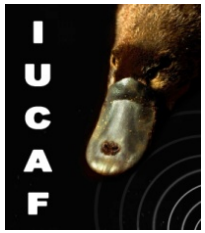
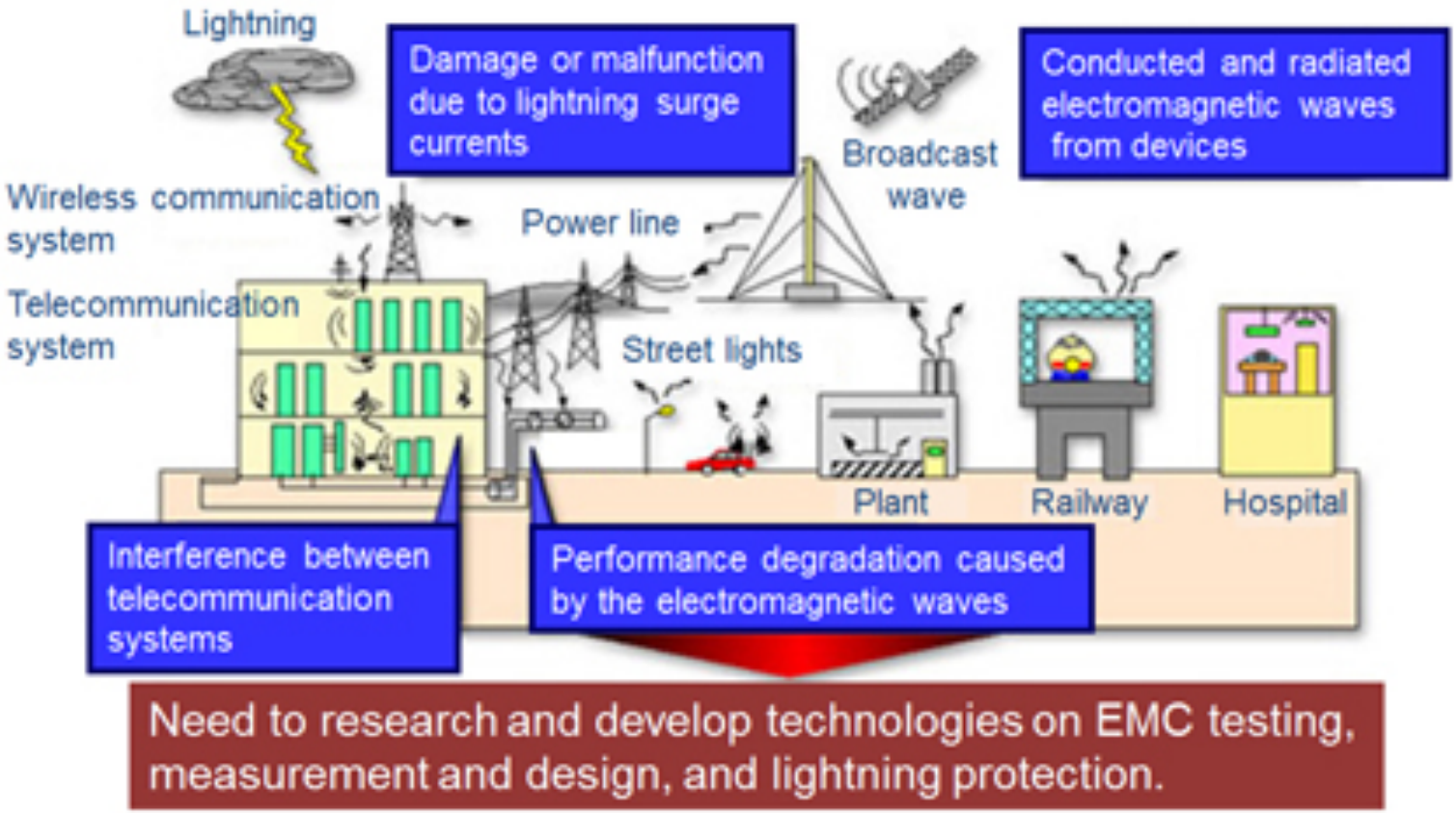


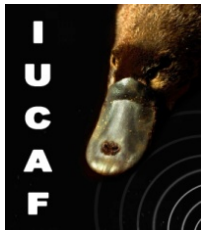

# Electro
# Magnetic
# Compatibility

**Masatoshi Ohishi**

**National Astronomical Observatory of Japan**
**IUCAF Chairman**

# Radio Noise


Lightning
Damage or malfunction due to lightning surge currents
Broadcast wave
Conducted and radiated electromagnetic waves from devices
Wireless communication system
Power line
Telecommunication system
Street lights
Plant
Railway
Hospital
Interference between telecommunication systems
Performance degradation caused by the electromagnetic waves
Need to research and develop technologies on EMC testing, measurement and design, and lightning protection.

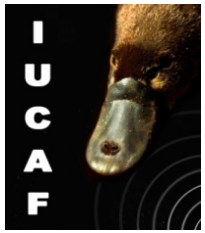



# EMC

- is a branch of electrical sciences which studies the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects (interference, or EMI) that such energy may induce

- aims to ensure that equipment items or systems will not interfere with or prevent each other's correct operation through spurious emission and absorption of EMI

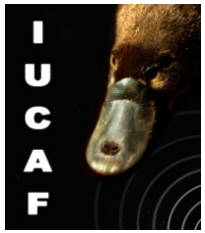
- is the control of EMI so that unwanted effects are prevented




# Standardization Bodies for EMC Regulations

| International | | Regional | | National | |
|---|---|---|---|---|---|
| IEC | TC77 | Europe | CEN | US | FCC |
| | CISPR | | CENELEC | | SAE |
| ISO | | | ETSI | UK | BSI |
| | | | | DE | VDE |
| | | | | JP, CN, KR,,,, | |

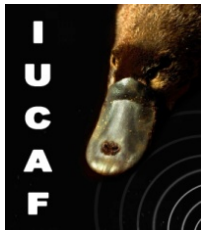
IEC: International Electrotechnical Commission
ISO: International Organization for Standardization
CENELEC: Comité Européen de Normalisation Electrotechniques
ETSI: European Telecommunications Standards Institute
FCC: Federal Communications Commission




# CISPR
# Comité International Spécial des Perturbations Radioélectriques

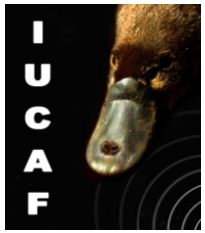
- **IEC** — International Electrotechnical Commission
  - **CISPR** — International Special Committee on Radio Interference
    * Specifies limits and measurement methods of electromagnetic disturbances emitted from electrical and electronic equipment for the protection of radio services.
    - **SC-A** — Radio-interference measurements and statistical methods
    - **SC-B** — Interference related to effects of industrial, scientific, and medical radio-frequency apparatus on other (heavy) industrial equipment, overhead power lines, high-voltage equipment, and electrical traction devices
    - **SC-D** — Effects of electromagnetic disturbances related to electrical/electronic equipment on vehicles and internal-combustion-engine-powered devices
    - **SC-F** — Interference related to household appliances tools, lighting equipment, and similar apparatus
    - **SC-H** — Limits for the protection of radio services
    - **SC-I** — Electromagnetic compatibility of information technology equipment, multimedia equipment, and radio receivers

CEPT, EBU, ETSI, IARU, ISO, ITU-R, ITU-T are liaison members of CISPR



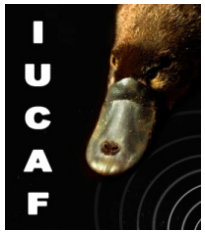

# CISPR Publications (1)

- **CISPR 11 - Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment -- Electromagnetic Disturbance Characteristics -- Limits and Methods of Measurement.**
- **CISPR 12 - Vehicles, boats, and internal combustion engine driven devices -radio disturbance characteristics -limits and methods of measurement**
- **CISPR 14 - Electromagnetic Compatibility -- Requirements for Household Appliance, Electric Tools, and Similar Apparatus: 1) Emissions, 2) Immunity.**




# CISPR Publications (2)

- CISPR 15 - Limits and methods of measurement of radio disturbance characteristics of Electrical lighting and similar equipment.
- CISPR 22 - Information Technology Equipment -- Radio Disturbance Characteristics -- Limits and Methods of Measurement.
- CISPR 24 - Information Technology Equipment -- Immunity characteristics -- Limits and Methods of Measurement.
- CISPR 25 - Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices -- Limits and Methods of Measurement.

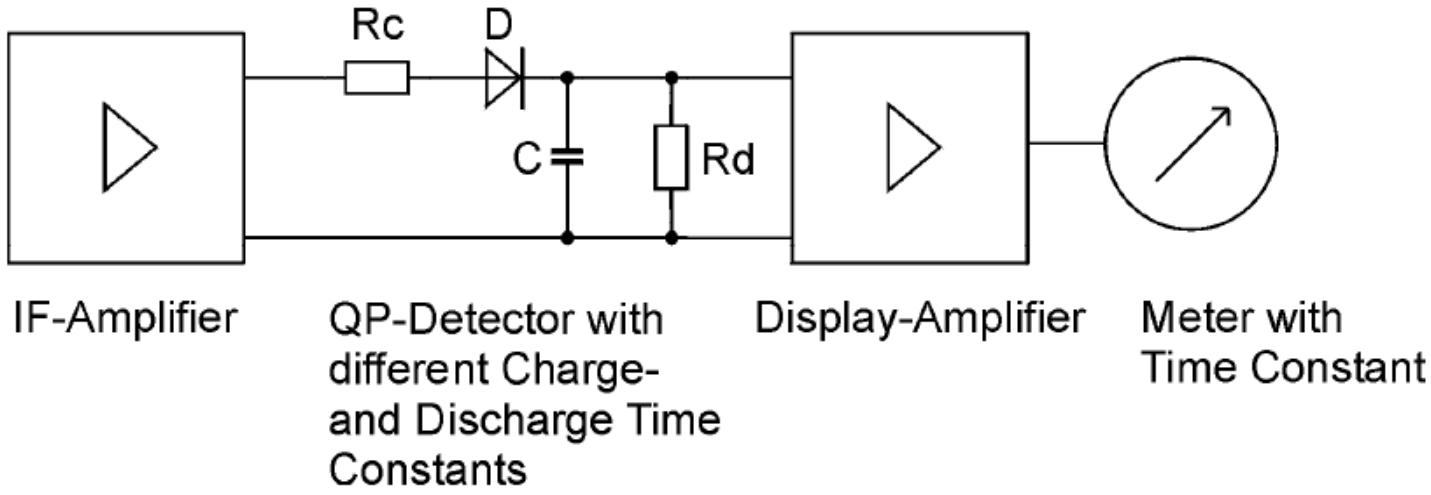



# CISPR Publications (3)

- **CISPR 16 – Specification for radio disturbance and immunity measuring apparatus and methods**

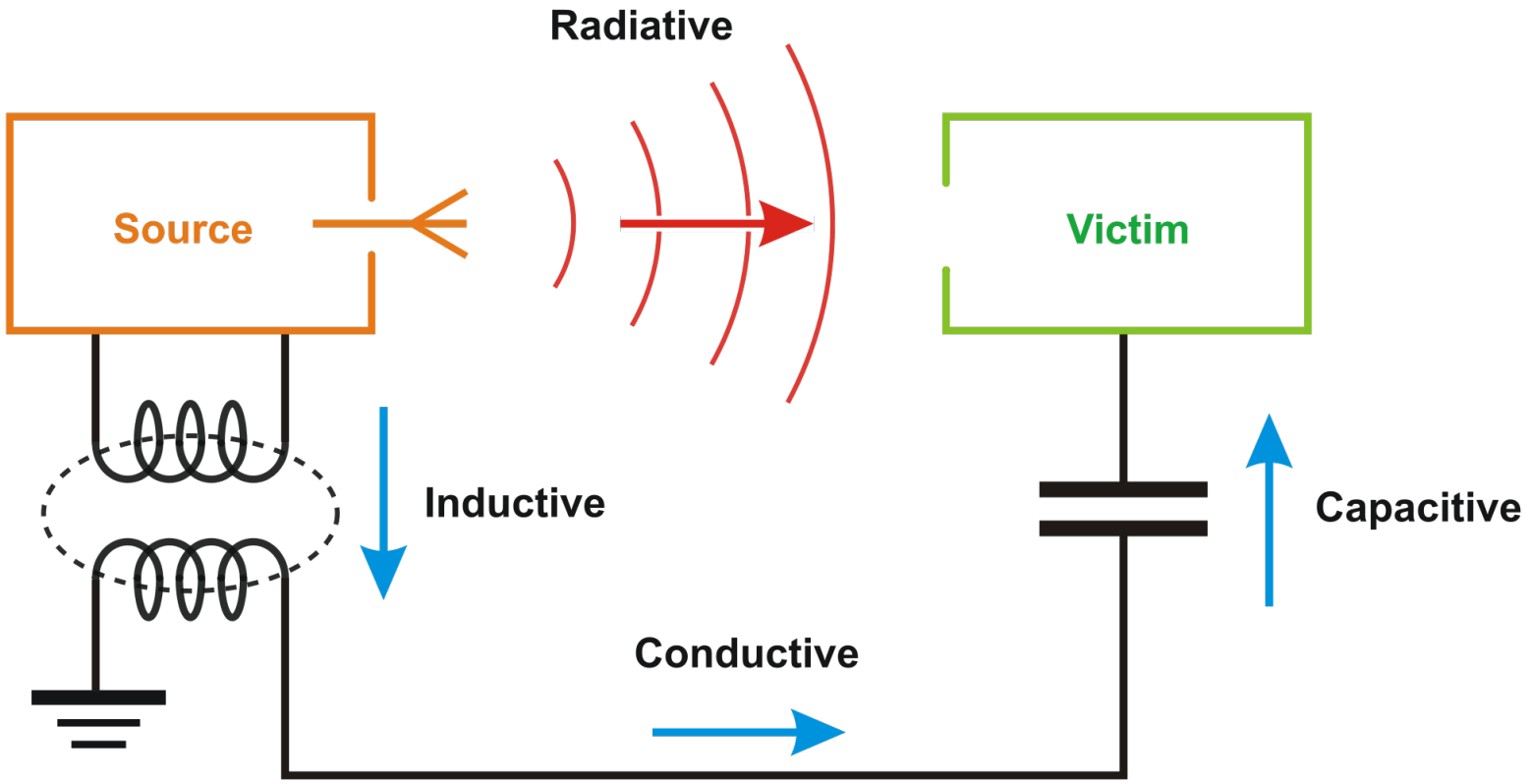
# Q.P.

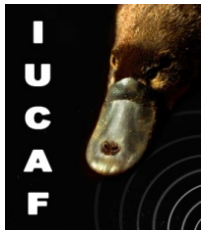
- Defined in CISPR 16: specifying equipment and methods for measuring disturbances and immunity; specific to EMI measurement
- Was believed to better indicate the subjective annoyance level experienced by a listener hearing impulsive interference to an AM radio station



# Measure, measure,,,

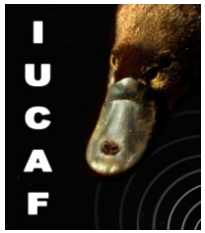
# Coupling Mechanisms






# In CISPR

- **Limits are defined:**
  - **Freq < 30 MHz – conductive emissions by means of "voltage" or "common-mode current"**
  - **Freq > 30 MHz – radiative emissions by means of electric field strength at 10 m**




# CISPR 22: conductive emissions at a telecommunication port

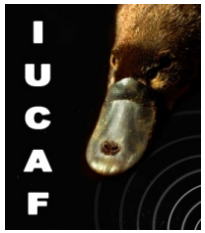
## Class A: for industrial use

| Freq. Range (MHz) | Voltage Limits dB(μV) | | Common-mode current Limits dB(μA) | |
|---|---|---|---|---|
| | Quasi Peak | Average | Quasi Peak | Average |
| 0.15 ~ 0.5 | 97~87 | 84~74 | 53~43 | 40~30 |
| 0.5 ~ 30 | 87 | 74 | 43 | 30 |

## Class B: for residential use

| Freq. Range (MHz) | Voltage Limits dB(μV) | | Common-mode current Limits dB(μA) | |
|---|---|---|---|---|
| | Quasi Peak | Average | Quasi Peak | Average |
| 0.15 ~ 0.5 | 84~74 | 74~64 | 40~30 | 30~20 |
| 0.5 ~ 30 | 74 | 64 | 30 | 20 |

**V (dB(μV)) = A (dB(μA))+20log150 = A (dB(μA))+44**



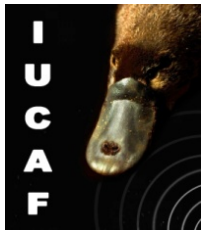

# CISPR 22: radiative emissions at a distance of 10m

## Class A: for industrial use

| Freq. Range (MHz) | Field Limits dB(μV/m) |
|---|---|
| | Quasi Peak |
| 30 ~ 230 | 40 |
| 230 ~ 1000 | 47 |

## Class B: for residential use

| Freq. Range (MHz) | Field Limits dB(μV/m) |
|---|---|
| | Quasi Peak |
| 30 ~ 230 | 30 |
| 230 ~ 1000 | 37 |




# International – Regional - National

| | Emissions | Immunity | Overvoltage |
|---|---|---|---|
| International standards | CISPR22 | CISPR24 | IEC Standards, ITU-T K Series |
| Japan | Report to the Telecommunications Council VCCI Technical Requirements | Report to the Telecommunications Council Industrial Guidelines | TTC Standards |
| EU | EN 55022 Regulations in each country UK: BS Germany: VDE | EN 55024 Regulations in each country UK: BS Germany: VDE | IEC Standards |
| USA | FCC 47CFR Part15 Subpart B NEBS: GR-1089-CORE | NEBS: GR-1089-CORE | NEBS: GR-1089-CORE |
| Korea | KCC KN22 | KCC KN24 | IEC Standards |
| China | GB 9254 | GB/T 17618 | GB/T 17626.5 |

: Regulation

BS: British Standards
EN: European Norm
GB: China national standards (Guobiao standard in Chinese)
KCC: Korea Communications Commission
KN: Korean national standards
NEBS: Network Equipment-Building Systems
TTC: the Telecommunication Technology Committee
VDE: Association for Electrical, Electronic & Information Technologies (Verband der Elecktrotechnik, Elektronik und Informationstechnik)

# One Odd Example -- PLT

**Make use of radio frequency signals applied on the power lines used for the distribution of mains electricity. Because electrical power lines are not designed for the transmission of high data rate signals, PLT signals on electrical power lines have the potential of causing interference to radiocommunication services.**

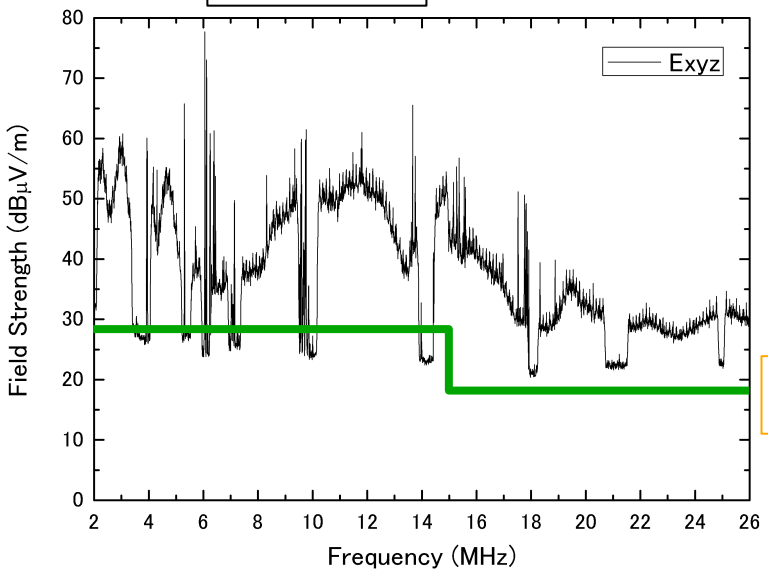
**→PLT devices are regarded to be ITE**
**→CISPR22 seems to be applied**

# Photos

West

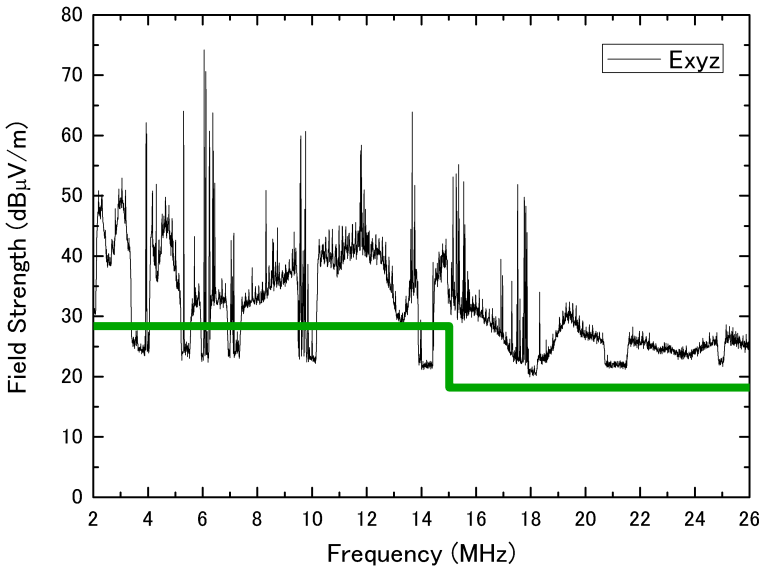
HD-PLC

5m

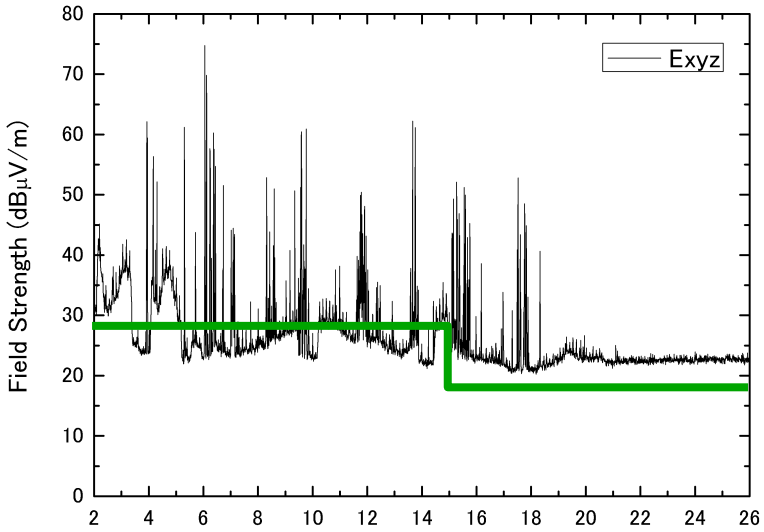



LIMITS

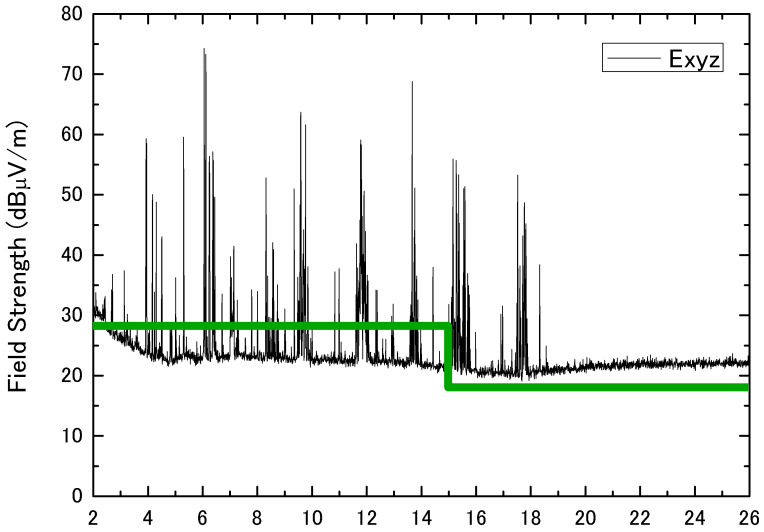
10m




30m



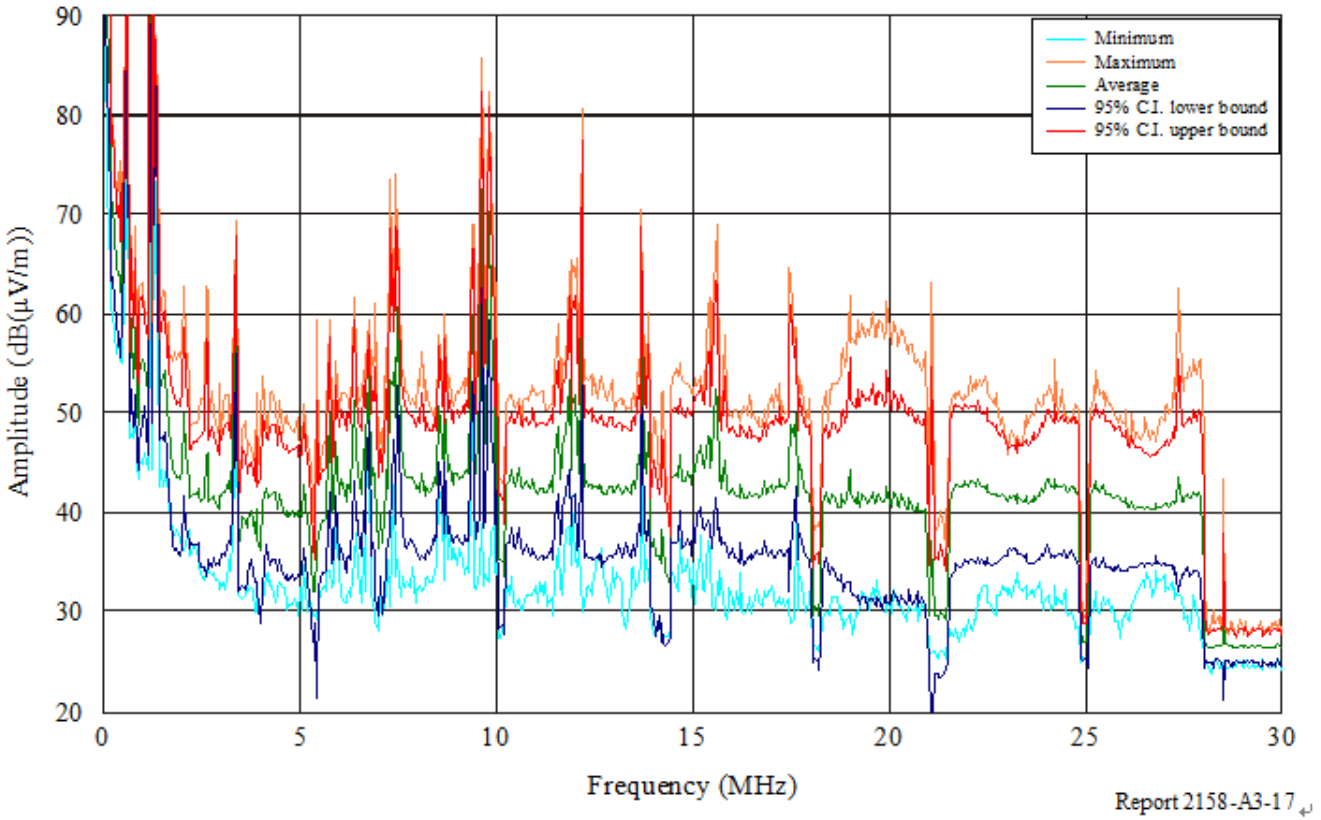

Ambient @ 10m



# Measurements in Canada (from Rep. ITU-R SM.2158)

FIGURE A3-17

**RF field strength distribution, PLT Device 3 (Homeplug AV) at 10 m**



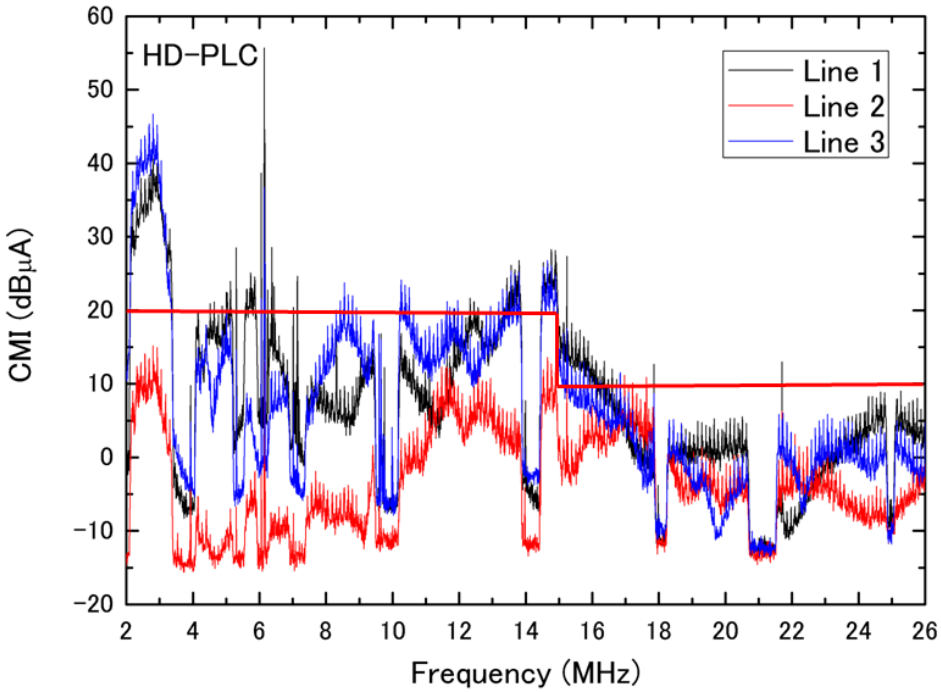
# Common Mode Current (CMI) Distribution

**Exceeds the CMI limit at around ~3MHz (by ~20dB)**

**Larger than at modem output**

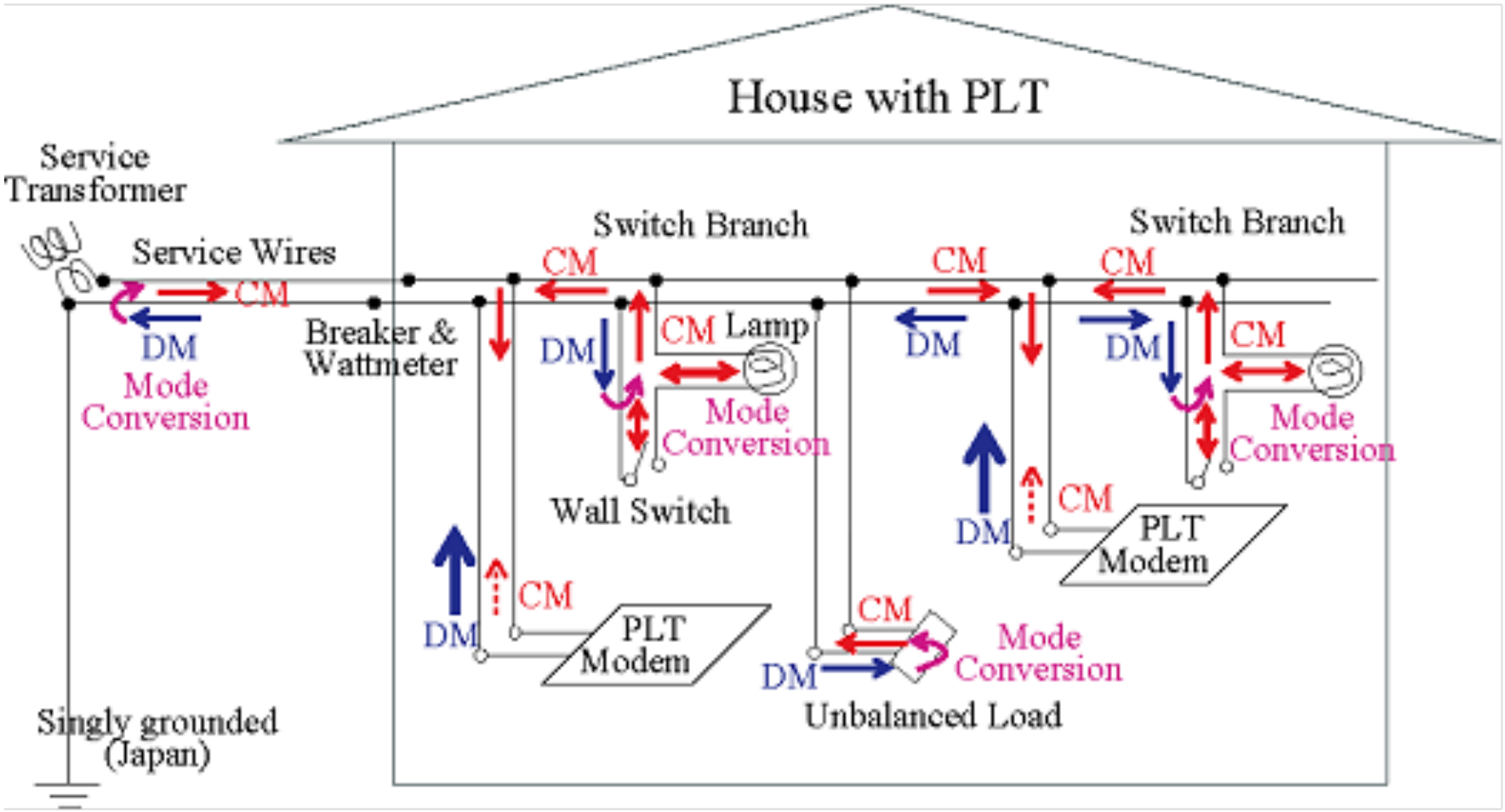
**Very large variation:**

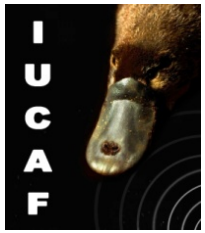
**Max - Min ~ 60dB**




**→ Standing wave / mechanism to generate CMI**

# Radiation Mechanism






# Summary

- Radio noise from “unintentional radiators” are regulated according to CISPR publications and their regional/national variances.
- For most cases CISPR standards work
- There are exceptions that the CISPR regulations can not work.
- ITU-R needs to collaborate with CISPR for suppressing radiated emissions to protect radiocommunication services.