Temperature_Measurement -- Overview

Temperature Measurement using LM35 Sensor

OBJECTIVES

After performing this lab exercise, learner will be able to:

- Program Arduino board to measure temperature.
- Convert the temperature changes to an equivalent voltage vaue using sensor
- Measure RMS / Mean voltage of the captured signal using inbuilt functions of the scope

EQUIPMENT

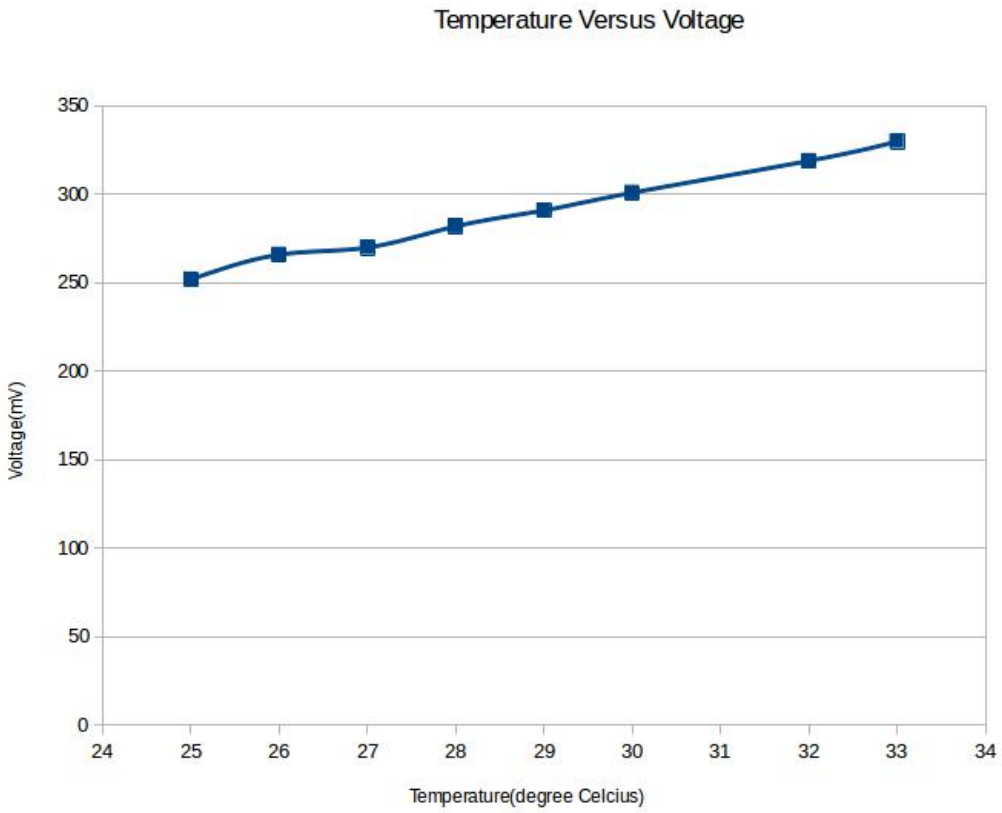
To carry out this experiment, you will need:

- TBS1KB - Digital Oscilloscope from Tektronix .
- Arduino Duemilanve or Uno board .
- Voltage probe (provided with oscilloscope) / BNC cables .
- Breadboard and connecting wires .
- LM35 Temperature Sensor.

THEORY

- The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature.
- Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.
- The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to +150°C temperature range.
- RMS Value: Root Mean Square value of voltage.

PLOT



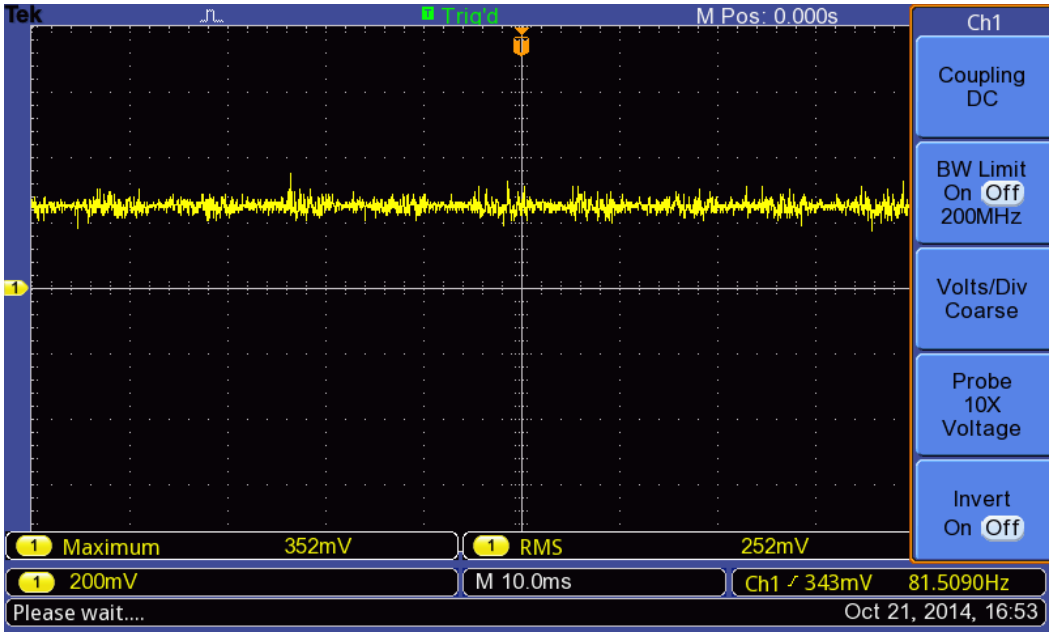
ARDUINO CODE

```
void setup()
{
  pinMode(A0, INPUT);
  Serial.begin(9600);
}

void loop()
{
  int temp = analogRead(A0);
  float new_temp = (5*temp*100)/1023;
  Serial.println(new_temp);
  delay(1000);
}
```

OUTPUT WAVEFORM

The output waveform would look like following, at Temperature = 25°C

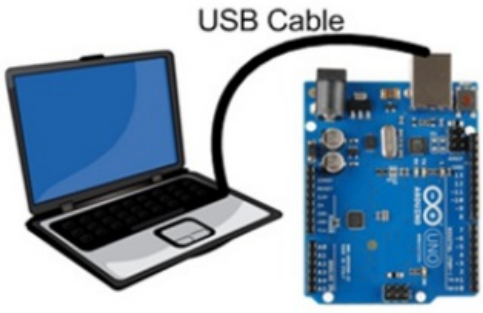


Temperature_Measurement -- Procedures

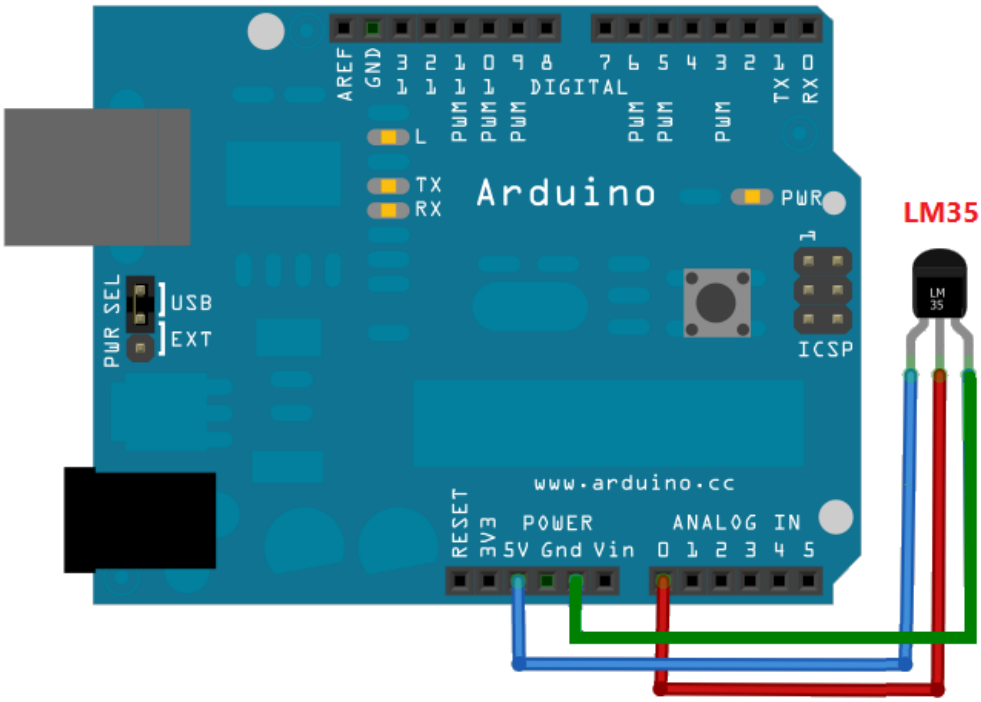
Step 1

DUT / SOURCE SETUP

- Ensure you have Arduino IDE (software to program the Arduino boards) installed on your computer.
- Connect the Arduino board to PC using USB cable



- Program the Arduino board with given code
- Connect the LM35 sensor output to A_0 pin of Arduino



Step 2

MEASUREMENT / SCOPE SETUP

• Power ON the oscilloscope
• Connect the Channel 1 probe of the oscilloscope to A_0 pin of Arduino
• Acquire the signal(s) from circuit on oscilloscope

Step 3

• Do the Autoset on the scope to efficiently capture and view the signal
• If AUTOSET feature is not enabled, then manually set the horizontal and vertical scale and trigger condition to view stable waveform without any clipping.

Step 4

• From the measurement menu, configure RMS measurement on acquired channel

Step 5

- Measure the RMS voltage at different temperatures.
- Tabulate the Temperature versus measured RMS voltage.

Step 6

Measure the RMS voltage at different temperatures and fill out the observation table:

Temperature (degree Celcius)	Voltage (mV)
25	
26	
27	
28	
29	
30	
32	
33	

Step 7

- From the tabulated Temperature versus measured RMS voltage, verify that it is a linear relationship. The plot would typically look like this: