Safety and Compliance Committee

- Meets once per month for 1 hour
- Safety and Compliance Database
  - Tracks changes in major industry compliance issues including materials, EMI-RFI, CISPR, etc.
  - E-mail alerts sent to anyone subscribed to the Safety and Compliance database, membership list is constantly growing
- Members share regular email blasts with articles of interest
- Monthly articles for How 2 Power, special section “Power Supply Safety and Compliance”
- Continued educational webinars
Bio – Josefine Lametschwandtner

- BS in Science with an emphasis on Electronics and Technology from FH Joanneum
- Lead EMC Engineer for RECOM Power
  - Joined in 2014
  - Previous experience with GE Medical Systems
- EMC filter development and testing
- Customer consulting around all EMC issues
- Organizes the RECOM EMC Seminar
- Tri-lingual (German, English, Spanish)
Immunity Testing of SMPS
Josefine Lametschwandtner, BSc
EMC-Webinar, 30th November 2021
Topics

- Susceptibility to interference
- Overview of tests
  - Transients
  - High frequency
  - General supply network
- Overview
General Principle

Interference due to radiation

Interference due to conduction

Jamming Source

Affecting Device

Jamming Sink
Electromagnetic compatibility according to the Directive 2014/30/EU means:

the ability of equipment to function satisfactory in its electromagnetic environment without introduction intolerable electromagnetic disturbances to other equipment in that environment.
Interconnections between different types of standards

- Product family Standards
  - Particular Standards
- Generic Standards
- Basic Standards
Overview: SMPS under stress

Transients

High Frequency

AC-Supply (Stability & Fields)
Basic Standards - Immunity; 61000-4-x

- ESD (61000-4-2)
- Surge (61000-4-5)
- Burst (61000-4-4)

\{ Transients \\

- HF-induced disturbances (61000-4-6)
- E-Field (61000-4-3)

\{ High Frequency \\

- Power frequency magnetic field (61000-4-8)
- Voltage Dips, Variations and Interruptions (61000-4-11)

\{ Power net \\

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Evaluation of Test Results

- **Criteria A**
  - Normal performance within limits specified by the Manufacturer, requestor or purchaser (e.g. tolerances)

- **Criteria B**
  - Temporary loss of function or degradation of performance which ceases after the disturbance ceases and from which the equipment under test recovers its normal performance, without operator intervention.

- **Criteria C**
  - Temporary loss of function or degradation of performance, the correction of which requires operator intervention

- **Criteria D**
  - Loss of function or degradation of performance which is not recoverable, due to damage to hardware or software, or loss of data.
Types of transients
    ESD
    Burst
    Surge

Intermittent and therefore hardly tangible
    Transients – fast
    Usually not permanent

Coping with voltage overshoot
    Valve
    Short circuit
    Energy conversion by discharge
ESD – Phenomena & Test Pulse

Short Profile:
- Very fast
- Low energy
- Repetition rate of 1 second
- Impact over field and current

Fig.: Test pulse – ESD [01]
ESD – Test Setup

Direct contact discharge
At all conductive touchable parts of the EUT

Indirect contact discharge
At vertical and horizontal Coupling plates

Air discharge
At all non-conductive parts of the EUT

Fig.: Test setup – ESD [02]
Impacts of ESD Damage or Malfunction

- Damage of „fragile“ Connections (Bonds)
- Damage of pn-junction of transistors
- Crosstalk
  - Triggering the Reset signal
  - Corruption of Data packets

Fig.: Bond connection can be damaged [03]

Fig.: Wrong signal due to Crosstalk [03]
ESD – Mitigations

■ Low impedance bypass for ESD-events
  ■ Strong enough to withstand an ESD-event
  ■ Fast enough to be effective within ns-range

■ N-Well-Resistor in Chip-Design

■ Diodes

■ Software
  ■ Monitor and repeat sent packets
Burst – Phenomena & Test Pulse

Short Profile:
- Very fast
- Low energy of the single pulses;
- Repetition frequency 100kHz / 5kHz
- Impact over field and current

Fig.: Test pulse – Burst [04]
Burst – Test Setup

Fig.: Test setup – Burst [05]

Fig.: Test equipment – Burst [05]
Burst – Phenomenon & Test Pulse

**Fig.:** Phenomenon – Burst [02]

**Fig.:** Phenomenon – Burst [06]
Burst – Mitigation

Filter:
- Power supply
- Data lines
- Communication lines

Floor plan:
- Zones

Reduction of parasitic Capacitance

Fig.: Beispiele für Maßnahmen gegen Störungen durch Burst [07]
Surge Phenomenon & Test Pulse

open circuit

short circuit

Short Profile:

- Quite slow
- High in energy
- Repetition frequency: 60s
- Impact due to current

Fig.: Test pulse – Surge [08]

Fig.: Test pulse – Surge [08]
Surge – Test Setup

Line-to-line – differential mode

Line-to-ground – common mode

Fig.: Test setup – Surge [08]
Surge – Mitigation

- Series resistor
- Spark gap
- Gas discharge valve
- Multilayer Varistor (MLV)
  - Low series resistor
  - Low response time (below 1ns)
  - Working Voltage up to 60V
- MOV
  - High current rating
- TVS
  - Low Clamping voltage
  - Fast
- Ferrite Beads
  - Suppression of HF-Signals
  - Low current rating

Fig.: Structure of different elements
High Frequency Noise & Disturbances

Types of high frequency noise:
  via lines
  via field

Type of disturbances:
  Induction of high frequency
  Permanent noise & disturbance

Reduce impact by:
  HF-Short circuit
  Shielding
  Damping
RF-Field – Phenomena & Test Signal

Fig.: Test Signal – RF-Field [09]

Fig.: potential jamming sources[09]
RF-Field – Test Setup

Fig.: Test Setup – RF-Field [09]

Fig.: Calibration Setup – RF-Field [09]
RF-Field – Mitigation

- Shielding
- Filter
- Connection to PE

Usually each remedial action set to reduce emission is also effective for susceptibility of a system.
HF-Induced Disturbances – Phenomena & Test Signal

Fig.: Test Signal – HF-induced disturbances [10]
HF-Induced Disturbances – Test Setup

**Fig.:** Test setup & equipment– HF-induced disturbances [10]
HF-Induced Disturbances – Mitigation

- Filter
- Connection to PE
- Shielding

Usually each remedial action set to reduce emission is also effective for susceptibility of a system.
Disturbances Related to Main Power Grid

Types of disturbances related to main power grid:
- H-Field
- Voltage dips, interruptions and variations

Type of interruption:
- Voltage Drop
- Coupling of 50Hz/60Hz-H-Field

Reduce impact by:
- Buffer by capacitor (vs. Safety)
- Shielding
- Use of components that are not sensitive to magnetic fields
- H-Field due to current – 50Hz/60Hz
- Coupling of these fields into EUT

Fig.: Test area – Power frequency magnetic field [11]
Power Frequency Magnetic Field – Mitigation

- Special Environment
- Shielding for H-Field
- Use of components that are not sensitive to magnetic fields
Voltage Dips, Interruptions and Variations – Phenomena & Test Signal

Simulates:

- Unstable power grid
- Variations in supply voltage
- Short interruptions

Fig.: Test Signal – Voltage dips, interruptions and variations [12]
Disruptions in Power Grid - Mitigation

- Capacitors:
  - Attention: EMC vs. Safety

- UPS (Uninterruptible Power Supply)

- Shutdown in a defined state
Overview: Stressors for SMPS

- **Transients:**
  - Input Lines – protective elements
  - Field – Shielding, Short circuit

- **HF-Disruptions:**
  - Power- & Data lines – Filter
  - Field – Shielding

- **Disruptions caused by the power grid:**
  - Lines – Buffer, Attention: Safety
  - H-Field – Special environment, special shielding
EMC tests simulate real phenomena and they have to lead reproducible results, wherever they are performed.

It is very likely, that a reduction in emission also could lead to a increase in susceptibility.

SMPS are also at the forefront when it comes to immunity.
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3. Aktive elektronische Bauelemente; Leonhard Stiny; Springer Verlag, 3. Auflage, 2016


5. IEC61000-4-4
Sources

6. Handbook on EN61000-4-4; Keith Armstrong; REO UK LTD

7. AN80994; Design Considerations for EFT Immunity
   Shruti Hanumanthaiah, Srinivas NVNS, Cypress

8. IEC61000-4-5

9. IEC61000-4-3

11. IEC 61000-4-6
Sources

11. IEC 61000-4-8

12. IEC 61000-4-11
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Q & A
Thank You

Please take the survey
We appreciate any ideas or suggestions for improvement.
Upcoming PSMA Events of Interest

- APEC in-person Safety and Compliance Meeting (March 2022)
- Visit the PSMA website for more information
Thank You and hope you have enjoyed the webinar

“Wisdom is not a product of schooling but of the lifelong attempt to acquire it.” – Albert Einstein

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