Electromagnetic Emission: Measurement without an Anechoic Chamber
- Pre-compliance emission troubleshooting at the workstation -

Sven König, Dipl.-Ing. (BA)
Development Engineer
- New measurement tools
- Practical troubleshooting on electronic devices
- EMC/EMI/ESD tests on IC’s
- Teaching seminars and competent customer support
EMC seminars & workshops consultations measurement tools for devices, assemblies and integrated circuits
Electromagnetic Emission:

Measurement without an anechoic chamber

- Pre-compliance emission troubleshooting at the workstation -
1. Theoretical part 1 – testing in anechoic chamber
2. Theoretical part 2 – source of radiated emission
3. ESA1 - measurement without an anechoic chamber
4. Troubleshooting strategies
5. Practical example
Testing in an Anechoic Chamber

- Necessary for certification
- Complex and expensive test procedure
- Anechoic chamber often only available in test labs
- Implementation of simpler methods is possible (GTEM, Stripeline)

➢ How are they comparable to the antenna measurements?

Are these methods the best way to solve emission problems much earlier during the initial design cycle
Are they the right tools for troubleshooting?
Source of Radiated Emission

Antenna excitation – DUT as a transmitting antenna:

- Structures of DUT-PCB are too small to transmit emission directly
- Need for connected cables or nearby metal structures
  - DUT is the source of antenna excitation
Source of Radiated Emission

galvanic antenna coupling

antenna coupling

situation at PCB

current inside the cable

RF generator

antenna

GND

switching IC

single cable
Source of Radiated Emission

antenna coupling by electric field

antenna coupling

situation at PCB

antenna

RF-generator

electric field $E$

antenna

PCB with adjacent metal element

cable, constructional element

electric field $E$

switching IC

switched line
Source of Radiated Emission

antenna coupling by magnetic field

antenna coupling

situation at PCB

current loop
RF-generator
magnetic field $B$

current loop
switching IC
magnetic field $B$
PCB

cable, constructional element
Measurement without an Anechoic Chamber

RF current measurement:

- Measurement of excitation current and antenna resonance current
- Small changes in the environment can cause big changes in current

- Uncertainties in measurement results
Measurement without an Anechoic Chamber

RF current measurement method with **ESA1**: 

- excitation currents are shorted by capacitors to the reference plane
- RF short-circuit should not exceed $\frac{1}{2}$ of the wavelength
ESAT – Emission development system

Data storage for comparison

Distance from module to reference plane of 2-5cm

RF current transformer

Auxiliary energy

Shielding tent

Spectrum analyser

RF bypass with probe tip
ESA1 – Emission development system

- Z23-1 shielding tent on GP 23 reference plane
- RF-R 400-1 H-field probe
- Spectrum analyser
- Filter
- HFW 21 RF current transformer
- DUT
- PA 203 preamplifier
- HFA 21 RF bypass
Research of emission sources

E/D Near-field search:

<table>
<thead>
<tr>
<th>Determine if the module is excited via an E/D field</th>
<th>Determine the excitation source</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-E02 near-field probe to detect the excitation fields</td>
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<tr>
<td>Printed circuit board</td>
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<td>Clocked semi-conductors, broad-band excitation</td>
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<tr>
<td>Conducting track with square-wave voltage as an electrode</td>
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<tr>
<td>Electric field $E$</td>
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<tr>
<td>RF-E05 near-field probe to detect excitation source</td>
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## Research of emission sources

H/B Near-field search:

<table>
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<th>Determine if the module is excited via an H/B field</th>
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</thead>
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<tr>
<td>RF-R400 near-field probe to detect the excitation fields</td>
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<table>
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<th>Determine the excitation source</th>
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<tr>
<td>RF-R2.5-5U near-field probe to detect the current loops</td>
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</tbody>
</table>

[Cable, structural part]
Troubleshooting Strategy
Troubleshooting Strategy
Troubleshooting Strategy

Test of complex devices – DUT with several potential emission sources:

1 - connector between the basic assembly and the interface module
2 - electronics (PHY with a microprocessor) on the interface module
3 - connector of the interface cable
Troubleshooting Strategy

Test of complex devices – detect emission sources on the connector between the basic assembly and the interface module:
Troubleshooting Strategy

Test of complex devices – detect emission sources in the interface module:
Troubleshooting Strategy

Test of complex devices – detect emission sources on the connector of the interface cable:
Troubleshooting Strategy

Test of complex devices – test the emission source of modules:
Practical Example

DUT: Arduino DUE evaluation board with ATMEL microcontroller

Power supply: 12 V

Ribbon cable with Signals, clock, supply

Power supply 12 V
Practical Example

Antenna measurement with a distance of 3 meters:
Results of antenna measurement with a distance of 3 meters:
Practical Example

ESA1 measurement – test set-up:
Practical Example

ESA1 measuring results:
Practical Example

Search of emission sources
- E/D near-field from the DC/DC converter (500 kHz):

Modification:
Shielding DC/DC converter
Practical Example

Results of ESA measurement with shielded DC/DC converter:

- Original
- Modification DC/DC converter
Practical Example

Results of Antenna measurement with shielded DC/DC converter:
Practical Example

Search of emission sources
- H near-field from the Clock line (16 MHz):

Modification:
47 pF at clock line
Practical Example

Results of ESA measurement with shielded DC/DC converter + 47 pF on the clock line:
Results of antenna measurement with shielded DC/DC converter + 47 pF on the clock line:
Conclusion

ESA1 - Measurement without an Anechoic Chamber

• Easy way to solve emission problems in earlier development stage
• Useful tool for troubleshooting
• Evaluate the emission of electronics direct on your workplace
• Shielding tent is reducing the electromagnetic interference from the outside
• Good to discover and compare the effectiveness of modifications
• Saves time and costs
Next events

Langer will be exhibiting with a table top at the Michigan & Chicago IEEE EMC Chapter this spring:

- May 3rd, 2016  **IEEE EMC Mini Symposium**, Chicago (Itasca, IL)
- May 5th, 2016  **IEEE EMC Fest**, Detroit (Liviona, MI)

You will have the opportunity to see firsthand our various PCB and IC probes, as well as our software.
Thanks for attending!

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