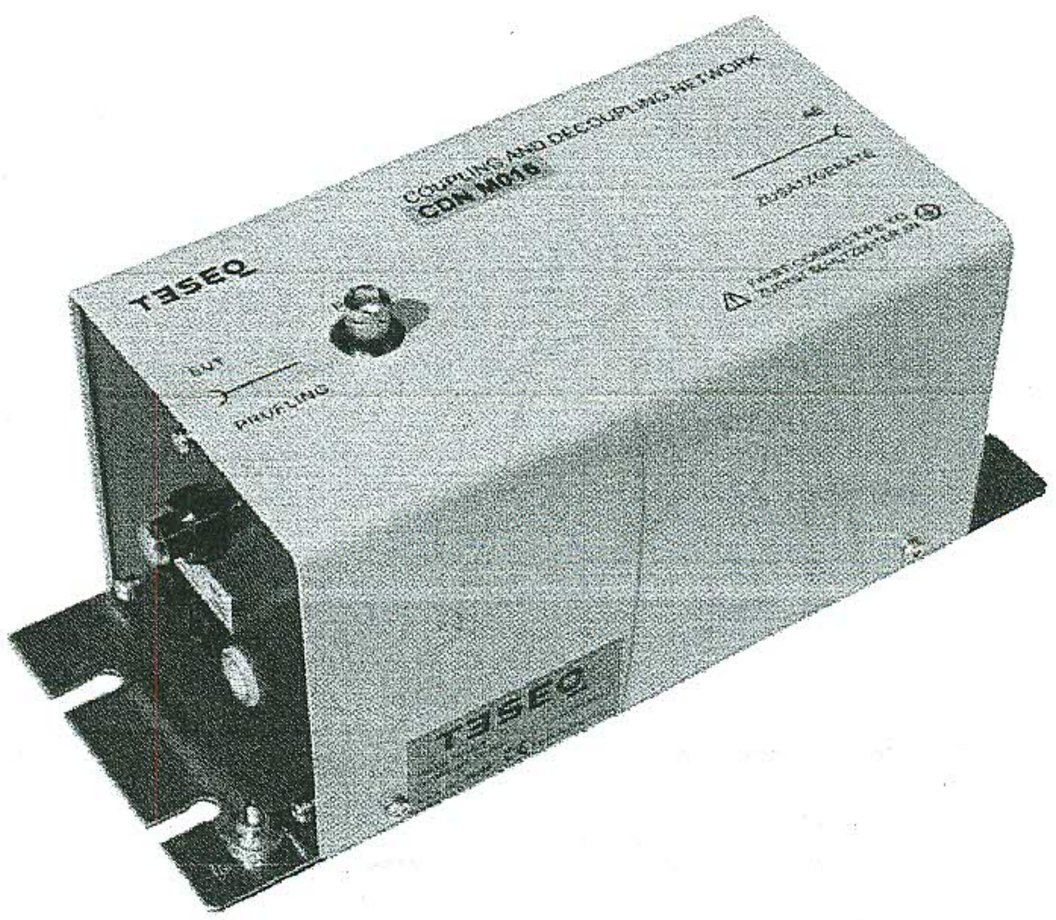
TESEQ

Coupling Decoupling Network (CDN)

CDN M-Type

OPERATING MANUAL



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This manual has been carefully checked.

However, TESEQ does not accept any liability for errors or inaccuracies.

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Contents

1 Safety advice

WARNING: **Lethal danger from high voltages and the risk of radiating illegal electromagnetic interference.**

The CDN may only be installed and used by authorised and trained EMC specialists.

The CDN must only be used for EMC tests as set down in these operating instructions.

These operating instructions form an integral part of the equipment and must be available to the operating personnel at all times. All the safety instructions and advice notes are to be observed.

Neither TESEQ GMBH nor any of the subsidiary sales organisations can accept any responsibility for personal, material or consequential injury, loss or damage that results from improper use of the equipment and accessories.

1.1 General

The coupling decoupling network (CDN) works at dangerous voltages.

Improper or careless handling can be fatal!

The instrument must not, in principle, be opened. Only where explicitly called for in the operating instructions may this be undertaken by a qualified specialist. Certain parts inside the instrument work at mains voltage or at high frequency and are not provided with any protection against being touched.

1.2 Protected earth (PE) and mains connection

Because of high leakage currents the safety connections of CDN M-type to the ground plane and protected earth (PE) are obligatory during the measurements.

Operation without a protective earth connection is forbidden.

A periodical check of protected earth (PE) and ground connections as well as all touchable parts is required.

Because of high leakage currents the failure current circuit breaker of the mains supply net might loosen. The insertion of an isolating transformer is necessary in this case.

The lines within the CDN are not protected by a fuse. Therefore the user must realize the protection of the CDN against short-circuit by using suitable fuses. In the fault case dangerously high voltage may be on the housing.

At CDNs M- type the calibrating components of the EUT- port are designed as screwing versions. Thereby a risk by an inadvertently leave of the shorting adapter in the EUT- port be avoided.

1.3 Installation

Operate the equipment only in dry surroundings. Allow any condensation that occurs to evaporate before putting the instrument into operation. Do not exceed the permissible ambient temperature, humidity or altitude.

The construction of the unit renders it unsuitable for use in an explosive atmosphere.

Only approved accessory items, connectors, adapters, etc. are to be used to ensure safe operation.

Radiated emissions may be generated, which far exceed the applicable limits.

Tests of radio disturbances should be performed preferable in shielded rooms.

Persons fitted with a heart pacemaker must not operate the instrument nor approach the test rig while it is in operation.

1.4 Applicable safety standards

Development and manufacture of the instrument complies with ISO 9001.
The equipment conforms to the safety requirements of IEC/ EN 61010-1 (Safety requirements for electrical equipment for measurement, control and laboratory use).

2 Unpacking, storage and transport

2.1 General

- Throw nothing away!

Packaging either: Keep for despatching the instrument for a calibration service
Return to the relevant sales outlet
Dispose of in an environmentally friendly manner

Packaging materials
Carton: Cardboard
Padding: CFC-free polystyrene foam
Plastic bags: Polyethylene

- Avoid the risk of condensation occurring!

If a large temperature difference has been experienced, allow time for the temperature to stabilise. This may take several hours.

2.2 Storage and transport

- Do not stack, either packaged or out of the packing.
- Do not up-end, arrows on the packaging must always point upwards.
- Protect from dampness, heat, cold and rain
- Do not throw.
- Do not sit or stand on the instrument and packaging.

2.3 Unpacking

- Is the packaging damaged?
  If **YES** ☎ → **transportation company**
- Are all the packages present and correct?
  If **NO** ☎ → **transportation company**
- Are the instrument or accessories damaged?
  If **YES** ☎ → **transportation company**
- Are the contents of the package complete?
  If **NO** ☎ → **sales outlet**
- Keep the instruction manual with the instrument.
- Keep the packaging.

2.4 Scope of delivery

- As shown in chapter 4.3

3 Application and standard requirements

3.1 General

IEC/EN 61000-4-6 specifies the design and performance of a range of coupling/decoupling networks (CDNs). Each CDN is specific to the type of cable and the intended signal carried on the cable. Teseq offers an extensive range of CDNs which fully comply with the requirements of the standard and provide a simple and reliable method of injecting RF energy into the equipment under test (EUT).
Whilst the published standard only specifies the performance of CDN from 150 kHz to 80 MHz, most of Teseq CDNs are specially designed to give the same performance to a wider frequency range. This is required by some product specific standards.
Each CDN is also useable for emission testing. Special types meet the requirements of CISPR 15 or can be used as impedance stabilization network (ISN) defined in CISPR 22.

3.2 IEC/EN 61000-4-6

3.2.1 Rules for selecting the injection method

For immunity tests according to IEC/EN 61000-4-6 „Immunity to conducted disturbances, induced by radio frequency fields" coupling and decoupling circuits are required. Coupling / decoupling networks (CDN) comprise these in one box. On one hand, they will be used for appropriate coupling of the disturbance signal to the different cables connected to the equipment under test (EUT). On the other hand, it will guarantee no affect of the test signal to the auxiliary equipment (AE) through suitable decoupling.
Each CDN is specific to the type of cable and the intended signal carried on the cable.

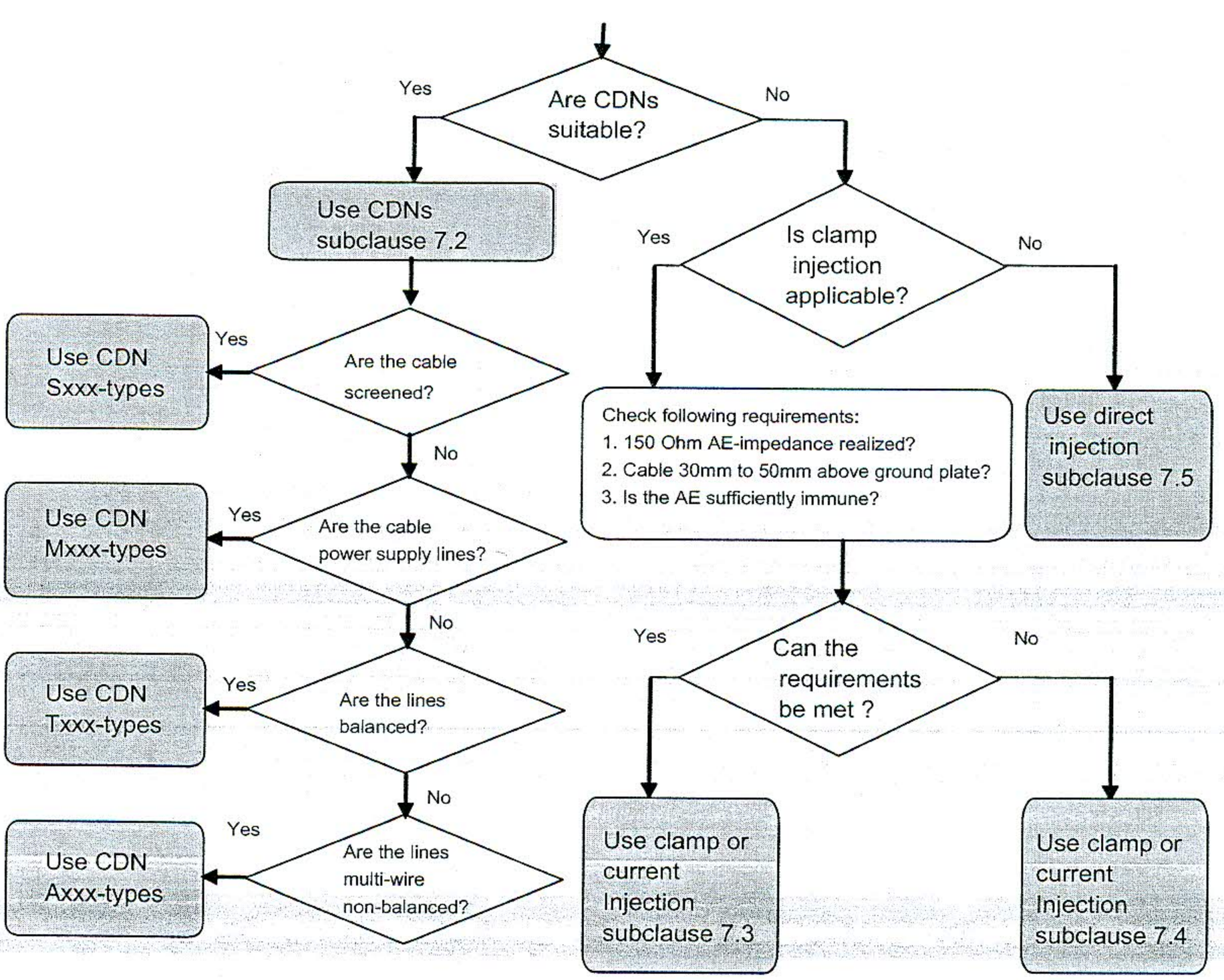


Figure 1: Rules for selecting the injection method

3.2.2 Requirements for the common mode impedance

Main parameter of CDNs is the common mode impedance $|Z_{ce}|$ at the EUT-port. The published standard only specifies the performance of CDN from 150 kHz to 80 MHz. Some product standards required the performance to the lower frequency of 10 kHz or to the higher frequency of 300 MHz.

	Frequency range	
Parameter	150 kHz - 26 MHz	26 MHz – 80 MHz
$\|Z_{ce}\|$	150 Ω ± 20 Ω	150 Ω $^{+60}_{-45}$ Ω

Table 1: Requirements of |Zce|

3.2.3 Test level setting and test set-up calibration

The test generator shall be connected to the RF port of the CDN. The EUT port of the coupling device shall be connected in common mode through the 150 Ω to 50 Ω adapter to a power meter with 50 Ω input impedance. The AE port of the CDN shall be terminated with 150 Ω. The set-up for level setting (also called calibration) is given in figure below for example.

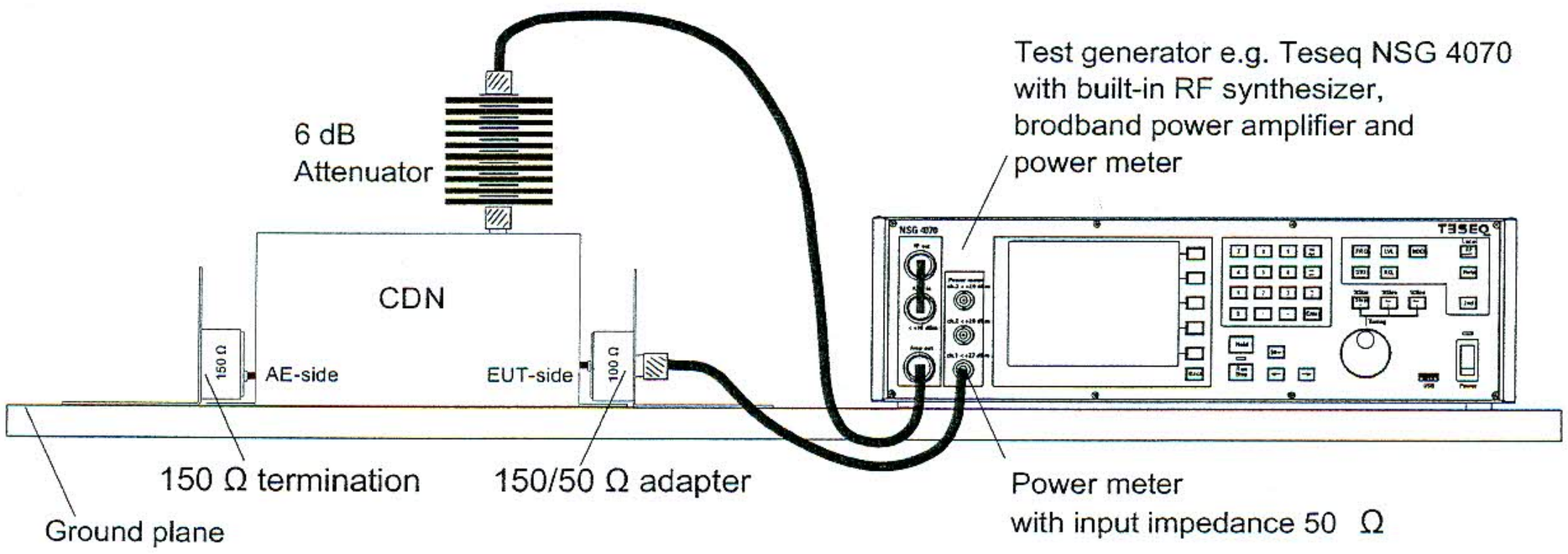


Figure 2: Set-up for level setting at the EUT port of coupling/decoupling devices

Test level of IEC 61000-4-6 second edition

- U_0 the open-circuit test levels (e.m.f.) of the unmodulated disturbing signal, expressed in r.m.s. are 1 V, 3 V or 10 V. The test levels are set at the EUT port of the coupling devices.
- For testing of equipment, this signal is 80 % amplitude modulated with a 1 kHz sine wave to simulate actual threats.

$U_{mr} = U_0/6 \pm 25$ %, in linear quantities, or
$U_{mr} = U_0 - 15.6$ dB ± 2 dB in logarithmic quantities.

NOTE 1: U_0 is the unmodulated disturbing signal and U_{mr} is the measured voltage. To minimize testing errors, the output level of the test generator is set by setting U_{mr} loads with 150 Ω and not by setting U_0.
NOTE 2: The factor 6 (15.6 dB) arises from the e.m.f. value specified for the test level. The matched load level is half the e.m.f. level and the further 3:1 voltage division is caused by the 150 Ω to 50 Ω adapter terminated by the 50 Ω measuring equipment.

Setup for level setting, equivalent circuit diagram

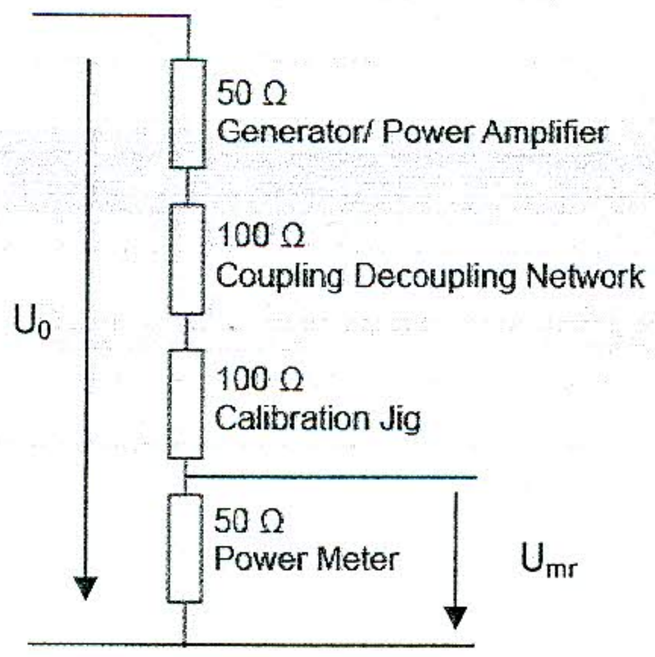


Figure 3: Equivalent circuit diagram

$$\frac{U_{mr}}{U_0} = \frac{50}{50+100+100+50}$$

$$U_{mr} = \frac{U_0}{6}$$

Test level	Measured voltage	Measured power
U_0 in V	U_{mr} in V	U_{mr} in dBm
1	0.1667	-2.55
3	0.5	6.99
10	1.667	17.45

Table 2: Test level and measured voltage

Test level setting procedure (example: CDN calibration with 1 V test level)

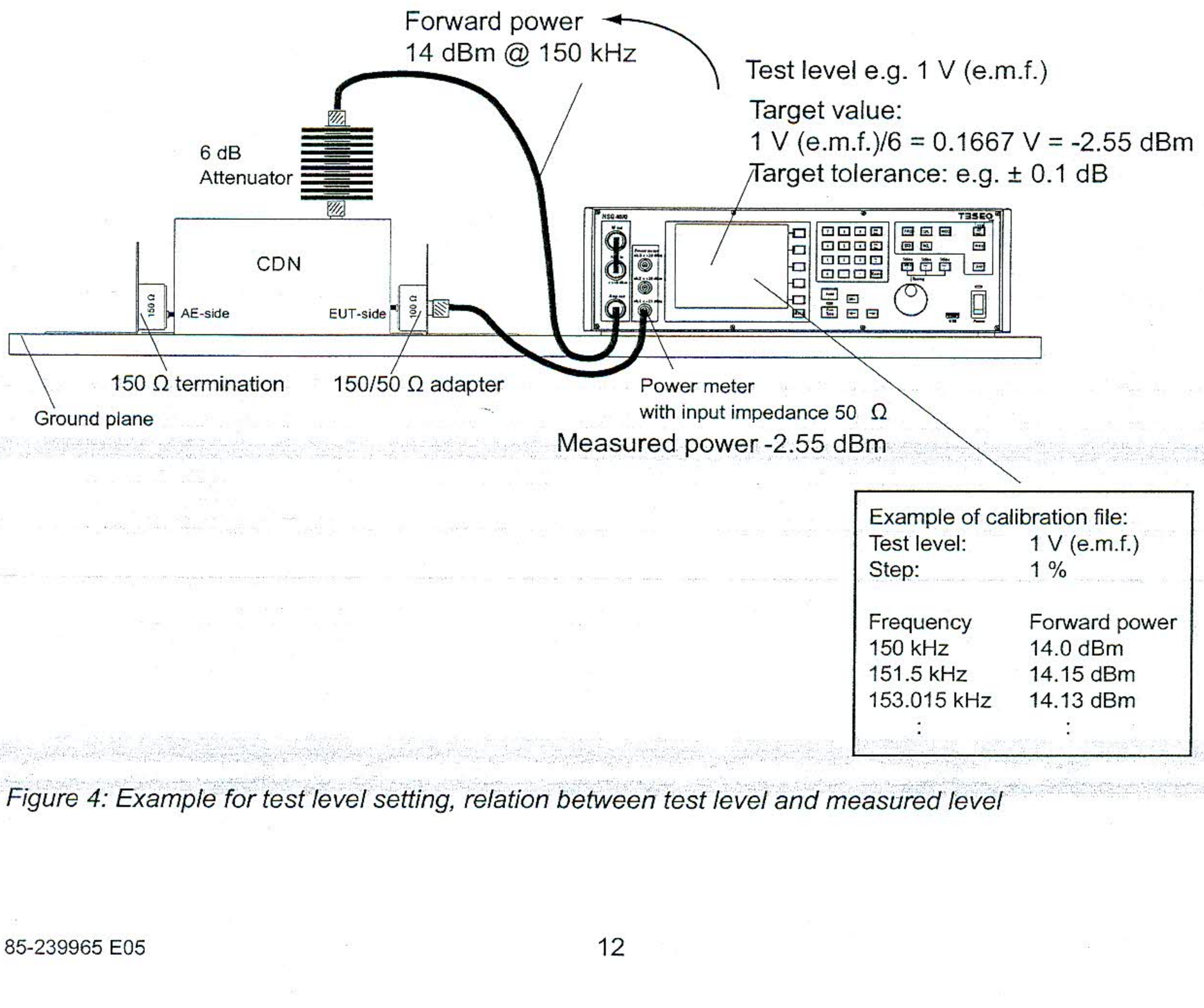


Figure 4: Example for test level setting, relation between test level and measured level

3.2.4 The test set-up with CDN

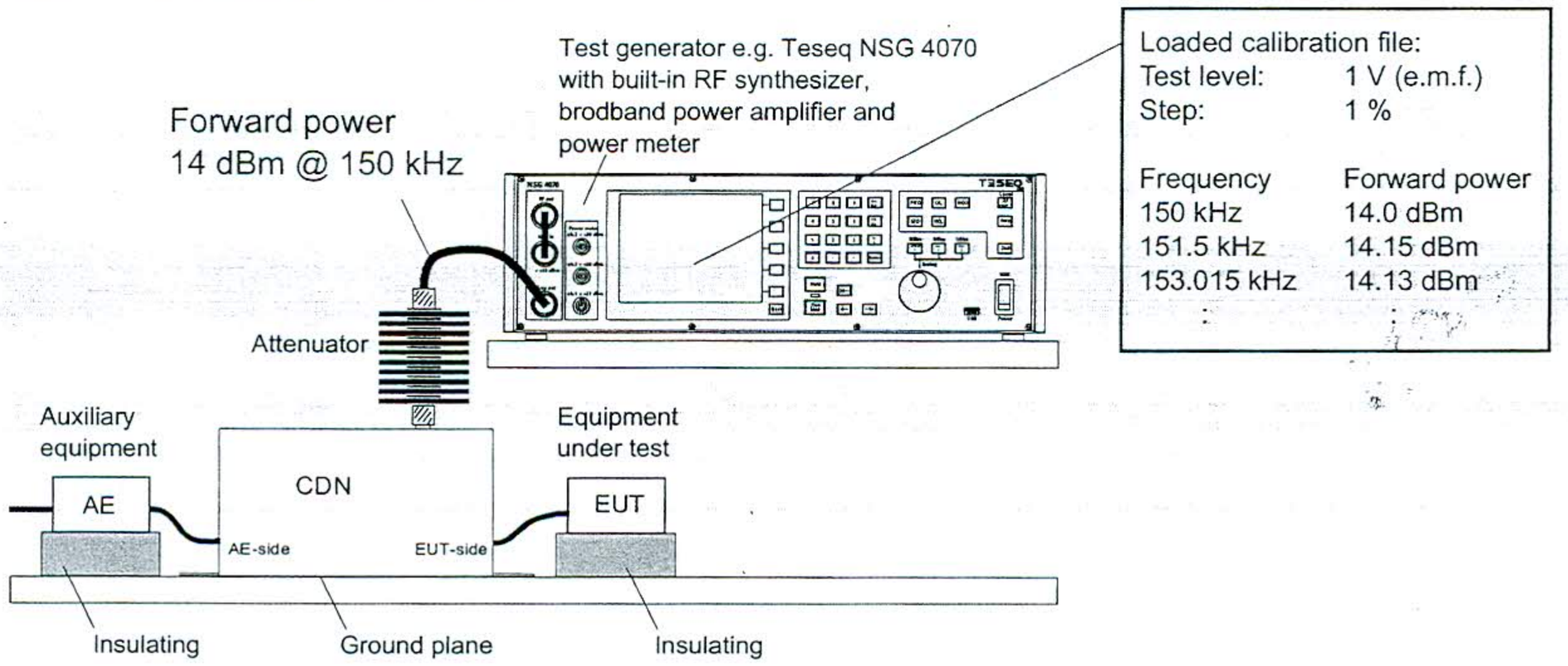


Figure 5: Example for test set-up, relation between test level and calibration file

3.3 Immunity tests in accordance with NAMUR NE 21

NAMUR (User Association of Process Control Technology in Chemical and Pharmaceutical Industries) recommendations and worksheets are working documents and practical reports prepared by NAMUR for their members. Their application is optional.
The paper NE 21 recommends amongst others the using of the standard IEC/EN 61000-4-6 „Immunity to conducted disturbances, induced by radio frequency fields". In difference to the IEC/EN 61000-4-6 the NAMUR recommendation starts from 10 KHz.

3.4 Immunity tests in accordance with IEC 60945

In difference to the IEC/EN 61000-4-6 the IEC 60945 (Maritime navigation and radio communication equipment and systems) starts from 10 KHz.

3.5 Emission tests in accordance with CISPR 15 (CDN method)

CISPR 15 offers as independent method the measurement of conducted emission instead of the radiated disturbances measurement. This method required CDNs as described in IEC/EN 61000-4-6. For the frequency range 80 MHz to 300 MHz the common mode impedance is 150 Ω +/- 60 Ω. The CDN voltage division factor for the frequency range 30 to 300 MHz shall be determined in accordance with figure 6. The CDN M216, CDN M316 and CDN A201 (part of CDN AF-type manual) are suitable for this application. The test set-up is given in figure 7.

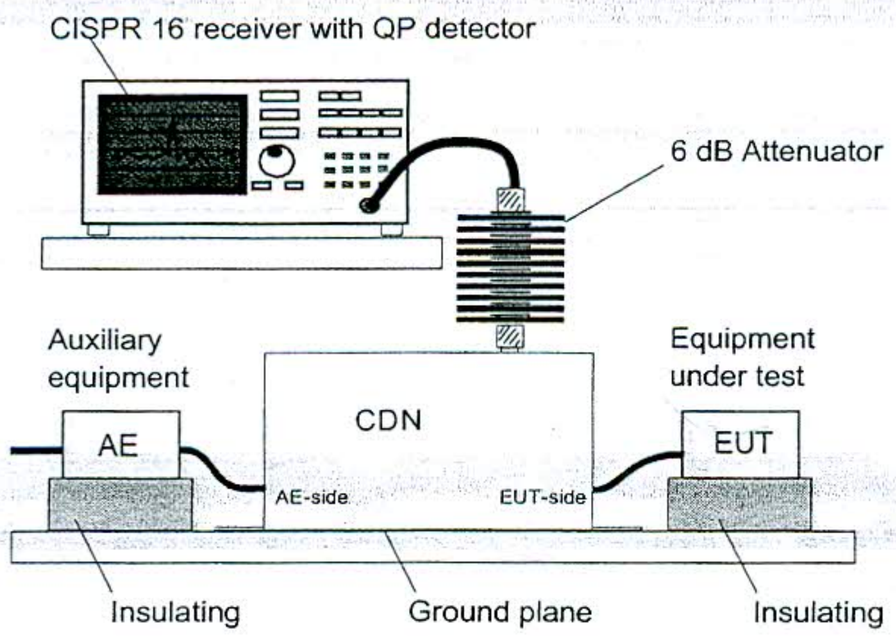


Figure 6: Example for test set-up, CISPR 15 CDN method

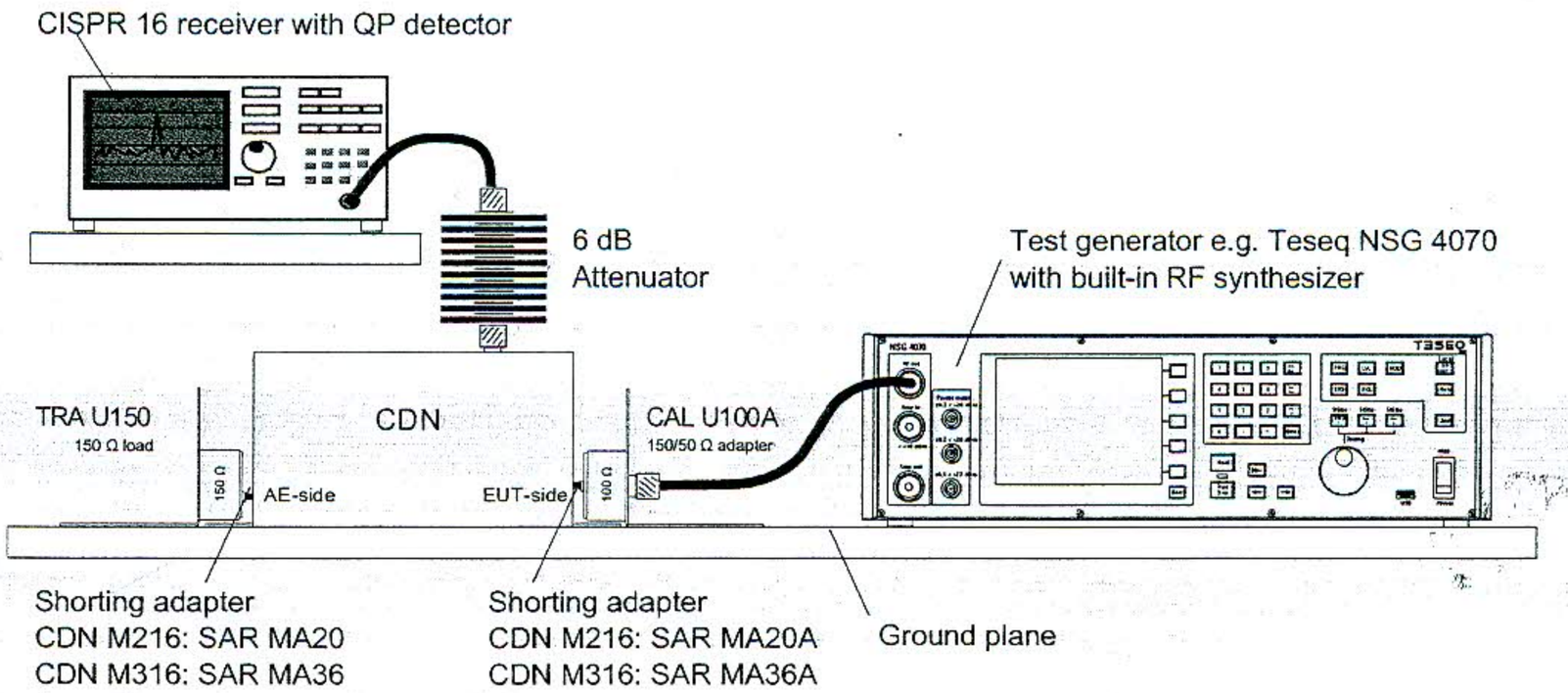


Figure 7: Example for the correction factor measuring set-up

Correction factor = CDN voltage division factor (e.g. 8.5.....12.5 dB) + 6 dB (attenuator)

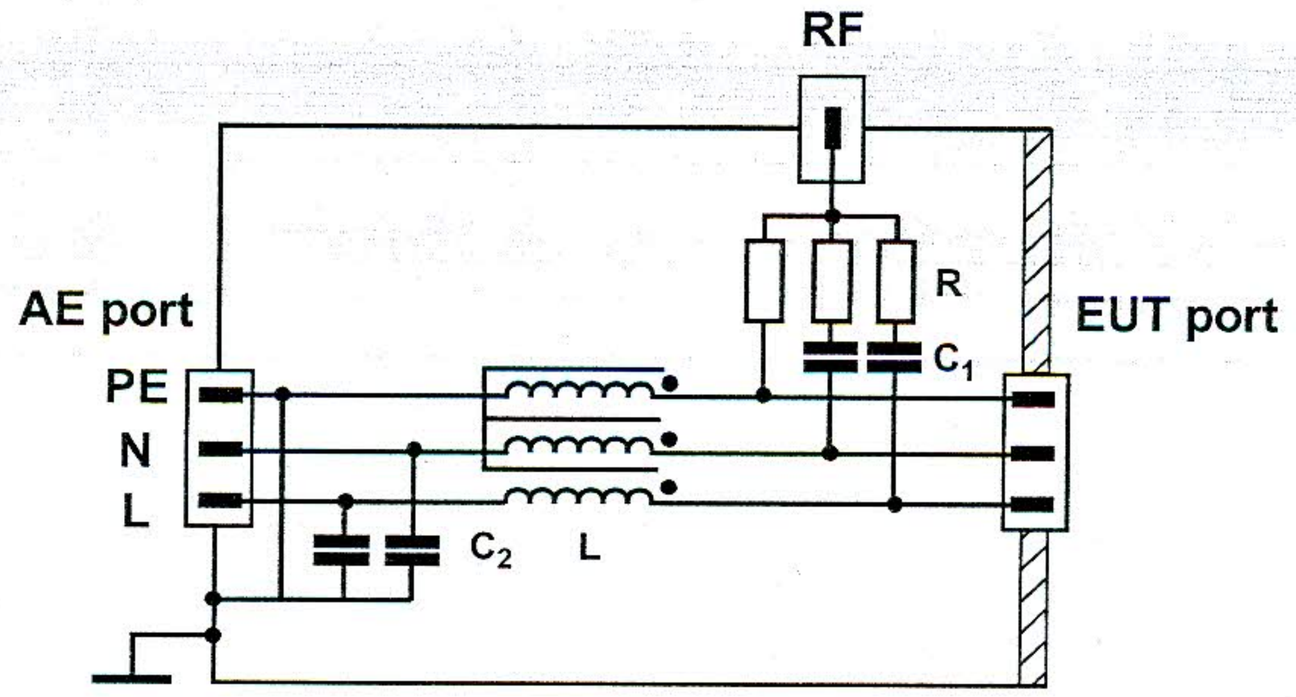
3.6 Other standards and applications

CDNs may also fulfill other standards and applications. Do not hesitate to contact TESEQ for more information. The chapter technical specification of this manual is based on the IEC/EN 61000-4-6 and may not include parameters below 150 kHz and above 80 (230) MHz.

4 CDNs for power supply lines

4.1 General

CDNs M-type are designed especially for power supply lines.
Figure 8 shows the principle construction of a CDN M3.



C1 (typ.) = 10 nF, C2 (typ.) = 47 nF. R = 300 Ω, L ≥ 280 µH at 150 kHz

Figure 8: Coupling and decoupling circuit of CDN M3

4.2 Product range

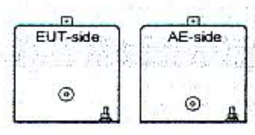
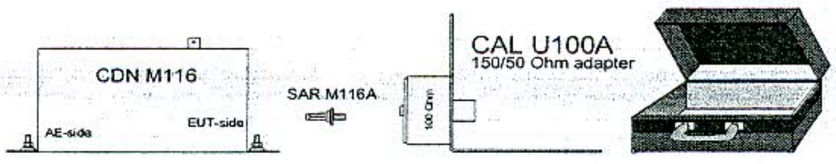
Depending on power line types and connectors different CDNs are required. Table 3 shows the standard delivery program of Teseq's CDN M-Type.

CDN		Line type	EUT		Connectors	
Type	Product		AC Voltage	max. Current	EUT-port	AE-port
M1	CDN M116	1 power line (PE)		1 A	Banana	
M2	CDN M210B	2 power lines	250 V	10 A	Schuko	IEC 320 C13
	CDN M216	2 power lines	250 V	16 A	Banana	
M2/M3	CDN M016	switchable 2 and 3 power lines	250 V	16 A	Banana	
M3	CDN M316	3 power lines (L+N+PE, 2L+PE)	250 V	16 A	Banana	
	CDN M316B	3 power lines (L+N+PE, 2L+PE)	250 V	16 A	Banana	IEC 320 C19
	CDN M325	3 power lines (L+N+PE, 2L+PE)	250 V	25 A	Banana	CEE 17 plug
M4	CDN M416	4 power lines (2L+N+PE, 3L+PE)	250 V	16 A	Banana	
	CDN M425	4 power lines (2L+N+PE, 3L+PE)	250 V	25 A	Banana	
M5	CDN M516	5 power lines (3L+N+PE)	250 V	16 A	Banana	CEE 17 plug
	CDN M525	5 power lines (3L+N+PE)	250 V	25 A	Banana	CEE 17 plug

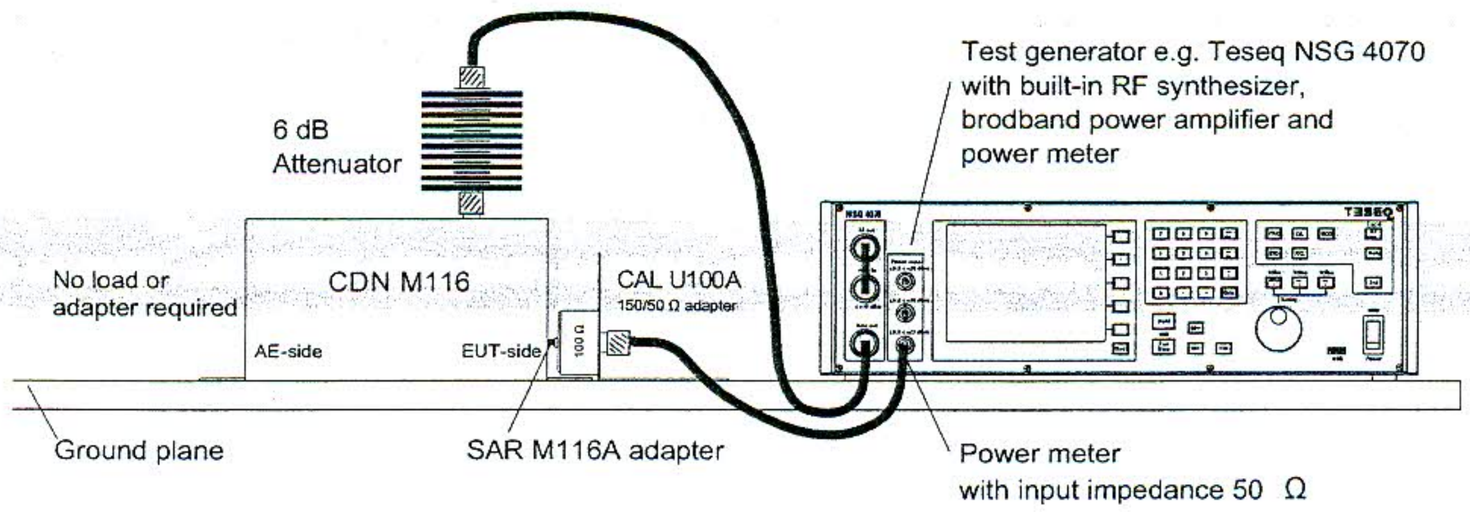
Table 3: CDN M-Type product range

4.3 Product details

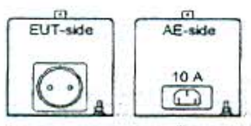
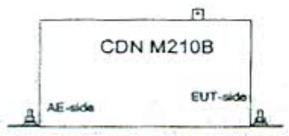
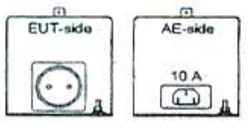
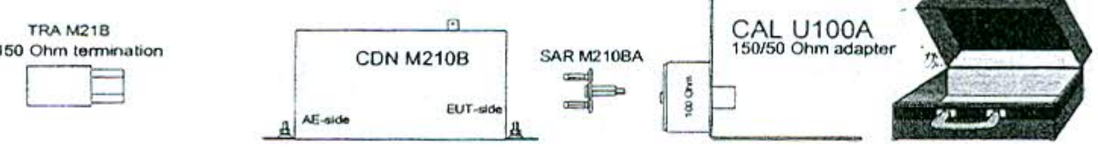
4.3.1 CDN M116

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M116 CDN M1 1 A, (banana)					
CDN 116S CDN M1 1 A, (banana) with calibration adapter set in suitcase					

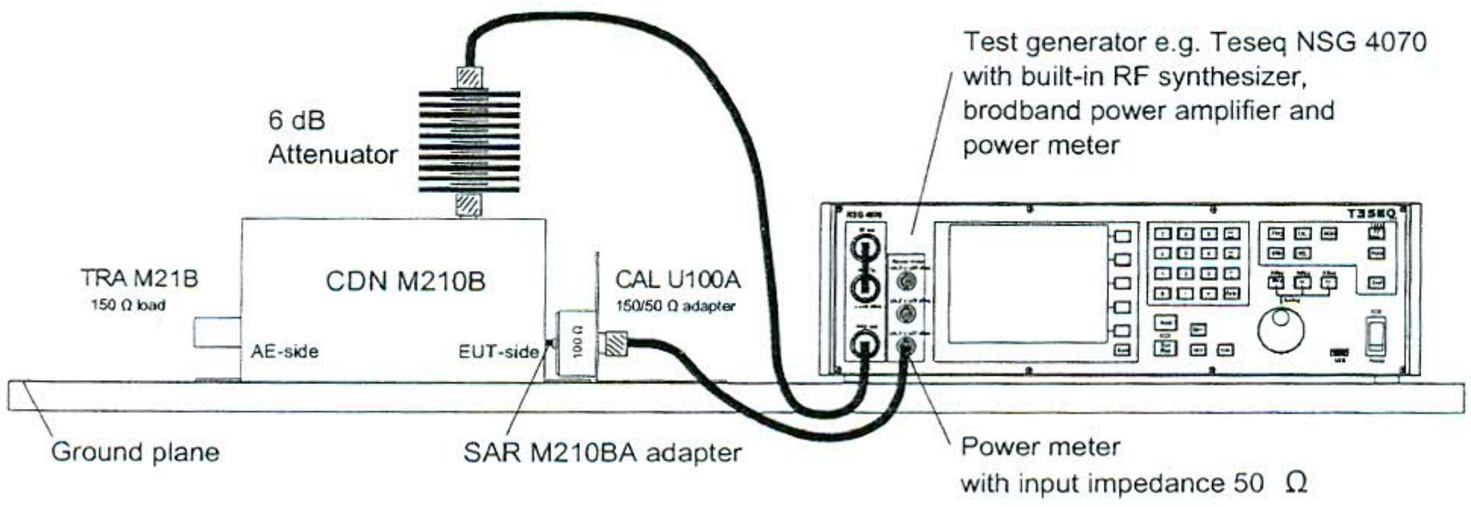
Test set-up calibration



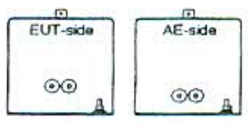
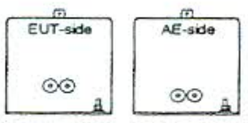
4.3.2 CDN M210B

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN 210B CDN M2 10 A, (AE Euro, EUT-socket 2lines)					
CDN 210BS CDN M2 10 A, (AE Euro, EUT-socket 2lines) with calibration adapter set in suitcase					

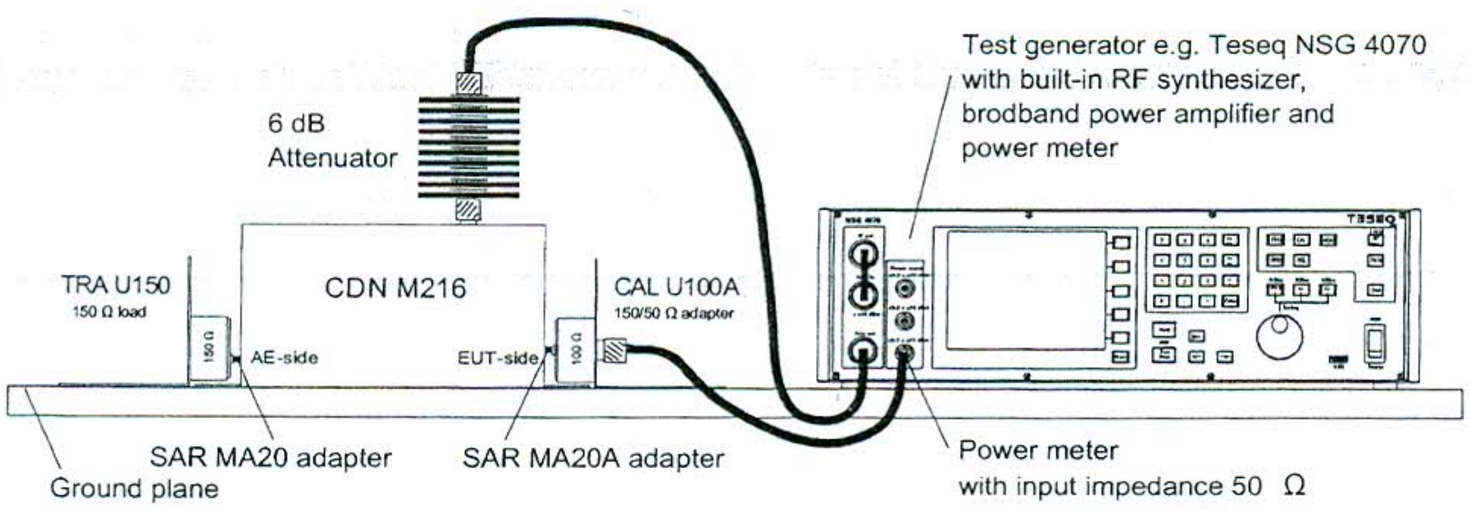
Test set-up calibration



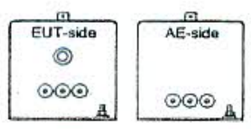
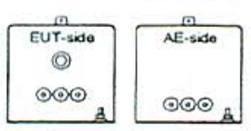
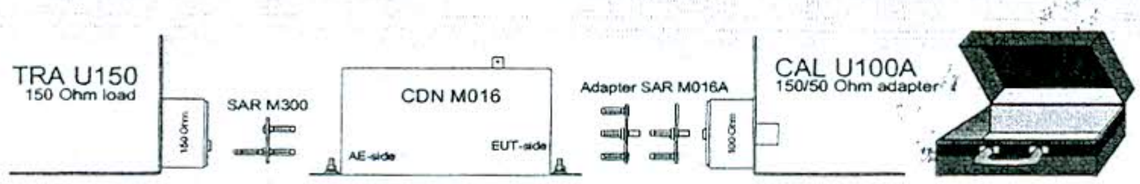
4.3.3 CDN M216

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M216 CDN M2 16 A, (banana)					
CDN M216 CDN M2 16 A, (banana) with calibration adapter set in suitcase					

Test set-up calibration

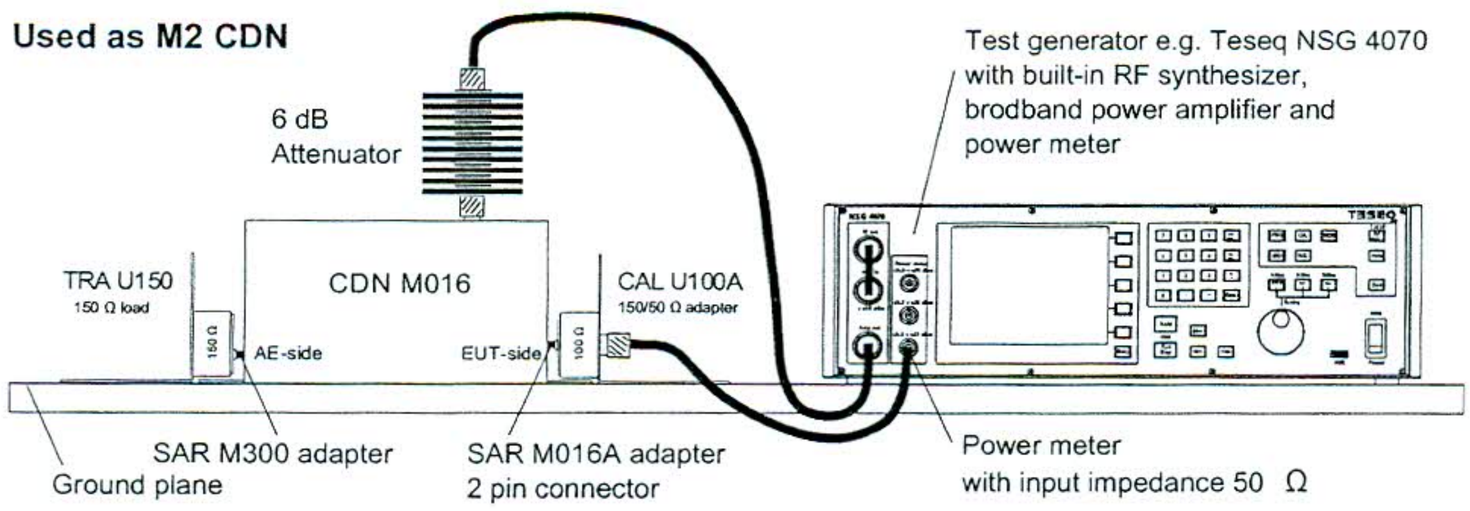


4.3.4 CDN M016

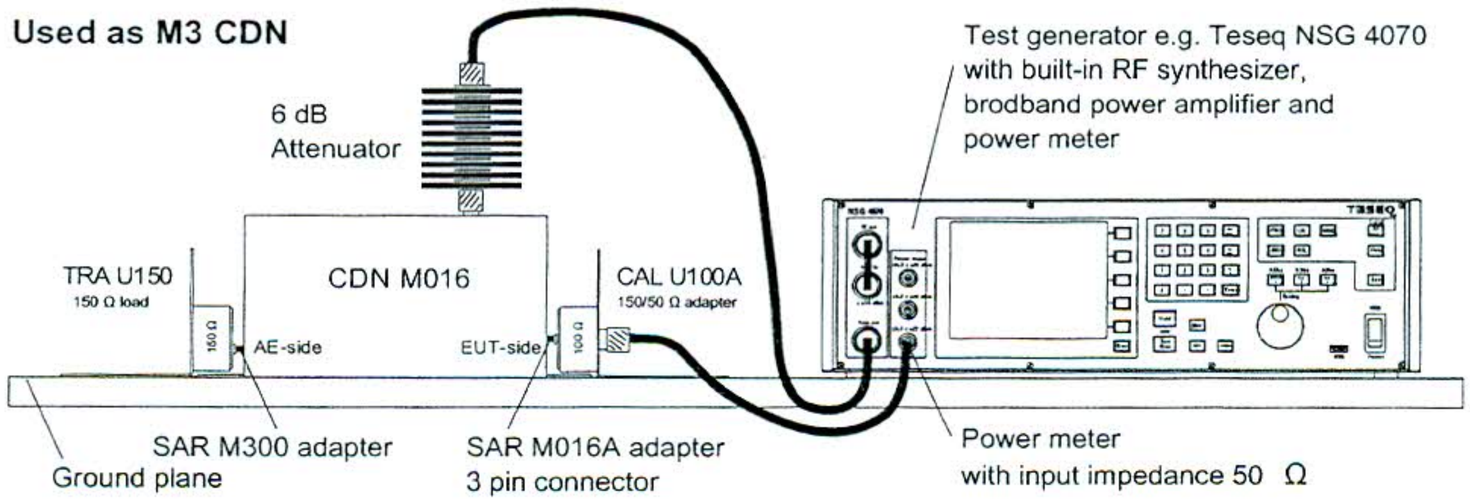
CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M016 CDN M2/3 switchable 16 A, (banana)					
CDN M016S CDN M2/3 switchable 16 A, (banana) with calibration adapter set in suitcase					

Test set-up calibration

Used as M2 CDN

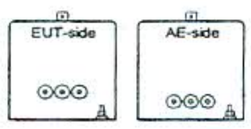
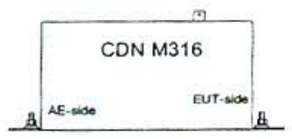
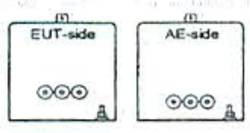
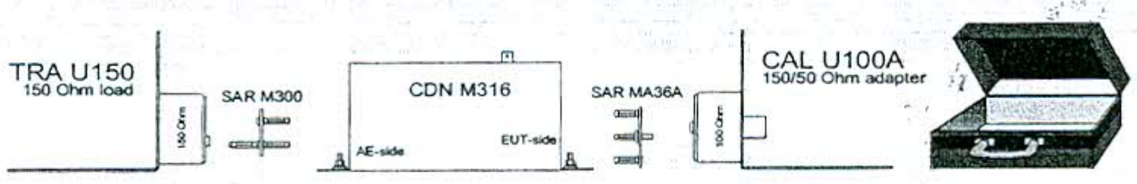


Used as M3 CDN

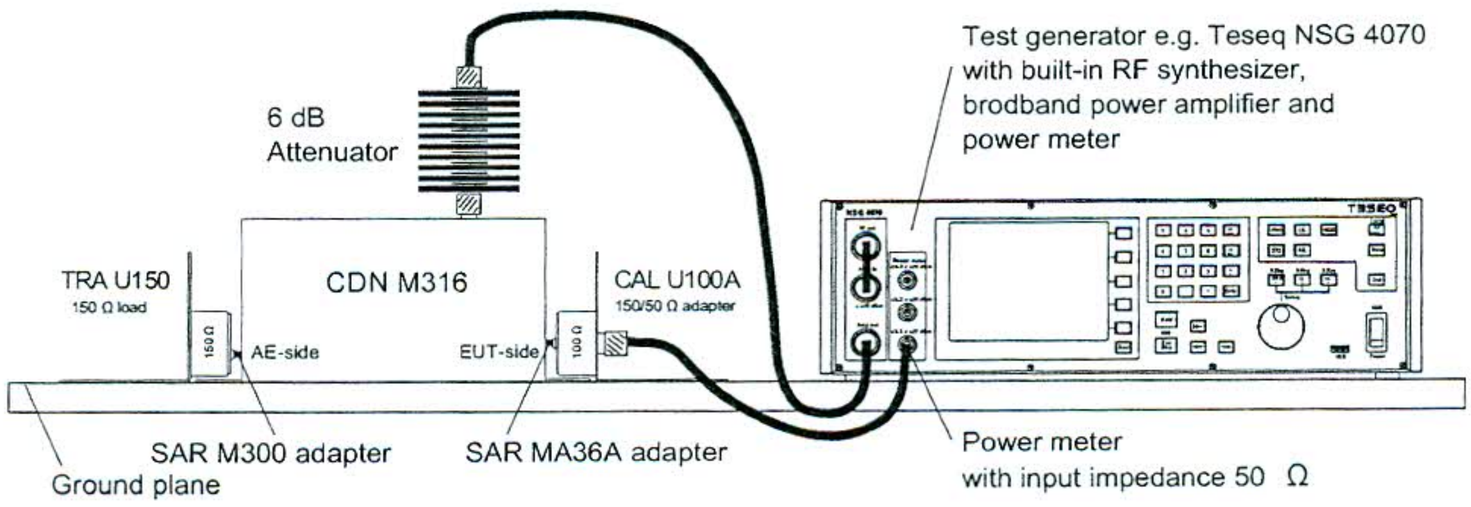


- Make sure to have the right position of the switch CDN M2 or M3 selected.
- Please connect the SAR M300 adapter with Line and Neutral to have via TRA U150 the 150 Ohms to ground and PE. The SAR M300 adapter has the same position for use as M2 and M3.

4.3.5 CDN M316

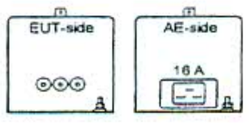
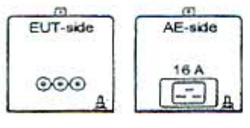
CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M316 CDN M3 16 A, (banana)					
CDN M316S CDN M3 16 A, (banana) with calibration adapter set in suitcase					

Test set-up calibration

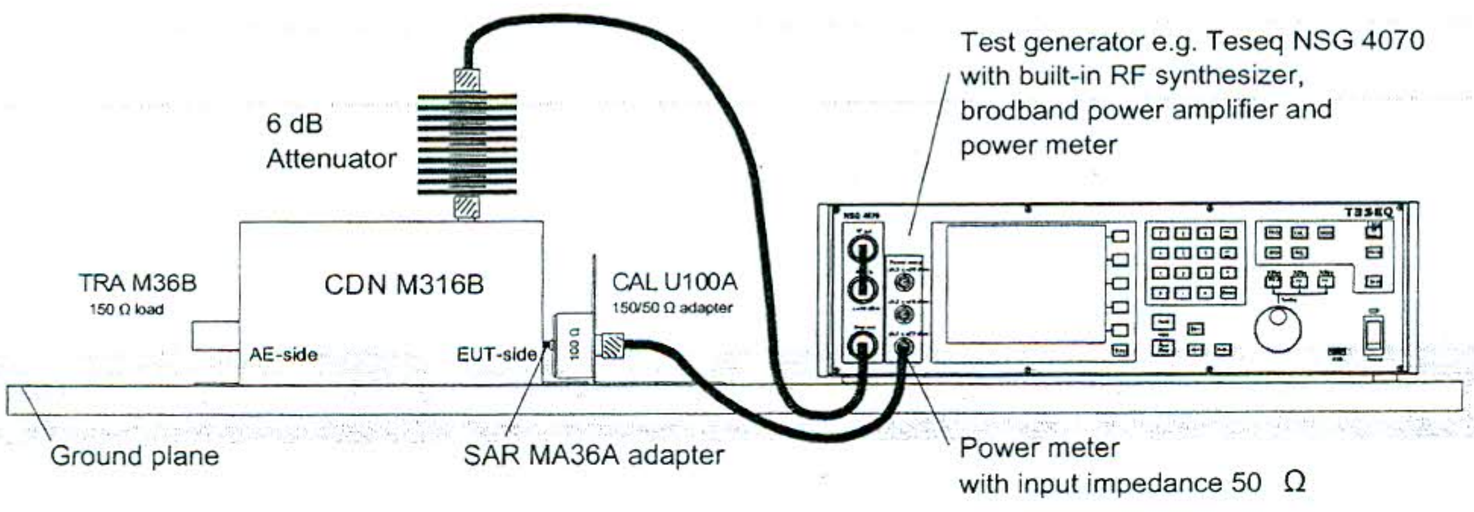


Please connect the SAR M300 adapter with Line and Neutral to have via TRA U150 the 150 Ohms to ground and PE.

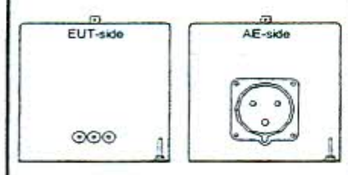
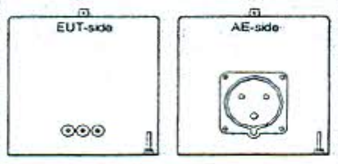
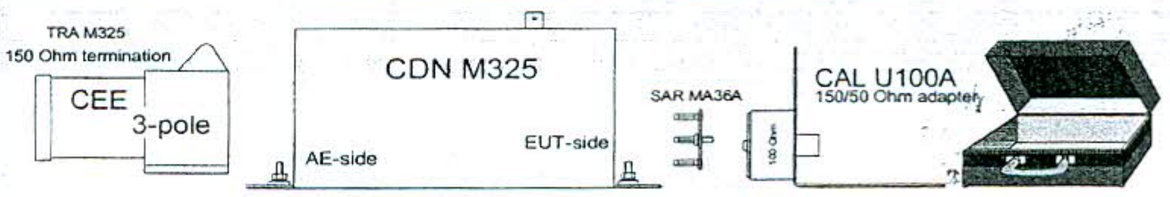
4.3.6 CDN M316B

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M316B CDN M3 16 A, (AE IEC, EUT banana)					
CDN M316BS CDN M3 16 A, (AE IEC, EUT banana) with calibration adapter set in suitcase					

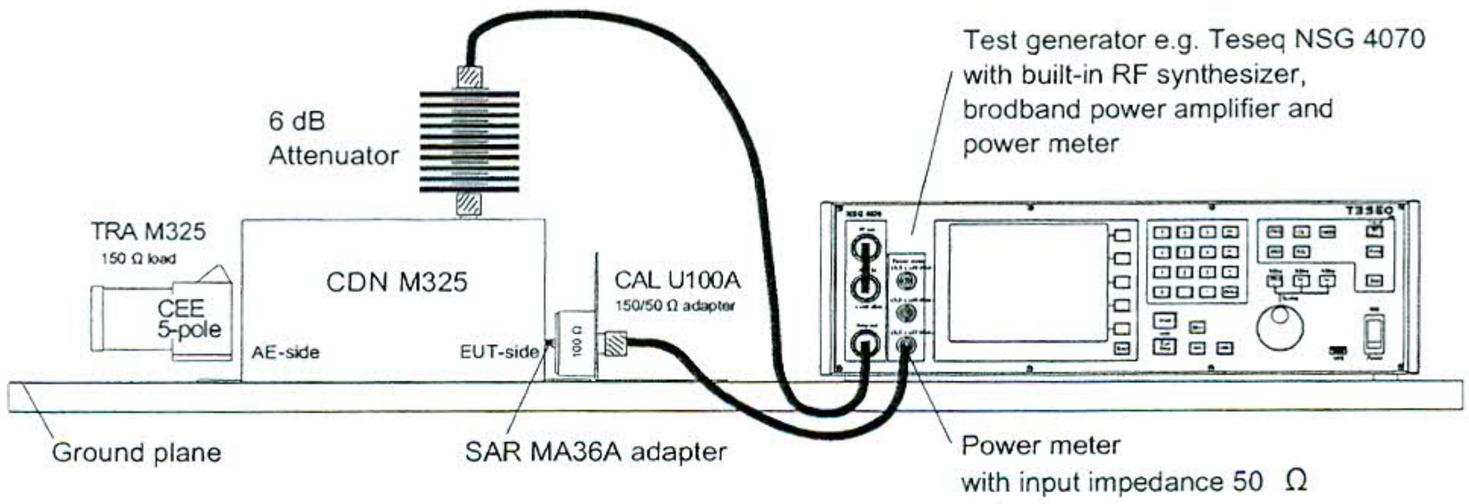
Test set-up calibration



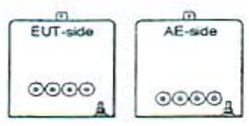
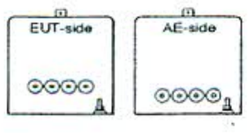
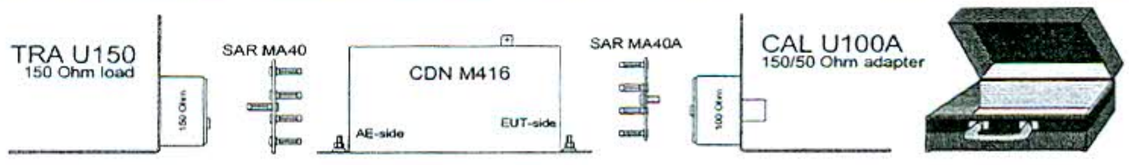
4.3.7 CDN M325

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M325 CDN M3 25 A, (AE CEE-plug, EUT banana)					
CDN M325S CDN M3 25 A, (AE CEE-plug, EUT banana) with calibration adapter set in suitcase					

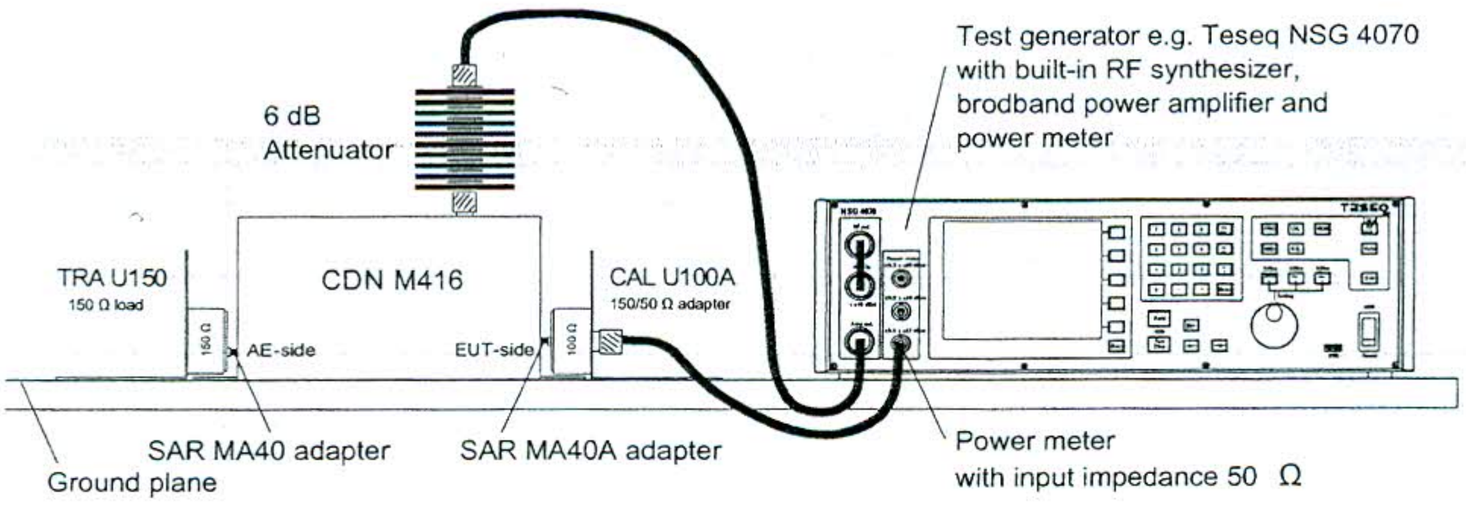
Test set-up calibration



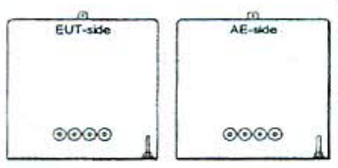
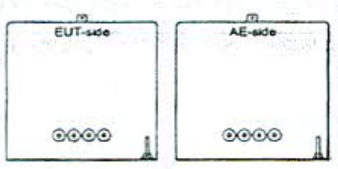
4.3.8 CDN M416

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M416 CDN M4 16 A, (banana)					
CDN M416S CDN M4 16 A, (banana) with calibration adapter set in suitcase					

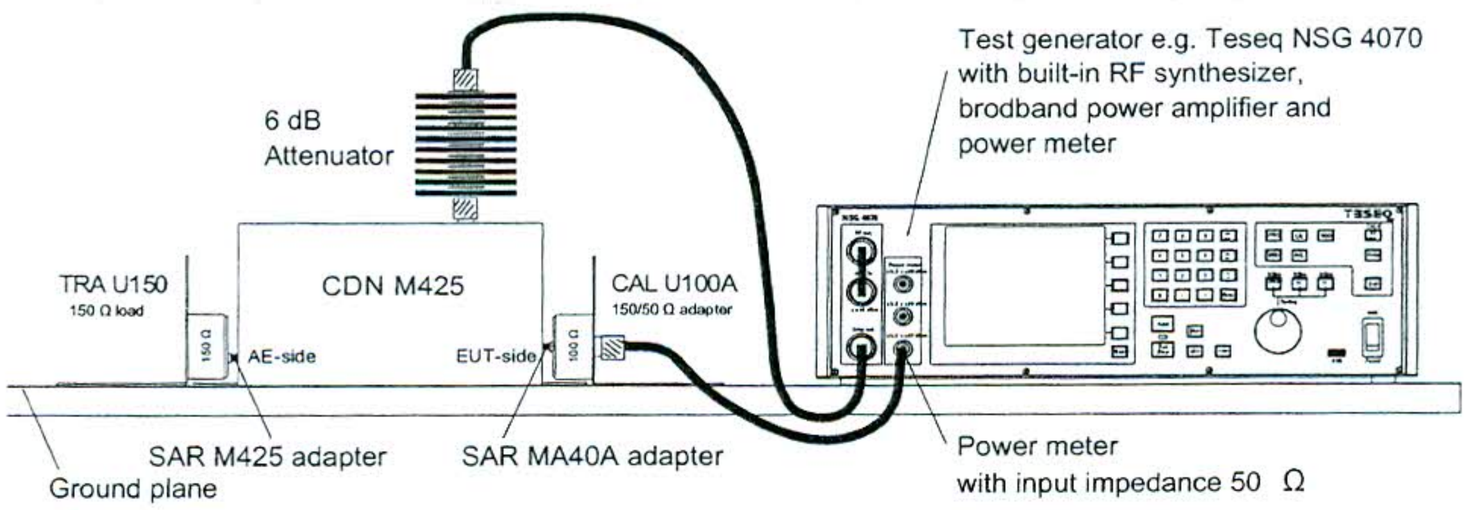
Test set-up calibration



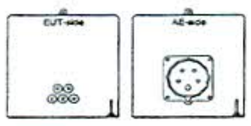
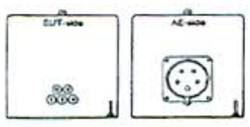
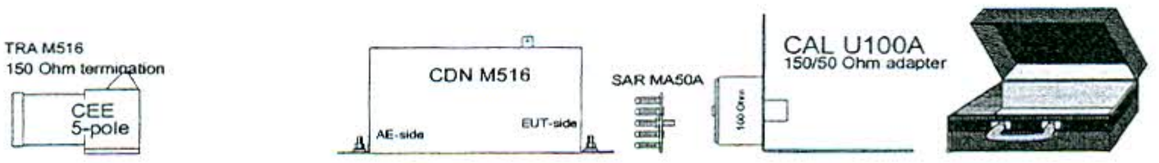
4.3.9 CDN M425

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M425 CDN M4 25 A, (banana)					
CDN M425S CDN M4 25 A, (banana) with calibration adapter set in suitcase					

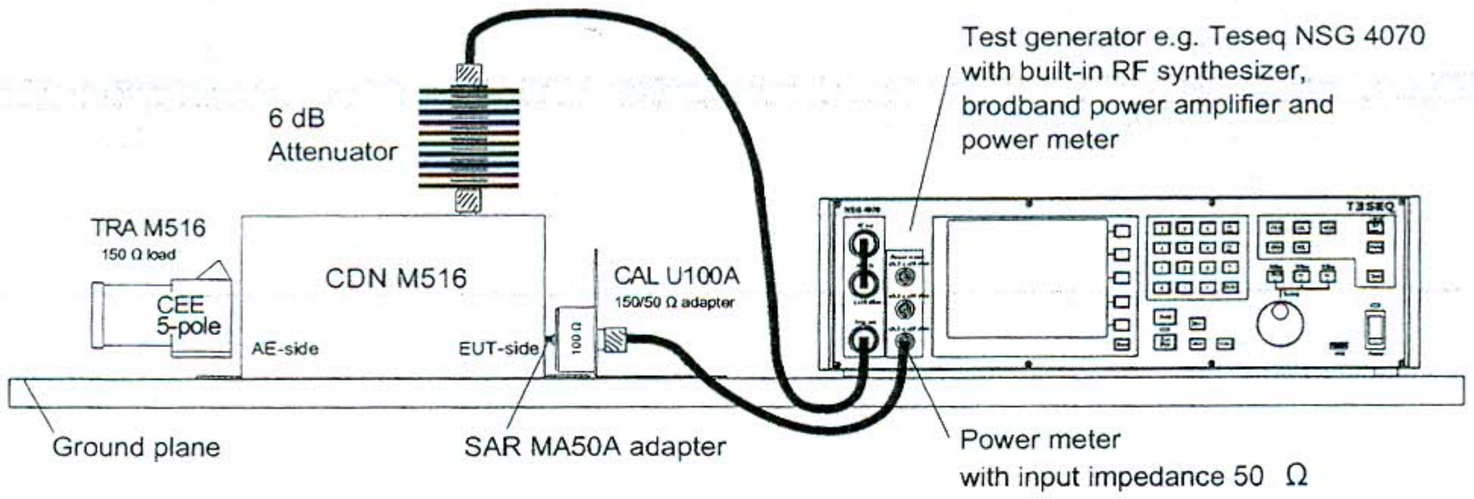
Test set-up calibration



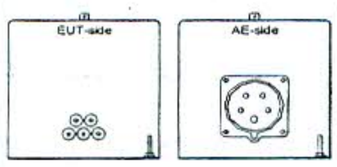
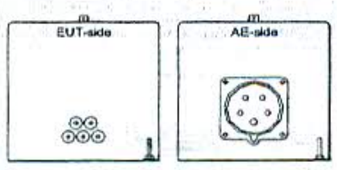
4.3.10 CDN M516

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M516 CDN M5 16 A, (AE CEE-plug, EUT banana)					
CDN M516S CDN M5 16 A, (AE CEE-plug, EUT banana) with calibration adapter set in suitcase					

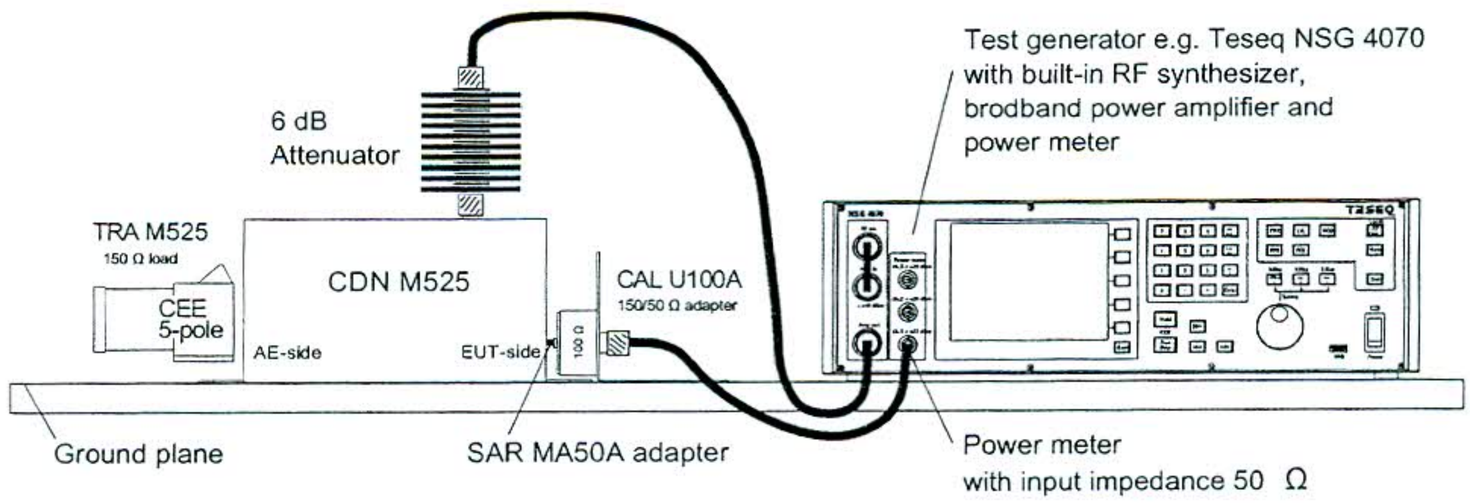
Test set-up calibration



4.3.11 CDN M525

CDN M-type	Connectors		Scope of delivery		
	EUT-port	AE-port	AE-port	Basic network	EUT-port
CDN M525 CDN M5 25 A, (AE CEE-plug, EUT banana)					
CDN M525S CDN M5 25 A, (AE CEE-plug, EUT banana) with calibration adapter set in suitcase					

Test set-up calibration



5 Technical specifications

Specification	M116	M016 M210B M216 M310B M316 M316B	M416 M516	M325 M425 M525
EUT- and AE port				
AC voltage		250 V	250 V	250 V
DC voltage		400 V	400 V	400 V
Current max.	1 A	16 A (M210B 10 A)	16 A	25 A
Test voltage		3 kV_{DC}, 2 sec	3 kV_{DC}, 2 sec	3 kV_{DC}, 2 sec
Common mode (CM) Impedance (EUT port)				
150 kHz – 26 MHz	150 Ω ± 20 Ω	150 Ω ± 20 Ω	150 Ω ± 20 Ω	150 Ω ± 20 Ω
26 MHz – 80 MHz	150 Ω $^{+60}_{-45}$ Ω	150 Ω $^{+60}_{-45}$ Ω	150 Ω $^{+60}_{-45}$ Ω	150 Ω $^{+60}_{-45}$ Ω
80 MHz – 230 MHz	150 Ω $^{+60}_{-45}$ Ω	150 Ω $^{+60}_{-45}$ Ω	-	150 Ω $^{+60}_{-45}$ Ω
RF coupling circuit				
Connector	BNC 50Ω	BNC 50Ω	BNC 50Ω	BNC 50Ω
RF voltage level	< 20 V	< 30 V	< 30 V	< 30V
Frequency range	0.15 – 230 MHz	0.15 – 230 MHz	0.15 – 80 MHz	0.15 – 230 MHz
Voltage division factor (In port / EUT)				
150 kHz – 80 MHz	9.5 dB ± 1 dB	9.5 dB ± 1 dB	9.5 dB ± 1 dB	9.5 dB $^{+3}_{-1}$ dB
80 MHz – 230 MHz (measured in a 150 Ω-system)	9.5 dB $^{+3}_{-2}$ dB	9.5 dB $^{+3}_{-2}$ dB		9.5 dB $^{+4}_{-1}$ dB
Insertion loss (EUT / AE) - f < 400Hz	< 0.1dB	< 0.1dB	< 0.1dB	< 0.1dB
Decoupling of CM disturbance (In-port / AE)				
150 kHz	> 70 dB	> 30 dB	> 30 dB	> 30 dB
1,5 MHz	> 60 dB	> 60 dB	> 60 dB	> 60 dB
30 MHz	> 55 dB	> 40 dB	> 40 dB	> 40 dB
230 MHz	> 35 dB	> 20 dB	> 20 dB	> 20 dB
Physical data				
Size (W x H x D) in mm	100x100x240	100x100x240	100x100x240	160x160x500
Weight	approx. 1.5 kg	approx. 1.5 kg	approx. 1.5 kg	approx. 6.5 kg
Environmental				
Operating temperature	Indoor use only +5°C to +40°C	Indoor use only +5°C to +40°C	Indoor use only +5°C to +40°C	Indoor use only +5°C to +40°C
Relative humidity	up to 80%	up to 80%	up to 80%	up to 80%

6 Maintenance

6.1 General

The CDNs included the accessories need no special maintenance. The maintenance is limited only for cleaning the contacts. The life time of the connectors is limited because of the contact durability. Teseq can replace the worn out connectors and offered a general adjustment of CDNs with adapters which might be necessary.

No modifications are to be carried out on the CDNs and accessories by the user.
It is recommended to send the units to a TESEQ Service Centre once a year for recalibration.

6.2 Cleaning

The cleaning shall be done with dry cloth. If a wed cleaning would become necessary, make sure that no humidity will enter inside of the unit and clean the instrument housing with a damp cloth using a little mild, non-abrasive household cleanser if necessary.

No chemicals may be used for cleaning purposes

7 Disposal

The unit is so çonstructed that it can be dismantles right down to the component level.