IEEE EMC Chapter - Hong Kong Section

EMC Seminar Series -

All about EMC Testing and Measurement Seminar 2

Introduction to Conducted Emission

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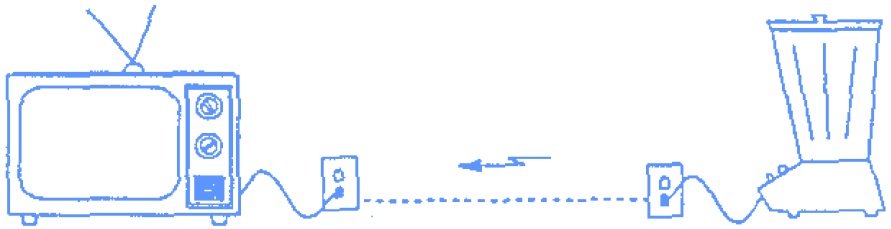

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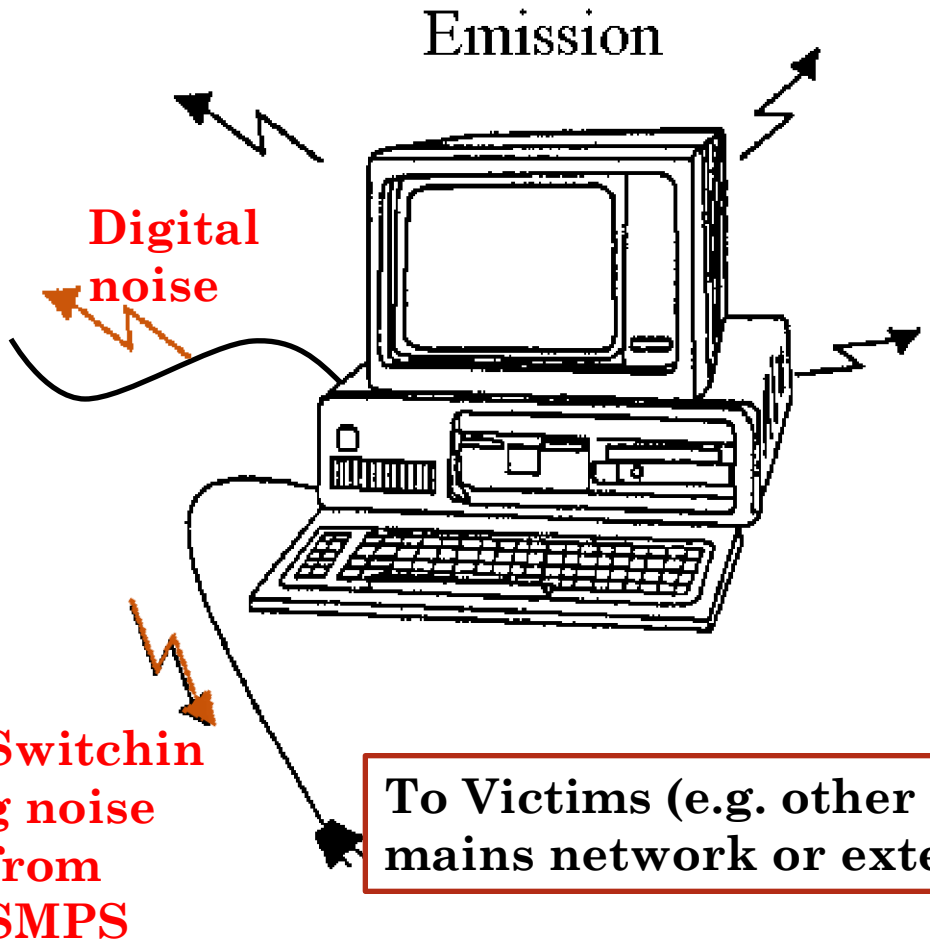
Topics to be covered

- Background on Conducted Emission
- Equipment and Test Setup

Types of Emission from Electrical and Electronics Appliances



- Radiated
  - Enclosures
- Conducted
  - Power port (AC/DC)
  - Signal/ control port
  - Telecommunications / Network Port (CAT5, 6)

Why we need to do Conducted Emission Tests?

- Conducted emission refers to the mechanism that enables electromagnetic energy to be created in an electronic device and coupled to it mains or telecommunications ports.
- Standardization bodies (e.g. CISPR, IEC) had set out the allowable conducted emissions from electronics devices, and stated the limits in various standards (e.g. product standards, generic standards).
- The conducted emission limits in the standard are determined on a probabilistic basis to keep the suppression of disturbances within economically reasonable limits while still achieving an adequate level of radio protection and electromagnetic compatibility.
- In exceptional cases, additional provisions may be required.
  - e.g. Fault conditions are not covered

EXAMPLES OF SOME COMMON CONDUCTED EMISSION STANDA

- **Product standards** in EU countries
  - CISPR 22 / EN 55022 for ITE products
  - CISPR 15 / EN 55015 for Lighting Equipment
  - CISPR 14 / EN 55014 for Household Appliances
  - CISPR 13 / EN 55013 for Sound and TV Broadcast Receivers
  - ETSI 301-489-x for radio equipment
  - Developed by CISPR and IEC, and adopted by EU countries as European Norm
- **Generic Standards** adopted in EU countries
  - IEC/ EN 61000-6-3 – for residential, commercial and light-industrial environments
  - IEC/ EN 61000-6-4 - for industrial environments
- Regulations in United States
  - Federal Communications Commission (FCC) - Code of Federal Regulation (CFR) Title 47) – Part 2, 15 and 18

CONDUCTED EMISSION LIMITS – E.g. EN 55022

Class A ITE - Mains port

Frequency range MHz	Limits dB(µV)	
	Quasi-peak	Average
0,15 to 0,50	79	66
0,50 to 30	73	60
NOTE The lower limit shall apply at the transition frequency.		

Class B ITE – Mains port

Frequency range MHz	Limits dB(µV)	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50
NOTE 1 The lower limit shall apply at the transition frequencies. NOTE 2 The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz.		

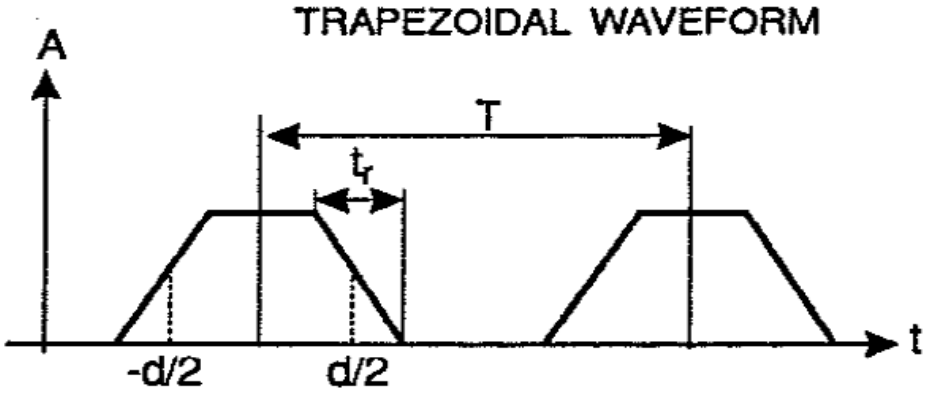
CONDUCTED EMISSION LIMITS

- Typical Frequency Range –150 kHz to 30 MHz (may down to 9kHz)
- Limits – Average and Quasi-peak
- Measured by using average detector and quasi peak detector in EMI receiver.
- For ITE, emission limits are divided into Class A and Class B products
  - Class B ITEs – intended primarily for use in the domestic environment; limits are more stringent.
  - Class A ITEs– all other ITE which satisfies the Class A ITE limits but not Class B; limits are more relax but Warning is required to be included in the instruction for use.

HOW IS RF DISTURBANCE GENERATED IN THE PRODUCTS?

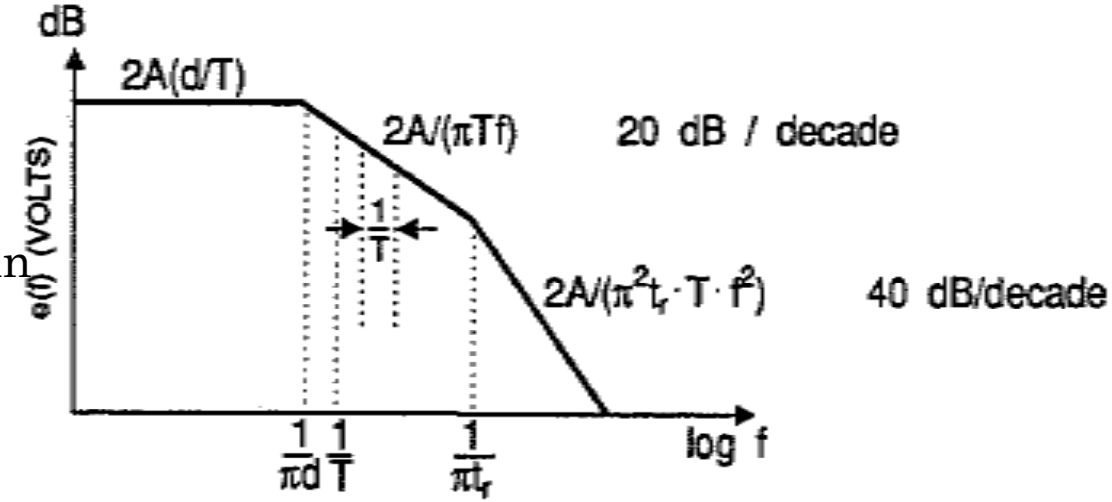
- Time Domain vs. Frequency Domain
  - Modern electronics use pulsed voltages and currents for communications, control and data processing.
  - SMPS using switching techniques to improve efficiency
  - Sudden changes in voltage and current cause EMC problems
  - The pulses are well defined in the time domain
  - Most EMI specification/standards are given in the frequency domain with max allowable noise amplitude (limits) as a function of frequency.

HOW IS RF DISTURBANCE GENERATED IN THE PRODUCTS? – FOURIER TRANSFORM



Time domain

Frequency domain

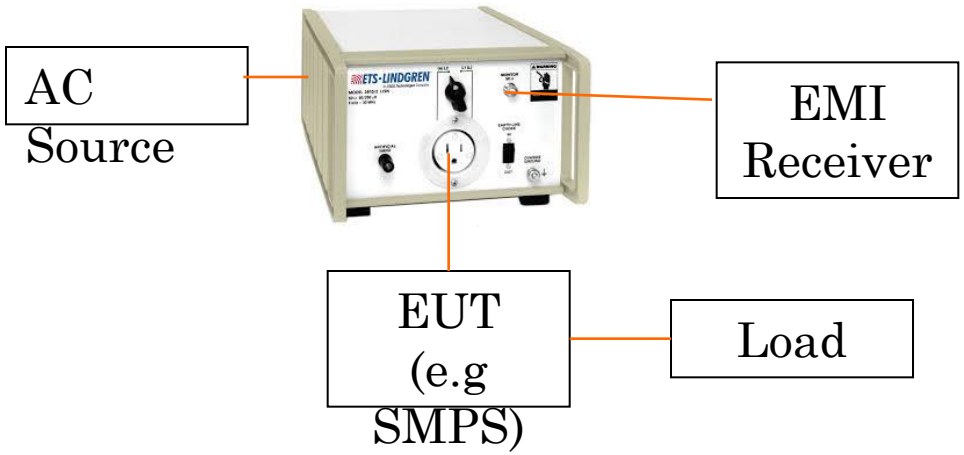


MEASURING EQUIPMENT NEEDED FOR CONDUCTED EMISSION MEASUREMENTS

- Line and impedance stabilizing networks (LISNs)
- Screened Rooms (ensure ambient signal levels at least 6dB below the limits)
- Measuring receivers with Average and CISPR detector
- Auxiliary measuring equipment

Measuring equipment needed for emission measurements - **LISNs**

- Line and impedance stabilizing networks (LISNs)
  - Stable Line Impedance as a function of frequency on the power line
  - Prevent External Noise (from the power line) Coupling in
  - Provide an RF noise measurement port (50 ohm)
- Characteristics are defined in CISPR 16-1-2



LINE AND IMPEDANCE STABILIZING NETWORKS (LISNs) – CHARACTERISTICS

- Impedance (50 Ω / 50 μH) - CISPR 16-1-2
  - Magnitude and phase of the impedance (150kHz to 30MHz) measured at an EUT port

RF port (to EMI Receiver) terminated with 50 ohm

Impedance measured at EUT port

The AMN shall have the impedance (magnitude and phase) versus frequency characteristic shown in Table 4 and Figure 1b in the relevant frequency range. Tolerances of ±20 % for the magnitude and of ±11,5° for the phase are permitted.

Table 4 – Magnitudes and phase angles of the V-Network (see Figure 1b)

Frequency MHz	Impedance magnitude Ω	Phase angle Degree
0,15	34,29	46,70
0,17	36,50	43,11
0,20	39,12	38,51
0,25	42,18	32,48
0,30	44,17	27,95
0,35	45,52	24,45
0,40	46,46	21,70
0,50	47,65	17,66
0,60	48,33	14,86
0,70	48,76	12,81
0,80	49,04	11,25
0,90	49,24	10,03
1,00	49,38	9,04
1,20	49,57	7,56
1,50	49,72	6,06
2,00	49,84	4,55
2,50	49,90	3,64
3,00	49,93	3,04

LINE AND IMPEDANCE STABILIZING NETWORKS (LISNs) – CHARACTERISTICS

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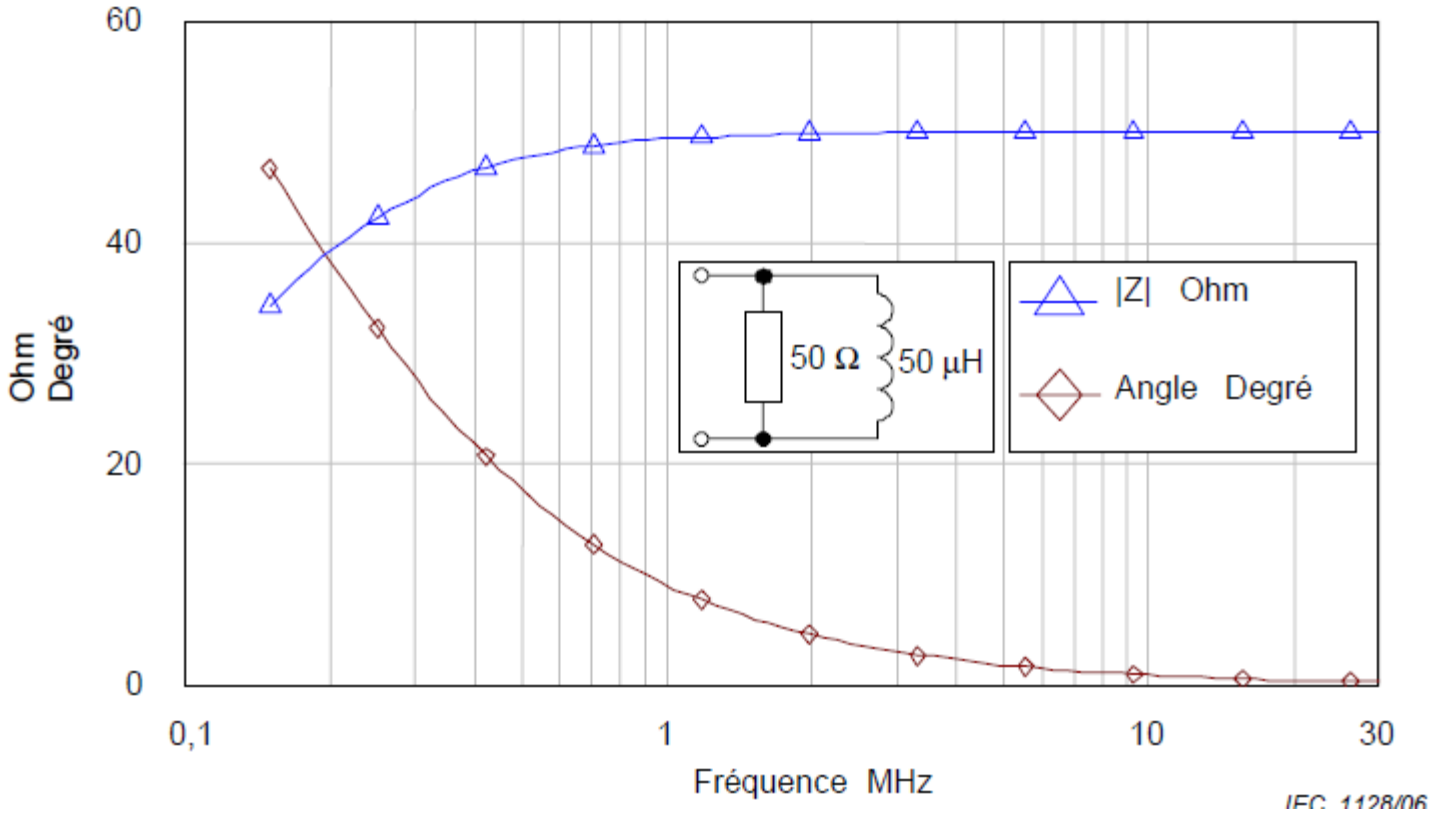
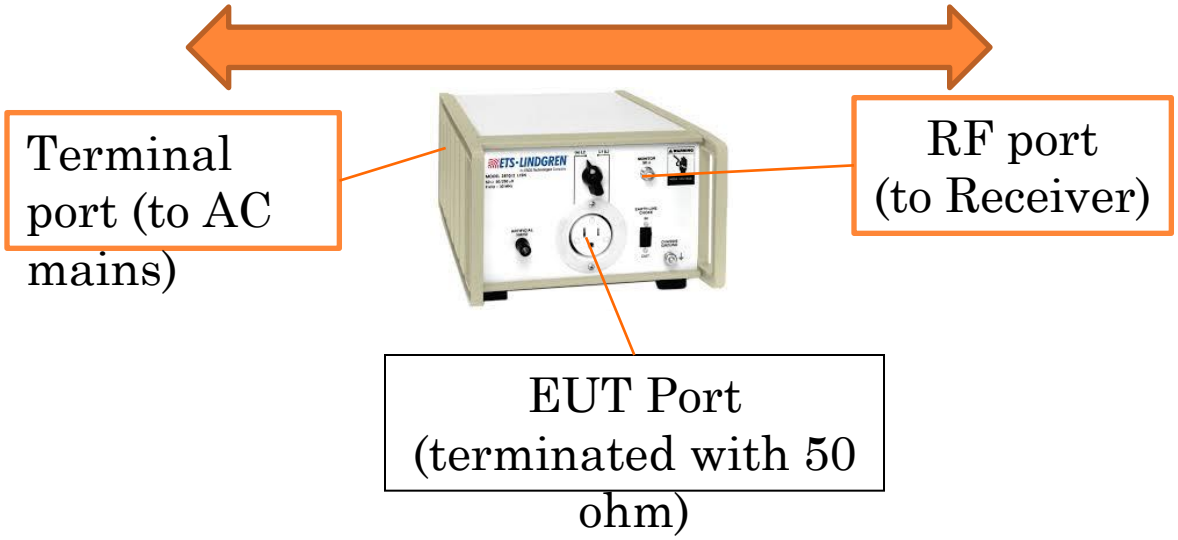


LINE AND IMPEDANCE STABILIZING NETWORKS (LISNs) – CHARACTERISTICS

- Isolation - CISPR 16-1-2
  - Unwanted signal and unknown impendence from the mains side do not affect the measurement.
  - Minimum isolation between each mains terminal and the receiver port > 40dB



- Voltage division factor between EUT port and RF outport

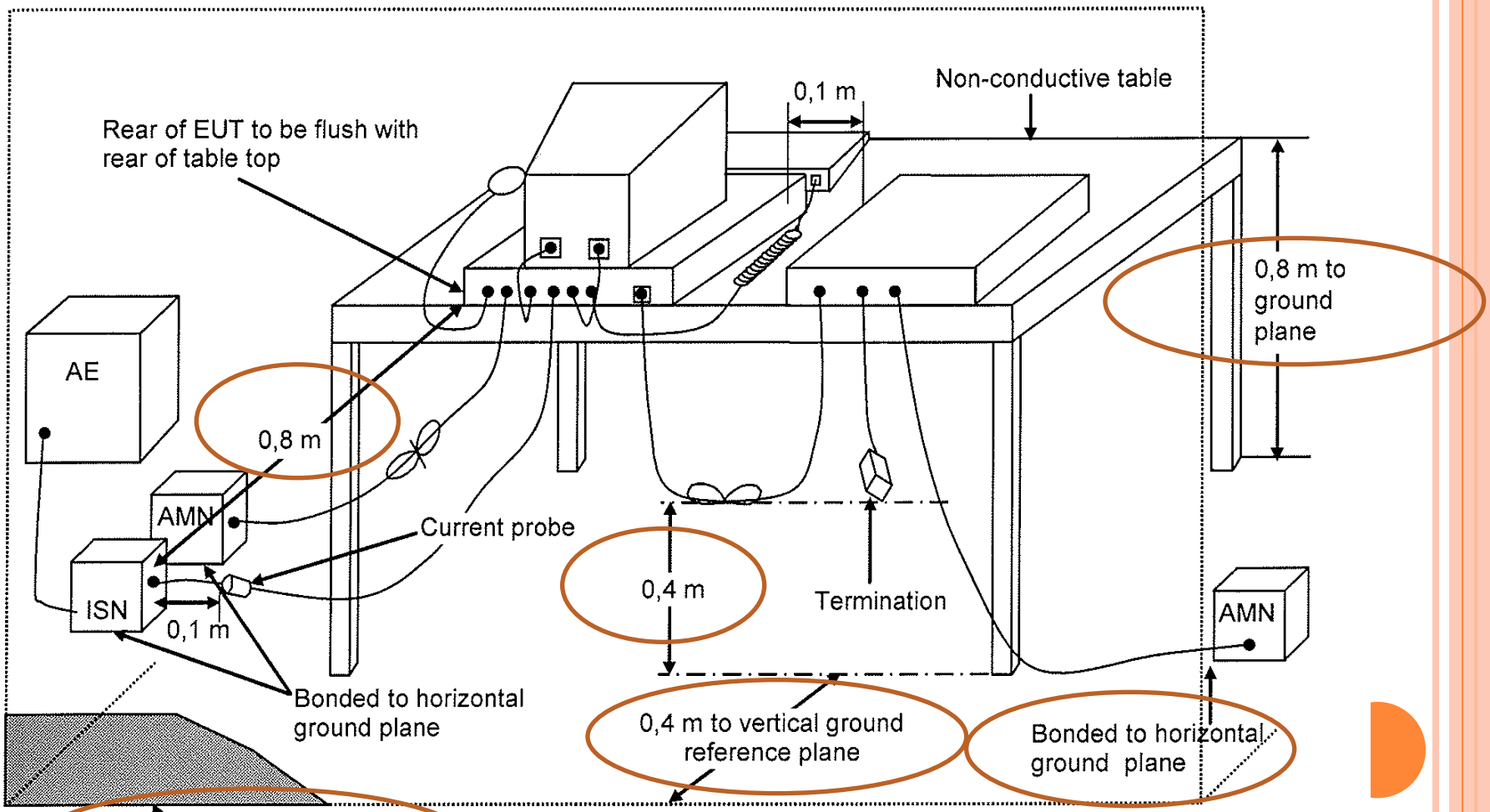
EMI Receivers

- Measure the emission levels by average and quasi-peak detectors
- Receivers must be calibrated by competence (accredited) calibration laboratory in accordance to CISPR 16-1-1 before use.
- CISPR 16-1-1 has clear defined the specifications and requirements of EMI receiver and its detectors (e.g. average and quasi-peak)
  - Input impedance
  - Sine-wave voltage accuracy
  - Response to pulse / variation with repetition frequency

Quasi-peak - From Wikipedia

- **Quasi-peak** means 'not quite peak', or 'aiming towards peak but not actually peak'.
- This was originally done because the quasi-peak detector was believed to better indicate the subjective annoyance level experienced by a listener hearing impulsive interference to an AM radio station.
- Over time standards incorporating quasi-peak detectors as the measurement device were extended to frequencies up to 1 GHz, although there may not be any justification beyond previous practice for using the quasi-peak detector to measure interference to signals other than AM radio.

Typical Test Setup – Table top equipment



Summary

- Conducted emission measurement applies to AC, DC, signal and telecommunication ports of all types of electronics products.
- LISN and EMI receiver which comply with CISPR requirements plus a reasonably quiet EM environment are crucial for performing conducted emission measurements.
- LISNs and Receivers must be calibrated according to CISPR requirements.
- Repeatability is very important for all types of EMC testing and proper test setup is always the key to achieve a good repeatability.

Thanks for your attention