CURRENT INJECTION PROBE
CIP 9136A

USER MANUAL

AMETEK®
COMPLIANCE TEST SOLUTIONS

TESEQ
Advanced Test Solutions for EMC

CURRENT INJECTION PROBE CIP 9136A

USER MANUAL

CONTENT

1. SAFETY ADVICE

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 AMETEK CTS Europe GmbH nor any of the subsidiary sales organizations or the manufacturer can accept any responsibility for personal, material or consequential injury, loss or damage that results from improper use of the equipment and accessories.

! **WARNING: Improper or careless handling can be fatal!**
Use of the CIP 9136A is restricted to authorized and trained specialists

1.1. General

- Use of the CIP 9136A is restricted to authorized and trained specialists
- To reduce the risk of electric shock, do not remove parts from the housing.
- No user serviceable parts inside.
- In the fault case (e.g. caused by the EUT) dangerously high voltage may be on the housing.
- Measurements on bare cables are forbidden!
- Operate the equipment only in dry surroundings.
- 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.
- Measurements of radio disturbances should be performed preferable in shielded rooms.

1.2. Installation

Ensure that a reliable return path for the interference current is provided between the item under test (EUT) and the generator. The reference ground plane and a proper contact from the probe to the plane as described in the relevant test standard serve this purpose well. Allow any condensation that occurs to evaporate before putting the instrument into operation.

1.3. Applicable safety standards

The manufacture of the instrument complies with ISO 9001. The product conforms with the requirements of the Low Voltage Directive (LVD) 2006/95/EC based on DIN EN 61010-1:2001 (Safety requirements for electrical equipment for measurement, control and laboratory use).

1.4. Test execution

Testing requires fixed clamp halves using the fixing screw. Do not exceed the permissible core temperature. Avoid any over load with adequate arrangements. Product overheating can cause electric shock and fire. The test area must be organized in such a way that no unauthorized persons have access during execution of a test. EUTs, together with all accessories and cables are to be regarded as being live during the execution of a test. The safety instructions concerning all the instruments and associated equipment involved in the test jig are to be observed. The configuration of the test jig is to be strictly in compliance with the methods described in the relevant standard to ensure that the test is executed in a standard-conform manner.

! **WARNING: The testing may cause a hot surface of the CIP 9136A.**
Avoid any touching of a hot CIP 9136A.

2. UNPACKING, STORAGE AND TRANSPORT

2.1. General

- Throw nothing away!

Packaging either:

- Keep for dispatching 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 stabilize. 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

- Current injection probe CIP 9136A
- Storage case
- Operating manual

Optional

- Traceable calibration (ISO17025), order only with device CIP 9136A
- Calibration jig PCJ 9201B

3. DESCRIPTION OF THE PRODUCT

3.1. General

The CIP 9136 probe has been manufactured to drawings and specifications laid down by QinetiQ. It meets the requirements for HIRF testing where conventional ferrite core material cannot handle the higher powers required (up to 1000 W), without changing characteristics when heated. Whilst having been initially designed to meet the specific requirements of Aircraft Testing from 10 kHz to 50 MHz, the CIP 9136's unique non-ferrite core allows wide band performance from 4 kHz - 400 MHz, and above.

The CIP 9136 core material is highly efficient and thermally rugged, thus allowing very high injected levels to be achieved with lower RF input powers. The core material can withstand far higher powers than conventional ferrite (up to 1000 W), which change characteristics in relation to the temperature.

The probe material meets the requirements of ISO 11452-4, RTCA/DO-160 section 20, MIL-STD-461 and other standards. The probe performance can be measured using Calibration Jig PCJ 9201.

The model CIP 9136A received a mechanical improvement, in difference to the original CIP 9136, for a better core positioning. This is mandatory in the low frequency range and it improves the insertion loss.

3.2. Construction of the product

Figure 1: CIP 9136A

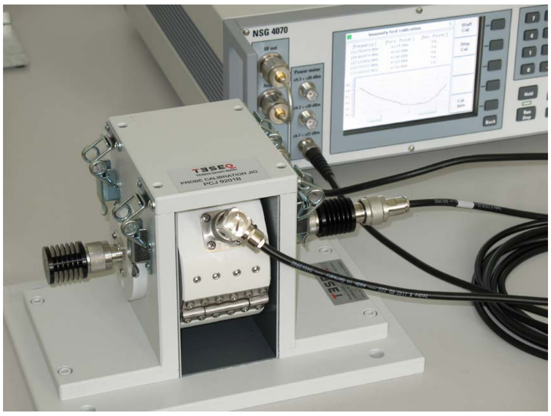

Figure 2: **CIP 9136A inserted in calibration fixture PCJ9201B with connected 10 W termination and 20 dB / 10 W attenuator (BCI application with compact generator NSG 4070)**

4. APPLICATIONS

4.1. Application immunity testing to IEC / EN 61000-4-6

The CIP 9136A can be used as injection clamp as given in edition 3 Annex A.1 of IEC / EN 61000-4-6 „Immunity to conducted disturbances, induced by radio frequency fields". The level setting procedure requires a calibration fixture as given in Figure A.1 of IEC / EN 61000-4-6 and provided with Teseq's PCJ 9201B. An extra current probe like the MD 4070, which is inserted between the injection clamp and the EUT, may also be required. In case the current exceeds the nominal circuit value, the stress level will be reduced until the measured current is equal to the maximum

4.1.1. Power requirements

The following graph shows the typical stress level in relation to the frequency range and used forward power.

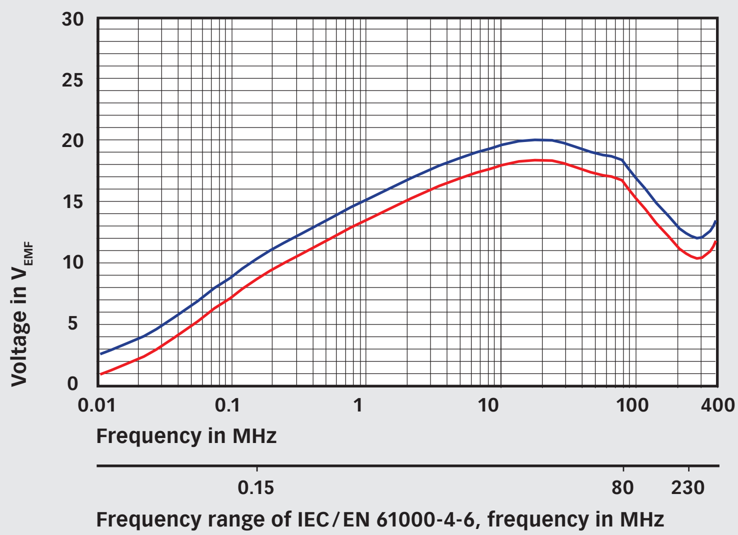

Figure 3: **IEC / EN 61000-4-6: Typical test levels with — 75 W and — 100 W forward power (including 6 dB attenuator and 5.1 dB modulation reserve)**

4.1.2. Calibration fixture

Calibration fixture, test generator and power meter are typically designed with 50 Ω impedance. The using of the 150 Ω test levels of IEC / EN 61000-4-6 requires an additional adaptation from 150 Ω to 50 Ω on the calibration jig. Teseq offers with PCJ 9201B a adequate calibration fixture as given in Figure A.1 of IEC / EN 61000-4-6. The adaptation from 150 Ω to 50 Ω can be provided with INA 721-100 and INA 721-150.

4.1.3. Attenuator

The 6 dB attenuator needs to be suitable for the used forward power. Best would be to be suitable for the max. forward power of the used power amplifier.

4.1.4. Test setup calibration in the 150 Ω system (preferred method)

The test generator is connected via 6 dB attenuator to the RF port of the current injection probe. The probe is inserted in a 50 Ω jig. The jig is connected with a 150 Ω to 50 Ω adapter to a power meter with 50 Ω input impedance. The other side of the jig is terminated with 150 Ω. The setup is shown in the figure below:

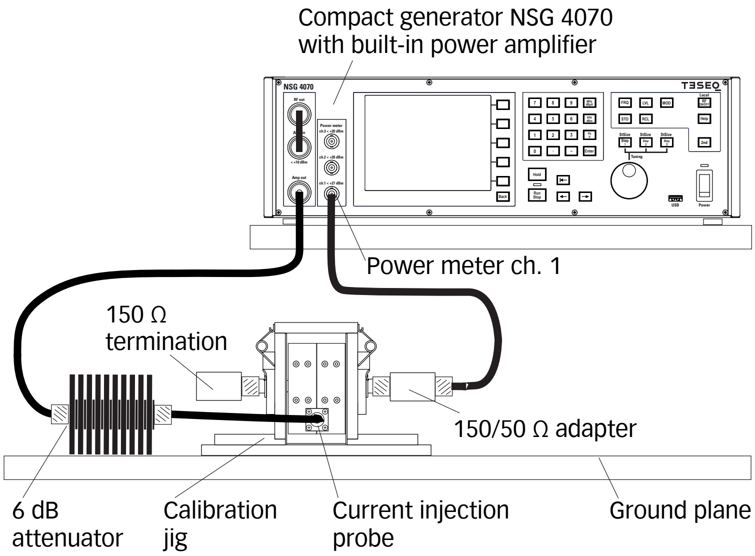

Figure 4: Test setup calibration according IEC / EN 61000-4-6 with current injection probe

4.1.5. Test setup calibration in the 50 Ω system

The test generator is connected via 6 dB attenuator to the RF port of the current injection probe. The probe is inserted in a 50 Ω jig. The jig is connected to a power meter channel 1. The other side of the jig is terminated with 50 Ω. The used test level needs to cover the difference between the 150 Ω and 50 Ω. An additional conversion factor of -9.5 dB represents this relation. The setup is shown in the figure below:

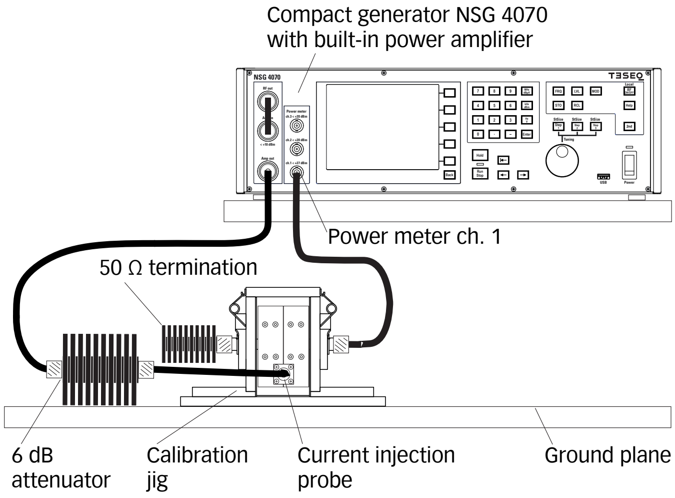

Figure 5: Test setup calibration with current injection probe in a 50 Ω system

4.1.6. EUT test setup with current injection probe

After calibration the jig and the adapters must be removed from the setup. The EUT must be connected through the current injection probe. A general example for the test setup with EUT is shown below:

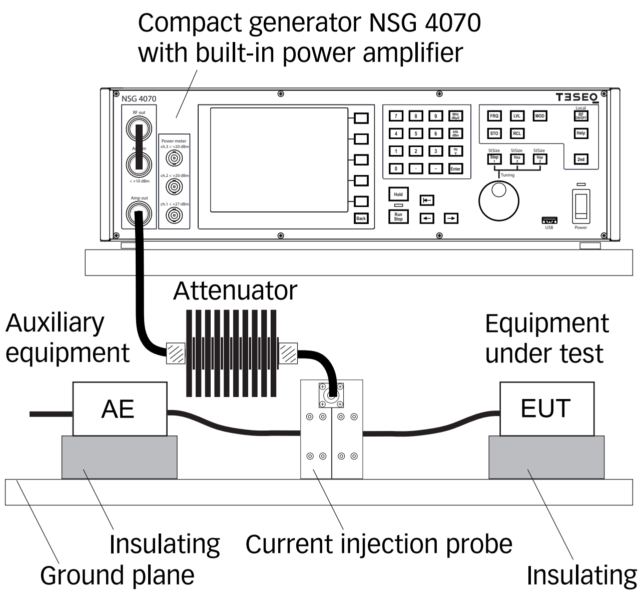

Figure 6: Test setup with EUT according IEC / EN 61000-4-6 with current injection probe

The test setup with using the monitoring probe is shown below.

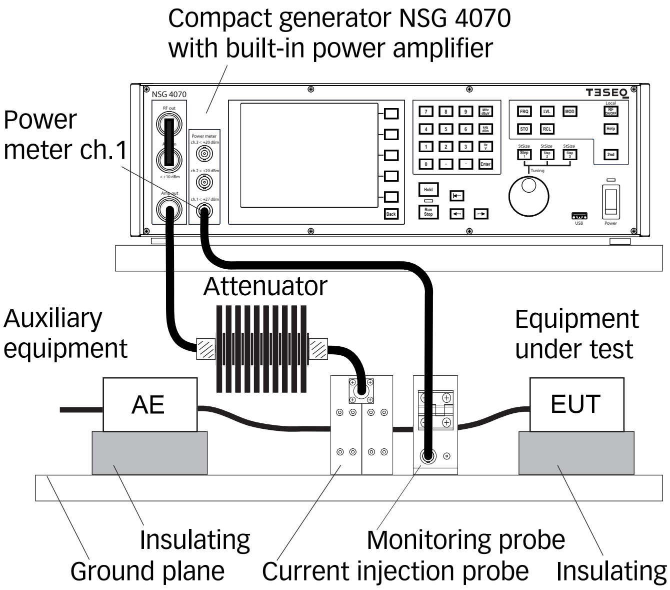

Figure 7: Test setup with EUT according IEC / EN 61000-4-6 with current injection probe and monitoring probe

4.2. Application BCI testing

The CIP 9136A is ideal for BCI testing as part of ISO 11452-4, MIL-STD-461 and other standards.

4.2.1. Power requirements

The standard ISO 11452-4 defines the range from 20 to 200 mA. Specific values, also above 200 mA, can be defined by the users of the standard, if necessary. Some standard using the unit dBµA and a stress level profile, which relates to the properties of the probes. The following graphs show the input power/ stress level relation.

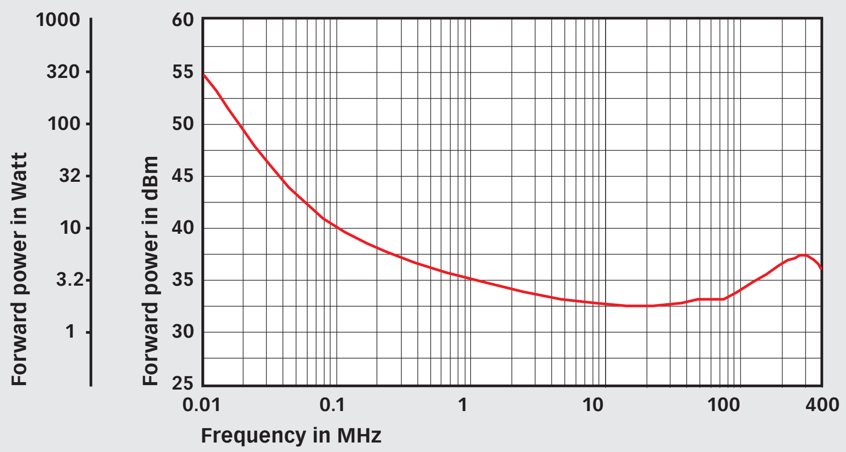

Figure 8: BCI application: Typical required forward power to inject 100 mA (100 dBµA)

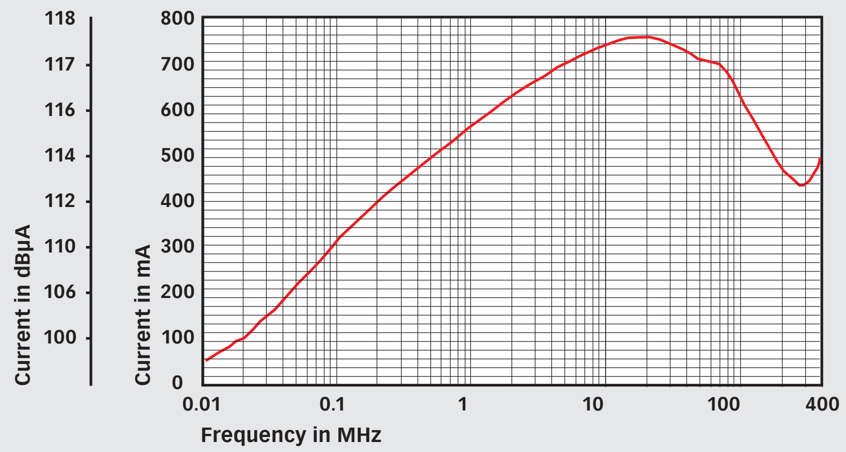

Figure 9: BCI application: Typical injected current with 100 W forward power

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4.2.2. Power limitation factor

The standard ISO 11452-4 defines a power limit for the Closed loop method. The test procedure used at each frequency is described as follows. Increase the forward power applied to the current injection probe and measure the injected current until either:

- the measured current reaches the specified test level, or
- the forward power reaches the power limit.

The value $P_{for\ cal}$. is known from the calibration procedure. The power limit is shown as:

$$P_{CW\ limit} = kP_{for\ cal}$$

$P_{CW\ limit}$	is the power limit
$P_{for\ cal}$.	is the forward power applied to reach the current test signal level in the jig
k	limitation factor (default value is 4)

! **The limitation factor of 4 requires 4 times higher forward power as calibrated. The power amplifier must be able to have this reserve. The connected hardware (directional coupler, power meter, attenuator and BCI probe) should be selected for the maximum level of the power amplifier.**

4.2.3. Power amplifier

Class A amplifiers are the best choice for BCI testing. Only this principle guarantees providing forward power independent of the matching. Teseq's CBA series power amplifiers are real class A. The maximum linear output power is given already below 0 dBm (see datasheet of the Teseq power amplifiers) input power.

4.2.4. Calibration jig

The calibration jig should be terminated by a 50 Ω load at one end and by a 50 Ω RF power meter at the other end.

4.2.5. Termination

The power requirements for the 50 Ω load are on the same level as the stress level. For example: A stress level of 400 mA requires at least a 8 W attenuator.

4.2.6. Calibration

All BCI test methods are based upon the use of forward power as the reference parameter. The specific test level (current) shall be calibrated by recording the forward power required to produce a specific current measured on a 50 Ω calibration jig for each test frequency. This calibration shall be performed with an unmodulated sinusoidal wave. Two different methods are usual. Very common is to use the CIP 9136A insertion loss values provided by the calibration lab (see also chapter 5) as factors for the test house software. The other opportunity is to calibrate the CIP 9136A with the equipment in the EMC lab. Such an example is shown in the next figure.

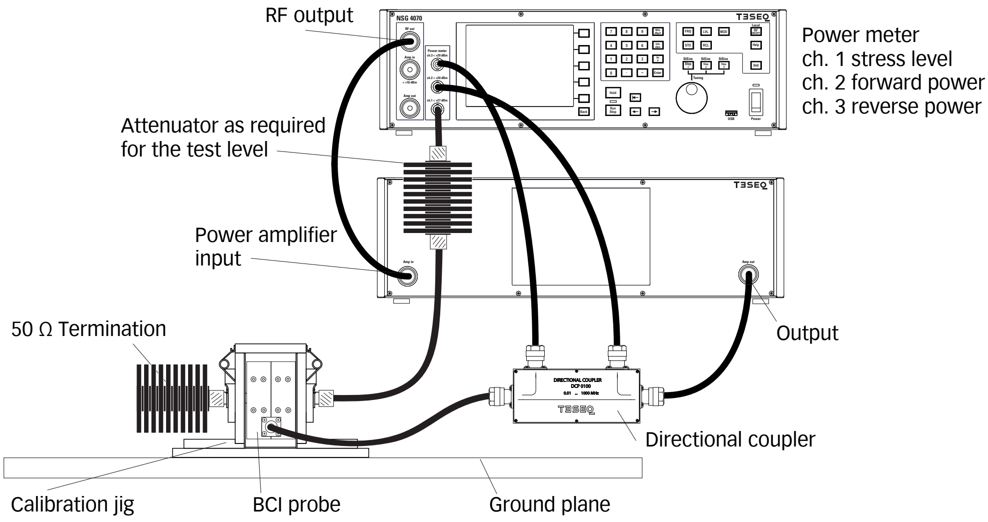

Figure 10: BCI calibration setup

4.2.7. Test setup

After calibration the jig must be removed from the setup. The EUT must be connected through the BCI probe. A general example of the test setup for the substitution method without current monitoring probe is shown in Figure 11. Figure 12 shows the setup for the substitution method with current monitoring probe for the Closed loop method.

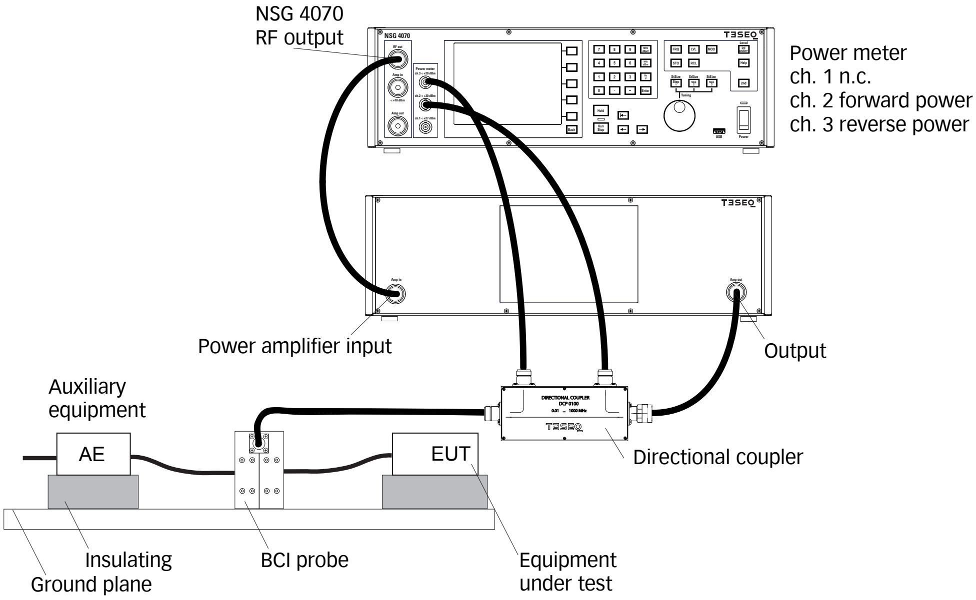

Figure 11: BCI test setup without current monitoring probe

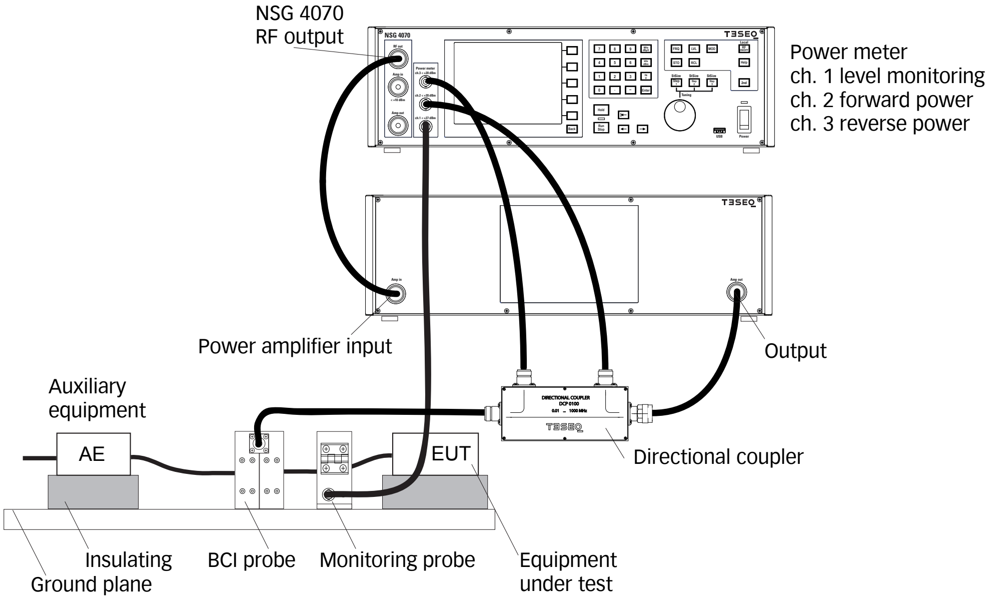

Figure 12: BCI test setup with current monitoring probe

5. VALIDATION PROCEDURE AND SET-UP

In the first step is needed to calibrate the network analyzer with connected 'open', 'short' and 'match' on the network analyzer cable of port A and B. The TOSM calibration will be completed with a Through between the cables of port A and B. The calibration fixture PCJ 9201 will not be considered.
The set-ups are shown in the next figures.

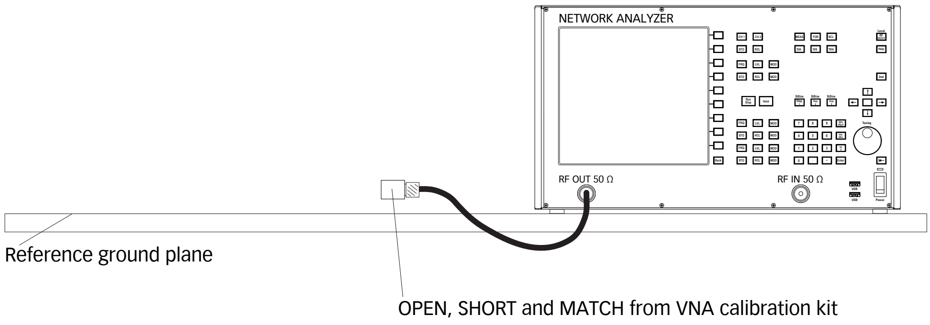

Figure 13: Port A: Calibration "open", "short" and "match"

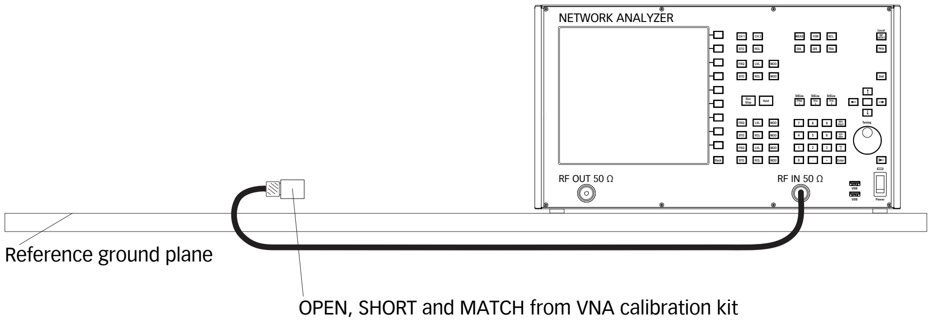

Figure 14: Port B: Calibration "open", "short" and "match"

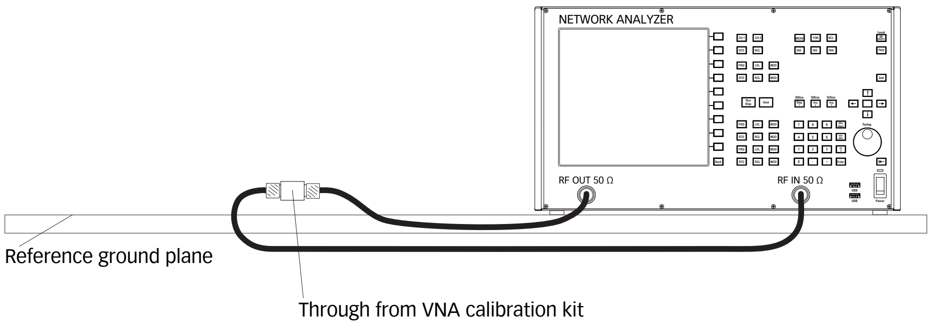

Figure 15: "Through" calibration

The CIP 9136A will be inserted in the horizontal and vertical centre of the calibration fixture PCJ 9201. One port of the network analyzer is connected to the PCJ 9201 and the other port to the CIP 9136A. The PCJ 9201 needs to be terminated with 50 Ω. The insertion loss measurement can now be performed.

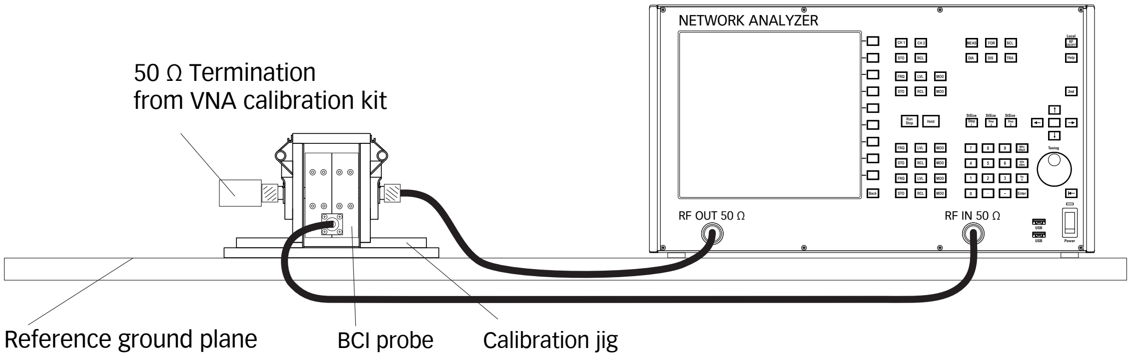

Figure 16: Insertion loss measurement

6. TECHNICAL SPECIFICATION

Frequency range:	4 kHz - 400 MHz
Window diameter:	43 mm
Outside diameter:	113 mm
Width:	61 mm
Weight:	approx. 2 kg
Input connector:	Type N
Max. input power:	1000 W
Max. time for continuous operation:	related to the core temperature
Rating at 10 kHz / 1000 W:	approx. 10 min*
Rating at 100 kHz / 500 W:	approx. 7 min*
Rating at 150 kHz / 500 W:	approx. 5 min*
Rating at 1 MHz to 400 MHz / 400 W:	approx. 3 min*
Max core temperature:	90˚C
Turns ratio:	1:1
Primary inductance @ 1 MHz:	4.7 µH typical
Self resonant frequency:	12 MHz typical
Impedance at resonance:	100 Ω typical
*) Time based on a core temperature rise from 23°C to max. 90°C	

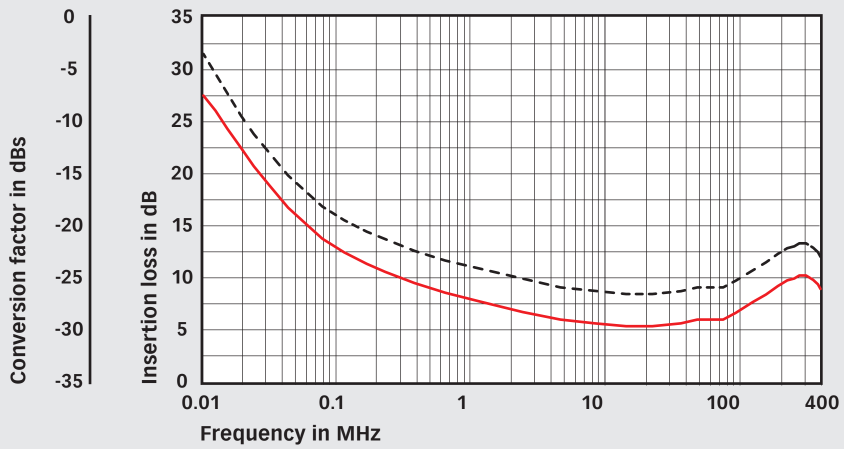

Figure 17: Insertion loss and conversion factor, — typical values, - - - Limit

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7. MAINTENANCE

7.1. General

The CIP 9136A needs no special maintenance. The maintenance is limited to the cleaning of the contacts. The life time of the connectors is limited because of the contact durability. AMETEK CTS can replace the worn out connectors and offers a general adjustment of the CIP 9136A.

No modifications are to be carried out on the CIP 9136A and accessories by the user.
It is recommended to send the unit to a AMETEK CTS Service Centre once a year for recalibration.

7.2. Cleaning

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

Chemicals must not be used for cleaning purposes

8. DISPOSAL

The unit is constructed that it can be dismantled right down to the component level.

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