THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

SCHOOL OF ENGINEERING AND APPLIED SCIENCE
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ECE 2110: CIRCUIT THEORY LABORATORY

Final Project Specifications

PROJECT DESCRIPTION

You have been hired at Apple, Inc. as a summer intern. You have been asked to design an inexpensive iPod® docking station. The docking station will amplify the music coming from the iPod and filter it to two different speakers. One speaker will play only the treble portion of the music, while the second speaker will play only the bass. The exact specifications follow.

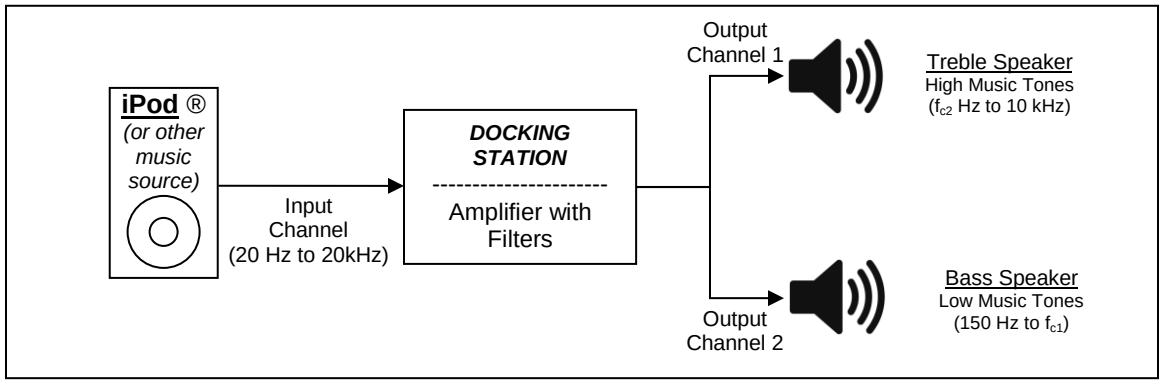

Figure 1 – High Level System Diagram

SPECIFICATIONS

- Power supply: $\pm 12V_{DC}$ with tolerance of $\pm$ $0.5V_{DC}$
- Input Channel:
  1. Unamplified audio signal (e.g. – music) with the following characteristics: Voltage range: (0 to ~$300mV_{rms}$); Frequency range: (20Hz to 20kHz)
  2. ***Bonus***: Secondary input signal (microphone): Voltage range: 0 to $500\mu V_{rms}$
- Two Output Channels:
  1. Channel 1 (Treble): Outputs music in frequency range: (f_{C2} to 10kHz)
  2. Channel 2 (Bass): Outputs music in frequency range: (150Hz to f_{C1})
  3. Cut-off frequencies f_{c1} & f_{c2} may be individually assigned by GTA
     a) If not assigned, default values: f_{c1} = 5kHz, f_{c2} = 4kHz
  4. Load (for each channel): 6Ω speaker
  5. Maximum power per channel: 1W
  6. Volume Control per music channel: -20dB to +20dB
  7. Volume Control per bonus microphone channel: 0 dB to +40 dB.
- Volume Meter Displays:
  1. A five level LED volume meter is required per output channel to show amplitude of music
  2. Channel 1 (Treble): Green LED bar
  3. Channel 2 (Bass): Red LED bar
  4. LED activation threshold levels: Must result in a visually appealing display

REQUIREMENTS

- A band-pass filter must be used for channel 1 and channel 2. The minimum roll-off is 20dB/dec.

EXTRA CREDIT

- Adding a microphone input
- Increasing each channel's band-pass filter roll-off to 40dB/dec
- Enclosing the project in a "project enclosure" box

GRADING

- 50% Demonstration
- 25% Oral Presentation
- 25% Written Report

DUE DATES

- For each portion (demo, oral, and written) will be posted on the lab website and Blackboard by your GTA.

DEMONSTRATION

- A working circuit will be demonstrated to GTA and Professor on the due date in the lab.
- Circuit will be tested using function generator set at $300mV_{rms}$ at cut off frequencies to verify -3dB behavior, and minimum output power for mid-range frequencies, using the oscilloscope.
- Verification of volume control will be performed:
    - Channel 1 will be turned up and Channel 2 down, to hear only treble.
    - Channel 2 will be turned up and Channel 1 down, to hear only base.
- Verification of working volume meter will be performed.
- Docking station will then be tested using music, grade for clarity of sound will be given.
- Student will be asked why certain design decisions were made, student must be prepared to answer.

ORAL PRESENTATION

- 5-10 minute presentation with 5 minute question and answer period to GTA and Professor. All presentations must be done using presentation software like MS PowerPoint.
- An electronic copy of the presentation must be submitted through blackboard or email to GTA prior to the presentation.
- Rough structure of oral presentation is as follows:
    - System Architecture Overview:
        - Discuss the design by using a block diagram representation.
        - Why did you connect the blocks of the system the way you did (series, parallel, power distribution, etc.).
    - Initial Calculations:
        - How did you go from the numbers in the specifications to the values you chose in your design?
            - *E.g. – why does your amplifier have the gain that it does?*
        - Why did you choose the type of output stage you chose?
            - *E.g. – could the LM471 OpAmp be used at the output?*
        - *You are basically walking viewer through your design process.*
    - Design of each stage:
        - Calculations for band-pass filter component values.
        - Calculations for LED display components.

        - Screenshots of PSPICE simulations for each filter, clearly indicating cut-off frequencies to show specifications have been met.
    - Implementation and Measurements
        - Photo of the final circuit.
        - Complete final Multisim schematic screenshot.
        - Table of relevant statistics (V_{in}, V_{out}, P_{out} to load, etc.).
    - Conclusions
        - % error for measured data vs. hand calculated vs. simulated data
        - How did your project compare to your calculations?
        - What would you do differently? How could you improve your design?

WRITTEN REPORT

- The formal lab report format must be used.
- The report should begin with a discussion of system architecture at the highest level (start from the block diagram given in figure 1.1 of this specification).
- Then work down each level, band-pass filters, amplifiers, etc.
- Show Multisim schematic for each component (e.g. the treble band-pass filter), the hand calculations for each component value, and finally the Multisim simulation for each component.
- Discuss the % error between calculated, simulated, and measured data in each component's sub-section of the report.
- Final tally of relevant statistics given in table format (V_{in}, V_{out}, P_{in}, P_{out}, Frequency range, etc.).
- Discuss difficulties encountered, changes you would make, lessons learned in the conclusion.
- An electronic copy of the written report must be submitted via Blackboard on the due date assigned.

EXTRA CREDIT CRITERIA

- Extra Credit will be granted if and only if the following criteria have been met:
    - Hand calculations, Multisim simulations, and demonstration have been performed and included in the written report.
    - Student can answer any and all questions regarding basic operation, and discuss calculations during oral presentation.
- The reward for extra credit will be:
    - Dropping of lowest lab report grade.
    - Additional incentives may be provided per the GTA's discretion.
- Students are forewarned from using circuits that they do not fully understand; putting something together that just "works" is unacceptable and will hurt your final grade. You absolutely must understand what you present.