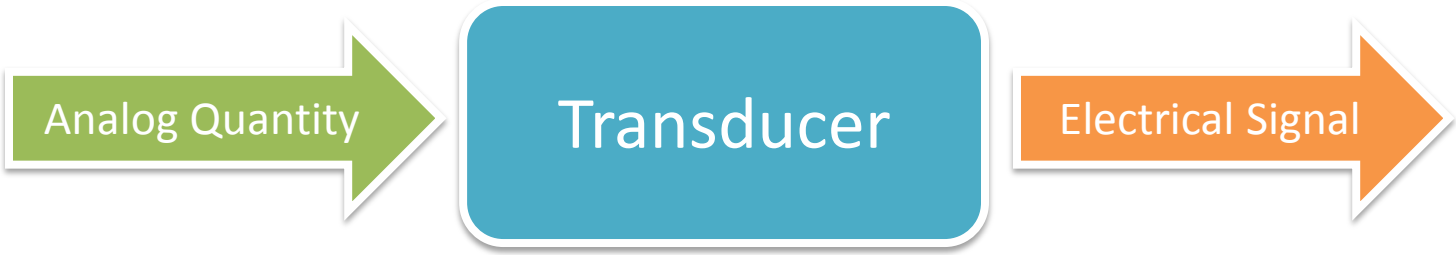
Embedded Systems Interfacing

Lecture Eight

Analog Sensors

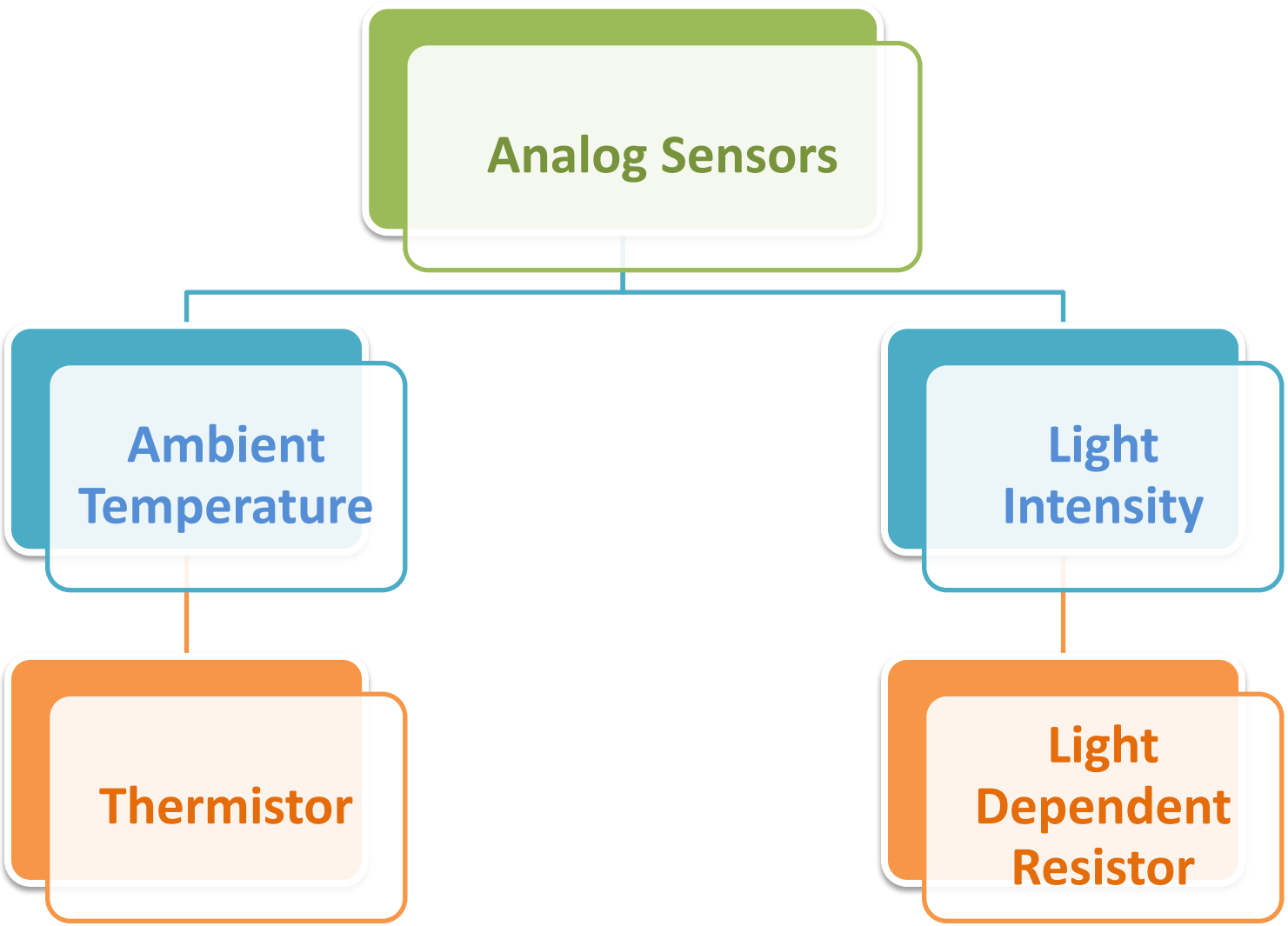
Transducer Definition

Transducer convert physical data such as ***temperature***, ***light intensity*** and ***speed*** to electrical signals. Depending on the transducer, the output produced is in the form of voltage , current , resistance or capacitance.



In order to be able to measure any analog quantity and make some processing on it, we need first to be able to prepare it in a form that allows the processor to read. Our main job is to convert any analog physical quantity to electrical signal then take this electrical signal on an ADC channel to read then it can be easily processed.

Examples


Analog Sensors
Ambient Temperature
Light Intensity
Thermistor
Light Dependent Resistor

Thermistor

Thermistor is an abbreviation for Thermal Resistor, it is a resistor that changes its resistance value by changing the ambient temperature. There are two types of thermistor:

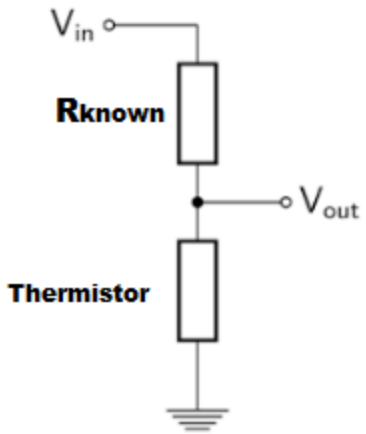
1- Positive Temperature Coefficient

Temperature and Resistance are ***directly*** proportional. When temperature increases the resistance increases.

2- Negative Temperature Coefficient

Temperature and Resistance are ***inversely*** proportional. When temperature increases the resistance decreases.

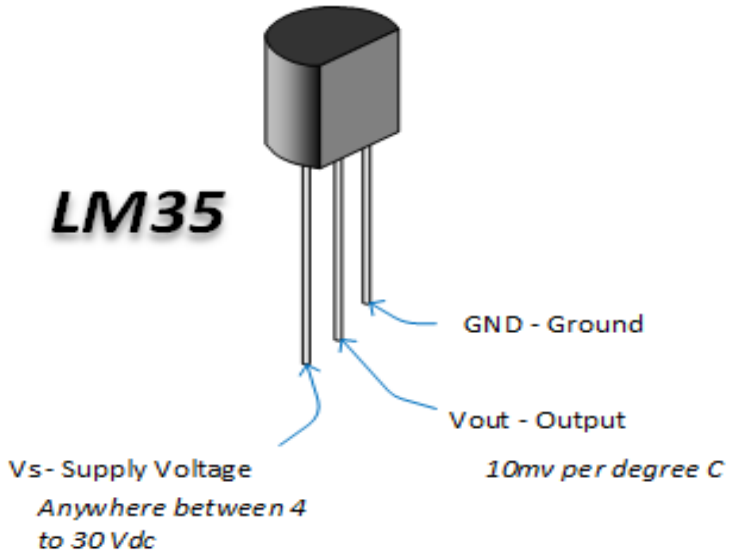
But, our objective is to transform any quantity to electrical signal (Voltage) not resistance in order apply it on ADC channel. So, now we need to transform the resistance to voltage, simply we can use a voltage divider circuit.



LM35 Module

The **LM35** series sensors are precision integrated circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature.

It means that the LM35 integrates the Themistor and the voltage divider circuit as its output is a voltage directly. It outputs ***10mv*** for each degree of Celsius temperature.



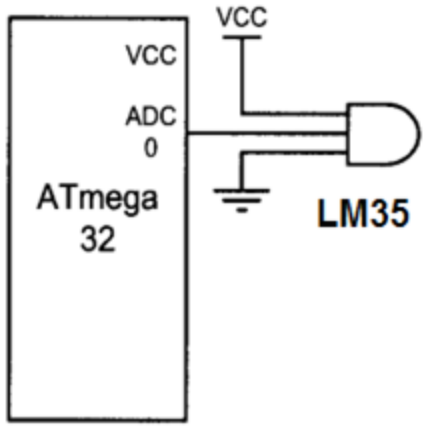
LM35 Temperature Sensor Series Selection Guide

Part	Temperature Range	Accuracy	Output Scale
LM35A	–55 C to +150 C	+1.0 C	10 mV/C
LM35	–55 C to +150 C	+1.5 C	10 mV/C
LM35CA	–40 C to +110 C	+1.0 C	10 mV/C
LM35C	–40 C to +110 C	+1.5 C	10 mV/C
LM35D	0 C to +100 C	+2.0 C	10 mV/C

Note: Temperature range is in degrees Celsius.

Temperature sensor

Connecting **LM35** output to the microcontroller ADC, for example channel 0 (Pin A0).



The following example code for converting the ADC value to temperature reading:

```
/* Get ADC Reading in 8 bit */
ADC_Reading = GetAdcValue();

/* Convert ADC to mv */
mv_Value = (ADC_Reading * 5000) / 256;

/* Convert mv to temperature */
Temperature_Value = (mv_Value / 10);
```

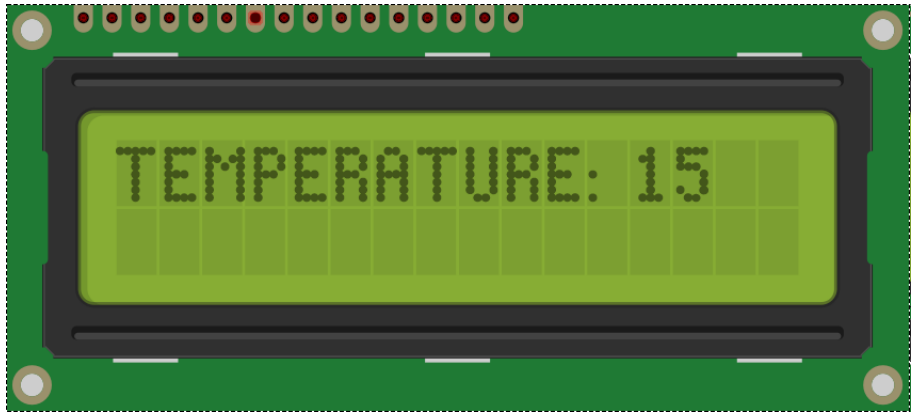
LAB 1

Implement a system that reads the ambient temperature and do the following:
1- if the temperature is less than 20 degree Celsius, turn on Green LED.
2- if the temperature is more than 20 and less than 40 degree Celsius, turn on Yellow LED.
3- if the temperature is more than 40 degree Celsius, Turn on Red LED and turn on a buzzer for indicating a dangerous.

Time To Code

LAB 2

Implement a system that display the ambient temperature on LCD and update it every 1 second.



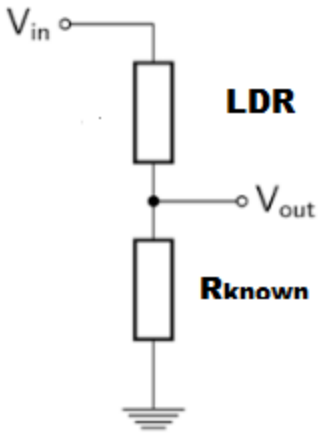
Time To Code

Light Intensity Sensor

Light Dependent Resistor (LDR) is a simple device that has the characteristic of changing its resistance based on the amount of light that hits it. Its resistance will be ***lower*** when a light is ***shone on*** it. When the light is ***removed*** the resistance will be at it's ***highest***.

The LDR will not give you an accurate reading to the amount of light but it will enable you to detect a transition between the amount of light that is available.

Similar to what has been done in thermistor interfacing, we will use a voltage divider circuit to read the value of the LDR.



Applying ohm's law:

$$\mathbf{LDR} = \frac{\mathbf{R}_{known}\,\mathbf{V}_{in} - \mathbf{R}_{known}\,\mathbf{V}_{out}}{\mathbf{V}_{out}}$$

LAB 3

Using LDR, implement a system that turns on a LED when it gets dark, and turns the LED off when it gets bright.

Time To Code

The End …

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