Alternative Radiated Emission Test Methods
Progress Achieved in IND60 Project

Project EMRP IND60: Improved EMC test methods in industrial environments

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Wroclaw, Poland
Outlines

• Introduction
• RE Measurements at Close Distance
• Surface Wire Method
• Absorbing Clamp Method
• Summary
Alternative Radiated Emission Tests

- RE tests at close distances
- Surface Wire Method
- Absorbing Clamp Method
- GTEM / TEM cells (striplines)
- Mode-stirred (Reverberation) chambers
- Time-Domain RE

Not Mentioned here
But in IND60
Some RE Test Standards

Purpose: to verify that electric field emissions from the EUT and its associated cabling do not exceed specific requirements

Main standard: **CISPR 22 (EN 55022)** (ITE Emissions)

Some Product standards:

- **EN 61000-6-4** (industrial environments)
- **CISPR 13** (Sound and television broadcast receivers)
- **CISPR 11** (scientific and medical equipment)
- **CISPR 14-1** (household appliances, electric tools)
- **CISPR 25** (Automotive Emissions)
- **MIL-STD 461E/F RE102** (Military)
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Motivation

Laboratory Environment

- Reflections: OK
- Near Field Effects: OK
- EUT-Antenna Coupling: OK

Industry Environment

- Reflections: ???
- Near Field Effects: ???
- EUT-Antenna Coupling: ???
RE Measurement at Close Distance

dummy EUTs

Radiated emission measurements

close distances

Correction factor

standard distances

- Correction factor

Dummy EUTs

0.3m, 0.5m, 1m

signal

receiver

3m (std)

h=1.7m (cd)

h=1-4m (std)

d=3m
(d constant, h: 1-4 m)
ETS-Lindgren Model 3180 Mini Biconical Antenna is scanned near the 6 different dummy EUT (electrical, magnetic or both) at the close distances 0.3m, 0.5m and 1m.

The dummy EUTs were scanned at different heights and points by using the small antenna at close distances.

For all the 6 setups, a metallic radiator box as an EUT with various configurations was used.

Finally, close distances results were compared with the standard distance (3m) results by using the same mini biconical antenna.
Measurement Setups with Mini Biconical Antenna

Setup1: 0.3m x 0.3m

Setup2 & Setup3: 0.7 m x 0.7 m, cables arranged differently

Setup4: external radiating cables

Setup5: loop antenna

Setup6: Rod antenna
Example Setup

➢ The EUT simulation used in Setup1

Setup1 EUT configuration

EUT Configurations and measurement distances/antenna heights

- Maximum value is recorded in both polarizations

<table>
<thead>
<tr>
<th>EUT configuration / Measurement Distance (d)</th>
<th>Antenna Height (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUT 1 0.3 x 0.3 m</td>
<td>0.3 m</td>
</tr>
<tr>
<td></td>
<td>1.75 m</td>
</tr>
<tr>
<td></td>
<td>1.65 m</td>
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<tr>
<td></td>
<td>1.65 m</td>
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<tr>
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<td>1.75 m</td>
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<td>0.5 m</td>
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<td></td>
<td>1.65 m</td>
</tr>
<tr>
<td></td>
<td>1.75 m</td>
</tr>
<tr>
<td>1 m</td>
<td>1.7 m</td>
</tr>
<tr>
<td>3 m</td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td>d: 3 m</td>
</tr>
</tbody>
</table>
|                                             | h: scan from 1 to 4 m

Other measurement parameters

- Mini Biconical Antenna
  - Measurement Range: 30 MHz - 1000 MHz
  - Spot Frequencies (MHz): 30, 60, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 998
- Height of EUT: 1.7 m
- Antenna polarization: Vertical and Horizontal

EUT Configurations and measurement distances/antenna heights
Comparison of Correction Factors with Mini Biconical Antenna

Average Deviation: \( \approx 5 \text{ dB} \)

- **d = 0.3 m**
  - Std = 3 m
- **d = 0.5 m**
  - Std = 3 m
- **d = 1 m**
  - Std = 3 m
Summary – RE at close distance

- Mini-biconical antenna generated broadband signal (30 – 1000 MHz)
  - RE measurements at different non-standard distances
  - 5 different EUTs
  - EUT is scanned at different points, max value is obtained
  - CF consistency between the setups
  - CF decreases with frequency in lower frequencies \(\rightarrow\) low radiation power
  - Promising results
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Surface Wire Method for RE Test

- Some research was realized as seen in the figure with the long surface wires in the Temca 2 project in the past.

- Further research is required for efficient experimental link between the surface wire and the standard method.

- For that reason, we decided to use a shorter surface wire seen below in our research to improve the surface wire method.

\[
AF \ (CF) = V_{\text{alternative\_method}} - E_{\text{standard\_method}}
\]
Surface Wire Measurement Setups

Surface Wire Method

- Frequency range: 30 MHz – 1000 MHz
- Spot frequencies (MHz): 30, 60, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000
- Wire length: 300 mm
- Wire diameter: 6 mm

Standard Method

- Frequency range: 30 MHz – 300 MHz, 200 MHz – 1000 MHz
- Spot frequencies (MHz): 30, 60, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000
- Antenna height: 1.55 m
- Antenna polarization: Vertical & horizontal

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<th>Biconical antenna</th>
<th>Log-per antenna</th>
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<td>200 MHz – 1000 MHz</td>
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<td>30, 60, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000</td>
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<tr>
<td>Wire diameter</td>
<td>6 mm</td>
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Surface Wire Test EUTs

- Internal antenna and twisted cable
- Internal antenna only
- Outside
Results: Correction Factors

EUT SIMULATION 1 with TX antenna and radiating cable

![Graphs showing correction factors for different frequency ranges and setups.](image-url)
Summary – RE Tests with Surface Wire

- Wire on the surface of EUT instead of standard methods in Lab @ 3m
- 6 EUTs differ in emission source and in openings
- Standard antennas: 30 MHz – 300 MHz, 200 MHz – 1000 MHz
- CF at low frequency is higher and tends to decrease with frequency
- Consistency in CF when increasing the number of openings.
- Consistency in CF when decreasing the slit sizes
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Thanks for Your attention...