ROHDE&SCHWARZ
Instruments
Division

Operating Manual

POWER METER
NRVS

1020.1809.02

Printed in the Federal
Republic of Germany

Tabbed Divider Overview

Contents

Data Sheets

Safety Instructions
Certificate of quality
EC Certificate of Conformity
List of R & S Representatives

Tabbed Divider

Contents

Page

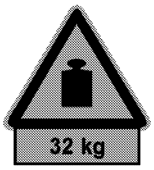
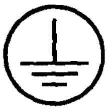
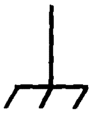
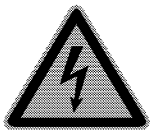
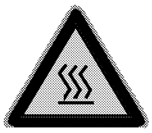
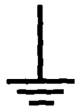
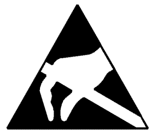
Page

Safety Instructions

This unit 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, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

							
Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.
2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).
3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.
4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.
5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.
6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.
7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.
8. If the unit 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 (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.
9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.
15. Any additional safety instructions given in this manual are also to be observed.

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

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 Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

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 ISO 9001.

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 à la norme ISO 9001.

095.1000 Bl. 0-0796

ROHDE&SCHWARZ

ROHDE&SCHWARZ
EC Certificate of Conformity

CE

Certificate No.: 9502203

This is to certify that:

Equipment type	Order No.	Designation
NRVS	1020.1809.02	Single Channel Power Meter
NRVS-B1	1029.2908.02	Sensor Check Source

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)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

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

Munich, 13.12.95

Central Quality Management FS-QZ / Becker

Support Center

Telefon / Telephone: (0180) 512 42 42

Fax: (++89) 41 29 - 137 77

e-mail: CustomerSupport@rsd.rohde-schwarz.com

Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen ab sofort unsere Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder e-mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Möchten Sie über Neuerungen und Updates zu einem bestimmten Gerät informiert werden, senden Sie bitte eine kurze e-mail unter Angabe des Gerätes. Sie erhalten dann regelmäßig die aktuellen Informationen zugesandt.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

If you wish to receive the latest news about and updates for a specific instrument, please send us a short e-mail indicating the instrument. We will then send you up-to-date information on a regular basis.

ROHDE&SCHWARZ

Adressen/Addresses

FIRMENSITZ/HEADQUARTERS — Telefon/Phone · Telefax · E-mail

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstraße 15 · 81671 München — +49 89 41 29- 0
Postfach 801469 · 81614 München — +49 89 41 29- 12164
Internet: www.rohde-schwarz.com — –

WERKE/PLANTS

ROHDE & SCHWARZ Messgerätebau GmbH — +49 83 31 10 8-0
Riedbachstraße 58 · 87700 Memmingen — +49 83 31 10 81 124
Postfach 16 52 · 87686 Memmingen — –

ROHDE & SCHWARZ GmbH & Co. KG
Werk Teisnach — +49 99 23 8 57-0
Kaikenrieder Straße 27 · 94244 Teisnach — +49 99 23 8 571-1 74
Postfach 11 49 · 94240 Teisnach — –

ROHDE & SCHWARZ GmbH & Co. KG · Werk Köln — +49 22 03 49-0
Graf-Zeppelin-Straße 18 · 51147 Köln — +49 22 03 49-51 3 08
Postfach 98 02 60 · 51130 Köln — –

TOCHTERUNTERNEHMEN/SUBSIDIARIES

ROHDE & SCHWARZ Vertriebs-GmbH — +49 89 4129-120 07
Mühldorfstraße 15 · 81671 München — +49 89 4129-135 67
Postfach 801469 · 81614 München — customersupport@rohde-schwarz.com

ROHDE & SCHWARZ International GmbH — +49 89 4129-120 05
Mühldorfstraße 15 · 81671 München — +49 89 4129-135 97
Postfach 80 14 60 · 81614 München — –

ROHDE & SCHWARZ Engineering and Sales GmbH — +49 89 4129-137 11
Mühldorfstraße 15 · 81671 München — +49 89 4129-137 23
Postfach 80 14 29 · 81614 München — –

R&S BICK Mobilfunk GmbH — +49 50 42 9 98-0
Im Landerfeld 7 · 31848 Bad Münder — +49 50 42 9 98-105
Postfach 20 62 · 31844 Bad Münder — rsbick@rsbick.rohde-schwarz.com

ROHDE & SCHWARZ FTK GmbH — +49 30 6 58 91-122
Wendenschloßstraße 168, Haus 28 — +49 30 65 550-221
12557 Berlin — –

SIT Gesellschaft für Systeme
der Informationstechnik mbH — +49 30 6 58 84-2 22
Wendenschloßstraße 168, Haus 28 — +49 30 6 58 84-1 83
12557 Berlin — sit.info@sit.rohde-schwarz.com

Zweigniederlassungen der Rohde & Schwarz Vertriebs-GmbH/Branch offices of Rohde & Schwarz Vertriebs-GmbH

Zweigniederlassung Berlin — (+49 30) 34 79 48-0
Ernst-Reuter-Platz 10 · 10587 Berlin — (+49 30) 34 79 48-48
Postfach 100620 · 10566 Berlin — customersupport@rohde-schwarz.com

Zweigniederlassung Büro Bonn — (+49 2 28) 918 90-0
Josef-Wirmer-Straße 1–3 · 53123 Bonn — (+49 2 28) 25 50 87
Postfach 140264 · 53057 Bonn — customersupport@rohde-schwarz.com

Zweigniederlassung Hamburg — (+49 40) 63 29 00-0
Steilshooper Allee 47 · 22309 Hamburg — (+49 40) 630 78 70
Postfach 602240 · 22232 Hamburg — customersupport@rohde-schwarz.com

Zweigniederlassung Köln — (+49 22 03) 807-0
Graf-Zeppelin-Straße 18 · 51147 Köln — (+49 22 03) 807-50
Postfach 900149 · 51111 Köln — customersupport@rohde-schwarz.com

Zweigniederlassung Mitte — (+49 61 02) 20 07-0
Siemensstraße 20 — (+49 61 02) 80 00 40
63263 Neu-Isenburg — customersupport@rohde-schwarz.com

Zweigniederlassung München — (+49 89) 41 86 95-0
Mühldorfstraße 15 · 81671 München — (+49 89) 40 47 64
Postfach 801449 · 81614 München — customersupport@rohde-schwarz.com

Zweigniederlassung Nürnberg — (+49 9 11) 64203-0
Donaustraße 36 — (+49 9 11) 64203-33
90451 Nürnberg — customersupport@rohde-schwarz.com

Zweigniederlassung Telekommunikation — (+49 61 02) 20 07-0
Siemensstraße 20 — (+49 61 02) 20 07-12
63263 Neu-Isenburg — customersupport@rohde-schwarz.com

ADRESSEN WELTWEIT/ADDRESSES WORLDWIDE

Algeria	ROHDE & SCHWARZ Bureau d'Alger 5 B, Place de Laperrine 16035 Hydra-Alger	(2) 59 24 53 (2) 69 46 08 –
Argentina	Precisión Electrónica SRL Av. Julio A. Roca 710 - Piso 6 1067 Buenos Aires	(14) 331 16 85 (14) 334 51 11 preelctr@satlink.com
Australia	ROHDE & SCHWARZ (AUSTRALIA) Pty. Ltd. Unit 6, 2-8 South Street Rydalmere, N.S.W. 2116	Sales (2) 8845 4100 (2) 9738 3988 Service (2) 8845 4188 (2) 9638 0832 sales@rsaus.rohde-schwarz.com service@rsaus. rohde-schwarz.com
Austria	ROHDE & SCHWARZ-ÖSTERREICH Ges. m. b. H. Sonnleithnergasse 20 1100 Wien	(1) 6 02 61 41 (1) 6 02 61 41-14 office@rsoe.rohde-schwarz.com
Azerbaijan	ROHDE & SCHWARZ Azerbaijan Liaison Office Baku Azerbaijan Avenue 35 370139 Baku	12 93 31 38 12 93 03 14 –
Baltic Countries	siehe/see Denmark	
Bangladesh	Business International Ltd. Corporation Office House No: 95/A, Block -'F' Road No: 4, Banani Dhaka - 1213	(2) 881 06 53 (2) 882 82 91 –
Belgium	ROHDE & SCHWARZ BELGIUM N.V. Excelsiorlaan 31 Bus 1 1930 Zaventem	(2) 7 21 50 02 (2) 7 25 09 36 info@rsb.rohde-schwarz.com
Bolivia	siehe auch/see also Argentina RIBCO LTDA. Av. Mariscal Santa Cruz 1392 Ed. Cámara Nacional de Comercio Piso 10, Of.1010-1011 La Paz	 (2) 32 84 03 (2) 39 30 47 gibatta@caoba.entelnet.bo
Brazil	ROHDE & SCHWARZ DO BRASIL LTDA. Av. Alfredo Egidio de Souza Aranha, 177 1° andar - Santo Amaro 04726-170 São Paulo- SP	 (11) 56 41 12 00 (11) 56 41 78 10

Adressen/Addresses

Brunei
GKL Equipment PTE. Ltd. 276 06 26
#11-01 BP Tower 276 06 29
396, Alexandra Road gkleqpt@signet.com.sg
Singapore 119954
Republic of Singapore

Bulgaria
ROHDE & SCHWARZ (2) 963 43 34
Representation Office Bulgaria (2) 963 21 97
39, Fridtjof Nansen Blvd. rohdebg@rsoe.com
1000 Sofia

Canada
Kommunikationstechnik/Communications Equipment:
ROHDE & SCHWARZ CANADA Inc. (613) 592 80 00
555 March Rd. (613) 592 80 09
Kanata, Ontario K2K 2M5 –

Messtechnik/T & M Equipment:
TEKTRONIX CANADA, Inc. (416) 747 50 00
3280 Langstaff Road, Unit 1 (905) 760 72 41
Concord, Ontario L4K 5B6 –

Chile
DYMEQ Ltda. (2) 277 50 50
Avenida Larraín 6666 (2) 227 87 75
Santiago dymeq@entelchile.net

China
ROHDE & SCHWARZ (10) 64 31 28 28
Representative Office Beijing (10) 64 37 98 88
Parkview Center, Room 602 –
No. 2 Jiangtai Road,
Chao Yang District
Beijing 100016, P. R. China

Colombia
Ferrostaal de Colombia (1) 415 77 00
Av. Eldorado Nro. 97-03 Interior 2 (1) 413 18 06
Santafé de Bogotá, D.C. mc_fsc@multiphone.net.co

Costa Rica
siehe/see Mexico (EPSA)

Croatia
siehe/see Austria

Republic of Cyprus
HINIS TELECAST LTD. (4) 42 51 78
Agiou Thoma 18 (4) 42 46 21
Kiti
Larnaca 7550

Czech Republic
ROHDE & SCHWARZ – Praha, s.r.o. (2) 24 32 20 14
Pod Kastany 3 (2) 24 31 70 43
160 00 Praha 6 rohdecz@rsoe.com

Denmark
ROHDE & SCHWARZ DANMARK A/S 43 43 66 99
Ejby Industrivej 40 43 43 77 44
2600 Glostrup RSDK@post1.tele.dk

Ecuador
REPRESENTACIONES (2) 25 22 51
MANFRED WEINZIERL (2) 25 22 51
Guanguiltagua 72 (39-93) mweinzierl@accessinter.net
Urbanización Jardines del Batán
Quito

Egypt
U.A.S. Universal Advanced Systems (202) 455 67 44
31 Manshiet El Bakry St., Heliopolis (202) 256 17 40
11341 Cairo uas@intouch.com

El Salvador
siehe/see Mexico (EPSA)

Estonia
ROHDE & SCHWARZ DANMARK A/S (6) 14 31 20
Estonian Branch Office (6) 14 31 21
Narva mnt. 13
10151 Tallinn

Finland
Orbis Oy (9) 47 88 30
P.O. B. 15 (9) 53 16 04
00421 Helsinki info@orbis.fi

France
ROHDE & SCHWARZ FRANCE (1) 41 36 10 00
Immeuble "Le Newton" (1) 41 36 11 10
9-11, rue Jeanne Braconnier –
92366 Meudon-la-Forêt Cédex

Niederlassung/Subsidiary Rennes:
ROHDE & SCHWARZ FRANCE (2) 99 51 97 00
Sigma 1 (2) 99 41 91 31
Rue du Bignon –
35135 Chantepie

Niederlassung/Subsidiary Toulouse:
ROHDE & SCHWARZ FRANCE (5) 61 39 10 69
Technoparc 3 (5) 61 39 99 10
B.P.501 –
31674 Labège Cédex
Büros/Offices:
Aix-en-Provence (4) 94 07 39 94
(4) 94 07 55 11
Lyon (4) 78 29 88 10
(4) 78 29 94 71
Nancy (3) 83 54 51 29
(3) 83 55 39 51

Ghana
KOP Engineering Ltd. (21) 77 99 13
P.O. Box 11012 (21) 22 47 69
3rd Floor Akai House, Osu
Accra

Greece
MERCURY SA. (1) 722 92 13
6, Loukianou Str. (1) 721 51 98
10675 Athens mercury@hol.gr

Guatemala
siehe/see Mexico (EPSA)

Honduras
siehe/see Mexico (EPSA)

Hong Kong
Schmidt & Co. (HK) Ltd. 25 07 03 33
9/F North Somerset House 28 27 56 56
Taikoo Place frankwong@shk.schmidtgroup.com
979 King's Road
Quarry Bay, Hong Kong

Hungary
ROHDE & SCHWARZ (1) 203 02 82
Budapesti Iroda (1) 203 02 82
Etele ut. 68 rohdehu@rsoe.com
1115 Budapest

Iceland
siehe/see Denmark

India
ROHDE & SCHWARZ (11) 683 74 84
India Pvt. Ltd.
244, Okhla Industrial Estate rsindiad@vsnl.com
Phase - III
New Delhi 110 020

Indonesia
P.T. REKANUSA SOLUSI (21) 576 16 02
Menara Rajawali, (21) 576 16 04
24th floor –
Jl Mega Kuningan Lot # 5.1
Kawasan Mega Kuningan
Jakarta 12950

Iran
ROHDE & SCHWARZ IRAN (21) 8 73 02 82
Liaison Office - Reg. N° RFC 1947 (21) 8 73 02 83
Dr. Beheschty Ave., Pakistan Ave., –
12th Street N° 1
Tehran 15317

Adressen/Addresses

Ireland	siehe/see Great Britain	
Italy	ROHDE & SCHWARZ ITALIA S.p.a. Via Tiburtina 1182 00156 Roma	(6) 41 59 81 (6) 41 59 82 70 –
	Centro Direzionale Lombardo Via Roma 108 20060 Cassina de´ Pecchi (MI)	(2) 95 70 41 (2) 95 30 27 72
Japan	ADVANTEST Corporation RS Sales Department Shinjuku-NS Building, 4-1 Nishi-Shinjuku Tokyo 163-08, Japan	(3) 33 42 75 53 (3) 53 22 72 70 yoshimu@inst.advantest.co.jp
Jordan	Middle East Development c/o Jordan Crown Engineering & Trading Co. P.O. Box 830414 Amman, 11183	(6) 465 96 71 (6) 465 96 72
Kazakhstan	ROHDE & SCHWARZ Kazakhstan Liaison Office Almaty Pl. Respubliki 15 480013 Almaty	32 72 63 55 55 32 72 63 46 33 –
Kenya	Excel Enterprises Limited Dunga Road P.O. Box 42 788 Nairobi	(2) 55 80 88 (2) 54 46 79
Korea	Hana Technica Corp. Seoul Kangnam, P.O. Box 1458 Young Dong Bldg. 4F 63-16 Nonhyun-Dong, Kang Nam-Ku Seoul	(2) 514 45 46 (2) 514 45 49 hanateco@unitel.co.kr
Kuwait	Group Five Trading & Contracting Co. P.O. Box 26645 Safat 13127 State of Kuwait	244 91 72 244 95 28
Latvia	Rohde & Schwarz Danmark A/S Latvian Branch Office Merkela iela 21-301 1050 Riga	(7) 50 23 55 (7) 50 23 60 rsdk@rsdk.rohde-schwarz.com
Lebanon	Rohde & Schwarz International Liaison Office Riyadh PO Box 361 c/o Haji Abdullah Alireza & Co. Riyadh 11411 – KSA	(1) 465 64 28 Ext. 303 (1) 465 64 28 Ext. 229
Liechtenstein	siehe/see Switzerland	
Lithuania	Rohde & Schwarz Danmark A/S Lithuanian Office Lukiskiu 5-228 2600 Vilnius	222 46 62 222 46 62
Luxembourg	siehe/see Belgium	
Malaysia	DAGANG TEKNIK SDN. BHD. No. 9, Jalan SS 4D/2 Taman People´s Park 47301 Petaling Jaya Selangor Darul Ehsan	(3) 7035503/7035568 (3) 7 03 34 39 danik@tm.net.my
Malta	ITEC – International Technology Ltd. B'Kara Road San Gwann	37 43 00 37 43 53 itec@keyworld.net
Mexico	Vertrieb Kommunikationstechnik/ Sales of Communications Equipment: ELECTROINGENIERIA de Precisión S.A. (EPSA) Uxmal 520 Colonia Vertiz Narvarte 03600 Mexico DF	 (5) 559 76 77 (5) 575 33 81 epsa@compuserve.com
	Vertrieb Messtechnik/Sales of T&M Equipment: Tektronix S.A. de C.V. Periférico Sur 5000, 8° Piso Col. Insurgentes Cuicuilco Del. Coyoacán 04530 Mexico, D.F.	 (5) 666 63 33 (5) 666 63 36
Nepal	Abishek Trade Links (P) Ltd. P.O.B. 9700 Kathmandu	(1) 25 69 30 (1) 24 25 73 Durbar@hotel.mos.com.np
Netherlands	ROHDE & SCHWARZ NEDERLAND B.V. Perkinsbaan 1 3439 ND Nieuwegein	(30) 600 17 00 (30) 600 17 99 Rob.DenHartog@rsn.rohde-schwarz.com
New Zealand	Nichecom Level 1 Tawa Plaza 210 Main Rd / P.O.B. 56-045 Tawa, Wellington	(4) 232 32 33 (4) 232 32 30 ISDN (4) 237 30 10 robin.hodgson@nichecom.co.nz
Nicaragua	siehe/see Mexico (EPSA)	
Nigeria	Ferrostaal (Nigeria) Ltd. 27/29 Adeyemo Alkaija Street P.O. Box 72021 Victoria Island Lagos	(1) 262 00 60 (1) 262 00 64
Norway	ROHDE & SCHWARZ NORGE Østensjøveien 36, P.O.B. 103 BRYN 0611 Oslo	23 17 22 50 23 17 22 69 –
Oman	T&M Equipment and Broadcasting: Mustafa & Jawad Science & Industry Co. Ltd. P.O. Box 3340 Post Code 112 Ruwi Sultanate of Oman	 60 20 09 60 70 66
Pakistan	TelcoNet Communications & Engineering 213/D, Ordnance Road Rawalpindi-Pakistan-46000	(51) 26 30 72 (51) 26 32 11 tnc@meganet.com.pk
Panama	siehe auch/see also Mexico (EPSA)	
	ELECTRONICO BALBOA S.A. Av. El Paical, Edif. El Dorado Urb. Los Angeles Panama City	614 93 64 236 18 20 pdubois@ebsa.com
Papua-New Guinea	siehe/see Australia	
Peru	siehe auch/see also Argentina	
	BMP INGENIEROS S.A. Av. José Gálvez Barrenechea 645 Urb. Corpac - San Borja Lima 41	(1) 225 40 30 (1) 475 15 13 wmelgarejo@bmp.com.pe

Adressen/Addresses

Philippines	MARCOM Industrial Equipment, Inc. MCC P.O.Box 2307 6-L Mezzanine Suite, Vernida I Condominium120 Amorsolo St. Legaspi Village Makati City/Philippines 3117	(2) 8 13 29 31 (2) 8 17 05 07
Poland	ROHDE & SCHWARZ Oddzial w Polsce ul. Stawki 2, Pietro 28 00-193 Warszawa	(22) 860 64 90 (22) 860 64 99 rohdepl@rsoe.com
Portugal	TELERUS Sistemas de Telecomunicações, S.A. Rua General Ferreira Martins, Lote 6,2.°B 1495 Algés	 (21) 412 35 90 (21) 412 36 00 telerus@mail.telepac.pt
Romania	ROHDE & SCHWARZ Representation Office Bucharest Uranus 98 Bloc U8, scara 2, etaj 5, ap. 36 76102 Bucuresti	(1) 410 68 46 (1) 411 20 13 rohdero@rsoe.com
Russian Federation	ROHDE & SCHWARZ Representative Office Moscow Kazachy per. 7 109017 Moscow	(095) 234 49 62 (095) 234 49 63 rohderus@rsoe.com
Saudi Arabia	Rohde & Schwarz Liaison Office c/o Haji Abdullah Alireza Co. Ltd. P.O.B. 361 Riyadh 11411	 (1) 465 64 28 (1) 465 07 82 –
Singapore	Vertrieb/Sales: INFOTEL TECHNOLOGIES LTD. 19 Tai Seng Drive Kinergy Building # 06-00 Singapore 535222	 287 68 22 284 95 55 general@infotel.com.sg
	Service: Rohde & Schwarz Support Centre Asia Pte. Ltd. 1 Kaki Bukit View #04-05/07 Techview Singapore 415941	 846 37 10 846 00 29 rssca@mbox4.singnet.com.sg
Slovak Republic	Specialne systemy a software, a.s. Svrcic ul 84104 Bratislava	(7) 65 42 25 29 (7) 65 42 07 68 3s@internet.sk
Slovenia	ROHDE & SCHWARZ Representation Ljubljana Koprska 92 1000 Ljubljana	(61) 123 46 51 (61) 123 46 11 rohdesi@rsoe.com
South Africa	Protea Data Systems (Pty) Ltd Communications & Measurement Division Private Bag X19 Bramley 2018	(11) 786 36 47 (11) 786 58 91 Colin.Forbes@protea.co.za
Spain	ROHDE & SCHWARZ ESPAÑA Salcedo, 11 28034 Madrid	(91) 334 10 70 (91) 729 05 06 rema@rsd.rohde-schwarz.com
Sri Lanka	LANKA AVIONICS 658/1/1, Negombo Road Mattumagala Ragama	(1) 95 66 78 (1) 95 83 11 –
Sudan	SolarMan Co. Ltd. P.O. Box 11 545 Karthoum	(11) 47 31 08 (11) 78 17 25
Sweden	ROHDE & SCHWARZ SVERIGE AB Flygfältsgatan 15 12830 Skarpnäck	(8) 605 19 00 (8) 605 19 80 info@rss.rohde-schwarz.com
Switzerland	Roschi Rohde & Schwarz AG Papiermühlestrasse 145, Postfach 3063 Ittigen	(31) 922 15 22 (31) 921 81 01 –
Syria	Electro Scientific Office Baghdad Street Dawara Clinical Lab. Building P.O.B. 8162 Damascus	(11) 231 59 74 (11) 231 88 75 –
Tanzania	Security Systems (T) Ltd. P.O. Box 7512 Dar Es Salaam	(22) 2 76 00 37 (22) 276 02 93
Taiwan	Lancer Communication Co., LTD. 16F, No. 30, Pei-Ping East Road Taipei	(2) 23 91 10 02 (2) 23 95 82 83 rosa.ho@lancercomm.com.tw
Thailand	Vertrieb Kommunikationstechnik/Sales Communications Equipment: TPP Operation Co., Ltd. 41/5 MoobanTarinee Boromrajchonnee Rd. Talingchan, Bangkok 10170	 (2) 880 93 45 (2) 880 93 47 –
	Vertrieb Messtechnik/Sales T & M Equipment: Schmidt Scientific (Thailand) Ltd. 212 Government Housing Bank Bldg. Tower II, 19th Floor, Rama 9 Rd., Huaykwang, Bangkapi, Bangkok 10320	 (2) 643 13 30-9 (2) 643 13 40 –
Turkey	ROHDE & SCHWARZ Liaison Office Istanbul Bagdad Cad. 191/3, Ard. 81030 Selamicesme-Istanbul	(216) 385 19 17 (216) 385 19 18 rsturk@superonline.com
Ukraine	ROHDE & SCHWARZ Representative Office Kiev ul. Patrisa Loumoumba, 4 252042 Kiev	(044) 268 60 55 (044) 268 83 64 rohdeukr@rsoe.com
United Arab Emirates	Service-Center für den Mittleren Osten/ Service Center for the Middle East: ROHDE & SCHWARZ Emirates L.L.C. P.O.B. 31156 Abu Dhabi	 (2) 631 20 40 (2) 631 30 40 –
	ROHDE & SCHWARZ Liaison Office Middle East P.O. Box 311 56 Abu Dhabi	(2) 63 35 670 (2) 63 35 671 –
	Vertrieb/Sales: ROHDE & SCHWARZ Liaison Office Dubai P.O.B. 53726 Dubai	 (4) 39 44 829 (4) 39 44 794 –
	R&S BICK Mobile Communication P.O.B. 17466 JAFZ, LOB 04-028 Dubai	 (4) 81 36 75 (4) 81 36 76 –
United Kingdom	ROHDE & SCHWARZ UK Ltd. Ancells Business Park Fleet, Hampshire GU 13 8UZ	(12 52) 81 13 77 (12 52) 81 14 47 –
Uruguay	siehe auch/see also Argentina	

	AEROMARINE S.A. Cerro Largo 1497 11200 Montevideo	(2) 400 39 62 (2) 401 85 97 aeromar@adinet.com.uy
USA	Kommunikationstechnik/Communications Equipment: ROHDE & SCHWARZ, Inc. 4425 Nicole Drive Lanham, MD 20706	 (301) 459 88 00 (301) 459 28 10 –
	Messtechnik/T & M Equipment: TEKTRONIX Inc. P.O.B. 500, M/S 50-216 Beaverton, OR 97076	 (800) 835 9433 Ext. 6630 (800) 835 7732 –
Venezuela	EQUILAB TELECOM C.A. Centro Seguros La Paz Piso 6, Local E-61 Ava. Francisco de Miranda Boleita, Caracas 1070	(2) 34 46 26 (2) 239 52 05 r_ramire@equilabtelecom.com.ve
	Military customers only: REPRESENTACIONES BOPIC S.A. Av. Diego Cisneros Centro Empresarial Los Ruices Of. 119, 1er piso Los Ruices Caracas	 (2) 985 21 29 (2) 985 39 94 incotr@cantv.net
Vietnam	Schmidt Vietnam Co., Ltd. 8/F, Schmidt Tower, Hanoi Intern. Technology Centre Cau Giay, Tu Liem, IPO Box 89 Hanoi	(4) 834 61 86 (4) 834 61 88 svnhn@schmidt group.com
Yugoslavia	see/siehe Austria	

Nicht aufgeführte Länder/Countries not listed:

	ROHDE & SCHWARZ INTERNATIONAL GmbH P.O.B. 80 14 69 81614 München / Germany Please fax to	 +49 89 41 29 136 62

2 Preparation for Use and Application Hints

2.1 Initial Start-up

2.1.1 Setting up the Instrument

The instrument may be operated in any position. It is therefore equipped with tiltable feet at the bottom.

- ***Do not cover the ventilation holes!***
- ***Ambient temperature 0 to 50 °C***
- ***Prevent moisture condensation. Once the instrument has become wet, it must be dried out before it is switched on.***

2.1.2 Rackmounting

For the height of the NRVS (2 units in height), two 19" adapters are supplied:

- ZZA-97 (order No.: 827.4527.00) with 2 units in height and
- ZZA-98 (order No.: 827.4533.00) with 3 units in height,

one unit in height corresponding to 44 mm.

To mount the NRVS alone or combined with an instrument of the same height, the ZZA-97 should be used. For combination with an instrument which is higher, it is recommended to use the ZZA-98. Both adapter kits include appropriate blank panels, which permit to implement all possible combinations. For rackmounting, refer to the mounting instructions enclosed.

2.1.3 Power Supply

The NRVS is designed for sinusoidal ac voltages in the ranges

115 V	+ 15/-22% (-15%)	47 up to 63 (440) Hz and
230 V	+ 15/-22%	47 up to 63 Hz.

Thus it can be connected to the standard line voltages of 100/110/115/120 V
and 220/230/240 V.

The instrument is set to 230 V by R&S. The setting may be easily altered without opening the instrument:

- Disconnect the power cable and
- switch the voltage selector to the desired position by means of a screw driver (Fig. 3-3).

Observe the respective VDE/IEC regulations when connecting the instrument to the ac supply!

The NRVS is designed in accordance to safety class I of VDE0411/IEC348. It is protected against short circuits by means of a thermal overload protection (resetting automatically!) integrated into the power transformer. It does not contain any fuse. The PE conductor is electrically connected to the casing.

2.1.4 Switch-On

The instrument is switched on using the ON/STB key on the front. The following messages appear one after the other on the alphanumeric display:

NRVS V x y IECADR zz	NRVS : instrument designation V x.y: firmware version number zz : IEEE bus address setting
INTERNAL CHECK	Self-test
PASSED	No fault has been detected during the self-test. (For error messages see 3.5.2).

Following this switch-on sequence, the sensor data are read in and checked (→ 2.1.5). The instrument is then ready for operation and assumes its state prior to the last switch-off. The zero correction is not automatically switched on, but has to be called up again.

The basic setting of the instrument can be obtained using the setup function:
SETUP → RCL 0 (→ 3. 3.11 SETUP)

Note: ***After switching off the instrument with the ONISTBY key, the transformer remains connected to ac supply, drawing a small amount of idle current.***

2.1.5 Connecting the Sensor

All power sensors NRV-Z and voltage probes URV5-Z can be connected to the NRVS. All the sensors and probes, designated as sensors throughout this manual, are individually calibrated with the calibration data stored in a non-volatile memory inside the probe connector housing. After connecting the sensor to the NRVS, calibration data are read in for further evaluation. The sensor has been connected properly if the black connector housing can be pushed into the receptacle until the detent position is reached. The outlet of the sensor cable must always be on the left side.

Connection and disconnection of a sensor is automatically detected by the NRVS and indicated by the following messages:

"READ SENSOR"	The sensor data are read in.
"NO SENSOR"	No sensor is connected.
"SENSOR ERROR "	The sensor cannot be identified, or the calibration data are defective.

2.2 Selection and Application of the Sensors

2.2.1 Safety Considerations

All sensors to the Power Meter NRVS permit to carry out voltage and power measurements according to different principles and for a variety of applications. They have a few characteristics in common which the user should know for safety reasons:

Ground connection

The metal casing of the NRVS must be connected to earth ground via the PE conductor of the built-in power plug. Be sure the power supply cord is properly connected to earth ground before connecting it to the instrument.

Although the ground connector of all sensors is electrically connected to earth ground via the metal casing of the NRVS, do not come into contact with dangerous voltages exceeding 50 V.

Maximum Ratings

Do not exceed the voltage and power limits which are specified for the sensors! Fire hazard! Danger of current surges!

2.2.2 Reducing Measurement uncertainty

Zero correction

Before measuring very low voltages and powers (critical range: sensitivity of sensor ... + 30 dB), switch on zero correction (→ 3.3.15).

Measuring outside the square law region

Voltage and power sensors with diode rectifiers permit to measure only relatively small levels up to about 22 mV/10 µW (220 mV/1 mW with a 20-dB divider connected ahead of the sensor) with rms weighting. With higher levels, measurement errors have to be expected for non-sinewave or amplitude-modulated signals.

Thermal sensors (NRV-Z51 to NRV-Z54) measure the true RMS value in the entire measuring range independent of the signal shape and the type of modulation.

Compensating for frequency response

To make use of the high accuracy specified for the sensors, frequency response correction should be switched on whenever possible (→ 3.3.4).

Microwave measurements are affected by various uncertainties, caused by the signal applied and the non-ideal behavior of the sensor used.

Please observe the hints below, before making high accuracy measurements. See also chapter 3.9.

2.2.3 Terminated Power Measurement

High-frequency sources such as RF and microwave generators, but also the outputs of passive components supplied (directional couplers, attenuator pads, power dividers, filters etc.) are characterized by the reflection coefficient and their available power.

For measurement purposes, the available power is of primary interest with the termination matched (source terminated with 50 or 75 Ω). It can be measured over a wide frequency and level range using the power sensors NRV-Z... (Fig. 2-1). Due to the high calibration accuracy and excellent matching of these sensors, only very small errors in measurement are obtained.

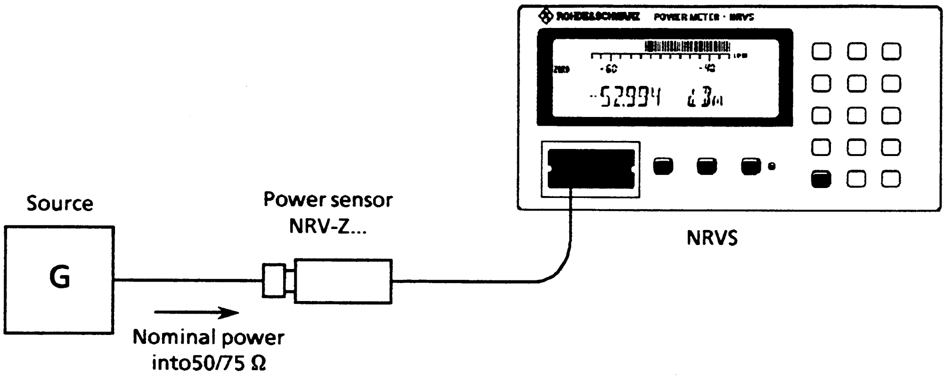


Fig. 2-1 Power measurement with terminating sensor NRV-Z... and NRVS

In the RF range, the insertion units URV5-Z2/Z4 and the RF probe URV5-Z7 can also used for power measurements (Fig. 2-2). They have an advantage over the NRV sensors whenever a larger dynamic range and a higher rating are required. Since the insertion units and the RF probe are calibrated in the same configuration (probe in the 50-Ω adapter), a relatively low measurement uncertainty can additionally be achieved.

In order to be able to display the voltage measured by the RF probe in the display units W and dBm, the reference impedance of the adapter must be entered before (REF → IMP → 50/75 Ω → STO). The insertion units contain this information in their data memory.

The measuring-head-specific frequency response correction data of all sensors can be considered in the display via the function CORR → FRQ →... .

Table 2-1 Recommended ranges of application for terminated power measurements

	Power sensors NRV-Z...	**Insertion unit URV5-Z2**	**Insertion unit URV5-Z4/50**	**RF probe in adapter URV-Z50**	**Insertion unit URV5-Z4/75**	**RF probe in adapter URV-Z3**
Frequency range	DC kHz to 26.5 GHz	9 kHz to 2 GHz	200 kHz to 2 GHz	20 kHz to 1 GHz	200 kHz to 2 GHz	20 kHz to 500 MHz
Level meas. range	-63 to +45 dBm	-60 to +33 dBm	-40 to +53 dBm	-60 to +33 dBm	-42 to +51 dBm	-62 to +31 dBm
Power meas. range	0.5 nW to 30 W	1 nW to 2 W	100 nW to 200 W	1 nW to 2 W	50 nW to 130 W	500 pW to 1.3 W
Rating	—	4,5 W	450 W	2 W	300 W	2 W
Impedance	50 and 75 Ω	50 Ω	50 Ω	50 Ω	75 Ω	75 Ω
Measuring accuracy	+ + + +	+ + +	+ + +	+ +	+ + +	+ +
Frequency response correction	yes	yes	yes	yes	yes	no

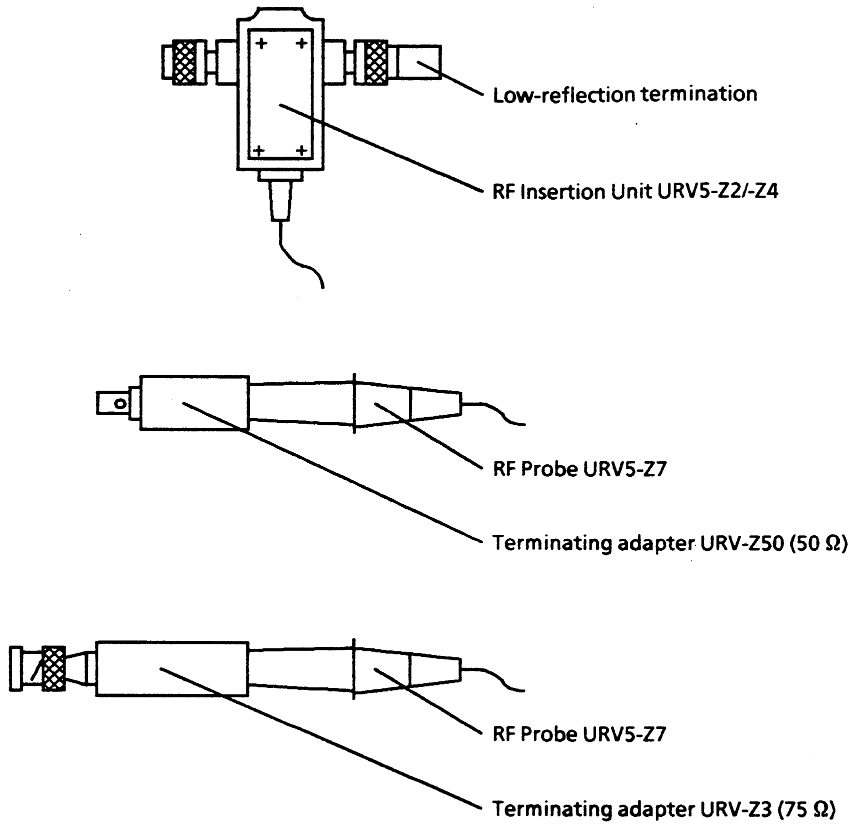
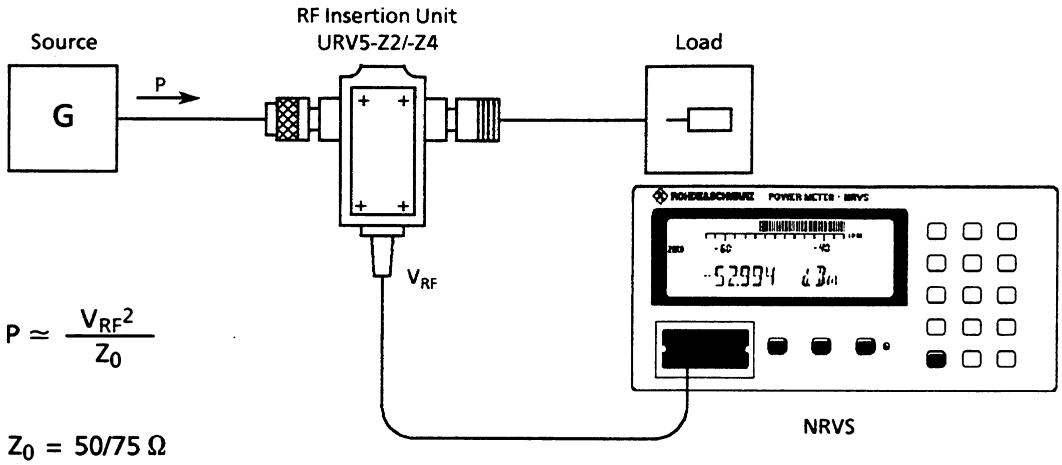


Fig. 2-2 Connection of insertion unit and RF probe for terminated power measurements

2.2.4 Level Measurement on coaxial Lines

Whenever the signal level on a transmission line is to be measured using simple means, the coaxial voltage measurement can be used (Fig. 2-3). With a small SWR, the voltage remains constant along the line and is a measure of the signal level or the transmitted power.



$$P \simeq \frac{V_{RF}^2}{Z_0}$$

$$Z_0 = 50/75\ \Omega$$

Fig. 2-3 RF level measurement using insertion unit and NRVS

Three insertion units as well as the RF probe with insertion adapter and plug-on divider are available for these measurements (Fig. 2-4 and table 2-2).

Table 2-2 Recommended ranges of application for the coaxial level measurement (insertion loss <0.5 dB and SWR <1.2 for the frequency ranges indicated - typ. values unless specified in the Technical Data).

	Insertion unit URV5-Z2	**Insertion unit URV5-Z4/50**	**RF probe in adapter (URV-Z6)**	**+ 20-dB divider (URV-Z6)**	**+ 40-dB divider (URV-Z6)**	**Insertion unit URV5-Z4/75**
Frequency range	9 kHz to 1 GHz	200 kHz to 2 GHz	20 kHzto 300 MHz	2 MHzto 400 MHz	1 MHzto 500 MHz	200 kHz to 2 GHz
Voltage meas. range	200 µV to 10 V	2 mV to 100 V	200 µV to 10 V	2 mV to 32 V	20 mV to 32 V	2 mV to 100 V
Level meas. range	-60 to +33 dBm	-40 to +53 dBm	-60 to +33 dBm	-40 to +43 dBm	-20 to +43 dBm	-42 to +51 dBm
Power meas. range	1 nW to 2 W	100 nW to 200 W	1 nW to 2 W	100 nW to 20 W	10 µW to 20 W	50 nW to 130 W
Rating	44 V_{pp}/50 $V_{=}$/ 15 V_{rms}	440 V_{pp}/1 k$V_{=}$/ 150 V_{rms}	44 V_{pp}/400 $V_{=}$/ 15 V_{rms}	440 V_{pp}/750 V_{pk}/ 32 V_{rms}	1,5 kV_{pp}/ 750V_{pk}/ 32 V_{rms}	440 V_{pp}/1 k$V_{=}$/ 150 V_{rms}
Impedance	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	75 Ω
Measuring accuracy	+ +	+ + +	+ +	o	+	+ + +
Frequency response corr.	yes	yes	no	no	no	yes

By selecting the display unit dBm or W (UNIT → dBm/W), the level and the power can automatically be displayed by the NRVS. When using the RF probe, the impedance (only 50 Ω!) must first be set (REF → IMP → 50 Ω, s. Abschn. 3.3.10). The insertion units already contain the impedance data in their data memory. To reduce the measurement uncertainty of the insertion units, the measuring-head-specific frequency response correction data can additionally be taken into account (FRQ → ...).

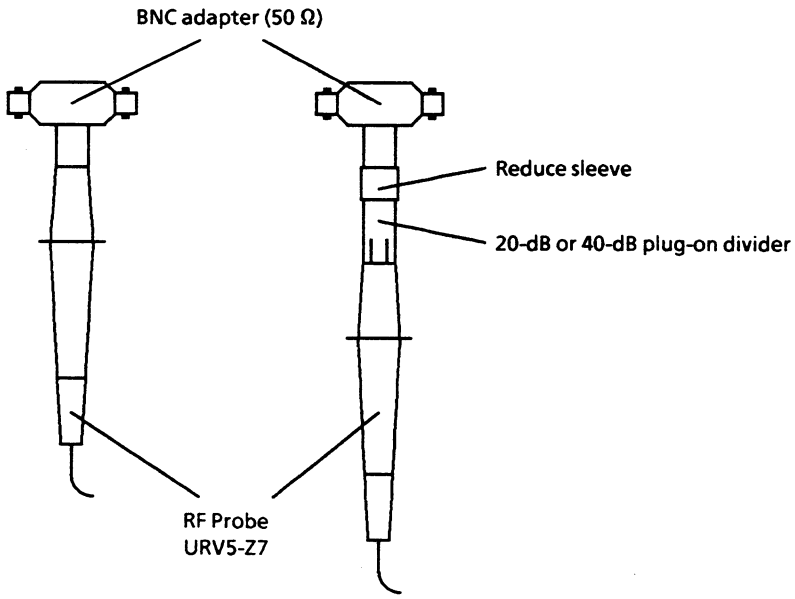


Fig. 2-4 Connection of the RF probe for coaxial level measurements

2.2.5 High-impedance A.C. Voltage Measurement using RF Probe

The RF Probe URV5-Z7 permits almost no-load high-frequency A.C. voltage measurements in electronic circuits (Fig. 2-5). The frequency range for this application extends from 20 kHz to about 400 MHz (up to 1 GHz for indication). The voltage measurement range extends from 200 µV to 10 V (up to 100 V or 1000 V with plug-on divider).

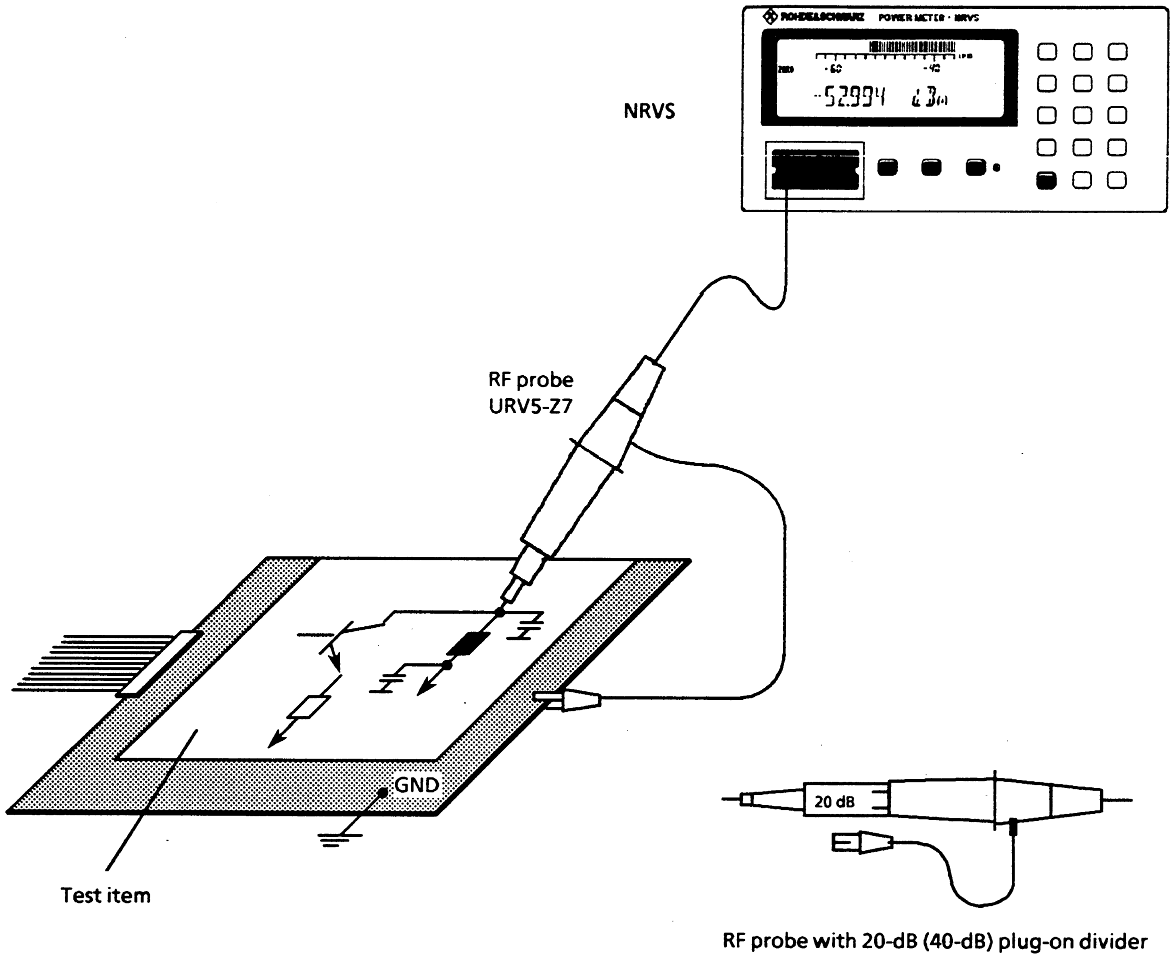


Fig. 2-4 A.C. Voltage measurement in RF circuits using probe and NRVS

In addition to expanding the voltage measurement range, the plug-on dividers also increase the input impedance (Table 2-1). The attenuation value of 20 or 40 dB can immediately be taken into account in the display using the function CORR → ATT → ... .

The ground connector of the RF probe is D.C. coupled with the metal casing of the NRVS! To avoid dangerous contact voltages (model 02) or current surges (model 03), do not connect the ground clip to dangerous contact voltages exceeding 50 V!

Table 2-1 Recommended ranges of application of the RF probe for high-impedance A.C. voltage measurement

	RF probe URV5-Z7	with 20-dB divider (URV-Z6)	with 40-dB divider (URV-Z6)
Frequency range	20 kHz to 300 MHz	1 MHz to 400 MHz	0,5 MHz to 500 MHz
Voltage measurement range	200 µV to 10 V	2 mV to 100 V	20 mV to 1000 V
Input impedance (at 10 MHz)	2,5 pF ‖ 80 kΩ	1 pF ‖ 1 MΩ	0,5 pF ‖ 10 MΩ
Rating	44 V_{pp}/400 $V_{=}$/15 V_{rms}	440 V_{pp}/ 1 $kV_{=}$/150 V_{rms}	3 kV_{pp}/1 $kV_{=}$/1050 V_{rms} 1)
Frequency response correction	no	no	no

1) Rating up to 40 MHz; for higher frequencies see Specifications URV5-Z7.

The measurement uncertainty for frequencies above 10 MHz considerably depends on the matching of the sensor. Instead of the ground cable, the low-inductance ground connection according to Fig. 2-6 should be used. This considerably improves the frequency response of the test setup and simultaneously reduces the magnetic field sensitivity.

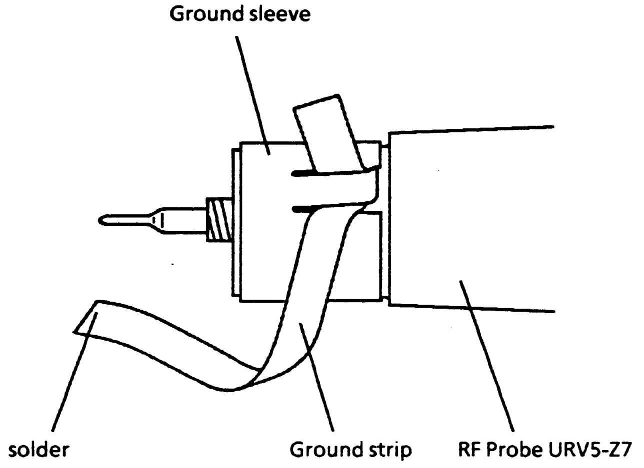


Fig. 2-6 Low-inductance ground connection

2.2.6 D.C. Voltage Measurement using D.C. Probe

Featuring a high input impedance, the D.C. Probe URV5-Z1 is particularly suitable for applications in RF circuits: determining the operation point of amplifiers, checking supply voltages etc. (Fig. 2-7).

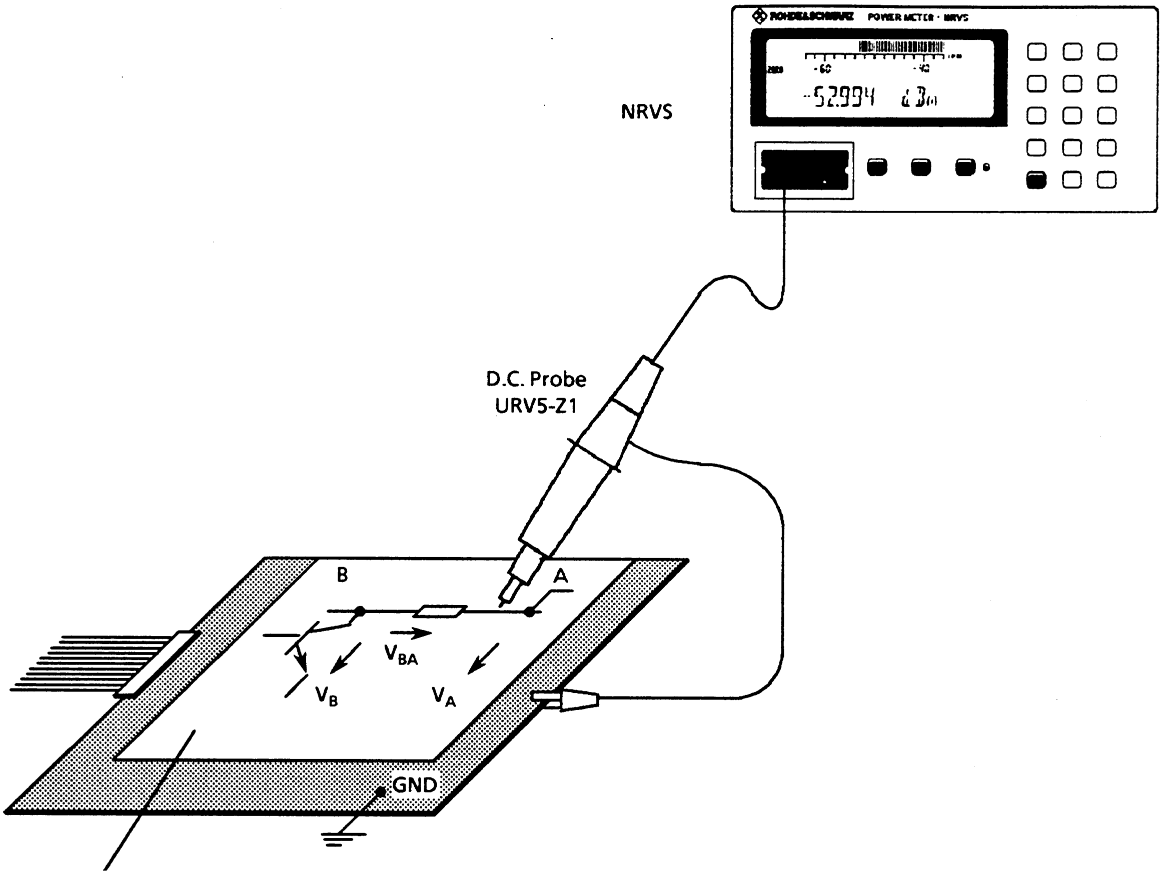


Fig. 2-7 Measure voltages and referred to ground voltage differences using D.C. Probe URV5-Z1 and NRVS

The ground connector of the D.C. probe is D.C. coupled with the metal casing of the NRVS! To avoid current surges (model 02) or short-circuits (model 03), do not connect the ground clip to dangerous contact voltages exceeding 50 V!

The best thing to do is always to keep the ground clip connected with circuit ground.

Table 2-4 Characteristics of D.C. Probe URV5-Z1.

Voltage measurement range	± (1 mV to 400 V)
Resolution	0.1 mV
Input impedance	9 MΩ ‖ 6 pF

Voltage differences between two test points (V_{BA} in Fig. 2-8) are measured as follows:

Test setup	NRVS
Lightly touch reference point (A) (reference measurement)	Check V_A. Shift zero point of NRVS (→ ZERO). Check display: 0 V. The text "ZERO" must be marked.
Lightly touch test point (B)	Read V_{BA}. By pressing the ZERO key again, the display is again referred to ground. ***Note:*** ***The zero adjustment can be performed using the D.C. probe up to max. ±20 V.***

2.3 Applications

The following measuring examples illustrate the wide range of applications of the NRVS. Most of the examples show power measurements, since they represent the widest range of application. Depending on the application, a Power Sensor NRV-Z..., an Insertion Unit URV5-Z2/Z4 or the RF Probe URV5-Z7 with 50 or 75-Ω adapter can be used. For the sake of simplicity, the illustrations always show power heads.

2.3.1 Attenuation Measurement (Substitution Method)

The NRVS permits coaxial attenuation measurements in the range 0 to 70 dB (NRV-Z...) or 0 to 90 dB (URV5-Z...) (Fig. 2-8). Set the source to the highest possible level if permitted by the test item and the sensor. Besides, the matching of RF and microwave generators should be improved using a low-reflection 3-to-10-dB attenuator pad.

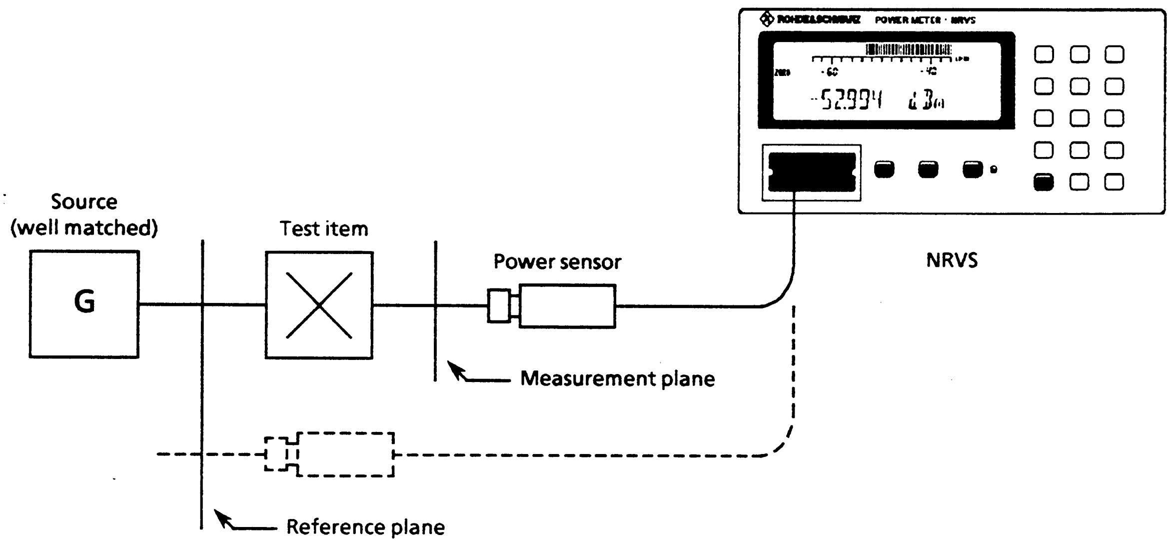


Fig. 2-8 Attenuation measurement via power comparison according to the substitution method

Procedure

Test setup	NRVS
Connect sensor to source (reference measurement).	Set unit ΔdB (UNIT→ REL→ ΔdB). Store measured value as reference value (MEAS-REF→ STO). Check display: 0 dB.
Insert test item	Read attenuation value

2.3.2 Sweep Tester for Transmission Measurements

Determination of the transmission parameters attenuation/gain according to the substitution method (section 2.3.1) is very exact, however, it always requires reconnection of the sensor for the reference measurement.

Higher measurement uncertainties are permissible for a lot of transmission measurements, and often only relative attenuation values are required. Fig. 2-9 shows an appropriate test assembly with a level-controlled generator, NRVS and XY-recorder for documentation of the frequency-dependent attenuation characteristic.

The sawtooth output of the generator provides a D.C. voltage which is linearly dependent on the frequency to the X-input of the recorder (frequency axis) and the DCFREQ input of the NRVS for the tracking frequency correction.

The level-proportional output voltage of the NRVS (DCLEV) is applied to the Y-input of the recorder.

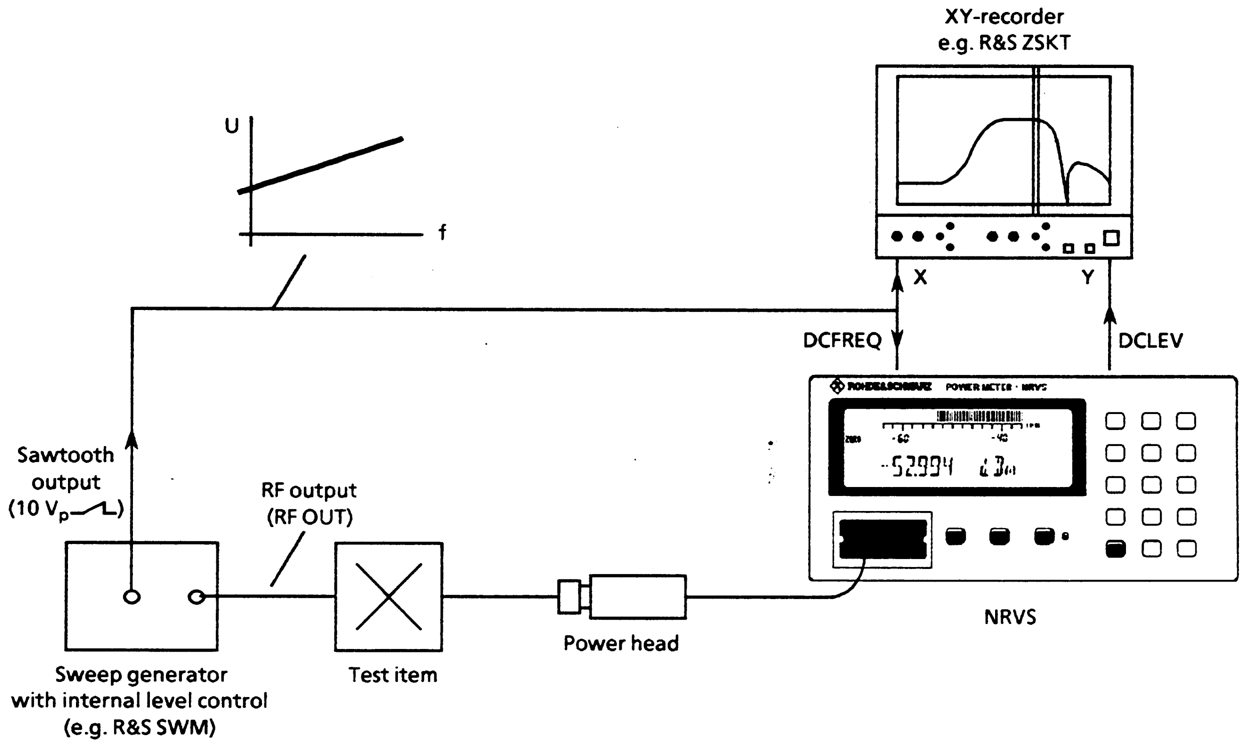


Fig. 2-9 Sweep tester with NRVS and XY recorder for transmission measurements

Sweep Generator	NRVS (V), recorder (R)
Set RF level. Switch on internal level control.	R: Set Y-sensitivity to 0.2 V/cm (deflection 0 to 15 cm). V: Set unit ΔdB (UNIT → REL → Δ dB). Select a resolution of 0.01 dB (FILTER → MANUAL → 0 ... 5 → STO). Select scale for display (DISP → BARGRPH → SCALE ...): Sensitivity 10 dB/cm → scope of display 150 dB, e.g. -120 to +30 dB 5 dB/cm → scope of display 75 dB, e.g. -70 to +5 dB 2 dB/cm → scope of display 30 dB, e.g. -20 to +10 dB 1 dB/cm → scope of display 15 dB, e.g. -15 to 0 dB
Enter start/stop frequency. Set manual sweep. Set reference frequency (0-dB point).	V: Enter voltage-frequency characteristic of sawtooth output (FREQ → DC INPUT → ADJUST ...). e.g. 0 V/start frequency and 10 V/stop frequency for SWM. Check display of reference frequency. Store instantaneous measured value as reference value (MEAS→REF → STO). Check display: 0 dB. R: Set 0-dB position. Set X-sensitivity. e.g. 0.5 V/cm for 20-cm deflection with 10-V deflection (SWM). Set position for reference frequency.
Start automatic sweep. Optimize sweep rate.	

2.3.3 Reflection Measurement using SWR Bridge

Due to their large dynamic range, the sensors for the NRVS are excellently suited for measuring low reflection factors, e.g. using SWR bridges of high directivity (Fig. 2-10). The power component reflected by the test item is cut off in the bridge, applied to the power sensor and displayed as return loss.

A short-circuit and/or a shielded open circuit are required for the measurement. The sensor should feature a sensitivity of at least 1 nW (-60 dBm), the source is to be set to the highest possible output power (1 to 20 mW, 0 to + 13 dBm).

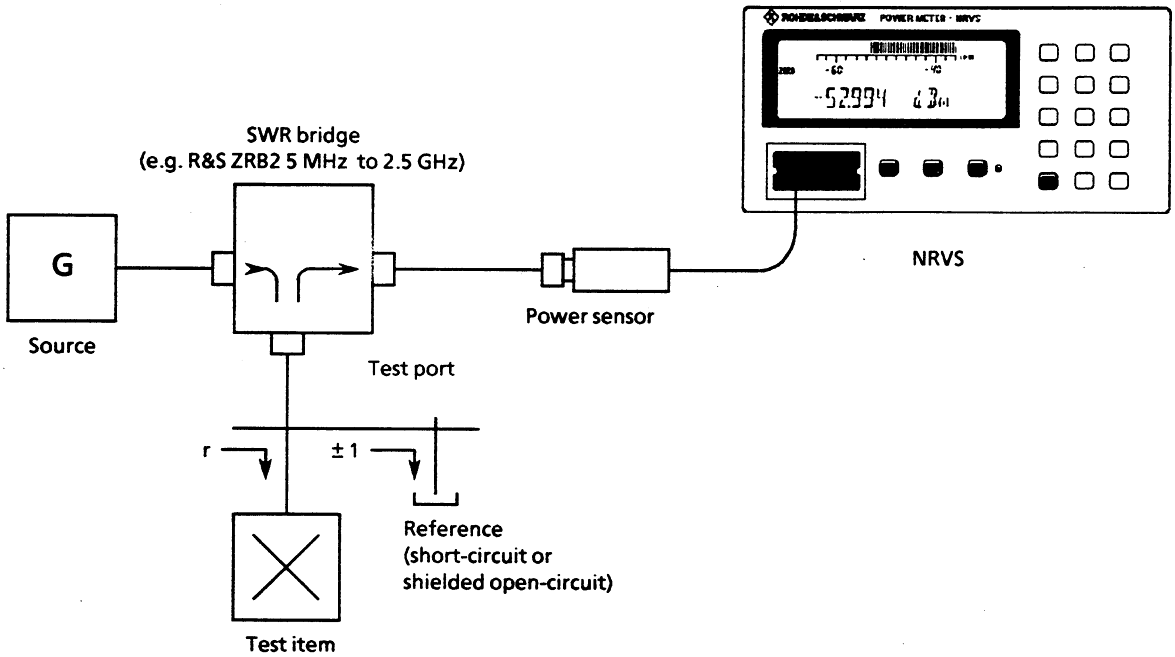


Fig. 2-10 Measurement of return loss using SWR bridge

Procedure

Test Port	NRVS
Connect short-circuit (reference measurement).	Set unit ΔdB (UNIT → REL → ΔdB). Store measured value as reference value (MEAS-REF→ STO). Check display: 0 dB.
If present, connect shielded open circuit of the same electrical length.	Check display: ± 1 dB. With greater deviations, vary the reference value such that the short-circuit and the open-circuit measurement result are symmetrical about 0 dB.
Connect test item.	Read the return loss.

2.3.4 Directional Power Measurement in the Shortwave Range

Many measuring tasks require continuous monitoring of the signal level on the junction between source and load, e.g. between transmitter and antenna. Exact measurement of the transmitted power, in particular with poor matching, is only possible with directional couplers.

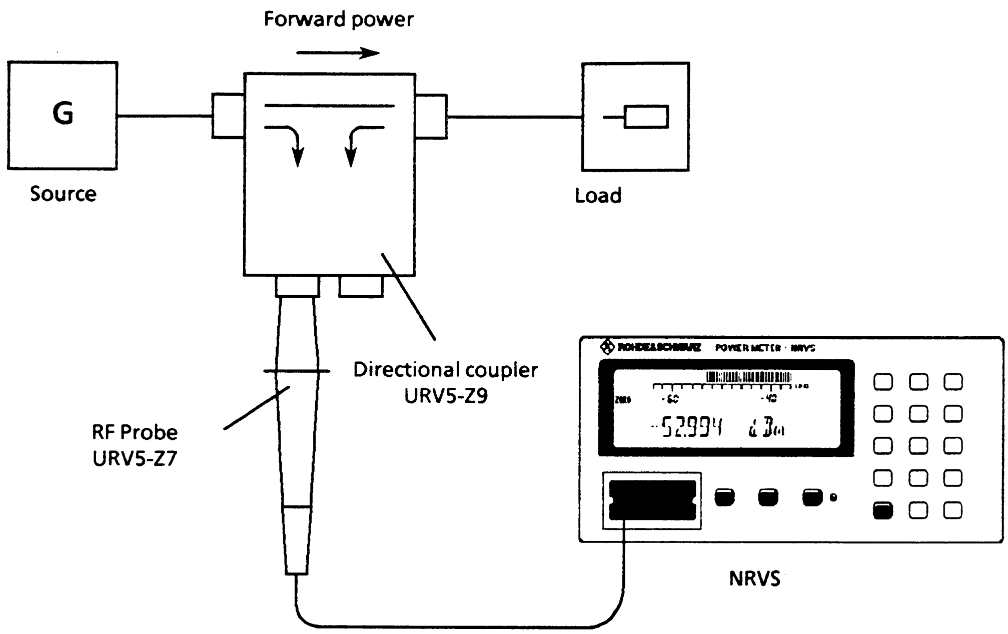


Fig. 2-11 Measurement of forward power from 10 µW to 2 kW and 100 kHz to 80 MHz using NRVS

In particular for the shortwave range and the adjacent bands, the Dual Directional Coupler URV5-Z9 is available. Using the RF Probe URV5-Z7 and the NRVS, the power applied to the load (forward power) can thus be measured. The probe for the reflected power output can be omitted without restriction of the accuracy.

The function CORR → ATT → CORR. BY → ... or REF → ATT → CORR. BY → ... can be used to take into account the coupling attenuation (typ. 40 dB) in the display. The individual values can be obtained from a detailed calibration report for the URV5-Z9.

Set the reference impedance to 50 Ω (REF → IMP → 50 Ω → STO).

2.3.5 RF Current Measurement

High-frequency currents up to about 300 MHz can be measured without opening the measuring circuit using so-called clamp-on current probes (Fig. 2-12). These current probes provide a voltage V proportional to the RF current I to a 50-Ω termination.

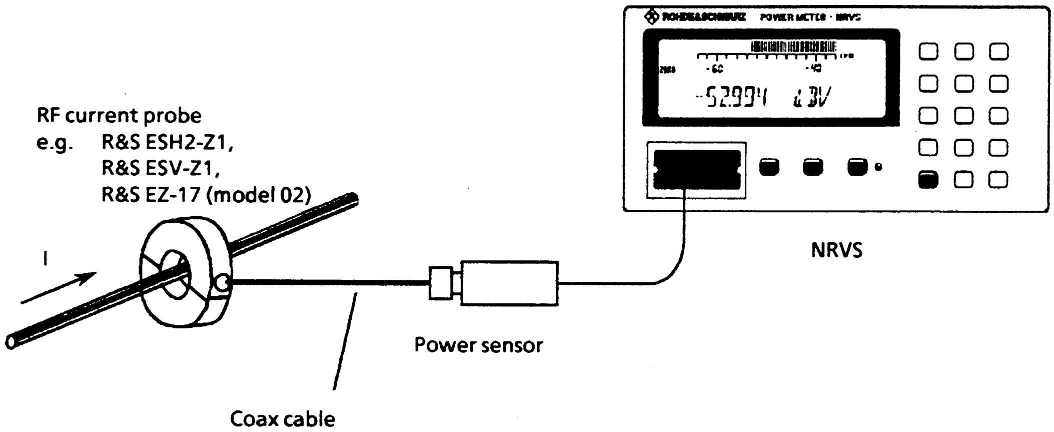


Fig. 2-12 RF current measurement with clamp-on current probe

The transmission response is characterized by the logarithmic conversion factor k:

$V/V = I/A \cdot 10^{-k/20\,dB}$

k must be entered with its sign into the NRVS as the attenuation correction value (ATT CORR → CORR.BY → ... or REF → ATT → CORR.BY →....) The numerical value read out in the unit V (UNIT → V) will then be equal to the current in A.

A terminated Insertion Unit URV5-Z2 is particularly suitable for use with the current probes ESH2-Z1, ESV-Z1 and EZ-17 (model 02) (Table 2-5).

Table 2-5 Current probe/sensor combinations for RF current measurement

	ESH2-Z1 + URV5-Z2	ESV-Z1 + URV5-Z2	EZ-17 (mod. 02) + URV5-Z2
Frequency range*)	100 (9) kHz to 30 MHz	20 MHz to 100 (300) MHz	5 MHz (9 kHz) to 100 MHz
Current measurement range	200 µA to 10 A	20 µA to 1A	50 µA to 2A
Conversion factor k	0 dB	-20 dB	-10 dB
Permissible current	10 A_{rms} / 15 A_{pp}	1,5 A_{rms} / 2 A_{pp}	2 A_{rms} / 3 A_{pp}

*) values in ( ): extended available frequency range with a frequency dependent conversion factor.

2.3.6 Level Control for Signal Generator

Signal generators are stabilized via an internal level control in general. A d.c. voltage proportional to the output level is generated via a directional-coupler/detector combination and used for control. This control voltage can often be supplied from outside as well. Such an external control is generally superior to the internal one since exact power meters can be used to measure the output level. Further, external control has the advantage that the power can be directly stabilized at the test object. The attenuation of filters or relatively long connection cables inserted between generator and test object is compensated.

Fig. 2-13 shows such a level control for signal generator SMP 02/22 in connection with power meter NRVS. It features high stability, a low amplitude error and a very simple operation: the RF level desired is simply entered into the NRVS in dBm or W as a reference value. Settling to a level or frequency change only takes 1 to 2s.

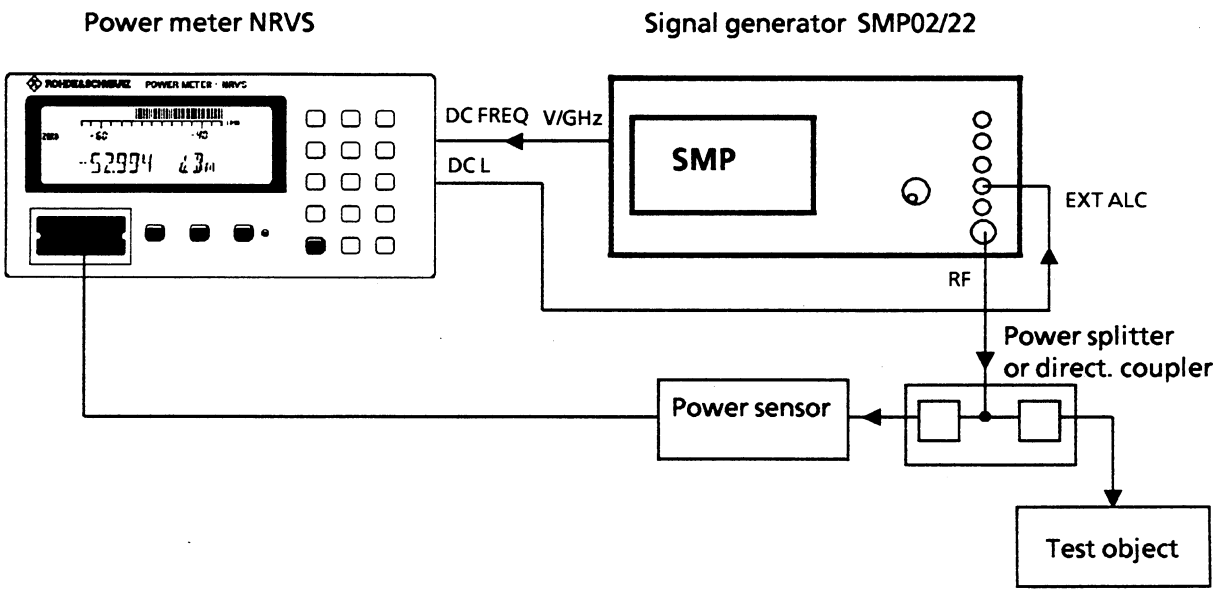


Fig. 2-13 Precision level control for SMP 0/22.

Function: The d.c. voltage output (DC) of the NRVS feeds a voltage proportional to the system deviation into the external ALC input of the SMP. This voltage is integrated and varies the output level until the system deviation disappears via a PIN control element. In addition, the frequency information is transmitted to the NRVS in the form of a d.c. voltage and used for frequency response correction of the sensor via output V/GHz of the SMP.
The control operates in a level range of -20 to +8.5 (SMP 02) or -20 to +20 dBm (SMP22), measured at the RF output of the SMP.
Almost all sensors of series NRV-Z can be used as power sensors. The following levels at the sensor should not be fallen below to ensure a high stability of the output power:

NRV-Z1, -Z4, -Z6, -Z7:	-30 dBm
NRV-Z2, -Z5, -Z8:	-10 dBm
NRV-Z51, -Z52:	-5 dBm

SMP	NRVS
Set frequency-proportional d.c. voltage UTILITIES AUX I/O V/GHZ 0.5 V/GHZ	Set unit ΔdB (UNIT → REL → ΔdB). Select a resolution of 0.01 dB (FILTER → MANUAL → 3 → STO). Set the display scale to ± 3 dB. (DISP → BARGRPH → SCALE → - 3 LOW → STO → + 3 UPP → STO). Enter coupling attenuation of directional coupler in dB (with power splitter 0 dB) (ATT CORR → CORR.BY → attenuation value → STO). Switch on frequency response correction (FREQ → DC-INPUT → ADJUST → LOW 1V → STO → LOW 2GHZ → STO → UPP 10V → STO → UPP 20GHZ → STO → ON). Enter nominal level as reference value in W or dBm (REF → LEV → level → STO).
Switch on external level control (EXT.ALC). LEVEL ALC SOURCE PMETER NRVS	

2.4 Fitting Optionen

2.4.1 Fitting Option NRVS-B1 (Sensor Check Source)

The sensor check source can be retrofitted into any NRVS basic unit provided that rear panel of the unit has an appropriate opening (labelling: POWER REF 1.00 mW · 50 MHz). No special accessories or knowledge are required for fitting the option. The sensor check source is factory set and so its specifications are guaranteed when it is installed in the NRVS basic unit.

Stick to the following order when fitting the option:

- Disconnect power plug (model 03) or Power Unit/Battery Charger UZ-35.
- Undo the two rear feet.
- Remove top and bottom cover (slightly lift at the back and withdraw towards the rear).
- Place unit onto a flat surface (batteries/rechargeable batteries or power supply facing upwards).
- Remove one cell of the battery/rechargeable battery set.
- Press out plug from the inside to clear opening in rear panel.
- Pass RF connector of sensor check source through opening in rear panel; the soldered side of the PCB is facing upwards.
- Fasten sensor check source with the supplied screws.
- Run twisted connecting line W1 through partition opening.
- Slide cable grommets over connecting line and insert into partition.
- Connect line on the one side to sensor check source and on the other to connector X505. Make sure that locks catch on both sides.
- Run connecting cable so that it cannot get trapped when closing the unit.
- Put unit back together in the reverse order. Prior to fixing rear feet tightly press the two covers.
- Switch on unit and test functioning of sensor check source (→ 3.8, 5.2.9).

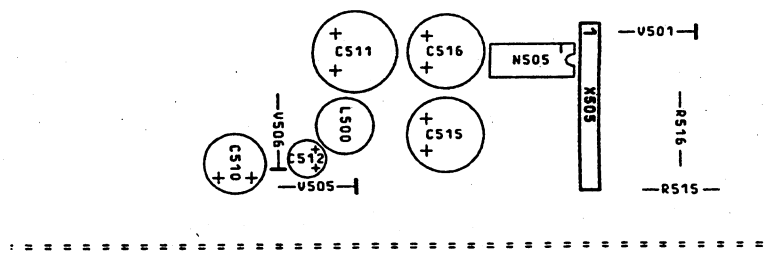


Fig. 2-14 Position X505

3 Operation

The NRVS can be operated both via the keyboard and via IEEE bus. In the following, the features of the instrument, keyboard and IEEE bus operation will be described.

3.1 Explanation of Front and Rear Panel Views

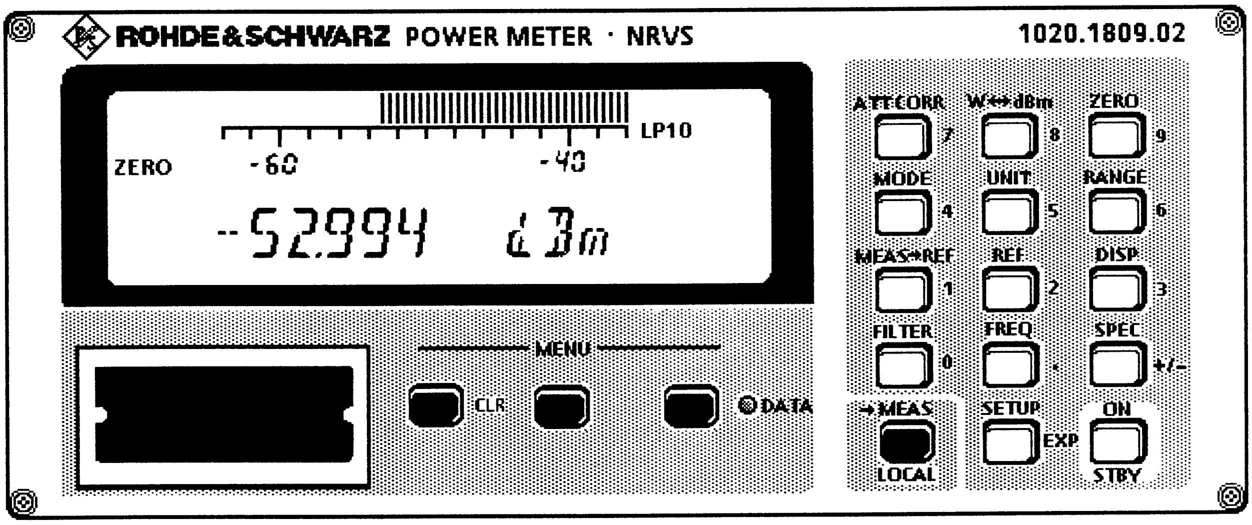


Fig. 3-1 Front view

ATT CORR 7	Taking into account an attenuator or amplifier preceding the sensor		(3.3.1)
W↔dBm 8	Direct selection of the displayed units (W or dBm)		(3.3.14)
ZERO 9	Zero correction		(3.3.15)
MODE 4	Measurement modes AVG, PULSE		(3.3.8)
UNIT 5	Displayed units	- absolute V, dBμV - relative dB, %W, %V	(3.3.13)
RANGE 6	Measurement range selection	- automatic - manual	(3.3.9)
MEAS→REF 1	Stores measured value as reference level		(3.3.7)

Key	Function	Details	Section
REF / 2	Enter reference value	- impedance - attenuation - level	(3.3.10)
DISP / 3	Display setting	- analog display - resolution of digital display and display filtering - display of correction frequency	(3.3.2)
FILTER / 0	Filter selection	- automatic - manual	(3.3.3)
FREQ / .	Frequency response correction of the sensor		(3.3.4)
SPEC / +/-	Special functions	- IEEE bus address - Testing the peripheral components - Setup lock-out	(3.3.12)
→MEAS / LOCAL	Return to measurement mode (→MEAS) Display IEEE bus address, return to manual operation (LOCAL)		(3.3.6) (3.3.5)
SETUP / EXP	Store or recall complete instrument setups, basic setting.		(3.3.11)
ON / STBY	Switch on/off NRVS.		(2.1.4)

MENU (CLR): Menu keys for further entries according to messages in the display

DATA: Keyboard switched to data input (3.2.1)

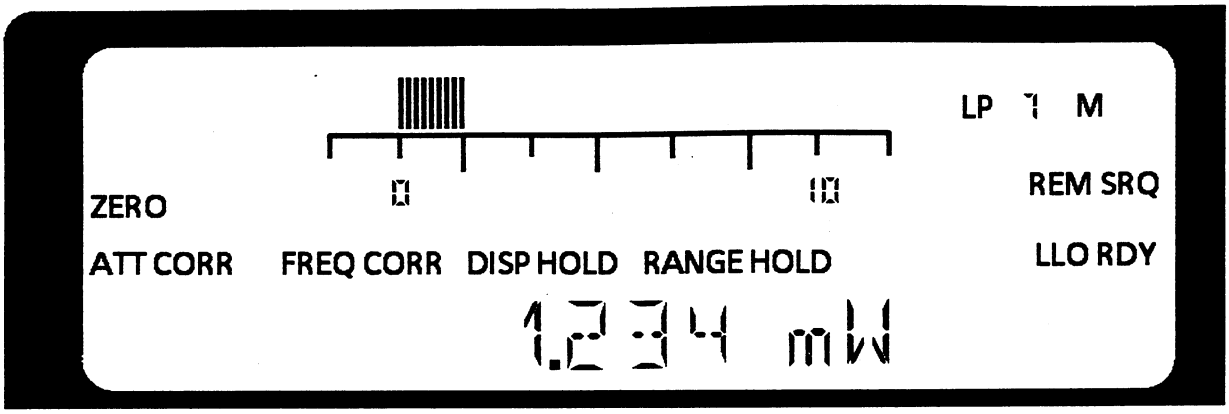


Fig. 3-2 Meaning of the fixed messages in the display

ATT CORR	Attenuation correction is activated	(3.3.1)
FREQ CORR	Frequency response correction is activated	(3.3.4)
DISP HOLD	Display is retained	(3.3.7)
RANGE HOLD	Measurement range is fixed	(3.3.9)
LLO	Switchover to manual operation using LOCAL key is disabled	(3.3.5) (3.7.3.1.2)
REM	Instrument is in remote state	(3.7.3.2.1)
SRQ	Instrument requests service from controller	(3.7.4)
RDY	Measurement result is available	
LP XX	Filter XX (XX = 0 to 12) is cut in	(3.3.3)
M	Filter is fixed	(3.3.3)
ZERO	Zero correction is switched on	(3.3.15)

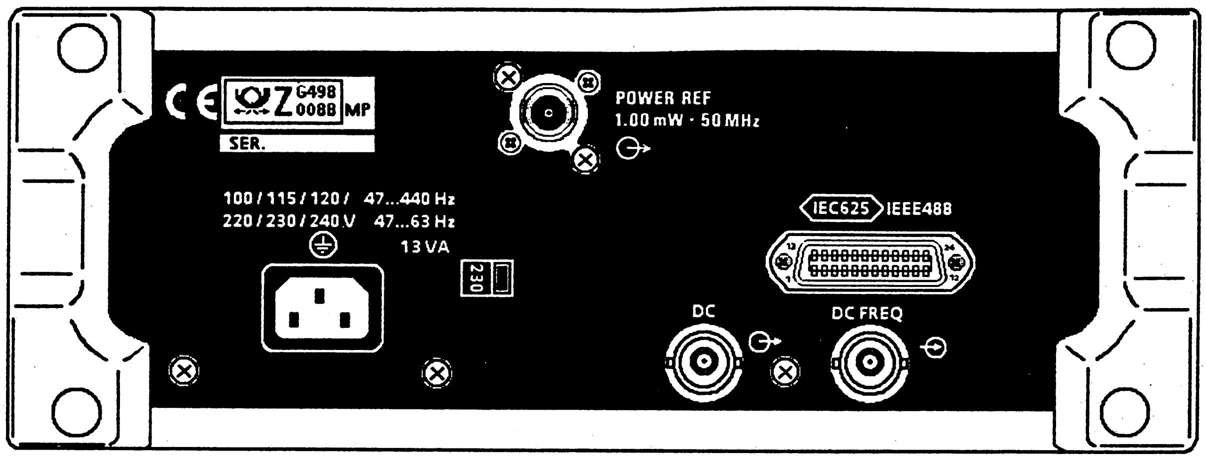
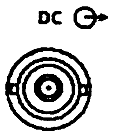
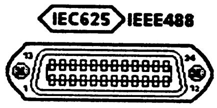


Fig. 3-3 Rear view



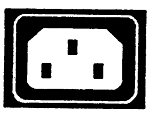
: DC voltage output (→ 3.8)



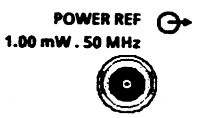
: IEEE bus connector (→ 3.7.1.1)

: DC frequency response correction input (→ 3.3.4)

: Voltage selector (→ 2.1.3)



: Power plug (→ 2.1.3)



: RF output sensor check source (→ 3.9)

3.2 Manual Operation

3.2.1 Menu Operation and Value Entries

The NRVS is menu-operated. This permits the manifold functions to be conveniently set using a relatively small number of keys.
Ten of the 15 keys in the righthand part of the front panel permit calling up a menu. The alphanumeric display line then displays up to three subfunctions, one of which can be selected by pressing the menu key below.

Meaning of general menu messages or characters

more (mre):	More subfunctions are available than can be indicated in the display line Pressing of more (mre) calls up the next menu level.
menu:	Return to the beginning of the menu
... * :	A message followed by an asterisk represents a comment.

By pressing a menu key, one of the following reactions is always produced:

- Setting the subfunctions
- Calling the next menu level
- Request for data entry
- Termination of a data input

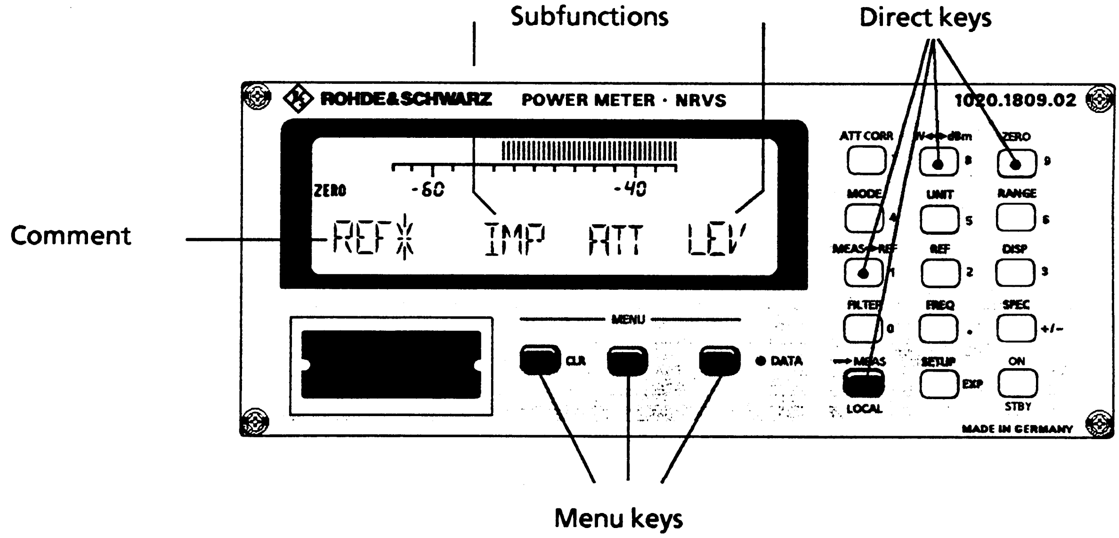


Fig. 3-4 Overview of operation

Data entry:

Some instrument settings require numerical data to be entered. When the LED marked by "DATA" is illuminated, the keys in the righthand keypad are assigned the meaning marked by blue notation. Entry of a number must be terminated by pressing the menu key designated as "STO". Using the CLR key, the last entered digit can be deleted during data entry.

Aborting menu operation:

→MEAS: This key permits to abort a menu at any point (even during numerical entry). The measurement will then be continued in the operating mode.

Direct keys which do not call up a menu:

W⇔dBm
ZERO
→MEAS / LOCAL
MEAS → REF

3.3 Operating Functions

The following section describes all keyboard functions. To provide a better overview, the equivalent IEEE bus commands are added to the individual functions. They will also be listed in a table in section 3.7.4.1. All functions are arranged according to their key assignment. The key descriptions are listed in alphabetical order.
Each key description is preceded by a header at the upper edge of the first page.

3.3.1 ATT CORR: Taking into Account an Attenuation or Amplification Preceeding the Sensor

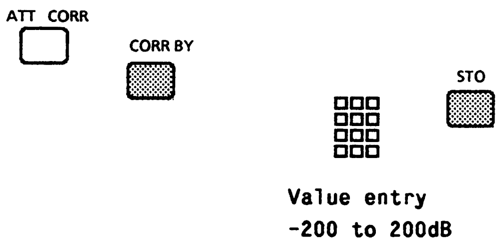
Subfunctions:

- CORR BY — Attenuation correction via given dB value
- ADJ TO — Attenuation correction by entering the nominal display value
- OFF — Switching off attenuation correction

CORR BY: Attenuation correction via given dB value

Function: The measured value is increased (reduced) by the attenuation value (gain value) entered in dB. A negative dB value compensates for an amplification, a positive one for an attenuation. After the value has been entered, the correction is automatically activated. The correction value entered remains stored after switching off the attenuation correction and is displayed again when the CORR BY function is called up again. It can be immediately activated by pressing the STO key.

Operation:



IEEE bus command:	**DA <data>**	Enter correction value
	KA1	Switch on attenuation correction

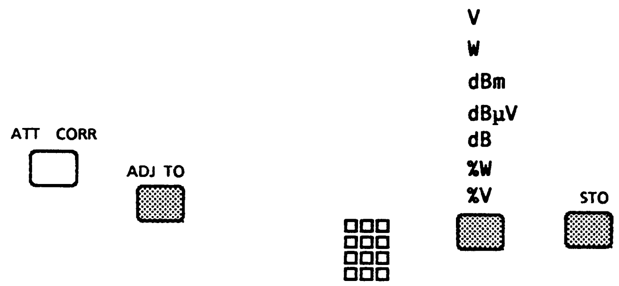
Display: An activated attenuation correction is indicated by the message ATT CORR in measurement mode.

Note: Attenuation correction via IEEE bus is only activated after switching it on explicitly. Entering a correction value alone is not sufficient.

ADJ TO: Entry of a desired display value to which the attenuation factor is to be matched.

Function: This function permits the display of any desired value based on the current measurement result. After entry of the nominal display value in all available units, the NRVS calculates the approprate attenuation/amplification factor.

Operation:



Value entry

IEEE bus command:

DAW <Data>	Enter display value in W
DAV <Data>	Enter display value in V
DAM <Data>	Enter display value in dBm
DAS <Data>	Enter display value in dBµV
DAD <Data>	Enter display value in dB
DAPW <Data>	Enter display value in %W
DAPV <Data>	Enter display value in %V
KA1	Switch on correction

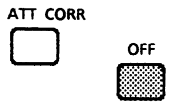
Display: An activated attenuation correction is indicated by the message ATT CORR in measurement mode.

Note: With remote control, attenuation correction has to be activated by means of command KA1 after entering the rated display value. The NRVS stores the calculated correction value, overwriting the correction factor if one was previously entered via the CORR BY function.

OFF: Switching off Attenuation Correction

Function: The attenuation correction is switched off, the correction value remains stored in nonvolatile memory.

Operation:



IEEE bus command: **KA0**

Display: The message ATT CORR disappears.

3.3.2 DISP: Display Settings

Subfunctions:

- BARGRPH — Configuration of analog display
- RESOL — Resolution and filtering of displayed result
- LEV + FRQ — Display of level and correction frequency
- LEV — Fading out of frequency display

BARGRPH: Configuration of analog display (menu)

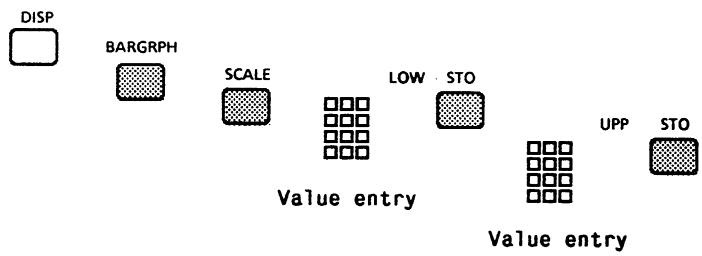
Subfunctions:

- SCALE — Fixed scaling of bar display with freely selectable full-scale values
- VOL — Volume display
- AUTO — Automatic scaling of bar display
- OFF — Fading out bar display

SCALE: Fixed scaling of bar display

Function: User-selectable fixed scaling of analog display. The first value entered determines the lower full-scale value, the second the upper one. Zero may lie inside or outside the analog scale. Thus the range of indication can be expanded at will, which is particularly suitable for adjustment

Operation:



IEEE bus command:	**DSL<Data>**	Enter lower full-scale value
	DSR<Data>	Enter upper full-scale value
	SC2	Switch on scale mode

Note: The full-scale values can be entered at will. However, they can only be indicated in the display with a three-digit mantissa at the maximum. If the entry comprises more than three digits, the digits which can no longer be displayed are truncated. In order for the mantissa of the input value to comply exactly with the displayed full-scale values, it is therefore advisable to enter a value with a maximally three-digit mantissa and the same exponents for both full-scale values. The full-scale values are entered without units. The full-scale values are maintained when the display unit is changed.

VOL: Volume display

Function: The VOL display indicates the volume inside the set measurement range. The designation FS (FULL SCALE) denotes the nominal value of the set measurement range (→ measurement range selection 3.3.9). Underrange or overrange of a measurement range can be easily detected using the VOL display.

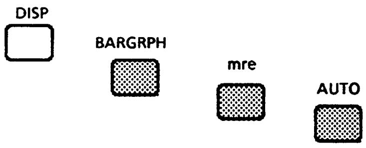
Operation:

IEEE bus command: **SC3**

AUTO: Automatic scaling of bar display

Function: The scale of the analog display is automatically selected by the instrument according to the respective display value.

Operation:



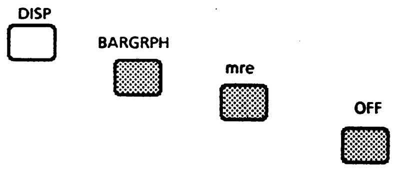
IEEE bus command: **SC1**

Note: If the measurement result is indicated in the basic unit of the sensor (W for NRV-Z ..., V for URV5-Z ...), display format and bargraph scale depend only on the measuring range.
In the case of calculated readouts of results (displayed unit different from basic unit, attenuation correction switched on, etc.) the output is formatted freely.

OFF: Fading out bar display

Function: Switch analog display off

Operation:



IEEE bus command: **SC0** Bar display is faded out

RESOL: Resolution of digital display and display filtering

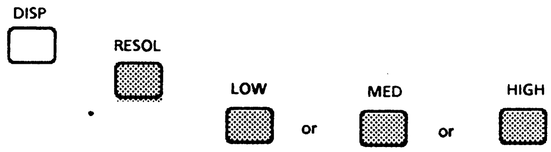
Function: The resolution of the displayed result can be varied between low (LOW), medium (MED) and high (HIGH).

	Displayed unit		
Resolution	**V, W**	**dBm, dB, dBμV**	**%W, %V**
LOW	$^1/_{100}$ R	0.1	1
MED	$^1/_{1000}$ R	0.01	0.1
HIGH	$^1/_{10000}$ R	0.001	0.01

R = Rated range value

If an automatic filter setting (→ 3.3.3) is selected, it is linked to the resolution setting.

Operation:



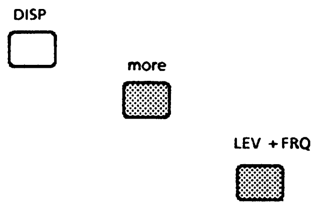
IEEE bus command: **RS2** (LOW)
RS3 (MED)
RS4 (HIGH)

Display: The current filter setting is indicated by the message LPxx.

LEV + FRQ: Display of correction frequency

Function: Display of the correction frequency on which the measurement result is based (→ 3.3.4 Frequency response correction) together with the level.

Operation:



IEEE bus command: **B1** Switch on frequency readout

Display: In addition to the measurement result, the correction frequency is displayed.

Examples:

1.234 mW	@	1.5 GHz	(static correction)
2.345 dBm		2.6 GHz	(dynamic correction)

Note: When frequency response correction is switched off, the default frequency specific to the sensor is displayed.

LEV: Fading out the correction frequency

Function: The readout of the correction frequency is faded out, only the measurement result is displayed.

Operation:

IEEE bus command: **B0** Switch off frequency display

3.3.3 FILTER: Filter Setting

Subfunctions:

- AUTOMATIC — Automatic filter selection
- MANUAL — Selection of a fixed filter

Function: For suppression of larger display variations due to noisy signals and the inherent noise of sensor and basic instrument, the NRVS is provided with various filters, which are either automatically selected by the instrument depending on the measurement range and the display resolution or manually set by the user. On the whole, 13 different filters are available (0 to 12). Filter 0 has the smallest, filter 12 the greatest effect.

For filters 4 to 12, filtering consists of the generation of the arithmetic average value of a number of subsequent measured values.

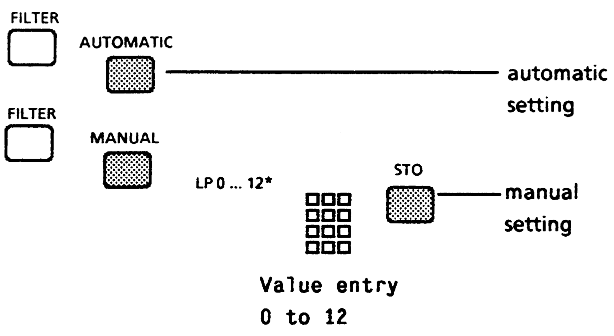
$$D = \frac{1}{n}\sum_{i=1}^{n} M_i$$

D = displayed result
M_i = ith measured value of a filtered measurement
n = number of single measured values(2^{x-3})
x = degree of filtering

For filters 0 to 3 only one measurement is carried out for each result displayed. The integration time of the A/D converter is then matched to the filter:

Degree of filtering	Integration time
3...12	2 × 20 ms
2	2 × 10 ms
1	2 × 5 ms
0	2 × 2 ms

Operation:



IEEE bus command:	**A0**	Automatic filtering
	A1	Fixed filter mode
	AV<x>	Filter selection for fixed filter mode, degree of filtering x (0 to 12)
	F<y>	Fixed filter setting compatible with NRV syntax (→3.7.13)

F0 ≡ AV11
F1 ≡ AV9
F2 ≡ AV7
F3 ≡ AV5
F4 ≡ AV3
F5 ≡ AV0

Display: The filter presently selected is indicated in the display by the message LPxx (xx = 0 to 12). In the fixed filter mode an "M" for manual is displayed on its right side.

Note: The automatic filter setting ensures that the optimum filter is set depending on the measurement range and the display resolution selected by the user (→ 3.3.2). The measurement rate results from the filter setting. Very small test signals (i.e. low measurement range) and a high display resolution require the most efficient filtering and thus result in the smallest measurement speed.
If automatic filter selection does not seem to be optimally suited to a particular measuring task, in which e.g. a greater measurement rate is required (increasing the display noise), a different filter can be set manually.
The relation between filter number, duration of measurement and noise is to be obtained from the specifications of the sensors and the NRVS.

3.3.4 FREQ: Frequency Response Correction

Subfunctions:

- DATA — Static frequency response correction
- DC INPUT — Dynamic frequency response correction
- OFF — Switching off frequency response correction

By entering the carrier frequency at which the measurement is made, the frequency response of the sensor can be corrected.
The frequency-dependent calibration factors are individually measured during production for each sensor and stored in the nonvolatile data memory of the probe.

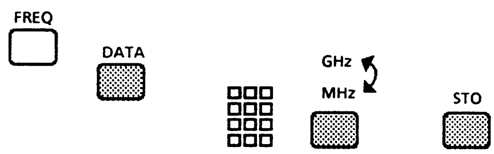
> Since the NRVS contains no frequency meter, the correction frequency entered and the carrier frequency at which the measurement is made must comply with each other. Otherwise, the measurement error may become greater than it would be without correction.

The correction frequency can be fed in via keyboard or IEEE bus (static frequency response correction) or as a frequency-proportional DC voltage as supplied by a sweep generator, for example, via the rear DC FREQ input (dynamic frequency response correction).

DATA: Static frequency response correction

Function: Entry of the test frequency via the keyboard and activation of the frequency response correction.

Operation:



Value entry
0 to 9999.9

IEEE bus command:		
	DF<Data>	Entry of correction frequency
	KF1	Switching on the correction

Display: FREQ CORR is displayed on the left side

Note: If the entered frequency lies between two calibration frequencies, the calibration factor is calculated by linear interpolation.
The entered correction frequency remains stored even after switching off the frequency response correction. When the static correction is called up again, it can be immediately activated by pressing the STO key.

DC INPUT: Dynamic frequency response correction

Function: Conversion of a DC voltage at the DC-FREQ input into an equivalent frequency for frequency response correction. The relationship between DC voltage and correction frequency is established by entering two points of the voltage to frequency characteristic.

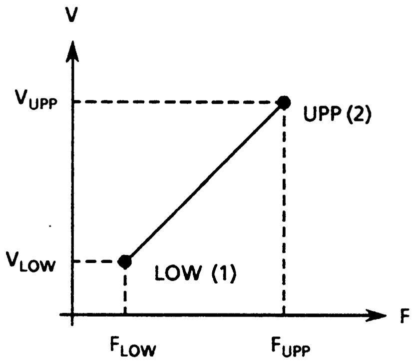
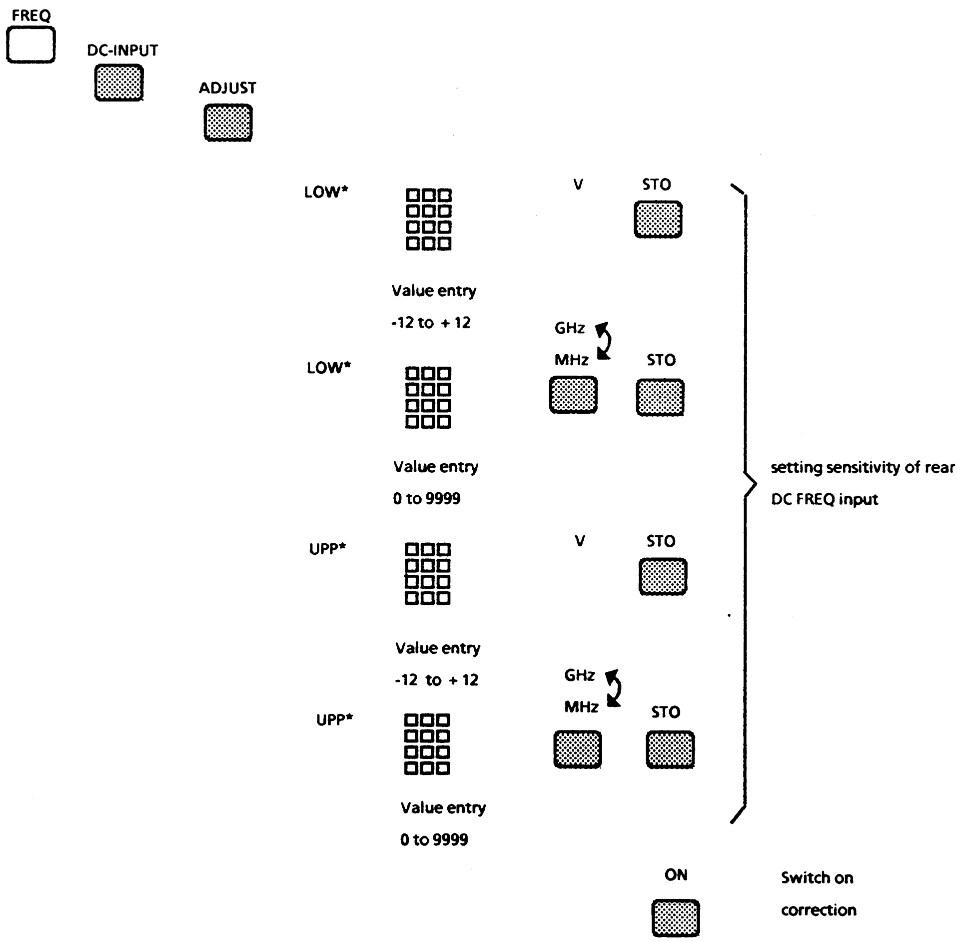


Fig. 3-5 Voltage to frequency characteristic

Operation:



IEEE bus command	**DCV1 <Data>**	Lower DC voltage in V
	DCF1 <Data>	Lower frequency in GHz
	DCV2 <Data>	Upper DC voltage in V
	DCF2 <Data>	Upper frequency in GHz
	KF2	Switch on dynamic correction

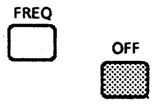
Display: The message FREQ CORR is displayed on the left.

Note: The dynamic frequency response correction assumes a linear relationship between correction frequency and DC voltage. The current correction frequency and the respective calibration factor are continuously calculated from the direct voltage applied (indication of correction frequency cf. 3.3.2). The static and the dynamic frequency response correction are mutually exclusive. If, e.g., a correction frequency is entered via DATA during a dynamic frequency response correction, the dynamic correction is deactivated and the static correction activated.

OFF: Switching off frequency response correction

Function: This function switches off the frequency response correction at the frequency entered by the user (static) or via the rear DC FREQ input.

Operation:



IEEE bus command: **KF0**

Display: The message FREQ CORR disappears from the display.

Note: With frequency response correction switched off, the calibration factor at the default frequency specific to the sensor (50 MHz in general) is used.

3.3.5 LOCAL: Return to Manual Operation

Function: If the instrument is in the remote control state (REM is read out on the display), manual operation via the keyboard is disabled.

It is enabled again by pressing the LOCAL key.

In manual operation, the IEEE bus address selected is briefly displayed after pressing the LOCAL key.

Operation:

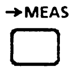
Display: Readout REM is cleared.

Note: Switchover from remote control to manual operation is only possible if the keyboard is not disabled by the IEEE bus command LOCAL LOCKOUT (readout LLO in the display).

3.3.6 →MEAS: Return to Measurement Mode/Indicating the IEEE Address

Function: This function permits terminating menu entries or aborting them at any time. The same applies to numerical entries. The numerical value entered so far is ignored, and the measurement is continued in the operating mode.
In the measurement mode, the IEEE bus address is shortly displayed after pressing the → MEAS key.

Operation:

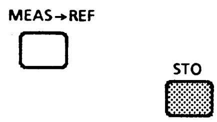


Display: IEEE bus address

3.3.7 MEAS→REF: Store Measurement Result as Level Reference Value

Function: After calling up the menu, the measurement result is retained in the display and can be transferred as reference value using STO or rejected using → MEAS.

Operation:



IEEE bus command: **X2** Trigger measurement and transfer result as level reference value

Display: While the retained measurement result is read out, the message DISP HOLD is indicated in the display.

Note: With relative units dB, %W or %V selected, the measurement result is stored as reference value in the basic unit (W or V) specifc to the sensor.

3.3.8 MODE: Measurement Modes

Subfunctions:

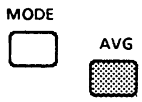
- AVG — Measurement of average power
- PULSE — Measurement of pulse power

Using RF sensors, the instrument can be operated in the measurement modes average value (AVG) and pulse power (PULSE).
DC probe URV5-Z1 only permits DC voltage measurements, and PEP sensors NRV-Z31 (models 02 to 04) are intended for measurement of peak envelope power only. Thus the error message ERROR ILLEGAL is displayed after pressing the MODE key with the above-mentioned sensors.

AVG: Measurement of average power

Function: The average power of modulated and unmodulated signals is measured. If the peak envelope power of modulated signals exceeds the square law range of diode sensors, significant measurement errors may occur.

Operation:



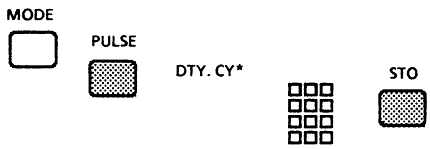
IEEE bus command: **M0**

Display: Readout of measurement result

PULSE: Measurement of Pulse Power

Function: With pulse modulation, the carrier power can be calculated from measured average power and the entered duty cycle. If the calculated pulse power exceeds the square law range of diode sensors, the complete measured value starts blinking.

Operation:



Value entry
0.01 to 100

IEEE bus command:

IEEE bus command:	**M1**	Switching on pulse function
	DY	Input of the duty cycle in %
	ZY	Output of the duty cycle

Display: "PUL" preceeding the measurement result

Notes: The value

$\frac{t}{T}$ in % is referred to as duty cycle

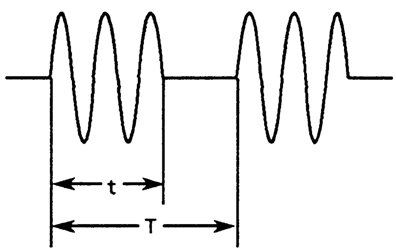


Fig. 3-6 Pulse-modulated RF oscillation

The following relation between pulse power and average power holds:

$$P_{PUL} = P_{AVG} \cdot \frac{T}{t} = P_{AVG} \cdot \frac{100}{\text{Duty cycle in \%}}$$

The determination of pulse power requires RMS weighting of the sensor. Therefore the measurement of pulse power in conjunction with diode sensors is restricted to the square law range.

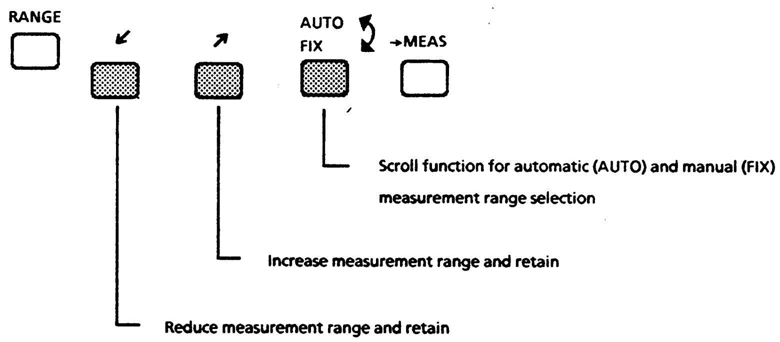
3.3.9 RANGE: Measurement Range Selection

Function: The entire measurement range of the NRVS is divided into several subranges that depend on the sensor used.

The instrument can perform measurements with automatic or manual range selection:

Using automatic range selection (AUTO) the suitable measurment range is set by the instrument itself depending on the measuring level. In the case of fixed range selection (FIX) the user can set a fixed measuring range. This can prevent an automatic resetting of the most sensitive measuring range whenever the measuring power is taken away. The instantaneous measuring range is indicated in the display in plain text left of arrows ↙ ↗ (e.g. 100 µW).

Operation:



IEEE bus command: **RG, RG0** Automatic range selection

RN<Data> Fixed measurement range selection by specifying the expected measured value in the sensor-specific basic unit (V for URV5-Z, W for NRV-Z). The NRVS then sets the appropriate measurement range.

Example: Power Sensor NRV-Z2

"RN 2E-3" sets the 10-mW range

When outputting the instrument status (→ 3.7.8) the measuring range is displayed in the RGx form (see below).

RG<x> Fixed setting of the measuring range by entering a range number.

Command RG <x> is identical with the corresponding instruction for power meter NRV with respect to syntax. However, the range number x is interpreted differently (Tab. 3-1).

Display: The rated range value is indicated in plain text left of arrows ↙ and ↗ in the display (e.g. 100 µW, 1 mW, 10 mW etc.). After activation of FIX, the message "RANGE HOLD" is read out in the display.

Note: With measurement range retained in fixed mode, measuring accuracy is reduced if the test level remains under the lower range limit.

Table 3-1 Measuring ranges for NRV and URV5 power sensors

NRV-Z1/ -Z3/ -Z4/ -Z6/ -Z7/ -Z15			NRV-Z2/ -Z5/ -Z8	
x	NRVS	NRV	NRVS	NRV
1	10 nW	10 mV	1 µW	100 mV
2	100 nW	100 mV	10 µW	1 V
3	1 µW	1 V	100 µW	10 V
4	10 µW	--	1 mW	
5	100 µW	--	10 mW	
6	1mW	--	100 mW	
7	20 (13)mW	--	500 mW	

NRV-Z31			NRV-Z32		NRV-Z33	
x	NRVS	NRV	NRVS	NRV	NRVS	NRV
1	1 µW	Meß-	100 µW	Meß-	1 mW	Meß-
2	10 µW	köpfe	1 mW	köpfe	10 mW	köpfe
3	100 µW	nicht	10 mW	nicht	100 mW	nicht
4	1 mW	kompatibel	100 mW	kompatibel	1 W	kompatibel
5	20 mW		2 (4) W		20 W	

NRV-Z51/ -Z52 / -Z55			NRV-Z53		NRV-Z54	
x	NRVS	NRV	NRVS	NRV	NRVS	NRV
1	10 µW	Meß-	1 mW	Meß-	10 mW	Meß-
2	100 µW	köpfe	10 mW	köpfe	100 mW	köpfe
3	1 mW	nicht	100 mW	nicht	1 W	nicht
4	10 mW	kompatibel	1 W	kompatibel	10 W	kompatibel
5	100 mW		10 W		30 W	

URV5-Z1			URV5-Z2/ -Z7		URV5-Z4	
x	NRVS	NRV	NRVS	NRV	NRVS	NRV
1	100 mV	1 V	1 mV	10 mV	10 mV	100 mV
2	1 V	10 V	10 mV	100 mV	100 mV	1 V
3	10 V	100 V	100 mV	1 V	1 V	10 V
4	100 V	400 V	1 V	10 V	10 V	100 V
5	400 V	--	10 V	--	100 V	--

3.3.10 REF: Reference Value Entries

Subfunctions:

- IMP — Reference impedance
- ATT — Taking into account a preceding attenuator pad or amplifier in the readout
- LEV — Level reference value

Impedance, attenuation and level can be entered as reference values for calculating the measurement result.

IMP: Reference impedance

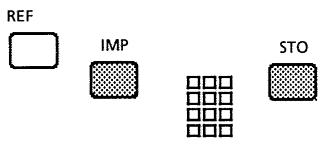
Function: Power P and voltage V applied to a load are related via its impedance Z:

$$P=\frac{V^2}{Z}$$

To convert voltage into power and vice versa, the impedance Z of the load must be known. In the case of power probes and insertion units (e.g. URV5-Z2), the impedance Z is equal to the characteristic impedance of the measuring head specified in the data sheet. It is automatically read out of the data memory of the measuring head and stored as impedance reference value after switching on or connecting the measuring head. It can be read out, however not varied via the function IMP.

When using the RF Probe URV5-Z7, the value of the load impedance must be entered if it does not comply with the reference impedance indicated. Otherwise there will be serious measuring errors when selecting display units W and dBm.

Operation:



Value entry
1 to 1000

IEC-bus command: **DZ <Data>** in Ω or
DR <Data> in Ω
Z1 Impedance output in Ω

Note: Commands DZ or DR cause an ERROR ILLEGAL if an AC measuring head is inserted.

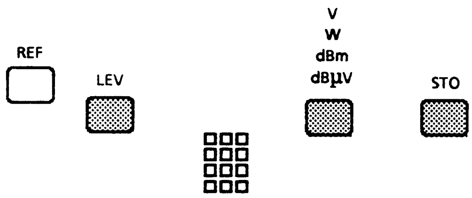
ATT: Attenuation correction

Function: This menu item comprises the subfunctions CORR BY and ADJ TO for attenuation correction, which can also be called up via the key ATT CORR (→ 3.3.1).

LEV: Level reference value

Function: Storing a level reference value for relative measurements.

Operation:




```
Value entry
 0...1E13 W
-1E13...1E13 V
-200...150 dBm
-100...300 dBμV
```

The desired unit can be selected by pressing the menu key below.

IEEE bus command:	**DU,DV <Data>**	reference value entry in V
	DS <Data>	reference value entry in dBμV
	DM <Data>	reference value entry in dBm
	DW <Data>	reference value entry in W
	Z0	reference value output

Note: The reference level value can be stored in all units available.
It is automatically converted to the required unit for relative measurements, if necessary. Don't forget to enter the characteristic impedance when using RF probes.

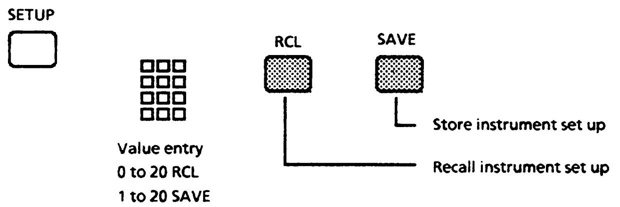
3.3.11 SETUP: Storing and Recalling Instrument Setups

Function: 20 different instrument setups can be stored/recalled at/from memory locations 1 to 20. Memory location 0 is reserved for the basic setting (→ 3.6).

Each setup comprises the following parameters:

• Measurement mode	(AVG, PULSE)
• Measurement range selection	(AUTO, FIX)
• Measuring range	
• Resolution of measured value	(LOW/MED/HIGH)
• Filter setting	(AUTOMATIC, MANUAL)
• Filter range	(LPxx)
• Displayed unit	
• Frequency response correction	(static/dynamic/off)
• Correction frequency	(statisch)
• V/F coordinates for dynamic frequency response correction	
• Attenuation correction	(on/off)
• Attenuation correction value	
• Display of correction frequency	(on/off)
• Scaling of bar display	(AUTO/SCALE/VOL/OFF)
• Full-scale values of scale function	
• Level reference value	
• Characteristic impedance	
• LC-Display	(on/off)

Operation:



IEEE bus command: **MR <0 to 20>** Recall instrument setup
MS <1 to 20> Store instrument setup

Note: Each data record of the SETUP memory is checked for its checksum when switching on the NRVS and calling up an instrument setup. If, e.g., a data record has been destroyed due to a change of the backup battery for the CMOS-RAM, the error message ERROR RECALL is displayed when the corresponding setting is tried to be called. Only when the SAVE key is pressed again, the data record in this memory is valid again and can be retrieved using RCL.
If four dashes are displayed instead of the SAVE message, SETUP memory is write-protected. To remove the write-protect: (SPEC → SETUP-LOCK→ OFF (→3.3.12)).

Zero correction is not influenced by calling up an instrument setup

3.3.12 SPEC: Special Functions

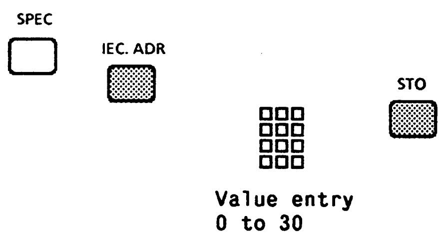
Subfunctions:

- IEC.ADR — Setting the IEEE bus address
- CHECKS — Keyboard test
  Testing LCD and LED (DATA)
- SETUP-LOCK — Write-protect setup memory

IEC.ADR: Setting the IEEE bus address

Function: Entering the IEEE bus address and storing it in non-volatile memory.

Operation:

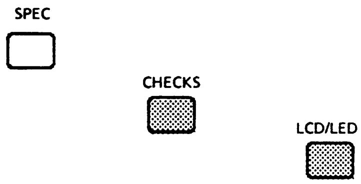


Note: The IEEE bus address stored is also displayed during the switch-on sequence (→ 2.1.4) and after pressing the LOCAL key.

CHECKS ->LCD/LED

Function: Validity check for LCD and LED (DATA).

Operation:



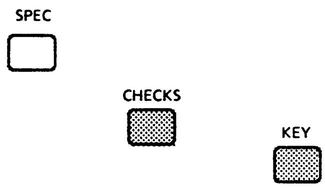
IEEE bus command: **S0**

Display: All segments of the liquid crystal display and the light-emitting diode are switched on.

CHECKS ->KEY

Function: Keyboard test
After the KEY-function has been selected, the instrument requests a keystroke by displaying "PRESS KEY". Subsequently it responds to every keystroke with the name of the pushed button (the ON/STBY key is an exception). If a key is pressed twice (deliberately or due to bouncing), the instrument returns to the measuring mode.

Operation:



IEEE bus command: **S1**

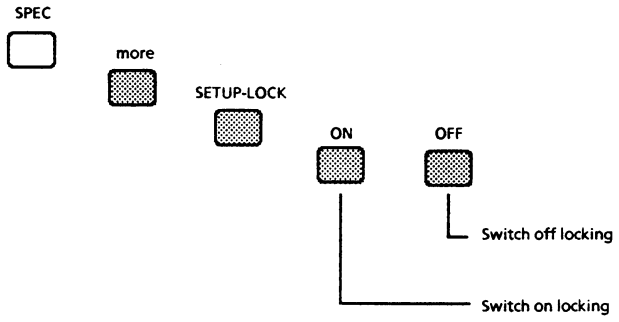
Display: The designation of the pressed key is indicated in the display.

Note: The keyboard test can be aborted by pressing any key twice.

SETUP - LOCK

Function: The setup memory is locked. When locking is switched on, no SETUP memory can be overwritten.

Operation:



Note: If the SETUP memory is locked, four dashes are indicated in the setup menu instead of SAVE.

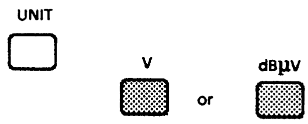
3.3.13 UNIT: Display Units

The UNIT key permits to set the absolute units V, dBµV and the relative units dB, %W, and %V.

Absolute display units

Function: Display of measurement result in V or dBµV

Operation:



IEEE bus command: **U7** display unit V
U8 display unit dBµV

Display: The measured value is converted into the selected unit.

Note: The following applies to the displayed value (D) in dBµV:

$$D[dB\,\mu V] = 20 * lg\left(\frac{V}{1\,\mu V}\right)$$

With power sensors, the voltage V is calculated from the measured power P and the characteristic impedance Z:

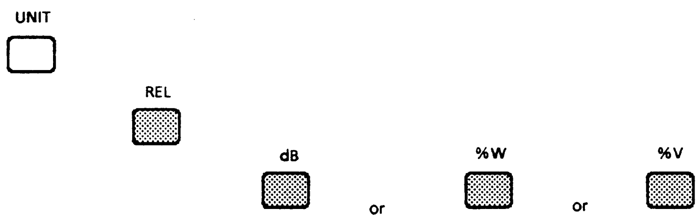
$$V = \sqrt{P * Z}$$

The display units W and dBm are selected using the W <-> dBm key.

Relative display units

Function: By selecting a relative display unit, the measurement result is displayed relative to a reference level value.

Operation:



IEEE bus command:

	U5	display unit dB
	U4,U4W	display unit %W
	U4V	display unit %V

Note: The reference level value can be entered via the keyboard (→ 3.3.10 REF→LEV), or the instantaneous measured value can be transferred as reference value using the MEAS→REF key (→3.3.7).

The displayed value (D) is calculated from the measured value and the reference value as follows:

$$D[dB] = 10 * lg\left(\frac{Meas.\ value}{Reference\ value}\right) \qquad (for\ powers)$$

$$D[dB] = 20 * lg\left(\frac{Meas.\ value}{Reference\ value}\right) \qquad (for\ voltages)$$

$$D[\%] = 100 * \left(\frac{Meas.\ value}{Reference\ value} - 1\right) \qquad (\%V\ for\ voltages,\ \%W\ for\ powers)$$

The reference value can be stored or measured in all available units. Based on characteristic impedance Z (→3.3.10), it is automatically converted into the unit necessary for evaluation.

3.3.14 W<->dBm: Direct Setting W or dBm

Function: Direct setting of the display units W or dBm. Key with scroll function for alternately switching between W and dBm.

Operation:

W↔dBm

IEEE bus command: **U0** display unit W
U1 display unit dBm

Display: The displayed value is converted into the unit W or dBm.

3.3.15 ZERO: Zero Correction

Function:

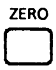
Zero correction is used to increase the measuring accuracy when measuring relatively small RF voltages or power levels, referred to the voltage or power rating of the sensor. For this purpose, the measured values are corrected such that an average of zero is indicated without test signal applied.

Switching on zero correction produces two effects:

- Starting an automatic measurement run to determine internal offset voltages with no power applied
- Subsequently, continuous correction of the measured value.

In general, DC voltage measurements using the DC Probe URV5-Z1 do not require zero correction, since the internal offset voltages can be neglected in this case. However, this function can be used to suppress unwanted external DC voltage offsets up to ± 20 V. The NRVS then subtracts the DC voltage applied when switching on zero correction from each measured value.

Operation:



Briefly pressing the ZERO key always starts a new zero measurement with subsequent correction.
Pressing the ZERO key for 1.5 seconds or longer will switch off zero correction.

IEEE bus command:

O0 Switch off zero correction.
O1 Start zero measurement and activate correction.

Display:

During zero measurement, the message "ZEROING" is indicated in the display. An activated zero correction is indicated by the message "ZERO" in the measurement mode. When zero correction is switched off, "ZERO TURNED OFF" is briefly displayed.

Note:

Zero errors may lead to large measurement uncertainties which increase with decreasing signal level. For proper zeroing, note the following:

- No test power may be applied to the sensor. (Otherwise, the error message "Error ZERO" will be displayed).
- After measuring large power levels, wait until the displayed value has stabilized.
- During zero measurement, do not move the cable of the sensor head too much.

- With varying ambient temperature, or if the instrument has not yet fully started up, check the display from time to time without test power applied and repeat, if necessary.

- The zero correction is not stored after switching off the instrument. Therefore, it should be performed each time the instrument is switched on.

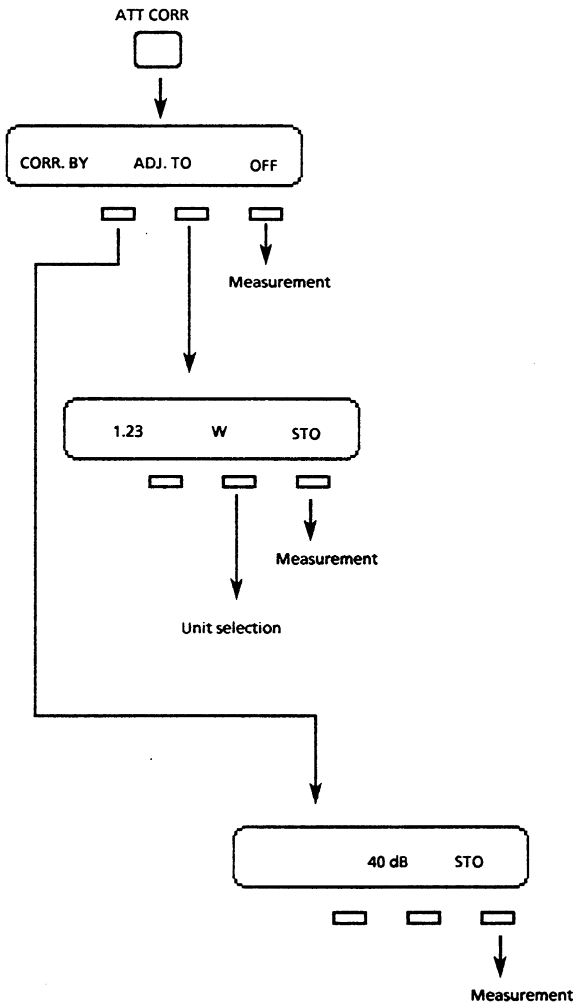
- The typical duration of the zero measurement is 4 seconds. In the case of filter settings 10, 11 and 12 (only in fixed filter mode) it takes between 20 and 40 seconds depending on the sensor.

- Zero measurement for the DC probe URV5-Z1 takes approx. 1 second, independent of the filter setting.

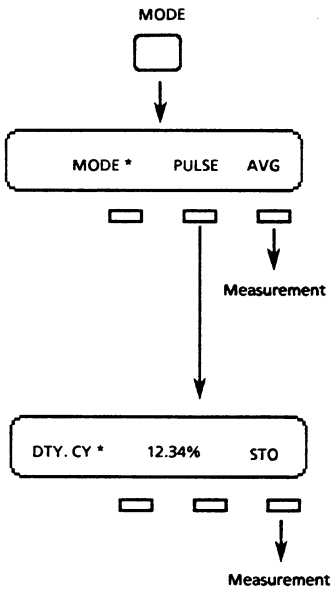
3.4 Menu Trees

The following illustrations are to provide an overview of the structure of the individual menus

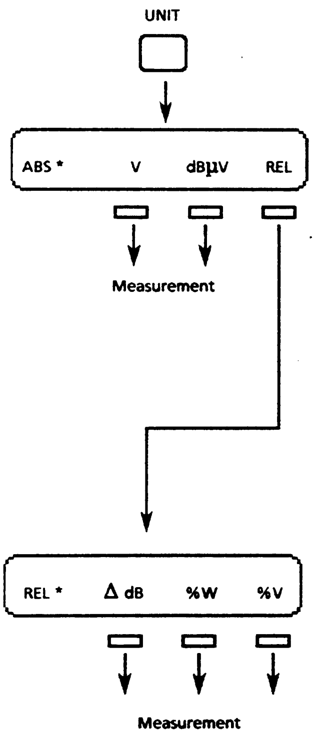
3.4.1 ATT CORR Menu



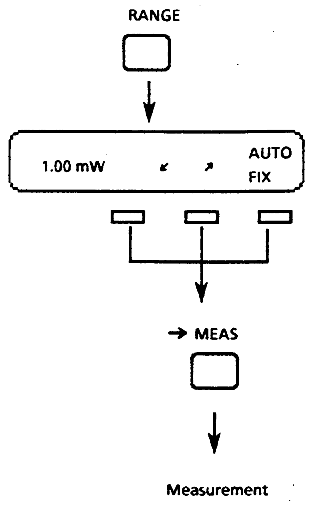
3.4.2 MODE Menu



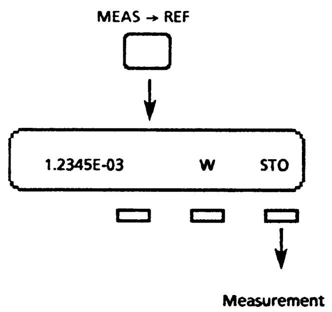
3.4.3 UNIT Menu



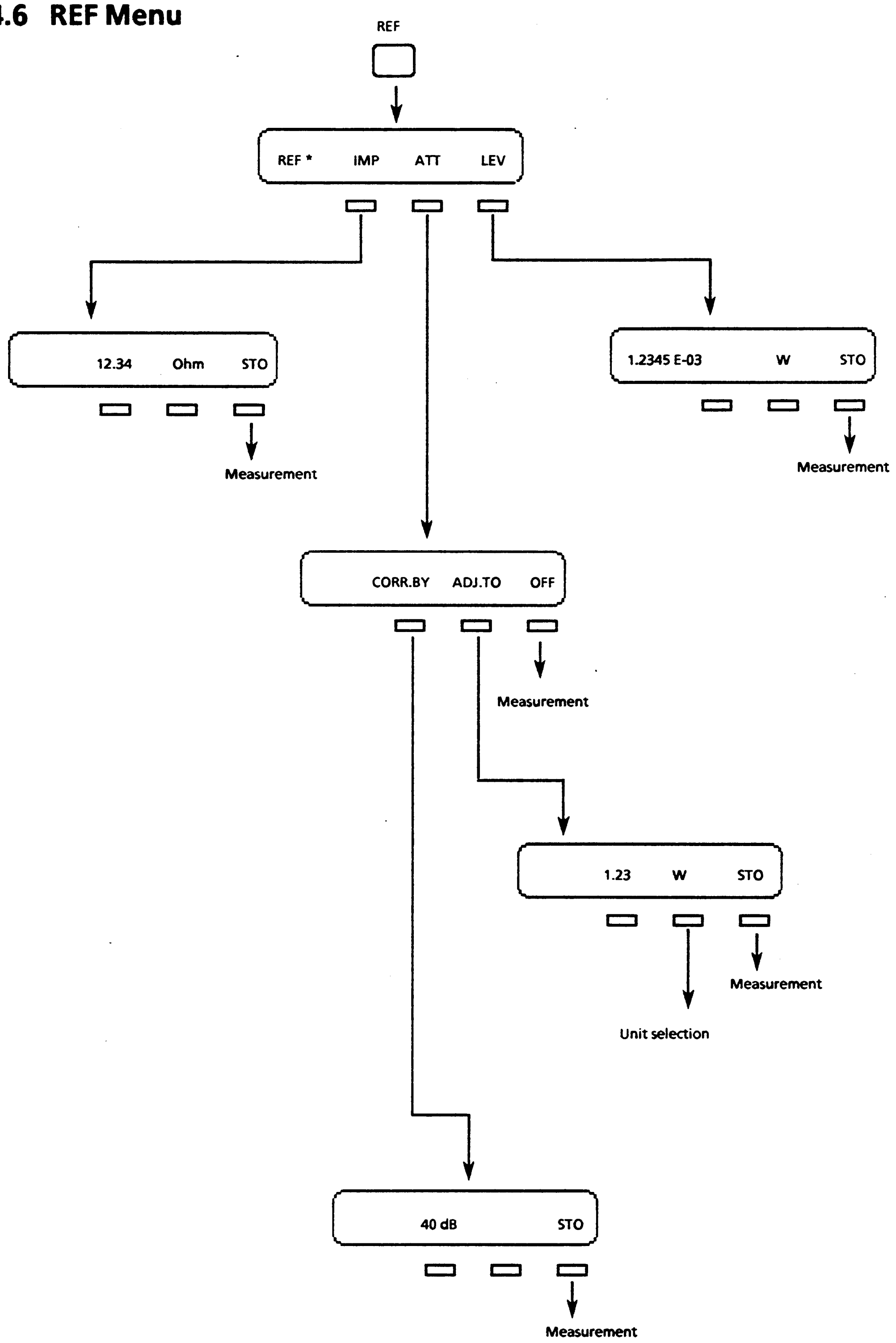
3.4.4 RANGE Menu



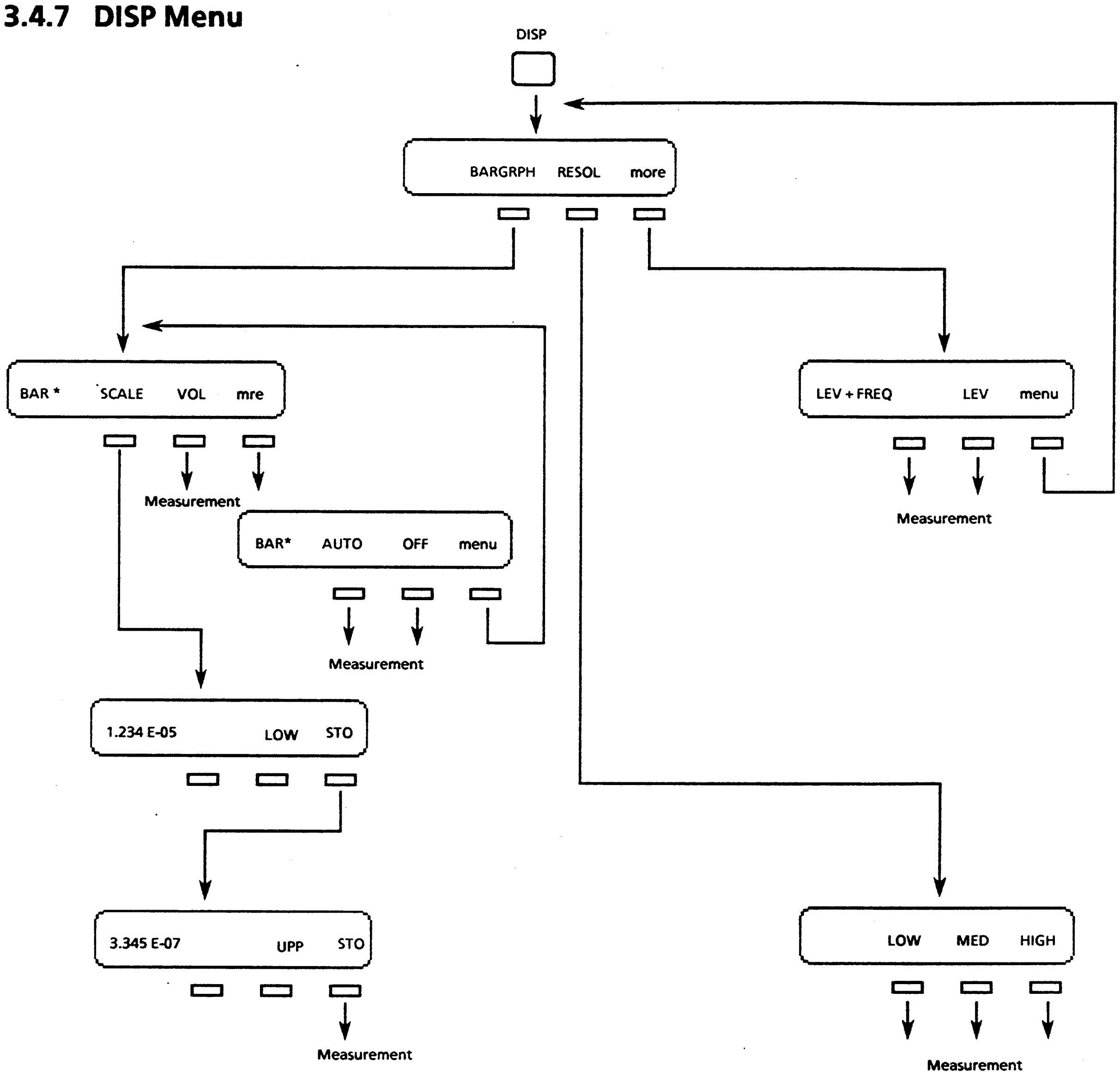
3.4.5 MEAS → REF Menu



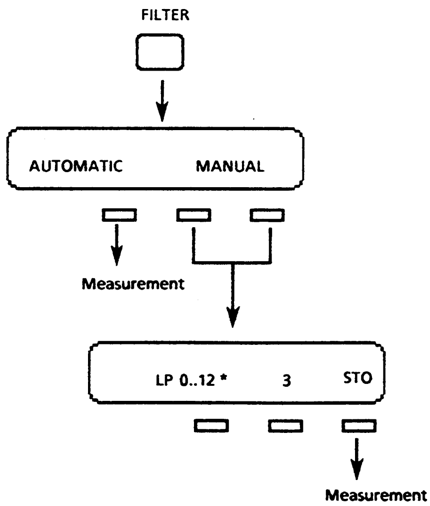
3.4.6 REF Menu


REF
REF * IMP ATT LEV
12.34 Ohm STO
Measurement
1.2345 E-03 W STO
Measurement
CORR.BY ADJ.TO OFF
Measurement
1.23 W STO
Measurement
Unit selection
40 dB STO
Measurement

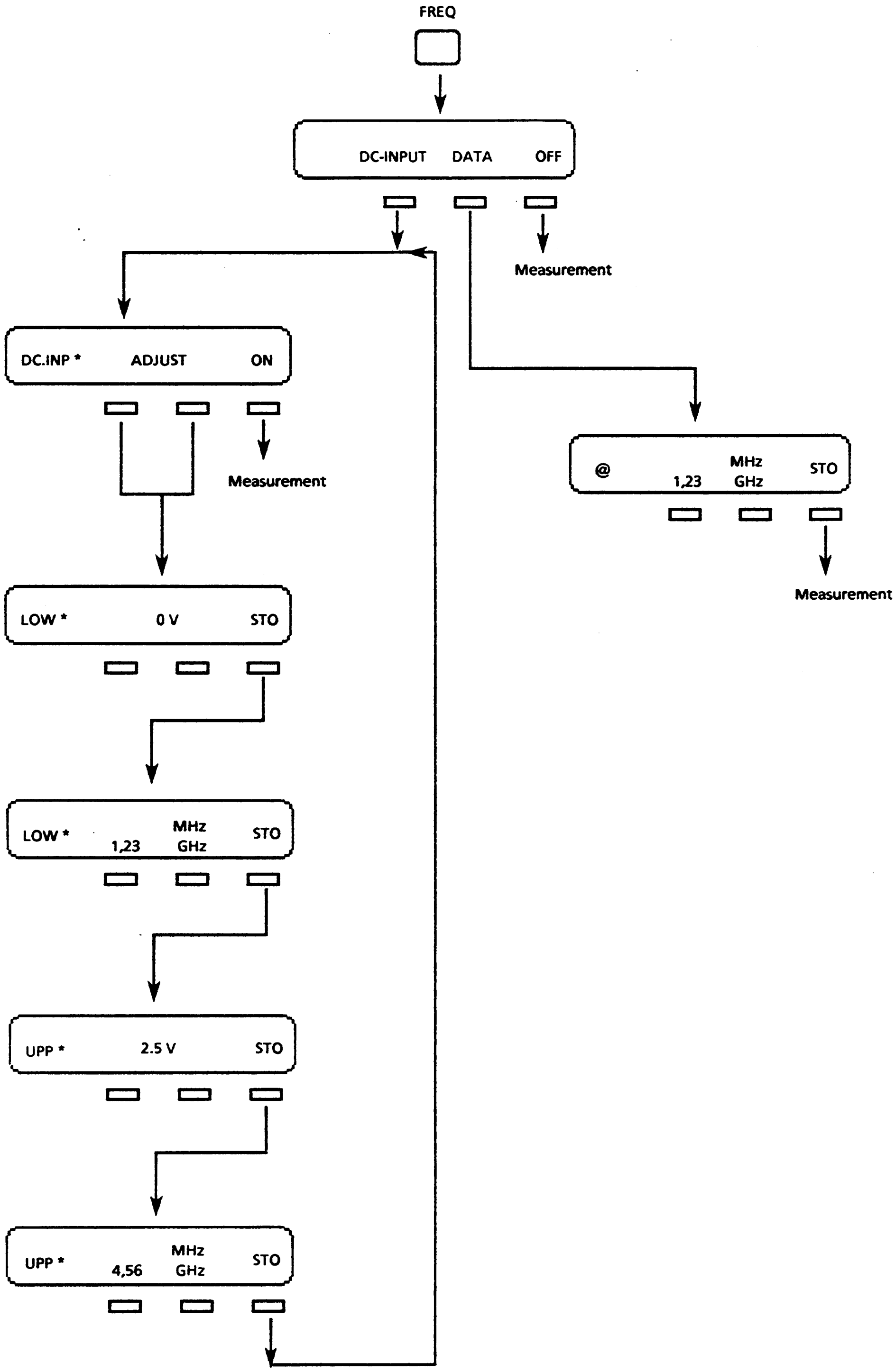
3.4.7 DISP Menu



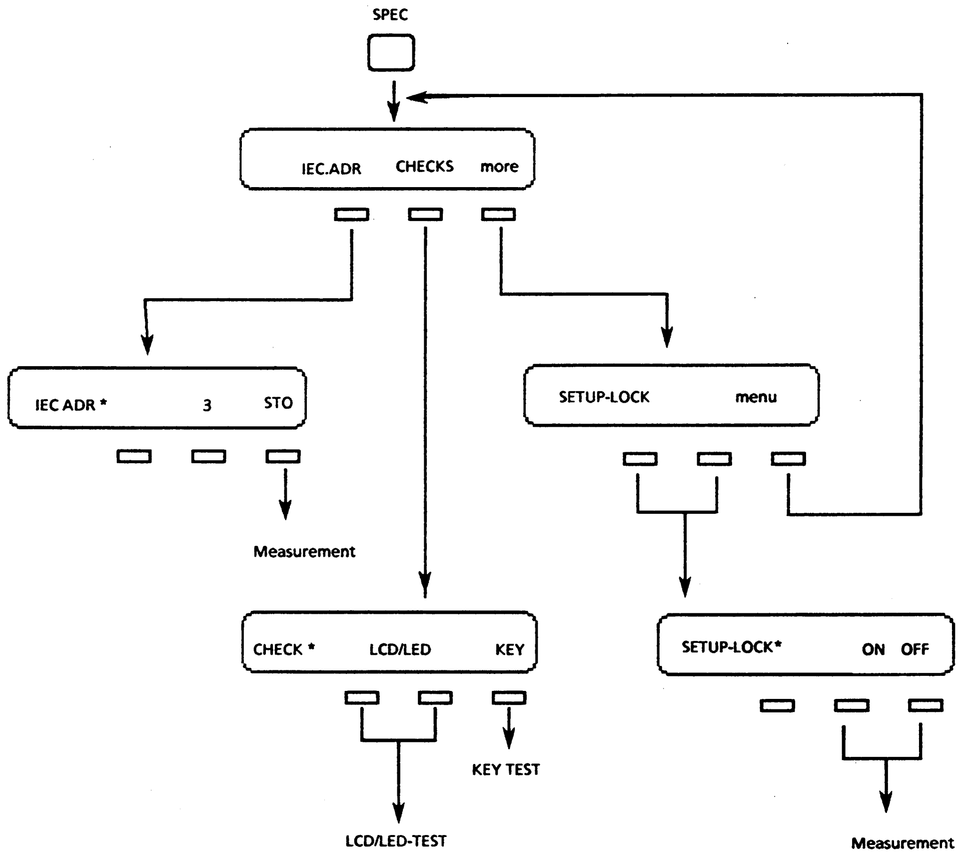
3.4.8 FILTER Menu



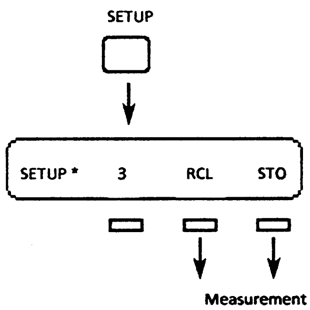
3.4.9 FREQ Menu



3.4.10 SPEC Menu



3.4.11 SETUP Menu



3.5 Instrument Reactions in the Display

3.5.1 Cautions

Table 3-2

OVERLOAD is indicated instead of a measured value	The maximum permissible voltage/power for the measured value has been exceeded. **Caution! The sensor might be destroyed!**
r. OVFL is indicated instead of a measured value	The selected measurement range has been exceeded to such an extent that no valid measurement is possible any more.
Message **"RANGE HOLD"** is blinking	With the measurement range retained (see 3.3.9), the test power exceeds the nominal value of the upper range limit, however, the measurement is still possible without errors.
Measured value is blinking	A pulse power is displayed, and the measured value exceeds the maximally permissible voltage/power for RMS weighting.
n. OVFL is displayed instead of a measured value	The measured value is larger than the value which can maximally be indicated in the display.
OVFL is displayed instead of a frequency value	The frequency to be displayed is larger than the value which can maximally be indicated.

3.5.2 Error Messages

All occurring errors are indicated to the user by an error message read out in the display. Errors occurring during keyboard operation must be confirmed using the →MEAS key, whereas errors occurring during interface operation remain on the display until the LOCAL key is pressed or the next valid command received (→ 3.7.7).

All errors indicated in the display can be called via IEEE bus from error status registers.

ERROR LIMIT:

A number entered via keyboard or interface lies outside the valid value range. The following table lists the limit values of all variable instrument parameters:

Table 3-3

Correction frequency	0 kHz to 10000 GHz
Voltages with dynamic frequency response correction	-12 V to + 12 V
Attenuation correction value	-200 to + 200 dB
Reference impedance	1 to 1000 Ω
Reference level value in V	-10^{13} to 10^{13} V
Reference level value in W	0 to 10^{13} W
Reference level value in dBm	-200 to + 150 dBm
Reference level value in dBµV	-100 to + 300 dBµV

ERROR SYNTAX:

A command entered via IEEE bus has not been understood by the instrument.

ERROR ILLEGAL:

The entered command has been understood, but does not make sense in the current context.

SENSOR ERROR:

The sensor connected has been identified as faulty.

ERROR ZERO:

A zero adjustment has been triggered without cutting off the test power. ± 20 V are permissible for the DC Probe (URV5-Z1) to enable differential measurements.

ERROR CALIB:

After switching on the instrument, the calibration data sets are checked for their checksum and plausibility. If one of these tests is negative, the above error message is displayed, and this calibration data set is replaced by ROM data until the next calibration or instrument repair.

The error message is displayed each time the instrument is switched on until the error has been eliminated.

Possible causes: Replacement of the lithium backup battery with the instrument switched off, hardware error

ERROR DATA:

After switching on the instrument, the instrument parameters are checked for their checksum. If the calculated checksum does not comply with the stored one, the above message is displayed. When the error message is confirmed, the basic setting is copied from the ROM into the main memory so that a valid instrument setup is provided. If the instrument functions properly, this message must not reappear when the instrument is switched on again.

Possible causes: Replacement of lithium backup battery with the instrument switched off, hardware error.

Caution:

In all probability, the stored instrument setups have also been destroyed.

ERROR RECALL:

This error message is displayed when an attempt is made to load an instrument setup via IEEE bus or keyboard from a memory, where no setup has been stored before.

ERROR SAVE:

An attempt has been made to store an instrument setup under the SETUP memory number 0. The memory number 0 contains the basic setup and cannot be overwritten.

ERROR LOCK:

The setup memories are locked. Nevertheless, an attempt has been made to store an instrument setup.

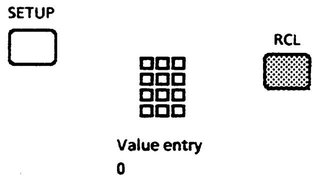
ERROR JUMPER:

An attempt has been made to call up calibration mode without having set the plug-in jumper X717 to the correct position on the main board.

ERROR HARDWARE:
An error has occurred in the hardware of the instrument. The error status registers provide detailed information on the type of the error (→ 3.7.7).

3.6 Basic Setting

The instrument is delivered in the basic setting. Almost all keyboard or IEEE bus entries change the instrument status. Return to the basic setting is possible using the following commands:



IEEE bus command:

C1 Basic setting of instrument status and IEEE bus interface

MR0 Basic setting of instrument status
The IEEE bus setting is not affected.

The two following tables illustrate the basic setting of instrument status and IEEE bus interface.

Table 3-4 Basic setting of instrument status

Instrument status parameters	**Basic setting**
Measurement mode	AVG
Measurement range selection	AUTO
Measuring range	—
Measured-value resolution	MEDIUM (3 1/2-digit)
Filter setting	AUTOMATIC
Filter range	—
Display unit	V/W (depending on sensor)
Frequency response correction	off
Correction frequency (static)	1 GHz
V/F coordinates for dynamic frequency response correction	(0 V, 1 GHz) (2 V, 18 GHz)
Attenuation correction	off
Attenuation correction value	40 dB

Continuation of Table 3-4

Instrument Status Parameter	Basic Setting
Display of correction frequency	off
Scale mode of bar display	AUTO
Full-scale values of SCALE function	0,10
Level reference value	1 V
characteristic impedance	50 Ω
LC-Display	on
Zero correction	off

The IEEE bus setting additionally affected by the command "C1" has the following basic setting:

Table 3-5 Basic setting of IEEE bus interface

Instrument Status Parameter	Basic Setting
End of string character	CR + LF
Alphaheader	on
SRQ request	off

Note:
After the basic setting "C1" command, the IEEE bus command "ST" provides the following string (→ 3.7.8):

"A0, AVxx, B0, G1, KA0, KF0, M0, N0, O0, Q0, RG0, RS3, SC1, U_0 or U_7, W3"

_: Space

xx: Filter which has automatically been selected by the instrument

3.7 Remote Control

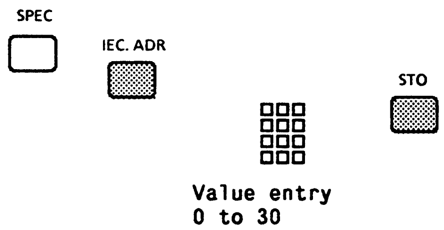
3.7.1 Preparation for IEEE Bus Operation

3.7.1.1 IEEE Bus Connection

The IEEE bus connection between controller and NRVS should consist of a shielded IEEE bus cable (e.g. 1 m long: R&S order number 0292.2013.15) in order to ensure high immunity to interference and minimum RF leakage.

3.7.1.2 Setting the IEEE Bus Address

The IEEE bus address can only be set via the keyboard using the following key sequence:



The address setting is stored in a nonvolatile memory. The IEEE bus address is factory-set to 7.

3.7.1.3 IEEE bus Interface

Characteristics of the interface:

The IEEE bus interface permits the NRVS to be remote-controlled by an external controller. The characteristics of the IEEE bus are summed up in the following items:

- Data bus 8-bit parallel
- Bidirectional data transfer
- Three-wire handshake
- High data transfer rate of max. 350 kB/s
- Up to 15 devices can be connected to the bus
- Total length of the connection cables up to 15 m (single connection up to 2 m)

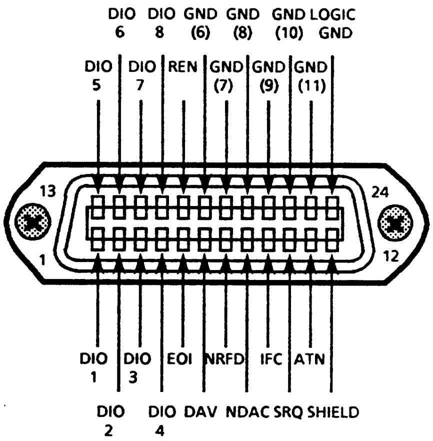


Fig. 3-7 IEEE bus connector

The IEEE bus interface is a 24-contact Amphenol socket, whose assignment is given in Fig. 3-7 and Table 3-1. The lines are divided into three groups:

- Data bus (8 lines),
- handshake bus (3 lines)
- and management bus (5 lines).

The lines are driven using negative logic, i.e. the messages are true (= 1) in the low state (0 V) and false (= 0) in the high state (5 V). Since the handshake and management lines are designed as open-collector outputs, the signals are ORed if several devices are parallel-connected via the bus.

Table 3-6 Pin assignment to IEC 626/1 (IEEE488-1)

Pin	Signal	Meaning	
1 2 3 4 13 14 15 16	DIO1(LSB) DIO2 DIO3 DIO4 DIO5 DIO6 DIO7 DIO8(MSB)	Data bus, bidirectional Transfer line for data, addresses and commands The data transfer is performed bit-parallel and byte-serial via the characters in the ISO 7-bit code (ASCII code).	Data bus
6	DAV	"Data valid" Listener uses DAV = L to indicate that the data applied to the data bus are valid.	Handshake bus
7	NRFD	"Not ready for data" Listener uses NRFD = L to indicate that it is not ready to accept data.	
8	NDAC	"Not data accepted" Listener uses NDAC = L to indicate that it has not accepted data yet.	
5	EOI	"End or identify" Depending on ATN, this signal has two meanings with respect to the signals applied to the data bus: ATN EOI Meaning on DIO 0 0 Data byte 1 0 Address or command 0 1 END (last data byte of a block) 1 1 IDENTIFY (request to identify after a service request)	Control bus
9	IFC	"Interface Clear" The system controller uses IFC = L to set the remote control circuits of all connected devices to a defined status (pulse length approx 100 µs)	
10	SRQ	"Service request" Using this line, each participating device equipped with this function can request service from the controller (SRQ = L).	
11	ATN	"Attention" The controller sets ATN = L while transmitting addresses or commands via the data bus. With ATN = H, data are transferred.	
17	REN	"Remote enable" The controller uses REN = L to switch the connected devices to remote control, manual operation being disabled.	
12 18 19 20 21 22 23 24	Shield GND GND GND GND GND GND Logic GND		

3.7.2 Interface Functions

The following IEEE bus interface functions are implemented with the NRVS:

Table 3-7 Interface functions

Syntax	Meaning
SH1	Handshake source function (full capability)
AH1	Handshake acceptor function (full capability)
T6	Talker function (capability to reply to serial poll)
L4	Listener function (unaddress if MTA)
SR1	Service request function (full capability)
RL1	Remote/local switchover function (full capability)
DC1	Device clear function (full capability)
DT1	Device trigger function (full capability)
PP0	No parallel poll implemented

Note on programming examples:

All programming examples refer to R&S BASIC V2.X and have to be matched to different IEEE bus environments, if necessary.

3.7.3 Universal Commands

Sections 3.7.3.1 and 3.7.3.2 list the most important universal commands necessary for the control. Further universal commands are to be obtained from the description of the controller used.

3.7.3.1 Unaddressed Universal Commands

3.7.3.1.1 Device Clear [DCL]

The DCL command sets the NRVS to a defined initial state. DCL corresponds to the command "C1" (→3.6) and should be used each time before using the bus and at the beginning of a program.

COMMAND (R&S-BASIC):

```
IECDCL
```

3.7.3.1.2 Local Lockout [LLO]

The LLO command disables manual operation on all devices connected to the IEEE bus. After the LLO command, the LOCAL key (→LOCAL) is disabled. The LLO command is used to protect against manual operating faults during IEEE bus control. Local lockout is indicated by the message LLO in the display.

COMMAND (R&S-BASIC):

```
IECLLO
```

The local lockout can be reset as follows:

- selectively until the next addressing as a listener:

  COMMAND (R&S-BASIC): `IECLAD 7` → 3.7.3.2.1
  `IECGTL` → 3.7.3.2.4

- definitely (for all devices connected to the bus):

  COMMAND (R&S-BASIC): `IECNREN`
  `IECREN`

3.7.3.2 Addressed Universal Commands

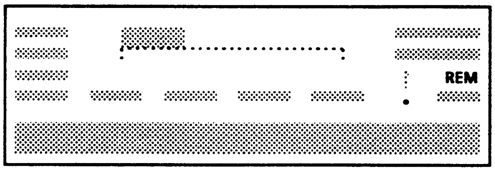
3.7.3.2.1 Send Listener Address (LAD)

A device is addressed as listener. The controller is connected to the device via IEEE bus. Then, the measuring instrument can receive addressed commands and data from the controller.

Example:

```
IECLAD 7
```

Readout in the display:



REMote is also displayed with the R&S controller-specific command IECOUT <address>,"string"

3.7.3.2.2 Send Talker Address (TAD)

A device is addressed as talker. This permits the controller to pick up data via IEEE bus.
This contributes to increase the measurement speed in combination with GET (Group execute trigger (→ 3.7.3.2.7).

Example:

```
IECLAD 7
IECGET
IECTAD 7
IEC$IN M$
```

3.7.3.2.3 Selected Device Clear (SDC)

Like the DCL command, the SDC command aborts each IEEE bus action which has not yet been terminated in the device addressed as listener and sets the device to a defined initial state according to the command "C1" (→ 3.6).

Example:

```
IECLAD 7
IECSDC
```

3.7.3.2.4 Go to local [GTL]

The GTL command enables all addressed devices to be manually operated again. If the NRVS is in calibration mode on reception of this command, the GTL command switches back to measurement mode. This command becomes ineffective when the device is again addressed to listen.

Lockout of the LOCAL key (Local Lockout, → 3.7.3.1.2) becomes temporarily ineffective until the device is again addressed as a listener using the GTL command. The LLO message at the display is maintained.

Example:

```
IECLAD 7     → 3.7.3.2.1
IECGTL
```

3.7.3.2.5 Command Output (ASCII String)

Using the IECOUT command, an IEEE bus device is addressed as listener and an ASCII string (e.g. common commands or device-specific commands) is sent to this device.

Example:

```
IECOUT 7,"DSL 20, DSR 40"      or

A$ = "RGO"
IECOUT 7,A$
```

3.7.3.2.6 Reading in of Measurement Result or Reply to Query (ASCII String)

The IECIN command permits to address an IEEE bus device as talker in order to read in an ASCII string from the IEEE bus output buffer of the device (measurement results or replies to queries) via the IEEE bus.

Example:

```
IECLAD 7: IECGET: REM Trigger measurement result
IECIN 7,MW$:      REM Read in measurement result
```

If the IECIN command is issued although the output buffer is empty, i.e. no measurement result has been triggered and there has been no query, either the string "NRVS NOT TRIGGERED" or the string "NRVS IN LOCAL MODE" is returned, depending on whether the NRVS is in remote or in local mode.

If SRQ generation is enabled, a special service request is generated in both cases (→ 3.7.4)

3.7.3.2.7 Group Execute Trigger [GET]

The GET command triggers a measurement result in the addressed device. The GET command is particularly suitable if high measurement rates are to be achieved. It provides the measurement result in the output buffer from where it can immediately be transferred into a string variable using an INPUT command. The GET command corresponds to the device-specific trigger command "X1", however, it requires less execution time.

Example:

```
100 IECLAD 7
110 IECGET:         REM Trigger and provide measurement result in output buffer
120 IECIN 7, M$:    REM Read in measurement result
130 PRINT M$:       REM Read out measurement result on screen
```

3.7.4 Service Request

By setting the SRQ (service request) line, the NRVS is able to request a service from the controller. This is useful if, for example, termination of a measurement or an error are to be indicated to the controller. The commands Q0 to Q3 (Table 3-8) permit to set the interface accordingly.

(*) in Table 3-8 means that SRQ is requested with the respective setting Q1 to Q3, (-) means that no SRQ is requested in this case. The SRQ request is generally switched off using the Q0 command.

If the controller performs a serial poll after reception of a service request, it can determine the instrument status that has caused the SRQ by decoding the status byte (Fig. 3-8 and Table 3-8).

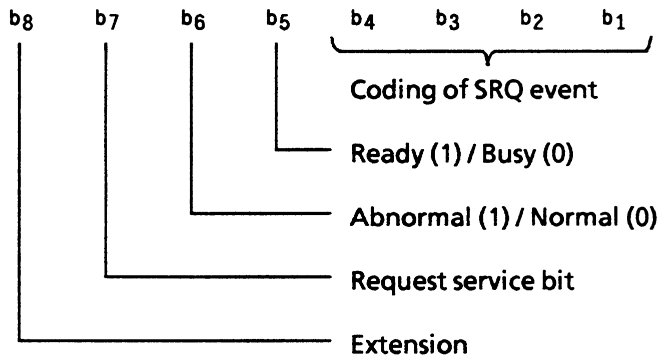


Fig. 3-8 Meaning of the status bits

Example:

`IECSPL 7,SB%`

Meaning:
Reading out the status byte from the device with IEEE bus address 7 and storage in variable SB%.

The instruction IECSPL 7, SB% replaces the individual instructions

```
IECSPE
IECTAD 7
IEC%IN SB%
IECMTA
IECSPD
```

Table 3-8 Coding of status byte

Instrument status	Status byte	Decimal equivalent	Setting commands		
			Q1	Q2	Q3
Measured value ready	0101 0000	80	*	–	–
Status info ready	0101 0101	85	*	*	–
Cal value ready	0101 0110	86	*	*	–
Zero measurement ready	0101 1010	90	*	*	–
Syntax error	0110 0000	96	*	*	*
Command illegal	0110 0001	97	*	*	*
Input date faulty	0110 0010	98	*	*	*
Controller input without trigger	0110 0011	99	*	*	*
Hardware error	0110 0100	100	*	*	*
NRVS not ready for output	0110 0101	101	*	*	*
Range exceeded with Range Hold *)	0110 0110	102	*	*	*
No sensor connected	0110 1000	104	*	*	*
Calibration faulty	0111 0001	113	*	*	*
Sensor changed (sensor data read in)	0111 0010	114	*	*	*
ZERO adjustment faulty	0111 0011	115	*	*	*

*) The range is overdriven to such an extent that a useful measurement is no longer possible. The message r. OVFL is indicated in the result display (→ 3.5.1).

3.7.4.1 Operating and Setting Commands

For reasons of clarity, each group of commands is supplemented by the reference to the respective keyboard entry as far as possible. References, which are specified by numbers only, refer to sections, in which the function is described in greater detail.

Table 3-9 Setting commands

Filter setting (filter)		
A0	Automatic filtering	(AUTOMATIC)
A1	Fixed filter mode with filter momentarily set	(MANUAL)
AV < 0...12 >	Fixed filter mode with filters 0 to 12	
F < 0...5 >	Fixed filter mode	(like NRV, → 3.7.13)
Display mode (SPEC->DISP)		
B0	The correction frequency is faded out.	(LEV)
B1	The measured value is displayed together with the correction frequency.	(LEV + FRQ)
Basic setting		
C1	Basic setting of the instrument status and the IEEE bus interface (except IEEE bus address) = A0, AVxx, B0, G1, KA0, KF0, M0, O0, RG0, RS3, SC1, U0 or U7 (depending on the sensor) and, additionally, N0, Q0, W3.	
MR0	Basic setting of the instrument status (SETUP → RCL 0). The IEEE bus setup remains unchanged. = A0, AVxx, B0, G1, KA0, KF0, M0, O0, RG0, RS3, SC1, U0 or U7 (depending on the sensor)	

xx: Filter number automatically set

Continuation of Table 3-9

Switching on/off LCD	
G0	Switch off LCD (→ 3.7.12)
G1	Switch on LCD (→ 3.7.12)
Attenuation correction (ATT CORR or REF → ATT)	
KA0	Switch off (OFF)
KA1	Switch on (ADJ.TO or CORR.BY → DATA→ STO)
Frequency response correction (FREQ)	
KF0	Switch off (OFF)
KF1	Switch on static frequency response correction (DATA → STO)
KF2	Switch on dynamic correction via the DC input (DC-INPUT → ON)
Measurement mode (MODE)	
M0	Average power (AVG)
M1	Pulse power (PULSE)
Storing and recalling of instrument setups (SETUP)	
MR <0...20>	Recall instrument setup from memory 0 to 20 (RCL)
MS <1...20>	Save instrument setup in memory 1 to 20 (SAVE)
Alphaheader (3.7.6)	
N0	With alphaheader
N1	Without alphaheader
Zero correction (ZERO)	
O0	Switch off
O1	Trigger zero measurement and activate correction
Measurement range (RANGE)	
RG, RG0	Automatic measurement range selection (AUTO)
RN<Datum>	Set measurement range (Presumable measured value in basic unit)
RG<1...7>	Set measurement range (like NRV, → 3.3.9)
Resolution of measured value (DISP → RESOL)	
RS2	2 1/2-digit (LOW)
RS3	3 1/2-digit (MED)
RS4	4 1/2-digit (HIGH)
Scale of bar display (DISP → BARGRPH)	
SC0	Switch off bar display (OFF)
SC1	Automatic scale (AUTO)
SC2	Fixed scale with any full-scale values (SCALE)
SC3	Volume display (VOL)

Continuation of Table 3-9

Special commands	
S0	LCD test (SPEC → CHECKS → LCD/LED)
S1	Keyboard test (SPEC → CHECKS → KEY)
S4	Date output of the five calibration functions
S6	Checksum of program memory (→ 3.7.5)
SE0	Global error byte (→ 3.7.7)
SE1	Hardware error byte (→ 3.7.7)
SE2	Error in calibration data sets (→ 3.7.7)
SE3	IEEE bus operating error (→ 3.7.7)
ST	Status output of all instrument setups (→ 3.7.8)
SP	Output of probe identification (→ 3.7.9)
SI	Output of calibration data (→ 3.7.11)
Display unit (UNIT) (UNIT → REL), (W ↔ dBm)	
U0	W
U1	dBm
U4V	%V
U4, U4W	%W
U5	dB
U7	V
U8	dBµV

Table 3-10 Interface Commands

Terminator with string output	
W0	NL
W1	CR
W2	ETX
W3	CR + NL
W4	EOI
W5	NL + EOI
W6	CR + EOI
W7	ETX + EOI
W8	CR + NL + EOI
SRQ request	
Q0	off
Q1	on (all SRQs)
Q2	on (except SRQ (80) all SRQs)
Q3	on (only error SRQ, > = 96)

Table 3-11 Data input commands

DV, DU	<Data>	Reference level value in V	
DM	<Data>	Reference level value in dBm	Reference level value input (REF → LEV)
DW	<Data>	Reference level value in W	
DS	<Data>	Reference level value in dBµV	
DR, DZ	<Data>	Characteristic impedance in ohms (REF → IMP)	
DA	<Data>	Attenuation correction value in dB (REF → ATT → CORR.BY → STO) or ATT CORR → CORR.BY → STO).	
DAW	<Data>	Displayed value in W to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAV	<Data>	Displayed value in V to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAM	<Data>	Displayed value in dBm to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAS	<Data>	Displayed value in dBµV, to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAD	<Data>	Displayed value in dB to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAPW	<Data>	Displayed value in %W to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DAPV	<Data>	Displayed value in %V to which the attenuation correction value is to be matched (REF → ATT → ADJ.TO → STO) or (ATT CORR → ADJ.TO → STO).	
DF	<Data>	Correction frequency in Hz (FREQ → DATA)	
DY	<Data>	Duty cycle in % (PULSE)	
DCV 1	<Data>	V1 in V	Voltage/frequency coordinates for dynamic frequency response correction via DC FREQ input (FREQ → DC-INPUT → ADJUST)
DCF 1	<Data>	F1 in Hz	
DCV 2	<Data>	V2 in V	
DCF 2	<Data>	F2 in Hz	
DSL	<Data>	Lower full-scale value (LOW)	Full-scale values (DISP → BARGRAPH → SCALE)
DSR	<Data>	Upper full-scale value (UPP)	

Table 3-12 Trigger commands

X0	Reset X3
X1	Trigger measurement
X2	Trigger and transfer measured value as reference value
X3	Automatic triggering is performed each time a measured value is requested.

Table 3-13 Output commands

Z0	Reference level value for relative display (in the unit stored)	
Z1	Characteristic impedance in Ω	
Z2	Correction frequency in Hz	
Z3	Attenuation correction value in dB	
ZCV1	V_1 in V	Frequency/voltage coordinates for automatic frequency response correction via DC FREQ input
ZCF1	F_1 in Hz	
ZCV2	V_2 in V	
ZCF2	F_2 in Hz	
ZF	Frequency equivalent for voltage applied at DCFREQ input	
ZY	Duty cycle in % (PULSE)	
ZSL	Lower full-scale value	
ZSR	Upper full-scale value	
ZV	Identification string (→ 3.7.10)	

3.7.5 Checksum of Program Memory

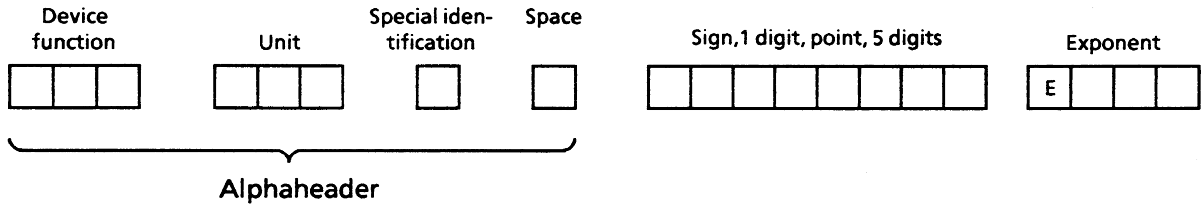
The NRVS software is stored in an EPROM. The checksum of the program memory corresponds to the sum of all bytes contained in this memory. This provides an additional security for identification of EPROM versions.

The string returned with the special command S6 has the following format:

`CHECKSUM:_xxxxxxx_(DEZ)_-_xxxxxx-_(HEX)` (_ = Space)

3.7.6 Alphaheader

All values, which can be called up via the IEEE bus interface using the output commands (Z..), can be assigned an alphaheader. The alphaheader precedes the actual numerical value within the returned character string. It contains additional information on the numerical value in a fixed format so that it can be easily evaluated by the host computer.
The format of a complete character string (alphaheader + numerical value) is illustrated below:



The device function describes the type of the returned value

Table 3-14 Coding of the device functions in the alphaheader

Device function	Meaning
AC_	Measured AC value
DC_	Measured DC value
PEP	Peak envelope power
PUL	Pulse power
REF	Reference value
ATT	Attenuation correction value
FRQ	Correction frequency for static frequency response correction
DCF	Frequency equivalent for DC voltage applied to the DC FREQ input
DTY	Duty cycle
SL_	Lower full-scale value
SR_	Upper full-scale value
CV1	V_1 — Voltage/frequency coordinates for automatic frequency response correction via DC FREQ input
CF1	F_1
CV2	V_2
CF2	F_2

Table 3-15 Coding of the unit in the alphaheader

Coding	Unit
V__	V
W__	W
DBU	dBµV
DBM	dBm
DB_	dB
%V_	%V
%W_	%W
HZ_	Hz
OHM	Ω
%__	%

_ = Space

Table 3-16 Coding of the special identification

Special identification	Meaning
_	Valid measured value
A	Full-scale value: automatic scaling
E	Hardware error. Measured value may be illegal.
F	Full-scale value: fixed scale
H	Scale is fixed and measured value exceeds righthand full-scale value.
L	Scale is fixed and measured value falls below lefthand full-scale value.
P	The read out value of pulse power is larger than the maximally permissible power for RMS weighting (only in the case of diode power sensors, → 3.3.8)
R	Overranging (Display: RANGE HOLD is blinking or r. OVFL)
!	Overload of the sensor or of the basic instrument (Display:OVERLOAD).

Example:

```
AC_V_ _!_1.4142E+01
```

3.7.7 Error Status Registers

The IEEE bus commands "SE0", "SE1", "SE2" and "SE3" permit to read the error status registers. Each byte is returned in the hexadecimal format in the form of two ASCII characters (0 to 9, A to F). The error status registers provide detailed information on the error status of the instrument.

All instrument errors are combined to a global error byte, one bit being assigned to each type of error.

Table 3-17 Global error byte (SE0)

Error bit	Meaning
0 (LSB)	Sensor is not recognized or is faulty(SENSOR ERROR).
1	Hardware error(ERROR HARDWARE).
2	Checksum of calibration data memory is faulty (ERROR CALIB).
3	Error with IEEE bus operation.
4	Error with ZERO measurement (ERROR ZERO).
5	Error with value entry (ERROR LIMIT).
6	Calibration offset measurement out of tolerance.
7	Calibration factor out of tolerance.

Error bits 3 to 7 are temporary bits and are reset after reading the global error byte. Bits 0 to 2 are directly linked with the occurrence of the respective error and remain set as long as the error exists.

The following error bits can be further decoded:

- Checksum of calibration data memory (4 bits / 1 byte)
- Hardware errors (56 bits / 7 bytes)
- IEEE bus operating errors (4 bits / 1 byte)

Tabelle 3-18 Hardware errors (SE1)

Error bits	Meaning
0	0 V Supply voltage of sensor
1	+5 V Supply voltage of sensor
2	+12 V Supply voltage of sensor
3,4	Reserved
5 to 10	Offset voltage of AC probe amplifier range 6 to 11
11, 12	Reserved
13, 14	Switch-off status of current source for temperature sensor
15	Temperature measuring voltage 100 µA-Sensor
16	Temperature measuring voltage 1 mA-Sensor
17 to 20	Offset voltage of DC probe amplifier, range 1 to 4
21	Offset current of DC probe amplifier
22	Supply voltage -12 V
23	Supply voltage -5 V
24	Supply voltage -6 V
25	Reserved
26	Offset of A/D converter
27 to 46	Reserved
47	Timeout of A/D converter
48	Offset DAC setting for AC probe amplifier
49	Offset DAC setting for DC probe amplifier
50 to 54	Reserved
55	Global error bit (ORing of bits 0 to 54)

A total of 14 characters of the following format are returned. Reserved bits are set to zero.

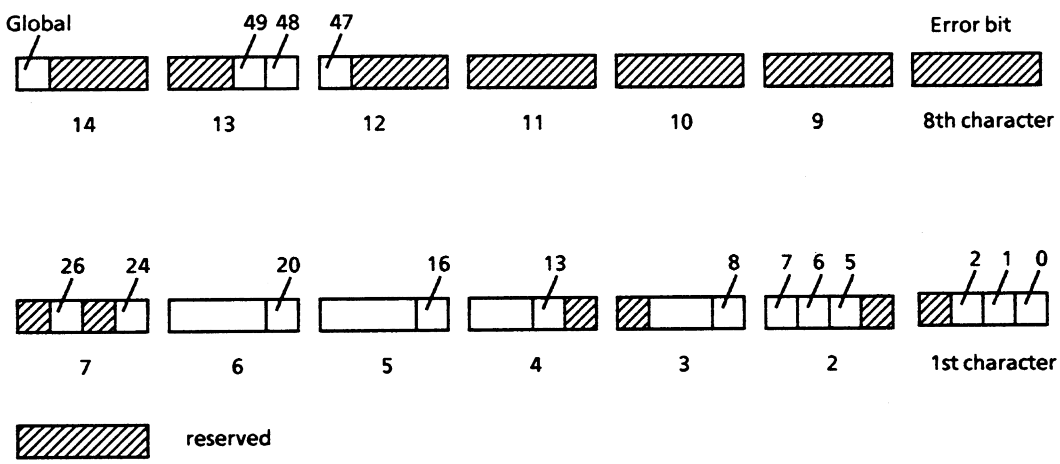


Fig. 3-9 Hardware error string

Table 3-19 Checksum of calibration data memory (SE2)

Error bits	Faulty data set
0	AC probe amplifier
1	DC probe amplifier
2	DC-FREQ input and DC output
3	Temperature sensor
4	Reserved
5	Reserved
6	Reserved
7	Reserved

The error bits are set/reset after initialization or calibration of the instrument.

Table 3-20 IEEE bus operating errors (SE3)

Error bits	Meaning
0	Command is illegal in the current context (ERROR ILLEGAL).
1	An attempt has been made to store an instrument setting under SETUP memory number 0 (ERROR SAVE).
2	An attempt has been made to read an instrument status memory, where no instrument status has been stored before (ERROR RECALL).
3	Calibration jumper on the main board is in the write-protection position (Error JMP).
4	Command has not been understood (ERROR SYNTAX).
5	Reserved
6	Reserved
7	Reserved

All bits are reset after reading of the error byte.

3.7.8 Status Output of All Instrument Setups

The character string of the instrument status output has the following format:

"Ax, AVxx, Bx, Gx, KAx, KFx, Mx, Nx, Ox, Qx, RGx, RSx, SCx, Uxx, Wx"

The upper-case letters represent the interface commands and the x are dummy values for their arguments.

3.7.9 Output of Probe Identification

In addition to its correction data, each probe contains an identification needed by the NRVS to identify the probe. This identification has a fixed format and contains the following units:

- Designation of sensor (12 characters)
- Commission number (10 characters)
- Calibration date (8 characters)

The following data fields are additionally provided with sensors with electrically erasable correction data memory:

- Stock number (12 characters)
- Name of calibration laboratory (20 characters)
- Calibration identification (20 characters)

3.7.10 Output of the Identification String

The NRVS answers the command "ZV" with the identification string

" ROHDE_&_SCHWARZ_NRVS_VER.:_x.x"
x.x = version number
_ = space

3.7.11 Output of Calibration Factors

The calibration factors are correction values for the various measurement functions and ranges of the NRVS. They are determined within the scope of a calibration and permanently stored in the battery-backed RAM.

They can be read out for the basic instrument NRVS using the IEEE bus command "SI". The NRVS returns a total of 34 lines of the following format upon the command "SI":

Table 3-21 Output of calibration data

Range Factor

```
AC+_RANGE_1__OK_CF=X.XXXXXX
AC-_RANGE_1__OK_CF=X.XXXXXX
AC+_RANGE_2__OK_CF=X.XXXXXX
AC-_RANGE_2__OK_CF=X.XXXXXX
AC+_RANGE_3__OK_CF=X.XXXXXX
AC-_RANGE_3__OK_CF=X.XXXXXX
AC+_RANGE_4__OK_CF=X.XXXXXX
AC-_RANGE_4__OK_CF=X.XXXXXX
AC+_RANGE_5__OK_CF=X.XXXXXX
AC-_RANGE_5__OK_CF=X.XXXXXX
AC+_RANGE_6__OK_CF=X.XXXXXX
AC-_RANGE_6__OK_CF=X.XXXXXX
AC+_RANGE_7__OK_CF=X.XXXXXX
AC-_RANGE_7__OK_CF=X.XXXXXX
AC+_RANGE_8__OK_CF=X.XXXXXX
AC-_RANGE_8__ER_CF=X.XXXXXX
AC+_RANGE_9__OK_CF=X.XXXXXX
AC-_RANGE_9__OK_CF=X.XXXXXX
AC+_RANGE_10_OK_CF=X.XXXXXX
AC-_RANGE_10_OK_CF=X.XXXXXX
AC+_RANGE_11_OK_CF=X.XXXXXX
AC-_RANGE_11_OK_CF=X.XXXXXX

DC__RANGE__1_OK_CF=X.XXXXXX
DC__RANGE__2_OK_CF=X.XXXXXX
DC__RANGE__3_OK_CF=X.XXXXXX
DC__RANGE__4_OK_CF=X.XXXXXX

TEMP_0.1MA___OK_CF=X.XXXXXX
TEMP_1__MA___OK_CF=X.XXXXXX

DC_FREQ<-____OK_CF=X.XXXXXX
DC_LEV->_(G)_OK_CF=X.XXXXXX
DC_LEV->_(0)_OK_CF=X.XXXXXX
```

_ = Space

The calibration factors are the quotients from actual value and nominal value and therefore lie within the range of 1. During calibration and upon switch-on, their plausibility is checked. If a calibration factor lies outside a tolerance of 5%, the error message "error CAL" is read out in the display. In the output string according to Table 3-21 (e.g.: AC -_ RANGE _8...), the extension "OK" is replaced by "ER" for the faulty calibration factor. When the instrument is switched on, a faulty calibration factor is replaced by its nominal value after confirmation of the error message "ERROR CALIB" (→MEAS).

3.7.12 Switching the Liquid Crystal Display On and Off

For technological reasons, the microprocessor of the NRVS takes a relatively long period of time to write on the LCD. In order to increase the measurement speed in IEEE bus operation, the bargraph or the complete liquid crystal display can therefore be switched off except for the status indications (REM etc.).

The appropriate IEEE bus commands are:

"SC0"	Switch off bargraph
"G0"	Completely switch off LCD

The time saved when the LCD is switched off partially or completely can be indicated as follows:

Table 3-22

Status of Display	Time Saved per Measurement	IEEE bus Command
Display on, bar off	6 ms	G1, SC0
Display off, bar off	18 ms	G0

An LCD (G0) which has completely been switched off can be reactivated by means of

- command G1
- switch-over to local mode (LOCAL key)
- switching the NRVS on and off.

Note: By switching over to local mode and switching the NRVS on and off the display can be activated only temporarily. When next addressing the NRVS via IEEE bus it is switched off again. Status G0 remains stored in background storage until it becomes ineffective by command G1.

3.7.13 Compatibility With the IEEE bus Syntax of R&S Power Meter NRV

The IEEE bus syntax of the NRVS has been adapted as far as possible to that of the NRV.

If the capabilities of the NRVS deviate from those of the NRV such that adaptation of the syntax is no longer possible, the NRV commands are either understood without reaction of the NRVS, or they produce a SYNTAX error.

Table 3-23

The following commands are understood without reaction of the instrument	
C0	Reading the probe data into the basic instrument. With the NRVS, the probe data are automatically read in after connecting a probe.
E0	Switching off PEAK(PEP) measurement.
IA	Input for channel A valid.
PA	Switchover to channel A.

Table 3-24

The following commands are not understood and produce a SYNTAX error	
E1	Switching on PEAK(PEP) measurement. The NRVS cannot measure PEP.
IB	Input for channel B valid. The NRVS has only one channel.
PB	Switchover to channel B. The NRVS has only one channel.
U2	Setting the output unit dBV
U3 [[V][W][X]]	Setting the output unit lin
U6 [[V][W][X]]	Setting the output unit X/Ref
Y0,Y1,YX	Switch off, switch on, trigger cyclical temperature measurement.
Y?	Poll to determine whether cyclical temperature measurement is switched on or off.
DB	Reference value output in dBV
H0,H1	Switch off/on help mode (PET timeout correction)
X4	Setting for continuous trigger
X8	Trigger command for both channels.
S5	Output of NRV error code.

Filter Setting

The NRV commands for filter setting (F0...F5) are understood by the NRVS and put into action accordingly. When outputting the instrument status (→ 3.7.8) the equivalent filter AVxx is displayed instead of the Fx setting.

Selection of Measuring Range

The NRVS understands the command RG<x>, however, uses the range number x in a different manner than an NRV (→ 3.3.9).

3.8 DC Voltage Output (DC)

The DC voltage output is primarily used for driving XY recorders, providing a positive DC voltage for this purpose, which is linearly connected with the bar display. 0 V corresponds to the lefthand and + 3 V to the righthand full-scale value.

It is advisable for most applications to have a fixed scale (DISP →-BARGRPH- →SCALE), since automatic changing of the scale affects the relationship between measured value and voltage at the DC voltage output. This might result in unwanted changing of the scale and thus in a sudden change in the recorded characteristic.

3.9 Sensor Check Source (Option)

The sensor check source can be used to check the connected sensor. It supplies a constant RF power of 1.00 mW at a frequency of 50 MHz (see specifications). The signal is almost free from harmonics and nonharmonics, so that no additional errors are encountered with diode power sensors. The sensor check source is permanently on.

- Sensors with a 50-Ω N connector can be directly connected to the sensor check source. For sensors with PC 3.5 connector, the adapter supplied with the sensor check source can be used.
- Sensors with a 75-Ω N connector have to be connected via a Matching Pad RAM or at least via a mechanical adapter. When using the RAM, its insertion loss of 5.72 dB has to be taken into account. Purely mechanical adapters always reduce the displayed power by approx. 4% to 0.96 mW due to the mismatch of the sensor which also causes major measurement uncertainties.
- Without a termination, Insertion Units URV5-Z2 and URV5-Z4 (50 Ω) display 6 dB too much (0.447 V or 4 mW).

3.10 Measurement Accuracy

Unavoidably, each measurement produces measurement errors originating from different causes. The actual error value in any measurement is almost never known. It is only possible to determine the possible maximum values of the individual errors and calculate limits within which the complete error may lie.

3.10.1 Mismatching

The high-frequency power sensors for the NRVS are used to measure the power, which a source can provide to a load with the impedance Z0. In general, both the impedance of the source and the impedance of the power sensor constituting the load deviate from the value Z0. The power error resulting from this mutual mismatch can be calculated as follows:

$$E_P = \frac{1 - |\Gamma_l|^2}{|1 - \Gamma_g \Gamma_l|^2} - 1 \qquad [1]$$

Γ_g: complex reflection coefficient of the source
Γ_l: complex reflection coefficient of the load

The numerator $1 - |\Gamma_l|^2$ in equation [1] includes an error component solely caused by the load. It is measured during calibration of the power sensors for the NRVS and is taken into account in the calibration factor (→ 3.10.2).

A second error component is produced by the denominator $|1 - \Gamma_g \Gamma_l|^2$. Since Γ_l and Γ_g are complex alternating current quantities, the error may be positive or negative depending on their phasing. In general, the reflection coefficient Γ_g of the source is not known according to magnitude and phase, which is why the magnitude of this error cannot be specified in the data sheet and cannot be calculated in practice either.
However, the error limits can be determined from the maximum values of the magnitudes of the reflection coefficients. The mismatch uncertainty Mu produced between source and load can be calculated in percent of power:

$$M_u[\%] = 100 * [(1 \pm r_g r_l)^2 - 1]$$

Approximately

$$M_u[\%] \approx \pm 200 * r_g * r_l$$

r_g Magnitude of reflection coefficient of source
r_l: Magnitude of reflection coefficient of load

3.10.2 Calibration Factor

Since the reflection coefficient of a power sensor is unavoidably greater than zero (or its VSWR >1), part of the power offered to the sensor is reflected. A further part is absorbed by power losses between RF connector and power sensor. All RF power sensors for the NRVS are individually measured at a great number of calibration frequencies during production. The measured power is compared with that provided by the calibration system, and the ratio between both values is stored as the calibration factor. If a measurement is performed with the NRVS with frequency response correction switched on, the measurement result is set off against the calibration factor associated with the entered test frequency before.

All measuring systems used by R&S for calibration of power sensors are based on the appropriate primary standards of the "Physikalisch-Technische Bundesanstalt PTB".

Nevertheless, the determination of the calibration factor also includes measurement uncertainties resulting from mismatch, power transmission errors and the measurement uncertainty of the primary standards. Depending on the frequency and the sensor used, the error limits of the calibration factor are specified as RSS errors in the data sheet (→ 3.10.7).

3.10.3 Linearity Error

An ideal power meter is supposed to feature a strictly proportional relationship between the applied test power and the displayed test power over the complete measurement range. In reality, however, power meters feature a linearity error, which depends on the output range and, in the case of power sensors with semiconductor diodes, also on the frequency.

The power sensors manufactured by R&S feature a very small linearity error, since the power characteristic of each power sensor is individually measured during production and stored in the non-volatile data memory. These data are used to correct the power displayed by the NRVS using a special algorithm so as to produce an almost perfect linearity. The residual error is indicated in the specifications of the power sensors.

3.10.4 Display Noise

The noise superimposed on the output signal generated by the power sensor causes small variations of the displayed value resulting in a measurement error. Since the generation of noise is statistical, it is useful to describe the noise quantity using the methods of probability analysis.

R&S specifies the double value of the standard deviation for the noise power. This means that in the case of 95% of a statistically sufficient number of measurements this value of the noise power is not exceeded.

The display noise is an additive value, i.e. the error caused by noise is the smaller, the greater the measuring power.

The value of the display noise can be affected by the filter setting (→ 3.3.3): Increasing the degree of filtering by one reduces the display noise power by approx. 30%.

3.10.5 Zero Error

A zero error is produced if a power other than zero is displayed without test power applied. In most cases, this offset is caused by temperature variations to which the power sensor is subjected. During zero adjustment (→ 3.3.15) the offset is measured and subtracted from the measured value in the following measurement.

The zero error is also an additive value, whose error influence is the smaller the greater the test power. When measuring small powers, it is therefore advisable to minimize temperature variations which might be produced by body heat transferred to the power sensor or heated RF connectors of signal generators and repeat the zero adjustment from time to time.

3.10.6 Temperature Influence

The temperature influence is an additional error, which is produced at a constant temperature deviating from 23 °C.

In the basic instrument NRVS, an additional error may arise outside the temperature range 18 to 28 °C, whose maximum value is indicated in the Specifications.

All power sensors feature a temperature coefficient which may achieve up to 0.5 %/degree. In the case of R&S power sensors, the temperature influence is corrected using a special algorithm: The temperature coefficient is stored in the non-volatile data memory of the power sensor, and each power sensor contains a temperature sensor, which the NRVS uses to carry out cyclical temperature measurements. This permits the temperature influence to be corrected except for a small residual error indicated in the Specifications.

3.10.7 Maximum and RSS Error

The RSS error of a sum of individual errors is the error which, in general, is not exceeded by 95% of all measurement results.

A correct error specification must include the two statements:

Error limits and size of the confidence interval, i.e. how many measurement results of a large number of measurements do not exceed the error limits.

With the maximum error, the confidence interval corresponds to 100%: The error limits are never exceeded. The maximum error E_{max} is the sum of the individual maximum errors $(E_{max})_i$:

$$E_{max} = \sum_{i=1}^{N} (E_{max})_i$$

In practice, the maximum error is only rarely achieved. If the complete error is the sum of a number of individual errors, which have independent causes (and this is the case with the individual errors described so far), it is very rare, statistically, that all individual errors simultaneously occur in a measurement with their maximum value and the same sign.

In the field of power measurements, it is therefore common practice to specify the RSS error (root sum of the squares) which is closer to practice.

This is the square root of the sum of the individual RSS errors squared $(E_{RSS})_i$:

$$E_{RSS} = \sqrt{\sum_{i=1}^{N} (E_{RSS})_i^2}$$

4 Maintenance

Under normal operating conditions, regular maintenance is not required apart from occasional cleaning of the inscription panel and display field. However, we recommend to check the lithium backup battery and recalibrate the basic instrument every 2 years (cf. Service Manual, section 7.3.4). For recalibration the user is recommended service kit NRVS-S1 (stock no. 1029.2708.02). The service kit permits computer-controlled testing, calibration and troubleshooting for the analog part and the DC output. To this end, it contains a special adapter for the analog part (instead of the sensor) as well as a floppy disk for the R&S controllers of the PSA family (or other IBM-compatible controllers). In addition, a D.C. calibrator and a digital multimeter (UDS5) are required.

For reasons of a high calibration accuracy, the calibration of sensors to the NRVS can only be performed with the manufacturer at present.

4.1 Cleaning the Inscription Panel and Display Field

If these parts are dirty, they only may be cleaned using a soft rag and non-alcoholic solvent, e.g. a commercially available detergent (no spirit or benzine). To this end, the inscription panel can be easily removed by unscrewing the four Phillips screws.

4.2 Checking and Replacing the Lithium Backup Battery

To protect the stored calibration data and reference values as well as complete setups while the instrument is switched off, a CMOS RAM with battery backup is provided.

The service life of the backup battery is typ. 5 years. However, the current consumption of the CMOS RAM and self-discharge of the battery are subject to large manufacturing tolerances. In particular at higher ambient temperatures, this may lead to faster battery discharge.

Checking the battery:

- Switch off instrument.
- Remove the two rear feet (4 Phillips screws).
- Push the lower instrument cover towards the rear panel and remove it.
- Switch on instrument.
- Measure the battery voltage after connection of a digital voltmeter to soldering terminals X700 and X701. Make sure not to produce a short-circuit from the positive battery terminal X700 to ground (Fig. 4-1).
- Battery voltage with new battery: $V_{nom} = 3.67$ V
  permissible limit: $V_{batt} \geq 3.2$ V.
- When the value falls below the permissible limit, replace the battery.

Replacing the battery:

- Careful handling during battery replacement may avoid data loss in the RAM. Recalibration will not be necessary then.
- Switch on instrument (RAM is supplied via $+5\ V_{DIG}$).
- Cut the fastening strap of battery G700 and unsolder the terminals. Make sure that the battery is not short-circuited (use ungrounded soldering iron).
- Solder new battery in place and fasten using a new fastening strap.
- Switch off the instrument and complete.
- If no error message appears when the instrument is put into operation again, the NRVS is immediately ready for use.
- If the error message "*ERROR CALIB*" (calibration data missing) appears, recalibrate the instrument as described in the Service Manual. Since data loss usually includes complete instrument setups, the error message "*ERROR DATA*" is also displayed.

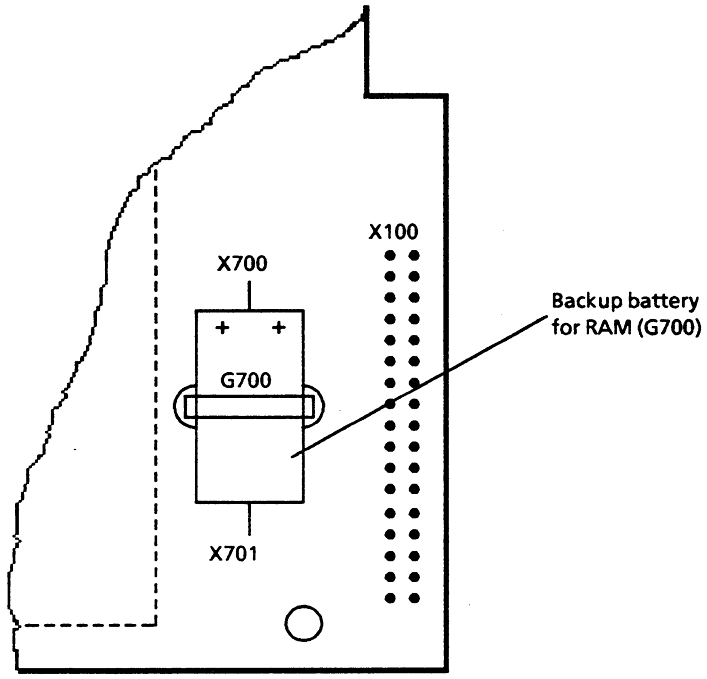


Fig. 4-1 Position of RAM backup battery on the mainboard

5 Testing the Rated Specifications

The performance tests described in this section check the interaction between the basic instrument NRVS and a sensor.

For separately testing the accuracy of the basic instrument alone service kit NRVS-S1 is required.

Before starting the performance tests the NRVS should have warmed up for at least two hours at a test temperature of 18 to 28 °C. An ambient temperature of 20 to 25 °C would be ideal, since the measuring instruments operate most accurately within this range. You are also kindly requested to ensure that the relative humidity of air does not exceed 80 % and supply voltage does not deviate from the set nominal value by more than ± 10 %.

5.1 Measuring Instruments and Auxiliary Means

Item No.	Instrument	Specifications	Recommended R&S instrument	Application Section
1	D.C. Calibrator	1 V to 400 V ±0.01 %		5.2.5
2	A.C. Calibrator	200 µV to 10 V ±0.1 % 100 kHz (200 kHz)		5.2.6
3	D.C. Probe URV5-Z1			5.2.4 5.2.5
4	RF Probe URV5-Z7 or 10-V Insertion Unit URV5-Z2			5.2.4 5.2.6
5	Thermocouple Sensor		NRV-Z51	5.2.9
6	Controller with IEC bus interface		PSA	5.2.3
7	D.C. Voltmeter		UDS5	5.2.7

5.2 Test Sequence

The test sequence corresponds to the test report given in section 5.3, from which the nominal values and permissible tolerances can also be obtained.

5.2.1 Testing the Switch-on Routine

After switching on, the NRVS should log on with the sequence described in section 2.1.4.

5.2.2 Testing the Function of Keyboard and Display

The function of the keyboard and display (LCD and LED) can be checked according to section 3.3.12 (**SPEC → CHECKS → LCD/LED und SPEC → CHECKS → KEY**). By operating any key, the key recognition is checked as well as possible bouncing detected. During the LCD-/LED test all segments in the LC display and the LED are controlled.

5.2.3 IEC Bus Interface

The stored IEC bus address is displayed during the switch-on sequence (cf. section 2.1.4). In manual mode it can be checked by pressing the "LOCAL" key or special function **SPEC → IEC.ADR**.

The check consists of testing the NRVS responses to some specific IEC bus commands.

The following list contains a complete measurement program for the R&S Process Controller PSA in the left-hand column, the responses of the NRVS or the screen outputs in the middle column and a brief outline of the individual test stages in the right-hand column. This description allows the users of other process controllers to write measurement programs to their own requirements. The following program is written in R&S Interpreter BASIC. In the program example, "7" is selected as IEC bus address.

An a.c. sensor URV5-Z2/-Z4/-Z7 or a power sensor NRV-Z... is to be inserted into the receptacle of the basic instrument and the NRVS to be initialized (e.g. by switching off and immediately on again) before the test is started.

PSA measurement program	Response of NRVS/PSA	Description
100 IECTERM 0 110 IECLAD 7 • 120 IECSDC 130 IECUNL 140 STOP	"REM" lights up. Measured value disappears	Terminators CR + NL Addressing Selected Device Clear Deaddressing
200 IECOUT 7, "AV3, U0, Q1" 210 IECOUT 7, "X1" 220 IECIN 7, A$ 230 PRINT A$ 240 ON SRQ1 GOSUB 270 250 IECOUT 7, "Q0" 260 GOTO 310 270 HOLD 500 280 IECSPL 7, V% 290 PRINT V % 300 RETURN 310 STOP	"RDY" and "SRQ" shortly light up, display of the measured value and of filter setting LP3M on NRVS display. AC W +3.51237E-10 * 80 *	Unit W, filter 3, SRQ request On Trigger Reading in the string in A$ Screen output Procedure branching statement on detection of SRQ SRQ request Off Serial poll Output of SRQ byte Return statement of the SRQ subprogram
400 IECTERM 1 410 IECOUT 7, "S0" 420 HOLD 500 430 IECOUT 7, "G1" 440 IECTERM 0 450 STOP	All display elements light up shortly, then bar graph and measured value fade	Terminator EOI Terminators CR + NL
500 IECOUT 7, "Q1" 510 IECLAD 7 520 IECGET 530 IECUNL 540 IECIN 7, A$ 550 PRINT A$ 560 ON SRQ1 GOSUB 590 570 IECOUT 7, "Q0" 580 GOTO 630 590 HOLD 500 600 IECSPL 7, V% 610 PRINT V% 620 RETURN 630 STOP	"RDY" and "SRQ" shortly light up. Display of the measured value and of filter setting LP3M on the NRVS display AC W +3.51237E-10 * 80 *	SRQ request On Addressing Group Execute Trigger Deaddressing Reading in the string in A$ Screen output Procedure branching statement on detection of SRQ SRQ request Off Serial poll Output SRQ byte Return statement in SRQ subprogram

* = Display on controller screen, measured value as an example

5.2.4 Connecting the Sensor

The following test permits to check the interaction between sensor and basic instrument. First, set the NRVS to LOCAL mode using the "LOCAL" key and remove the sensor from the instrument. The display must then read out "no SENSOR". For checking, plug any sensor into the "SENSOR" receptacle. After a certain response time and the output of "READ SENSOR" while the sensor memory is being read, measured values must be displayed. When the sensor is removed, the display "NO SENSOR" must appear again. If the contents of the probe memory are read out with errors, the display reads "SENSOR ERROR".

5.2.5 D.C. Measurement Accuracy

In the subsequent measurements, the NRVS measures the output voltage of a D.C. calibrator using a D.C. Probe URV5-Z1 (Fig. 5-1).

Instrument Settings:

Unit	UNIT	V
Resolution	RESOL	HIGH (4½digit)
Zero correction	ZERO	OFF (press ZERO key longer)
Attenuation correction	ATT CORR	OFF
Range	RANGE	AUTO
Filter	FILTER	AUTOMATIC

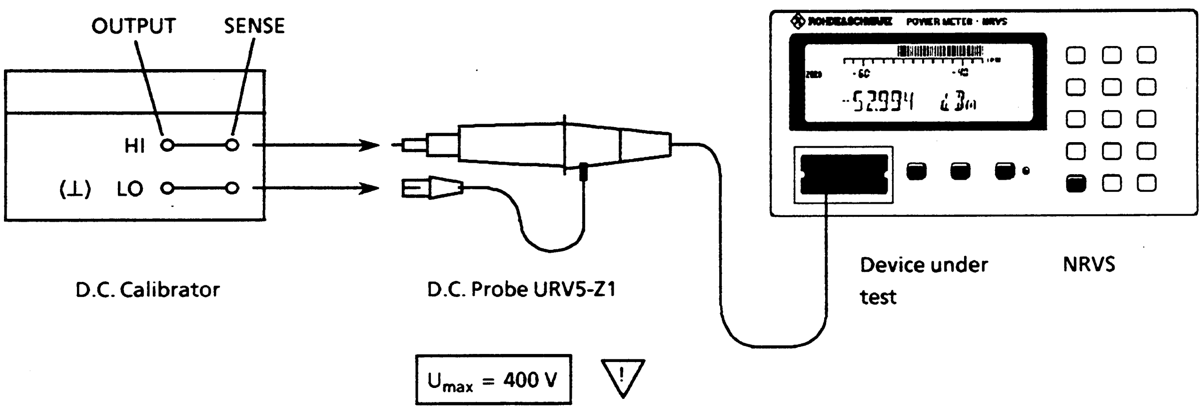


Fig. 5-1 Checking the D.C. measurement accuracy

5.2.6 A.C. Measurement Accuracy

The following tests permit to determine the A.C. measurement accuracy of the basic instrument NRVS by measuring the output voltage of an A.C. calibrator using an RF Probe URV5-Z7 or a 10-V Insertion Unit URV5-Z2 (Fig. 5-2). Make sure that the noise voltage (determined in broadband measurement) of the A.C. calibrator does not exceed 200 µV. Otherwise, a divider or a lowpass filter has to be provided at the calibrator output.

Calibrator settings: 0.2 mV/10 Hz

With this calibrator setting, zero adjustment of the NRVS is started. Due to the low frequency, only the residual noise voltage is measured and eliminated like an offset error.

After the zero adjustment, the frequency is set to 100 kHz (200 kHz with RF probe) and the output voltage measured at the following values:

0.2 mV / 10 mV / 100 mV / 1 V / 10 V

The permissible display values can be obtained from the test report (section 5.3).

You are kindly requested to perform the measurements in the given order!
After high voltages have been measured, the RF probes need some recovery time before small levels can be measured again.

Instrument settings:

Unit	UNIT	V
Resolution	RESOL	HIGH (4½ digit)
Attenuation correction	ATT CORR	OFF
Frequency response correction	FREQ CORR	OFF
Range	RANGE	AUTO
Filter	FILTER	AUTOMATIC

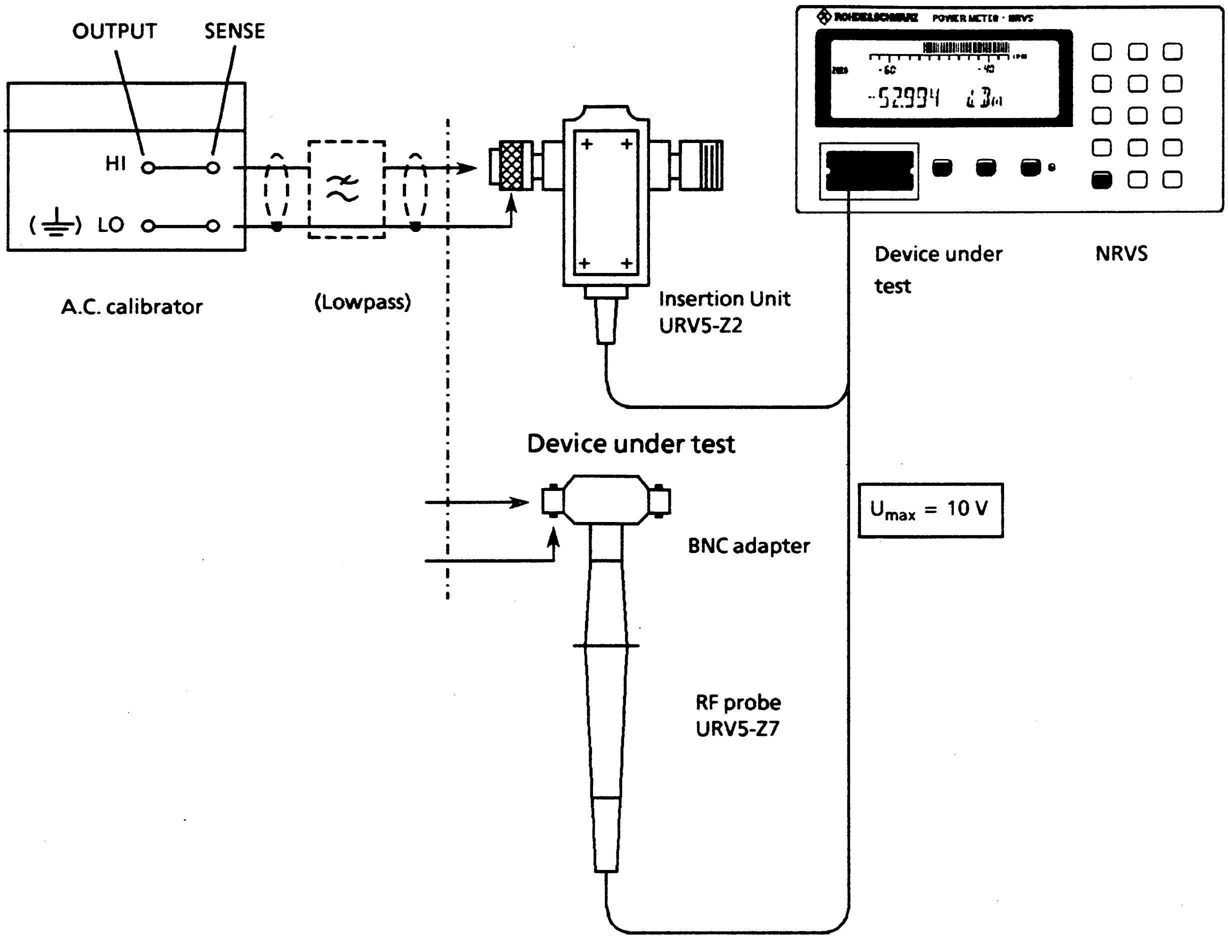


Fig. 5-2 Checking the A.C. measurement accuracy

5.2.7 D.C. Voltage Output

The voltage range of the D.C. voltage output can be checked using a D.C. calibrator and the selectable scale. To this end, set the D.C. calibrator to 1 V and connect to the NRVS via D.C. Probe URV5-Z1. After the measured value has been transferred as reference value, a symmetrical scale can be freely selected (e.g. ± 10 dB). A single bar is then positioned at midscale, and the D.C. output should provide a D.C. voltage of + 1.50 V. When selecting 0 dB as the left-hand or right-hand full-scale value, a voltage of 0 V or + 3.00 V, respectively, should be obtained at the output and the single bar is above the left-hand or right-hand full-scale value.

Procedure:

- **Feed 1 V DC into NRVS via URV5-Z1**
- **MEAS → REF → STO** — Taking measurement value as a reference value
- **UNIT → REL → ΔdB** — Selection of relative unit in dB
- **DISP → BARGRPH → SCALE** — Scaling of bar display
- **-10 → STO** — Left-hand scale value (LOW) is -10 dB
- **10 → STO** — Right-hand scale value (UPP) is 10 dB

The single bar should now be positioned above the zero at midscale. The DC output should provide 1,5V.

- **DISP → BARGRPH → SCALE** — Scaling of bar display
- **0 → STO** — Left-hand scale value (LOW) is 0 dB
- **STO** — Right-hand scale value (UPP) remains 10 dB

The single bar should now be positioned left above the zero. The DC output should provide 0 V.

- **DISP → BARGRPH → SCALE** — Scaling of the bar display
- **-10 → STO** — Left-hand scale value (LOW) is -10 dB
- **0 → STO** — Right-hand scale value (UPP) is 0 dB

The single bar should now be positioned at the right above the zero. The DC output should provide 3,0 V.

When accessing the NRVS via the IEC bus, a convenient setting of the scale values is possible using commands
DSL <numerical value> for the left-hand scale value (LOW) and/or.
DSR <numerical value> for the right-hand scale (UPP) value.

An A.C. voltage at f ≈ 50 Hz and a typical peak-to-peak value of 5 mV is superimposed on the output voltage.

Due to the standard setting of a symmetrical scale when using a DC probe, the DC output provides a voltage of 1,5 V if the input voltage measured via the DC probe is 0 V!

5.2.8 DC FREQ Input

The DC-FREQ input can be checked by applying a D.C. voltage. For this purpose the input must be first scaled.

Operating Sequence:

• **FREQ → DC-INPUT → ADJUST**	
• **0 (V) → STO**	Low voltage is 0 V
• **1 (GHz) → STO**	Low frequency is 1GHz
• **10 (V) → STO**	UPP voltage is 10 V
• **11 (GHz) → STO**	UPP frequency is 11 GHz
• **ON**	Frequency correction on
• **DISP → more → LEV + FREQ**	Frequency display on

With 2 V DC applied, the instrument should indicate (read) 3 GHz. With 8 V DC applied, a reading of 9 GHz should be obtained.

General relation: $$f = f_1 + \frac{f_2 - f_1}{V_2 - V_1} \cdot (V - V_1)$$

V: applied D.C. voltage

f: calculated frequency

5.2.9 Testing the Sensor Check Source (Option)

The output power is measured with Thermocouple Sensor NRV-Z51. The limit values given in the test report also contain the errors of the basic unit and the sensor. The influence of the ambient temperature is also taken into account.

How to proceed:

- Connect thermocouple sensor to URV35.
- Set the basic unit:

Unit	UNIT	W
Resolution	RESOL	HIGH (4½ digit)
Attenuation correction	CORR ATT	OFF
Frequency response correction	CORR FRQ	OFF
Range	RANGE	AUTO
Filter	FILTER	AUTOMATIC

- Carry out zero adjustment (ZERO key) at the earliest 1 minute after having connected the sensor.

- Connect sensor to sensor check source and measure power.

5.3 Test Report

R&S
NRVS
Order no.: 1020.1809.02
Serial no.: ....

Date: ....

Name: ....

Item	Characteristic	Measure-ment to section	Min	Actual	Max	Unit
1	Switch-on sequence	5.2.1	—	—	—	—
2	Testing the function of keyboard and display	5.2.2	—	—	—	—
3	Testing the IEC bus interface	5.2.3	—	—	—	—
4	Testing the sensor connection	5.2.4	—	—	—	—
5	Testing the D.C. measurement accuracy	5.2.5				
	0 V		-6E-4	—	+6E-4	V
	+ 1V		+0.9955	—	+1.0045	V
	- 1 V		-0.9955	—	-1.0045	V
	+10 V		+9.959	—	+10.041	V
	+100 V		+99.59	—	+100.41	V
	+400 V		+397.6	—	+402.4	V
6	Testing the A.C. measurement accuracy	5.2.6				
	Zero adjustment		—	—	—	
	0.2 mV		0.174	—	0.223	mV
	10 mV		9.883	—	10.117	mV
	100 mV 100 KHz		98.83	—	101.17	mV
	1 V (200 KHz)		0.9883	—	1.0117	V
	10 V		9.883	—	10.117	V
7	Testing the D.C. voltage output	5.2.7				
	1.50 V		+1.495	—	+1.505	V
	0.00 V		-0.0055	—	+0.005	V
	3.00 V		+2.995	—	+3.005	V
8	Testing the DC FREQ input	5.2.8				
	2 V		2.99	—	3.01	GHz
	8 V		8.97	—	9.03	GHZ
9	Testing the sensor check source	5.2.9	0.98	—	1.02	mW