



**DesignNews**

Embedded Controls Development with OpenPLC

# DAY 5 : ESP-Based Controlled 7-Segment LED Display with OpenPLC

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## Webinar Logistics

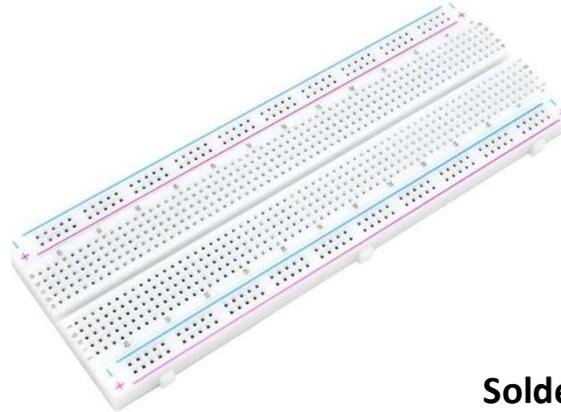
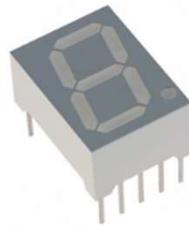
- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Attendee Chat’ by maximizing the chat widget in your dock.



## Dr. Don Wilcher

Visit 'Lecturer Profile' in your console for more details.

## Course Kit and Materials

**ESP32 WROOM32D DEVKITC****Solderless Breadboard x2****Adafruit Parts Pal Kit****L298N Motor Drive Controller****7 Segment LED Display,  
Common Cathode****Solderless Breadboard  
Power Supply Module with  
9V Battery Clip Power Cable**

## Agenda:

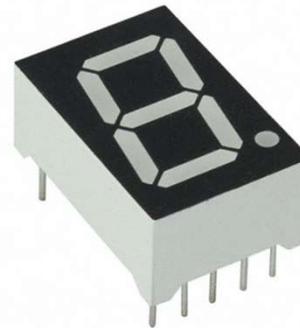
- 7 Segment LED Basics
  - a) Common Cathode
  - b) Common Anode
  - b) Creating Discrete Letters and Numbers
- ESP32-OpenPLC-7 Segment LED Driver Concept
- Electronic Circuit Schematic Diagram
- Lab: Build and Test an ESP32-OpenPLC Smart Indicator Flasher

## Research Perspective

“Embedded electronics is a subfield of electronics that can unite the power of programming with the power of electronics” (Zemmouri et al., 2023).

## 7 Segment LED Display Basics

- Alphanumeric information can be displayed on a specialized module called a 7-segment LED display.
- Light Emitting Diodes (LEDs) are arranged in the shape of numbers and letters and offer easily visible display.
- Common names commonly used are
  - a) 7 Segment Displays
  - b) Seven-segment indicators



## 7 Segment LED Display Basics...

### Parts of a 7-Segment LED Display

- Light-emitting segments (a-g)
- Dot light emitting component (Decimal point: DP)
- General name for the seven segments (a-g: Digits-Dig)

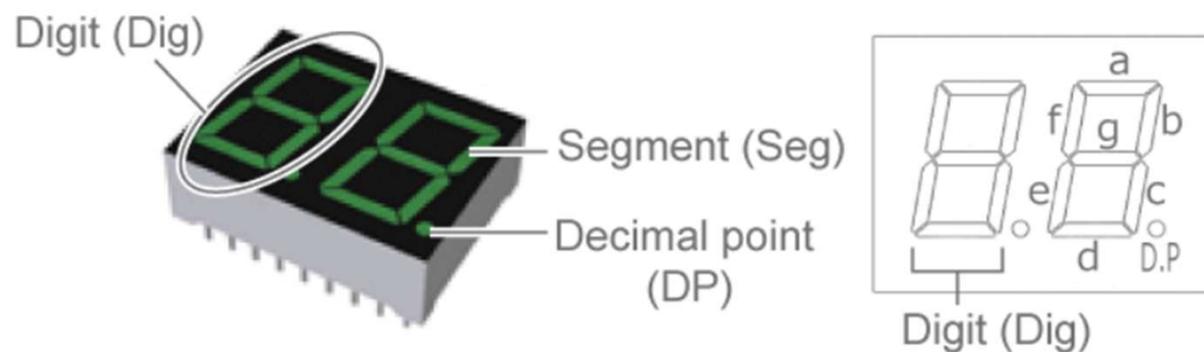


Illustration courtesy of  
ROHM Semiconductor

## Question 1

**Alphanumeric information can not be displayed on a 7-Segment LED display.**

- a) True**
- b) False**



## 7 Segment LED Display Basics...

### 7-Segment LED Display Configurations

- There are two kinds of LED display device circuits
  - a) Common Anode (CA)
  - b) Common Cathode (CC)
- Common Anode: The common (COM) pin is positive.
- Common Cathode: The common (COM) pin is negative.

## 7 Segment LED Display Basics...

### 7-Segment LED Display Configurations

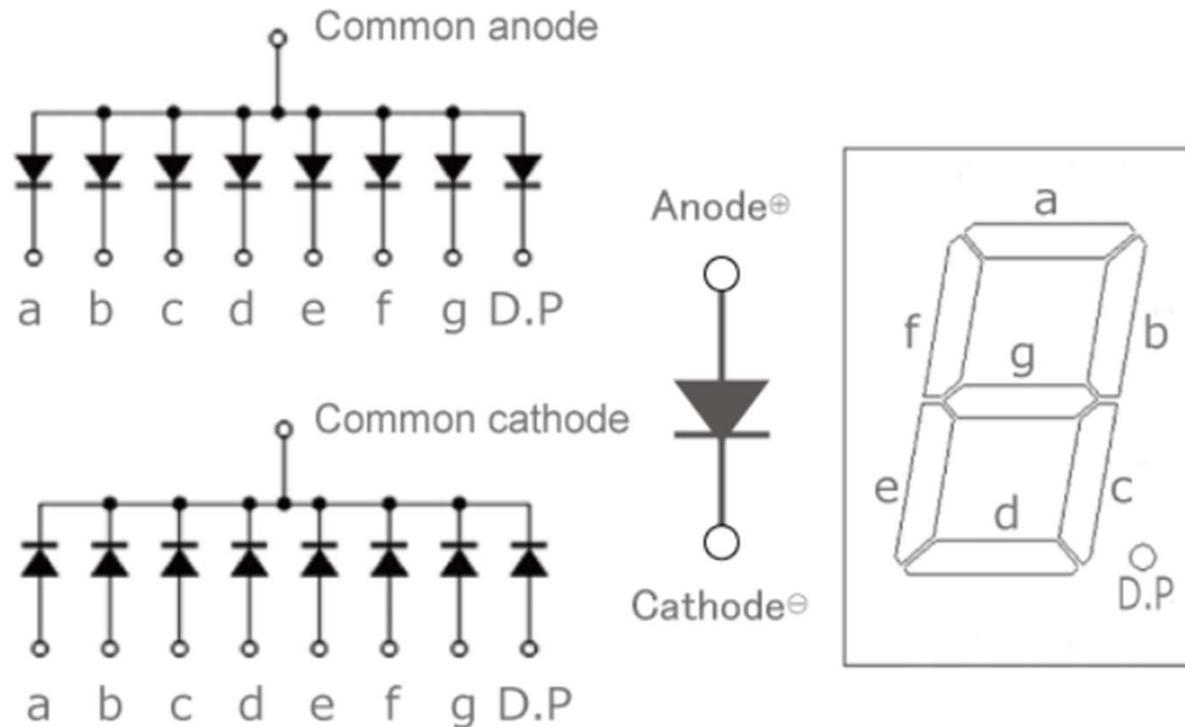


Illustration courtesy of  
ROHM Semiconductor

## Question 2

**There are three kinds of LED display device circuits.**

- a) True**
- b) False**



## Creating Discrete Letters and Numbers

Toggle Switches are used to create Letters and Circuits on a CA 7-Segment LED Display.

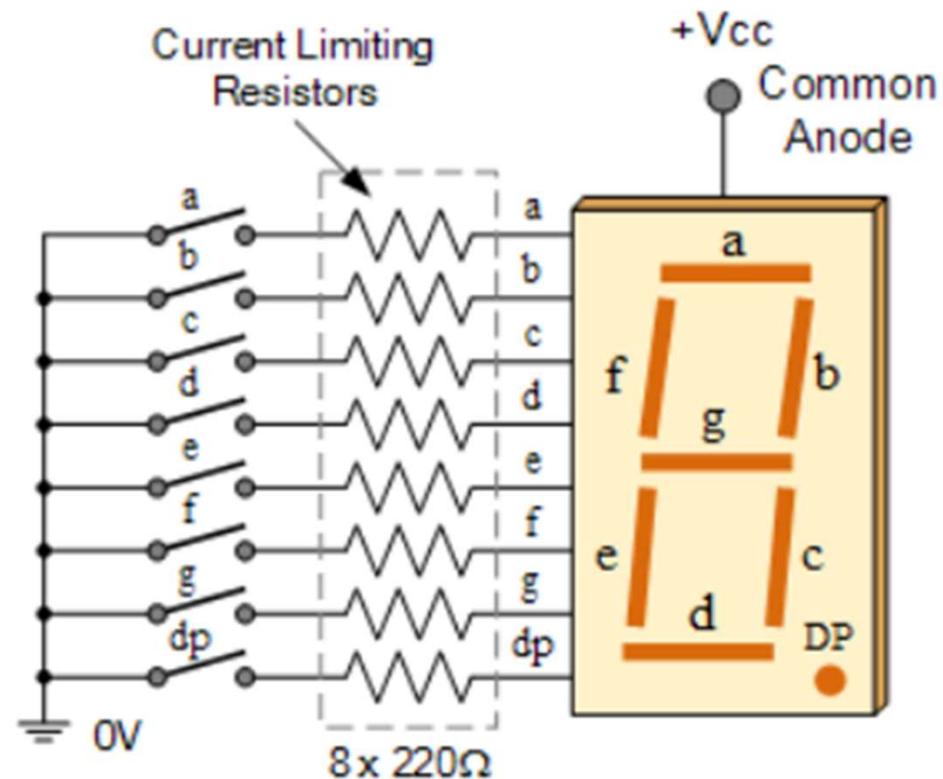
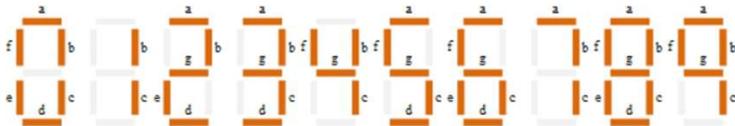


Illustration courtesy of  
Electronics-Tutorial

# Creating Discrete Letters and Numbers ...

Truth Table used to determine what individual segments to turn on to create numbers



Decimal Digit	Individual Segments Illuminated						
	a	b	c	d	e	f	g
0	x	x	x	x	x	x	
1		x	x				
2	x	x		x	x		x
3	x	x	x	x			x
4		x	x			x	x
5	x		x	x		x	x
6	x		x	x	x	x	x
7	x	x	x				
8	x	x	x	x	x	x	x
9	x	x	x			x	x

Illustration courtesy of Electronics-Tutorial

# Creating Discrete Letters and Numbers . . .

Digital Circuit used to drive a Common Cathode 7-Segment LED Display

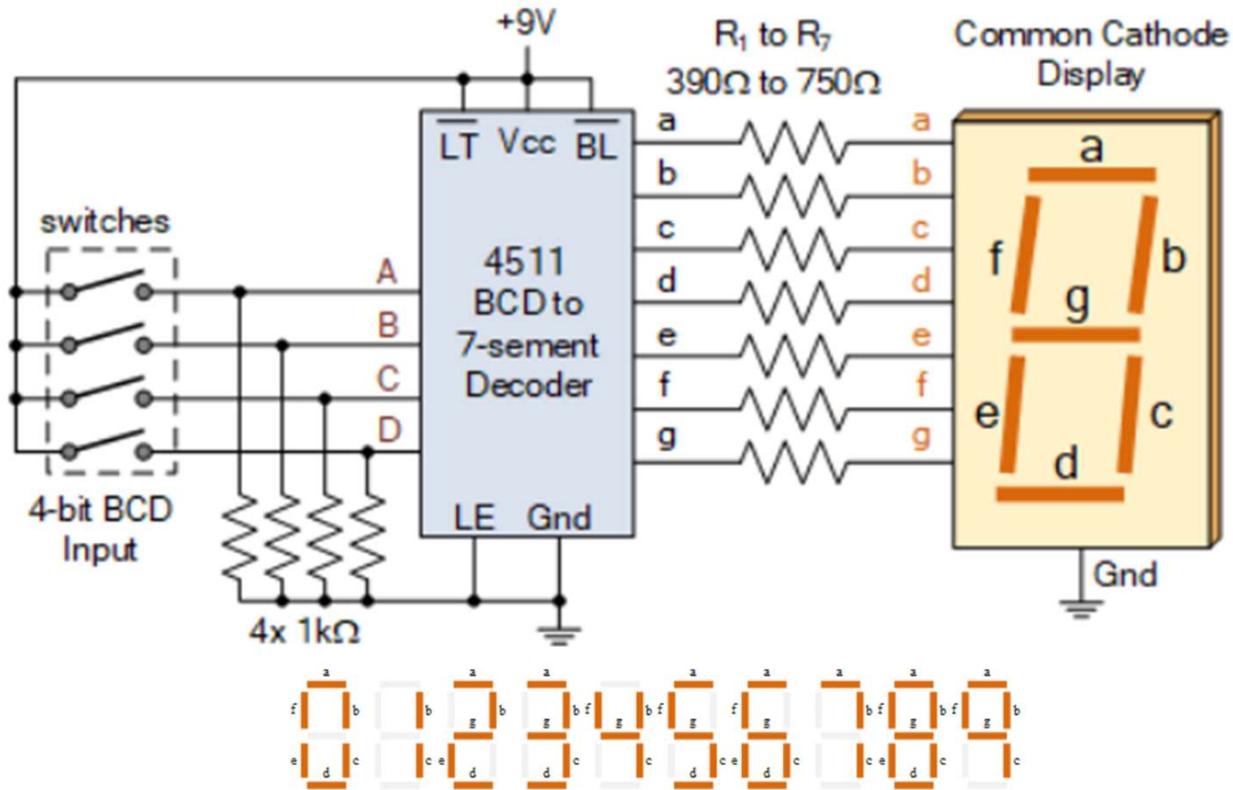


Illustration courtesy of Electronics-Tutorial

## Question 3

**In reviewing slide 15, with switches D and C closed, what number will be displayed on the 7-Segment Display.**

- a) 5**
- b) 4**
- c) 7**
- d) 9**



## Creating Discrete Letters and Numbers ...

Letters that can  
be created on a  
7-Segment LED  
Display

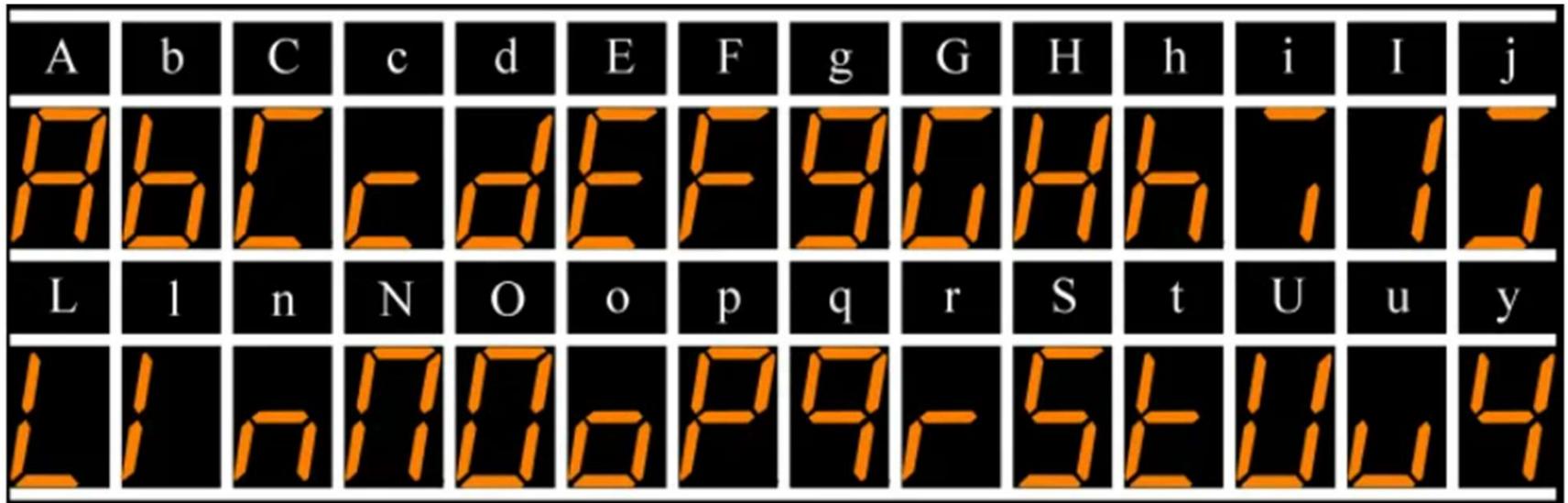


Illustration courtesy of Opto  
Plus LED Corp

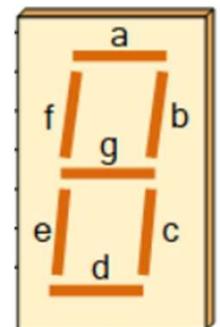
# Creating Discrete Letters and Numbers ...

Illustration courtesy of Opto  
Plus LED Corp

A	a	b	c	d	e	f	g	dp
	v	v	v		v	v	v	
			v	v	v	v	v	
	v			v	v	v		
				v	v		v	
		v	v	v	v		v	
	v			v	v	v	v	

F								
	v				v	v	v	
	v	v	v	v		v	v	
	v		v	v	v	v		
		v	v		v	v	v	
			v		v	v	v	
	v		v					

Letters that can  
be created on a  
7-Segment LED  
Display



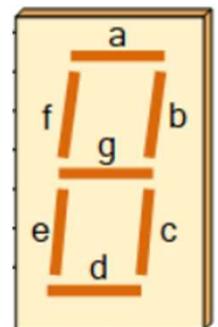
# Creating Discrete Letters and Numbers ...

Illustration courtesy of Opto Plus LED Corp

l								
		v	v					
j								
	v		v	v				
L								
				v	v	v		
l								
					v	v		
n								
			v		v		v	

N								
	v	v	v		v	v		
o								
	v	v	v	v	v	v		
o								
			v	v	v		v	
p								
	v	v			v	v	v	
q								
	v	v	v			v	v	
r								
					v		v	
s								
	v		v	v		v	v	
t								
				v	v	v	v	

Letters that can be created on a 7-Segment LED Display



# Creating Discrete Letters and Numbers ...

U								
		v	v	v	v	v		
u								
			v	v	v			
y								
		v	v			v	v	

Letters that can be created on a 7-Segment LED Display

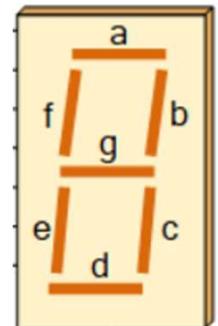
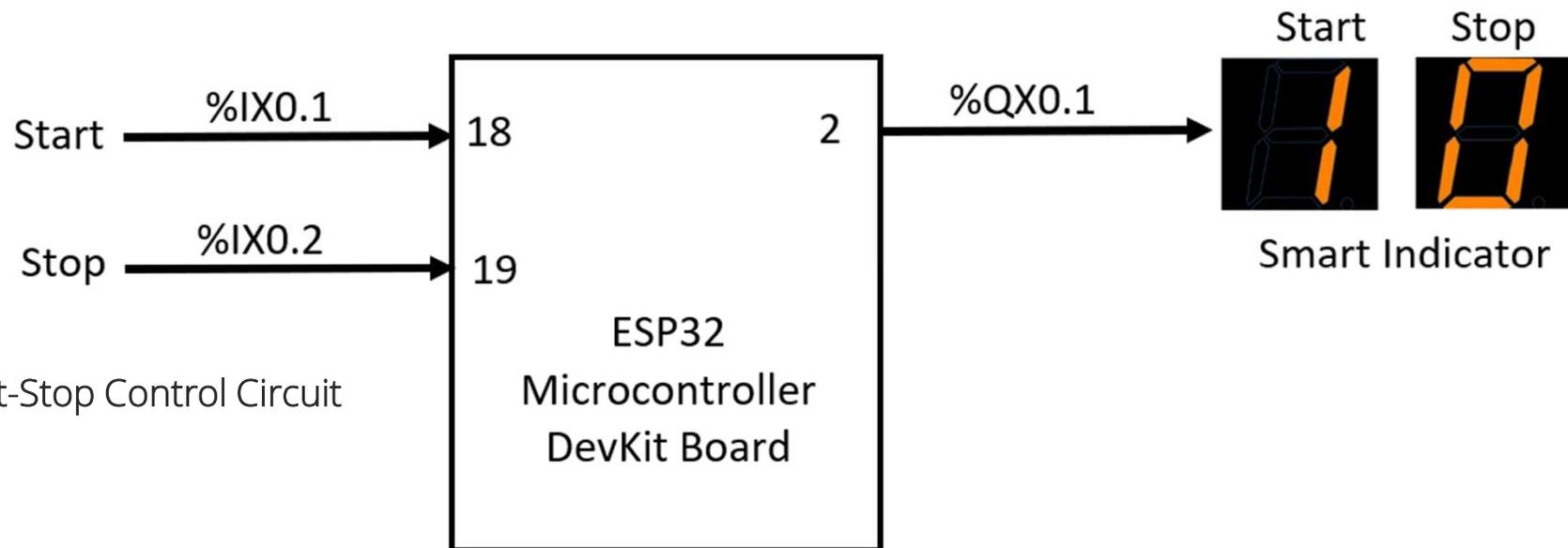


Illustration courtesy of Opto Plus LED Corp

## ESP32 OpenPLC 7-Segment LED Driver Concept



The Start-Stop Control Circuit

The Smart Indicator will display a binary 1 for (Start Event) and binary 0 for Stop condition

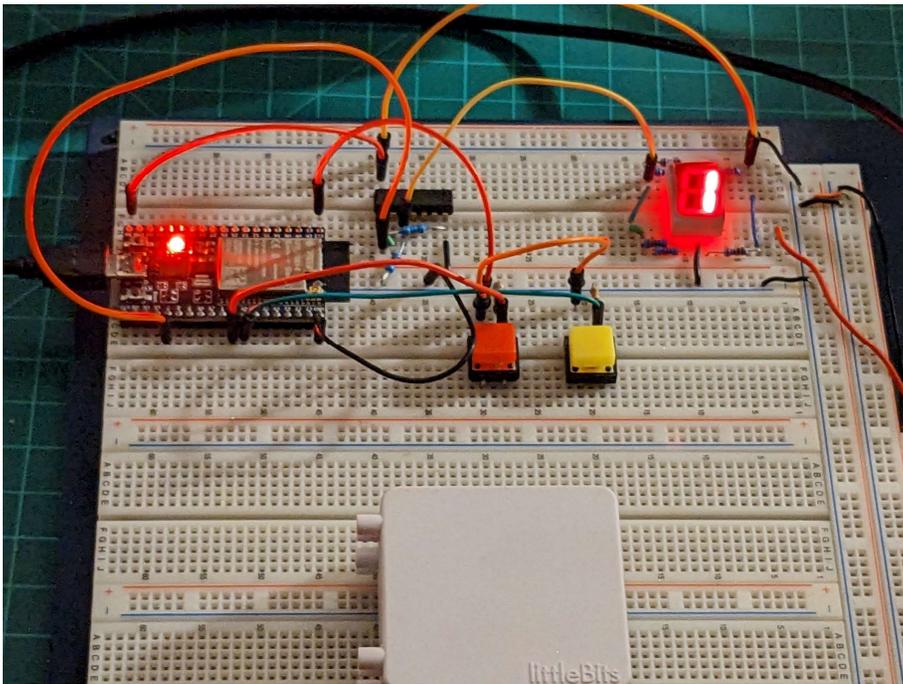
## Question 4

On slide 21, address %IX0.2 is assigned to pin\_\_\_\_\_.

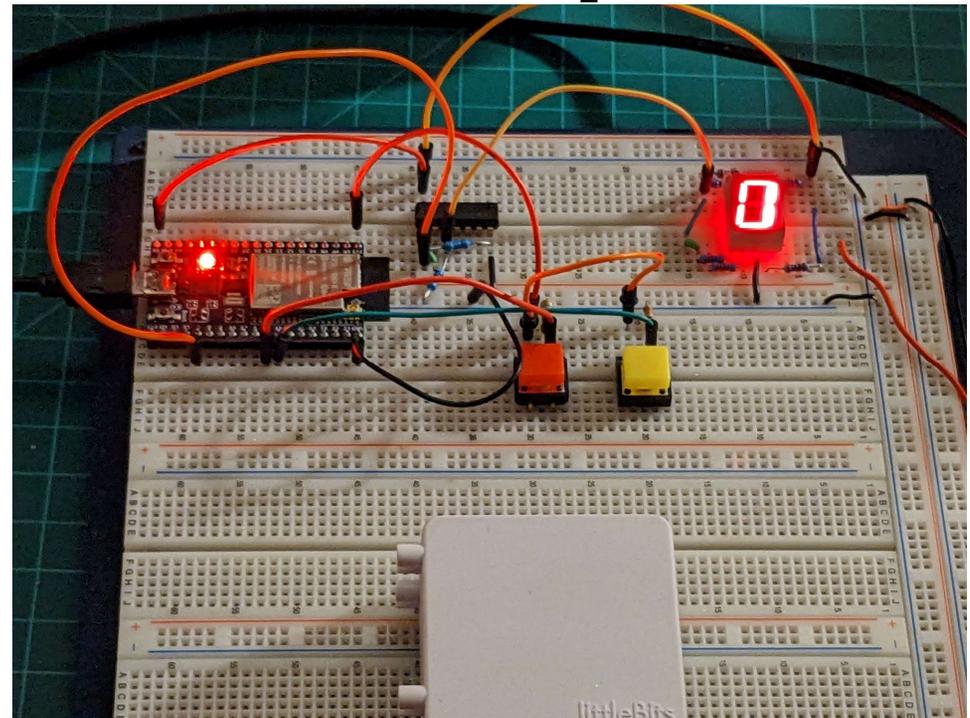
- a) 17
- b) 18
- c) 2
- d) 19



## ESP32 OpenPLC 7-Segment LED Driver Concept...



The Start-Stop Control Circuit:

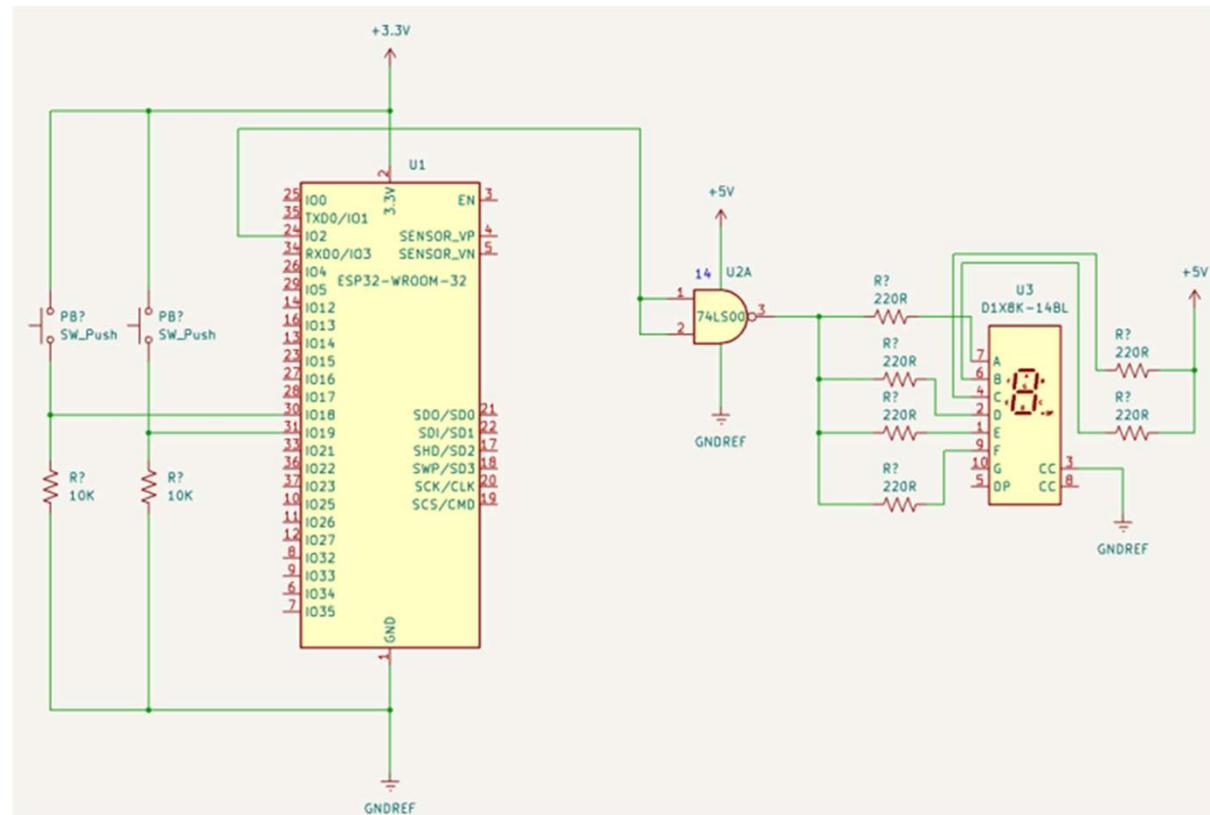


The Smart Indicator will display a binary 1 for (Start Event) and binary 0 for Stop condition

## ESP32 OpenPLC 7-Segment LED Driver Concept

### Electronic Circuit Schematic Diagram

The Smart Indicator will display a binary 1 for (Start Event) and binary 0 for Stop condition



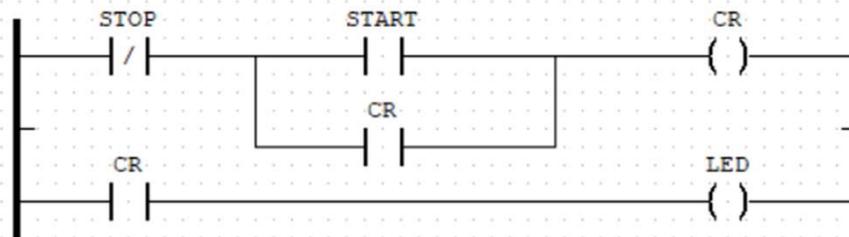
## ESP32 OpenPLC 7-Segment LED Driver Concept

ESP32\_Start\_Stop\_Controller

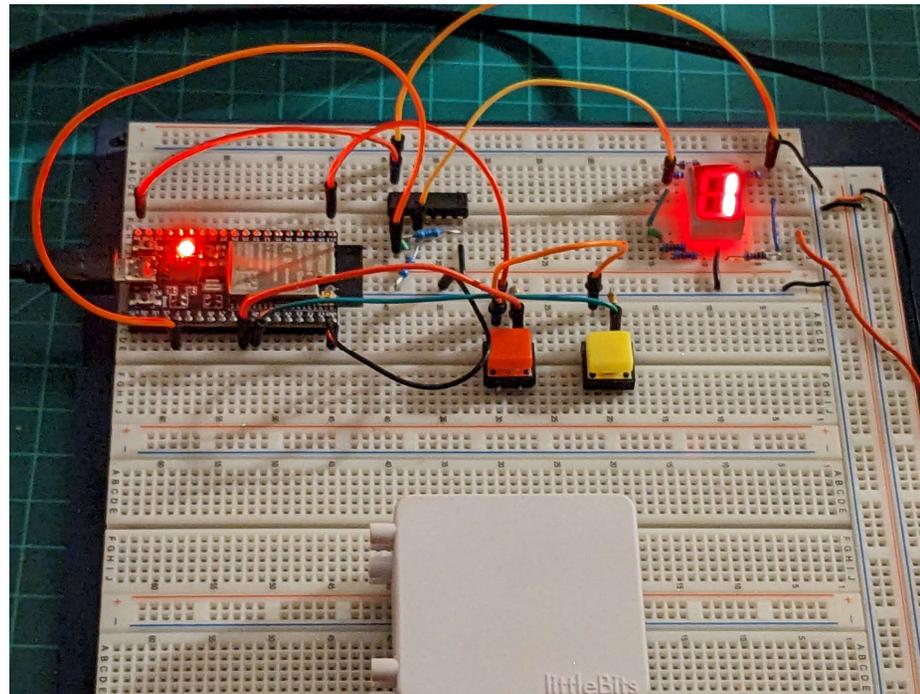
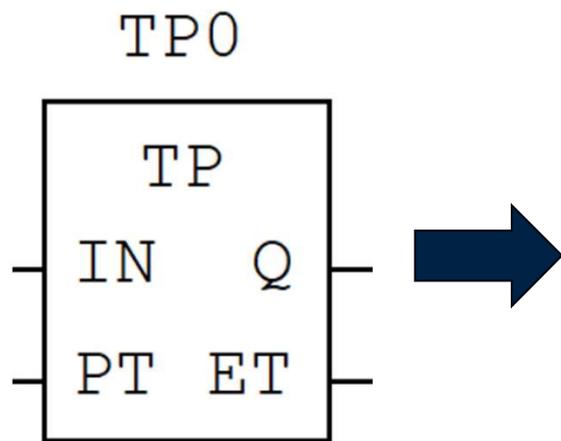
Description:  Class Filter: All

#	Name	Class	Type	Location	Initial Value	Option	Documentation
1	START	Local	BOOL	%IX0.1			Pin 18 on ESP32 microcontroller
2	STOP	Local	BOOL	%IX0.2			Pin 19 on ESP32 microcontroller
3	CR	Local	BOOL				Internal Memory Bit for OpenPLC
4	LED	Local	BOOL	%QX0.1			Pin 2 on ESP32 microcontroller

Ladder  
Diagram  
program  
with  
Tags



# Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher



## Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher...

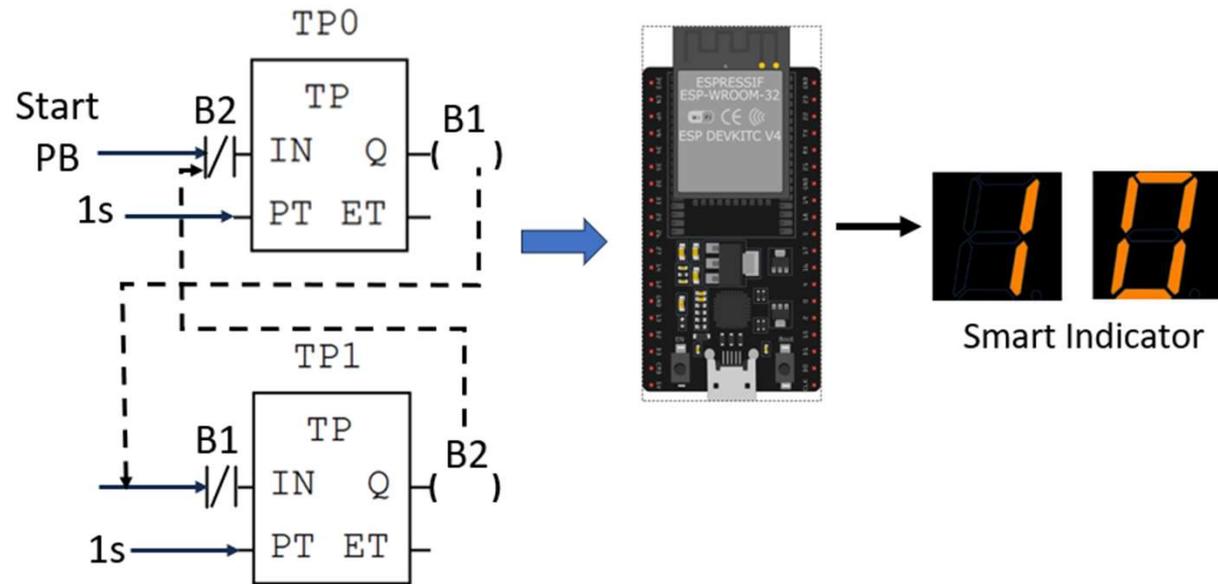
### Lab Objectives:

- Participants will learn to Build an ESP32 OpenPLC Smart Indicator Flasher.
- Participants will learn to program the ESP32 microcontroller using OpenPLC.
- Participants will learn to run and test the ESP32 Counter UP Motor Controller LD program on an ESP32 microcontroller.

# Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher...

OpenPLC  
Interlocking  
Timers LD  
program

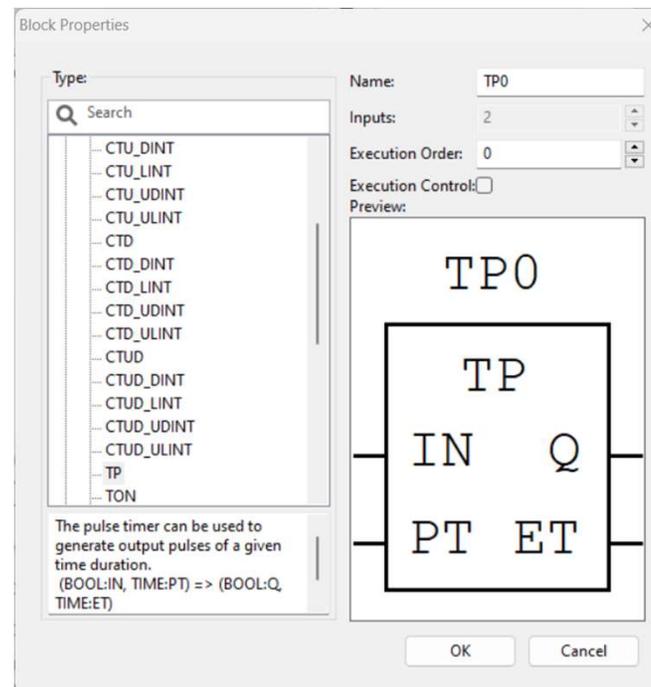
## Concept Diagram



# Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher...

## Pulse Timer Function Block Diagram

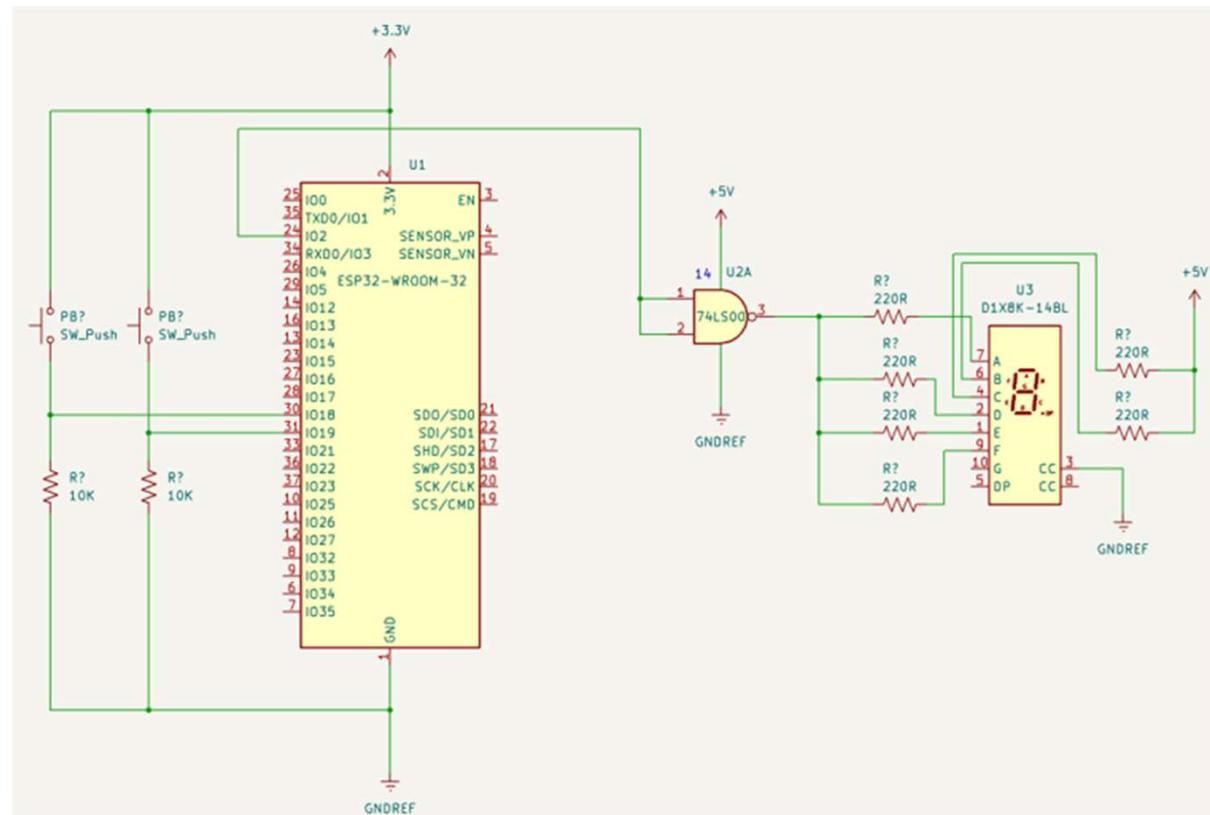
When Elapsed Time (ET) =  
Preset Time (PT): --→ Q is  
High



## ESP32 OpenPLC 7-Segment LED Driver Concept

### Electronic Circuit Schematic Diagram

The Smart Indicator will display a binary 1 for (Start Event) and binary 0 for Stop condition

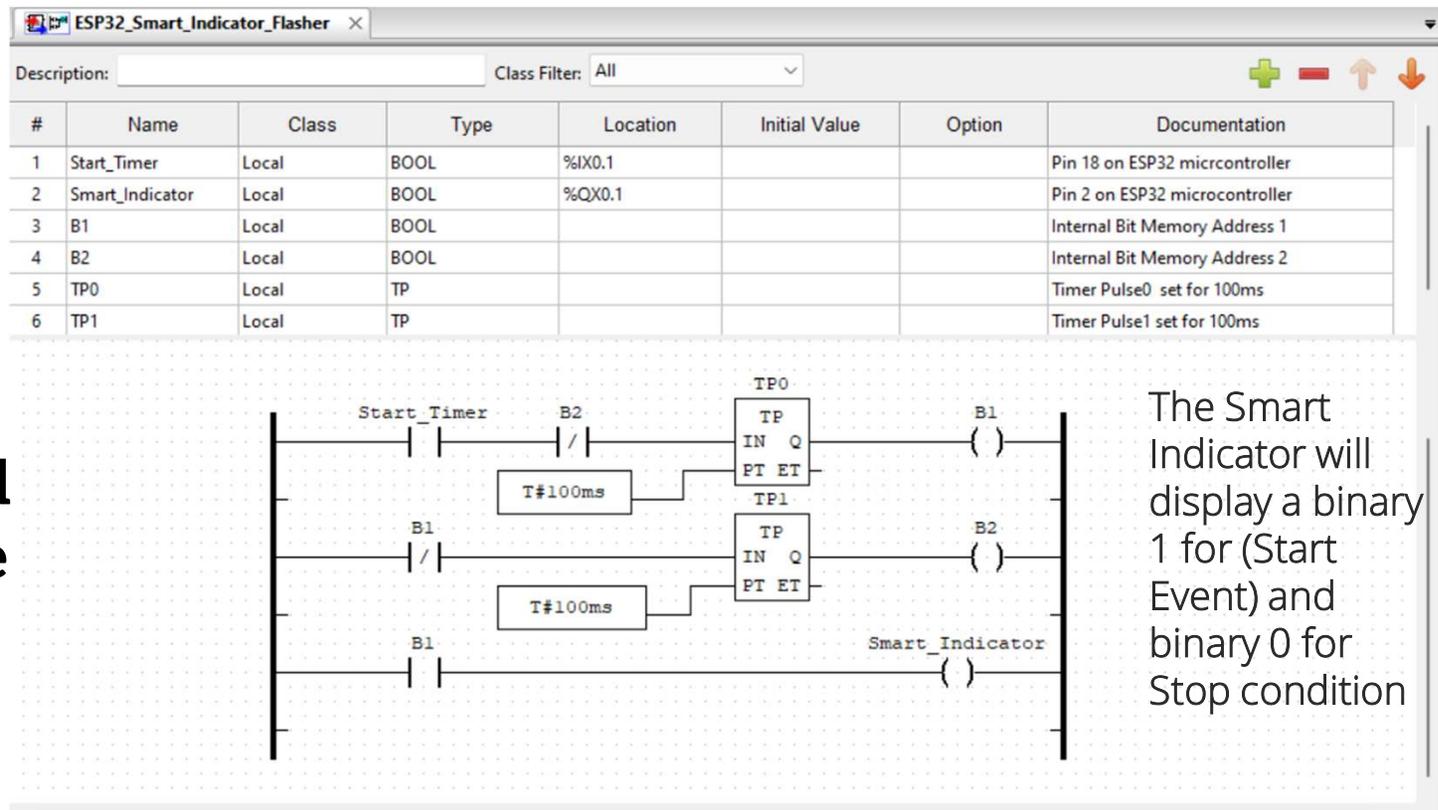


# Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher...

## ESP32 OpenPLC Smart Indicator Flasher LD

### program

Review Days 1 and 2 steps to build the Start-Stop Control Circuit LD as a reference

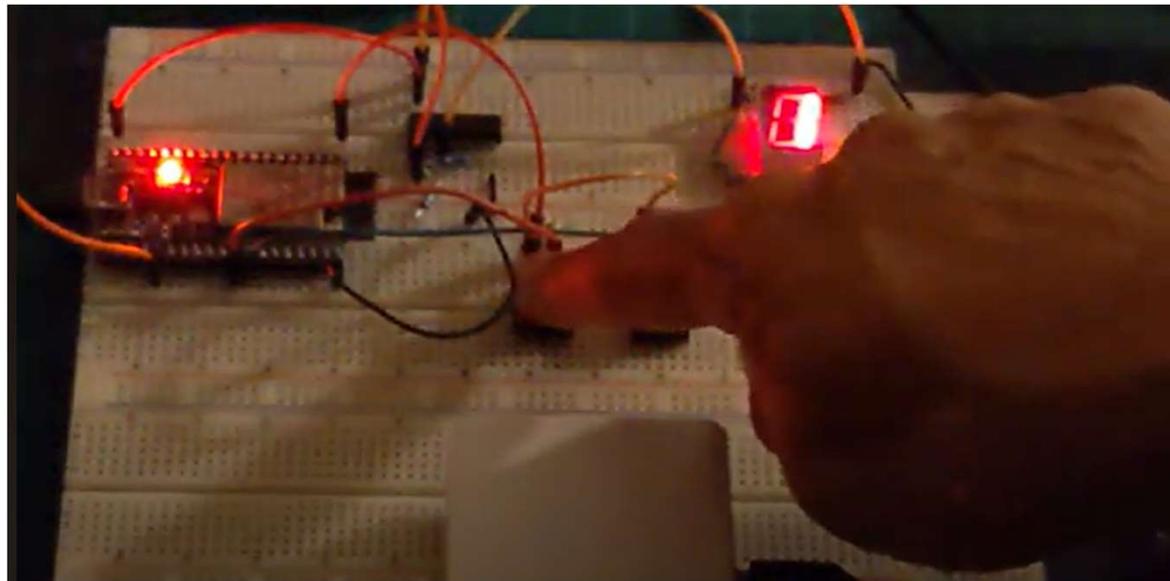


# Lab: Build and Test an ESP32 OpenPLC Smart Indicator Flasher...

## Functional ESP32 OpenPLC Smart Indicator Flasher

YouTube Video

<https://youtu.be/ekkadDCOIGs>



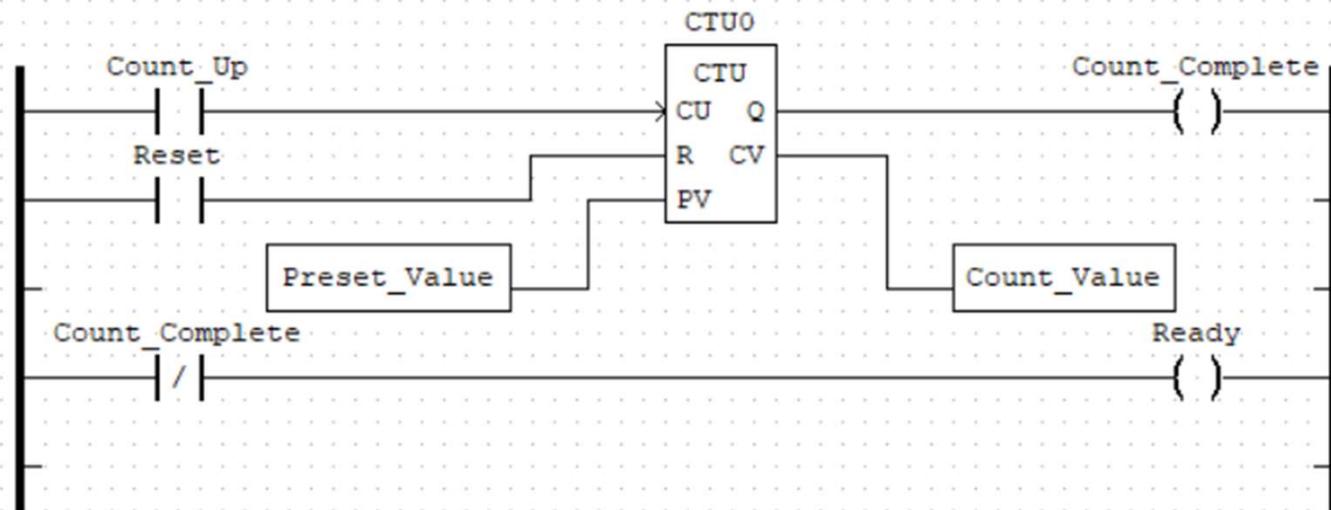
Get ESP32 OpenPLC Smart Indicator Flasher LD program below!

[https://github.com/DWilcher/HCI\\_Electronics/blob/main/Embedded\\_Controls\\_Development\\_Code.zip](https://github.com/DWilcher/HCI_Electronics/blob/main/Embedded_Controls_Development_Code.zip)

## Lab: Build and Test an ESP32 OpenPLC Motor Driver Controller...

Create Tags for the CountUp DC Motor Controller

**Review Days 1 and 2 steps to build the Start-Stop Control Circuit LD**



Get ESP32\_CountUp\_Controller LD program below!

[https://github.com/DWilcher/HCI\\_Electronics/blob/main/Embedded\\_Controls\\_Development\\_Code.zip](https://github.com/DWilcher/HCI_Electronics/blob/main/Embedded_Controls_Development_Code.zip)

## Question 5

**What condition allows Q-output to turn on using a Pulsed Timer (TP) Function Block Diagram?**

- a)  $ET > PT$**
- b)  $ET < PT$**
- c)  $ET = PT$**
- d)  $PT = ET$**



## Thank you for attending

Please consider the resources below:

International Electrotechnical Commission. (2003). *International standard (IEC61131-3)*.  
[https://d1.amobbs.com/bbs\\_upload782111/files\\_31/ourdev\\_569653.pdf](https://d1.amobbs.com/bbs_upload782111/files_31/ourdev_569653.pdf)

OpenPLC.(2023). Openplc overview. <https://autonomylogic.com/docs/openplc-overview/>

Wilcher. D. (2023, September 28). *PLC ladder logic on an arduino: Build a start-stop control circuit*.  
<https://control.com/technical-articles/plc-ladder-logic-on-an-arduino-building-a-start-stop-circuit/>

Zemmouri, A., Barodt, A., Dahou, H., Alarequi, M., Eigouri, R., Htou, L., & Benbrahim, M. (2023). A microsystem design for controlling a dc motor by pulse width modulation using microblaze soft-core. *International Journal of Electrical and Computer Engineering*, 13(2), 1337-1448.  
[https://www.researchgate.net/publication/365994306\\_A\\_microsystem\\_design\\_for\\_controlling\\_a\\_DC\\_motor\\_by\\_pulse\\_width\\_modulation\\_using\\_MicroBlaze\\_soft-core](https://www.researchgate.net/publication/365994306_A_microsystem_design_for_controlling_a_DC_motor_by_pulse_width_modulation_using_MicroBlaze_soft-core)



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