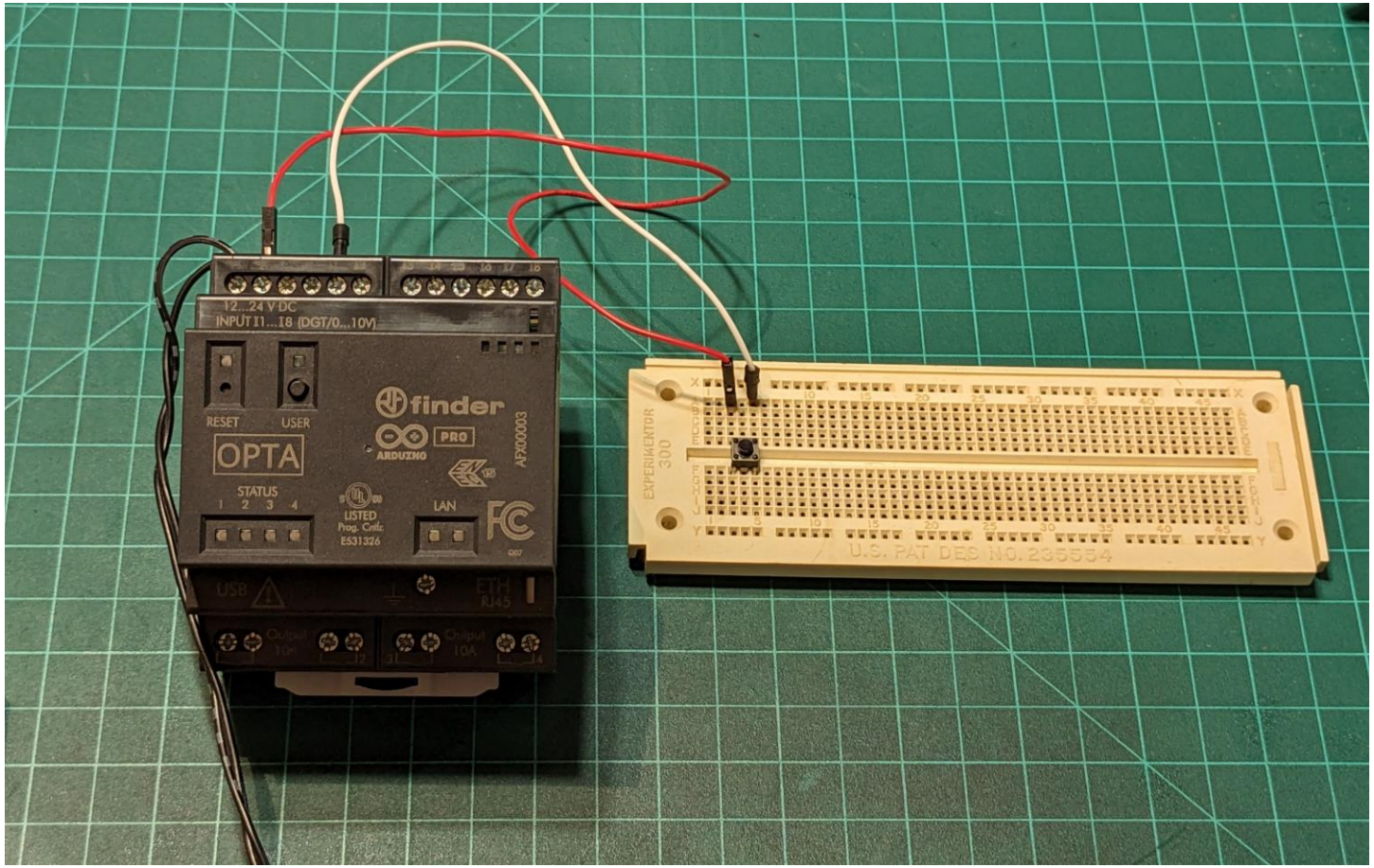


Illustration courtesy of IEC 6113-3 Standard, Second Edition 2003.

Lab: Hello World Ladder Diagram Program



Lab: Hello World Ladder Diagram Program

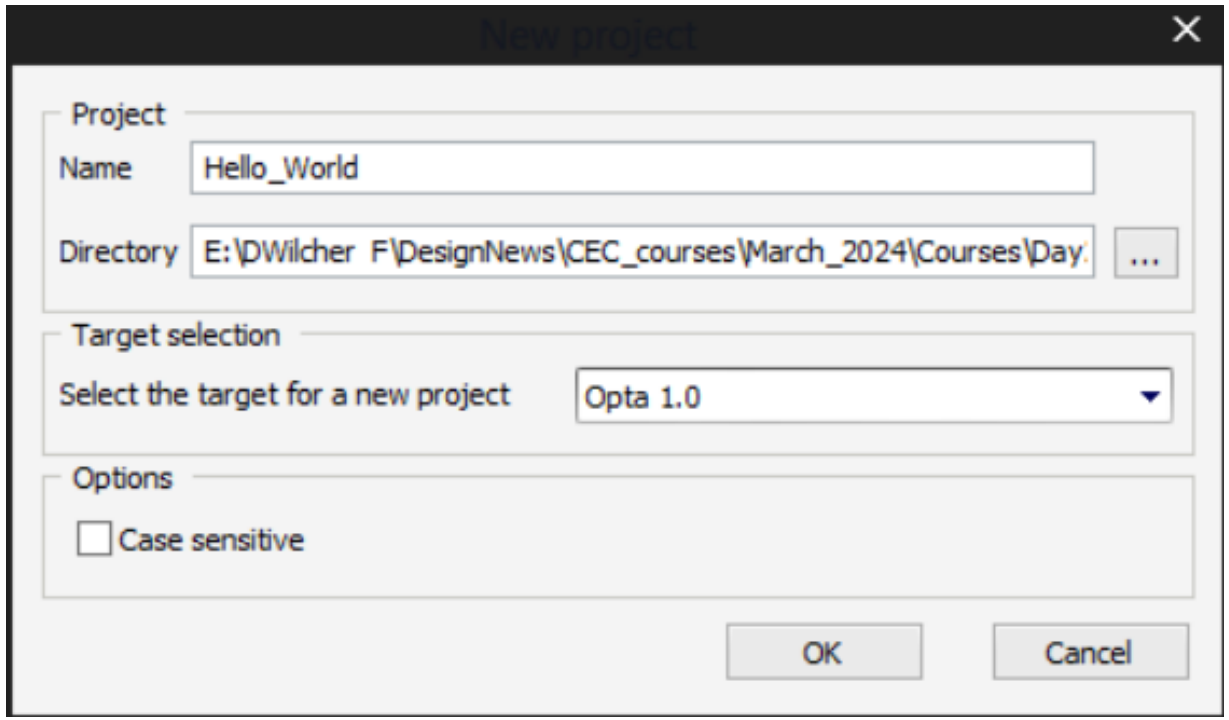
Lab Objectives:

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

Lab: Hello World Ladder Diagram Program. . .

To create a New Project:

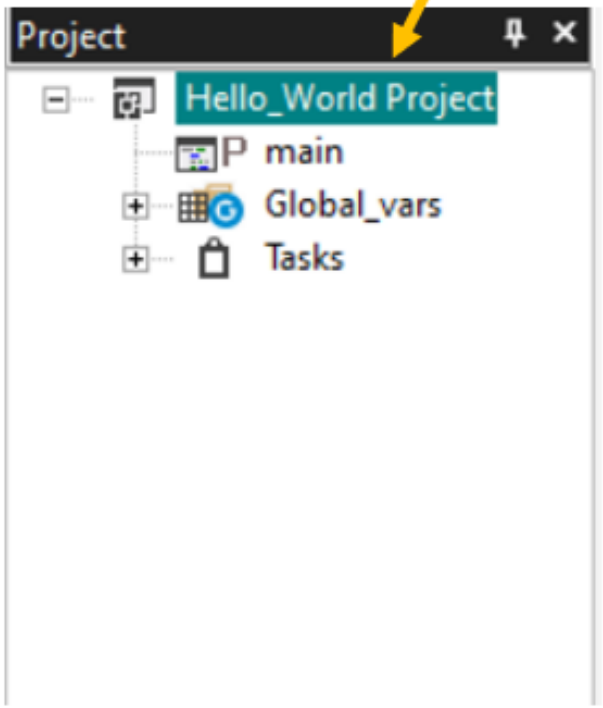
- Go to the toolbar
  File>New object

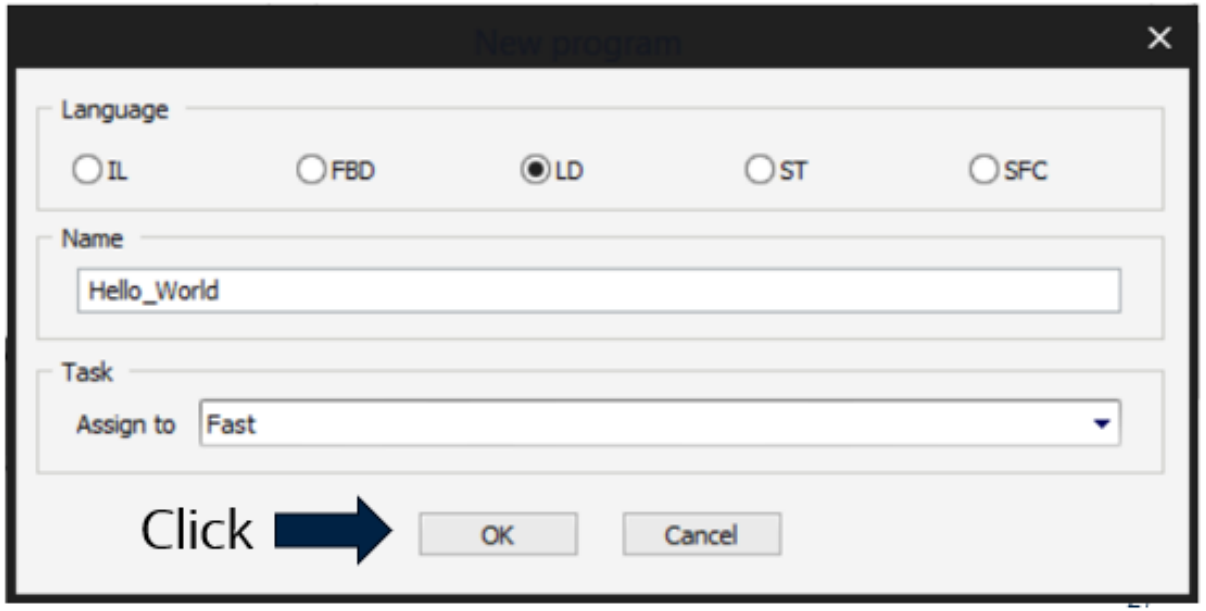


Lab: Hello World Ladder Diagram Program. . .

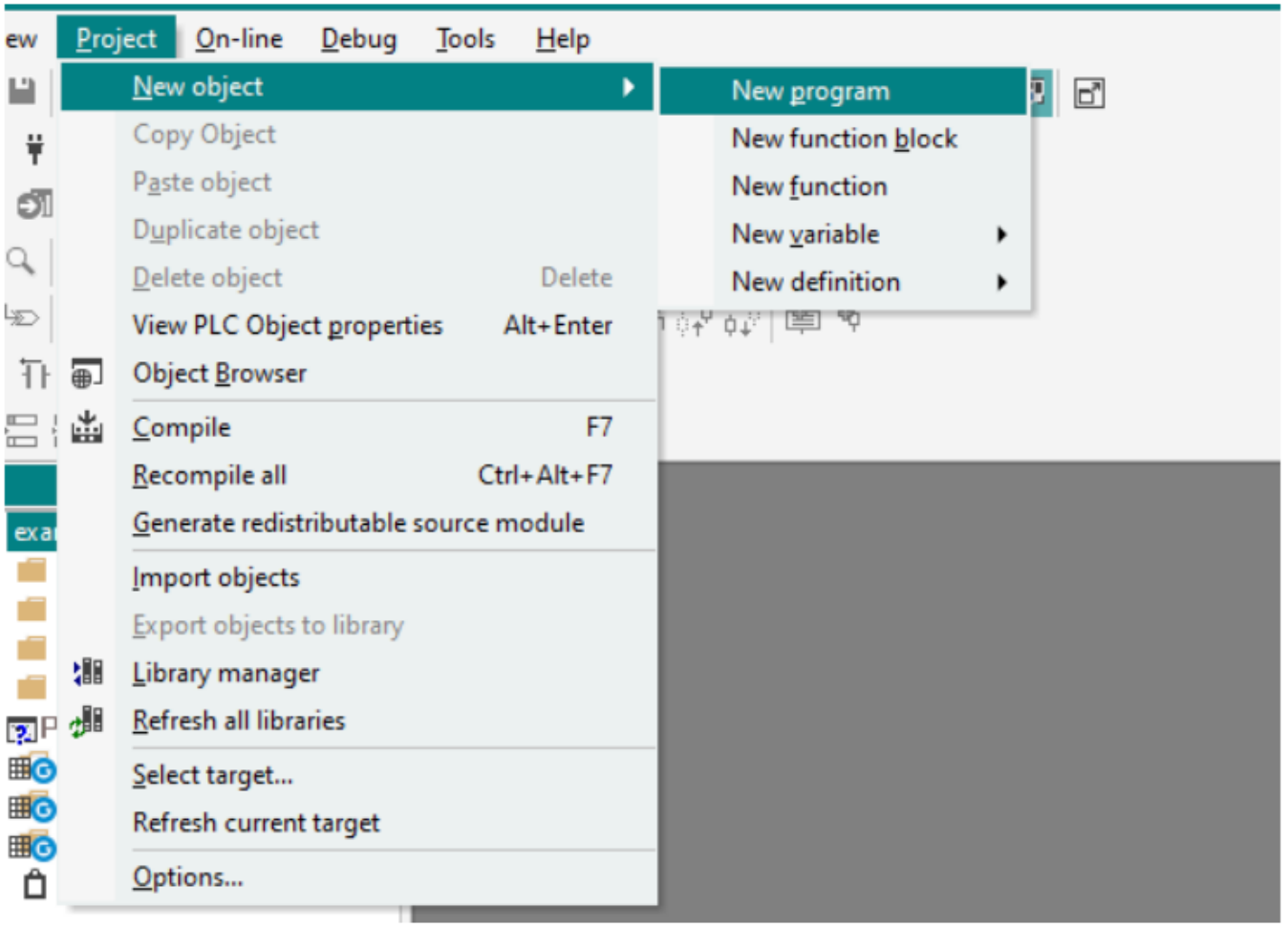
Select Project Name

Go to the toolbar
Project>New object>New Program





Lab: Hello World Ladder Diagram Program. . .

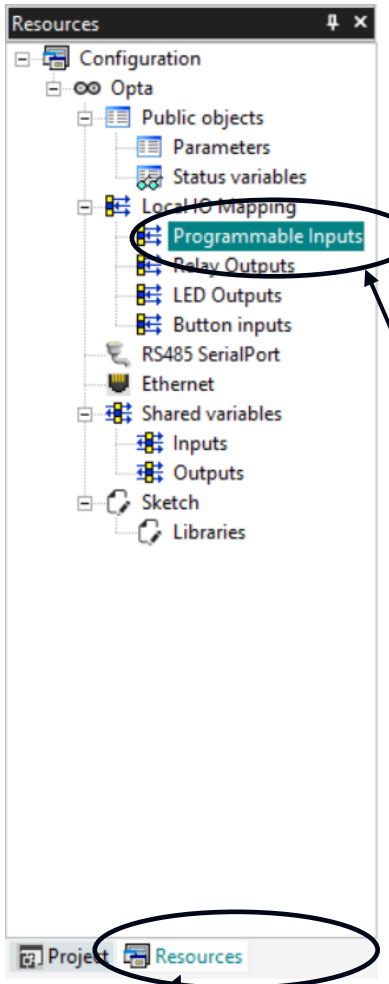


Visual Steps

To create a new program:

- Open your project tab.
- Go to the toolbar Project>New object>New program

Lab: Hello World Ladder Diagram Program. . .



Programmable inputs mapping

Assign UnAssign Analog resolution: 16 bits

#	Name	Variable	IOType	Type	DataBlock	Description
1	I1		Digital	BOOL	%IW0.0	I1 programmable input
2	I2	Start	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
6	I6		Digital	BOOL	%IW0.5	I6 programmable input
7	I7		Digital	BOOL	%IW0.6	I7 programmable input
8	I8		Digital	BOOL	%IW0.7	I8 programmable input

Click this Button

Type Here

Naming Input Variable (Tag)

Click the Resources Button

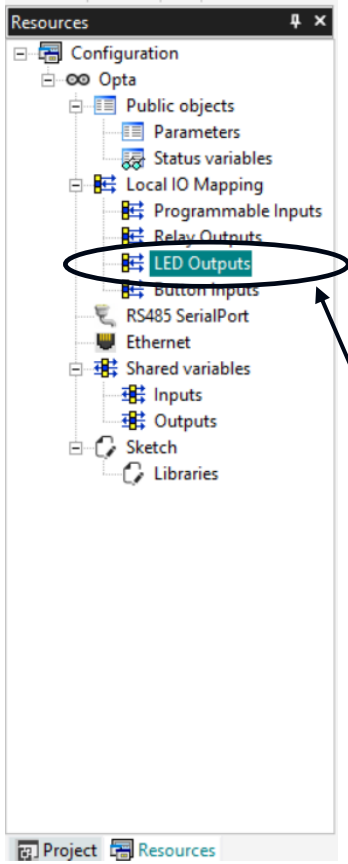
Question 4

In the Resources window, the Programmable Outputs window allows defining variables or tags for Programmable Inputs.

a) True

b) False

Lab: Hello World Ladder Diagram Program. . .



LED outputs mapping

Assign **UnAssign**

#	Name	Variable	Type	DataBlock	Description
1	L1	Hello_World	BOOL	%QX1.0	L1 LED output
2	L2		BOOL	%QX1.1	L2 LED output
3	L3		BOOL	%QX1.2	L3 LED output
4	L4		BOOL	%QX1.3	L4 LED output
5	LR		BOOL	%QX1.4	LR LED output (RED)
6	LG		BOOL	%QX1.5	LG LED output (GREEN)
7	LB		BOOL	%QX1.6	LB LED output (BLUE)

Click this Button

Type Here

Naming Output Variable (Tag)

Lab: Hello World Ladder Diagram Program. . .

To create a Ladder Diagram program:

- Open your project tab.
- Go to the toolbar **Project>New object>New program**

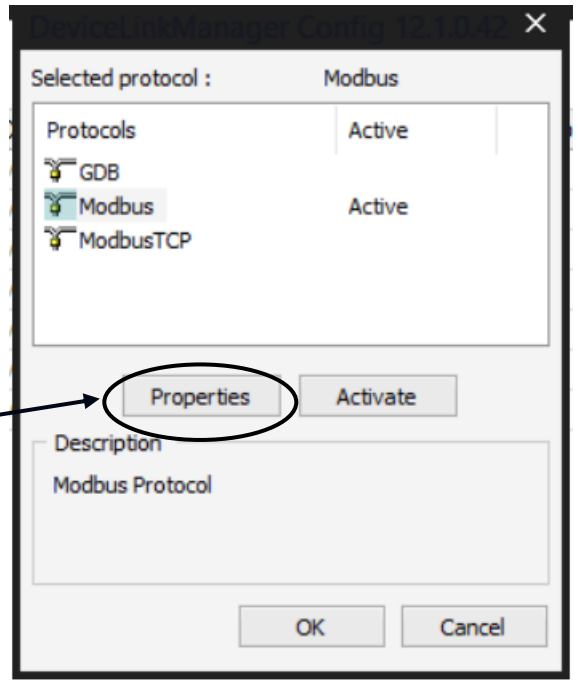
Completed Ladder Diagram Program

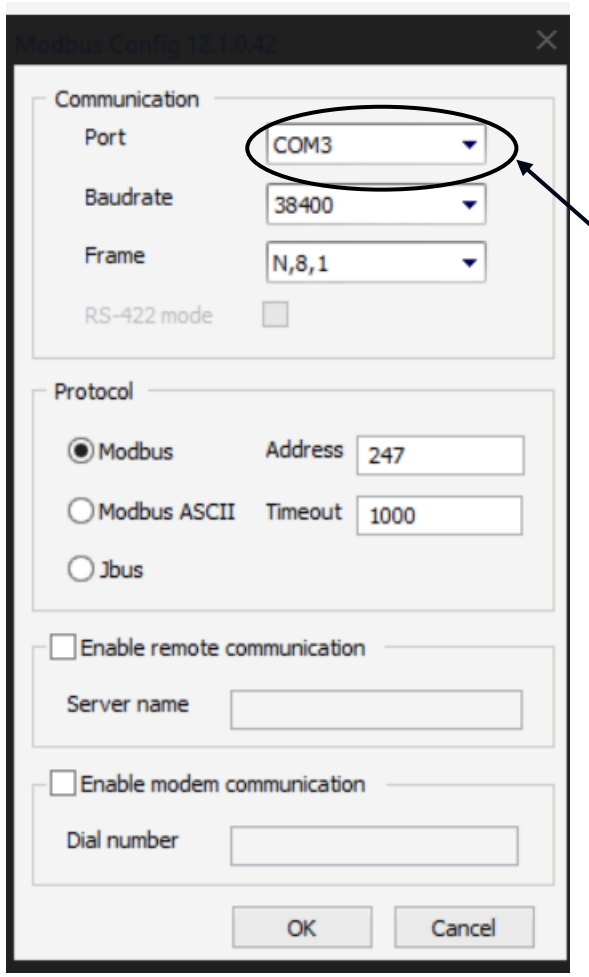
Lab: Hello World Ladder Diagram Program. . .

To download a Ladder Diagram program to an Arduino Opta:

- On-line.
- Setup Communication

Click Properties Button

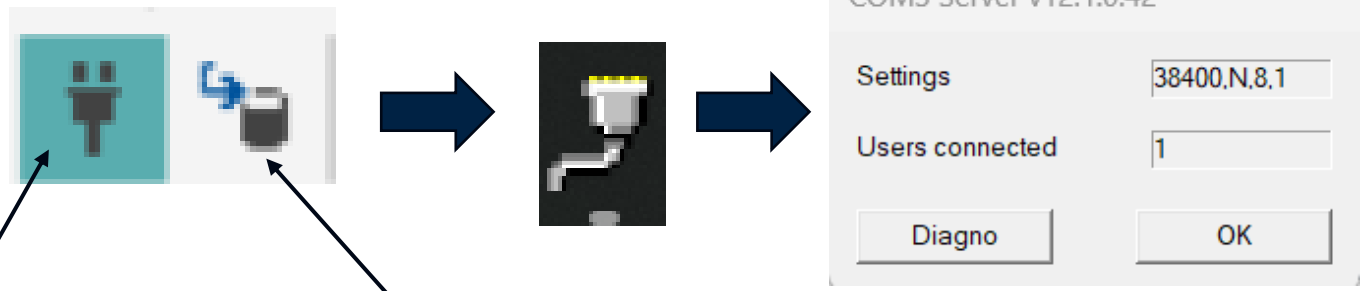




Select the First COM port from the list

Lab: Hello World Ladder Diagram Program. . .

Connecting to Arduino Opta

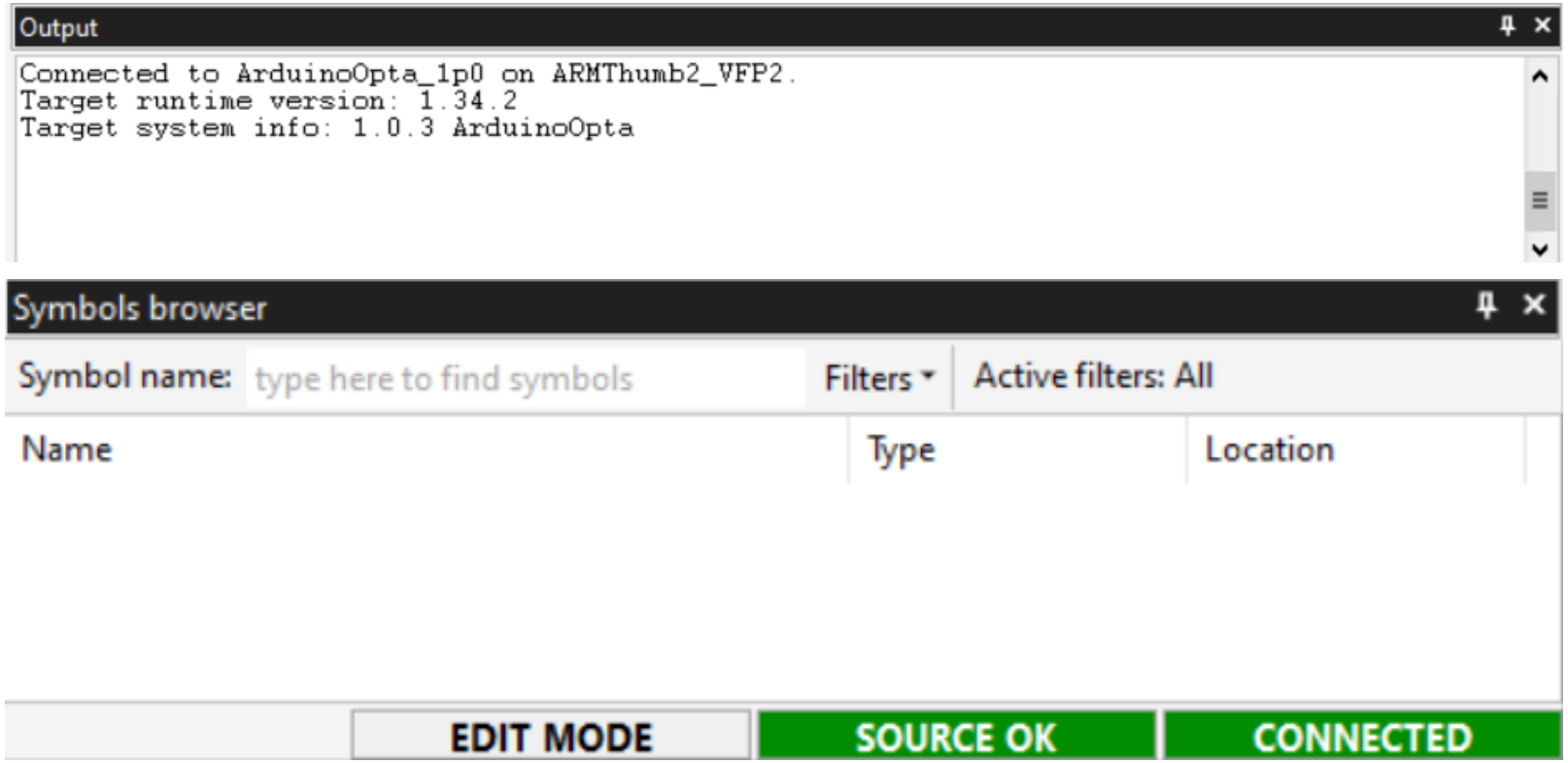


Click the Button to Connect to Arduino Opta

Download “Hello World” LD to Arduino Opta

Lab: Hello World Ladder Diagram Program. . .

Arduino PLC IDE is
connected to the Opta



Lab: Hello World Ladder Diagram Program. . .

Output

```
Checking compatibility between application binary file and run-time environment .. complete

Preparing for PLC application download .. done.
Downloading file C:\Users\mrdon\Documents\Hello_World\Build\Hello_World.cod .. completed.
Booting PLC application ..
done.

0 warnings, 0 errors.

Connected to ArduinoOpta_1p0 on ARMThumb2_VFP2.
Target runtime version: 1.34.2
Target system info: 1.0.3 ArduinoOpta
```

Completed Lab plus Extra Video Clip

https://youtu.be/ttP0NEyCFD0

Question 5

Which line of code allows for the USER Button status to be read?

a) 1.34.2
b) 1.34.3
c) 1.34.4
d) none of the above

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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