

U.S. EMC Regulations

ESDM

U.S. EMC Regulations

- Responsibility of FCC to formulate and update
 - Regulations keep evolving as technology changes
 - Important to refer latest documents
 - FCC regulates radio and wired communication in U.S.
 - Deals with control of interference
 - 3 Sections – Title 47 of Code of Federal Regulations
 - 1) Part 15 – RF devices
 - 2) Part 18 – ISM equipment
 - 3) Part 68 – Terminal equipment for telephone n/wAll are for non licensed electronic equipment.

Part 15

- Pertains to a radio-frequency device
 - It is any device that in its operation is capable of emitting radio-frequency energy by radiation, conduction or other means
- RF emission could be intentional or unintentional
- RF energy -> 9KHz to 3000 GHz

Part 15

- Purpose of part 15
 - 1) To provide for the operation of low power transmitters without a radio station license
 - 2) To control interference to authorized radio communication services
 - (Digital electronics falls in this category)
- Divided into 6 subparts
 - A) General
 - B) Unintentional radiators
 - C) Intentional radiators
 - D) Unlicensed personal communication devices
 - E) Unlicensed national information infrastructure devices
 - F) Ultra wide band operation

Part 18

- ISM Equipment -> Industrial, Scientific, Medical
 - Any device that uses radio waves for industrial, scientific, medical or other purposes (WiPwrTr) and
 - That is neither used nor intended for radio comm.
- e.g. Medical diathermy, Industrial heating, RF welders, RF lighting devices,
- devices that use radio waves to induce physical changes in matter

Part 68

- Standard for protection of telephone n/w from harm caused by connection of Terminal Equipment (TE) and its wiring
 - Electrical hazards to company workers
 - Damage to equipment
 - Malfunction of billing equipment
 - Degradation of service to persons other than the user of terminal equipment
- Defining and Publishing now done by TIA (TIA-968) through ACTA (Administrative council for terminal attachments)
- Also for compatibility of hearing aids

Part 68

- Approval processes
 - 1) Provide declaration of conformity
 - 2) Get equipment certified by Telecom certifying Body (TCB) accredited by NIST.

FCC Part 15, Subpart B

- Applies to virtually all digital electronics
- *Limits the maximum allowable radiated emission and maximum allowable conducted emission of AC power line*
- Any device working with (Clock) frequency $> 9\text{KHz}$ is a digital device
- Two digital device classes
 - Class A – Commercial, industrial or business environment
 - Class B – Residential Environment
- Emission limits for Class B are 10dB more restrictive than Class A (proximity to TV and Radio Rx)

FCC Part 15, Subpart B

- Every digital device for sale or lease requires authorization by FCC
- For PC and peripherals, a manufacturer can demonstrate compliance through "***Declaration of Conformity***"
- DoC is a procedure where the manufacturer takes measurements or takes other steps to ensure compliance with applicable standard
 - Submission of test data to FCC not mandatory

FCC Part 15, Subpart B

- All other products (i.e. Class A and remaining Class B) manufacturer must verify compliance
- Verification is self certification similar to 'Declaration of Conformity'
- For digital devices, measurements are to be performed according to ANSI C63.4-1992, excl. Sections 5.7,9 and 14.

Emissions

- FCC part 15 limit the max allowable conducted emission on AC power line in the range of 0.15 to 30MHz
- Max radiated emission in frequency range of 30MHz to 40GHz

Radiated Emission Test

- Requires a OATS (Open area test site)

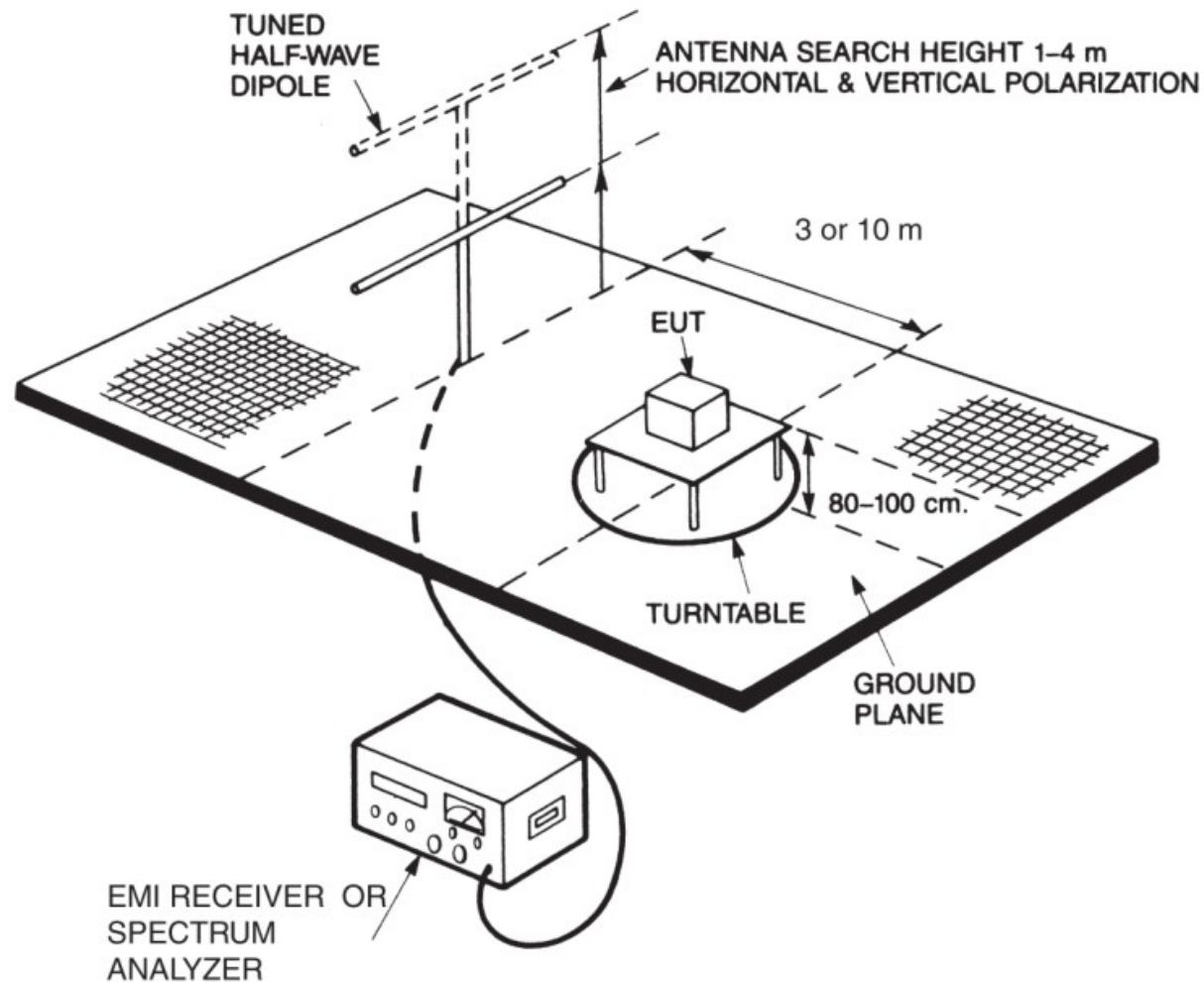


FIGURE 1-2. Open area test site (OATS) for FCC radiated emission test.

Radiated Emission Test

- Or an shielded room with absorbers (Anechoic chamber)



Radiated Emission Test

- Receive antenna -> 30-100MHz tuned dipole or linearly polarized broadband antenna.
- In case of dispute, dipole will take precedence
- Above 1GHz, polarized horn antenna shall be used

Radiated Emission Limits

TABLE 1-1. FCC Class A Radiated Emission Limits Measured at 10 m.

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	Field Strength (dB $\mu\text{V/m}$)
30–88	90	39.0
88–216	150	43.5
216–960	210	46.5
>960	300	49.5

TABLE 1-2. FCC Class B Radiated Emission Limits Measured at 3 m.

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	Field Strength (dB $\mu\text{V/m}$)
30–88	100	40.0
88–216	150	43.5
216–960	200	46.0
>960	500	54.0

Radiated Emission Limits

TABLE 1-3. FCC Class A and Class B Radiated Emission Limits Measured at 10 m.

Frequency (MHz)	Class A Limit ($\mu\text{V/m}$)	Class B Limit (dB $\mu\text{V/m}$)
30–88	39.0	29.5
88–216	43.5	33.0
216–960	46.5	35.5
> 960	49.5	43.5

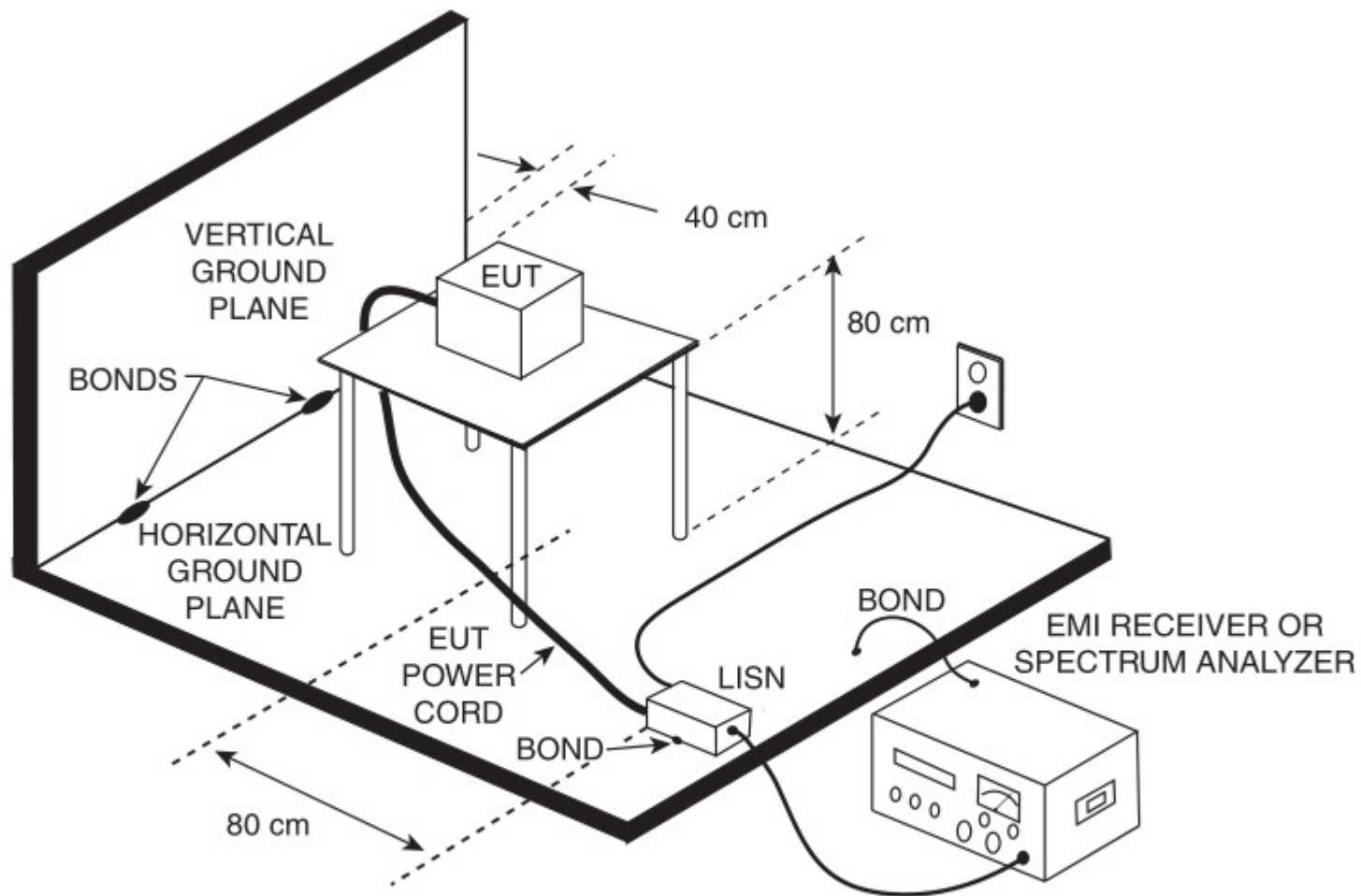
TABLE 1-4. Upper Frequency Limit for Radiated Emission Testing.

Maximum Frequency Generated or Used in the EUT (MHz)	Maximum Measurement Frequency (GHz)
< 108	1
108–500	2
500–1000	5
> 1000	5 th Harmonic or 40 GHz, whichever is less

Conducted Emissions

- Limits on the voltage that is conducted back into the AC power use
- Below 30MHz, primary cause of interference with Radio comm. occurs by conducting RF energy onto AC power line
 - Subsequently radiating it from power line
- Conducted emissions are radiated emissions in disguise

Conducted Emissions



BOND METER, LISN AND GROUND PLANES TOGETHER

FIGURE 1-3. Test setup for FCC conducted emission measurements.

Conducted Emissions

- LISN – Line impedance stabilization network
- Peak Measurements – representative of noise from narrowband sources such as clocks
- Average measurements – representative of broadband noise sources

Conducted Emissions

TABLE 1-5. FCC/CISPR Class A Conducted Emission Limits.

Frequency (MHz)	Quasi-peak (dB μ V)	Average (dB μ V)
0.15–0.5	79	66
0.5–30	73	60

TABLE 1-6. FCC/CISPR Class B Conducted Emission Limits.

Frequency (MHz)	Quasi-peak (dB μ V)	Average (dB μ V)
0.15–0.5	66–56 ^a	56–46 ^a
0.5–5	56	46
5–30	60	50

^aLimit decreases linearly with log of frequency.

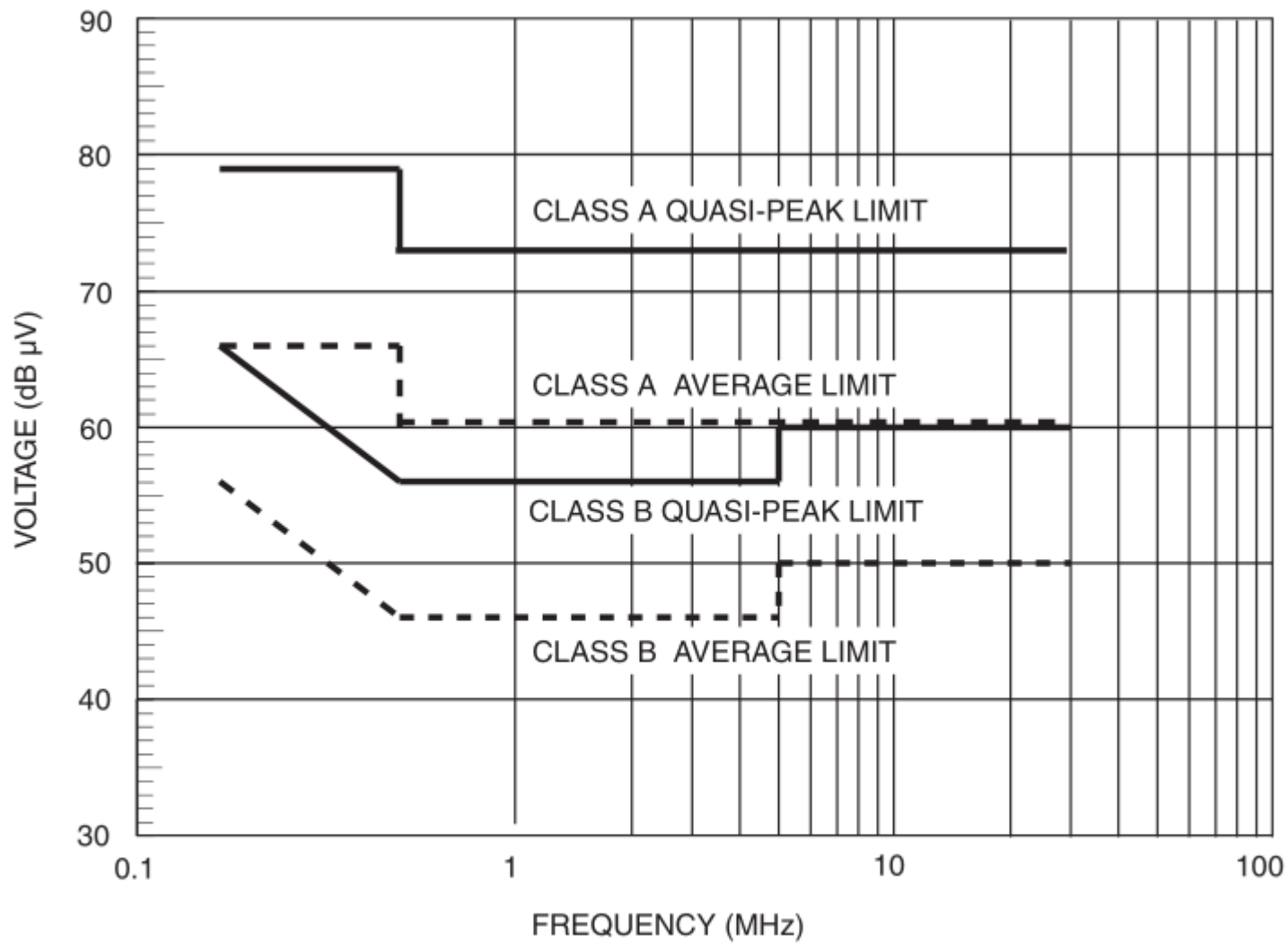


FIGURE 1-4. FCC/CISPR conducted emission limits.

FCC Administrative Procedures

- The FCC rules not only specify the technical standards (limits) that a product must satisfy but also
 - the administrative procedures that must be followed
 - the measuring methods that must be used to determine compliance
- Most administrative procedures are contained in
 - Part 2, Subpart I (Marketing of Radio Frequency Devices),
 - Subpart J (Equipment Authorization Procedures), and
 - Subpart K (Importation of Devices Capable of Causing Harmful Interference) of the FCC Rules and Regulations

FCC Administrative Procedures

- Not only must a product be tested for compliance with the technical standards contained in the regulations,
 - but also it must be labelled as compliant and
 - information must be provided to the user on its interference potential
- In addition , the rules also contain a noninterference requirement
 - If product causes harmful interference the user may be required to cease operation of the device (Responsibility of the user)

FCC Administrative Procedures

- In addition to the initial testing, the rules also specify that the manufacturer or importer is responsible for the continued, or ongoing, compliance of subsequently manufactured unit
- If a change is made to a compliant product, the manufacturer has the responsibility to determine whether that change has an effect on the compliance of the product

FCC Administrative Procedures

- Exempted subclasses from meeting the technical standards of the rules
 - 1) Digital devices in transportation
 - 2) Industrial control systems
 - 3) ISM equipment
 - 4) Digital devices exclusively used in an appliance such as a microwave oven, dishwasher, clothes dryer, air conditioner, and so on
 - 5) Specialised medical devices
 - 6) Devices with power consumption $< 6\text{nW}$, for e.g., a digital watch
 - 7) Joystick controller or mouse with no circuitry
 - 8) Devices that operate below 1.705MHz and that do not operate on power line

Susceptibility regulations

- To regulate the susceptibility of home electronics equipment and systems
 - e.g. radio/TV receivers, burglar alarms, security systems, automatic garage openers, stereo or Hi-Fi systems
- minimum immunity level objective might be 2 to 3 V/m
- susceptibility levels of < 1 V/m are bad design

Other Areas

- Medical Equipment
 - Most medical equipments (except those under part 18) are exempt from FCC rules
 - FDA regulates medical equipments
- Telecom
 - Exempt if installed in dedicated building
- Automotive
 - Exempt from FCC part 15
 - Have to conform to CISPR, SAE regulations

Other Areas

- Automotive
 - SAE J551 – Vehicle level EMC
 - SAE J1113 – Component level EMC
 - Cover both emissions and immunity and some are of the toughest EMC standards in the world
 - Close proximity of circuits
 - High voltage discharges (spark ignition systems)
 - High current motor drive systems
 - Radiated emissions are 40dB more stringent than FCC class B
 - Radiated immunity tests are specified up to an electric field strength of 200V/m