Chapter 8

Digital and Analog Interfacing Methods

Lesson 16

Moisture Measurement using MCU Based Instrumentation

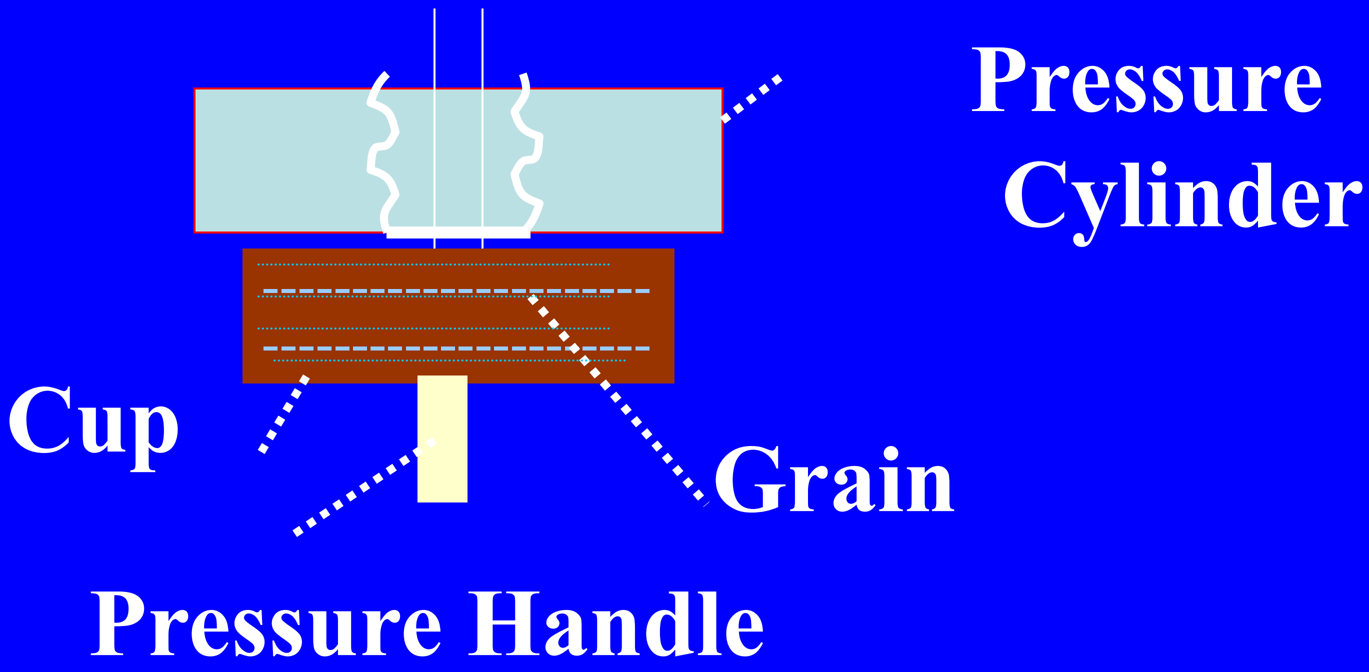
Moisture Measuring based on Resistance sensing

- Moisture (as measured by a compressed moist-sample resistance)

Moisture Measuring by Capacitance sensing

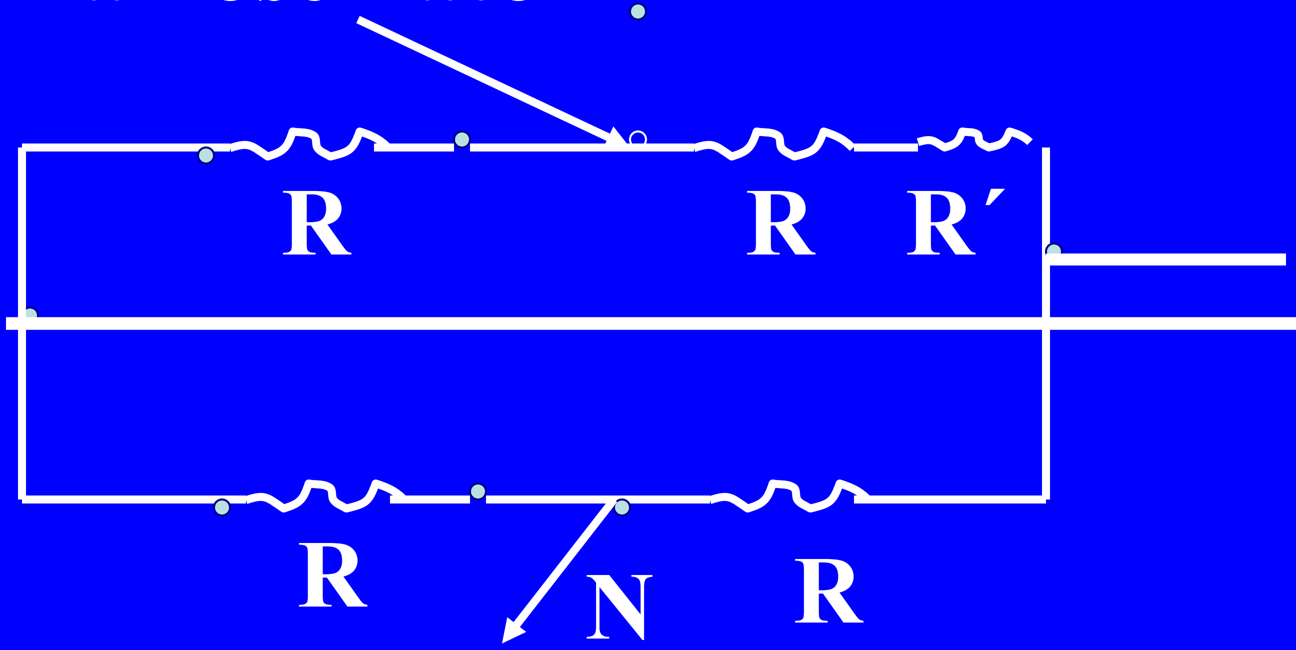
- Capacitance sensor senses resonance condition offsets when capacitance changes
- ADC analog input at MCU gives the dielectrics thickness or level in a reactant filled tank

Moisture measuring cell



Moisture Meter

Whetstone Bridge



Whetstone Bridge

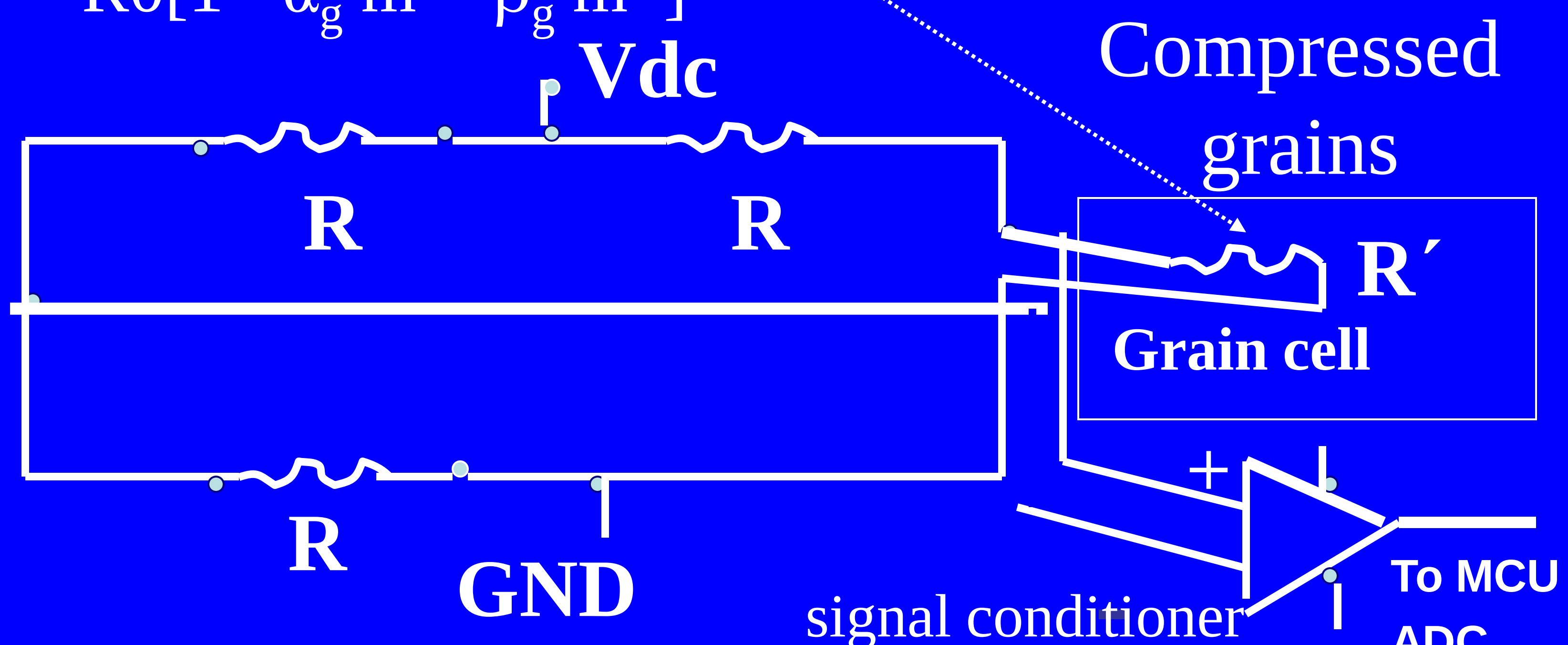
- All four arms Resistances equal when R′= 0, bridge is balanced
- Output = 0V for any analog input when bridge is balanced

Whetstone Bridge

- Assume R′ is resistance of the sensor of a physical quantity.
- All but one Resistance is equal, the output depends on the ratio of (R + R′)/R, bridge is not balanced
- Output not = 0V for a non-zero analog input when bridge is not balanced
- All Resistances are of the same order, bridge gives maximum sensitivity

Moisture sensed by Resistance

$R' = R0[1 + \alpha_g m + \beta_g m^2]$
or $R' = R0[1 - \alpha_g m - \beta_g m^2]$

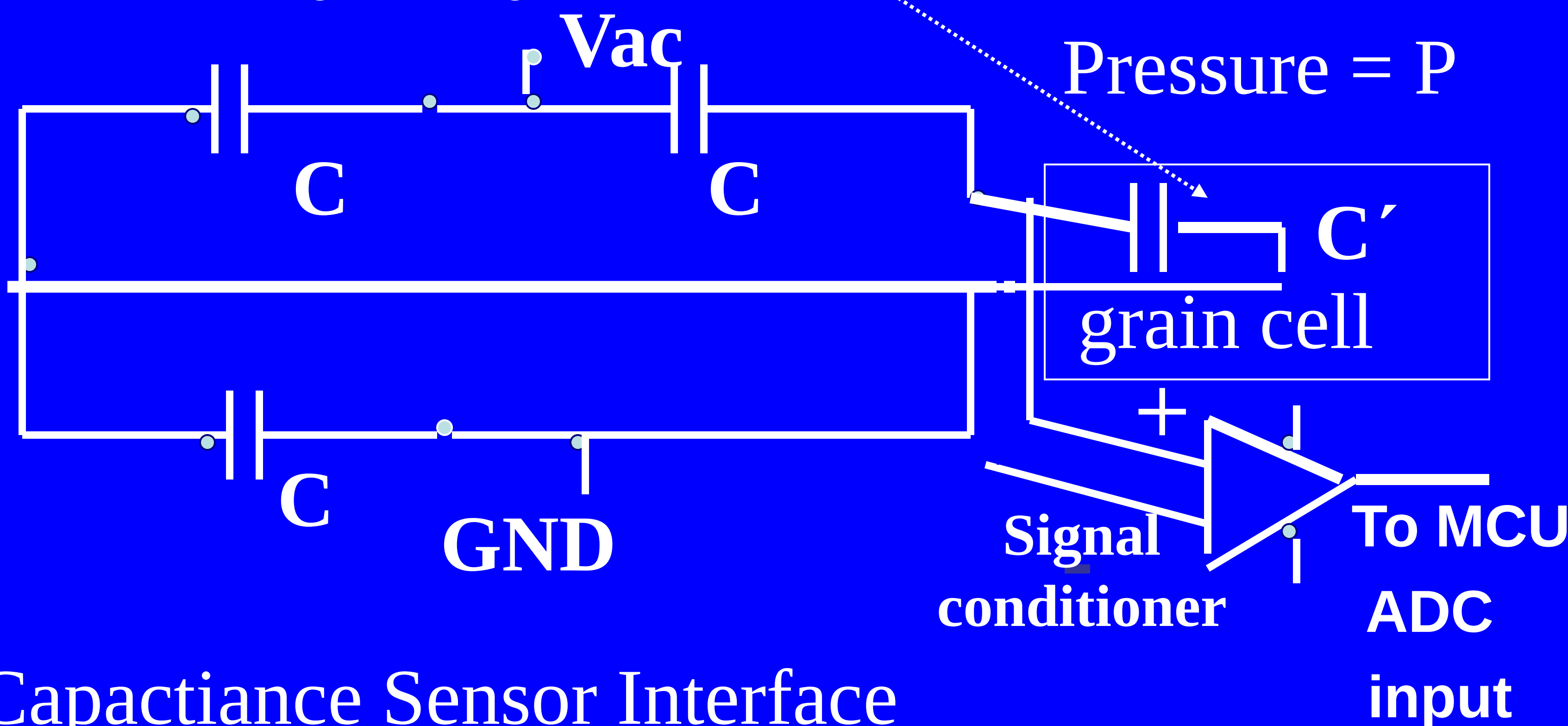


Resistance Sensing Interface

Capacitive bridge ac current change on moisture changes

$C'^{-1} = C0^{-1}\,[1 + \alpha_c\, C^{-1} + \beta_c\, C^{-2}]$

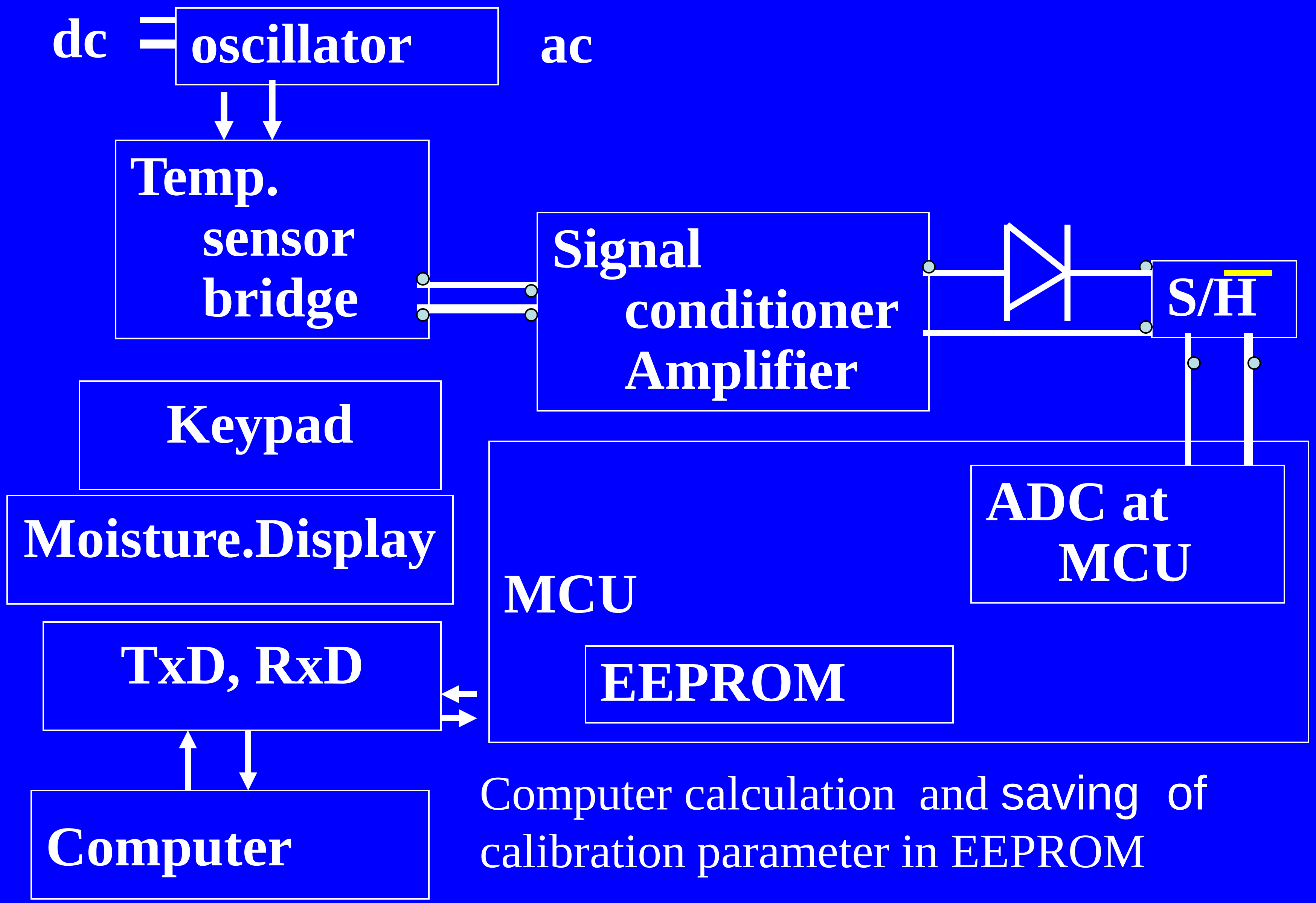
or $C' = C0[1 - \alpha_c\, C - \beta_c\, C^2]$



Capactiance Sensor Interface

Signal Conditioner

- Design such that output obtained = 0 V for input to ADC when temperature or pressure is at certain minimum limiting value and ADC output is 00000000.
- For obtaining reference Voltage input V_{ref} to ADC when temperature or pressure is at certain maximum limiting value and ADC output is 11111111.



Computer calculation and saving of calibration parameter in EEPROM

TxD and RxD Interface to Computer

- Keypad for entering the sample name, physical parameter name, time and date of measurements and other features
- Computer calculation of calibration parameters α_g and β_g, α_c and β_c and saving in EEPROM
- Periodic calculation and revision of calibration parameters and saving in EEPROM (if required)

Linearity considerations for each type of grain

- ADC measured value R is proportional to the measured parameter m by the following linear equation.

$R = a_0 + a_1.m$

Non-Linearity considerations for each type of grain

- ADC measured value R is not proportional to the measured parameter m by the following linear equation.

$R = a_0 + a_1.m + a_2.\ m^2 + + a_3.m^3 + a_4.\ m^4 + ...$

Linearity and Non Linearity Lookup Table for each type of grain

- 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 for each type of grain

- 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 changes noted using signal conditioner,precision rectifier, sample-hold amplifier and MCU-ADC
- Lookup table and coefficients for accounting offset, proportionality and nonlinear coefficients for each type of grain

End of Lesson 16

Moisture Measurement using MCU Based Instrumentation