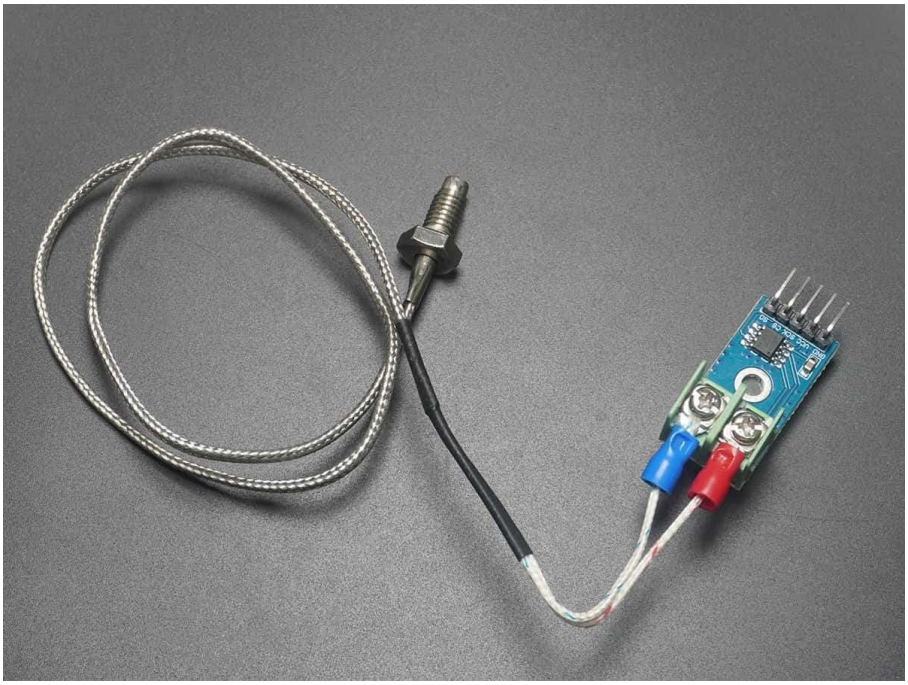
Thermocouple Interfacing with AVR ATmega16/ATmega32

Overview of Thermocouple



Thermocouple

A thermocouple consists of two different conductors forming an electrical junction at different temperatures.

Due to thermo effect, thermocouples produce a voltage which is dependent on temperature.

Temperature can be found out from this voltage.

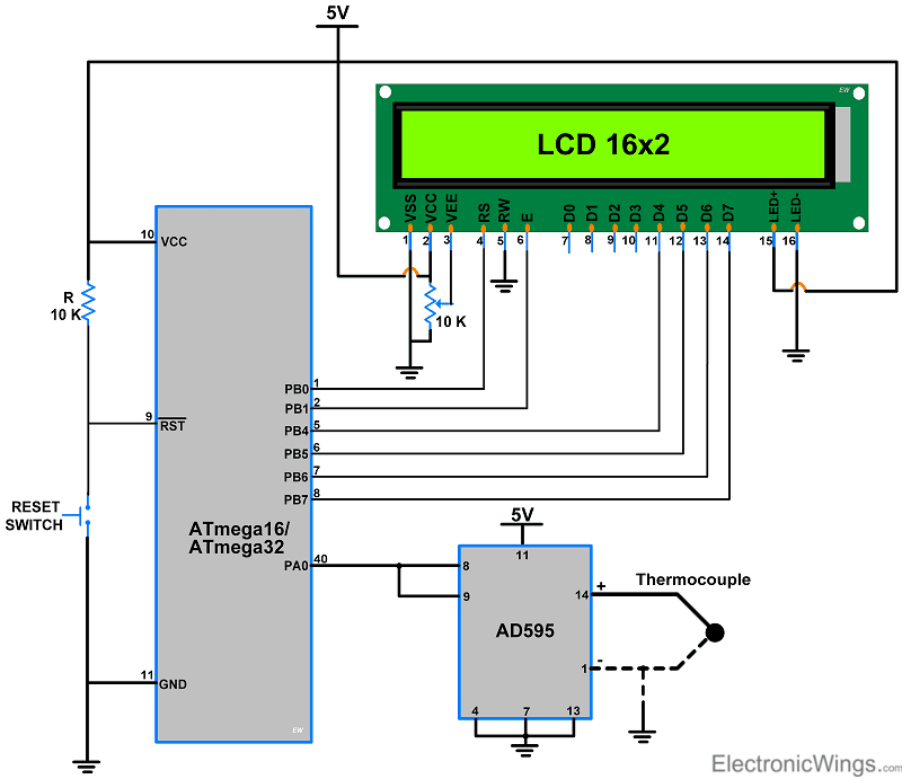
ADC output of this voltage can be processed by a microcontroller to give the temperature.

For more information about Thermocouple and how to use it, refer to the topic **Thermocouple** (http://electronicwings.com/sensors-modules/thermocouple) in the sensors and modules section.

For information about ADC in ATmega16 and how to use it, refer to the topic **ADC in AVR ATmega16/ATmega32** (http://electronicwings.com/avr-atmega/atmega1632-adc) in the ATmega inside section.

Connection Diagram of Thermocouple with ATmega16/32

- The complete interfacing diagram of the thermocouple is shown in figure below.



Interfacing Thermocouple With ATmega16/ATmega32

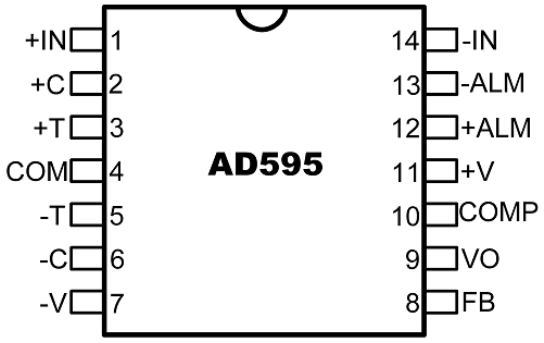
AD595

- AD595 is a complete instrumentation amplifier (Monolithic Thermocouple Amplifiers) with a Cold Junction Compensation.
- AD595 is compatible with a K-type thermocouple, while AD594 is compatible with a J-type thermocouple.
- It combines ice point reference with the pre-calibrated amplifier to produce a high-level output (10mV/°C) directly from the thermocouple output.
- AD595 gain trimmed to match transfer characteristic of K-type thermocouple at 25°C. The output of a K-type thermocouple in this temperature range is 40.44uV/°C.
- The resulting gain for AD595 is 247.3 (10mV/°C divided by 40.44uV/°C).

- The input offset voltage for AD595 is 11uV, this offset arises because the AD595 is trimmed for a 250 mV output while applying a 25°C thermocouple input.
- The output of AD595 is

AD595 Output = (Type K Voltage + 11 uV) x 247.3

- The IC AD595 pin diagram is shown in the figure below.



Pin diagram of AD595

Note: if you connect +5 volt and ground to the AD595 you can measure the temperature 0ºC to +300ºC, for more information refers to AD595 datasheet.

Programming for Thermocouple

Steps:

1. Initialize the ADC and LCD.
2. Take the data from the AD595 instrumentation amplifier.
3. Convert the ADC value into ºC using the below formula,

$$C = \frac{(\mathrm{adcValue} * 4.88) - 0.0027}{10}$$

Why 0.0027 subtracted in the above formula

AD595 provides output as follows,

AD595 Output = (Type K Voltage + 11 uV) x 247.3

- The above formula shows AD595 provides output with amplified offset voltage. So, we have to eliminate the total offset voltage (11 uV * 247.3) to get an accurate temperature value.

Note: 11 uV is an offset voltage of the IC AD595 instrumentation amplifier for K-type thermocouple.

4. Display Temperature on 16x2 LCD.

Thermocouple Code for ATmega16/32

```
/*
 * ATmega16_Thermocouple.c
 *
 * http://www.electronicwings.com
 */


#define F_CPU 8000000UL
#include <avr/io.h>
#include "LCD16x2_4bit.h"
#include <util/delay.h>
#include <stdlib.h>

void ADC_Init()
{
	DDRA=0x0;			/* Make ADC port as input */
	ADCSRA = 0x87;			/* Enable ADC, fr/128  */
}

int ADC_Read()
{
	ADMUX = 0x40;			/* Vref: Avcc, ADC channel: 0 */
```

Video of Temperature Measurement using Atmega16/32

Components Used

ATmega 16 ATmega 16	X 1	(https://www.mouser.in/ProductDetail/Microchip-Technology-Atmel/ATMEGA16L-8PU?qs=%2Fha2pyFaduiGCJtTvs2wv8fVZbVAalLu7Iq%2FglTS0tALAx6fMenLvg%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/atmega-16/1/datasheet)
Atmega32 Atmega32	X 1	(https://www.mouser.in/ProductDetail/Microchip-Technology-Atmel/ATMEGA32-16PU?qs=aqrrBurbvGdpkmgj7RWmsQ%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/atmega32/1/datasheet)

Components Used

K TypeThermocouple Glass Braid Insulated K TypeThermocouple Glass Braid Insulated	X 1	(https://www.mouser.com/ProductDetail/Adafruit/270?qs=GURawfaeGuACMa%252Bo9T3i3g%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/k-typethermocouple-glass-braid-insulated/1/datasheet)
AD595 THERMOCOUPLER AMPLIFIER AD595 THERMOCOUPLER AMPLIFIER	X 1	(https://www.mouser.com/ProductDetail/Analog-Devices/AD595ADZ?qs=NmRFExCfTkG5hTKeP7qMog%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/ad595-thermocoupler-amplifier/1/datasheet)

Components Used

Breadboard Breadboard	X 1	(https://www.mouser.com/ProductDetail/BusBoard-Prototype-Systems/BB830?qs=VEfmQw3KOauhPeTwYxNCaA%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/breadboard/1/datasheet)
LCD16x2 Display LCD16x2 Display	X 1	(https://www.mouser.com/ProductDetail/Adafruit/1447?qs=XAKIUOoRPe6AClmsjw7y7g%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0)

Downloads

Atmega Thermocouple Project file	Dow nloa d (/api/download/platform-attachment/356)

Comments

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very nice.... tutorial
great job
plz. make a code for interfacing RTD PT100 to micro controller (AVR/PIC).

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can you give me the code in assembly level language used for AT89c51

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