



## Summary:

Student will learn how to measure electric signals using an oscilloscope. Student will generate PWM and digital outputs and attempt to view them with the oscilloscope.

## Materials:

Each student team should have the following materials, equipment, and supplies:

1. Oscilloscope with probes.
2. One Arduino Mega w/ USB cable
3. A computer with Arduino IDE installed
4. Breadboard
5. Jumpers or wires

## Procedure:

- 1) Power on the oscilloscope. Boot up may take some time depending on the model.
- 2) Attach the oscilloscope probe to Channel 1.
- 3) Attach the clip of the probe to a jumper or strip of wire. Secure the ground clip to the Arduino's ground
- 4) Upload the following code to the Arduino Mega:

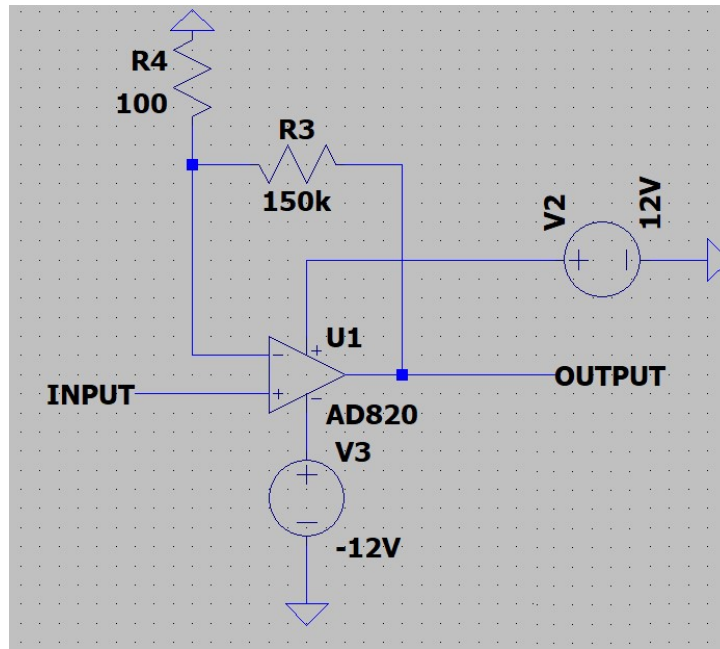
```
int PwmRate = 127;
int PwmPin = 4;

void setup() {
  pinMode(PwmPin, OUTPUT);
}

void loop() {
  analogWrite(4, PwmRate);
  delay(5);
}
```

- 5) Measure the output of Pin 4 using the oscilloscope. Adjust the amplitude and time scales until a 1 kHz square wave is shown.
- 6) Change the variable PwmRate to 64. Measure the output of Pin 4. How does the signal compare to the original?
- 7) Change variable PWMRate to 192. Measure the output of Pin 4. How does the signal compare to the two previous measurements?

- 8) Build the following non-inverting amplifier on the breadboard. Connect Pin 4 to the input of the amplifier by attaching a wire from the Arduino to the breadboard.



- 9) Measure the signal at the output of the amplifier. How has it changed?