Generic shield

Isolation (galvanic)
Distance
Polarization
Near ground lead, net or plane
Surrounding metal enclosure
Filter

Remember weakest link in a chain...

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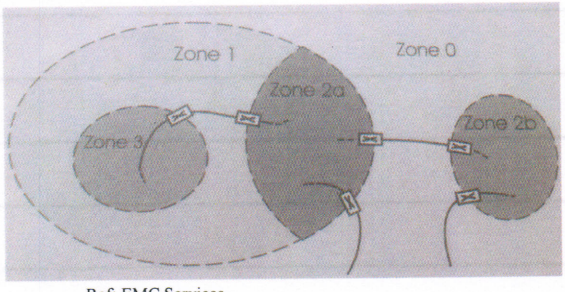
☒ = Filter

Zoning Example



Ref: EMC Services

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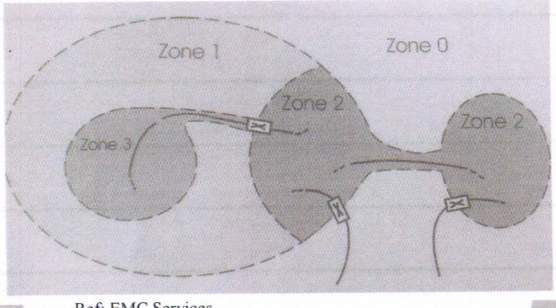
Lots of filters => Expensive

Zoning Example



Ref: EMC Services

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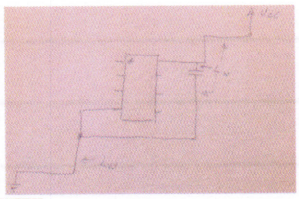
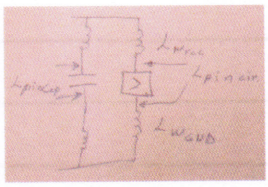
PCB power

Very important part of the board.
Wires => inductance approx 1nH/mm
Example, power lines





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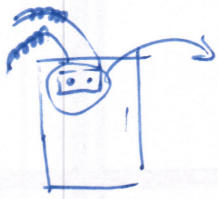

Capacitors for input

Always put capacitor on input of power at PCB

Could be 10-100 uF + a small 10 nF

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If you try to draw a lot of current, inductance in wires will cause a voltage drop. Big cap prevents this.

Designing electronics for EMC

Zoning
PCB layout
Power plane
Partitioning
Decoupling

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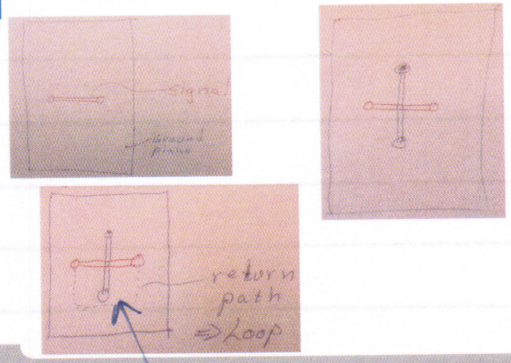
Power plane no cutting (2-layer)



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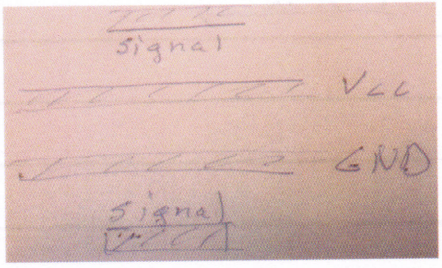
Antenna in loop

Multilayer PCB

4-layer (or more) is standard for production.



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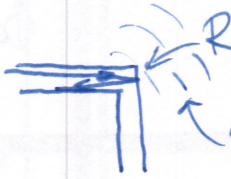
Becomes a dipole antenna



Signal traces

Keep short, length depending on frequencies on signal

Sharp edges can give reflections and radiation.

Home made boards will be easier to solder if wires and pads are as big as possible.

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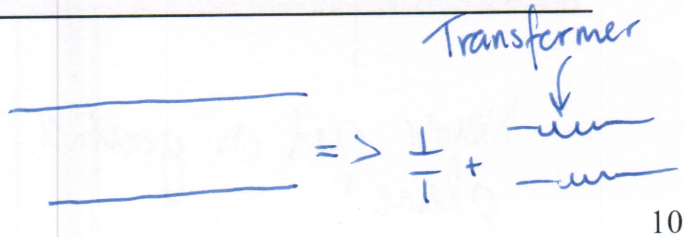
Shouldn't mix adjacent signal types.



Impedance in wires

The inductance for a wire on a PCB could be something like

http://www.eeweb.com/toolbox/broadside-trace-inductance/

So 10 cm of wire ~ 1μH
at 1 MHz => ωL = 6.8Ω

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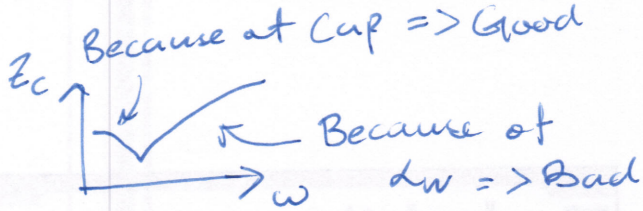
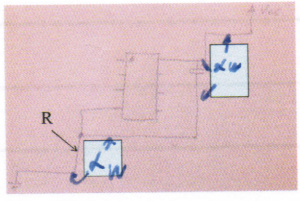


Wire ground



What happens at DC?
And AC?

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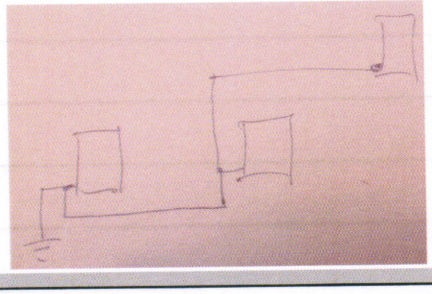
Serial ground

PCB power

Never this way!



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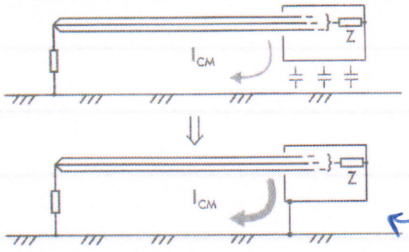
Not referring to same ground on high freq.

Common Mode current in a cable



- Lower Common Mode impedance results in higher Common Mode current. Grounding is thus not always desirable

Source: EMC services

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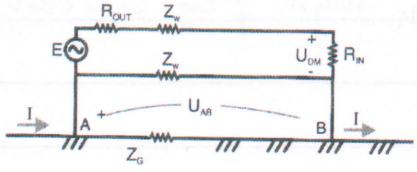
Even higher I_{cm}

Common impedance coupling or CM to DM conversion



$Z_w << R_{IN}$; $Z_w << R_{OUT}$; $Z_w >> Z_G$

$U_{AB} = U_{CM} = I \cdot Z_G$; Interference contribution: $U_{DM} = \frac{U_{CM} \cdot R_{IN}}{R_{OUT} + R_{IN}}$

CM = Common mode
DM = Differential mode

Note: The output port is also exposed to disturbance

Source: EMC services

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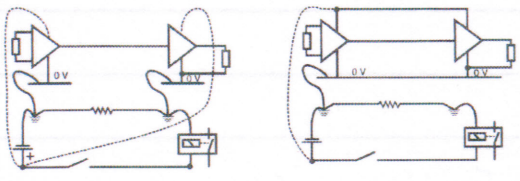
$R_{in} = 1M\Omega$ $R_{out} = 1k\Omega$

$U_{CM} = 0,1V$

$U_{DM} = \frac{0,1 \cdot 1M}{1k + 1M} \approx 0,1V$

Avoid common impedance coupling



- Use dedicated common voltage and 0 V return for communicating modules
- Floating sensors
- Floating loads

Source: EMC services

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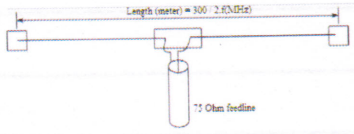
Antennas

Dipole antenna



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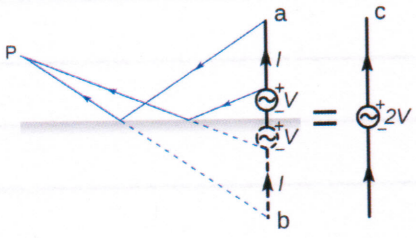
Rod antenna



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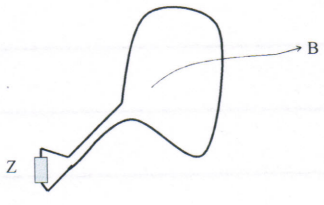
Loop antenna



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Electro Static Discharge ESD

Several discharge are performed:

4 kV in contact with the box

8 kV with a specified airgap

4

Electro Magnetic Pulse EMP

Nuclear explosions

Lightning

5

A, V

Much power, low energy

30kA

100 A

ms

50 µs

t

500 MJ ≈ 12 l petrol

The big drill

Source (culprit)
Interference emission
from a source

Victim have some immunity
against disturbance

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