EE230: Experiment 9
How Dark Is Dark

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1 Overview of the experiment

1.1 Aim of the experiment

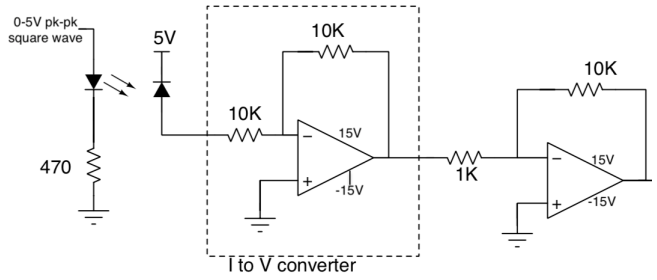
The aim of this experiment is to differentiate between different contrast of black color in print out and then determining whether cartillage needs to be changed.
Using the principle of phase detection to remove the noise in it produced by ambient light

1.2 Methods

We know that the reflectance is different for black, grey and white colors, so the photo current value will be also different if LED shines light on the target surface and the reflected light is detected by the photodiode. But it will have a lot of noise, thus to remove noise we use PSD.

2 Experimental results

2.1 I-V converter/ amplifier circuits



circuit for I-V converter

V	Vg(black reflector)	Vg(no reflecter)
0	0.18	0.89
2	0.27	0.98
3	0.4	1.2
5	0.76	1.51

Table:No white light

V	Vg(black reflector)	Vg(no reflecter)
0	0.21	0.85
2	0.30	1.0
3	0.46	1.3
5	0.83	1.82

Table:With white light

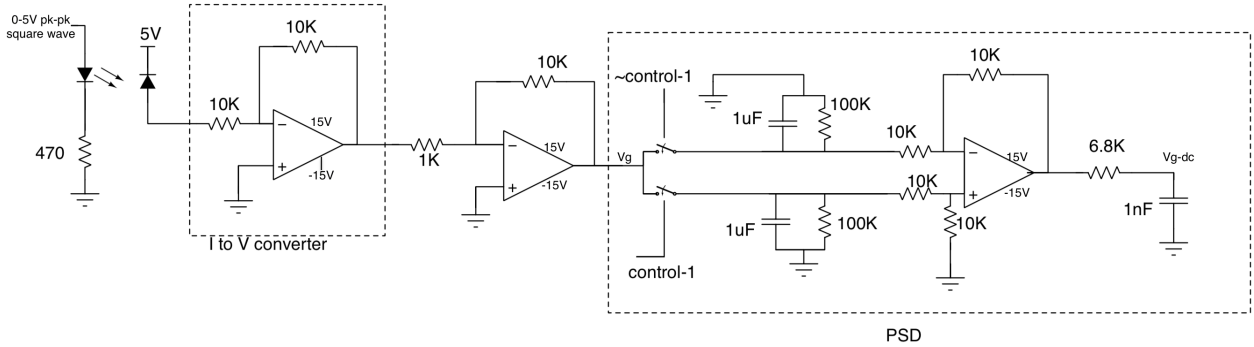
V	Vg(black reflector)	Vg(no reflecter)
0	0.36	1.47
2	0.44	1.56
3	0.6	1.69
5	0.93	2.04

Table:With white light(Max brightness)

We can easily see thatV_g is high if there is no reflector as more surrounding light enters the photo-diode plate.As black surface absorbs most of the light

therefore V_g for black surface will be less as less reflected light will fall on photo-diode.
If there is an additional light source then more light will be reflected from the surface so moreV_g . Even if there is no surface then also some light will directly fall on the photodiode surface and hence increase the V_g . We can also see that the V_g increases as the brightness of white light increases.

2.2 Using the PSD circuit

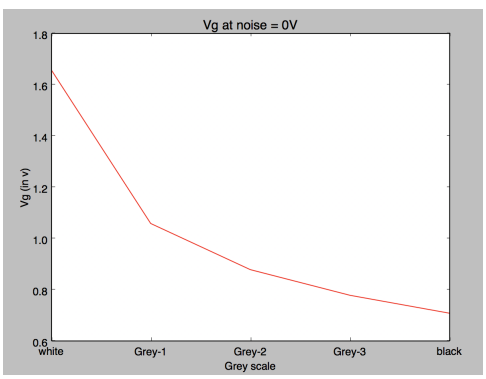


Circuit after adding PSD

Vamp	Vg	Vdc
5	1.34	0.68
4	0.95	0.55
3.5	0.78	0.44
3	0.57	0.34
2.5	0.39	0.22

Table:Measurement of Vg and Vdc for different pk-pk voltage to LED

We can see that V_{dc} is less than V_g and some noise gets cancelled.We can also see that we can safely operate till $V = 2.5V$.
Plot the graph of Vg vs Grey scale and Vdc vs Grey scale in order to observe the significance of PSD.



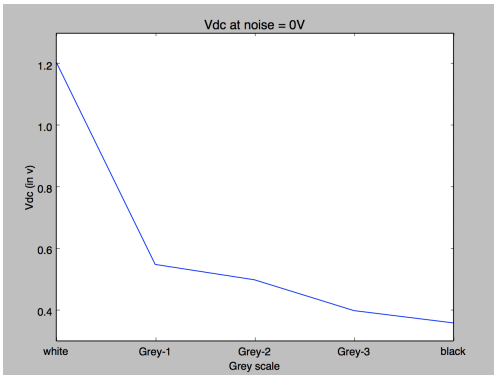


Figure 1: For noise = 0V

	noise 0	Noise 2	noise 4
white	1.66	1.65	1.93
grey1	1.06	1.04	1.17
grey2	0.88	0.87	1.01
grey3	0.78	0.75	0.91
black	0.71	0.7	0.84

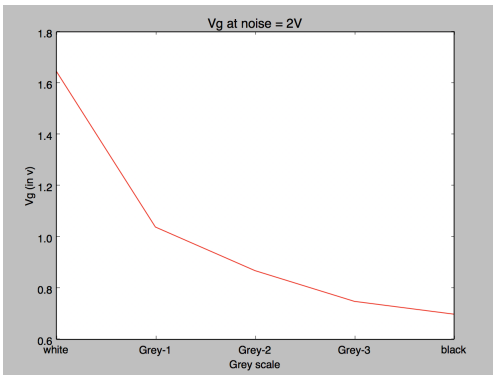
Table:Without PSD (V_g)

	noise 0	Noise 2	noise 4
white	1.21	1.21	1.22
grey1	0.55	0.56	0.55
grey2	0.5	0.52	0.5
grey3	0.4	0.47	0.4
black	0.36	0.37	0.36

Table:With PSD (V_{dc})

We can see that without Psd there is significant change in Vg value . But the change is very less if we use PSD as most of the noise gets cancelled. We can also see that the Vg is always greater than the Vdc as it contains noise also. Hence PSD is required to remove noise.

From these graph we can clearly see than Vdc and Vg behave in similar way for different grey scale. Thus Vdc can be used instead of Vg. But we prefer to use Vdc as it shows very little variation due to white light noise. Thus our reading will be more accurate if we use PSD to remove effect of



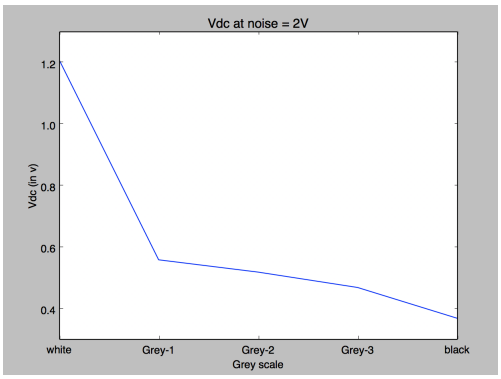
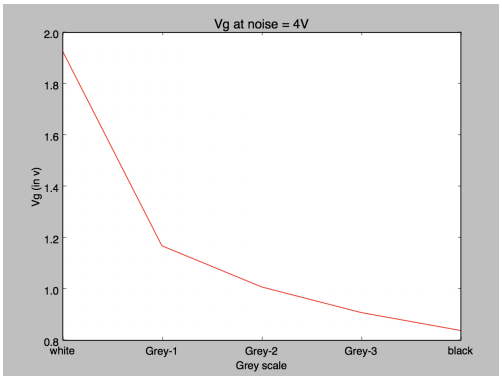


Figure 2: For noise = 2V



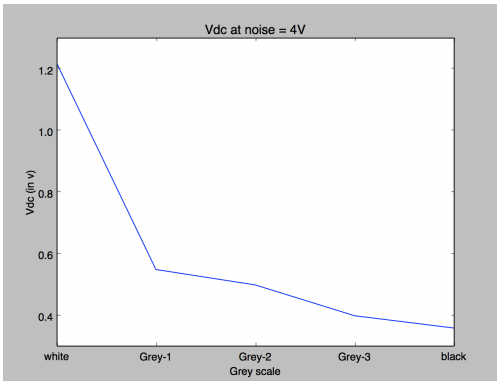


Figure 3: For noise = 4V

ambient light.

2.3 Printer Cartridge gradually running out of ink

Slots	**Light**	**middle**	**Dark**
S1	0.335	0.332	0.329
S2	0.433	0.419	0.404
S3	0.685	0.673	0.631
S4	1.363	1.129	1.125

We can see that if the paper is put close to the led then theV_{dc} is very high cam pared to when it is placed far away. we can also see clearly that the difference between dark print and light print is max when paper is close to the led.
We can conclude that if $V_{dc}$is more than 1.3 then printer is not suitable for printing as the print is very light.