



KNX Hardware Requirements and Tests

4

Safety and Environmental Requirements – EMC Test Set-ups

2

Summary

This document describes the Test Set-ups for EMC Testing

This document is part of the KNX Specifications v2.1.

Version 01.01.01 is a KNX Approved Standard.

Document Updates

Version	Date	Modifications
1.0	1999.08	Approved Standard
1.1RfV	2003.09	Update according modified standards - restructuring of the handbook – preparation for release for voting
1.1FV	2004.06	Integration of comments from release for voting cycle – preparation for final voting
1.1 AS	2009.02	Finalisation of chapter for publication in V2.0 of the KNX specifications (o.a. taking into account approval of AN106 and AN109)
01.01.01	2013.10.21	Editorial updates for the publication of KNX Specifications 2.1.

Filename: 04_02 HW Requirements for KNX Products - EMC Test Set-ups - v01.01.01 AS.docx
Version: 01.01.01
Status: Approved Standard
Savedate: 2013.10.21
Number of pages: 28

Contents

1	General Remarks	4
2	General abbreviations.....	4
3	Test set up for immunity.....	5
3.1	Test set up for powerline	5
3.1.1	General.....	5
3.1.2	EN 61000-4-2 Electrostatic Discharge (ESD)	5
3.1.3	EN 61000-4-3 RF Fields.....	7
3.1.4	EN 61000-4-4 Fast Transients (Bursts)	8
3.1.5	EN 61000-4-5 Transients (Surge).....	9
3.1.6	EN 61000-4-6 Radio Frequency Voltage	9
3.1.7	EN 61000-4-8 Power Frequency Magnetic Field	10
3.1.8	EN 61000-4-11 Voltage Dips / Voltage Interruption	10
3.1.9	EN 50065-2-1 Narrow-band Conducted Interference.....	10
3.2	Test set up for radio frequency	10
3.2.1	EN 61000-4-2 Electrostatic discharge (ESD)	10
3.2.2	EN 61000-4-3 Radio frequency fields	11
3.2.3	EN 61000-4-4 Fast transients / bursts.....	13
3.2.4	EN 61000-4-5 Transients / surge	14
3.2.5	EN 61000-4-6 Radio frequency common mode voltage on signal cables.....	14
3.2.6	EN 61000-4-11 Voltage dips and short interruptions	15
3.3	Test set up for twisted pair.....	15
3.3.1	Introduction.....	15
3.3.2	EN 61000-4-2 Electrostatic Discharge (ESD)	16
3.3.3	EN 61000-4-3 RF Fields.....	17
3.3.4	EN 61000-4-4 Fast Transients (Bursts)	17
3.3.5	EN 61000-4-5 Transients (Surge).....	19
3.3.6	EN 61000-4-6 Radio Frequency Voltage	21
3.3.7	EN 61000-4-8 Power Frequency Magnetic Field	24
3.3.8	EN 61000-4-11 Voltage Dips / Voltage Interruption	24
4	Test set up for emission.....	25
4.1	Test set up for powerline	25
4.1.1	Radio Emission Interference Voltage on Connections and Process Connections.....	25
4.1.2	Radio Frequency Interference Field Strength.....	25
4.2	Test set up for radio frequency	25
4.2.1	Electromagnetic Interference (EMI): Noise-field intensity	25
4.2.2	Electromagnetic Interference (EMI): Interference voltage.....	26
4.3	Test set up for twisted pair.....	27
4.3.1	General.....	27
4.3.2	Radio Emission Interference Voltage on Power Supply Connections and Process Connections.....	27
4.3.3	Radio Frequency Interference Field Strength.....	28

1 General Remarks

This chapter is divided into several clauses describing the test arrangements for different media. Devices connected to different media such as media-coupler shall be tested according the requirements of all implemented media.

All tests shall be carried out with the KNX bus minimum standard configuration enabling testing the proper function of an Equipment Under Test (EUT).

In order to verify performance criterion A, the EUT shall be stimulated at least every second respectively a bus transmission is needed every second.

EUT's with two bus connections (e.g. Line Coupler) shall be active on both paths.

2 General abbreviations

A	Attenuation
AN	Artificial Mains Network
AFS	Additional Filter Section
AT	Antenna
C	Coupling Network
CC	Capacitive coupling clamp
CDN	Coupling-decoupling network
CU	Communication unit
D	Device needed for functional test of the EUT
DF	Decoupling filter
EUT	Equipment under Test
F	Filters decoupling the D from the test signal. These filters may not reduce the test signal for the EUT.
G	Generator
HF	High frequency
M	Measuring set 50 Ω
MEQU	Measurement equipment
PF	Passing filter
PSU	Power supply unit
R	Reference Ground (EN 55022, metal wall)
RF	Radio frequency
T/R	Transmitter/receiver
U_{N+S}	Mains Voltage with coupled test signals
VN	Artificial mains V-network

3 Test set up for immunity

This part is provided as a guideline to assist the application of the basic EMC standards. In case of conflict with the basic EMC standards, the basic EMC standards apply.

3.1 Test set up for powerline

3.1.1 General

The EUT and the corresponding device CU (the stimulus), used to establish that communication between the two devices is possible, are supplied via two artificial networks AN A and AN B. Two $660\ \mu\text{H}$ inductors F are connected between each of the two conductors of AN A and AN B and are used for signalling purposes, i.e. to provide a controlled signal coupling between the EUT and CU.

This test-set-up is only applicable for testing the behaviour of the communication part and process connections of a device.

For power-parts of switches or dimmers - if any - additional EMC tests can be necessary according to the relevant product-standard.

The power source for all tests is Port A, if not otherwise stated. This ensures stable conditions for the communication between the stimulus (CU) and the EUT. All test set-ups are shown with the connection at the mains entry point Port A instead of the complete general test set-up according to Figure 1.

If the communication between EUT and the stimulus CU is not possible during the test caused by the additional attenuation of the coupling network C and the generator G, the stimulus CU can be connected to port A.

General Test set-up

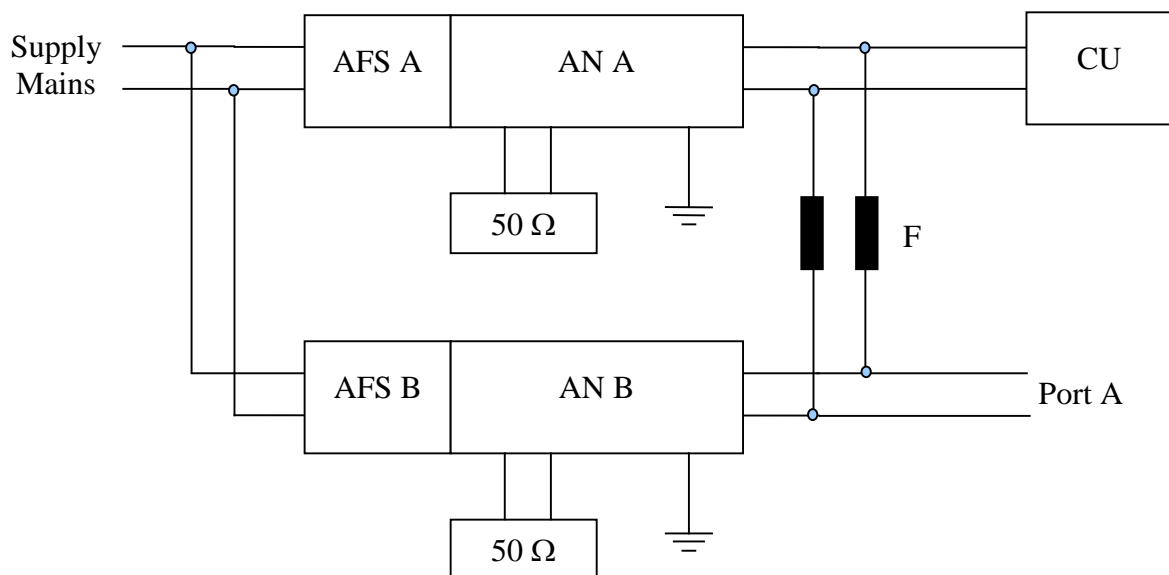


Figure 1 – General test set-up

3.1.2 EN 61000-4-2 Electrostatic Discharge (ESD)

The test procedure and test set-up shall follow EN 61000-4-2.

The EUT shall be active in connection with the auxiliary device D. The test set-up is isolated from and located at 10 cm above an earthed metal plane (reference ground).

1. Contact discharge on perpendicular metal test plane.

The discharge tip shall be contacted to the middle of the test plane. The discharge voltage shall be switched on.

2a. Air discharge (only for devices with a surface which can be touched in normal use).

The ESD generator shall be adjusted to its relevant discharge voltage. The air discharge tip shall be conducted along the touchable surface of the EUT.

2b. Contact discharge (only for devices with earthed conductive surface that can be touched in normal use).

The discharge tip shall be contacted to earthed conductive surfaces of the EUT. The discharge voltage shall be switched on.

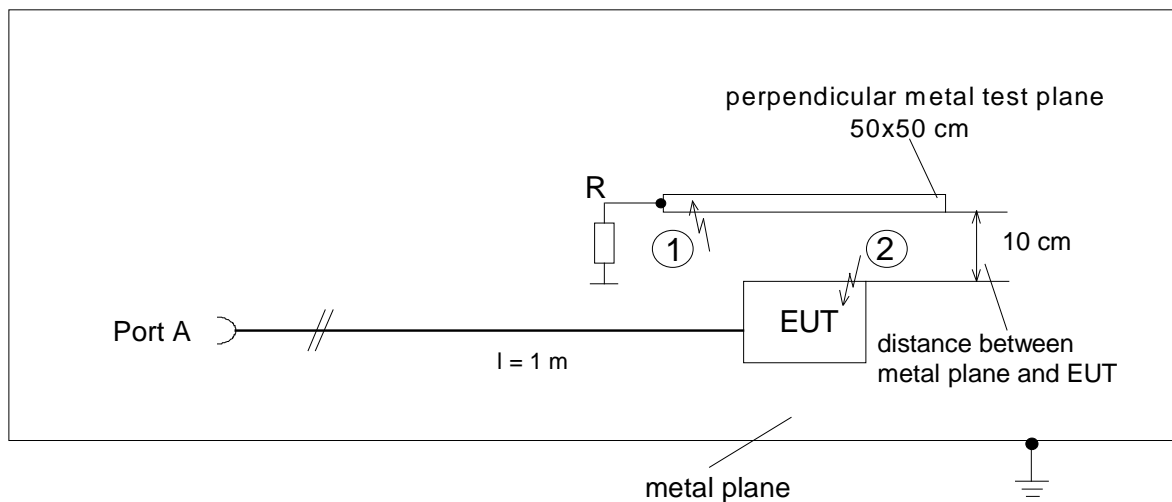


Figure 2 – Electrostatic Discharge Test

3.1.3 EN 61000-4-3 RF Fields

The test procedure shall follow EN 61000-4-3.

The antenna is located at the marked position (see Figure 3). The measurement shall be carried out with various EUT positions. During each constant phase of the test signal (e.g. 1 s interval), one transmission or EUT stimulation shall be carried out.

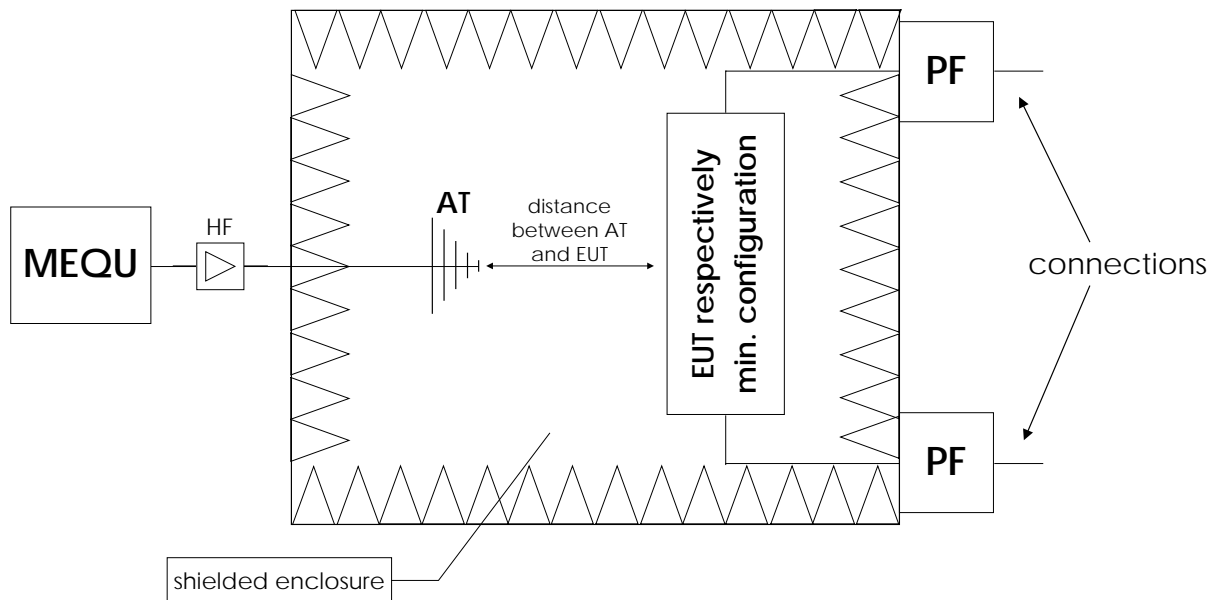


Figure 3 - Measurement in the shielded enclosure

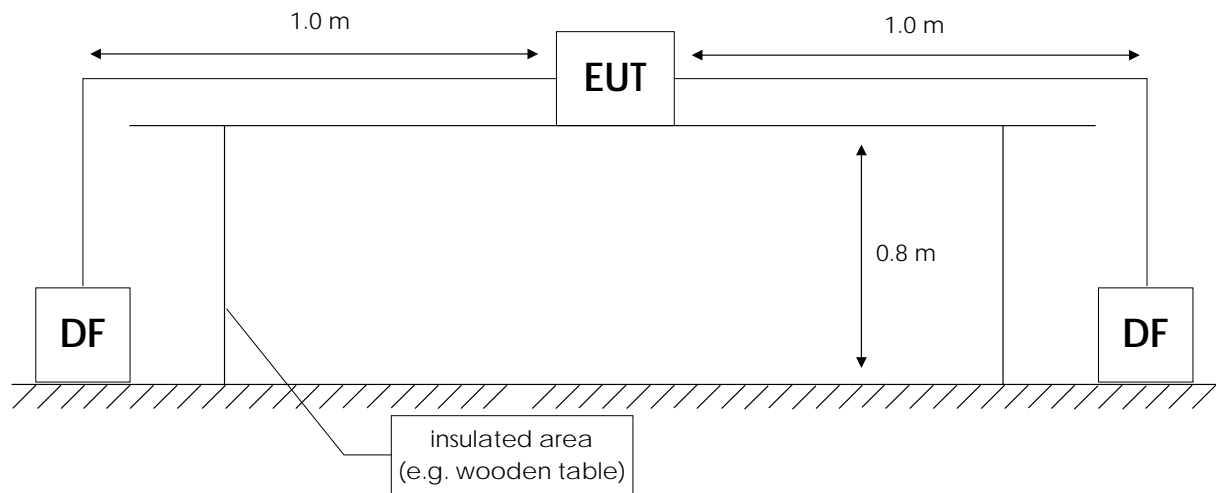


Figure 4 – Side view

3.1.4 EN 61000-4-4 Fast Transients (Bursts)

The test procedure shall follow EN 61000-4-4.

If there is a metallic mounting plate (DIN rail), the test shall be carried out with isolated rail 10 cm above the reference ground plane and with the mounting plane directly contacted to the reference ground.

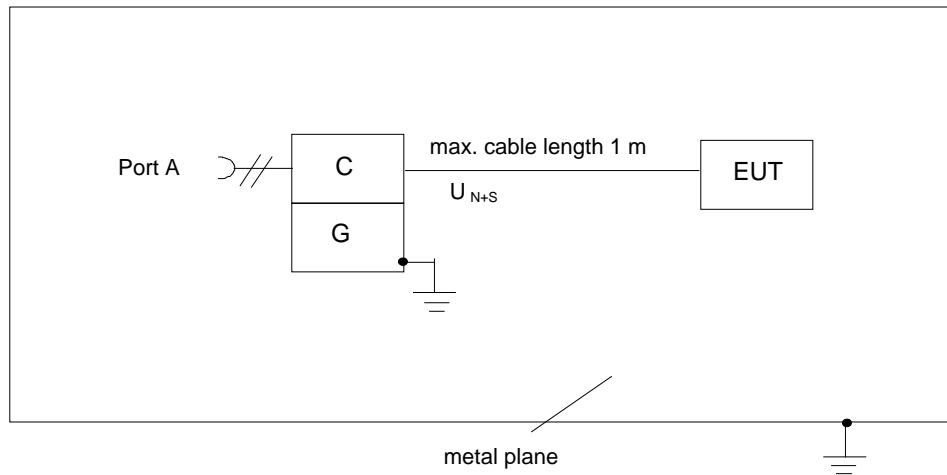


Figure 5 - Test at the Mains Connection of the PL-Device

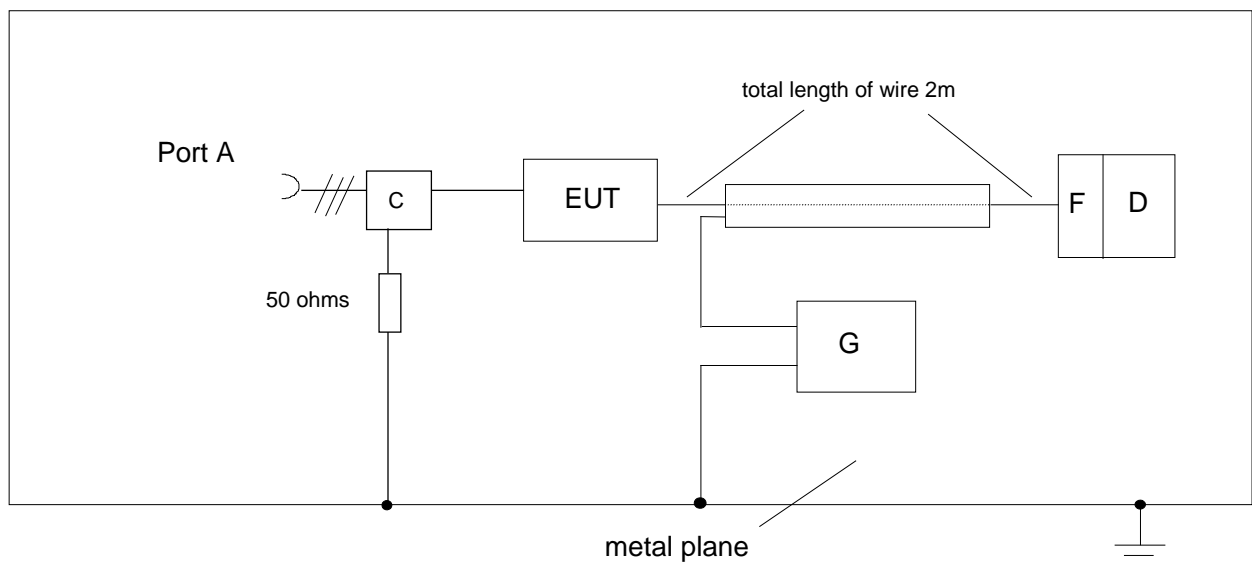


Figure 6 - Test at the Process Connections of the PL-Device

3.1.5 EN 61000-4-5 Transients (Surge)

The test procedure and test set-up shall follow EN 61000-4-5.

All tests shall be carried out with a combination wave (hybrid) generator (1.2/50 μ s). The EUT shall be mounted as in practical use. Existing metal mounting plates shall be grounded to the reference ground (generator ground connector).

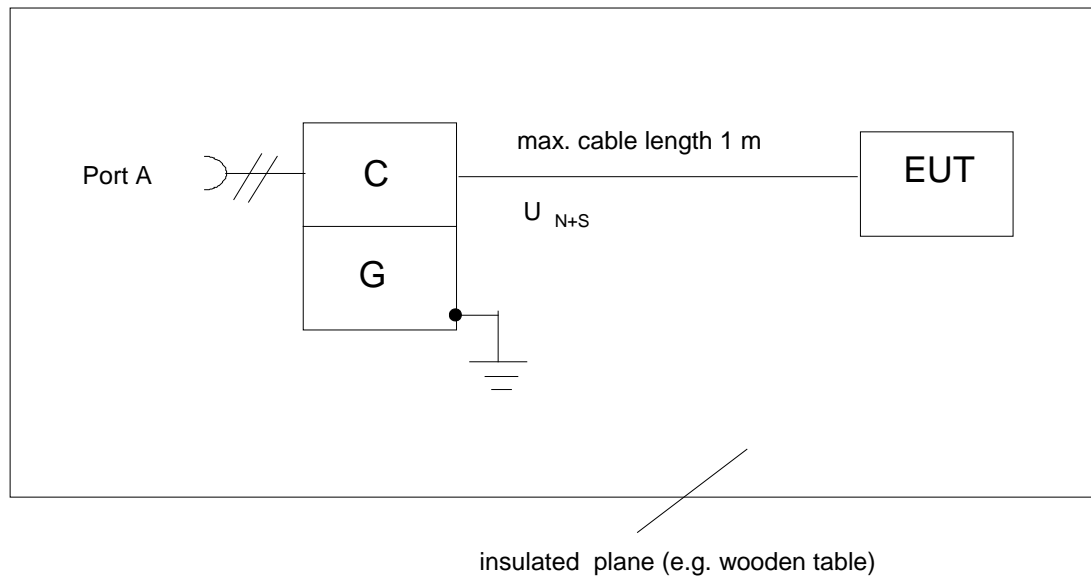


Figure 7 - Test at the mains and process connections of PL device

3.1.6 EN 61000-4-6 Radio Frequency Voltage

The test procedure shall follow EN 61000-4-6.

All tests shall be carried out with a RF generator as specified in EN 61000-4-6.

The EUT shall be mounted as in practical use. Existing metal mounting plates shall be grounded to the reference ground.

The test set-up shall be isolated from and located at 10 cm above an earthed metal plane (reference ground).

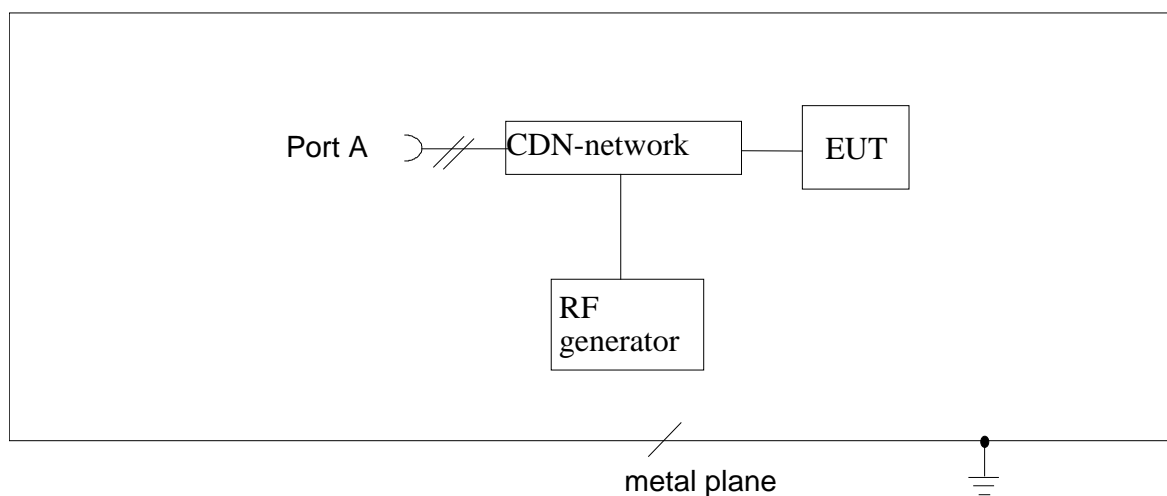


Figure 8 - Test at the Mains Connection of the PL-Device

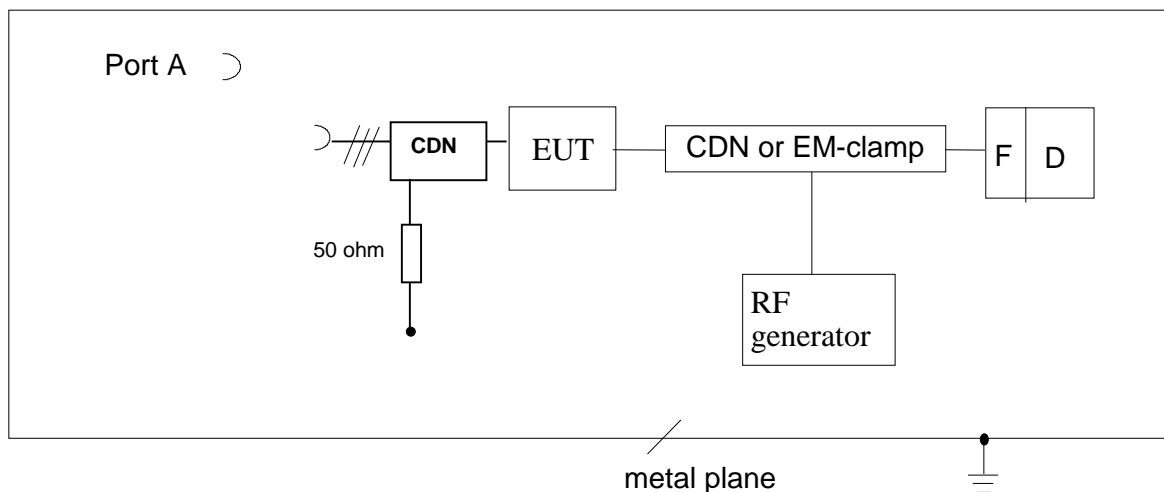


Figure 9 - Test at the Process Connection of the PL-Device

3.1.7 EN 61000-4-8 Power Frequency Magnetic Field

Applicable only to devices containing components susceptible to magnetic fields, e.g. Hall elements, electro-dynamic microphones, etc.

The test procedure shall follow EN 61000-4-8.

3.1.8 EN 61000-4-11 Voltage Dips / Voltage Interruption

The test procedure shall follow EN 61000-4-11.

A Powerline device is not able to transmit information during mains interruption. As a consequence the EUT cannot be stimulated during the test. The test is therefore carried out without the stimulus CU. After the test the stimulus CU shall be connected to the EUT: It has passed the test if the communication is possible.

3.1.9 EN 50065-2-1 Narrow-band Conducted Interference

The test procedure shall follow EN 50065-2-1.

The EUT shall be mounted as in practical use. Existing metal mounting plates have to be grounded to the reference ground.

The test set-up shall be isolated from and located at 10 cm above an earthed metal plane (reference ground).

For this test the 50 Ω resistor at AN B shall be replaced by a generator and a measurement device, each with an impedance of 50 Ω . The EUT is connected to Port A. During the calibration of the voltage level, the EUT is disconnected from Port A.

3.2 Test set up for radio frequency

3.2.1 EN 61000-4-2 Electrostatic discharge (ESD)

The general test requirements and test procedure shall follow EN 61000-4-2. The test arrangement shall be in accordance with Figure 10.

For the test with contact discharge, the electro-static discharge switch will be set on the surface of the metal test plane and the test voltage will be switched on.

For the test with air discharge, the electro-static discharge switch generator will be adjusted to a test voltage and the discharge electrode then will be approached fast to the surface of the equipment under test.

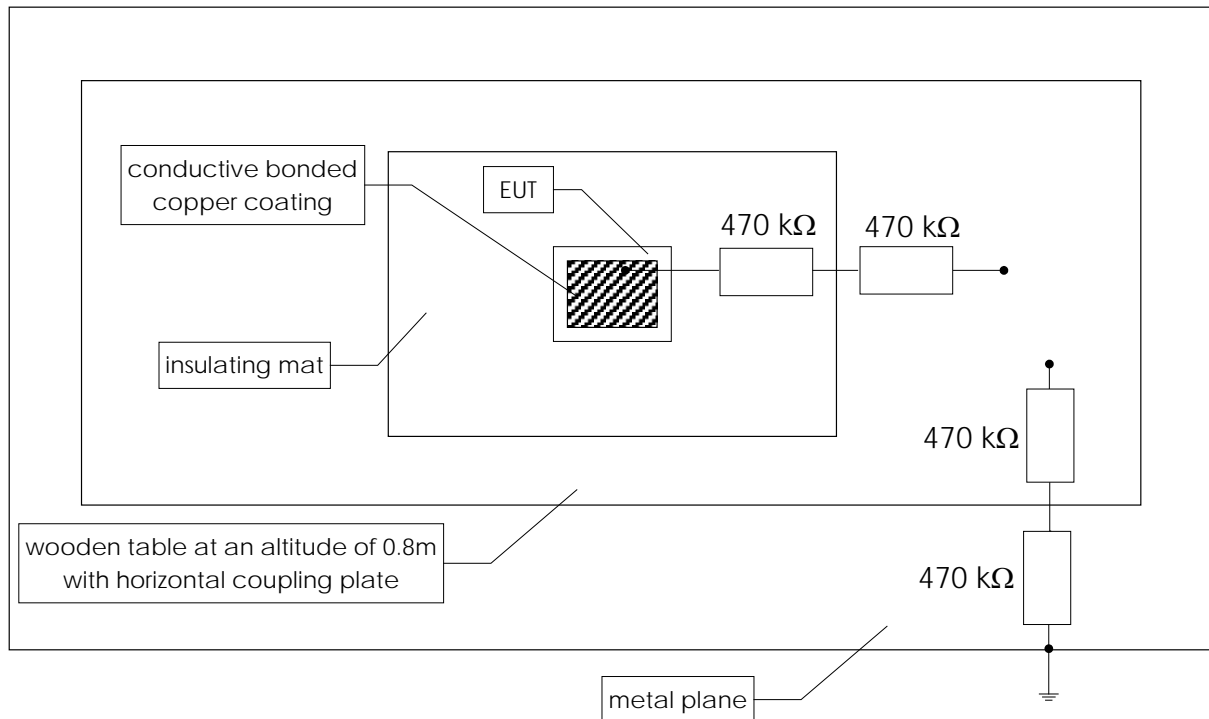


Figure 10 - Electrostatic discharge

3.2.2 EN 61000-4-3 Radio frequency fields

The test procedure shall follow EN 61000-4-3. The test arrangements shall be in accordance with Figure 11 and Figure 12.

The decoupling filter and the passing filter shall be designed for the frequency range 80 MHz to 1 000 MHz and 1 400 MHz to 2 000 MHz.

For test field strength shall be provided an unmodulated carrier signal. For testing of equipment, this carrier signal is 80 % amplitude modulated with 1 kHz sine wave to simulate actual threats.

Because of the magnitude of the field strengths generated, the tests shall be made in an anechoic chamber.

The transmitting antenna shall be placed at a distance sufficient to allow a calibration area of 1,5 m x 1,5 m to fall within the beam width of the transmitted field. If the area intended to be occupied by the face of actual EUT is larger than 1,5 m x 1,5 m, then a calibration at different radiation positions will be necessary in order that the area to be occupied by the EUT may be illuminated in a series of tests ('partial illumination').

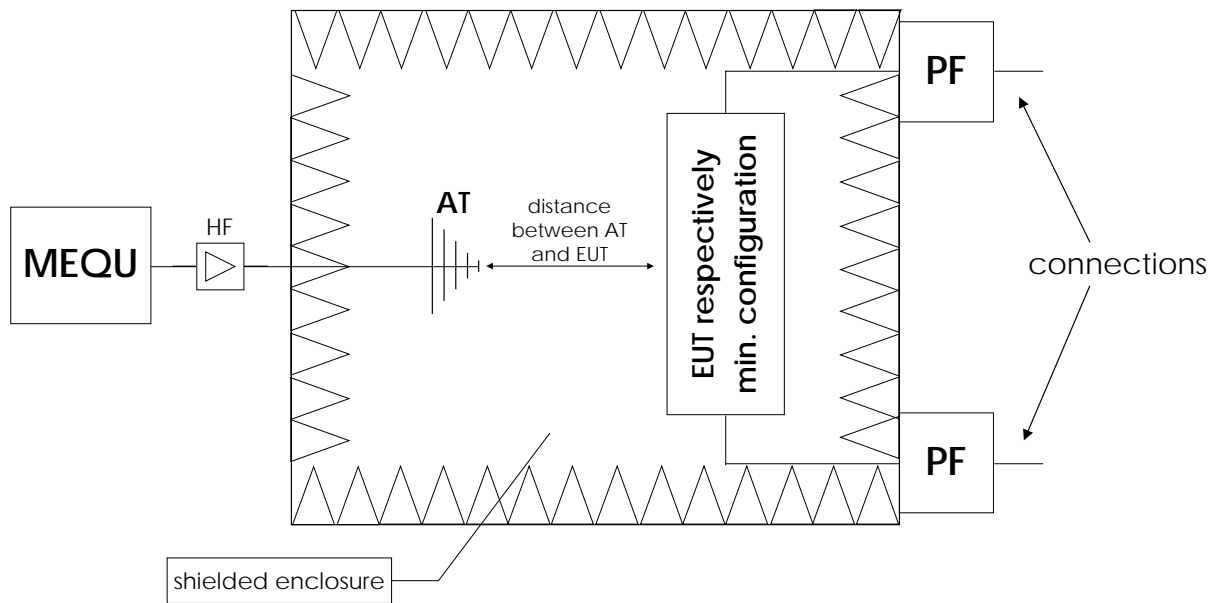


Figure 11 - Measurement in the shielded enclosure

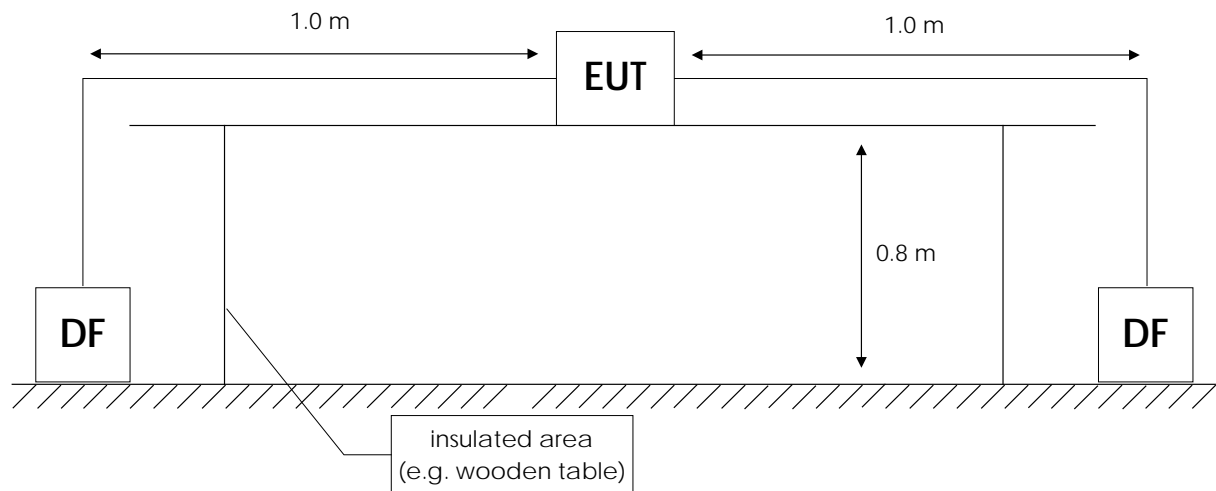


Figure 12 - Side view

3.2.3 EN 61000-4-4 Fast transients / bursts

The general test set-ups and the test procedure shall follow EN 61000-4-4. The test arrangements shall be in accordance with Figure 13 and Figure 14.

If there is a metallic mounting plate at the equipment under test, the test shall be done both with the mounting plate not connected and connected to earth by an HF connection (low inductance).

The equipment under test shall be set in operation with the communication unit(s).

The connection of the test equipment ground cables to the ground reference plane and all bondings shall provide minimum inductance.

The connection of the capacitive coupling clamp to the metal plane / earth shall have a $50\ \Omega$ impedance with minimum lead connection. This resistance avoids reflections, which can cause false test strength.

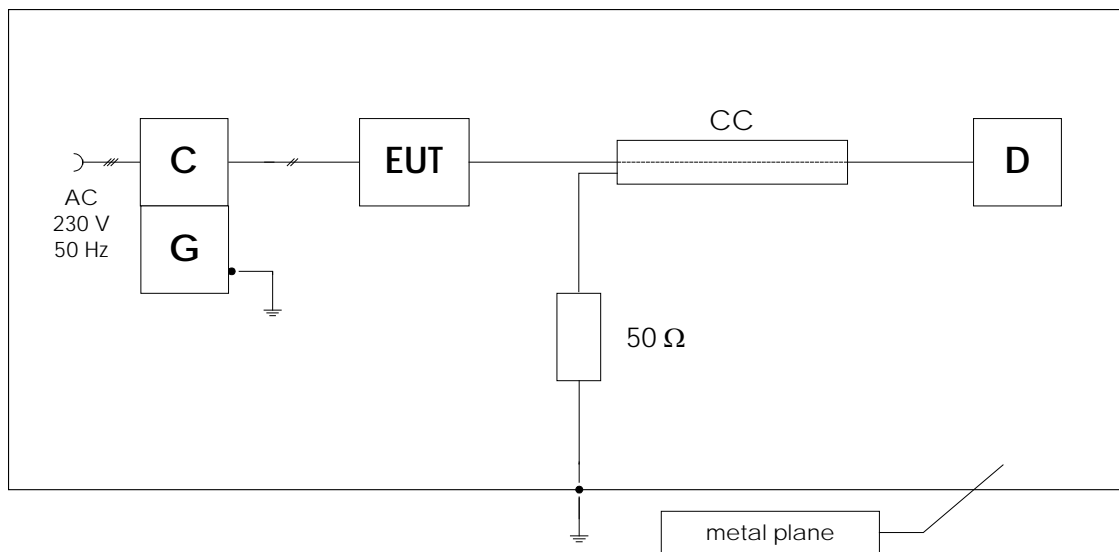


Figure 13 - Fast transients

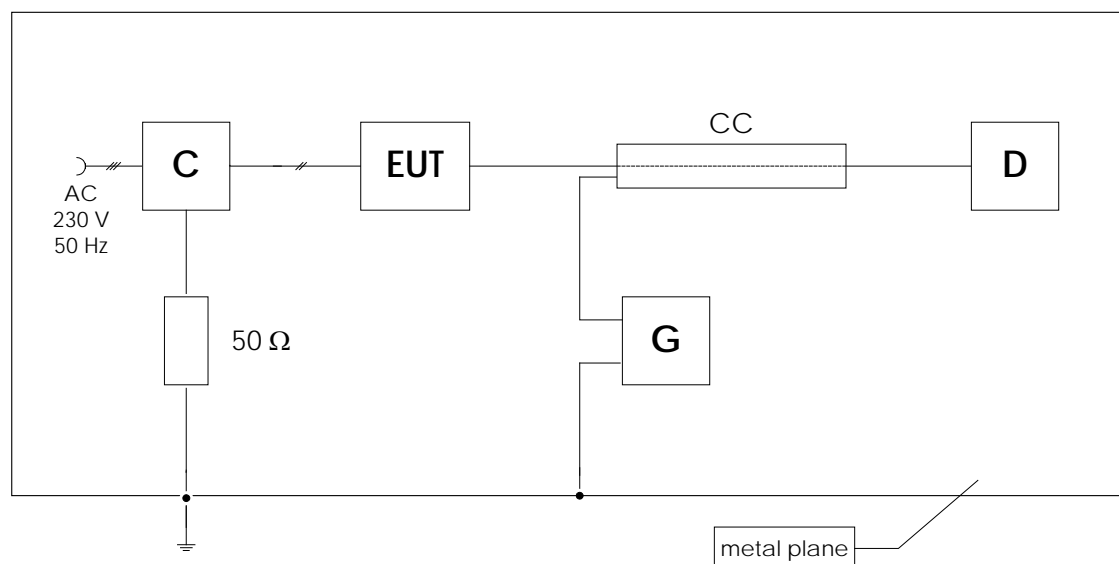


Figure 14 - Fast transients

3.2.4 EN 61000-4-5 Transients / surge

The general test setups and the test procedure shall follow EN 61000-4-5. The test arrangements shall be in accordance with Figure 15.

The equipment under test shall be mounted in a similar way as it is done in the field. If the equipment under test has a metallic mounting plate this plate shall be connected to earth.

The surges have to be applied line to line and line(s) and earth. When testing line to earth the test voltage has to be applied successively between each of the lines and earth, if there is no other specification.

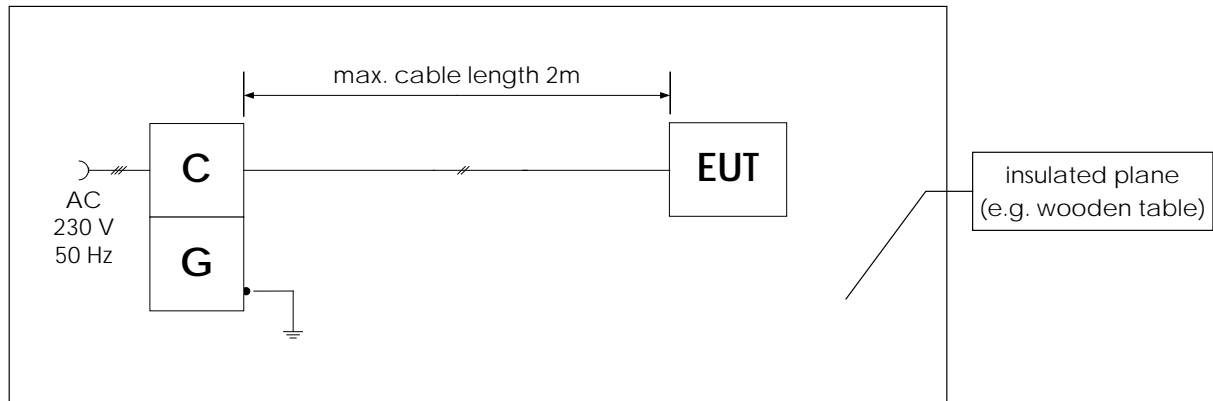


Figure 15 - Transients

3.2.5 EN 61000-4-6 Radio frequency common mode voltage on signal cables

The test procedure shall follow EN 61000-4-6. The test arrangement shall be in accordance with Figure 16.

The test object is placed on a 0,1 m thick support of isolating material, placed on a metal ground plane. A 150 Ω common mode coupling-decoupling network (CDN) is used as coupling network. The total generator impedance is 150 Ω . The CDN includes a filter, which isolates the auxiliary equipment from radio frequency voltage.

The test set-up is calibrated to the open terminal voltage (without modulation) corresponding to the specified test voltage.

A sweep is performed in the frequency range of 0,15 MHz to 80 MHz. The generator is amplitude modulation modulated, 1 kHz modulation frequency, 80 % modulation depth.

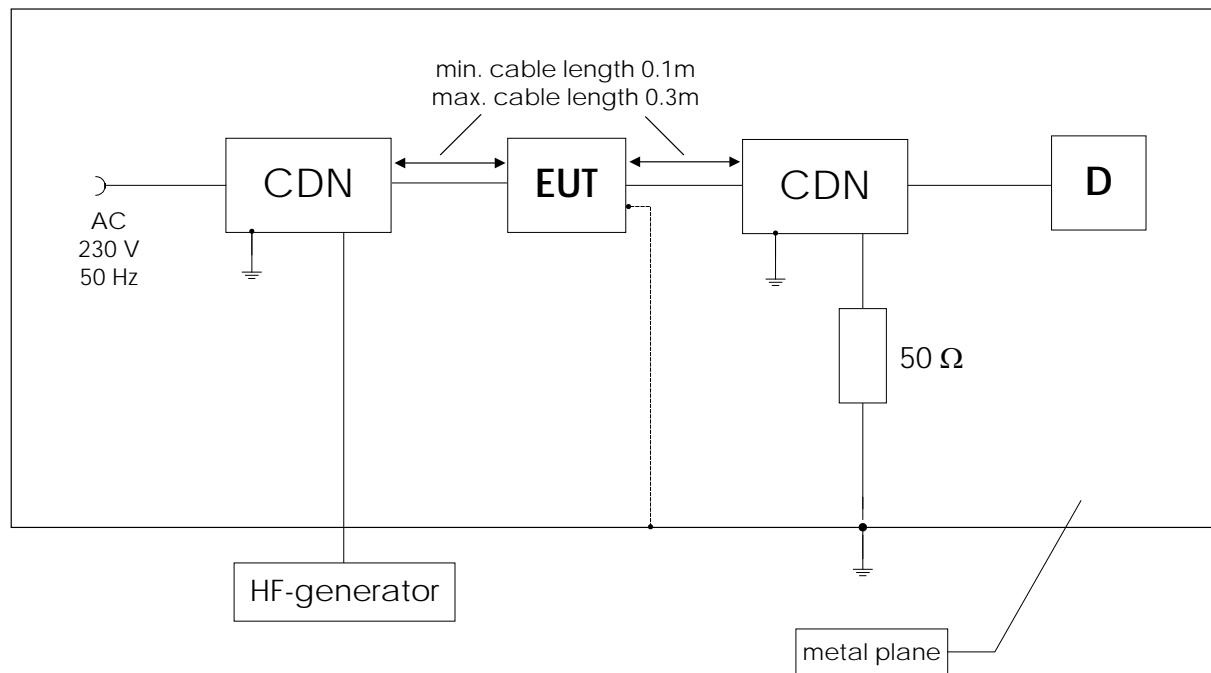


Figure 16 - Test arrangement for EN 61000-4-6

3.2.6 EN 61000-4-11 Voltage dips and short interruptions

The general test requirements and the test procedure shall follow EN 61000-4-11. The test arrangement shall be in accordance with Figure 17.

The test shall be done with a minimum configuration from the power supply point of view.

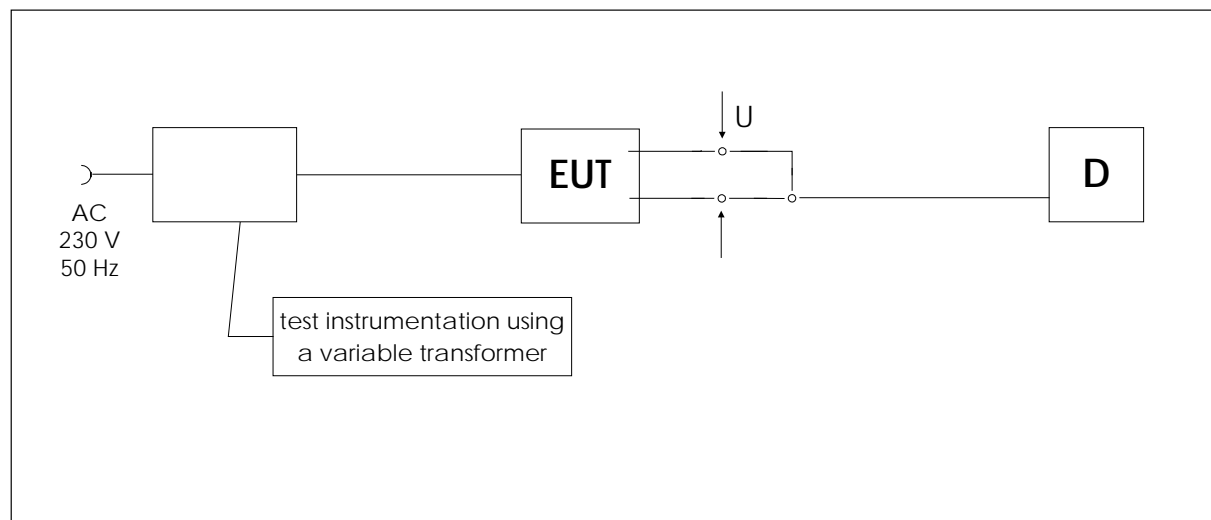


Figure 17 - Test arrangement for voltage dips and variations

3.3 Test set up for Twisted Pair

3.3.1 Introduction

All tests shall be done with a minimum HBACS configuration. A minimum HBACS configuration is a set of devices, which makes it possible to test the proper function of an equipment under test (EUT). The EUT shall be stimulated at least every second respectively there shall be a bus transmission every second in order to verify performance criterion A condition.

The attenuation of the signals shall be specified in the test report.

The filters for test signals are optional but they should be used in order to make the test independent of possible influences/malfunction of the Communication units caused by the test signals. The implementations of these filters are testing dependent. If filters are used they shall be specified in the test report.

The impedance Z ($R=50\ \Omega$, $C=0,47\ \mu\text{F}$) shall be connected to each wire of a cable or of a set of wires (e.g. all wires of a bus cable connected to the EUT, all wires of the UI) at the location as shown in the test arrangements. In case that the I/Os are Mains or PELV connections, Z shall be replaced by a direct connection to earth.

NOTE 1 Z is a load to have a defined impedance to ground.

In the test arrangements of this part, dotted lines are drawn from the EUT to the ground plane/earth. This means, that the maximum capacity or distance of the EUT to the ground plane/earth shall be specified and that in cases where the EUT has an accessible metal surface or shielding, the test shall be done with and without connecting this metal surface or shielding to earth.

3.3.2 EN 61000-4-2 Electrostatic Discharge (ESD)

The test procedure shall follow EN 61000-4-2.

The EUT must be active in connection with the CU, and if applicable, with auxiliary device D. The test set-up is isolated from and located at 10 cm above an earthed metal plane (reference ground).

1. Contact discharge on perpendicular metal test plane

The discharge tip shall be contacted in the centre of the test plane. The discharge voltage will be switched on.

2. Air discharge (only for devices with a non-conductive surface, which can be touched in normal use)

The ESD generator shall be adjusted to its relevant discharge voltage. The air discharge tip shall be conducted along the touchable surface of the EUT.

3. Contact discharge (only for devices with earthed conductive surface that can be touched in normal use)

The discharge tip shall be contacted to earthed conductive surfaces of the EUT. The discharge voltage shall be switched on.

The encircled 1 in the drawing refers to item 1, where the encircled 2 refers to item 2 and 3 above.

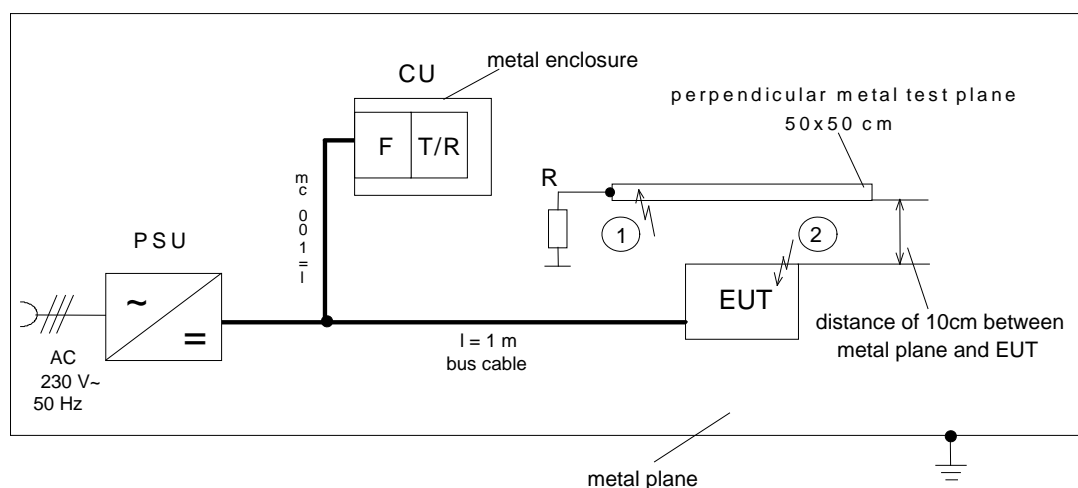


Figure 18 - Test at the Enclosure

3.3.3 EN 61000-4-3 RF Fields

The test procedure shall follow EN 61000-4-3.

The antenna is located at the marked position (see Figure 19). The measurement shall be carried out with various EUT positions (for more details, see EN 61000-4-3).

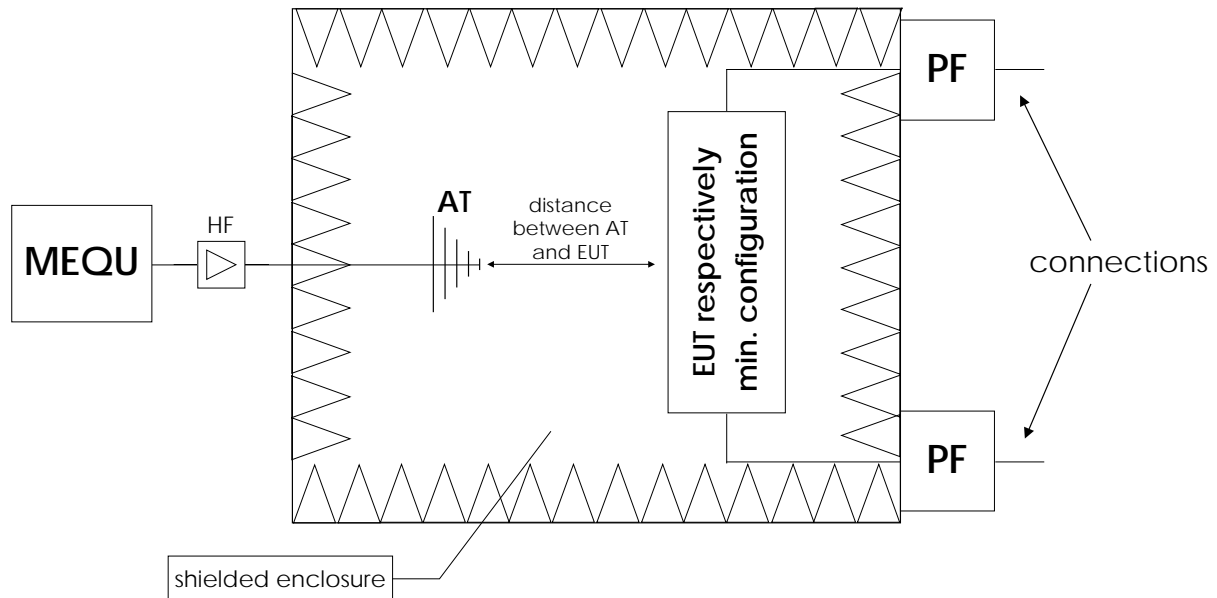


Figure 19 - Measurement in the shielded enclosure

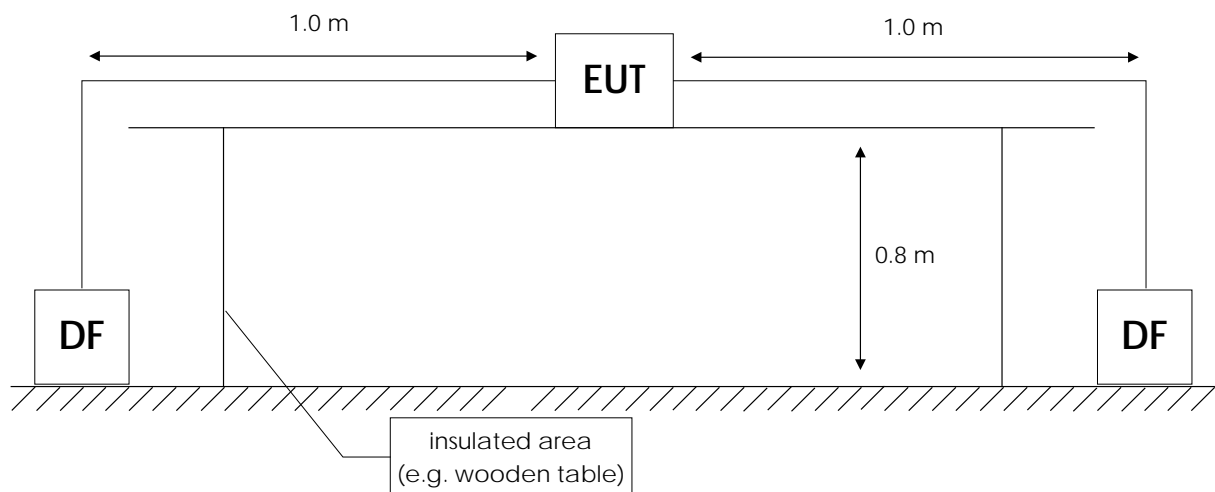


Figure 20 – Side view

3.3.4 EN 61000-4-4 Fast Transients (Bursts)

The test procedure shall follow EN 61000-4-4.

If there is a metallic mounting plate (DIN-rail), the test must be carried out with an insulated rail 10 cm above the reference ground plane and with the mounting plane directly contacted to the reference ground.

The dotted line between the EUT and the metal plane respectively an asterisk in the underneath figures signifies: ‘Optional – use depends on type of EUT’.

The optional CC can be replaced by a device causing the same RF load.

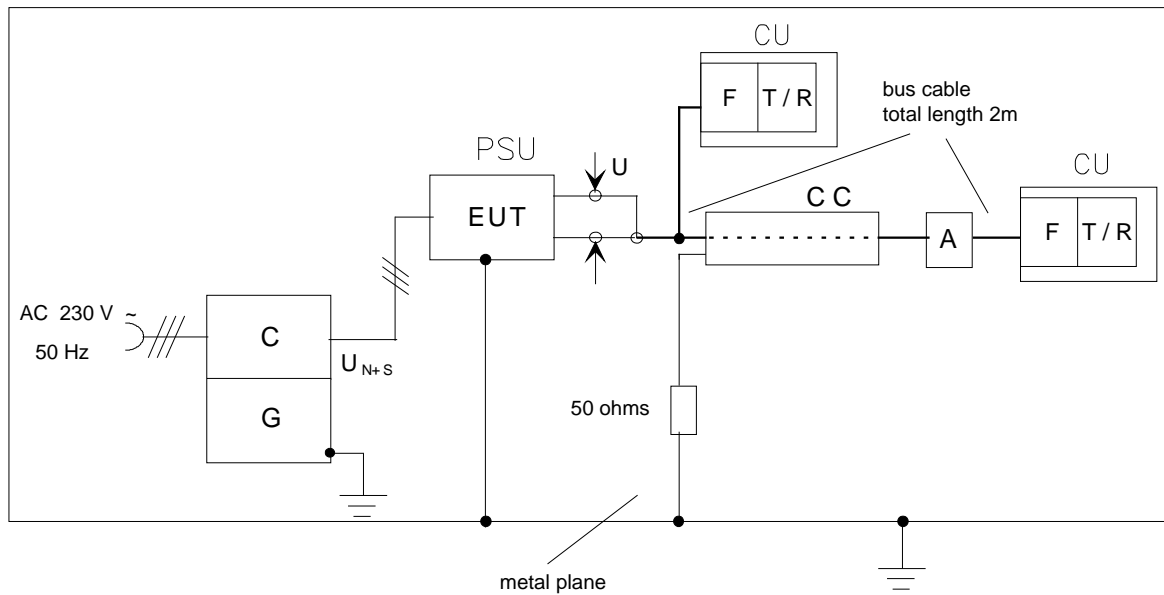


Figure 21 - Test at the mains connection of the power supply

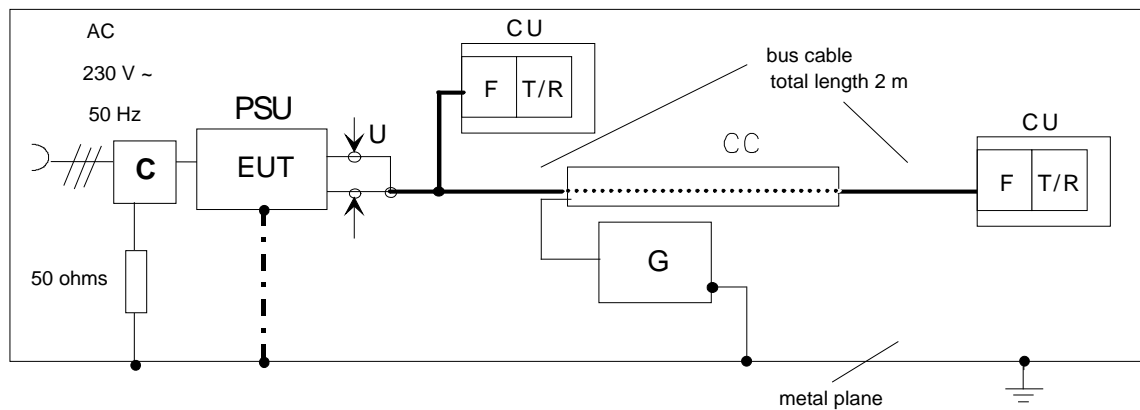


Figure 22 - Test at the bus connection of the power supply

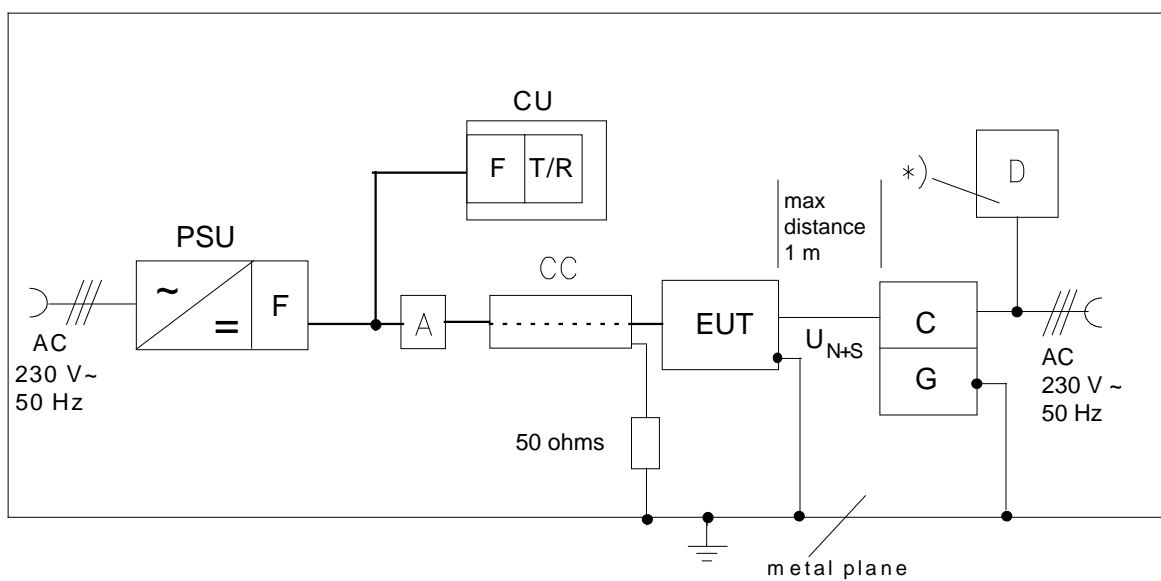


Figure 23 - Test at the mains connection of bus devices

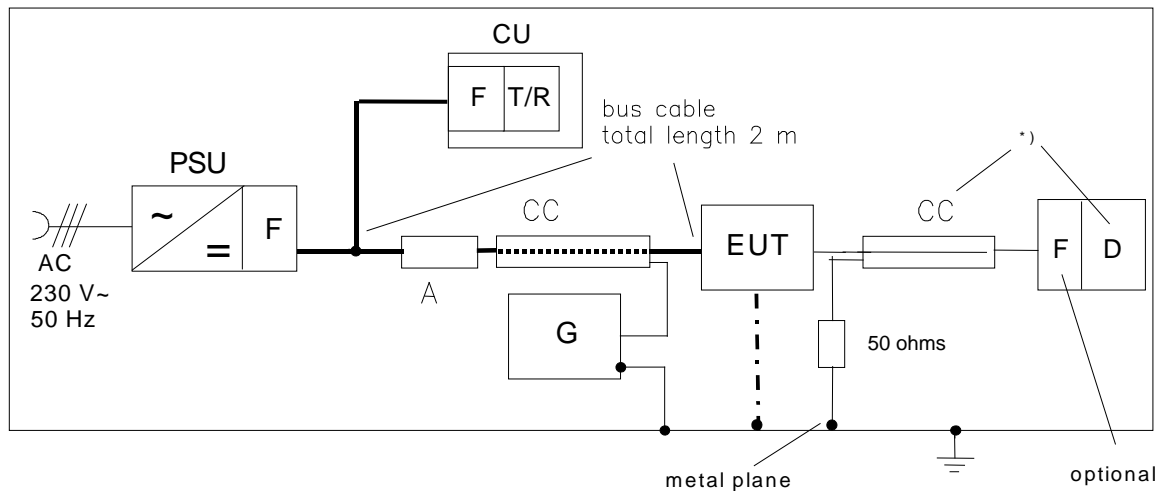


Figure 24 - Test at the bus connection of bus devices

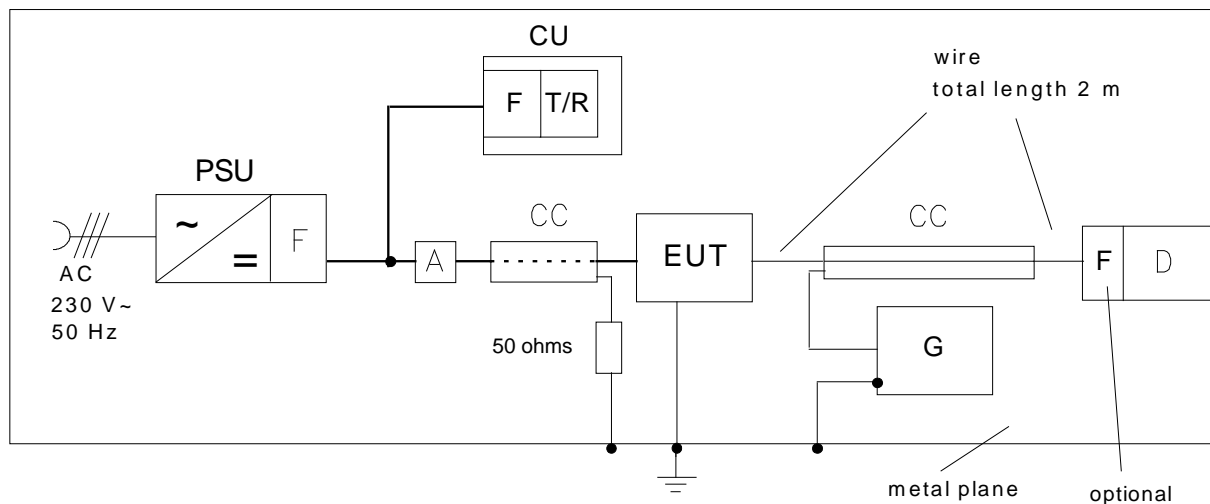


Figure 25 - Test at the process connection of bus devices

The auxiliary device D and the coupling clamp CC shall be connected to the EUT if necessary to test other interfaces. Device D can contain other interfaces e.g. a power supply. Examples for such EUT's are RS232 interfaces, binary inputs, binary outputs, etc.

3.3.5 EN 61000-4-5 Transients (Surge)

The test procedure and the test set-up shall follow EN 61000-4-5.

All tests will be carried out with combination wave (hybrid) generator (1.2/50 μ s).

The EUT is mounted as in practical use. Existing metal mounting plates have to be grounded to the reference ground (generator ground connector).

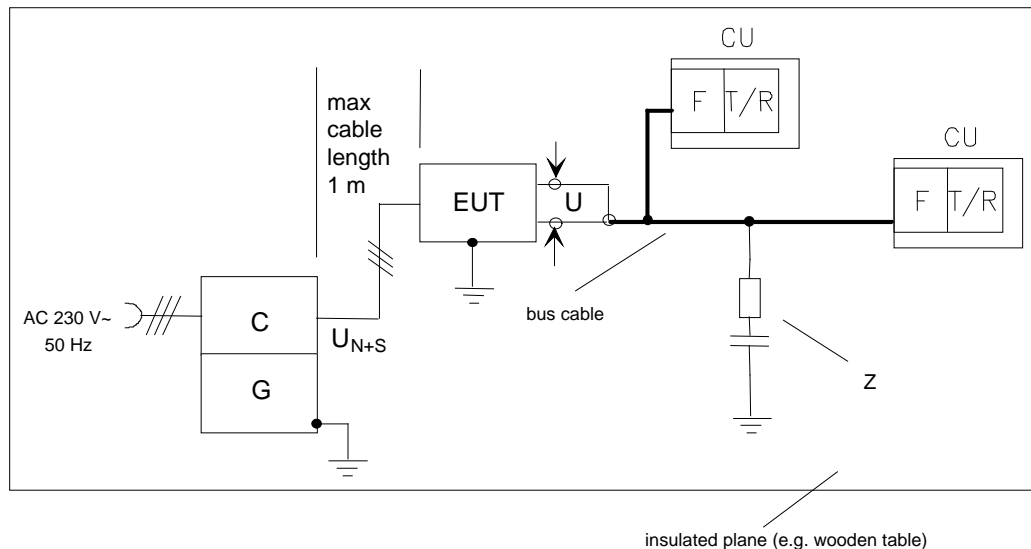


Figure 26 - Test at the mains connection of the power supply

During the common mode test, the test voltage shall be applied in between each mains wire and earth separately in accordance with EN 61000-4-5, Fig. 7.

During the differential mode test, the test voltage shall be applied in between the mains wires in accordance with EN 61000-4-5, Fig. 6.

The output voltage shall be measured with a differential probe providing sufficient common mode rejection or two high voltage probes measuring to ground and a differential indication.

The resulting output voltage on the bus side may not exceed 45 V.

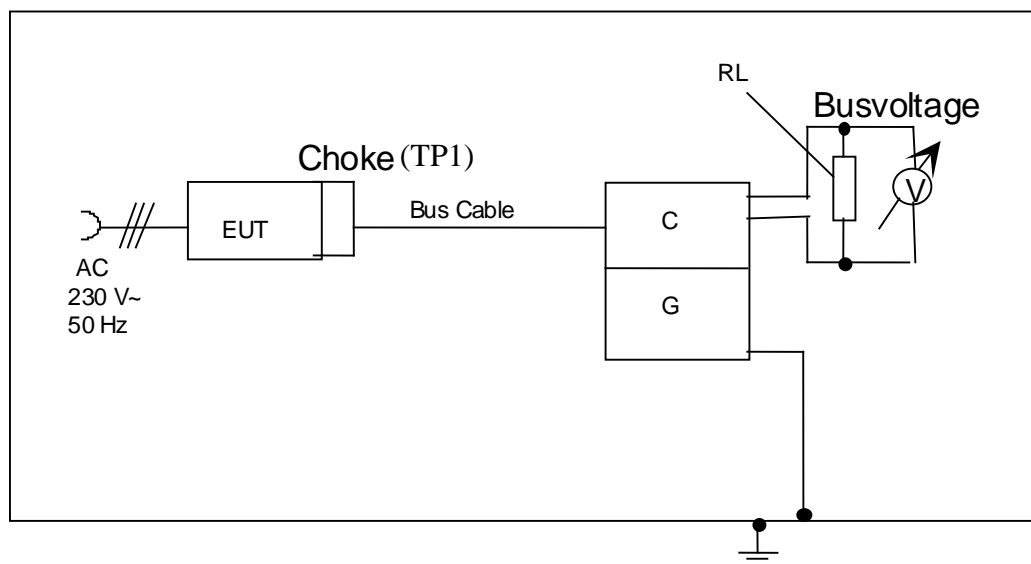


Figure 27 - Test at the bus connection of the power supply

During the common mode test, the test voltage shall be applied in between the bus wires and earth in accordance with EN 61000-4-5 Fig. 12 - switch position 0.

At the differential mode test, the test voltage shall be applied in between the bus wires in accordance with EN 61000-4-5, Fig. 10 with decoupling network as used in Fig. 12.

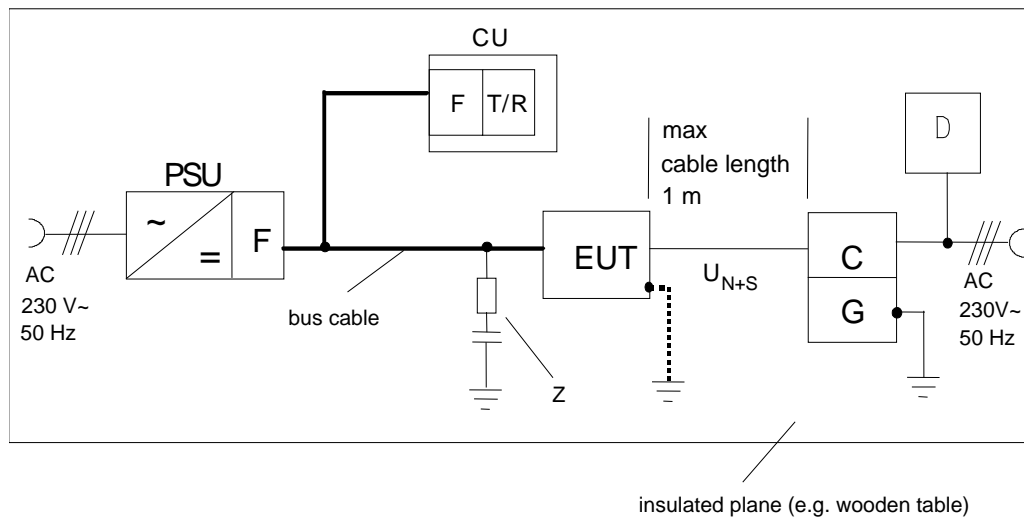


Figure 28 - Test at the mains connection and process connections of bus devices

The auxiliary device D or auxiliary power supply shall be connected to the EUT if necessary.

During the common mode test, the test voltage shall be applied in between each wire and earth separately in accordance with EN 61000-4-5.

During the differential mode test, the test voltage shall be applied in between the wires in accordance with EN 61000-4-5.

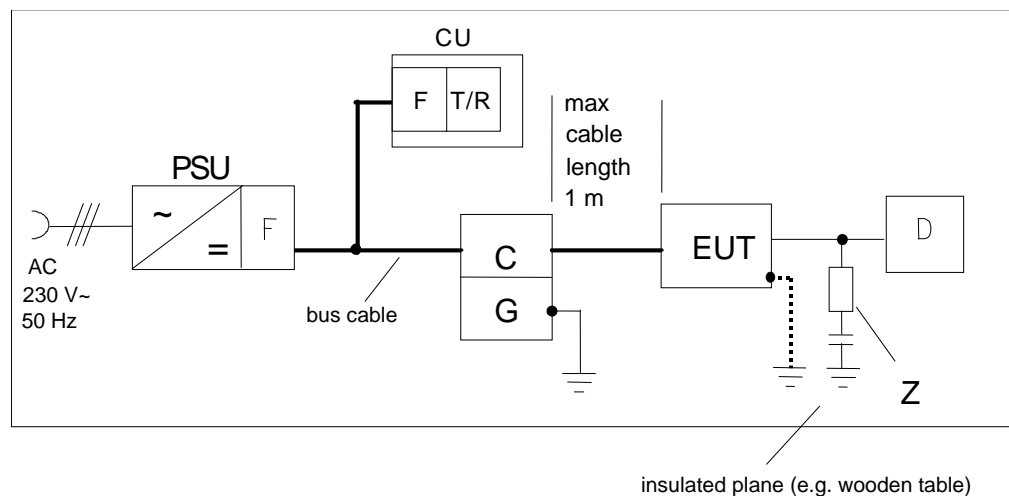


Figure 29 - Test at the bus connection of bus devices

The auxiliary device D together with the impedance Z and a power supply shall be connected to the EUT, if necessary.

During the common mode test, the test voltage shall be applied in between the bus wires and earth in accordance with EN 61000-4-5 Fig. 12 - switch position 0.

3.3.6 EN 61000-4-6 Radio Frequency Voltage

The test procedure shall follow EN 61000-4-6

All tests shall be carried out with a RF generator as specified in EN 61000-4-6.

The EUT shall be mounted as in practical use. Existing metal mounting plates shall be grounded to the reference ground (metal plane).

The test set-up shall be isolated from and located at 10 cm above an earthed metal plane (reference ground).

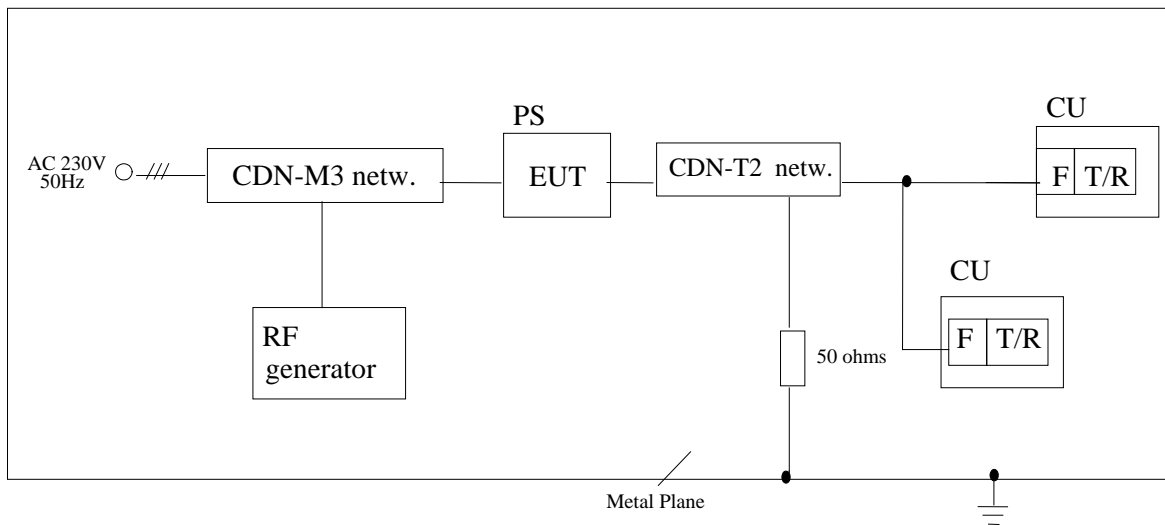


Figure 30 - Test at the mains connection of the power supply

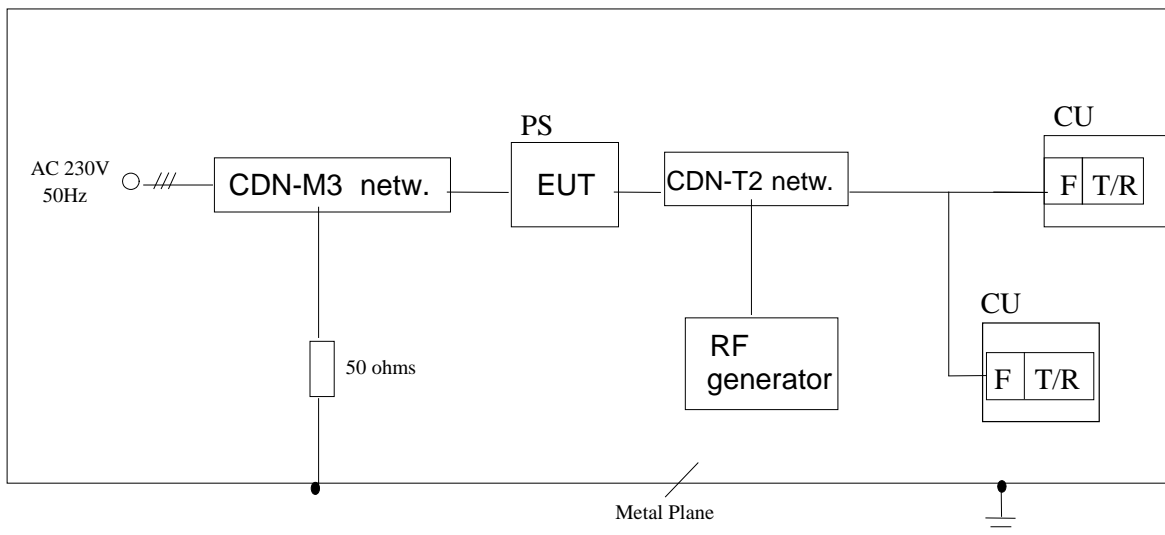


Figure 31 - Test at the bus connection of the power supply

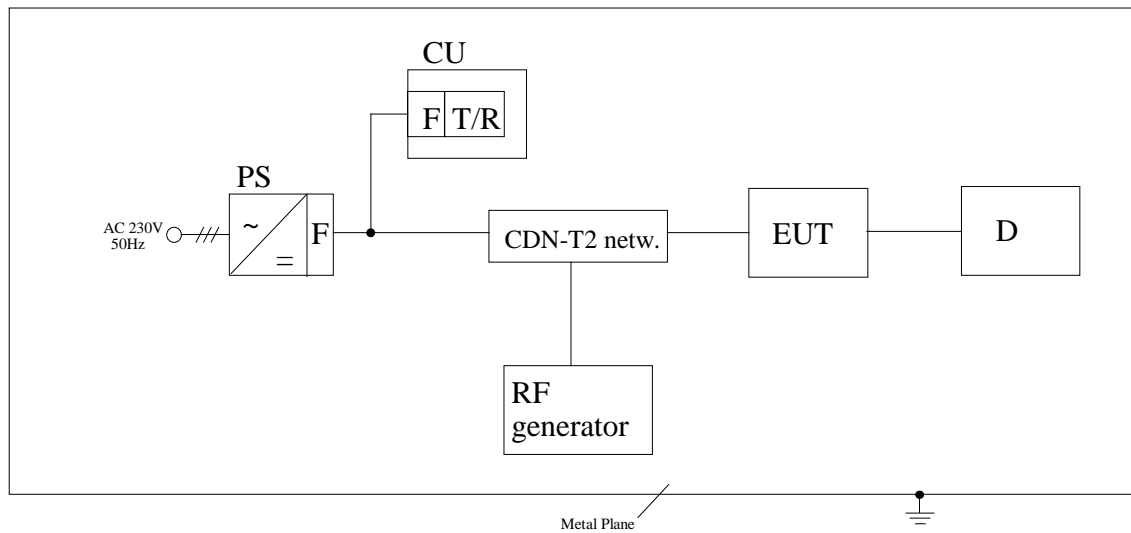


Figure 32 - Test at the bus connection of bus devices

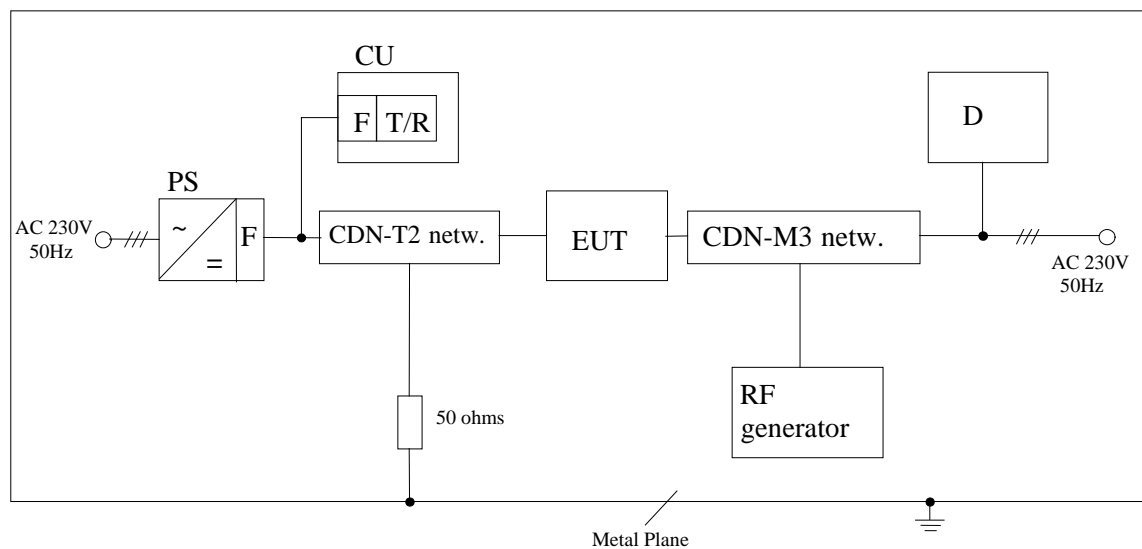


Figure 33 - Test at the mains connection of bus devices

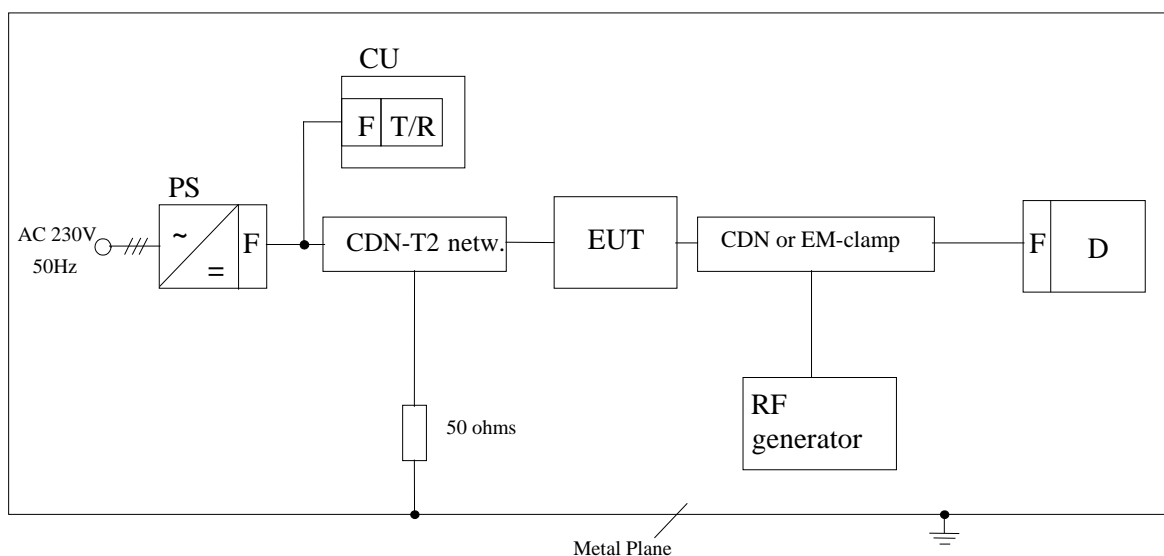


Figure 34 - Test at the process connection of bus devices

3.3.7 EN 61000-4-8 Power Frequency Magnetic Field

Applicable only to devices containing components susceptible to magnetic fields, e.g. Hall elements, electro-dynamic microphones, etc.

The test procedure shall follow EN 61000-4-8.

3.3.8 EN 61000-4-11 Voltage Dips / Voltage Interruption

The test procedure shall follow EN 61000-4-11.

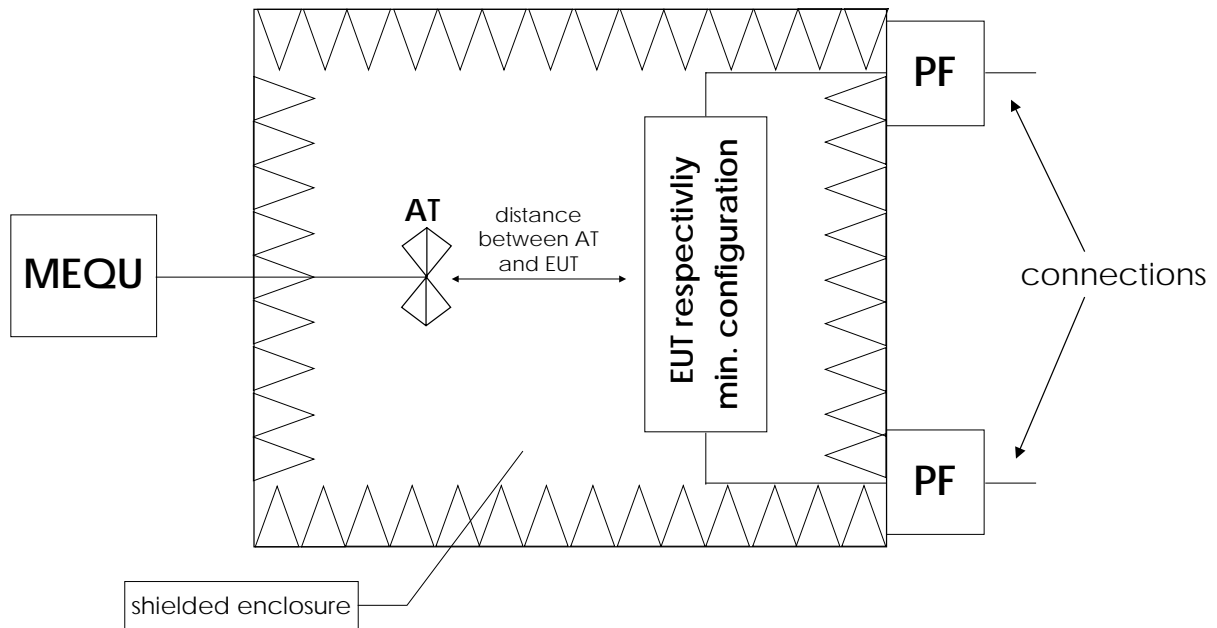


Figure 36 - Example of a test arrangement in the shielded enclosure

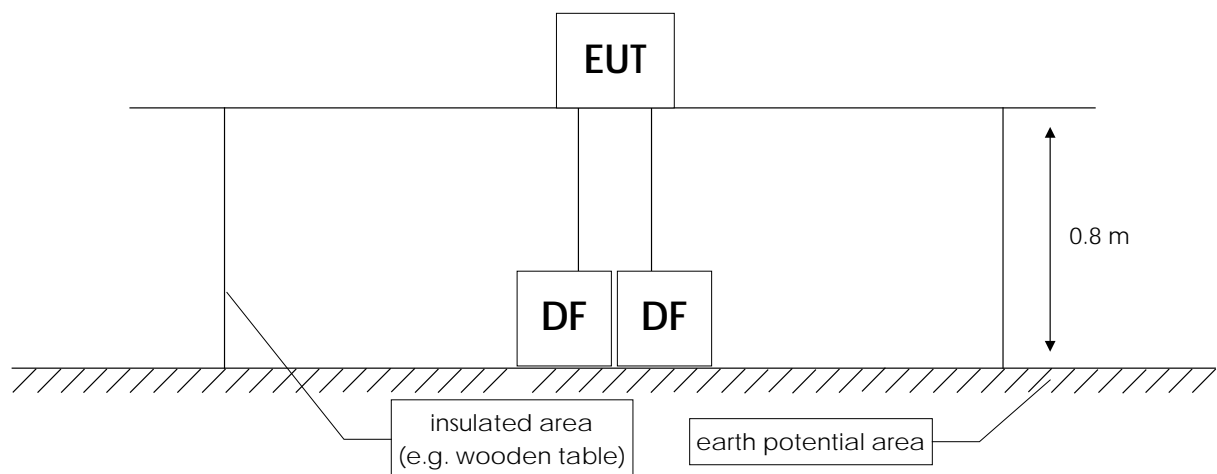


Figure 37 – Side view

4.2.2 Electromagnetic Interference (EMI): Interference voltage

The test procedure shall follow ETSI EN 301489-1. The test arrangements are described in Fig. 7-3-3.

The interference voltage measurements may be carried out in a shielded room, too. In this case the shielded room wall is used like a ground plane.

The measurements shall be arranged in a frequency range of 0,15 MHz to 30 MHz.

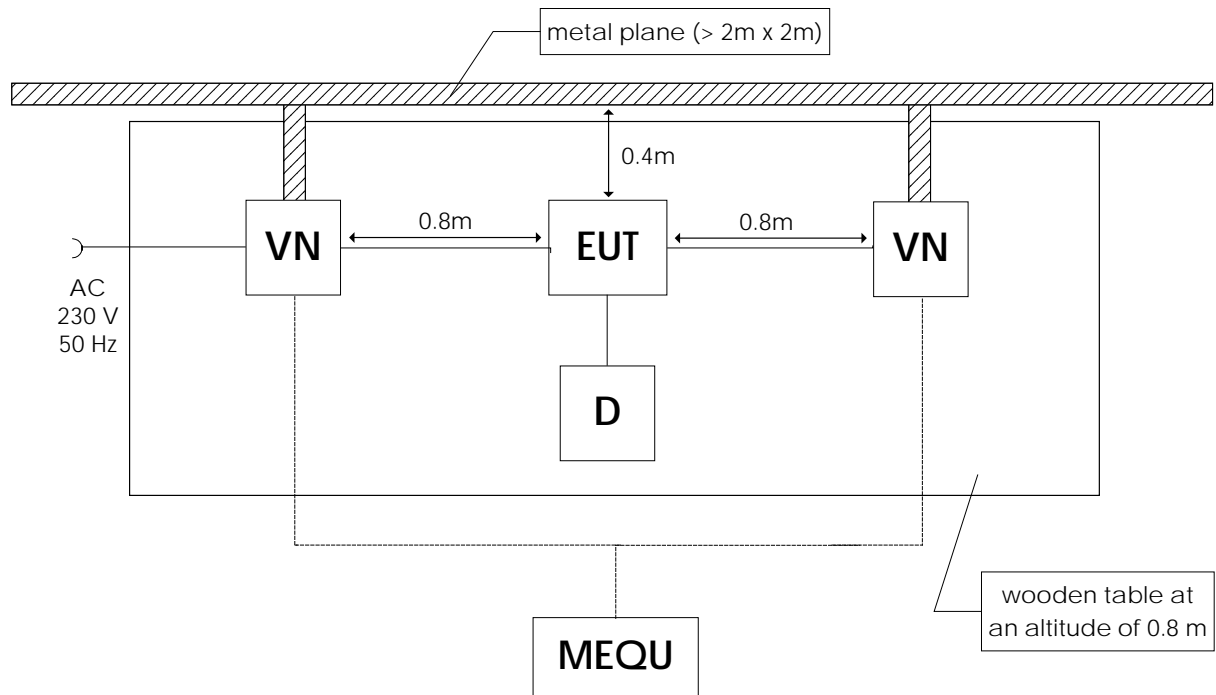


Figure 38 - Test arrangement of interference voltage

4.3 Test set up for twisted pair

4.3.1 General

Test procedure shall follow EN 55022. Tests have to be performed according to the method defined in EN 55022. Examples of test arrangements are described in figure 22 to 26. An attempt shall be made to maximize the emission consistent with the typical applications by varying the configuration of the test sample.

4.3.2 Radio Emission Interference Voltage on Power Supply Connections and Process Connections

Test procedure shall follow EN 55022.

The asterisk * in the underneath figures signifies: 'optional – use depends on type of EUT'.

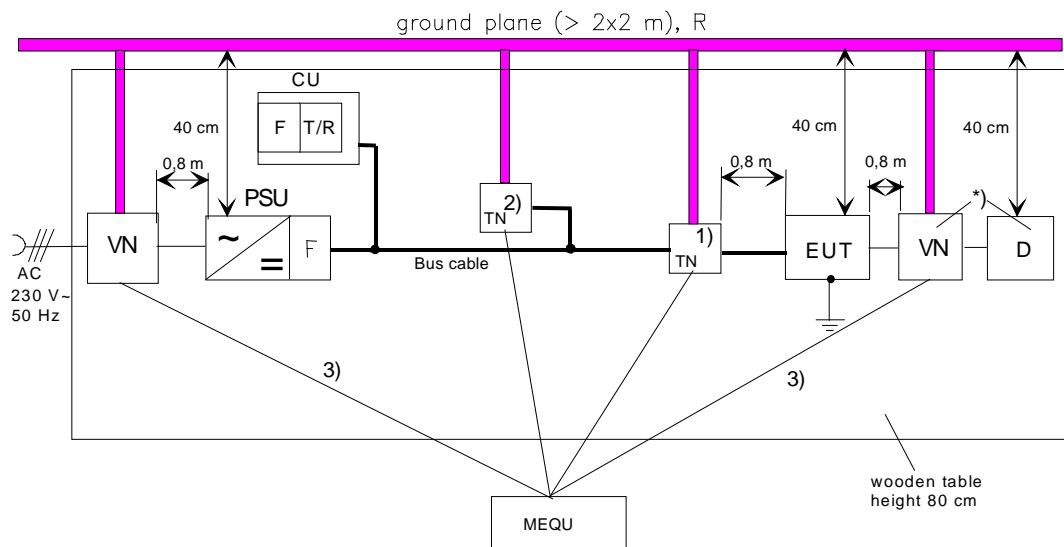


Figure 39 - Test set-up for radio emission interference voltage

3) Test Points

1) or 2) are alternatively used:

1) On bus, only the asymmetric radio frequency voltage has to be measured.

2) On bus, the asymmetric radio frequency voltage of the entire minimum configuration has to be measured.

Artificial network used as line termination has to be terminated with $50\ \Omega$ at the measurement output.

The CU is shown in Figure 39 for the execution of a bus device test. When testing a power supply device, the CU shall be mounted beside the bus device.

The device D in combination with the V-network VN is needed for process connections. Instead of D, a power supply can be connected if necessary.

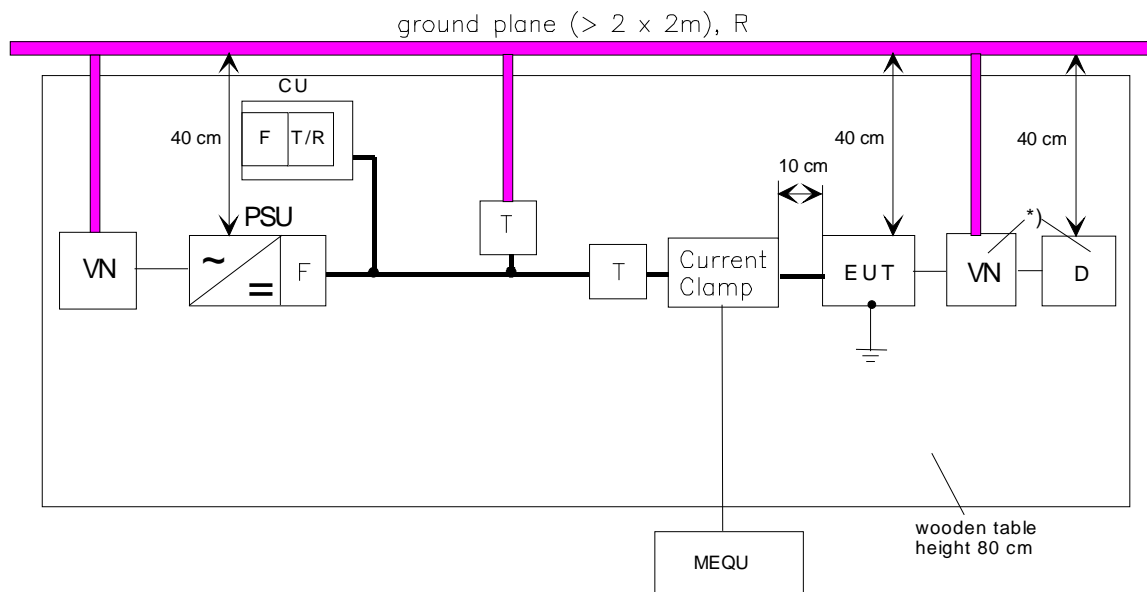


Figure 40 - Test Set-up for common mode noise current test

An artificial network used as line termination shall be terminated with $50\ \Omega$ at the measurement output.

4.3.3 Radio Frequency Interference Field Strength

The test is carried out in accordance with EN 55022 and relevant product standard.