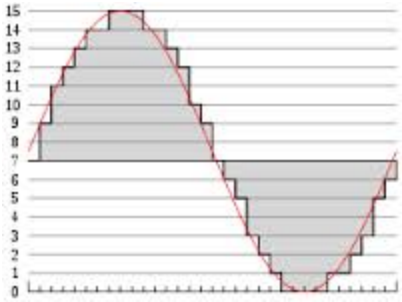
PCM Lab Activity



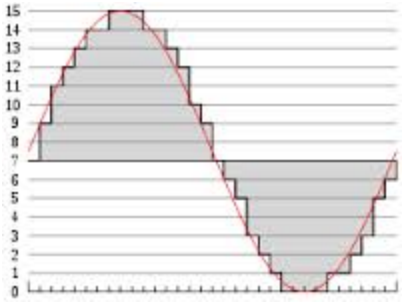
The purpose of this lab activity is to introduce some of the concepts used in Pulse Code Modulation (PCM).

As part of this lab activity the student will be:

- Interfacing a microphone to an OP-AMP amplifier
- Designing a Low Pass Filter (LPF) with gain a proper cutoff frequency
- Interfacing a power amplifier to a speaker
- Interfacing with a Sample & Hold circuit
- Experiencing the digitization of speech
- Experiencing the reconstruction of speech
- Measurement and determination of quantizing noise
- Demonstrating the causes and prevention of aliasing

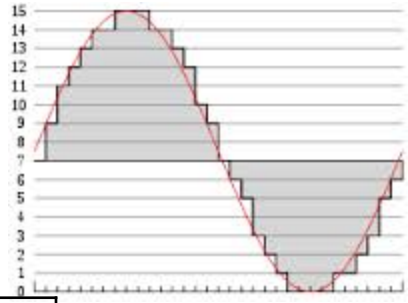
In this lab, students will build a PCM modulator and demodulator using Linear techniques. Basically, linear Analog to Digital (ADC) and linear Digital to Analog (DAC) integrated Circuits are used rather than the non-linear . These are the ADC0804 and the DAC0808 respectively.

PCM Lab Activity



1. Design the Modulator-Demodulator system as per the given block diagram
2. Generate the schematic for your system (Identify all components and the connections thereof)
3. Simulate your system using either Circuit Maker, PSPICE, or Multisim (If an IC is not available in the simulator library use an equivalent component).
4. Build your system
   a) Test your system using a sine wave for the analog input
   b) Test your system using speech for the analog input signal
   c) Demonstrate the Aliasing effect
   d) Measure & determine the quantization error
5. Your circuit must be aesthetically pleasing
6. Generate a video of your project presenting the design process and demonstrating the outcome.
7. The project grading rubric is shown on the next page.

PCM Lab Activity - Rubric

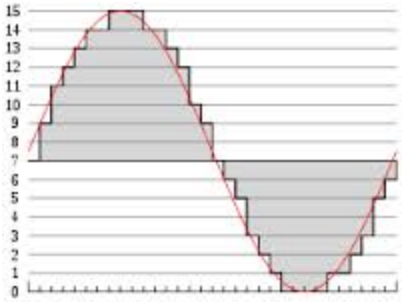


Working Outcomes	Percentage	Grade
Microphone Interface	5%	
Low Pass Filter amplifier	10%	
Sample & Hold Circuit	10%	
Analog to Digital Conversion	10%	
Digital to Analog Conversion	10%	
Speaker Interface	5%	
Circuit Aesthetics	10%	
Schematics	5%	
Circuit Simulations	5%	
Aliasing Demonstration	10%	
Level of Understanding	10%	
Video	10%	

Enzo Paterno

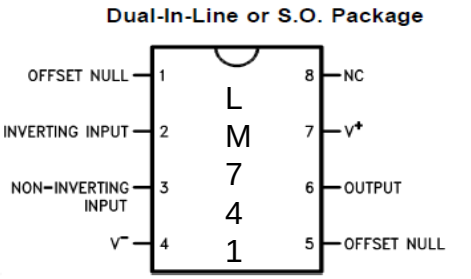
GRADE:

PCM Lab Activity

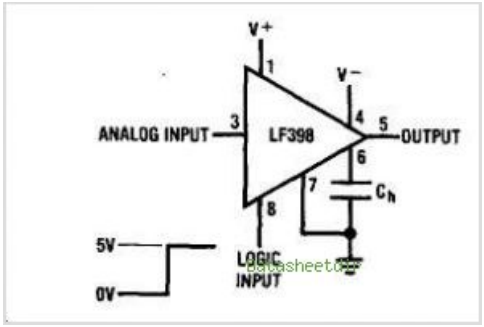


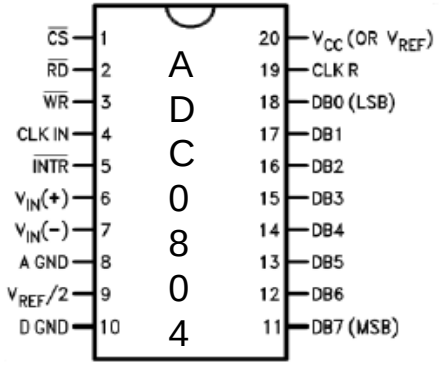
Transmitter Circuit

Microphone → LPF & Gain → Sample & Hold → Linear ADC

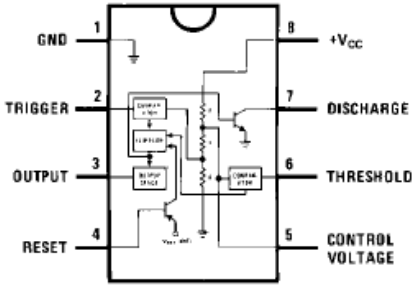


LF398



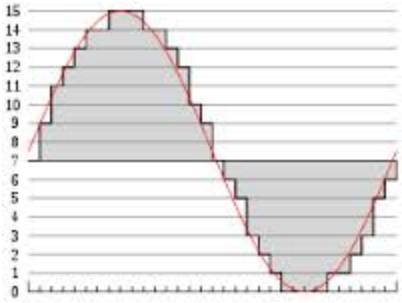


LM555



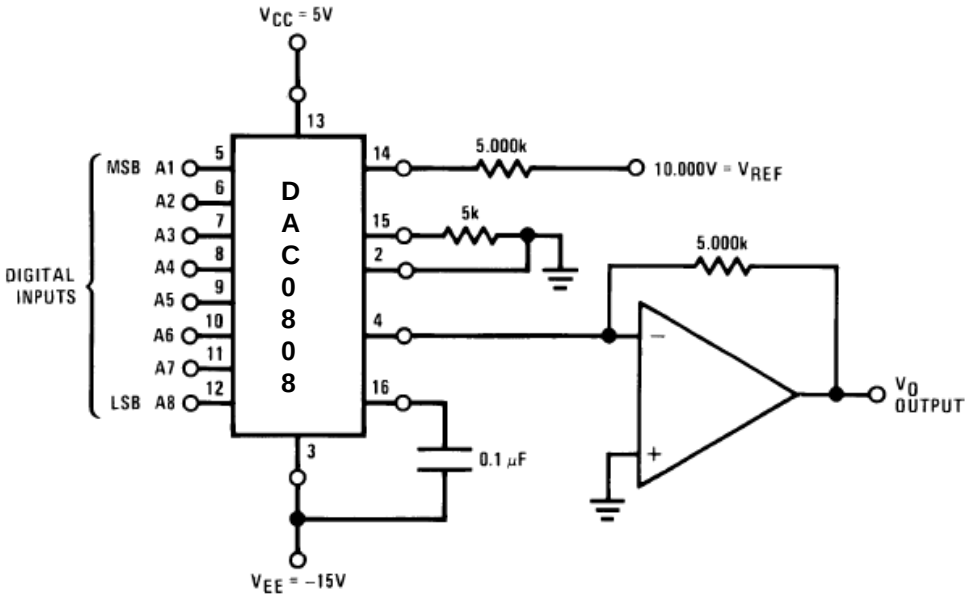
Sampling Clock

PCM Lab Activity

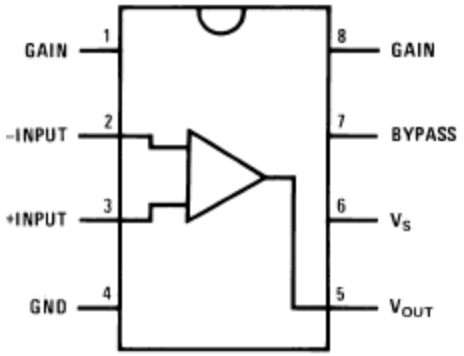


Receiver Circuit

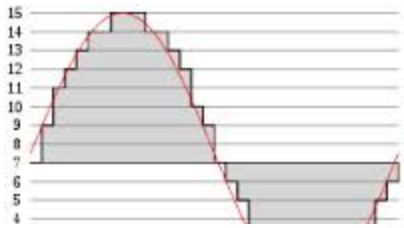
DAC ⇒ Power Amplifier ⇒ Audio Speaker

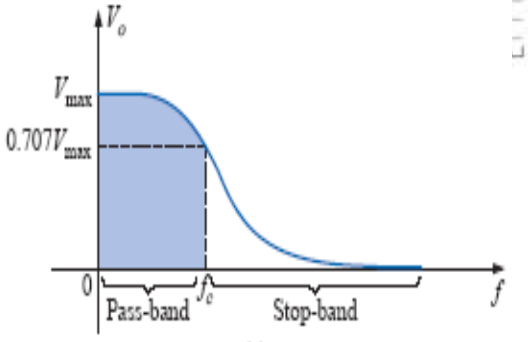


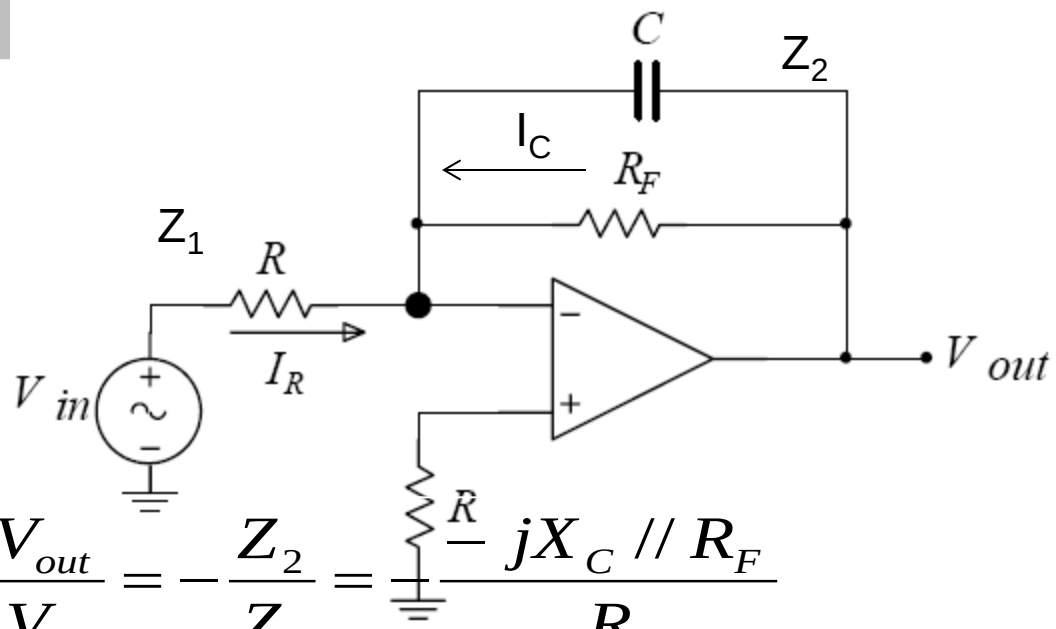
LM386



1st order LPF – OP-AMP Circuit





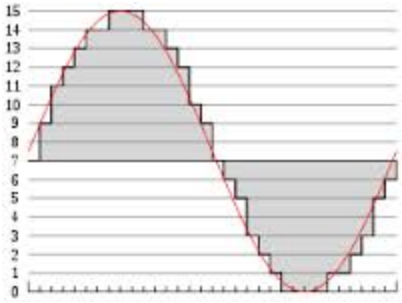


$$H(\omega) = \frac{V_{out}}{V_{in}} = -\frac{Z_2}{Z_1} = -\frac{jX_C \,//\, R_F}{R}$$

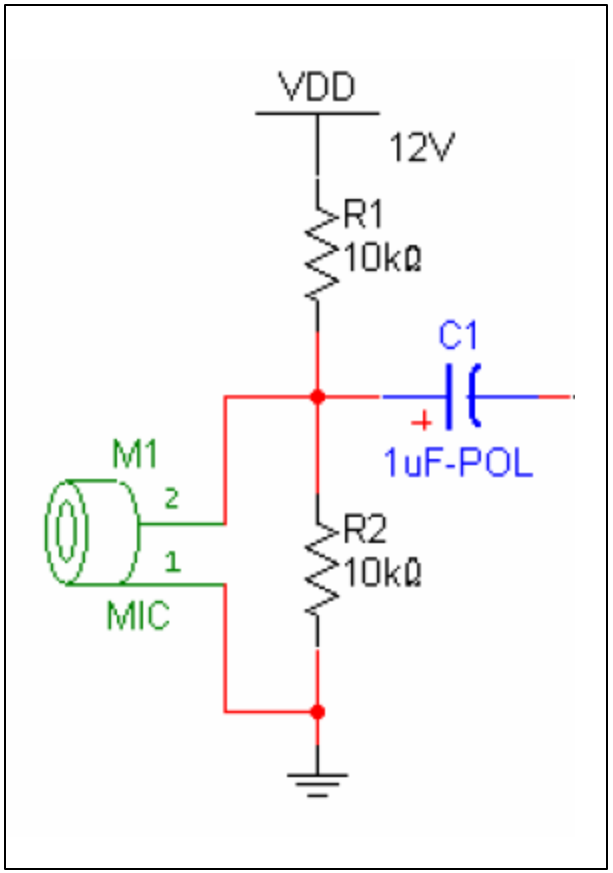
$$H(\omega) = -\frac{R_F \Big/ J\omega C}{R\left[\frac{1}{J\omega C} + R_F\right]} = \frac{R_F \Big/ J\omega C}{R\left[\frac{1 + J\omega R_F C}{J\omega C}\right]}$$

$$H(\omega) = \frac{R_F}{R}\frac{1}{1 + J\omega R_F C} \rightarrow \left|H(\omega)\right| = \frac{R_F}{R}\frac{1}{\sqrt{1 + (\omega R_F C)^2}}$$

Transducer Interfaces



Microphone Interface



Speaker Interface