

EMC Seminar Series

All about EMC Testing and Measurement Seminar – 1

Introduction to EMC Conducted Immunity

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Organized by :



Basic Immunity Standards: IEC 61000-4

Testing and measurement techniques

HF conducted disturbances

IEC 61000-4-4: - Electrical fast transient/burst immunity test

IEC 61000-4-5: - Surge immunity test

IEC 61000-4-6: - Immunity to conducted disturbances, induced by radio-frequency fields

IEC 61000-4-12: General - High power electromagnetic (HPEM) effects on civil systems

IEC 61000-4-18: Damped oscillatory wave immunity test

Electrostatic discharges

IEC 61000-4-2: - Electrostatic discharge immunity test

Basic Immunity Standards: IEC 61000-4

Testing and measurement techniques

LF radiated disturbances

IEC 61000-4-8: Power frequency magnetic field immunity test

HF radiated disturbances

IEC 61000-4-3: - Radiated, radio-frequency, electromagnetic field immunity test

IEC 61000-4-9: - Pulse magnetic field immunity test

IEC 61000-4-10: - Damped oscillatory magnetic field immunity test

IEC 61000-4-20: - Emission and immunity testing in transverse electromagnetic (TEM) waveguides

IEC 61000-4-21: - Reverberation chamber test methods

Basic Immunity Standards: IEC 61000-4

Testing and measurement techniques

LF conducted disturbances

IEC 61000-4-11 : - Voltage dips, short interruptions and voltage variations immunity tests

IEC 61000-4-13: - Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests

IEC 61000-4-14: - Voltage fluctuation immunity test for equipment with input current not exceeding 16 A per phase

IEC 61000-4-16: - Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz

IEC 61000-4-17: - Ripple on d.c. input power port immunity test

IEC 61000-4-27: - Unbalance, immunity test for equipment with input current not exceeding 16 A per phase

IEC 61000-4-28: - Variation of power frequency, immunity test for equipment with input current not exceeding 16 A per phase

IEC 61000-4-29: - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity test

IEC 61000-4-30: - Power quality measurement methods

IEC 61000-4-34: - Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase

Basic Immunity Standards: IEC 61000-4

Testing and measurement techniques

- The object of these standards is to establish a common and **reproducible** basis for evaluating the performance of electrical and electronic equipment

Generic Product Standard

- **E.g. CISPR24: Information technology equipment - Immunity characteristics - Limits and methods of measurement**
 - IEC 61000-4-2 Electro-static Discharge
 - IEC 61000-4-3 Radiated, radio-frequency, electromagnetic field immunity test
 - IEC 61000-4-4 Electrical Fast Burst Transients
 - IEC 61000-4-5 Surge
 - IEC 61000-4-6 Immunity to conducted disturbances
 - IEC 61000-4-8: Power frequency magnetic field immunity test
 - IEC 61000-4-11 Voltage Dips, Interruption and Variations

IEC 61000-4-6

Immunity to conducted disturbances,
induced by radio-frequency fields

IEC 61000-4-6 : Conducted RF Immunity

- Conducted RF Immunity simply refers to a product's immunity to unwanted noisy RF voltages and currents carried by its external wires and cables
- RF noise e.g.: digital processing, switch-mode power conversion, will generate RF noise on its external cables.
- Products which connected to such equipment will therefore be subjected to conducted electromagnetic disturbances at RF in both differential-mode and common-mode on their interconnecting cables.

IEC 61000-4-6 : Conducted RF Immunity

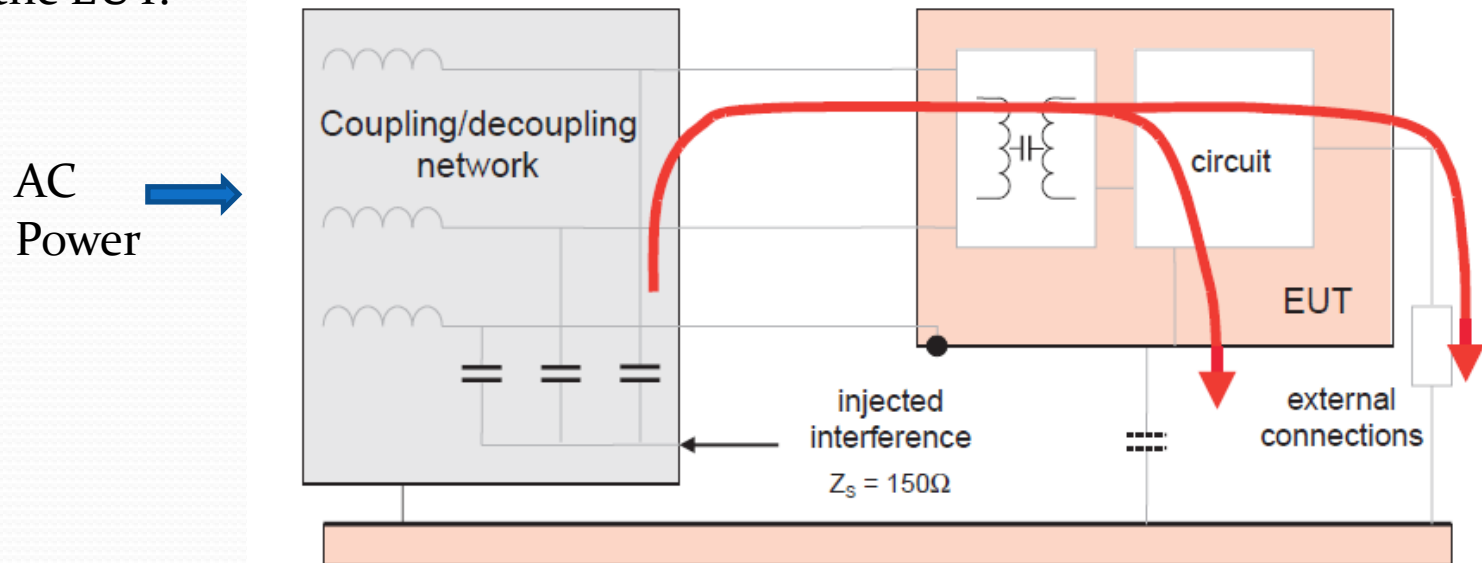
- Sufficient level of conducted RF noise can cause errors or malfunctions in analogue or digital circuits
 - Analogue Circuits: measurement errors of thermocouple, resistance thermometers, strain gauges and microphone
 - Digital Circuits: software suffers from false keypresses or control signals, false resets ..

IEC 61000-4-6 : Conducted RF Immunity

- IEC 61000-4-6 relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection) which can couple the equipment to the disturbing RF fields is excluded.

IEC 61000-4-6 : Conducted RF Immunity

- How does the test works?
 - Simplified Equivalent Circuit – The disturbance is applied in common mode with respect to the ground reference plane and therefore generated a current, whose magnitude depends on the EUT's RF *common mode* impedance at each port, which flows into and through the circuits with in the EUT.



IEC 61000-4-6 : Conducted RF Immunity

- This standard defines:
 - range of test levels;
 - disturbance signal;
 - test equipment;
 - equipment verification
 - test setup;
 - test procedure;
 - test report

IEC 61000-4-6 : Conducted RF Immunity

Test Levels

No tests are required for induced disturbances caused by electromagnetic fields coming from intentional RF transmitters in the frequency range 9 kHz to 150 kHz.

Table 1 – Test levels

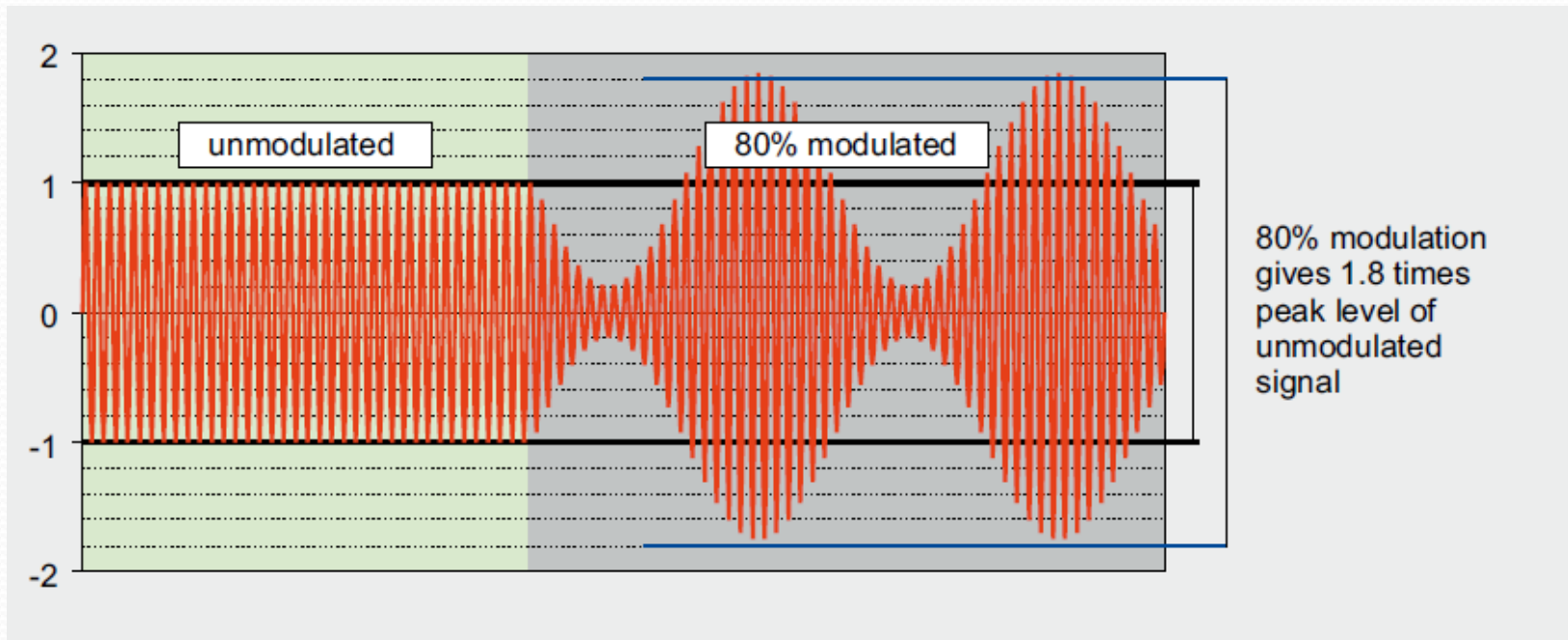
Frequency range 150 kHz – 80 MHz		
Level	Voltage level (e.m.f.)	
	U_0 dB(μ V)	U_0 V
1	120	1
2	130	3
3	140	10
X ^a	Special	

^a X is an open level.

Depending on different product standards, test up to **230MHz** may required.

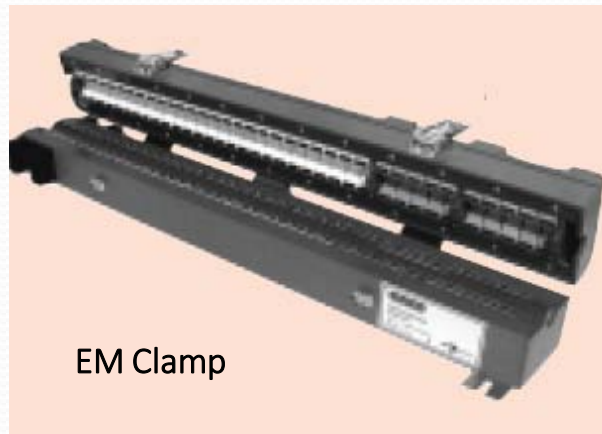
IEC 61000-4-6 : Conducted RF Immunity

- **RF noise** - amplitude modulated (AM) by a 1 kHz sine wave with a modulation depth of 80 %.



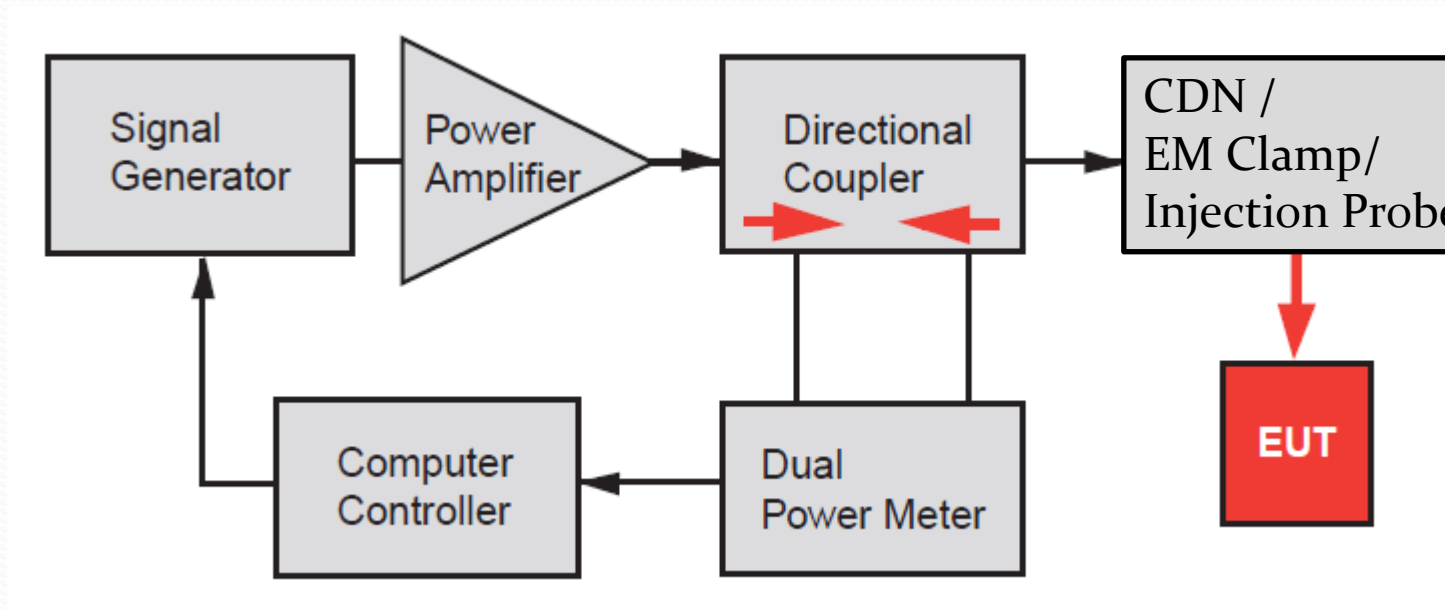
IEC 61000-4-6 : Conducted RF Immunity

- Major Test Equipment:
 - Signal Generator
 - Power Amplifier and Power Meter
- Coupling Devices:
 - CDN (Coupling-Decoupling Network)
 - EM Clamp
 - Current Injection Clamp
 - Direct Injection



IEC 61000-4-6 : Conducted RF Immunity

- Test Equipment System – Schematic Diagram



IEC 61000-4-6 : Conducted RF Immunity

The coupling and decoupling network should provide:

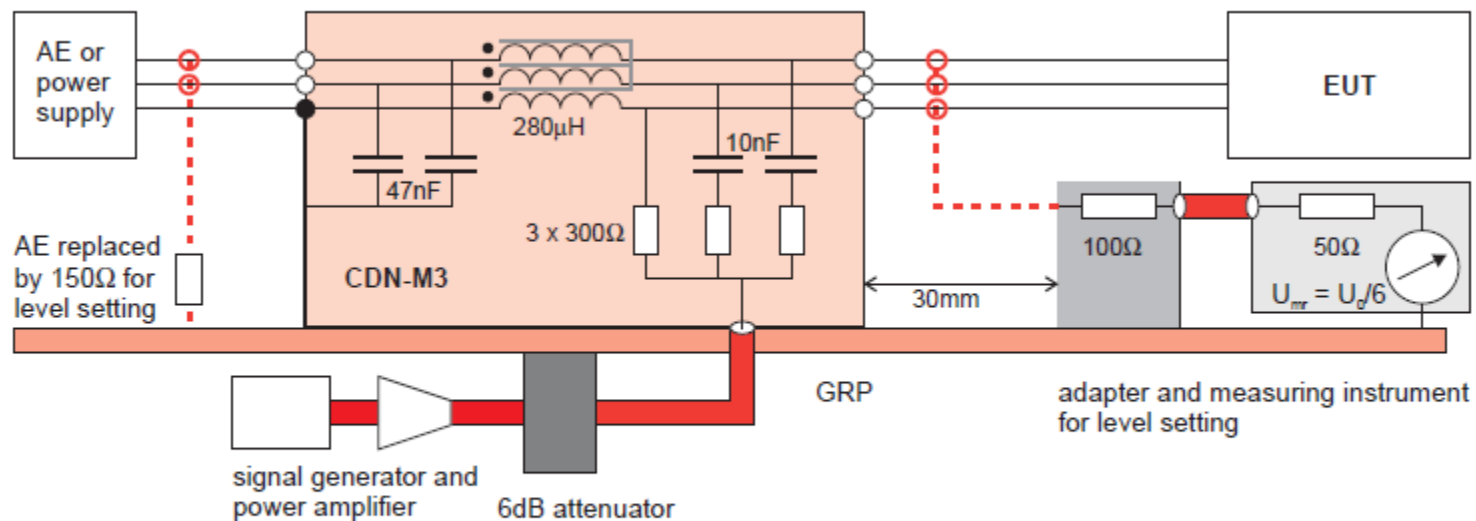
- coupling of the disturbing signal to the EUT;
- stable impedance, seen from the EUT, independent of the AE common-mode impedance;
- decoupling of the AE from the disturbing signal to prevent interference of the AE;
- transparency to the wanted signal.

- CDN

- M₁ – Power supply line 1 line
- M₂ – Power supply line 2 line
- M₃ – Power supply line 3 line
- T₂ – for cable with 1 symmetric pair (2 wire)
- T₄ – for cable with 2 symmetric pairs (4 wire)
- T₈ – for cable with 4 symmetric pairs (8 wire)
- Many other types of CDN are available for different type of cables

IEC 61000-4-6 : Conducted RF Immunity

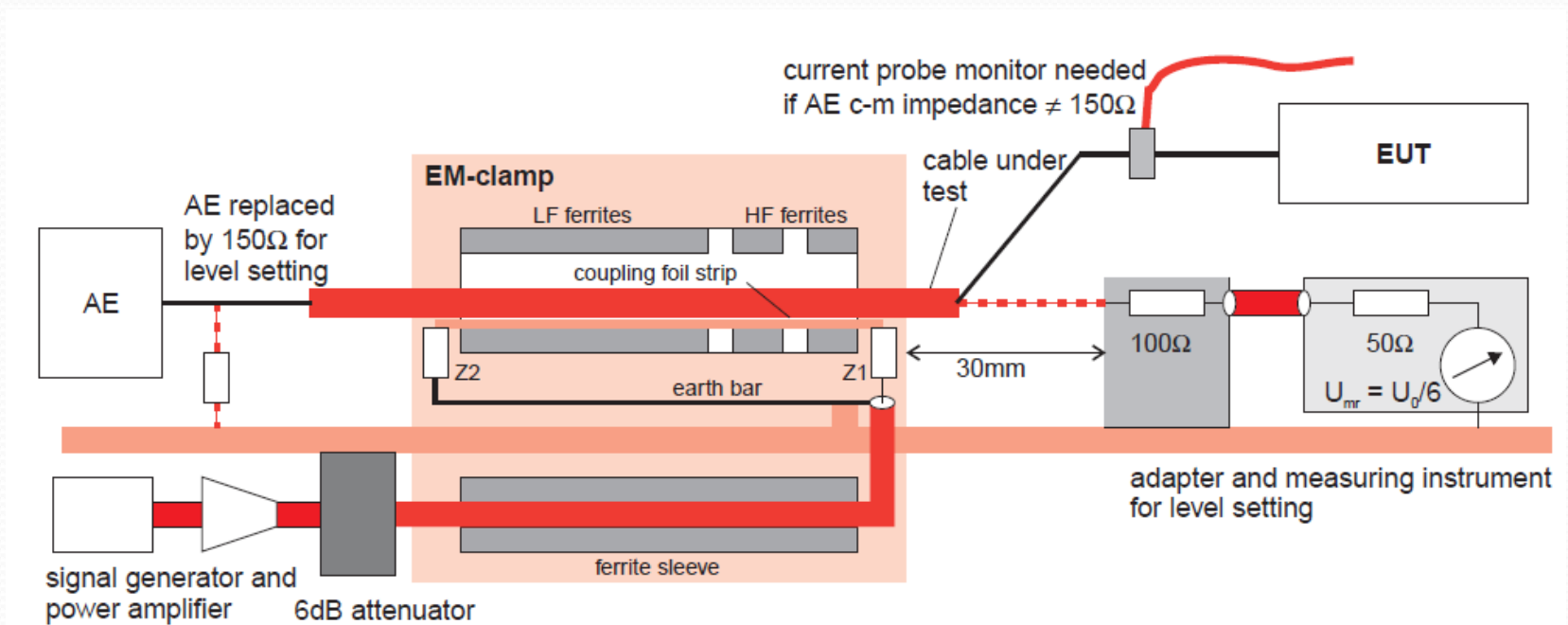
- Schematic diagram with CDN-M3



The coupling/decoupling network: example for 3-line mains

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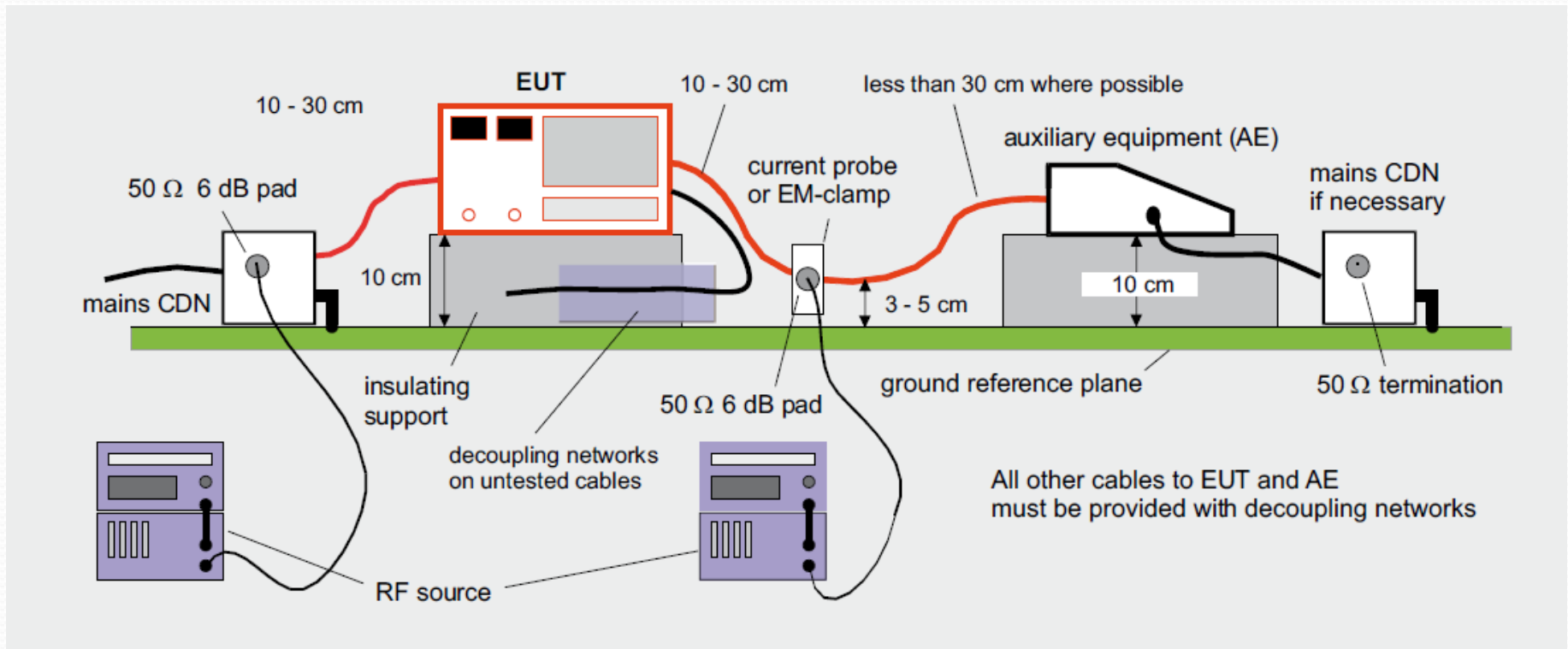
- Schematic diagram with EM Clamp



Detail of EM Clamp and Current Injection Probe is in Annex A of the standard

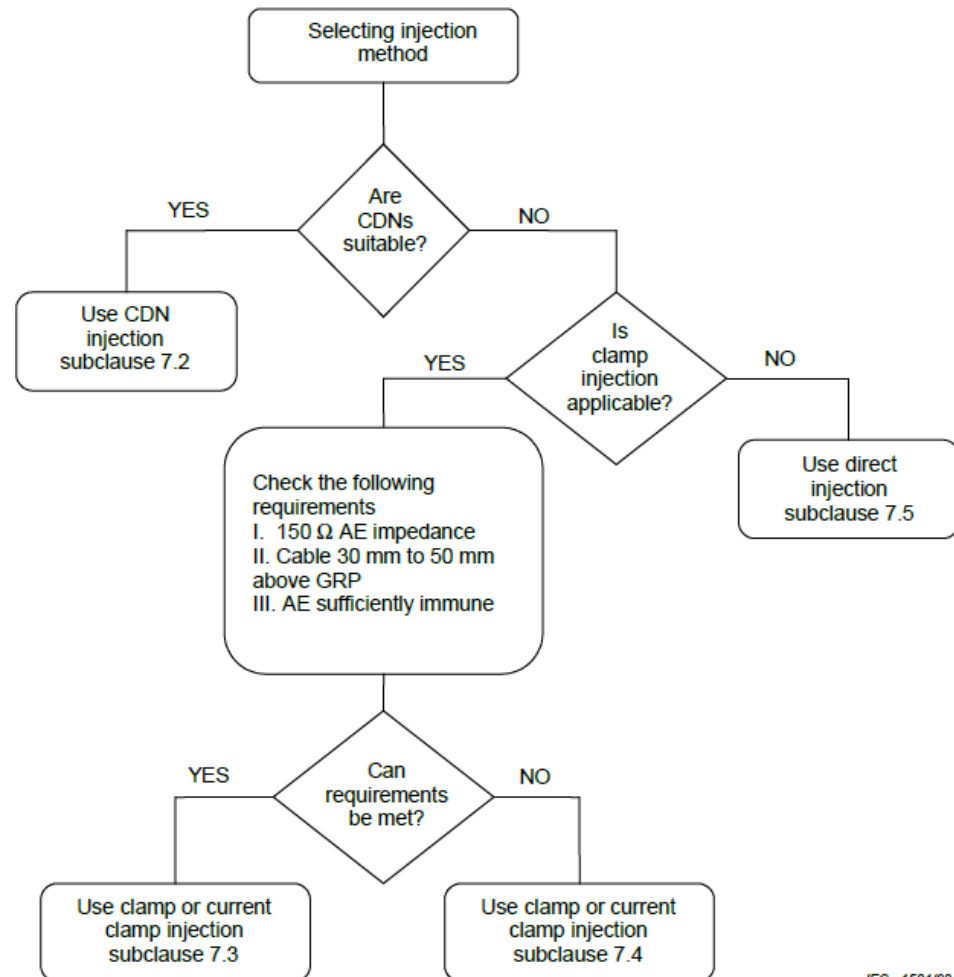
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- Setup example for EUT with auxiliary equipment



IEC 61000-4-6 : Conducted RF Immunity

- Injection method decision tree:



IEC 61000-4-6 : Conducted RF Immunity

- Test setup consideration:
 - Ports to be tested
 - Setup of CDN injection method
 - Setup of Clamp Injection method when common-mode impedance can be met
 - Setup of Clamp Injection method when common-mode impedance cannot be met
 - Setup of direct injection method
 - Single unit EUT
 - Multiple units EUT

IEC 61000-4-6 : Conducted RF Immunity

- Test Procedure

The frequency range is swept from 150 kHz to 80 MHz, using the signal levels established during the setting process, and with the disturbance signal 80 % amplitude modulated with a 1 kHz sine wave, pausing to adjust the RF signal level or to change coupling devices as necessary. Where the frequency is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value. The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 s. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately.

IEC 61000-4-6 : Conducted RF Immunity

- In practice, carrying out Conducted RF Immunity test can be very straight forward
- The test usually is run by software controlled test system
- For simple household appliance such as washing machine, refrigerator .. etc, test time for once is less half an hour
 - Inject disturbance noise to AC main only
 - EUT operation is simple

Thank You