R&S®ZVL
Vector Network Analyzer
Quick Start Guide

ROHDE & SCHWARZ

The Quick Start Guide describes all R&S®ZVL models:

- R&S® ZVL3 (frequency range up to 3 GHz),   stock no. 1303.6509K03
- R&S® ZVL6 (frequency range up to 6 GHz),   stock no. 1303.6509K06
- R&S® ZVL3-75 (frequency range up to 3 GHz),   stock no. 1303.6509K75
- R&S® ZVL13 (frequency range up to 15 GHz),   stock no. 1303.6509K13

The following abbreviations are used throughout this manual:
R&S®ZVL is abbreviated as R&S ZVL.
R&S® FSL-xxx as R&S FSL-xxx.

Basic Safety Instructions

Always read through and comply with the following safety instructions!

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standards of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment they require are designed, built and tested in accordance with the safety standards that apply in each case. Compliance with these standards is continuously monitored by our quality assurance system. The product described here has been designed, built 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, you must observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, the Rohde & Schwarz group of companies will be happy to answer them.

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

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.
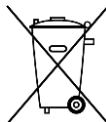
Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before and when using the product. It is also absolutely essential to observe the additional safety instructions on personal safety, for example, that appear in relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories. For product-specific information, see the data sheet and the product documentation.

Safety labels on products

The following safety labels are used on products to warn against risks and dangers.

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation	| ○	ON/OFF Power
18 kg	Caution when handling heavy equipment	⏻	Standby indication
	Danger of electric shock	⎓	Direct current (DC)

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Symbol	Meaning	Symbol	Meaning
	Caution ! Hot surface	∿	Alternating current (AC)
	Protective conductor terminal To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth	≂	Direct/alternating current (DC/AC)
	Earth (Ground)	▢	Class II Equipment to identify equipment meeting the safety requirements specified for Class II equipment (device protected by double or reinforced insulation)
	Frame or chassis Ground terminal		EU labeling for batteries and accumulators For additional information, see section "Waste disposal/Environmental protection", item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section "Waste disposal/Environmental protection", item 2.
	Warning! Laser radiation For additional information, see section "Operation", item 7.		

Signal words and their meaning

The following signal words are used in the product documentation in order to warn the reader about risks and dangers.

⚠ DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates information considered important, but not hazard-related, e.g. messages relating to property damage. In the product documentation, the word ATTENTION is used synonymously.

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

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Operating states and operating positions

The product may be operated only under the operating conditions and in the positions specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury or death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of ±10 % shall apply to the nominal voltage and ±5 % to the nominal frequency, overvoltage category 2, pollution degree 2.

2. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). An installation that is not carried out as described in the product documentation could result in personal injury or even death.

3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

If the information on electrical safety is not observed either at all or to the extent necessary, electric shock, fire and/or serious personal injury or death may occur.

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the mains-supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.

2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a protective conductor contact and protective conductor.

3. Intentionally breaking the protective conductor either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.

4. If there is no power switch for disconnecting the product from the mains, or if the power switch is not suitable for this purpose, use the plug of the connecting cable to disconnect the product from the mains. In such cases, always ensure that the power plug is easily reachable and accessible at all times. For example, if the power plug is the disconnecting device, the length of the connecting cable must not exceed 3 m. Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, the disconnecting device must be provided at the system level.

5. Never use the product if the power cable is damaged. Check the power cables on a regular basis to ensure that they are in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.

6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).

7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.

8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.

9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.

10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC 60950-1 / EN 60950-1 or IEC 61010-1 / EN 61010-1 standards that apply in each case.

11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.

12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.

13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.

14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.

15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.

16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.

17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.

18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

1. Operating the products requires special training and intense concentration. Make sure that persons who use the products are physically, mentally and emotionally fit enough to do so; otherwise, injuries or material damage may occur. It is the responsibility of the employer/operator to select suitable personnel for operating the products.

2. Before you move or transport the product, read and observe the section titled "Transport".

3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.

4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal/Environmental protection", item 1.

5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.

6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.

7. Laser products are given warning labels that are standardized according to their laser class. Lasers can cause biological harm due to the properties of their radiation and due to their extremely concentrated electromagnetic power. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).

8. EMC classes (in line with EN 55011/CISPR 11, and analogously with EN 55022/CISPR 22, EN 55032/CISPR 32)
   – Class A equipment:
     Equipment suitable for use in all environments except residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings
     Note: Class A equipment is intended for use in an industrial environment. This equipment may cause radio disturbances in residential environments, due to possible conducted as well as radiated disturbances. In this case, the operator may be required to take appropriate measures to eliminate these disturbances.
   – Class B equipment:
     Equipment suitable for use in residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings

Repair and service

1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.

2. Adjustments, replacement of parts, maintenance and repair may be performed only by electrical experts authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, protective conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

Batteries and rechargeable batteries/cells

If the information regarding batteries and rechargeable batteries/cells is not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury, and, in some cases, death. Batteries and rechargeable batteries with alkaline electrolytes (e.g. lithium cells) must be handled in accordance with the EN 62133 standard.

1. Cells must not be taken apart or crushed.

2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.

3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.

4. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.

5. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.

6. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde & Schwarz type (see parts list) in order to ensure the safety of the product.

7. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

8. Follow the transport stipulations of the carrier (IATA-DGR, IMDG-Code, ADR, RID) when returning lithium batteries to Rohde & Schwarz subsidiaries.

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.

2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.

3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

Waste disposal/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde & Schwarz customer service center.

2. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste, but must be collected separately.
Rohde & Schwarz GmbH & Co. KG has developed a disposal concept and takes full responsibility for take-back obligations and disposal obligations for manufacturers within the EU. Contact your Rohde & Schwarz customer service center for environmentally responsible disposal of the product.

3. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

4. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

For additional information about environmental protection, visit the Rohde & Schwarz website.

Instrucciones de seguridad elementales

¡Es imprescindible leer y cumplir las siguientes instrucciones e informaciones de seguridad!

El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestro sistema de garantía de calidad controla constantemente que sean cumplidas estas normas. El presente producto ha sido fabricado y examinado según el certificado de conformidad de la UE y ha salido de nuestra planta en estado impecable según los estándares técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, el usuario deberá atenerse a todas las indicaciones, informaciones de seguridad y notas de alerta. El grupo de empresas Rohde & Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda sufrir daño. El uso del producto fuera de sus fines definidos o sin tener en cuenta las instrucciones del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del mal uso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto hace necesarios conocimientos técnicos y ciertos conocimientos del idioma inglés. Por eso se debe tener en cuenta que el producto solo pueda ser operado por personal especializado o personas instruidas en profundidad con las capacidades correspondientes. Si fuera necesaria indumentaria de seguridad para el uso de productos de Rohde & Schwarz, encontraría la información debida en la documentación del producto en el capítulo correspondiente. Guarde bien las informaciones de seguridad elementales, así como la documentación del producto, y entréguelas a usuarios posteriores.

Tener en cuenta las informaciones de seguridad sirve para evitar en lo posible lesiones o daños por peligros de toda clase. Por eso es imprescindible leer detalladamente y comprender por completo las siguientes informaciones de seguridad antes de usar el producto, y respetarlas durante el uso del producto. Deberán tenerse en cuenta todas las demás informaciones de seguridad, como p. ej. las referentes a la protección de personas, que encontrarán en el capítulo correspondiente de la documentación del producto y que también son de obligado cumplimiento. En las presentes informaciones de seguridad se recogen todos los objetos que distribuye el grupo de empresas Rohde & Schwarz bajo la denominación de "producto", entre ellos también aparatos, instalaciones así como toda clase de accesorios. Los datos específicos del producto figuran en la hoja de datos y en la documentación del producto.

Instrucciones de seguridad elementales

Señalización de seguridad de los productos

Las siguientes señales de seguridad se utilizan en los productos para advertir sobre riesgos y peligros.

Símbolo	Significado	Símbolo	Significado
	Aviso: punto de peligro general Observar la documentación del producto	| ◯	Tensión de alimentación de PUESTA EN MARCHA / PARADA
	Atención en el manejo de dispositivos de peso elevado		Indicación de estado de espera (standby)
	Peligro de choque eléctrico	---	Corriente continua (DC)
	Advertencia: superficie caliente	∼	Corriente alterna (AC)
	Conexión a conductor de protección	≂	Corriente continua / Corriente alterna (DC/AC)
	Conexión a tierra	▯	El aparato está protegido en su totalidad por un aislamiento doble (reforzado)
	Conexión a masa		Distintivo de la UE para baterías y acumuladores Más información en la sección "Eliminación/protección del medio ambiente", punto 1.
	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)		Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos Más información en la sección "Eliminación/protección del medio ambiente", punto 2.
	Advertencia: rayo láser Más información en la sección "Funcionamiento", punto 7.		

Instrucciones de seguridad elementales

Palabras de señal y su significado

En la documentación del producto se utilizan las siguientes palabras de señal con el fin de advertir contra riesgos y peligros.

⚠ **PELIGRO**	Indica una situación de peligro que, si no se evita, causa lesiones graves o incluso la muerte.
⚠ **ADVERTENCIA**	Indica una situación de peligro que, si no se evita, puede causar lesiones graves o incluso la muerte.
⚠ **ATENCIÓN**	Indica una situación de peligro que, si no se evita, puede causar lesiones leves o moderadas.
AVISO	Indica información que se considera importante, pero no en relación con situaciones de peligro; p. ej., avisos sobre posibles daños materiales. En la documentación del producto se emplea de forma sinónima el término CUIDADO.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el área económica europea. Pueden existir definiciones diferentes a esta definición en otras áreas económicas o en aplicaciones militares. Por eso se deberá tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación del producto y solamente en combinación con el producto correspondiente. La utilización de las palabras de señal en combinación con productos o documentaciones que no les correspondan puede llevar a interpretaciones equivocadas y tener por consecuencia daños en personas u objetos.

Estados operativos y posiciones de funcionamiento

El producto solamente debe ser utilizado según lo indicado por el fabricante respecto a los estados operativos y posiciones de funcionamiento sin que se obstruya la ventilación. Si no se siguen las indicaciones del fabricante, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte. En todos los trabajos deberán ser tenidas en cuenta las normas nacionales y locales de seguridad del trabajo y de prevención de accidentes.

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de ±10 % sobre el voltaje nominal y de ±5 % sobre la frecuencia nominal. Categoría de sobrecarga eléctrica 2, índice de suciedad 2.

2. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptos para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (p. ej. paredes y estantes). Si se realiza la instalación de modo distinto al indicado en la documentación del producto, se pueden causar lesiones o, en determinadas circunstancias, incluso la muerte.

3. No ponga el producto sobre aparatos que generen calor (p. ej. radiadores o calefactores). La temperatura ambiente no debe superar la temperatura máxima especificada en la documentación del producto o en la hoja de datos. En caso de sobrecalentamiento del producto, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

Seguridad eléctrica

Si no se siguen (o se siguen de modo insuficiente) las indicaciones del fabricante en cuanto a seguridad eléctrica, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.

2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.

3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.

4. Si el producto no está equipado con un interruptor para desconectarlo de la red, o bien si el interruptor existente no resulta apropiado para la desconexión de la red, el enchufe del cable de conexión se deberá considerar como un dispositivo de desconexión.
   El dispositivo de desconexión se debe poder alcanzar fácilmente y debe estar siempre bien accesible. Si, p. ej., el enchufe de conexión a la red es el dispositivo de desconexión, la longitud del cable de conexión no debe superar 3 m).
   Los interruptores selectores o electrónicos no son aptos para el corte de la red eléctrica. Si se integran productos sin interruptor en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.

5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.

6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).

7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.

8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.

9. En las mediciones en circuitos de corriente con una tensión U_{eff} > 30 V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).

10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.

11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.

13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.

14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.

15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.

16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.

17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.

18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.

2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".

3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados —los llamados alérgenos (p. ej. el níquel)—. Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.

4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación/protección del medio ambiente", punto 1.

5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.

6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.

7. Los productos con láser están provistos de indicaciones de advertencia normalizadas en función de la clase de láser del que se trate. Los rayos láser pueden provocar daños de tipo biológico a causa de las propiedades de su radiación y debido a su concentración extrema de potencia electromagnética. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).

8. Clases de compatibilidad electromagnética (conforme a EN 55011 / CISPR 11; y en analogía con EN 55022 / CISPR 22, EN 55032 / CISPR 32)
   – Aparato de clase A:
   Aparato adecuado para su uso en todos los entornos excepto en los residenciales y en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.
   Nota: Los aparatos de clase A están destinados al uso en entornos industriales. Estos aparatos pueden causar perturbaciones radioeléctricas en entornos residenciales debido a posibles perturbaciones guiadas o radiadas. En este caso, se le podrá solicitar al operador que tome las medidas adecuadas para eliminar estas perturbaciones.
   – Aparato de clase B:
   Aparato adecuado para su uso en entornos residenciales, así como en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.

Reparación y mantenimiento

1. El producto solamente debe ser abierto por personal especializado con autorización para ello. Antes de manipular el producto o abrirlo, es obligatorio desconectarlo de la tensión de alimentación, para evitar toda posibilidad de choque eléctrico.

2. El ajuste, el cambio de partes, el mantenimiento y la reparación deberán ser efectuadas solamente por electricistas autorizados por Rohde & Schwarz. Si se reponen partes con importancia para los aspectos de seguridad (p. ej. el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Después de cada cambio de partes relevantes para la seguridad deberá realizarse un control de seguridad (control a primera vista, control del conductor de protección, medición de resistencia de aislamiento, medición de la corriente de fuga, control de funcionamiento). Con esto queda garantizada la seguridad del producto.

Instrucciones de seguridad elementales

Baterías y acumuladores o celdas

Si no se siguen (o se siguen de modo insuficiente) las indicaciones en cuanto a las baterías y acumuladores o celdas, pueden producirse explosiones, incendios y/o lesiones graves con posible consecuencia de muerte. El manejo de baterías y acumuladores con electrolitos alcalinos (p. ej. celdas de litio) debe seguir el estándar EN 62133.

1. No deben desmontarse, abrirse ni triturarse las celdas.

2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.

3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.

4. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.

5. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.

6. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).

7. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

8. En caso de devolver baterías de litio a las filiales de Rohde & Schwarz, debe cumplirse las normativas sobre los modos de transporte (IATA-DGR, código IMDG, ADR, RID).

Transporte

1. El producto puede tener un peso elevado. Por eso es necesario desplazarlo o transportarlo con precaución y, si es necesario, usando un sistema de elevación adecuado (p. ej. una carretilla elevadora), a fin de evitar lesiones en la espalda u otros daños personales.

2. Las asas instaladas en los productos sirven solamente de ayuda para el transporte del producto por personas. Por eso no está permitido utilizar las asas para la sujeción en o sobre medios de transporte como p. ej. grúas, carretillas elevadoras de horquilla, carros etc. Es responsabilidad suya fijar los productos de manera segura a los medios de transporte o elevación. Para evitar daños personales o daños en el producto, siga las instrucciones de seguridad del fabricante del medio de transporte o elevación utilizado.

3. Si se utiliza el producto dentro de un vehículo, recae de manera exclusiva en el conductor la responsabilidad de conducir el vehículo de manera segura y adecuada. El fabricante no asumirá ninguna responsabilidad por accidentes o colisiones. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Asegure el producto dentro del vehículo debidamente para evitar, en caso de un accidente, lesiones u otra clase de daños.

Eliminación/protección del medio ambiente

1. Los dispositivos marcados contienen una batería o un acumulador que no se debe desechar con los residuos domésticos sin clasificar, sino que debe ser recogido por separado. La eliminación se debe efectuar exclusivamente a través de un punto de recogida apropiado o del servicio de atención al cliente de Rohde & Schwarz.

2. Los dispositivos eléctricos usados no se deben desechar con los residuos domésticos sin clasificar, sino que deben ser recogidos por separado.
Rohde & Schwarz GmbH & Co.KG ha elaborado un concepto de eliminación de residuos y asume plenamente los deberes de recogida y eliminación para los fabricantes dentro de la UE. Para desechar el producto de manera respetuosa con el medio ambiente, diríjase a su servicio de atención al cliente de Rohde & Schwarz.

3. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.

4. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

Se puede encontrar más información sobre la protección del medio ambiente en la página web de Rohde & Schwarz.

Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

Europe, Africa, Middle East	Phone +49 89 4129 12345 customersupport@rohde-schwarz.com
North America	Phone 1-888-TEST-RSA (1-888-837-8772) customer.support@rsa.rohde-schwarz.com
Latin America	Phone +1-410-910-7988 customersupport.la@rohde-schwarz.com
Asia/Pacific	Phone +65 65 13 04 88 customersupport.asia@rohde-schwarz.com
China	Phone +86-800-810-8228 / +86-400-650-5896 customersupport.china@rohde-schwarz.com

ROHDE & SCHWARZ

R&S ZVL Documentation Map

Standard Documentation

The following documentation is supplied with the instrument.

The help systems are embedded in the instrument, offering quick, context-sensitive reference to the information needed for operation and programming. The help systems contain the complete user documentation for the network analyzer including all optional features. The instrument provides two help files for the network analyzer modes and for the spectrum analyzer mode.

You can also transfer the help files RSZVLhelp.chm (network analyzer mode plus basic functions) and RSFSLhelp.chm (spectrum analyzer mode plus supplementary spectrum analyzer options) to your PC and use them as standalone help files.
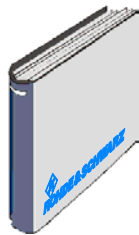
The quick start guide contains the data sheet ("Product Brochure" and "Specifications"), describes everything that is needed to put the instrument into operation and helps you get familiar with the analyzer. The quick start guide gives an introduction to the instrument's functionality and provides procedures for typical measurement tasks.

For an overview and a short description of R&S ZVL options refer to section "Optional Extensions" in the "System Overview" chapter at the end of the quick start guide.

The CD-ROM provides the complete user documentation for the network analyzer:

- The online help system in two different HTML-based formats (*.chm for transfer to the hard disk and WebHelp for viewing from the CD).

- Printable (*.pdf) versions of the online help systems. The R&S ZVL operating manual describes the R&S ZVL instrument including network analyzer mode. A separate manual describes the spectrum analyzer mode (with option R&S ZVL-K1) and the supplementary spectrum analyzer options.

- The quick start manual in printable form.

- The service manual in printable form.

- Links to different useful sites in the R&S internet.

Glossary of Terms

A

Active channel: Channel belonging to the active trace. The active channel is highlighted in the channel list below the diagram. The active channel is not relevant in remote control where each channel can contain an active trace.

Active marker: Marker that can be changed using the settings of the Marker menu (Delta Mode, Ref. Mkr -> Mkr, Mkr Format). The active marker is also used for the Marker Functions. It appears in the diagram with an enlarged marker symbol and font size and with a dot placed in front of the marker line in the info field.

Active menu: The menu containing the last executed command. If the softkey bar is displayed (Display - Config./View - Softkey Labels on), then the active menu is indicated on top of the softkey bar.

Active trace (manual control): Trace that is selected to apply the settings in the Trace menu. The active trace is highlighted in the trace list of the active diagram area. It can be different from the active trace in remote control.

Active trace (remote control): One trace of each channel that has been selected as the active trace (CALCulate[Ch]:PARameter:SELect <Trace Name>). Many commands (e.g. TRACE...) act on the active trace. It can be different from the active trace in manual control.

C

Cal pool: The cal pool is a collection of correction data sets (cal groups) that the analyzer stores in a common directory. Cal groups in the pool can beapplied to different channels and setups.

Calibration: The process of removing systematic errors from the measurement (system error correction). See also TOSM, TOM, TRM, TRL, TNA.

Calibration kit: Set of physical calibration standards for a particular connector family.

Calibration standard: Physical device that has a known or predictable magnitude and phase response within a given frequency range. Calibration standards are grouped into several types (open, through, match,...) corresponding to the different input quantities for the analyzer's error models.

Calibration unit: Integrated solution for automatic calibration of 1 to 4 ports (accessory ZV-Z41). The unit contains calibration standards that are electronically switched when a calibration is performed.

Channel: A channel contains hardware-related settings to specify how the network analyzer collects data. Each channel is stored in an independent data set. The channel settings complement the definitions of the Trace menu; they apply to all traces assigned to the channel.

Confirmation dialog box: Standard dialog box that pops up to display an error message or a warning. The current action can be either continued (OK) or cancelled (Cancel) on closing the dialog box.

Crosstalk: The occurrence of a signal at the receive port of the analyzer which did not travel through the test setup and the DUT but leaks through other internal paths. Crosstalk causes an isolation error in the measurement which can be corrected by means of a calibration.

D

Data trace: Trace filled with measurement data and updated after each sweep (dynamic trace).

Diagram area: Rectangular portion of the screen used to display traces. Diagram areas are arranged in windows; they are independent of trace and channel settings.

Directivity error: Measurement error caused by a coupler or bridge in the analyzer's source port causing part of the generated signal to leak through the forward path into the receive path instead of being transmitted towards the DUT. The directivity error can be corrected by means of a full one port calibration or one of the two-port calibration methods (except normalization).

Discrete marker: The stimulus value of a discrete marker always coincides with a sweep point so that the marker does not show interpolated measurement values.

E

Excursion: Difference between the response values at a local maximum (minimum) of the trace and at the two closest local minima (maxima) to the left and to the right.

F

Forward: A measurement on a two-port DUT is said to be in forward direction if the source signal (stimulus) is applied to port 1 of the DUT.

I

Isolation error: Measurement error caused by a crosstalk between the source and receive port of the analyzer.

L

Limit check: Comparison of the measurement results with the limit lines and display of a pass/fail indication.

Limit line: A limit line is a set of data to specify the allowed range for some or all points of a trace. Typically, limit lines are used to check whether a DUT conforms to the rated specifications (conformance testing).

Load match error: Measurement error caused by a mismatch of the analyzer's receive (load) port causing part of the signal transmitted through the DUT to be reflected off the receive port so that it is not measured there. The load match error can be corrected by means of a two-port calibration (except normalization).

M

Marker: Tool for selecting points on the trace and for numerical readout of measured data. A marker is displayed with a symbol (a triangle, a crossbar or a line) on the trace; its coordinates are shown in the marker info field.

Mathematical trace: Trace that is calculated according to a mathematical expression, e.g. the one defined in the Define Math dialog. The expression is a mathematical relation between constants and the data or memory traces of the active setup.

Measurement point: Result of the measurement at a specified stimulus value (frequency/power/time).

Measurement result: Set of all measurement points acquired in a measurement (e.g. a sweep). The measurement result is displayed in a diagram area and forms a trace.

Memory trace: Trace that is associated to a data trace and stored in the memory. Data traces and the associated memory traces share the same channel and scale settings. Alternatively, memory traces can be imported from a file.

P

Partial measurement: Measurement at a specified stimulus value maintaining definite hardware settings. Depending on the measurement type, several partial measurements may be needed to obtain a measurement point. A full n-port S-parameter measurement requires n partial measurements with n different drive ports.

Peak: Local maximum or local minimum (dip) on the trace. In the Trace - Search menu, it is possible to define a minimum excursion that both types of peaks must have to be considered valid.

R

Reflection tracking error: Frequency-dependent variation of the ratio of the reflected wave to the reference wave at a test port when an ideal reflection coefficient (= 1) is measured. The reflection tracking error can be corrected by means of a reflection normalization or one of the more sophisticated calibration methods.

Reverse: A measurement on a two-port DUT is said to be in reverse direction if the source signal (stimulus) is applied to port 2 of the DUT.

S

Setup: A setup comprises a set of diagram areas with all displayed information that can be stored to a NWA setup file (*.zvx). Each setup is displayed in an independent window.

Source match error: Measurement error caused by a mismatch of the analyzer's source port causing part of the signal reflected off the DUT to be reflected again off the source port so that it is not measured there. The source match error can be corrected by means of a full one-port calibration or a two-port calibration (except normalization).

Stimulus value: Value of the sweep variable (frequency/power/time/point number) where a measurement is taken. Also termed sweep point.

Sweep: Series of consecutive measurements taken at a specified sequence of stimulus values = series of consecutive measurement points.

Sweep point: Value of the sweep variable (stimulus value: frequency/power/time) where a measurement is taken.

Sweep range: Continuous range of the sweep variable (frequency/power/time) containing the sweep points where the analyzer takes measurements. In a Segmented Frequency sweep the sweep range can be composed of several parameter ranges or single points.

Sweep segment: Continuous frequency range or single frequency point where the analyzer measures at specified instrument settings (generator power, IF bandwidth etc.). In the Segmented Frequency sweep type the entire sweep range can be composed of several sweep segments.

T

TOSM: A calibration type using four known standards (through, open, short, match), also called SOLT or 12-term error correction model. TOSM calibration is available for 2, 3 and 4-port measurements.

Trace: A trace is a set of data points that can be displayed together on the screen. The trace settings specify the mathematical operations used to obtain traces from the collected data. They complement the definitions of the Channel menu. Each trace is assigned to a channel. The channel settings apply to all traces assigned to the channel.

Trace point: Point on the screen which is an element of the displayed trace. The trace points for ratios and wave quantities can be derived from the entire set of measurement points using different detector settings.

Transmission tracking error: Frequency-dependent variation of the ratio of the transmitted wave to the reference wave at a test port when an ideal transmission coefficient (= 1) is measured. The transmission tracking error can be corrected by means of a transmission normalization or one of the more sophisticated calibration methods.

W

Window: Rectangular portion of the screen showing all diagram areas of a particular setup. Windows are limited by a blue frame with several icons. The analyzer uses standard windows provided by the operating system.

Table of Contents

1 Preparing for Use

This chapter gives an overview of the front panel controls and connectors of the network analyzer and gives all information that is necessary to put the instrument into operation and connect external devices. Notes on reinstallation of the analyzer software appear at the end of the chapter.

⚠️ **CAUTION**

Please make sure to observe the instructions of the following sections so that you cannot endanger people or cause damage to the instrument. This is of particular importance when you use the instrument for the first time. Also observe the general safety instructions at the beginning of this manual.

Chapter 2 of this manual provides an introduction to the operation of the analyzer by means of typical configuration and measurement examples; for a description of the operating concept and an overview of the instrument's capabilities refer to Chapter 3. For all reference information concerning manual and remote control of the instrument refer to the online help system or its printed/printable version. A more detailed description of the hardware connectors and interfaces is also part of the help system.

1.1 Front Panel Tour

The front panel of the network analyzer consists of the VGA display with the softkey area, the hardkey areas, and the connectors area. Brief explanations on the controls and connectors, the hardkey area and the rear panel can be found on the next pages.
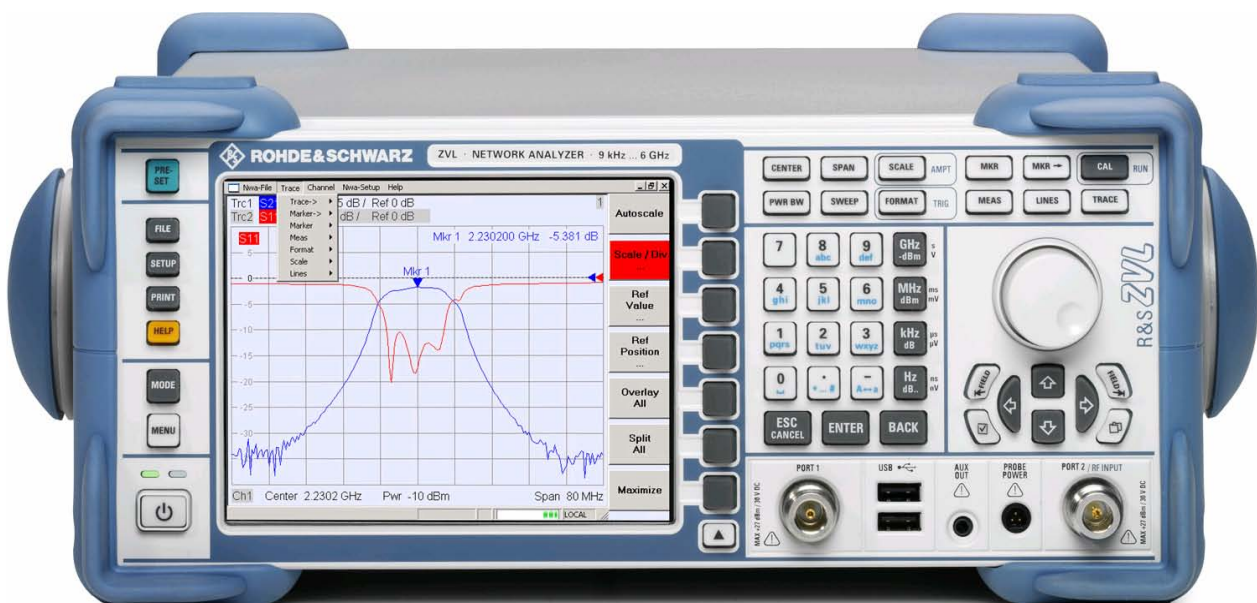
1.1.1 Display

The analyzer is equipped with a color display providing all control elements for the measurements and the diagram areas for the results.

- Refer to section *Navigation Tools of the Screen* in Chapter 3 to learn how to use menus, keys and softkeys.
- Refer to section *Display Elements* in Chapter 3 to obtain information about the results in the diagram area.
- Refer to section *Display Menu* in the online help system and learn how to customize the screen.
- Refer to the data sheet for the technical specifications of the display.

Screen saver

The screen saver function of the operating system switches off the display if the analyzer receives no command for more than a specified period of time. It is switched on again if any front panel key is pressed. To change the screen saver properties, press *SETUP – General Setup – More – Open Start Menu* (or connect an external keyboard and press CTRL + ESC) to open the start menu, and click Control Panel – Display – Screen Saver.

1.1.2 Setup Keys

The front panel keys to the left of the display provide utility functions, assistance, and alternative measurement modes. Some of the keys are related to the spectrum analyzer mode (with option R&S ZVL-K1), irrespective of the active mode.

- PRESET performs a general factory preset or user preset, depending on the "Preset Scope" selected in the System Configuration menu.

- FILE provides standard Windows™ functions to create, save, and recall spectrum analyzer settings and results. For detailed information refer to the spectrum analyzer help system (HELP). Alternatively, use the functions in the Nwa-File menu of the network analyzer mode.

- SETUP provides basic instrument configurations. For detailed information refer to the spectrum analyzer help system (HELP). Alternatively, use the functions in the Nwa-Setup menu of the network analyzer mode, in particular the System Config. settings.

- PRINT customizes the printout, selects and configures the printer. For detailed information refer to the spectrum analyzer help system (HELP). Alternatively, use the functions in the Nwa-File menu of the network analyzer mode

- HELP calls the help system, depending on the active context. The network analyzer and spectrum analyzer modes are

described in two separate help systems.

- MODE opens a dialog to switch between the network analyzer and spectrum analyzer modes.

- MENU activates the highest softkey menu level of the current spectrum analyzer context. For detailed information refer to the spectrum analyzer help system (HELP). In network analyzer mode, use the Function Keys or the menus across the top of the main application window.

1.1.3 Function Keys

The keys in the upper right part of the front panel provide direct access to the most important measurement settings. Each key opens a drop-down menu (softkey menu) or activates a menu command (softkey) of the graphical user interface. The softkeys are hidden after a while to make room for the display and the measurement results.

The links in the short descriptions below will take you to the detailed description for the network analyzer mode. If the spectrum analyzer option (R&S ZVL-K1) is active, the keys have a similar function. The network analyzer keys SCALE, FORMAT, and CAL have no direct equivalent in spectrum analysis; they are replaced by the AMPT, TRIG, and RUN keys, respectively.

- CENTER or SPAN define the center frequency and the width of the sweep range.
- SCALE defines how the current trace is presented in the diagram. If the spectrum analyzer option (R&S ZVL-K1) is active, the key provides additional functions affecting the displayed signal amplitude (AMPT).
- PWR BW defines the power of the internal signal source, sets the step attenuators and the IF bandwidths.
- SWEEP defines the scope of measurement, including the sweep type, the number of points, the measurement delay and the periodicity of the measurement.
- FORMAT defines how the measured data is presented in the graphical display. If the spectrum analyzer option (R&S ZVL-K1) is active, the key provides trigger settings (TRIG).


- MKR positions markers on a trace, configures their properties and selects the format of the numerical readout.
- MARKER-> provides marker functions that allow you to search for values on traces, define the sweep range, scale the diagram, and introduce an electrical length offset.

- CAL provides all functions that are necessary to perform a system error correction (calibration). If the spectrum analyzer option (R&S ZVL-K1) is active, the key starts a new measurement (RUN).
- MEAS selects the quantity to be measured and displayed.
- LINES defines limits for measured values and activates the limit check.
- TRACE provides functions to handle traces in diagram areas, evaluate trace statistics, and store trace data.

1.1.4   Navigation Keys

The navigation keys below the rotary knob are used to navigate within the analyzer screen and the Help system, to access and control active elements.
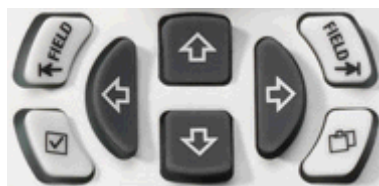
The *Left Field* (= Tab) or *Right Field* (= Shift Tab) keys switch between several active elements in dialogs and panes, e.g. in order to access:

- All control elements (e.g. buttons, numerical or text input fields, radio buttons, checkmarks, combo boxes etc.) in a dialog

- All links in a Help topic (not possible with the rotary knob)

The *Cursor Up* and *Cursor Down* keys are used to:

- Scroll up and down in lists, e.g. in pull-down lists, among menu items, in a list of keywords, in the Help table of contents, or in the Help topic text

- Increase and decrease numeric input values

Cursor Up (Down) become inactive or switches to the previous (next) dialog element as soon as the beginning of the list is reached. *Cursor Up (Down)* is equivalent to a rotation of the rotary knob to the right (left).

The *Cursor Left* and *Cursor Right* keys are used to:
- Move the cursor to the left or right within input fields

- Compress or expand menus or the Help table of contents

- Access the previous (next) menu in the menu bar

The *Checkmark* (= Space) key can be used to
- Insert a space character into character entry fields

- Switch a checkmark control in a dialog on or off

- Activate the selected active control element, e.g. a button in a

dialog or a link in the Help system

● Scroll down in Help topic

The *Next Tab* key opens the next tab of a dialog, e.g. in the Help navigation pane or in some of the spectrum analyzer dialogs.

1.1.5 Data Entry Keys

The data entry keys are used to enter numbers and units.

Key activation

The data entry keys are only enabled while the cursor is placed on a data input field in a dialog or in the Help navigation pane.

The keys 0 to 9 enter the corresponding numbers. In addition, these keys can be used to insert characters in character input fields; see section Data Entry in chapter 2.

The function of the . and – keys depends on the data type of the active input field:

● In numeric input fields, the keys enter the decimal point and change the sign of the entered numeric value. Multiple decimal points are not allowed; pressing – for a second time cancels the effect of the first entry.

● In character input fields, the keys enter a dot and a hyphen, respectively. Both entries can be repeated as often as desired.

The function of the four unit keys depends on the data type of the active input field; see Data Entry section in Chapter 3.

● In numeric input fields (e.g. in the numeric entry bar), the *GHz / -dBm, MHz / dBm, kHz / dB* or *Hz / dB..* keys multiply the entered value with factors of $10^{(-)9}$, $10^{(-)6}$, $10^{(-)3}$ or 1 and add the appropriate physical unit.

● In character input fields, the keys are inactive.

ENTER is used to:
● Activate the selected active control element, e.g. a button in a dialog or a link in the Help

● Confirm selections and entries made and close dialogs

ENTER is equivalent to pressing the rotary knob.

The ESC CANCEL key is used to:
● Close dialogs without activating the entries made (equivalent to the *Close* button)

● Close the Help

BACK deletes the last character before the cursor position or the selected character sequence. If an entire numeric value is selected, BACK deletes the whole entry.

1.1.6 Rotary Knob

The rotary knob can be turned in both directions or pressed.

Turning the rotary knob is equivalent to the action of the cursor up and down keys. Turn the knob in order to
● Increase or decrease numerical values

● Scroll within lists

● Switch to the previous or next dialog element

● Pressing the rotary knob is equivalent to the action of the ENTER key. Press the knob in order to:

● Activate the selected active control element, e.g. a button in a dialog or a link in the Help

● Confirm selections and entries made and close dialogs

1.1.7 Power On/Off Key

The power on/off toggle switch is located in the bottom left corner of the front panel.

The key serves two main purposes:
● Save settings, shut down and switch off.

● Toggle between standby and ready state, if the instrument is AC-supplied and appropriately configured.

1.1.8 Test Ports

N-connectors labelled PORT 1 and PORT 2/ RF INPUT. The test ports serve as outputs for the RF stimulus signal and as inputs for the measured RF signals from the DUT (response signals).

● With a single test port, it is possible to generate a stimulus signal and measure the response signal in reflection.
● With 2 test ports, it is possible to perform full two-port measurements; see S-Parameters section in Chapter 3.
● The two network analyzer ports are equivalent. If the Spectrum Analysis option (R&S ZVL-K1) is active, test port PORT 2 serves as an AC-coupled input for the analyzed RF signal; PORT 1 is not used.


NOTICE

Input levels

The maximum input levels at all test ports according to the front panel labeling or the data sheet must not be exceeded.
In addition, the maximum input voltages of the other input connectors at the front and rear panel must not be exceeded.

1.1.9 USB Connectors

Two single Universal Serial Bus connectors of type A (master USB), used to connect a keyboard (recommended: PSL–Z2, order number 1157.6870.03), mouse (recommended: PSL–Z10, order number 1157.7060.03) or other pointing devices, the Calibration Unit (accessory R&S ZV-Z5x), a printer or an external storage device (USB stick, CD-ROM drive etc.).
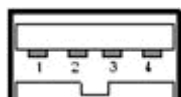
Using an adapter cable (R&S NRP–Z4), a power sensor can be connected, as an alternative to the power sensor connector on the rear panel that is only available with option Additional Interfaces, R&S FSL–B5.

EMI conformity, cable length

For maintaining the EMI conformity of the R&S ZVL only appropriate USB accessories may be used.

Passive connecting USB cables should not exceed 4 m in length. Use the original USB connecting cable or another high–quality cable. The maximum current per USB port is 500 mA.

1.1.10 PROBE POWER

Connector for supply voltages of +15 V to –12 V and ground for active probes and preamplifiers. A maximum current of 140 mA is available. This connector is suitable as power supply for high-impedance probes from Agilent.

1.2 Rear Panel Tour

This section gives an overview of the rear panel controls and connectors of the network analyzer.

The following rear panel connectors require special attention:

- The (fuse-protected) mains connector in the lower left corner is used to connect the analyzer to the AC power supply; see *Power on and off.*
- The *DC power supply* connector and the *Battery Pack* are alternatives for the AC power supply via the mains connector; see DC Power Supply and Battery.
- *LAN* is used to connect the analyzer to a Local Area Network; see *Remote Operation in a LAN.*

The remaining rear connectors are described in detail in the annex *Hardware Interfaces* in the online help system.

- *EXT. TRIGGER / GATE IN* is an input for external TTL trigger signals.
- *EXT REF* serves as an input for an external 10 MHz reference signal.

The following connectors require additional hardware options (see rear panel labeling):

- *POWER SENSOR* is used for connecting power sensors of the R&S NRP-Zxy family.
- *Noise Source Control* provides the supply voltage for an external noise source.
- *IF/VIDEO OUT* is an output for the IF signal or video signal.
- *AUX PORT* provides control signals for external devices.
- *OCXO* provides the internal 10 MHz reference signal, which may be used to synchronize external devices. The connector can be used as an input for external reference signals, too.
- *IEC Bus* is the GPIB bus connector (according to standard IEEE 488 / IEC 625).

NOTICE

Input levels, AUX PORT

The maximum input levels and voltages of the input connectors at the front and rear panel must not be exceeded.

When using the AUX PORT, watch the pin assignment carefully. A short-circuit may damage the instrument.

1.3 Putting the Instrument into Operation

This section describes the basic steps to be taken when setting up the analyzer for the first time.

NOTICE

General safety instructions

Before turning on the instrument, please make sure that the following conditions are fulfilled:

- Instrument covers are in place and all fasteners are tightened.

- Fan openings are free from obstructions.

- Signal levels at the input connectors are all within the specified maxima.

- Signal outputs are correctly connected and not overloaded.

- The instrument is dry and shows no condensation.

Non-observance may cause damage to the instrument!

1.3.1 Unpacking the Instrument and Checking the Shipment

The instrument is shipped together with its mandatory accessories in a cardboard box. In order to unpack its contents proceed as follows:

1. Open the cardboard box.

2. Remove the accessories packed into the box and take the instrument out of the packaging.

3. Check the shipment against the list of accessories to ensure that all items are included.

4. Remove the two protective caps from the front and rear and carefully inspect the analyzer to make sure that it was not damaged during shipment.
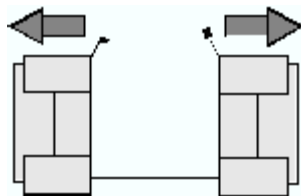
Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the container and packing material.

Equipment returned or sent in for repair must be packed in the original container or packing with electrostatic protection. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors.

1.3.2 Instrument Setup

The network analyzer is designed for use under laboratory conditions, either on a bench top or in a rack. The general ambient conditions required at the operating site are as follows:

- The ambient temperature must be in the ranges specified for operation and for compliance with specifications (see data sheet).
- All fan openings including the rear panel perforations must be unobstructed. The distance to the wall should be at least 10 cm.

NOTICE

Electrostatic discharge

To avoid damage of electronic components of the DUT and the analyzer, the operating site must be protected against electrostatic discharge (ESD). ESD is most likely to occur when you connect or disconnect a DUT or test fixture to the analyzer's test ports.

To prevent ESD damage use a wrist strap and grounding cord and connect yourself to ground.

1.3.3 Bench Top Operation

If the analyzer is operated on a bench top, the surface should be flat.

In order to move the handle into the desired position, pull at both side knobs and turn the handle.
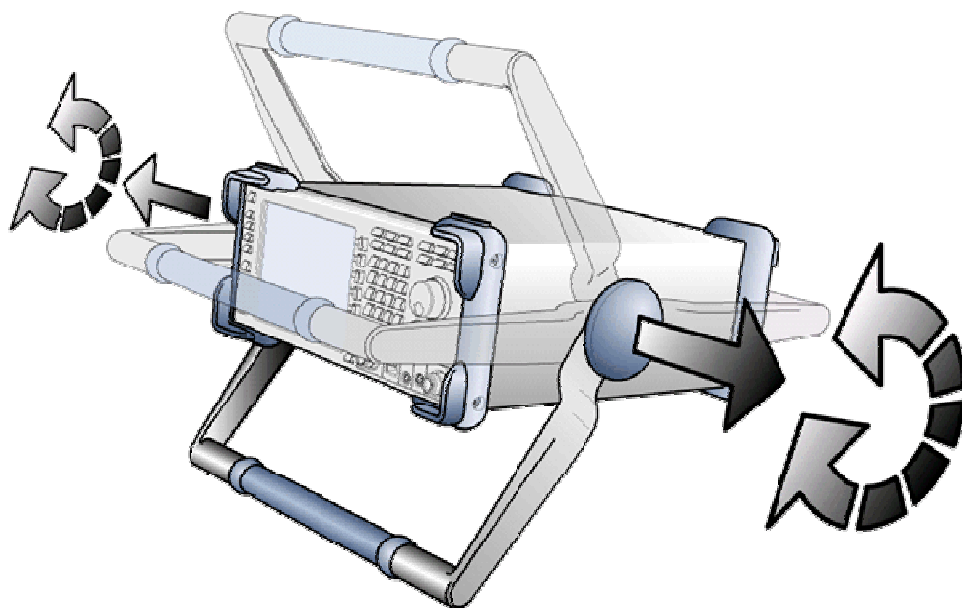
⚠ **WARNING**

Danger of injury

To avoid injuries, place the instrument on a stable surface and do not stack other instruments or material on top of it.

1.3.4 Mounting in a 19" Rack

Using the adapter R&S ZZA-S334 (order no. 1109.4487.00) the instrument can be mounted in 19" racks according to the mounting instructions supplied with the rack adapter.

NOTICE

● Allow for sufficient air supply in the rack.

● Make sure that there is sufficient space between the ventilation holes and the rack casing.

1.3.5 EMI Protective Measures

In order to avoid electromagnetic interference, the instrument may only be operated when it is closed and with all shielding covers fitted. Only appropriate shielded signal and control cables may be used.

1.3.6 Power Supply Options

The R&S ZVL is equipped with an AC power supply connector. In order to use the analyzer independently from an AC power supply, it can be fitted with a DC power supply connector (option DC Power Supply, R&S FSL–B30) and/or a battery pack (option NIMH Battery Pack, R&S FSL–B31). Refer toDC Power Supply and Battery for further information.

From the available power supplies, the R&S ZVL selects the one to use according to the following priority scheme:

Priority	Power Supply
1	AC power supply
2	DC power supply
3	Battery

For example, if the R&S ZVL is connected to both an AC and a DC power supply, it uses the AC power supply. If it is suddenly disconnected from the AC power supply, it switches to the DC power supply.

1.3.7 Connecting the Instrument to the AC Supply

The network analyzer is automatically adapted to the AC supply voltage supplied. The supply voltage must be in the range 100 V to 240 V; 50 Hz to 60 Hz (see also the *General Data* section in the "Specifications"). The mains connector is located at the bottom left corner of the rear panel.

► Connect the network analyzer to the AC power source using the AC power cable delivered with the instrument.

Since the instrument is assembled in line with the specifications for safety class EN61010, it may only be connected to an outlet that has a ground contact.

The power consumption of the analyzer depends on the installed options (see "Specifications").

1.3.8 Power on and off

The mains connector is located at the bottom left corner of the rear panel.

► To turn the power on or off, press the AC power switch to position I (On) or 0 (Off).

After power-on, the analyzer is booted and reaches its ready state.

The AC power switch can be permanently on. Switching off is required only if the instrument must be completely removed from the AC power supply.

1.3.9 Instrument States with AC Power Supply

The power on/off key is located in the bottom left corner of the front panel.

If the R&S ZVL is AC supplied the power on/off key switches between the following states:

- In the switched off state, both LEDs are off. The analyzer is completely disconnected from the power supply. The instrument is re-started using the mains power switch on the rear panel.
- In standby state, the right, amber LED is on. The standby power only supplies the power switch circuits, the optional oven quartz (OCXO, 10 MHz reference oscillator, option ZVL-B4, order no. 1164.1757.02), the battery (option NIMH Battery Pack, R&S FSL–B31), and the fan. The network adapter remains active, too. The power consumption of the R&S ZVL is much reduced. In this state it is safe to switch off the AC power and disconnect the instrument from the power supply.
- In ready state, the left, green LED is on, indicating that all modules are power-supplied. After performing its startup procedure, the analyzer is ready for operation.

The *SETUP -> More -> Shutdown Off/Standby* softkey determines the behavior of the power on/off key:

- In the default setting *(Shutdown: Off)*, the standby state is blocked. The power on/off key switches the R&S ZVL from ready to off state. Use this instrument configuration if you want to avoid any power consumption while you do not use your instrument.
- If *Shutdown: Standby* is selected, you can use the power on/off key to toggle between standby and ready state. Use this configuration if you want to be able to resume your measurements quickly, avoiding the complete startup procedure and the system check.

If the R&S ZVL is DC or battery supplied, the *Shutdown:Standby* option is not effective, see section DC Power Supply and Battery below.

⚠ **CAUTION**

Power supply in standby mode

The instrument is still power-supplied while it is in standby mode.

1.3.10 Replacing Fuses

The instrument is protected by two fuses (IEC 127 – T 3.15 H / 250 V) located on the rear panel at the right side of the AC power switch.

> ⚠️ **DANGER**
>
> **Shock hazard**
>
> For fuse replacement, ensure that the instrument is switched off and disconnected from the power supply by removing the plug from the AC and DC power connector.

To replace the fuses

1. Open the lid of the AC power connector.

2. Lift the fuse holder out of its slot.

3. Exchange the two fuses.

4. Put the fuse holder back in its slot and close the lid.

1.3.11 DC Power Supply and Battery

While the R&S ZVL is disconnected from the AC power supply, it can be supplied either by a DC power (option DC Power Supply, R&S FSL–B30) or a battery (option NIMH Battery Pack, R&S FSL–B31); see Power Supply Options. With DC power or battery supply, the AC power switch on the rear panel is disabled. The power on/off key on the front panel is used to switch the analyzer on or off, irrespective of the *SETUP -> More -> Shutdown Off/Standby* setting.

- While the R&S ZVL is switched off, press the power on/off key to initiate the startup procedure until the R&S ZVL enters its ready state. The left, green LED is on.
- While the R&S ZVL is switched on (ready), press the power on/off key to switch the analyzer off. Both LEDs are off.

When using the DC power supply or battery, note the safety instructions below. Please also refer to the detailed information about DC Power Supply and the Battery Pack.

> 💡 **Battery low**
>
> The battery symbol in the status bar changes to "battery low" when the battery needs to be charged. At the same time, a message box is displayed where you can either shut down the instrument or continue measuring.

> ⚠ **CAUTION**
>
> **DC power supply**
>
> The power supply (SELV) that is used must fulfill the requirements for reinforced/double insulation for main supply circuits in accordance to DIN/EN/IEC 61010 (UL 61010B–1, CSA C22.2 No. 1010.1) or DIN/EN/IEC 60950 (UL 1950, CSA C22.2 No. 950). It is recommended to fuse the DC power supply appropriately. Before switching on the instrument check the connection for correct polarity.

> ⚠ **CAUTION**
>
> **Battery pack**
>
> The power supply that is used must fulfill the requirements for reinforced/double insulation for main supply circuits in accordance to DIN/EN/IEC 61010 (UL 61010B–1, CSA C22.2 No. 1010.1) or DIN/EN/IEC 60950 (UL 1950, CSA C22.2 No. 950).
>
> **Note:** If the battery is not to be used for a longer time, it is recommended to remove it and store it separately.

1.3.12 Charging the Battery

The battery can be charged via the AC or the DC power supply without being removed:

- To charge the battery using the AC power supply, connect the instrument to the mains supply and switch on the AC power on the rear panel. The power on/off key on the front panel can be set either way.
- To charge the battery using the DC power supply, connect the instrument to the DC power supply.

If you have more than one battery packs in use, you can also charge them outside the instrument using the power supply unit of option R&S FSL–Z4 (DC Supply for FSL–B31, stock no. 4052.3041.00). An LED with the inscription "Charge" is switched on during charging.

Charging conditions	Approximate duration
AC power supply, standby mode	5 h
AC power supply, instrument is switched on	9 h
DC power supply, instrument is switched off	5 h
DC power supply, instrument is switched on	9 h
External charging (battery removed)	5 h

1.4 Maintenance

The network analyzer does not require any special maintenance. Make sure that the air vents are not obstructed. The outside of the instrument is suitably cleaned using a soft, line-free dust cloth.

NOTICE

Instrument damage caused by cleaning agents. Cleaning agents contain substances that may damage the instrument, e.g. solvent-containing cleaning agents may damage the front panel labeling or plastic parts.
Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The address of our support center and a list of useful contact addresses can be found on the *Contact* page.

1.4.1 Storing and Packing

The network analyzer can be stored at the temperature range quoted in the data sheet. When it is stored for a longer period of time the instrument should be protected against dust.

The original packing should be used, particularly the protective caps at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

1.5 Starting and Shutting down the Analyzer

To start the analyzer, proceed as follows:

● If you use the AC power supply, make sure that the instrument is connected to the mains supply and switch the power switch on the rear panel to position I (On).
● If you use the DC power supply, make sure that the instrument is connected and press the power on/off key on the front panel.

The analyzer automatically performs a system check, boots the Windows XP operating system and then starts the analyzer (NWA) application. If the last analyzer session was terminated regularly, the NWA application uses the last setup with all instrument settings.

To shut down the analyzer, proceed as follows:

● With AC power supply, press the power on/off key to save the current setup, close the NWA application, shut down Windows XP and set the instrument to standby or off state, depending on the *SETUP -> More -> Shutdown Off/Standby* settings. Refer to section *Instrument States with AC Power Supply*. From the standby state, you can set the AC power switch to position 0 (Off) to turn the analyzer completely off..
● With DC power supply or battery, press the power on/off key to switch the analyzer off.

Power on/off key, OCXO

Do not press the power on/off key longer than 3 seconds.

The AC power switch also interrupts the power supply of the OCXO (option OCXO Reference Frequency, R&S FSL–B4). When you switch the instrument back on, be sure to comply with the extended warm–up phase specified in the data sheet.

NOTICE

Saving instrument settings

When using the AC power supply, it is strongly recommended to press the power on/off key on the front panel before disconnecting the power. If you set the power switch on the rear panel to 0 while the NWA application is still running, you will lose the current settings. Moreover, loss of program data can not be excluded if the application is terminated improperly.

With DC power supply or battery, it is safe to switch off the instrument using the power on/off key on the front panel.

1.6   Connecting External Accessories

The equivalent USB ports on the front panel of the analyzer can be used to connect a variety of accessories:

- A mouse simplifies operation of the instrument using the controls and dialogs of the Graphical User Interface (GUI).
- A keyboard simplifies the entry of data.
- A printer generates hard copies of the screen contents.

In addition the analyzer provides an interface for network integration:

- An external monitor shows the magnified GUI with all diagram areas, measurement results and control elements.
- A LAN connection can be established in order to access the hard disk or control the analyzer from an external PC.

1.6.1   Connecting a Mouse

A USB mouse can be connected to one of the Universal Serial Bus connectors on the front panel.
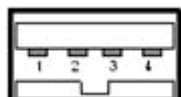
The mouse is detected automatically when it is connected. It is safe to connect or disconnect the mouse during the measurement.

Mouse configuration

Use the *Start – Control Panel – Mouse* menu of Windows XP to configure the mouse properties. To access Windows XP, press *SETUP – General Setup – More – Open Start Menu* (or connect an external keyboard and press CTRL + ESC).
Operating the analyzer does not require a mouse. You can access all essential functions using the keys on the front panel.

1.6.2   Connecting a Keyboard

A keyboard can be connected to one of the Universal Serial Bus connectors on the front panel.
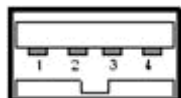
The keyboard is detected automatically when it is connected. The default input language is English – US. It is safe to connect or disconnect the external keyboard during the measurement.

Keyboard configuration

Use the Start – Control Panel – Keyboard or Regional and Language Options menu of Windows XP to configure the keyboard properties. To access Windows XP, press *SETUP – General Setup – More – Open Start Menu* (or connect an external keyboard and press CTRL + ESC).

Operating the analyzer does not require a keyboard. You can access all essential functions using the keys on the front panel. In combination with a mouse, the front panel keys provide access to all instrument functions.

1.6.3 Connecting a Printer

A printer can be connected to one of the Universal Serial Bus connectors on the front panel.
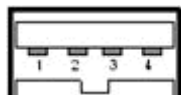
It is safe to connect or disconnect the printer during the measurement. When printing a copy (PRINT)*,* the analyzer checks whether a printer is connected and turned on and whether the appropriate printer driver is installed. If required, printer driver installation is initiated using Windows XP's *Add Printer Wizard*. The wizard is self-explanatory. A printer driver needs to be installed only once, even though the printer may be temporarily removed from the analyzer.

Printer driver installation

A great variety of printer drivers is available on the analyzer. To obtain the complete list, access Windows XP (press the *Windows* key) and open the Add Printer Wizard in the *Start – Control Panel – Printer and Faxes* menu.

You can load updated and improved driver versions or new drivers from an installation disk, USB memory stick or another external storage medium. Alternatively, if the analyzer is integrated in a network, you can install driver data stored in a network directory. In either case, use the *Add Printer Wizard* to complete the installation.

Printer configuration

Use the *Page Setup* dialog or the *Start – Control Panel – Printers and Faxes* menu of Windows XP to configure the printer properties. To access Windows XP, press *SETUP – General Setup – More – Open Start Menu* (or connect an external keyboard and press CTRL + ESC).

1.6.4 Connecting a Monitor

A standard DVI monitor can be connected to the DVI-D connector in the lower right corner of the rear panel. The monitor displays the magnified R&S ZVL screen with all diagram areas, measurement results and control elements. Connection of an analog VGA monitor is not supported.

After connecting the monitor, use the *SETUP – General Setup – More – Monitor Int/Ext* softkey to display the screen contents on the external monitor. To display the screen contents on the R&S ZVL and on the external monitor simultaneously, proceed as follows:

1. Connect an external keyboard to the instrument and press CTRL + ESC to access the operating system.

2. On the right side of the task bar, click the monitor icon.

3. Select *Graphics Options – Output To – Intel(R) Dual Display Clone – Monitor + Digital Display.*

Intrument control from the external monitor

With an additional mouse or keyboard connected to the analyzer, you can control the measurement from the external monitor. If desired, press *SETUP – General Setup – More – Soft Frontpanel* to add the soft frontpanel (front panel key emulation) to the analyzer screen.

1.6.5 Connecting a LAN Cable

A LAN cable can be connected to the LAN connector on the rear panel of the analyzer.

To establish a LAN connection proceed as follows:

1. Refer to section *Assigning an IP Address* and learn how to avoid connection errors.

2. Connect an appropriate LAN cable to the LAN port. Use a commercial RJ-45 cable to establish a non-dedicated network connection, or a cross-over RJ-45 cable to establish a dedicated connection between the analyzer and a single PC.

Dedicated vs. non-dedicated network connections

There are two methods to establish a LAN connection of the analyzer:

● A non-dedicated network (Ethernet) connection from the analyzer to an existing network made with an ordinary RJ-45 network cable. The analyzer is assigned an IP address and can coexist with a computer and with other hosts on the same network.

● A dedicated network connection between the analyzer and a single computer made with a cross-over RJ-45 network cable. The computer must be equipped with a network adapter and is directly connected to the analyzer. The use of hubs, switches, or gateways is not needed, however, data transfer is still made using the TCP/IP protocol.

The IP address information is displayed in the *Info – Setup Info* dialog.

1.7   Remote Control in a LAN

A LAN connection is used to integrate the analyzer into a home/company network. This offers several applications:

- Transfer data between a controller and the analyzer, e.g. in order run a remote control program.
- Control the measurement from a remote computer using the *Remote Desktop* application.
- Use external network devices (e.g. printers).

NOTICE

Virus protection

An efficient virus protection is a prerequisite for secure operation in the network. Never connect your analyzer to an unprotected network because this may cause damage to the instrument software.

To establish the connection proceed as follows:

1. Access Windows XP, e.g. by pressing *SETUP – General Setup – More – Open Start Menu* (see section Accessing Windows XP's Start Menu on p.).

2. Open Windows XP's control panel.

3. Select System and open the *Remote* tab in the *System Properties* dialog. Enable *Allow users to connect remotely to this computer*.

4. Assign an IP address to the analyzer following the directions below and connect the analyzer to the network as described in *Connecting a LAN Cable*.

5. Create a *Remote Desktop Connection* using the analyzer's IP address.

Password protection

The analyzer uses a user name and password as credentials for remote access. In the factory configuration, instrument is preset for both the user name and the password. To protect the analyzer from unauthorized access, it is recommended to change the factory setting.

1.7.1   Assigning an IP Address

Depending on the network capacities, the TCP/IP address information for the analyzer can be obtained in different ways.

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), all address information can be assigned automatically.

● If the network does not support DHCP, or if the analyzer is set to use *alternate TCP/IP* configuration, the addresses must be set manually.

By default, the analyzer is configured to use dynamic TCP/IP configuration and obtain all address information automatically. This means that it is safe to establish a physical connection to the LAN without any previous analyzer configuration.

NOTICE

Address selection

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the analyzer to the LAN. Contact your network administrator to obtain a valid IP address, because connection errors can affect the entire network.

Manual TCP/IP configuration

To disable dynamic TCP/IP configuration and enter the TCP/IP address information manually proceed as follows:

1. Obtain the IP address and subnet mask for the analyzer and the IP address for the local default gateway from your network administrator. If needed, also obtain the name of your DNS domain and the IP addresses of the DNS and WINS servers on your network.

2. Press the SETUP front panel key to the left of the analyzer's display.

3. In the softkey menu opened, press General Setup – Network Address– DHCP: Off.

4. Enter your IP-Address and Subnet Mask.

To enter additional IP address information, you have to access the operating system of the R&S ZVL.

1. Access Windows XP using an external keyboard; see Accessing Window XP's Start Menu.

2. Open the *Control Panel – Network Connections – Local Area Connection Status – Local Area Connection Properties – Internet Protocol (TCP/IP) Properties* dialog and enter the complete address information, e.g.:
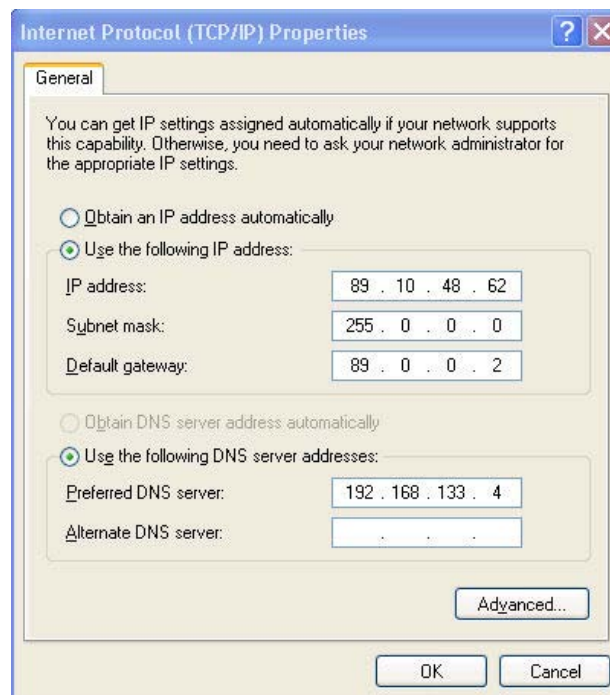
For more information refer to the Windows XP Help.

1.7.2 Remote Desktop Connection

Remote Desktop is a Windows application which can be used to access and control the analyzer from a remote computer through a LAN connection. While the measurement is running, the analyzer screen contents are displayed on the remote computer, and *Remote Desktop* provides access to all of the applications, files, and network resources of the analyzer.

To set up a *Remote Desktop* connection

1. Connect the analyzer to a LAN and determine its IP address; see *Remote Control in a LAN*.

2. Set up your remote computer (integrated in the LAN) to use *Remote Desktop* and create the *Remote Desktop* connection to the analyzer.

For detailed information about *Remote Desktop* and the connection refer to the Windows XP Help.

1.8   Windows XP

The analyzer is equipped with a Windows XP operating system which has been configured according to the instrument's features and needs. Changes in the system configuration can be necessary in order to

● Establish a LAN connection
● Customize the properties of the external accessories connected to the analyzer
● Call up additional software tools

NOTICE

Operating system settings

The operating system is adapted to the network analyzer. To avoid impairment of instrument functions, only change the settings described in this manual. Existing software must be modified only with update software released by Rohde & Schwarz. Likewise, only programs authorized by Rohde & Schwarz for use on the instrument must be executed.

The *Start* menu of the operating system is accessed as described below. All necessary settings can be accessed from the Start menu, in particular from the Control Panel*.*

1.8.1   Accessing Windows XP's Start Menu

The Windows XP Start menu provides access to the Windows XP functionality and installed programs. From the Start menu, you can navigate to the submenus by using the mouse or the cursor keys of the keyboard.

The simplest way to access the Start menu is by pressing *SETUP – General Setup – More – Open Start Menu.* This will not close the measurement application.

If you find it more convenient, you can also use an external keyboard to access the Start menu,

► On your keyboard, press the Windows key or the CTRL+ESC key combination.

To return to the measurement screen use one of the following methods:

1. Press the ALT+TAB key combination to switch to the analyzer application.

2. In the Windows task bar (opened via ALT + Tab), click the "R&S Analyzer Interface" icon.

1.9 Firmware Update

Upgrade versions of the analyzer firmware are supplied as setup files (*msi). To perform a firmware update, you can either use the softkeys associated with the SETUP front panel key or the Instrument_Update_Tool. The latter procedure is recommended if installation via SETUP is not practicable.

Setup files

To prepare the installation, copy the setup file to any storage medium accessible from the analyzer. This may be the internal hard disk, an external storage medium (USB memory stick, CD-ROM with external drive) or a network connection (LAN, GPIB bus).

NOTICE

Calibration unit

The Calibration Unit (accessory R&S ZV-Z5x) must be disconnected during a firmware update.

To install new fimware using the SETUP menu,

1. Press SETUP > More > Firmware Update and open the Firmware Update dialog box.

2. Enter the update path of your firmware, depending on the installation medium that you use. You can also Browse… the update path in the dialog.

3. Click Execute to start the installation.

The installation program will guide you through the installation. If installation fails, use the Instrument_Update_Tool as described below.

Setup files can be stored and installed again. The default drive name of the USB interfaces is C:. External storage devices are automatically mapped to the next free drive, i.e. D:, E: etc.

Remote control: `SYST:FIRM:UPD 'D:\FW_UPDATE'`

To install new fimware using the update tool,

4. Close all applications.

5. Access Window XP's startup menu, e.g. by pressing *SETUP – General Setup – More – Open Start Menu* (see section Accessing Windows XP's Start Menu on p.).

6. Select Programs > Accessories > Instrument_Update_Tool.

7. In the dialog box opened, select the ZVL.package file and click Open.

8. In the Install Manager dialog box opened, click Install.

1.9.1   Operation with and without Administrator Rights

With firmware version V3.xx (image version 3.11) and higher, the network analyzer may be operated with or without administrator rights. Some administrative tasks (e.g. a firmware update) do require administrator rights; refer to the detailed description of the SETUP softkeys in chapter 4 of the operating manual.

In the default configuration, auto login is enabled, and an account with administrator rights is active. This means that no password is required, and the full functionality of the analyzer is available to any user. An additional user account without administrator rights is pre-defined.

To install new fimware using the update tool,

To change the user account, access Windows XP's Start menu, e.g. by pressing *SETUP – General Setup – More – Open Start Menu* (see section Accessing Windows XP's Start Menu on p.) and click *Settings – Control Panel – User Accounts*. In the dialog opened, you can also change the passwords for the user accounts. User accounts with the following user names and passwords are pre-defined::

Description	User name	Pasword
Default account, with administrator rights	Instrument	894129
Account without administrator rights	NormalUser	894129

(De)activating auto login

After being turned off, the R&S ZVB will return to the *Instrument* account without prompting for a password. To de-activate the automatic login mechanism,

1. Access the Start menu and select *Run...*

2. In the dialog box opened, enter C:\R_S\INSTR\USER\NO_AUTOLOGIN.REG and confirm.

Auto login is deactivated. The next time you switch on the R&S ZVL, you will have to enter a user name and a password. Proceed in the same way, using the C:\R_S\INSTR\USER\AUTOLOGIN.REG file, to re-activate automatic login.

Firmware upgrade and downgrade

An update from a firmware version <V3.xx to version V3.xx or higher does not replace the image. To replace the image version, contact your R&S service representative. The image upgrade is possible on instruments with a DVI-D connector on the rear panel.

A downgrade of the firmware from V3.xx or higher to version <V3.xx requires the `BackGrade` program, which can be accessed from the Windows XP Start menu of the analyzer:

1. Access the Start menu.

2. Click *Programs – Accessories – BackGrade* and confirm with OK.

3. Perform the firmware update using the *Instrument Update Tool* described above.

LXI

The LXI functionality including the home page is unavailable while the instrument is operated without administrator rights.

Table of Contents

2 Getting Started

The following chapter presents a sample session with a R&S ZVL network analyzer and explains how to solve basic tasks that you will frequently encounter when working with the instrument.

⚠️ **CAUTION**

General safety instructions

Before starting any measurement on your network analyzer, please note the instructions given in Chapter *Preparing for Use*.

In the *System Overview* you will find detailed information on customizing the instrument and the display according to your personal preferences. For a systematic explanation of all menus, functions and parameters and background information refer to the reference chapters in the online help system.

Windows operation

In the following we assume that you are familiar with standard Windows dialogs and mouse operation. Refer to sections Using Front Panel Keys and Data Entry to learn how to access instrument functions and control dialogs without a mouse and keyboard.

2.1 Reflection Measurements

In a reflection measurement, the analyzer transmits a stimulus signal to the input port of the device under test (DUT) and measures the reflected wave. A number of trace formats allow you to express and display the results. depending on what you want to learn from the data. Only one analyzer test port is required for reflection measurements.

In the following example, the analyzer is set up for a reflection measurement, a frequency sweep range and measurement parameter is selected, the instrument is calibrated and the result is evaluated using various formats.

2.1.1 Instrument Setup for Reflection Measurements

In order to prepare a reflection measurement, you have to connect your DUT (which is assumed to have a male N 50 Ω connector) to one of the (equivalent) analyzer test ports. Besides, it is recommended to preset the instrument in order to set it to a definite, known state.

1. Proceed as described in section *Starting the Analyzer and Shutting Down* in Chapter 1 to switch on the instrument and start the NWA application.

2. Connect the input port of your DUT to test port 1 of the network analyzer.

3. Press the PRESET key in the upper left corner of the front panel to perform a factory preset of the analyzer.

The analyzer is now set to its default state. The default measured quantity is the transmission S-parameter S_{21}. This quantity is zero in the current test setup, so the trace shows the noise level.

2.1.2 Parameter and Sweep Range Selection

After preset the display shows a diagram with a dB Mag scale. The sweep range (scale of the horizontal axis) is equal to the maximum frequency range of the analyzer, and the S-parameter S_{12} is selected as a measurement parameter.

To obtain information about the reflection characteristics of your DUT you have to select an appropriate measurement parameter and specify the sweep range.

1. Press the CENTER function key to the right of the display to open the associated numeric entry bar (Center Frequency). Enter the center of your desired frequency range in (e.g. 5.25 GHz).

   If you use the data keys at the front panel for data entry, simply type 5.25 and terminate the entry with the *G/n* key. Refer to section *Data Entry* to learn more about entering numeric values and characters.
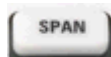
2. Press SPAN and enter the width of the frequency range you want to measure (e.g. 0.5 GHz).

   In addition to the linear frequency sweep considered in this example the analyzer provides frequency sweeps with a logarithmic or segmented frequency axis. Refer to *Setting up a Sweep* for more application examples.

3. Press MEAS and select the forward reflection coefficient S_{11} as a measurement parameter.
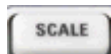
4. Press SCALE and activate the *Autoscale* function.

   The analyzer adjusts the scale of the diagram to fit in the entire S_{11} trace,

leaving an appropriate display margin.

Refer to section *Scaling Diagrams* to learn more about the different methods and tools for diagram scaling.
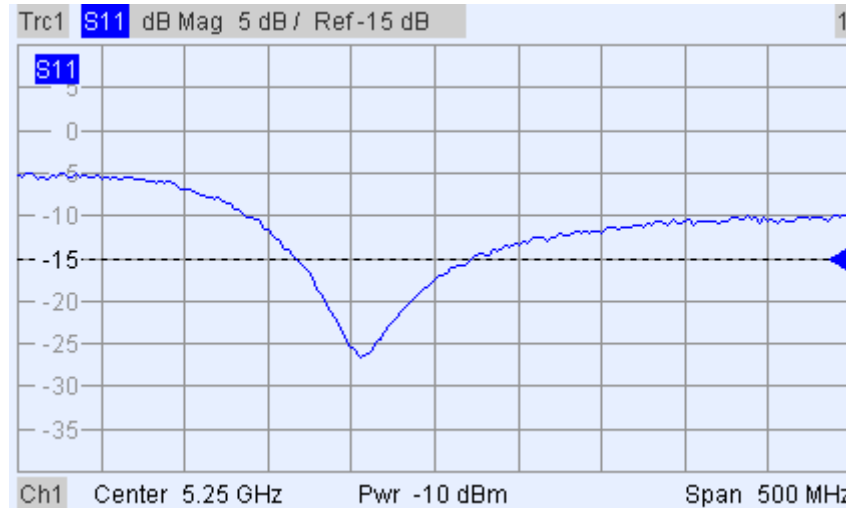

2.1.3 Instrument Calibration

The analyzer provides sophisticated calibration methods for all types of measurements. Which calibration method is selected depends on the expected system errors, the accuracy requirements of the measurement, on the test setup and on the types of calibration standards available.

In the following we assume that the calibration kit ZV-Z21 contains an appropriate male short standard with known physical properties. With a single short standard, it is possible to perform a normalization, compensating for a frequency-dependent attenuation and phase shift in the signal path.

Due to the analyzer's calibration wizard, calibration is a straightforward, menu-guided process.

1. Unscrew the DUT and connect the male short standard from calibration kit ZV-Z21.

2. Press the CAL function key to open the calibration menu.

3. Activate *Start Cal – One Port P1 – Normalization (Short)* to open the calibration wizard for the selected calibration type.
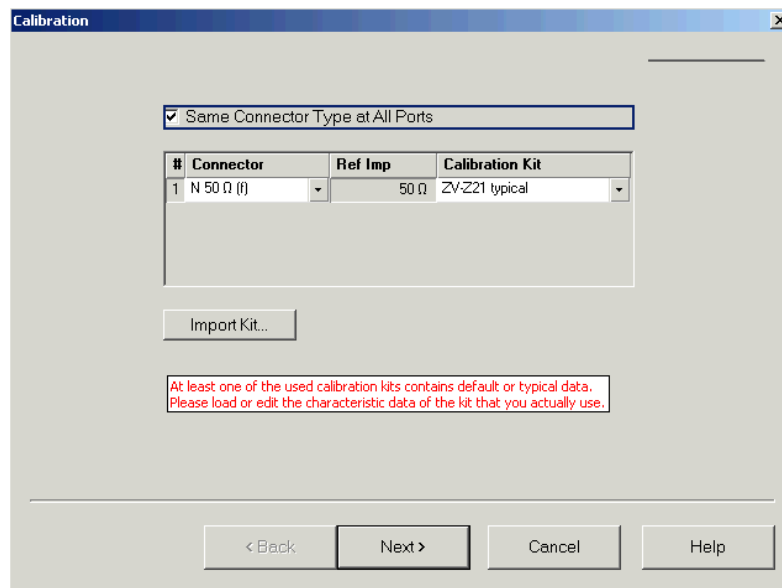
4. In the first dialog of the wizard, select the calibration kit (here: ZV-Z21) and the test port connector (here: N 50 Ω (f), corresponding to a male calibration standard), and click *Next*.

If you have not yet imported the exact cal kit data of your calibration kit, you can use the typical data as shown above. Typical data provide an approximate description of a calibration kit mode. To import the actual (accurate) data of your kit, press Import Kit... and select the appropriate cal kit file.
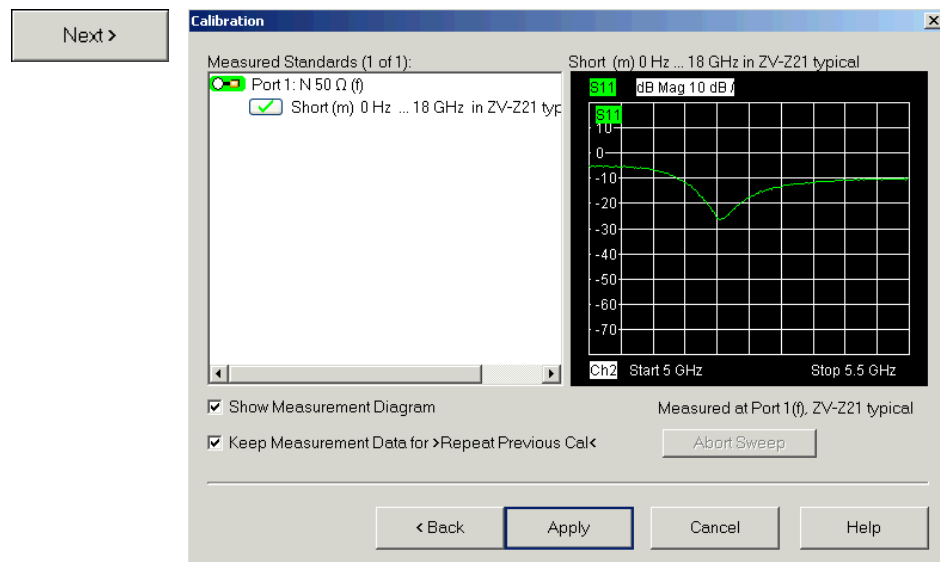
The next dialog of the calibration wizard shows that only a single calibration standard needs to be measured.

5. Click the box *Short (m)...* to initiate the measurement of the connected short standard.

The analyzer performs a calibration sweep and displays a message

box with a progress bar. After completing the sweep the analyzer generates a short sound and a green checkmark appears in the checkbox.

| Apply |

6. Click *Apply* to close the wizard, calculate and store the system error correction data and apply them to the current measurement.

7. Remove the short standard and connect the DUT again.

2.1.4 Evaluation of Data

The analyzer provides various tools to optimize the display and analyze the measurement data. For instance, you can use markers determine the maximum of the reflection coefficient, and change the display format to obtain information about the phase shift of the reflected wave and the impedance of your DUT.

| MKR |

1. Press the MKR function key. This places Marker 1 to its default position (center of the sweep range).

A marker symbol (triangle) appears on the trace. The stimulus value (frequency) and response value (magnitude of the reflection coefficient converted to a dB value) at the marker position is displayed in the *marker info field* in the upper right corner of the diagram.

| MKR → |

2. Press the MKR --> function key, open the *Marker Search* submenu and activate *Min Search*.

The marker jumps to the absolute minimum of the curve in the entire sweep range. The *marker info field* shows the coordinates of the new marker position.
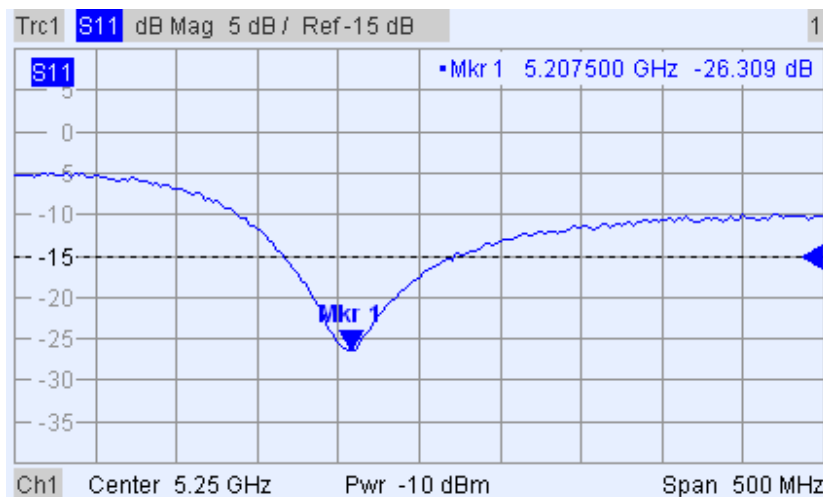
| FORMAT |

3. In the TRACE keypad, press FORMAT and select the *Phase* of the reflection coefficient to be displayed.

The phase is shown in a Cartesian diagram with a default vertical scale of –225 deg to +225 deg. The *marker info field* shows the frequency and phase at the marker position.
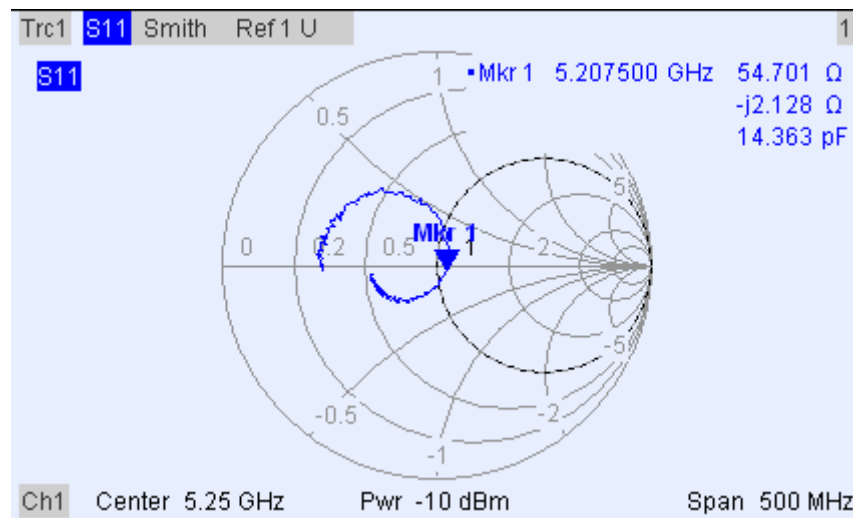
FORMAT   4.   Still in the FORMAT menu, select *Smith*.

The Smith chart shows lines of constant real and imaginary part of the impedance in the reflection coefficient plane.

Refer to section *Display Formats and Diagram Types* in Chapter 3 to learn more about the diagram properties.

2.1.5   Saving and Printing Data

The analyzer provides standard functions for saving measurement settings and for printing the results. You can use these functions as if you were working on a standard PC. Moreover you can export your trace data to an ASCII file and reuse it in a later session or in an external application.

Data transfer is made easier if external accessories are connected to the analyzer or if the instrument is integrated into a LAN. Refer to sections *External Accessories* and Remote Control in a LAN in Chapter 1 to obtain information about the necessary steps.

TRACE   1.   Press TRACE and activate More 1/3 – Import/Export Data – Export Data.

2.   In the *Export Complex Data* dialog opened, select a file location, format and name and activate *Save*.

The active trace data is written to an ASCII file.

Refer to section *Trace File Formats* to learn more about trace files and their use.

PRINT   3.   Press the PRINT key to the left of the display; then press *Device Setup*.

4.   In the *Hardcopy Setup* dialog opened, select *Printer*.

5.   Close the dialog and press *Print Screen* to create a hardcopy of your diagram.

6. Press *Device Setup* again and select a file format or *Clipboard.*

7. Close the dialog and press *Print Screen* again to copy the diagram to a file or an external application.

Nwa-File   8. Open the *Nwa-File* menu and select *Save NWA As...*

9. In the *Save As* dialog opened, select a file location, format and name and activate *Save.*

The active setup is stored to a file and can be reused in a later session.

Proceed as described in section *Starting the Analyzer, Shutdown* to shut down your analyzer.

2.2 Transmission Measurements

A transmission measurement involves the same steps as a reflection measurement. Note the following differences:

● The test setup for transmission measurements involves two DUT and analyzer ports. You can connect the input of your DUT to port 1 of the analyzer, the output to port 2. After a preset, the analyzer will measure the forward transmission S-parameter S_{21}.

● The analyzer provides special calibration types for transmission measurements. Use the calibration wizard and select an appropriate type. A TOSM calibration will correct the system errors for all transmission and reflection S-parameters.

2.3 Basic Tasks

The following sections describe how to solve basic tasks that you will frequently encounter when working with the instrument. In particular you can learn how to access instrument functions and control dialogs without a mouse and keyboard.

2.3.1 Control via Front Panel Keys

Although a mouse and external keyboard simplify the operation of the instrument, you can access all essential functions using the keys on the front panel. The following examples are intended to make you familiar with front panel key operation.

To Access a Particular Menu Command ...

1. Press the MENU key to the left of the display to access the menu bar and open the *Nwa-File* menu.

2. Use the keys in the NAVIGATION keypad or the rotary knob to navigate between and within the menus.

*   Use the *Cursor Left* and *Cursor Right* keys to change between the different menus in the menu bar. When the first option in a pull-down menu is a submenu, the submenu will be opened first before proceeding to the next option in the menu bar.

*   Use the *Cursor Up and Cursor Down* keys to scroll up and down in a menu.
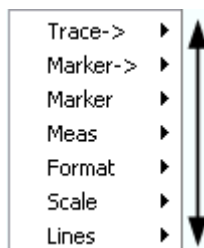
*   ENTER, the *Cursor Right* key or the rotary knob (if pressed) expand a submenu, open a dialog or initiate an action, depending on the selected command type.

*   ESC CANCEL or the *Cursor Left* key compress the current submenu and move the cursor one menu level up or close the active dialog, depending on the selected softkey type.
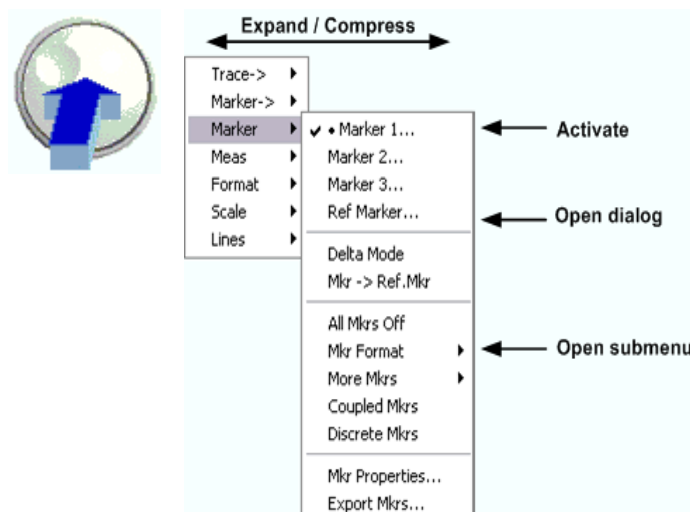
3. As soon as you reach the desired menu command (which must not be one opening a submenu) press ENTER or press the rotary knob to initiate an action or open a dialog.

After command execution or after closing the dialog, the menu bar is deactivated and the cursor returns to the diagram/softkey area.

To Make a Selection in a Dialog...

1. Press a softkey or a menu item followed by three dots to open a dialog.

2. Use the navigation keys and/or the rotary knob to access the controls in the dialog.

● Press *Left Field* or *Right Field* or the cursor keys to switch between the control elements in a dialog.

● Press the cursor keys to switch between several entries in a list of alternative or independent settings.
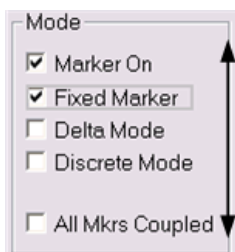
3. Use the data entry keys or the rotary knob to enter numbers. Use the on-screen keyboard for character entry. For more details refer to Data Entry.

4. Press ENTER, ESC CANCEL or press the rotary knob to close the active dialog.

2.3.2 Data Entry

The analyzer provides dialogs with various types of input fields where you can enter numeric values and character data. Data entry with a mouse and an external keyboard is a standard procedure known from other Windows applications. However, there are various alternative ways to enter data.

Using Front Panel Keys

If no mouse and no external keyboard is connected to the analyzer, you can use the data entry keys to enter numbers and units.

To enter a numeric value

1. Place the cursor into a numeric data input field in a dialog or in the numeric entry bar.

2. Press the data entry keys.

- Use *0* to *9* enter the corresponding numbers.

- Use *.* and *-* to enter a decimal point or change the sign of the value.

- Use *GHz / -dBm, MHz / dBm, kHz / dB,* or *Hz / dB..* to multiply the entered value with factors of $10^{(-)9}$, $10^{(-)6}$, $10^{(-)3}$ or 1 and/or add the appropriate physical unit.

To enter a character string

1. Place the cursor into a character data input field in a dialog.

2. Press the data entry keys as if you were writing a short message on your mobile phone.

The different characters assigned to each key are displayed in a popup dialog.

- Press *0* to *9* once to enter the corresponding numbers.
- Press the keys repeatedly to select one of the other characters assigned to the key.
- Wait 2 seconds to confirm an entry.

- Use *.* or *–* to enter a dot or a hyphen.
- Use the sign key to change from upper case to lower case and vice versa.

- Use the checkmark key to enter a space.
- Use the BACK key to correct wrong entries, deleting the character to the left of the current cursor position.

- Press ENTER to complete an entry.
- Press ESC CANCEL to close the popup dialog, discarding the entries made.

3. To enter letters you can also use one of the following methods:

- If the active input field has a ⬚ symbol, then use the analyzer's on-screen keyboard.
- Otherwise, use an external keyboard or a mouse and Windows XP's on-screen keyboard.

Using the Analyzer's On-Screen Keyboard

The on-screen keyboard allows you to enter characters, in particular letters, without an external keyboard. It is available for all character input fields which have a ⬚ symbol.

Operation with front panel keys

1. Place the cursor into a character data input field in a dialog or in the numeric entry bar.

2. Press ENTER or the *Checkmark* key to open the on-screen keyboard.

3. Use the cursor keys or turn the rotary knob to move the cursor to a character.

4. Press ENTER or the rotary knob to select the character for the input string.

5. After completing the input string use the *Right Field* key to move to the *OK* button.

6. Press ENTER or the rotary knob to apply your selection and close the keyboard.

Operation with a mouse

1. Click the keyboard symbol to open the on-screen keyboard.

2. Click a sequence of characters and *OK* to apply your selection and close the keyboard.

You can also access Windows XP's on-screen keyboard from the start menu. Press *SETUP – General Setup – More – Open Start Menu* (or connect an external keyboard and press CTRL + ESC) to open the start menu, and click *Programs – Accessories – Accessibility – On-Screen Keyboard.* From the start menu, you can also access other useful software accessories.

2.3.3 Scaling Diagrams

The analyzer provides several alternative tools for setting the sweep range and customizing the diagrams. Pick the method that is most convenient for you.

Setting the Sweep Range

The sweep range for all channels is displayed in the channel list across the bottom of the diagram area:

To change the sweep range, use one of the following methods:

- Press the CENTER or SPAN function keys on the front panel.
- Right-click the start or stop value in the channel list and select *Start, Stop, Center, Span* from the context menu.
- Select *Start, Stop, Center, Span* from the *Channel – Center* or *Channel – Span* menus.
- Use the marker functions (MARKER —> function key).

Reference Value and Position

The analyzer provides three parameters for changing the scale of the vertical (response) axis:

- Changing the *Ref Value* or *Ref Position* shifts the trace in vertical direction and adjusts the labels of the vertical axis. *Ref Value* also works for radial diagrams.
- Changing the *Scale/Div* modifies the value of the vertical or radial diagram divisions and thus the entire range of response values displayed.
- The *Scale/Div* and the *Ref Value* is indicated in the scale section of the trace list.

| Trc2 | S21 | dB Mag | 40 dB / | Ref -200 dB | Ch1 | Invisible |
Trc3	S21	Phase	45° /	Ref 0°	Ch2	
Trc7	S21	dB Mag	10 dB /	Ref 0 dB	Ch2	Math
Mem8[Trc7]	S21	dB Mag	10 dB /	Ref 0 dB	Ch2	

To change one of the parameters use one of the following methods:

● Press the SCALE function key on the front panel.
● Right-click the scale section in the trace list and select the parameters from the context menu.
● Select the parameters from the *Trace – Scale* menu.
● Use the marker functions (MARKER —> function key).

Autoscale

The *Autoscale* function adjusts the scale divisions and the reference value so that the entire trace fits into the diagram area. To access *Autoscale*, use one of the following methods:

● Press the SCALE function key on the front panel.
● Right-click the scale section in the trace list and select *Autoscale* from the context menu.
● Select *Autoscale* from the *Trace – Scale* menu.

Circular Diagrams

The radial scale of a circular *(Polar, Smith* or *Inverted Smith)* diagram can be changed with a single linear parameter, the *Ref Value*. The reference value defines the radius of the outer circumference.

● Increasing the *Reference Value* scales down the polar diagram.
● Decreasing the *Reference Value* magnifies the polar diagram.

The *Reference Value* is indicated in the scale section of the trace list.

| Trc1 | S21 | Polar | 0.26 U / | Ref 1.3 U |
| Trc3 | S21 | Smith | 0.2 U / | Ref 1 U |

To change the *Reference Value* use one of the following methods:

● Press the SCALE function key on the front panel.
● Right-click the scale section in the trace list and select the parameter from the context menu.
● Select the parameter from the *Trace – Scale* menu.
● Use the marker functions.

The *Autoscale* function also works for polar diagrams.

Using Marker Functions

Marker functions are a convenient tool for scaling (in particular: magnifying) diagrams without entering explicit numeric values. You simply place a marker to a trace point and use the marker values to change the sweep range or move the trace relative to the vertical axis. A mouse makes it easier to activate (click) or move (drag and drop) markers.
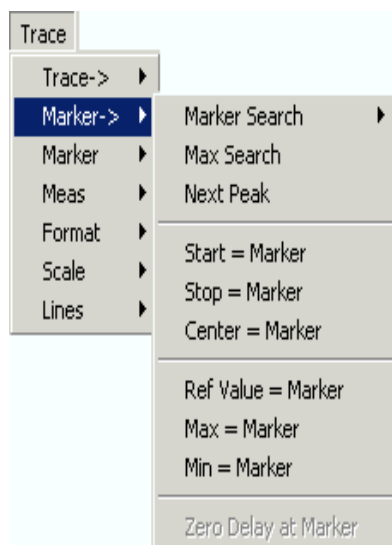
To set the sweep range use one of the following methods:

● **Define Start and Stop values**

1. Create two normal markers, e.g. the markers *Mkr 1* and *Mkr 2,* and place them to the desired start and stop values of the sweep range.

2. Activate *Mkr 1* and click *Trace – Marker --> – Start = Marker.*

3. Activate *Mkr 2* and click *Trace – Marker --> – Stop = Marker.*

● **Use a definite Span**

1. Create a marker and set it to delta mode.

2. The analyzer automatically creates a reference marker in addition to the delta marker.

3. Place the reference marker to the desired start value of the sweep range.

4. Set the value of the delta marker equal to the desired (positive or negative) span.

5. Activate the delta marker and click *Trace – Marker --> – Span = Marker.*

To move the trace relative to the vertical axis proceed as follows:

1. Create a normal marker, e.g. the marker *Mkr 1,* and place it to a particular trace point. E.g. you can use the marker *Search* functions to locate a maximum or minimum on the trace.

2. Click *Trace – Marker --> – Max = Marker* to move the trace towards the upper diagram edge, leaving the values of the vertical divisions *(Scale Div.)* and the overall vertical scale unchanged. Analogously, click *Min = Marker* to move the trace towards the lower diagram edge, or click *Ref Value = Marker* to move the trace towards the Reference Value.

Enlarging the Diagram Area

The analyzer provides different tools for customizing the contents and size of the diagram areas:

● *Maximize* allows you to enlarge the active diagram area to occupy the whole window. A double-click on any point in the diagram area is equivalent to the *Maximize* function.
● The *Title,* the *Softkey Labels,* the *Status Bar* and the *Front Panel Keys* are optional display elements which you can hide in order to gain space for the diagram.
● Use the context menu of the diagram area or the Nwa-Setup – Display menu to access the scaling functions above.

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3 System Overview

The following chapter provides an overview of the analyzer's capabilities and their use. This includes a description of the basic concepts that the analyzer uses to organize, process and display measurement data, of the screen contents, possible measured quantities, and calibration methods.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference description on the graphical user interface (GUI Reference)in the online help system.

3.1 Basic Concepts

The analyzer provides a variety of functions to perform a particular measurement and to customize and optimize the evaluation of results. To ensure that the instrument resources are easily accessible and that user-defined configurations can be conveniently implemented, stored and reused the instrument uses a hierarchy of structures:

- *Global resources* can be used for all measurements, irrespective of the current measurement session or setup.
- A *setup* comprises a set of *diagram areas* with all displayed information that can be stored to a setup file.
- The diagram areas show traces which are assigned to channels. See section Traces, Channels and Diagram Areas.
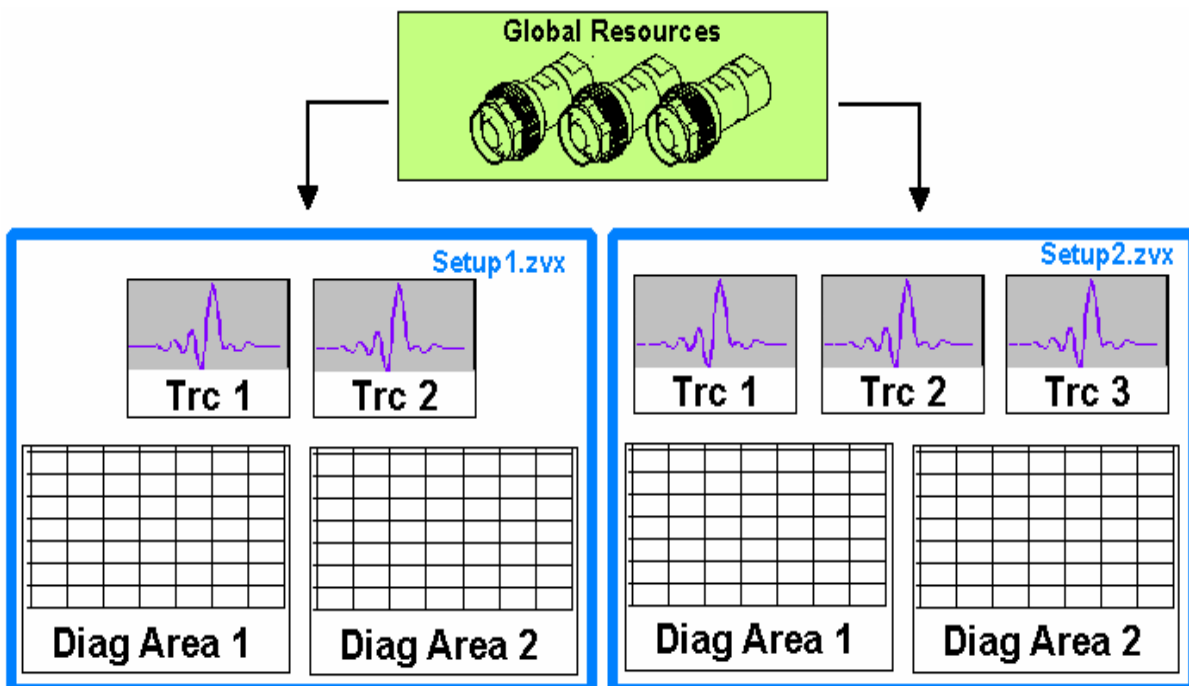
3.1.1 Global Resources

The analyzer provides global settings that are mostly hardware-related and can be used for all measurements, irrespective of the current measurement session or setup. The settings are stored in independent files and do not enter into any of the setup files. The following settings correspond to global resources:

- Calibration kits
- Connector types
- Cal pool data including system error correction and power correction data
- Color schemes

The data related to global resources are not affected by a *Preset* of the analyzer. However, it is possible to delete or reset global resource data using the *Resets* tab in the *System Config* dialog.

3.1.1.1 Setups

A setup comprises a set of *diagram areas* with all displayed information that can be stored to a NWA setup file (*.nwa) and reused. Each setup is displayed in an independent window. The setup file contains the following information:

- General settings related to the setup
- The trace settings for all traces in the diagram areas
- The channel settings for all channels associated to the traces
- The display settings for each diagram area

The *Nwa-File* menu is used to organize setups.

Demo setups

In the *System – External Tools* submenu, you can find demo setups *.vbs for various measurement scenarios. You can modify the demo setups and store them to a *.nwa file for later use.

3.1.2 Traces, Channels, and Diagram Areas

The analyzer arranges, displays or stores the measured data in *traces* which are assigned to *channels* and displayed in *diagram areas*. To understand the menu structure of the instrument and quickly find the appropriate settings, it is important to understand the exact meaning of the three terms.

- A trace is a set of data points that can be displayed together in a diagram area. The trace settings specify the mathematical operations used in order to obtain traces from the measured or stored data and to display them.
- A channel contains hardware-related settings to specify how the network analyzer collects data.

● A diagram area is a rectangular portion of the screen used to display traces. Diagram areas belonging to the same setup are arranged in a common window. The settings for diagram areas are described in section *Display Elements* in this chapter.

A diagram area can contain a practically unlimited number of traces, assigned to different channels. Diagram areas and channels are completely independent from each other.
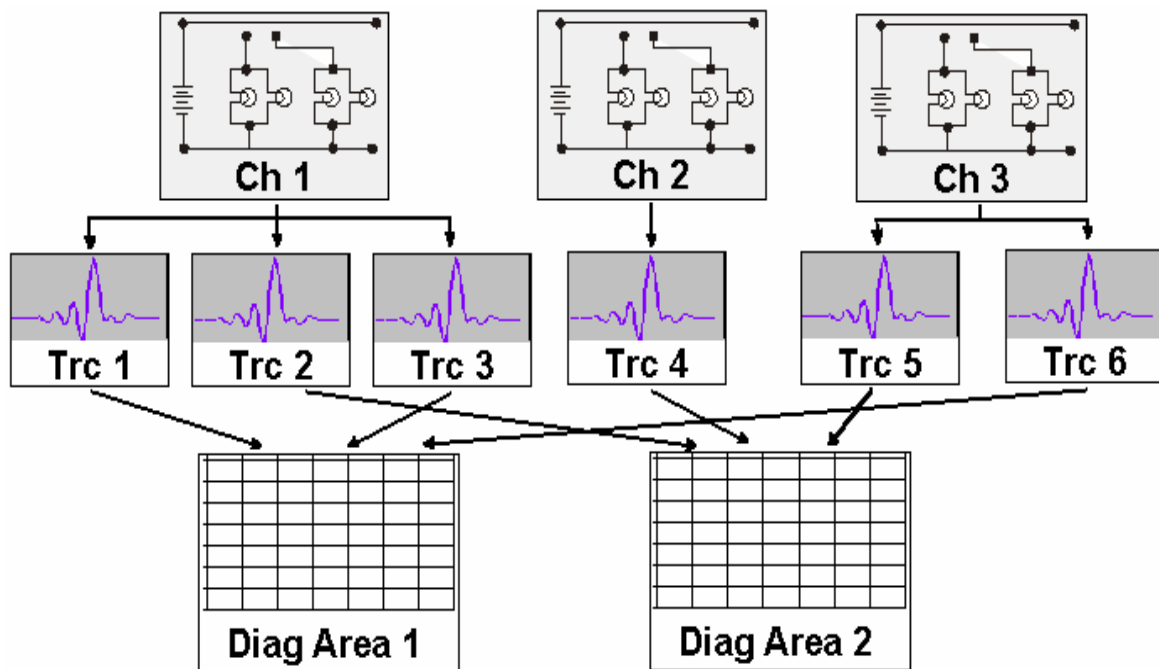
3.1.2.1 Trace Settings

The trace settings specify the mathematical operations used in order to obtain traces from the measured or stored data. They can be divided into several main groups:

● Selection of the measured quantity (S-parameters, impedances,...)
● Conversion into the appropriate display format and selection of the diagram type
● Scaling of the diagram and selection of the traces associated to the same channel
● Readout and search of particular values on the trace by means of markers
● Limit check

The *Trace* menu provides all trace settings. They complement the definitions of the *Channel* menu. Each trace is assigned to a channel. The channel settings apply to all traces assigned to the channel.

Active Traces

If a trace is selected in order to apply the trace settings, it becomes the active trace. In manual control there is always exactly one active trace, irrespective of the number of channels and traces defined. The active channel contains the active trace. In remote control, each channel contains an active trace; see section Active Traces in Remote Control in the help system.

3.1.2.2 Channel Settings

A channel contains hardware-related settings to specify how the network analyzer collects data. The channel settings can be divided into three main groups:
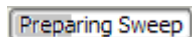
● Control of the measurement process *(Sweep)*
● Description of the test setup *(Power* of the internal source, IF filter *Bandwidth* and *Step Attenuators, Port Configuration)*
● Correction data (Calibration, Port Extensions)

The *Channel* menu provides all channel settings.

Sweep initialization

After changing the channel settings or selecting another measured quantity, the analyzer needs some time to initialize the new sweep. This preparation period increases with the number of points and the number of partial measurements involved. It is visualized by a Preparing Sweep symbol in the status bar:

Preparing Sweep

All analyzer settings can still be changed during sweep initialization. If necessary, the analyzer terminates the current initialization and starts a new preparation period. During the first sweep after a change of the channel settings, an additional red asterisk symbol appears in the status bar:

Ch1:

3.1.3 Data Flow

The analyzer processes the raw measurement data in a sequence of stages in order to obtain the displayed trace. The following diagram gives an overview.

The diagram consists of an upper and a lower part, corresponding to the data processing stages for the entire channel and for the individual traces. All stages in the diagram are configurable.

All stages are described in detail in Chapter 4 of the help system, *GUI Reference.*
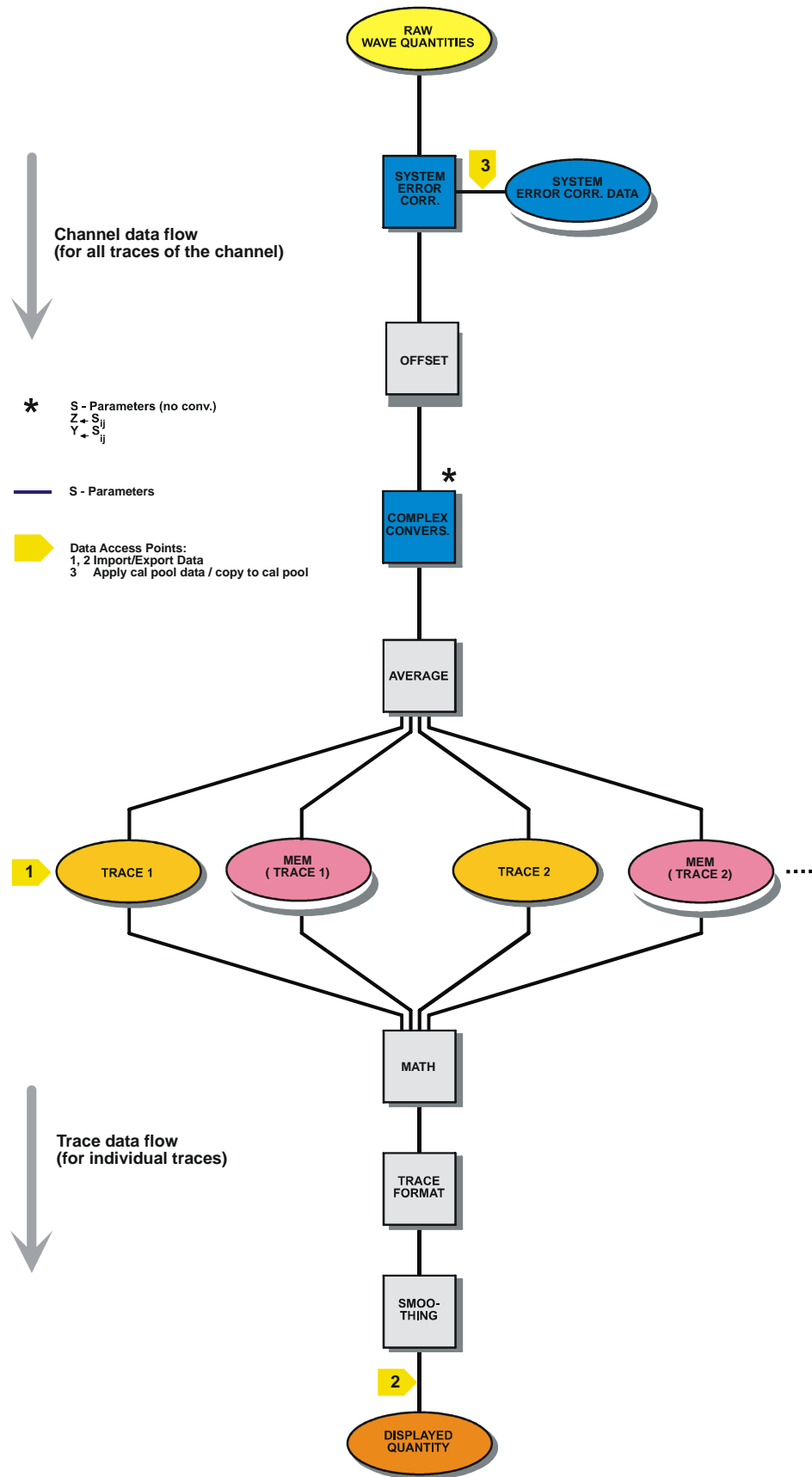
3.1.4 Navigation Tools of the Screen

This section describes the operating concept of the network analyzer, including the alternative navigation tools for mouse and hardkey operation, the trace settings, markers and diagram areas. For a description of the different quantities measured by the analyzer refer to the *Measured Quantities* section.

The main window of the analyzer provides all control elements for the measurements and contains the diagram areas for the results. There are several alternative ways to access an instrument function:

● Using the menus and submenus of the menu bar (provides all settings)
● Using the softkeys of the softkey bar (alternative to the previous method)
● Using the hardkey bar (preselection of the most important menus)
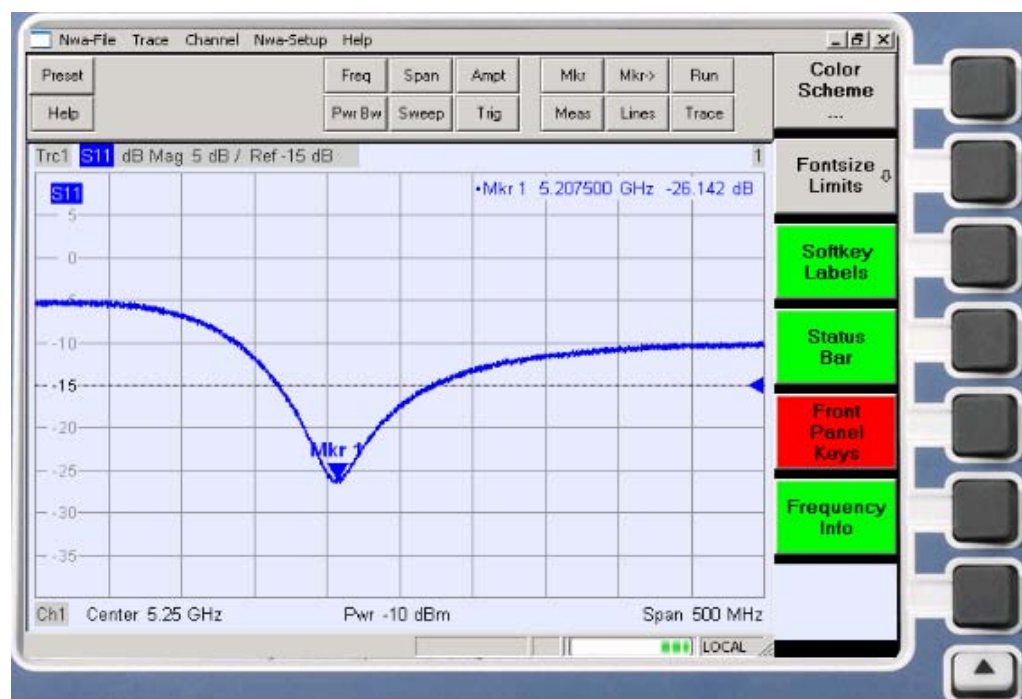
● Refer to section *Display Elements* to obtain information about the results in the diagram area.
● Refer to section *Display Menu* in the reference chapter and learn how to customize the screen.

3.1.4.1 Menu Bar

All analyzer functions are arranged in drop-down menus. The menu bar is located across the top of the diagram area:

Menus can be controlled in different ways:

- With a mouse, like the menus in any Windows application. A left mouse click expands a menu or submenu. If a menu command has no submenu assigned, a left mouse click opens a dialog or directly activates the menu command.
- Using the front panel keys.
- With a combination of the previous methods, using the hardkey bar (front panel key bar, activated via *Setup/Display Config./Front Panel Keys)*.

The active menu is the menu containing the last executed command.

When you select a command in a new menu the softkey bar is updated to reflect the new active menu with all commands. You can continue operation using the softkeys.

Overview of menu functions

- The *Control* ☐ menus provide standard Windows functions to control windows.
- The *File* menu provides standard Windows functions to create, save or recall setups and to shut down the application.
- The *Trace* menu provides all trace settings and the functions to create, select, modify and store different traces. In addition the menu provides the marker, search and limit check functions.
- The *Channel* menu provides all channel settings and the functions to create, select, modify and store different channels. This incudes the functions for calibration.
- The *Display* menu provides all display settings and the functions to create, select, modify and arrange different diagram areas.
- The *NWA-Setup* menu provides standard Windows™ functions to arrange different windows on the screen, display options, reverse operations, return to a defined instrument state, and retrieve information on the instrument. Besides, it provides configurations for the user interface and for remote control operation.
- The *Help* menu provides assistance with the network analyzer and its operation.

3.1.4.2   Menu Structure

All menus show an analogous structure.
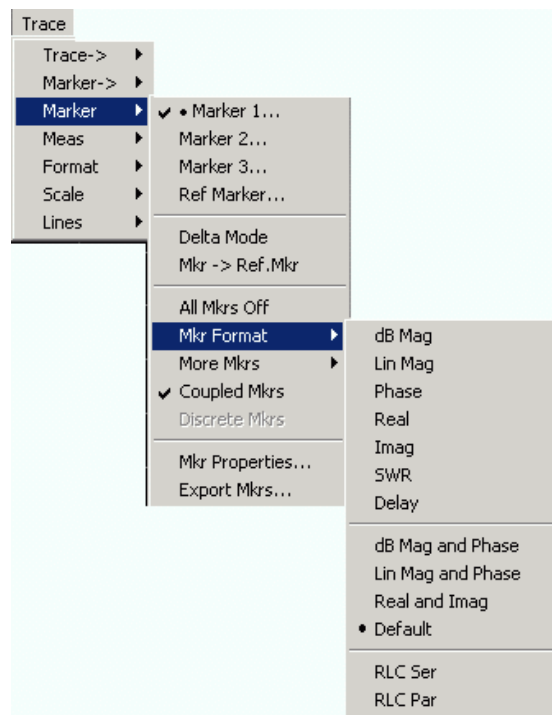
- A menu command with a right arrow ▶ expands a submenu with further related settings. **Example:** *Marker* ▶ expands a submenu to position markers on a trace and configure their properties.
- A menu command with three dots appended calls up an input field or a dialog providing several related settings. **Example:** *Marker 1...* opens an input field to enter the frequency of marker 1.
- A menu command with no arrow or dots directly initiates an action. **Example:** *Delta Mode c*onverts the active marker to a delta marker.
- A dot preceding the menu command indicates the current selection in a list of alternative settings. **Example:** In the figure above, the default format is selected as marker format.

3.1.4.3 Softkey Bar

The softkey bar displays the commands of the active menu so that they can be activated by hitting the associated keys on the front panel. It contains two different softkey types:

Function softkeys
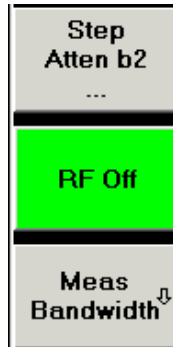
Up to 7 softkeys, each corresponding to a command of the active menu. The function of the softkeys and their labels are strictly equivalent to the corresponding menu commands.

- Three dots indicate that the softkey calls up a dialog providing several related settings.

- A down arrow ⇩ indicates a submenu with further related settings.

- A softkey with no arrow or dots directly initiates an action.

...

Navigation softkey (optional)

Softkey no. 7 is reserved for navigation:

More 1/2, *More 2/2* etc.toggle between groups of softkeys which belong to the same menu. The softkeys are provided whenever the active menu contains more than 6 commands.

The lowest front panel key to the right of the display activates the higher-level menu. This works in all menus except the top-level one listing the main menus in the menu bar.

The softkey bar is automatically updated when the active menu is changed.

Hiding display elements

You can hide the softkey bar and gain screen space for the diagram areas if you use a mouse to control the analyzer (see *Setup/Display Config.*). All settings are accessible from the menus listed in the menu bar across the top of the screen. Moreover, you don't have to display the softkey bar permanently in order to make use of its functionality. Hitting any of the keys associated to the softkey bar will make it visible for a period of time sufficient to select the next instrument function.

3.1.4.4 Front Panel Key Bar

The front panel key bar (hardkey bar, *Setup/Display Config.)* displays the most commonly used setup and function keys of the analyzer. Clicking a key symbol executes the action of the corresponding key.

The front panel key bar provides access to the basic groups of settings with a single mouse click. It is particularly useful if the analyzer is controlled with a mouse or via *Remote Desktop*. Alternatively the settings are accessible from the menus of the menu bar or from the softkey bar.

The front panel key bar is hidden by default to gain screen space for the diagram areas.

3.1.4.5 Status Bar

The status bar (Setup/Display Config.) shows the statistics for the sweep average (if sweep average is on). the progress of the sweep, a symbol for the current power supply option (AC, DC, battery, battery low), and the control mode of the analyzer (LOCAL or REMOTE).

During sweep initialization, the progress bar for the sweep is replaced by a [Preparing Sweep] symbol. During the first sweep after a change of the channel settings, an additional red asterisk symbol appears:

You can hide the status bar and gain screen space for the diagram areas.

3.1.5 Display Elements in the Diagram Area

The central part of the screen is occupied by one or several diagram areas.

Diagram Areas

A diagram area is a rectangular portion of the screen used to display traces. Diagram areas are arranged in windows; they are independent of trace and channel settings. A diagram area can contain a practically unlimited number of traces, assigned to different channels (overlay mode).

Diagram areas are controlled and configured by means of the functions in the *Display* menu and the following additional settings:

● The settings in the *Nwa-Setup – Display* submenu arrange several windows containing one or more diagram areas within the entire screen. Each window corresponds to a setup. Only one setup can be active at a time, and only the traces of the active setup are updated by the current measurements.
● Various settings to assign traces to diagram areas are provided in the *Trace – Trace-> – Traces* submenu.

Diagram areas may contain:

● Measurement results, in particular the traces and marker values
● An indication of the basic channel and trace settings
● Context menus providing settings related to the current screen

The examples in this section have been taken from Cartesian diagrams. All other diagram types provide the same display elements.
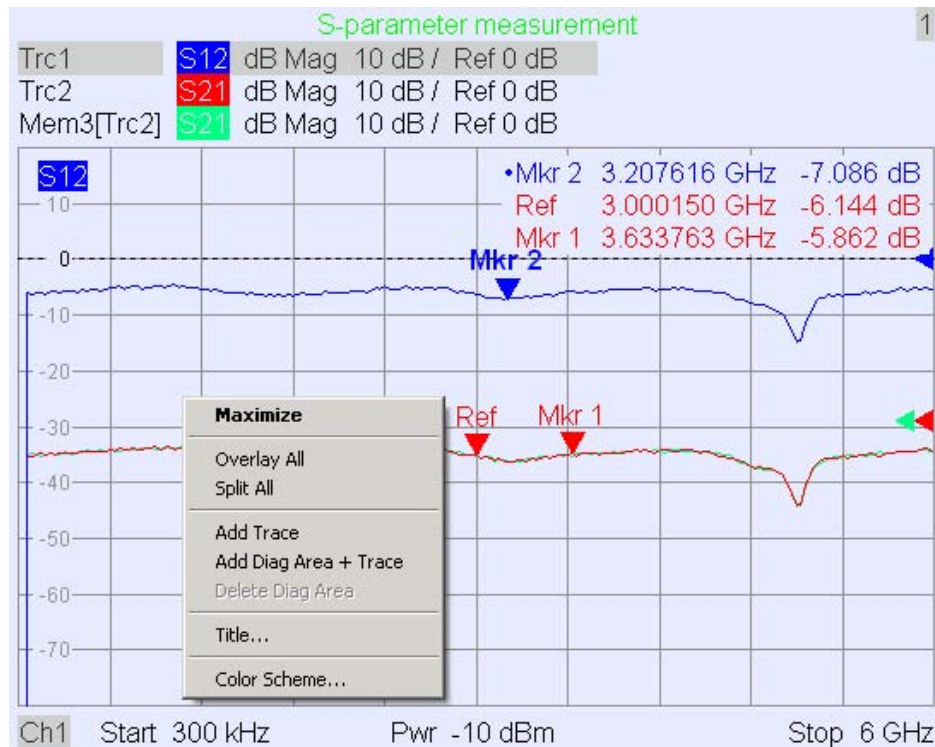
3.1.5.1 Title

Across the top of the diagram area, an optional title describes the contents of the area. Different areas within a setup are distinguished by area numbers in the upper right corner.

Use the context menu or the functions in the *Display* menu to display, hide or change the title and to add and customize diagram areas.

3.1.5.2 Traces

A trace is a set of data points displayed together in the diagram area. The individual data points are connected so that each trace forms a continuous line.
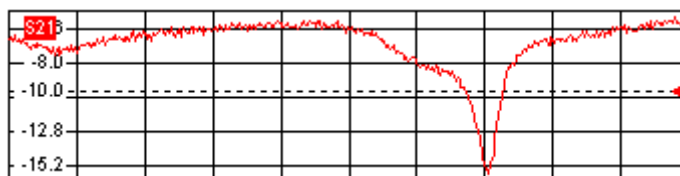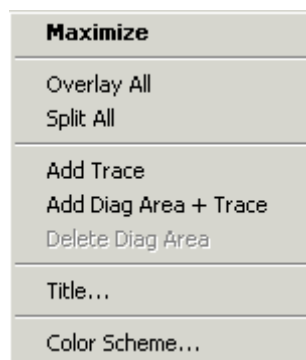

The trace can be complemented by the following display elements, plotted with the same color:

- *Reference value* (for all traces): The *Reference Value* is indicated with a triangle
  ┄◀ at the right edge of the diagram and a dashed, horizontal line. The value and
  position of the triangle can be changed in order to modify the diagram scale and
  shift the trace vertically.
- Measured quantity (for the active trace): The measured quantity is indicated in the
  left upper corner of the diagram.

A trace can be either a data trace, a memory trace, or a mathematical trace; see *Trace Types* below.

Context menu of the diagram area

A right mouse click on any point of the diagram area (except the marker info field and
the measured quantity info) opens a context menu:

Maximize
Overlay All
Split All
Add Trace
Add Diag Area + Trace
Delete Diag Area
Title...
Color Scheme...

The settings correspond to the most common commands in the *Nwa-Setup – Display*
and *Nwa-Setup – Display Config* menus.

3.1.5.3 Trace Types

The analyzer uses traces to display the current measurement result in a diagram area
but is also capable of storing traces to the memory, recalling stored traces, and
defining mathematical relations between different traces. There are three basic trace
types:

- Data traces show the current measurement data and are continuously updated as
  the measurement goes on. Data traces are dynamic traces.
- Memory traces are generated by storing the data trace to the memory. It
  represents the state of the data trace at the moment when it was stored.Memory
  traces are static traces which can be stored to a file and recalled.
- Mathematical traces are calculated according to a mathematical relation between
  constants and the data or memory traces of the active setup. A mathematical trace
  that is based on the active data trace is dynamic.

It is possible to generate an unlimited number of memory traces from a data trace and
display them together, see *Data -> Mem*. Markers and marker functions are available
for all trace types.

The trace type of each trace in a diagram area is indicated in the trace list. You can
also make each trace *Invisible* without deleting it.

3.1.5.4 Trace List and Trace Settings

The main properties of all traces assigned to the diagram area are displayed in the trace list in the upper left corner.

Each line in the trace list describes a single trace. The active trace is highlighted. The lines are divided into several sections with the following contents (from left to right):

- Trace name indicates the current trace name. The default names for new traces are Trc<n> where <n> is a current number. A *Mem...* preceding the trace name indicates a memory trace. Right-click the section and call the *Trace Manager* from the context menu to change the trace name.
- Measured quantity indicates the measured quantity, e.g. an S-parameter or an impedance. The measured quantity of the active trace is also displayed in the diagram area below the trace list.
- Format shows how the measured data is presented in the graphical display (trace format).
- Scale shows the value of the vertical or radial diagram divisions (Scale Div.) and the Reference Value.
- Channel shows the channel that each trace is assigned to. The channel section is omitted if the all traces in the diagram area are assigned to the same channel.
- Type shows *Invisible* if a trace is hidden and *Math* if the trace is a mathematical trace. *GAT* indicates that a time gate is active for the trace. Right-click the trace name and click *Show Data* or *Show Mem* from the context menu to display and hide data and memory traces. Use the *Trace Funct(ions)* to define mathematical traces. Right-click any of the sections in the trace list (except *Type)* to open a context menu and access the most common tasks related to the section.

Context menus of the trace list

A right mouse click on the trace name, the measured quantity, and the format and scale section of the trace list opens the following context menus, respectively:

The settings correspond to the most common commands in the *Trace – Trace Select, Trace – Trace Funct, Trace – Meas, Trace – Format* and *Trace – Scale* menus.

A red label Cal Off ! appears behind the trace list if the system error correction no longer applies to one or more traces; see Calibration Overview.

3.1.5.5　Markers

Markers are tools for selecting points on the trace and for numerical readout of measured data. The analyzer provides three different basic marker types.
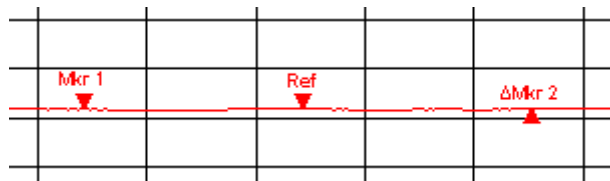
- A (normal) marker *(Mkr 1, Mkr 2, ...)* determines the coordinates of a measurement point on the trace. Up to 10 different normal markers can be assigned to a trace.
- A reference marker *(Ref)* defines the reference value for all delta markers.
- A delta marker *(Δ)* indicates the coordinates relative to the reference marker.
- The stimulus value of a *discrete marker* always coincides with a sweep point so that the marker does not show interpolated measurement values.

The markers 1 to 4 are also used for bandfilter search mode. The examples below show a bandpass search and a bandstop search, respectively.

- *Mkr 1* indicates the maximum (minimum) of the peak.
- *Mkr 2* and *Mkr 3* indicate the lower and upper band edge where the trace value has decreased (increased) by a definite *Level* value.
- *Mkr 4* indicates the center of the peak, calculated as the arithmetic mean value of the *LBE* and *UBE* positions*.*

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3.1.5.6   Marker Info Field

The coordinates of all markers defined in a diagram area are displayed in the info field, which by default is located in the upper right corner.
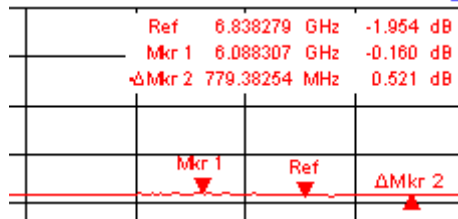
The list contains the following information:

- *Mkr 1, Mkr2,* ... denote the marker numbers.
- Markers are displayed with the same color as the associated trace.
- The marker coordinates are expressed in one of the marker formats selected via *Marker Format.* The formats of the markers assigned to a trace are independent of each other and of the trace format settings.
- The active marker has a dot placed in front of the marker line.
- A Δ sign placed in front of the marker line indicates that the marker is in *Delta Mode.*

Customizing the marker info field

To change the position, appearance or contents of the marker info field use one of the following methods:

- Double-click the info field to open the Marker Properties dialog with extended settings for all markers of the active trace.Select the options in the Show Info panel to customize the information in the info field (Active Trace Only, Stimulus Info Off).
- Right-click the info field to open a context menu providing frequently used marker settings.
- To change the position of the marker info field, select *Movable Marker Info* from the context menu. Drag-and-drop the info field to any position in the active diagram area.
- To change the format of the active marker, select *Mkr Format.*
- To express the coordinates of the active marker relative to the reference marker, activate the *Delta Mode.*
- Open the *Nwa-Setup* dialog and open the *System Configuration* dialog to toggle between non-transparent and transparent info fields.
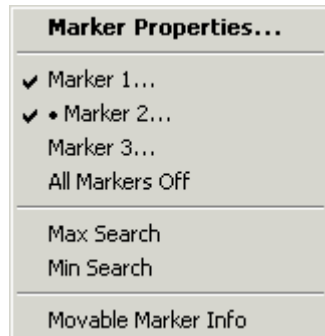
For more information: Show Info Table

In addition to the marker info field, the analyzer provides an info table with extended marker information.

Marker	Trace	Stimulus	Response	Delta	Discr	Fixed	Tracking	Search Range
Ref	Trc1	3.440171000 GHz	-6.426 dB	☐	☑	☑	Off	Full Range
Mkr 1	Trc1	4.000150000 GHz	-5.364 dB	☐	☐	☐	Off	Full Range

The table is hidden by default. To display the table double-click the marker info field to open the *Marker Properties* dialog.

Context menu of the marker info field

A right mouse click on the marker info field opens a context menu:

Marker Properties...
✔ Marker 1...
✔ • Marker 2...
Marker 3...
All Markers Off
Max Search
Min Search
Movable Marker Info

Movable Marker Info allows the marker info field to be placed to any position in the diagram area. The remaining settings correspond to the most common commands in the *Trace – Marker* and *Trace – Search* menus.

3.1.5.7 Channel Settings

The main properties of all channels assigned to the traces in the diagram area are displayed in the channel list below the diagram.

Ch1	Center	5.1 GHz	—	Pwr	-10 dBm		Span	500 MHz
Ch2	Start	1 GHz	—	Pwr	-10 dBm		Stop	2.5 GHz

Each line in the channel list describes a single channel. The channel of the active trace is highlighted. The lines are divided into several sections with the following contents (from left to right):

- Channel name indicates the current channel name. The default names for new channels are Ch<n> where <n> is a current number. Right-click the section and call the *Channel Manager* from the context menu to change the channel name.
- Start value of the sweep indicates the lowest value of the sweep variable (e.g. the lowest frequency measured), corresponding to the left edge of the Cartesian diagram.
- Color legend shows the display color of all traces assigned to the channel. The colors are different, so the number of colors is equal to the numbers of traces assigned to the channel.
- Additional stimulus parameter shows either the power of the internal signal source (for frequency sweeps and time sweeps) or the CW frequency (for power sweeps).
- Stop value of the sweep indicates the highest value of the sweep variable (e.g. the highest frequency measured), corresponding to the right edge of the Cartesian diagram. Right-click any of the sections in the trace list (except *Color legend)* to open a context menu and access the most common tasks related to the section.

Context menus of the channel list

A right mouse click on the channel name, the sweep range, and the additional parameter section of the channel list opens the following context menus, respectively:
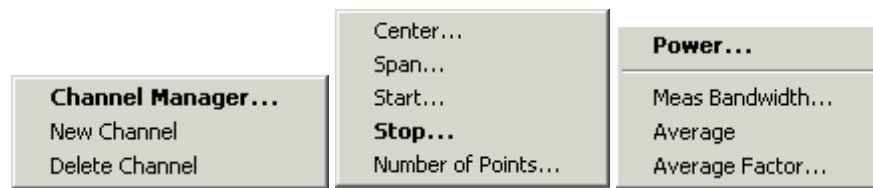
The settings correspond to the most common commands in the *Channel – Channel Select, Channel – Center, Span* and *Channel – Pwr Bw* menus.

3.1.5.8 Context Menus

To provide access to the most common tasks and speed up the operation, the analyzer offers context menus (right-click menus) for the following display elements:

- Diagram area
- Marker info field
- Trace list (separate context menus for trace name section, measured quantity section, format section, scale section, and channel section)
- Channel list (separate context menus for channel name section, sweep range section, additional parameter section)

Working with context menus requires a mouse. Click inside the display element that you want to work with using the **right** mouse button.

Except from some particular screen configurations, anything you can do from a context menu you can also do from the menu bar using front panel keys and softkeys. Use whatever method is most convenient for you.

3.1.6 Dialogs

Dialogs provide groups of related settings and allow to make selections and enter data in an organized way. All softkeys with three dots behind their labeling (as in *Mkr Properties...*) call up a dialog. The dialogs of the analyzer have an analogous structure and a number of common control elements.

Dialog Transparency

The *Dialog Transparency* function (*Nwa-Setup – System Config* menu) varies the transparency of all dialogs. With an appropriate setting, you can control the dialogs and at the same time view the underlying traces and display elements.

We assume that you are familiar with standard Windows dialogs and mouse operation. Refer to Using Front Panel Keys to learn how to control dialogs without a mouse and keyboard.
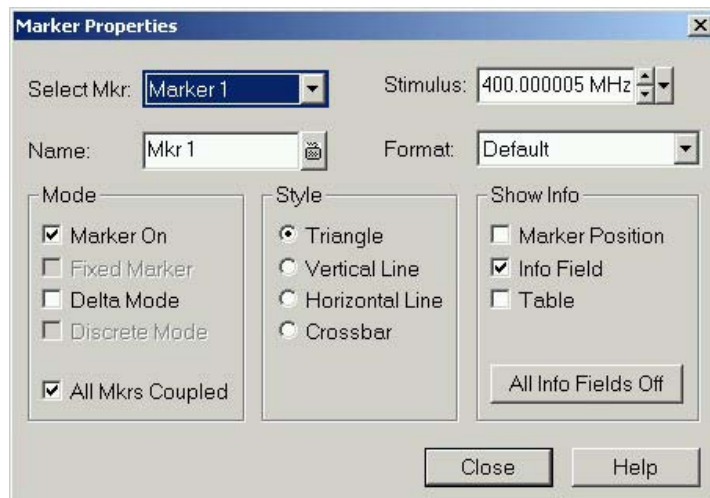
3.1.6.1 Immediate vs. Confirmed Settings

In some dialogs, the settings take effect immediately so that the effect on the measurement is observable while the dialog is still open. This is especially convenient when a numeric value is incremented or decremented, e.g. via the rotary knob.

In most dialogs, however, it is possible to cancel an erroneous input before it takes effect. The settings in such dialogs must be confirmed explicitly.

The two types of dialogs are easy to distinguish:

● Dialogs with immediate settings provide a *Close* button but no *OK* button. Example: *Step Size* dialog.
● Dialogs with confirmed settings provide both an OK button and a Cancel button. Example: On-screen keyboard.

You can also cancel an immediate setting using *Setup – Undo*.

3.1.6.2 On-Screen Keyboard

A keyboard symbol next to a character input field opens the analyzer's on-screen keyboard.


The on-screen keyboard contains two sets of characters plus the following additional controls:

- *Shift* changes between the two character sets containing lower case letters/numbers and upper case letters/special characters, respectively.
- *<= BS* deletes the current string in the alphanumeric input field.
- *OK* applies the current selection and closes the keyboard. The current string is written into the input field of the calling dialog. See also *Immediate vs. Confirmed Settings*.
- *Cancel* discards the current selection and closes the keyboard. The input field of the calling dialog is left unchanged.

The on-screen keyboard allows you to enter characters, in particular letters, without an external keyboard; see *Data Entry.* To enter numbers and units, you can also use the DATA ENTRY keys on the front panel of the instrument.

3.1.6.3   Paste Marker List

A pull-down list symbol next to a numeric input field opens a list of all current stimulus and response marker values of the active trace. Any of the marker values can be selected as a numeric entry. If the physical unit of the selected marker value is inconsistent (mismatch of stimulus and response values) then the numeric value is used without the unit.
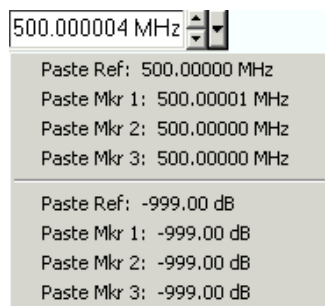

The response values in the paste marker list are not updated as the analyzer continues measuring, so they may differ from the values in the marker info field.

To open the paste marker list you can also click on the input field and use the space bar of your keyboard or the checkmark key in the navigation area at the front panel of the analyzer.

3.1.6.4   Numeric Entry Bar

Single numeric values can be entered using the input field of the numeric entry bar. The numeric entry bar appears just below the menu bar as soon as a function implying a single numeric entry is activated. In contrast to dialogs, it does not hide any of the display elements in the diagram area.
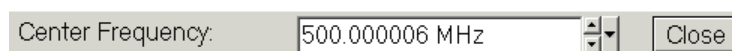
The numeric entry bar contains the name of the calling function, a numeric input field including the Cursor Up/Down buttons for data variation and a *Close* button. Besides it is closed automatically as soon as an active display element in the diagram area is clicked or a new menu command is activated.

3.1.7 Display Formats and Diagram Types

A display format defines how the set of (complex) measurement points is converted and displayed in a diagram. The display formats in the *Trace – Format* menu use the following basic diagram types:

- Cartesian (rectangular) diagrams are used for all display formats involving a conversion of the measurement data into a real (scalar) quantity, i.e. for *dB Mag, Phase, Group Delay, SWR, Lin Mag, Real, Imag* and *Unwrapped Phase.*
- Polar diagrams are used for the display format *Polar* and show a complex quantity as a vector in a single trace.
- Smith charts are used for the display format *Smith* and show vector like polar diagrams but with grid lines of constant real and imaginary part of the impedance.
- Inverted Smith charts are used for the display format *Inverted Smith* and show vector like polar diagrams but with grid lines of constant real and imaginary part of the admittance.

**Trace formats and measured quantities**

The analyzer allows arbitrary combinations of display formats and measured quantities (Trace – Meas). Nevertheless, in order to extract useful information from the data, it is important to select a display format which is appropriate to the analysis of a particular measured quantity; see Measured Quantities and Display Formats.

3.1.7.1 Cartesian Diagrams

Cartesian diagrams are rectangular diagrams used to display a scalar quantity as a function of the stimulus variable (frequency).

- The stimulus variable appears on the horizontal axis (x-axis), scaled linearly (sweep type *Lin Frequency)* or logarithmically (sweep type *Log Frequency).*
- The measured data (response values) appears on the vertical axis (y-axis). The scale of the y-axis is linear with equidistant grid lines although the y-axis values may be obtained from the measured data by non-linear conversions*.*

The following examples show the same trace in Cartesian diagrams with linear and logarithmic x-axis scaling.
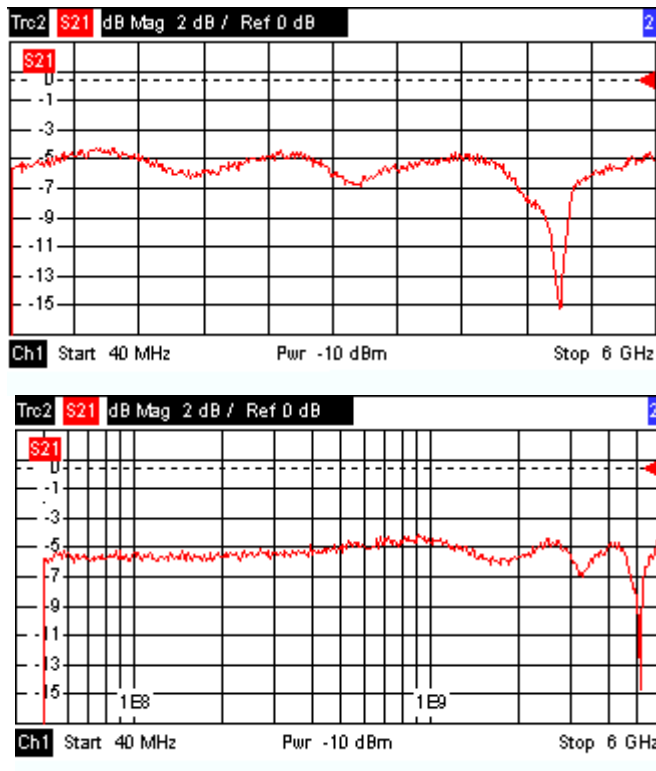
3.1.7.2 Conversion of Complex into Real Quantities

The results to be selected in the *Trace – Meas* menu can be divided into two groups:

● S-Parameters, Impedances, and Admittances are complex.
● Stability Factors are real.

The following table shows how the response values in the different Cartesian diagrams are calculated from the complex measurement values $z = x + jy$ (where x, y, z are functions of the sweep variable). The formulas also hold for real results, which are treated as complex values with zero imaginary part (y = 0).

| Trace Format	Description	Formula
dB Mag	Magnitude of z in dB	$|z| = sqrt (x^2 + y^2)$ dB Mag(z) = 20 * log|z| dB
Lin Mag	Magnitude of z, unconverted	$|z| = sqrt (x^2 + y^2)$
Phase	Phase of z	$\phi (z) = arctan (y/x)$
Real	Real part of z	Re(z) = x
Imag	Imaginary part of z	Im(z) = y
SWR	(Voltage) Standing Wave Ratio	SWR = (1 + |z|) / (1 − |z|)
Group Delay	Group delay, neg. derivative of the phase response	$- d \phi (z) / d\omega$ ($\omega = 2\pi * f$)

An extended range of formats and conversion formulas is available for markers. To convert any point on a trace, create a marker and select the appropriate marker format. Marker and trace formats can be selected independently.

3.1.7.3 Polar Diagrams

Polar diagrams show the measured data (response values) in the complex plane with a horizontal real axis and a vertical imaginary axis. The grid lines correspond to points of equal magnitude and phase.

- The magnitude of the response values corresponds to their distance from the center. Values with the same magnitude are located on circles.
- The phase of the response values is given by the angle from the positive horizontal axis. Values with the same phase on straight lines originating at the center.

The following example shows a polar diagram with a marker used to display a pair of stimulus and response values.
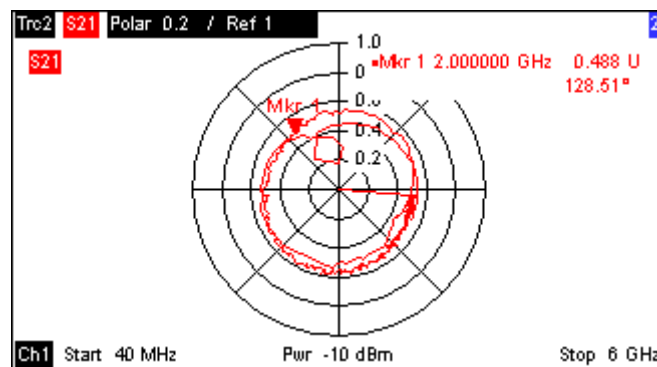
Example: Reflection coefficients in polar diagrams

If the measured quantity is a complex reflection coefficient (S_{11}, S_{22} etc.), then the center of the polar diagram corresponds to a perfect load Z_0 at the input test port of the DUT (no reflection, matched input), whereas the outer circumference ($|S_{ii}| = 1$) represents a totally reflected signal.
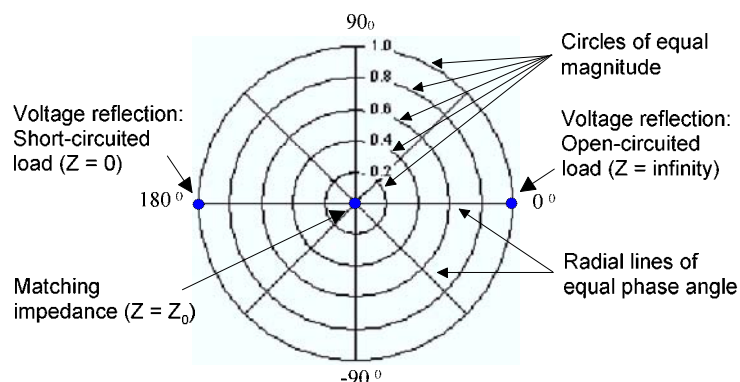
Examples for definite magnitudes and phase angles:

- The magnitude of the reflection coefficient of an open circuit (Z = infinity, I = 0) is one, its phase is zero.

● The magnitude of the reflection coefficient of a short circuit (Z = 0, U = 0) is one, its phase is -180^0.

3.1.7.4 Smith Chart

The Smith chart is a circular diagram that maps the complex reflection coefficients S_{ii} to normalized impedance values. In contrast to the polar diagram, the scaling of the diagram is not linear. The grid lines correspond to points of constant resistance and reactance.

● Points with the same resistance are located on circles.
● Points with the same reactance produce arcs.

The following example shows a Smith chart with a marker used to display the stimulus value, the complex impedance Z = R + j X and the equivalent inductance L (see marker format description in the help system).
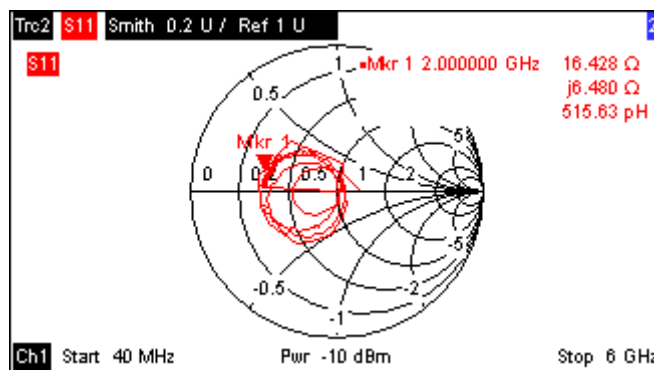

Polar diagram types

A comparison of the Smith chart, the inverted Smith chart and the polar diagram reveals many similarities between the two representations. In fact the shape of a trace does not change at all if the display format is switched from *Polar* to *Smith* or *Inverted Smith* – the analyzer simply replaces the underlying grid and the default marker format.

Smith chart construction

In a Smith chart, the impedance plane is reshaped so that the area with positive resistance is mapped into a unit circle.
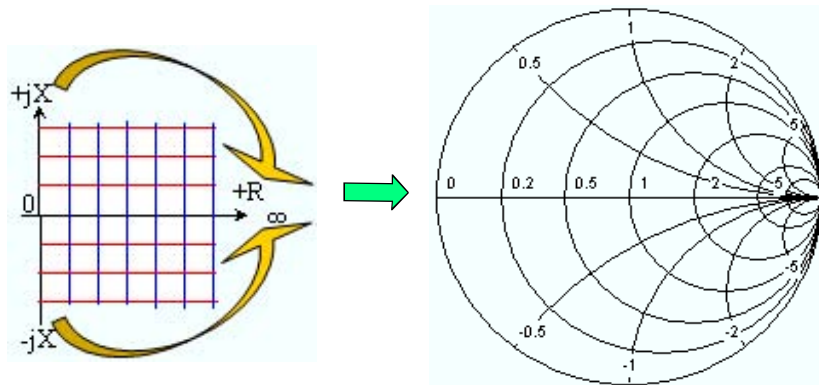
The basic properties of the Smith chart follow from this construction:

● The central horizontal axis corresponds to zero reactance (real impedance). The center of the diagram represents $Z/Z_0 = 1$ which is the reference impedance of the system (zero reflection). At the left and right intersection points between the horizontal axis and the outer circle, the impedance is zero (short) and infinity (open).
● The outer circle corresponds to zero resistance (purely imaginary impedance). Points outside the outer circle indicate an active component.
● The upper and lower half of the diagram correspond to positive (inductive) and negative (capacitive) reactive components of the impedance, respectively.

Example: Reflection coefficients in the Smith chart

If the measured quantity is a complex reflection coefficient Γ (e.g. S_{11}, S_{22}), then the unit Smith chart can be used to read the normalized impedance of the DUT. The coordinates in the normalized impedance plane and in the reflection coefficient plane are related as follows (see also: definition of matched-circuit (converted) impedances):

$Z / Z_0 = (1 + \Gamma) / (1 - \Gamma)$

From this equation it is easy to relate the real and imaginary components of the complex resistance to the real and imaginary parts of Γ:

$$R = \mathrm{Re}(Z/Z_0) = \frac{1 - \mathrm{Re}(\Gamma)^2 - \mathrm{Im}(\Gamma)^2}{[1 - \mathrm{Re}(\Gamma)]^2 + \mathrm{Im}(\Gamma)^2}, \quad X = \mathrm{Im}(Z/Z_0) = \frac{2 \cdot \mathrm{Im}(\Gamma)}{[1 - \mathrm{Re}(\Gamma)]^2 + \mathrm{Im}(\Gamma)^2},$$

in order to deduce the following properties of the graphical representation in a Smith chart:

● Real reflection coefficients are mapped to real impedances (resistances).
● The center of the Γ plane ($\Gamma = 0$) is mapped to the reference impedance Z_0, whereas the circle with $|\Gamma| = 1$ is mapped to the imaginary axis of the Z plane.
● The circles for the points of equal resistance are centered on the real axis and intersect at Z = infinity. The arcs for the points of equal reactance also belong to circles intersecting at Z = infinity (open circuit point (1,0)), centered on a straight vertical line.
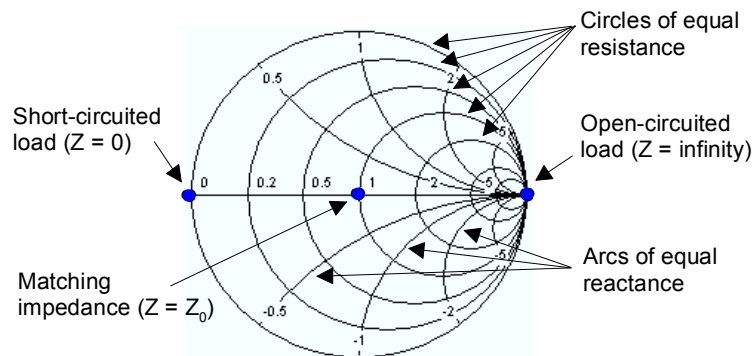
Examples for special points in the Smith chart:

● The magnitude of the reflection coefficient of an open circuit (Z = infinity, I = 0) is one, its phase is zero.

● The magnitude of the reflection coefficient of a short circuit (Z = 0, U = 0) is one, its phase is -180^0.

3.1.7.5 Inverted Smith Chart

The inverted Smith chart is a circular diagram that maps the complex reflection coefficients S_{ii} to normalized admittance values. In contrast to the polar diagram, the scaling of the diagram is not linear. The grid lines correspond to points of constant conductance and susceptance.

● Points with the same conductance are located on circles.

● Points with the same susceptance produce arcs.

The following example shows an inverted Smith chart with a marker used to display the stimulus value, the complex admittance Y = G + j B and the equivalent inductance L (see marker format description in the help system).
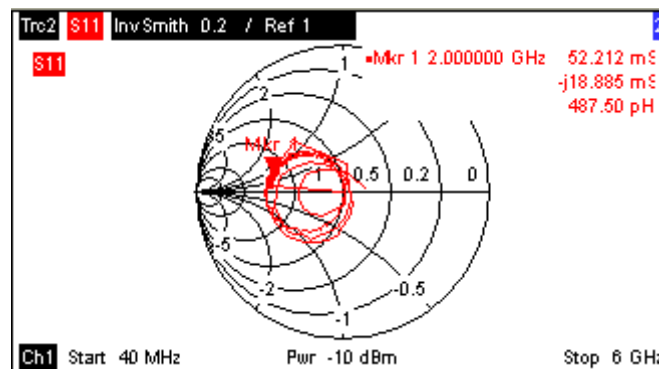

Polar diagram types

A comparison of the Smith chart, the inverted Smith chart and the polar diagram reveals many similarities between the two representations. In fact the shape of a trace does not change at all if the display format is switched from *Polar* to *Smith* or *Inverted Smith* – the analyzer simply replaces the underlying grid and the default marker format.

Inverted Smith chart construction

The inverted Smith chart is point-symmetric to the Smith chart:
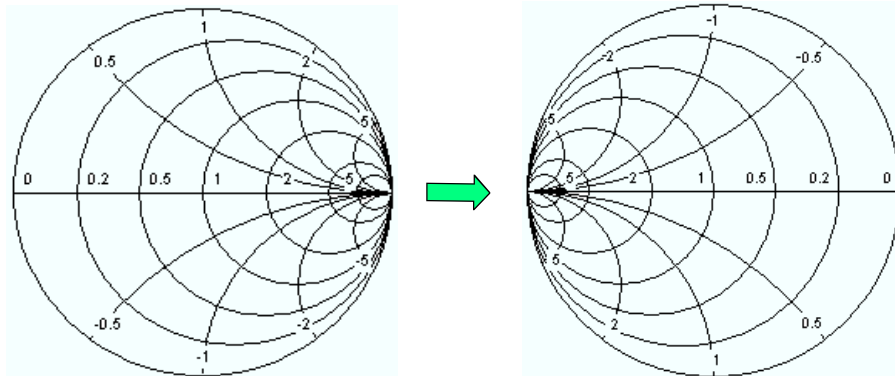
The basic properties of the inverted Smith chart follow from this construction:

- The central horizontal axis corresponds to zero susceptance (real admittance). The center of the diagram represents $Y/Y_0 = 1$, where Y_0 is the reference admittance of the system (zero reflection). At the left and right intersection points between the horizontal axis and the outer circle, the admittance is infinity (short) and zero (open).
- The outer circle corresponds to zero conductance (purely imaginary admittance). Points outside the outer circle indicate an active component.
- The upper and lower half of the diagram correspond to negative (inductive) and positive (capacitive) susceptive components of the admittance, respectively.

Example: Reflection coefficients in the inverted Smith chart

If the measured quantity is a complex reflection coefficient Γ (e.g. S_{11}, S_{22}), then the unit inverted Smith chart can be used to read the normalized admittance of the DUT. The coordinates in the normalized admittance plane and in the reflection coefficient plane are related as follows (see also: definition of matched-circuit (converted) admittances):

$Y / Y_0 = (1 - \Gamma) / (1 + \Gamma)$

From this equation it is easy to relate the real and imaginary components of the complex admittance to the real and imaginary parts of Γ

$$G = \mathrm{Re}(Y/Y_0) = \frac{1 - \mathrm{Re}(\Gamma)^2 - \mathrm{Im}(\Gamma)^2}{\left[1 + \mathrm{Re}(\Gamma)\right]^2 + \mathrm{Im}(\Gamma)^2}, \quad B = \mathrm{Im}(Y/Y_0) = \frac{-2 \cdot \mathrm{Im}(\Gamma)}{\left[1 + \mathrm{Re}(\Gamma)\right]^2 + \mathrm{Im}(\Gamma)^2},$$

in order to deduce the following properties of the graphical representation in an inverted Smith chart:

- Real reflection coefficients are mapped to real admittances (conductances).
- The center of the Γ plane ($\Gamma = 0$) is mapped to the reference admittance Y_0, whereas the circle with $|\Gamma| = 1$ is mapped to the imaginary axis of the Y plane.
- The circles for the points of equal conductance are centered on the real axis and intersect at Y = infinity. The arcs for the points of equal susceptance also belong to circles intersecting at Y = infinity (short circuit point (–1,0)), centered on a straight vertical line.
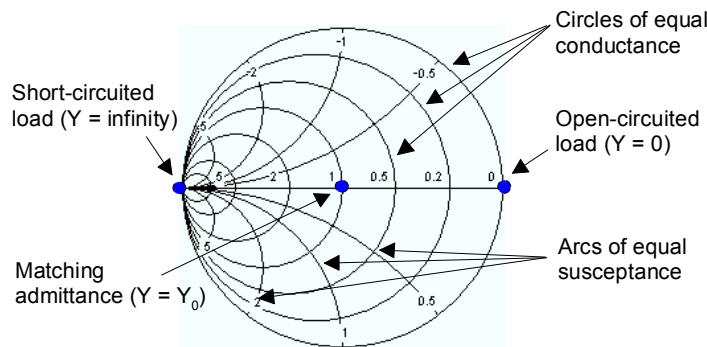
Examples for special points in the inverted Smith chart:

- The magnitude of the reflection coefficient of a short circuit (Y = infinity, U = 0) is one, its phase is -180^0.
- The magnitude of the reflection coefficient of an open circuit (Y = 0, I = 0) is one, its phase is zero.

3.1.7.6 Measured Quantities and Display Formats

The analyzer allows any combination of a display format and a measured quantity. The following rules can help to avoid inappropriate formats and find the format that is ideally suited to the measurement task.

- All formats are suitable for the analysis of reflection coefficients S_{ii}. The formats *SWR, Smith* and *Inverted Smith* lose their original meaning (standing wave ratio, normalized impedance or admittance) if they are used for transmission *S-parameters*.
- The complex *Impedances,* and *Admittances* are generally displayed in one of the Cartesian diagrams with linear vertical axis scale or in a polar diagram.
- The real *Stability Factors* are generally displayed in a linear Cartesian diagram *(Lin Mag* or *Real).* In complex formats, real numbers represent complex numbers with zero imaginary part.

The following table gives an overview of recommended display formats.

	Complex dimensionless quantities: S-parameters	Complex quantities with dimensions: impedances, admittances	Real quantities: Stability Factors
Lin Mag	☑	☑ (default for impedances, admittances)	☑ (default)
dB Mag	☑ (default)	☑	–
Phase	☑	☑	–
Real	☑	☑	☑
Imag	☑	☑	–
Unwrapped Phase	☑	☑	–
Smith	☑ (reflection coefficients S_{ii})	–	–
Polar	☑	–	–

|	Complex dimensionless quantities: S-parameters	Complex quantities with dimensions: impedances, admittances	Real quantities: Stability Factors
Inverted Smith	☑ (reflection coefficients S_{ii})	–	–
SWR	☑ (reflection coefficients S_{ii})	–	–
Group Delay	☑ (transmission coefficients S_{ij})	–	–

The default formats are activated automatically when the measured quantity is changed.

3.2 Measured Quantities

This section gives an overview of the measurement results of the network analyzer and the meaning of the different measured quantities. All quantities can be selected in the *Trace – Meas* submenu.

3.2.1 S-Parameters

S-parameters are the basic measured quantities of a network analyzer. They describe how the DUT modifies a signal that is transmitted or reflected in forward or reverse direction. For a 2-port measurement the signal flow is as follows.
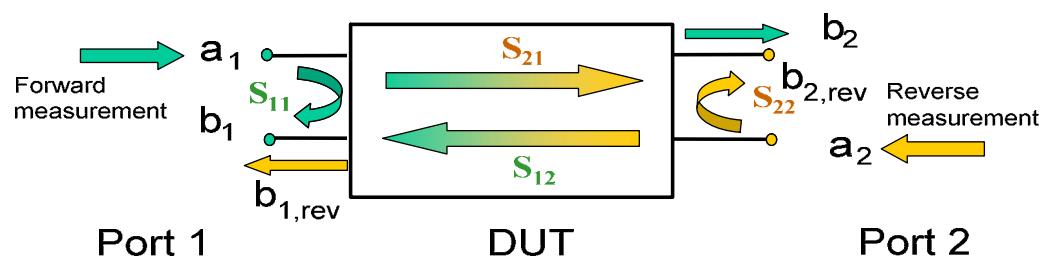
Extensions to the signal flow

The figure above is sufficient for the definition of S-parameters but does not necessarily show the complete signal flow. In fact, if the source and load ports are not ideally matched, part of the transmitted waves are reflected off the receiver ports so that an additional a_2 contribution occurs in forward measurements, an a_1 contribution occurs in reverse measurements.

The scattering matrix links the incident waves a_1, a_2 to the outgoing waves b_1, b_2 according to the following linear equation:

$$\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} * \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$$

The equation shows that the S-parameters are expressed as $S_{<out><in>}$, where <out> and <in> denote the output and input port numbers of the DUT.

Meaning of 2-port S-parameters

The four 2-port S-parameters can be interpreted as follows:

● S_{11} isthe input reflection coefficient, defined as the ratio of the wave quantities b_1/a_1, measured at PORT 1 (forward measurement with matched output and a_2 = 0).
● S_{21} is the forward transmission coefficient, defined as the ratio of the wave quantities b_2/a_1 (forward measurement with matched output and a_2 = 0).

- S_{12} is the reverse transmission coefficient, defined as the ratio of the wave quantities b_1 (reverse measurement with matched input, $b_{1,rev}$ in the figure above and $a_1 = 0$) to a_2.
- S_{22} is the output reflection coefficient, defined as the ratio of the wave quantities b_2 (reverse measurement with matched input, $b_{2,rev}$ in the figure above and $a_1 = 0$) to a_2, measured at PORT 2.

Meaning of squared amplitudes

The squared amplitudes of the incident and outgoing waves and of the matrix elements have a simple meaning:

$\|a1\|^2$	Available incident power at the input of a two-port (= the power provided by a generator with a source impedance equal to the reference impedance Z_0)
$\|a2\|^2$	Available incident power at the output
$\|b1\|^2$	Reflected power at the input of a two-port
$\|b2\|^2$	Reflected power at the output
$10*log\|S_{11}\|^2$ (= $20*log\|S_{11}\|$)	Reflection loss at the input
$10*log\|S_{22}\|^2$	Reflection loss at the output
$10*log\|S_{21}\|^2$	Insertion loss at the input
$10*log\|S_{12}\|^2$	Insertion loss at the output

3.2.2 Impedance Parameters

An impedance is the complex ratio between a voltage and a current. The analyzer provides converted impedances: each impedance parameter is obtained from a single S-parameter.

The converted, matched-circuit impedances describe the impedances of a DUT that is terminated at its outputs with the reference impedance Z_{0i}. i numbers the analyzer/DUT port.
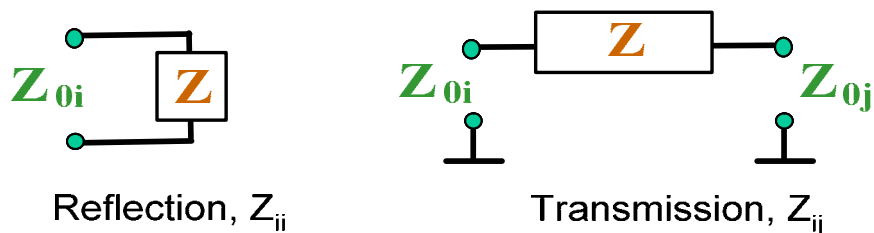
Reflection, Z_{ii} Transmission, Z_{ij}

The analyzer converts a **single** measured S-parameter to determine the corresponding converted impedance. As a result, converted Z-parameters cannot completely describe general n-port DUTs:

- A reflection parameter Z_{ii} completely describes a one-port DUT. For n-port DUTs (n>1) the reflection parameters Z_{ii} describe the input impedances at ports i (i = 1 to n) under the condition that each of the other ports is terminated with its reference impedance (matched-circuit parameters).

● A two-port transmission parameter Z_{ij} (i ≠ j) can describe a pure serial impedance between the two ports.

Relation with S-parameters

The converted impedances Z_{ii} are calculated from the reflection S-parameters S_{ii} according to:

$$Z_{ii} = Z_{0i} \frac{1 + S_{ii}}{1 - S_{ii}} ,$$

The transmission parameters are calculated according to:

$$Z_{ij} = 2 \cdot \frac{\sqrt{Z_{0i} \cdot Z_{0j}}}{S_{ij}} - \left(Z_{0i} + Z_{0j}\right), \quad i \neq j ,$$

The converted admittances are defined as the inverse of the impedances.

Example:

Z_{11} is the input impedance of a 2-port DUT that is terminated at its output with the reference impedance Z_0 (matched -circuit impedance measured in a forward reflection measurement).

Tip: You can also read the converted impedances in a reflection coefficient measurement from the Smith chart.

3.2.3 Admittance Parameters

An admittance is the complex ratio between a current and a voltage. The analyzer provides converted admittances: each admittance parameter is obtained from a single S-parameter.

The converted admittance parameters describe the input admittances of a DUT with fully matched outputs.The converted admittances are the inverse of the converted impedances.

The analyzer converts a **single** measured S-parameter to determine the corresponding converted admittance. As a result, converted Y-parameters cannot completely describe general n-port DUTs:

● A reflection parameter Y_{ii} completely describes a one-port DUT. For n-port DUTs (n>1) the reflection parameters Y_{ii} describe the input admittances at ports i (i = 1 to n) under the condition that each of the other ports is terminated with its reference impedance (matched-circuit parameters).
● A two-port transmission parameter Y_{ij} (i ≠ j) can describe a pure serial impedance between the two ports.

Relation with S-parameters

The converted admittances Y_{ii} are calculated from the reflection S-parameters S_{ii} according to:

$$Y_{ii} = \frac{1}{Z_{0i}} \frac{1 - S_{ii}}{1 + S_{ii}} = 1/Z_{ii} \; ,$$

where i numbers the analyzer/DUT port. The transmission parameters are calculated according to:

$$Y_{ij} = \frac{S_{ij}}{2 \cdot \sqrt{Z_{0i} \cdot Z_{0j}} - S_{ij} \cdot \left(Z_{0i} + Z_{0j} \right)} = 1/Z_{ij}, \quad i \neq j, \quad i, j = 1, \, ..., \, 99$$

Example:

Y11 is the input admittance of a 2-port DUT that is terminated at its output with the reference impedance Z_0 (matched-circuit admittance measured in a forward reflection measurement).

You can also read the converted admittances in a reflection coefficient measurement from the inverted Smith chart.

3.3 Calibration Overview

Calibration is the process of eliminating systematic, reproducible errors from the measurement results (system error correction). The process involves the following stages:

1. A set of calibration standards is selected and measured over the required sweep range. For many calibration types the magnitude and phase response of each calibration standard (i.e. its S-parameters if no system errors occur) must be known within the entire sweep range.

2. The analyzer compares the measurement data of the standards with their known, ideal response. The difference is used to calculate the system errors using a particular error model (calibration type) and derive a set of system error correction data.

3. The system error correction data is used to correct the measurement results of a DUT that is measured instead of the standards.

Calibration is always channel-specific because it depends on the hardware settings, in particular on the sweep range. The means that a system error correction data set is stored with the calibrated channel.

The analyzer provides a wide range of sophisticated calibration methods for all types of measurements. Which calibration method is selected depends on the expected system errors, the accuracy requirements of the measurement, on the test setup and on the types of calibration standards available.

Due to the analyzer's calibration wizard, calibration is a straightforward, menu-guided process. Moreover, it is possible to perform the entire calibration process automatically using a calibration unit (accessory R&S ZV-Z5x).

Storing system error correction data

The system error correction data determined in a calibration procedure is stored on the analyzer. You can read this correction data using the remote control command [SENSe<Ch>:]CORRection:CDATa. You can also replace the correction data of the analyzer by your own correction data sets.

A label *Cal Off !* appears behind the trace list if the system error correction no longer applies to one or more traces:

This may happen for the one of the following reasons:

● The sweep range is outside the calibrated frequency range.
● The channel calibration is not sufficient for the measured quantity (e.g. a one-port calibration has been performed, but the measured quantity is a transmission parameter).
● The system error correction has been switched off deliberately (Correction Off).

3.3.1 Calibration Standards and Calibration Kits

A calibration kit is a set of physical calibration standards for a particular connector type. The magnitude and phase response of the calibration standards (i.e. their S-parameters) must be known or predictable within a given frequency range.

The standards are grouped into several types (open, through, match,...) corresponding to the different input quantities for the analyzer's error models. The standard type also determines the equivalent circuit model used to describe its properties. The circuit model depends on several parameters that are stored in the cal kit file associated with the calibration kit.

As an alternative to using circuit models, it is possible to describe the standards by means of S-parameter tables stored in a file.

The analyzer provides a large number of predefined cal kits but can also import cal kit files and create new kits:

● A selection of predefined kits is available for all connector types. The parameters of these kits are displayed in the *Add/Modify Standards* dialog, however, it is not possible to change or delete the kits.
● Imported and user-defined kits can be changed in the *Calibration Kits* dialog and its various sub-dialogs.

Calibration kits and connector types are global resources; the parameters are stored independently and are available irrespective of the current setup.

3.3.2 Calibration Types

The analyzer provides a wide range of calibration types for one, two or more ports. The calibration types differ in the number and types of standards used, the error terms, i.e. the type of systematic errors corrected and the general accuracy. The following table gives an overview.

Calibration Type	Standards	Parameters	Error Terms	General Accuracy	Application
Reflection Normalization	Open or Short	S_{11} (or S_{22}, ...)	Reflection tracking	Low to medium	Reflection measurements on any port.
Transmission Normalization	Through	S_{12}, S_{21}	Transmission tracking	Medium	Transmission measurements in any direction and between any combination of ports.
Full One-Port	Open, Short, Match[1]	S_{11} (or S_{22}, ...)	Reflection tracking, Source match Directivity,	High	Reflection measurements on any port.
One-Path Two-Port	Open, Short, Match[1] (at source port), Through[2]	S_{11}, S_{21} (or S_{22},...)	Reflection tracking, Source match, Directivity, Transmission tracking	Medium to high	Unidirectional transmission measurements in any direction and between any combination of ports.

Calibration Type	Standards	Parameters	Error Terms	General Accuracy	Application
TOSM	Open, Short, Match[1] (at each port), Through[2] (between the 2 ports)	All	Reflection tracking, Source match, Directivity, Load match, Transmission tracking	High	Reflection and transmission measurements on DUTs with 2 ports.

1) Or any other 3 known one-port standards. To be used in a guided calibration, the known standards must be declared to be open, short, and match irrespective of their properties.

2) Or any other known two-port standard. See remark above.

- The calibration type must be selected in accordance with the test setup. Select the calibration type for which you can obtain or design the most accurate standards and for which you can measure the required parameters with best accuracy.

3.3.2.1 Normalization

A normalization is the simplest calibration type since it requires the measurement of only one standard for each calibrated S-parameter:

- One-port (reflection) S-parameters (S_{11}, S_{22}, ...) are calibrated with an open or a short standard providing the **reflection tracking** error term.
- Two-port (transmission) S-parameters (S_{12}, S_{21}, ...) are calibrated with a through standard providing the **transmission tracking** error term.

Normalization means that the measured S-parameter at each sweep point is divided by the corresponding S-parameter of the standard. A normalization eliminates the frequency-dependent attenuation and phase shift in the measurement path (reflection or transmission tracking error). It does not compensate for directivity or mismatch errors. This limits the accuracy of a normalization.

3.3.2.2 Full One-Port Calibration

A full one-port calibration requires a short, an open and a match standard to be connected to a single test port. The three standard measurements are used to derive all three reflection error terms:

- The short and open standards are used to derive the **source match** and the **reflection tracking** error terms.
- The match standard is used to derive the **directivity** error.

A full one-port calibration is more accurate than a normalization but is only applicable for reflection measurements.

3.3.2.3   One-Path Two-Port Calibration

A one-path two-port calibration combines a full one-port calibration with a transmission normalization, so it requires a short, an open and a match standard to be connected to a single test port plus a through standard between this calibrated source port and a second load port. The four standard measurements are used to derive the following error terms:

● The short and open standards are used to derive the **source match** and the **reflection tracking error** terms at the source port.
● The match standard is used to derive the **directivity error** at the source port.
● The through standard provides the **transmission tracking error** term.

A one-path two-port calibration requires only four standards to be connected (instead of 7 for a full two-port TOSM calibration) and is suitable when only the forward (e.g. S_{11} and S_{21}) or reverse S-parameters (e.g. S_{22} and S_{12}) are to be measured and the DUT is well matched, especially at the load port.

3.3.2.4   TOSM Calibration

A TOSM (Through – Open – Short – Match) calibration requires the same standards as the one-path two-port calibration, however, all measurements are performed in the forward and reverse direction. TOSM is also referred to as SOLT (Short – Open – Load = Match – Through) calibration. The four standards are used to derive 6 error terms for each signal direction:

● In addition to the **source match** and **reflection tracking** error terms provided by the one-path two-port calibration, TOSM also provides the **load match**.
● The **directivity** error is determined at both source ports.
● The **transmission tracking** is determined for each direction.

The number of required standard measurements and of error terms for 2-port measurements is shown in the following table.

Number of ports	Number of standards to be connected	Number of standard measurements	Number of error terms
2	2 * 3 +1 = 7	2 * 3 +2 * 1 = 8	2 * 3 + 2 * 2 = 10

An open, through and match measurement is required at each port; in addition, a through must be measured between the two ports and in both directions.

The analyzer automatically performs each through measurement in both directions, so the number of connected standards is smaller than the number of measurements.

3.3.3 Automatic Calibration (Introduction)

A Calibration Unit is an integrated solution for automatic system error correction of vector network analyzers. For R&S ZVL3-75 analyzers (75 Ω variant of R&S ZVL3), Rohde & Schwarz offers the calibration unit R&S ZV-Z53, stock number 1164.0473.75. This calibration unit supports a frequency range between 300 kHz and 3 GHz. With its two N 75 Ω (f) connectors, it is suited for one-port and two-port calibration.

The unit contains calibration standards that are electronically switched when a calibration is performed. The calibration kit data for the internal standards are also stored in the calibration unit, so that the analyzer can calculate the error terms and apply the calibration without any further input.

Advantages of automatic calibration

- Automatic calibration is generally faster and more secure than manual calibration, because:
- There is no need to connect several standards manually.
- Invalid calibrations due to operator errors (e.g. wrong standards or improper connections) are almost excluded.
- No need to handle calibration kit data.
- The internal standards don't wear out because they are switched electronically.

Automatic calibration is less flexible than manual calibration, because it is cannot be performed for segmented sweep.

NOTICE

Connection and use of the calibration unit

Please observe the safety instructions in the "Technical Information" provided with the calibration unit to avoid any damage to the unit and the network analyzer. Safety-related aspects of the connection and operation of the units are also reported in chapter 5 (GUI Reference) of the operating manual or in the network analyzer's help system.

3.4 Optional R&S ZVL Extensions

The R&S ZVL network analyzer can be upgraded with various hardware and software options, providing enhanced flexibility and an extended measurement functionality. The available options are listed in the *SETUP – More – System Info – Versions + Options* dialog. Options can be enabled by means of a license key, to be entered in the SETUP menu after an appropriate firmware version has been installed. The new supported options for each firmware version are listed in the "What's New..." section of the network analyzer help system.

The R&S ZVL options can be grouped as follows:

● Measurement modes: The option enables a special operating mode. Only one measurement mode can be active at a given time. The basic instrument modes are *Network Analyzer* (NWA, no option required) and *Spectrum Analyzer* (SAN, with option R&S ZVL-K1). The SAN mode provides a number of supplementary measurement modes, e.g. *WiMAX OFDM/OFDMA Analysis* mode (with option R&S FSL.K93). The supplementary SAN modes also require option R&S ZVL-K1.
● Additional measurements: The option extends a particular measurement mode, providing additional measurement functionality. The analyzer provides additional measurements for the NWA and the SAN modes.

The relationship between the R&S ZVL options and measurement modes is shown below.
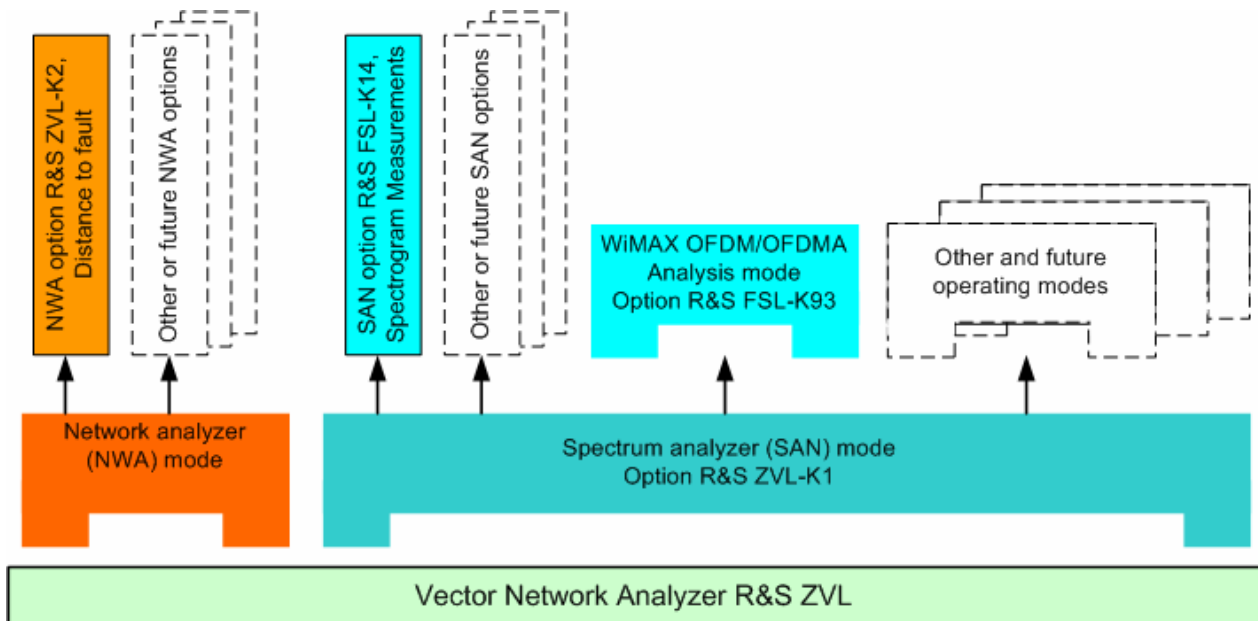
Accessing measurement modes, remote control

All measurement modes are accessed by means of the MODE front panel key. When a new mode is selected, the appearance of the user interface and the control elements change. At the same time, the instrument adjusts its remote-control command set to the functionality of the selected operating mode.

While a particular measurement mode is active, the functionality of the other modes is generally not available. The same applies to the remote-control commands. Basic instrument functions, i.e. the softkeys associated with the FILE, SETUP, PRINT, and MODE front panel keys and the related commands, are available in all operating modes.

The R&S ZVL options listed below are described in detail in the reference chapters of the NWA help system (NWA options) or in the separate SAN help system (SAN options). For a complete list of options, accessories, and extras refer to the R&S ZVL product brochure.

Option	Option Type	Functionality
ZVL-K2, Distance-to-Fault	NWA option	Transformation of the trace to time domain in order to analyze the impulse response and locate faults and discontinuities on cables
ZVL-K3 Time Domain	NWA option	Transformation of the trace to time domain in order to analyze responses, transformation back to the frequency domain
ZVL-K1, Spectrum Analysis	SAN option, measurement mode	Basis spectrum analyzer functions providing the frequency spectrum of the measured RF signal. The option also provides a wide range of pre-configured power measurements. For operation see the R&S ZVL-K1 Software Manual.
FSL-B6, TV Trigger	SAN option	TV trigger, especially for service in the analog TV field.
FSK-B8, Gated Sweep	SAN option	Gated sweep, especially for the modulation spectrum of GSM signals or bursted WLAN signals.
FSL-K7, AM/FM/φM Measurement Demodulator	SAN option	Analog modulation analysis for amplitude, frequency or phase modulated signals.
FSL-K8, Bluetooth Measurements	SAN option	Bluetooth transmitter (TX) tests in line with the Bluetooth® RF test specification, including EDR tests.
FSL-K14, Spectrogram Measurements	SAN option	Spectrogram display and trace recording for general spectrum measurements.
FSL-K30, Noise Figure and Gain Measurements)	SAN option, measurement mode	Noise figure and noise temperature measurements, especially suited for manufacturers of amplifiers.
FSL-K72, WCDMA Measurements (3GPP/FDD BTS)	SAN option, measurement mode	Transmitter (TX) tests on 3GPP/FDD downlink signals including HSDPA and HSUPA channels.
FSL-K91, WLAN OFDM Analysis	SAN option, measurement mode	Transmitter (TX) tests on WLAN signals in line with the WLAN standards IEEE 802.11a/b/g/j.
FSL-K93, WiMAX OFDM/OFDMA Analysis	SAN option, measurement mode	Transmitter (TX) tests on WLAN signals in line with standard IEEE 802.16-2004 and IEEE 802.16e-2005 for mobile WiMAX-Signals including WiBro.

The following sections provide a short introduction to the software options.

3.4.1   Distance-to-Fault (R&S ZVL-K2)

The network analyzer measures and displays complex S-parameters and other quantities as a function of the frequency. The measurement results can be filtered and mathematically transformed in order to obtain the impulse response, which often gives a clearer insight into the characteristics of the DUT.

The impulse response is special type of a time-domain representation. A fault (discontinuity) on a transmission line causing reflection results in a spike on the impulse response trace of the reflection coefficient. With option R&S ZVL-K2, the analyzer can display the impulse response trace and calculate the distance between the reference plane and the fault from the propagation time, taking into account the electrical properties of the transmission line (Cable Type). Moreover it is possible to define which of the peaks will be considered as being due to a fault, and to draw up and export a list of the detected peaks.

3.4.2   Time Domain (R&S ZVL-K3)

The network analyzer measures and displays complex S-parameters and other quantities as a function of the frequency. The measurement results can be filtered and mathematically transformed in order to obtain the time domain representation, which often gives a clearer insight into the characteristics of the DUT.

Time domain transforms can be calculated in band pass or low pass mode. For the latter the analyzer offers the impulse and step response as two alternative transformation types. A wide selection of windows can be used to optimize the time domain response and suppress sidelobes due to the finite sweep range. Moreover, it is possible to eliminate unwanted responses by means of a time gate and transform the gated result back into the frequency domain.

3.4.3   Spectrum Analysis (R&S ZVL-K1)

The spectrum analysis option provides the basic functionality for measuring an arbitrary RF signal in the frequency domain. Evaluation tools such as markers and limit lines allow a refined analysis of the measurement results. A wide range of predefined power measurements cover typical RF measurement tasks, in particular:

- Zero span power measurements
- Channel and adjacent channel power measurement
- Measurement of occupied bandwidth
- CCDF measurement (amplitude statistics of signals)

Option R&S ZVL-K1 is a prerequisite for all supplementary spectrum analyzer (SAN) options; see table and figure above.
For operation see the R&S ZVL-K1 Software Manual.

3.4.4   TV Trigger (R&S FSL-B6)

Option R&S FSL-B6 adds a TV trigger to option ZVL-K1, in order to select different sections of a TV video signal for display and facilitate the analysis. This option is especially suited for all doing any service in the analog TV field.

3.4.5   Gated Sweep (R&S FSL-B8)

The gated sweep mode removes switching transients from the spectrum. This is advantageous for the analysis of pulsed-carrier signals, e. g. to investigate the modulation spectrum of GSM signals or WLAN signals.

3.4.6   AM/FM/φM Measurement Demodulator (R&S FSL-K7)

The AM/FM/φM Measurement Demodulator option R&S FSL-K7 converts the ZVL into an analog modulation analyzer for amplitude, frequency or phase modulated signals. It measures not only characteristics of the useful modulation, but also factors such as residual FM or synchronous modulation.

3.4.7   Bluetooth Measurements (R&S FSL-K8)

Option R&S FSL-K8 provides measurements on Bluetooth transmitters. All measurements are carried out in line with the Bluetooth® RF test specification Rev. 2.0+DER and cover basic rate as well as Enhanced Data Rate (EDR) packets.

3.4.8   Spectrogram Measurements (R&S FSL-K14)

Option FSL-K14 adds a spectrogram display and trace recording to the ZVL. The spectrogram view gives a history of the spectrum and helps to analyze intermittent problems or variations in frequency and level versus time.

3.4.9   Noise Figure and Gain Measurements (R&S FSL-K30)

Option R&S FSL-K30 adds the capability to measure noise figure and noise temperature. This enables manufacturers of amplifiers to analyze all necessary characteristics, e.g. noise figure, nonlinear parameters such as harmonics, intermodulation or ACPR, as well as S-parameters.

In addition to the spectrum analyzer option R&S ZVL-K1, option R&S FSL-K30 also requires option R&S FSL-B5, Additional Interfaces (providing the noise source control voltage), and an external preamplifier to specify the measurement uncertainties. DC supply for the external preamplifier can be derived from the probe power socket; a matching connector can be ordered as spare part (1065.9480.00).

Noise source: E.g. NC 346 types from Noisecom.

3.4.10   WCDMA Measurements (3GPP/FDD BTS) (R&S FSL-K72)

The R&S FSL-K72 adds transmitter (TX) measurements on 3GPP downlink signals including HSDPA/HSUPA signals. The measurement types comprise code domain power, signal channel power, adjacent channel power, and spectrum emission mask.

3.4.11   WLAN OFDM Analysis (R&S FSL-K91)

Option R&S FSL-K91 provides transmitter (TX) tests, especially spectrum and modulation measurements, on signals in line with the WLAN standards IEEE 802.11a/b/g/j.

3.4.12   WiMAX OFDM/OFDMA Analysis (R&S FSL-K93)

Option R&S FSL-K93 provides transmitter (TX) tests, especially spectrum and modulation measurements on signals in line with IEEE 802.16-2004 and IEEE 802.16e-2005 for mobile WiMAX-Signals including WiBro.

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