Semiconducor investigation

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Serial configuration

- port='COM3’,
- Baud rate=9600 bits/sec,
- Byte size=8,
- parity='N’,
- Stop bits=1,
- timeout=5

Commands used

- serial. write(Type: string, int, float) sends command to serial port, the Arduino receives it and execute
- serial. readline( ) reads the next line in the serial buffer on the computer
- <S x.xx> set voltage to x.xx volts
- <V2> read LED's voltage
- <I1> read current that passes through LED
- .encode( ) method converts utf-8 encoded strings into a series of ASCII 8-bit bytes.
- .decode(utf-8) method converts ASCII bytes into utf-8 strings

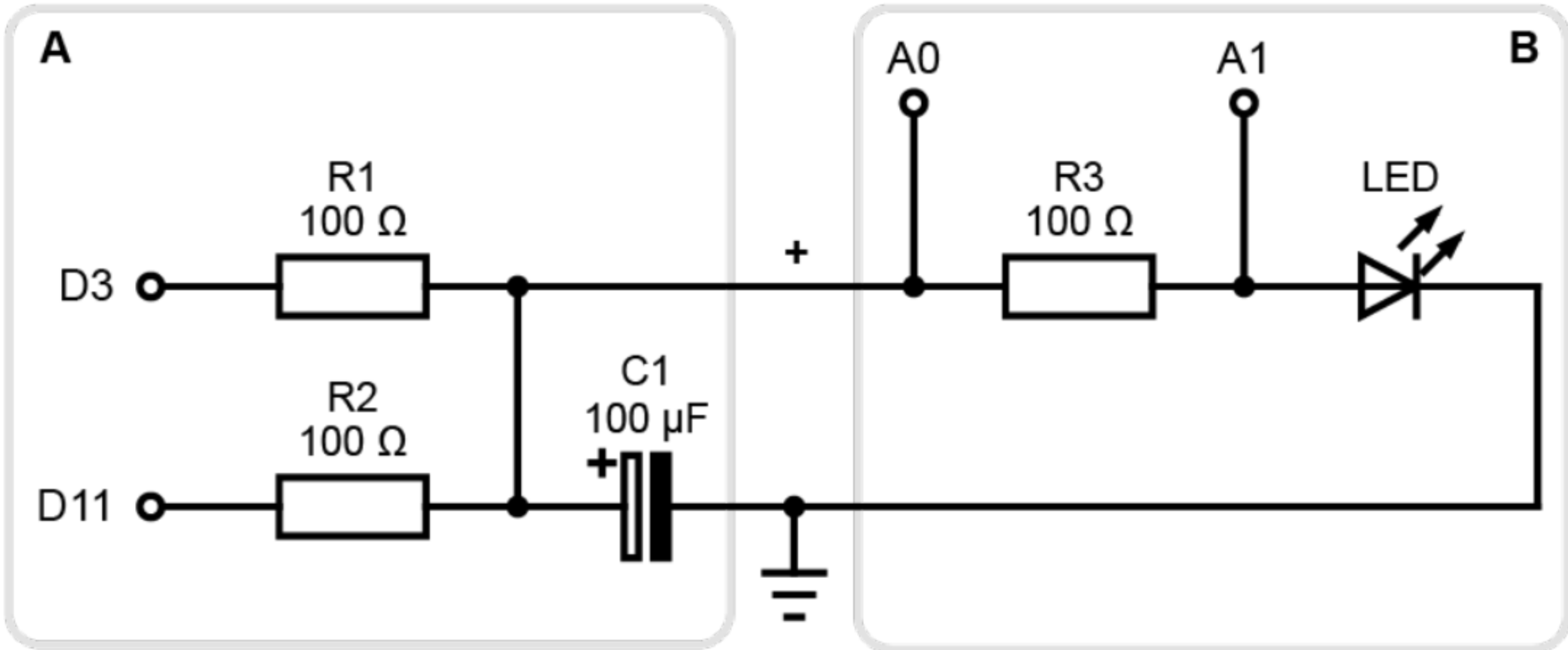


Fig. A1. Circuit used to measure the current – voltage behaviour of an LED

Run

Function that should be called once all parameters (components, serial, time delay, samples, range) are set

Repeat for each component

Input

Requires user to press enter to confirm that they have connected the correct component before the code runs

Create new directory to save all data for component

Collect data

Data collection method. Output: Text file containing data for set parameters

Open writeable text file, write parameters and date

Repeat n times between starting voltage and ending voltage, increasing the voltage V by (end-start)/n each time.

- Write to serial to set input voltage to V as defined above
- Read the serial information recieved to clear the buffer; returned set voltage is not wanted
- Time delay before the readings are taken so that the LED has time to equilibrate
- Write to serial with the commands to return voltage across and current through the component
- Read the next two lines received in the serial buffer and set the data in each line to a variable (1st is voltage, 2nd is current)
- Write a new line to the file with a column for voltage and a column for current

Analysis method

Calculates averages and standard deviations across the data for each component

Open a writeable text file, write parameters date and headers.

Open all the data files saved in the specific folder into a list

Repeat for each row in all of the files

- Open the next row of every file and add all the voltages to a list and all the currents to another list.
- Calculate the average and standard deviation for both voltage and current.
- Write each values in a separate column on a new line in the output file.

Key

- Function / object method
- Loop
- Describing an operation

Order

Read from outside to inside, top to bottom, left to right with that order of priority

Get data

Converts collumnated data in a text file to a dictionary with collumn headings as indexes with correpsonding lists of data

Opens text file containing data

Identifies the column headers and creates a dictionary of empy lists whos indexes are the column headers

Repeat for each line in file

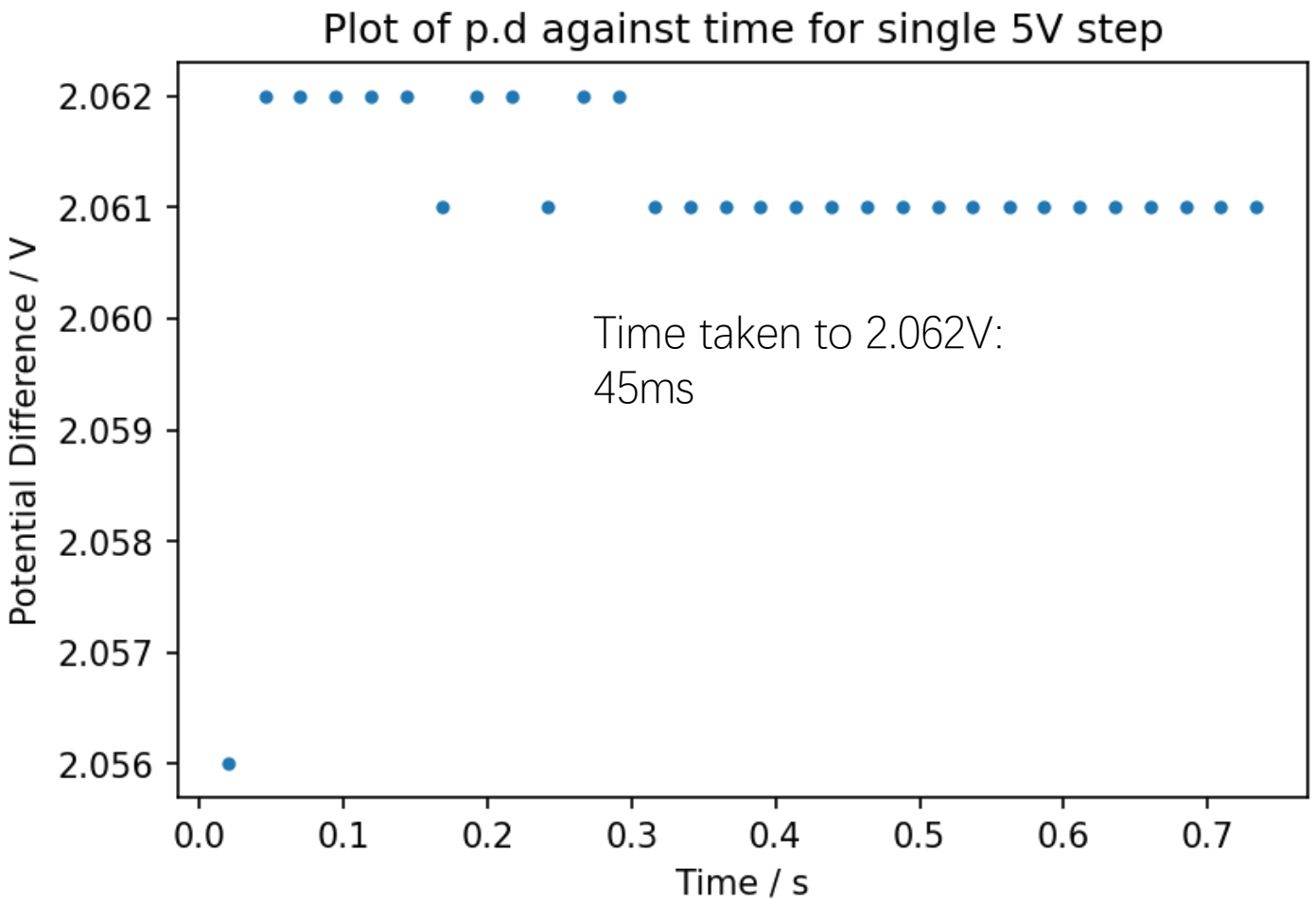
- Split the line by spaces into separate data values
- Convert data to floats and append to the corresponding list in the dictionary created above

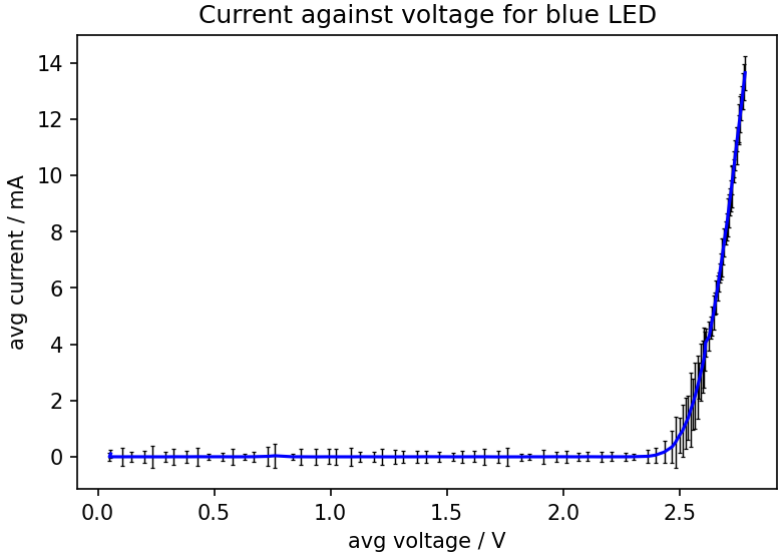
Return a dictionary containing all the data

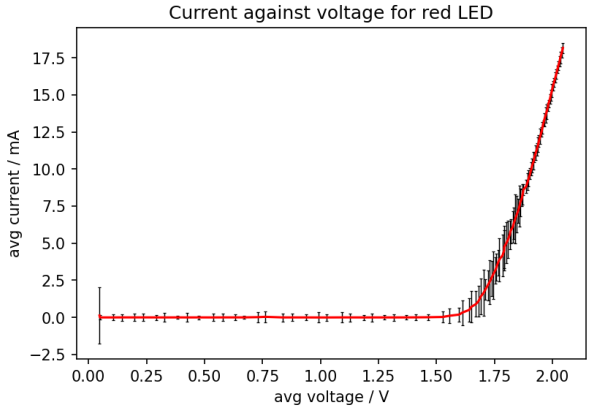
Annotated code:

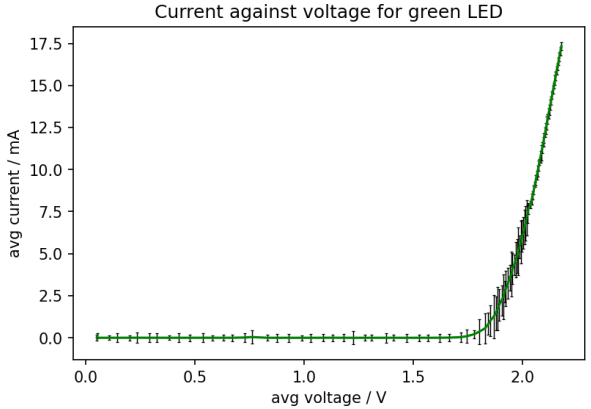
- Time to share my screen

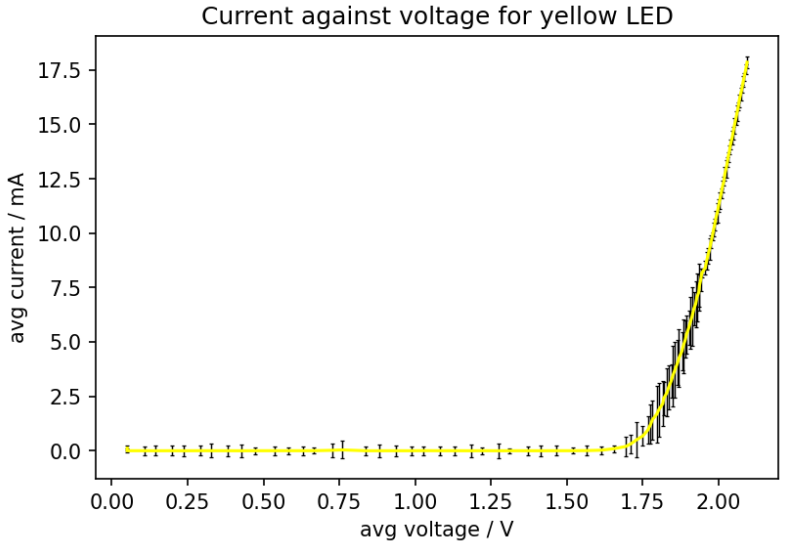
Time delay

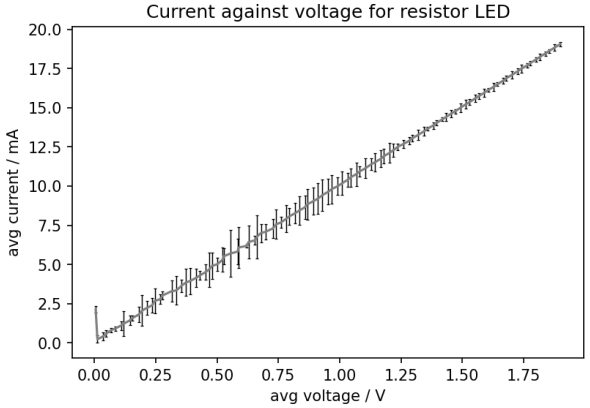

Plot of p.d against time for single 5V step
Potential Difference / V
2.062
2.061
2.060
2.059
2.058
2.057
2.056
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Time / s
Time taken to 2.062V:
45ms









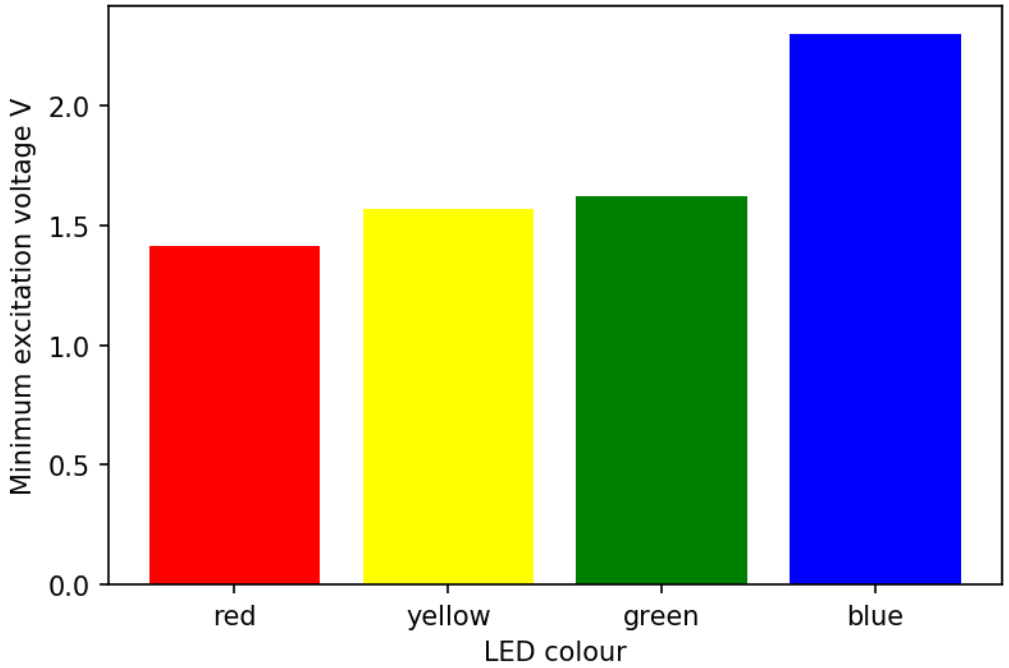


Plots

Error bars exaggerated x 50

Threshold voltage

- Red: 1.412
- Yellow: 1.567
- Green: 1.622
- Blue: 2.302



- E.g., Blue

000000000002, −0.0054, −0.0042, −0.004, −0.0021, −0.003, −0.0007, −0.0008, −0.0032, 9.999999999999991e−05, −0.0035000000000000005, −0.0022, −0.0024000000000000002, 0.0012000000000000001, 0.015200000000000002, 0.05500000000000001, 0.1665, 0.35359999999999997, 0.5088999999999999,

```
print(test_dat["avg_current"].index(0.0012000000000000001))
print(test_dat["avg_voltages"][47])
```

```
47
2.3022
```

Observations

- The current goes up at different potentials (Threshold voltage, V_T).
- Red has the smallest V_T and blue has the largest
- Due to band gap difference (blue largest, red smallest), so different excitation energy. E=hf
- Uncertainty is largest when voltage increase rapidly