Sources of Noise, Coupling Mechanisms

Choose yourself and new technologies

HUMAN CAPITAL

Wrocław University of Technology

EUROPEAN SOCIAL FUND

Project co-financed from the EU European Social Fund

Wrocław University of Technology

Master programmes in English
at Wrocław University of Technology

References

Basic:

Ott H. W., *Electromagnetic Compatibility Engineering*, Wiley, Hoboken, NJ, 2009

Additional:

Williams T., *EMC for Product Designers*, Elsevier-Newnes, 4-th ed., Oxford, 2007

HUMAN CAPITAL

Wrocław University of Technology

EUROPEAN SOCIAL FUND

Project co-financed from the EU European Social Fund

Wrocław University of Technology

Master programmes in English
at Wrocław University of Technology

Source of illustrative materials

All the illustrative materials have been taken from:

Ott H. W., *Electromagnetic Compatibility Engineering*, Wiley, Hoboken, NJ, 2009

HUMAN CAPITAL

Wrocław University of Technology

EUROPEAN SOCIAL FUND

Project co-financed from the EU European Social Fund

„Transmitters" and „Receivers"

- Transmitters (sources of disturbance)
  - car ignition systems
  - fluorescent lamps
  - universal motors
  - power supply units
  - switching contacts
  - atmospherical discharges
  - integrated circuit microprocessors
  - etc.
- Receiver
  - broadcasting and TV receivers
  - automation systems
  - microelectronics (e.g. cars, toys)
  - measuring instruments, controlling devices and instruments
  - data processing equipment (Computers)
  - heart pacemakers
  - bio-organisms
  - etc

Sources of Noise, Coupling Mechanisms

TYPICAL NOISE PATH

Three elements necessary to produce an interference problem:
- a noise source,
- a receptor circuit, susceptible to the noise,
- a coupling channel to transmit the noise from the source to the receptor.

In addition, the noise must be emitted:
-at a frequency that the receptor is susceptible,
-with an amplitude sufficient to affect the receptor, and
-by a time the receptor is susceptible to the noise.

TYPICAL NOISE PATH

Definition of the problem.

Done by determining:
- what is the noise source,
- what is the receptor,
- what is the coupling channel
- what are the frequency, amplitude, time (FAT) characteristics of the noise.

Three ways to break the noise path:
- changing the characteristics of the noise at the source,
- making the receptor insensitive to the noise, or
- eliminating or minimizing the transmission through the coupling channel.

In some cases, the noise suppression techniques must be applied to two or to all three parts of the noise path.

TYPICAL NOISE PATH

Most likely applied suppression techniques.

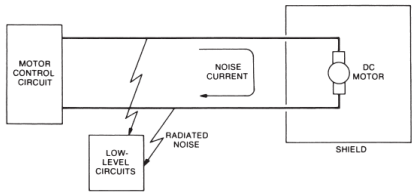
In the case of an **emission** problem, we are most likely to attack the source of the emissions by changing its characteristics—its frequency, amplitude, or time.

For a **susceptibility** problem, we are most likely to direct our attention to modifying the receptor to increase its immunity to the noise.

In many cases, modifying the source or receptor is not practical, which then leaves us with only the option of controlling the coupling channel.

TYPICAL NOISE PATH

An example. A shielded direct current (dc) motor connected to its motor-drive circuit.



METHODS OF NOISE COUPLING

Conductively Coupled Noise

One of the most obvious ways to couple noise into a circuit is on a conductor. A wire run through a noisy environment may pick up noise and then conduct it to another circuit. There it causes interference.

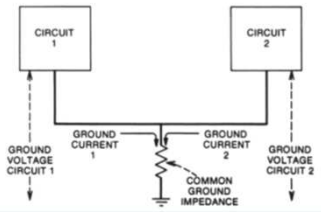
The solution is to prevent the wire from picking up the noise or to remove the noise from it by filtering before it interferes with the susceptible circuit.

METHODS OF NOISE COUPLING

Common Impedance Coupling

Common impedance coupling occurs when currents from two different circuits flow through a common impedance.

Example 1

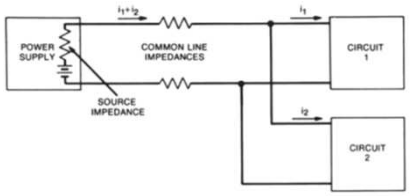


Wrocław University of Technology
Master programmes in English
at Wrocław University of Technology

METHODS OF NOISE COUPLING

Common Impedance Coupling

Example 2



Any change in the supply current required by circuit 2 will affect the voltage at the terminals of circuit 1 because of the common impedances of the power supply lines and the internal source impedance of the power supply.

Wrocław University of Technology
Master programmes in English
at Wrocław University of Technology

METHODS OF NOISE COUPLING

Electric and Magnetic Field Coupling

Radiated electric and magnetic fields provide another means of noise coupling. All circuit elements, including conductors, radiate electromagnetic fields whenever a charge is moved.

In addition to this unintentional radiation, there is the problem of intentional radiation from sources such as broadcast stations, mobile telephones and radar transmitters.

When the receiver is **close** to the source (near field), electric and magnetic fields are considered separately.
When the receiver is **far** from the source (far field), the radiation is considered as combined electric and magnetic or electromagnetic radiation.

Wrocław University of Technology Master programmes in English at Wrocław University of Technology

SYSTEM LEVEL SUPRESSION

To implement system level suppression, the following techniques are generally required:
a. Shielding
b. b. Gasketing
c. Grounding
d. Filtering
e. Decoupling
f. Proper track routing
g. Circuit impedance control
Symetrization
h. Isolation and separation
i. I/O interconnect design
j. PCB suppression techniques designed internal to a component package

Wrocław University of Technology Master programmes in English at Wrocław University of Technology

SYSTEM LEVEL SUPPRESSION

Even with all of these items, multiple techniques of suppression to achieve a compliant product can be required.

HUMAN CAPITAL Wrocław University of Technology
Project co-financed from the EU European Social Fund

Wrocław University of Technology Master programmes in English at Wrocław University of Technology

Test questions examples:

1. Name elements necessary to produce an interference problem.
2. What are three ways to break the noise path ?
3. What are the three most imported noise charakteristics ?

HUMAN CAPITAL Wrocław University of Technology
Project co-financed from the EU European Social Fund