# EE230: Experiment 9
# How Dark Is Dark

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## 1 Overview of the experiment

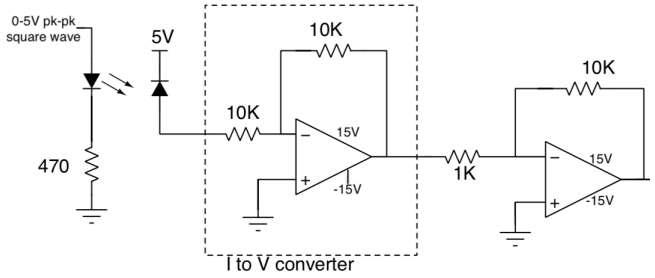
### 1.1 Aim of the experiment

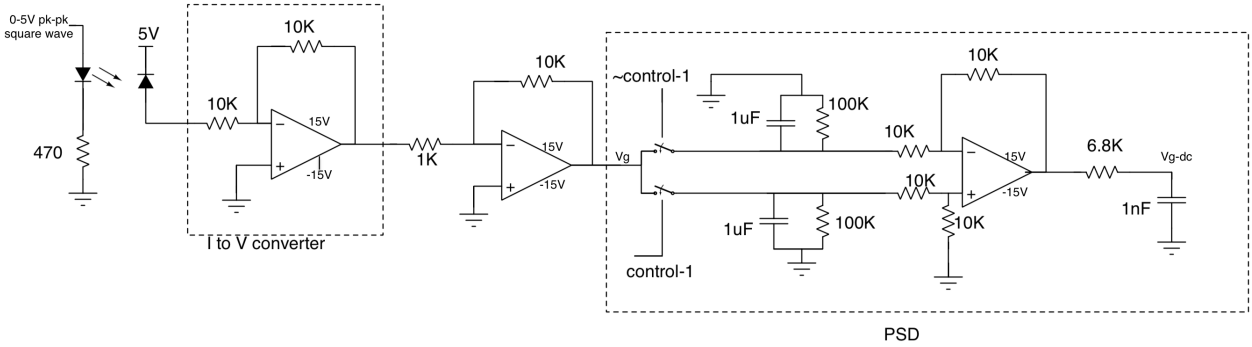
The aim of this experiment is to differentiate between different contrast of black color print out and using the principle of phase detection to remove the noise in it
We will also use

### 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




| 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 |

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 |

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 |

with white light(Max brightness)

We can easily see that$V_g$ 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 more$V_g$ . 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.

**Q. 10 With a DMM, measure the RMS voltage of the signal (Vg ) at the output of amplifier and the DC voltage after the low pass filter (Vdc ).**

**Take measurements of Vg and Vdc at 5V, 4V, 3.5 V, 3V, and 2.5 V**

| 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 |

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.**

| | 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 |

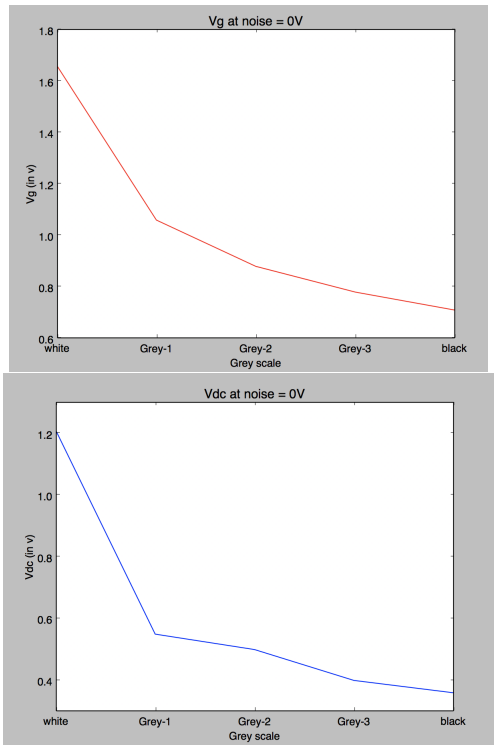
Without PSD ($V_g$)

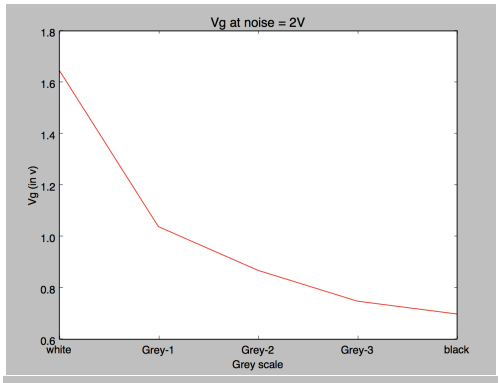
| | noise 0 | Noise 2 | noise 4 |
|---|---|---|---|
| white | 1.21 | 1.21 | 1.22 |
| grey1 | 0.55 | 0.56 | 0.55 |
| grey2 | 0.5 | 0.52 | 0.5 |
| grey3 | 0.4 | 0.47 | 0.4 |
| black | 0.36 | 0.37 | 0.36 |

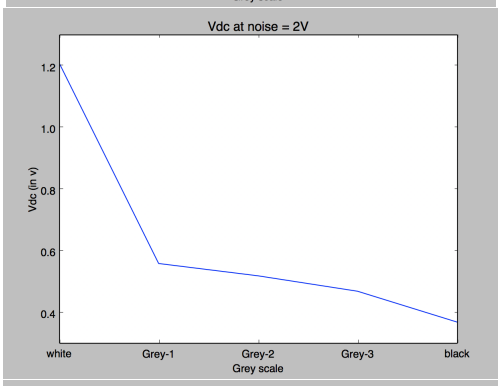
With PSD ($V_{dc}$)

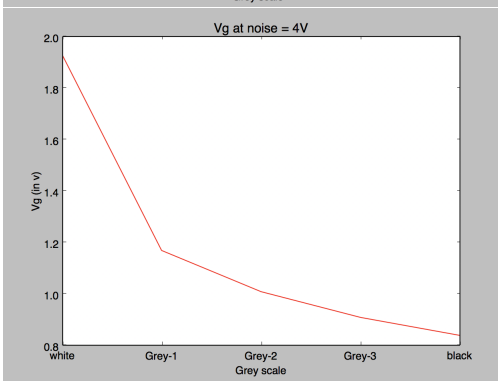
We can see that without Psd there is significant change in Vg value . But the change is very less if we use PSD as most of the noise gets cancelled. We can also see that the Vg is always greater than the Vdc as it contains noise also. Hence PSD is required to remove noise.

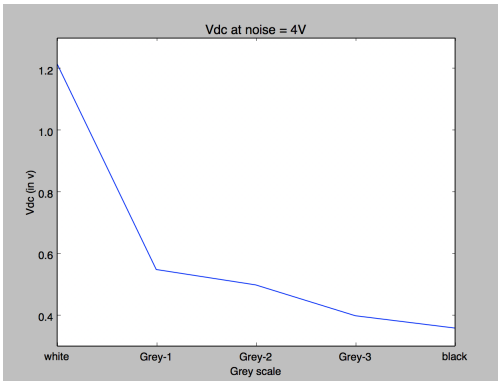
**Printer Cartridge gradually running out of ink**




Vg at noise = 2V
Vg (in v)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
white
Grey-1
Grey-2
Grey-3
black
Grey scale


Vdc at noise = 2V
Vdc (in v)
1.2
1.0
0.8
0.6
0.4
white
Grey-1
Grey-2
Grey-3
black
Grey scale


Vg at noise = 4V
Vg (in v)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
white
Grey-1
Grey-2
Grey-3
black
Grey scale




| 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 the$V_{dc}$ 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.