Laboratory Journal

Electronics in Space E7003R

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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

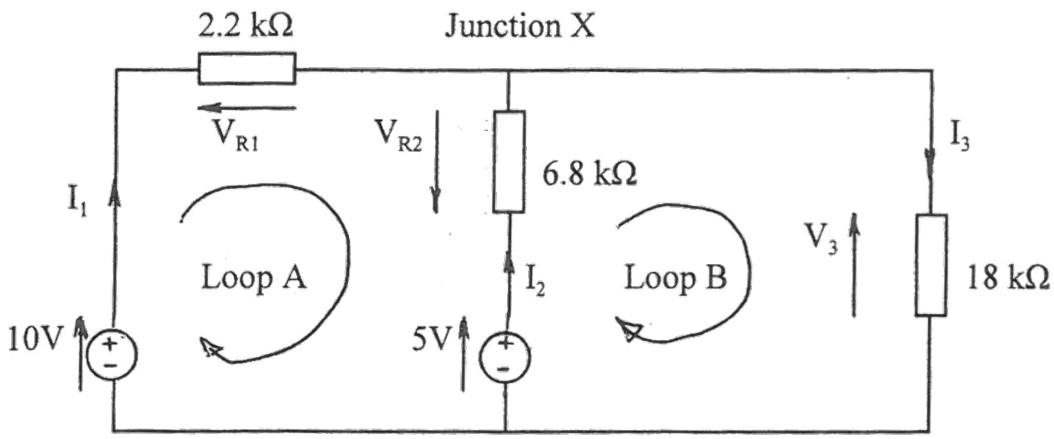

Figure 1: DC Measurement Setup

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

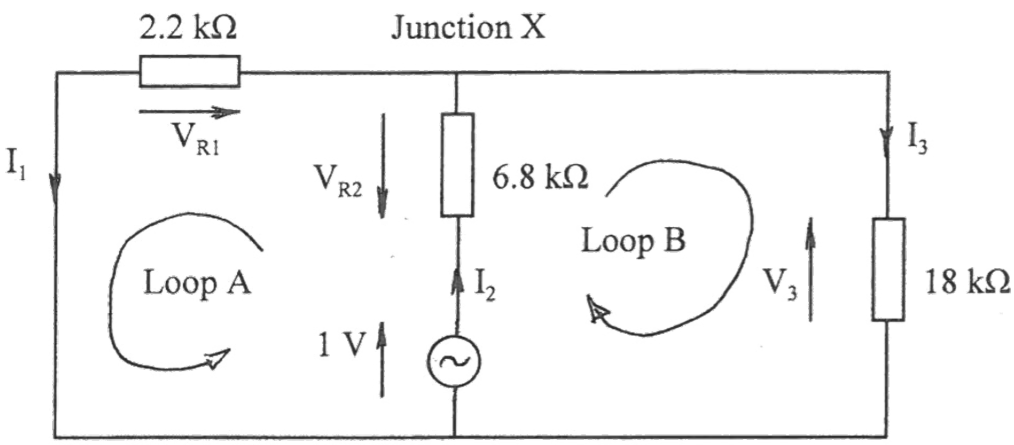

Figure 2: AC Measurement Setup

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

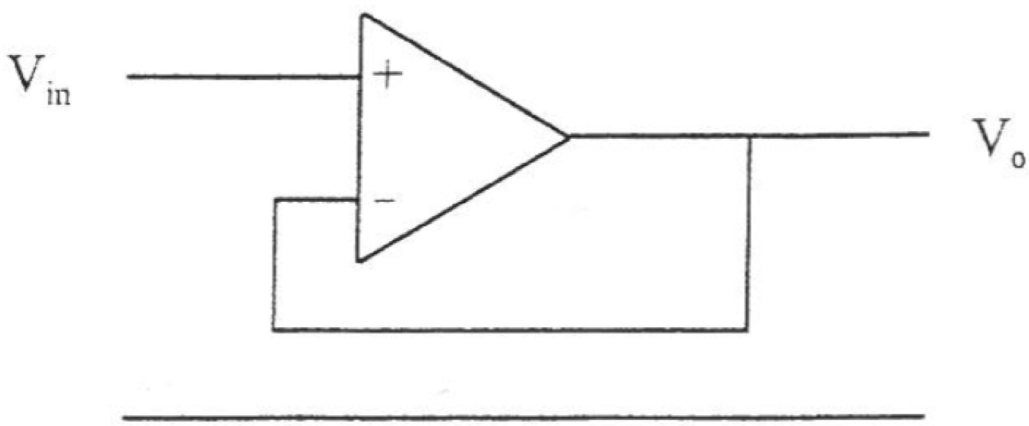

Figure 1: Circuit A, the voltage follower

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

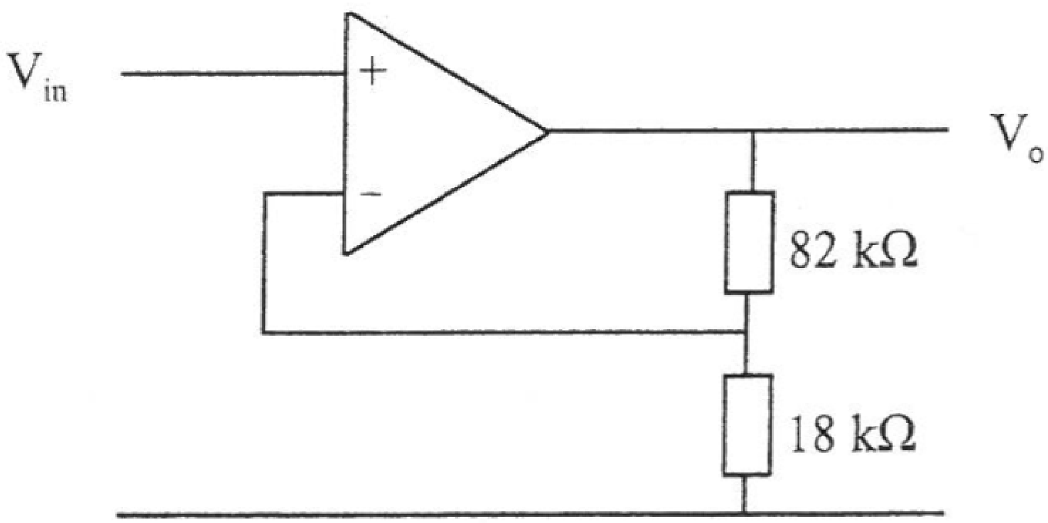

Figure 2: Circuit B, the non-inverting amplifier

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.

calculate gain here

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

add picture here, should be image 17 or something

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.

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.

add image here, pic 19

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.

4 The Current to Voltage Amplifier

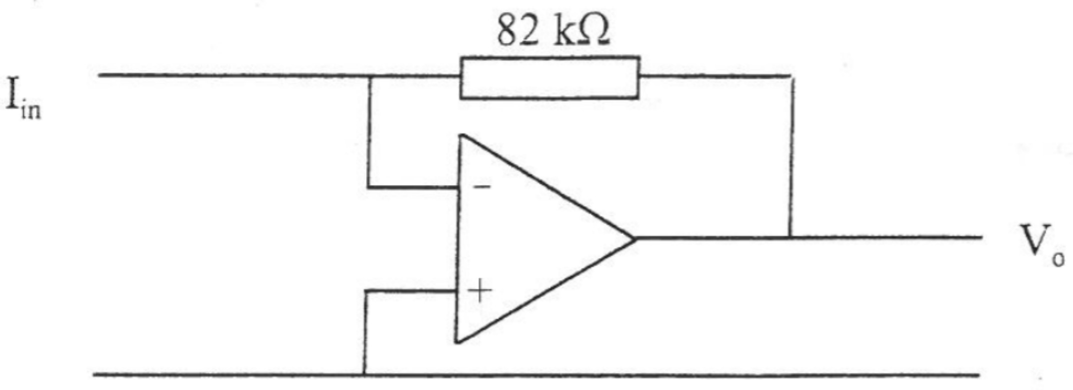

Figure 3: Circuit C, the current to voltage amplifier

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

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calculatee the DC and AC transfer impedances

5 The Inverting Amplifier

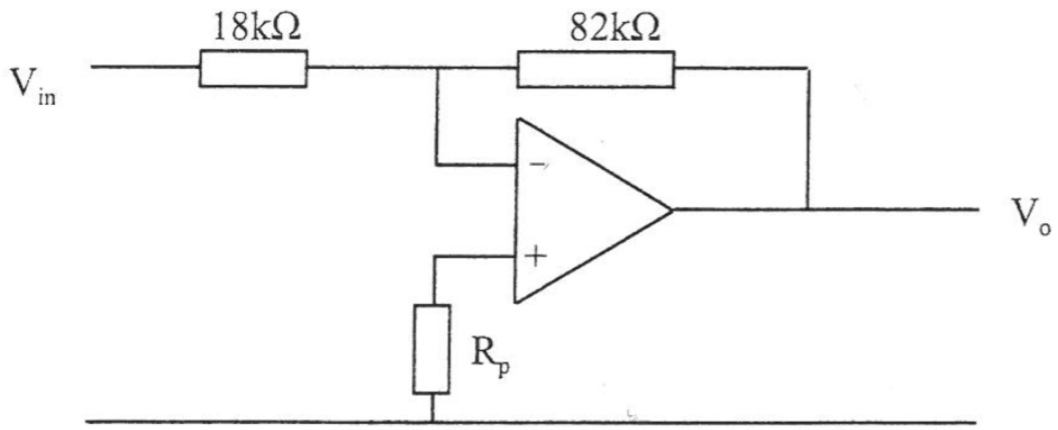

Figure 4: Circuit D, the inverting amplifier

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.

get the image here!

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

6 The Summing Amplifier

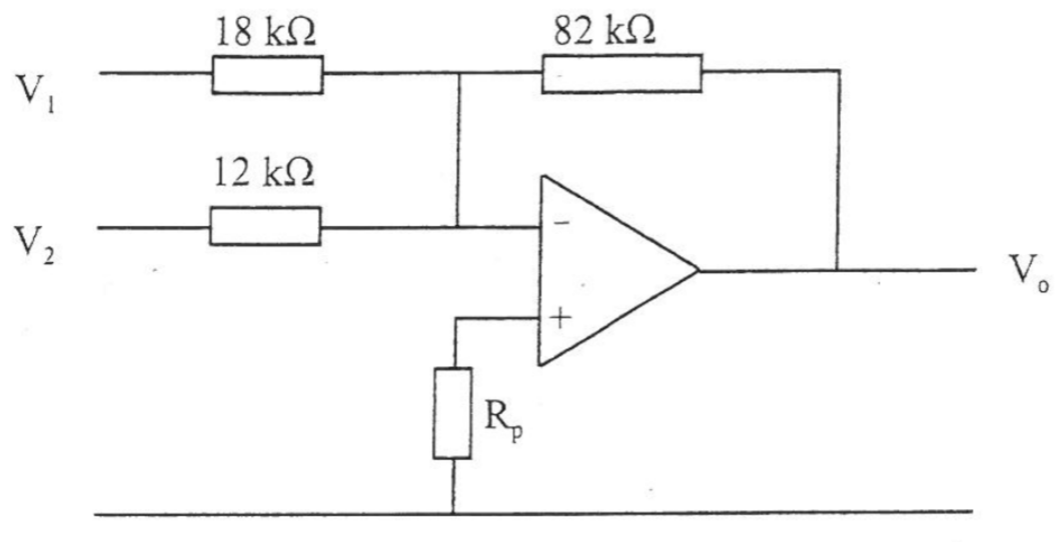

Figure 5: Circuit E, the summing amplifier

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 calculate relationship bla

insert image 23

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.
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

7 The Differential Amplifier

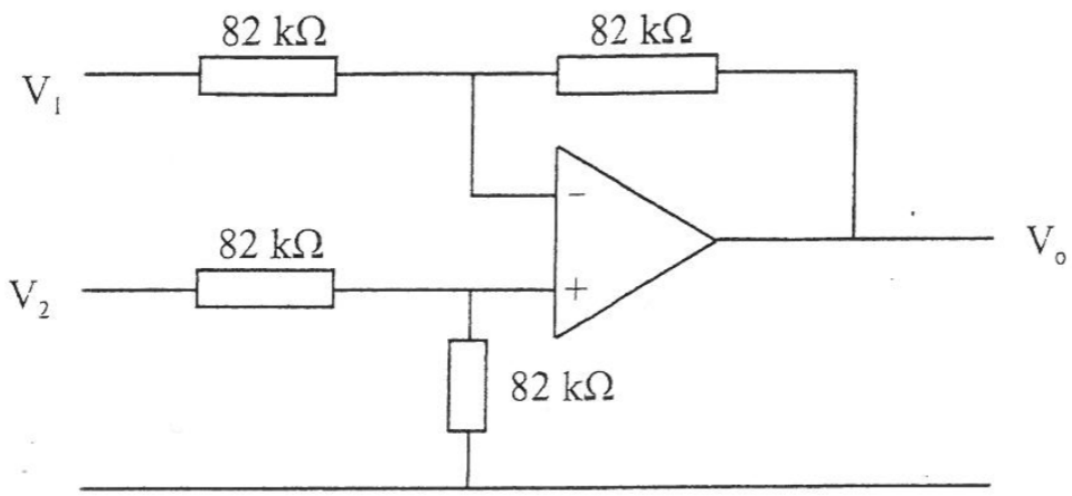

Figure 6: Circuit F, the differential amplifier

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

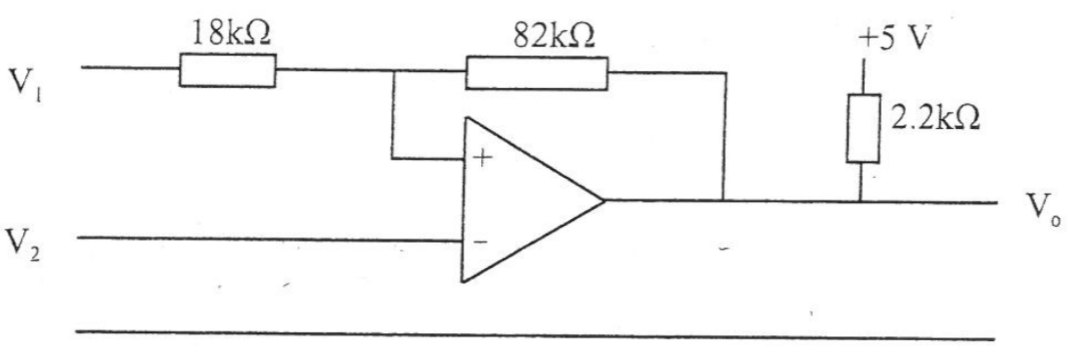

Figure 7: Circuit G, the Schmitt Trigger Comparator

Thursday, 18 February 2016

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

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insert images

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 .

Monday, 29 February 2016

1 EMC Lab

tbd. not needed for labbook

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

Wednesday, 02 March 2016

1 CMOS Array

1.1 Introduction

tbd

2 Experiment Setup

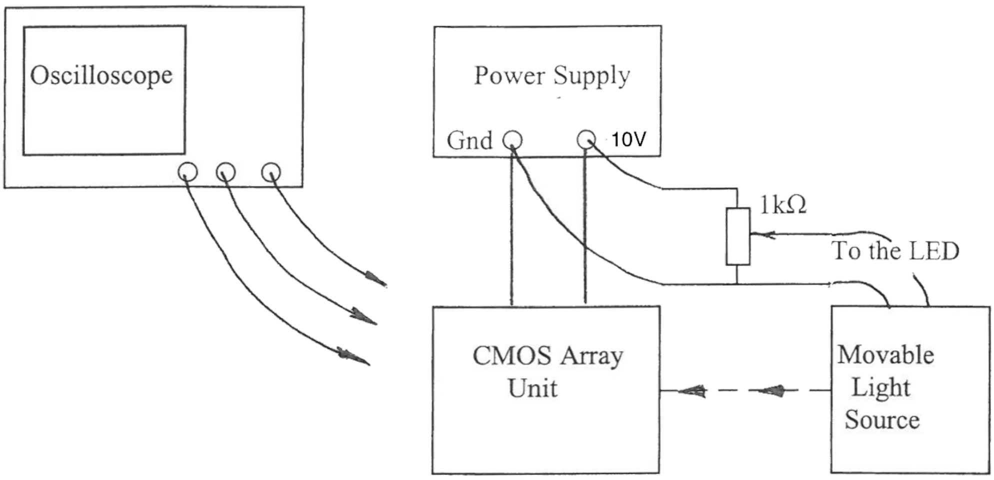

Figure 1: CMOS Array Experiment Setup

2.1 Procedure

1. Arrange and connect up the equipment as shown above.
2. Connect the oscilloscope to the CMOS array unit with:
   Input 1 to Video Output;
   Input 2 to EOS, End Of Scan;
   Ext. Input to St, Start of Read Out;
   Set the time base source to Ext.

3. On the CMOS array unit set the adjustable controls for the clock frequency, Clk Freq, and the exposure time, Ex Time, to their centre positions and the Gain switch to Low.

4. With the room darkened and the reading lamp on, switch on the power supply to the LED and adjust its position across the optical bench so that it is in the centre of the bench. Set up the optical system to focus a small spot on to the centre of the CMOS array. Include an adjustable iris in the system so that the light level can be altered.

   Note, the height of the optical bench may have to be adjusted.

5. On the oscilloscope set:
   Time base to 10 msec/division;
   Input 1 on 1 Volt/division;
   Input 2 on 5 Volts/division.
   With the reading lamp on examine the Video output and the EOS displays. The whole of the array should be seen to be illuminated on the video output display. The EOS should be at the end of the video read out. Note, if the room lights are on the illumination level of the array will be so high that the array stops working.

2.2 Results

3 Clock Frequency

3.1 Procedure

1. Connect input 2 on the oscilloscope to display the clock, Clk, with the time base at 10 msec.

2. Alter the clock frequency to see the effect on the video display. Turning the control to the left reduces the clock frequency and should increase the time for the read out. Increasing the frequency should reduce the time for the read out.

3. Reset the clock frequency control to the centre position.

   Using the oscilloscope measure the time taken to read out the whole of the array and then measure the clock frequency by reducing the time base on the oscilloscope until the clock waveform can be seen. Print out the relationship between the video waveform and the clock waveform.

   Check that the relationship between the clock frequency, the number of pixels and the time for a complete read out is correct.

4. On the video trace measure the zero output Voltage level and the peak output voltage level when the pixels are saturated. The difference is the voltage range from dark to saturated for the pixels.

3.2 Results

After connecting the input 2 on the oscilloscope and setting the time base, the clock frequency is set to minimum, see Fig. 2. Altering the clock frequency changes the amount of time needed to read out the CMOS Array, see Fig. 3 and Fig. 4.

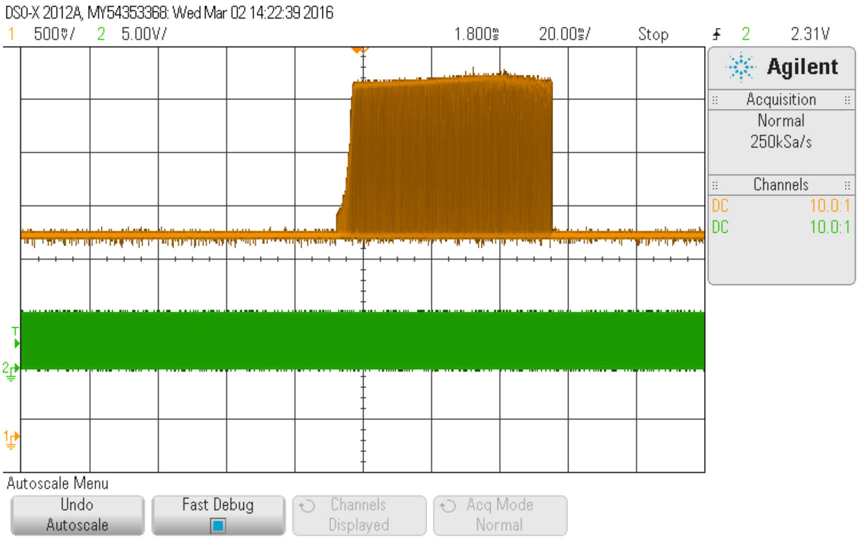

Figure 2: Clock Frequency at minimum

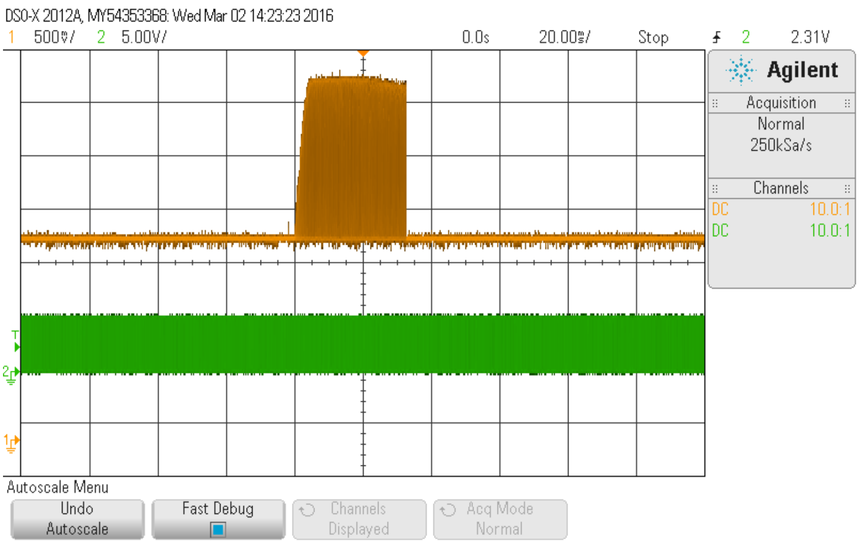

Figure 3: Clock Frequency at centre point

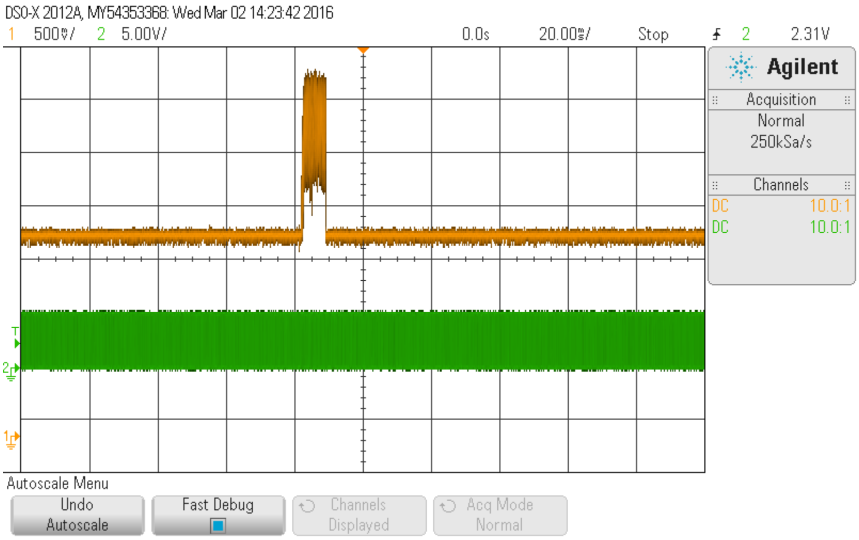

Figure 4: Clock Frequency at maximum

Now the clock frequency control is again set to the center point and the read-out time of one pixel is measured using the oscilloscope. This results in an read-out time of 39.8 usec for one pixel, see Fig. 5 and a read out time of 37.522 msec (6).

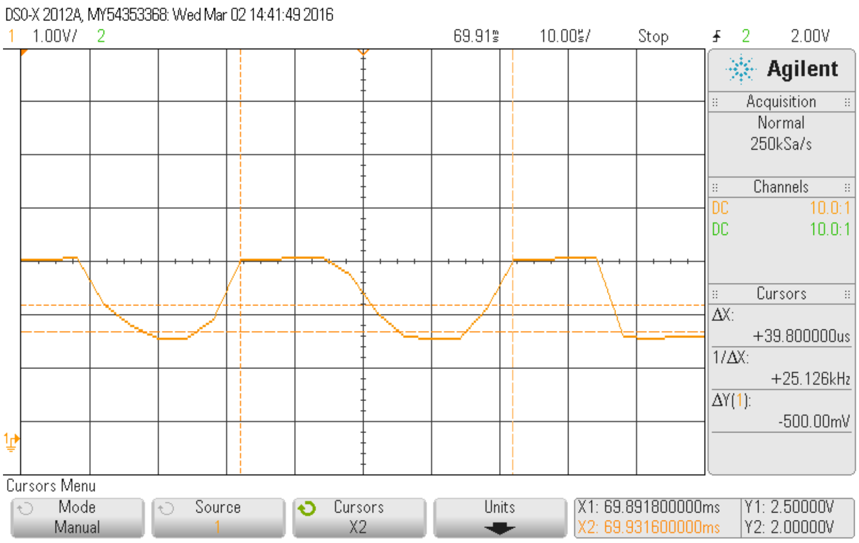

Figure 5: Read Out Time of one pixel, with clock frequency set to centre point

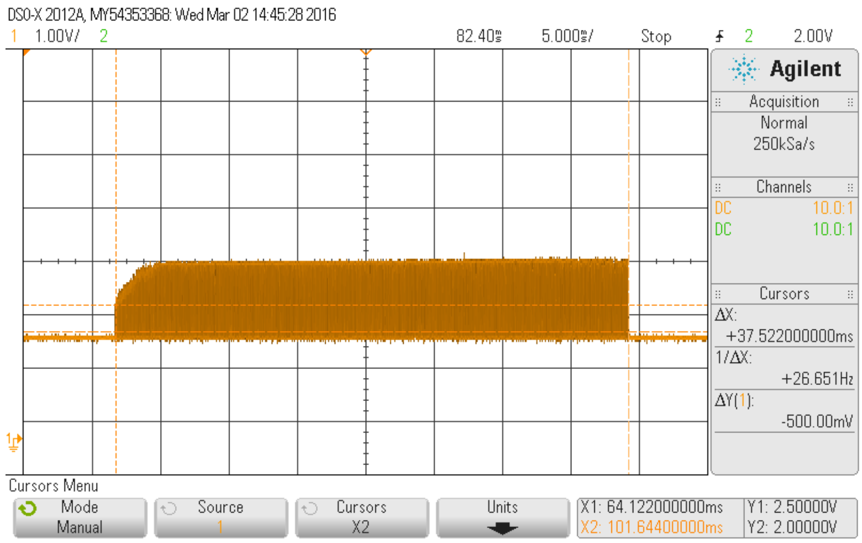

Figure 6: Read Out Time of whole array, with clock frequency set to centre point

To see the relationship between the clock frequency and the video waveform the time base of the oscilloscope is reduced, as one can see in Fig. 7. The frequency used is 108.695 kHz.

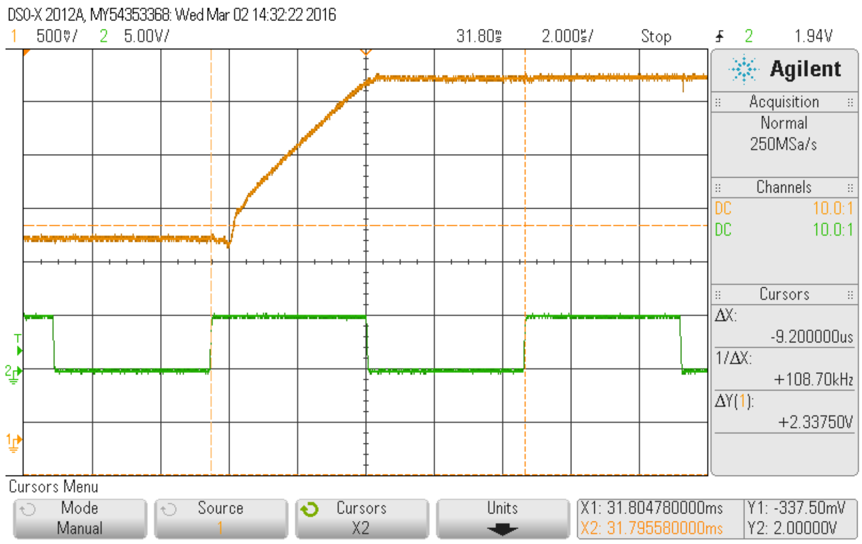

Figure 7: Measuring the clock frequency

This measurement seems to be correct, but there's a slight deviation from the expected values. According to the data sheet of the CMOS Array the Read-out time for one pixel

equals four clock cycles. In our case it results in 4.32 clock cycles for one pixel, which might be the result of a not perfect measurement.
Also, the expected read-out time for the whole CMOS Array equals 40.7552 msec (the whole read-out time of the array divided by the read-out time of one pixel), which is slightly more the measured 37.522 msec. This might also be the result of a non-perfect measurement.

Now, the zero output voltage level is measured with saturated pixels (see Fig. 8) and results in 1.8375V. The voltage range from dark to saturated pixels is 1.53V (see Fig. 9).

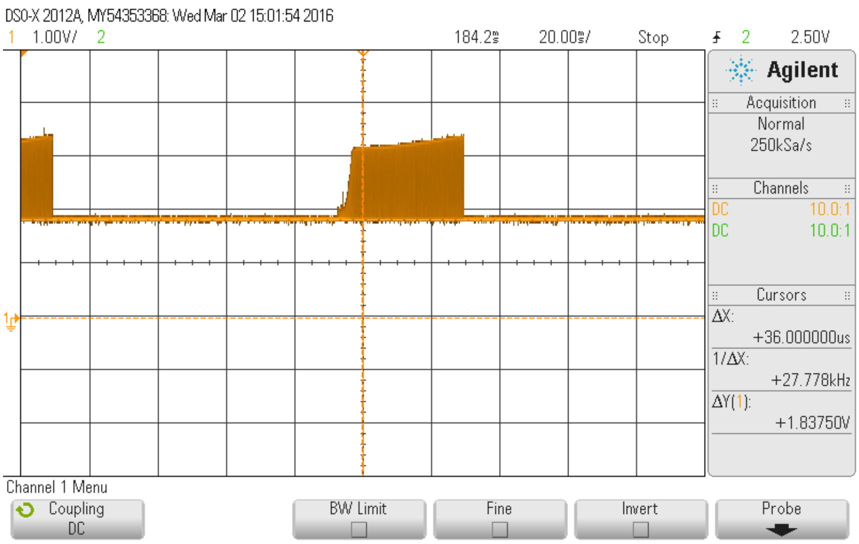

Figure 8: Measuring the Zero Output Voltage Level

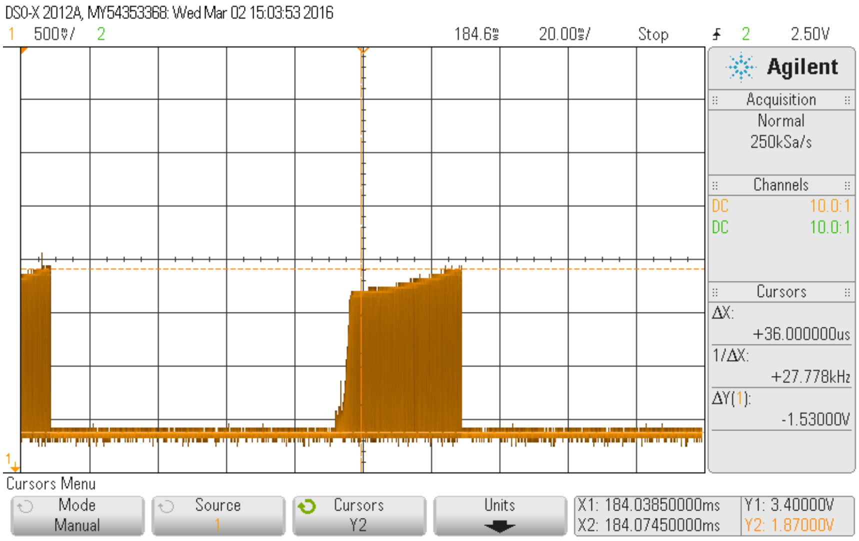

Figure 9: Measuring the Voltage Range from dark to saturated pixels

4 Exposure Time

4.1 Procedure

1. With the clock and exposure controls at their mid positions set the oscilloscope time base to 50 msec/division. Several read outs from the array should be seen. The exposure time is the time between the start of successive readouts.

   Check that the exposure time is independent of the clock frequency. Reset the clock frequency to the centre position.

2. Vary the exposure time control, Ex Time, and view the effect on the oscilloscope screen. In this system it is possible for the exposure time to be less than the read out time. Reduce the exposure time until the successive video readouts overlap and note the effect. In a practical instrument this should not be allowed to happen.

   Check that even with low exposure times and low gain too much light stops the CMOS Array from working.

4.2 Results

After setting the time base to 50 msec/div we again set all controls to their centre position. Obviously the exposure time is independent from the clock frequency. We verify this by varying the clock frequency and observing the oscilloscope readings. In Figures 10, 11 and 12 the effect of varying the exposure time can be seen.

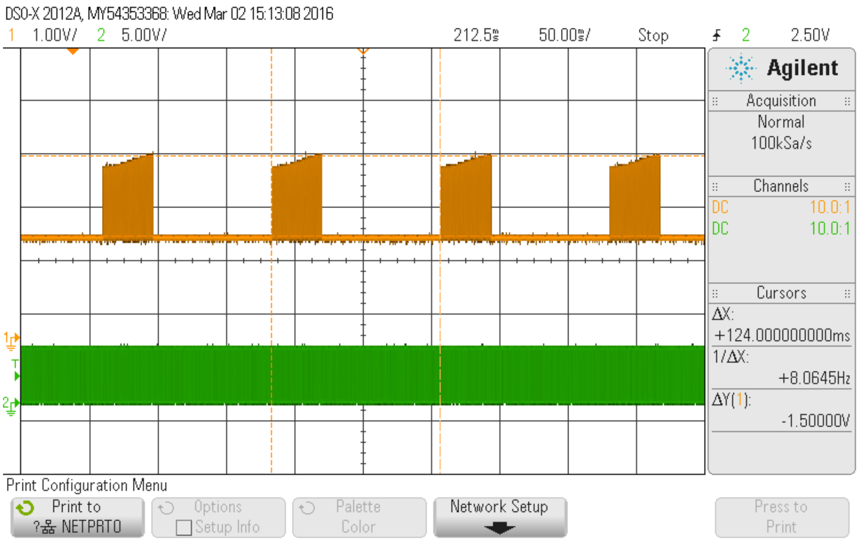

Figure 10: Exposure Time at centre position

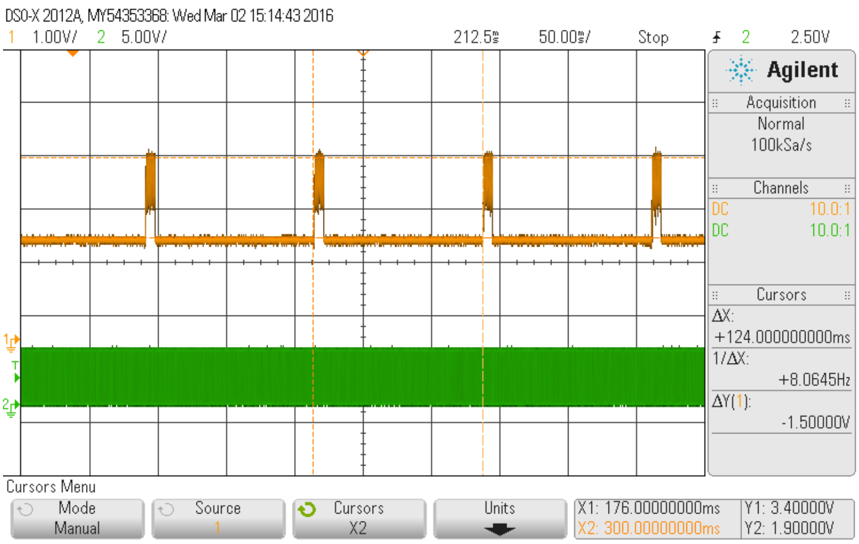

Figure 11: Exposure Time at maximum position

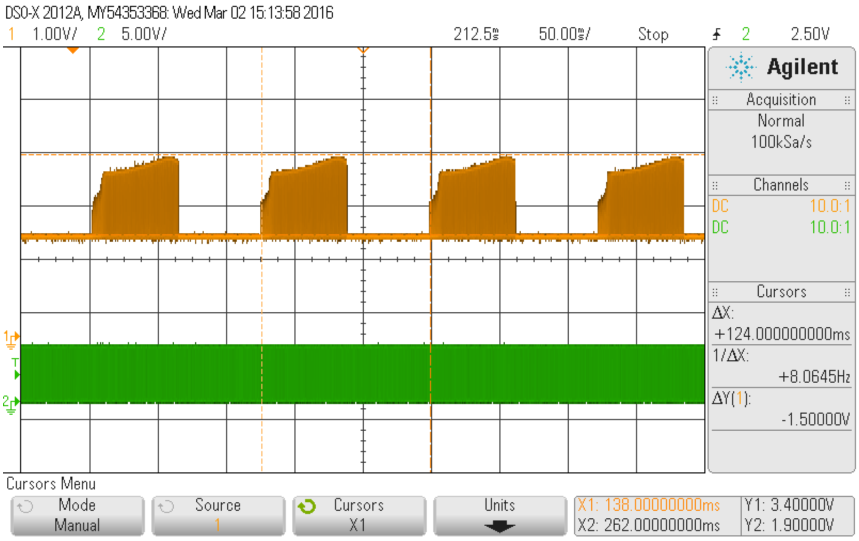

Figure 12: Exposure Time at minimum position

If the exposure time is reduced too much, successive CMOS Array readings can overlap, as one can see in Fig. 13. Obviously, this results in a data set that's unusable, since the start and end of each frame is overlapping. Also, if the CMOS Array is under full illumination while having the exposure and gain set to a low value, the CMOS Array stops working (see Fig.).

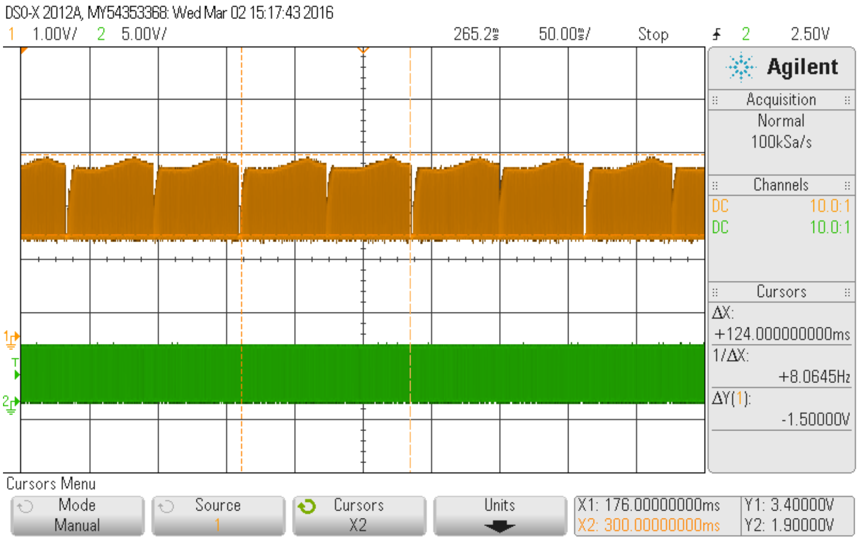

Figure 13: Overlapping Video Readings

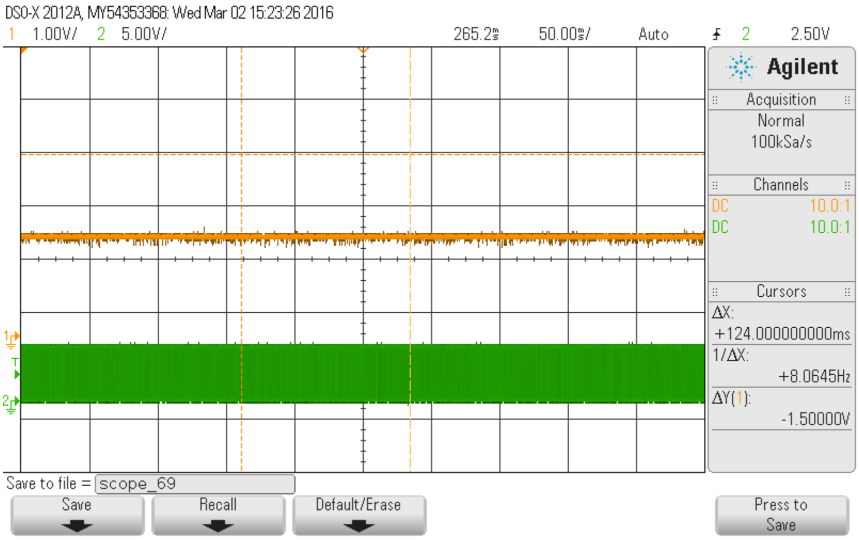

Figure 14: Full Illumination of the CMOS Array while having low gain and low exposure time

5 Spot Illumination

5.1 Procedure

1. On the array unit set the clock frequency and the exposure time to their centre positions and the gain to low.

   On the oscilloscope:
   set the time base to 10 msec/division;
   connect input 2 on the oscilloscope to display EOS..
   Illuminate the array with a spot at the centre of the array and turn all the lighting in the room off.

2. Check, on the oscilloscope, that the illuminated part of the array is near the centre of the array, if not adjust the position.

   Adjust the brightness of the illumination using the iris and the potentiometer until the read out from the illuminated part of the array can just be seen on the oscilloscope. Switch the gain to Hi gain and record the change.

   Move the display of the illuminated part of the array to the centre of the oscilloscope screen using the horizontal display control.

   Expand the display by changing the time base to somewhere between 100usec and 500usec so that the individual pixel outputs from the charge amplifier can be seen.

For one of the pixels at the centre of the illuminated part of the array measure the magnitude of the output for both low and high gain. Make sure that the pixel is not being driven into saturation at high gain. Determine the ratio of high to low gain.

3. While still examining the individual pixels connect input 2 to the trigger output on the array unit. Record the relationship between the two traces and comment on why the trigger output is provided.

5.2 Results

Again, all controls are set to their centre position, the gain is set to low and the LED is arranged in such a way, that the CMOS Array is illuminated only at its centre. Figure 15 shows the spot illumination at low gain, Fig. 16 shows the exact same illumination, but at high gain.

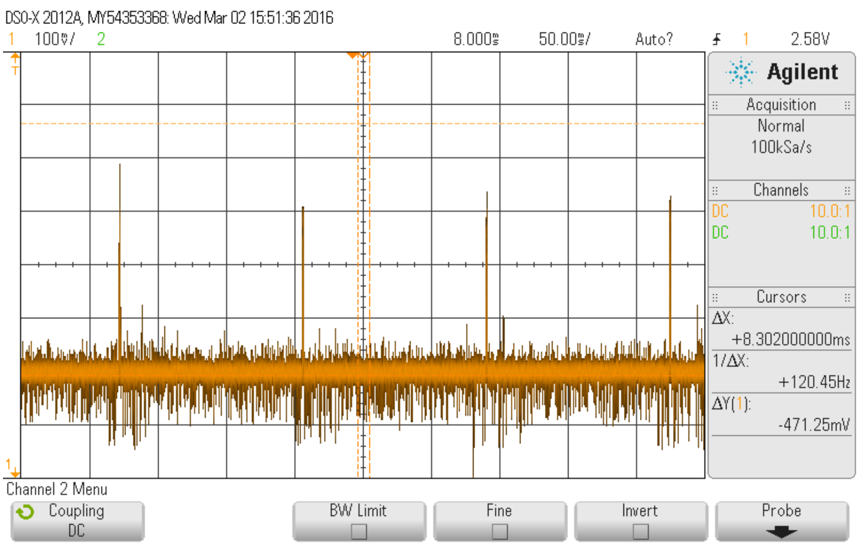

Figure 15: Spot Illuminated CMOS Array at low gain

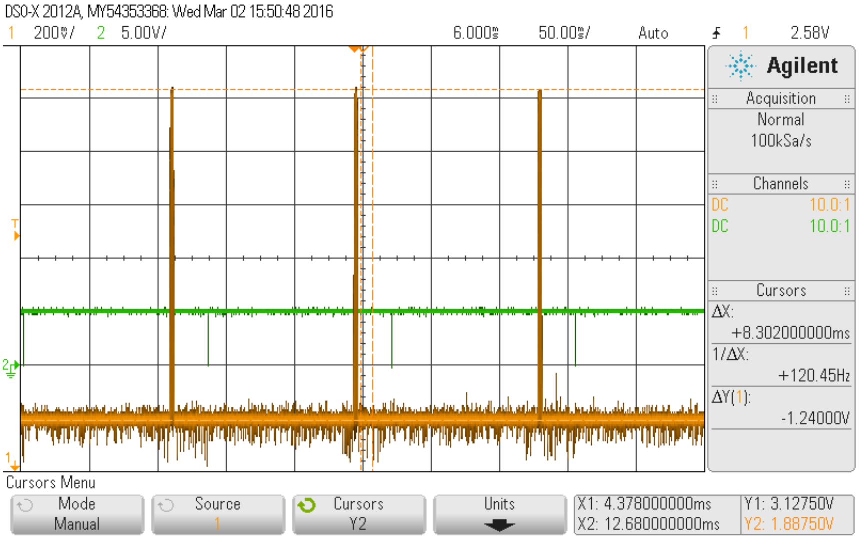

Figure 16: Spot Illuminated CMOS Array at high gain

In Figure 17 and 18 the time base was changed to 50 msec/div and 200 msec/div to see the individual pixels. The magnitude of the output voltage at low gain is 353.75mV and at high gain 1.2275V.

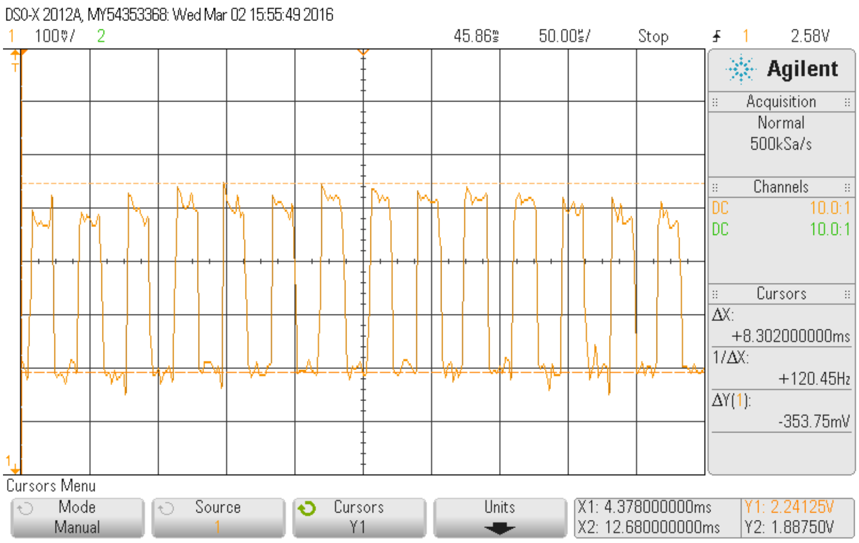

Figure 17: Output voltage magnitude at low gain

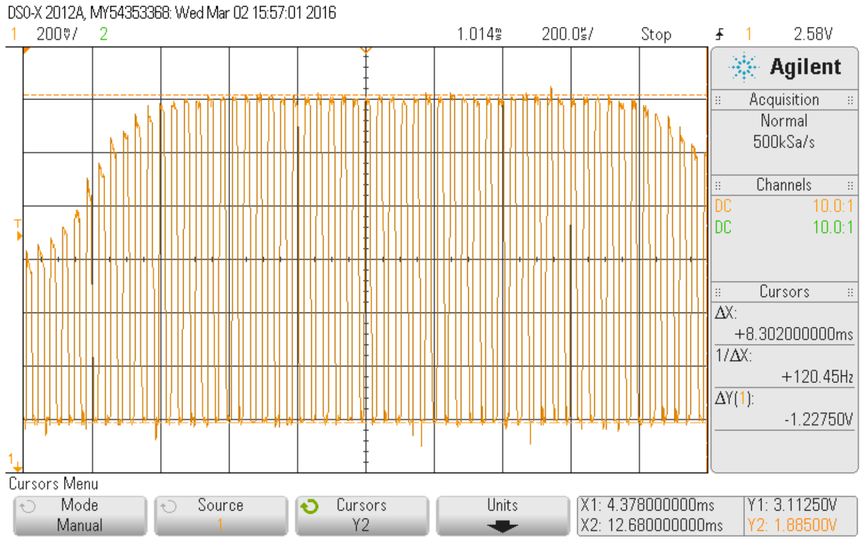

Figure 18: Output voltage magnitude at high gain

calculate gain ratio here

Now the input 2 is connected to the Trigger output at the CMOS Array. The Trigger waveform looks like expected according to the data sheet (see Fig. 19).

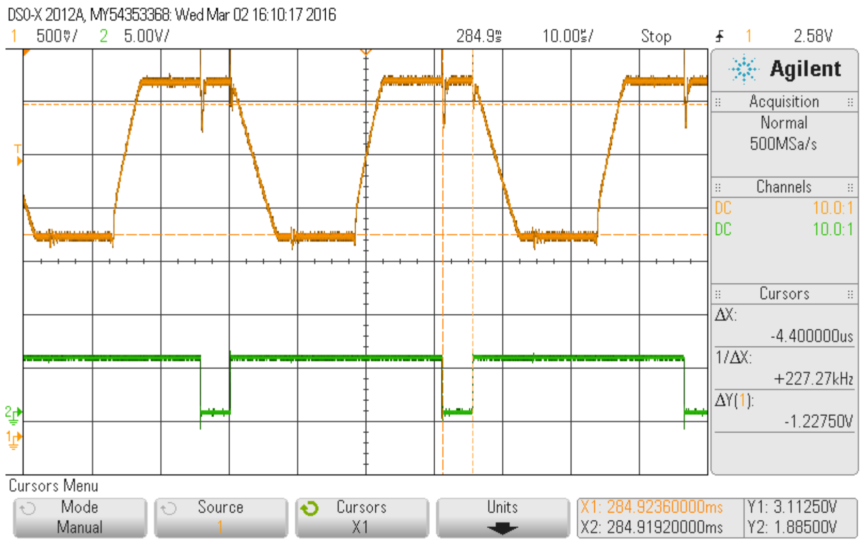

Figure 19: Trigger Output

The Trigger is used to signal the user or the application, that the CMOS Array reached stable values and is available for readout.