PRAG 304L: Electrical Diagnostics for Farm Machinery Lab
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Lab 2: Using Basic Electrical Diagnostic Tools

1. Overview

In this lab, you will explore fundamental electrical diagnostic tools commonly used in troubleshooting and maintaining farm machinery. A **multimeter** is an essential tool that measures voltage, current, and resistance in electrical circuits, helping diagnose faults like short circuits or broken connections. An **oscilloscope** is an advanced diagnostic instrument used to visualize and analyze electrical signals as waveforms, allowing you to observe changes in signal amplitude, frequency, and timing. The **Arduino board** is a microcontroller platform widely used for prototyping and automation, offering a simple interface to interact with sensors and control actuators in farm machinery applications. The **Raspberry Pi** is a compact single-board computer that provides greater computational capabilities, enabling advanced diagnostics, data logging, and control applications in precision agriculture. Understanding these tools will prepare you to diagnose and address electrical issues effectively in modern farm machinery**.**

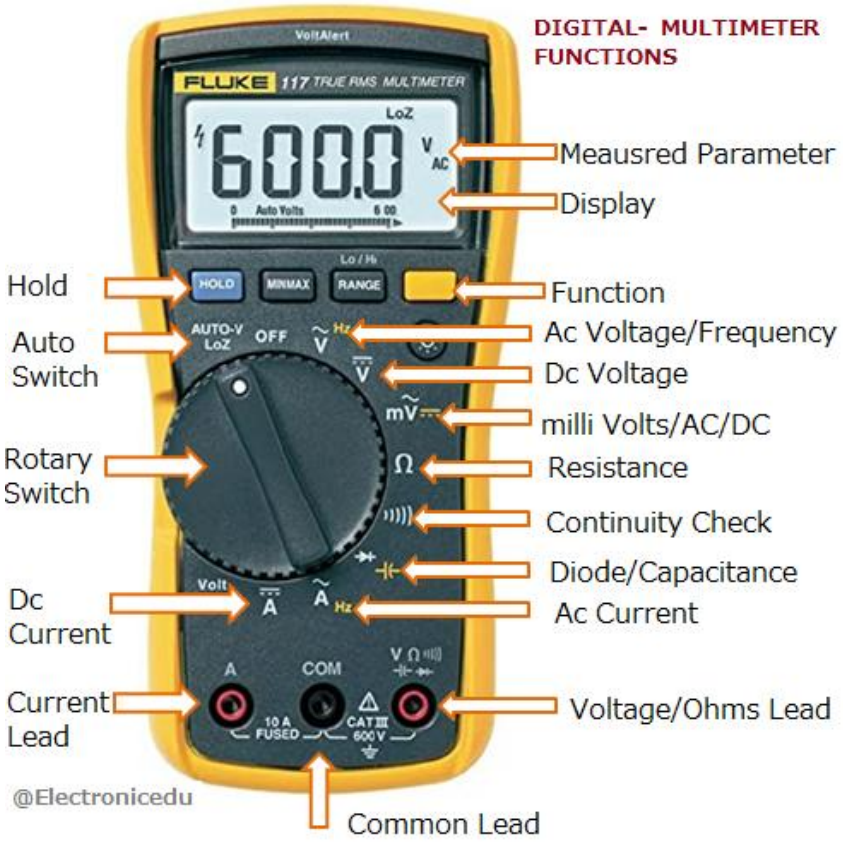

Fig. 1 A digital multimeter showing function of each button

Image source: https://www.electronicedu.com/2020/07/functions-of-multi-meter.html

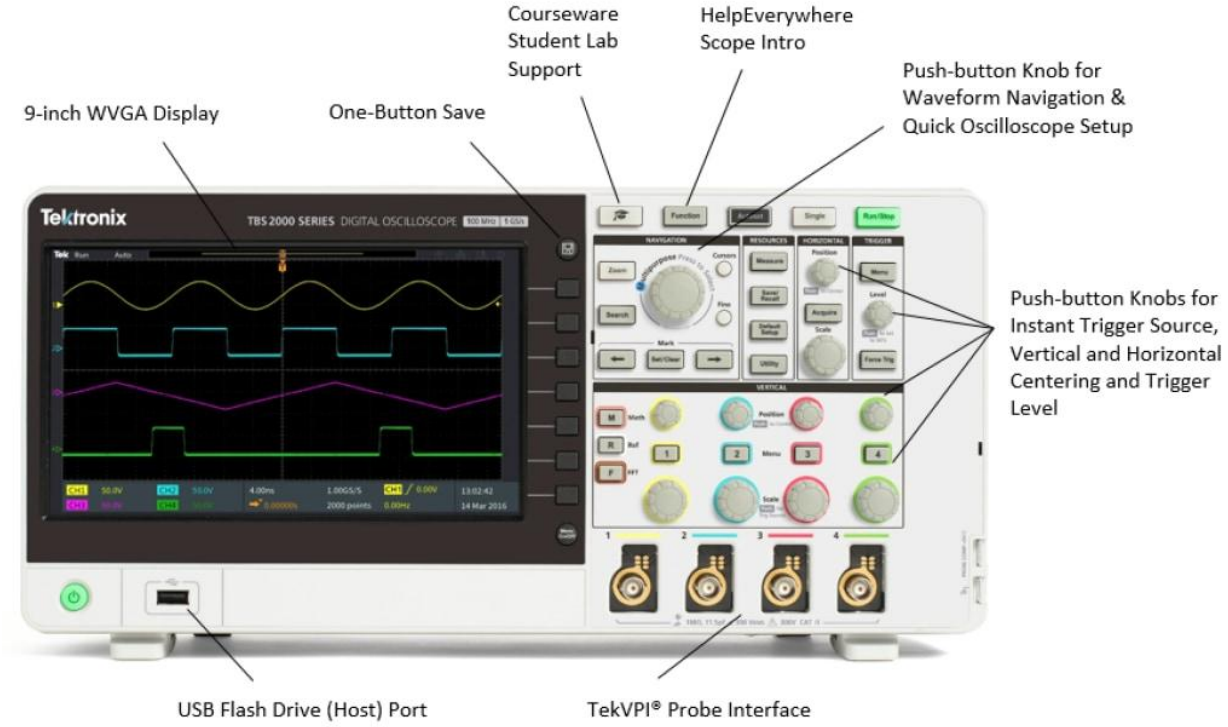

Fig. 2 A typical digital oscilloscope (image source: https://my.mouser.com/new/tektronix/tektronix-tbs2000b-oscilloscopes/)

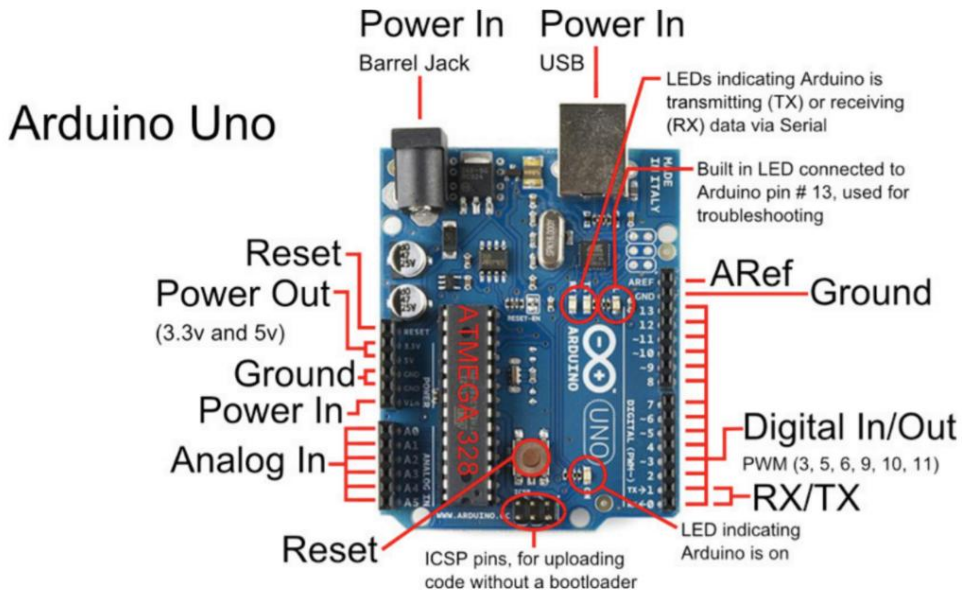

Fig. 3 Arduino Uno microcontroller board

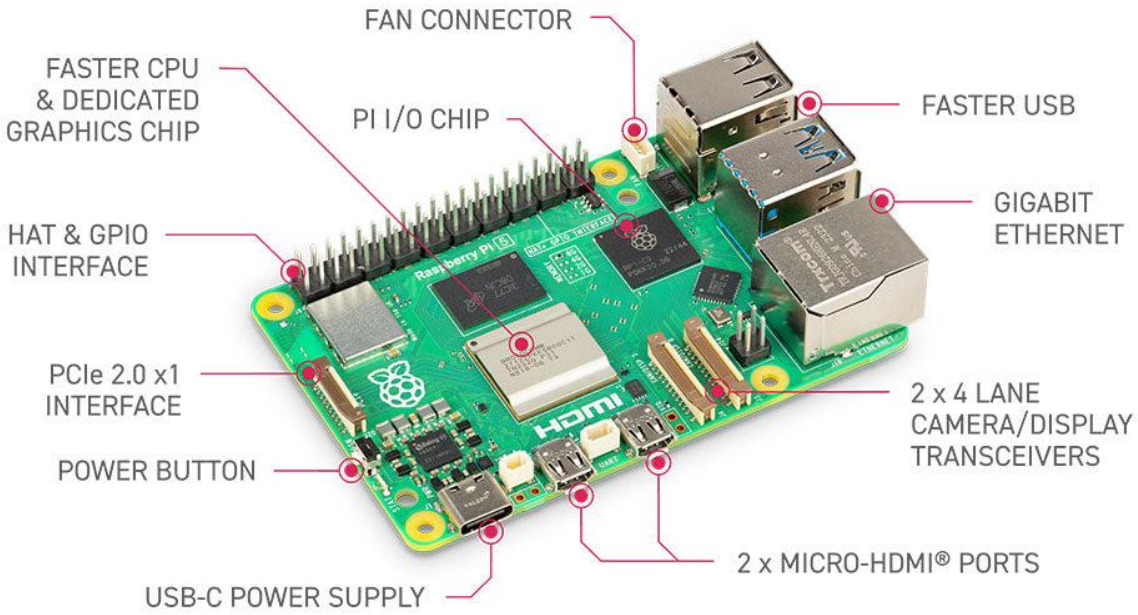

Fig. 4 Raspberry Pi5 minicomputer board

2. Objectives

The objective of this lab is to familiarize you with basic electrical diagnostic tools such as the multimeter, oscilloscope, Arduino board, and Raspberry Pi. You will learn how to use these tools, interpret their readings, and understand their applications in diagnosing and maintaining farm machinery.

3. Experiment

Experiment 1: Using a Multimeter

Materials Needed

i. Multimeter
ii. Breadboard
iii. Resistors (e.g., 1 kΩ, 10 kΩ)
iv. Battery (e.g., 9V)
v. Connecting wires

Procedure

i. Set the multimeter to the appropriate measurement mode (e.g., voltage, resistance, or current).
ii. Measure the voltage of the battery by connecting the probes to the terminals.
iii. Build a simple circuit on the breadboard using a resistor and the battery.
iv. Measure the resistance of the resistor directly using the multimeter.
v. Measure the current through the circuit by connecting the multimeter in series.

Lab Report

You should include the following in your lab report with respect to Experiment 1.

i. A labeled diagram of the circuit.
ii. Measurements for voltage, resistance, and current.
iii. Observations about how the readings match Ohm's Law (V=IR).

Experiment 2: Using an Oscilloscope

Materials Needed

i. Oscilloscope
ii. Function generator
iii. Connecting cables

Procedure

i. Connect the function generator (or any other source of signal generation) to the oscilloscope using the appropriate cables.
ii. Set the function generator (or any other source of signal generation) to produce a sine wave with a frequency of 1 kHz and an amplitude of 2V.
iii. Observe the waveform on the oscilloscope screen.
iv. Adjust the time base and voltage scale to better view the waveform.
v. Measure the frequency and peak-to-peak voltage using the oscilloscope's measurement tools.

Lab Report

You should include the following:

i. A screenshot or sketch of the observed waveform.
ii. Measured values for frequency and peak-to-peak voltage.

Experiment 3: Introduction to Arduino

Materials Needed

i. Arduino Uno board
ii. USB cable
iii. LED
iv. 220 Ω resistor
v. Breadboard
vi. Connecting wires
vii. Computer with Arduino IDE installed

Procedure:

i. Connect the Arduino board to the computer using the USB cable.
ii. Open the Arduino IDE and write a simple program to blink an LED:

```
void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  delay(1000);
}
```

iii. Upload the program to the Arduino board.

iv. Connect the LED and resistor to pin 13 and ground.
v. Observe the blinking LED.

Lab Report

You should include:

i. A description of the Arduino setup.
ii. The code used in the experiment.
iii. Observations on how the LED blinks and any troubleshooting steps.

Experiment 4: Introduction to Raspberry Pi

Materials Needed

i. Raspberry Pi (any model)
ii. MicroSD card with Raspberry Pi OS
iii. Power supply
iv. HDMI cable and monitor
v. USB keyboard and mouse

Procedure

1. Set up the Raspberry Pi by inserting the microSD card and connecting the peripherals (monitor, keyboard, and mouse).
2. Power on the Raspberry Pi and log into the operating system.

Lab Report:

You should include:

i. Steps to set up the Raspberry Pi.