# 传导发射测量传感器

## 传感器——有源/无源：

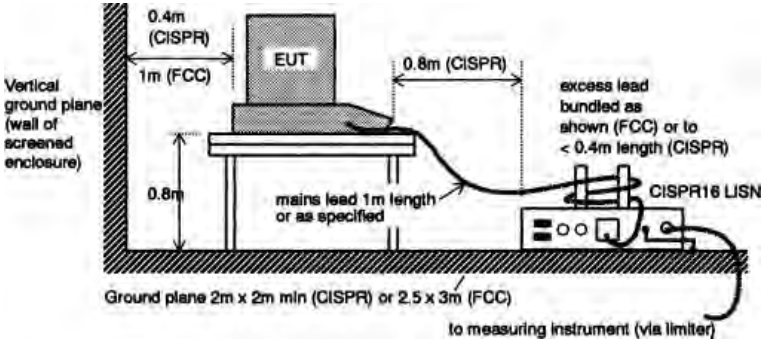
- LISN（也称为AMN）
- ISN（也称为AAN）
- CDNE
- 射频电流监测探头
- 吸收夹具
- 电压探头
- 电容式电压探头
- 磁性近场探针（仅限调试）
- LISN Mate（CM/DM调试）



# 进行发射测量在哪里测量？

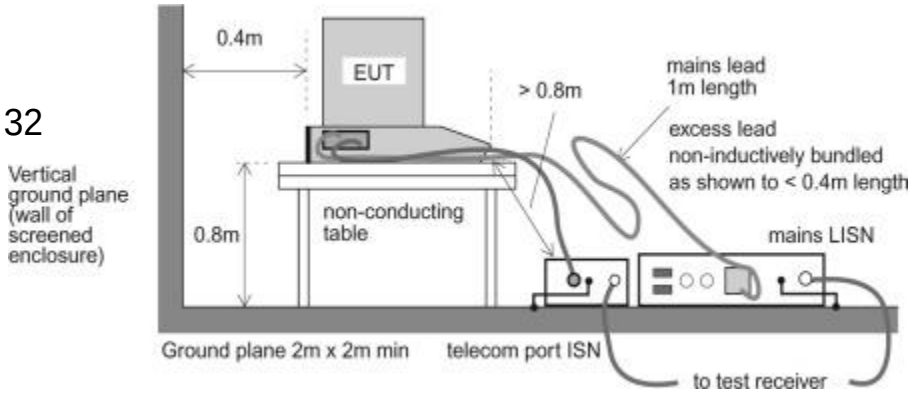
计算机电源电缆示例：

CISPR 32




示例计算机、电源电缆、以太网电缆：

CISPR 32

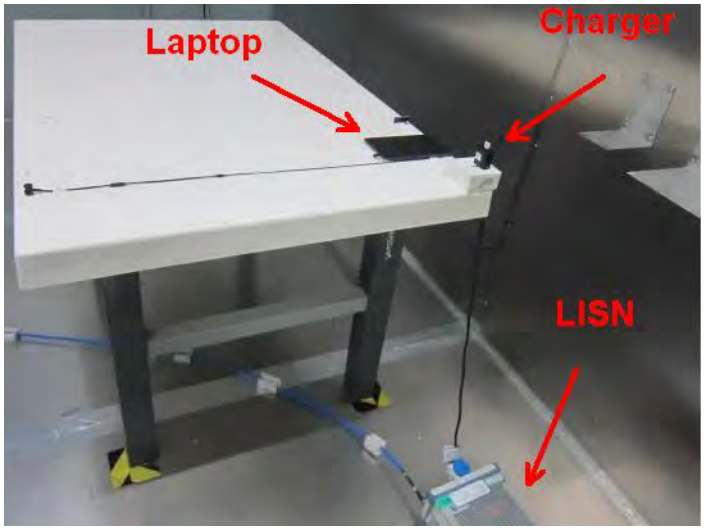



只有用于语音、数据和信令传输的端口，旨在通过直接连接到单用户或多用户通信网络（例如CATV、PSTN、ISDN、xDSL、LAN和类似网络）来互连广泛分散的系统，才需要进行发射测试

# 进行发射测量在哪里测量？

**笔记本电脑示例：**

CISPR 32




- 在充电器的电源侧测量传导发射
  · 充电器输出到笔记本电脑的直流电缆上没有测量值

为什么忽略直流电源线、USB、HDMI、音频等电缆上的传导噪声？

辐射发射测试将解决这些电线上过多的传导噪声问题。
因此，在合规前测试期间，使用射频电流监测探头检查这些电缆的传导噪声是一种良好的做法。

V1.0

# 传导发射测量
# USB、HDMI…电缆的合规前调查：

在测试辐射发射时，我应该应用哪些限制来确定传导发射是否会导致故障？哪个换能器？

CISPR 32

**Table A.11 – Requirements for asymmetric mode conducted emissions from Class B equipment**

**Applicable to**

1. wired network ports (3.1.30)
2. optical fibre ports (3.1.24) with metallic shield or tension members
3. broadcast receiver tuner ports (3.1.8)
4. antenna ports (3.1.3)

| Table clause | Frequency range MHz | Coupling device (see Table A.7) | Detector type / bandwidth | Class B voltage limits dB(μV) | Class B current limits dB(μA) |
|---|---|---|---|---|---|
| A11.1 | 0,15 – 0,5 | AAN | Quasi Peak / 9 kHz | 84 – 74 | n/a |
| | 0,5 – 30 | | | 74 | |
| | 0,15 – 0,5 | AAN | Average / 9 kHz | 74 – 64 | |
| | 0,5 – 30 | | | 64 | |
| A11.2 | 0,15 – 0,5 | CVP and current probe | Quasi Peak / 9 kHz | 84 – 74 | 40 – 30 |
| | 0,5 – 30 | | | 74 | 30 |
| | 0,15 – 0,5 | CVP and current probe | Average / 9 kHz | 74 – 64 | 30 – 20 |
| | 0,5 – 30 | | | 64 | 20 |
| A11.3 | 0,15 – 0,5 | Current Probe | Quasi Peak / 9 kHz | n/a | 40 – 30 |
| | 0,5 – 30 | | | | 30 |
| | 0,15 – 0,5 | Current Probe | Average / 9 kHz | | 30 – 20 |
| | 0,5 – 30 | | | | 20 |

The choice of coupling device and measurement procedure is defined in Annex C.

Screened ports including TV broadcast receiver tuner ports are tested with a common-mode impedance of 150 Ω. This is typically accomplished with the screen terminated by 150 Ω to earth.

AC mains ports that also have the function of a wired network port shall meet the limits given in Table A.9.

The test shall cover the entire frequency range.

The application of the voltage and/or current limits is dependent on the measurement procedure used. Refer to Table C.1 for applicability.

Testing is required at only one EUT supply voltage and frequency.

Applicable to ports listed above and intended to connect to cables longer than 3 m.

将电流探针放在电缆的中心，检查最大振幅的发射，然后沿电缆移动探针以找到最大振幅的位置

# 传导发射测量
# 充电器/PPSU直流电缆合规前调查？

充电器/PPSU直流电缆合规前调查：
在测试辐射发射时，我应该应用哪些限制来确定传导发射是否会导致故障？
哪个换能器？

CISPR 32

**Table A.9 – Requirements for conducted emissions from the AC mains power ports of Class B equipment**

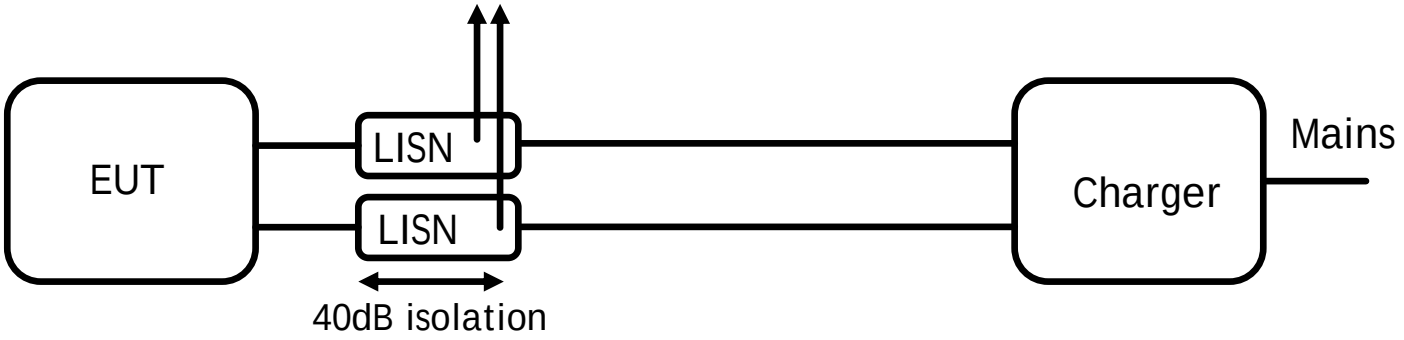
| Applicable to<br>1. AC mains power ports (3.1.1) | | | | |
|---|---|---|---|---|
| **Table clause** | **Frequency range MHz** | **Coupling device (see Table A.7)** | **Detector type / bandwidth** | **Class B limits dB(µV)** |
| A9.1 | 0,15 – 0,5 | AMN | Quasi Peak / 9 kHz | 66 – 56 |
| | 0,5 – 5 | | | 56 |
| | 5 – 30 | | | 60 |
| A9.2 | 0,15 – 0,5 | AMN | Average / 9 kHz | 56 – 46 |
| | 0,5 – 5 | | | 46 |
| | 5 – 30 | | | 50 |
| Apply A9.1 and A9.2 across the entire frequency range. | | | | |

使用LISN，并对相关标准的交流电源端口的传导发射应用规定的相同限值

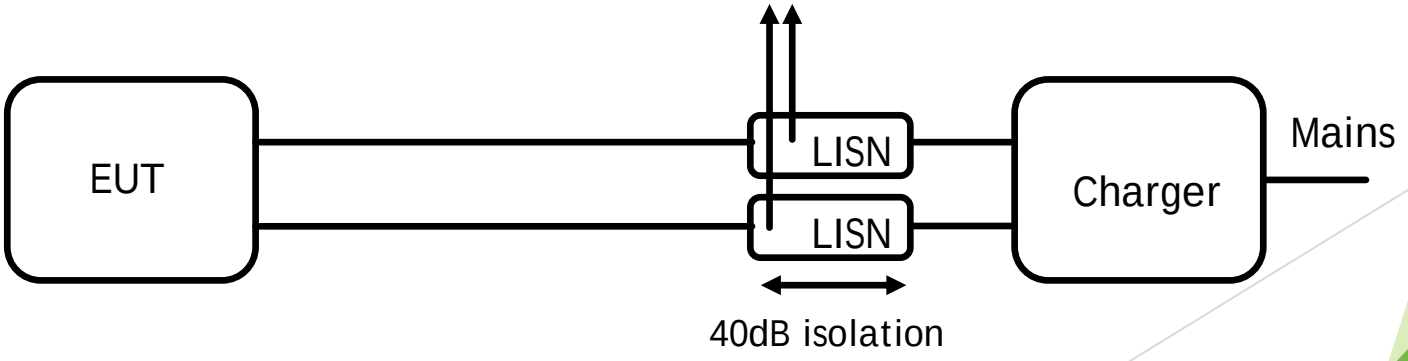
# 传导发射测量
# 充电器/PPSU直流电缆合规前调查？

**我应该如何设置测量？**

频谱分析仪，充电器侧噪声



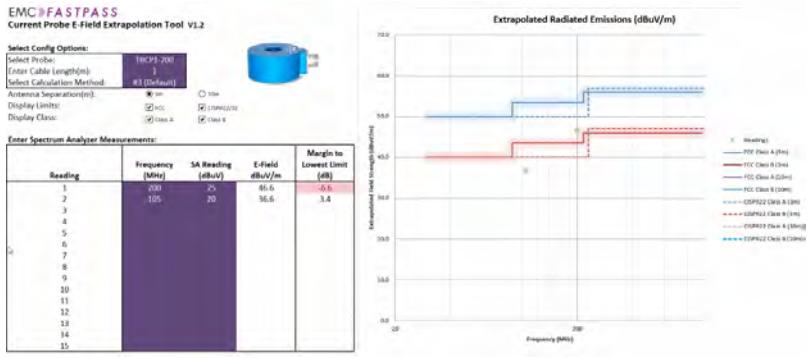

频谱分析仪，EUT侧噪声



# 传导发射测量电流探针电场外推？

**基于射频电流测量计算电缆辐射发射的三种方法**

Article and tool from EMCfastpass:
https://emcfastpass.com/current-probe-e-field-emi-testing/
https://emcfastpass.com/wp-content/uploads/2019/09/mat-cmi.pdf




引文，EC专家Heny Ott：
“在您可能进行的所有各种类型的EMC测量中，共模电流测量是最有用的。”

**电流探头E场外推也在EMCview软件中实现**

# 进行发射测量在哪里测量？

## Example luminaries - CISPR 15



**Table 11 – Overview of standardized conducted disturbance measurement methods**

| Interface | Limits | Frequency range | Reference |
|---|---|---|---|
| Electric power supply interface | Table 1 | 9 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (ancillary equipment: AMN)<br>CISPR 16-2-1 (measurement method) |
| Wired network interfaces other than power supply interface (e.g. for communication or data transfer) | Table 2 | 150 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (AAN, CVP)<br>CISPR 16-2-1 and 8.4 (measurement method) |
| | Table 3[a] | 150 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (current probe)<br>CISPR 16-2-1 and 8.4 (measurement method) |
| Local wired port – electrical power supply interface of ELV lamps | Table 1 or Table 4 | 9 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (ancillary equipment: AMN)<br>CISPR 16-2-1 and A.5.1 (measurement method) |
| Local wired port – other than the electrical power supply interface of ELV lamps | Table 5 | 150 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (voltage probe)<br>CISPR 16-2-1 and 8.5.2.2 (measurement method) |
| | Table 6 | 150 kHz to 30 MHz | CISPR 16-1-1 (receiver)<br>CISPR 16-1-2 (current probe)<br>CISPR 16-2-1 and 8.5.2.3 (measurement method) |

[a] Depending on the EUT port under test and on the selected test method, the applicable limit will be Table 2 or Table 3 or both.

根据接口/端口，使用不同的传感器。什么是端口？->查找标准中的术语和定义

# 进行发射测量在哪里测量？

## 示例灯具——CISPR 15——端口和接口

### 3.4 Terms and definitions related to interfaces and ports

**3.4.1**
**AC electric power supply interface**
connection point to an external AC electrical supply network

**3.4.2**
**communication/data/network interface**
point of connection for data and signalling transfers intended to interconnect widely dispersed systems via such means as direct connection to multi-user telecommunications networks (e.g. local area networks like Ethernet, token ring, etc.)

**3.4.3**
**control interface**
point at which a conductor or cable is attached to the lighting equipment for the purpose of controlling the function of the equipment

**3.4.4**
**DC electric power supply interface**
connection point to an external DC electrical supply network

**3.4.5**
**electric power supply interface**
connection point at which a conductor or cable carrying the primary electrical power needed for the operation (functioning) of the lighting equipment is connected, and through which also conducted electromagnetic disturbance may couple to the electromagnetic environment

Note 1 to entry: It is possible to connect cables to such an interface for transmission of electric power from DC and/or AC mains power distribution systems which has a topology such that an electromagnetic disturbance easily couples to the electromagnetic environment.

**3.4.6**
**enclosure port**
artificial non-intentional wireless interface of the lighting equipment through which electromagnetic disturbances can radiate into the environment

Note 1 to entry: Based on IEC 61000-6-3:2006/AMD1:2010, 3.1.2.

Note 2 to entry: The artificial interface can consist of for instance seams and apertures in the physical metallic enclosure, but also limited lengths of each of its wired interfaces. In the frequency range above 30 MHz typically one third of a wavelength of the length of the wired interfaces can contribute to radiated disturbances. Therefore, also included are wired interfaces to auxiliary equipment which are intended to be connected with cables of less than 3 m length.

**3.4.7**
**electrical interface**
connection point of equipment at which a conductor or cable is attached for various purposes such as powering, control or communication

# 进行发射测量在哪里测量？

## 灯具示例——CISPR 15——限值示例

**Table 1 – Disturbance voltage limits at the electric power supply interface**

| Frequency range | Limits [a] dB(μV) | | Method |
|---|---|---|---|
| | Quasi-peak | Average | |
| 9 kHz to 50 kHz | 110 | – | CIPR 16-2-1 and 8.3 |
| 50 kHz to 150 kHz | 90 to 80[b] | – | |
| 150 kHz to 0,5 MHz | 66 to 56[b] | 56 to 46[b] | |
| 0,5 MHz to 5,0 MHz | 56[c] | 46[c] | |
| 5 MHz to 30 MHz | 60 | 50 | |

**Table 5 – Disturbance voltage limits at local wired ports: local wired ports other than electrical power supply interface of ELV lamp**

| Frequency range MHz | Limits dB(μV)[a] | | Method |
|---|---|---|---|
| | Quasi-peak | Average | |
| 0,15 to 0,50 | 80 | 70 | CISPR 16-2-1 (voltage probe method) See 8.5.2.2 |
| 0,50 to 30 | 74 | 64 | |
| [a] At the transition frequency, the lower limit applies. | | | |

**Table 6 – Disturbance current limits at local wired ports: local wired ports other than electrical power supply interface of ELV lamp**

| Frequency range MHz | Limits dB(μA) | | Method |
|---|---|---|---|
| | Quasi-peak | Average | |
| 0,15 to 0,50 | 40 to 30 | 30 to 20 | CISPR 16-2-1 See 8.5.2.3 |
| 0,50 to 30 | 30 | 20 | |
| NOTE 1 The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz. | | | |
| NOTE 2 The current disturbance limits are derived for use of a common mode (asymmetric mode) impedance of 150 Ω, and the conversion factor applied is 20 log(150) = 44 dBΩ. | | | |

这些只是CISPR 15中规定的几个限制

# 进行发射测量在哪里测量？

示例灯具CISPR 15基本测量布置

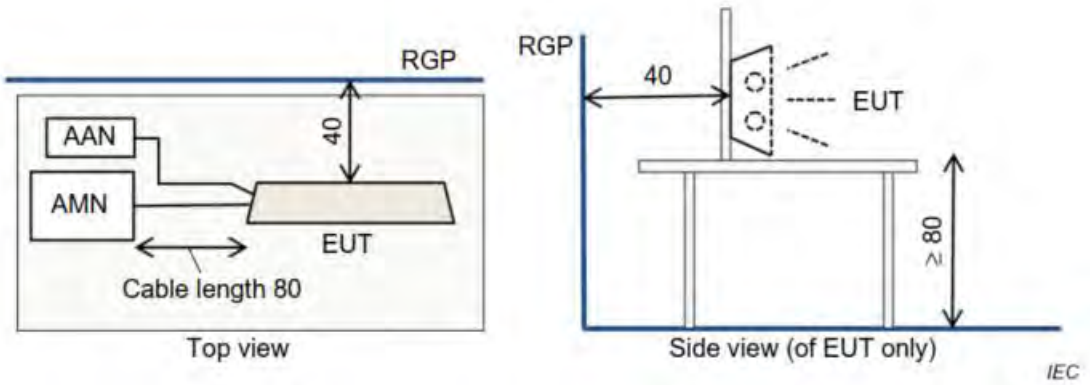



**Figure B.3b – Vertical RGP setup (option 2)**

例如，智能家居-带控制接口的灯具

- 用LISN测量的干线传导排放
- 用AAN（不对称人工网络）测量的控制IF传导排放

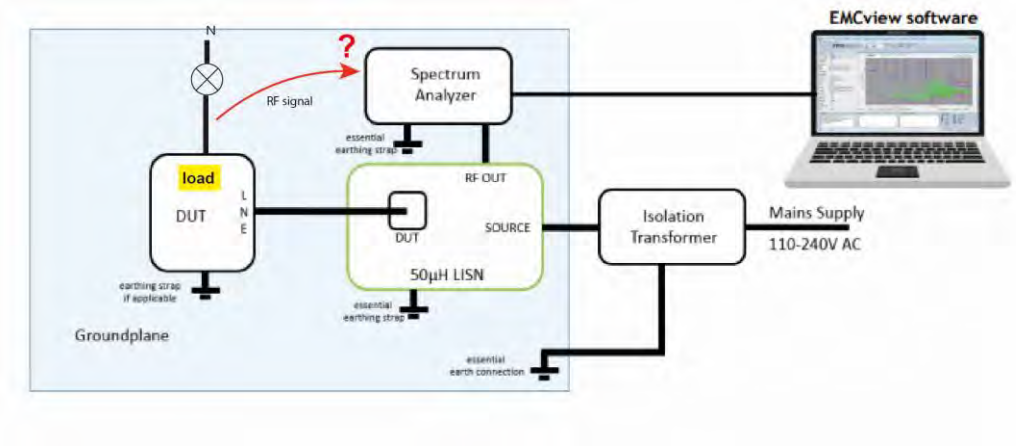
# 进行发射测量在哪里测量？

## 示例灯具CISPR 15客户问题

“”

几周前，我们从Tekbox购买了一个用于传导排放的EMC套件，我们已经在使用它，对此我们非常满意。
然而，为了满足规定（CISPR 15），我们还需要测量DUT负载端子（而不仅仅是电源端子）的传导发射。
随信附上一张图表以澄清此事。
我问她，你是否知道做这个测量需要什么；你需要一个特殊的探针吗？还是有必要以不同的方式将LISN连接到DUT？
不幸的是，目前我还没有在tekbox手册中找到关于它的主题。

“”




答案：
电压探头

深圳市国测电子有限公司

# 传导发射测量电压探头

不能用LISN测量的端子上的干扰电压可以用电压探针测量。这种端子的例子是用于天线、控制线、信号线和负载线的连接插孔。通常，电压探针用于测量共模干扰电压。探针在待测端子和参考地之间呈现高RF阻抗。

- 一些标准明确规定使用电压探头。
- 在某些情况下，不能使用LISN：具有非常高电流或高电压的电源线。

# 进行发射测量在哪里测量？

## 灯具示例——CISPR 15
## 特殊情况“CDNE”，用于表征辐射发射的传导发射测量

**Table 10 – Radiated disturbance limits and associated measurement methods in the frequency range 30 MHz to 1 GHz**

| Testing method [a] | Reference [g] | Frequency range MHz | Quasi-peak limits [d] |
|---|---|---|---|
| OATS or SAC at 10 m distance | CISPR 16-2-3 | 30 to 230<br>230 to 1 000 | 30 dB(μV/m)<br>37 dB(μV/m) |
| OATS or SAC at 3 m distance | CISPR 16-2-3 | 30 to 230<br>230 to 1 000 | 40 dB(μV/m)<br>47 dB(μV/m) |
| FAR at 3 m distance | CISPR 16-2-3 | 30 to 230<br>230 to 1 000 | 42 to 35 [e] dB(μV/m)<br>42 dB(μV/m) |
| TEM-waveguide [b] | IEC 61000-4-20 | 30 to 230<br>230 to 1 000 | 30 dB(μV/m)<br>37 dB(μV/m) |
| CDNE method [c, f] | CISPR 16-2-1 | 30 to 100<br>100 to 200<br>200 to 300 | 64 to 54 [e] dB(μV)<br>54 dB(μV)<br>54 to 51 [e] dB(μV) |

[a] Any of the methods and the associated limits can be applied to demonstrate compliance.

[b] The TEM-waveguide is limited to EUTs without cables attached and with a maximum size according to 6.2 of IEC 61000-4-20:2010 (the largest dimension of the enclosure at 1 GHz measuring frequency is one wavelength, 300 mm at 1 GHz).

[c] The CDNE method and the associated limits up to 300 MHz can be only applied for EUTs with clock frequencies below or equal to 30 MHz. In such a case, the product is deemed to comply with the requirements between 300 MHz and 1 000 MHz. The CDNE-limits between 200 MHz and 300 MHz specified in Table 10 are more stringent than the limits given in CISPR 15:2013. An increasing margin (up to 10 dB at 300 MHz) has been applied between 200 MHz and 300 MHz. If the CDNE test fails, then any of the other methods and associated limits can still be applied [a].

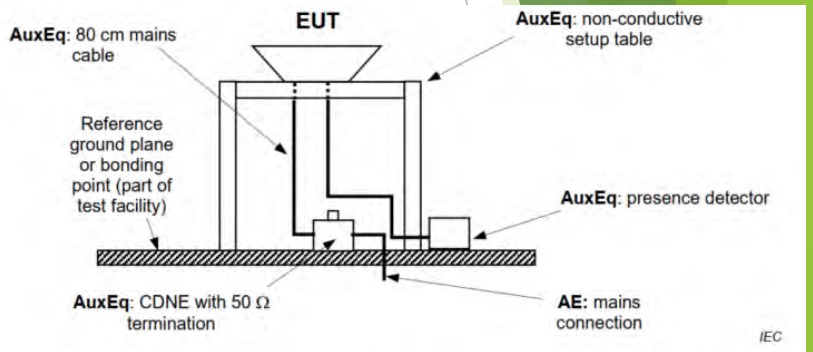



**Figure C.3 – Example of arrangement of a luminaire during the radiated (OATS, SAC or FAR) disturbance measurement**

# 进行发射测量在哪里测量？

## 灯具示例——CISPR 15
## 特殊情况“CDNE”，用于表征辐射发射的传导发射测量

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| FAR at 3 m distance | CISPR 16-2-3 | 30 to 230<br>230 to 1 000 | 42 to 35 [e] dB(μV/m)<br>42 dB(μV/m) |
| TEM-waveguide [b] | IEC 61000-4-20 | 30 to 230<br>230 to 1 000 | 30 dB(μV/m)<br>37 dB(μV/m) |
| CDNE method [c, f] | CISPR 16-2-1 | 30 to 100<br>100 to 200<br>200 to 300 | 64 to 54 [e] dB(μV)<br>54 dB(μV)<br>54 to 51 [e] dB(μV) |

[a] Any of the methods and the associated limits can be applied to demonstrate compliance.

[b] The TEM-waveguide is limited to EUTs without cables attached and with a maximum size according to 6.2 of IEC 61000-4-20:2010 (the largest dimension of the enclosure at 1 GHz measuring frequency is one wavelength, 300 mm at 1 GHz).

[c] The CDNE method and the associated limits up to 300 MHz can be only applied for EUTs with clock frequencies below or equal to 30 MHz. In such a case, the product is deemed to comply with the requirements between 300 MHz and 1 000 MHz. The CDNE-limits between 200 MHz and 300 MHz specified in Table 10 are more stringent than the limits given in CISPR 15:2013. An increasing margin (up to 10 dB at 300 MHz) has been applied between 200 MHz and 300 MHz. If the CDNE test fails, then any of the other methods and associated limits can still be applied [a].

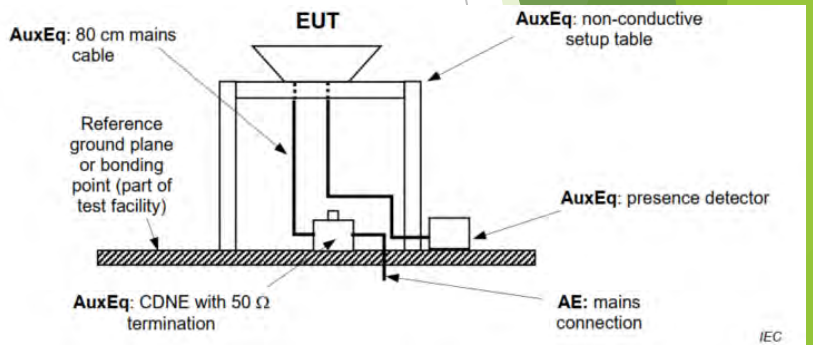



**Figure C.3 – Example of arrangement of a luminaire during the radiated (OATS, SAC or FAR) disturbance measurement**

# 传导发射测量干扰功率？

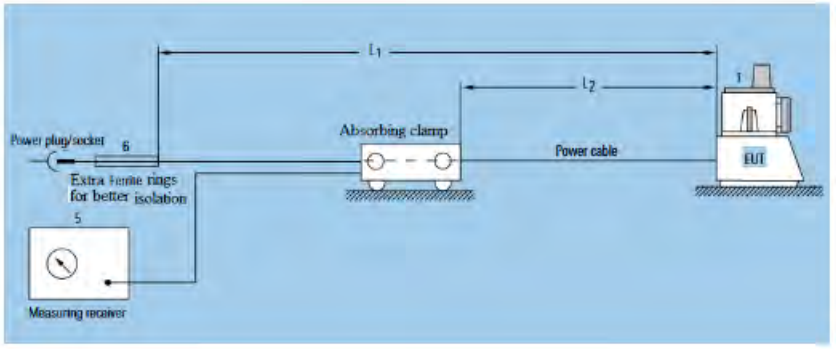
CISPR 14，家用电器、电动工具及类似产品

9 kHz-30 MHz的传导发射测量->LISN
**30 MHz-300 MHz的干扰功率测量->吸收钳**

**Table 2a – Disturbance power limits for the frequency range 30 MHz to 300 MHz**

| | Household and similar appliances | | Tools | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Frequency range | | | Rated motor power not exceeding 700 W | | Rated motor power above 700 W and not exceeding 1 000 W | | Rated motor power above 1 000 W | |
| (MHz) | dB (pW) Quasi-peak | dB (pW) Average[a] | dB (pW) Quasi-peak | dB (pW) Average [a] | dB (pW) Quasi-peak | dB (pW) Average [a] | dB (pW) Quasi-peak | dB (pW) Average [a] |
| 30 to 300 | Increasing linearly with the frequency from: | | | | | | | |
| | 45 to 55 | 35 to 45 | 45 to 55 | 35 to 45 | 49 to 59 | 39 to 49 | 55 to 65 | 45 to 55 |

a If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.




# 传导发射测量总结

LISN是测量传导发射最常用的换能器。
LISN只能测量供电线路上的传导排放
LISN是有创换能器
LISN具有低通特性和有限的频率范围

用于监测传导发射的最通用的换能器是RF电流探头。
射频电流探头测量电源、数据和控制线上的传导发射
射频电流探头是非侵入式换能器
射频电流探头具有较宽的频率ra


所有其他换能器都有相当专业的应用

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