Laboratory Journal

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Arthur Scharf

arthur.scharf@gmail.com

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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

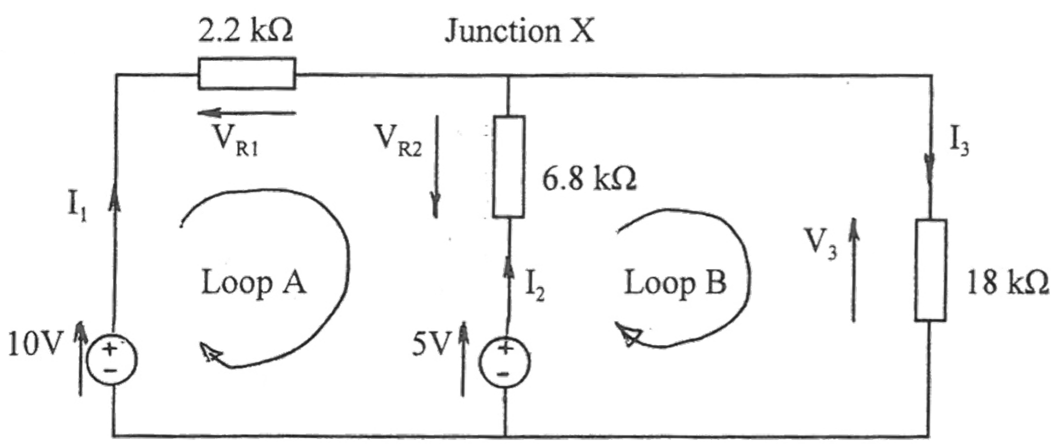

Figure 1: DC Measurement Setup

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

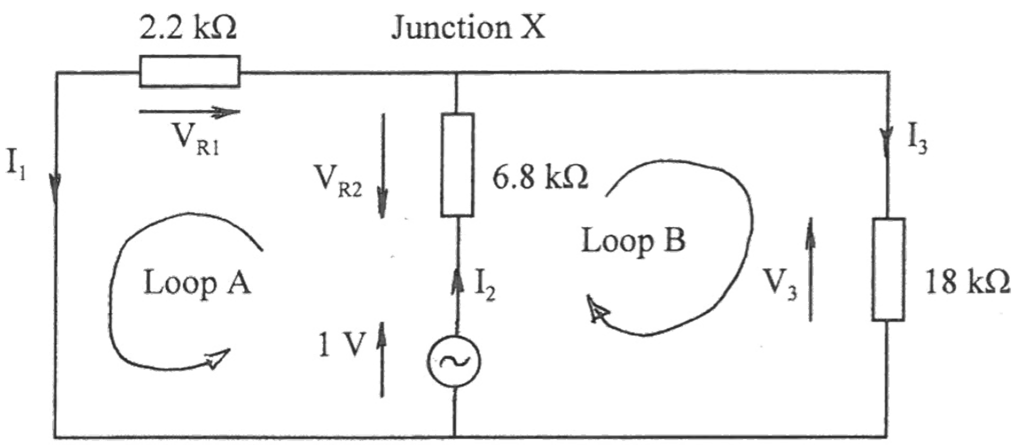

Figure 2: AC Measurement Setup

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

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

add image here and calculate proper gains!

value of about 2V (the bottom is a bit more, because of the DC offset!), therefore the AC Gain is 2.

3 The Non-inverting Amplifier

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.

3.1 Results

modifying Circuit of A -¿ $R_8 2 is R = 81.85 kOhm; R2 = 17.52 kOhm$
2) apply 0 Volta -¿ output ofset voltage: 24.7 mV 3) DC VOltage input 0.992V; measured: 5.51V 4) AC voltage input: peak to peak: 1V; -¿ (picture scope 17) peak to peak 5.6 Volt
Chip burned twice -¿ turned off opa amp power supply before turning off the input power
5) slew rate -¿ picture 19 or something; peak to peak voltage is 6.1; rise time 5.752; slew rate 6.1V / (1.5us * 5 us) = 0.813 us/V

4 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 i 15 supply for the Op-amp.

   Circuit C 82 k9

   Iin V'O

2. Connect the input to ground, 0 Volts, and measure the dc output voltage using the multi- meter. 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

Using again 82kOhm from before and a 10kOhm resistor (because it was available) -¿ this results in Vout of 8.2, with a current of 1mA -¿ nope, using 18kOhm to get 4.55V in the end as output; at first we got with input of 0V an output of about 13V; -¿ 71.5mV in the ned -¿ because cable was wrong connected; 2) input DC 0.991V -¿ output oltage 4.41V 3) AC input: 1V peak to peak; putput: 4.7V(scope 21)

5 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

$\mathrm{R}_p should be 14.76 kOhm (see lecture; because of imperfections) -> using 14.962 kOhm 2) 53.9 mV dcoff$
$0.991V(gain should be -4.555) DC output voltage: -4.42V 4) AC peak to peak: 1V(pic22)$

6 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, Circuit E 18 k9. 82 k9 Vl 12 M) V, Vo
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

Recalculation of Rp: 6.8 -¿ using 6.778kOhm using 11.957kOhm for R_2
Applying 0V to both inputs: 119.6mV 2) now apply 0.488V to both inputs -¿ V 5.39V theoretical : -5.55 3) AC voltage: 0.6V peak to peak -¿ not using AC AC , but DC of 0.488V and AC of 0.5V peak to peak ; AC as swaure wave -¿ very noisy with small values using now AC Voltage (sine wave) -¿ recalculated (picture 23) -¿ varying the AC input makes the picture clearer =P

7 The Differential Amplifier

7.1 Procedure

1. Connect up the circuit of the differential amplifier shown in Circuit F below using a i 15 supply for the op-amp and noting that all the resistors are identical in value. Circuit F 82 k!) 82 k!) V] - H 82 ko. ' v, V2 l 82 ko.

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.

4. Repeat 4 with the two input voltages exchanged.

5. 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.

6. Repeat 6 with the two input voltages exchanged.

7.2 Results

2) offset -¿ 20.0mV 3) setting INput voltage to 9.79V; measured output: 20.3mV V2 -¿ 4.98V V1 -¿ 7.19V -¿ Vout 2.188V now switch the V2 and V1 -¿ Vout 2.242V 5) V1 9.99V as input ; V2 = 10.56V -¿ output 0.607V 6) switch them now -¿ Vout -¿-0.544V

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8 The Schmitt Trigger Comparator

8.1 Procedure

8.2 Results

$R_2.2- > 2.1959kOhm82- > 81.7718- > 17.991$
second part:
slew rate -¿ 150ns see pic 27
see pic 28 (use 10% and 90% for the measurements) 12V -¿ per microseconds