



1ST MAKER SPACE

**Design.
Build.
Sustain.**

Frog Microcontroller Trainer (FMT): Logical Operators
Length of Time: 2 x 55 Minutes
Recommended for Intermediate

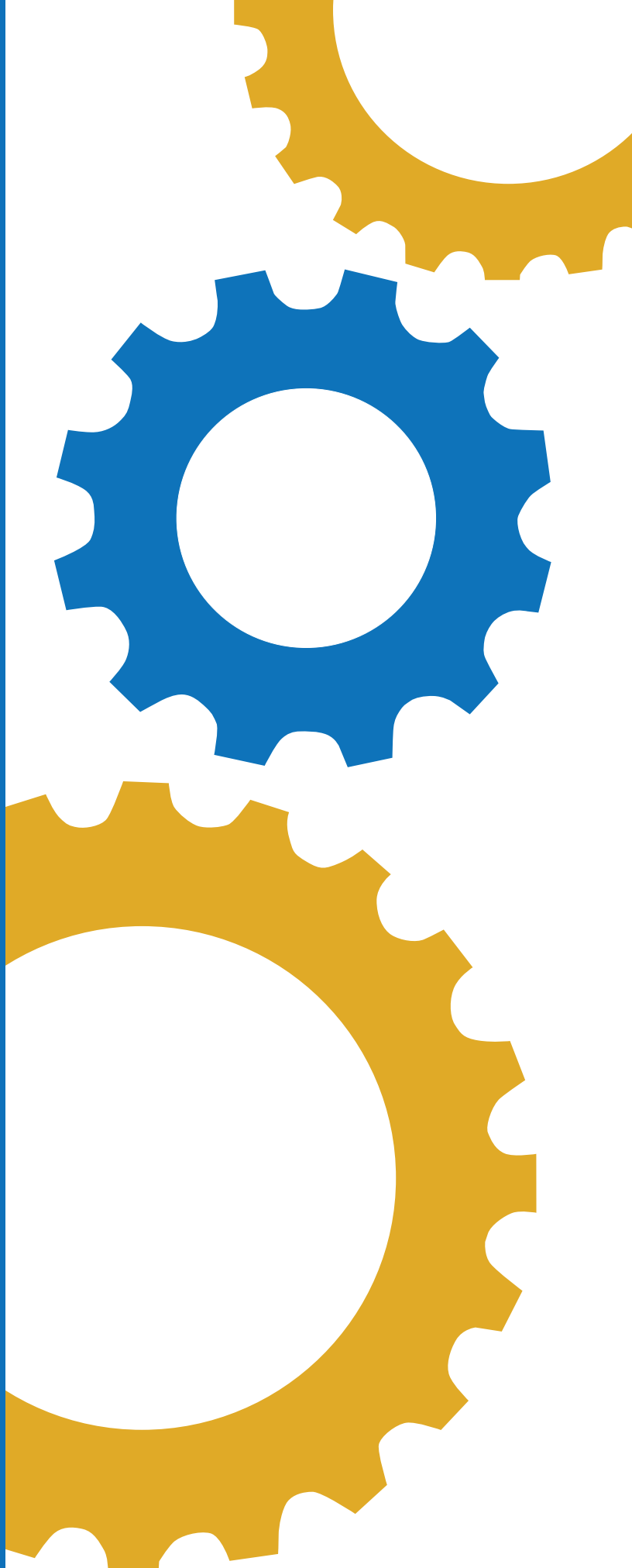
Overview:

- In this project you'll learn about using AND logic with buttons to turn on LED1 only when both buttons are pressed. In this project you'll learn about using OR logic with buttons to turn on LED1 when SW1 OR SW2 are pressed.

Objectives:

Students will be able to:

- Understand AND/OR logic and how it can be used to control specific switches
- Explore truth tables to assist in understanding logical operators
- Test sketch on FMT
- Generate code to control switches and LEDs





Indiana standards for Principles of Computing:

- 7183.D2.2- Apply basic logical structures, file handling, matrices, and arrays to program algorithms.
- 7183.D2.3- Apply truth tables, Boolean logic, control structures, relational and logical operators to program algorithms

Indiana STEM Integration Standards:

- HS.DM.1- Use multiple systems of measurement (i.e., standard and metric) and data sets (e.g., plots, tables, graphs, charts) defined in course-level content standards to analyze real-world scenarios and the mathematical relationships represented by the data.
- HS.AM.2- Create advanced models (e.g., mathematical models, computer simulations) to represent and explain natural and designed systems, defined in course-level content standards.

CSTA:

- 1A-CS-02 Use appropriate terminology in identifying and describing the function of common physical components of computer systems.
- 1B-AP-12 Modify, remix or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features.
- 1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended.
- 2-AP-16 Incorporate existing code, media, and libraries into original programs, and give attribution.

Materials:

- [Frog Microcontroller Trainer](#) from 1st Maker Space
- USB Power Cord
- Arduino IDE
- PC or Mac
- Chromebooks if using Arduino Create for Education App
- Introduction to Microcontroller Trainer Lesson (if needed as a resource)

Preparation:

- Ensure students have a compatible device and have downloaded the Arduino IDE software on device.
- Ensure all students know how to properly connect the FMT to the device via the USB cable.

Background Information:

In this lesson students will learn about logical operators. This function is useful for making comparisons.



Lesson Elements

Introduction to Logic Operators and Truth Tables – 25 minutes

Provide each student a copy of the student handout. Go over what a logical operator is and how it can be used. In this case, switches will be used to control LED 1/PIN 13. Introduce truth tables and have students help you complete them and predict what the outcomes might mean for this application.

Access 1MS Code – 15 minutes

Visit the 1st Maker Space [website](#) and access the library of code developed specifically for the FMT. Here, you will find a section with various code (called projects) written for each major component of the trainer. The teacher will locate the sketch by clicking on 3.02- AND logic. You will also need to locate the 3.03- OR logic project for this lesson.

Project 3.02 AND Logic

In this project, you'll learn how to use logical AND (&&) to control an LED with two buttons!

[Read More →](#)

Project 3.03 OR Logic

In this project, you'll learn how to use logical OR (||) to control an LED with either button!

[Read More →](#)

Here, one can find the sketch to share with students. Students can simply copy the code by selecting the blue copy button.

Project Code:

```

////////////////////////////////////
// 3.02 - AND Logic

byte SW1 = 1;
byte SW2 = 0;
bool pressed = 0;

byte LED1 = 13;

void setup() {
  pinMode(SW1, INPUT);
  pinMode(SW2, INPUT);

  pinMode(LED1, OUTPUT);
}

void loop() {
  bool SW1State = digitalRead(SW1);
  bool SW2State = digitalRead(SW2);

  if (SW1State == pressed && SW2State == pressed) {
    digitalWrite(LED1, HIGH);
  }
  else {
    digitalWrite(LED1, LOW);
  }
}
////////////////////////////////////

```

Copy

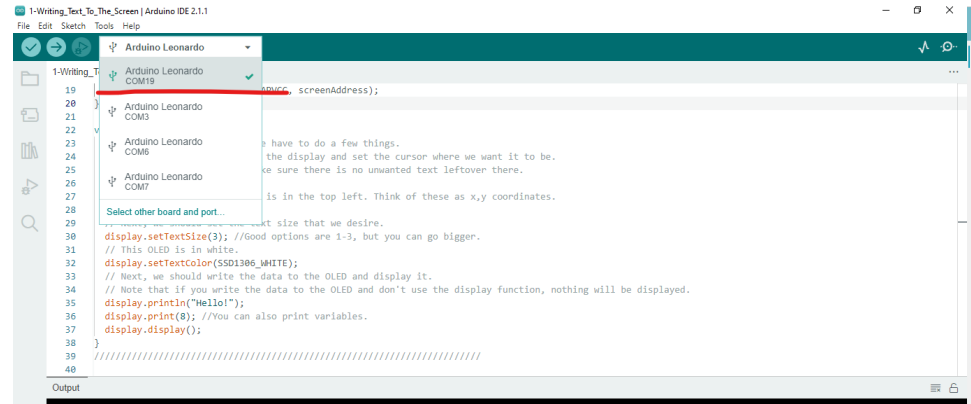
Connect the Trainer and

Plug the Frog Microcontroller Trainer into your computer's USB port. Using the dropdown box near the top, select the Arduino



Verify the Sketch— 10 minutes

Leonardo and appropriate COM port. **Note:** Mac computers may automatically select the port.



Making sure the USB cable is connecting the FMT to the computer, verify the sketch by clicking on the check mark in the upper left-hand corner.

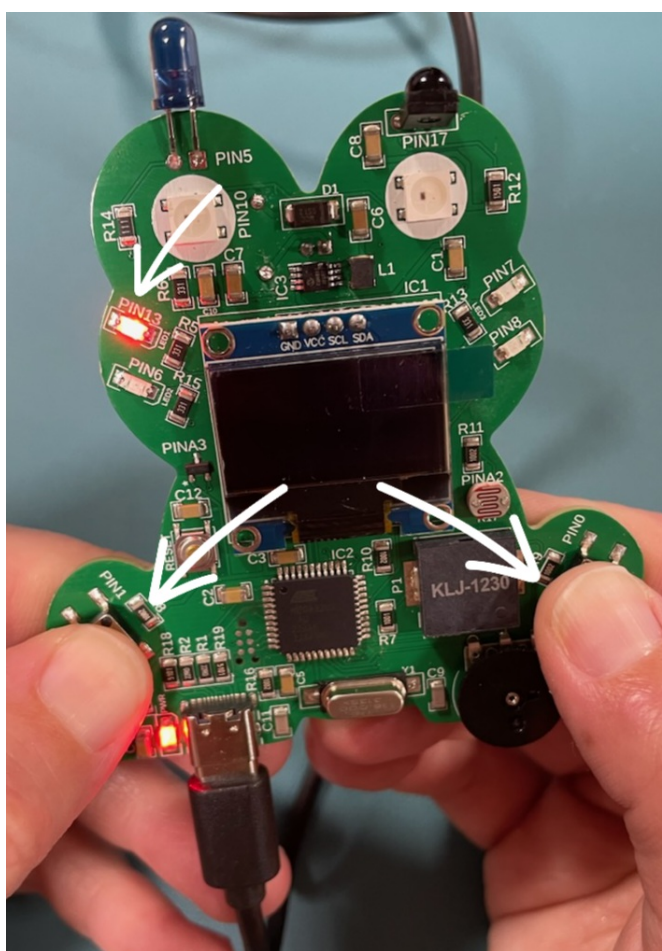


Once verified, upload the sketch to the trainer by clicking the right-facing arrow. It will turn yellow.

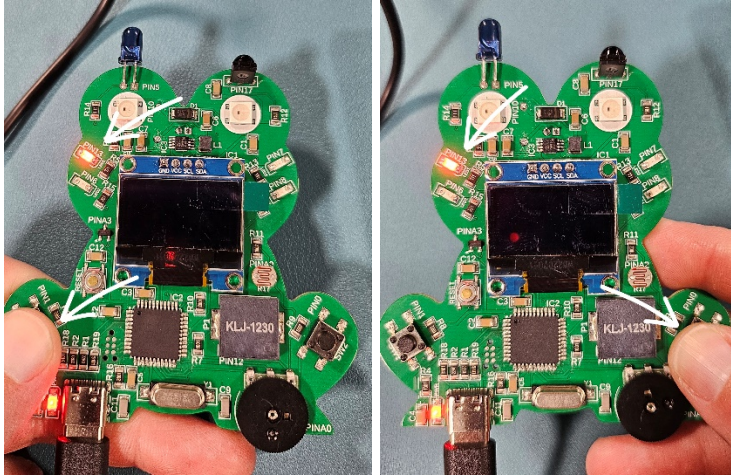


```
sketch_dec15a | Arduino IDE 2.2.1
File Edit Sketch Tools Help
Arduino Leonardo
sketch_dec15a.ino
1 //////////////////////////////////////////////////// 1.03 - Analog Write
2 byte LED1 = 13;
3 void setup() {
4   pinMode(LED1, OUTPUT);
5   analogWrite(LED1, 127);
6 }
7 void loop() {
8
9 }
10 ////////////////////////////////////////////////////
```

For 3.02: To understand if the sketch is working correctly, the LED 1/Pin 13 should ONLY illuminate when BOTH SW1 and SW2 are pressed.





	<p>For 3.03: To understand if the sketch is working correctly, the LED 1/Pin 13 should ONLY illuminate when EITHER SW1 or SW2 is pressed.</p> 
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<p>Generate a New Sketch – 30 Minutes</p>	<p>Once students have successfully run the sketch, they will now generate an entirely new sketch to achieve any of the following challenges.</p> <p>Make an LED turn on when:</p> <ul style="list-style-type: none"> SW1 is not pressed SW2 is not pressed SW1 is pressed and SW2 is not pressed SW1 is not pressed OR SW2 is not pressed
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<p>Career Exploration:</p> <ul style="list-style-type: none"> • A good resource is the IDOE Career Explorer database. • Another good resource for career information is the Bureau of Labor Statistics 	
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<p>Practical Application:</p> <p>A logical operator is a symbol or word used to connect two or more expressions such that the value of the compound expression produced depends only on that of the original expressions and on the meaning of the operator. Common logical operators include AND, OR, and NOT. These operators are commonly used in programming to make decisions based on multiple conditions, to combine or negate conditions, and to control the flow of a program. They are frequently used in conditional statements, loops, and expressions to create complex conditions and control structures.</p>	
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<p>What's Next?:</p> <ul style="list-style-type: none"> • FMT: Project 4.04- Tone Functions 	
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Additional Resources:

- 1st Maker Space Frog Microcontroller Library
- 1st Maker Space Learn Arduino with the Frog Microcontroller

Performance Assessment/Check for Understanding:

- Was the student able to successfully load the sketch to the FMT?
- Was the student able to generate code that allowed the switches to control the LED when:
 - SW1 and SW2 are pressed?
 - SW1 or SW2 is pressed?
 - SW1 is not pressed?
 - SW2 is not pressed?