MONITORING DEVICE
MD 4070A

USER MANUAL

AMETEK®
COMPLIANCE TEST SOLUTIONS

TESEQ
Advanced Test Solutions for EMC

MONITORING DEVICE
MD 4070A

USER MANUAL

CONTENT

1. SAFETY ADVICE

Observe all precautions to assure your personal safety. Read the user manual carefully. Pay special attention to safety and operation details!

1.1. Safety and warning symbols

Please take note of the following explanations of the symbols used in order to achieve the optimum benefit from this manual and to ensure safety during operation of the equipment.

		This symbol warns of a potential risk of shock hazard. Use standard safety precautions to avoid personal contact with these voltages.
		This symbol indicates where a caution is required. Refer to the operating instructions located in the manual in order to protect against personal injury or damage the equipment. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause damage to equipment. Such damage may invalidate the warranty. Do not proceed until its conditions are fully understood and met.
		This symbol indicates non-ionizing radiation. Non-ionizing radiation may pose a health hazard to operators. Protective measures such as switching off the RF before entering the Faraday cage, level limitation and/or spatial distance are common measures.
		This symbol indicates access of persons with pacemakers prohibited.
		This symbol indicates the ground terminal.
		This symbol indicates the protective earth terminal.

1.2. Safety Aspects

These operating instructions form an integral part of the equipment and must be available to the operating personnel at all times. The user must obey all safety instructions and warnings.
Neither AMETEK CTS Europe GmbH nor any of its subsidiary sales organizations 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 generator is restricted to authorized and trained specialists

1.3. Connection to the mains and PE

- Before switching on the device, check whether the selected voltage matches the supply voltage. The position of the voltage selector must correspond with the mains. If you change the mains voltage, replace the fuses according the recommended value.
- A proper protective earth connection through the connector of the power cord is essential for safe operation.
- High leakage currents can cause the residual current circuit breaker of the mains to trip. In this case, the use of an isolating transformer is required.
- Handle the power cord carefully. Hold the plug when unplugging the cord.
- Never use the product if the power cord or the plug is damaged.
- Use only power cords and connector specified for your product.
- Do not abuse the cord. Never use the cord for carrying, pulling or unplugging the unit. Keep cord away from heat, oil, sharp edges or moving parts.
- Prevent the device from being switched on or energized unintentionally. Make sure that the switch is in the off position before connecting the device to the mains.
- Disconnect the power plug if you are not going to use the device for a long period of time.

1.4. Connections to other ports with dangerous voltages (AE, EUT, RF port ...)

- Only use the connection cables and plugs specified for your product which enable safe working. They must comply with the required classification and have suitable voltage and current ratings for the application. .
- Handle the connection cable carefully. Hold the plug when unplugging the cable.
- Never use the product if the connection cable or plug is damaged.
- Avoid touching conductive parts unless they have been de-energized by suitable means and secured against being switched on again for the period of handling. Industrial connectors often have insufficient protection against electric shock due to their application.

1.5. Connection to the ground plane or Faraday cage

- Remove the protective foil from under the device and adapter housing to ensure good electrical contact.
- Light equipment should be weighted down, clamped to the base plate or other measures should be taken to ensure good electrical contact over a wide surface area and on a permanent basis.

- Connect the device with the ground plane before using.
- The operation without a second, only with a tool removable earth leakage connection is prohibited.
- Check the ground connection at regular intervals.

- Ensure that a reliable return path for the interference current is provided between the equipment under test (EUT) and the generator. The reference ground plane and the earth connections to the instrument as described in the relevant test standard serve this purpose well.

1.6. Disconnection from the mains, PE, ground and control devices

- Always set the power switch to the "Off" position and wait few seconds before disconnecting the power cord.
- Disconnect the power cord and all connection cords when moving the unit.

1.7. Use proper fuses

- To avoid fire hazard, use only fuses as specified in the parts listing for your product - matching type, voltage and current rating.

1.8. Risk of electric shock

WARNING

- To reduce the risk of electric shock, do not remove parts from the housing.
- There are no user serviceable parts inside the unit. Certain parts inside the instrument work at mains voltage or at high frequency and are not provided with any protection against being touched.
- Only approved accessory items, connectors, adapters, etc. are to be used to ensure safe operation.

WARNING

- The lines inside the device are not protected by a fuse. Therefore, the user must implement the protection of the device against short-circuits by means of suitable fuses.
- Avoid an overload by taking suitable precautions.
- In the event of a fault, dangerous and unexpected voltages may occur. Avoid touching conductive parts unless they have been de-energized by suitable means and secured against being switched on again for the period of handling.

1.9. Operating Environment

- 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. Operate the unit not in explosive surroundings.
- No objects filled with liquids, such as coffee cups, shall be placed on the unit.
- Do not insert foreign objects in the ventilation holes.
- Do not obstruct the ventilation holes (also on the underside). Ventilation should not be impeded by covering the ventilation openings with items or other equipment.
- Avoid high temperatures. Allow for sufficient heat dispersion when installed in a rack. Do not place the product on radiators or fan heaters. The ambient temperature must not exceed the maximum specified temperature of this product.
- Keep the test area clean and well lit. Cluttered or dark areas invite accidents.

1.10. Test execution

- Check once again that all connections are proper including the ground and protective earth.
- Remove any adjusting key or wrench before switching on or energizing the device.
- The test area must be organized that no unauthorized persons have access during execution of a test.
- Operating the product requires special training and intense concentration. Make certain that persons who use the products are physically, mentally and emotionally fit enough to operate the products; otherwise injuries or material damage may occur.
- 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 setup are to be observed.
- The configuration of the test setup is to be strictly in compliance with the methods described in the relevant standard to ensure that the test is executed in a compliant manner.
- Working with high voltages alone is dangerous and prohibited by law.
- The high voltages must be switched off when nobody is present.

1.11. Dangers concerning the generator

- Local regulations for the protection of radio services must be observed. The interference generated by the generator can cause both conducted and radiated interference.
- If the radiated energy exceeds the permissible level, a shielded chamber with filtering of the supply lines or similar must be used. Decisive for the measures are the used levels, the geometry of the setup, the frequency range and the distance to the neighbor.
- Depending on the level used, the effectiveness of the connected antenna, TEM cell or similar, fields can be generated using appropriate power amplifiers, from which the operating personnel must be protected by suitable measures.
- Localized burning, arcing or ignition of explosive gases.
- Disruption of unrelated electronic, telecommunications or navigational installations or heart pacemakers through intentional and unintentional radiation of RF energy.

WARNING

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

1.12. Dangers concerning the EUT

- EUTs are frequently simply functional samples that have not previously been subjected to any safety tests. Therefore, in some cases, the EUT is quickly damaged through internal overloads caused by the control electronics being disrupted. The EUT may even begin to burn.
- As soon as the EUT shows signs of damage the test should be stopped and the equipment under test should be switched off.
- Possible erroneous behavior by the EUT for example, a robotic device may misbehave, or a temperature regulator may fail.
- Even when power is off, capacitors may retain an electrical charge.

1.13. Applicable safety standards

- Development and manufacture of the instrument complies with ISO 9001.
- The equipment conforms with the essential requirements of the Low Voltage Directive (LVD) 2014/35/EU based on DIN EN 61010-1.

1.14. Intended use

WARNING

The purpose of this instrument is the measuring of signals for EMC testing. Depending on the test stand layout, configuration, wiring, and the characteristics of the EUT itself, a significant amount of electromagnetic radiation may be generated that can affect people as well as other equipment and systems.

The device is designed for operation in industrial as well as home environment. For the intended operation, electromagnetic fields are generated by the connection of coupling devices (antennas, clamps, CDN etc.) or by the injection on lines. The operator, persons in the vicinity and the environment must be protected by suitable measures, e.g. Faraday cage.

1.15. Warranty Terms

AMETEK CTS provides this written warranty covering the product stated above, and if the buyer discovers and notifies AMETEK CTS in writing of any defect in material or workmanship within the applicable warranty period stated above, then AMETEK CTS may, at its option: repair or replace the product; or issue a credit note for the defective product; or provide the buyer with replacement parts for the product.

The buyer will, at its expense, return the defective product or parts thereof to AMETEK CTS in accordance with the return procedure specified below. AMETEK CTS will, at its expense, deliver the repaired or replaced product or parts to the buyer. Any warranty of AMETEK CTS will not apply if the buyer is in default under the purchase order agreement or where the product or any part thereof:

- is damaged by misuse, accident, negligence or failure to maintain the same as specified or required by AMETEK CTS;
- is damaged by modifications, alterations or attachments thereto which are not authorized by AMETEK CTS;
- is installed or operated contrary to the instructions of AMETEK CTS;
- is opened, modified or disassembled in any way without AMETEK CTS's consent; or
- is used in combination with items, articles or materials not authorized by AMETEK CTS.

The buyer may not assert any claim that the products are not in conformity with any warranty until the buyer has made all payments to AMETEK CTS provided for in the purchase order agreement.

1.16. Prohibition of unauthorized conversions and modifications

The user is not entitled to the device to perform its own modifications and adaptations. Modifying parts on the generator by unauthorized persons will void the warranty of the device and the correct functioning cannot be guaranteed.

1.17. Specific accessories required for safety reason

Only use accessories approved by AMETEK CTS for these generators and intended as accessories for these devices. Measuring instruments for the measurement of instrument parameters shall be designed for the maximum voltage and current from the generator. Otherwise safety cannot be guaranteed.

1.18. Procedure in case of hazard

If a hazard could exist due to an unintended condition of the device, the following procedure is recommended: Disconnect the device- and EUT power supplies from the power supply and ensure that the device is always earthed via the supply lines or a different ground connection. Wait at least 15 minutes and ground all outputs via a 10 kΩ, 15 W resistor. Call an AMETEK service center.

2. UNPACKING, STORAGE AND TRANSPORT

2.1. General

Save all packing materials! They will be needed in order to safely package the equipment for calibration service or repair.

Packaging materials

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

▶ Avoid the risk of condensation!

If a large temperature difference has occurred, allow time for the temperature to stabilize. This may take several hours.

2.2. Storage and transport

- ▶ Do not stack, either packaged or unpacked.
- ▶ Do not stand on 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
- Open the packaging, remove the accessories.
- Grip the instrument at the sides and lift it from the packaging.
- Are the instrument or accessories damaged? If YES ☎ transportation company
- Are the contents of the package complete? If NO ☎ Teseq sales office
- Keep the instruction manual with the instrument.
- Keep the packaging.

2.4. Scope of delivery

- Monitoring device MD 4070A
- Remote cable LE 242
- Power supply unit PSU 6001 for countries: Euro, UK, US, JP, AUS
- Storage case
- Operating manual

Optional

- Traceable calibration (ISO17025), order only with device MD 4070
- Calibration jig PCJ 9201B
- FIX MD4070: Positioning fixture for MD 4070 in PCJ 9201

3. DESCRIPTION OF THE PRODUCT

3.1. General

The monitoring device MD 4070A can be used as an active or passive current sensor probe to measure the current in a conductor without connecting it directly. The MD 4070A allows fast and easy measurement as it can be quickly clamped around the current carrying conductor.

The MD 4070A is characterized over the frequency range from 4 kHz to 400 MHz. The frequency-dependent correction factor is used when calculating an unknown current I, from the measured output voltage Vo. Vo is measured across the load termination connected to the MD 4070A output. The correction factor is only valid if the load termination on the MD 4070A output is 50 Ω.

3.2. Construction of the product

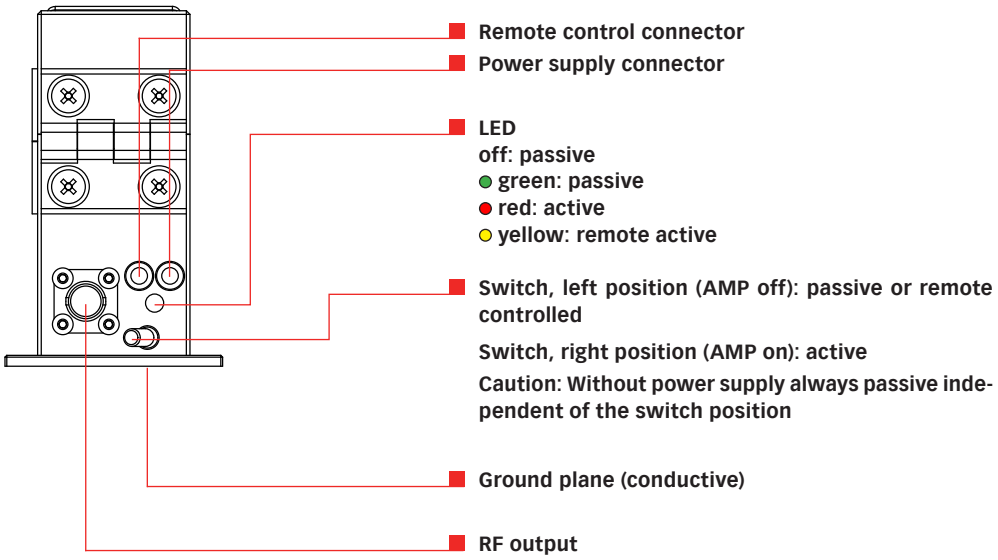


Figure 1: View to the connections (side view)

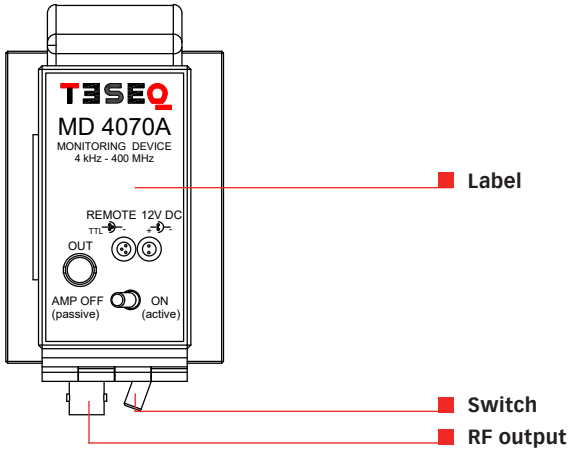
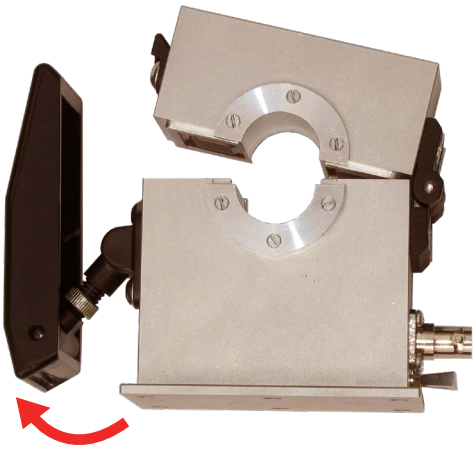


Figure 2: Top view with label (explanation of the connections and the switch positions)

Figure 3: MD 4070A

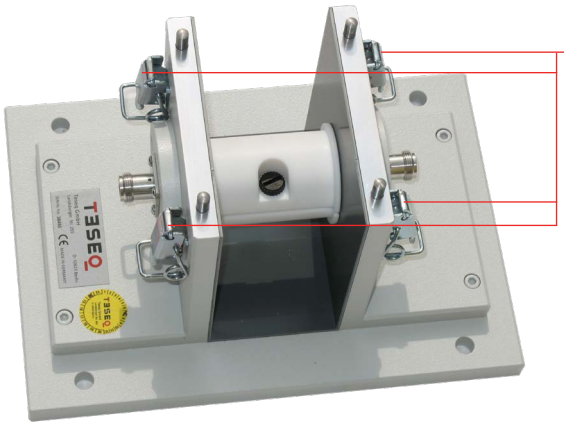
Figure 4: MD 4070A in suitcase with cable LE 242 and power supply unit PSU 6001



Opening of the clamp

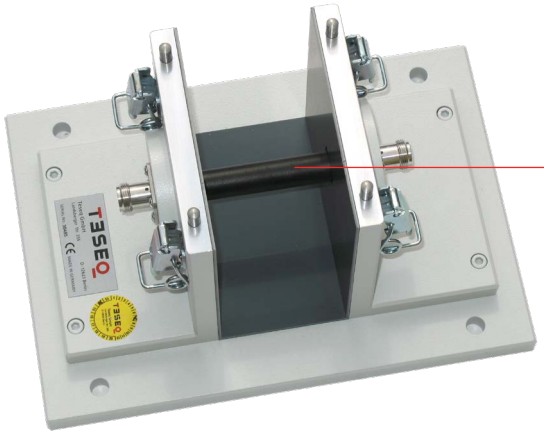
Figure 5: Side view

3.3. Positioning of MD 4070A in PCJ 9201



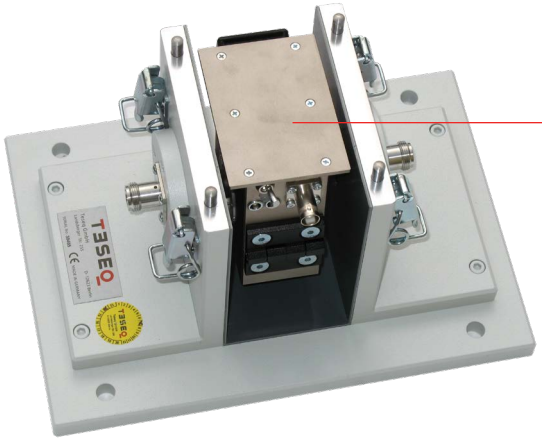
- Open all four fasteners and remove the top cover of the jig PCJ 9201

Figure 6: Step 1



- Remove the distance holder of the jig PCJ 9201 (White plastic part as shown in Figure 6. Only required for CIP 9136.)

Figure 7: Step 2



- Insert MD 4070A upside down in the jig

Figure 8: Step 3

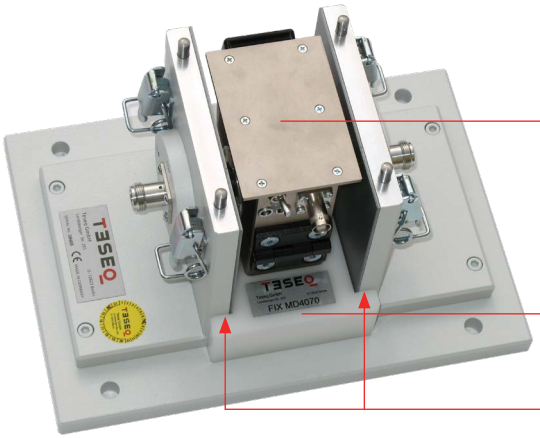


Figure 9: Step 4

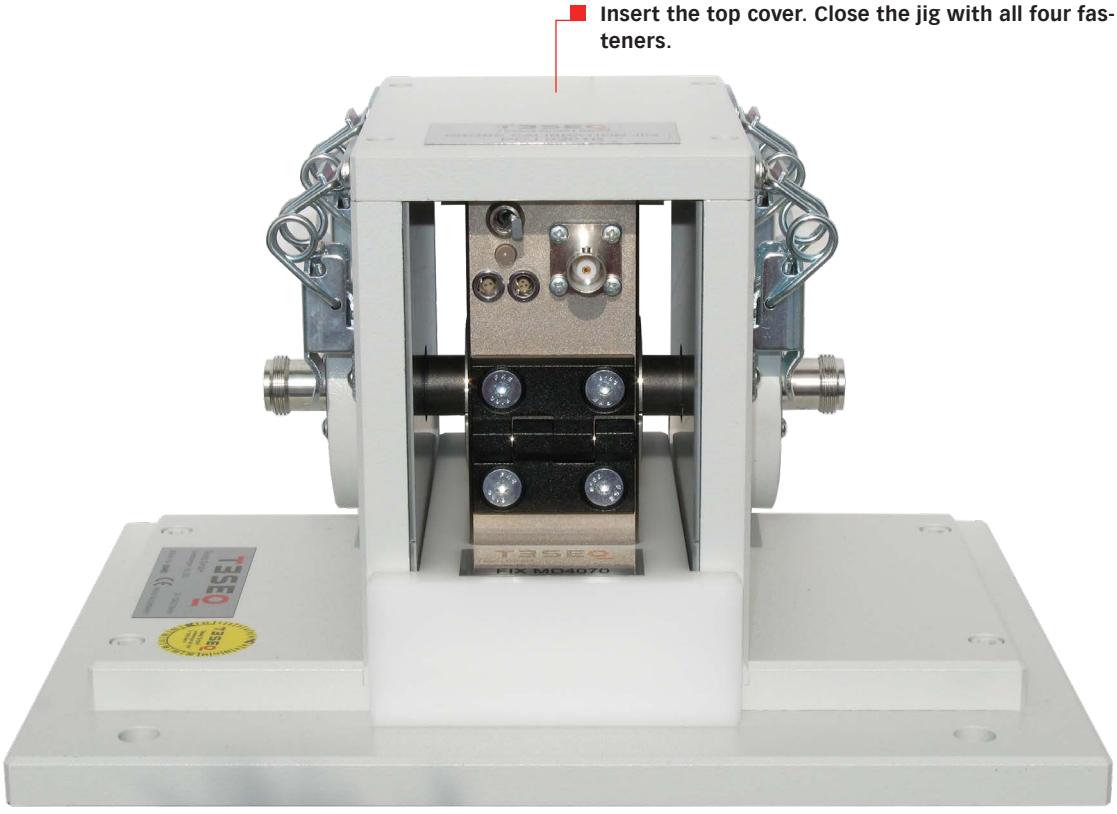


Figure 10: Step 5

4. APPLICATIONS

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

The MD 4070A can be used for the procedure for clamp injection when the common-mode impedance requirements cannot be met given in chapter 7.4 of IEC/EN 61000-4-6 „Immunity to conducted disturbances, induced by radio frequency fields". This requires an extra current probe inserted in between the injection clamp and the EUT. The current resulting from the induced voltage (stress level) shall be monitored. If the current exceeds the nominal circuit value, the stress level shall be reduced until the measured current is equal to the maximum given below.

I_{max} is the maximum current
U_0 is the stress level

Maximum current $$I_{max} = \frac{U_0}{150\ \Omega}$$

Test level in V_{EMF}	Maximum current I_{max} in mA	Measured power at 50 Ω in dBm if I_{max} is measured with MD 4070A (passive) and S21=-22 dB	Measured power at 50 Ω in dBm if I_{max} is measured with MD 4070A (active) and S21= +10 dB
1	6.667	-18.5*[1]	12.5
3	20	-9.0	22
10	66.667	1.5	(32.5)*[2]

*[1)] Value below the noise level of channel 1 of the NSG 4070 (applicable for NSG 4070A)
*[2)] Value above the max. level of the MD 4070A in the active mode. Value above the max. level of the power meter channel 1 of NSG 4070.

Table 1: Test level and maximum current

4.2. Application BCI testing

The MD 4070A can be used as current monitor for BCI testing.

The use of a current measurement probe is optional (ISO 11452-4) for the substitution method. The use of the probe can provide useful information during investigative work on the cause of events and the variances in test conditions after system modifications. Please note the monitoring probe may affect the injected current.

The use of a current measurement probe is mandatory for the closed loop method. The probe is needed to measure the induced current and allows the power limitation as may required from the standard.

4.3. Calibration of the monitoring device

The test generator shall be connected to one port of the 50 Ω calibration jig which is terminated with 50 Ω on the other side. The MD 4070A needs a connection to the power meter channel 1 of the NSG 4070. The following pictures provide set-up examples for the NSG 4070 with built-in power amplifier and with external power amplifier. The calibration has to be carried out in a 50 Ω calibration jig. The use of the 150 Ω to 50 Ω adapter is not allowed during the calibration of the monitoring device.

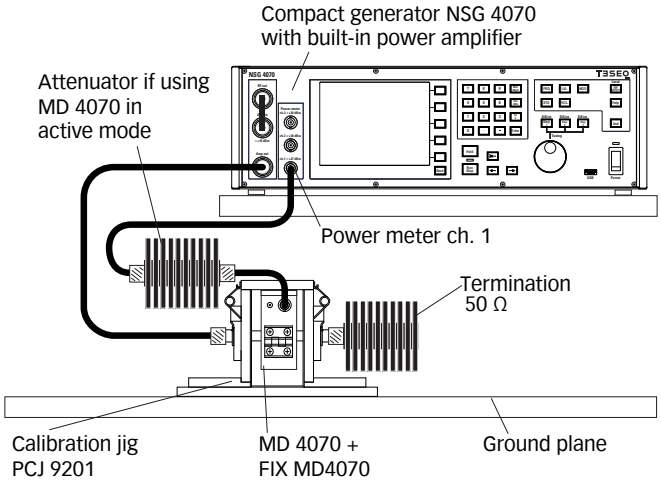


Figure 11: Set-up for calibration of the MD 4070A

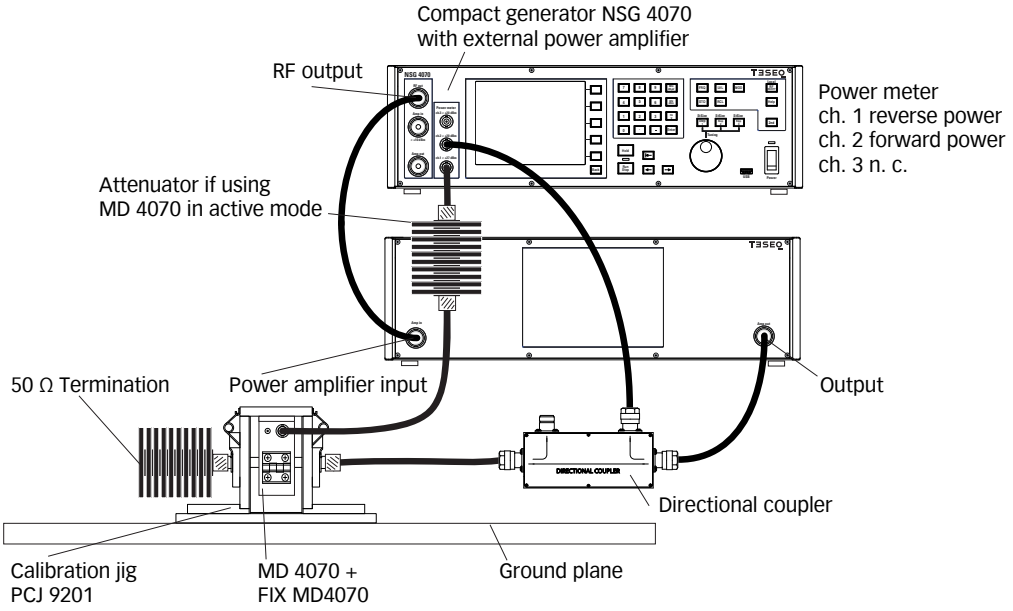


Figure 12: Set-up for calibration of the MD 4070A with NSG 4070 and external power amplifier

CAUTION: Using power amplifiers with more than 100 Watts requires to protect power meter channel 1 with an attenuator of at least 10 dB for example MD 4070A in active mode.

4.4. Test set-up with EUT

Next figures show a typical test set-up with EUT. Please note that a calibration of the test set-up and the monitoring device is required for the test.

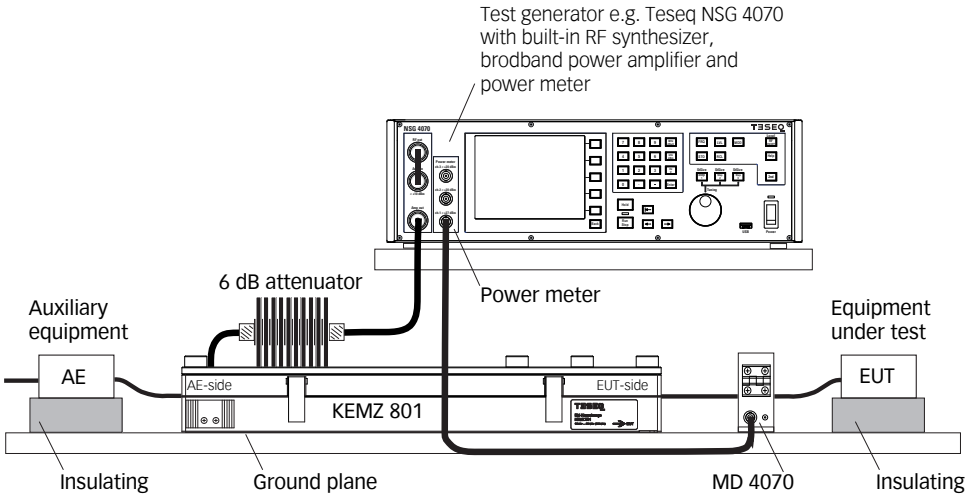


Figure 13: Test set-up example with EM-clamp and MD 4070A

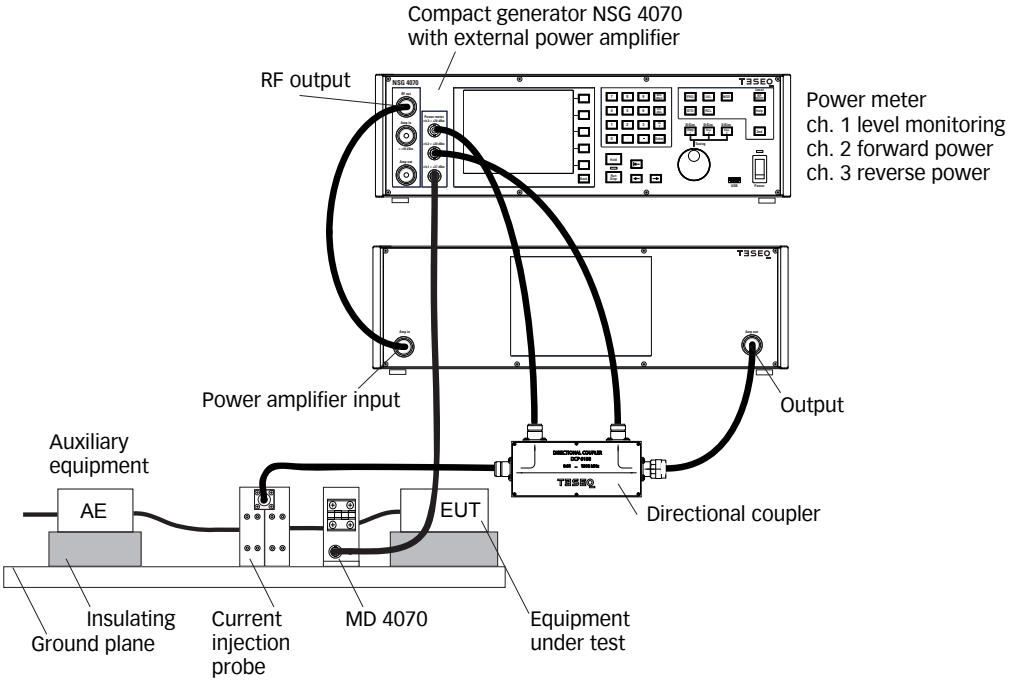


Figure 14: Test set-up example with current injection probe, MD 4070A and NSG 4070 with external power amplifier

4.5. Remote connection to NSG 4070

The user port interface of NSG 4070 allows the remote controlling of MD 4070A. The following figures show the required connections.

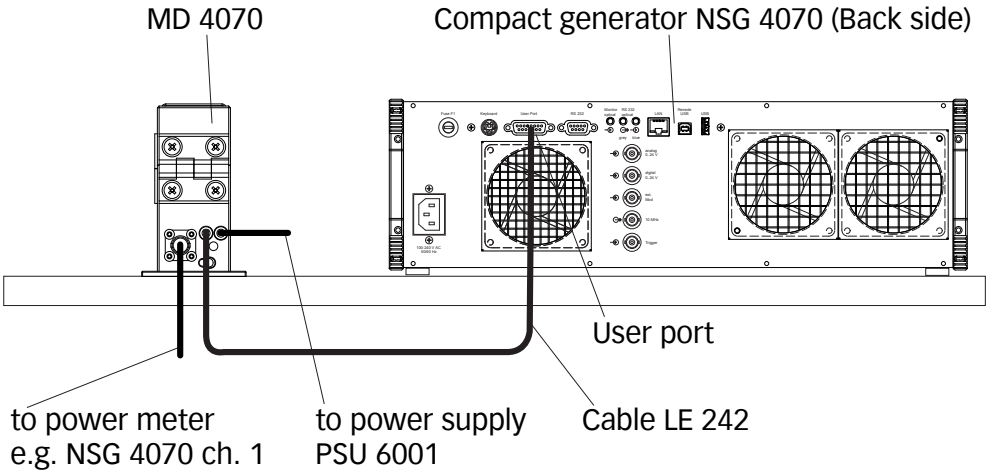


Figure 15: Remote connection to NSG 4070

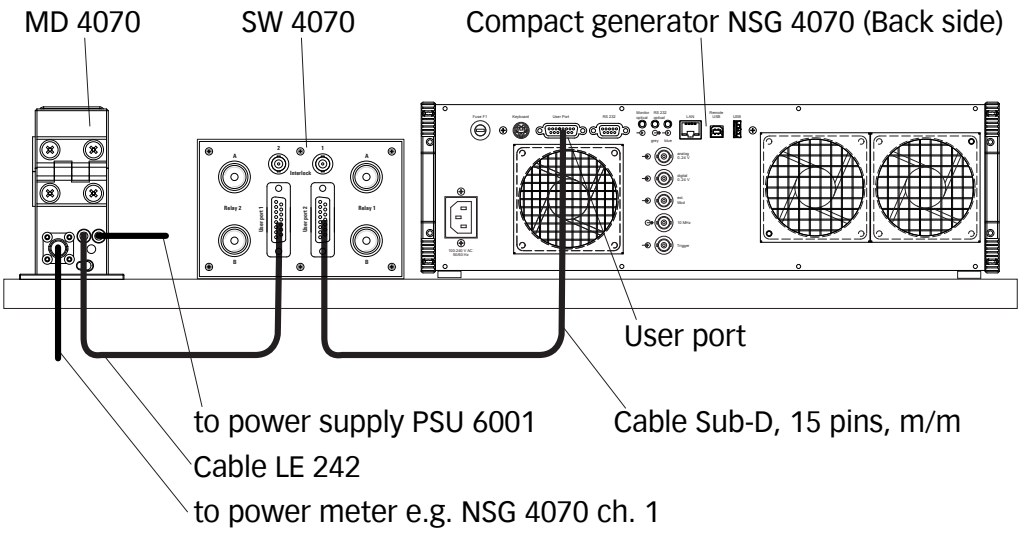


Figure 16: Remote connection to SW 4070 and NSG 4070

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.

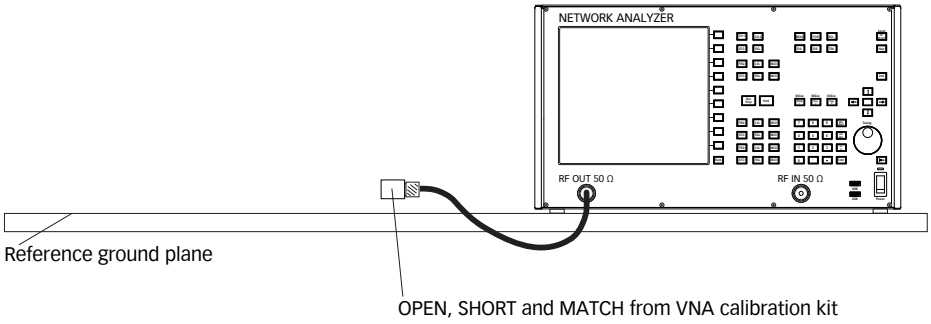


Figure 17: Port A: Calibration "open", "short" and "match"

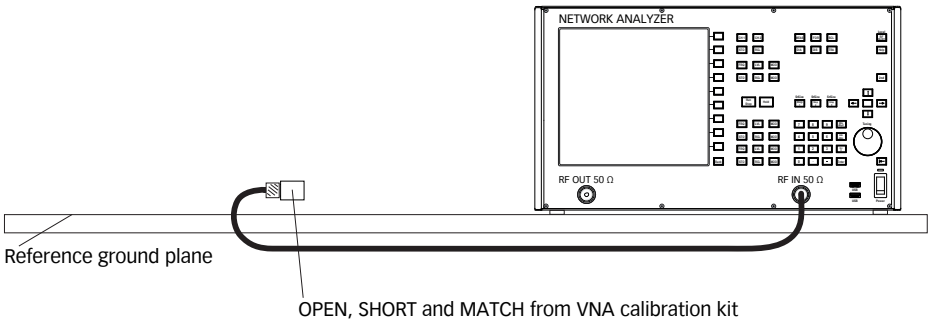


Figure 18: Port B: Calibration "open", "short" and "match"

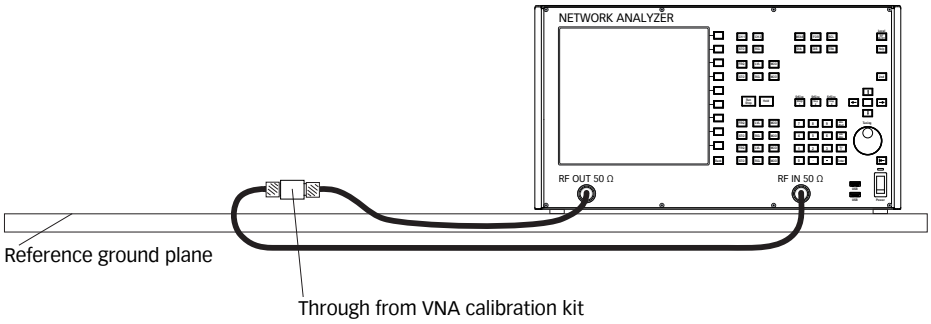


Figure 19: "Through" calibration

The MD 4070A needs to be turned with the unit's ground plane to the top and pressured by a non-conductive material that has a very low relative permittivity (e. g. Polystyrene polystyrene foam) against the top plate of the calibration fixture to establish a good electrical connection. The MD 4070A has to be placed in the horizontal 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 MD 4070A. The PCJ 9201 needs to be terminated with 50 Ω. The insertion loss measurement can now be performed in the active and passive mode of the MD 4070A.

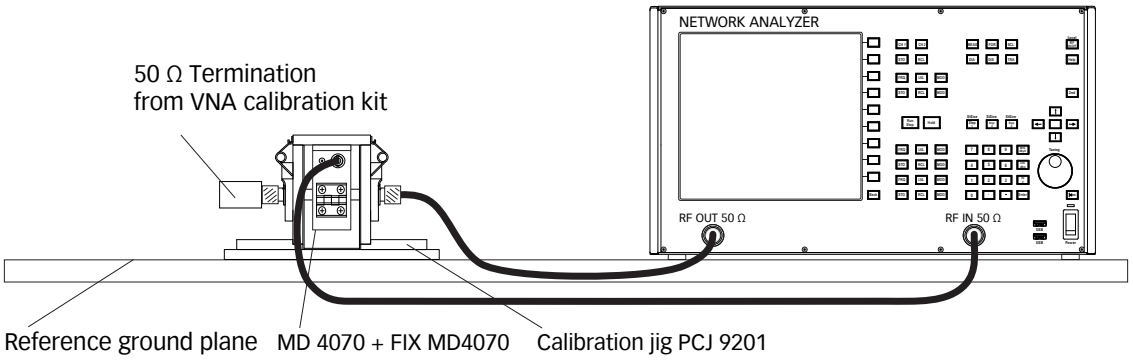


Figure 20: Insertion loss measurement

6. CORRECTION FACTOR AND CONVERSION

The operation with NSG 4070 and its included remote software requires no further consideration of the user. The firmware/software calculates the current based on the transmission S21 results measured during the probe calibration procedure in the active and passive mode of the probe.

Applications with MD 4070A and NSG 4070 or MD 4070A and other immunity systems with a test house software may require to use correction factors as described below.

Transfer impedance in Ω

The transfer impedance versus frequency allows the calculation of an unknown current in linear units using the following formula:

$I = V_0 / Z_t$ with I = current in A
with V_0 = voltage in V
with Z_t = transfer impedance in Ω

For example:
Voltage measured at 100 kHz = 13 mV
Transfer impedance at 100 kHz = 4.53 Ω
Current = 13 mV / 4.53 Ω = 2.87 mA

Relation of transmission factor S21, special example with transfer impedance of 1 Ω in a 50 Ω system:

$S21 = 20 * \log_{10} (1\ \Omega / 50\ \Omega) = -33.98$ dB
with S21 in dB
with Z_t = 1 Ω , Z_t = transfer impedance in Ω
with Z_0 = 50 Ω , Z_0 = system impedance in Ω

Relation transmission factor S21 and transfer impedance:

$Z_t = 10^{((S21+33.98)/20)}$
with S21 in dB
with Z_t = transfer impedance in Ω

Relation transmission factor S21 and insertion loss IL:

S21 = -IL
with S21 in dB
with IL in dB

Relation transmission factor S21 and correction factor k in dBS, dB1/Ω, dBµA/µV:

$k = -S21 + 20 * \log_{10} (1\ \Omega / 50\ \Omega)$
with S21 in dB

Correction factor in dBS, dB1/Ω, dBA/V

The correction factor is used when calculating an unknown current in the logarithmic scale. The following formula shows the relation.

$I = V_0 + k$ with I = current in dBA , dBµA, etc.
with V_0 = voltage in dBV, dBµV, etc.
with k = correction factor in dBS, dB1/Ω, dBµA/µV

For example:
Voltage measured at 100 kHz = 78 dBµV
Correction factor at 100 kHz = -13.13 dBS
Current = 78 dBµV -13.13 dBS = 64.87 dBµA

S21	Insertion loss	Transfer impedance	Correction factor	Transfer admittance	Correction factor
dB	dB	Ω	dBΩ	S, 1/Ω	dBS, dB1/Ω
14	-14	250	48	0.004	-48
0	0	50	34	0.02	-34
-14	14	10	20	0.1	-20
-20	20	5	14	0.2	-14
-34	34	1	0	1	0
-40	40	0.5	-6	2	6
-54	54	0.1	-20	10	20

Table 2: Conversion example in 50 Ω system

7. TECHNICAL SPECIFICATION

7.1. Electrical specification

7.1.1. Passive mode

Frequency range:	4 kHz to 400 MHz
Transmission S21:	typical -22 dB ±3 dB (50 Ω system, 100 kHz to 230 MHz)
Transfer impedance:	see graph for typical values
Signal output:	BNC socket
Max. signal current:	1 A

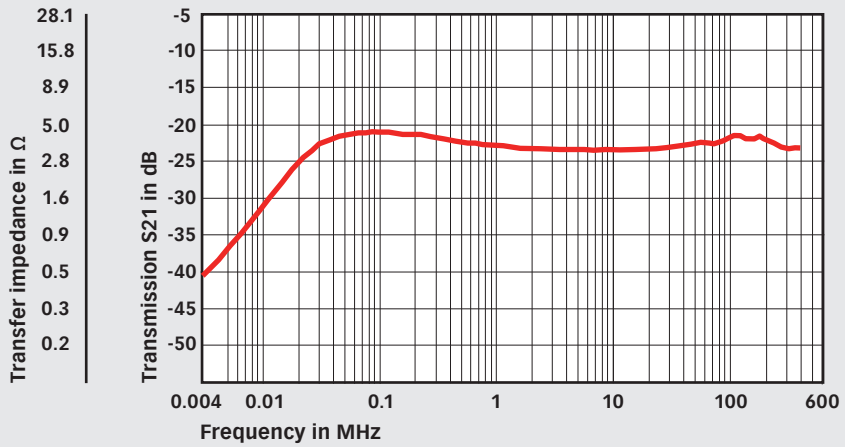


Figure 21: Passive mode: Typical transfer impedance and transmission S21

7.1.2. Active mode

Frequency range:	4 kHz to 400 MHz
Transmission S21:	typical +10 dB ±3 dB (50 Ω system, 100 kHz to 100 MHz)
Transfer impedance:	see graph for typical values
Max. signal current (linear):	30 mA
1 dB compression point (output):	>27 dBm
Supply voltage:	12 V
Supply current:	approx. 0.6 A
DC-connector:	ODU-female 2 pins, plus on all inner conductors

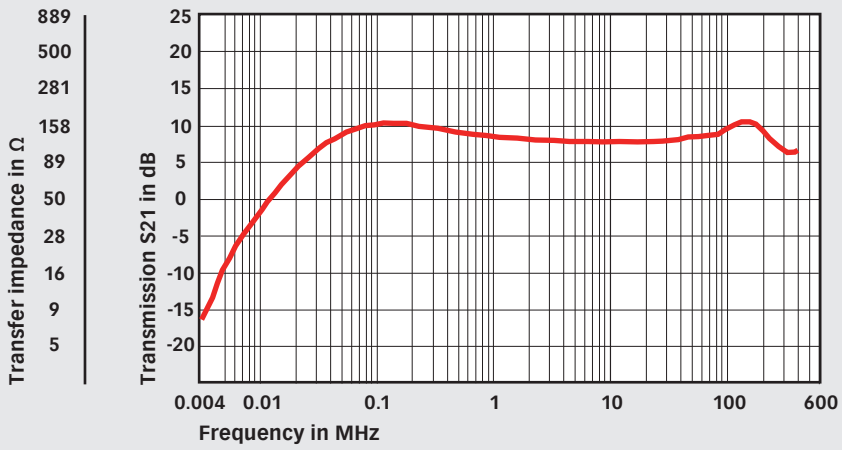


Figure 22: Active mode: Typical transfer impedance and transmission S21

7.2. Remote control

Level:	TTL up to 12 V (high = active, low = passive)
Switch:	passive (LED green)
DC-connector:	ODU-female 3 pins, plus on all inner conductors
Cable LE 242	
Purpose:	Connection to NSG 4070 user port, pin 9 (Digital out 3)
Connectors:	D-Sub 15 pins male, ODU-male 3 pins, plus on all inner conductors
Length:	approx. 1.5 m

7.3. Environmental conditions

Classification:	Indoor use only
Operating temperature:	0°C to +40 °C
Storage and transport temperature:	-10°C to +60 °C
Relative humidity:	up to 90% (no moisture condensation)

7.4. Mechanical specification of the probe

Size (W x H x D):	113 x 98 x 59 mm³
Free cable diameter:	23 mm
Weight:	approx. 830 g

7.5. Specification of the power supply unit PSU 6001

Country code for mains connector:	Euro, UK, US, JP, AUS
Input:	100 to 240 V, 47 to 63 Hz, 400 mA
Output:	12 V DC, 1.25 A
DC-connector:	ODU-male, 2 pins, plus on inner conductors
Cable length:	approx. 2 m
Weight:	approx. 220 g

8. MAINTENANCE

8.1. General
The MD 4070A including the accessories need 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. Teseq can replace the worn out connectors and offers a general adjustment of the MD 4070A with adapters which might be necessary.

No modifications are to be carried out on the MD 4070A and accessories by the user.
It is recommended to send the unit to a AMETEK CTS service centre once a year for recalibration.

8.2. 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

9. DISPOSAL

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

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