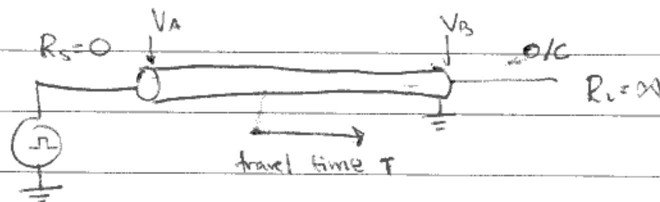
ELEC 3106
Study Notes

By Tommy Sailing

Semester 1 2013 – Electrical Engineering
The University of New South Wales

NOTES - Week 5 : Supply & Grounding

Coaxial cable

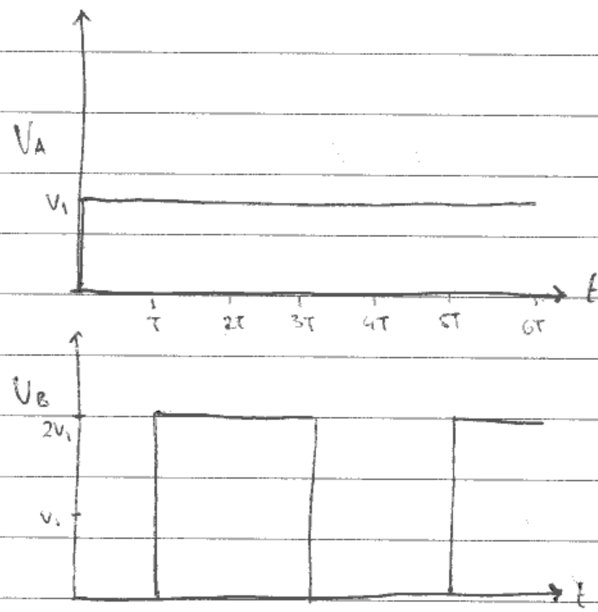


$\Gamma_s = -1 \quad \Gamma_L = 1$

reflective coefficient

input pulse

↳ Voltage you will hit at recieving end may be higher!



in some components on PCB we have over voltage protection to avoid these kinds of situations

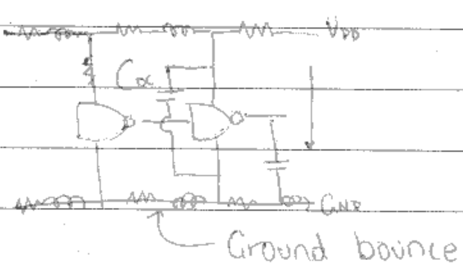
Matched load & source

$R_S = 0, \; R_L = \infty \rightarrow \Gamma_L = 1$

$R_S = 0, \; R_L = 0 \rightarrow \Gamma_L = -1$

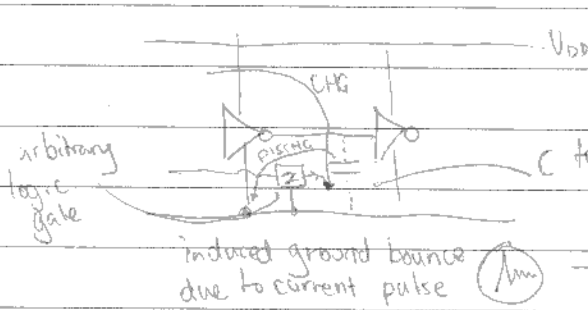
$R_S = Z_0, \; R_L = Z_0 \quad \Gamma_S = \Gamma_L = 0$

Supply & Grounding



Sag in supply voltage due to inductance along the whole tracks.

C_{∞} → store spare charge somewhere!



C too great to put into chip.

→ Might be sufficient to falsely trigger Z.

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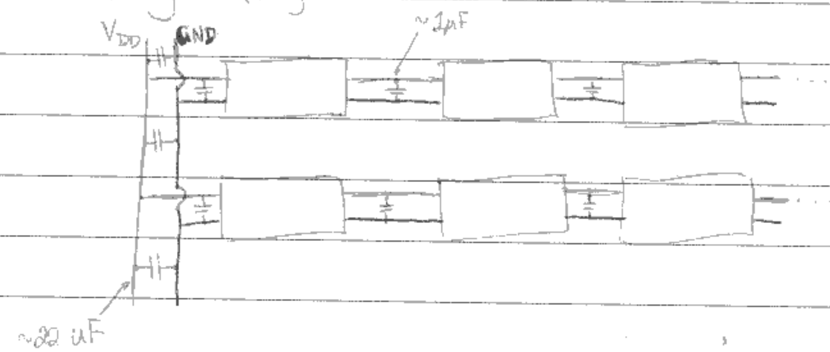
- How big should C_{DC} be?

  Basic idea: C_{DC} stores enough charge so that the supply voltage drop does not fall too much.

  $\Delta V_{DD} = \frac{n_{(gates)} Q}{C_{DC}}$ ← e.g. 200pC, $\Delta V_{DD} \sim 100mV$ ∴ $C_{DC} \approx 20nF$. Can't put that on a chip!

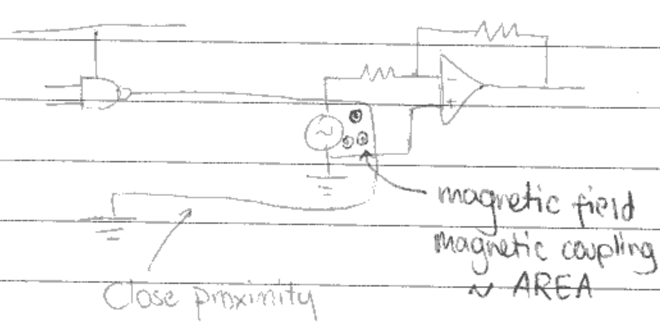
  You can't eliminate this problem, but you can minimise it.

- Decoupling supply

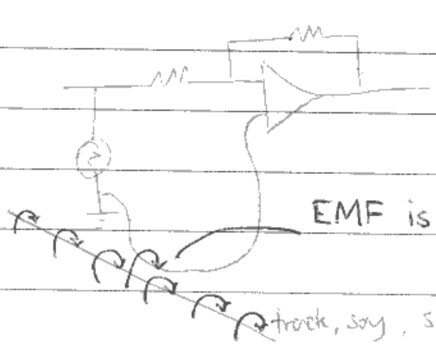


Each chip has a decoupling capacitor of a few μF, and the track has a board level decoupling capacitor array ~10-20μF

- Ground loops ⚠WARNING



Introduced an EMF along an input path of another circuit! Affects how you connect your PCB tracks! EMF induced into loop in series with input!



Low freq / med freq range. high freq have their own EMF interference!

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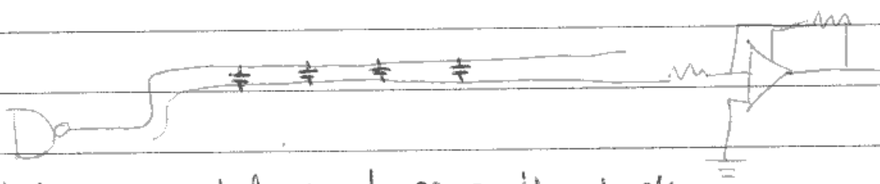
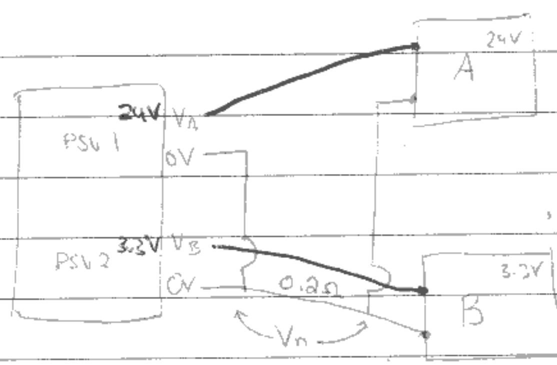
- Stray capacitance coupling
  - → if tracks are in close proximity.



→ magnitude of coupled signal of another track depends on speed of L/H & H/L transitions.

- Power supply returns

Is this connection OK?



∴ Tracks have nonzero resistance / impedance.

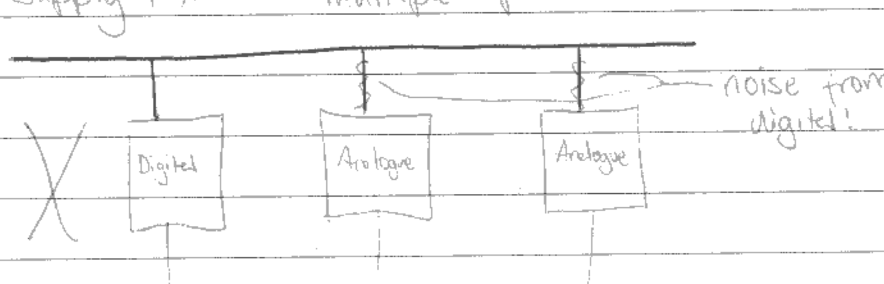
- Suppose ~24V currents are ~ 1A.
- Suppose ~3.3V currents are ~ 100mA.

Will be a potential difference across that track V_n

$$\therefore V_n \simeq 1.1A \times 0.2\Omega$$
$$\simeq 0.22V$$

→ Effective supply is $3.3V - 0.22V \simeq 3.08V$
you will lose power supply if you connect through a high current board!

→ Supply rail with multiple taps



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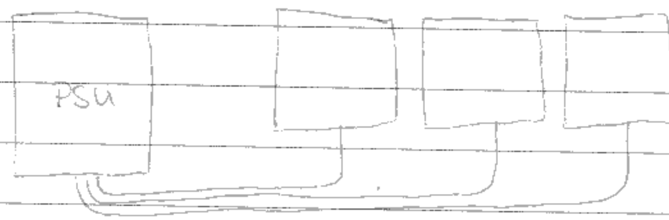
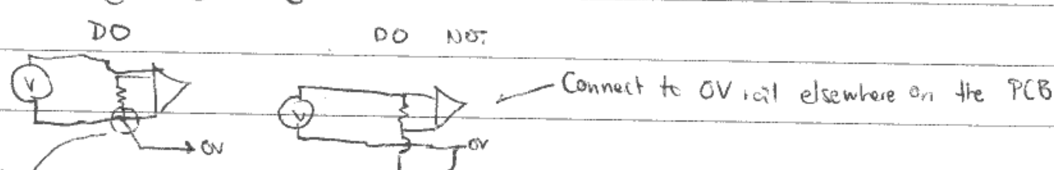
→ Star connection



The rule is, always separate your supply returns so that the load currents for each supply will flow in separate conductors.

→ Input signal grounding

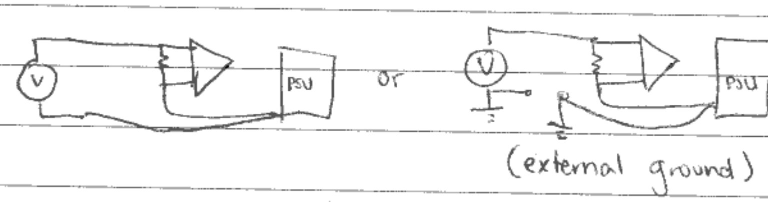


↑ 2 wire single ended input connection is to take to a ground return directly to the reference point

Reference point → look for the point from which the input voltage must be developed in order for the amplifier gain to act on it.

You do this because you don't want an unwanted signal to appear in the pathway (external nor internal)

Also do not



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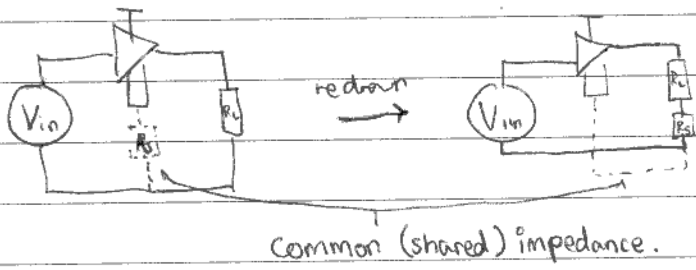
→ <u>Output signal grounding</u>

↳ Inputs respond unfavourably to external interference

↳ Outputs cause "interference" and operate at higher currents (than inputs) and could be the source of unwanted feedback.



$$\frac{V_o}{V_{in}} = \frac{A}{1 + \frac{AR_s}{R_L + R_s}},$$

but $\frac{AR_s}{R_L \mp R_s} = -1$

∴ unstability due to oscillation!

Solution : ☑ Avoid common impedance between input path and output ground!

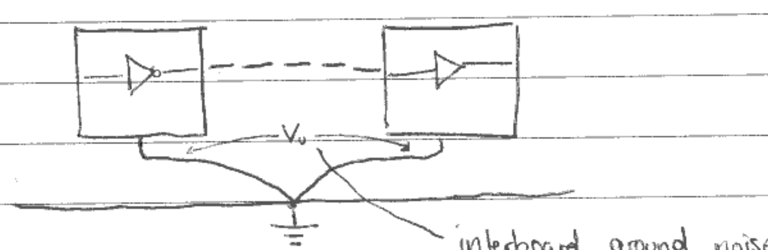
☑ Take output ground return directly to the point from which the output is sourced.

Check whether output return current will flow so that it will not affect the rest of the circuit

<u>Interboard grounding + connections</u>

↳ may not be a problem, depends on signal levels

↳ ground injected noise always present.



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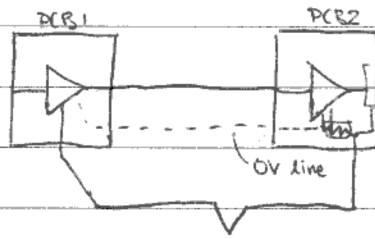
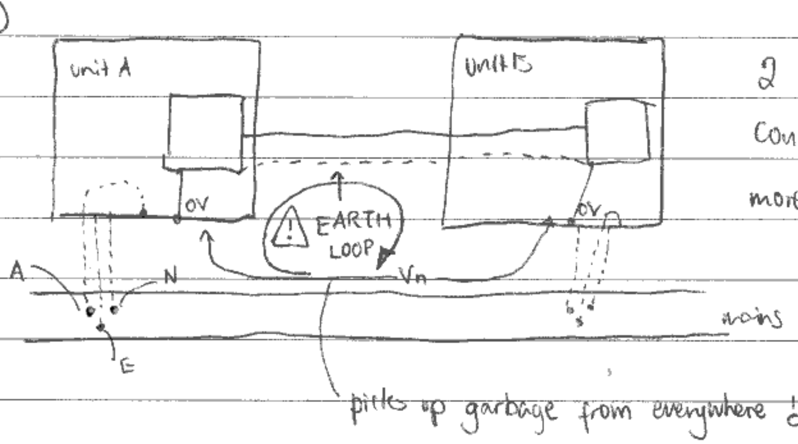
Alternative:
- use differential connection



Separate return ground from input side of the interface from the rest of the ground of that PCB.

Ground connection between units

(MAINS)



2 mains powered units connected by 1 or more signal cable

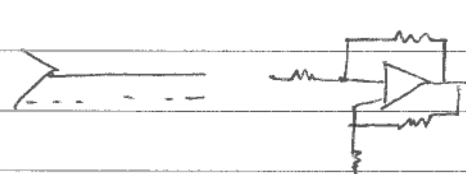
mains wiring

- Intermit ground connection via mains
- Vn = difference in noise between grounds (ground noise)
  - ↳ coupled the mains earth conductors (unpredictable!) (uncontrollable!)
- If connected to the same power point outlet, Vn may be small.

Options!

☑ Float one unit to break the loop, by disconnecting the Earth connection. But that imposes a safety issue by losing ground!

☑ Transmit signal via a differential link



☑ Isolate the interface with transformer coupling or an optical link. (might limit bandwidth)

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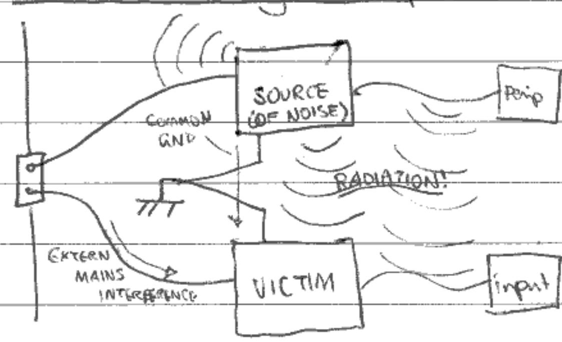
EMI: Electromagnetic Interference



- cable to cable
- casing to casing
- casing to mains cable

Low frequency: predominantly mode of coupling are direct along wires or by magnetic induction.

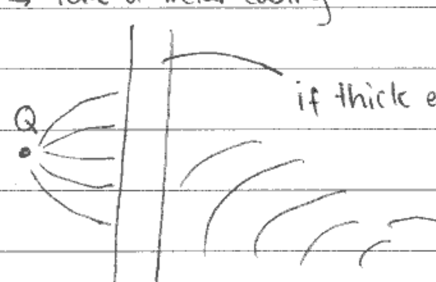
High frequency: each conductor (wire, metal casing, pcb track) acts like an antenna

Approach to EMC design

- ☑ Avoid radiating (hurr durr)
- ☑ Good grounding practise
- ☑ Use slower circuits

Shielding Issues

↳ take a metal casing



if thick enough, it will block the electrostatic field

and will impede the electromagnetic radiation!

$$\delta = \sqrt{\frac{1}{\pi f \mu \sigma}}$$ (3115) skin effect.

e.g. Cu at 30 MHz, $\delta \simeq 13\mu m$

However, ventilation holes, connections, etc mean that you can't have a perfect shielding case.

RULE OF THUMB: sensitive parts must not go near holes.

For $\lambda < 2d$ → No shielding, for $\lambda > 2d$ (l.f.) shielding effectiveness increases linearly at a rate of 20dB/decade.