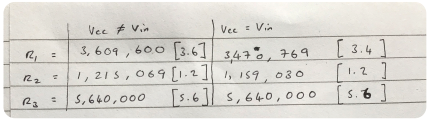
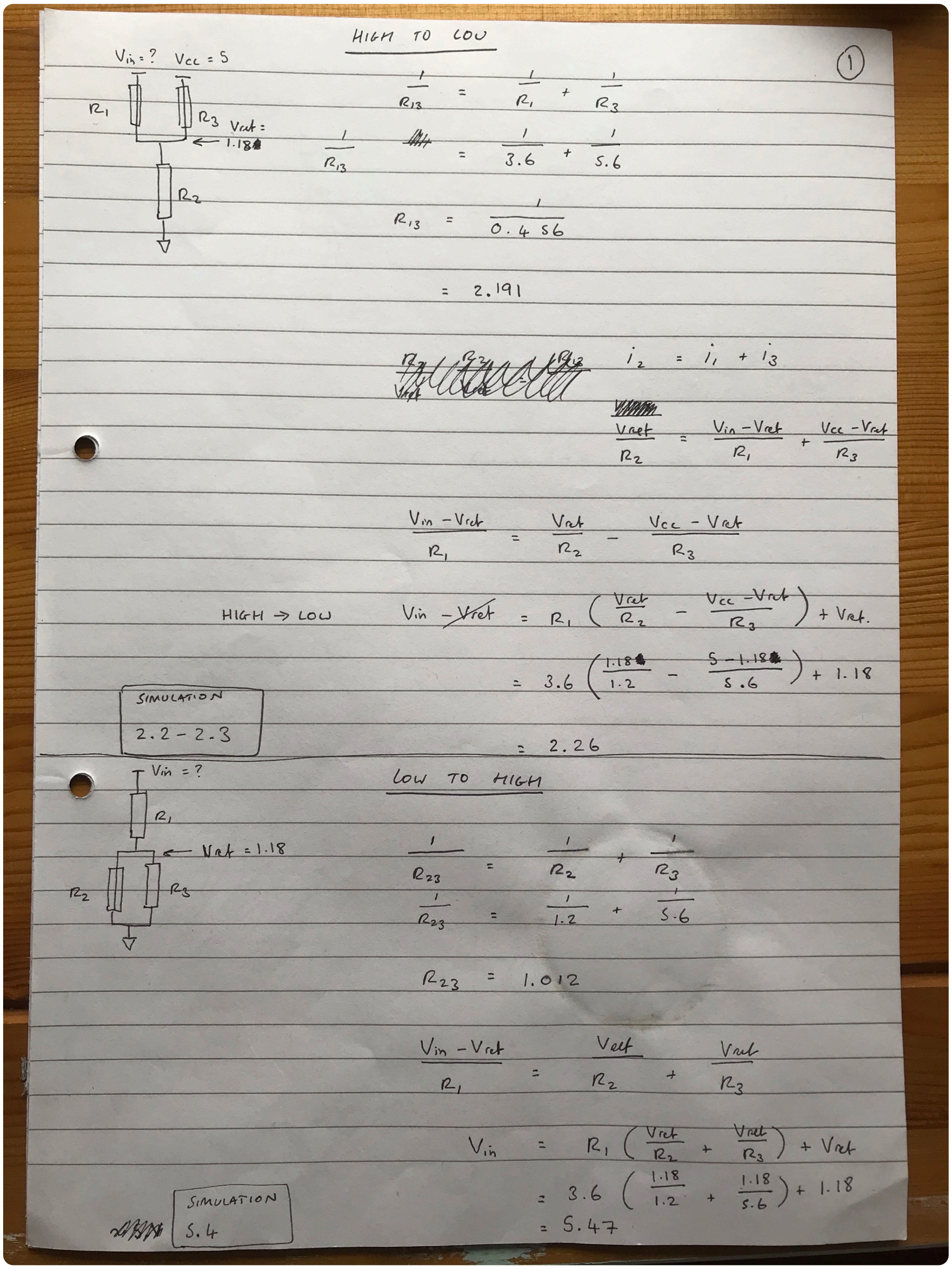


		$V_{cc} \neq V_{in}$	$V_{cc} = V_{in}$
R_1	=	3,609,600 [3.6]	3,470,769 [3.4]
R_2	=	1,215,069 [1.2]	1,159,030 [1.2]
R_3	=	5,640,000 [5.6]	5,640,000 [5.6]

Resister values using maxim calculations



HIGH TO LOW

1

$$\frac{1}{R_{13}} = \frac{1}{R_1} + \frac{1}{R_3}$$

$$\frac{1}{R_{13}} = \frac{1}{3.6} + \frac{1}{5.6}$$

$$R_{13} = \frac{1}{0.456}$$

$$= 2.191$$

$$i_2 = i_1 + i_3$$

$$\frac{V_{ref}}{R_2} = \frac{V_{in} - V_{ref}}{R_1} + \frac{V_{cc} - V_{ref}}{R_3}$$

$$\frac{V_{in} - V_{ref}}{R_1} = \frac{V_{ref}}{R_2} - \frac{V_{cc} - V_{ref}}{R_3}$$

HIGH → LOW

$$V_{in} \cancel{- V_{ref}} = R_1\left(\frac{V_{ref}}{R_2} - \frac{V_{cc} - V_{ref}}{R_3}\right) + V_{ref}.$$

$$= 3.6\left(\frac{1.18}{1.2} - \frac{5 - 1.18}{5.6}\right) + 1.18$$

$$= 2.26$$

SIMULATION
2.2 − 2.3

LOW TO HIGH

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{23}} = \frac{1}{1.2} + \frac{1}{5.6}$$

$$R_{23} = 1.012$$

$$\frac{V_{in} - V_{ref}}{R_1} = \frac{V_{ref}}{R_2} + \frac{V_{ref}}{R_3}$$

$$V_{in} = R_1\left(\frac{V_{ref}}{R_2} + \frac{V_{ref}}{R_3}\right) + V_{ref}$$

$$= 3.6\left(\frac{1.18}{1.2} + \frac{1.18}{5.6}\right) + 1.18$$

$$= 5.47$$

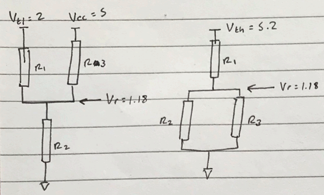
SIMULATION
5.4

Upper and lower threshold voltages using resister values calculated above

Deriving equations to calculate resister values for given threshold values

2

DESIGNING : SELECT R VALS USING HYSTERESIS BAND.



$$i_2 = i_1 + i_3$$

$$\frac{V_r}{R_2} = \frac{(V_{tL} - V_r)}{R_1} + \frac{(V_{cc} - V_r)}{R_3} \quad [A]$$

$$i_1 = i_2 + i_3$$

$$\frac{(V_{th} - V_r)}{R_1} = \frac{V_r}{R_2} + \frac{V_r}{R_3} \quad [B]$$

~~Equate A & B, eliminate R_2~~

Equate A & B, eliminate R_2 :

$$\frac{(V_{tl} - V_r)}{R_1} + \frac{(V_{cc} - V_r)}{R_3} = \frac{(V_{th} - V_r)}{R_1} - \frac{V_r}{R_3}$$

Collect terms

$$\frac{(V_{cc} - \cancel{V_r}) + \cancel{V_r}}{R_3} = \frac{(V_{th} - \cancel{V_r}) - (V_{tl} - \cancel{V_r})}{R_1}$$

$$[C] \quad \frac{V_{cc}}{R_3} = \frac{V_{th} - V_{tl}}{R_1}$$

$$\boxed{\text{MAXIM EQTN B} \quad \frac{V_{cc}}{R_3} = \frac{V_{HB}}{R_1}}$$

CHOOSE R_3 $\rightarrow$ $R_3 = \dfrac{V_{ref} - V_{out}}{i_3}$

$$R_3 = \frac{V_r}{i_{r3}} = \frac{1.18}{0.2 \times 10^{-6}} = 5{,}900{,}000 \leftarrow \text{SMALLEST.}$$

$$R_3 = \frac{V_{cc} - V_r}{i_{r3}} = \frac{5 - 1.18}{0.2 \times 10^{-6}}$$

$$R_3 = 5.9$$

$$R_1 = \frac{R_3 (V_{th} - V_{tl})}{V_{cc}}$$

$$= \frac{5.9 (3.2)}{5}$$

$$= 3.776 \approx 3.8$$

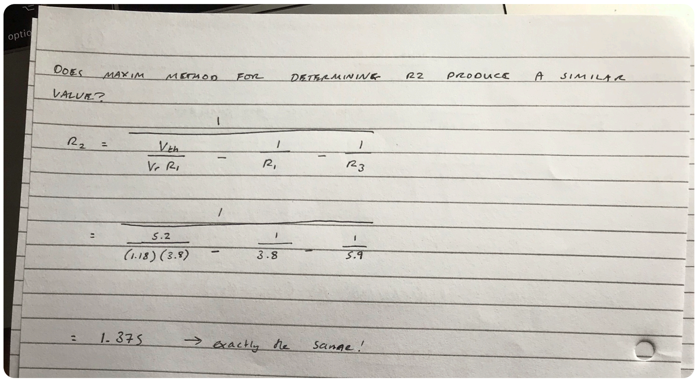
$$R_2 = \frac{V_r}{\left[\frac{V_{th} - V_r}{R_1}\right] - \frac{V_r}{R_3}}$$

$$= \frac{1.18}{\left[\frac{5.2 - 1.18}{3.8}\right] - \left(\frac{1.18}{5.9}\right)}$$

$$= 1.375 \approx 1.4$$

SIMULATION	LOW	= 2V
	HIGH	= 5.1V

Do maxim equations give same result?



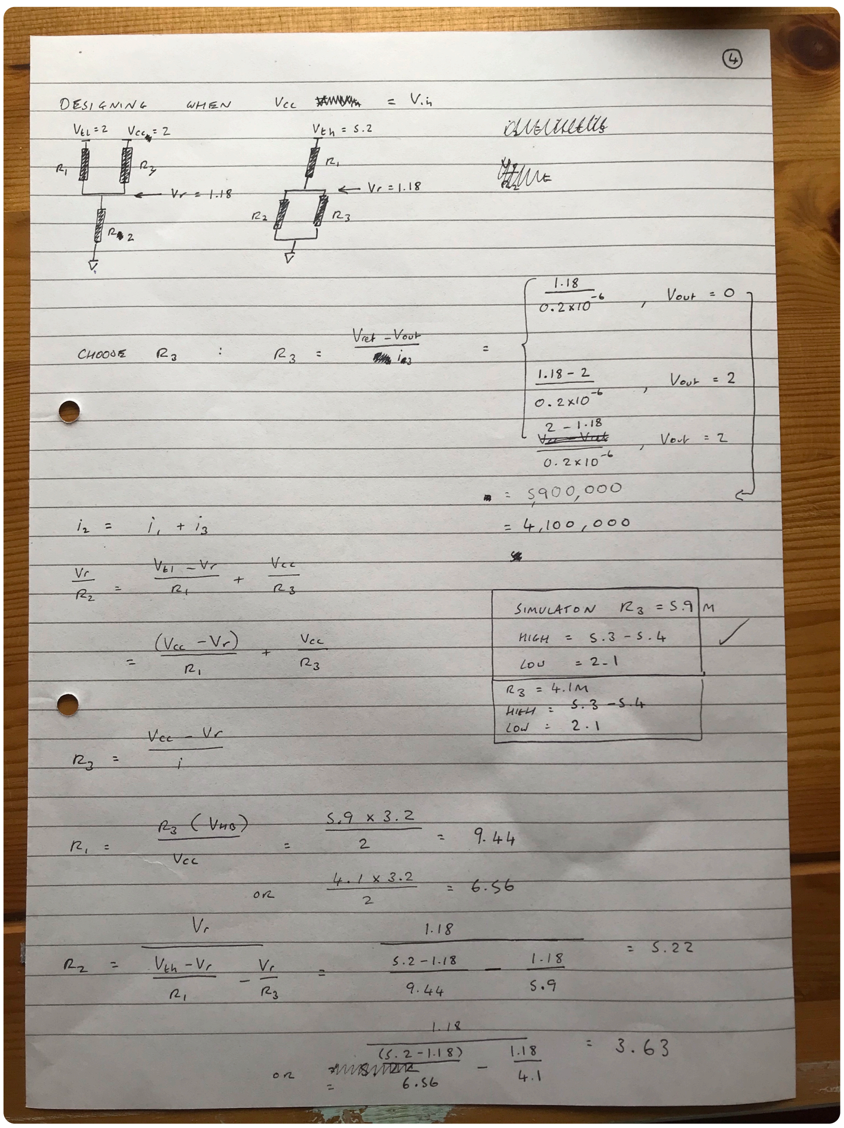
DOES MAXIM METHOD FOR DETERMINING R2 PRODUCE A SIMILAR VALUE?

$$R_2 = \frac{1}{\frac{V_{th}}{V_r R_1} - \frac{1}{R_1} - \frac{1}{R_3}}$$

$$= \frac{1}{\frac{5.2}{(1.18)(3.8)} - \frac{1}{3.8} - \frac{1}{5.9}}$$

$= 1.375 \rightarrow$ exactly the same!

Calculations for resister values for a given hysteresis band where vin = vsupply+



4

DESIGNING WHEN $V_{cc} = V_{in}$

CHOOSE R_3 : $R_3 = \frac{V_{ref} - V_{out}}{i_{R3}} = \begin{cases} \frac{1.18}{0.2\times10^{-6}}, & V_{out} = 0 \\ \frac{1.18 - 2}{0.2\times10^{-6}}, & V_{out} = 2 \\ \frac{2 - 1.18}{0.2\times10^{-6}}, & V_{out} = 2 \end{cases}$

$= 5900,000$

$= 4,100,000$

$i_2 = i_1 + i_3$

$$\frac{V_r}{R_2} = \frac{V_{tL} - V_r}{R_1} + \frac{V_{cc}}{R_3}$$

$$= \frac{(V_{cc} - V_r)}{R_1} + \frac{V_{cc}}{R_3}$$

$$R_3 = \frac{V_{cc} - V_r}{i}$$

SIMULATION	$R_3 = 5.9$ M
HIGH	= 5.3 - 5.4
LOW	= 2.1
$R_3 = 4.1$M	
HIGH	= 5.3 - 5.4
LOW	: 2.1

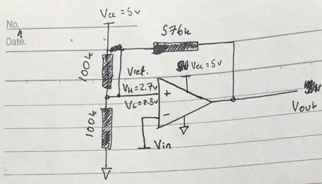
✓

$$R_1 = \frac{R_3 (V_{HB})}{V_{cc}} = \frac{5.9 \times 3.2}{2} = 9.44$$

or $\frac{4.1 \times 3.2}{2} = 6.56$

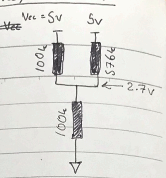
$$R_2 = \frac{V_r}{\frac{V_{th} - V_r}{R_1} - \frac{V_r}{R_3}} = \frac{1.18}{\frac{5.2 - 1.18}{9.44} - \frac{1.18}{5.9}} = 5.22$$

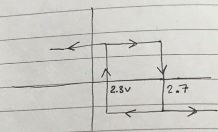
or $= \frac{1.18}{\frac{(5.2 - 1.18)}{6.56} - \frac{1.18}{4.1}} = 3.63$



$V_{out} = V_{cc}$, $V_{ref} = 2.7v$

~~Vout = Vcc~~





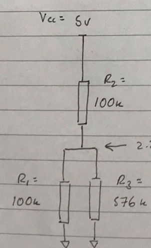
$V_{in} > 2.7v$

$V_{out} \rightarrow 0v$

$V_{in} < 2.3v$

$V_{out} \rightarrow 5v$

$V_{out} = GND$, $V_{ref} = 2.3v$

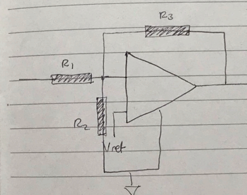


(c)

$$V_{THR} = V_{ref} \times R_1 \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right]$$

(d) Why & how does replacing R_3 w/ D effect output?

$$R_3 = \frac{V_{ref} - 0}{i_{R3}} \qquad R_3 = \frac{V_{cc} - V_{ref}}{i_{R3}}$$

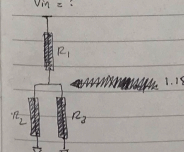


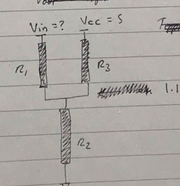
~~Vout = high~~

High to low transition.

Vin =

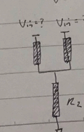
~~Tripping point~~





Low to high transit.

Vin =



High to low transition

Vin =