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StudentZone—ADALM2000 Activity: IC Temperature Sensors

Antoniu Miclaus, System Applications Engineer

Objective

The objective of this lab activity is to measure ambient temperature using integrated circuit temperature transducers that provide an output (current or voltage) proportional to absolute temperature.

Temperature Measuring Using the AD22100

Background

The AD22100 is a monolithic temperature sensor with on-chip signal conditioning. Its operating temperature range is −50°C to +150°C, making it ideal for use in numerous applications. The signal conditioning eliminates the need for any trimming, buffering, or linearization circuitry, greatly simplifying the system design and reducing the overall system cost. The output voltage is proportional to the temperature and the supply voltage, and it swings from 0.25 V at −50°C to 4.75 V at +150°C using a single 5.0 V supply.

Materials

- ADALM2000 Active Learning Module
- Solderless breadboard and jumper wire kit
- AD22100 temperature sensor

Hardware Setup

For temperature measuring, it is necessary to connect the sensor to the power supply and the output to the oscilloscope. Figure 2 shows the sensor connections on a solderless breadboard.

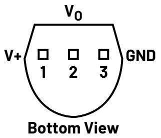

Figure 1. AD22100 temperature sensor pinout.

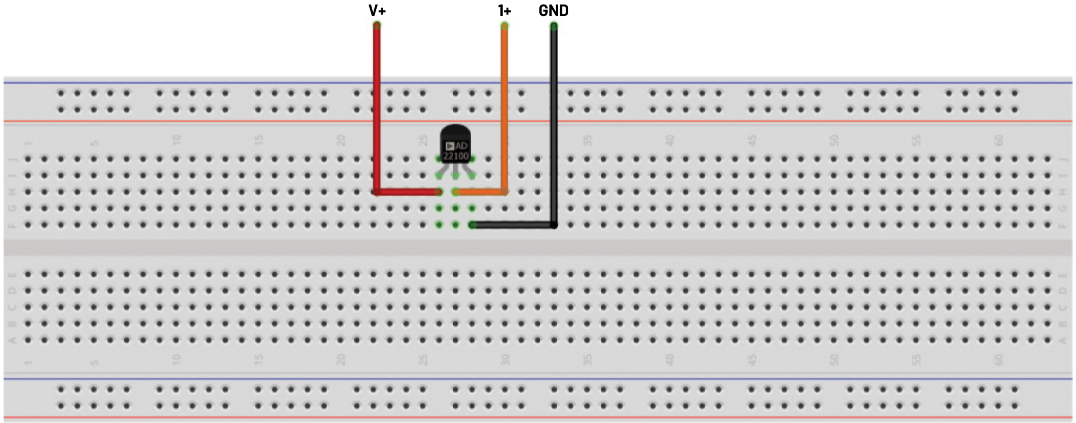

Figure 2. Breadboard connections for an AD22100 temperature sensor.

Procedure

Open Scopy and enable the positive power supply to 5 V. On Channel 1 of the oscilloscope, you will see the output voltage of the sensor. To obtain the value of the temperature, it is necessary to refer to the sensor's data sheet to get the output voltage function.

$$V_{OUT} = \left(\frac{V+}{5\ V}\right) \times \left(1.375\ V + 22.5\left(\frac{mV}{°C}\right) \times T_A\right) \quad (1)$$

From the output voltage function given by Equation 1, you can extract the equation for the ambient temperature (T_A).

$$T_A = \frac{\left(\frac{V_{OUT}}{\left(\frac{V+}{5\ V}\right)} - 1.375\ V\right)}{\left(22.5\left(\frac{mV}{°C}\right)\right)} \quad (2)$$

Add a new math channel to the oscilloscope where you will see the value of the temperature. Insert Equation 2 in the f(t) field and set the M1 channel resolution to 10 V/div. Enable the measure feature of the oscilloscope. The mean measurement of M1 will display the actual ambient temperature.

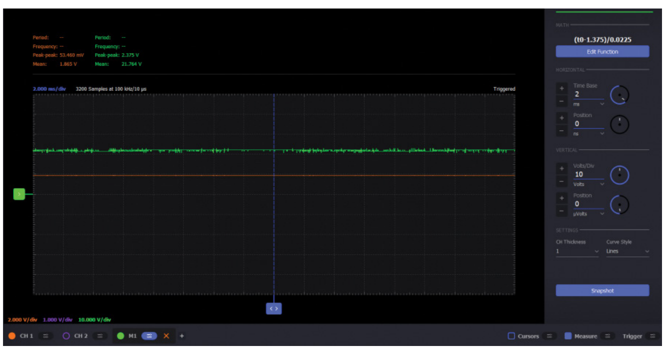

Figure 3. Output voltage and temperature measurements.

Temperature Measuring Using the AD592

Background

The AD592 is a 2-terminal monolithic integrated circuit temperature transducer that provides an output current proportional to absolute temperature. For a wide range of supply voltages, the transducer acts as a high impedance temperature-dependent current source of 1 μA/K. With a single voltage supply (4 V to 30 V), the AD592 offers 0.5°C measurement accuracy on a wide operating temperature range (–25°C to +105°C).

Materials

- ADALM2000 Active Learning Module
- Solderless breadboard and jumper wire kit
- AD592 current temperature sensor
- One 1 kΩ resistor

Hardware Setup

Figure 4 shows the sensor pinout. As you can only measure voltage with the ADALM2000, it is necessary to connect a resistor at the sensor's output and apply Ohm's law to compute the current value.

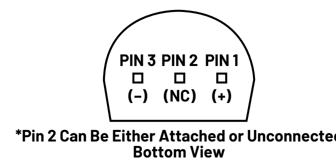

Figure 4. AD592 current temperature sensor pinout.

Make the connections as shown in Figure 5.

Procedure

Open Scopy and enable the positive power supply to 5 V. On Channel 1 of the oscilloscope, you will see the voltage on the resistor. To obtain the current, apply Ohm's law.

$$V = I \times R \quad (3)$$

The current through the resistor is the voltage read on Channel 1 divided by its resistance value. Because the resistor used is 1 kΩ, the numeric value of the current is the same as the voltage but in microamperes. From the sensor's data sheet, we know that its output current increases with 1 μA/K and that the output current at 0°C is 273 μA.

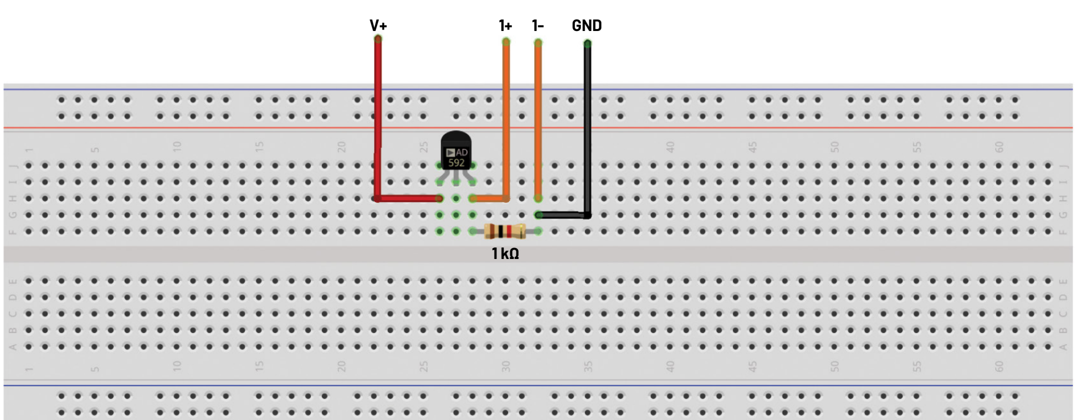

Figure 5. AD592 breadboard connections.

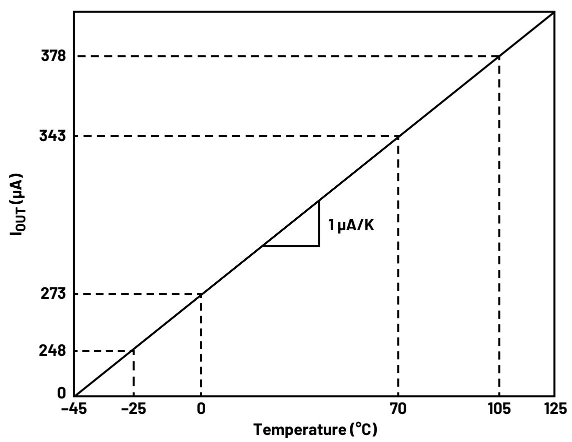

Figure 6. Output current vs. temperature for AD592.

Knowing this, we can apply the formula for conversion from K to °C:

$$°C = K - 273.15 \tag{4}$$

To display the temperature on the oscilloscope tool, add a new math channel with Equation 4 as a function. Keep in mind that Channel 1 voltage is in mV and the sensor's output current is in µA. This means that if you want to obtain the temperature on Channel M1 you have to subtract 0.273 from the value read on CH1.

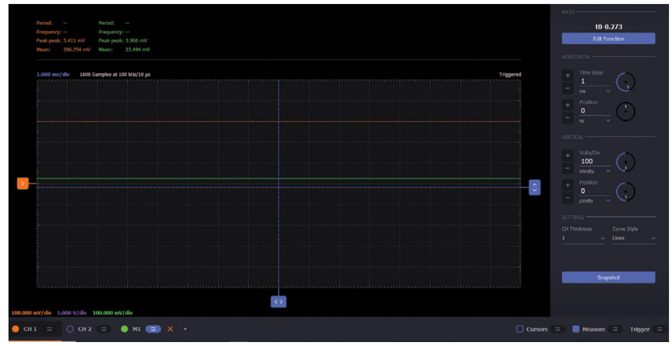

Figure 7. Resistor voltage and temperature measurements.

Question:

What are the differences between the operation of the AD22100 voltage output temperature sensor and the AD592 current output temperature sensor?

You can find the answers at the StudentZone blog.

About the Author

Antoniu Miclaus is a system applications engineer at Analog Devices, where he works on ADI academic programs, as well as embedded software for Circuits from the Lab®, QA automation, and process management. He started working at ADI in February 2017 in Cluj-Napoca, Romania. He is currently an M.Sc. student in the software engineering master's program at Babes-Bolyai University and he has a B.Eng. in electronics and telecommunications from the Technical University of Cluj-Napoca.