**Project 2 – op amp circuit to perform linear operation**

Introduction

Op amps can be used to perform linear operations. For example, a Celsius-to-Fahrenheit converter performs a linear transformation to convert a Celsius temperature value into a corresponding Fahrenheit temperature value. More specifically, the circuit takes an DC input signal Vc, and converts it into an output signal Vf by performing a linear transformation: Vf = 1.8 Vc + 3.2 (A = 1.8, B = 3.2). This circuit can be part of an actual product such as a thermometer. At 37°C, a temperature transducer sends a 3.7V DC input signal to the temperature converter circuit. The converter circuit produces a DC output of 9.86V. Another circuit then takes this 9.86V signal and displays it as 98.6°F on a display screen.

Project Specification

Please design an op amp circuit that performs a linear operation. Here are the design specifications.

1. The output voltage is Vout = A Vin + B, where A and B are pre-assigned constants.
2. The constants A and B will be assigned beforehand by your instructor, and satisfies 0 < A < 1, B < 0. They must have 2 digits after the decimal.
3. For circuit elements, you may use as many LM741op amps and resistors as you need.
4. The power supply of your system is limited to the ±15V rails and the ground rail. The input signal voltage Vin must be generated from some or all of these 3 rails. No additional outside voltage is permitted in this circuit product.
5. Use as few op amps as possible to make the circuit work.

You must create a test plan to test the performance of the product that you are designing. Your product demo must include the following results:

1. The output voltage range – low and high voltages;
2. The complete voltage transfer curve (VTC) – both a data table and a plot.

Your project will be evaluated based on

1. Its functionality (it does the job);
2. How it meets the specifications given (it does the job well);
3. How good a test plan you have created (How do you prove that it does the job);
4. Its complexity (how economical it is in terms of using circuit elements). For example, a circuit with fewer op amps is generally better than a circuit with more op amps.

**Suggested design process**

First, design the entire circuit with LTSpice (using the LM741 model) and run simulations. Then build the circuit product based on your LTspice design.

**LTspice file demo and upload (60 points)**

LTSpice circuit file (.asc) and the requisite files for plotting (.plt, .raw, .txt)

**Product demo (80 points)**

1. Construct the physical circuit of the final product.
2. Demo the linear operation of your product.
3. Show the data table and the plot of the Results section of your project report (see below).

**Project report upload (10 points)**

Your report should include these subject headings:

1. The final design circuit schematic (hand sketch or LTspice circuit image)
2. A short description of the system, explaining the various functional blocks of your system
3. Test plan: brief description of your test plan
4. Results

A (preassigned value) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; B (preassigned value) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input voltage limits (predetermined values) are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Measured results:

|  |  |
| --- | --- |
| Output voltage lower limit (V) |  |
| Output voltage upper limit (V) |  |
| VTC slope (V/V) |  |
| VTC intercept (V) |  |
| VTC plot: |  |

VTC data table

|  |  |
| --- | --- |
| Input voltage | Output voltage |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
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1. Conclusions and lessons learned