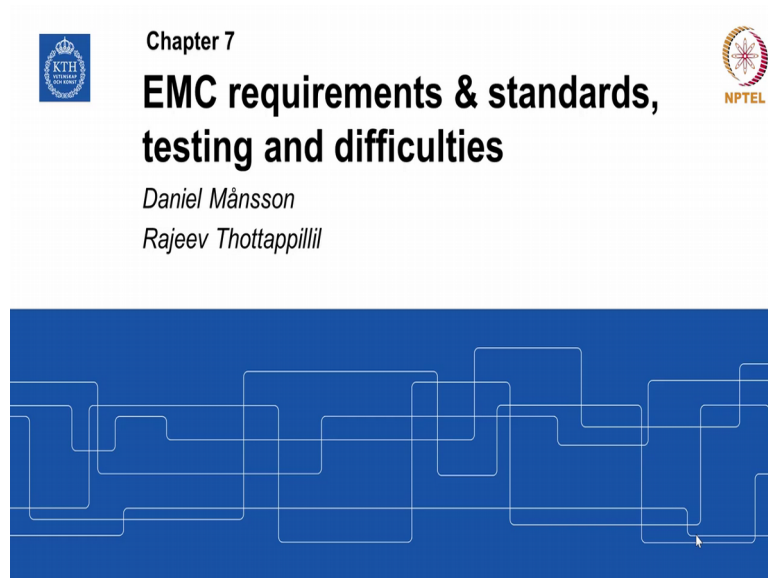


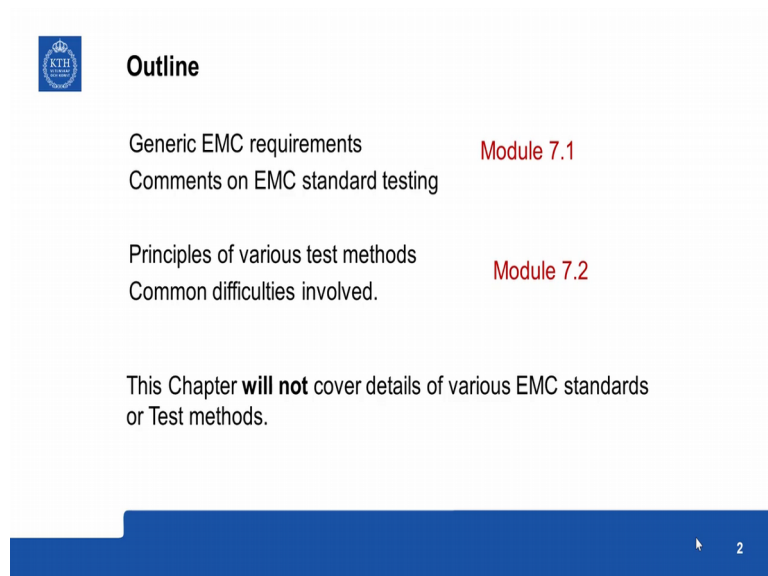
Electromagnetic compatibility, EMC
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Module 7.1
EMC requirements and standards, testing and difficulties

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(())(0:13) and standards some of the testing methods and difficulties, this chapter is more like a survey we will not go to much deep into it. Information is readily available in many public forums.


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The outline as like this first a description of generic EMC requirements concentrating on the requirements in the USA and European Union and some comments on EMC standard testing.

Then module 2 principal of various test methods and some of the common difficulties involved. This chapter will not cover details of various EMC standards or test methods because these are always changing all the time and one need to always look for the most recent updates and EMC standards are in general kind of a common consensus among the regulatory bodies representing the government, various industries and consumers.

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EMC requirements

- Standards exist to **mirror the requirements set by governing bodies** in a country or region. The essential requirement of any EMC directive is that systems/products should be constructed in such a way that:
 - the electromagnetic **disturbance it generate does not exceed** a level allowing radio and communication equipment and other devices to operate as intended, and Emission testing
 - the product has an **adequate level of intrinsic immunity** to electromagnetic disturbance so that it is immune from electromagnetic disturbance from other sources in its environment. Immunity testing

Standards – 'a consensus position'

IEC, EN, CISPR, FCC, MIL-STD, ... Test levels, test methods

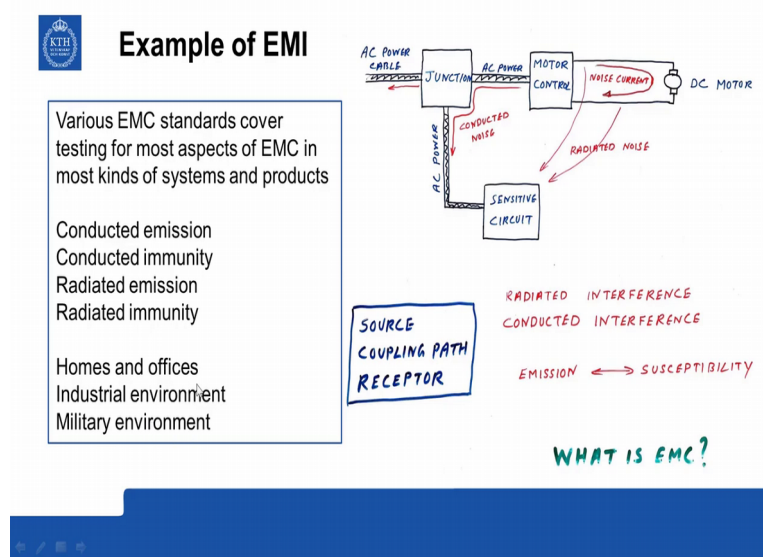
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What are the EMC requirements which we have seen in chapter 1 and 2 The general principles. The standards exit to mirror the requirements set by governing bodies in a country or region. Now the most essential comments of any EMC directive issued by a government as regards to systems and products it is about how electromagnetic disturbance when it is generated is not exceeding certain levels allowing radio and communication equipment and other devices to operate as intended and also this products that should have adequate level of intrinsic immunity to electromagnetic disturbance.

So one is the emission should not be more than certain level, so this is covered by various instructions on how to test for emission from equipment and devices so that other devices are working as intended without disturbance then when it comes to immunity testing, adequate level of intrinsic immunity is specified and test methods for that are also specified so that equipment are working in the intended environment as it should. So standards are really a consensus position between the various factors together and it does not solve all the issues of EMC because if you have really want to design system that it should never fail or disturb other systems then it can be very expensive, so you need to have some reasonable limits and reasonable immunity.


So standard specified test levels as well as test methods and there are many different standards issued by different bodies say for example International Electrotechnical Commission has several standards issued based on the regulations given by other regulatory bodies in USA or Europe. When you have a European Norm usually IEC and European Norm are kind of same then you have this industry standard CISPR, then FCC Federal Communication Committee of the USA and you have this US military standard, so these are also widely adopted military standards. Any equipment that are sold to US military or US military establishment has to comply with this.

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Now what other things tested, so this is from chapter 1 explaining the different ways of having interference you have this conducted emission due to that you can have EMC issues and ((5:34)) to that conducted immunity, then radiated emission and radiated immunity, so all these things are covered under various EMC standards and there will be test methods specified also. Now this can happen in various kinds of environment. There are 3 commonly used environment home and offices, industrial environment, so in industrial environment you have higher threshold for emission and immunity then you have military environment where you expect extremely harsh environment. In addition to that you have special cases like civil aviation then other radio and complication equipment specifically in ((6:36)) for those purposes.

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Most followed EMC Regulations around the world

US


- The body responsible for regulation of EMC emissions in the USA is the **Federal Communications Commission (FCC)**.

The FCC Declaration of Conformity or the FCC label or the FCC mark is a certification mark employed on electronic products manufactured or sold in the United States which certifies that the electromagnetic interference from the device is under limits approved by the Federal Communications Commission.



EU

- For the majority of electrical and electronic products, EMC requirements in the European Union are covered by the **EMC Directive (2014/30/EU)** for the CE marking



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2 of the most followed EMC regulations around the world are from US and EU that is because most of the products made in say for example in China and up in US or EU and not only that this will be 2 places where for the first time EMC was taken seriously as most advanced economies and they started to making regulations and other countries usually follow those regulations adopted into their national practice.

So in the USA the body responsible for regulation of EMC emission is Federal Communication Commission FCC, so the FCC declaration of conformity it is called FCC label or FCC mark it is a certification mark employed on electronic products manufactured or sold in the United States and it certifies that the electromagnetic interference from devices is under limits approved by the Federal Communication Commission, so it is a very powerful body FCC, so this is the symbol for the FCC label.

The corresponding body in EU is European Union, various directives of the European Union, so one particular directive for EMC is EMC directive 2014/30/EU, so this is the latest one and the compliance certificates CE marking is provided when this mark are, this directives are fulfilled, so this is symbol for CE. So in many products you can see either this or this or sometimes both if a product is for both places. We will see more details of EMC directives below.

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EMC requirement 2014/30/EU

- E.g., Any electrical or electronic product marketed in countries belonging to the European Economic Community must meet the requirements of the European Union's Electromagnetic Compatibility (EMC) Directive 2014/30/EU.
- Some important and interesting part to 2014/30/EU includes:



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EMC requirement 2014/30/EU

“(8) The equipment covered by this Directive should include both apparatus and fixed installations. [...]”

“(20) It is necessary to ensure that products from third countries entering the Union market comply with this Directive [...]”

“(26) Fixed installations, including large machines and networks, may generate electromagnetic disturbance, or be affected by it. [...] In terms of electromagnetic compatibility, it is irrelevant whether the electromagnetic disturbance is produced by apparatus or by a fixed installation. Accordingly, fixed installations and apparatus should be subject to a coherent and comprehensive regime of essential requirements.



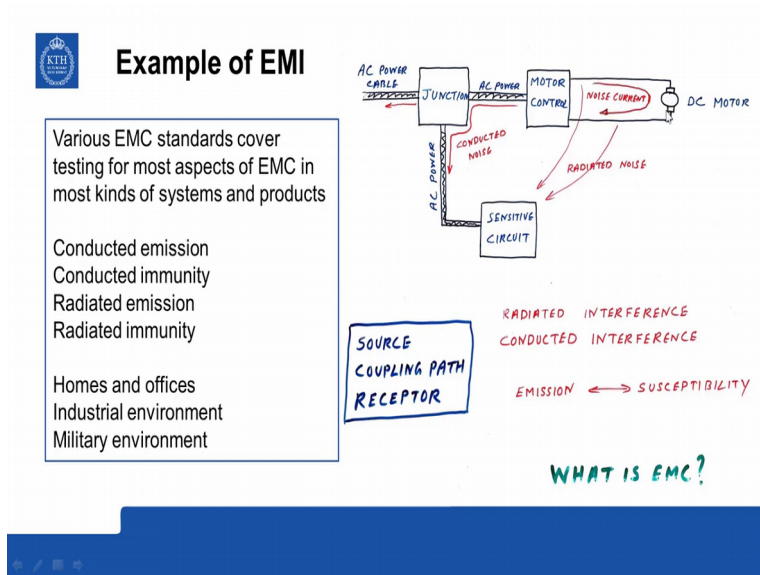
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So EMC requirements 2014/30/EU any electrical or electronic product marketed in countries belonging to the European Economic Community must meet the requirements of European Union's electromagnetic compatibility directive. Now there are some important and interesting parts that we can highlight here say for example clause 8 says that equipment covered by this directive should include both apparatus and fixed installations because apparatus are not stationary or standing alone it is connected to fixed installations often.

20 says that it is necessary to ensure that products from 3rd countries entering the union market comply with this directive, so any product made in India, China or Thailand or Brazil entering European Union also should comply with this directive so the directive has a worldwide range that way. Fixed installation including large machines and network, may

generate electromagnetic disturbance or affected by it. In terms of electron magnetic compatibility, it is irrelevant whether the electromagnetic disturbance is produced by apparatus or by a fixed installation. Accordingly, fixed installation and apparatus should be subject to a coherent and comprehensive regimen of essential requirements.

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This we have seen in the 1st example you notice here, so here the noise will be produced by the DC motor over here but then it goes to the power system and gets distributed, so for the sensitive circuit it may be like that it is the fixed installation that is giving out this noise and from there it will be radiating also, so all these things are coming together in the electromagnetic environment.

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EMC requirement 2014/30/EU

“(35) The CE marking, indicating the conformity of apparatus, is the visible consequence of a whole process comprising conformity assessment in a broad sense.”

CE

“(36) Due to their specific characteristics, fixed installations need not be subject to the affixing of the CE marking or to the EU declaration of conformity.”

Now this CE marking indicating the conformity of apparatus is the visible consequence of a whole process comprising conformity assessment in a broad sense. Now how this assessment is to be done? So this is what the standards are specified, so these are just what are the requirements will be set by this directive, the standards will tell how a class of equipment should be tested, what kind of test methods are used?

What are the levels for conducted emission, conducted immunity, radiated emission and radiated immunity and how do you interpret the test results? All these things, so then after all this process the equipment will be given this certification which is a legal requirement. Now due to their specific characteristics, fixed installation will not be subject to the affixing of the CE marking all to the EU declaration of conformity. However in the testing of the individual products, the fixed installation has the somehow... its characteristics has to be included.

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EMC requirement 2014/30/EU

Some important systems are covered by other regulations:

“(10) **Radio equipment and telecommunications terminal equipment** should not be covered by this Directive since they are already regulated by Directive 1999/5/EC [...]”

(11) **Aircraft or equipment intended to be fitted into aircraft** should not be covered by this Directive since they are already subject to special Union or international rules governing electromagnetic compatibility.”

Some important systems are covered by other regulations, say for example radio equipment and telecommunication terminal equipment, so it has got its own directive, they have some, due to the sensitive nature they have some (())(13:09) special requirements. Similarly, aircraft or equipment intended to be fitted into aircraft they have extremely stringent conditions to be met, so that also is covered by special international rules.

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EMC standard testing issue

- When designing a system, it is important to consider the **most likely EM environment** the system will be placed in.
- Thus, we can most probably avoid a mismatch between the disturbances present and the standards the system is tested against.
- For example, if a normal laptop is tested against a standard for residential equipment it should not be used in, e.g. a industrial environment with harsher EM environment.
- Conformity to the electromagnetic environment have to apply for all systems. **Industrial systems are tested against harsher disturbances and are allowed to have higher levels of emissions.**

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So when designing a system it is important to consider the most likely EM environment that system will be placed in, so the testing is done accordingly and CE marking or FCC marking is given accordingly but many of these equipment can be quite generic and it may get...may be that they will be used in other environment also. For example a normal laptop, it is tested against a standard for residential equipment because that is where mostly it will be used but you can carry a laptop into an industrial environment with a harsher EM environment and use it over there but then of course that laptop is not really suitable for those environment. Now industrial systems are tested against harsher disturbance and are allowed to have higher levels of emission.

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EMC standard testing issue

Mismatch between standard for residential and for industrial systems. Industrial systems should withstand $\approx 3x$ more.

Immunity levels - enclosure port			
Frequency	80 - 1000 MHz	1.4 - 2.0 GHz	2.0 - 2.7 GHz
E - field	3 V/m	3 V/m	1 V/m

IEC 61000-6-1: "Electromagnetic compatibility (EMC) –

Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments"

Immunity levels - enclosure port			
Frequency	80 - 1000 MHz	1.4 - 2.0 GHz	2.0 - 2.7 GHz
E - field	10 V/m	3 V/m	1 V/m

IEC 61000-6-2: "Electromagnetic compatibility (EMC) –


Part 6-2: Generic standards – Immunity for industrial environments"

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So this we can see in this, so what is shown here this extra (14:42) from IEC standard 61000-61 electromagnetic compatibility 6-1 is generic standards or immunity of residential, commercial and light industrial environment. Similarly you have this extension to this same standard that covers immunity for industrial environment, so you can see that immunity levels are different for the standards especially between 80 megahertz and 1 gigahertz for normal residential and offices it is 3 volts per metre.



So up to 3 volts per metre phase it should withstand even if it fails at 4 volts per metre does not matter still it is as per conformity whereas if that equipment is to be used in industrial environment its specification is 10 volts per metre because we have harsher environment for the industry for this particular frequency. For other frequency they tend to be the same, so the environment where the equipment is to be used that also is coming into these standards.

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EMC standard testing issue

- If, e.g., a system is bought from an industrial supplier it has been tested against industrial environments and then it is allowed to emit more noise and still be CE marked and conform to the EMC regulation via a EMC test laboratory.
- However, if installed in a lab or home it can still cause EMI in, e.g., a normal laptop as this is tested against a standard not so harsh.



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To elaborate on this, a system is bought from an industrial supplier and it has been tested against industrial environments you know some kind of a system and if it is installed in a process lab or home it can cause EMI because it is permitted to emit much larger noise than that normally will find at home or light offices, so where it is going to be used is very important.

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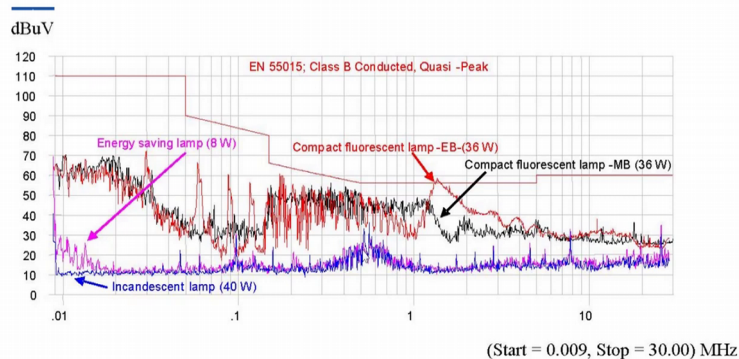
EMC standard testing issue

- Another important issue to remember is that even though a component/system is CE marked it might not actually mean that it is well designed, tested or conform to requirements!
- There are, e.g., many cases of lamps being the cause of EMI! (Notice below that even the incandescent bulb emits noise for some frequencies.)

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Now a component may be CE marked it only shows that, that particular component does not emit more than specified in that particular environment for that particular frequency band of course it does not prevent that component from emitting beyond those specified bands or being immune beyond that specified bands. So CE marking is not really any task for well-designed component of the quality of the component, how important this is you have seen when we discuss about (())(17:41) EMI where the services can be... need not follow in the standard pathways or standard specifications it can be anything, so there can be some equipment under CE marking that can be more vulnerable than other equipment under CE marking in non-ideal situations.

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["The Comparison of Conducted EMI Emission and Electrical Performances of Lamps", Uyalson, C.; Khan-ngern, W., Power Electronics and Drive Systems, 2007. PEDS '07. 7th International Conference on];
<https://ieeexplore.ieee.org/document/4487931>

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Thank you!

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So one example can be given here using lamps, so this is taken from this particular publication on comparison of conducted EMI emission and electrical performance of lamps, so this is the conducted emission limits what is shown here dB micro volt that is coming from this European norm 55015 class B conducted, so as per the standard test procedures it is done, so all this devices are kind of confirming to these standards they are below this particular limit, so these are the normal incandescent lamp 40 watt you can see the noise when you have this energy saving lamp 8 watt noise produced by that then you have this compact fluorescent lamp 36 watt and this also is another compact fluorescent lamp, so you can see that depending upon the make we can have many different types of noises.

Now this product satisfies base standard no problem but suppose if you are in a laboratory doing very sensitive measurements then for general lighting purposes you may have you can choose any of these things but depending upon the sensitive nature of the experiments that you are conducting in your research lab you know some of these lamps maybe more suitable than the other lamps, so just because one product confirmed to the standard does not mean that all of them are the same for that particular application then I have different noise level being produced. Only thing it says that it is below the limit specified. Thank you that is end of module 1.