Laboratory Journal

Electronics in Space E7003R

Arthur Scharf

Beginning 16 February 2016

Contents

Tuesday, 16 February 2016

1 DC Circuit Measurements

1.1 Introduction

In this Experiment the voltages across a DC-Circuit (as shown in Fig. 1) shall be calculated and then measured with.

1.2 Procedure

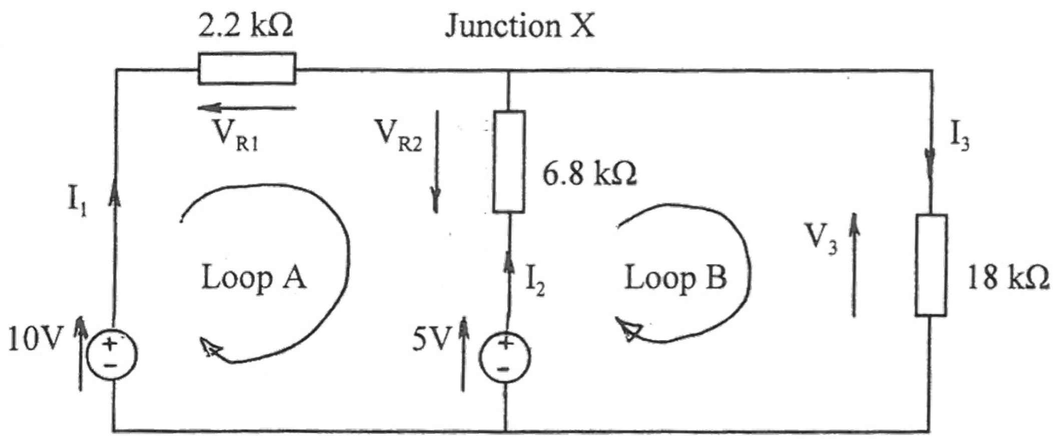

Figure 1: DC Measurement Setup

1. Switch on all the instruments you intend to use. They take time to warm up and reach a stable performance
2. Select the resistors that you need for the circuit. Note in your log book the colour code on each and the value. The details of the colour code is on the top of the resistor box and is also in any ELFA, RS or Farnell Catalogue.
3. Connect up the circuit shown in Fig. 1 , dc on the bread board with long wires for the power supplies.

4. Set the dual power supply to independent outputs with 10 Volts on one output and 5 Volts on the other. Connect these to your circuit. Check that the current limits are set working and set them to suitable values.

5. Check that the voltmeter is Switched to do measurements and use it to measure all the voltages in the circuit. That is both dc supply voltages and the voltages across the resistors, V_{RI}, V_{R2} and V_3. Record the values in the log book.

6. Use the oscilloscope to measure the voltages that were measured in 4 above. Again record these.

   Note the oscilloscope measures with reference to ground or zero volts. You can use the difference function on the oscilloscope to find the voltages across R1 and R2. Connect one input probe at one end of the resistor and the other probe at the other end. Then switch the display to the difference by:
   i Press the plusminus key between the inputs.
   ii Turn Function 1 ON using the left hand key below the display.
   iii Press the Function 1 menu key.
   iv press the selection key to give 1-2. The display should now give the difference between the two inputs. Whether the result is positive or negative depends on which end of the resistor you connected each probe.

1.3 Results

Selecting resistors: All Resistances were checked with a voltmeter after choosing the

Table 1: Chosen Resistance

Resistance	**Color Code**
2.2 kΩ	Red Red Black Brown Brown
6.8 kΩ	Blue Gold Black Brown Brown
18 kΩ	Brown Gray Blue Red Brown

appropriate resistor. The 18 kΩ resistor was slightly off the expected value, with a value of 17.78 kΩ.
After setting the current limits the voltage of the two channels of the Power Supply were set to 9.94V and 5.04V.
Then the voltages at the Resistors were measured using an ordinary Multimeter (cf. Table 2).
Now the dropped voltage across the resistors is measured again, by using an oscilloscope with two probes, one connected before the appropriate resistor and the other after the resistor. By subtracting the measured values we obtain the dropped voltage (cf. Table 3). This Measurement is only done for R_1 and R_2, as requested in the procedure.

Table 2: Voltage Drop measured with Voltmeter in DC-Circuit

Resistance	**Measured Voltage Drop**
$R_1 = 2.2$ kΩ	$V_{R1} = 1.94$ V
$R_2 = 6.8$ kΩ	$V_{R2} = 2.975$ V
$R_3 = 18$ kΩ	$V_3 = 8.00$ V

Table 3: Voltage Drop measured with Oscilloscope in DC-Circuit

Resistance	**Measured Voltage Drop**
$R_1 = 2.2$ kΩ	$V_{R1} = 1.6347$ V
$R_2 = 6.8$ kΩ	$V_{R2} = 3.015$ V

1.4 Summary

2 AC Circuit Measurement

2.1 Introduction

2.2 Procedure

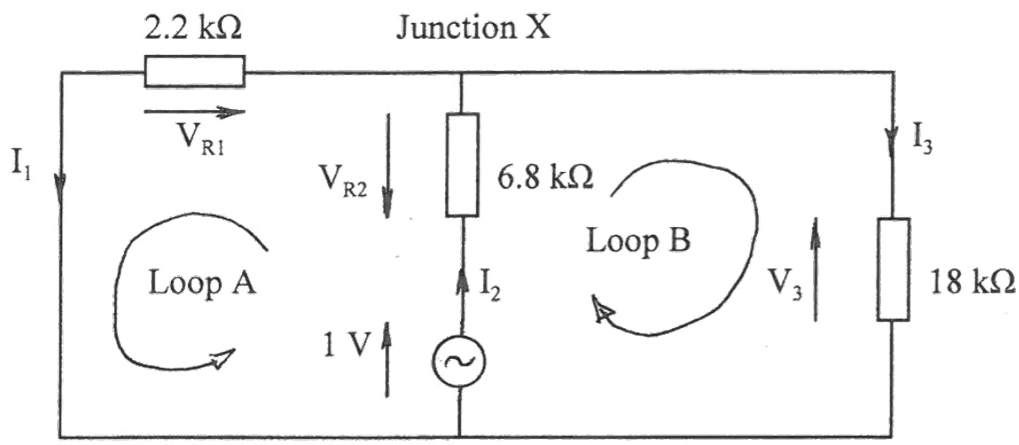

Figure 2: AC Measurement Setup

1. Modify the circuit on the bread board to that shown in 2

2. Check that the voltmeter is switched to ac measurements. Note it reads the RMS value.

3. Set the oscillator or function generator to 1 kHz and set the output voltage to 1 Volt using the voltmeter. Then connect the output to your circuit using a coaxial cable with crocodile clips on it. p

4. Using the voltmeter measure all the voltages in the circuit. That is the ac supply voltage and the voltages across the resistors, V_{RI}, V_{Rz} and V_3. Record the values in the log book.

5. Use the oscilloscope to measure the voltages that were measured in 4 above. Again record these.

6. Print out one of the oscilloscope displays.
   i Press Print/Utility above the inputs.

   ii Press Print Screen at the bottom of the screen. Include the print out in the logbooks.

2.3 Results

After modifying the circuit on the bread board and setting the AC Power Supply to 1V at 1kHz, the Power Supply is connected to the circuit on the bread board. Now the Voltages across the resistors:

Table 4: Voltage Drop measured with Voltmeter in AC-circuit

Resistance	**Measured Voltage Drop**
$R_1 = 2.2$ kΩ	$V_{R1} = 0.218$ V
$R_2 = 6.8$ kΩ	$V_{R2} = 0.77$ V
$R_3 = 18$ kΩ	$V_3 = 0.218$ V

Now the voltages are measured again with the oscilloscope, by using two probes again, and measuring the Peak-to-Peak voltage. The corresponding RMS-values can be seen in Table 5.
For the measurement of V_{R2} a picture was taken, see Figure 3.

Table 5: Voltage Drop measured with Oscilloscope in AC-circuit

Resistance	**Peak-to-Peak Voltage**	**RMS Voltage**
$R_1 = 2.2$ kΩ	$V_{R1} = 0.75$ V	$V_{R1} = 0.2652$ V
$R_2 = 6.8$ kΩ	$V_{R2} = 2.0$ V	$V_{R2} = 0.7$ V
$R_3 = 18$ kΩ	$V_3 = 0.75$ V	$V_3 = 0.2652$ V

Figure 3: Oscilloscope Measurement of V_{R1} (both probes connected to the same point before resistance, measured to 0V Ground)

2.4 Summary

Thursday, 18 February 2016

1 Basic Operational Amplifier Circuits - Introduction

for the appropriate circuts we connect the 2-Output SC Power SUpply in Series to get -15V and +15V; the middle Point(Point of connection between + of one and - of the oterh is connected to GND to have GND as reference).

2 The Voltage Follower

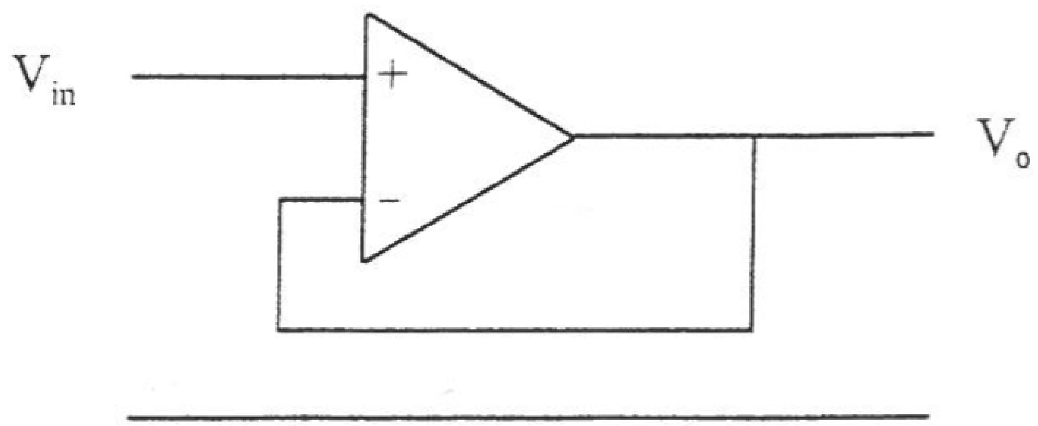

Figure 1: Circuit A, the voltage follower

2.1 Procedure

1. Connect up the circuit of the voltage follower shown in Circuit A below using a ± 15 V supply for the Op-amp.

2. Connect the input to ground, 0 Volts, and measure the dc output voltage using the multimeter. This is the output off-set voltage.

3. Apply a suitable dc voltage to the input, measure it and the dc output voltage and calculate the dc gain.

4. Apply a suitable ac voltage to the input and observe the output voltage on the oscilloscope. Measure the ac input voltage and the ac output voltage and calculate the ac gain.

2.2 Results

After connecting the 2-Output DC-Power Supply to a configuration that allows +15V and -15V Output as well as Ground (connecting the two Power Outputs in series, Ground reference taken from the middle of the connection) and connecting the circuit, the power supply is switched on. Now the Output Voltage is measured with a multimeter, which gives a value of **2.5mV**, which corresponds to the output offset voltage.
Now the input voltage is replaced with a 5.02V DC input provided by another DC Power Supply.
Measuring the Output Voltage again with the Voltmeter, gives a value of **5.03V**, which results in a gain of **0.1V**.
Now the DC input is replaced with an AC input, set to 0.302V RMS, and the oscilloscope is connected. Measuring the Peak-to-Peak value of the curve (see image) gives a peak value of about 2V (the bottom is a bit more, because of the DC offset!), therefore the AC Gain is 2.

add image here and calculate proper gains!

3 The Non-inverting Amplifier

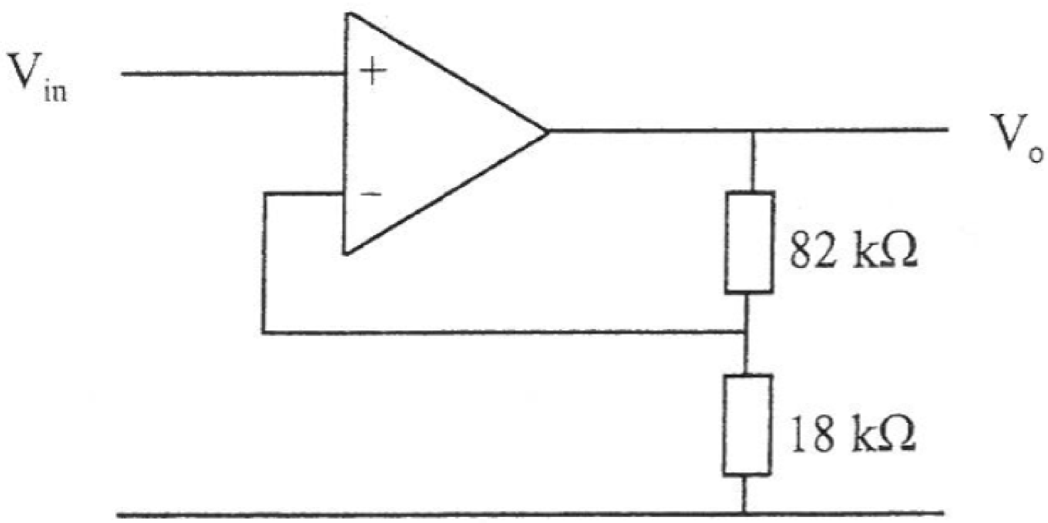

Figure 2: Circuit B, the non-inverting amplifier

Thursday, 18 February 2016

3.1 Procedure

1. Connect up the circuit of the non-inverting amplifier shown in Circuit B by modifying the above circuit A.

2. Repeat the steps 2, 3, and 4 of Procedure A above for this circuit.

3. Apply a square wave input to V_{in} and observe the output voltage on the oscilloscope. Measure the slew rate of the amplifier output.

3.2 Results

Now the circuit from the previous experiment is modified by adding two Resistors R_{82} and R_{18}. Verifying the resistors with the resistor measurement device gives $R_{82} = 81.85$ kΩ and $R_{18} = 17.52$ kΩ.

Again, 0 Volts are applied and the output is measured with a multimeter, which gives 24.7 mV, the output offset voltage.

The 0V input is now replaced by a 0.992V DC input, and the output is measured again: 5.51V. .

calculate gain here

After measuring, the OpAmp started to smoke and we shut off all power supplies. We suspect a short circuit somewhere in the wiring, but could not see any problem. Therefore we dismantled the whole circuit & power supply wiring and wired it again. Since we had the measurement for the DC input already and were short on time, we decided to continue with the AC measurement.

After reconnecting and checking the circuit again, we connect the AC input with a peak-to-peak voltage of 1V . Measuring the output with the oscilloscope gives us a peak-to-peak voltage of 5.6V. After the measurement we again experienced the issue described above. Even now we could not find any short-circuit in the wiring.

add picture here, should be image 17 or something

A small investigation led us to the conclusion, that we switched off the OpAmp Power Supply before turning off the OpAmp Input, which is most likely the causing issue for the disintegration of the OpAmps.

Re-wiring and measuring again, gives us now a value of 6.1V Peak to Peak (with 1V peak-to-peak input) when AC input is applied. Now we could measure the slew rate of 0.813 uS/V, with a rise time of 5.752s.

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4 The Current to Voltage Amplifier

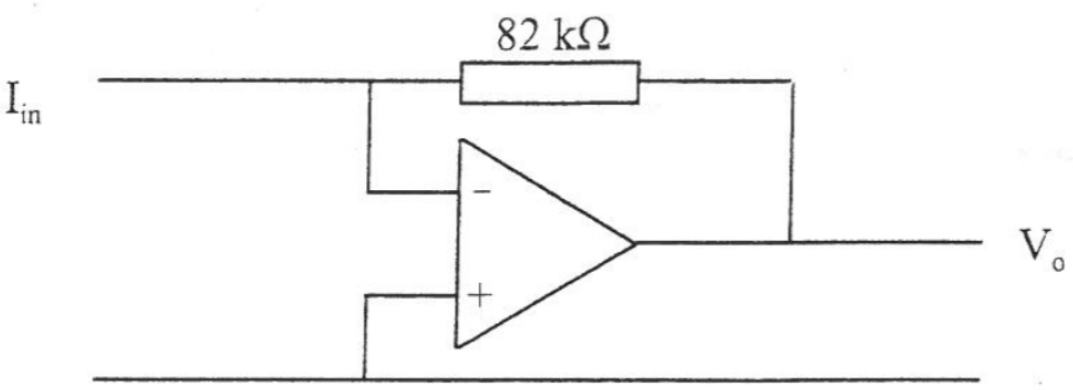

Figure 3: Circuit C, the current to voltage amplifier

4.1 Procedure

1. Connect up the circuit of the current to voltage amplifier shown in Circuit C below again using a ± 15 supply for the Op-amp.
2. Connect the input to ground, 0 Volts, and measure the dc output voltage using the multimeter. This is the output off-set voltage.
3. To measure the input current to output voltage ratios, for do and for ac, for this circuit requires do and ac input currents. These can be obtained from appropriate voltage sources via suitable values of resistor. For the do and ac measurements decide on a value of current that will give you a convenient output voltage and choose suitable source voltages and resistor values to give these. For each apply the current to the input and measure it and the output voltage. Calculate the dc and the ac transfer impedances.

4.2 Results

After connecting and checking the wiring and applying 0V to the OpAmp input we measured a output offset voltage of 71.5mV.
Calculating an appropriate resistor value gave us a resistor value of 18 kΩ to have an voltage output of about 5V. Using the resistors from the experiment before and measuring the output by applying a DC input voltage of 0.991V, we obtained a V_Out of 4.55V, which is quite close to the calculated value.
Again, this measurement was done using a AC power input of 1V peak-to-peak resulting in a voltage output of 4.7V.

include here how done

add image 21 here

calculatee the DC and AC transfer impedances

5 The Inverting Amplifier

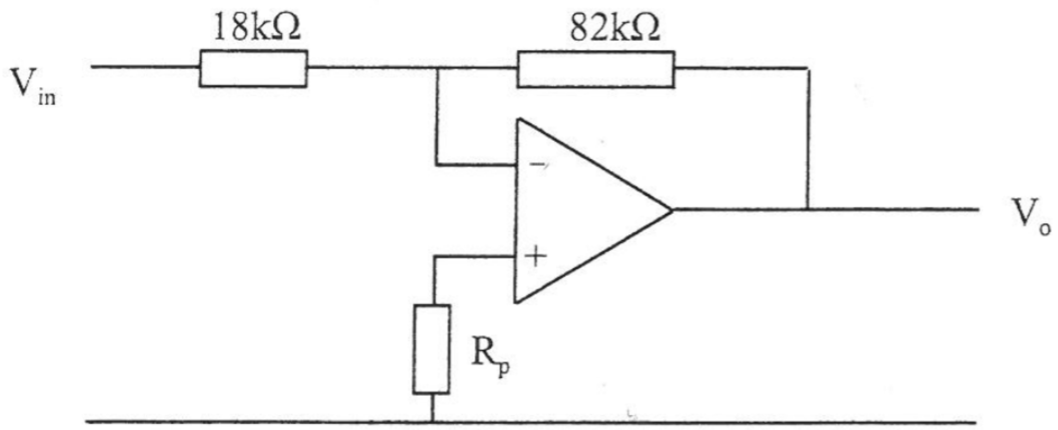

Figure 4: Circuit D, the inverting amplifier

5.1 Procedure

1. Connect up the circuit of the inverting amplifier shown in Circuit D by modifying the above circuit C. This involves the calculation of a suitable value for the resistor Rp.

2. Repeat the steps 2, 3, and 4 of Procedure A above for this circuit.

5.2 Results

Calculating an appropriate R_P is done as stated in the lecture on OpAmps, and results in a value of $R_P = 14.76$ kΩ. After selecting a resistor with the closest value (14.962 kΩ, verified with the resistance measurement device), we again applied 0V to the input.

This results in a DC offset voltage of 53.9mV.

Applying a DC input voltage of 0.991V, we measure -4.42V at the OpAmp output, which corresponds to the theoretical calculated gain value of -4.55.

Applying a AC input voltage of 1V peak-to-peak we obtain

get the image here!

6 The Summing Amplifier

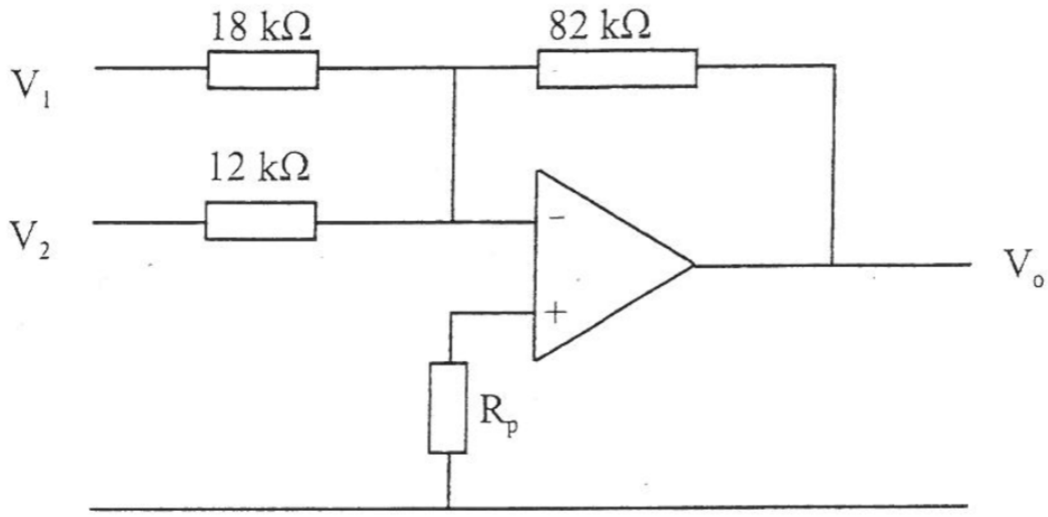

Figure 5: Circuit E, the summing amplifier

6.1 Procedure

1. Connect up the circuit of the inverting amplifier shown in Circuit E by modifying the above circuit D. This involves the recalculation of a suitable value for the resistor R1,
2. Connect both of the inputs to ground, 0 Volts, and measure the dc output voltage using the multi-meter. This is the output off-set voltage.
3. Apply two suitable dc voltages one to each of the inputs, measure them and the dc output voltage and calculate the relationship between the input voltages and the output voltage.
4. Apply a suitable ac voltage to one input and say a square wave of a to the other input, inspect these and the output voltage using the oscilloscope and print out the appropriate screens. Account for the output voltage waveform in terms of the input voltages and the relationship between the inputs and the output. Vary the frequency of one of the inputs and inspect the results.

6.2 Results

After modifying the circuit to match the wanted Circuit given in FIgure , recalculation ref einfgen

of the R_P value gives a resistance of 6.9 kΩ. We again use the closest resistor we can find (6.778 kΩ, verified with the resistance measurement device). For R_2 a resistor with the value of 11.957 kΩ is used.
Connecting both inputs to 0V results in an output of 119.6mV.
Applying 0.448V to both inputs, results in an output of 5.39V, which matches the theoretical calculated value of 5.55V.

calculate relationship bla

Now, other than stated in the procedure, we were advised to use one AC and one DC input instead of a square wave input. We now apply a DC input with 0.448V and a AC (sine wave) with a peak value of 0.5V. Picture

insert image 23

7 The Differential Amplifier

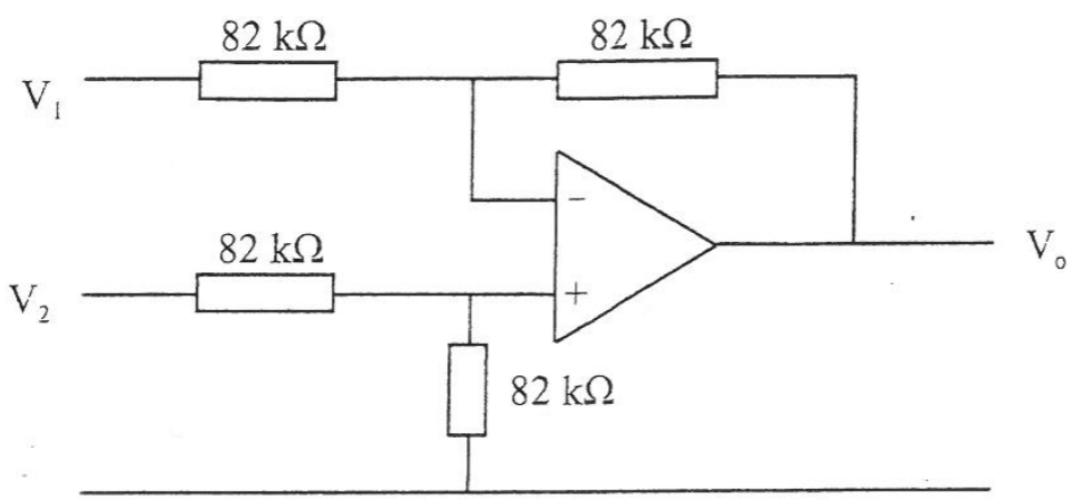

Figure 6: Circuit F, the differential amplifier

7.1 Procedure

1. Connect up the circuit of the differential amplifier shown in Circuit F below using a ± 15 supply for the op-amp and noting that all the resistors are identical in value.

2. Connect both of the inputs to ground, 0 Volts, and measure the dc output voltage using the multi-meter. This is the output off-set voltage.

3. Connect the two inputs together and apply a large voltage (say 10 Volts) to them. Measure this input voltage and the output voltage and calculate the common mode gain, hopefully less than unity. You can consider subtracting the output off-set voltage from the common mode output voltage before calculating the common mode gain.

4. Apply two very different values of dc voltage one to each of the inputs, measure them and the dc output voltage and calculate the relationship between the input voltages and the output voltage.

5. Repeat 4 with the two input voltages exchanged.

6. Apply two very similar but large values (say around 10 Volts) of dc voltage one to each of the inputs, measure them and the dc output voltage and calculate the relationship between the input voltages and the output voltage.

7. Repeat 6 with the two input voltages exchanged.

7.2 Results

We again modified the circuit to match the one given in figure insert ref

1. Applying 0V input and measuring the output, results in a dc offset voltage of 20.0mV

2. After setting the input voltages to 9.79V (connected together), we obtain a measured output voltage of 20.3mV, which matches our expectations. Now we modify the input voltages, so that $V_1 = 7.19$V and $V_2 = 4.98$V. This gives us an output of 2.188V. Switching these inputs results again in an voltage output of 2.242V. alc relationship between the in and out

3. Now we set $V_1 = 9.99$V and $V_2 = 10.56$V. This results in a voltage output measurement of 0.607V. Switching the inputs again gives a $V_{out} = 0.544$V

8 The Schmitt Trigger Comparator

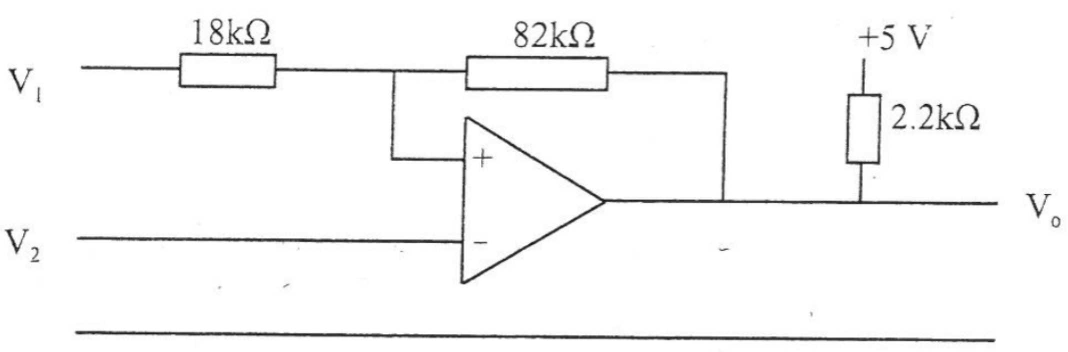

Figure 7: Circuit G, the Schmitt Trigger Comparator

8.1 Procedure

1. Connect up the circuit of the Schmitt Trigger Comparator circuit shown in Circuit G below using a ± 15 Volt supply for the LM 311 comparator.

2. Connect input V_2 to Ground and apply a variable DC voltage at V_1. Starting with V_1 negative and the output at 0 Volts increase the voltage on V_1 and note the value of V_I at which the output switches to +5 Volts. Then decrease the voltage on V_I until the output again switches to O Volts and note the voltage on V_I at this point.

3. Apply a saw tooth waveform to V_2 at a frequency of 10 kHz and observe the output waveform and the sawtooth input waveform on the oscilloscope. Vary the dc voltage on V_I and observe the variation in the width of the pulses at the output. This is known as pulse width modulation.

4. Using the oscilloscope measure the slew rate of the comparator and compare it with that of the op-amp.

8.2 Results

After rewiring and connecting the power supply we were advised to skip number 2 of the procedure. For the circuit the following resistor values were used (verified with the resistor measurement device): $R_{2.2} = 2.1959$ kΩ, $R_{82} = 81.77$ kΩ and $R_{18} = 17.991$ kΩ. Now we applied a waveform at a frequency of 10 kHz to V_2 and observed the waveform on the oscilloscope (see figures). Measuring the slew rate with the oscilloscope we obtained a slew rate of 150ns (see images 27 and 28 .

insert images

insert images

Monday, 29 February 2016

1 EMC Labs

1.1 Introduction

look at the network analyzer which can do a lot of nice things.
the whole system is calibrated to 50 Ohm.
10hz to 500MHz for source, and records all the measurements
measures the input impediance, transfer, and measure the output impediance
slide with different stuff that can be measured.
one of the labs: ground plane -¿ serial ground should not be used cause crappy; using loudspeaker cables cause they're cheap users are represented with capacitors
second lab: investigate shielding effect of different materials, steel grud, steel, mumetal,brass,coppe,alumonum
one transmitter and one receiver, inbetween the shield -¿ measure now the atteniuation
the other lab: look into components , R,L,C, then look at the circuit board: the greem plate with a lot of strips, different traces
Component analyzing with network analyzer different components with different values of R, C and L basically, each component gets crappy at some specific frequency.
and for high frequency applications one does not use resistors.
next experiment: now use the serial ground config interesting thing: reducing noise by using capacitors doe not work properly, because they introduce some noise by themselves (???)
next experiment: use the green plane with different ground configuration, the best one to use is the one thats closest to a coax cable, because there's the least amount of noise introduced into ground by the signal (best attenuation of about -30dB or something

1.2 Summary

Wednesday, 02 March 2016

1 CMOS Array

1.1 Introduction

1.2 Procedure

1.3 Summary