Friday 1
August 2014

8 am.
ESDM IT I

9 am.
1) Why is EMI a vital problem? What are
10 am. the ways to prevent EMI? (6)
→ Electromagnetic interference is an electromagnetic
11 am. emission that causes a disturbance in
another piece of electrical equipment. EMI
12 pm. can be attributed to a wide span of the
electromagnetic spectrum including radio, DC &
1 pm. even microwave frequencies, Because anything
that carries rapidly changing electrical current
2 pm. gives off electromagnetic emissions.
• EMI compromises the performance of electrical
3 pm. equipment by obstructing & degrading data
Sometimes even losing data completely.
4 pm.

5 pm. • Ways to prevent EMI
→ Keeping electronic devices away from heavy
6 pm. machinery, motors or generators.
→ Using shielded cables.
7 pm. → Using EMI filters.

NOTES

8 am.

2) Compare Systems Approach &

9 am. Crisis approach.

→ Crisis Approach

10 am. • Design first, fix later

• Expensive add ONs

11 am. • Band aid approach.

12 pm. Systems Approach

• EMC considered throughout the process

1 pm. • EMC problems addressed at prototype stage with testing.

2 pm. • Cost effective & desirable

• Mitigation techniques are simple at single

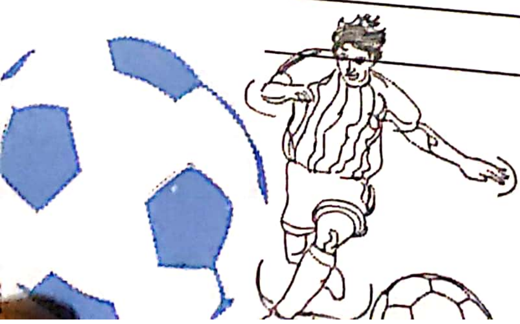
3 pm. stage or subsystem.

4 pm.

5 pm.

6 pm.

7 pm.



NOTES

Sunday

August 2014

3

8 am.

9 am. 3) Derive expression for Noise Voltage induced into the centre conductor due to the ~~outermost~~

10 am. current in the ?

11 am.

12 pm.

1 pm.

2 pm.

3 pm.

4 pm.

5 pm.

6 pm.

7 pm.

NOTES

8 am.

4) In the fig below, the stray capacitance between
9 am. ~~in~~ conductors 1 & 2 is 50 pF. Each conductor has capacitance to gnd of 150 pF. conductor
10 am. 1 has 10V ac signal at the frequency of 100KHz on it. Find the noise voltage
11 am. picked up by conductor 2 if its termination is at

12 pm. (a) ∞ resistance

(b) 1000 Ω resistance

1 pm. (c) 50 Ω resistance.

2 pm. ⇒ (a) at ∞ resistence

$$R \geq \frac{1}{j\omega(C_{12}+C_{2G})}$$

3 pm.

$$V_N = \left(\frac{C_{12}}{C_{12}+C_{2G}}\right)V_1$$

4 pm.

$$V_N = \left(\frac{50}{50+150}\right)\times 10$$

5 pm.

$$V_N = 2.5\text{ V}$$

6 pm.

(b) at 1000 Ω resistence

7 pm. when $R \leq \dfrac{1}{j\omega(C_{12}+C_{2G})}$

$$V_N = j\omega R C_{12} V_1$$

NOTES

8 am.

$V_N = j(2\pi\ 100k) \times 1000 \times 50 \times 10^{-12} \times 10$

$V_N = 314\ mV$

9 am.

10 am. (c) at $50\ \Omega$ resistance

$V_N = R \le \dfrac{1}{j\omega(C_{12}+C_{2G})}$

11 am.

$V_N = j\omega R C_{12} V_1$

12 pm.

$V_N = j(2\pi\ 100k) \times 50 \times 50 \times 10^{-12} \times 10$

$V_N = 15.7\ mV$

1 pm.

2 pm.

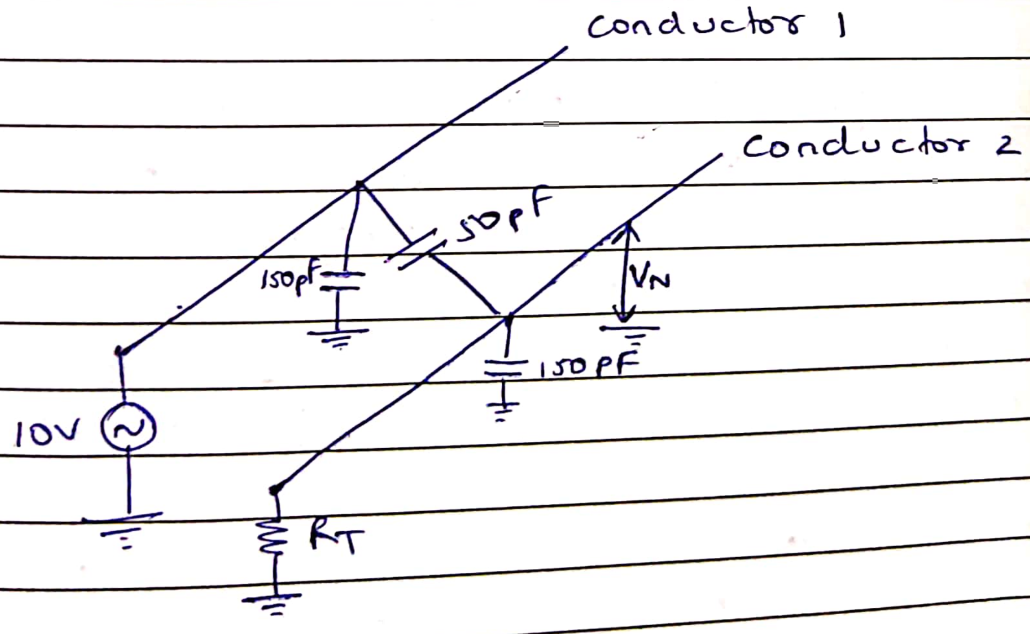
3 pm.

4 pm.

5 pm.

6 pm.

7 pm.



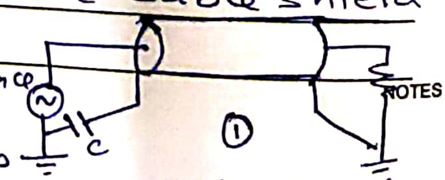
NOTES

8 am. 5 Q) Why is multipt gnd system considered to be a good choice at freq above
9 am. 100 KHz? How does a hybrid gnd function?

⇒ Multipoint ground systems are considered
10 am. to be a good choice at freq above 100 KHz
① bcuz they minimize the ground noise
11 am. voltage Vg in eqn $V_g = I_g Z_g$ by minimizing the ground impedance Z_g.
12 pm. - In multipoint system shown circuits are connected to the nearest available low-
1 pm. impedance ground plane.
• The connection between each ckt & ground shud
2 pm. be as short as possible to minimize their impedance

~~Hybrid grounds~~: • Increasing thickness of ground plane
3 pm. has no effect on it's high frequency impedance bcuz
1) It is the inductance not the resistance of the gnd that
4 pm. determines it's impedance &
2) High frequency current only flow on the surface
5 pm. of the plane because of the skin effect.

6 pm. Hybrid gnd :- when signal freq. covers wide range above & below 100KHz then Hybrid gnd may be a soln.
7 pm. • System grounding config. behaves differently at diff. freq. w.r.t
① • at low freq. C is high impedance & the cable shield is single pt grounded at load end only.
• at high freq. C is low impedance & cable shield is effectively grounded at both ends



cable shielding config

NOTES

Thursday 7

August 2014

8 am. 6) Q) Why is EMC important? Explain briefly the 2 main aspects of EMC.

9 am. What are the advantages of taking the systems approach in EMC design.

10 am. => EMC → electromagnetic compatibility

11 am.

12 pm. EMC → 2 aspects → Emission
→ Susceptibility

Susceptibility : 1) Capability of device or ckt to respond to

1 pm. ~~upto~~ unwanted EM energy

2) Opposite of susceptibility is immunity

2 pm. • immunity level

- upto which the device or ckt can work

3 pm. without degradation or with defined margin of safety.

4 pm.

5) ~~Q~~. The ground inductors provide a low impedance

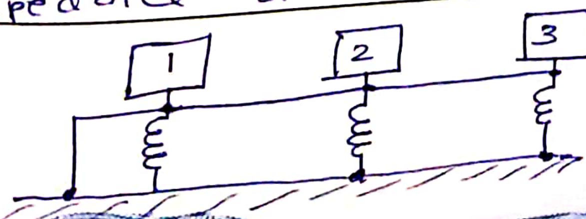
5 pm. safety ground at 50/60 Hz, & ground isolation at high freq.

• If the ground conductor is removed the

6 pm. product passes EMC, but that is a safety violation

7 pm. • An inductor or choke added in series with the ground wire will provide a low impedance at 50/60 Hz, while providing a high impedance at the much higher noise frequencies

NOTES



8 Friday
August 2014

8 am.

AG) susceptibility can be self regulating

9 am. – If a device is being affected by radiation, one may stop buying the product.

10 am.

Emission

11 am. • it is the interference causing potential of the product.

12 pm. • Controlling emission from one product may eliminate an interference problem for many

1 pm. other products.

• emission is not self regulating.

2 pm. – its own emission may not affect itself.

3 pm.

advantages of systems approach

4 pm. 1) EMC is considered throughout the design process

2) EMC problems are addressed at prototype

5 pm. stage with testing.

3) Cost effective & desirable.

6 pm. 4) Mitigation techniques are simple at single stage or subsystem

7 pm.

NOTES

8 am.

7) Discuss the effect of shield on capacitive
9 am. coupling. Explain why an unshielded
twisted pair ~~cable~~ will provide protection
10 am. against capacitive pickup, when its terminations
are balanced.

11 am. ⇒

12 pm.

1 pm.

2 pm.

3 pm.

4 pm.

5 pm.

6 pm.

7 pm.

NOTES

8 am.

5) Define signal grounding with neat diagrams

9 am. Explain single pt ground systems with neat diagrams, why do single pt of ground

10 am. systems fail at high freq.

11 am. → • A ground is often defined as an equipotential point or plane that serves as a reference

12 pm. potential for a circuit or system → voltage definition of ground

1 pm. • Low impedance path for current to return to source → current definition of a ground.

2 pm.

• Search for diagram of signal grounding

3 pm.

Single pt ground systems:

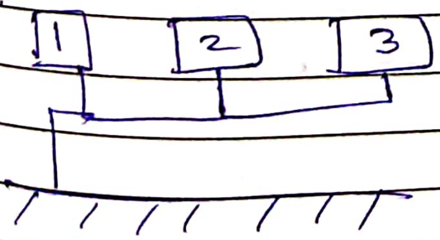
4 pm. • There are 2 subclasses → with series connections / → with parallel "

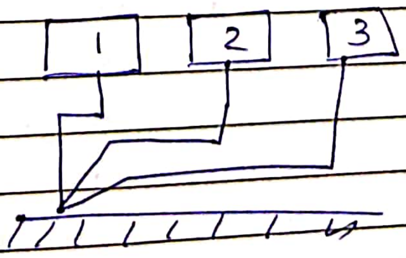
• The series connection is called common or daisy

5 pm. chain & ||le connection is called separate or star grounded system

6 pm.

7 pm.





NOTES

series connection

||le connection

8 am. • Single pt grounds are used at low frequencies from dc upto 20 kHz

9 am. • They should usually ~~do~~ not be used above 100 kHz, although sometimes this limit can

10 am. be pushed as high as 1 MHz.

• With single-pt grounding, we control the

11 am. ground topology to direct the ground current to flow where we want it to flow

12 pm. which decreased I_g in sensitive portions of ground.

1 pm. • from $V_g = I_g Z_g$ we see that as $I_g \downarrow$ voltage drop in that portion of ground $\downarrow$.

2 pm.

3 pm. Series Connection of all the individual ckt grounds

4 pm. • The impedance z shown represents those of the ground conductors & I_1, I_2 & I_3 are the

5 pm. ground currents of circuits 1, 2 & 3 respectively

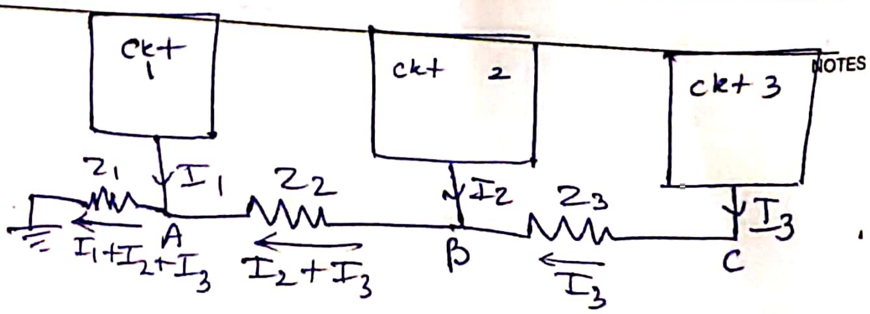
• Potential at pt A $V_A = (I_1 + I_2 + I_3) Z_1$

6 pm. & $V_C = (I_1 + I_2 + I_3) Z_1 + (I_2 + I_3) Z_2 + I_3 I_3$

• This ckt is least desirable but is used

7 pm. bcuz of simplicity.

• pt A is at lower potential than B & C



NOTES

8 am.

Parallel ground system

9 am. • Most desirable. bcuz no cross coupling occurs between ground current from different

10 am. ckt. The potential at A & & C are

$V_A = I_1 Z_1$

11 am. $V_C = I_3 Z_3$

• The ground potential of a ckt is now a

12 pm. function of the ground current & impedance of that ckt only.

1 pm. • This ~~sys~~ system can be mechanically cumbersome however because in a large system an

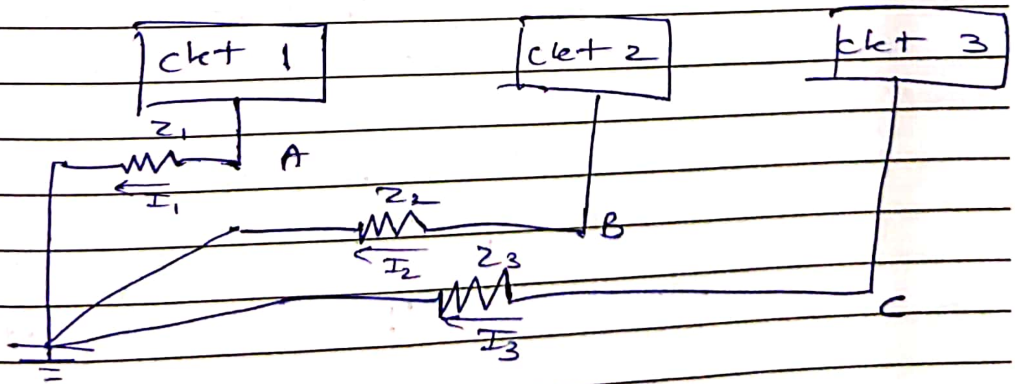
2 pm. unreasonable no of ground conductors may be necessary.

3 pm.

4 pm.

5 pm.

6 pm.



7 pm.

NOTES

14 Thursday
August 2014

8 am. **at high frequencies**

9 am. 1) at high freq. there is no such thing called single pt ground.

10 am. 2) figure shown below shows what happens when a single pt ground configuration

11 am. is attempted at high frequencies.

3) Bcuz of their Inductance, the ground

12 pm. conductors represent high impedance.

4) However at high freq. the impedance

1 pm. of the stray capacitance between the circuits & ground is low.

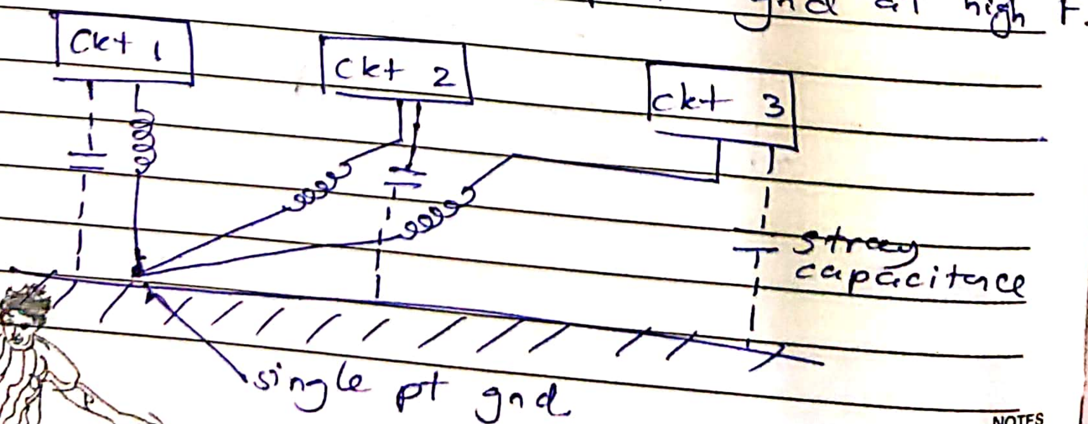
2 pm. 5) The ground current ∴ flows through the low impedance of the stray capacitance

3 pm. & not the high impedance that results from the inductance of the long ground

4 pm. conductors.

6) The result is a multipoint gnd at high F.

5 pm.



6 pm.

7 pm.

NOTES

8 am.

9 am. ① Explain how shielding helps in preventing magnetic radiation from a conductor.

10 am. → The best way to protect against magnetic fields at the receptor is to

11 am. decrease the area of the receptor loop

→ The area of interest is the total area

12 pm. enclosed by current flow in the receptor ckt

→ If a non magnetic shield placed around

1 pm. a conductor causes the current to return over a path that encloses a smaller area

2 pm. then some protection against magnetic fields will have been provided by the

3 pm. shield

→ This protection is caused by reduced loop

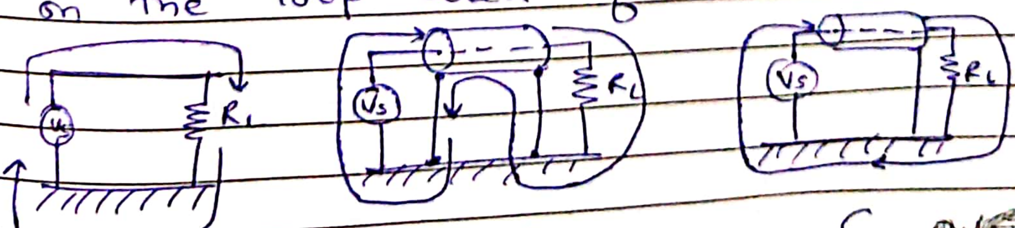
4 pm. area & not by shielding properties of the shield

5 pm.

→ Figure illustrates the effect of a shield

6 pm. on the loop area of a circuit

7 pm.



A B C

NOTES

16 Saturday
August 2014

8 am. • The source Vs is connected to the load R_L by a single conductor, using
9 am. a ground return path.
• The area enclosed by the current is
10 am. the rectangle between the conductor & the ground plane.
11 am.
• in fig B, a shield is placed
12 pm. around the conductor & grounded at both ends. If the current returns through
1 pm. the shield rather than the ground plane then the area of the loop is decreased.
2 pm. & a degree of magnetic protection is provided.
3 pm. • The current will return through the shield if the freq. is greater than 5 times the
4 pm. shield cuttoff freq. as previously shown
5 pm. • A shield placed around the conductor & grounded at one end only, as shown
6 pm. in C, does not change the loop area & ∴ provides no magnetic protection.
7 pm. • The arrangement in B does not protect against magnetic fields at freq. below the shield cutoff freq. because then most of the current returns through the gnd plane & not through the shield.

NOTES