

Digital Circuit Radiation II

Controlling Common-Mode Radiation

Choose yourself and new technologies

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

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

Project co-financed from the EU European Social Fund

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

Digital Circuit Radiation

Radiation from digital electronics can occur as either **differential mode or common mode**.

Differential-mode radiation is the result of the normal operation of the circuit
Common-mode radiation is the result of parasitics in the circuit

No common-mode current is required for normal system operation.

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

CONTROLLING COMMON-MODE RADIATION

The common-mode radiation is proportional to the source frequency, the length of the antenna (cable), and the magnitude of the common-mode current on the antenna.

The common-mode current is the only parameter completely under the EMC designer's control.

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

CONTROLLING COMMON-MODE RADIATION

The net common-mode current on a cable can be controlled by:

1. Minimizing the common-mode source voltage, normally the ground potential
2. Providing a large common-mode impedance (choke) in series with the cable
3. Shunting the current off the cable
4. Shielding the cable
5. Isolating the cable from the PCB ground, for example, with a transformer or optical coupler

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

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

CONTROLLING COMMON-MODE RADIATION Common-Mode Voltage

The first step in controlling the common-mode radiation is to minimize the common-mode voltage that drives the antenna (cable).

HUMAN CAPITAL Wroclaw University of Technology

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

CONTROLLING COMMON-MODE RADIATION Cable Filtering and Shielding

Even when the ground voltage is minimized, it is usually not sufficient to control the common-mode radiated emission.

HUMAN CAPITAL Wroclaw University of Technology

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

CONTROLLING COMMON-MODE RADIATION Cable Filtering and Shielding

A: UNSHIELDED CABLE
B: PROPER SNIP SHIELD CONNECTION
C: NO SHIELD CONNECTION
D: PARTIAL SHIELD CONNECTION
E: SHIELD CONNECTED TO PCB GROUND

HUMAN CAPITAL Wroclaw University of Technology

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

CONTROLLING COMMON-MODE RADIATION

Cable Filtering and Shielding

Cable shields should be terminated to the enclosure not to the PCB ground, but there are economic advantages to mounting the I/O connectors on the PCB, not on the enclosure.

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

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

CONTROLLING COMMON-MODE RADIATION

Cable Filtering and Shielding

Filtering of the I/O cables can be accomplished by adding a high impedance in series with the common-mode noise (e.g., a common-mode choke or ferrite core), or by providing a low-impedance shunt (a capacitor) to divert the common-mode noise to "ground."

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

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

CONTROLLING COMMON-MODE RADIATION

Separate I/O Grounds

If I/O connectors and/or cable filter capacitors are to be mounted on the PCB, then access is needed to the enclosure ground on the PCB.

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

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

CONTROLLING COMMON-MODE RADIATION Separate I/O Grounds

Digital PCB with a separate "clean" I/O ground plane that contains only I/O cable filter capacitors and connectors

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

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

CONTROLLING COMMON-MODE RADIATION Separate I/O Grounds

Generally, the key is to have a low inductance connection between the I/O ground and the enclosure.

The PCB's power plane should not be allowed to extend into the I/O ground area.

The clean I/O ground should be located at the point where the cables leave/enter the system.

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

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

CONTROLLING COMMON-MODE RADIATION Separate I/O Grounds

The effectiveness of the I/O cable filter capacitors depends on the common-mode source impedance of the driving circuits. Sometimes, better results can be obtained by using a series resistor, ferrite, or inductor in addition to, or instead of, the cable filter capacitor.

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