

INVESTIGATING THE OPERATING PRINCIPLE OF A K-TYPE THERMOCOUPLE TEMPERATURE SENSOR USING ARDUINO UNO

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Annotation: The principle of operation of the K-type thermocouple sensor is studied in the article. In the following sections, the connection diagram of the thermocouple to the ARDUINO UNO and the process controller software are developed. Also, the explanation of the method required for the temperature control system is discussed.

Introduction. Temperature measurement and control is of great importance in manufacturing today, as it plays a major role in ensuring product quality, safety, and energy efficiency. A K-type thermocouple is a widely used temperature sensor made from two different metals, usually Chromel (Nickel-Chromium alloy) and Alumel (Nickel-Aluminum alloy), which produce a small voltage when there is a temperature difference between the two junctions. This voltage, called the Seebeck voltage, is proportional to the temperature difference and can be measured by a microcontroller like the Arduino UNO. A thermocouple works on the principle of the Seebeck effect: when two different metals are joined at two different temperatures, a voltage (known as thermoelectric voltage) is generated. This voltage is proportional to the temperature difference between the hot junction (the point exposed to temperature) and the cold junction (the reference junction).

Thermocouple sensors are one of the most common and reliable tools for detecting and controlling temperature today. They are used in industry, scientific research, automated systems, and even in everyday life.

A thermocouple consists of two different metal wires, the ends of which are joined together (the junction is hot). Since the metal wires are of different types, they generate an electrical voltage depending on the temperature difference. This phenomenon is called the Seebeck effect.

Materials:

Ni-Cr (nickel-chromium): Positive wire.

Ni-Al (nickel-alumel): Negative wire.

Main characteristics of K-type thermocouple

Measuring range:

Standard range: -200°C to $+1260^{\circ}\text{C}$.

But in some practical applications it is limited to $\pm 1200^{\circ}\text{C}$.

The K-type thermocouple is connected to the Arduino via the MAX6675 thermocouple module.



MAX6675 thermocouple module

The MAX6675 thermocouple module is the temperature measurement for intended special module is a K- type thermocouples with It works . It is clear. temperature to measure and microcontrollers , such as Arduino , provide easy The module is usually industry equipment , furnaces , boilers , laboratory equipment and other high the temperature required to be observed in places is used .

MAX6675 module basic features

1. Thermocouple type : K- type only thermocouple with works .

1. Measurement range :

2. From 0°C to 1024°C (for K-type only).

3. Accuracy :

4. $\pm 2^{\circ}\text{C}$ accuracy with works .

Digital interface :

1Transmits data via Serial Peripheral Interface (SPI).

2Data transfer is carried out via three pins:

3CLK (Clock): Clock signal .

4CS (Chip Select): Modular connection manages .

5DO (Data Out): Transmits data.

In this study, we will investigate the operating principle of a K-type thermocouple temperature sensor and demonstrate how it can be interfaced with an ARDUINO UNO microcontroller to measure temperature.

Components Required:

1. K-type thermocouple sensor

2. ARDUINO UNO board

3. MAX6675 or MAX31855 thermocouple-to-digital converter
4. Jumper wires
5. Breadboard
6. LCD or Serial Monitor (for displaying the temperature)

Working Principle: The K-type thermocouple generates a small voltage (millivolts) when there is a difference in temperature between the two junctions. This voltage is proportional to the temperature difference, and this phenomenon is known as the Seebeck effect. The generated voltage is very small and needs to be amplified and converted into a readable digital signal.

To interface a K-type thermocouple with ARDUINO UNO, a thermocouple-to-digital converter like the MAX6675 or MAX31855 is used. These converters amplify the small voltage generated by the thermocouple and convert it to a digital signal that the ARDUINO UNO can read.

Procedure:

1. Connect the K-type thermocouple to the MAX6675 or MAX31855 converter. The wiring diagram will show connections for power (VCC, GND), and communication lines (SCK, CS, and SO for SPI interface).
2. Connect the MAX6675/31855 to the ARDUINO UNO using the SPI pins (MISO, MOSI, SCK, and CS).
3. Write the ARDUINO code to initialize the thermocouple module and read the temperature data. The ARDUINO IDE provides libraries for these modules that simplify the process of communication.
4. Display the temperature on the Serial Monitor or an LCD screen to observe the results.



MAX6675 's Advantages and Disadvantages :

Advantages :

- SPI interface via only 3 wires with works (SCK, CS, SO).
- Thanks to the built-in ADC (Analog-to-Digital Converter) exact numerical result gives .
- Error inspection available – thermocouple disconnected or wrong connecting if so , it determines .
- Low power consumption with works .

Disadvantages :

- K-type thermocouple only with works , other with types (J, T, E, N) suitable will not come .
- Maximum with temperature 1024°C limited , some industry sectors for this enough it's not .
- $\pm 2^{\circ}\text{C}$ accuracy high accuracy required processes for defect to be possible .

MAX6675 module to Arduino UNO microcontroller connection scheme .

We first of all our module to power We connect the VCC and GND pins of the MAX6675 module To the +5V and GND pins of the Arduino We connect. So then the ISP interface our connection it is possible , this For this, we connect the SCK, CS, SO pins of the MAX6675 module Arduino optional entrance exit to the pins we connect .

Sample ARDUINO Code:

cpp

Copy

```
#include <SPI.h> #include <MAX6675.h> // Define the pins connected to MAX6675 int
thermoDO = 4; int thermoCS = 5; int thermoCLK = 6; MAX6675 thermocouple(thermoCLK,
```

```
thermoCS, thermoDO); void setup() { Serial.begin(9600); delay(500); // wait for the sensor to
stabilize } void loop() { Serial.print("Temperature: "); Serial.print(thermocouple.readCelsius());
Serial.println(" °C"); delay(1000); // Wait for a second before reading again }
```

Using the ARDUINO UNO, we can successfully interface with a K-type thermocouple sensor and measure temperature in a wide range of applications, from industrial processes to scientific experiments. The MAX6675 or MAX31855 thermocouple-to-digital converters simplify the process of interfacing the thermocouple with ARDUINO, enabling accurate temperature measurements and real-time data display.

With MAX6675 module work for Arduino or other in microcontrollers "max6675.h" from the library use possible . Via API thermocouple from the sensor the temperature reading , errors verification and data again work possible .

Program code:

```
#include "max6675.h"
```

```
int thermoDO = 7; // SO
```

```
int thermoCS = 6; // CS
```

```
int thermoCLK = 5; // SCK
```

```
MAX6675 thermocouple( thermoCLK , thermoCS , thermoDO );
```

```
void setup() {
  Serial.begin (9600);
  Serial.println (" Temperature ruler ");
}
```

```
void loop() {

  Serial.print ("Tb = ");
  Serial.print ( thermocouple.readCelsius ());
  Serial.println ( );
  Serial.print ("T = ");
}
```

Conclusion. K -type thermocouple temperature sensors industrial , laboratory and scientific research in the fields wide In this study , the working principle of a thermocouple was studied using an Arduino UNO and a MAX6675 module.

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