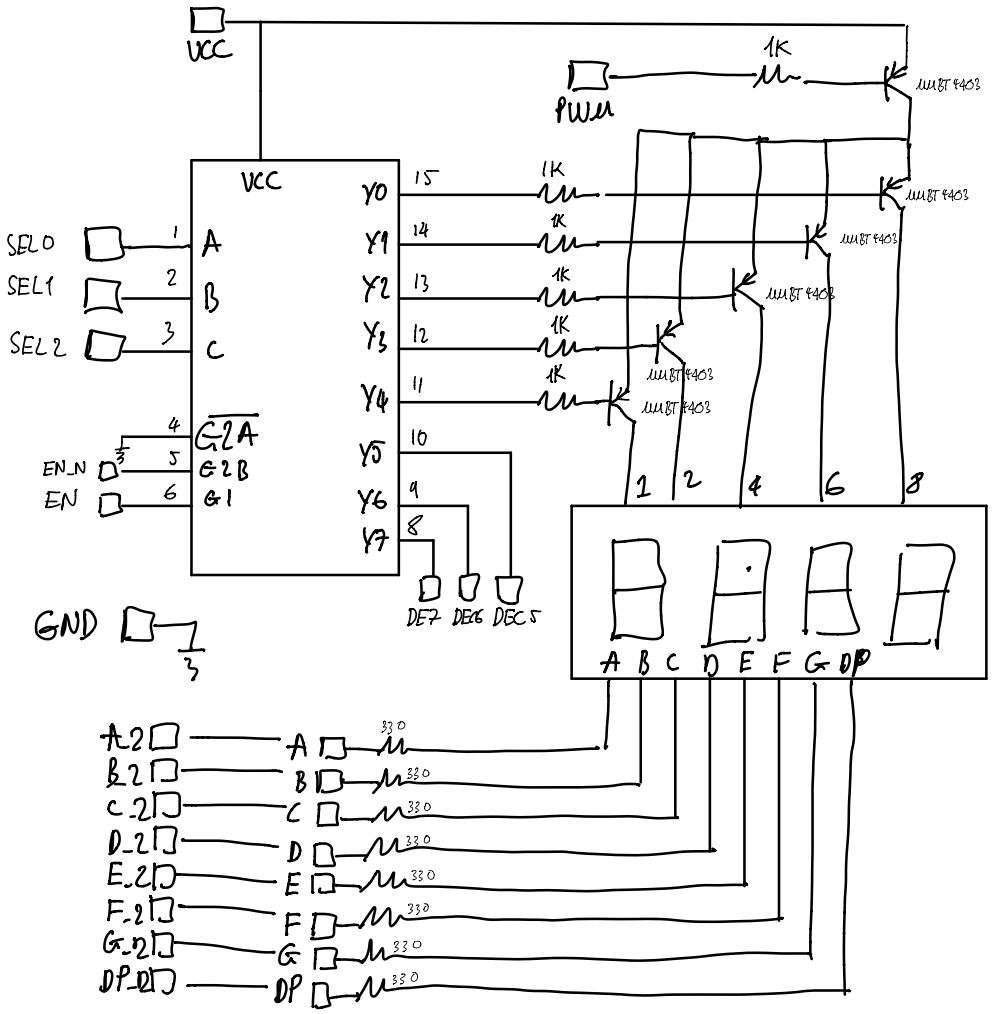
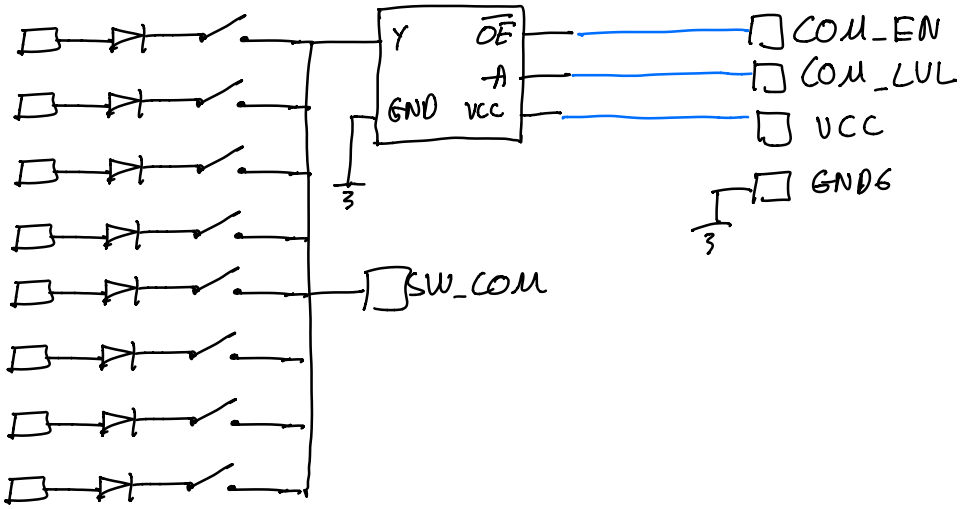
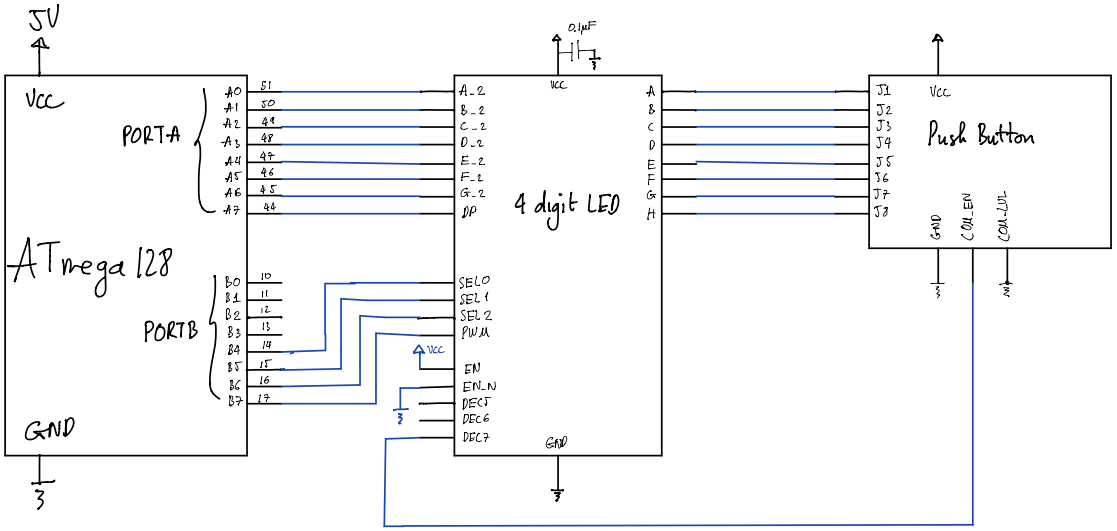
4 LED BOARD.

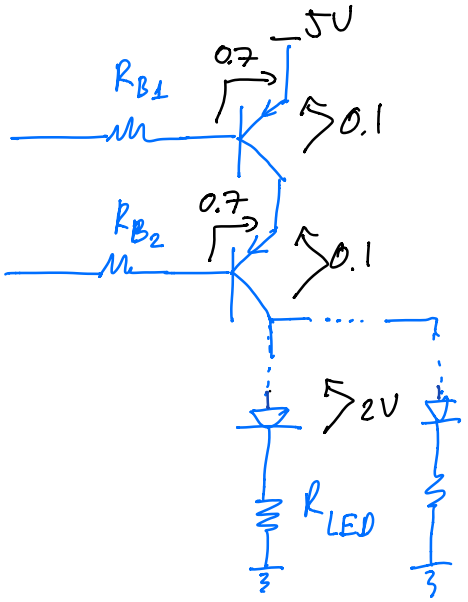

VCC
PWM
1K
MBT9403
VCC
SEL0
SEL1
SEL2
EN_N
EN
GND
A
B
C
G2A
G2B
G1
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
DE7
DE6
DE5
A B C D E F G DP
A_2
B_2
C_2
D_2
E_2
F_2
G_2
DP_2
330

Push Button Board



Schematic





According to the datasheet of the LED,
continous current per each segment = 20mA
voltage drop accross the LED is 2V

$I = 20mA$

$V_{led} = 2V$

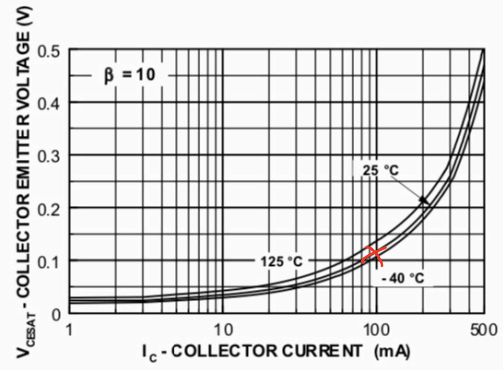


Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

We can drive up to 8 segments with 1 BJT

$I_{max} = 20mA * 8 = 160mA$

Let adjust our calculation to allow only 100mA

$\Rightarrow V_{CE} = 0.1V$

Calculating voltage drop accross R_{LED}

$V_{R_{led}} = 5 - 0.1 \times 2 - 2 = 2.8\ V$

$\Rightarrow R_{led} = \frac{2.8}{100mA / 8} = 224\ \Omega$

closest in the box is 330Ω

$\Rightarrow I_{LED\ with\ R=330\Omega} = 8.4mA$ | $R_{LED} = 330\Omega$

1] The sum of all IOL, for all ports, should not exceed 400mA.
2] The sum of all IOL, for ports A0 - A7, G2, C3 - C7 should not exceed 100mA.
3] The sum of all IOL, for ports C0 - C2, G0 - G1, D0 - D7, XTAL2 should not exceed 100mA.
4] The sum of all IOL, for ports B0 - B7, G3 - G4, E0 - E7 should not exceed 100mA.

if R_{LED} is $330\Omega \Rightarrow I_{Led} = 8.4\,mA$

$I_{8\,Leds} = 67.2\,mA < 100mA$

Port A is OK to drive all 8 Leds (include the dot)

For the R_{B_2}, we have $\beta = 10$

$I_C = 58.8\,mA \Rightarrow I_B \approx \frac{I_C}{\beta} = 5.88\,mA$

$|V_{BE}| = 0.7\,V$ ← voltage drop accross emitter - base

$\Rightarrow V_{R_{B_2}} = 5 - 0.1 - 0.7 = 4.2\,V$

$\Rightarrow R_{B_2} = \frac{4.2}{5.88\,mA} = 0.714\,k\Omega$

closest is $1K\Omega$

We will only drive one digit at a time

$\Rightarrow R_{B_2} = R_{B_1} = 1K$

Recheck for saturation. $I_B = \frac{5 - 0.7}{1K} = 4.3\,mA$

$h_{FE\,min} = 100 > \frac{I_C}{I_B} = 3 \Leftarrow I_{C\,1led} = I_B + I_{Led} = 12.7\,mA$

@ $I_C = 150\,mA$

$h_{FE_{min}} = 100 > \frac{I_C}{I_B} = 16.7 \Leftarrow I_{C\,8led} = I_B + I_{Led} \times 8 = 71.8\,mA$

@ $I_C = 150\,mA$

BJT always in saturation

Checking for LED visibility

We are pushing 8.4 mA through each LED

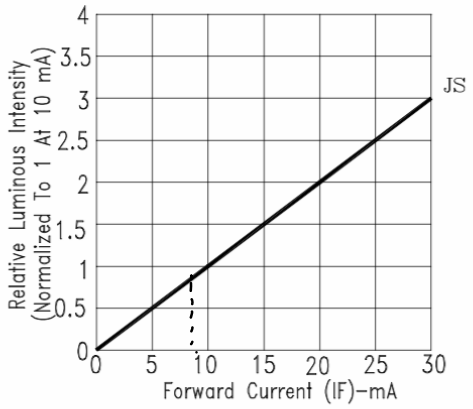


Fig4. RELATIVE LUMINOUS INTENSITY VS. FORWARD CURRENT

⇒ Relative lumen intensity = 0.8

⇒ Lumen intensity = 0.8 × 650

= 520 μcd

Also, the LED is delayed for 1 ms each pulse for human eyes.