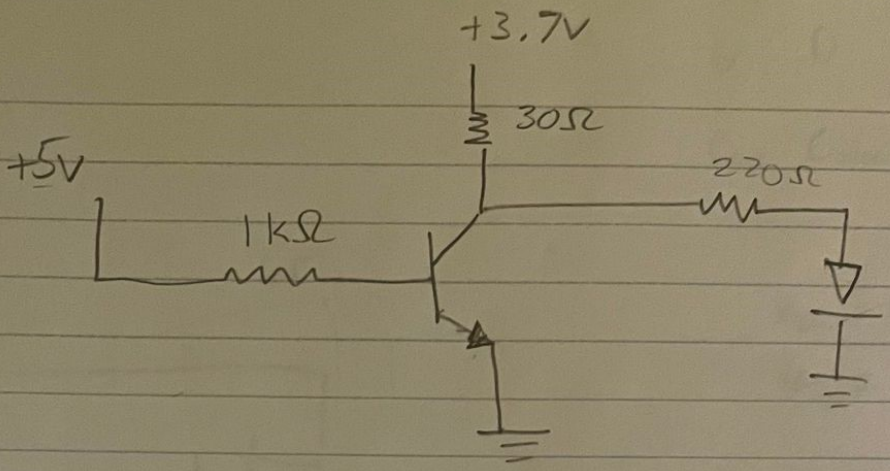
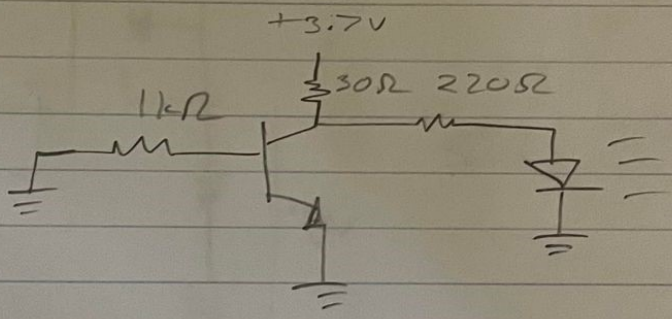
PN2222A

OFF

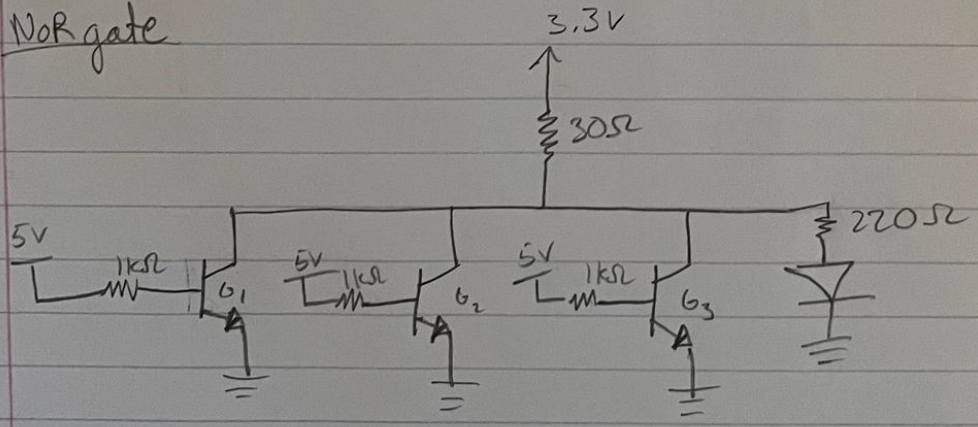


ON



- Acts as a switch for MKR 1400 GSM.

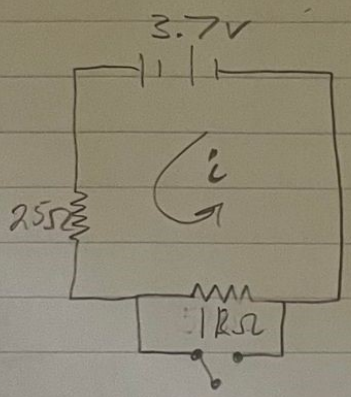
NOR gate



G_1	G_2	G_3	LED
0	0	0	1
0	0	1	0
.	.	.	0
.	.	.	0
.	.	.	0
1	1	1	0

SMS module switch

OPEN

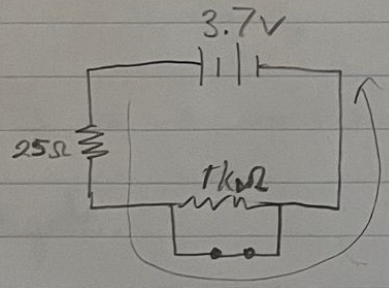


$$I = \frac{3.7V}{R_1 + R_2} = \frac{3.7V}{528 + R_1} = 3.3\,mA$$

Battery has a 2000 mAh

$$\frac{2000\,mAh}{mA} = 555\ hours = 23\ days$$

Closed



$$I = \frac{3.7V}{R_1} = \frac{3.7V}{25} = 148\,mA$$

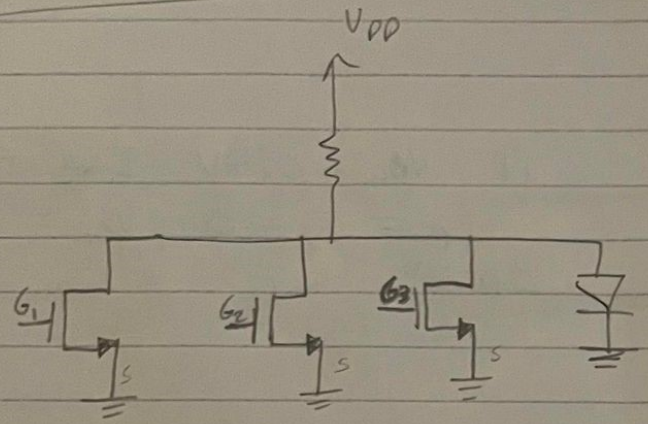
Battery has a 2000 mAh

$$\frac{2000\,mAh}{148\,mA} = 13\ hours$$

- Need to Adjust resistance values to save battery life while also powering device.

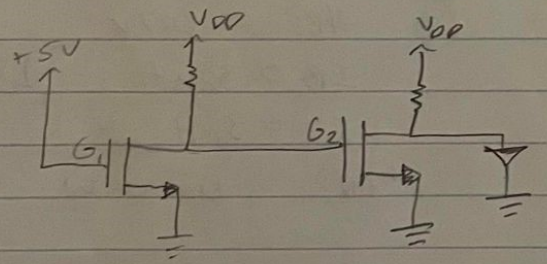
☆ MKR pins need 7mA to run

3 input NOR Gate



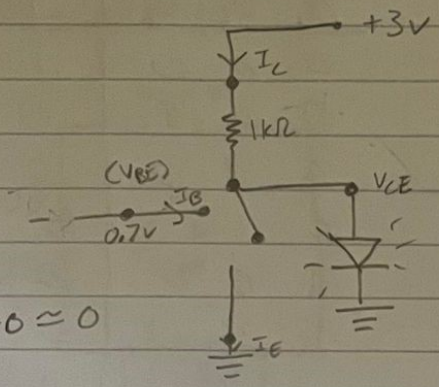
G_1	G_2	G_3	LED
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Not Gate



Transistor as a switch

1.)



$I_B \simeq 0$

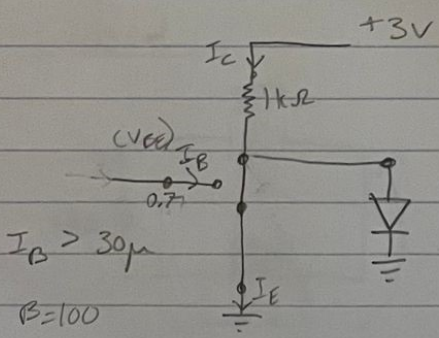
$\beta = 100$

① $V_{BE} < 0.7V$ [cut OFF]

$I_B \simeq I_C = 0$ $V_{CE} = +3V_{(max)}$

"OFF"

2.)



$I_B > 30\mu$

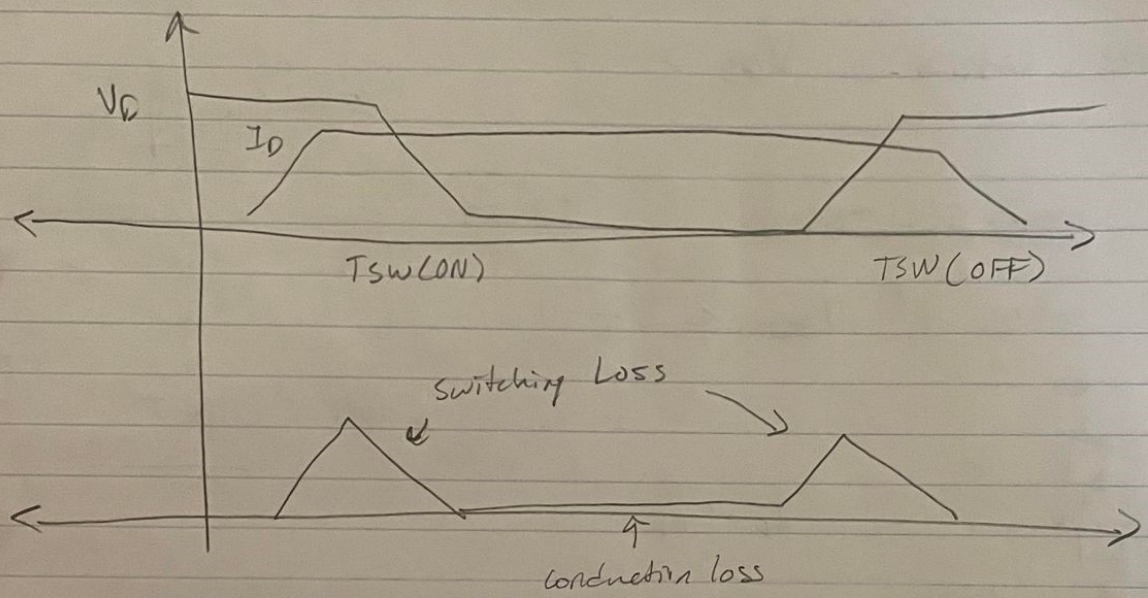
$\beta = 100$

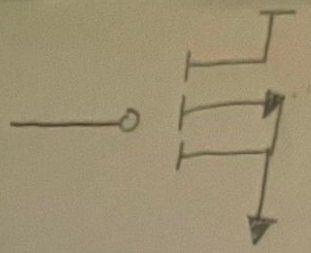
② $V_{BE} = 0.7V$

$I_B > 30\mu A$ [Saturation]

$I_C = 3mA_{(max)}$ $V_{CE} = 0_{(min)}$

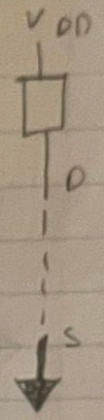
"ON" No Glow


V_D
I_D
$T_{SW(ON)}$
$T_{SW(OFF)}$
switching Loss
conduction loss

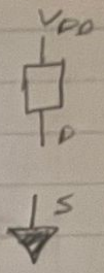


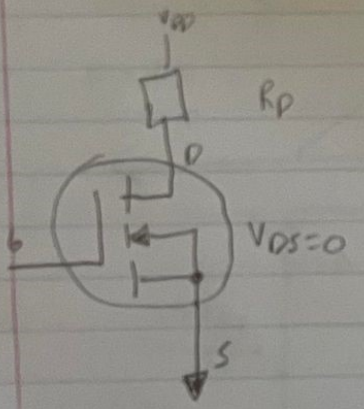
Mosfets

Active when $V_{GS} > V_T$



Off when $V_{GS} < V_T$





$I_D = \frac{V_{DD}}{R_D}$

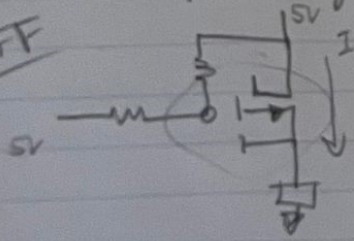
$I_D = 0 \Rightarrow V_{DS} = V_{DD}$

Gate threshold voltage determines the operating voltage of control line
Static drain source determines the Rds of Mosfet when active.

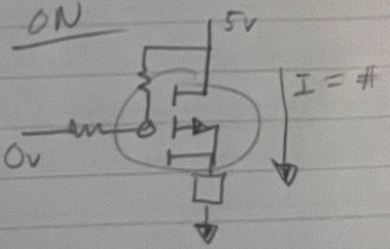
★ Add resistor before capacitor to restrict current to be less than pin allowed current.

P channel depletion type switch

OFF



ON



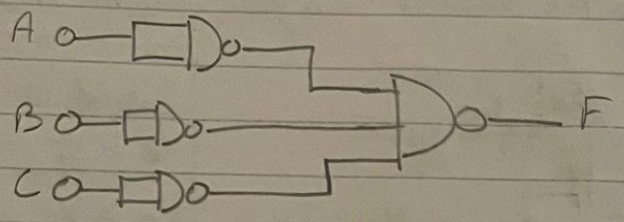
$Q_G(MAX)$ = total charge needed to turn on MOSFET

$Q = I \times T$

$Q = 20mA \times T$

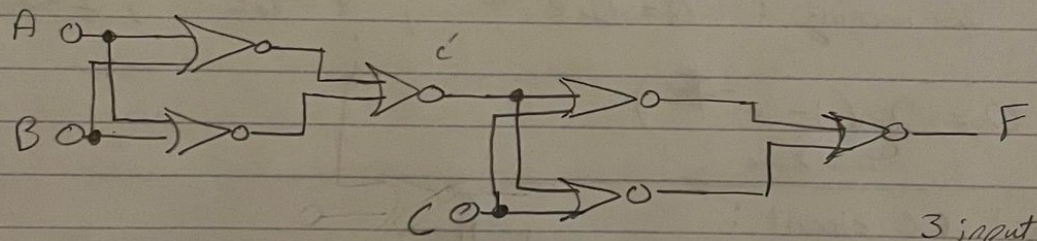
$T = 1\mu s$

- OR Gate out of NANDs



3 input OR Gate

- OR Gate out of NORs



3 input OR Gate

Marshall Arrell

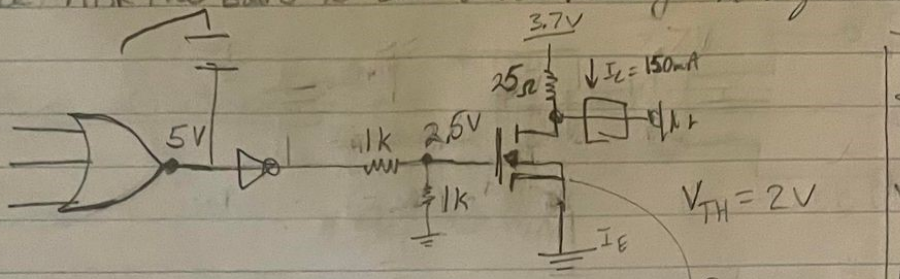
22μF = 1_5 = 3.03V

SMS module Battery Switch

Problem: Need to reduce power consumption of MKR 1400 board.

Solution: Add an OR gate, resistor, capacitor, & transistor to act as a switch to power the MKR 1400 board to send a text message in a given amount of time.

Diagram:

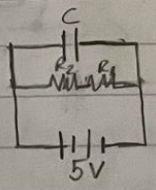


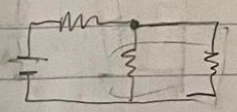
Saturation	Cutoff
$V_B > V_E$	$V_E > V_B$
$V_B > V_C$	$V_C > V_B$
Active	
$V_C > V_B > V_E$	

Formulas: Discharging: $Q = Q_0 e^{-\frac{t}{RC}}$; $V = V_0 e^{-\frac{t}{RC}}$; $I = I_0 e^{-\frac{t}{RC}}$

Charging: $Q = Q_0 (1 - e^{-\frac{t}{RC}})$ ← Initial charge

Diagram of just RC circuit:





C = 0.10 mF

R_1 = 1 kΩ, R_2 = 1 kΩ

V_0 = 5V

$Q_0 = CV_0 = 10_m F \times 5V =$ C

$RC = \tau = 10mF \times 1\ k\Omega =$ 10 s

Voltage after RC: $V = V_0 e^{-\frac{t}{RC}} = V_0 e^{-\frac{RC}{RC}} = 5e^{-1} =$ 1.8 V

Voltage after 0.5s: $V = V_0 e^{-\frac{t}{RC}} = V_0 e^{-\frac{0.5}{1}} = 5e^{-\frac{0.5}{10}} =$ 4.76 V

When 5V = $V_{R_2} = 5v(\frac{1}{2}) \approx 2.5V > 0.7V = V_{BE}$

★ needs to be less than V_C to avoid saturation mode of transistor

★ V_B needs to be greater than V_{BE} to enter active mode.

★ needs to be greater than V_E to avoid cutoff mode.