ROHDE&SCHWARZ

Test and Measurement
Division

**Manual**

# Passive Voltage Probe

# R&S ESH2-Z3

**299.7810.56**

# Attenuator

# R&S ESH2Z31

**827.6513.06**

Printed in the Federal
Republic of Germany

# Safety instructions on the use of Passive Voltage Probe ESH2-Z3

**The International Electrotechnical Commission (IEC) for measuring instruments has replaced the IEC348 standard by the more stringent IEC61010-1 standard. Due to this change, we see it necessary to draw your attention again to the following safety-relevant information:**

1. The new IEC61010-1 standard specifies overvoltages in four overvoltage classes according to the site of operation.
   Please note that the passive voltage probe has been exclusively designed and tested for use in power supply circuits of overvoltage class II only.
   (Networks/circuits of overvoltage class II are normally all circuits following power distributors located on floors or lines from main distributors which are more than 15 m away from the latter.)
2. Use the probe exclusively for measurements on networks fused with max. 16 A.
3. Passive Voltage Probe ESH2-Z3 includes the following safety measures:
   - Y capacitor (breakdown voltage 2.7 kV)
   - protective insulation of probe casing
   - guard collar of probe to provide protection against accidental slipping of operator's hand

   Prior to using the probe, check
   - whether the protective insulation around the probe is intact
   - whether the guard collar is rigidly fixed
   - whether the Y capacitor is intact: by measuring the DC resistance between the probe tip and the inner cable conductor to the test receiver; the DC resistance should be >1 MΩ.
   - whether the ground terminal is tightly screwed to the probe casing.
4. Make sure that the ground cable is always tightly screwed to the probe. Prior to connecting the probe to the AC supply, make a connection between the ground cable and the ground which is equivalent to a protective conductor connection. Another safety measure that can be taken to protect the user is to connect the probe to a test receiver which itself is linked to protective earth.
5. We strongly recommend to use an isolating device to ensure that prior to connecting the probe to the AC supply its power connector is free of voltage. This equally applies to disconnecting the probe from the AC supply.
6. Only skilled and qualified personnel shall use this probe in networks with voltages constituting a shock hazard.

# Contents

# Grouped Safety Messages

**Make sure to read through and observe the following safety instructions!**

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standard of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, the Rohde & Schwarz group of companies will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or, if expressly permitted, also in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.

## Symbols and safety labels

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| Observe product documentation | Weight indication for units >18 kg | Danger of electric shock | Warning! Hot surface | PE terminal | Ground | Ground terminal | Attention! Electrostatic sensitive devices |

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| Supply voltage ON/OFF | Standby indication | Direct current (DC) | Alternating current (AC) | Direct/alternating current (DC/AC) | Device fully protected by double/reinforced insulation |

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories.

## Tags and their meaning

| | |
|---|---|
| DANGER | DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury. |
| WARNING | WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. |
| CAUTION | CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. |
| NOTICE | NOTICE indicates a property damage message.<br>In the product documentation, the word ATTENTION is used synonymously. |

These tags are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the tags described here are always used only in connection with the related product documentation and the related product. The use of tags in connection with unrelated products or documentation can result in misinterpretation and thus contribute to personal injury or material damage.

## Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
   prescribed operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude 2000 m above sea level, max. transport altitude 4500 m above sea level.
   A tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.
2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the product must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test).
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens, e.g. nickel) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.
4. If products/components are mechanically and/or thermically processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled, e.g. for disposal purposes, by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

5. If handling the product yields hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation.
6. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer/operator is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.
7. Operating the products requires special training and intense concentration. Make certain that persons who use the products are physically, mentally and emotionally fit enough to handle operating the products; otherwise injuries or material damage may occur. It is the responsibility of the employer to select suitable personnel for operating the products.
8. Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
9. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with earthing contact and protective earth connection.
10. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
11. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.
12. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.
13. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
14. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, this can result in sparks, fire and/or injuries.
15. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
16. For measurements in circuits with voltages $V_{rms}$ > 30 V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
17. Ensure that the connections with information technology equipment comply with IEC 950/EN 60950.
18. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
19. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a license electrician.

20. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that suitable protection is provided for users and products.
21. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.
22. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.
23. Rohde & Schwarz products are not protected against penetration of liquids, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock for the user or damage to the product, which can also lead to personal injury.
24. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.
25. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.
26. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.
27. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. Do not short-circuit batteries and storage batteries.
    If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries must be recycled and kept separate from residual waste. Batteries and storage batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.
28. Please be aware that in the event of a fire, toxic substances (gases, liquids etc.) that may be hazardous to your health may escape from the product.
29. The product can be very heavy. Be careful when moving it to avoid back or other physical injuries.
30. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves).
31. Handles on the products are designed exclusively for personnel to hold or carry the product. It is therefore not permissible to use handles for fastening the product to or on means of transport such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport and for observing the safety regulations of the manufacturer of the means of transport. Noncompliance can result in personal injury or material damage.
32. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. The driver is always responsible for the safety of the vehicle. The manufacturer assumes no responsibility for accidents or collisions.
33. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the product documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.
34. Prior to cleaning, disconnect the product from the AC supply. Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluent for cellulose lacquers.

# Supplement to Data Sheet
# ESH2-Z3

In comparison to data sheet 756.4320.14, the following has changed:

**Specifications:**

Input impedance 1.5 kΩ ± 2 % || 6 pF

**Ordering information:**

| | | |
|---|---|---|
| Passive probe | ESH2-Z3 | 0299.7810.56 |

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 2002-15

This is to certify that:

| Equipment type | Stock No. | Designation |
|---|---|---|
| ESH2-Z3 | 0299.7810.54 /.56 | Passive Voltage Probe |
| ESH2-Z31 | 0827.6513.06 | Attenuator |

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN 61010-31 : 2002

Affixing the EC conformity mark as from 2002

**ROHDE & SCHWARZ GmbH & Co. KG**
**Mühldorfstr. 15, D-81671 München**

Munich, 2006-11-07

Central Quality Management MF-QZ / Radde

## Certified Quality System

# DIN EN ISO 9001 : 2000
# DIN EN 9100 : 2003
# DIN EN ISO 14001 : 2004

DQS REG. NO 001954 QM UM

## QUALITÄTSZERTIFIKAT

*Sehr geehrter Kunde,*
Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Managementsystems entwickelt, gefertigt und geprüft.
Das Rohde&Schwarz Managementsystem ist zertifiziert nach:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

## CERTIFICATE OF QUALITY

*Dear Customer,*
you have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde&Schwarz quality management system is certified according to:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

## CERTIFICAT DE QUALITÉ

*Cher Client,*
vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde&Schwarz a été homologué conformément aux normes:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

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# Customer Support

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For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

## Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish.
We will take care that you will get the right information.

## USA & Canada

Monday to Friday (except US public holidays)
8:00 AM – 8:00 PM Eastern Standard Time (EST)

| | |
|---|---|
| Tel. from USA | 888-test-rsa (888-837-8772) (opt 2) |
| From outside USA | +1 410 910 7800 (opt 2) |
| Fax | +1 410 910 7801 |
| E-mail | CustomerSupport@rohde-schwarz.com |

## East Asia

Monday to Friday (except Singaporean public holidays)
8:30 AM – 6:00 PM Singapore Time (SGT)

| | |
|---|---|
| Tel. | +65 6 513 0488 |
| Fax | +65 6 846 1090 |
| E-mail | CustomerSupport@rohde-schwarz.com |

## Rest of the World

Monday to Friday (except German public holidays)
08:00 – 17:00 Central European Time (CET)

| | |
|---|---|
| Tel. from Europe | +49 (0) 180 512 42 42* |
| From outside Europe | +49 89 4129 13776 |
| Fax | +49 (0) 89 41 29 637 78 |
| E-mail | CustomerSupport@rohde-schwarz.com |

* 0.14 €/Min within the German fixed-line telephone network, varying prices for the mobile telephone network and in different countries.

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1171.0200.22-02.00

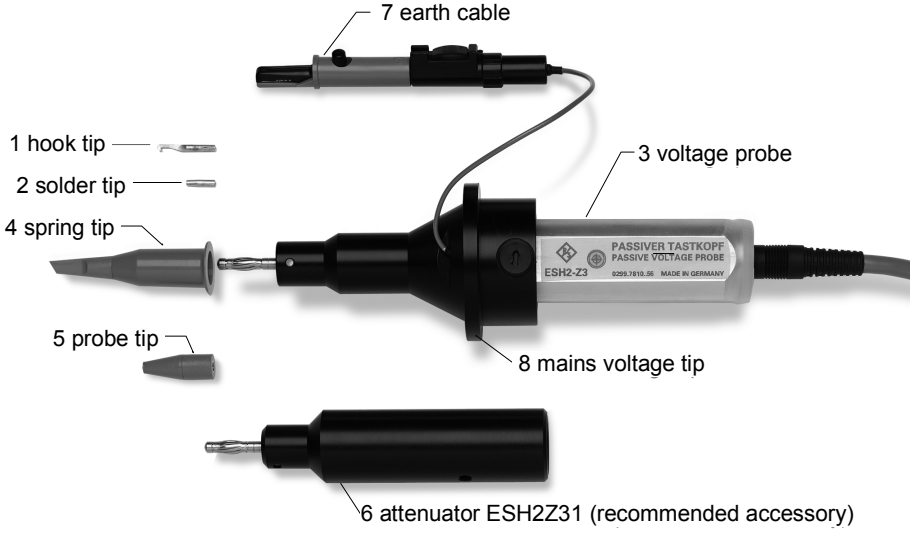
# 1 Preparation for Use and Operating Instructions

## Preparation for Use

Insert the BNC plug of the Passive Voltage Probe R&S ESH2-Z3 into the RF input socket of the test instrument. When using the an R&S Test Receiver, use the transducer table to enter the values of the voltage division factor and activate the transducer factor. This causes the level indicated on the receiver to increase by 30 dB corresponding to the voltage division factor (VDF) of the probe.

## Operating Instructions

When measurements are made on circuits carrying AC supply voltages, make sure that the mains voltage tip **8** (Order No.1156.5805.00) with the guard collar is plugged onto the probe. This is essential to prevent from accidental slipping of the operator's hand.
Take care to ground the associated test instrument to the AC supply earth or, if this cannot be done, ground the probe permanently to the protective earth (reference ground).
Depending on the measurement to be performed, the probe can be used with the following accessories:




For disturbance voltage measurements in the frequency range 9 kHz to 30 MHz ground connection of the probe is very important. It is to be established by connecting the earth cable **7** to the RF ground of the item under test.
In compliance with the CISPR Publication 16-2-1, the ground lead should have a length as short as possible (length of earth cable **7** 190 mm). A rather short ground connection always proves desirable, for otherwise this connection might pick up other disterbances, or testresults may be influenced by magnetic fields.

For measurements where the RF ground requires a longer ground lead, the length l of the lead must comply with CISPR Publication 16-2-1 i.e. it must be less than or equal to one tenth of the wavelength of the frequency to be measured. Such a ground lead can be connected to the probe by means of the earth cable **7** fitted with the banana plug (remove crocodile clamp).

# 2 Measurement

## Determining the Interference Source Impedance Zs

Generally, interference sources have low impedance so that measurements using the R&S ESH2-Z3 produce correct results. Though, the levels measured with an undefined source impedance may be incorrect. In order to determine the impedance Zs of the interference source, first measure the level without and then with attenuator **6** at a test frequency complying with CISPR Publication 16-2-1, Section 2.4.6.2 (see Fig. 1). Due to the different loading and voltage division of the probe with the same Zs a difference in indication A occurs. The interference source impedance Zs can be determined by means of this difference in indication A shown by curve A , Fig. 2. The difference in indication A is 6 dB with very low source impedances and approaches 0 dB with very high impedances.
The reduction in indication A can be computed from equation (1), the interference source impedance Zs from equation (2).

$$A = 20\log\frac{|Z_s| + 1500}{|Z_s| + 3000} \quad \text{in dB} \quad (1)$$

$$|Z_s| = \frac{3000 \cdot 10^{(A/20)} - 1500}{1 - 10^{(A/20)}} \quad \text{in } \Omega \quad (2)$$

## Measuring and Evaluating the Interference Level

Curve B in Fig. 2 gives the measurement error in dB with a defined interference source impedance Zs. In this case, the measurement carried out with the probe without attenuator **6** is referred to EMF and the readout on the test receiver is in dBµV. The corrected interference level (EMF) is obtained by adding the errors B (from curve B or from equation 3) to the indicated level.
The measurement error B is given by

$$B = 20\log\frac{|Z_s| + 1500}{1500} \quad \text{in dB} \quad (3)$$

Example: The interference level measured at the frequency f by means of the probe without attenuator is 44 dBµV while that measured with the attenuator is 39.7 dBµV.
The difference is 44 dB - 39.7 dB = 4.3 dB. The interference source impedance obtained from equation (2) is Zs = 841.6 Ω and the indication error B given by equation (3) is 3.9 dB. Hence, the corrected interference level is:

44 dBµV + 3.9 dB = 47.9 dBµV (EMF)

The reduction in indication A = 5 dB specified in CISPR Pubilcation 16-2-1, Section 2.4.6.2, corresponds to an interference source impedance of 427 Ω and thus results in an indication error of -2.17 dB.
Zs < 370 Ω in the test frequency range permits continuous measurements to be made with the maximum error of 2.2 dB.

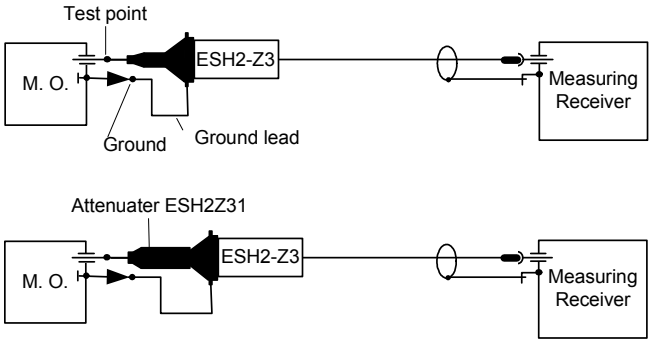
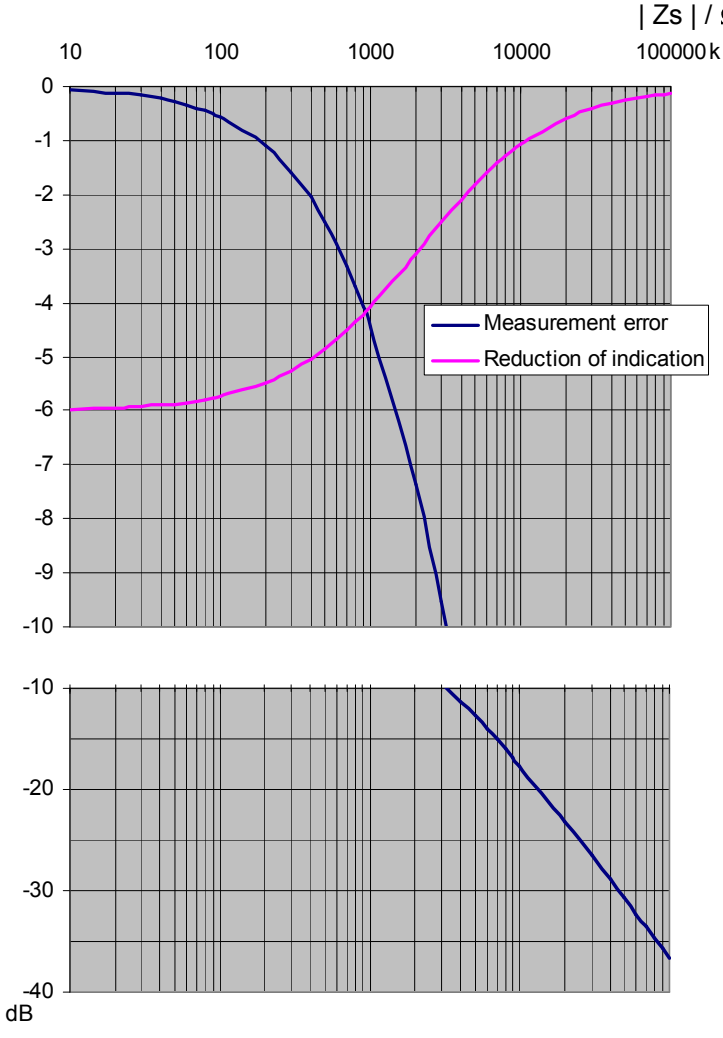



Fig. 1 Determination of interference source impedance $Z_S$



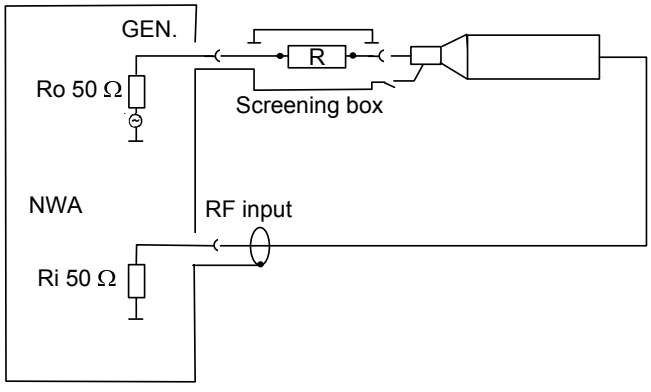

Measurement error: $$A = 20 \log \frac{|Z_s| + 1500}{|Z_s| + 3000} \quad \text{in dB} \quad (1)$$

Reduction of indication: $$|Z_s| = \frac{3000 \cdot 10^{(A/20)} - 1500}{1 - 10^{(A/20)}} \quad \text{in } \Omega \quad (2)$$

Fig. 2 Reduction of indication A and measurement error B as function of interference source impedance $Z_S$

# Practical Effects of the EUT Source Impedance on the measurement results with the Pasive Probe R&S ESH2-Z3 and R&S ESH2Z31

The test setup in **Fehler! Verweisquelle konnte nicht gefunden werden.** has been used to show the effects of the EUT source impedance on the measurement results with the Passive Voltage Probe ESH2-Z3 and Attenuator ESH2Z31.




Source impedance Zs = Rs
Rs = R + Ro
Ro = 50 Ω

Fig. 3 Test setup for the measurement of the measurement of the effect of the EUT source impedance on results. Screening box und mit “R” beschriften)

The results are shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**

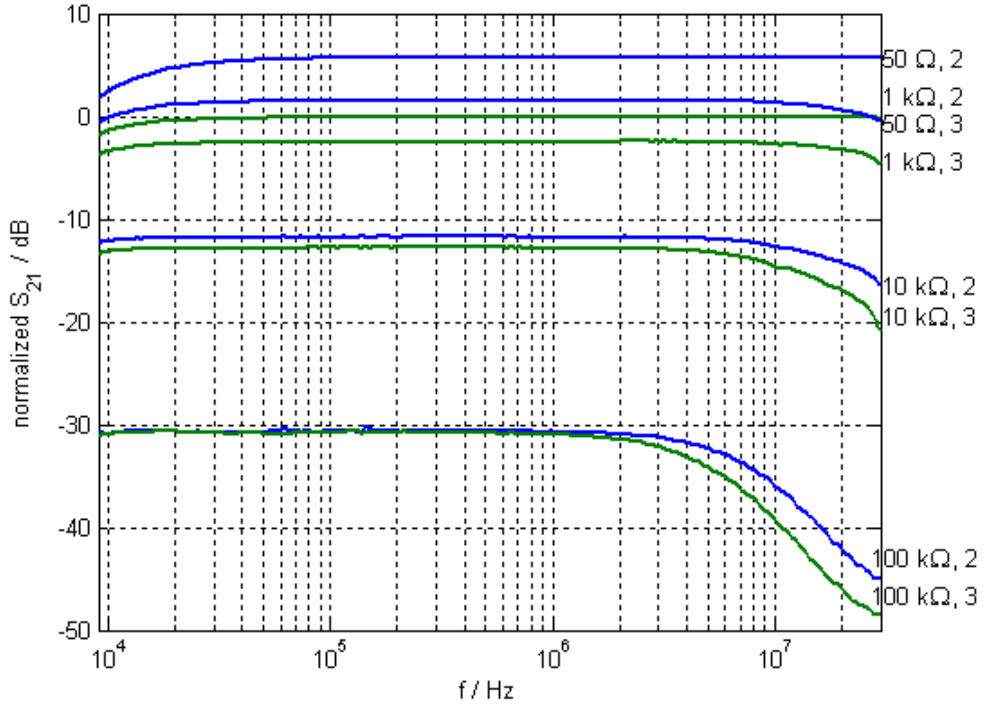



Fig. 4 Comparison of test results with R&S ESH2-Z3 (2) and R&S ESH2-Z3 + R&S ESH2Z31 (3)Maintenance

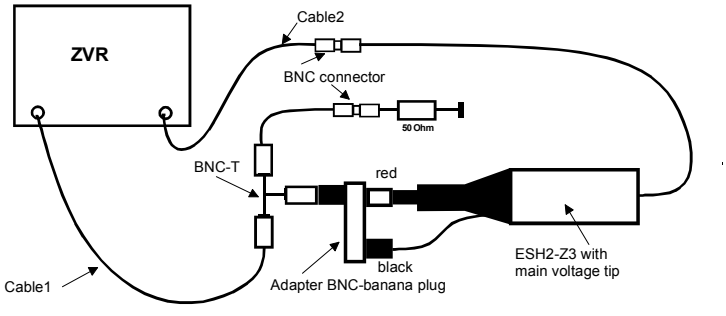
# 3 Required Measuring Equipment

| Item | Designation, required specifications Recommended R&S equipment | Type | Order No. |
|---|---|---|---|
| 1 | Network analyzer 9 kHz..100 MHz | R&S ZVR | 1127.8551.61 |
| 2 | Calibration kit | | |
| 3 | 2 x BNC measurement cable | | |
| 4 | 2 x BNC connector | | 0017.6559.00 |
| 5 | BNC-T connector | | 0017.6588.00 |
| 6 | Adapter BNC-banana plug | | 0017.6742.00 |

# Recalibration

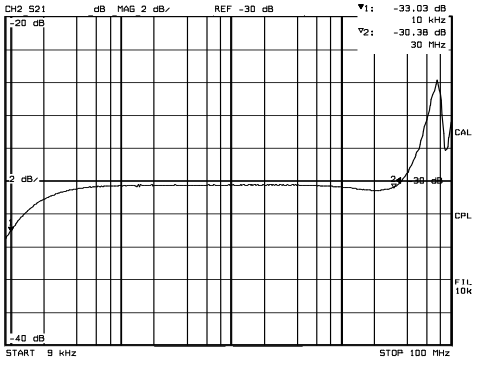
Recalibration of the Passive Voltage Probe R&S ESH2-Z3 is carried out by a two-port measurement using the test setup shown below.

*Test setup:*
Remove crocodile clamp from earth cable. So the banana plug can be put into the BNC-banana adapter.




*Measurement:*
feed through (S21) 9 kHz..30 MHz:..... -30 dB +1/-5 dB

Typical result of S21:



# 4 Circuit Description

## Electrical Function

(See circuit diagram 349.7099 S)

The Passive Probe is designed to comply with CISPR Publication 16-1-2 in conjunction with IEC 61010-1 and thus includes a Y-capacitor to decouple it from any AC supply voltages which may be present in the equipment under test.

The voltage attenuation is determined by the relation of R1 and R2 in parallel with Ri (Ri = 50 Ω receiver input impedance). For high-precision measurements, the RF input attenuation of the receiver should be >10 dB. The typical additional error resulting from the deviation of the receiver input impedance with the RF attenuation switched off is less than 1.5 dB. The frequency response is flat up to 30 MHz due to the probe tip capacitance to ground and the capacitance of the RF cable having a defined length. Therefore, type and length of the RF cable must not be changed.

The attenuator contains a 1470 Ω resistor which is provided to double the probe input impedance.