Successive Approximation ADC: Play 20 questions with Vin ... Is Vin more than $\frac{5V}{2}$? if yes MSB is 1, otherwise 0.

↳ is Vin more than $\frac{3}{4}5V$? if yes next bit also 1 otherwise

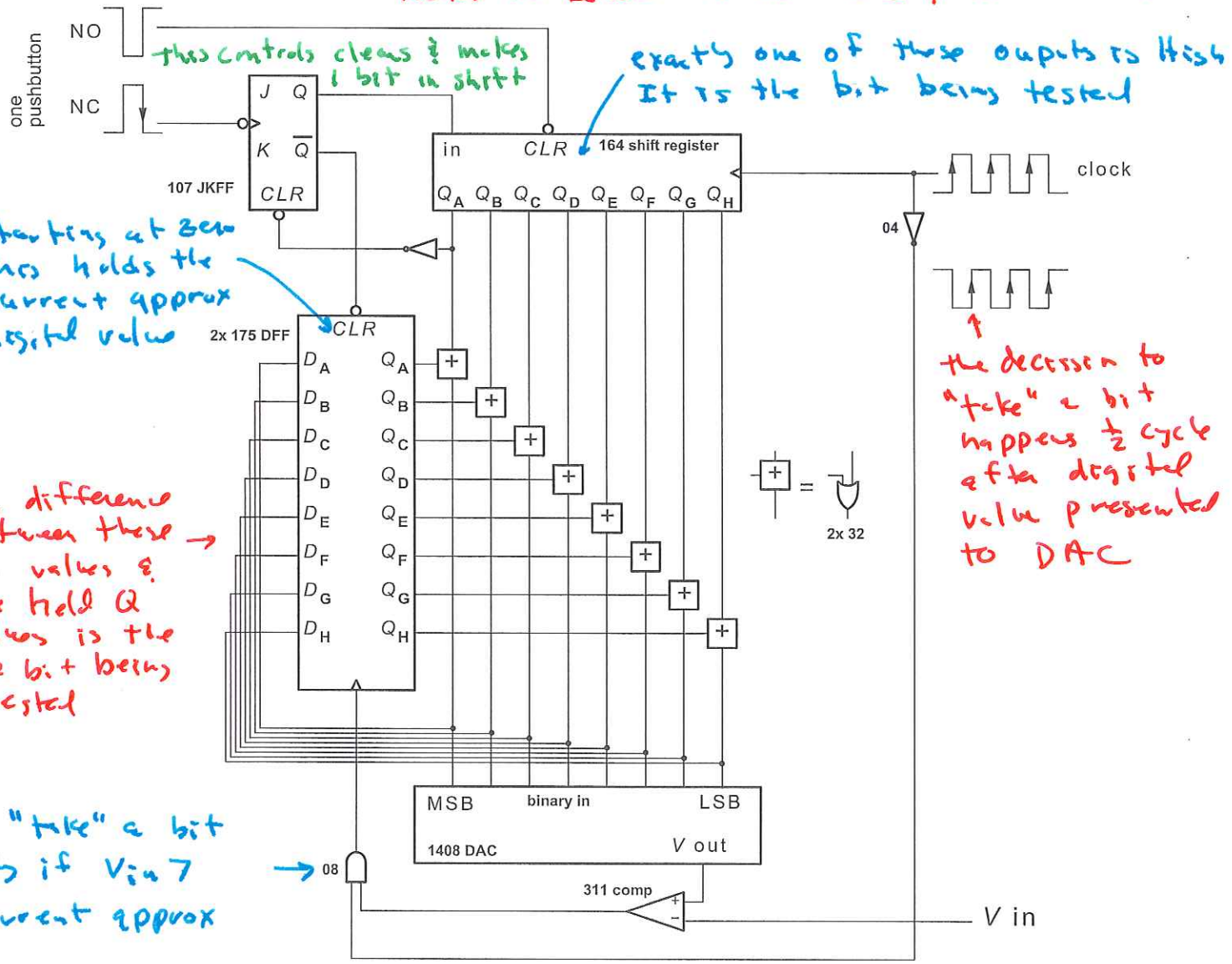
↳ is Vin more than $\frac{7}{8}5V$?

↳ is Vin more than $\frac{1}{4}5V$? if yes next bit is 1.

↳ is Vin more than $\frac{5}{8}5V$?

answer to each question gives next bit of approx digital value

Note: in below A is MSB; H to LSB



exactly one of these ouputs is High It is the bit being tested

the decision to "take" a bit happens $\frac{1}{2}$ cycle after digital value presented to DAC

the difference between these D values & the held Q values is the one bit being tested

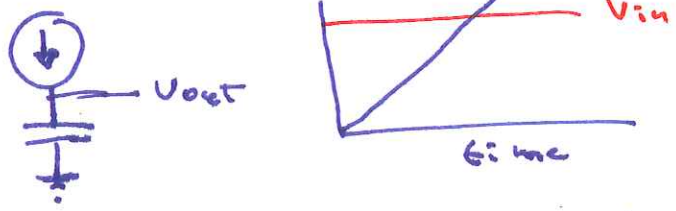
we "take" a bit only if Vin > Current approx

Note: in actual circuit 1408 DAC produces a negative voltage output. If thinking ab positive DAC outputs reverse +- on comparator

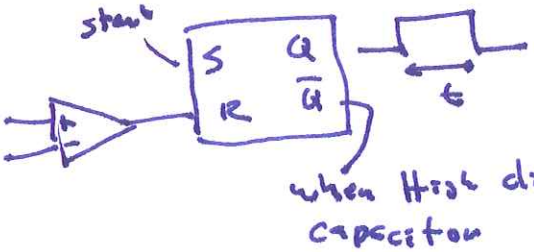
Single slope ADC : $V_{in} \rightarrow$ time (measure with period meter)

plan: make a upward ramp voltage & time when ramp voltage = V_{in}

$V_{out} = \frac{It}{C}$



time how long it takes $V_{out} = V_{in}$ with comparator & period meter



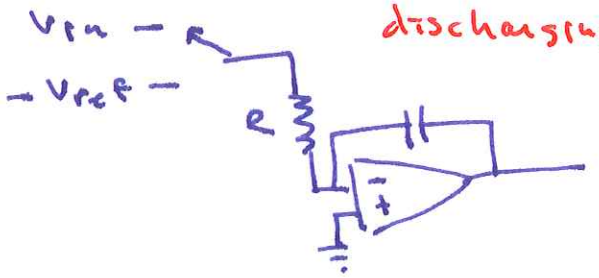
Note: $V_{in} \propto t$ but proportionality constant depends on C [bad]

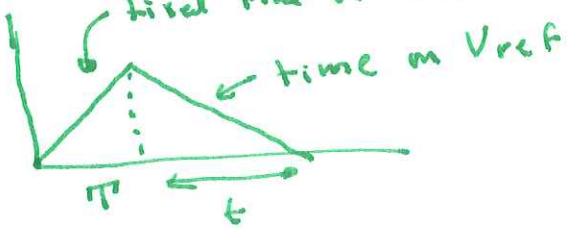
Dual Slope (common in DMM)

charging current = $\frac{V_{in}}{R}$

discharging current = $\frac{V_{ref}}{R}$

} same total charge on/off

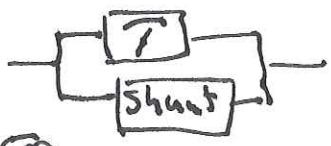




$Q = \frac{V_{in}}{R} T = \frac{V_{ref}}{R} t$

$V_{in} = V_{ref} \frac{t}{T}$ ← does not depend on R or C

Remark: How do old needle meters work? The needle is attached to a coil of wire in a magnetic field. Force (& hence torque) on coil proportional to current. needle attached to torsional spring with torque $\propto$ angle so $I \propto$ torque $\propto$ angle. Note: this is designed to work with small currents so most of current goes thru a low resistance shunt



To measure voltage: 

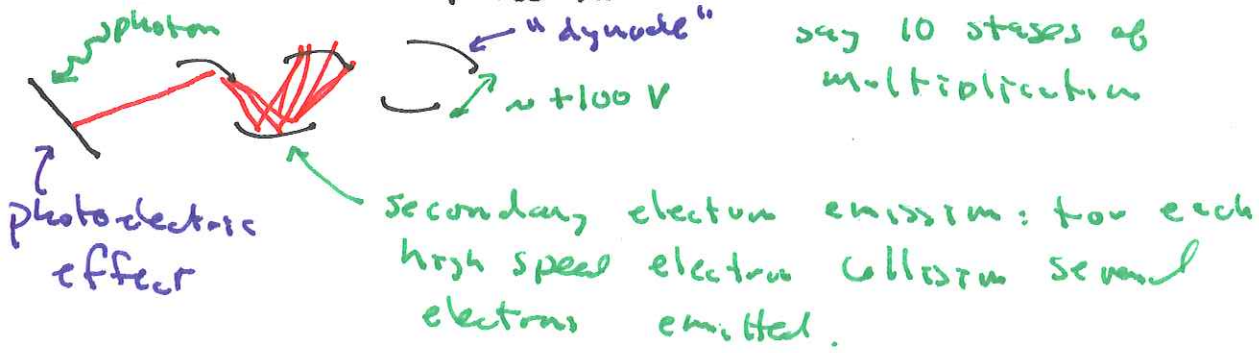
Current thru A = $\frac{\Delta V}{R}$

Note: see that V = high resistance, A = low resistance.

New topic: Transducers

photo multiplier tube (single photon detection) "PM"

photo electric effect: 1 photon ⇒ 1 e^-. Accelerate e^- so when slams into plate many electrons emitted (electron "multiplication"



Net result: 1 photon in, 10^8–10^9 electrons out — enough to measure "pulse" out

Aim: Spend this week talking about how to convert physical quantities (light, pressure, temperature ...) into electrical quantities (voltage, current, frequency ...)