

Basic aspects of EMC

EMC basic aspects

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IEP

References

1. Williams T., *EMC for Product Designers*, Elsevier-Newnes, 5th ed., Oxford, 2015
2. Ott H. W., *Electromagnetic Compatibility Engineering*, Wiley, Hoboken, NJ, 2009

Illustrations in this presentation are taken mostly from above

EMC – Electro-Magnetic Compatibility

From Collins dictionary:

Compatible - adjective
If things, for example systems, ideas, and beliefs, are compatible, they work well together or can exist together successfully.
Synonyms of compatible: agreement, consistency, accordance, affinity

compatibility - uncountable noun
Synonyms: consistent, in keeping, consonant,

EMC – Electro-Magnetic Compatibility

- Apparatus (systems) can coexist and cooperate without disturbances from electromagnetic phenomena
- and not introducing electromagnetic disturbances to the environment

EMC subjects

Electro-magnetic compatibility means the ability of an electrical device (component, system), to work properly in its electro-magnetic environment, without introducing intolerable electro-magnetic disturbances to anything in that environment.

Noise vs. Interference

Noise – electric signal other than desired:

- intrinsic noise sources as thermal noise or shot noise, flicker noise
- natural *disturbances* as lightning or sunspots,
- man – made *noise* coupled from EM environment,
- but
- **not** distortion produced in a circuit due to nonlinearities unless coupled to other part of circuits

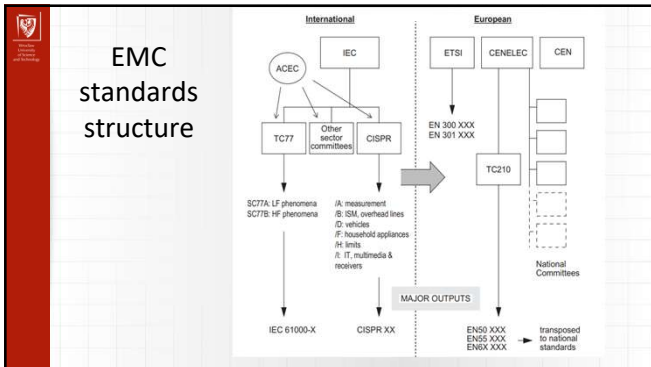
Interference – undesired effect of noise

Noise vs. Interference

- interference can be eliminated – for example by eliminating nonlinearities
- noise cannot be eliminated – can be reduced in magnitude, until it no longer causes interference

Electromagnetic phenomena which can be expected to interfere with control systems are:

- supply voltage interruptions, dips, surges and fluctuations;
- fast transient overvoltages (spikes and surges) on supply, signal and control lines;
- electrostatic discharge (ESD) from a charged object or person;
- radio frequency fields, both pulsed (radar) and continuous, coupled directly into the equipment or onto its connected cables;
- low frequency magnetic or electric fields




- ### Abbreviations:
- IEC International Electrotechnical Commission
 - CENELEC European Committee for Electrotechnical Standardization
 - CISPR International Special Committee for Radio Interference
 - CEN European Committee for Standardization
 - ETSI European Telecommunications Standards Institute
- TC210 = the committee charged with preparing the EMC standards
 TC77 = "The United Nations for EMC"

Directive 2014/30/EU
 of the European Parliament and of the Council of 26
 February 2014 on the harmonisation of the laws of the
 Member States
 relating to ElectroMagnetic Compatibility

Applicable from 20 April 2016.


Summary of references of harmonised standards published in the
 Official Journal – Directive 2014/30/EU



This Directive applies to apparatus liable to cause electromagnetic disturbance or the performance of which is liable to be affected by such disturbance.


It defines the protection requirements and inspection procedures relating thereto.

Electromagnetic emissions of most electrical and electronic products are controlled and it is ensured that these products are not themselves unduly affected by electromagnetic interference



Apparatus affected

- ▷ Domestic audio and video receivers
- ▷ industrial equipment
- ▷ mobile radio and commercial radiotelephone equipment
- ▷ medical and scientific apparatuses and devices
- ▷ information technological appliances (e.g. computer)
- ▷ domestic appliances and household electronic equipment
- ▷ radio equipment ("walkie-talkie")
- ▷ electronic teaching devices
- ▷ telecommunication equipment and networks
- ▷ radio and television broadcast transmitters
- ▷ lights and fluorescent lamps



Exceptions:

1. Benign equipment
 - a) It is incapable of generating or contributing to electromagnetic emissions which exceed a level allowing radio and telecommunication equipment and other equipment to operate as intended;
 - b) It will operate without unacceptable degradation in the presence of electromagnetic disturbance normally consequent upon its intended use.
2. Other Directives
 - a) 98/79/EC in vitro medical devices;
 - b) 93/42/EEC medical devices;
 - c) 72/245/EEC EMC of vehicles as amended by 95/54/EC, 2004/104/EC, and now UNECE Regulation 10, but see section 5.1.1.2 regarding non-safetycritical aftermarket equipment;
 - d) 75/322/EEC EMC of agricultural or forestry tractors as amended by 2000/2/EC;
 - e) 97/24/EC two- and three-wheel motor vehicles;
 - f) 96/98/EC on marine equipment;
 - g) 90/384/EEC non-automatic weighing instruments
3. Components
 - a) Its sole purpose is to be incorporated into the device,.

EXCLUSIONS

- Certain installations (combinations of items put together at a given place to fulfil a specific function but not designed for supply as a single functional unit)
- Spare parts
- Second hand apparatus
- Apparatus for use in a sealed electromagnetic environment
- Some military equipment
- Certain radio equipment for radio amateurs which is not available commercially
- Apparatus which - irrespective of their design - can neither emit nor be affected by electromagnetic disturbance

Apparatus/System ?


Component

COMPONENTS and FINISHED PRODUCTS

- **Component** is any unit used in the assembly of an apparatus, which can perform a direct function, e.g. electronic circuit boards, electric motors, cards for computer systems (can be separately placed on the market).
Single Commercial Unit with CE; if it is not ready to use: no CE, only assembly instructions.
For Components without direct function (e.g. resistors, diodes, integrated circuits, ...) EMC directive does not apply.
- **Finished product** means a device having always a direct function and enclosure of its own, e.g. a TV receiver (for the end-user)


SYSTEMS and INSTALLATIONS

- **System** means the combination of several types of apparatus to perform a specific task. The end user is assembling the so called system, e.g. a computer system with monitor, keyboard, printer etc. The manufacturers of each apparatus are complying with the EMC directive, they are CE marked and separate instructions exist.
- **Installation** means several combined apparatus or several systems assembled in a specific place in order to fulfil a specific purpose, which is not released on the market as a combined unit. All systems and apparatus included in the installation shall fulfil the requirements of the directive and be installed in accordance with the manufacturer's instructions to ensure that satisfactory EMC properties are achieved for the installation.



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Components
Apparatus – finished product
 System
 Installation



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Regulations:
 1.General -IEC 6xxxxxx (EN6...)
 2. Apparatus specific -EN5xxxx
 3. Radio Equipment Directive...
 4. National (e.g. FCC.....)
 5. Other standards (e.g. Aeronautic,
 Automotive, Manufacturer



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Manufacturer regulation (example for automotive):

AEC (Automotive Electronics Council) standards are a set of voluntary qualification standards that specify requirements for the reliability and testing of electronic components used in the automotive industry . Their main purpose is to ensure high quality and long-term reliability of components that must operate in the harsh environmental conditions found in cars.

The two main standards:

- AEC-Q100: "Failure Mechanism Based Stress Test Qualification for Integrated Circuits, Qualification of integrated circuits (ICs) exposed to various factors such as temperature, humidity, and vibration
- AEC-Q200: "Stress Test Qualification for Passive Components". Qualification of passive electronic components such as resistors, capacitors, and inductors

Other standards and legislation

- **Automotive**
 - Europe-Automotive EMC Directive 2004/104/EC
 - International - ISO, CISPR and SAE
 - Manufacturer tests
 - Specialist requirements (ambulances, police.....)
- **Militari**
 - USA - MIL-STD-461/462 (now MIL-STD-461G)
 - UK - DEF STAN 59-411
- **Aerospace**
 - Europe - EUROCAE/ED-14
 - USA - RTCA/DO-160
- **Rail** (e.g. EN 50121/EN 50155 or London Underground....)
- **Safety standards** – e.g. ex (explosive hazard)

CE + CE = ~~CE~~

Costs

Elements of EMC planning:

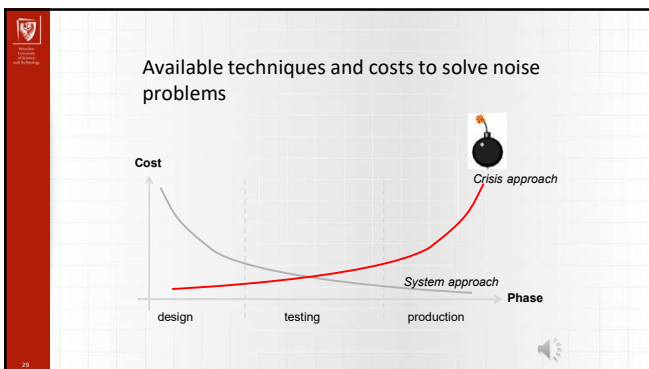
- Basic design
- Supplied components/parts
- Layout of electronic boards
- Selection of housing case
- additional measures

Time

Development Prototype Manufacturing Installation

Two approaches to EMC engineering:

- **Crisis approach** – designer proceed with a total disregard of EMC – EMC problems are solved by „add on“ („Band Aid“)
 - very expensive and nervous
- **System approach** – designer proceed with EMC rules at the beginning
 - 90 % of problems are eliminated during designing process



- the steps to take for a new product to achieve compliance and bear the CE
- A. Case of Self certification**
1. From the marketing specification, determine what type of product it will be and what environment it will be sold for use within
 2. Specify the standards that the product must meet
 1. General -IEC 6xxxxx...
 2. Apparatus specific -EN5xxxx
 3. International (e.g FCC)
 4. RED (Radio Equipment Directive)....
 5. Other standards (e.g. Aeronautic)....
 3. Draw up a test plan, !!!!!!!
 1. Describe in detail the versions of product and configuration
 2. Decide the pass/fail criteria
 4. If your product is in the phase of prototype or pre-production stages you can make pre-compliance tests to check the performance of the product and also the validity of the test plan – modify, if necessary, both design and test plan.
 5. Conduct full in-house testing or have a specialized company do it on one or more production samples.
 6. Mark the product with the CE mark and your empowered signatory can sign the Declaration of Conformity (valid for ten years) (If other New Approach Directives apply, a parallel process needs to be followed for each).
 7. The product can be placed on the market.
 8. Take steps to ensure that any changes in production or technology do not change the properties of the product, otherwise tests must be conducted again.
- B. The case of hiring a Notified Body** (this approach is in addition to the steps outlined above).
1. In step 3 above, select a Notified Body capable of evaluating the product type in question. Provide them with documentation and expect a statement confirming compliance, as well as an invoice.
 2. In practice, NB can be selected in step 1 above. NB will help you decide what standards must be met, create a test plan and execute it, and invoice.
