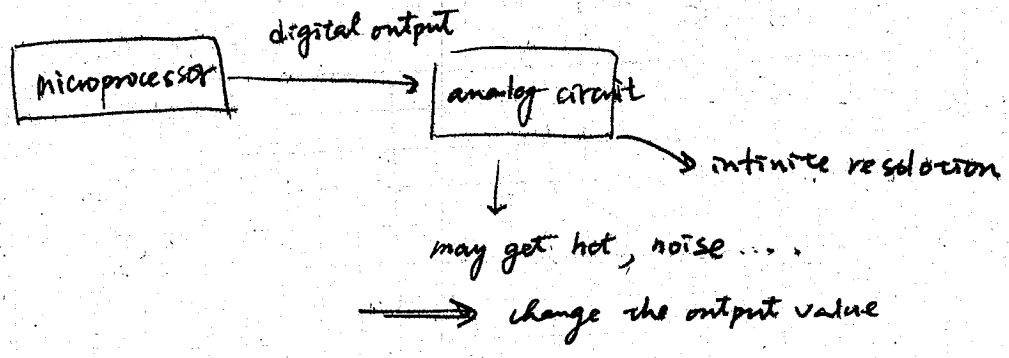
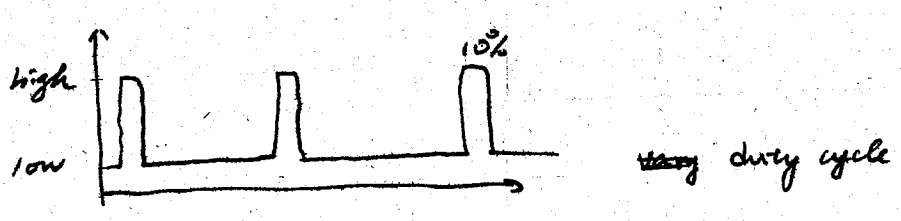
· PWM (Pulse Width Modulation)

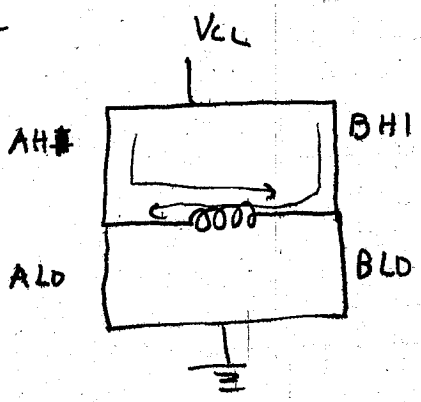




ex) 9 Volt battery to a light bulb

50 ms on
50 ms off
⋮
50% duty cycle → bulb feels it were connected to a 4.5 V battery

· H-bridge

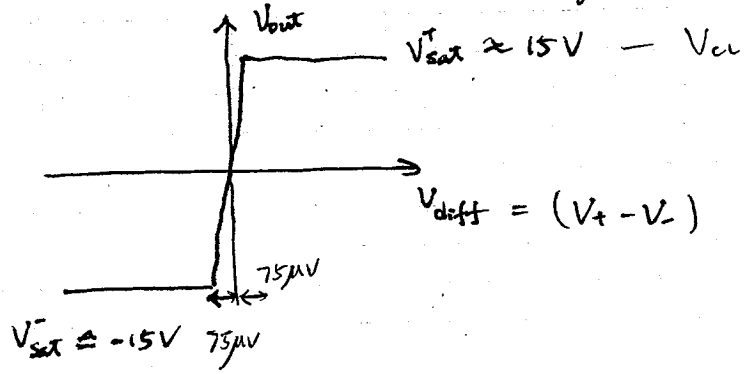


current can go either way to the motor by controlling the on-offs of AHI, ALD BHI, BLD

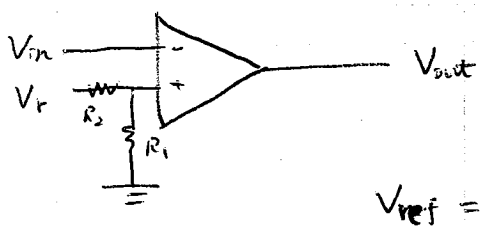
- bi-directional current switch with intrinsic protection diodes
- current sensing LMD 18200
- over current protection
- thermal warning / shut down
- sing / magnitude control
- Braking
- application examples

Digital ~~output~~ IN

- OP (operation amplifier) working area: Saturating



- Comparater

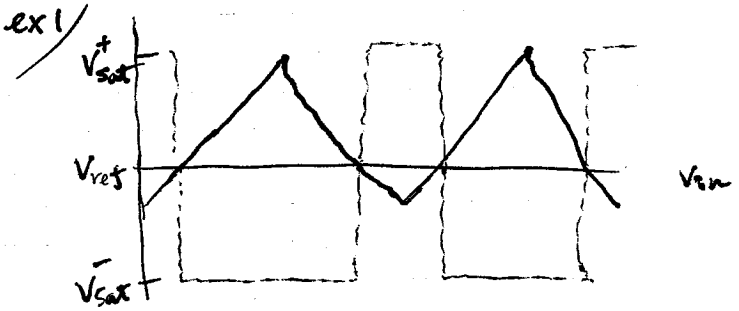


$$V_{ref} = V_r \cdot \frac{R_1}{R_1 + R_2}$$

When $V_{in} > V_{ref} \longrightarrow V_{out} \approx -15V$

$V_{in} < V_{ref} \longrightarrow V_{out} \approx 15V$

ex1/



ex2/ Air conditioner

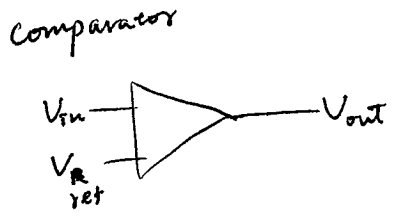
temperature → voltage → V_{in} → ?°C

V_{ref} = 28°C

open & close all the time

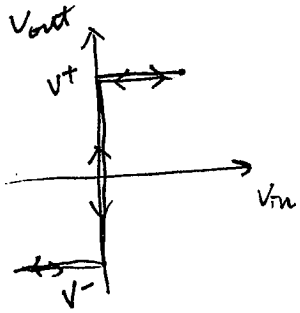
(how to solve it?

Schmitt Trigger → comparator with hysteresis

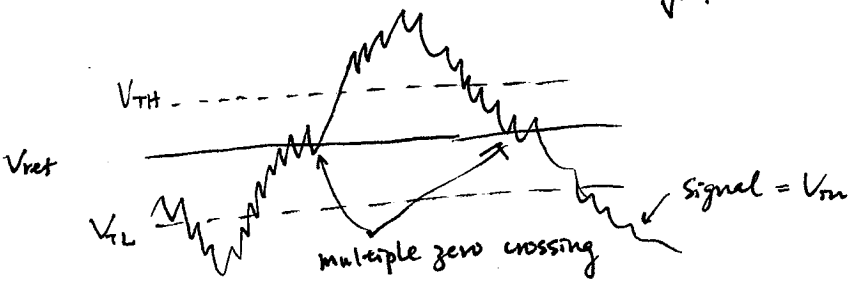


$V_{in} > V_{ref} \rightarrow V_{out} = V^+$

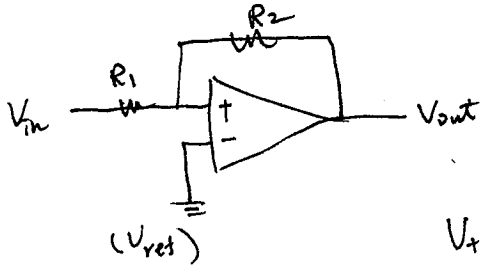
$V_{in} < V_{ref} \rightarrow V_{out} = V^-$



problem



Schmitt Trigger (bistable circuit)



$V_+ = ?$

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

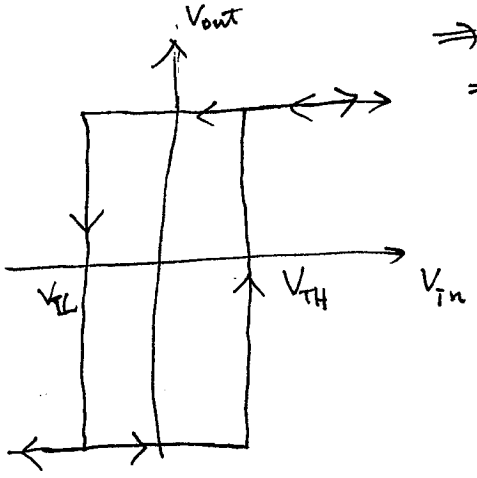
$$\Rightarrow V_+ = V_{out}\frac{R_1}{R_1+R_2} + V_{in}\frac{R_2}{R_1+R_2}$$

$\Rightarrow V_+$ from positive to just pass 0, before passing 0

$\Rightarrow$ ~~if~~ $V_+ > 0 \Rightarrow V_{out} = V^+$

$\Rightarrow$ by setting $V_+ \approx 0$, $V_{out} = V^+ \Rightarrow V_{in} = -V^+ \cdot \frac{R_1}{R_2} = V_{TL}$

$\Rightarrow$ afterwards $V_+ < 0$, $V_{out} = V^-$ and continue to be V^- for $V_+ < 0$



$\Rightarrow$ On the other hand

$\Rightarrow$ V_+ from negative to just pass 0, before passing 0

$\Rightarrow$ $V_+ < 0 \Rightarrow V_{out} = V^-$

$\Rightarrow$ by setting $V_+ \approx 0$, $V_{out} = V^- \Rightarrow V_{in} = -V^- \frac{R_1}{R_2} = V_{TH}$

$\Rightarrow$ afterwards $V_+ > 0$, $V_{out} = V^+$ and continue to be V^+ for $V_+ > 0$

the state will maintain between V_{TL} & V_{TH}

$\Rightarrow$ bistable with hysteresis

$\Rightarrow$ Schmitt trigger