UNIVERSIDAD CARLOS III DE MADRID

LABORATORY

Electronic Instrumentation

PROJECT #2

ESCUELA POLITÉCNICA SUPERIOR
DEPARTAMENTO TECNOLOGÍA ELECTRÓNICA

PROJECT #2: OPTOELECTRONIC SENSOR WITH SYNCHRONOUS DETECTION

2.1 Description of the Set-up.

The objective of this project is to design and calibrate an optoelectronic instrumentation system to measure the optical attenuation of a medium. The light emitted by an LED (TSUS540) passes through the medium which has a variable transmissivity. The variation of light intensity is detected by a photodiode (BPW34). A circular plastic sheet which has segments colored based on a grey scale is used to change the light transmitted to the photodiode. This sheet is fixed to a small fan which is voltage controlled.

The scheme for the sensor is shown in Figure 2.1 and it is composed of two parts:

1. Emitter Circuit: Fixes the bias point for the LED. Modulation of light intensity is achieved introducing a 100 kHz, 1 Vpp signal through the coupling capacitor.
2. Detector Circuit: The photocurrent from the BPW34 is converted to voltage by Rfg. The signal is coupled to the output with a follower.

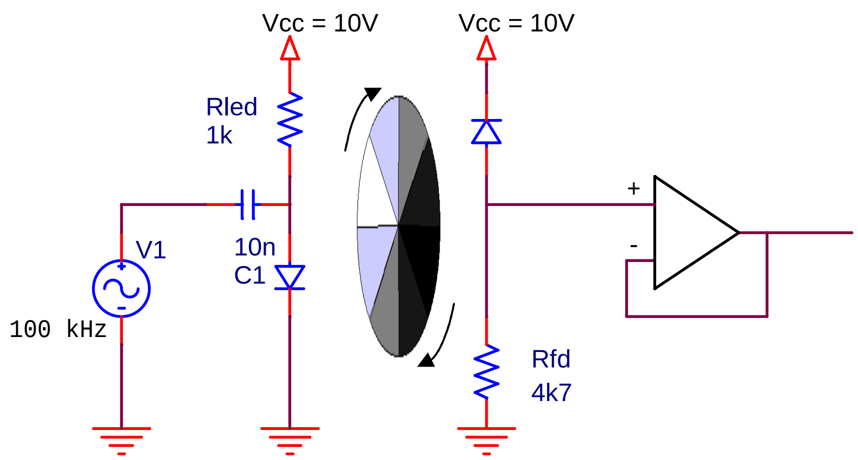

Figure 2.1: *Optoelectronic sensor system*

The block diagram for the signal conditioning circuit to be used is shown in Figure 2.2. The different blocks are to be designed by the student and should match the following specifications:

1. Band Pass Filter: The signal of interest recovered by the detector is modulated in amplitude at the carrier frequency. In order to eliminate any DC and low frequency

components that may interfere in the signal conditioning, you are required to filter the signal using a Sallen & Key pass-band filter with at least a Q of 5.

2. Synchronous Demodulation: A balanced modulator/demodulator from Analog Devices is to be used (AD630). Use the scheme shown in Figure 2.2, to implement this functionality. Students are referred to the data sheets for this component for further details on this block

3. Low Pass Filter: Design an adequate RC filter at the output of the AD630 in order to remove the high frequency components. A ladder RC filter is proposed in Figure 2.2, but other schemes can be used (a minimum roll-off of -60 dB/dec is advised)

4. Amplifier Stage: The final amplification stage is to be designed to deliver a maximum output voltage of 5V for maximum opacity of the medium (see below).

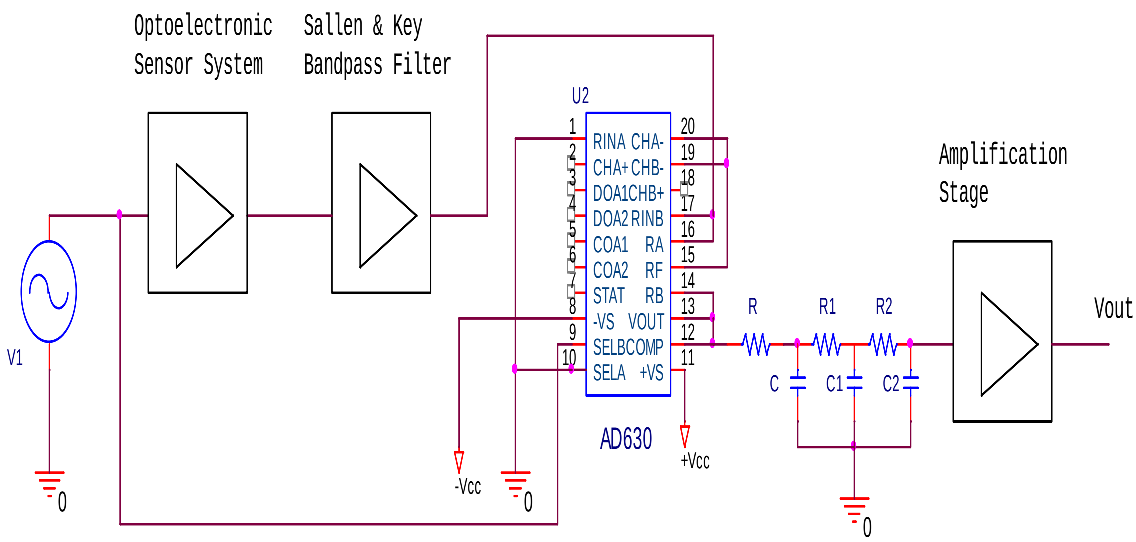

Figure 2.2. *Block diagram of the system to be constructed.*

2.2. System Adjustment and Calibration.

a) <u>Static Characterization:</u>

Modulate the LED at the carrier frequency (100kHz) with the fan <u>unconnected</u>**.**

- Adjustments to the circuit:

Turn the position of the grey scale sheet so as to obtain the maximum voltage at the output. Adjust the gain of the output amplifier so as to obtain the full scale value mentioned above (5 Volts).

- Calibration:

Complete two calibration cycles varying the position of the grey scale sheet for each grey scale color, noting at least for each point:

- Amplitude (Vpp) of the 100 kHz signal obtained at the detector block output.
- Output voltage of the complete system.

b) Dynamic Characterization:

Make sure that the adjustments made in the previous part have not been altered and connect the fan.

Characterize, taking note of the frequency, voltage peak to peak, DC level, and waveform, the signals which you observe in the following points of the circuit:

- Emitter block input
- Detector block output
- Sallen & Key Filter Output
- AD630 Output
- Low Pass Filter Output
- System Output

Represent in an oscillogram each one of the signals which you have measured.