Measurments:

1. Segment Current: -

we will measure the voltage drop across the current limiting resistor; then, devide it over the Resistance of that Resistor.

⇒ Resistance = 470 Ω

⇒ mesured voltage drop = 2.80V

∴ current $= \frac{2.8}{470} = 5.96$ mA

∴ Calculated current = 6.6mA

∴ deviation between them = 0.3

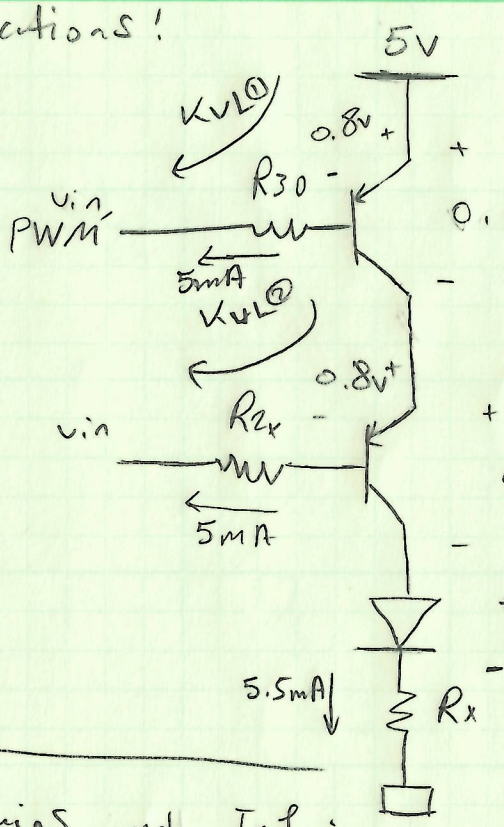
2. Duty cycle

I Programed the code with the intention to have around 22 % duty cycle for each digit, it's the program needs some time to be off taking input which counted for in the above value.

⇒ using an oscilliscope, I will be measuring the duty cycle.

⇒ measured duty cycle ≈ 24.0%

Calculations!



* We need 5.5mA per segment, so, $I_{Cmax} = 44mA$
* This value satisfies all the limitations we have
* to make sure I_B is big enough to operate the BJT in saturation, we will choose I_B to be $\Rightarrow I_B = 5mA$

Solving KVL① !-

$$R_{30} = \frac{5-0.8}{5mA} = \underline{840\Omega}$$

Solving KVL② !

$$R_{2x} = \frac{5-0.08-0.8}{5mA} = \underline{820\Omega}$$

for the current limiting Resistors, as mentioned above, 5.5mA per LED should work perfectly and satisfy all the constrains !-

$$\Rightarrow R_x = \frac{5-2(0.08)-1.72}{5.5\,mA}$$

$$R_x = 570\Omega$$

Constrains and Info:

LED!-
- Fwd voltage drop @ 5.5mA = 1.72v
- Max current = 25 mA

Atmega:
- I sink per Pin = 20mA (max)
- I sink per PORT = 100mA (max)

Decoder:
- I sink = 8 mA (max)

Transistor!-
- $V_{CE(sat)} = -0.08v$ @ $I_C \simeq 40mA$
- $V_{BE(sat)} = -0.8v$ @ $I_C \simeq 40mA$

I can't find the exact values for the Resistors so I changed them as follows!-

$R_x = 470\Omega$
$R_{2x} = 1K\Omega$

$\therefore$ new $I_{LED} = \frac{5-0.08(2)-1.72}{470}$

$\therefore I_{LED} = 6.64mA$

$\therefore$ new $I_B = \frac{4.2}{1K} = 4.2mA$

$\therefore$ This still satisfy the constrains ✓

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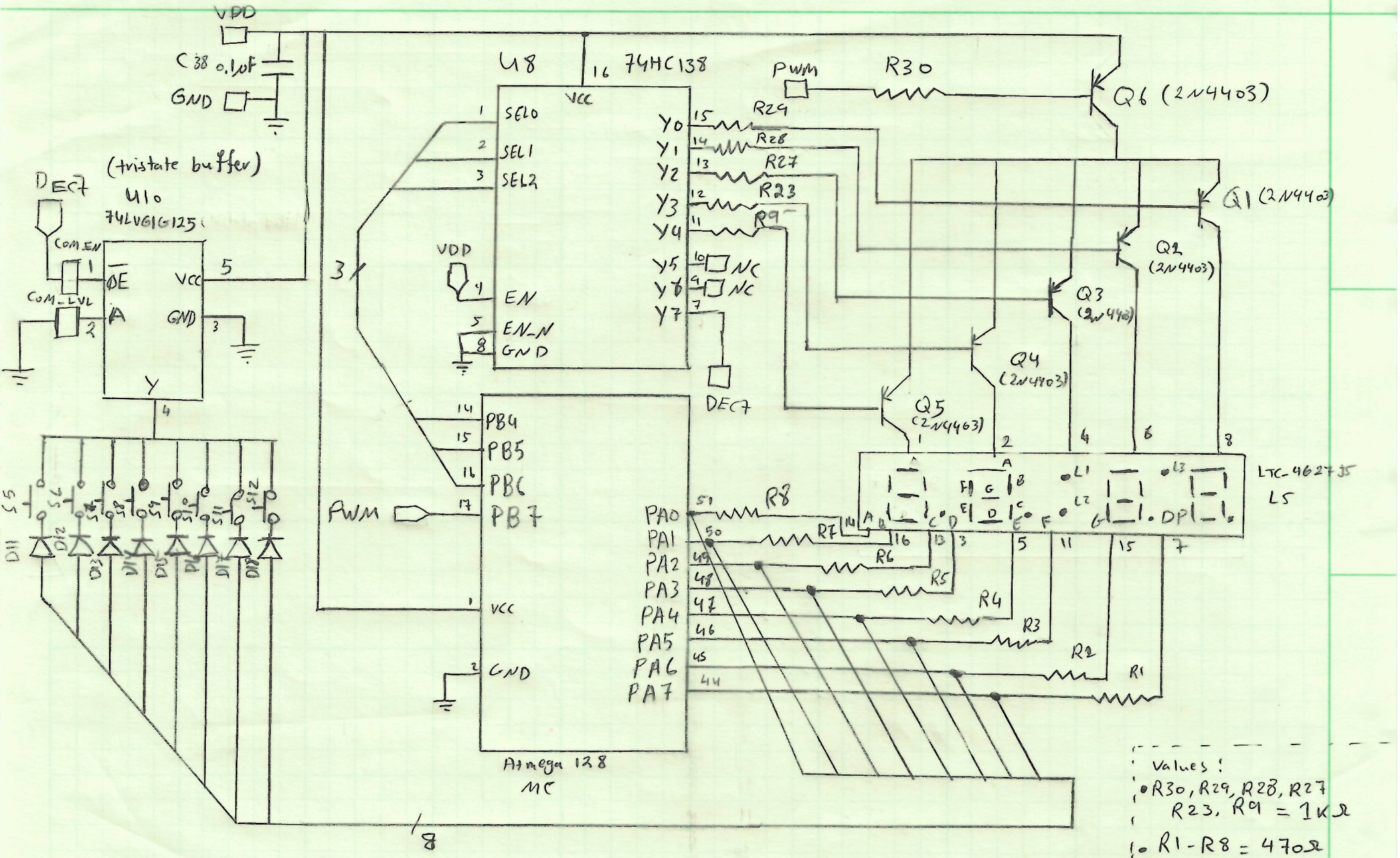

Values:

- R30, R29, R28, R27, R23, R9 = 1kΩ
- R1 - R8 = 470Ω
- see Resistors Page

Resistor values: