DG220 Introducing Electronics

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Introduction

This report contains all questions from the chapters, practical assignments,building blocks, and evidence photos of the DG220 Introducing Electronics assignment.
In addition, the final reflections can be found at the end of this report.

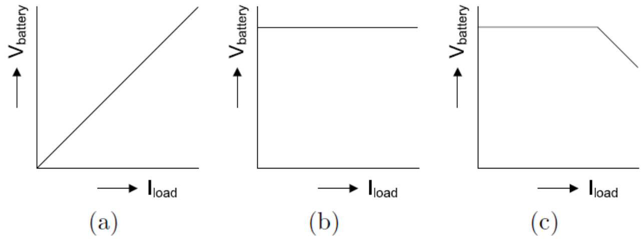
The structure of this report works with three different coloms at every page. In the first colum, the given parts of a specific question are given. The second colom contains the calculations and the third colom gives the outcome.

2.1
battery of 1,5V / 300mA.Hr
average current of 50mA

Parallel: 300 x 2 = 600 mA
600mA/50mA = ... Hr
Series: 1,5 x 2 V = 3V
300mA/50mA = ...Hr

Parallel: 6 hours
Series: 12 hours

2.2



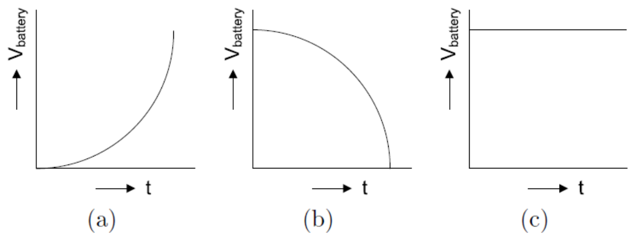
Ideal power source V stays constant independent of I.

Non-ideal power source loses V when I becomes too high.

Ideal power source: graph B

Non-ideal power source: graph C

2.3



An ideal power source keeps a constant V, independent of the time.

A non-ideal realistic power source, loses V over a longer period of time.

Ideal power source: graph C

Non-ideal power source: graph B

2.4
Vout = 50V
Imax = 2A
operating voltage = 50V
max output power = 50W
efficiency = 35%

Pout/Psource x 100%
50W/Psource x 100% = 35%
50W x 100% = 35% x Psource
(50W x 100%)/35% = Psource
Psource = 143W

The voltage of the source is too high for the power supply of 100W. This means that the supply is not sufficient for the amplifier.

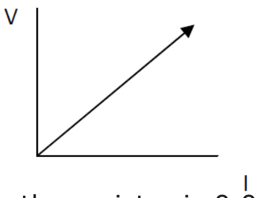
2.5
electricity grid = 50Hz
light bulb flickers 2x in 1 period

f= 2 x 50Hz = 100Hz
Human eye can see 20Hz

Because the human eye can only see 20Hz max, they can not see the flickering of a 100Hz light bulb.

3.1
graph V = f(I) with R constant

V = f(I)
R = V/I



3.2
V = 10V
R = 1 kΩ

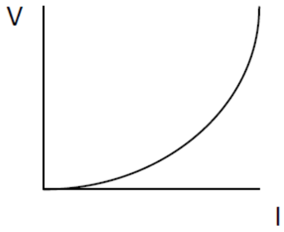
I = R x V
I = 1000/10
I = 0,01 A
P = V x I
P = 10 x 0,01
P = 0,1 W

Current through the resistor is 0,01A

The power dissipated is 0,1W

3.3
graph P = f(I) with R constant

R = U/I



3.4
Big resistors can handle larger powers than smaller ones. In addition, big resistors have more space to give their heat which results in functioning better at high temperatures.

3.5
R = 1kΩ (14W, +/- 1%)
Vsource = 15 V
Imax = 1A

Pmax = V x I = 15 x 1 = 15W
P = (V^2)/R = (15^2)/10010 = 0,23W

The resistor can handle a power of 0,250W.
The max supplied power is 0,23W.

3.6
R = 500Ω, +/- 2%, 1/2W for a circuit

1/((1/1000)+(1/1000)) = 500Ω

The solution is to place two 1kΩ resistors in parallel.

3.7
1% Resistors of E12 series are needed

4kΩ = 1,8kΩ + 2,2kΩ
5kΩ = 1/((1/10kΩ)+(1/10kΩ))

1,8kΩ, 2,2kΩ, and two 10kΩ are needed

4 Capacitance and Capacitors

<u>4.1</u>
Capacitor C = 100pF
DC-source V = 12V

Q = C x V = (100x10^-12) x 12 = 1,2 x 10^-9C
E = 1/2 x CV^2 = 1/2 x 100 x 10^-12 x 12^2
E = 7,2x10^-9
dt = (C x dV)/I = (100x10^-12x90)/(50x10^-3)
dt = 1,8 x 10^-7 s

The total amount of charge stored on it is 1,2 x 10^-9 C
The total amount of electrical energy stored on it is 7,2 x 10^-9
It takes 1,8 x 10^-7 s to charge the capacitor to 90 V

<u>4.2</u>
Zc(w) = 1/(2pi x f x C)

According to the formula, when f increases, Zc will decrease. In addition, when f decreases, Zc will increase

Zc will increase when f decreases
Zc will decrease when f increases

<u>4.3</u>
C = Q/V
Cre = C1+C2+C3...+Cn

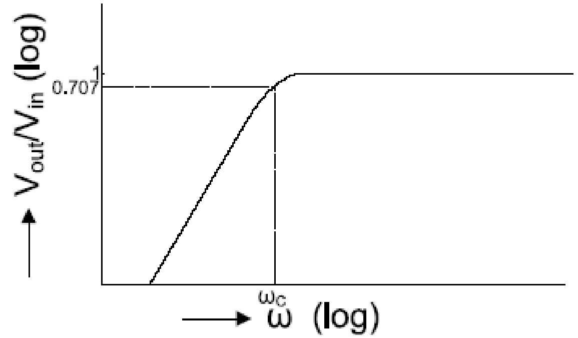
Q = C1 x V1 + C2 x V2 + C3 x V3
As V = 1, Q = C1 + C2 + C3
Cre x V = C1 + C2 + C3, so Cre = C1 + C2 + C3

This shows that the derive of this question holds

<u>4.4</u>
Cre1 = (C1,C2,C3) in series

Cre1 = 1/((1/1)+(1/1)+(1/1) = 1/3 microF
Cretotal = 1/ ((1/Cre2)+(1/C5)) = 1/(1,3+1)
Cretotal = 0,57 microF

The equavalent capacitance of the circuit equals 0,57 microF



<u>4.5</u>
RC low-ass filter: Vout(w) = (Zc/Zre) x Vin(w)
Vout(w) = ((1/wC)/root(R^2+(1/(w^2 x c^2)))) x Vin(w)

Vc = I x Zc = low-pass filter
Vr = I x R = high-pass filter
Vout(w) = (Zc/Zre)xVin(w)
fuction of the high-pass function becomes
Vout(w) = (R/Zre)xVin(w)

<u>4.6</u>
Cut-off point = Vout/Vin = 0,707
Zc = R

Vout/Vin = (1/wC)/(root((1/(w^2xC^2))+(1/(w^2xC^2)))
Vout/Vin = 0,2/root((1/5^2)+(1/5^2)))
Vout/Vin= 0,707

Vout/Vin = R/root(R^2+R^2)
Vout/Vin = 100/(100^2+100^2)
Vout/Vin = 0,707

Both outcomes give Vout/Vin = 0,707

5 Inductance and Inductors

5.1
I through an inductor which is suddenly cut off

A magnetic field is created during the charging time of an inductor. When turning the power off, the magnetic energy will flow through the components. If the energy is too high, the components get damaged.

5.2
Isource = 100mA
L = 1mH

Emagnetic = 0,5 x LI^2 = 50 x 10^-6 J

The energy stored is 50 x 10^-6 Joule

5.3
Zl(w) = wL = 2pi x fL

According to the formula, When the frequency increases, the value of Zl will also increase. When the frequency decreases, the value of Zl will also decrease

When f increases, Zl increases
When f decreases, Zl decreases

5.4
L1 = 0,33 mH
L2 = 68 uH
L3 = 12 mH

The inductors are in parallel, so Lre will be smaller than the smallest inductor. According to this, Lre < 68 uH

The correct answer is 2. Lre < 68 uH

5.5
L1 = 2mH
L2 = 3mH
L3 = 250 uH
L4 = 750 uH
L5 = 1 mH

Lre = L1 + Le1 + Le2
L1 = 2 x 10^-3
Le1 = 1/(1/3mH+1/3mH) = 7,5 x 10^-4
Le2 = L3 + Le1 = 250 mH + 7,4 x 10^-4
Le2 = 1 x 10^-3
Lre = 2 x 10^-3 + 7,5 x 10^-4 + 1 x 10^-3
Lre = 3,75 mH

The equivalent inductance is 3,75 mH

5.6
Filter drawn is high or low pass.

If f is small, Zl will be small. This results that Vout will be low, which means that the low frequencies are filtered.

The filter is a high-pass filter.

5.7
The high-pass filter of question 5.6

When intercharging the inductors with the resistors, you will get a low-pass filter.
Vout(w) = R/Zre x Vin(w)
Vout(w) = R/(root(R^2 + w^2 x L^2)) x Vin(w)

When intercharging, you get a low-pass filter.

5.8
Vin1 = 100 kHz
Vin2 = 0 Hz
Vin3 = approaching infinity

I = Vin/Zre = Vin/(root(R^2 x 2l^2))
Zl(w) = wL = 2pi x fL
(see next page)

1. I = 8,5 mA
2. I = 10 mA
3. I = approaching 0

f = 100 kHz and Zl = 628 Ω --> I = 8,5 mA
f = 0Hz and Zl = 0 Ω --> I = 10mA
f = infinite and Zl = infinite Ω --> I = 0

5.9
Pprimary = Psecondary

Pprimary = P secondary
Pprimary = Vp x Ip
Pseoncary = Vs x Is
Vp x Ip = Vs x Is

Ideal transformer has no lost of current and voltage, which results in no loss of energy. For this, you need an effectiveness of 100%, which is non realistic.

6 Kirchoff's Law

<u>6.1</u>

Vbattery = 12V
R1 = 400 Ω
R2 = 290 Ω
I1 - I2 = 0

(Va-Vb)/R1 - (Vb-0)/R2 = 0
(12-Vb)/400 - (Vb-0)/290 = 0
(290(12-Vb))/400 - (400Vb)/290 = 0
(290(12-Vb)-400Vb)/116000 = 0
290(12-Vb)-400Vb = 0
3840 - 290Vb - 400Vb = 0
3840 - 690Vb = -
690Vb = 3840
Vb = 3840/690 = 5,04 V

The potential for node B according to the KCL method equals 5,04 V

<u>6.2</u>

Loops within picture 6.2

The whole system can be seen as a loop

Vb-R1-R3-R4-Vb is also a loop

<u>6.3</u>

Vbattery = 12V
R1 = 400 Ω
R2 = 290 Ω

VR1 + VR2 - VB = 0
I1 x R2 + (I1-I2) x R2-Vb = 0
VR3 + VR4 - VR2 = 0
I2 x R3 + I2 X R4 + (I2-I1) x R2 = 0

<u>6.4</u>

Vb = 9V
V1 = 3,7 V
Apply KVL to all loops
V2 = ?
V4 = 1,3 V, V3 = ?

V1+V2-Vb = 0
V3+V4-V2 = 0
V1+V3+V4-Vb = 0
V1 + V2 - Vb = 3,7 + V2-9 = 0
V2 =9 - 3,7 = 5,3 V
V1+V3+V4-Vb = 3,7+V3+1,3-9 = 0
V3 = 9-3,7-1,3 = 4V
3,7 + 5,3 - 9 = 0

V2 = 5,3 V
V3 = 4V
3,7 + 5,3 - 9 = o

<u>6.5</u>

Vbattery1 = 10 V
Vbattery2 = 5 V
R1 = 2 kΩ
R2 = 500 Ω
R3 = 2 kΩ

IR1 = Va - Vb / R1 = 10 - Vb / 2000
IR2 = Vb - Vd / R2 = Vb - 0 / 500
IR3 = Vc - Vb / R3 = 5 - Vb / 2000
IR1 - IR1 + IR3 = 0
(10 - Vb / 2000) - (Vb / 500) + (5 - Vb / 2000)
= 0 = 15/2000 - (6/2000 x Vb)
Vb = 2,5 V
2000 x I1 + 500 x (I1 + I2) – 10 = 0
2000 x I2 + 500 x (I1 + I2) – 5 = 0
I1 = 3,75 mA & I2 = 1,25 mA
Vab = I1 x R1 = 0,00375 x 2000 = 7,5 V
Vcb = I2 x R3 = 0,00125 x 2000 = 2,5 V
Vb = Vbattery1 – Vab = 10 – 7,5 = 2,5 V

For both KCL and KVL Vb equals 2,5 V

7.1

Vin, R1, and R2 in a circuit

Voc = R2/(R1+R2) x Vin
I1 = V/R1
Isc = Vin/R1
R2 = 0
Rt = Rn = Voc/Isc
Rn = ((R2/(R1+R2)xVin)/(Vin/R1)
Voc = Rt x Isc

1. Voc = R2/(R1+R2) x Vin
2. Isc = Vin/R1
3. Rn = ((R2/(R1+R2)xVin)/(Vin/R1)
4. Voc = Rt x Isc

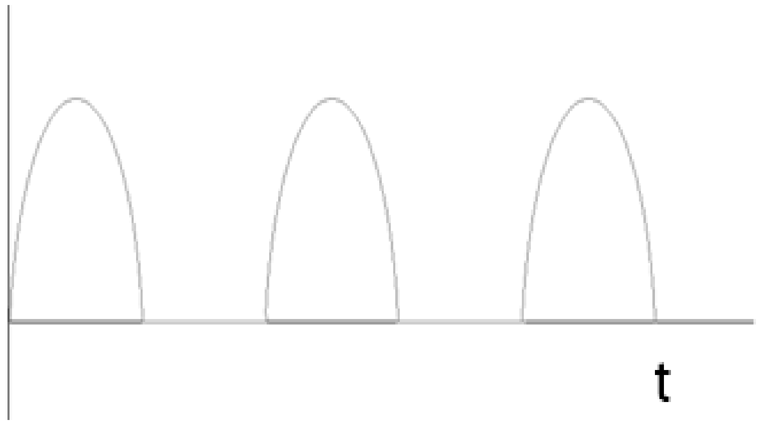
7.2

Vin = 10V
R1 = 1 kΩ
R2 = 1 kΩ
R3 = 1 kΩ
R4 = 1 kΩ

Voc = R3/(R1+R2+R4)xVin
Voc = 1000/3000 x 10 = 3,3 V
Rre = R1 + 1/(1/R2+1/R3) + R4
Rre = 1000 + 1/(1/1000 + 1/1000) + 1000
Rre = 2500 Ω
Isc = Vin/(R1+R2+R4) = 10/3000 = 3,3 mA
Rt = Voc/Isc = 3,3/3,3 = 1000 Ω = 1 kΩ

Voc = 3,3 V
Rt = 1 kΩ

8.1
Circuit given with Vin, R, and Vout



8.2
Vin = 9V
VLED = 2V
I = 15mA

V = 9 – 2 = 7 V
R = V / I = 7 / 0,015 = 466.67 = 470 Ω

A good value for R will be 470 Ω

9.1
Circuit of question 9.1

The potential difference between the emitter and base must be negative, due to the PNP transistor. When the output voltage of the subcircuit is 5V, the potential difference is 0V, so the lamp is not switched on. When the output voltage of the subcircuit is 0V, the potential difference is -5V, so the lamp will switch on.

To switch the lamp on, we need the output voltage to be 0V.

9.2
V = L(dl/dt)
L = 1mH
dl = 100mA
dt = 1us

V = L(dl/dt) = 1mh x (100/1) = 100V
BC550 can handle 45 V
2N3439 can handle 350 V
BC618 can handle 55 V

A small current can lead to a high potential difference according to the calculation. Due to this, the 2N3439 should be used.

9.3
NPN transistor

The potential difference of the bas-emitter should be possitive for a NPN transistor.
0,6 + 0,6 = 1,2 V

Two transistors are connected, so 1,2 V are needed to conduct.

9.4
Ic = Beta x Ib

Beta = Ib/Ic = 200/0,4 = 500
2N3773 = 24mA
BD139 = 100mA
BC618 = 20000mA
Vneeded = Vxhigh - Vbe = 5V - 1,6V = 3,4V
R= V/I = 3,4/0,4 = 8,5 kΩ

The resistor BC618 is best to fulfill the requirements according to this calculation.
Rb should be 8,5 kΩ

10.1
Figure 10.4

Vin = I x R1
Vout = 1 + I x R2
Vout = 1+(R2/R1)xVin

10.2
Why kΩ instead of Ω

The current will be very high and the change to damage the circuit is also high when using a resistor with low resistance. Due to this, a resistor with a high resistance is used.

10.3
When Vin is higher than the supply voltage

The output voltage will never become higher than the supplied voltage. When the input voltage is higher than the supplied voltage, the output will be clipped.

2
Calculate Rretotal, I1, I2, I3, I4, and Vout
R2, R3, and R4,5 are in parallel
R1, R6, R4 and R5 are in series

1/Rre = 1/((1/R2)+(1/R3)+(1/R4,5))
Rre = 2 kΩ
Rretotal = R1 + R6 + Rre = 2,2 + 3,3 + 2
Rretotal = 7,5kΩ
I1 = Vin/Rretotal = 10/7,5 = 1,3mA
I2 = V2/R1 = 2,7/10 = 0,27mA
I3 = V2/R3 = 2,7/4,7 = 0,57mA
I4 = V2/(R3+R5) = 2,7/5,5 = 0,49mA
Vout = (I1xR6)+(I4xR5) = 6V

Rretotal = 7,5 kΩ
I1 = 1,3 mA
I2 = 0,27 mA
I3 = 0,57 mA
I4 = 0,49 mA
Vout = 6V

3
Measurement I1 = 0,130 mA
Measurement I2 = 0,268 mA
Measurement I3 = 0,568 mA
Measurement I4 = 0,488 mA
Measurement Vout = 6,02 V

4
Resistance value between knob A and B is 11kΩ at the maximum

5
R4 and R5 are replaced by a potmeter and the knob is adjusted to 5V

6
Measurement A, C = 8,12 kΩ
Measurement B, C = 3,18 kΩ

7
R4 = 8,12 KΩ
R5 = 3,18 kΩ

Rre2 = R4+R5 = 8,12+3,18 = 11,30 kΩ
Rre = 1/((1/R2)+(1/R3)+(1/Rre2))
Rre = 2,5 kΩ
Rretotal = R1+Rre2+R6 = 2,2+2,5+3,3 = 8 kΩ
I = V/R
I1 = Vin/Rretotal = 10/8 = 1,25mA
Vre = 0,00125 x 2,5 = 3,125 V
I4 = Vre/Rre2 = 3,125/1 = 0,28mA
Vout = I1xR6+I4XR5
Vout = 0,2x10^3x3100+1,25x10^3x3300 = 5V

Vout equals 5V by calculation

2
All three give Vout 0,4V

3
Measurement 100Hz gives 0,12V
Measurement 1kHz gives 0,89V
Measurement at 100kHz gives 2V

Zc(w)=1/(2pi x 100 x 1 x 10^7) = 15,9 kΩ
Vout =1000/(root(1000^2+159000^2))
x2=0,126V
Zc(w)=1/(2pi x 1000 x 1 x 10^7) = 1,6 kΩ
Vout =1000/(root(1000^2+1600^2))x2=1,06V
Zc(w)=1/(2pi x 100000 x 1 x 10^7) = 0,016 kΩ
Vout =1000/(root(1000^2+16^2))x2=2V

100Hz gives Vout 0,126 V
1kHz gives Vout 1,06 V
100kHz gives Vout 2V

The higher the frequency, the higher Vout

4
Measurement 100Hz gives 2V
Measurement 1kHz gives 1,43V
Measurement 100kHz gives 0,1V

5
fc = 1/(2pi x Rc)
R = 1000
c = 1 x 10^-7

fc = 1/(2pi x 1000 x 1 x 10^-7) = 1,6 kHz

6
The voltage drops when approaching zero when the frequency gets higher. This means that the filter is a low-pass filter.

The order in which you chose the resistor and capacitor, determines whether it is a low-pass or a high-pass filter.

Practical Assignment 3

1
The KVL method is used

I1 = Vr1 + Vr2 – Vbat1 = 0
Ir1 x Rr1 + (I1 + I2) R2 – 10 = 0
2200Ir1 + 470Ir1 + 470Ir2 = 10
I2 =Vr3 + Vr2 + Vr4 – Vbat2 = 0
Ir3 x Rr3 + (Ir2 +I2) Rr2 + Ir4 x Rr4 – Vbat2 = 0
2200Ir2 + 470Ir2 + 470Ir1 + 5600Ir2 = 5
8270Ir2 + 470Ir1 = 5
Ir1 = (5 – 8270Ir2)/470
Ir1 = 0,011 – 17,6Ir2
2670 x (0,011 – 17,6Ir2) + 470Ir2 = 10
-28,40 + 46,99Ir2 – 470Ir2 = -10
46522I2 = 18,40
Ir2 = 0,4mA
Ir1 = 2670Ir1 + 470 x 0,0004 = 10
Ir1 = 3,7 mA

3
Measurement of V1 gives 7,83 V
Measurement of V2 gives 1,863 V
Measurement of V3 gives 0,894 V
Measurement of V4 gives 2,274 V

4
Measurement of V1 gives 7,83 V
Measurement of V2 gives 1,863 V
Measurement of V3 gives 0,894 V
Measurement of V4 gives 2,274 V

Calculation of V1 gives 8,14 V
Calculation of V2 gives 1,927 V
Calculation of V3 gives 0,88 V
Calculation of V4 gives 2,24 V

We noticed a difference within the total amount of the calculated outcomes versus the measured outcomes. We asume this has something to do with R2, but we can not tell exactly why there is a difference.

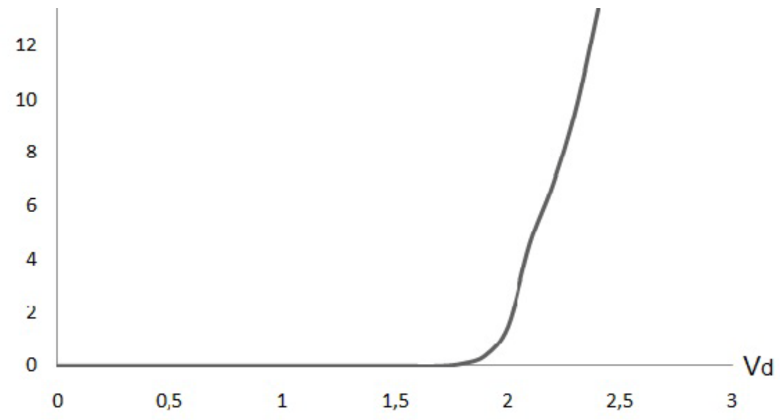
1

a 100 Ω resistor is used. The function generated is used at a frequence of 1kHz and an amplitude of 2Vrms.
The input is connected to the output of the 50 Ω output of the function generator.

Vout is measured at 1,395 V
Vout = R/(R+Zout)xVin
Zout = (RxVin)/Vout -R
Zout = 400/1,395 - 100 = 43 Ω

The output resistance of the function generator has a value of 43,37 Ω

Vd 0,0 = Id 0,0
Vd 0,1 = Id 0,0
Vd 0,2 = Id 0,0
Vd 0,3 = Id 0,0
Vd 0,4 = Id 0,0
Vd 0,5 = Id 0,0
Vd 0,6 = Id 0,0
Vd 0,7 = Id 0,0
Vd 0,8 = Id 0,0
Vd 0,9 = Id 0,0
Vd 1,0 = Id 0,0
Vd 1,1 = Id 0,0
Vd 1,2 = Id 0,0
Vd 1,3 = Id 0,0
Vd 1,4 = Id 0,0
Vd 1,5 = Id 0,0
Vd 1,6 = Id 0,0
Vd 1,7 = Id 0,0
Vd 1,8 = Id 0,09
Vd 1,9 = Id 0,41
Vd 2,0 = Id 1,45
Vd 2,1 = Id 4,69
Vd 2,2 = Id 6,93
Vd 2,3 = Id 9,55
Vd 2,4 = Id 13,4



The LED started to conduct at 1,8 voltage and it started to shine brighter very fast after this point. This is how we determined the knee voltage.

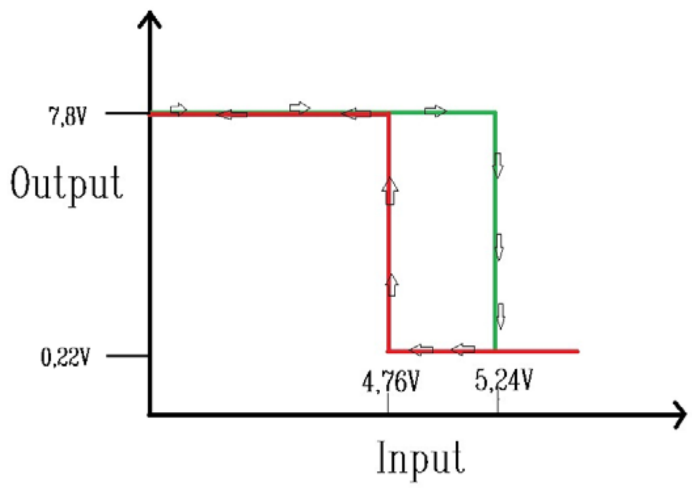
Rb	Ic	Vce	Vbe
100 kΩ	24 mA	3,758 V	0,705 V
10 kΩ	43 mA	1,460 V	0,775 V
4,7 kΩ	48 mA	0,662 V	0,801 V
2,2 kΩ	51 mA	0,233 V	0,819 V
1 kΩ	51 mA	0,170 V	0,822 V
0,47 kΩ	51 mA	0,165 V	0,824 V

Vce becomes close to 0 V when saturation is reached. Because an ideal switch has no potential difference and Vbe is abote te saturation point, it becomes close to 0V.
Vbe becomes bigger when the resistors get smaller. This is due to the formula Vbe = (Ib+Ic) x Rbe. If Ib increases, the potential difference becomes bigger as well.

2
Vin = ((R2xR3)/(R2+R3))/(R2+((R2xR3)/
(R1+R3))) x Vout = 9090,909/19090,9 x 10
Vin = 4,76 V
Vin = R2/((R1+((R1xR30/(R1+R3))) x Vout =
10000/19090,9 x 10
Vin = 5,24 V

Vin = 4,76 V
Vin = 5,24 V

3



Building Block 1

$V_{in} = 12V$
$0V =< V_{out} =< (V_{in} - 2V)$

$R1 = V/I = 12/0,5 = 2,4\ k\Omega$

$V_{out} = 12V - 2V = 10V$

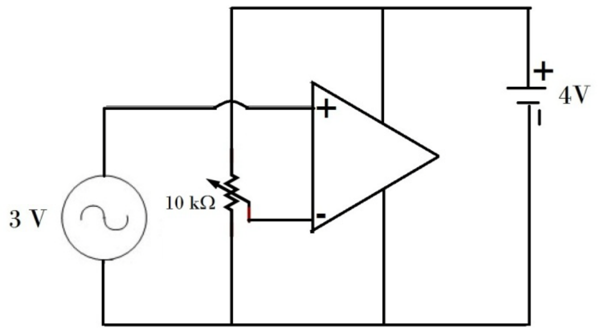
$V_{out}/V_{in} = R2/(R2+R1)$
$R2 = V_{out}/V_{in} \times R2+R1 = 10/12 \times R2 + 2,4k\Omega$
$R2 \times 0,167 = 2,4\ k\Omega$
$R2 = 14,38\ k\Omega$

$I_{max} = V/R1 = 12/2,4 = 5mA$
$I_{min} = V/R2 = 12/14,38 = 0,8mA$

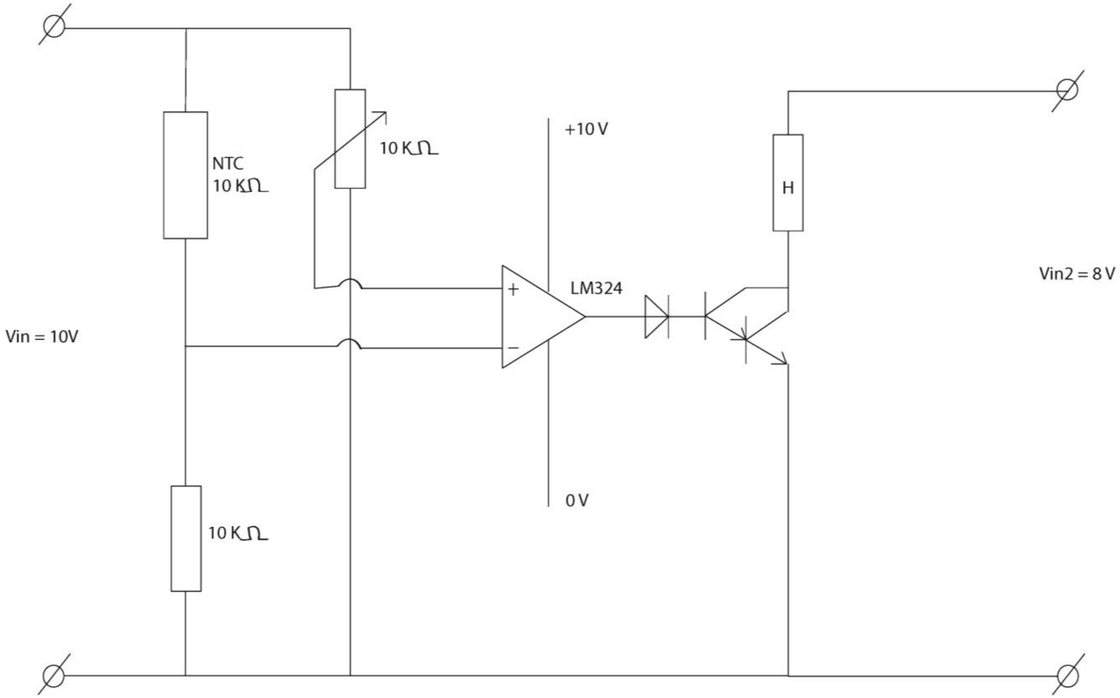
The resistor of R1 should be 2,4 kΩ.
The potmeter needs a resistance of at least 5kΩ
For this circuit, we used a potmeter of 20kΩ.

Building Block 3

We used a potential meter of 10kΩ, an opamp LM324, a power source of 4V from the power supply, and the function generator power source with Vpeak 3V.
When we adjust the potentiometer, the pulse width can be modulated.



Building Block 4



Vin2 = P / I = 4W / 0,5A = 8V

The Opamp compares two values; the reference setting and the sensor value. When comparing these values, the output voltage equals the positive supply voltage. In the other case, the output voltage is equal to the negative supply. The power resistor will be triggered when the NTC has a higher resistance value than the potmeter (creating a threshold). The output value of the Opamp will turn 0V when the desired temperature is reached. Due to this, the power resistor turns off. This turning on and off will repeat itself.

Final reflection Marlou van der Lee

My intention with this assignment was to learn the basics of electronics and how to build simple circuits and do calculations. During my projects, I did a lot of mechanics, but almost no electronics. Due to the fact that I want to become able to build more complex prototypes, I took this assignment.

I experienced difficulties when making the questions and doing the building blocks because I had almost no experience with building circuits or doing calculations untill this assignment. In addition, it was a lot of information and tasks within the short amount of time that the assignment provided. I need more time to understand and learn theoratical information such as provided in this assignment than an average student. Next to my project and other assignment, I did not have enough time to study everything as deep as I would like to. However, this assignment triggered me to learn more about electronics and to practice more by using electronics within my project next semester.

The hardest part for me, was to ‘understand’ what I am doing, instead of just filling in the formulas that are given. The practical assignments took a lot of time, but were of great value when trying to understand how electronics work.

Realisticly, I think this assignment gave me a good basic understanding of electronics and their posibilities. However, I need to invest more time to learn how I can implement the gained knowledge in a more complex way within my prototypes. In addition, this assignment learned me that the best way to learn, is doing practical assignments and building blocks. Due to this, I want to spend more time to the electrical part of prototyping within my next project in order to gain more knowledge and to explore new posibilities.

Final reflection Luke Alexander Josef Vink

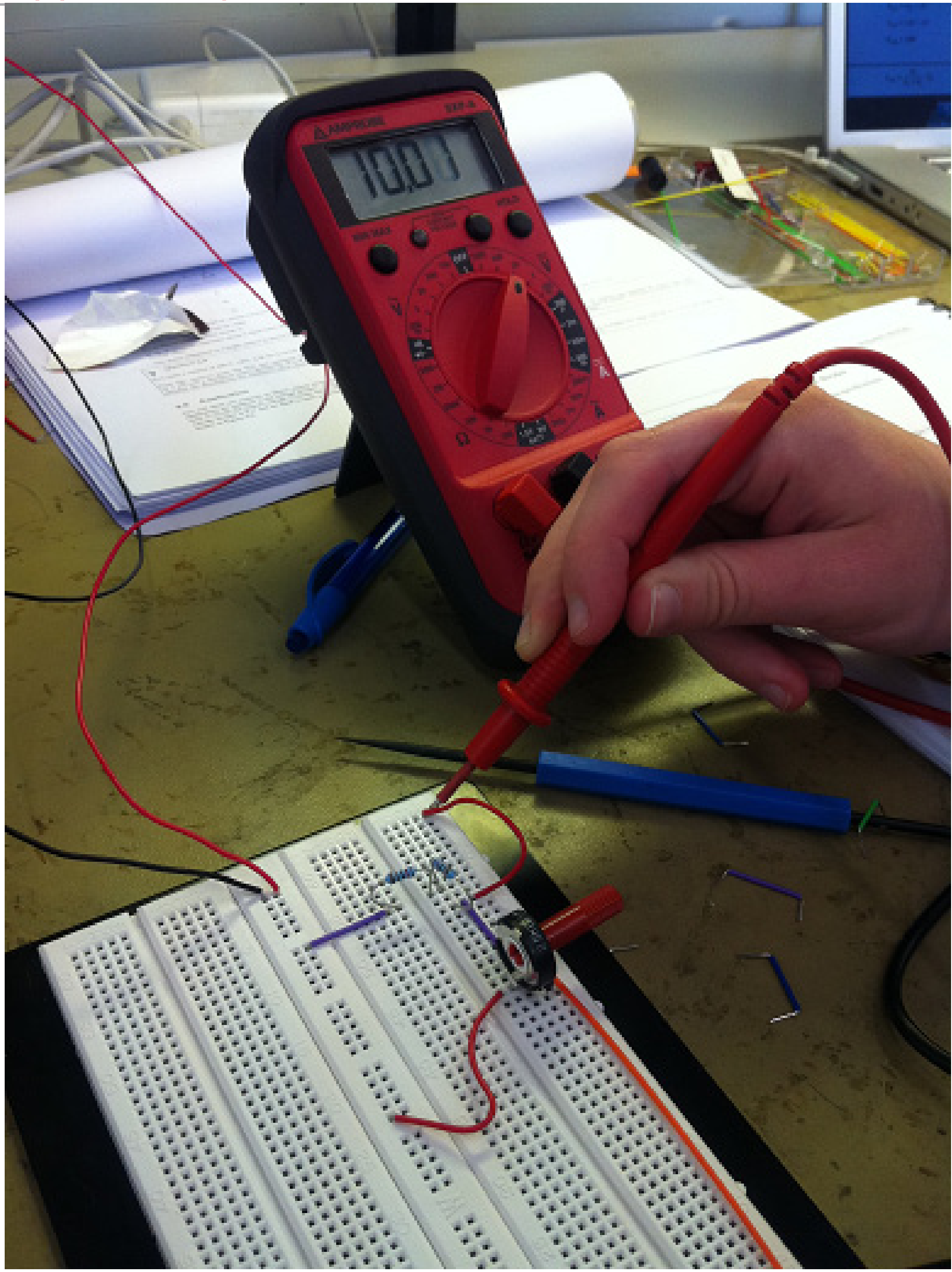
I took this assignment as a challenge for myself, as a logical next step and with the intention of solidifying my knowledge of electronics. I have built quite a few electronic projects so far without much knowledge of what is going on, and how to prevent issues and so on. This assignment for me was an opportunity to learn to better design circuits and know without needing to ask.

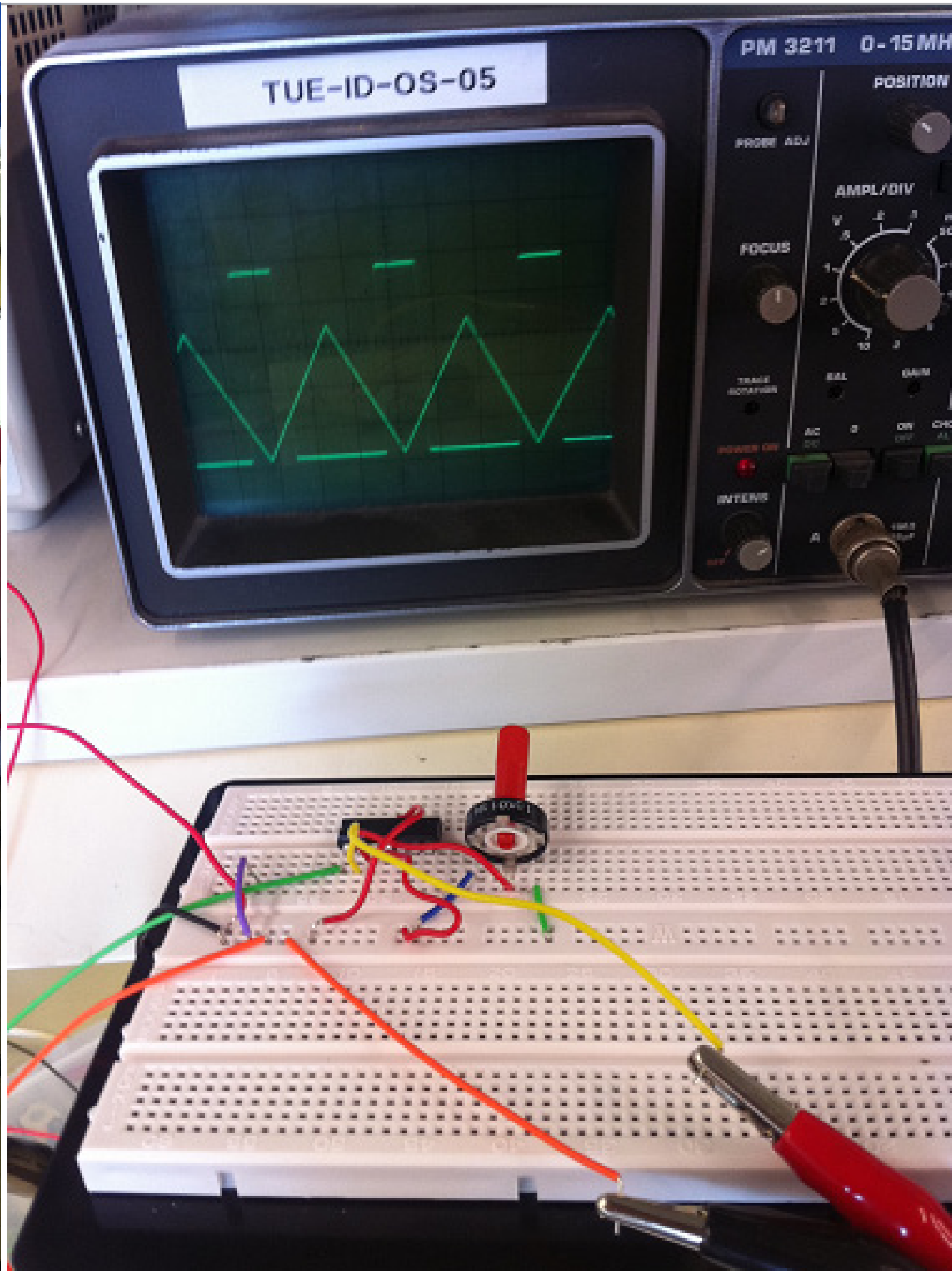
As it turns out, the assignment was for me, an overload of information in a short amount of time, some things of course I would never really use, others which I feel are extremely valuable, such as the section on transistors, op-amps and the section explaining voltage dividers and their extensive use throughout the assignment.

While I feel I am not quite as competent in mathematics, and thus the calculations were difficult, I feel with a little more time I could have very much grasped the assignment. Nevertheless, I had many realizations throughout the lectures about my own projects, discovered why things had gone wrong and thus I feel I very much developed my understanding of introducing electronics. I feel I learned the most as I went through and checked my calculations with others who had also done the assignment.

Had I the chance to redo this assignment, I might perhaps apply more time to really grasping each topic as it came along however ideal as it is, and this would have been very difficult under my current circumstances. I hope to use the knowledge I have gained in all of my future projects, this already beginning this semester, as I needed to build a motor control circuit for my project, in which I remembered to add resistance to protect the motor.

Overall despite the difficulties I had, I am very glad I had this assignment, and even happier about the teachers approach, which was beyond helpful and understanding.

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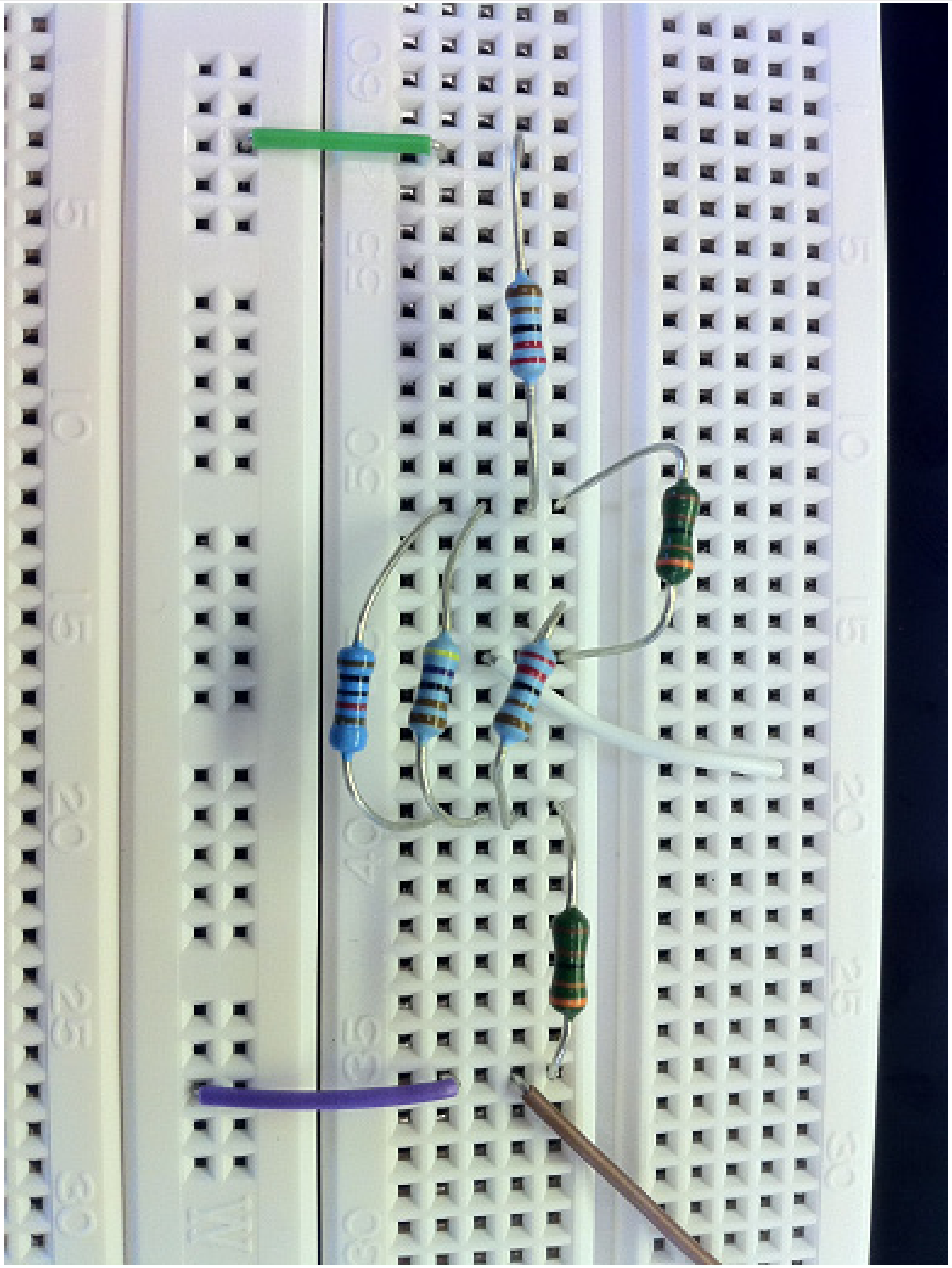

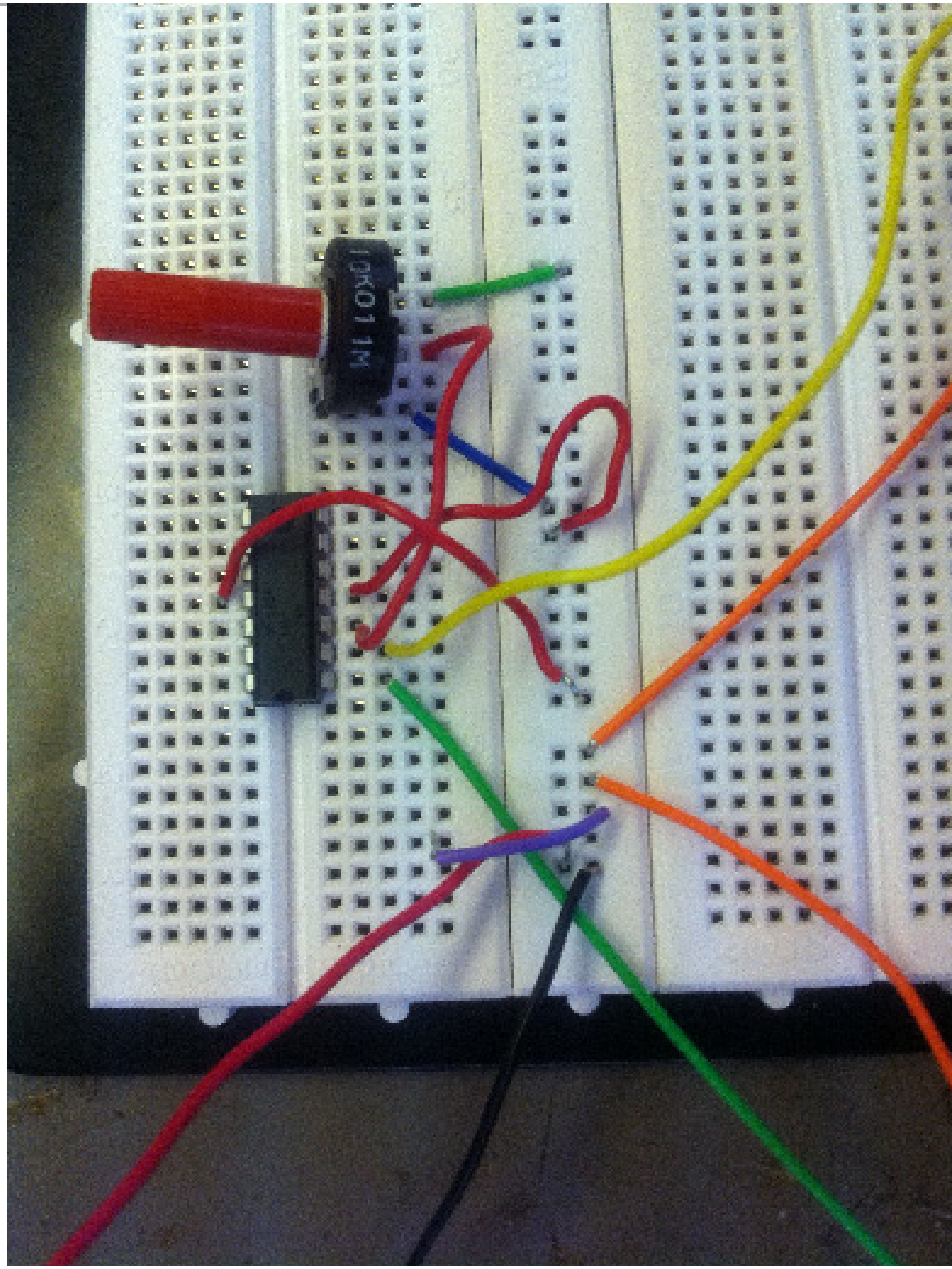

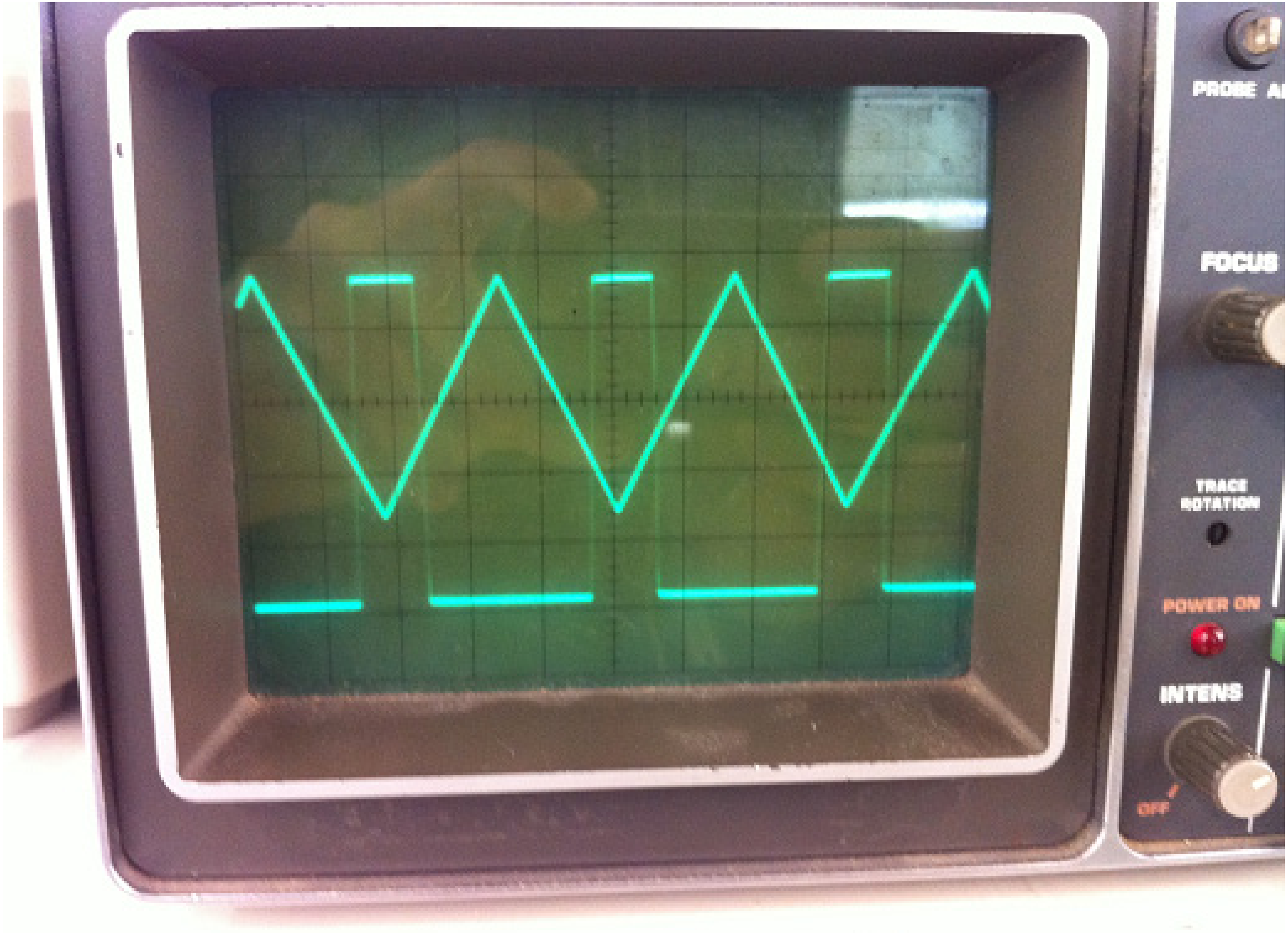
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