Chapter 8

Digital and Analog Interfacing Methods

Lesson 17

Physical Parameter Sensors and MCU Based Instrumentation

Resistive sensors

Resistance sensor senses

- Temperature (RTD),
- Pressure (bismuth-telluride wire),
- Moisture (grain or rice or milk or coffee powder),
- Magnetic field (bismuth wire)
- Strain gauge(semiconductor)

Resistive sensors

- Sensor in one of the arm of Whetstone bridge
- Signal conditioner (plus a precision rectifier in case of a.c.signal) and Sample Hold (S/H) and
- ADC at MCU

Capacitance sensor

- Capacitance sensor senses resonance condition offsets when capacitance changes
- ADC analog input at MCU gives the dielectrics thickness or level in a reactant filled tank

Capacitive Sensor Application Examples

Capacitive Sensor Application to study paper thickness and its uniformity in a paper mill

- Placing dielectrics for example, paper near electrodes changes capacitance

Capacitive Sensor Application to reactants level measurement at a tank in a cement mill

Inductance based Sensor (LVDT) Interface

Inductive sensor

- Use a single coil or a double coil like in an LVDT(pair of oppositely wounded coils)
- Senses induced currents sense or currents imbalance at a transformer

Inductive Sensor Application Examples

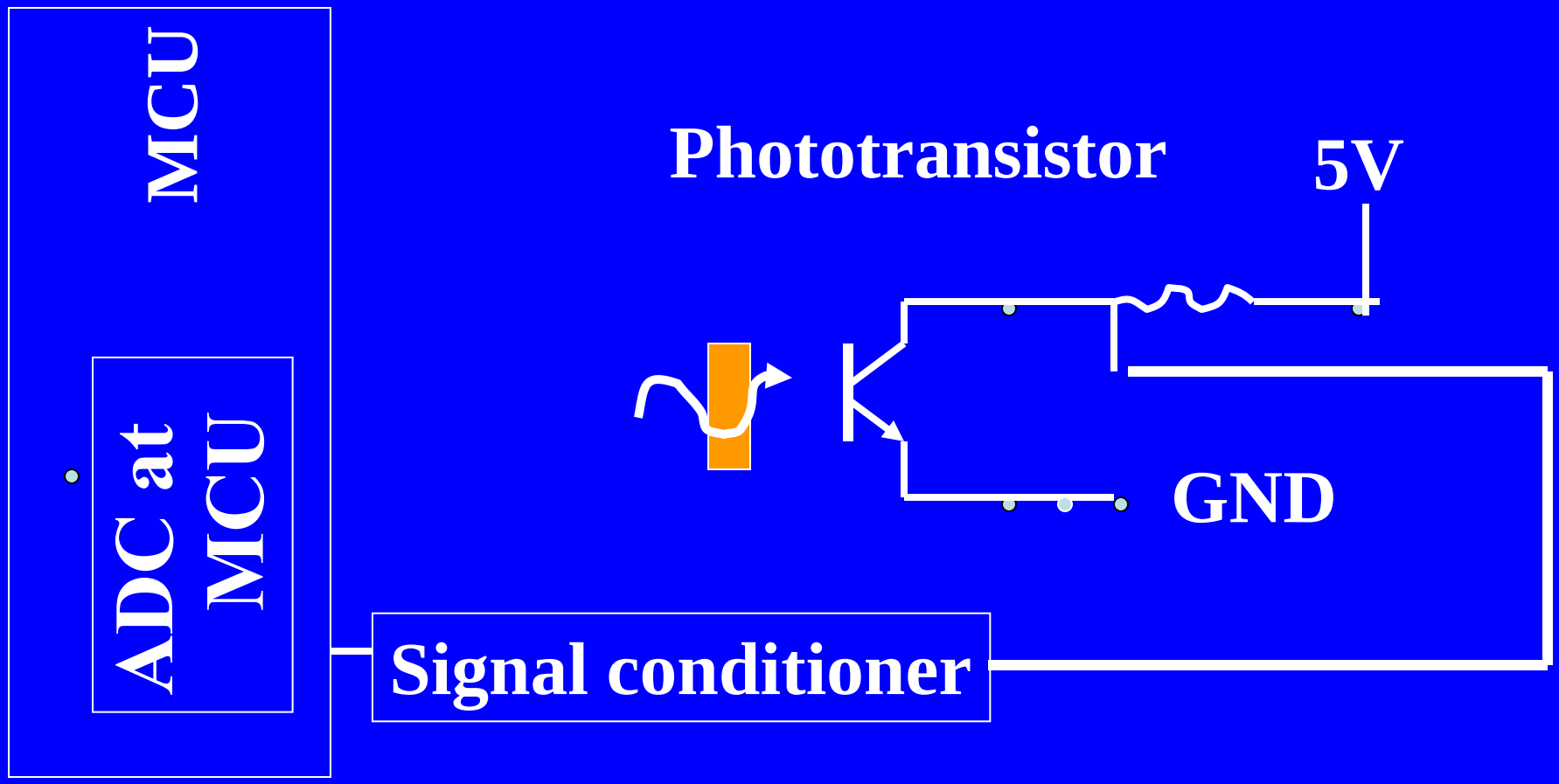
- Metal foil thickness measurement

Current based (Light level) Sensor Interface

Optical Sensors

- Phototransistor senses light levels
- ADC at MCU notes the ambient light levels

Light Level sensor Circuit



Temperature Sensor Interface

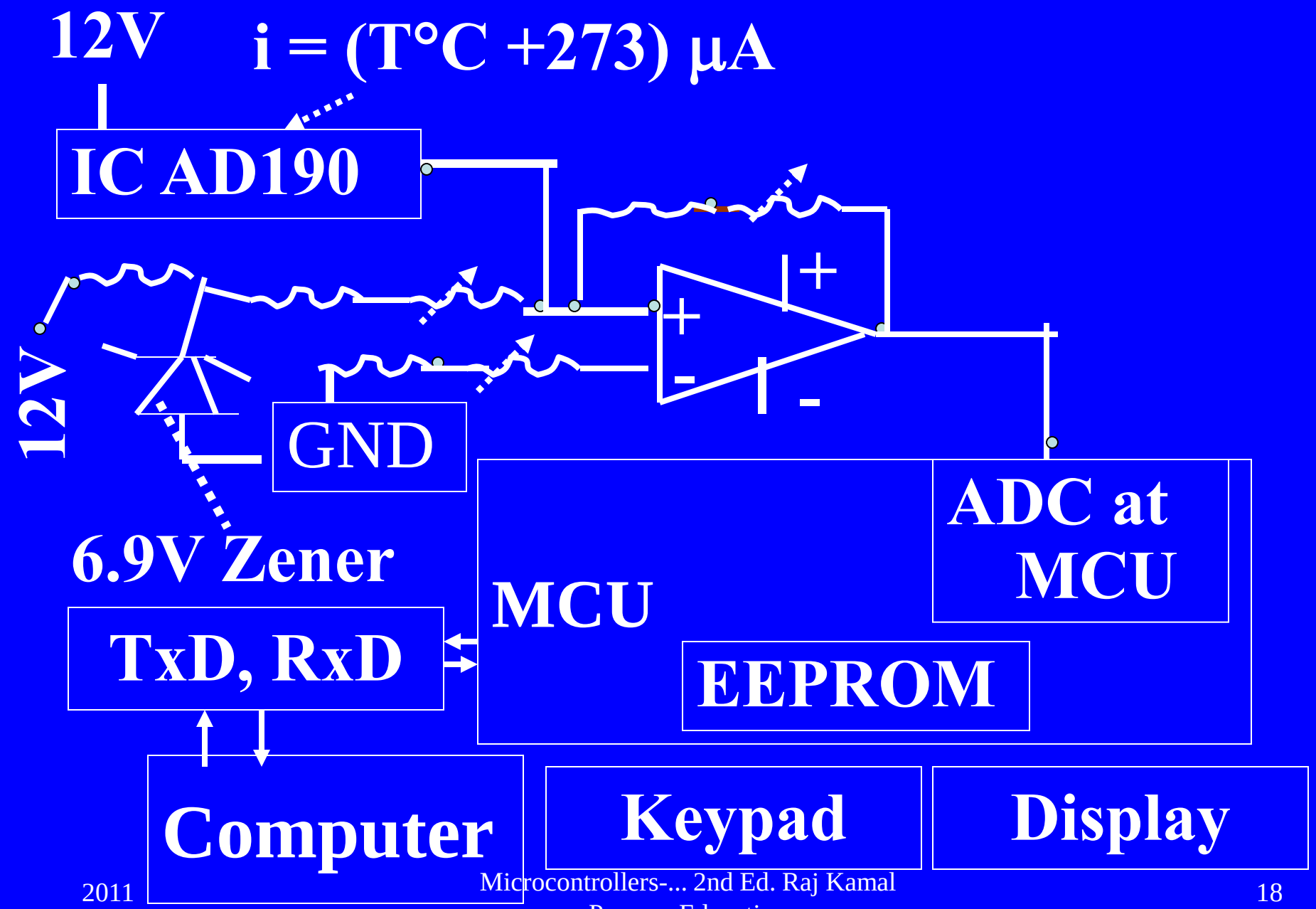
NTC and PTC

Resistance sensor

- NTC (Negative Temperature Coefficient) Decrease in R with increase in T (Semiconductor Oxide)
- PTC (Positive Temperature Coefficient) Increase in R with increase in T (Metal Alloy or Platinum wire)

IC based Temperature Sensor

- AD590 an IC to measure temperatures between 0°C and 100°C.
- Saturation current is proportional to temperature in Kelvin


12V
i = (T°C +273) µA
IC AD190
12V
GND
6.9V Zener
TxD, RxD
MCU
ADC at MCU
EEPROM
Computer
Keypad
Display

Temperature Sensor Interface

Linearity considerations

- ADC measured value P is proportional to the measured parameter x by the following linear equation.

$P = a_0 + a_1.x$

Non-Linearity considerations

- ADC measured value P is not proportional to the measured parameter x by the following linear equation.

$P = a_0 + a_1.x + a_2.\ x,^2 + + a_3.x^3 + a_4.\ x^4 + \ldots.$

Linearity and Non Linearity Lookup Table

- The non-linearity effects can be taken into account by using a lookup table that is stored at the flash memory in the MCU.
- Flash stores the verified physical parameter value vs. the observed ADC input.

Linearity and Non Linearity considerations

- Also a computer program calculates the offset, proportionality coefficient and non-linearity coefficients and saves in flash. Then it re-programs the parameters in the flash memory when re-calibrating the instrument and regenerates lookup table

Summary

We learnt

- Whetstone bridge
- Resistance, capacitance or inductance or current changes noted using signal conditioner,precision rectifier, sample-hold amplifier and MCU-ADC
- Lookup table and coefficients for accounting offset, proportionality and nonlinear coefficients

End of Lesson 17

Physical Parameter Sensors and MCU Based Instrumentation