THE UNIVERSITY OF TEXAS AT ARLINGTON

COMPUTER SCIENCE AND ENGINEERIG

LABORATORY 3 REPORT

**ELECTRONICS LABORATORY**

Submitted toward the partial completion of the requirements for CSE 3323-002

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**Lab 3: Inverting Summer & Difference Amps**

**Part 1:**

**Inverting Summer**

Circuit Diagram:

A diagram of a circuit

Description automatically generated

Built Circuit & Output:

A electronic device with wires connected to it

Description automatically generated A screen with colorful lines on it

Description automatically generated

Findings:

1)

A electronic device with wires connected to it

Description automatically generated A electronic device with wires connected to it

Description automatically generated

2) Verify small signal gain is -5 for the fcn gen input:

Vo/Vin = 520mV/110mV = -4.7 ~ -5

3) Verify small signal gain is -1 for pot input:

Vo/Vpot\_out = 0.0112/-0.011 = -1

A close up of a device

Description automatically generated

4) Verify that pot output *offsets* the function generator output at op amp output. With function generator set as in step 2, adjust the pot to low, near center, and high outputs.

Low Center High

A screen with a screen showing a wave

Description automatically generated with medium confidence A screen with a graph on it

Description automatically generated A screen with a colorful graph

Description automatically generated with medium confidence

5) Verify that connecting 3rd input to ground (vs open ckt) does not significantly affect gains for other two inputs at low frequency (say 1 KHz).

Connected to Ground

A circuit board with wires and wires

Description automatically generated A screen with colorful lines on it

Description automatically generated

Open

A circuit board with wires and wires

Description automatically generated A screen with colorful waves on it

Description automatically generated

6) How much peak-to-peak output swing do you see at the onset of clipping?

8.6 V

A screen with colorful lines on it

Description automatically generated

Now offset the output +2V by adjusting the pot. Now how much pk-pk swing can you get at clip onset?

5.6V

A screen with a screen showing a wave

Description automatically generated with medium confidence A close-up of a device

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**Part 2:**

**Difference Amps**

Circuit Diagram:

A diagram of a circuit

Description automatically generated

Findings:

1. Demonstrate small signal inverting operation over frequency (G=-1) w V1 as input from fcn\_gen, V2 connected to pot.

Vo/Vin = 0.120/0.120 = 1

A screen with a colorful screen

Description automatically generated with medium confidenceA circuit board with wires and wires

Description automatically generated

Determine bandwidth. What did you expect?

Bandwidth = 600 Hz

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency kHz | Vin | Vout | Gain |
| 1 | 0.12 | 0.118 | -0.14598 |
| 5 | 0.12 | 0.116 | -0.29447 |
| 10 | 0.12 | 0.115 | -0.36967 |
| 15 | 0.12 | 0.113 | -0.52206 |
| 20 | 0.12 | 0.116 | -0.29447 |
| 30 | 0.12 | 0.113 | -0.52206 |
| 50 | 0.12 | 0.112 | -0.59926 |
| 100 | 0.12 | 0.111 | -0.67717 |
| 200 | 0.12 | 0.111 | -0.67717 |
| 500 | 0.12 | 0.096 | -1.9382 |
| 550 | 0.12 | 0.085 | -2.99525 |
| 600 | 0.12 | 0.078 | -3.74173 |
| 700 | 0.12 | 0.065 | -5.32536 |
| 900 | 0.12 | 0.049 | -7.7797 |
| 1000 | 0.12 | 0.0372 | -10.1728 |

1. Verify small signal noninverting operation (G = 1) with V2 as input from fcn gen and V1 connected to the pot.

Vo/Vin = 0.116/0.120 = 0.96 ~ 1

A screen with a colorful line on it

Description automatically generated with medium confidence A circuit board with wires

Description automatically generated

Measure bandwidth. What did you expect?

Bandwidth = 600 Hz

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency kHz | Vin | Vout | Gain |
| 1 | 0.12 | 0.113 | -0.52206 |
| 5 | 0.12 | 0.112 | -0.59926 |
| 10 | 0.12 | 0.112 | -0.59926 |
| 15 | 0.12 | 0.112 | -0.59926 |
| 20 | 0.12 | 0.11 | -0.75577 |
| 30 | 0.12 | 0.11 | -0.75577 |
| 50 | 0.12 | 0.108 | -0.91515 |
| 100 | 0.12 | 0.108 | -0.91515 |
| 200 | 0.12 | 0.108 | -0.91515 |
| 500 | 0.12 | 0.1 | -1.58362 |
| 550 | 0.12 | 0.091 | -2.4028 |
| 600 | 0.12 | 0.08 | -3.52183 |
| 700 | 0.12 | 0.06 | -6.0206 |
| 900 | 0.12 | 0.038 | -9.98795 |
| 1000 | 0.12 | 0.03 | -12.0412 |

1. Measure common mode gain with fcn generator driving both V1 AND V2 (V1=V2). Measure at a few of the same freqs used in step 1.

A close up of a device

Description automatically generatedA circuit board with wires on it

Description automatically generated

|  |  |  |
| --- | --- | --- |
| Frequency kHz | Vin | Vout |
| 500 | 5.32 | 0.132 |
| 520 | 5.32 | 0.13 |
| 540 | 5.32 | 0.124 |
| 560 | 5.4 | 0.122 |
| 580 | 5.4 | 0.12 |
| 600 | 5.4 | 0.118 |
| 650 | 5.4 | 0.109 |
| 700 | 5.4 | 0.104 |
| 750 | 5.4 | 0.1 |
| 800 | 5.4 | 0.09 |

1. CALCULATE CMRR (common mode rejection ratio) = 20log(diff gain/C gain) from the CM and diff gain measurements at a few frequencies across the bandwidth.

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency kHz | Vin | Vout | CMRR |
| 500 | 5.32 | 0.132 | 17.58852 |
| 520 | 5.32 | 0.13 | 17.72113 |
| 540 | 5.32 | 0.124 | 18.13157 |
| 560 | 5.4 | 0.122 | 18.2728 |
| 580 | 5.4 | 0.12 | 18.41638 |
| 600 | 5.4 | 0.118 | 18.56236 |
| 650 | 5.4 | 0.109 | 19.25147 |
| 700 | 5.4 | 0.104 | 19.65933 |
| 750 | 5.4 | 0.1 | 20 |
| 800 | 5.4 | 0.09 | 20.91515 |

1. 5) Measure large signal low frequency (1KHz) clip threshold with no offset, driving either V1 or V2.

A close-up of several electronic devices

Description automatically generated

1. Estimate the op-amp’s slew rate limit in V/us starting with low freq output = 6V ppk

Slew Rate = 3.68/11.3 = 0.33

A pair of white electronic devices

Description automatically generated