

# R&S®FSH4/8

## Handheld Spectrum Analyzer

### Operating Manual



1309.6275.12 – 08

The Operating Manual describes the following R&S®FSH models and options

- R&S FSH4 (1309.6000.04)
- R&S FSH4 (1309.6000.14)
- R&S FSH4 (1309.6000.24)
- R&S FSH8 (1309.6000.08)
- R&S FSH8 (1309.6000.18)
- R&S FSH8 (1309.6000.28)
- R&S FSH-K14 (1304.5770.02)
- R&S FSH-K41 (1304.5612.02)
- R&S FSH-K42 (1309.5629.02)
- R&S FSH-K44 (1309.5658.02)
- R&S FSH-K45 (1309.5641.02)
- R&S FSH-K46 (1304.5729.02)
- R&S FSH-K46E (1304.5764.02)
- R&S FSH-K47 (1304.5787.02)

The contents of this manual correspond to firmware version 1.42 or higher.

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The following abbreviations are used throughout this manual:

R&S®FSH is abbreviated as R&S FSH.

# 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 attached 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 intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

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





**Symbols and safety labels**

						
Observe product documen-tation	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

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.

### Tags and their meaning

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

	indicates a hazardous situation which, if not avoided, will result in death or serious injury.
	indicates a hazardous situation which, if not avoided, could result in death or serious injury.
	indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
	indicates the possibility of incorrect operation which can result in damage to the product.

In the product documentation, the word ATTENTION is used synonymously.

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

### Operating states and operating positions

*The product may be operated only under the operating conditions and in the positions specified by the manufacturer. 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. The R&S ZVH is protected against dripping water and dust (IP degree 51). 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, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude 4600 m above sea level, max. transport altitude 12000 m above sea level. A tolerance of  $\pm 10\%$  shall apply to the nominal voltage and of  $\pm 5\%$  to the nominal frequency.

2. 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 death.

### Electrical Safety

*If the information on electrical safety is not observed either at all 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 AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. If the product does not have a power switch for disconnection from the AC supply network, the plug of the connecting cable is regarded as the disconnecting device. In such cases, always ensure that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, a disconnecting device must be provided at the system level.
3. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, you can ensure that the cable will not be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.
4. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
5. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, sparks that result in fire and/or injuries may occur.
6. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
7. For measurements in circuits with voltages  $V_{\text{rms}} > 30 \text{ V}$ , suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
8. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC60950-1/EN60950-1 or IEC61010-1/EN 61010-1 standards that apply in each case.
9. 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.

10. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
11. 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.
12. 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.
13. 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.
14. 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", 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.

#### **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, PE 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. Keep cells and batteries out of the hands of children. If a cell or a battery has been swallowed, seek medical aid immediately.
5. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
6. 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.
7. 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.

8. 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.

### Transport

1. 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.
2. 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

1. 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.

## Informaciones Elementales de Seguridad

### **Es imprescindible leer y observar 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 adjunto 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.

#### Símbolos y definiciones de seguridad

						
Ver documentación de producto	Peligro de golpe de corriente	¡Advertencia! Superficie caliente	Conexión a conductor protector	Conexión a tierra	Conexión a masa conductora	¡Cuidado! Elementos de construcción con peligro de carga electrostática

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.

### Palabras de señal y su significado

	PELIGRO identifica un peligro inminente con riesgo elevado que provocará muerte o lesiones graves si no se evita.
	ADVERTENCIA identifica un posible peligro con riesgo medio de provocar muerte o lesiones (graves) si no se evita.
	ATENCIÓN identifica un peligro con riesgo reducido de provocar lesiones leves o moderadas si no se evita.
	AVISO indica la posibilidad de utilizar mal el producto y, como consecuencia, dañarlo.  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. El producto solamente debe ser utilizado según lo indicado por el fabricante referente a la situación y posición de funcionamiento. R&S ZVH está protegido contra roción y polvo (modo de protección IP 51). 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, grado de suciedad 2, categoría de sobrecarga eléctrica 2, uso solamente en estancias interiores, utilización hasta 4600 m sobre el nivel del mar, transporte hasta 12000 m sobre el nivel del mar. Se aplicará una tolerancia de  $\pm 10\%$  sobre el voltaje nominal y de  $\pm 5\%$  sobre la frecuencia nominal.
2. 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. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de conexión como interruptor. En estos casos se deberá asegurar que el enchufe siempre sea de fácil acceso (de acuerdo con la longitud del cable de conexión, aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para el corte de la red eléctrica. Si los productos sin interruptor están integrados en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.
3. 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.
4. 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).
5. 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.
6. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.
7. En las mediciones en circuitos de corriente con una tensión  $U_{\text{eff}} > 30 \text{ V}$  se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
8. 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.
9. 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.
10. 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.

11. 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.
12. 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.
13. 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.
14. 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", 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

### 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.

### 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. Mantener baterías y celdas fuera del alcance de los niños. En caso de ingestión de una celda o batería, avisar inmediatamente a un médico.
5. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.
6. 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.
7. 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).

8. 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.

### **Transporte**

1. 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.
2. 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**

1. 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.

### Kundeninformation zur Batterieverordnung (BattV)

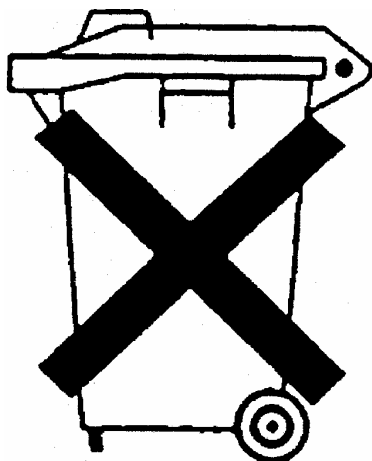
Dieses Gerät enthält eine schadstoffhaltige Batterie. Diese darf nicht mit dem Hausmüll entsorgt werden.

Nach Ende der Lebensdauer darf die Entsorgung nur über eine Rohde&Schwarz-Kundendienststelle oder eine geeignete Sammelstelle erfolgen.

### Safety Regulations for Batteries (according to BattV)

This equipment houses a battery containing harmful substances that must not be disposed of as normal household waste.

After its useful life, the battery may only be disposed of at a Rohde & Schwarz service center or at a suitable depot.



### Normas de Seguridad para Baterías (Según BattV)

Este equipo lleva una batería que contiene sustancias perjudiciales, que no se debe desechar en los contenedores de basura domésticos.

Después de la vida útil, la batería sólo se podrá eliminar en un centro de servicio de Rohde & Schwarz o en un depósito apropiado.

### Consignes de sécurité pour batteries (selon BattV)

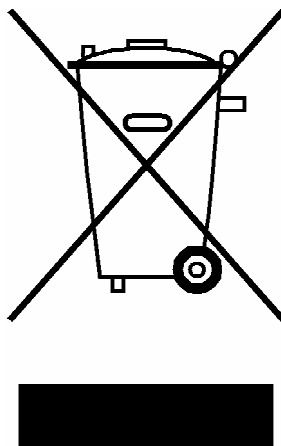
Cet appareil est équipé d'une pile comprenant des substances nocives. Ne jamais la jeter dans une poubelle pour ordures ménagères.

Une pile usagée doit uniquement être éliminée par un centre de service client de Rohde & Schwarz ou peut être collectée pour être traitée spécialement comme déchets dangereux.

# Customer Information Regarding Product Disposal

The German Electrical and Electronic Equipment (ElektroG) Act is an implementation of the following EC directives:

- 2002/96/EC on waste electrical and electronic equipment (WEEE) and
- 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).



Product labeling in accordance with EN 50419

Once the lifetime of a product has ended, this product must not be disposed of in the standard domestic refuse. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

Rohde & Schwarz GmbH & Co. KG has developed a disposal concept for the environmental-friendly disposal or recycling of waste material and fully assumes its obligation as a producer to take back and dispose of electrical and electronic waste in accordance with the ElektroG Act.

Please contact your local service representative to dispose of the product.





# Qualitätszertifikat

## Certificate of quality

## Certificat de qualité

Certified Quality System  
**ISO 9001**

Certified Environmental System  
**ISO 14001**

### Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde&Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

### Der Umwelt verpflichtet

- ▮ Energie-effiziente, RoHS-konforme Produkte
- ▮ Kontinuierliche Weiterentwicklung nachhaltiger Umweltkonzepte
- ▮ ISO 14001-zertifiziertes Umweltmanagementsystem

### Dear Customer,

You have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde&Schwarz quality management system is certified according to standards such as ISO 9001 and ISO 14001.

### Environmental commitment

- ▮ Energy-efficient products
- ▮ Continuous improvement in environmental sustainability
- ▮ ISO 14001-certified environmental management system

### Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde&Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

### Engagement écologique

- ▮ Produits à efficacité énergétique
- ▮ Amélioration continue de la durabilité environnementale
- ▮ Système de gestion de l'environnement certifié selon ISO 14001

**75** Years of  
Driving  
Innovation



**ROHDE & SCHWARZ**

CE Declaration of Conformity



Certificate No.: 2008-45

This is to certify that:

Equipment type	Stock No.	Designation
FSH4	1309.6000.04/.14/.24	Handheld Spectrum Analyzer
FSH8	1309.6000.08/.18/.28	

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

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)
- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN 61010-1: 2001  
EN 61326-1: 2006  
EN 61326-2-1: 2006  
EN 55011: 2007 + A2: 2007  
EN 61000-3-2: 2006  
EN 61000-3-3: 1995 + A2: 2001+ A2: 2005

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

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

Munich, 2010-09-14

Central Quality Management GF-QZ / Chadzelek

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# **1 Putting into Operation**

For details refer to the Quick Start Guide, chapter 2 "Putting into Operation".

## **2 Getting Started**

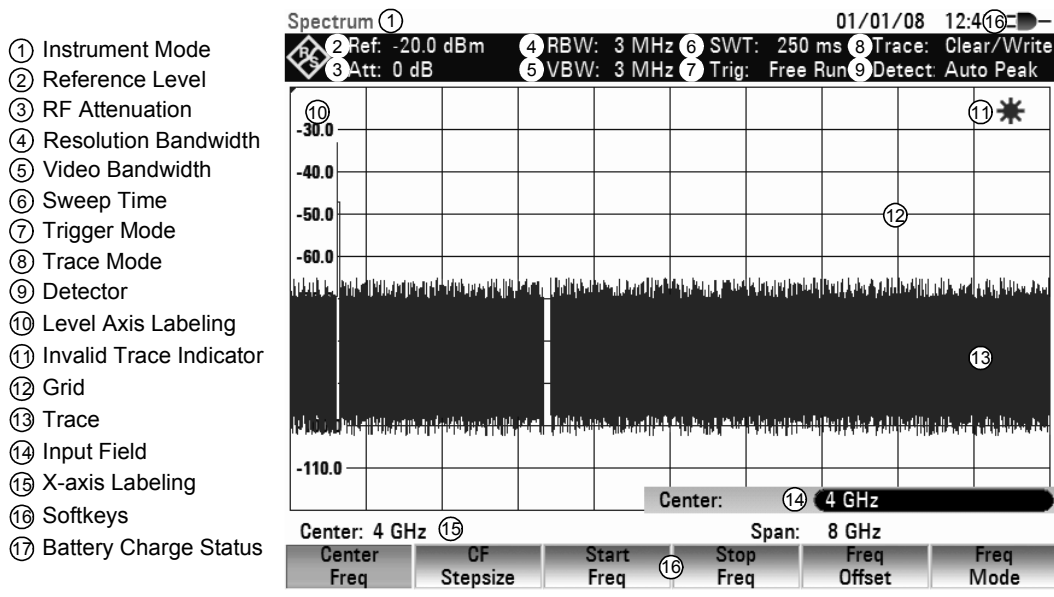
For details refer to the Quick Start Guide, chapter 3 "Getting Started".



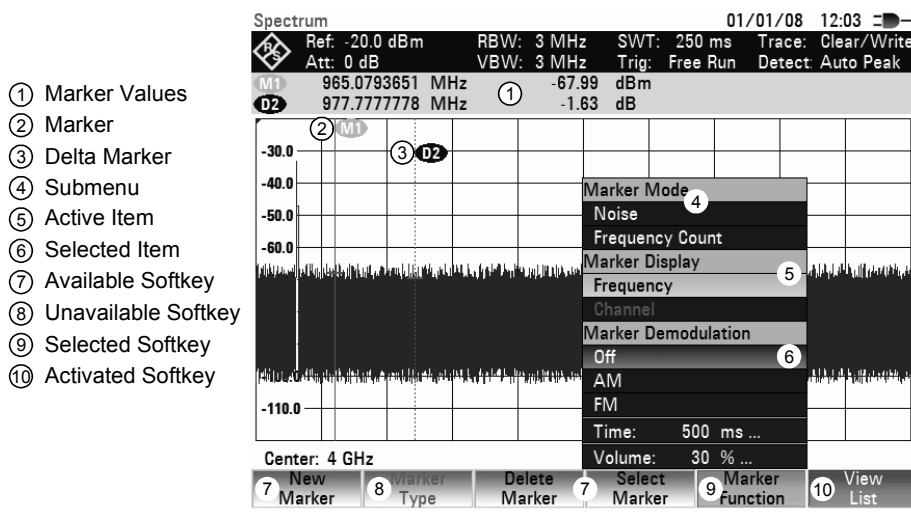
### 3 Operation

#### 3.1 Screen Layout

##### 3.1.1 Screen layout for spectrum-mode measurements without markers



##### 3.1.2 Screen layout when the marker mode is selected



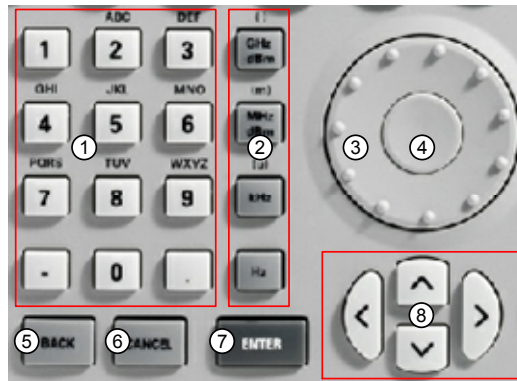
The color of the softkey labelling and its background indicate the status of the softkey function in question:

Softkey color	Meaning
Gray background, white labeling	Softkey function is turned off
Gray background, gray labeling	In the current setting, this softkey function is not available
Green background	Softkey function is turned on
Red background	Softkey function has been activated for value entry or selecting a menu function

### 3.2 Entering Measurement Parameters

Settings and texts are entered either by directly calling the functions or by entering values, units or texts separately. The R&S FSH has a variety of operating modes.

- ① Alpha-numeric keypad
- ② Unit keys
- ③ Rotary Knob
- ④ ENTER Key
- ⑤ BACK Key
- ⑥ CANCEL Key
- ⑦ ENTER Key
- ⑧ Cursor Keys



#### 3.2.1 Entering values and texts

Values are entered using the number keys (0 to 9), the decimal point key (.) and the minus key (-) in the alphanumeric keypad. The alphanumeric keypad is also used to enter letters, e.g. file names for data sets. If the R&S FSH is expecting a letter entry, it automatically assigns the letters above the keys to the keys in the alphanumeric keypad. The keys have multiple assignments. The desired letter is obtained by pressing the key the appropriate number of times, similar to a mobile phone keypad. The key assignments are listed below:

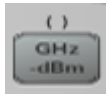
Key	1.	2.	3.	4.	5.	6.	7.	8.	9.
1	1								
2	a	b	c	2	A	B	C		
3	d	e	f	3	D	E	F		
4	g	h	i	4	G	H	I		
5	j	k	l	5	J	K	L		
6	m	n	o	6	M	N	O		
7	p	q	r	s	7	P	Q	R	S
8	t	u	v	8	T	U	V		
9	w	x	y	z	9	W	X	Y	Z
-	-								
0	0	blank	_						
.	.								

You can delete any letter or digit you have entered with the BACK key. Pressing the BACK key deletes the last keystroke that has been entered. Complete entries can be removed with the CANCEL key.

Values can also be entered with the rotary knob or the cursor keys. The entry is changed in steps and the R&S FSH immediately sets the appropriate entry parameter.

### 3.2.2 Entering units

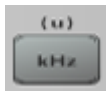
To enter a unit for a value entry, terminate the entry with a unit key. Use the unit keys down the right-hand side of the alphanumeric keypad. These keys have multiple assignments which depend on the unit entry expected by the R&S FSH.



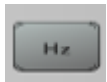
GHz, -dBm, V, s



MHz, dBm, dBmV, mV, ms



kHz, dB $\mu$ V,  $\mu$ V,  $\mu$ s



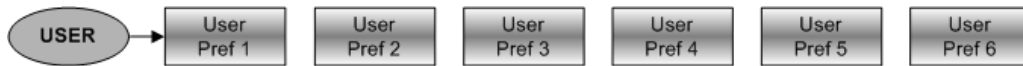
Hz

The relative level unit dB as well as the unit meter for distances can be entered with any of the unit keys.

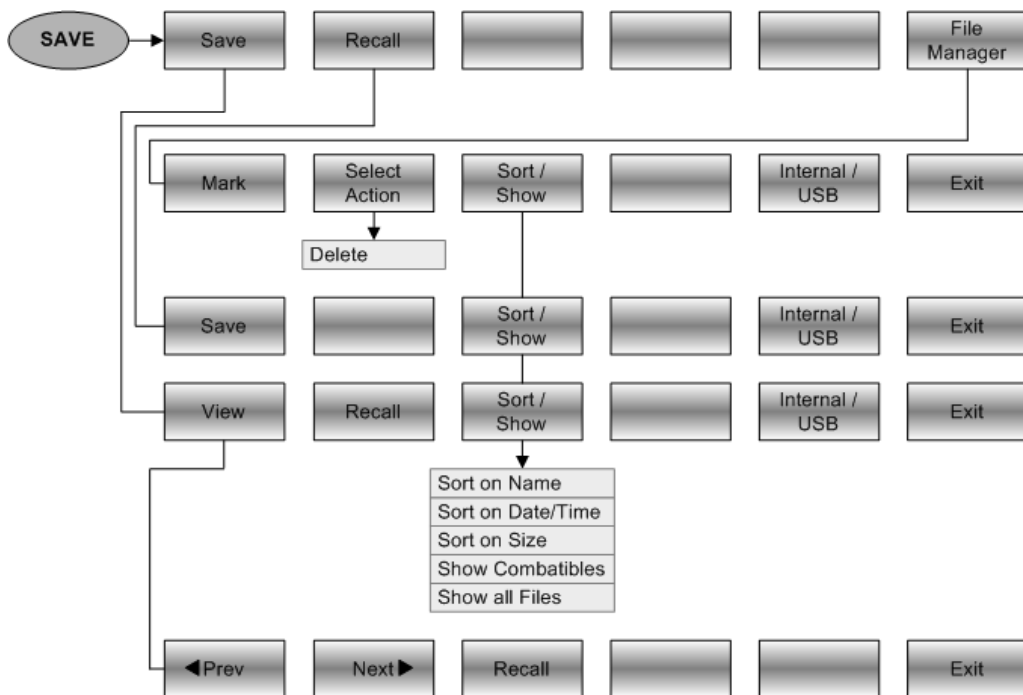
### 3.3 Menu Overview

#### 3.3.1 Softkeys available for all measurement modes

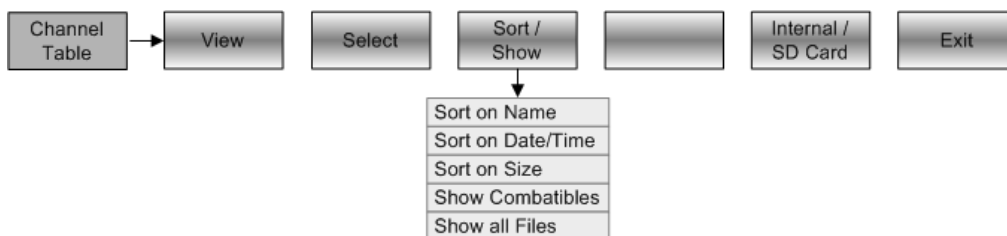
##### 3.3.1.1 User settings



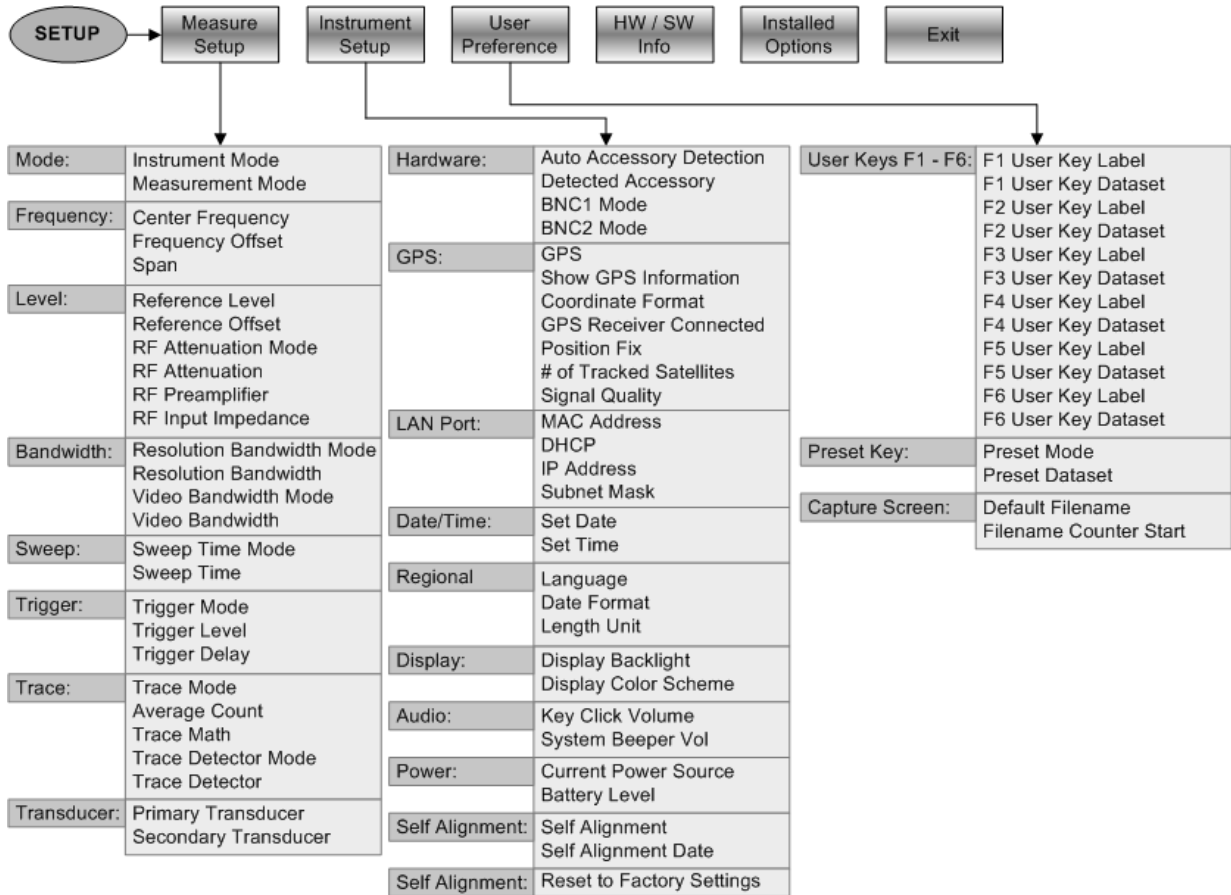
##### 3.3.1.2 File management



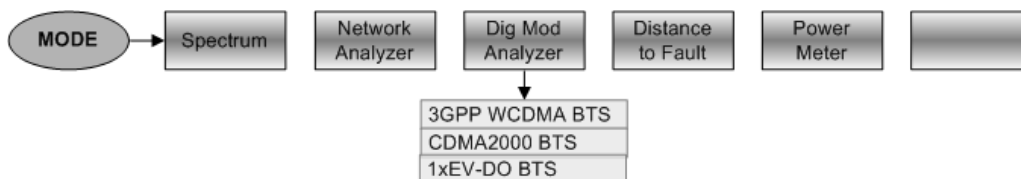
##### 3.3.1.3 Table Management



3.3.1.4 General settings



3.3.1.5 Selection of the measurement mode



### 3.3.2 Softkeys of the spectrum analyzer mode

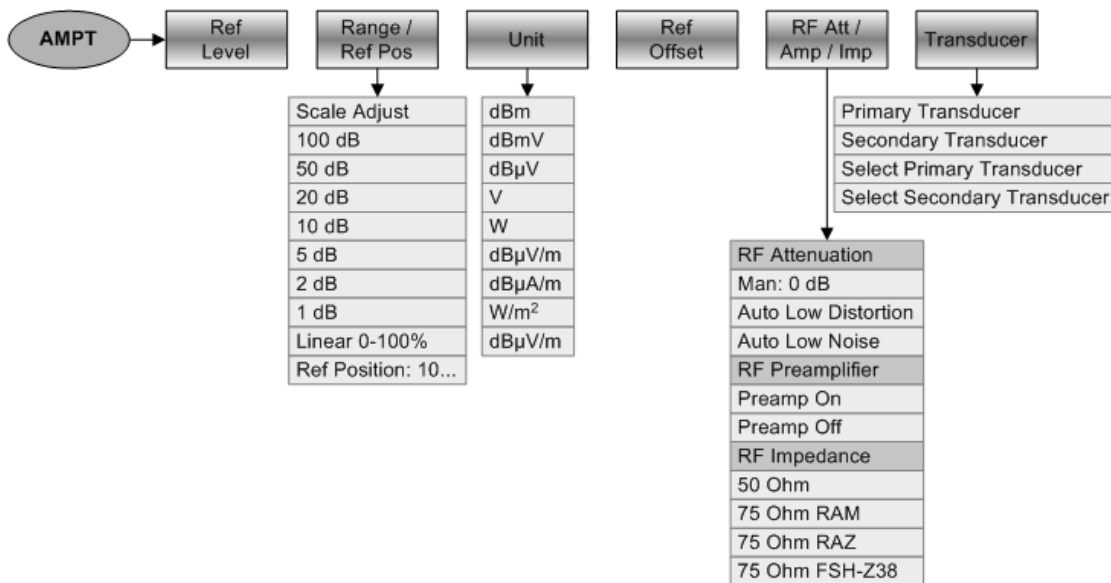
#### 3.3.2.1 Frequency entry



#### 3.3.2.2 Frequency span



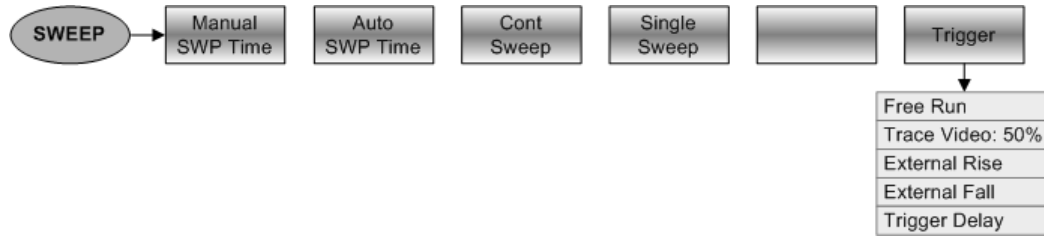
#### 3.3.2.3 Level settings



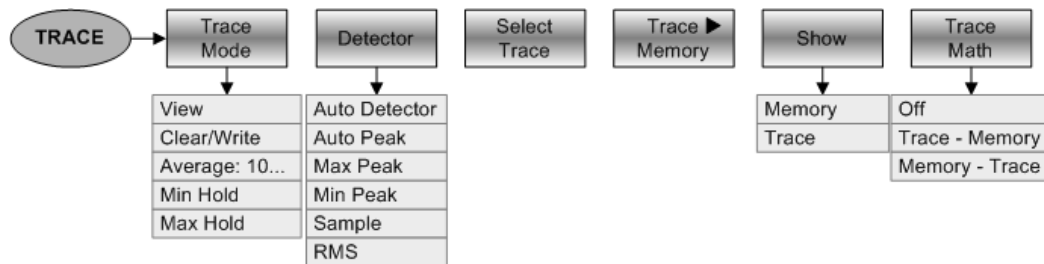
#### 3.3.2.4 Bandwidth settings



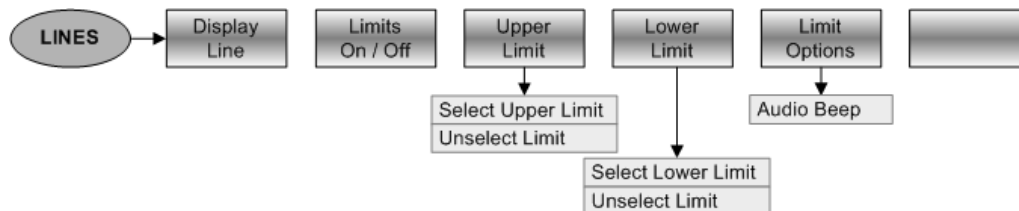
**3.3.2.5 Sweep**



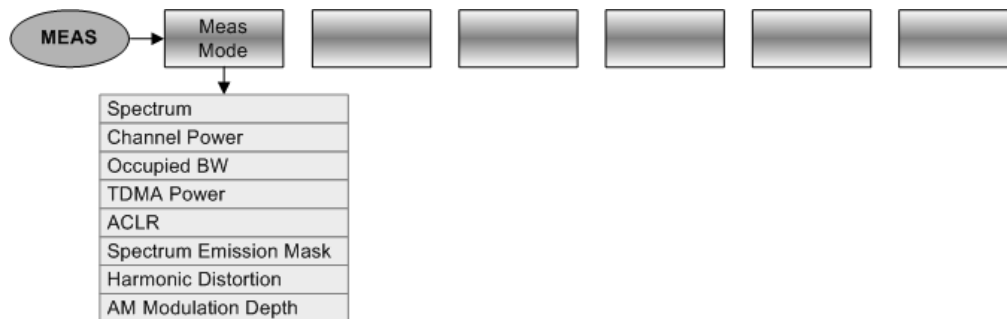
**3.3.2.6 Trace settings**



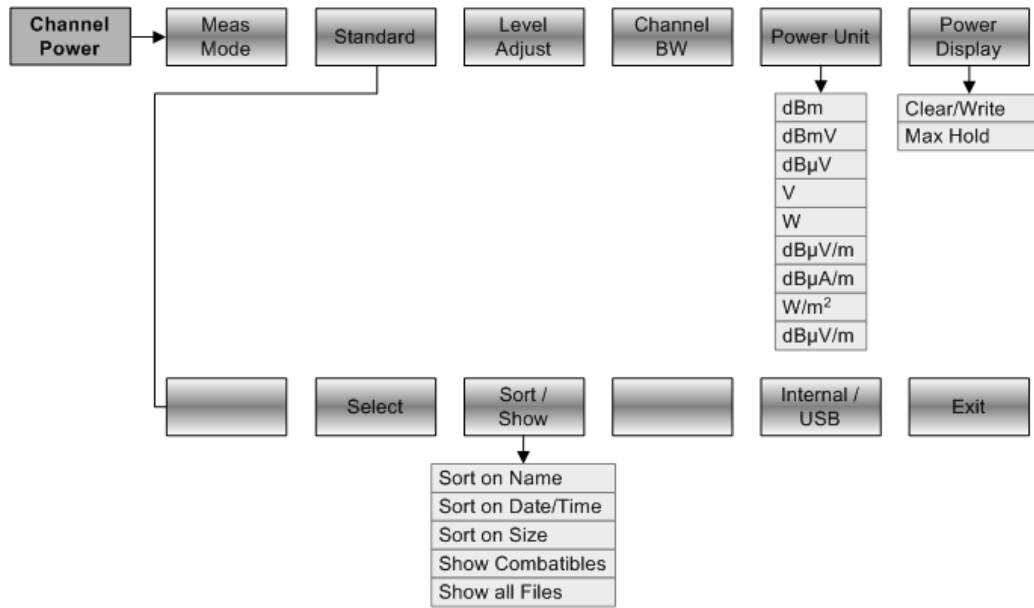
**3.3.2.7 Limit lines**



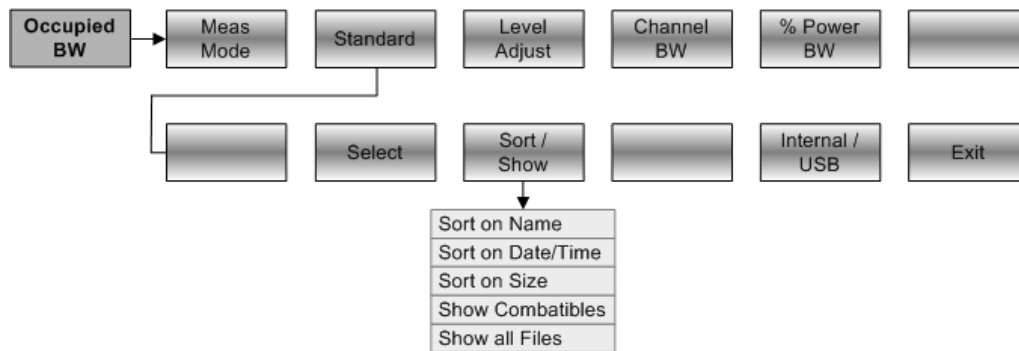
**3.3.2.8 Measurement functions**



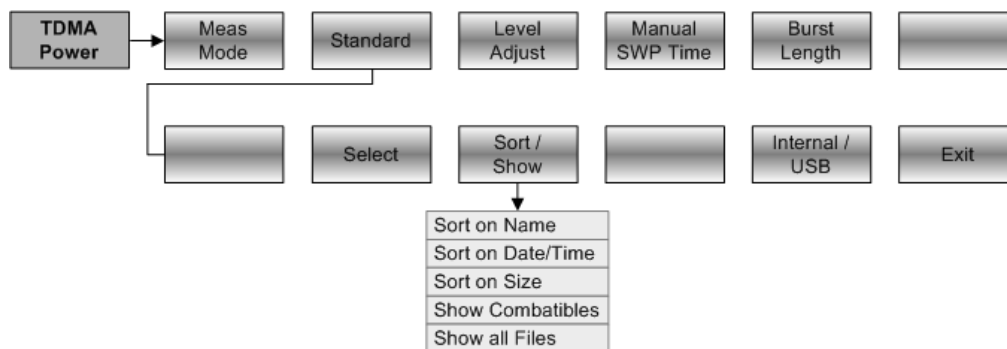
**Channel power**



**Occupied Bandwidth**

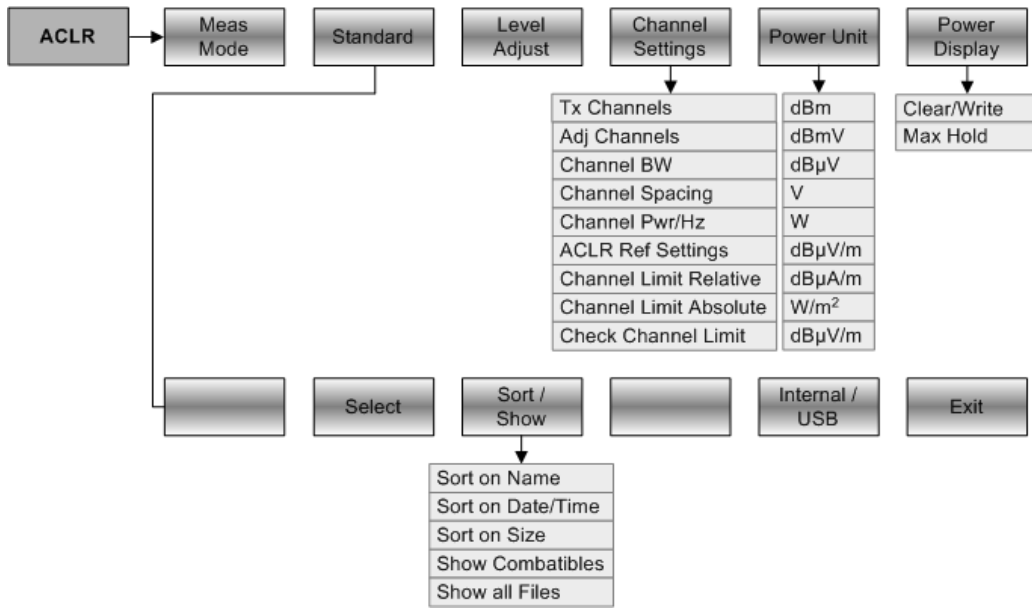


**TDMA Power**

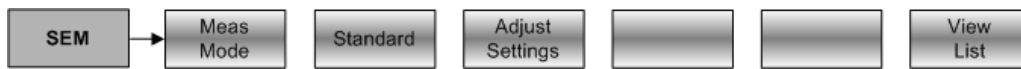




**ACP / ACLR**



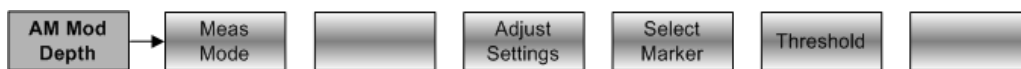
**Spectrum Emission Mask**



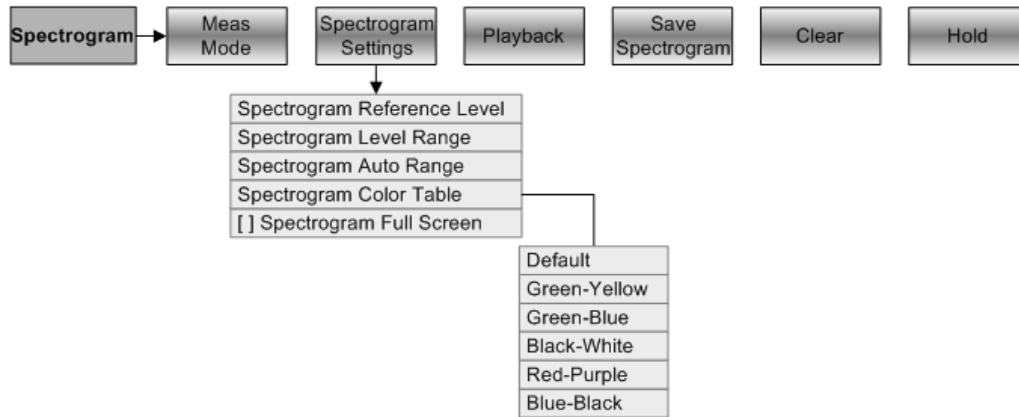
**Harmonic Distortion**



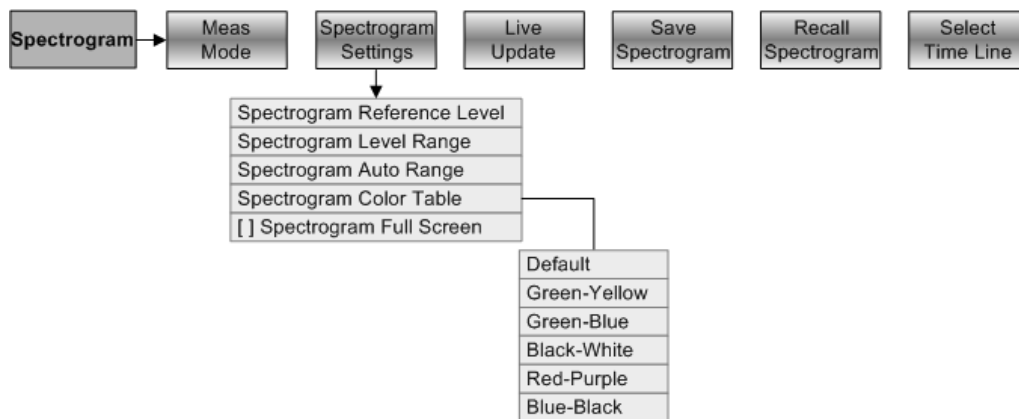
**AM Modulation Depth**



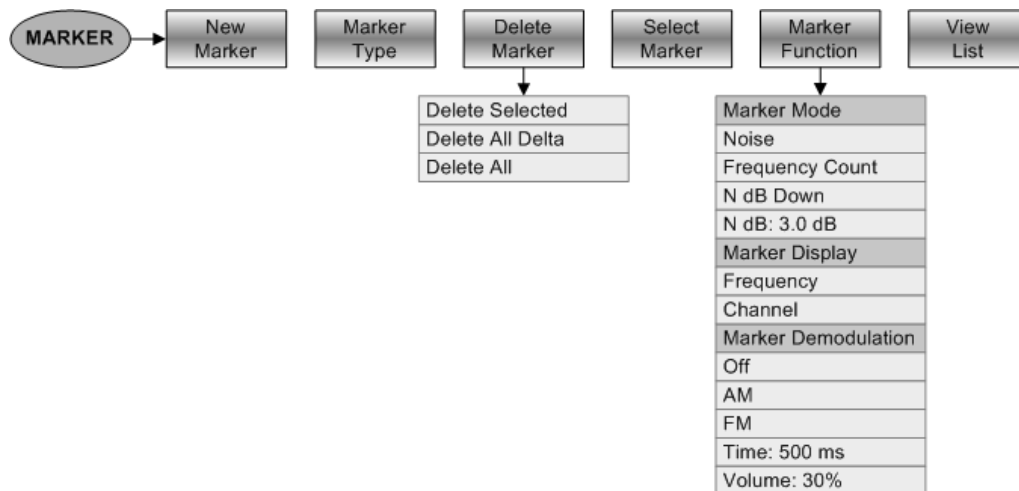
### Spectrogram



### Spectrogram Playback Mode



### 3.3.2.9 Marker



3.3.2.10 Marker position

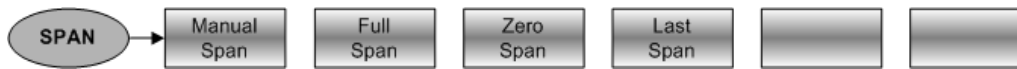


### 3.3.3 Softkeys of the network analyzer mode

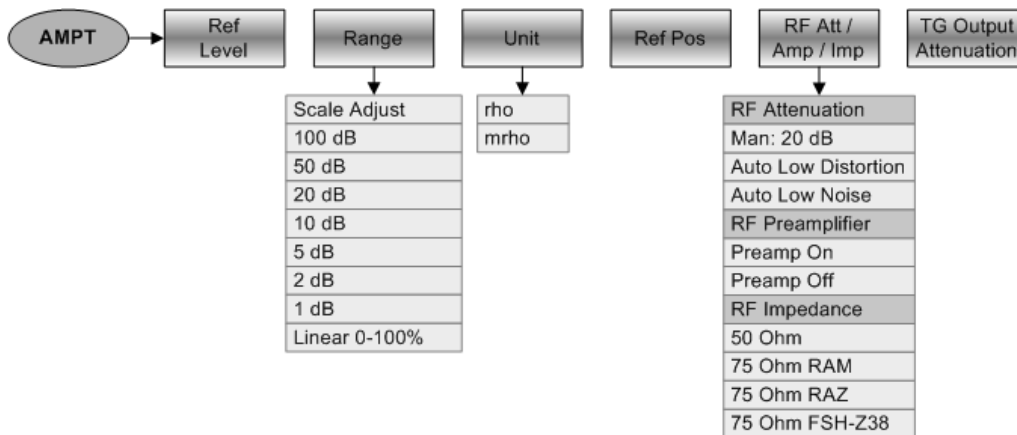
#### 3.3.3.1 Frequency entry



#### 3.3.3.2 Frequency span



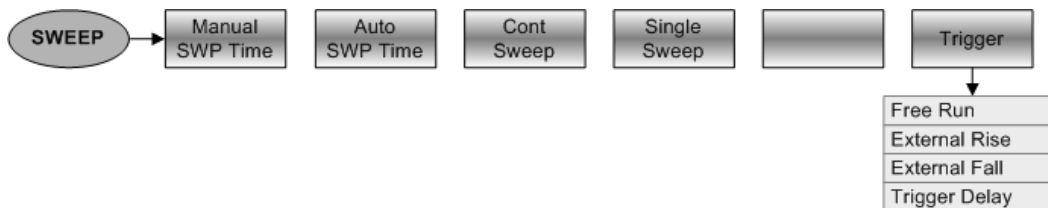
#### 3.3.3.3 Level settings



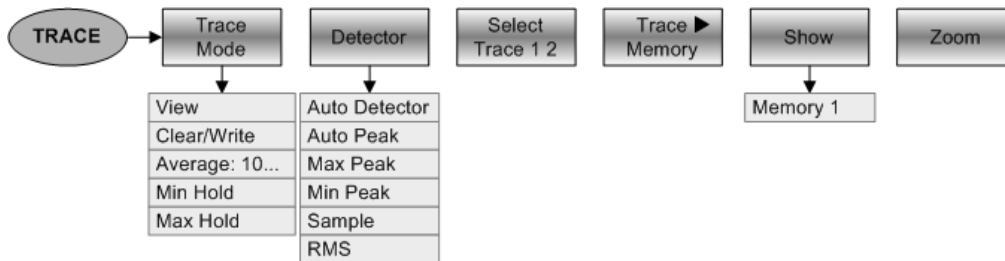
#### 3.3.3.4 Bandwidth settings



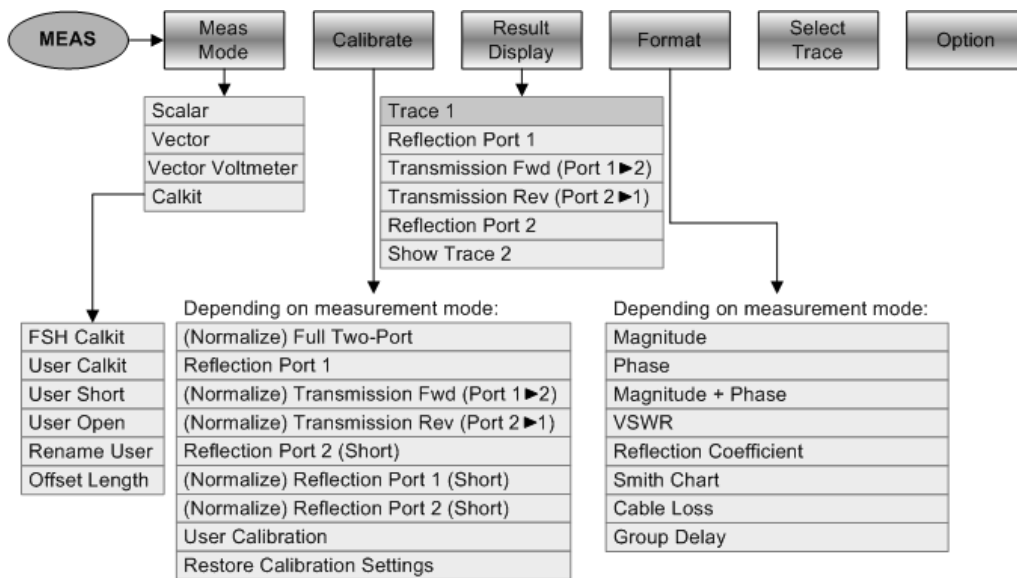
#### 3.3.3.5 Sweep



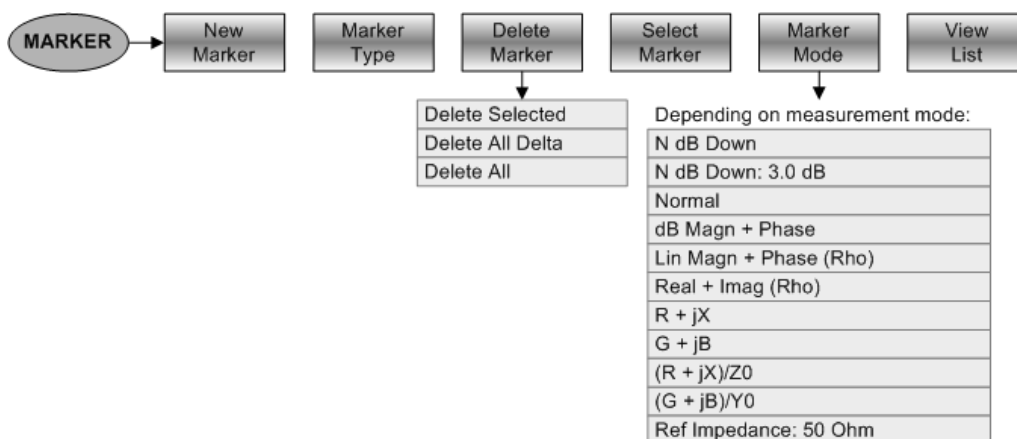
3.3.3.6 Trace settings



3.3.3.7 Measurement functions



3.3.3.8 Marker

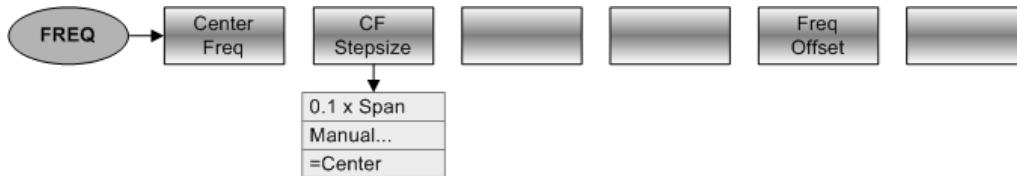


### 3.3.3.9 Marker position



### 3.3.4 Softkeys of the Dig Mod Analyzer

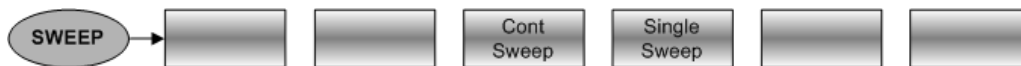
#### 3.3.4.1 Frequency Entry



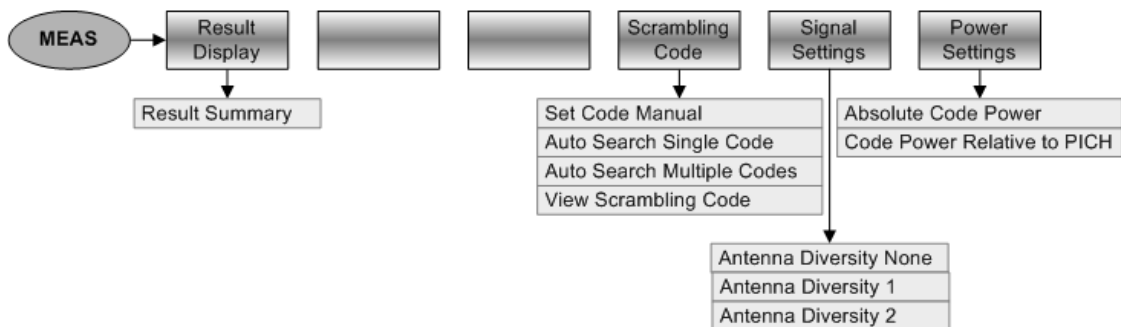
#### 3.3.4.2 Level Settings



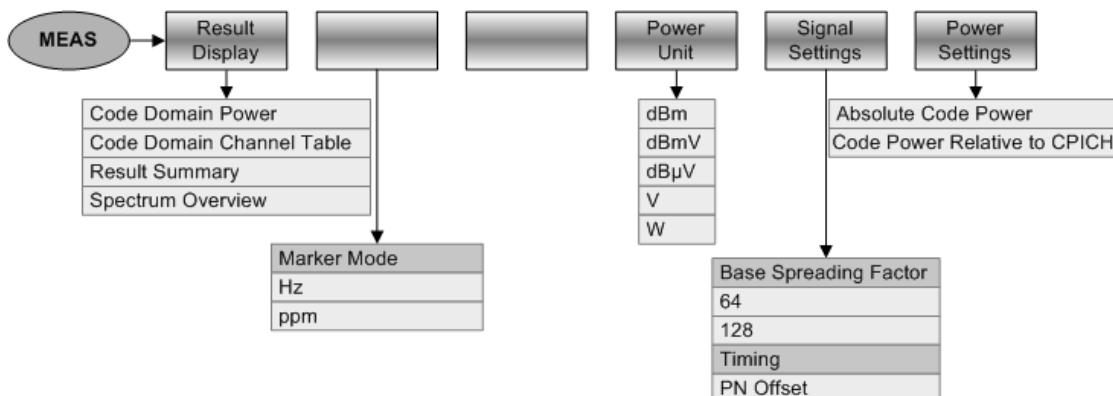
#### 3.3.4.3 Sweep



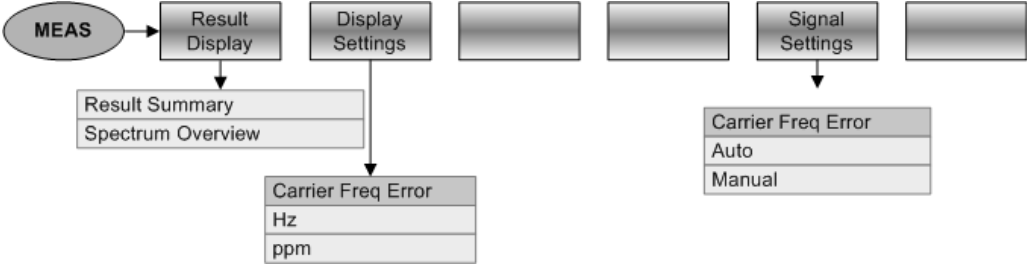
#### 3.3.4.4 Measurement Function (3GPP WCDMA BTS)



#### 3.3.4.5 Measurement Function (CDMA2000 BTS)



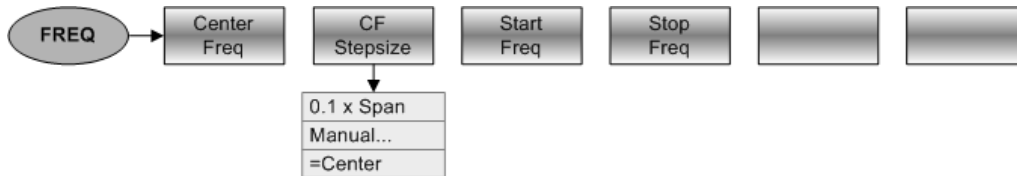
3.3.4.6 Measurement Function (1xEV-DO BTS)





### 3.3.5 Softkeys of the Distance to Fault mode

#### 3.3.5.1 Frequency entry



#### 3.3.5.2 Frequency span

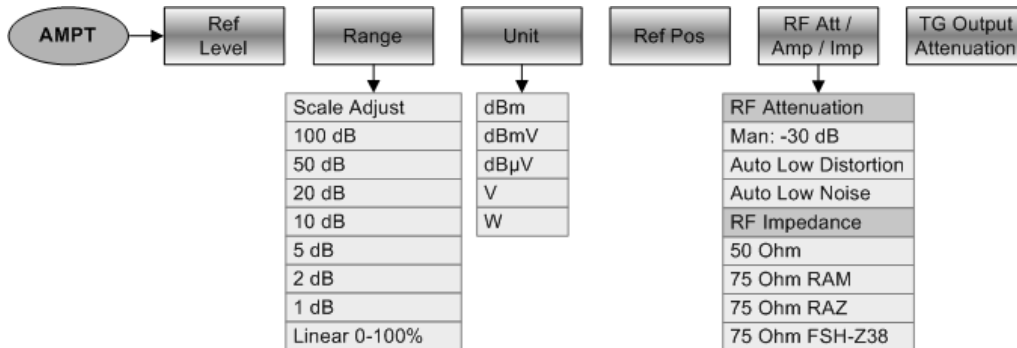
##### DTF Span



##### Reflection and Spectrum Span



#### 3.3.5.3 Level settings



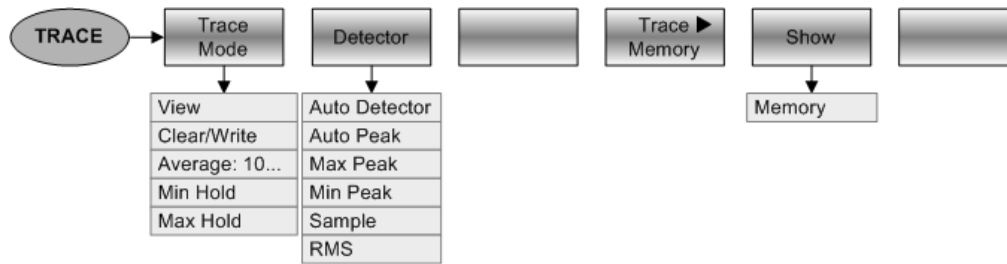
#### 3.3.5.4 Bandwidth settings



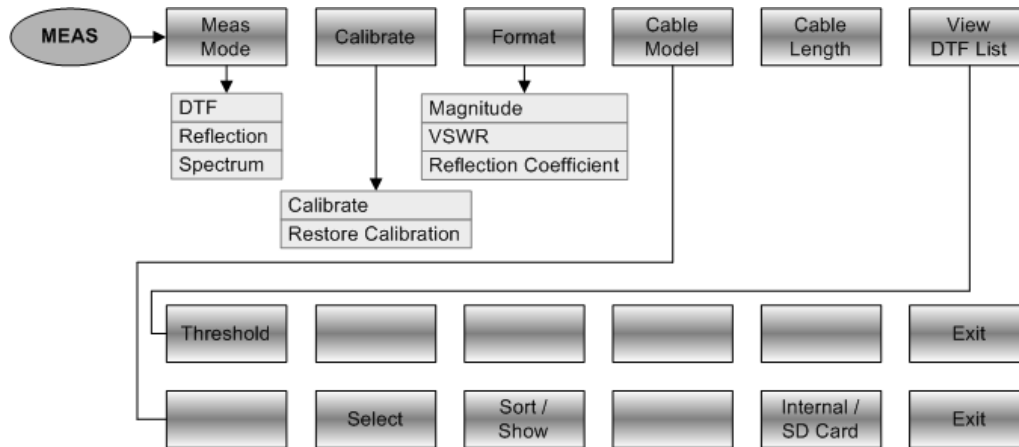
#### 3.3.5.5 Sweep



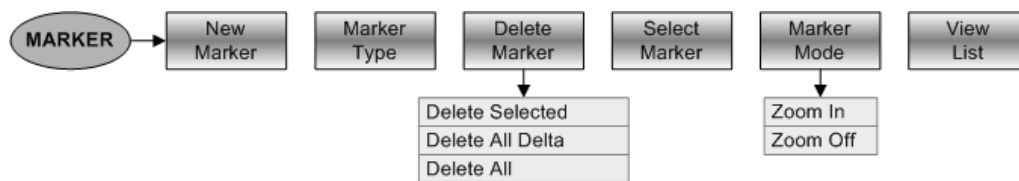
**3.3.5.6 Trace settings**



**3.3.5.7 Measurement functions**



**3.3.5.8 Marker**



**3.3.5.9 Marker position**



### 3.3.6 Softkeys of the Power Meter mode

#### 3.3.6.1 Frequency entry



#### 3.3.6.2 Level settings

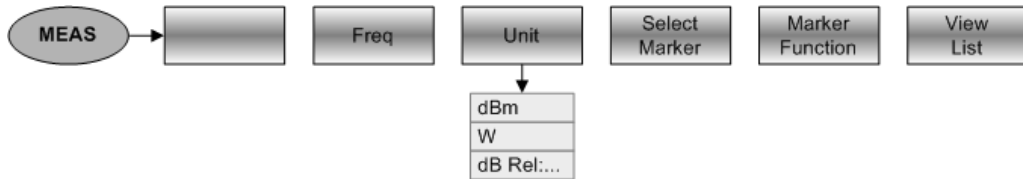


#### 3.3.6.3 Sweep

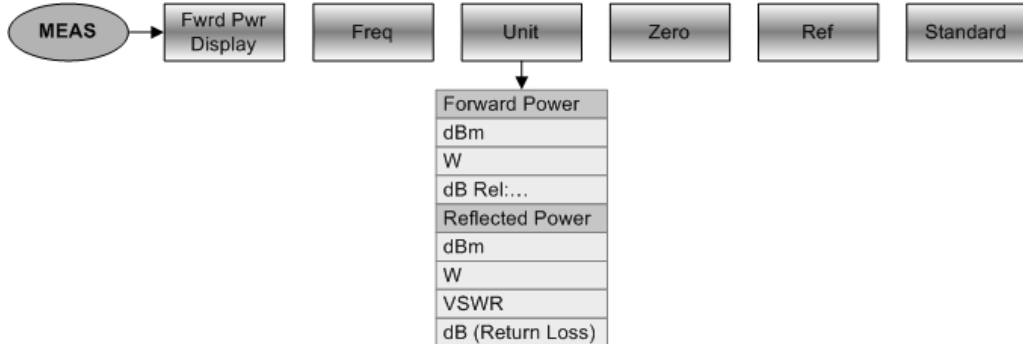


#### 3.3.6.4 Measurement functions

##### Power Meter Mode:



##### Directional Power Meter Mode:



## 4 Instrument Functions

### 4.1 Instrument Default Setup

Pressing the PRESET key, sets the R&S FSH to its default setup. It is best to to preset the R&S FSH when you are going to perform a new measurement task. You can then make the new settings on the basis of the more familiar default setup without the old settings affecting the measurement.

- Press the PRESET key.  
The R&S FSH is immediately set to the default setup.

### 4.2 Measurement Setup

The measurement setup provides an overview of all current measurement parameters of the active operating mode. This means that all the measurement settings can be checked easily at a glance. The status display can be saved to a file as measurement documentation. By default, the R&S FSH stores a screenshot of the result display in the \*.png file format in its internal flash memory. From there it can be transferred to a PC using the R&S FSH4View software.




The measurement setup screen and its contents are customized for each operating mode of the R&S FSH. Therefore, the order and number of displayed settings is different in each mode.

#### Operating sequence

- Press the SETUP key.
- Press the MEASURE SETUP softkey.  
The R&S FSH displays the current measurement parameters on the screen.
- Scroll through the setup screen with the rotary knob or the cursor keys to see all settings that do not fit in the display.  
There is a scroll bar to indicate whether there are additional parameters in the list.  
The display can be used as a way of checking the settings. You can change settings by using the appropriate key and menu.

Measurement Setup	
Mode	
Instrument Mode	Spectrum Analyzer
Measurement Mode	Spectrum
Frequency	
Center Frequency	4 GHz
Frequency Offset	0 Hz
Span	8 GHz
Reference Level	
Reference Level	-20.0 dBm
Reference Offset	0.0 dB
RF Attenuation Mode	Auto Low Distortion
RF Attenuation	0 dB
RF Preamplifier	Off
RF Input Impedance	50 Ω
Bandwidth	
Resolution Bandwidth Mode	Auto
Measure Setup	Instrument Setup
User Preference	HV/SW Info
Installed Options	Exit

Saving the measurement setup:

- Press the USER PREFERENCE softkey.  
Select the file format of the screenshot. You can choose the \*.png (default) or \*.jpg file format.
- Press the  key.  
The R&S FSH stores a screenshot in the internal flash memory.

Exiting the measurement setup:

- Press the EXIT softkey.  
The R&S FSH returns to the original setting.



## 4.3 Setting the Frequency

The FREQ key sets the R&S FSH's frequency. You can specify the frequency in terms of the center frequency (center freq. = frequency at the center of the frequency axis in the measurement diagram) or the start and stop frequency for a particular span.

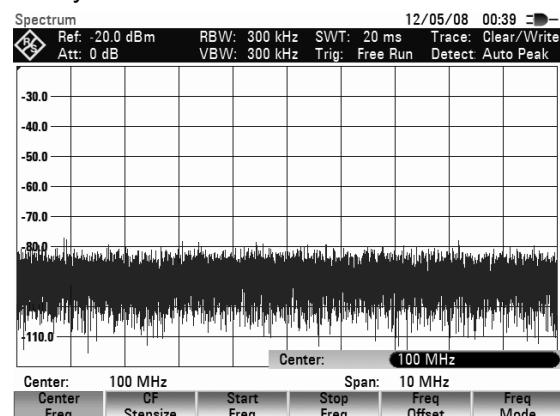
It is best to enter the center frequency when you want to measure a signal at a known frequency. When you are investigating signals, e.g. harmonics, that are within a particular frequency range, the best option is entering a start and stop frequency to define the span.

### 4.3.1 Entering the Center Frequency

- Press the FREQ key.  
The R&S FSH opens the frequency menu. Center frequency entry is always activated, so that the frequency settings can be made with the minimum number of keystrokes. If inactive, you can open the field with the CENTER FREQ softkey.

The current center frequency is displayed in the value entry box. You can enter a new center frequency directly with the number keys, the rotary knob or the cursor keys.

- Enter the frequency you'd like with the number keys
- Confirm the frequency entry with the appropriate unit (GHz, MHz, kHz or Hz).  
The frequency you have entered becomes the new center frequency. The value entry box remains open for any further entries.
- Alternatively, you can change the center frequency with the rotary knob or the cursor keys and confirm the entry with the ENTER key.
- Press the CANCEL key to close the entry box.



When setting the center frequency with the rotary knob, the smallest possible step is a pixel. As the trace consists of about 631 pixels, each step is equal to 1/630 of the span. When you use the cursor keys, a frequency step is equal to 10 % of the span (= 1 grid division). If you'd like to use a different step size, you can define it with the CF STEPSIZE function (CF = center frequency).

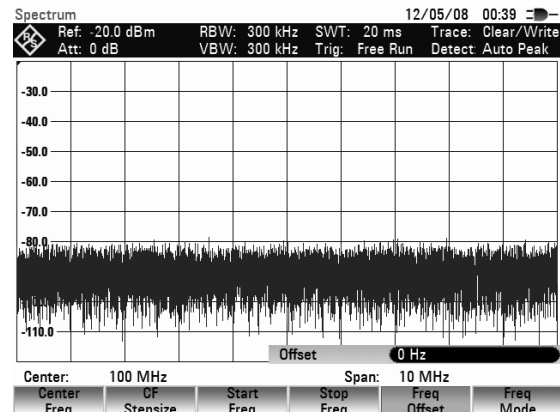
While adjusting the center frequency, you may obtain a value that is outside the R&S FSH's maximum span. If this happens, the R&S FSH automatically reduces the span.

### 4.3.2 Setting a Frequency Offset

For measurements on frequency converters such as satellite downconverters, it is often convenient to reference the results to the frequency prior to conversion. For this purpose, the R&S FSH offers a frequency offset that arithmetically shifts the center frequency to higher or lower frequencies; thus, the R&S FSH displays the input frequency of the DUT.

Positive frequency offset is possible in the range from 1 Hz to 100 GHz, in steps of 1 Hz. The size of the permitted negative frequency offset depends on the start frequency you have set. The start frequency, taking into account the frequency offset, is always  $\geq 0$  Hz.

- Press the **FREQ** key.
- Press the **FREQ OFFSET** softkey.  
The R&S FSH opens the frequency offset entry field.
- Enter the required frequency offset
- Confirm the entry with the corresponding unit.  
The R&S FSH adds the frequency offset to the center frequency you have set. A red dot at the center frequency display indicates that a frequency offset has been set.

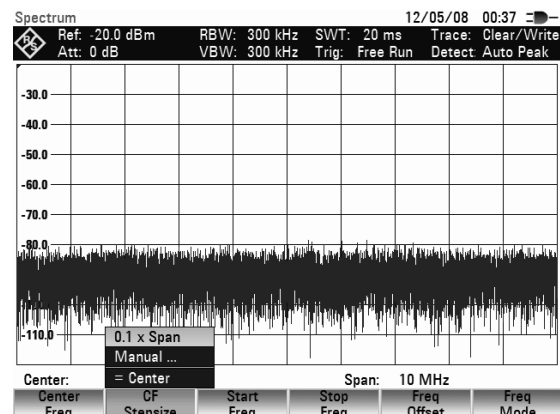


- Deactivate the frequency offset by entering an offset of 0 Hz.

### 4.3.3 Entering the Center-Frequency Step Size

- Press the **CF STEPSIZE** key.  
A submenu to set the step size opens. It contains the following step size options:

- **0.1 x SPAN** (default setting)  
the step size is equal to 10 % of the span (= 1 division on the vertical scale).
- **= CENTER**  
the step size is equal to center frequency. This setting is ideal for measurements on harmonics. On each frequency increment, the center frequency moves to the next harmonic.
- **MANUAL...**  
any step sizes possible. This makes it easy to investigate a spectrum with frequencies at constant intervals.



- Select the stepsize you need with the rotary knob or the cursor keys
- Confirm the selection with the **ENTER** key.

If you select "0.1 x SPAN" or "= CENTER", the R&S FSH makes the setting internally. If you select "MANUAL...", the value entry box opens and indicates the current step size.

- Change the step size with the rotary knob, the cursor keys or the number keys.
- Confirm the entry with the **ENTER** key or the **CF STEPSIZE** softkey.

### 4.3.4 Entering the Start and Stop Frequency

- Press the START FREQ softkey.  
The value entry box for the start frequency opens. The box displays the current frequency.
- Define the start frequency with the number keys, rotary knob or cursor keys.
- Confirm the entry with the ENTER key or one of the unit keys if you have entered the frequency with the number keys.  
The R&S FSH sets the new start frequency. The x axis labelling changes from "Center" and "Span" to "Start" and "Stop".
- Press the STOP FREQ softkey.  
The value entry box for the stop frequency opens. The box displays the current frequency.
- Define the stop frequency with the number keys, rotary knob or cursor keys.
- Confirm the entry with the ENTER key or one of the unit keys if you have entered the frequency with the number keys.  
The R&S FSH sets the new stop frequency.

If you enter a stop frequency on the R&S FSH which exceeds the maximum stop frequency of the instrument model, the R&S FSH will set the stop frequency to the maximum permissible stop frequency. If you reach this frequency limit with the rotary knob or the cursor keys, the R&S FSH will ignore any further rotary ticks or cursor steps.

### 4.3.5 Working with Channel Tables

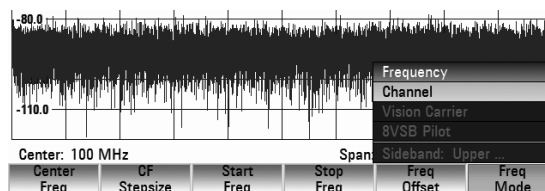
Almost all transmission systems divide their assigned frequency ranges into channels, with a specific frequency assigned to each channel. The R&S FSH therefore allows you to define channel assignments using familiar terms to keep operation simple.

You can define channel tables using the R&S FSH4View software and load them into the R&S FSH. The R&S FSH can store more than 100 different channel tables that you can activate via the softkeys. The maximum number of channel tables may be reduced if transducer factors, cable models, limit values or data sets are stored simultaneously (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

Refer to the manual of the R&S FSH4View software for information on how to create channel tables.

#### Switching to channel entry:

- Press the FREQ key.
- Press the FREQ MODE softkey.
- Select CHANNEL from the submenu with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FREQ MODE softkey.



The R&S FSH opens a dialog box that shows all available channel tables that have been loaded into the R&S FSH with R&S FSH4View.

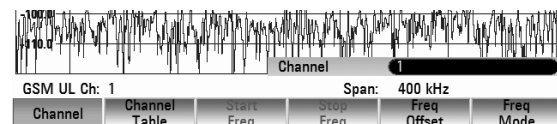
- Select the channel table you need with the rotary knob or the cursor keys.
- If necessary, you can sort the available channel tables by name, date or size using the SORT/SHOW softkey. In addition, you can hide channel tables that are incompatible with the current instrument settings.
- Confirm the selection with the SELECT softkey. The R&S FSH activates the channel table and uses it for future measurements.

To indicate an active channel table, the R&S FSH shows the channel number together with the name of the selected channel (e.g. GSM UL Ch 1) instead of the center frequency. The label of the CENTER FREQ softkey now reads CHANNEL.

Stat	Name	Size	Date	Time
\Public\				
	CATV.chntab	1 kB	11/05/2008	20:09
	GSM DLchntab	1 kB	11/05/2008	20:12
	GSM ULchntab	1 kB	11/05/2008	20:36
	PCS DLchntab	1 kB	11/05/2008	20:12
	PCS ULchntab	1 kB	11/05/2008	20:11

Free: 27 MB

Select Sort/Show Internal/SD-Card Exit



The R&S FSH center frequency is the frequency corresponding to the displayed channel number from the channel table. The R&S FSH accepts only channel numbers when entering the center frequency. Tuning the frequency with the rotary knob or the cursor keys is also done using channel numbers. All other measurement parameters such as SPAN or RBW (resolution bandwidth) are user-selectable as with the entry of frequencies.

The entries for the start frequency (START FREQ) and the stop frequency (STOP FREQ) are inactive when defining channels.

Channel numbers are assigned to frequencies as follows:

- The first channel is assigned a channel number and a frequency.
- All subsequent channels have ascending numbers.
- The frequency spacing between channels is fixed. It can also be negative, i.e. the center frequency of the R&S FSH decreases with ascending channel number.
- In transmission systems containing gaps in the frequency range (as in the case of television, for example), a channel table can comprise multiple ranges.



## 4.4 Setting the Span

The span is the frequency range centered on the center frequency that a spectrum analyzer displays on the screen. What span should be selected for a particular measurement depends on the signal to be investigated. A rule of thumb is that it should be at least twice the bandwidth occupied by the signal.

For frequency domain measurement the R&S FSH4 has a minimum span of 100 Hz and a maximum span of 3.6 GHz. The maximum span for the R&S FSH8 is 8 GHz.

If you set the span to 0 Hz (zero span), measurements are performed in the time domain.

### Operating sequence:

- Press the SPAN key.

The R&S FSH opens the span menu. Upon pressing the SPAN key, manual span entry is always activated. If inactive, you can open the entry box with the MANUAL SPAN softkey.

- Enter the span you need with the number keys.
- Confirm the entry with the appropriate unit (GHz, MHz, kHz or Hz), or
- Change the span with the rotary knob or the cursor keys. The span is set immediately after the change is made.

- Press the CANCEL key to close the entry box.

- Press the FULL SPAN key.

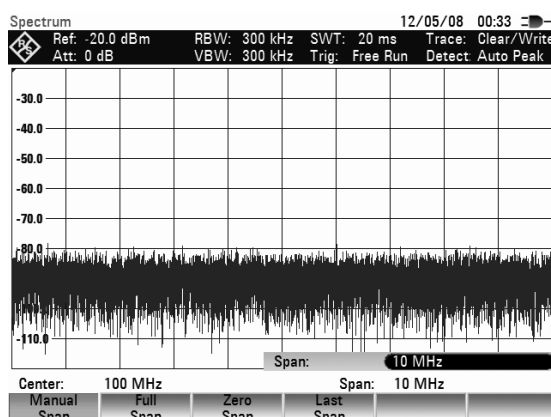
The R&S FSH displays the spectrum over the full span which extends to 3.6 GHz (R&S FSH4) or to 8 GHz (R&S FSH8). (CENTER = 1.8 GHz, SPAN = 3.6 GHz / CENTER = 4 GHz, SPAN = 8 GHz).

The R&S FSH has a LAST SPAN softkey so that you can toggle between span settings with just one keystroke.

- Press the LAST SPAN key.

The span that was set immediately before the current span is restored.

The ZERO SPAN softkey sets the span to 0 Hz. The R&S FSH measures the signal level only at the center frequency that has been set. As a spectrum cannot be displayed when measurements are made at a single frequency, the display mode switches to the time domain. The x-axis of the measurement diagram becomes the time axis and level is plotted against time. The display always starts at 0 s and stops after the sweep time that has been set (set with the SWEEP key, see also "[Setting the Sweep](#)").



## 4.5 Setting the Amplitude Parameters

The Amplitude menu contains all settings that relate to level display settings. You can access it via the AMPT key.

The reference level (REF) is the level represented by the uppermost grid line in the measurement diagram. The input signal gain up to the display stage is set with the reference level. If the reference level is low, the gain is high, which means that even weak signals are displayed clearly. If the input signals are strong, a high reference level must be set to prevent an overload of the analyzer signal path and to keep the signal display within the display range. When displaying the spectrum of a composite signal, the reference level should be at least high enough to ensure that all the signals are within the measurement diagram.

The RF attenuation setting at the input of the R&S FSH is directly coupled to the reference level. If the reference level is high, RF attenuation is switched on in steps of 10 dB according to the following table so that the input mixer always remains in the linear range.

The R&S FSH has two different modes for the attenuation setting. You can select the modes with the RF ATT / AMP / IMP softkey. In Auto Low Distortion mode, the R&S FSH sets the RF attenuation 10 dB higher in line with the table, making the stress of the input mixer 10 dB less at the specified reference level. If the spectrum is densely occupied with signals, e.g. in a television cable network, the input mixer reduces the R&S FSH's inherent spurious products. However, the inherent noise display of the R&S FSH increases due to the increased attenuation in front of the input mixer.

In Auto Low Noise mode, the R&S FSH sets the RF attenuation 10 dB lower. This increases the sensitivity of the R&S FSH, which means that the inherent noise display decreases due to the lower attenuation in front of the input mixer.

Reference Level	Preamplifier OFF		Preamplifier ON	
	RF attenuation		RF attenuation	
	Low Noise	Low Distortion	Low Noise	Low Distortion
≤ -30 dBm	0 dB	0 dB	0 dB	0 dB
-29 bis -25 dBm	0 dB	0 dB	0 dB	5 dB
-24 bis -20 dBm	0 dB	0 dB	0 dB	10 dB
-19 bis -15 dBm	0 dB	5 dB	5 dB	15 dB
-14 bis -10 dBm	0 dB	10 dB	10 dB	20 dB
-9 bis -5 dBm	5 dB	15 dB	15 dB	25 dB
-4 bis 0 dBm	10 dB	20 dB	20 dB	30 dB
1 bis 5 dBm	15 dB	25 dB	25 dB	35 dB
6 bis 10 dBm	20 dB	30 dB	30 dB	40 dB
11 bis 15 dBm	25 dB	35 dB	35 dB	40 dB
16 bis 20 dBm	30 dB	40 dB	40 dB	40 dB
21 bis 25 dBm	35 dB	40 dB	40 dB	40 dB
26 bis 30 dBm	40 dB	40 dB	40 dB	40 dB

You can check the status of the RF attenuation and the preamplifier in the measurement setup dialog box (see [Measurement Setup](#)).

By default, the reference level is in dBm. However, the units dBmV, dBμV, Watt and Volt are also available. Unit selection is of most relevance to the marker level display as the marker level is displayed in the unit of the reference level.

A reference offset (REF OFFSET) can be defined for the reference level. The reference offset is a way of increasing the reference level by a certain amount. This is useful if, for example, an attenuator or amplifier has been inserted before the RF input. The R&S FSH automatically takes the loss or gain into account when the level is displayed and no manual calculations are necessary. A loss introduced at the RF input must be entered as a positive number and a gain as a negative number.

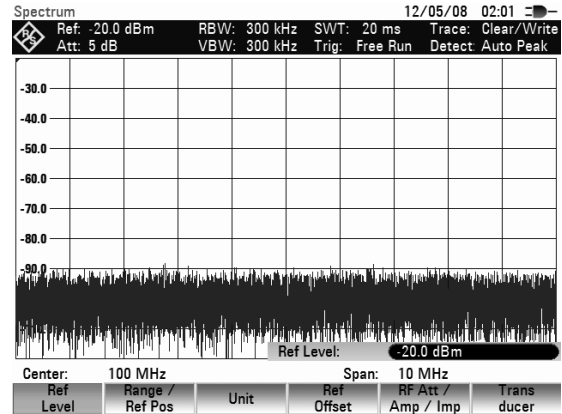
The measurement range (RANGE) determines the resolution along the level axis in the measurement diagram. When the PRESET or default setting has been selected, the level axis is scaled in dB. The measurement range is 100 dB or 10 dB per division (10 dB/DIV). The R&S FSH also provides the level ranges 50 dB (5 dB/DIV), 20 dB (2 dB/DIV), 10 dB (1 dB/DIV) and 1 dB (0.1 dB/DIV), which enhance the resolution along the level axis. However, increasing resolution does not increase the accuracy of, for example, the marker level readout, but only makes it easier to read values off the trace. You can also select a linear level scale with LIN 0-100 %. The level is expressed as a percentage (0 % to 100 %) of the reference level. This mode is useful if you want to display, for example, a carrier being amplitude modulated in the time domain (SPAN = 0 Hz).

The R&S FSH can also handle measurements on 75 Ω systems. The R&S FSH does not select a 75 Ω RF input per se, but instead only a 75 Ω matching pad connected at the RF input. The 50/75 Ω Matching Pad R&S RAZ is recommended for 75 Ω matching (see recommended accessories). The R&S FSH automatically considers the conversion factor when a value of 75 Ω is set. Other

matching pads such as the R&S RAM or R&S FSH-Z38 can be taken into account by using a transducer factor (included with the R&S FSH4View control software).

### 4.5.1 Setting the Reference Level

- Press the AMPT key.  
The R&S FSH opens the amplitude menu. Upon pressing the AMPT key, reference level entry is always activated. If inactive, you can open the entry box with the REF LEVEL softkey.
- Define a reference level with the number keys, rotary knob or cursor keys.
- Confirm the entry with the ENTER key or one of the unit keys (-dBm or dBm for relative measurements or (, m, μ, n for absolute measurements) if you have entered the reference level with the number keys.

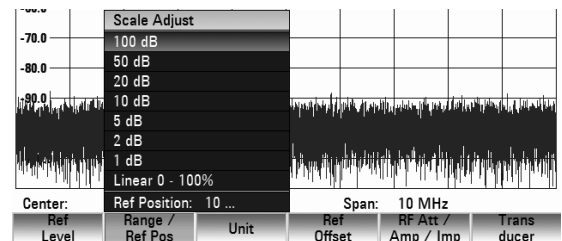


Any changes you make to the reference level with the rotary knob or the cursor keys are immediate. The trace moves as you make changes to the reference level.

- Press the CANCEL key to close the entry box.

### 4.5.2 Entering the Display Range

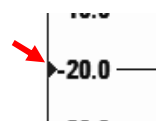
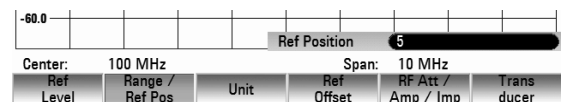
- Press the AMPT key.
- Press the RANGE/REF POS softkey.  
A submenu opens. The various options for scaling the level axis are displayed.
- Select the scaling you need with the rotary knob or the cursor keys.
- Confirm your selection with the ENTER key or the RANGE/REF POS softkey.



The R&S FSH sets the scaling option you have chosen immediately.

You can define the position of the reference level by moving the trace to another grid line to display signals that would normally overlap with the top border of the diagram.

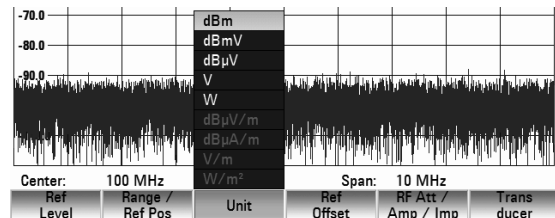
- Press the RANGE/REF POS softkey.
- Select REF POSITION: 10 with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
An entry box opens.
- Select the grid line you want with the number keys, the rotary knob or the cursor keys. '10' corresponds with the upper grid line, '0' to the lower grid line.
- Confirm the entry with the ENTER key.



A triangle marks the current position of the reference level on the selected grid line.

### 4.5.3 Entering the Display Unit

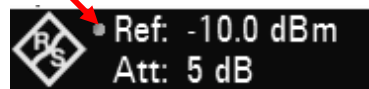
- Press the AMPT key.
- Press the UNIT softkey.  
A submenu opens. The various unit options for the reference level are displayed.
- Select the unit you want with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the UNIT softkey.  
The R&S FSH immediately switches the unit.



### 4.5.4 Entering the Reference Offset

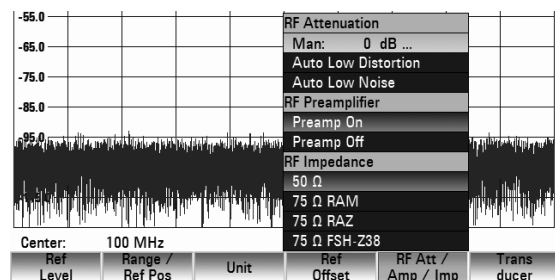
- Press the AMPT key.
- Press the REF OFFSET softkey.
- Enter the reference offset you need with the number keys, rotary knob or cursor keys.
- Confirm the entry with the ENTER key or one of the unit keys if you have entered the reference offset with the number keys.  
The reference offset unit is always dB – no matter what unit is used for the reference level.

A red dot in front of the reference level display indicates that a non-zero reference offset has been set.

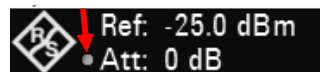


### 4.5.5 Entering of the RF-Attenuation

- Press the AMPT key.
- Press the RF ATT/AMP/IMP softkey.  
The R&S FSH opens a submenu to select RF ATTENUATION, RF PREAMPLIFIER and RF IMPEDANCE.  
The RF attenuation can be preset at your discretion to between 0 dB and 40 dB in 5 dB steps ("Man:" entry), or set automatically to low sensitivity to interfering signals ("Auto Low Distortion" setting) or to high input sensitivity ("Auto Low Noise" setting).
- Select the item you want with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.



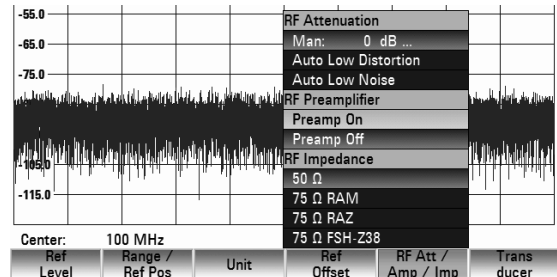
A red dot in front of the RF Attenuation display indicates that manual ('Man:') selection of the attenuation has been set.



### 4.5.6 Switching the RF Preamp on/off

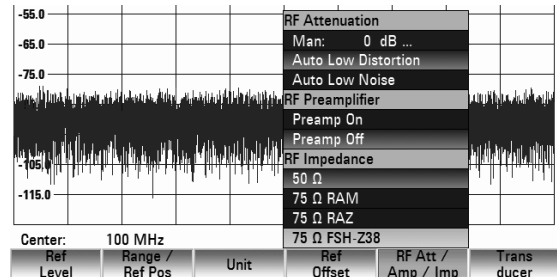
To increase the input sensitivity, the R&S FSH has an integrated 20 dB preamplifier upstream of the input mixer. This is switched off in the default state. You can switch it on to measure low power signals.

- Press the AMPT key.
- Press the RF ATT/AMP/IMP softkey.  
The R&S FSH opens a submenu to select RF ATTENUATION, RF PREAMPLIFIER and RF IMPEDANCE.
- Select PREAMP ON or PREAMP OFF with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.



### 4.5.7 Entering the Input Impedance

- Press the AMPT key.
- Press the RF ATT/AMP/IMP softkey.  
A submenu opens. The two input impedance options “50 Ω” and “75 Ω” are displayed.
- Select the input impedance you need with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key..



If you have selected 75 Ω, and do not connect a matching pad to the RF input, level readings will be incorrect.

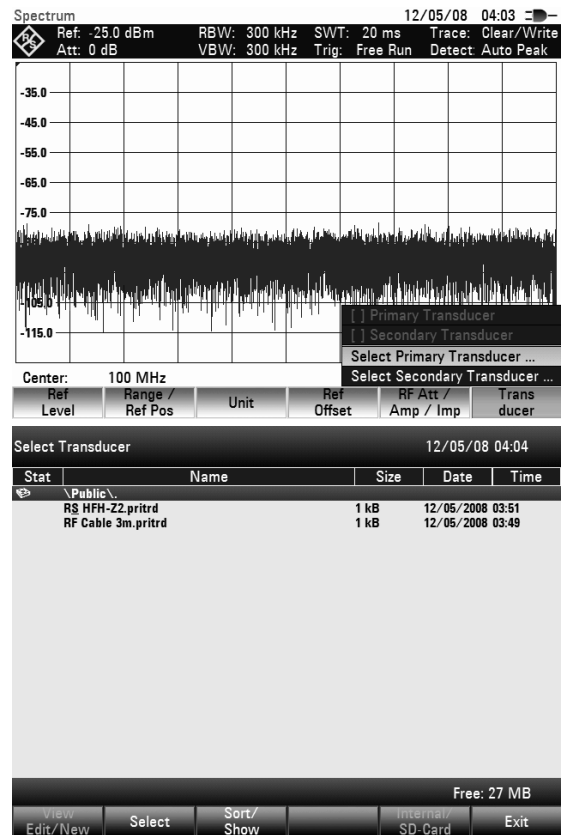
### 4.5.8 Selecting a Transducer Factor

In many cases, the R&S FSH is not connected directly to the output of the device under test. Instead, the signal comes via a cable, amplifier, antenna or a combination of these.

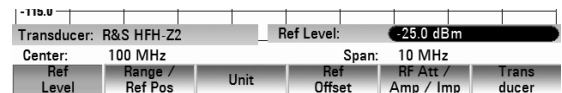
The R&S FSH can account for the frequency shifts of up to two connecting components in the measured results. For this purpose, so called transducer factors have been defined. You can load transducer factors into the R&S FSH with the R&S FSH4View software. Each transducer factor consists of a list of frequency/level pairs that describe the frequency shift of the measuring accessory. For antennas, the unit of the measured electrical or magnetic field strength is included, for isotropic antennas in each case the frequency stage for the x-, y- and z-directions.

For more information on how to create and edit transducer factors refer to the R&S FSH4View manual. You can enable two inputs (Primary and Secondary Transducer) from the list of transducer factors available for the R&S FSH, in order to take, for example, a combination of cable and antenna or cable and amplifier into account. Note that only one of the two transducers in use may have a unit other than “dB”.

- Press the AMPT key.
- Press the TRANSDUCER softkey.  
The R&S FSH opens a submenu to select the primary and secondary transducer factors.
- Select the SELECT PRIMARY TRANSDUCER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
A list of factors that are available as primary transducer factors opens.
- Select the transducer factor you need with the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
In the transducer submenu, the PRIMARY TRANSDUCER menu item is check marked.



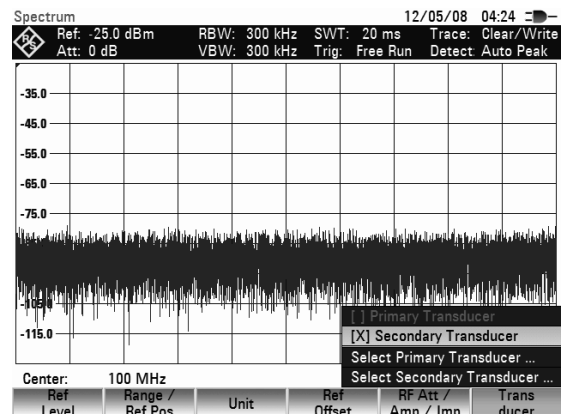
The R&S FSH displays the transducer factor in use in addition to the entry field of the reference level.



To select an additional transducer factor, use the menu entry SELECT SECONDARY TRANSDUCER and proceed as described above.

To switch off a selected transducer factor, proceed as follows:

- Press the AMPT key.
- Press the TRANSDUCER softkey.  
The R&S FSH opens a submenu to select primary and secondary transducer factors.
- Select the PRIMARY TRANSDUCER or SECONDARY TRANSDUCER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.



The transducer factor is no longer included in the level display.

## 4.6 Setting the Bandwidths

A key feature of a spectrum analyzer is that it can display the frequency spectrum of a signal. The resolution bandwidth determines how well a spectrum analyzer can separate adjacent frequencies. Spectrum analyzers usually also have adjustable video bandwidths. The video bandwidth is determined by the cutoff frequency of the lowpass used to filter the video voltage before it is displayed. The video voltage is the spectrum analyzer term for the voltage produced when the IF signal that has been band-limited by the resolution filter is envelope detected. The video voltage is smoothed by video filtering to, say, reduce noise on the trace. Unlike the resolution bandwidth, the video bandwidth has no effect on the resolving power of the spectrum analyzer.

### 4.6.1 Resolution Bandwidth

The resolution bandwidth (RES BW) of a spectrum analyzer determines the frequency resolution of spectrum measurements. A sine signal is displayed on the screen "through" the passband of the selected resolution filter. Therefore, a suitably small resolution bandwidth is required if two or more signals whose frequencies are close together are to be displayed separately. The frequency difference between two sinusoidal carriers, for example, cannot be less than the selected resolution bandwidth if the carriers are to be resolved.

The resolution bandwidth that you select also has an effect on the noise displayed by the spectrum analyzer. If the bandwidth is small, the displayed noise drops. If you reduce or increase the bandwidth by a factor of 3, the displayed noise drops or goes up by 5 dB. If the bandwidth is changed by a factor of 10, the displayed noise changes by 10 dB.

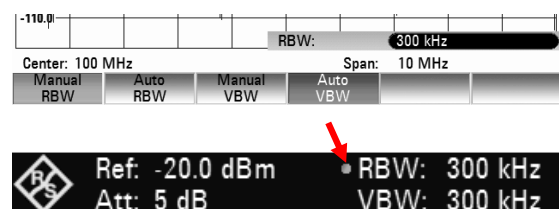
The resolution bandwidth you select also has an effect on the sweep speed. If the true spectrum is to be displayed, the bandfilters that determine the resolution bandwidth must settle at all frequencies of interest. Narrow bandfilters take longer to settle than wide filters. This is why you have to set a longer sweep time for narrow resolution bandwidths. If the bandwidth is reduced by a factor of 3 (e.g. from 10 kHz to 3 kHz), the sweep time must be increased by a factor of 9. If the reduction factor is 10 (e.g. from 10 kHz to 1 kHz) the sweep time must be increased by a factor of 100.

The R&S FSH has resolution bandwidths from 1 Hz to 3 MHz in a 1, 3, 10 sequence. In the R&S FSH's default state, the resolution bandwidth is coupled to the span, i.e. if the span is reduced, the R&S FSH automatically applies a smaller resolution bandwidth. In turn this means that you do not have to set the resolution bandwidth separately in many cases – a higher frequency resolution is automatically set when the span is reduced.

All models offer a 200 kHz resolution bandwidth in addition. This bandwidth has to be selected manually, i.e. it will not be activated automatically in the AUTO RES BW mode (resolution bandwidth coupled to span).

#### Operating sequence:

- Press the BW key.  
The menu to select the bandwidth opens. By default, the AUTO RBW softkey is active (green).
- Press the MANUAL RBW softkey  
The RBW entry box opens. It shows the current bandwidth.  
  
A red dot in front of the RBW display indicates that the resolution bandwidth is no longer coupled to the span.
- Enter the resolution bandwidth you want with the number keys and confirm the entry with the appropriate unit (MHz, kHz or Hz), or
- Select the resolution bandwidth with the rotary knob or the cursor keys and confirm the selection with the ENTER key.



- Press the CANCEL key to close the entry box.
- Press the AUTO RES BW softkey.  
The resolution bandwidth again is coupled to the span. The AUTO RBW softkey label is highlighted in green to show that the coupled mode has been selected.  
The red dot in front of the RBW display disappears.



#### Setting the 200 kHz resolution bandwidth

You have to enter the 200 kHz resolution bandwidth with the number keys.  
When using the rotary knob or the cursor keys, the 200 kHz bandwidth will be skipped.

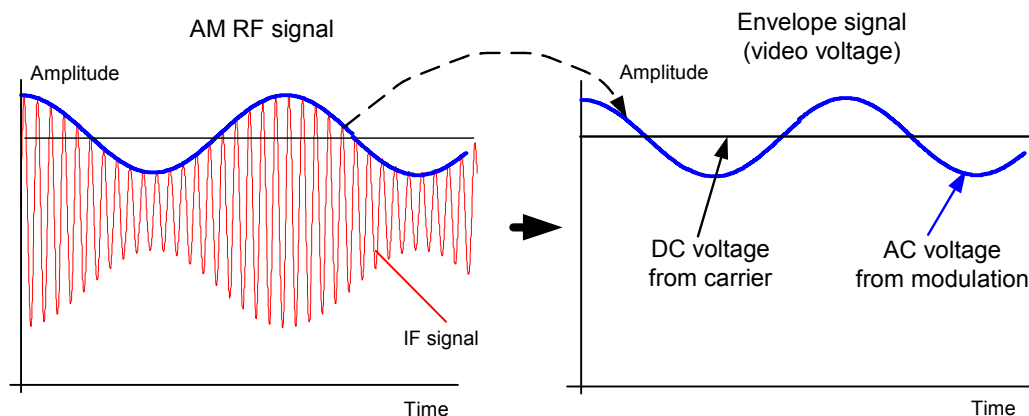


#### Automatic adjustment of the sweep time

In its default mode the R&S FSH automatically adjusts the sweep time as soon as you change the resolution bandwidth. This is to make sure that the settling time required for the selected resolution filter is properly taken into account. The maximum allowed sweep time is 1000 s. For narrow resolution filters this value would be exceeded for large spans. In order to avoid this the R&S FSH adjusts the span automatically as soon as the maximum sweep time is reached.

## 4.6.2 Video Bandwidth

The video bandwidth smoothes the trace by reducing noise. When the filtered IF signal is envelope-detected, an IF sine signal becomes a DC voltage in the video signal. If the sine signal is amplitude-modulated, a signal whose frequency is the same as the AM frequency is produced in the video signal apart from the DC voltage from the carrier. The figure below shows an RF signal modulated with a sine signal and the corresponding video signal in the time domain.



The envelope signal contains a DC component corresponding to the carrier level and an AC component whose frequency is the same as the AM frequency. If the bandwidth of the video filter is less than the frequency of the AC component, the latter will be suppressed depending on its maximum frequency. If the AM component is to be displayed faithfully, the cutoff frequency must be greater than the modulation frequency.

If there is noise on the sine signal, the modulation signal can be thought of as noise. If the video bandwidth is reduced, the high-frequency noise components above the cutoff frequency of the video filter will be rejected. The smaller the video bandwidth, the smaller the noise amplitude at the video filter output.



Therefore, the following rules of thumb can be applied to setting the video bandwidth:

- If you are performing measurements on modulated signals, the video bandwidth must be sufficiently large so that desired modulation components are not rejected ( $\geq$  RBW).
- If signals are to be kept free of noise, the smallest video bandwidth possible should be selected ( $\leq 0.1 \times$  RBW).
- If measurements are being performed on pulsed signals, the video bandwidth should be at least three times greater than the resolution bandwidth so that the pulse edges are not distorted.

Like the resolution bandwidth, the video bandwidth has an effect on sweep speed. The spectrum analyzer must pause before each measurement to allow the video filter to settle.

The R&S FSH has video bandwidths from 1 Hz to 3 MHz in a 1, 3, 10 sequence. When the default settings are selected, they are coupled to the resolution bandwidth. The video bandwidth equals the resolution bandwidth. When the resolution bandwidth is changed, the R&S FSH automatically sets the appropriate video bandwidth. This means that, in many cases, the video bandwidth does not need to be set separately. When the resolution bandwidth is changed, the video bandwidth is changed automatically.

#### Operating sequence:

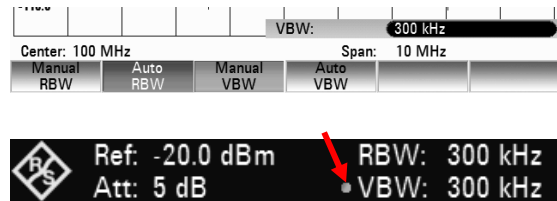
- Press the BW key.

The menu for setting bandwidths opens. When the default setting has been selected, the softkey label for setting the bandwidth automatically is highlighted in green.

- Press the MANUAL VBW softkey.

The VBW entry box opens. It shows the current bandwidth.

A red dot in front of the VBW display indicates that the video bandwidth is no longer coupled to the resolution bandwidth.



- Enter the video bandwidth you want with the number keys and confirm the entry with the appropriate unit (MHz, kHz or Hz), or
- change the video bandwidth to the value you want using the rotary knob or the cursor keys.
- Press the CANCEL key to close the entry box.
- Press the AUTO VBW softkey.

The video bandwidth again is coupled to the resolution bandwidth. The AUTO RBW softkey label is highlighted in green to show that the coupled mode has been selected.

The red dot in front of the RBW display disappears.

## 4.7 Setting the Sweep

If the span is  $> 0$ , the sweep time is the time the spectrum analyzer takes to traverse the displayed span to measure the spectrum. Certain boundary conditions must be met if a spurious spectrum is not to be displayed.

One boundary condition is the resolution bandwidth. If the resolution filter is to settle, the dwell time within the filter bandwidth must have the right value. If the sweep time is too short, the resolution filter does not settle and the displayed level is too low (see also “[Setting the Bandwidths](#)”).

The second boundary condition is the selected span. If the span is increased, the sweep time must be increased proportionally.

The R&S FSH provides automatic sweep time coupling to help users set the sweep time by coupling it to the resolution bandwidth and span that have been set. When automatic coupling (AUTO SWEEP TIME) is selected, it always sets the shortest sweep time possible to ensure that sine signals in the spectrum are displayed correctly. If you activate manual sweep time, a red dot in front of the SWP display indicates that the sweep time is no longer coupled to the resolution bandwidth and the span. If the sweep time is so short that level errors occur, the R&S FSH informs you by displaying a red circle in the measurement diagram.

The R&S FSH requires a minimum sweep time of 20 ms per 600 MHz of span. If you set a larger span, the R&S FSH automatically adapts the minimum sweep time in the coupled mode.

If the span = 0 Hz, the R&S FSH displays video voltage versus time instead of a spectrum. The x-axis of the measurement diagram becomes the time axis. It starts at 0 s and ends at the sweep time you have selected.

The minimum sweep time when the span = 0 Hz is 200  $\mu$ s, the maximum 1000 s.

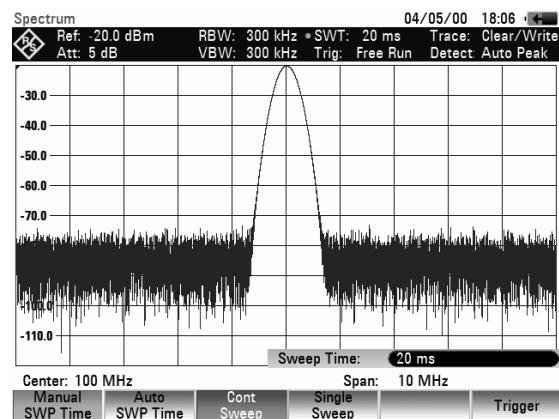
### 4.7.1 Sweep Time

- Press the SWEEP key.

The softkey menu for entering sweep parameters opens. By default, automatic coupling (AUTO SWP TIME) is active. In this mode, the sweep time is coupled to the resolution bandwidth, the video bandwidth and the span.

- To enter the sweep time, press the MANUAL SWP TIME softkey.

The Sweep Time entry box opens. It shows the current sweep time.



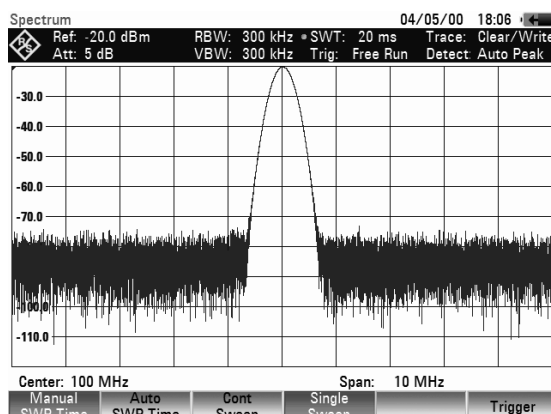
- Enter a new sweep time with the number keys and confirm the entry with one of the unit keys, or
  - change the sweep time with the rotary knob or the cursor keys and confirm the entry with the ENTER key.
- Whenever you make a change, the sweep time is immediately set to its new value. The SWT readout shows the current sweep time.
- Press the CANCEL key to close the entry box.

### 4.7.2 Sweep Mode

When the default settings are active, the R&S FSH is in the continuous sweep mode, i.e. when one sweep of the span has been completed, the sweep is automatically repeated from the start of the span. The trace is updated after each sweep.

The continuous mode may not be needed for some applications, e.g. when a single event is to be recorded on certain trigger conditions being met. Therefore, the R&S FSH has a SINGLE SWEEP mode. When the single sweep mode is selected, the R&S FSH sweeps once over the span or displays the time-domain video signal once in the zero-span mode. The measurement will only be repeated if you press the SINGLE SWEEP softkey.

- Press the SWEEP key.  
By default, continuous sweep mode (CONT SWEEP) is active.
- Press the SINGLE SWEEP softkey.  
The SINGLE SWEEP softkey label turns green.  
The R&S FSH performs a single sweep and waits for further entries.
- Press the CONT SWEEP softkey.  
The R&S FSH sweeps continuously again.



### 4.7.3 Trigger

To respond to events, the R&S FSH has a variety of trigger functions. The trigger can either be external or generated internally.

- FREE RUN      A new sweep starts on completion of the previous sweep. This is the default setting for the R&S FSH.
- VIDEO      A sweep starts when the video voltage exceeds a certain value you can set. Video triggering is only available in zero span mode (span = 0 Hz). When a frequency spectrum is being displayed, (span  $\geq$  10 kHz), there is no guarantee that a signal that generate a video voltage is present at the start frequency. Under these circumstances, the R&S FSH would never perform a sweep.
- EXTERNAL RISE / EXTERNAL FALL      A sweep starts on the rising edge (RISE) or on the falling edge (FALL) of an external trigger signal. The external trigger signal is fed in via the BNC connector EXT TRIGGER. The switching threshold is 1.4 V, i.e. a TTL signal level.
- GATED TRIGGER      When the gated trigger is active, a gate signal that is applied to the R&S FSH trigger input controls the sweep. The R&S FSH starts measuring when the applied gate signal becomes active and the set gate delay has expired, and it interrupts the measurement as soon as the defined gate length is reached. With the gate signal becoming active the next time the measurement is resumed etc. Pulsed signals can be measured by this method, if the gate delay and gate length are selected in a way that the measurement is only performed while the pulse is active. Gated measurement is possible in the frequency domain (span > 0) and the time domain (span = 0), but it is available only in combination with an external gate signal.

When video trigger or external trigger are selected, you can delay the start of the measurement with respect to the trigger event by entering a delay time (DELAY). In this way, time differences between the trigger event and the measurement can be allowed for.

The trigger readout (TRIG) shows the current trigger setting.

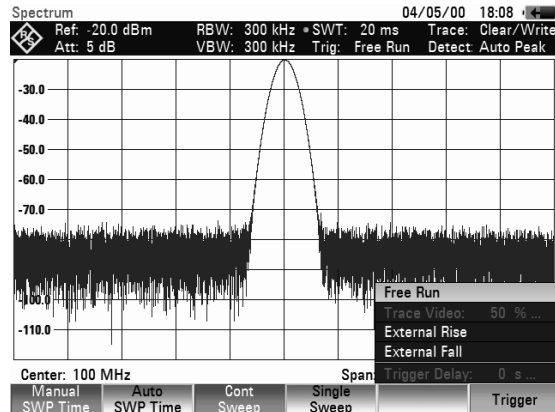
#### Operating sequence:

- Press the SWEEP key.
- Press the TRIGGER softkey.  
The submenu for setting the trigger opens. By default, Free Run is active.

In zero span mode (span = 0 Hz), you can select any trigger. If the span > 0, the Video and Delay items are not available.

- Select the setting you want with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the TRIGGER softkey.

The trigger readout (TRIG) shows the current trigger setting.



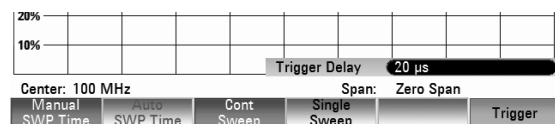
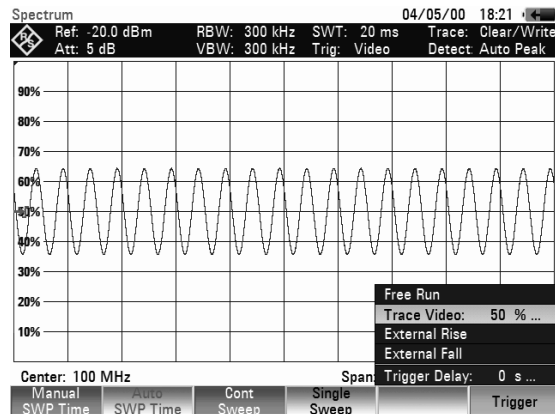
If you have selected the VIDEO... trigger, you have to specify the trigger level and any trigger delay (DELAY...). The trigger level is expressed as a percentage (%) of the reference level. 100% means that the trigger level equals the reference level, 50% that the trigger level is in the middle of the y axis of the trace diagram (default setting). The position of the video trigger on the level axis is shown by a ">".

- Press the TRIGGER softkey.
- Select the TRACE VIDEO menu item with the rotary knob or the cursor keys.
- Change the video-trigger threshold with the cursor keys or the rotary knob (0 to 100 %).
- Confirm the selection with the ENTER key or the TRIGGER softkey.

The entry box closes. The trigger threshold is set immediately after entry.

- If you require a trigger delay, press the TRIGGER softkey.
- Select the DELAY... menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the TRIGGER softkey.

The R&S FSH opens a entry box to enter the delay time.



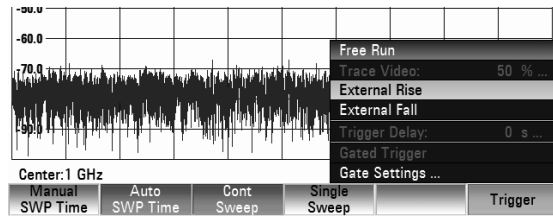
- Enter the delay time with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key or one of the unit softkeys, if you have entered the delay time with the number keys.

The range for the trigger delay is 0 µs to 100 s. The resolution depends on the selected delay time. The table below lists the delay time resolution values:

Trigger delay (DELAY)	Resolution
0 to 1 ms	10 µs
1 ms to 10 ms	100 µs
10 ms to 100 ms	1 ms
100 ms to 1 s	10 ms
1 s to 10 s	100 ms
10 s to 100 s	1 s

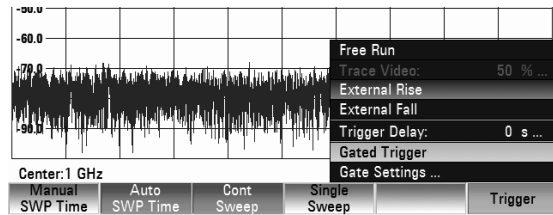
When the external trigger is active (EXTERNAL RISE or EXTERNAL FALL), it is possible to activate a gated sweep.

- Press the SWEEP key.
- Press the TRIGGER softkey.
- Select EXTERNAL RISE or FALL with the rotary knob or the cursor keys to enable the external trigger.
- Confirm your selection with the ENTER key or the TRIGGER softkey.



Now that the external trigger is active, the GATED TRIGGER becomes available for selection.

- Press the TRIGGER softkey again.
  - Select the GATED TRIGGER menu item with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the TRIGGER softkey.
- The gated sweep is now active.

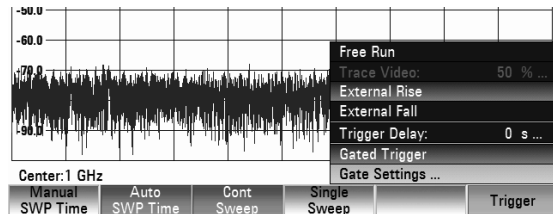


In order to get appropriate results, the gate delay and gate length must be set in a way that the measurement is active during the interesting part of the signal. You can also modify the sweep time in order to match the x-axis to the length of the signal and therefore set the gate delay and gate length parameters more accurately.

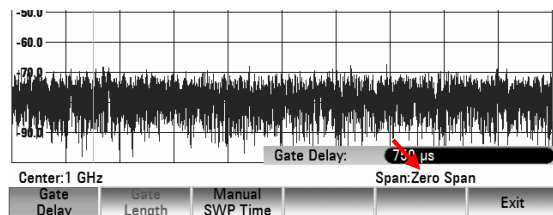
The gate delay parameter defines the time between the trigger event and the beginning of the actual measurement. The gate length defines the duration of the measurement, before it is interrupted and the next gate signal is anticipated to resume the measurement.

To define the gate delay and the gate length, proceed as follows:

- Press the TRIGGER softkey.
  - Select GATE SETTINGS with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key.
- The R&S FSH opens a softkey submenu that controls the gate settings. At the same time, the R&S FSH switches into time domain (span = 0), as indicated in the display.



- Press the MANUAL SWP TIME softkey and set the sweep time in a way that the portion of interest of the signal is visible on the screen.
- Press the GATE DELAY softkey to define the time when the measurement should start.



- Enter the delay time you need with the number keys, the rotary knob or the cursor keys.
  - Confirm the entry with the ENTER key.
  - Press the GATE LENGTH softkey to define the duration of the measurement, before it is interrupted and the next gate signal is anticipated.
- The delay time and gate length are represented by vertical red lines in the diagram area.

- After setting the gate delay and gate length, exit the gate settings menu with the EXIT softkey.
- The R&S FSH returns to the frequency domain provided it was active before setting up the gated trigger. The original span is restored. The R&S FSH is ready to perform measurements with an accurately set gate.

## 4.8 Trace Settings

The R&S FSH provides a measurement trace and two reference traces in memory.

### 4.8.1 Trace Mode

A variety of display modes can be selected for the trace:

- **CLEAR/WRITE**

The R&S FSH clears the old trace during a new sweep. This is the default setting.

- **AVERAGE**

The R&S FSH takes the level average over consecutive traces. In the default setting, averaging is on a pixel-by-pixel basis, sliding over the ten previous traces. Alternatively, you can set the number of averagings between 2 and 999. This reduces the effects of noise, for example, but has no effect on sine signals. The average mode, therefore, makes it easy to display sine signals in the vicinity of noise.

- **MAX HOLD**

The trace indicates the maximum value that has been measured up to that point in time. The Max Hold mode is only cancelled if another setting is selected and the trace pixels from the new setting cannot be compared with the trace pixels from the previous setting – for example if the span is changed. Intermittent signals in the spectrum or the maximum of fluctuating signals are easy to find with MAX HOLD.

- **MIN HOLD**

The trace indicates the minimum value that has been measured up to that point in time. The Min Hold mode is only cancelled if another setting is selected and the trace pixels from the new setting cannot be compared with the trace pixels from the previous setting – for example if the span or the center frequency is changed. With MIN HOLD, sine signals within the noise can be highlighted or intermittent signals suppressed.

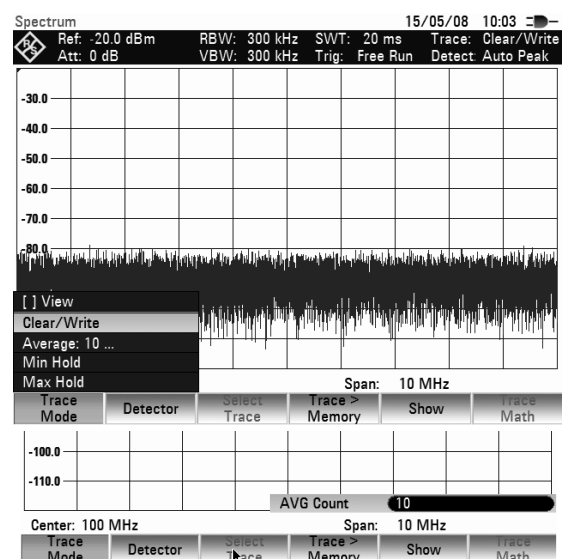
- **VIEW**

The R&S FSH freezes the presently displayed trace. The measurement is aborted. This, for instance, allows subsequent evaluation of spectra with the aid of the marker.

#### Operating sequence:

- Press the TRACE key.
- Press the TRACE MODE softkey.  
The submenu for setting the trace mode opens.
- Select the trace mode you want with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the TRACE MODE softkey.  
The "Trace:" display shows the current trace mode.

If you select the AVERAGE trace mode, the AVG COUNT entry box opens. It displays the number of averagings the R&S FSH performs.



You can perform the following actions:

- Confirm the displayed number of averagings with the TRACE softkey or the ENTER key.
- Enter a new value between 2 and 999 with the number keys. Confirm the new number of averagings with the ENTER key.
- Change the number of averagings with the rotary knob. Confirm the entry with the ENTER key. The R&S FSH averages the pixels of the trace across the set number of averagings.

If the sweep is continuous, the R&S FSH then performs a sliding averaging. In the SINGLE SWEEP mode, it performs exactly those sweeps defined with AVG COUNT and averages the traces. It then stops the sweep and displays the averaged trace.

In the trace mode VIEW, the settings used for measuring the trace are displayed. This ensures that the measurement conditions can be clearly specified in result documentation.

## 4.8.2 Detector

The detector processes a spectrum analyzer's video voltage before it is displayed. The detector is pixel-oriented, i.e. it determines how the level at each pixel will be displayed. The R&S FSH always measures the whole spectrum. However, the trace only has 631 pixels in the x direction for displaying results. If a large span is selected, all the spectrum information must somehow be represented using only 631 points. Each pixel represents a frequency range equal to span/631. Four different detectors are available:

- **AUTO PEAK**

When the Auto Peak detector is selected, the R&S FSH displays the maximum and minimum level at each pixel for the frequency range in question. This means that when Auto Peak detection is selected no signals are lost. If the signal level fluctuates, as is the case with noise, the width of the trace is a measure of signal fluctuation. Auto-peak detection is the default setting.

- **MAX PEAK**

Unlike the Auto Peak detector, the Max Peak detector only finds the maximum value within the frequency range associated with one trace pixel. Its use is recommended for measurements on pulse-like signals or FM signals.

- **MIN PEAK**

The Min Peak detector yields the minimum value of the spectrum within a pixel of the trace. Sine signals are displayed with correct level but noise-like signals are suppressed. The Min Peak detector can be used to highlight sine signals in the noise spectrum.

- **SAMPLE**

The Sample detector does not "summarize" any aspect of the spectrum which is available in its complete form in the R&S FSH, but instead shows only one arbitrary measurement point within a pixel. The Sample detector should always be used for measurements with span = 0 Hz, as this is the only way of correctly representing the timing of the video signal. The Sample detector can also be used to measure noise power as noise usually has a uniform spectrum with a normal amplitude distribution. If the Sample detector is used for signal spectrum measurements with a span that is greater than (resolution bandwidth x 631), signals may be lost.

- **RMS**

The RMS detector measures spectral power over a pixel. No matter what the signal shape, power measurements with the RMS detector always give the true power. RMS detection is recommended for power measurements on digitally modulated signals in particular. This is because the RMS detector is the only R&S FSH detector that can give stable, true power readings. Display stability can easily be obtained by increasing the sweep time, as the measurement time for the power/pixel increases the greater the sweep time. If you are making noise measurements, for example, the trace will be highly stable if a long sweep time is selected.

However, the bandwidth occupied by the signal to be measured should at least equal the frequency covered by a trace pixel or the selected resolution bandwidth (whichever is larger). Otherwise, the power shown by the R&S FSH is too low because there are spectral components within the frequency range covered by the pixel which do not come from the signal under measurement (e.g. noise).

To obtain the true power, the video bandwidth (VBW) too should be selected to be greater than the resolution bandwidth (RBW). Otherwise, an averaging effect caused by video bandlimiting comes into play before the RMS value is calculated.

Both automatic operation and manual operation are available for setting the detector. In automatic operation, the R&S FSH selects the detector that is suitable for the trace mode that is set. In manual operation, the selected detector is always maintained regardless of the trace mode.

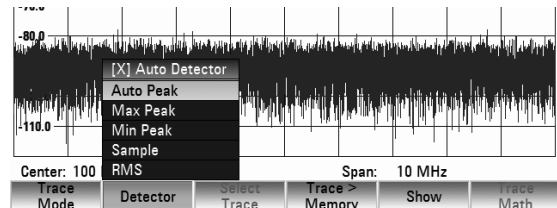
Setting of the detector in automatic operation:

Trace mode	Detector
Clear/Write	Auto Peak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

#### Operating sequence:

- Press the TRACE key.
- Press the DETECTOR softkey.  
The submenu for selecting the detector opens.

If automatic operation has been selected, the AUTO DETECTOR menu item is marked with X and the R&S FSH displays the detector that is set to match the trace mode that is set.



#### Switching automatic operation on and off:

- Select the AUTO DETECTOR menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the DETECTOR softkey.  
The R&S FSH puts a check mark in front of the AUTO DETECTOR menu item to indicate that the function is active [X] or inactive [ ].

When automatic operation is active, the R&S FSH also sets the detector that matches the current trace mode.

#### Selecting the detector manually:

- Select the detector you want to use with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the DETECTOR softkey.  
The "DETECT:" display shows the current detector.

If AUTO DETECTOR is switched on and a detector that does not accommodate automatic operation is set, the R&S FSH will switch automatic operation off.

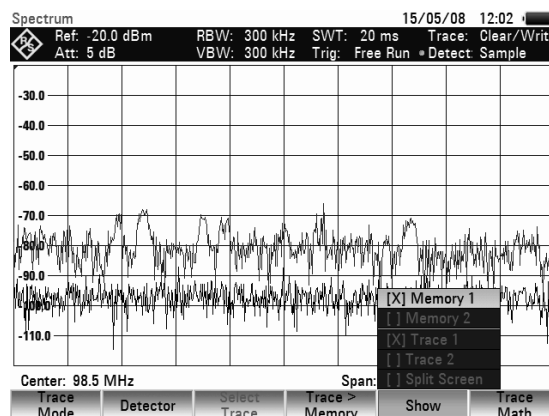


### 4.8.3 Trace Memory

The R&S FSH can transfer a trace to the trace memory and also display the current trace and the trace in the trace memory for comparison. The saved trace is always displayed in white to distinguish it from the current trace.

#### Operating sequence:

- Press the TRACE key.
- Press the TRACE -> MEMORY softkey.  
The R&S FSH transfers the trace to the trace memory.
- Press the SHOW softkey.
- Select the memory trace from the menu with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
The R&S FSH displays the saved trace in white. The menu entry of the selected memory trace is marked with an [X] to indicate that the trace in the trace memory is being displayed.



- To remove the memory trace from the screen, press the SHOW softkey again.
- In the menu select the memory trace marked by an [X]
- Confirm with the ENTER key.  
The selected memory trace will be removed from the screen.



The memory traces are bit-mapped into the picture memory. Therefore, when the memory trace is recalled, it will not be adapted to any modifications of the reference level or span that may have been made in the meantime.

When a stored data set is called, the R&S FSH stores the associated trace in the trace memory. The stored trace can be displayed with SHOW MEMORY.

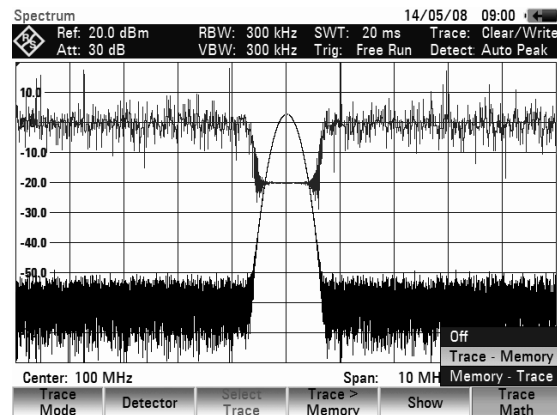
### 4.8.4 Trace Mathematics

The R&S FSH can subtract a saved trace from the active trace and display the difference.

#### Operation sequence:

- Press the TRACE key.
- Press the TRACE > MEMORY softkey.  
The R&S FSH transfers the currently displayed trace to the trace memory.
- Press the SHOW softkey. Select the memory trace and confirm your selection with ENTER.  
The R&S FSH displays the memory trace in white.

- To remove the memory trace from the screen, press the SHOW softkey again. Select the memory trace marked by an [X]
- Confirm the selection with the ENTER key.
- Press the TRACE MATH key and select TRACE – MEM or MEM – TRACE. The R&S FSH displays the difference between the saved trace and the active trace.
- To remove the saved trace from the screen, press the TRACE MATH softkey again and select OFF.



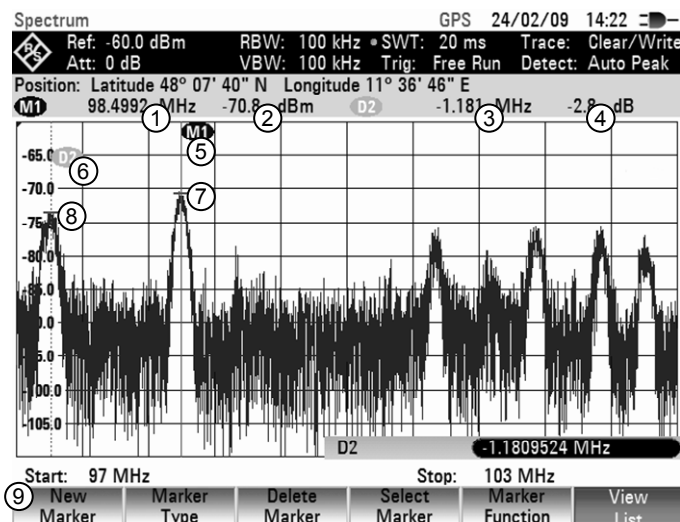
## 4.9 Using Markers

The R&S FSH has six markers, five of which can be used as either marker or delta marker.

The markers cannot leave the trace and indicate the frequency and level of the point they are positioned on. The frequency indicated by a marker is shown by a vertical line which extends from the top to the bottom of the measurement diagram. A list above the trace diagram shows the frequency and level position of the markers in question. The level unit of the marker is the same as that of the reference level.

The position of a delta marker is indicated by a dashed line to distinguish it from a normal marker. The delta marker level is always a relative to the main marker level and so the delta marker level unit is always dB. The delta marker frequency is always relative to the main marker – in other words, the delta marker frequency is the frequency difference between the frequency at the point marked by the main marker and the frequency at the point marked by the delta marker.

- ① Marker frequency
- ② Marker level
- ③ Deltamarker frequency
- ④ Deltamarker level
- ⑤ Marker symbol
- ⑥ Deltamarker symbol
- ⑦ Marker
- ⑧ Deltamarker
- ⑨ Marker menu



## 4.9.1 Controlling Markers

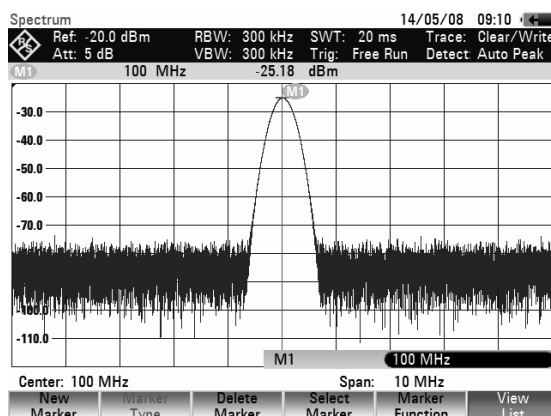
### Controlling a marker

- Press the MARKER key.  
The marker menu opens.

If, as yet, no marker has been activated, the main marker (MARKER) is turned on automatically and placed on the maximum level of the spectrum. In addition, the value entry box for the marker frequency opens.

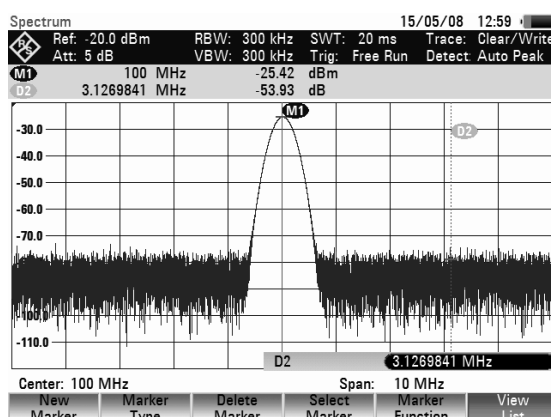
You can perform the following actions:

- Change the marker position with the rotary knob or the cursor keys.
- Enter a marker position with the number keys and confirm the entry with one of the unit keys.
- Confirm the marker position with the ENTER key.



### Controlling a delta marker:

- Press the MARKER key.
- Press the NEW MARKER softkey.  
The R&S FSH activates the delta marker and places it on the second largest signal of the trace.  
The marker list above the diagram shows the marker position relative to the normal marker (M1). The R&S FSH always shows the frequency difference and the level difference between the points marked by the main marker and the delta marker. Simultaneously, the value entry box for the delta marker frequency difference opens.



You can perform the following actions:

- Enter a delta marker position with the number keys and confirm the entry with one of the unit keys.
- Change the delta marker position with the rotary knob or the cursor keys.
- Confirm the delta marker position by pressing the ENTER key.

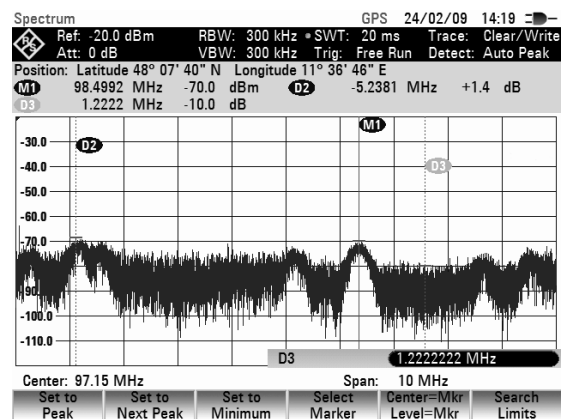
## 4.9.2 Automatic Marker Positioning

The R&S FSH offers functions that make setting the markers easier or allow to make instrument settings on the basis of the current marker position:

- **PEAK**  
The Peak function places the marker or the delta marker on the highest level value of the trace. The function acts on the active marker.
- **NEXT PEAK**  
The Next Peak function places the active marker or delta marker on the next highest level value of the trace, relative to its current position.
- **MINIMUM**  
The Minimum function places the marker or delta marker on the lowest value of the trace. The function acts on the active marker.  
  
When the trace is displayed in the CLEAR/WRITE mode, the marker is placed on the lowest maximum of the trace.
- **CENTER = MKR FREQ**  
The Center = MKR function adjusts the center frequency to the current marker or delta marker frequency, depending on which marker is active.  
  
This function is particularly useful if you want to investigate a signal more closely using a smaller span. You can do this by first placing the signal in the center of the span and then reducing the span.
- **REF LVL = MKR LVL**  
The Ref Lvl = MKR Lvl makes the current marker level the reference level. This makes it easy to optimize the R&S FSH's level display range if the levels being investigated are low.

### Operating sequence

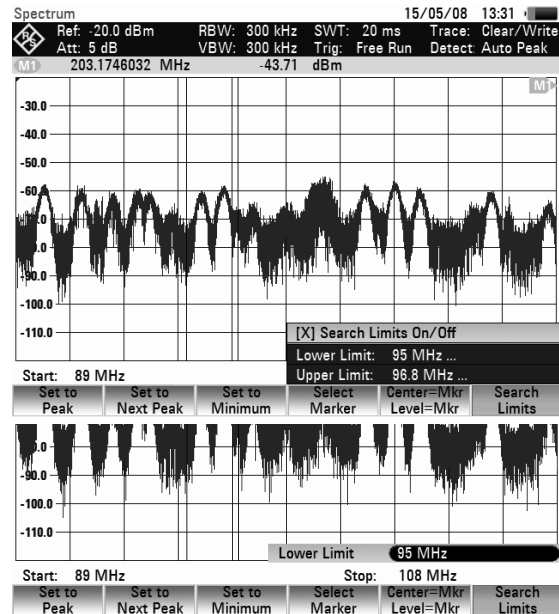
- Press the MKR-> key.
- Press the softkey with the function you want.  
The R&S FSH performs the action you have selected.



### Using marker search limits

The R&S FSH allows you to use only a limited section of the trace for the PEAK, NEXT PEAK and MINIMUM functions. This is beneficial, for example, if you want to sample only spurious emissions with the marker search functions and want to omit useful signals.

- Press the SEARCH LIMITS softkey.
  - Select SEARCH LIMITS ON/OFF with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the SEARCH LIMITS softkey.
- The R&S FSH activates the marker search limits. [X] marks an active search limit. Two vertical lines show the left and right limits in the diagram.
- Press the SEARCH LIMITS softkey again to define the marker search range.



- Select the LOWER LIMIT menu item with the rotary knob or the cursor keys
  - Confirm the selection with the ENTER key or the SEARCH LIMITS softkey.
- The R&S FSH opens the entry box to define the start frequency of the search range.
- Enter a start frequency with the number keys.
  - Confirm the entry with one of the unit keys or
  - Select the start frequency with the rotary knob or the cursor keys and confirm the entry with the ENTER key.

The R&S FSH indicates the start of the search range by a vertical line in the diagram.

The procedure for entering the stop frequency for the search range is analogous to that for entering the start frequency.

### Deactivating marker search limits

If you activate marker search limits, the SEARCH LIMITS softkey in the marker to menu turns green. In addition, an [X] in front of the SEARCH LIMITS ON/OFF menu item indicates an active search range. To deactivate the marker search range,

- Press the SEARCH LIMITS softkey.
  - Select the SEARCH LIMITS ON/OFF menu item with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the SEARCH LIMITS softkey.
- The softkey SEARCH LIMITS is no longer highlighted and the [X] in front of the SEARCH LIMITS ON/OFF menu item disappears.

### 4.9.3 Using more than One Marker at a Time (Multimarker Mode)

To measure different signals in a trace, the R&S FSH has the multimarker function. Up to six different markers are available. Marker 1 measures in absolute units. Markers 2 to 6 can measure in absolute units (marker) as well as relative units (delta). The reference for delta markers is always marker 1.

#### Working with several markers

- Press the MARKER key.
- Press the NEW MARKER softkey several times. On each key-press, the R&S FSH creates a new marker and places it on the next lower signal peak. The marker label contains the number and type of the marker in question (M1, D2, D3 etc.). M stands for a normal marker, D stands for a delta marker. The label of the active marker has a red background, while the other markers have a grey background.

The first marker you create (M1) is always a normal marker. All other markers are by default delta markers, i.e. their position is displayed relative to marker 1.

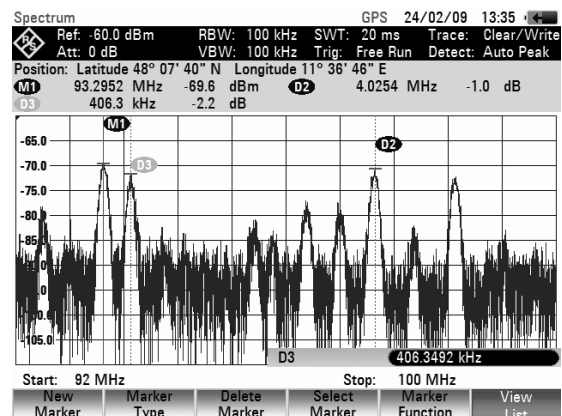
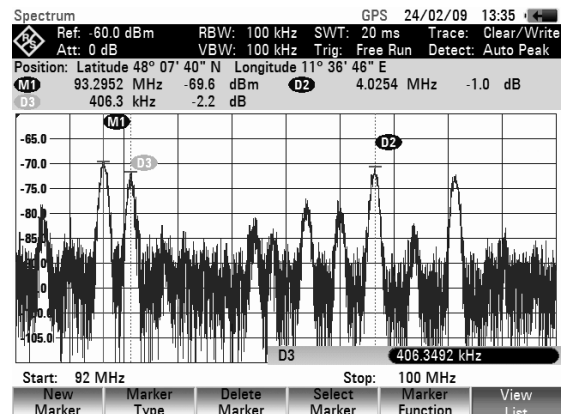
- Press the MARKER TYPE softkey in order to transform a delta marker into a normal marker. The marker label changes (e.g. D2 -> M2), and the marker position is displayed in absolute values.

In order to select a previously created marker, press the SELECT MARKER softkey repeatedly until the label of the desired marker turns red.

The R&S FSH opens the entry box for the frequency of the selected marker or the spacing between the delta marker and the reference marker M1.

- Place the marker or delta marker near the position you want it in with the cursor keys. When moving the marker with the cursor keys, the step size is 10% of the x-axis.
- Fine-tune the marker or delta marker to the signal with the rotary knob. When moving the marker with the rotary knob, the step size corresponds to the pixel spacing of the trace.

- Alternatively, enter the position you want the marker or delta marker in with the number keys and confirm the entry with one of the unit keys. The marker label of the marker or delta marker you have edited last, i.e. the active marker, is red. All marker functions always relate to the active marker.

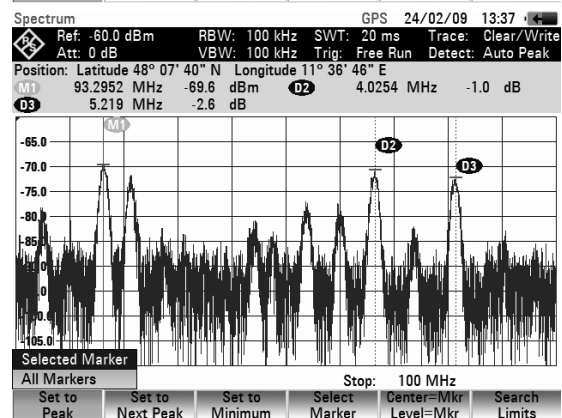
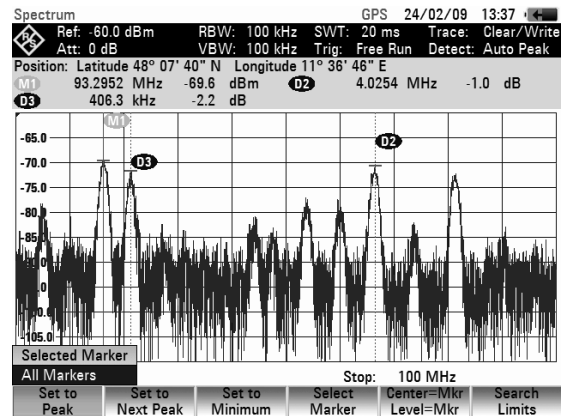


**Automatic marker positioning**

Automatic positioning of markers in multimarker mode is similar to that of the normal marker. The different functions always apply to the active marker, which is also indicated for the various functions in the MKR-> menu (example: Selected Marker to Peak).

In addition, it is possible to position all active markers (M1 through M6) on the peak of a trace.

- In the SET TO PEAK menu, select ALL MARKERS
- Confirm this with the ENTER key or the SET TO PEAK softkey.  
The R&S FSH sets all active markers on the maxima of the trace.



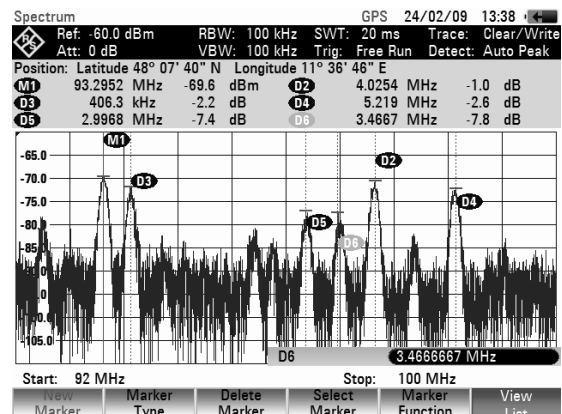
**Displaying the marker list**

The R&S FSH can display a list of all active markers and delta markers and their values.

- Press the VIEW LIST softkey.  
The R&S FSH displays a list of all active markers and delta markers.

If you press the VIEW LIST softkey again, the R&S FSH closes the marker table extension from marker 3 to 6.

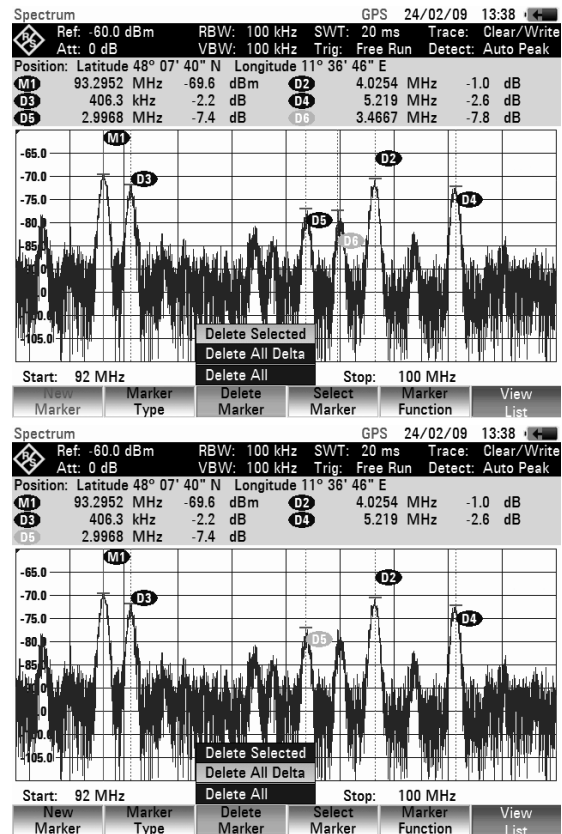
By default, the marker list is active.



### Deactivating markers

Markers can be deactivated one at a time or all at once.

- To deactivate markers one at a time, press the SELECT MARKER softkey repeatedly until the marker or delta marker you want to delete turns red.
  - The entry box for the selected marker appears.
- Press the DELETE MARKER softkey.
- Select the DELETE SELECTED menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.
  - The R&S FSH deletes the selected marker.
- To deactivate all markers at once, press the DELETE MARKER softkey.
- Select the DELETE ALL DELTA or DELETE ALL menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the DELETE MARKER softkey.
  - The R&S FSH deletes all markers and/or delta markers.



#### Deactivating normal markers

If you deactivate normal markers, the R&S FSH also deactivates all delta markers, because they use marker 1 as a reference.

## 4.9.4 Marker Functions

Apart from displaying the level and frequency at the marker position (NORMAL setting), the R&S FSH can also perform other forms of analysis at the marker position. For example, the R&S FSH can calculate the noise power density referred to 1 Hz bandwidth (NOISE function) or measure the frequency of a signal at the marker position (FREQ COUNT function). The filter bandwidth or the signal bandwidth is measured with the N DB DOWN function.



#### Deactivating marker functions

To return to normal marker mode, enter the marker function menu (MARKER FUNCTION softkey) and select the active marker function again. Confirm your selection with the ENTER key.

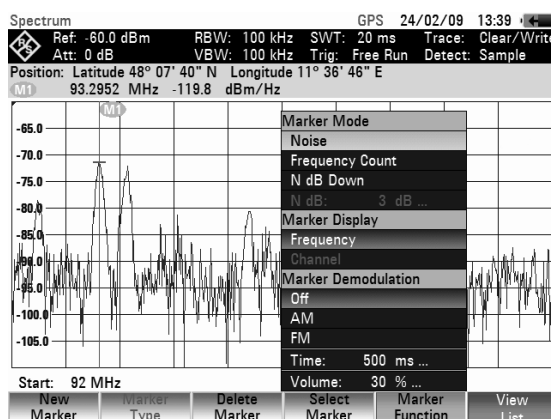


#### 4.9.4.1 Measuring the Noise Power Density

The NOISE function is used to calculate the noise power density at the marker position. The R&S FSH calculates the noise power density in dBm/(1 Hz) from the trace pixel values, the selected resolution bandwidth, the detector and the level display mode (absolute or relative). To stabilize the noise power display, the R&S FSH uses the pixel on which the marker is positioned and the four pixels to the right and the four pixels to the left of the marker pixel. Noise power density can provide useful information when measurements are made on noise or digitally modulated signals. However, valid results are obtained only if the spectrum in the vicinity of the marker has a flat frequency response. The function gives incorrect results if measurements are made on discrete signals.

##### Operating sequence

- Press the MARKER key.
- Press the MARKER FUNCTION softkey.
- Select the NOISE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MARKER FUNCTION softkey again.  
The R&S FSH now indicates the marker level in dBm/Hz. If a delta marker is the active marker, it displays the result in dBc/Hz. The result is referred to the marker 1.



#### 4.9.4.2 Measuring the Frequency

The FREQUENCY COUNT function is used to measure the frequency at the marker position. The accuracy of the marker frequency readout is then no longer dependent on the pixel resolution of the trace, but only on the accuracy of the internal reference frequency.

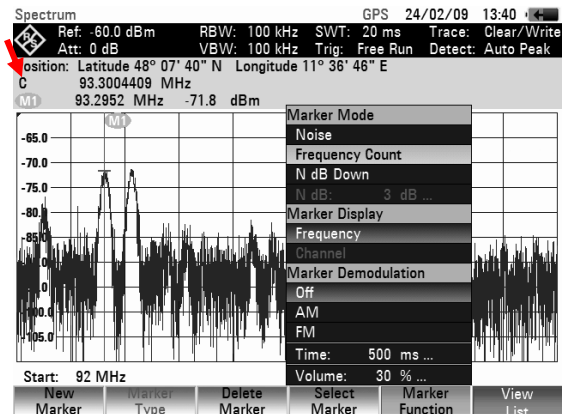
The R&S FSH calculates the marker frequency from the center frequency, the span and the frequency of the trace pixel on which the marker is positioned. The trace has 631 pixels corresponding to 631 frequency coordinates. The frequency resolution is therefore relatively coarse – especially if a large span is set. To circumvent this problem, the R&S FSH's internal frequency counter can be used. When you are performing frequency measurements, the R&S FSH briefly stops the sweep at the marker position and measures the frequency using the frequency counter. The resolution of the frequency counter is 0.1 Hz and so is considerably higher than the resolution that is obtained without the FREQUENCY COUNT function. Even though the resolution is high, frequency counting is extremely fast due to a special algorithm for the IQ baseband signal (approx. 30 ms at a resolution of 1 Hz). Basically, the accuracy of the frequency readout depends only on the accuracy of the internal reference frequency (TCXO).

The frequency counter only gives completely accurate readings for sine signals that are at least 20 dB above the noise floor. If the S/N ratio is less, noise affects the results.

**Operating sequence**

- Press the MARKER key.
- Press the MARKER FUNCTION softkey.
- Select the FREQUENCY COUNT menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MARKER FUNCTION softkey.

The R&S FSH now displays the counted marker frequency with a resolution of 1 Hz. To indicate that the FREQUENCY COUNT function is on, the marker symbol changes from M1 to C.



**4.9.4.3 Measurement of the Signal Bandwidth**

The N DB DOWN function is a way to measure a signal or the filter bandwidth.

Upon activation, two temporary markers are placed on the left and right of the active reference marker. In the measurement screen these are displayed as two vertical lines. The R&S FSH shows the bandwidth of the reference markers in a field above the measurement screen.

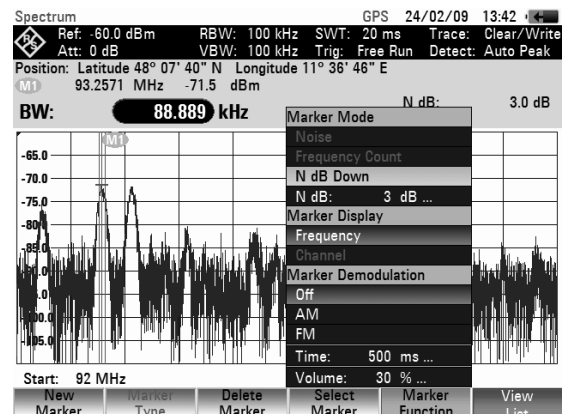
The distance to the reference marker is by default 3 dB below the reference marker. You can also adjust this value via the N DB: N DB... menu item. Entering a positive value sets the temporary markers below the reference marker. If it is, for any reason, not possible to calculate the frequency spacing, dashes are displayed instead of a value.

Upon entering a negative value, the function turns into a n dB up function. You can use a n dB up function, for example, for measurements on notch filters.

**Operating sequence**

- Press the MARKER key.
- Press the MARKER FUNCTION softkey.
- Select the N DB DOWN menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MARKER FUNCTION softkey.

The R&S FSH displays two temporary markers on the left and on the right of the reference marker M1. It also shows the bandwidth of the n dB down markers (in this case 88.889 kHz).

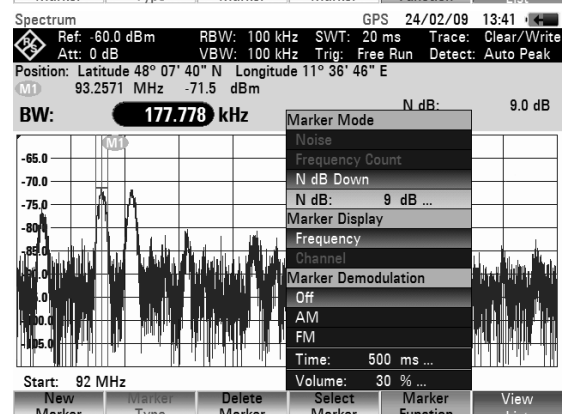


You can then adjust the distance of the temporary markers.

- Press the MARKER FUNCTION softkey.
- Select the N DB DOWN: N DB:... menu item with the rotary knob or the cursor keys.

The R&S FSH opens a entry box to define a different dB value (in this case 9 dB).

- Confirm the entry with the ENTER key.
- The R&S FSH again shows the temporary markers, this time with a broader bandwidth (in this case 177.778 kHz).



## 4.9.5 AF Demodulation

The R&S FSH has an AM and FM demodulator for audiomonitoring signals. The demodulated AF signal can be listened to with the internal speaker or headphones (optional accessories). The headphones are connected to the 3.5 mm jack on the top side of the instrument. As the R&S FSH makes the uncontrolled video voltage audible in the case of AM demodulation, it is advisable to set the reference level so that the level of the signal to be demodulated is near the reference level.

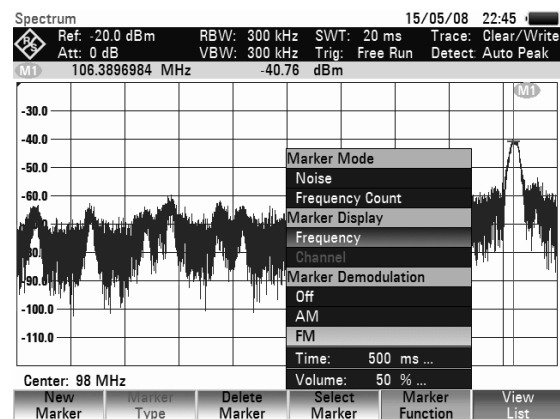
When spectrum measurements are being made, the R&S FSH demodulates the signal at the marker frequency for a settable period of time. The sweep stops at the marker frequency for the demodulation period and then continues. If time-domain measurements are being made (span = 0 Hz), the R&S FSH performs continuous demodulation.

### Operating sequence:

- Press the MARKER key.
- Press the MARKER FUNCTION softkey.  
The submenu for setting demodulation parameters opens. If no markers are active, the R&S FSH automatically activates a marker and positions it on the trace maximum.
- Select the demodulation scheme you want with the rotary knob or the cursor keys.
- Confirm your selection with the ENTER key.

### Note:

*When the AF demodulation mode is selected, the R&S FSH automatically turns off the noise marker or the frequency counter.*

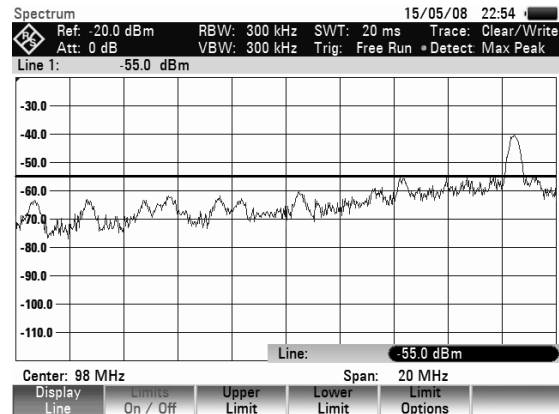


- To enter the demodulation time, select the TIME... item in the menu.  
The currently set demodulation time is displayed in the value entry box. The demodulation time range is 100 ms to 500 s. If the R&S FSH is set to span = 0 Hz, the demodulation time setting is irrelevant as continuous demodulation is always performed.
- Change the time with the cursor keys or the rotary knob or enter a time using the number keys and confirm with the ENTER key.
- To adjust the volume, select the VOLUME... menu item and confirm your selection with the ENTER key.  
The R&S FSH displays the volume in % in the value entry box. The volume range is 0 % (very low) to 100 % (full volume).
- Adjust the volume or enter the volume in % with the number keys, the rotary knob or the cursor keys.
- Confirm with the ENTER key.

## 4.10 Using the Display Line

In addition to the markers, the R&S FSH provides a horizontal line for determining the signal level in the display.

- Press the LINES key.
- Press the DISPLAY LINE softkey.  
The R&S FSH displays a horizontal line across the entire diagram. The Y position of the line is indicated at the top left of the diagram (Line: -55 dBm in the diagram shown at the right).
- You can move the line with the rotary knob or the cursor keys in the Y direction. Alternatively, you can enter a level position with the number keys.
- Confirm the entry with the ENTER key.  
The softkey label DISPLAY LINE turns green and the entry box closes.



In contrast to the markers, the position of the display line is pixel-oriented. The line resolution in the Y direction therefore depends on the measurement range set in the Y direction. For a display range of 100 dB, it is 0.3 dB. If you set the line with the rotary knob, the R&S FSH always uses the step size of the display resolution in the Y direction, e.g. 0.3 dB for a 100 dB level measurement range. The cursor keys, on the other hand, always move the line by 10 % of the display range in the Y direction. For fast setting of the display line, we therefore recommend to set the line near the desired position with the cursor keys and then to use the rotary knob for fine adjustment.

## 4.11 Using Limit Lines

Limit lines set limits for level characteristics vs time or frequency on the display that must not be exceeded. For instance, the upper limits of permissible spurious or harmonics of a DUT are marked by limit lines. In the R&S FSH, you can preset the upper and lower limit value with the help of limit lines. Thus, a spectrum or level characteristic in the time domain (span = 0 Hz) can be checked either visually on the screen or automatically by verifying limit violations.

A limit line consists of at least two and at most 25 value pairs (points) on the x-axis (frequency, time or length) and the y-axis (level). The R&S FSH links the individual points by straight lines. The values on the x-axis may be specified in absolute units (e.g. frequency in MHz) or relative units referenced to the center of the measured trace (e.g. center frequency). Relative units are of advantage, for instance, when you want to measure modulated output signals. If the center frequency is varied, the mask on the screen remains unchanged. The points on the y-axis are always values in dB. If the scale on the y-axis is linear (unit V or W), the R&S FSH automatically switches to the respective dB unit after a limit line has been switched on.

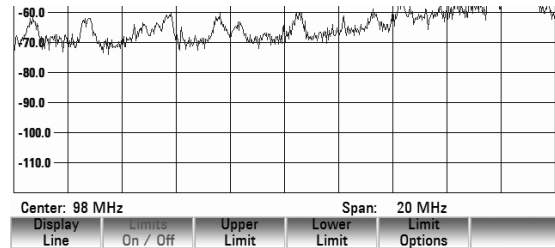
You can create and edit limit lines with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of limit lines the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

Refer to the manual of the R&S FSH4View software for information on how to create limit lines.

**Operating sequence**

- Press the LINES key.  
The softkey menu for controlling limit lines opens.

The R&S FSH distinguishes between upper limit lines (UPPER LIMIT) and lower limit lines (LOWER LIMIT). In the case of upper limit lines, it checks if the results are above the limit. In case of lower limit lines, it checks if the result is below the line.



The predefined limit lines already available with the R&S FSH can be used to mark both upper and lower limit values.

- Depending on the application, press the UPPER LIMIT or LOWER LIMIT softkey.  
The R&S FSH displays a list of available limit lines. If no limit line is active, the R&S FSH by default marks the first value in the list. If no limit lines are available, the cursor will be placed on folder "\Public\."

Select Limit Line					15/05/08 23:36	
Stat	Name	Size	Date	Time		
\Public\						
	Absolute Limit.abslim	1 kB	15/05/2008	23:34		
	Fieldstrength.abslim	1 kB	15/05/2008	23:35		
	FreqMask1.abslim	1 kB	15/05/2008	23:35		
	PowerMask.abslim	1 kB	15/05/2008	23:34		

Free: 27 MB

The unit of the limit line and the unit currently set on the x-axis have to be identical. In order to determine the limit lines that are compatible to the current settings, you can filter the data sets accordingly:

- Press SORT/SHOW softkey.
- Select the SHOW COMPATIBLE menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key.  
The R&S FSH displays those limit lines that are compatible to the current instrument settings.

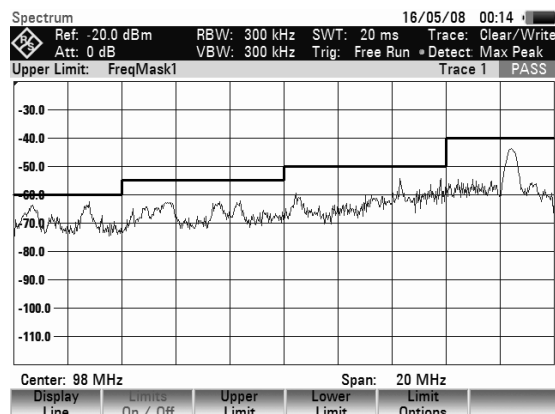
In order to display all lines again

- Press SORT/SHOW softkey.
- Select the SHOW ALL menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key.

The file type indicates whether a data set contains a limit line with absolute frequency, time or length values (\*.abslim) or values relative to the center of the x-axis (\*.rellim).

**Switching on a limit line**

- Select the limit line you need from the list the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
The R&S FSH returns to the limite lines menu and activates and displays the corresponding limit line. It also shows the name and type of the active limit line in a table above the result display.
- Press the EXIT softkey to exit the limit lines dialog box.



### Switching off a limit line

- Press the LINES key.
- Press the UPPER LIMIT or LOWER LIMIT softkey.
- Select the DESELECT LIMIT menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.
- Alternatively, you can deactivate all active limit lines at the same time with the LIMITS ON/OFF softkey.

## 4.11.1 Measurements with Limit Lines

During a measurement, the R&S FSH checks the trace for upper and lower limit violations after each frequency sweep. As long as all measured values are within the limits, it displays PASS above the result display. If however, only a single value (or pixel of the trace) is outside the limits, the R&S FSH displays a FAIL notice in the table above the result display.

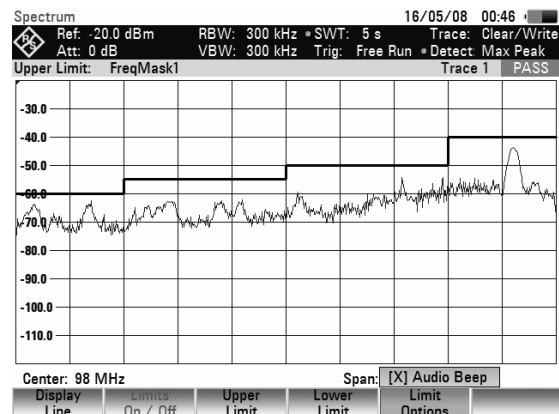
You can deactivate the automatic limit check at any time.

- Press the LIMITS ON/OFF softkey.  
The R&S FSH deactivates all limit lines.

### Activating the beeper

In addition to the PASS / FAIL messages on the screen, you can use an acoustic signal to indicate limit violations.

- Press the LIMIT OPTIONS softkey.
- Select the AUDIO BEEP menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key.  
An [X] in front of the AUDIO BEEP menu item indicates that the beeper is active. If the audio beep is active, the R&S FSH outputs a beep each time a limit is violated.



## 4.11.2 Definition Range of Limit Lines

If a limit line is not defined in the entire frequency range or displayed span, a check is not performed outside the definition range.

## 4.11.3 Data Sets Containing Limit Lines

The R&S FSH stores data sets together with any limit lines that may have been active for the measurement in question. When such a data set is recalled, the associated limit lines are available too. They do however not appear in the list of limit lines.

## 4.12 Performing Measurements

If you want to perform complex measurements, the R&S FSH provides measurement functions that perform certain measurement tasks with a minimum of keystrokes or, in conjunction with various accessories, will allow you to perform advanced measurements. These functions are collected under the MEAS key.

### 4.12.1 Measuring the Channel Power of Continuously Modulated Signals

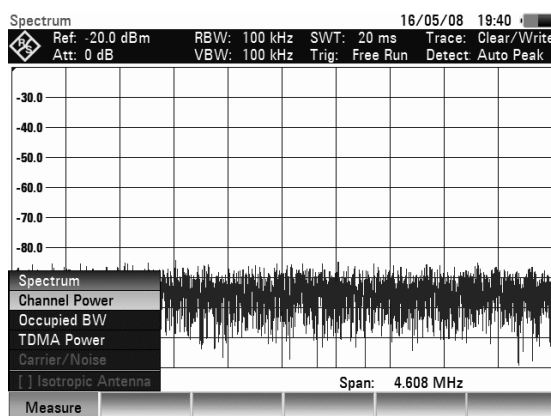
With the channel power measurement you can selectively measure the power of modulated signals. Unlike a power meter which measures power over its whole frequency range, the channel power measurement allows you to measure the power in a specific transmission channel. Other signals in the frequency spectrum have no effect on the result.

When measuring the channel power, the R&S FSH uses a resolution bandwidth that is small compared to the channel bandwidth to determine the spectrum of the channel. It then integrates the results on the trace to give the total power of the channel. The R&S FSH takes into account the selected display mode (absolute or relative), the selected detector and the resolution bandwidth. That means that you can compare the result to the result that would have been obtained from a thermal power meter. The small resolution bandwidth acts like a narrow channel filter and so prevents out-of-channel emissions from affecting the result.

The R&S FSH already comes with an assortment of predefined standards like 3GPP WCDMA, cdmaOne or CDMA2000 1x. You can, however, customize channel settings to set up the R&S FSH for other communication standards.

#### Operating sequence:

- Press the MEAS key.
- Press the MEASURE softkey.  
The submenu for selecting the measurement functions opens.
- Select the CHANNEL POWER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
The R&S FSH starts the channel power measurement and displays the softkey menu of the channel power measurement.

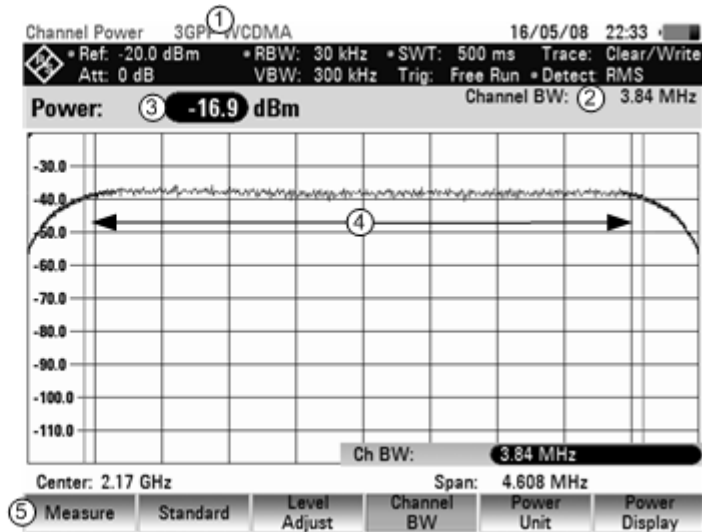


Two vertical lines in the measurement diagram indicate the channel bandwidth. The measured channel power is shown in large letters below the measurement diagram.

The default setting is power measurement for 3GPP WCDMA signals.

Screen layout for channel power measurements:

- ① Standard
- ② Channel Bandwidth
- ③ Channel Power
- ④ Channel Bandwidth
- ⑤ Channel Power Menu



#### 4.12.1.1 Selecting the Standard

The R&S FSH already comes with some predefined standards that you can use for channel power measurements. However, you can create new configurations to perform measurements on other standards as well.

- Press the STANDARD softkey.  
A dialog to select the standard opens.
- Select one of the available standards with the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
The R&S FSH loads the configuration selected standard. It automatically sets the optimal span, resolution bandwidth, video bandwidth, sweep time and detector for the standard.

Stat	Name	Size	Date	Time
	Public			
	3GPP WCDMA.chpstd	1 kB	16/05/2008	19:35
	cdma2000 1x.chpstd	1 kB	16/05/2008	19:36
	cdmaOne.chpstd	1 kB	16/05/2008	19:37

Free: 27 MB

Select Sort/Show Internal SD Card Exit

You can create and edit standards with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of standards the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

For more information on how to create and edit configurations refer to the R&S FSH4View manual.

#### 4.12.1.2 Setting the Reference Level

When selecting the reference level, make sure that you do not overload the R&S FSH.

As the power is measured with a small resolution bandwidth compared to the signal bandwidth, it is still possible to overload the R&S FSH, even if the trace is within the measurement diagram. To prevent an overload, perform the measurement with the largest resolution bandwidth possible using the peak detector. If you set these parameters, it is not possible for the trace to exceed the reference level..

To simplify operation and to prevent incorrect measurements, the R&S FSH has an automatic routine for setting the reference level.



- Press the AMPT key.
- Press the LEVEL ADJUST softkey.  
The R&S FSH performs a measurement to determine the optimal reference level.



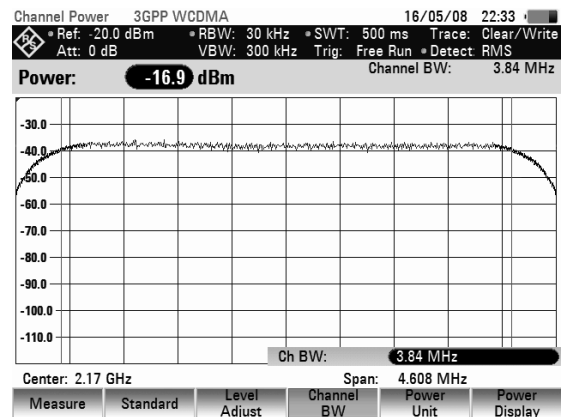
It uses a resolution bandwidth of 1 MHz, a video bandwidth of 1 MHz and the peak detector. After finishing the automatic measurement, the R&S FSH sets the optimal reference level.

#### 4.12.1.3 Setting the Channel Bandwidth

The channel bandwidth specifies the frequency range around the center frequency, over which the R&S FSH performs the power measurement.

- Press the MEAS key.
- Press the CHAN BW softkey.  
The Ch. BW value entry box opens.
- Enter the channel bandwidth you need with the number keys and confirm the entry with one of the unit keys or
- Enter the channel bandwidth with the rotary knob or the cursor keys and confirm the entry with the ENTER key.

The R&S FSH sets the appropriate span for the channel bandwidth that you have entered (span = 1.2 x channel bandwidth). This ensures that no incorrect channel power measurements are made.



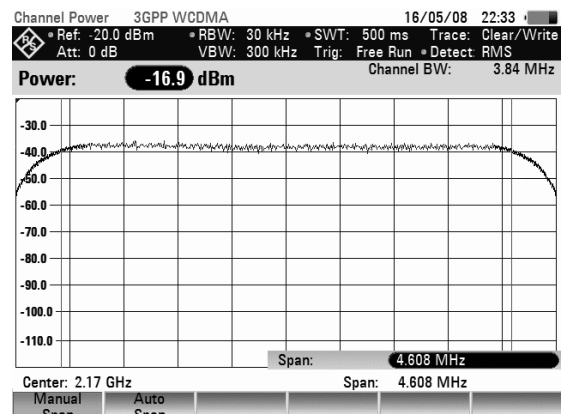
The minimum channel bandwidth that you can set is 833 Hz at a span of 1 kHz.

#### 4.12.1.4 Changing the Span

Usually, the span the R&S FSH sets yields optimal results. But sometimes you also need to see the spectrum outside the current span to detect other signal components that you need to include in the measurement. Therefore, you can adjust the span to up to ten times the channel bandwidth and still be able to see the spectrum outside the measurement channel.

##### Operation sequence:

- Press the SPAN key.  
The AUTO SPAN softkey is active and the optimum span for the channel power measurement is set.
- Press the MANUAL SPAN softkey.  
The entry box to adjust the span opens.
- Enter the span you need with the number keys and confirm the entry with one of the unit keys, or
- Enter the span with the rotary knob or the cursor keys and confirm the entry with the ENTER key.



The largest possible span for the channel power measurement is ten times the channel bandwidth. At larger spans, the result of the channel power measurement would be increasingly imprecise, because too few points of the trace occur in the channel to be measured.

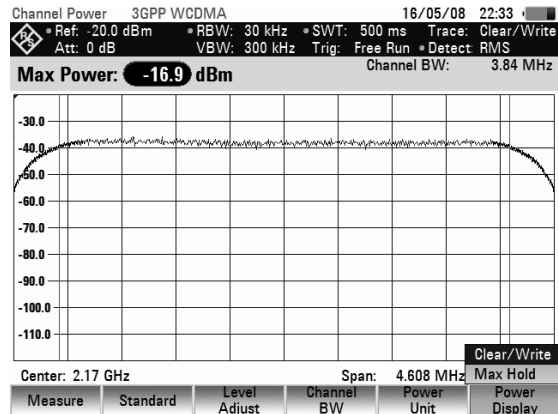
- Press the AUTO SPAN softkey to again set the optimum span.

**Measurement of maximum channel power:**

If signal levels fluctuate significantly, you can define the maximum channel power with the Max Hold function.

**Operation sequence:**

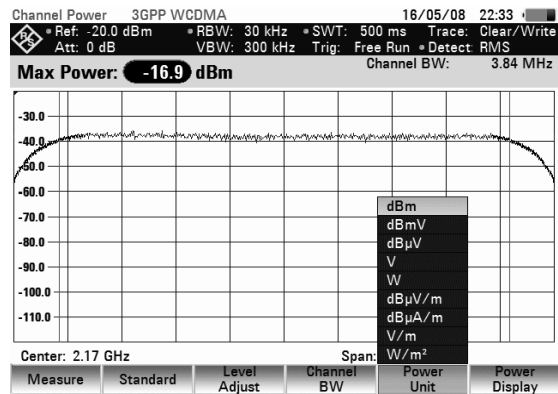
- Press the MEAS key.
  - Press the POWER DISPLAY softkey.
  - Select MAX HOLD with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the POWER DISPLAY softkey.  
The power display switches from "Power" to "Max Power".
  - To deactivate the Max Hold function, press the POWER DISPLAY softkey.
  - Select CLEAR/WRITE with the rotary knob or the cursor keys
  - Confirm the selection with the ENTER key.
- The power display switches from "Max Power" to "Power".



**4.12.1.5 Unit for Power Display**

The R&S FSH can apply different units to the power output. The default unit is dBm..

- Press the MEAS key.
- Press the POWER UNIT softkey.  
The R&S FSH opens the submenu to select the unit.
- Select the unit you want with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the POWER UNIT softkey.  
The R&S FSH displays the power level in the selected unit.



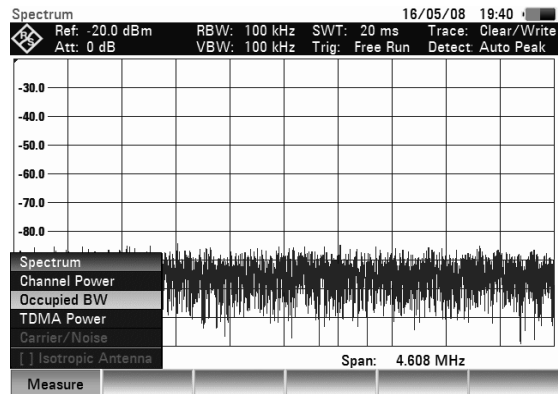
**4.12.2 Measuring the Occupied Bandwidth**

Proper operation of a transmission network requires that all transmitters adhere to the bandwidths assigned to them. The occupied bandwidth is defined as the bandwidth that contains a specified percentage of the entire power of the transmitter. In the R&S FSH, the power percent can be set between 10 % and 99.9 %. Numerous standards require a percent of 99 %. This is also the default setting of the R&S FSH.

After entering the channel bandwidth, the R&S FSH automatically selects the measurement parameters so that you can attain the best result.

**Operation sequence:**

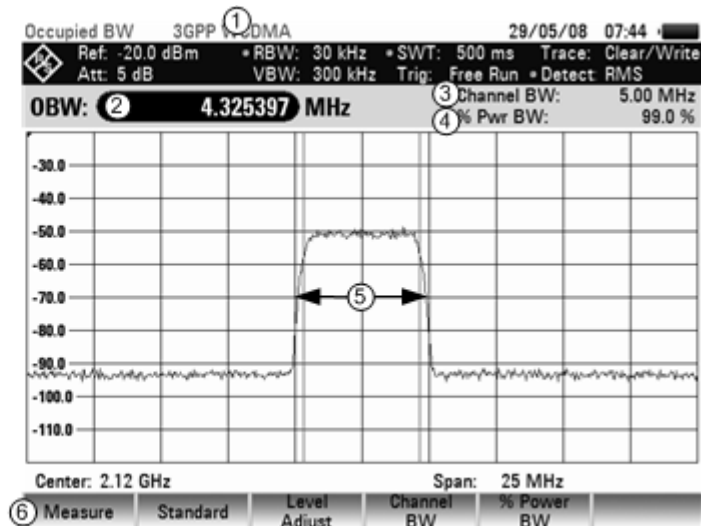
- Press the MEAS key.
- Press the MEASURE softkey.  
The R&S FSH opens the measurement menu.
- Select the OCCUPIED BW menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEASURE softkey.  
The R&S FSH starts the Occupied Bandwidth measurement and shows the corresponding softkey menu.



Two vertical lines in the measurement diagram indicate the occupied bandwidth. Above the trace window, you can see the numeric value (OBW) that was measured.

**Screen layout for measuring the occupied bandwidth:**

- ① Standard
- ② Occupied Bandwidth
- ③ Channel Bandwidth
- ④ Power Percentage
- ⑤ Occupied Bandwidth
- ⑥ OBW Menu



**4.12.2.1 Selecting a Standard**

The R&S FSH already comes with some predefined standards that you can use for measuring the occupied bandwidth. However, you can create new configurations to perform measurements on other standards as well.

- Press the STANDARD softkey.  
A dialog to select the standard opens.
- Select one of the available standards with the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
The R&S FSH loads the configuration selected standard. It automatically sets the optimal span, resolution bandwidth, video bandwidth, sweep time and detector for the standard.



You can create and edit standards with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of standards the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

For more information on how to create and edit configurations refer to the R&S FSH4View manual.

If you change the settings or create datasets, note that

- the span is always coupled to the channel bandwidth (CHANNEL BW). Changes to either of those automatically adjust the other (= 5 x channel bandwidth).
- the resolution bandwidth should be between 1% and 4% of the channel bandwidth. This ensures that the occupied bandwidth is measured with high accuracy.
- the video bandwidth must be at least three times the resolution bandwidth. This prevents incorrect results due to the compression of signal peaks by the video filter.
- the RMS detector is recommended. This ensures that the power measurement is always correct irrespective of the waveform being investigated.
- the sweep time must be set so that the result is stable. If you increase the sweep time, the R&S FSH also increases the integration time for the RMS detector and thus ensures more stable measured values.

#### **4.12.2.2 Setting the Reference Level**

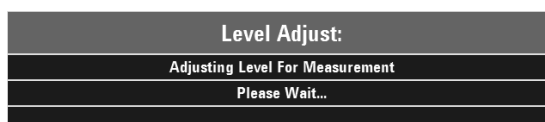
When selecting the reference level, make sure that you do not overload the R&S FSH.

As the power is measured with a small resolution bandwidth compared to the signal bandwidth, it is still possible to overload the R&S FSH, even if the trace is within the measurement diagram. To prevent an overload, perform the measurement with the largest resolution bandwidth possible using the peak detector. If you set these parameters, it is not possible for the trace to exceed the reference level.

To simplify operation and to prevent incorrect measurements, the R&S FSH has an automatic routine for setting the reference level.

- Press the AMPT key.
- Press the LEVEL ADJUST softkey.

The R&S FSH performs a measurement to determine the optimal reference level.



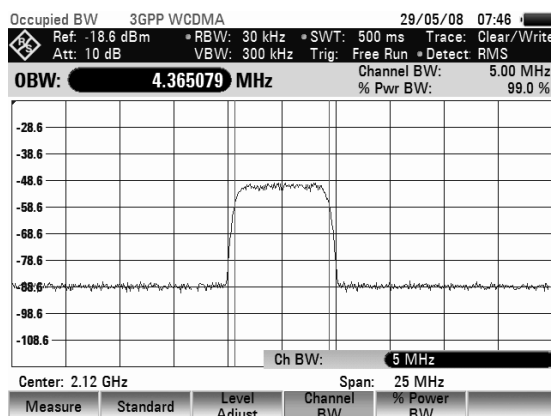
It uses a resolution bandwidth of 1 MHz, a video bandwidth of 1 MHz and the peak detector. After finishing the automatic measurement, the R&S FSH sets the optimal reference level.

### 4.12.2.3 Setting the Channel Bandwidth

The channel bandwidth determines the span and therefore the resolution bandwidth and sweep time the R&S FSH uses for measuring the occupied bandwidth.

- Press the MEAS key.
- Press the CHAN BW softkey.  
The Ch. BW value entry box opens.
- Enter the channel bandwidth you need with the number keys and confirm the entry with one of the unit keys or
- Enter the channel bandwidth with the rotary knob or the cursor keys and confirm the entry with the ENTER key.

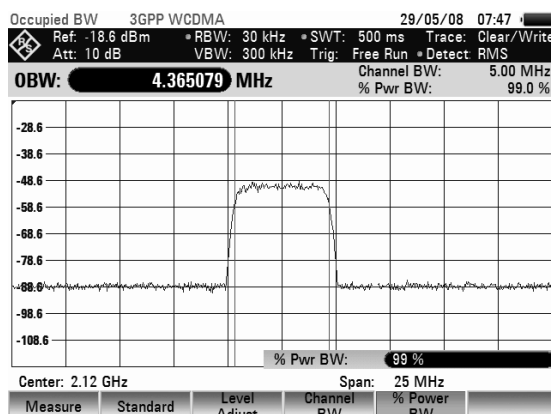
The R&S FSH sets the appropriate span for the channel bandwidth you have entered (span = 5 x channel bandwidth) This ensures that no incorrect channel power measurements are made.



The minimum channel bandwidth that you can set is 2 kHz. If you attempt to enter a smaller channel bandwidth, the R&S FSH will automatically set 2 kHz.

### 4.12.2.4 Entering the Power Percent to Determine the Occupied Bandwidth

- Press the MEAS key.
- Press the % POWER BW softkey.  
The R&S FSH opens the % Pow BW entry box.  
In this box, you can define the power percent relative to the total span power that defines the occupied bandwidth (percent of total power).
- Enter the percentage you need with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key or the % POWER BW softkey.



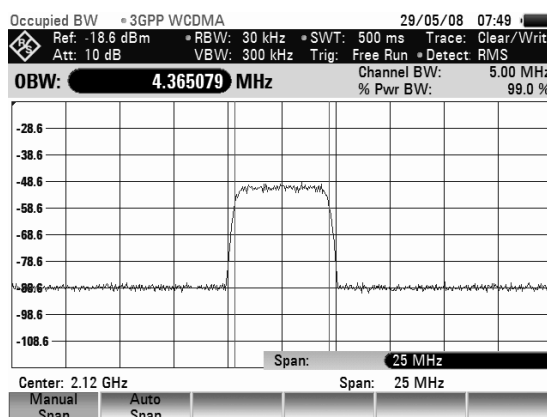
The R&S FSH now displays the occupied bandwidth graphically in the trace window and numerically above the trace window.

### 4.12.2.5 Changing the Span

Usually, the span the R&S FSH sets yields optimal results. But sometimes you also need to see the spectrum outside the current span to detect other signal components that you need to include in the measurement. Therefore, you can adjust the span to up to ten times the channel bandwidth and still be able to see the spectrum outside the measurement channel.

**Operation sequence:**

- Press the SPAN key.  
The AUTO SPAN softkey is active and the optimum span for the channel power measurement is set.
- Press the MANUAL SPAN softkey.  
The entry box to adjust the span opens.
- Enter the span you need with the number keys and confirm the entry with one of the unit keys, or
- Enter the span with the rotary knob or the cursor keys and confirm the entry with the ENTER key.



The largest permissible span for measuring the occupied bandwidth is ten times the channel bandwidth. At larger spans, the result of the channel power measurement would be increasingly imprecise, because too few points of the trace occur in the channel to be measured.

- Press the AUTO SPAN softkey to again set the optimum span.

### 4.12.3 Power Measurements on TDMA Signals

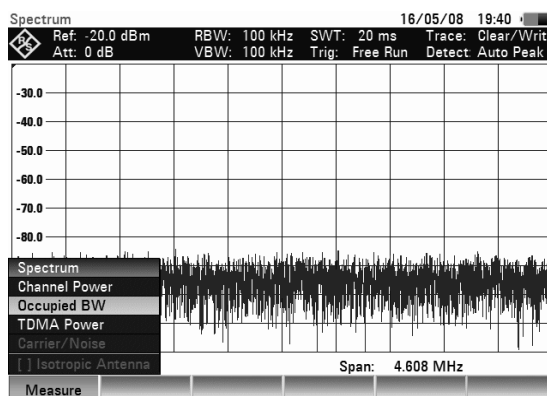
When TDMA (time division multiple access) methods are used, e.g. for GSM, several users share a channel. Each user is assigned a period of time or timeslot. With the TDMA POWER measurement, you can determine the power over one of the timeslots.

The TDMA power measurement is a measurement in the time domain (span = 0 Hz). You can start it on an external or video trigger and specify the power measurement time.

To prevent incorrect power measurements in the time domain, make sure that the whole signal is within the selected resolution bandwidth. If the resolution bandwidth is too small, the displayed power will be lower than the actual power.

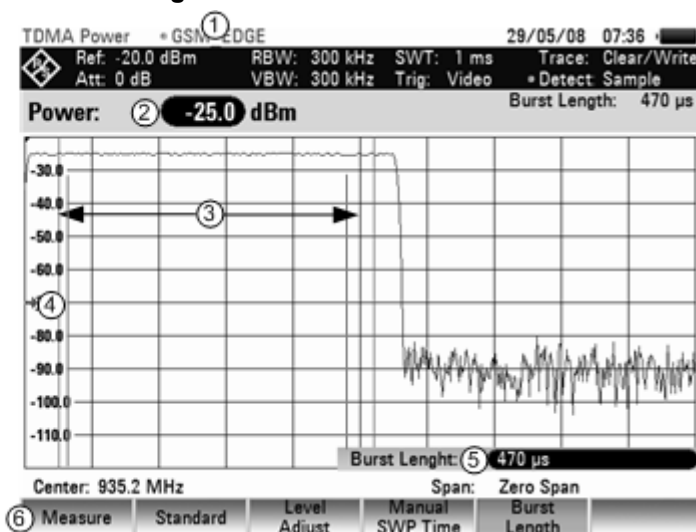
**Operation sequence:**

- Press the MEAS key.
- Press the MEASURE softkey.  
The R&S FSH opens the measurement menu.
- Select the TDMA POWER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEASURE softkey.  
The R&S FSH starts the TDMA power measurement and shows the corresponding softkey menu.



Screen Layout for power measurements on TDMA signals:

- ① Standard
- ② Power Readout
- ③ Measurement Limits
- ④ Trigger Level
- ⑤ Measurement Time
- ⑥ TDMA Power Menu



### 4.12.3.1 Selecting a Standard

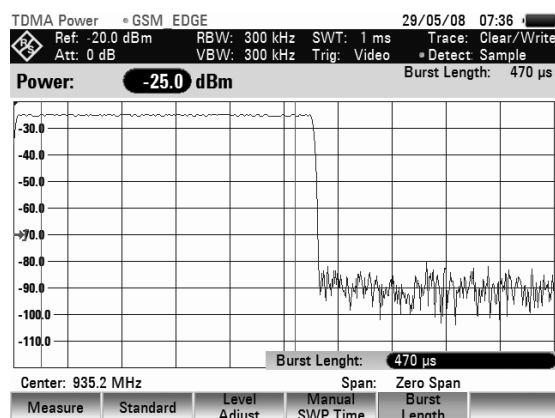
On activating the measurement, the R&S FSH automatically selects the GSM/EDGE standard. All default settings are selected so that power measurements on GSM or EDGE bursts give true readings. You can create and edit standards with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of standards the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

For more information on how to create and edit configurations refer to the R&S FSH4View manual.

### 4.12.3.2 Setting the Burst Length

The burst length is the measurement time over which the R&S FSH performs a power measurement. You can select a value less than or equal to the sweep time.

- Press the BURST LENGTH softkey.
  - The value entry box to specify the burst length opens.
- Enter the time you need with the number keys and confirm the entry with one of the unit keys or
- Enter the time you need with the rotary knob or the cursor keys and confirm the entry with the ENTER key.
  - The R&S FSH performs the measurement over the time you have entered.



If the measurement time you have entered was greater than the sweep time, the R&S FSH sets a burst length equal to the sweep time. To work with a greater burst length, you have to increase the sweep time first.

The minimum burst length is the time corresponding to one trace pixel (= sweep time / 631).

### 4.12.3.3 Setting the Reference Level

When selecting the reference level, make sure that you do not overload the R&S FSH if the signal's power is stronger than the maximum reference level.

Because the R&S FSH's resolution bandwidths are implemented digitally after the A/D converter, the signal level at the A/D converter can be higher than the level indicated by the trace, depending on the selected resolution bandwidth.

To prevent the A/D converter from being overloaded, the signal must be measured at the widest resolution bandwidth and video bandwidth with the peak detector. The trace maximum then determines the best reference level.

To simplify operation and to prevent incorrect measurements, the R&S FSH has an automatic routine for setting the reference level.

- Press the AMPT key.
- Press the LEVEL ADJUST softkey.  
The R&S FSH performs a measurement to determine the optimal reference level.



It uses a resolution bandwidth of 3 MHz, a video bandwidth of 3 MHz and the peak detector. After finishing the automatic measurement, the R&S FSH sets the optimal reference level.

### 4.12.3.4 Power Readout

The R&S FSH displays the measured power and the selected burst length above the trace window (Power = nn.nn dBm).

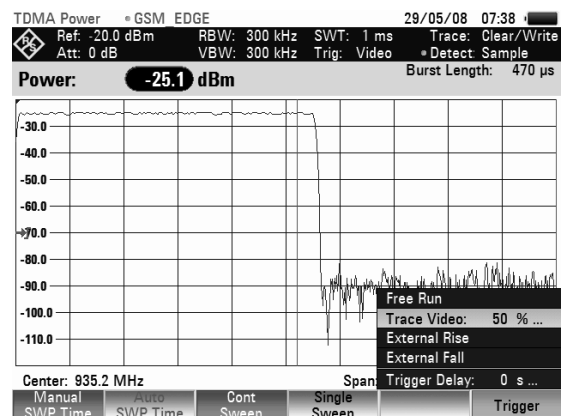
### 4.12.3.5 Setting the Trigger

A trigger is usually required to perform power measurements on bursts. In the default setting, the R&S FSH is configured to use the video trigger at 50 % of the Y scale on the measurement diagram. Assuming that the burst on which the measurement is to be made crosses the 50 % point of the trigger, the R&S FSH will trigger on the rising edge of the burst.

Should this not be the case, you have to adjust the trigger level so that the R&S FSH is triggered by the burst edge. Otherwise no measurement will be performed.

If the DUT has a trigger facility, the external trigger can also be used for the measurement.

- Connect the DUT's trigger output to the R&S FSH's trigger input.
- Press the SWEEP key.
- Press the TRIGGER softkey.
- Select the EXTERNAL RISE or EXTERNAL FALL menu item (rising or falling edge) with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the TRIGGER softkey.



Select the appropriate trigger delay to position the burst in the measurement window.

- Press the TRIGGER softkey.
- Select the TRIGGER DELAY menu item with the rotary knob and confirm with the ENTER key
- Enter the trigger delay with the number keys and confirm the entry with one of the unit keys or Enter the trigger delay with the rotary knob or the cursor keys until the TDMA burst is inside the vertical lines that indicate the measurement range and confirm the entry with the ENTER key.



### 4.12.4 Measuring the Adjacent Channel Leakage Ratio (ACLR)

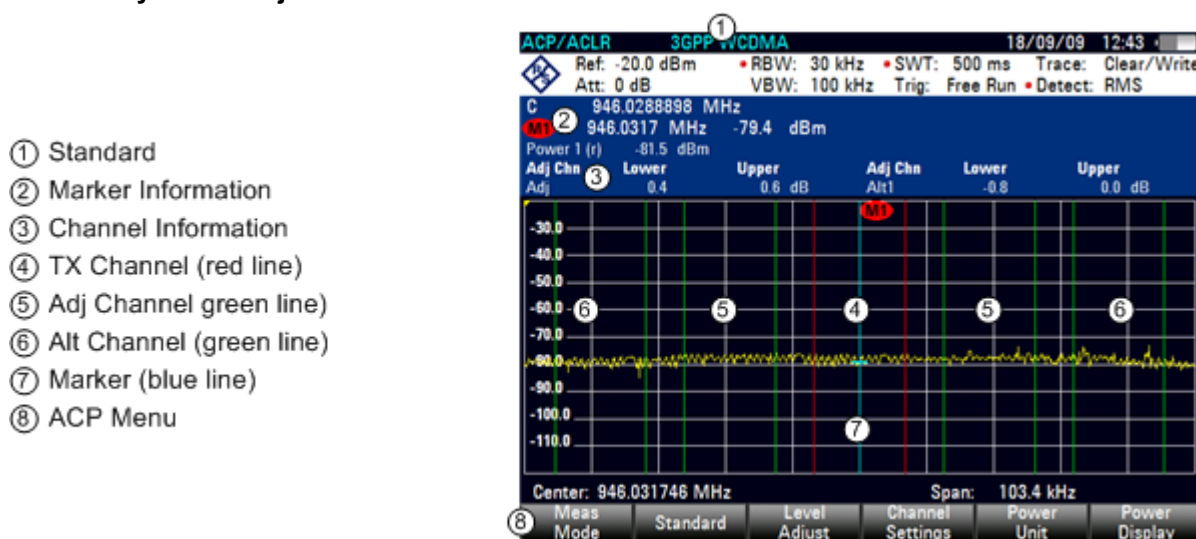
The Adjacent Channel Leakage Ratio (ACLR) measurement is a method to measure the power over more than one transmission channel and also evaluate the power of the adjacent (or alternate) channels of the transmission channel. The ACLR performs measurements according to a specific channel configuration, e.g. a particular radio communications standard.

#### Starting the Measurement:

- Press the MEAS key.
- Press the MEAS MODE softkey.  
The submenu for selecting the measurement functions opens.
- Select the ACLR menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEASURE softkey.

In principle, the ACLR measurement works like the Channel Power measurement in that it determines the spectrum within the channel using a resolution bandwidth that is small compared to the channel bandwidth. In addition to the channel bandwidth, the ACLR measurement is also defined by the channel spacing, the bandwidth of adjacent channels and the adjacent channel spacing. The R&S FSH offers measurements on up to 12 carrier channels and 12 adjacent channels to either side of the carrier. When measuring more than one carrier or adjacent channels, the R&S FSH shows the powers of each channel in a list below the marker list. The channel itself is marked by red (transmission channels) or green (adjacent channels) vertical lines.

#### Screen Layout for Adjacent Channel Power measurements:



The predefined standards are the same as for Channel Power measurements (3GPP WCDMA, cdmaOne and CDMA2000 1x systems). However, you can also customize the settings to set up the R&S FSH for other radio communication standards. You can define the settings directly on the R&S FSH or define and manage them using the R&S FSH4View software.

When customizing settings, make sure to consider the following points to get valid and accurate measurement results:

- Reference Level  
Make sure not to overload the R&S FSH as the power is measured with a resolution bandwidth that is small in comparison with the signal bandwidth. As with Channel Power measurements, use the ADJUST LEVEL softkey to automatically set the reference level to an optimal level.

- Setting the Span:

The frequency span must at least cover the carriers and the adjacent channels plus a measurement margin of about 10% to get valid results.



If the frequency span is too large in comparison to the channel bandwidth (or the adjacent-channel bandwidths) being examined, only a few points on the trace are available per channel. This reduces the accuracy of the waveform calculation for the channel filter used, which has a negative effect on the measurement accuracy. It is therefore strongly recommended that the formulas mentioned be taken into consideration when selecting the frequency span.

If the span is automatically calculated by the R&S FSH with the AUTO SPAN softkey, the span is calculated as follows:

$$(No. \text{ of transmission channels} - 1) \times \text{transmission channel spacing} + 2 \times \text{transmission channel bandwidth} + \text{measurement margin}$$

with the measurement margin being approx. 10% of the value obtained by adding the channel spacing and the channel bandwidth.

- Setting the Resolution Bandwidth:

The RBW should not be too high or too small to get both an acceptable measurement speed and a suppression of spectral components outside the channels. As a rule of thumb, it is recommended to set it to about 1% to 4% of the channel bandwidth.

You can select a larger resolution bandwidth if the spectrum within the channel to be measured and around it has a flat characteristic. In the standard setting, e.g. for standard cdmaOne at an adjacent channel bandwidth of 30 kHz, a resolution bandwidth of 30 kHz is used. This yields correct results since the spectrum in the neighborhood of the adjacent channels normally has a constant level. For standard NADC/IS136 this would not be possible, for example, since the spectrum of the transmit signal penetrates into the adjacent channels and a too large resolution bandwidth causes a too low selection of the channel filter. The adjacent-channel power would thus be measured too high.

If the RBW is automatically calculated by the R&S FSH with the AUTO RBW softkey, the RBW is calculated as follows:

$$RBW \leq 1/40 \text{ of channel bandwidth}$$

The R&S FSH then selects the maximum possible resolution bandwidth resulting from the available RBW steps (1, 3) is selected.

- Setting the Video Bandwidth

To obtain correct power measurements, the video signal must not be limited in bandwidth. A restricted bandwidth of the logarithmic video signal would cause signal averaging and thus result in a too low indication of the power (-2.51 dB at very low video bandwidths). Therefore, the VBW should be at least three times the RBW.

If the RBW is automatically calculated by the R&S FSH with the AUTO VBW softkey, the RBW is calculated as follows:

$$VBW \geq 3 \times RBW$$

The R&S FSH then selects the smallest possible VBW with regard to the available step size will be selected.

- Selecting the Detector:

It is best to use the RMS detector. This detector correctly indicates the power irrespective of the characteristics of the signal to be measured. The whole IF envelope is used to calculate the power for each measurement point. The IF envelope is digitized using a sampling frequency which is at least five times the resolution bandwidth which has been selected. Based on the sample values, the power is calculated for each measurement point using the following formula:

$$P_{RMS} = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^N s_i^2}$$

with

$s_i$  = linear digitized video voltage at the output of the A/D converter

N = number of A/D converter values per measurement point

PRMS = power represented by a measurement point

When the power has been calculated, the power units are converted into decibels and the value is displayed as a measurement point.

In principle, the sample detector would be possible as well. Due to the limited number of measurement points used to calculate the power in the channel, the sample detector would yield less stable results.

#### 4.12.4.1 Selecting the Standard

The R&S FSH already comes with some predefined standards that you can use for measuring the ACLR. However, you can create new configurations to perform measurements on other standards as well.

##### Loading Predefined Standards

The R&S FSH already comes with several predefined standards when it is shipped. It is also possible to create a new standard and permanently store it on the R&S FSH via the R&S FSH4View software.

- Press the STANDARD softkey.  
A dialog box with all available standards opens.
- Select the standard you want using the rotary knob or the cursor keys.
- Confirm your selection with the ENTER key or the STANDARD softkey.

The R&S FSH sets the selected standard. The optimal span, resolution bandwidth, video bandwidth, sweep time and detector for the standard are selected automatically.

Select Standard					18/09/09 17:20
Stat	Name	Size	Date	Time	
	\Public\Standards\...				
	3GPP WCDMA.chpstd	1 kB	22/01/2009	02:43	
	cdma2000 1x.chpstd	1 kB	29/09/2008	16:16	
	cdmaOne.chpstd	1 kB	29/09/2008	16:16	
	LTE (ChBw 10 MHz).chpstd	1 kB	21/01/2009	05:12	
	LTE (ChBw 15 MHz).chpstd	1 kB	21/01/2009	05:13	
	LTE (ChBw 1.4 MHz).chpstd	1 kB	21/01/2009	05:12	
	LTE (ChBw 20 MHz).chpstd	1 kB	21/01/2009	05:13	
	LTE (ChBw 3 MHz).chpstd	1 kB	21/01/2009	05:12	
	LTE (ChBw 5 MHz).chpstd	1 kB	21/01/2009	05:12	
	TD-SCDMA.chpstd	1 kB	30/09/2008	17:07	

Free: 15 MB

Select    Sort/Show    Internal/SD-Card    Exit

##### Creating Standards with the R&S FSH4View software

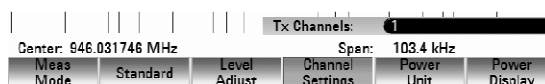
You can create and edit standards with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of standards the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

For more information on how to create and edit configurations refer to the R&S FSH4View manual.

### 4.12.4.2 Configuring the Measurement

#### Setting the Number of Channels

- Press the CHANNEL SETTINGS softkey.
- Select the TX CHANNELS menu item with the rotary knob or the cursor keys.  
The entry box to set the number of channels opens.



- Enter the number of transmission channels you need with the number keys.
- Confirm the entry with the ENTER key.
- Press the CHANNEL SETTINGS softkey.

- Select the ADJ CHANNELS menu item with the cursor keys or the rotary knob.  
The entry box to set the number of adjacent channels opens.



- Enter the number of adjacent / alternate channels you need and confirm the input with the ENTER key.  
The borders of Tx channels are displayed red in the trace diagram, the borders of adjacent and alternate channels are displayed green.

#### Setting the Channel Bandwidth

The channel bandwidth specifies the frequency range about the center frequency, over which the R&S FSH performs the power measurement.

- Press the CHANNEL BW softkey.  
The R&S FSH opens a dialog box to define the channel bandwidths for all channels.
- Select the channel you want to change the bandwidth for with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
You can now edit the channel spacing.
- Enter the channel bandwidth you need with the number keys and confirm the entry with the appropriate unit, or



- Enter the channel bandwidth you need with the rotary knob or the cursor keys and confirm the entry with the ENTER key.  
The R&S FSH automatically sets the appropriate span for the channel bandwidth according to the criteria described above to ensure that no incorrect channel power measurements are made.

#### Setting the Channel Spacing

In case of the R&S FSH, the channel spacing is defined as the distance between the center frequency of the transmission channel and the center frequency to the next transmission channel or the distance between the center frequency of the transmission channel and the center frequency of the adjacent channel.



Note that some radio communication standards, e.g. CDMA2000 DS / MC1 / MC3 and IS95 B / C, IS97 B / C, IS98 B / C, define the channel spacing differently, namely the distance from the center of the transmission channel to the closest border of the adjacent channel. The R&S FSH does not consider these specifics. It always regards the channel spacing as the distance between the center of a channel and the center of its neighboring channel.

- Press the CHANNEL SETTINGS softkey.
- Select the CHANNEL SPACING menu item with the rotary knob or the cursor keys.  
The R&S FSH opens a dialog box to define the spacings for all transmission channels and adjacent / alternate channels.
- Select the channel you want to change the spacing for with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.  
You can now edit the channel spacing.

TX / ACP Channel Spacing	
TX1-2	20 kHz
TX2-3	20 kHz
TX3-4	20 kHz
TX4-5	20 kHz
TX5-6	20 kHz
TX6-7	20 kHz
TX7-8	20 kHz
TX8-9	20 kHz
TX9-10	20 kHz
TX10-11	20 kHz
TX11-12	20 kHz
Adj	20 kHz
Alt1	20 kHz
Alt2	20 kHz
Alt3	20 kHz
Alt4	20 kHz
Alt5	20 kHz

- Enter the spacing you need with the number keys and confirm the entry with the appropriate unit or
- Enter the spacing you need with the rotary knob or the cursor keys and confirm the entry with the ENTER key.
- Press the EXIT softkey to exit the dialog box.  
The R&S FSH now takes the new values into account for future measurements.

When performing measurements on multi-carrier signals, you can define the spacing of the transmission (Tx) channels to one another. By default, the R&S FSH assumes equal spacing between all Tx channels in the system. Therefore, the spacing you enter for the first two Tx channels is automatically applied to all other Tx channels.

If you do measurements on systems with a different channel spacing for each Tx channel, you can also set the channel spacing for each Tx channel separately by entering the respective number in the fields.

If the spacings are not equal, the channel distribution according to the center frequency is as follows:

- Odd number of TX channels  
The middle TX channel is centered to center frequency.
- Even number of TX channels  
The two TX channels in the middle are used to calculate the frequency between those two channels. This frequency is aligned to the center frequency.

Adjacent or alternate channel spacing is also available for single-carrier measurements. The R&S FSH can perform measurements on up to 12 adjacent channels. Usually the first adjacent channel to the Tx channel is referred to as the Adjacent Channel (ADJ). All others are called Alternate Channels (ALT1 to ALT11).

By default, the R&S FSH assumes that the distance of the adjacent channels to each other is the same. In that case, you only have to enter the first spacing value. The R&S FSH then calculates all higher adjacent channels from that value. If you change the spacing of one of the higher channels, the R&S FSH only updates the channel spacings above the one you have changed, but not those below.

So, for example, if you set the first adjacent channel spacing (ADJ) to 20 kHz, the following spacings are 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), 100 kHz (ALT4), 120 kHz (ALT5) and so on.

If you then change the spacing of the third alternate channel (ALT3) to 100 kHz, the R&S FSH adjusts the alternate channels above the third one accordingly: 125 kHz (ALT4), 150 kHz (ALT5) and so on.

### Normalization of Measurement Results

By default, the power of the channels and adjacent channels is displayed in the unit dBm. It is also possible to display the power density of the signal to, for example, measure the signal/noise power density or obtain the signal to noise ratio.

- Press the CHANNEL SETTINGS softkey.  
Select the CHANNEL PWR/HZ menu item to activate normalization.

The R&S FSH switches the unit from dBm to dBm/Hz.

The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:

$$\text{channel power density} = \text{channel power} - \log_{10}(\text{channel bandwidth})$$

### Displaying Absolute and Relative Results

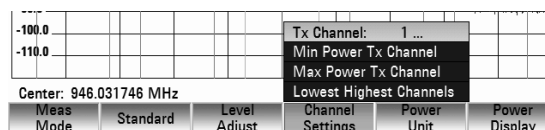
You can set up the result display to either show the absolute power of the adjacent channels or the power relative to one of the transmission channels.

- Press the POWER DISPLAY softkey.  
Select either the ABSOLUTE menu item to display the absolute results or the RELATIVE menu item to display the power relative to one of the transmission channels.

### Selecting the Reference Channel

When determining relative power values for the adjacent channels, you can set a specific transmission channel as the reference channel.

- Press the CHANNEL SETTINGS softkey.
- Select the ACLR REF SETTING menu item with the rotary knob or the cursor keys.



The R&S FSH opens a another submenu to select the reference channel.

- Select the method of determining the reference channel using the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key.

The following methods are available:

- TX CHANNEL:  
Select a specific transmission channel by entering its number as the reference.
- MIN POWER TX CHANNEL:  
The channel with the lowest power level is the reference channel.
- MAX POWER TX CHANNEL  
The channel with the highest power level is the reference channel.
- LOWEST HIGHEST CHANNEL

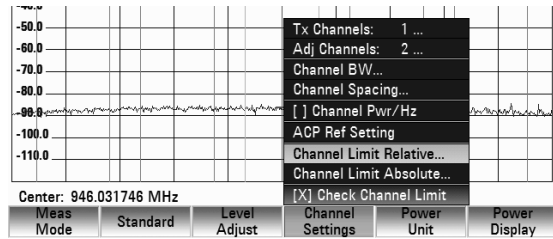
The outer left-hand transmission channel is the reference channel for the lower adjacent channels. The outer right-hand transmission channel is the reference channel for the upper adjacent channels.

### Setting and Checking the Limits

Limit checks in ACLR measurement mode are independent of limit line handling. You can define a limit for each of the adjacent channels. Limits for adjacent channels can be set either in absolute or relative terms.

**Defining relative limits**

- Press the CHANNEL SETTINGS softkey.
- Select the CHANNEL LIMIT RELATIVE menu item
- Confirm the selection with the ENTER key.  
The R&S FSH opens a dialog box to define the relative limits for each adjacent channel.
- Select the input field of an adjacent or alternate channel with the rotary knob or the cursor keys and active the field with the ENTER key.
- Select the channel you want to check with the SELECT softkey.  
The channel turns green and the check box in the first column is marked.
- Enter the limit value you need with the number keys.
- Confirm the entry with the ENTER key.  
The R&S FSH automatically activates the check flag, so that the limit is included in future limit checks.



Channel Limit Relative	
Adj	0.0 dB
Alt1	-10.0 dB
Alt2	0.0 dB
Alt3	0.0 dB
Alt4	0.0 dB
Alt5	0.0 dB
Alt6	0.0 dB
Alt7	0.0 dB
Alt8	0.0 dB
Alt9	0.0 dB
Alt10	0.0 dB
Alt11	0.0 dB

To deactivate the limit check for a specific channel, move the cursor to the channel in question with the rotary knob or the cursor keys and deselect it with the SELECT softkey.

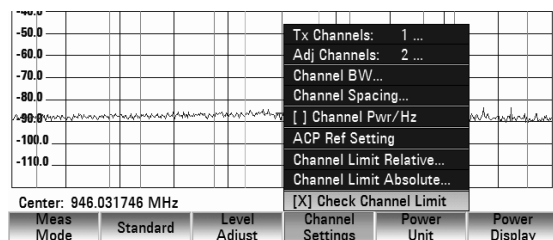
**Defining absolute limits**

- Press the CHANNEL SETTINGS softkey.
- Select the CHANNEL LIMIT ABSOLUTE menu item.
- Confirm the selection with the ENTER key.  
The R&S FSH opens a dialog box to define the absolute limits for each adjacent or alternate channel.
- The procedure of defining absolute limits is analogous to that of defining relative limits.

Channel Limit Absolute	
Adj	-40.0 dBm
Alt1	-45.6 dBm
Alt2	0.0 dBm
Alt3	0.0 dBm
Alt4	0.0 dBm
Alt5	0.0 dBm
Alt6	0.0 dBm
Alt7	0.0 dBm
Alt8	0.0 dBm
Alt9	0.0 dBm
Alt10	0.0 dBm
Alt11	0.0 dBm

**Performing a limit check**

- Press the CHANNEL SETTINGS softkey.
- Select the CHECK CHANNEL LIMITS menu item with the rotary knob or the cursor keys and confirm the selection with the ENTER key.  
The R&S FSH automatically performs limit checks. The results of the limit check are displayed in the table above the trace. If a result fails the limit check, it turns red and has a star (\*) in front of its power level.



Power 1 (r)	-91.6 dBm				
Adj Chn	Lower	Upper	Adj Chn	Lower	Upper
Adj	* 0.7	-0.7 dB	Alt1	* 0.0	* 1.4 dB

### 4.12.5 Measuring the Spectrum Emission Mask

The Spectrum Emission Mask (SEM) measurement is a method to detect spurious emissions or intermodulation products of a signal. When performing a SEM measurement, the R&S FSH checks the signal against a spectral mask to see whether the signal is in compliance to a specific standard or not. Therefore, the R&S FSH provides predefined Spectrum Emission Masks for various telecommunications standards.

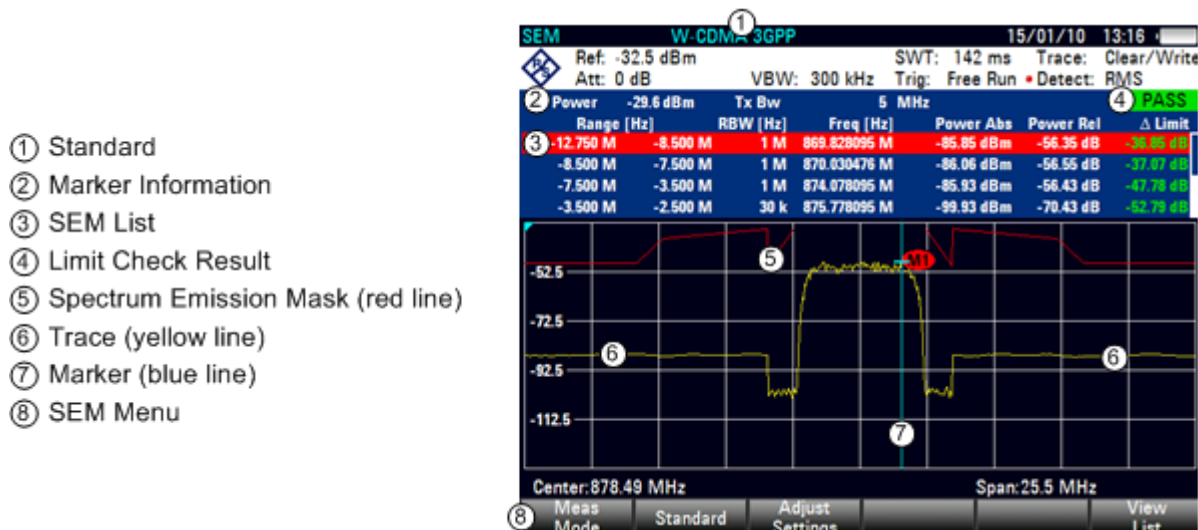
However, you can define your own spectral masks with the R&S FSH4View software to perform measurements in frequency ranges other than the predefined. To learn how to define Spectrum Emission Masks, refer to the FSH4View manual.

#### Starting the Measurement:

- Press the MEAS key.
- Press the MEAS MODE softkey.  
The submenu for selecting the measurement functions opens.
- Select the SPECTRUM EMISSION MASK menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

Note that the frequency range of the actual measurement depends on the start and stop frequency you have set on the R&S FSH. Correct measurement results are therefore only possible if the frequency ranges of the SEM are inside the current span of the R&S FSH.

#### Screen Layout for the Spectrum Emission Mask measurement



#### 4.12.5.1 Selecting a standard

Several predefined standards are already installed on the R&S FSH to use for Spectrum Emission Mask measurements. It is also possible to customize settings or create new standards using the R&S FSH4View software.

#### Loading Predefined Standards

The R&S FSH already comes with several predefined standards when it is shipped. All predefined standards are in accordance to the standard specifications. It is also possible to create a new standard and permanently store it on the R&S FSH via the R&S FSH4View software.



- Press the STANDARD softkey.  
A dialog box with all available standards opens.
- Select the standard you want with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the STANDARD softkey.

The R&S FSH sets the selected standard. The optimal span, resolution bandwidth, video bandwidth, sweep time and detector for the standard are selected automatically.

Stat	Name	Size	Date	Time
	\Public\Standards\...			
	802_11a_10MHz_5GHz_band.semstd	2 kB	14/01/2010	13:10
	802_11a_20MHz_5GHz_band.semstd	2 kB	14/01/2010	13:10
	cdma2000_BC0_-INF_28_dBm.semstd	2 kB	14/01/2010	13:10
	cdma2000_BC0_SR1.semstd	2 kB	14/01/2010	13:10
	ETSI_5GHz_RLAN.semstd	2 kB	14/01/2010	13:10
	LTE_10_MHz_Uplink.semstd	2 kB	14/01/2010	13:10
	LTE_Category_A_+1GHz.semstd	2 kB	14/01/2010	13:10
	LTE_Category_A_-1GHz.semstd	2 kB	14/01/2010	13:10
	LTE_Category_B_+1GHz.semstd	2 kB	14/01/2010	13:10
	LTE_Category_B_-1GHz.semstd	2 kB	14/01/2010	13:10
	W-CDMA_3GPP_31_39_dBm.semstd	2 kB	14/01/2010	13:10
	W-CDMA_3GPP.semstd	2 kB	14/01/2010	13:10
	WiBro_TTA_40_INF_dBm.semstd	2 kB	14/01/2010	13:10
	WiBro_TTA_40_INF_dBm.semstd	2 kB	14/01/2010	13:10
	WIMAX_10MHz_Downlink.semstd	2 kB	14/01/2010	13:10
	WIMAX_10MHz_Uplink.semstd	2 kB	14/01/2010	13:10
	WIMAX_20MHz_Downlink.semstd	2 kB	14/01/2010	13:10
	WIMAX_20MHz_Uplink.semstd	2 kB	14/01/2010	13:10
	WIMAX_ETSI_EN_30254401_31_39.semstd	2 kB	14/01/2010	13:10

### Creating Standards with the R&S FSH4View software

You can create and edit standards with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of standards the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "Saving and Loading Instrument Settings and Measurement Results" in this manual).

For more information on how to create and edit configurations refer to the R&S FSH4View manual.

### 4.12.5.2 Optimizing measurement settings

After selecting the standard and applying the signal to the R&S FSH, you can optimize measurement settings to avoid overloading the R&S FSH.

- Press the ADJUST SETTINGS softkey.  
The R&S FSH adjusts the reference level and the span

### 4.12.5.3 Viewing the results in a table

You can add a table to the display that shows the measurement results in numerical form.

- Press the VIEW LIST softkey.  
The R&S FSH shows a list above the trace diagram. If the list contains more than four entries, you can scroll through the list with the rotary knob or the cursor keys to see the other results. Note that scrolling works only if there is no active input field.

Range [Hz]	RBW [Hz]	Tx Bw	Freq [Hz]	Power Abs	Power Rel	Δ Limit
-12.750 M	-8.500 M	1 M	869.828095 M	-85.85 dBm	-56.35 dB	-96.06 dB
-8.500 M	-7.500 M	1 M	870.030476 M	-86.06 dBm	-56.56 dB	-97.07 dB
-7.500 M	-3.500 M	1 M	874.078095 M	-85.93 dBm	-56.43 dB	-97.78 dB
-3.500 M	-2.500 M	30 k	875.778095 M	-99.93 dBm	-70.43 dB	-92.79 dB

The list contains the following information:

- Tx Power  
Power level of the transmission channel.
- Tx Bandwidth  
Bandwidth of the transmission channel.
- PASS / FAIL information  
If the signal is within the limits of the spectral mask, the R&S FSH shows **PASS**, if not it shows **FAIL**.

- Range [Hz]  
Frequency range. The first number is the start frequency, the second number the stop frequency of each defined frequency range. The character following the number indicates the unit (k = kHz, M = MHz, G = GHz)
- RBW [Hz]  
Resolution bandwidth the corresponding frequency range is measured with.
- Freq [Hz]
- Power Abs  
Absolute peak power in the corresponding frequency range.
- Power Rel  
Relative peak power in relation to the channel power of the reference channel.
- $\Delta$  Limit  
Minimum distance from the limit line to the trace in the corresponding frequency range. Negative values or a zero indicate a passed SEM limit check, positive values indicate a violation of the limit check.

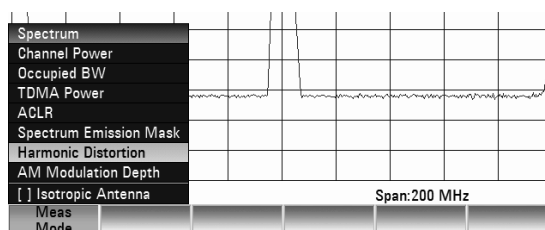
### 4.12.6 Measuring the Harmonic Distortion

The Harmonic Distortion measurement is an easy way to identify the harmonics of a DUT. In addition to the graphic display of the harmonics, this measurement mode also calculates the Total Harmonic Distortion (THD) and shows the results.

You can perform a Harmonic Distortion measurement in frequency sweep (span > 0) and zero span mode (span = 0). When starting the measurement, the R&S FSH looks for the first harmonic of the signal (= the highest signal) in the defined frequency range. It then adjusts the frequency axis so that all harmonics are visible. In zero span mode, the center frequency remains the same.

#### Starting the measurement:

- Press the MEAS key.
- Press the MEAS MODE softkey.  
The submenu for selecting the measurement functions opens.
- Select the HARMONIC DISTORTION menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.



The search for harmonics starts as soon as you enter the Harmonic Distortion measurement. Upon entering the measurement, the R&S FSH automatically adjusts the settings in order to display the selected number of harmonics (default = 2) on the screen.

Screen layout for determining the Harmonic Distortion

- ① Harmonics List
- ② Total Harmonic Distortion in %
- ③ Total Harmonic Distortion in dB
- ④ Trace
- ⑤ Markers (indicating harmonics)
- ⑥ Harmonic Distortion Menu

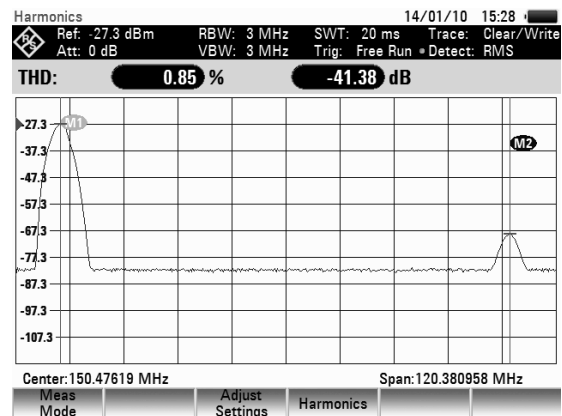


Defining the number of harmonics

By default, the R&S FSH shows the signal and its first harmonic. Each harmonic is indicated by a marker that the R&S FSH places on the harmonic (here M1 and M2). Note that all of the markers that have been set are normal markers that show the absolute frequency of the harmonic.

At the same time, the R&S FSH also calculates the values for the total harmonic distortion (THD) and shows the results in a box above the trace diagram. The values are output in % as well as dB,

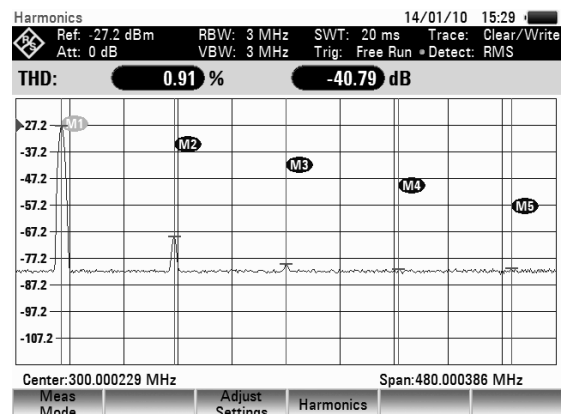
If you want to see more than one harmonic, the R&S FSH can show up to six harmonics.



- Press the HARMONICS softkey.
- Enter the number of harmonics you'd like to see in the input field.
- Confirm the entry with the ENTER key or the HARMONICS softkey.

The R&S FSH places the markers on the other harmonics even if they are outside of the display range.

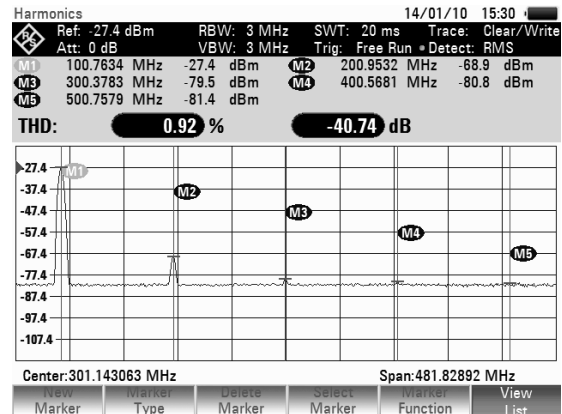
- Press the ADJUST SETTINGS softkey.
- The R&S FSH adjusts the reference level, center frequency and span in a way that all harmonics are visible in the diagram area.



**Activating the harmonics list**

To see the exact frequency of the harmonic, you can activate the marker list that shows the value for each marker.

- Press the MKR key.
- Press the VIEW LIST softkey.  
The R&S FSH displays the marker list that contains the values for each harmonic.

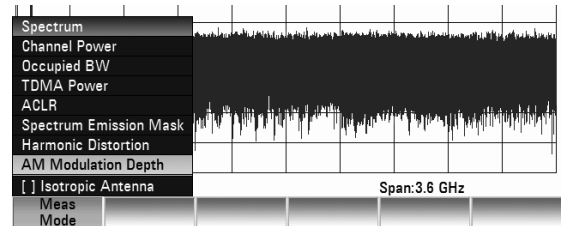


**4.12.7 Measuring the AM Modulation Depth**

The AM Modulation Depth measurement analyzes AM modulated signals and calculates the modulation depth of the signal using the measurement results. Note that the measurement works properly only if you apply an AM modulated signal.

**Starting the measurement:**

- Press the MEAS key.
- Press the MEAS MODE softkey.  
The submenu for selecting the measurement functions opens.
- Select the AM MODULATION DEPTH menu item with the rotary knob or the cursor keys.
- Confirm your selection with the ENTER key or the MEAS MODE softkey.

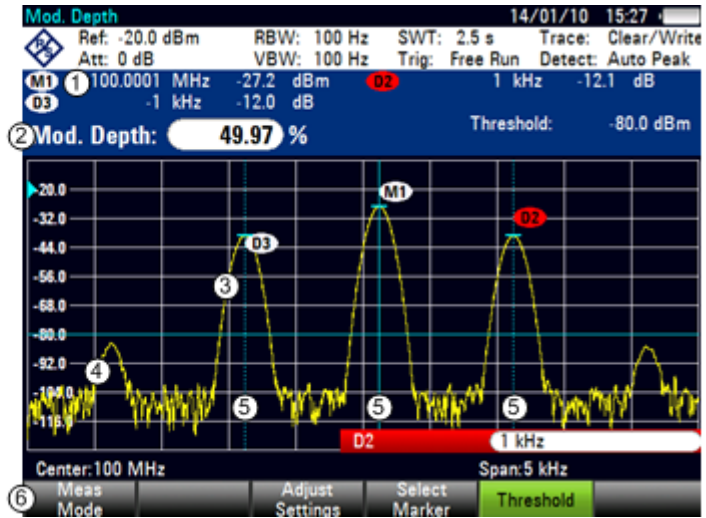


After you have started the measurement, the R&S FSH places three markers on the trace. The first marker is placed on the peak power level. The R&S FSH assumes that position as the level of the carrier. The second and third markers are delta markers. These are placed symmetrically on the adjacent peak values to the left and right of the carrier.

By default, delta marker 2 is active for editing. If you move the delta marker to another position, the other delta marker will be moved by the same distance relative to the normal marker. Note that this happens only if you move delta marker 2 (D2). When moving delta marker 3 (D3), only this marker is repositioned.

From the values of the markers, the R&S FSH then calculates the AM modulation depth. The AM modulation depth is the ratio between the power values at the reference marker and at the delta markers. When the powers of the two AM side bands are not the same, the R&S FSH uses the mean value of the two sideband values.

Screen layout for the AM Modulation Depth measurement

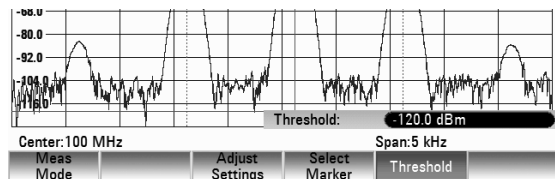


- ① Marker List
- ② Modulation Depth
- ③ Trace
- ④ Threshold Line
- ⑤ Markers
- ⑥ AM Mod Depth Menu

Setting a threshold

You can set a threshold that defines the minimum power level the signal must have. If the power of the signal is below the threshold, the R&S FSH will not set the markers and therefore will not calculate the modulation depth.

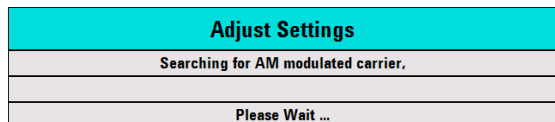
- Press the THRESHOLD softkey  
A dialog box opens.
- Enter the threshold value you need and confirm it with the ENTER key.  
The threshold is represented as a horizontal blue line in the diagram area.



Optimizing the settings

In order to get the best results, you can use the automatic adjustment routine that the R&S FSH offers.

- Press the ADJUST SETTINGS softkey.  
The R&S FSH performs a sweep and repeats the peak search sequence for the three markers.



Activating the marker list

To see the exact frequency of the carrier and its sidebands, you can activate the marker list that shows the value for each marker.

- Press the MKR key.
- Press the VIEW LIST softkey.  
The R&S FSH displays the marker list that contains the values for carrier and sideband.

### 4.12.8 Working with the Spectrogram Result Display

With option R&S FSH-K14, you can view measurement results in a spectrogram on the R&S FSH.

The spectrogram result display shows the spectral density of a signal in the frequency domain and over time simultaneously.

Like other result displays, the horizontal axis represents the frequency span. The vertical axis represents time. Time in the spectrogram runs chronologically from top to bottom. Therefore, the top of the diagram is the present. A third dimension shows the amplitude for each frequency by mapping different colors to every power level. The result is therefore a two dimensional diagram.

The color the R&S FSH assigns to a power level that was measured depends on:

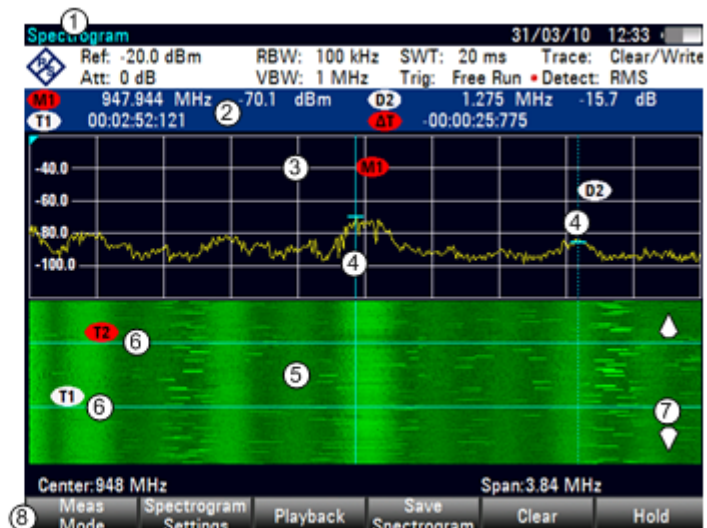
- the color table you have selected
- the spectrogram reference level
- the spectrogram level range

The spectrogram consists of horizontal lines, each one pixel high, that are called frames. In the default state, a frame is added to the spectrogram after each sweep. This means that the amount of data in a frame depends on the sweep time. As the spectrogram in the R&S FSH runs from top to bottom, the outdated time line(s) move down one position, so that the present frame is always on top of the diagram. Therefore, the sequence of frames is chronological.

- Press the MEAS key.
  - Press the MEAS MODE softkey.
  - Select the SPECTROGRAM menu item with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the MEAS MODE softkey.
- The R&S FSH starts the spectrogram result display.

#### Screen layout for the spectrogram

- ① Result Display
- ② Marker and Time Line Information
- ③ Spectrum Result Display (optional)
- ④ Marker / Deltamarker (vertical lines)
- ⑤ Spectrogram
- ⑥ Time Lines T1 and T2 (horizontal lines)
- ⑦ Scroll Directions
- ⑧ Spectrogram Menu



By default, the spectrogram result display consists of two windows. The upper window shows the measured spectrum as a trace line. The lower window shows the measurement results in a spectrogram. The chronological information in the spectrogram is restricted by the internal memory of the R&S FSH. The R&S FSH stores 1024 frames or spectrums that have been measured in its memory. As the height of the display is smaller, some of the data becomes invisible after a time.

### 4.12.8.1 Controlling the spectrogram update

The spectrogram starts running as soon as you enter the spectrogram mode, if you are in continuous sweep mode.

If you are in single sweep mode, the R&S FSH does not add a line to the spectrogram until you initiate the next single sweep.

You can stop the update of the spectrogram in continuous sweep mode.

➤ Press the MEAS key.

➤ Press the HOLD softkey.

Note that in continuous sweep mode the measurement in the spectrum result display does not stop. The trace in the upper window still updates continuously. Only the spectrogram view stops.

➤ Press the HOLD softkey again.

The R&S FSH resumes updating the spectrogram.

The spectrogram result display is filled with results until you change a measurement setting. As soon as a setting is changed, the spectrogram clears and starts to fill again.

You can also clear the spectrogram manually

➤ Press the MEAS key.

➤ Press the CLEAR softkey.

### 4.12.8.2 Browsing through the signal history

There are two ways to view parts of the measurement result history that have moved outside the visible area of the spectrogram.

➤ Press the MEAS key.

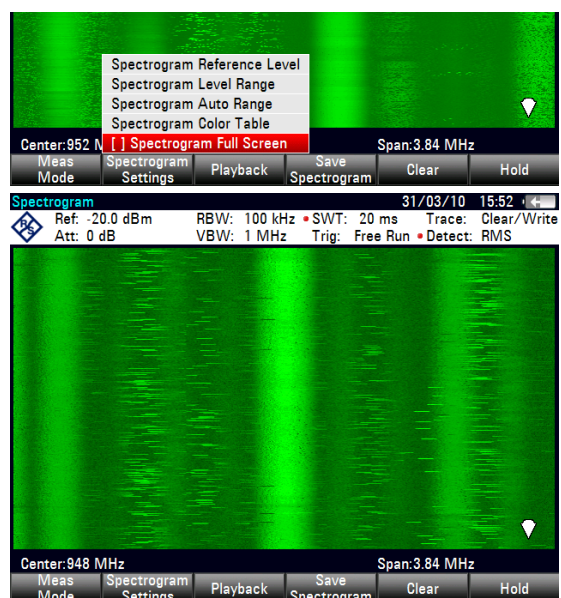
➤ Press the SPECTROGRAM SETTINGS softkey.

➤ Select the [ ] SPECTROGRAM FULL SCREEN menu item.

➤ Confirm the selection with the ENTER key or the SPECTROGRAM SETTINGS softkey.

The R&S FSH now uses the full diagram area of the screen for the spectrogram. The number of lines in the spectrogram and therefore the displayed time period more than doubles.

The SPECTROGRAM FULL SCREEN menu item is marked by an [X].



It may, however, be necessary that the spectrum result display is still visible to evaluate measurement results. For this purpose, the spectrogram has an (invisible) scrollbar that you can use to scroll up and down the spectrogram to the frame that you'd like to see.

**Scrolling through the spectrogram**

- Turn the rotary knob or use the UP and DOWN cursor keys whenever you are viewing the spectrogram.

The R&S FSH scrolls through the spectrogram history.

Note that this is only possible as long as no input field or menu is active. To resume the spectrogram scroll function in this case,

- Press the CANCEL key
- Use the rotary knob or the UP and DOWN cursor keys again.  
The R&S FSH resumes scrolling through the spectrogram history.

The symbols on the right side of the spectrogram indicate the position of the spectrogram part currently displayed on the screen:

- A single down arrow in the right lower corner of the spectrogram indicates that the uppermost frame still represents the most recently recorded trace.
- Two arrows (one up, one down) indicate that the spectrogram area displayed is somewhere in the middle of the available history.
- A single up arrow in the upper right corner of the spectrogram indicates that the lowest line of the spectrogram represents the end of the history buffer.

**4.12.8.3 Configuring the Display**

As colors are an important part of the spectrogram, the R&S FSH offers various ways to customize the display for best viewing results.

The first and most obvious way to configure the display is to select a different color scheme.

- Press the SPECTROGRAM SETTINGS softkey.
- Select the SPECTROGRAM COLOR TABLE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the DISPLAY SETTINGS softkey.  
The R&S FSH opens a submenu that contains several color schemes.
  - Default:
  - Green-Yellow:
  - Green-Blue
  - Black-White
  - Red-Purple
  - Blue-Black

- Select the color scheme with the rotary knob or the cursor keys.

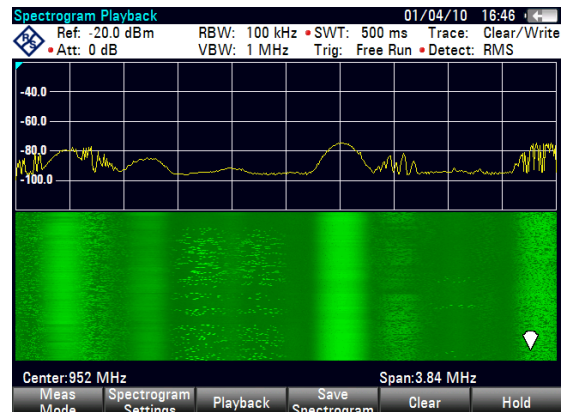
The following examples are based on the green-yellow color scheme.

- Confirm the selection with the ENTER key or the SPECTROGRAM SETTINGS softkey.  
The R&S FSH adjusts the screen colors according to your selection.

It is possible that the color distribution is not ideal in the current configuration. You have two ways to set things straight.



By cutting the reference level, you can eliminate amplitudes from the color map that are not part of the signal. Example: By default, the spectrogram reference level is 30 dBm. That means that signal parts with an amplitude of 30 dBm would be yellow in the spectrogram, and signal parts with a very small amplitude would be dark green. Everything in between is a shade of the colors between. As the colors are distributed over a very large range (about a 150 dBm or more), it is likely that you can not distinguish details in the signal you have measured.



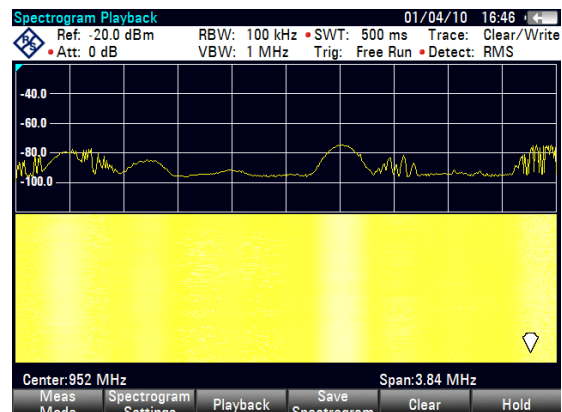
Therefore you should adjust the color map to the overall shape of the signal you are measuring. Let's say, for example, that the signal has an amplitude range of about 30 dB with the maximum amplitude at about -60 dBm and the minimum amplitude at about -100 dBm and the Green-Yellow color scheme. With the default settings, the spectrogram is made up exclusively of green colors and it's not easy to distinguish amplitude levels. That's because the yellow color shades are completely out of range.

To get a better result, change the spectrogram reference level to a level near the maximum power level that has been measured first.

- Press the SPECTROGRAM SETTINGS softkey.
- Select the SPECTROGRAM REFERENCE LEVEL menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the SPECTROGRAM SETTINGS softkey. The R&S FSH opens an input field to enter the spectrogram reference level.
- Enter the reference level you need with the number keys, the rotary knob or the cursor keys. The reference level should be near the maximum level that has been measured while the spectrogram was running. In the example, the reference level should be at about -60 dBm.
- Confirm the entry with the ENTER key. The R&S FSH now shifts the reference level of the spectrogram to the value you have entered.

Note that the spectrogram reference level does not affect the spectrum result display, as well as the spectrum reference level (AMPT menu) does not affect the spectrogram. In the screenshot the spectrum trace is therefore exactly the same as in the previous picture.

The result however, still does not show signal differences in detail. The only thing that happened is that the colors have shifted, in the example to yellow, because the color that corresponds to the reference level has shifted from green to yellow. All other colors that are part of the color scheme are still unused, because the spectrogram level range is still the same (150 dB).



- Press the SPECTROGRAM SETTINGS softkey.
- Select the SPECTROGRAM LEVEL RANGE menu item with the rotary knob or the cursor keys.

- Confirm the selection with the ENTER key or the SPECTROGRAM SETTINGS softkey.

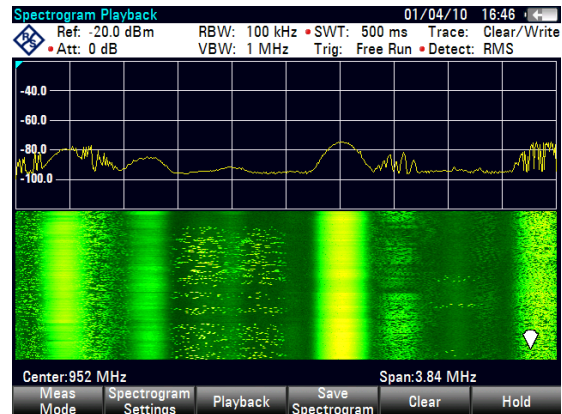
The R&S FSH opens an input field to enter the spectrogram level range.

In the example, the level range of the signal is from about -60 dBm to about -100 dBm. Therefore set the level range to 40 dB to get the whole signal.

- Confirm the entry with the ENTER key.

As the level range is now adjusted, the R&S FSH is able to map its complete color range to the level range of the signal. This means that signal parts with a low amplitude are in a shade of green while signal parts with a high amplitude are yellow.

The best way to display a spectrogram is therefore to reduce the level range until the lowest signal part is mapped to the lower end of the color map and the highest signal part to the upper end of the color map.

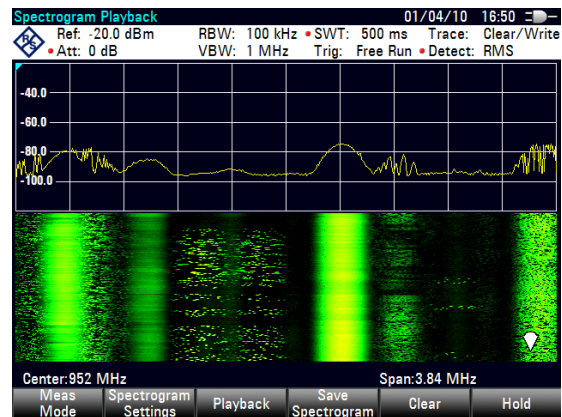


In a last step you can configure the spectrogram in a way that it only shows signal peaks in color and the noise floor in black. To get a result like that you have to reduce the level range, until the noise floor is outside the displayed range.

- Instead of entering a level range of 40 dB, enter a level range of 35 dB or even 30 dB.

This will provide a high contrast between signal parts that are above the noise floor, and the noise floor, which is drawn in black.

To show details of the noise floor and exclude the peak levels you have to lower the spectrogram reference level, until it is just above the noise floor. The R&S FSH will then display the signal parts that are above the reference level in only one color, which is the color at the upper border of the color map.



#### 4.12.8.4 Recording a Spectrogram

You can save the data of the spectrogram for documentation or for further analysis of the recorded data.

- Press the MEAS key.
- Press the SAVE SPECTROGRAM softkey. The R&S FSH opens a dialog box to save the current spectrogram.

- Enter the name of the spectrogram with the alphanumeric keys. By default, the R&S FSH saves the spectrogram as 'Spectrogram###' with ascending numbers.

- Press the SAVE softkey to store the spectrogram. Now that you have saved the spectrogram, you can replay it any time you want.

Save Spectrogram 26/04/10 14:30

Stat	Name	Size	Date	Time
Public				
<input type="checkbox"/>	Cable Models			
<input type="checkbox"/>	Channel Tables			
<input type="checkbox"/>	Datasets			
<input type="checkbox"/>	Limit Lines			
<input type="checkbox"/>	Screen Shots			
<input type="checkbox"/>	Standards			
<input type="checkbox"/>	Transducers			
	Spectrogram001.spm	1304 kB	01/04/2010	14:02
	Spectrogram002.spm	948 kB	10/03/2010	16:04
	Spectrogram003.spm	948 kB	10/03/2010	16:12
	Spectrogram004.spm	948 kB	10/03/2010	16:32
	Spectrogram005.spm	948 kB	10/03/2010	16:33
	Spectrogram006.spm	948 kB	10/03/2010	16:58

Spectrogram001 Free: 9 MB

Save Sort/Show Internal SD-Card Exit

The number of spectrograms that you can store on the R&S FSH's internal memory depends on the other datasets that are currently on the R&S FSH.

#### 4.12.8.5 Playback of a Spectrogram

If you have recorded a spectrogram and have saved it in internal memory, a memory stick or the SD card, you can view the results of that measurement at a later time.

- Press the PLAYBACK softkey
- or
- Press the MEAS MODE softkey.
- Select the SPECTROGRAM PLAYBACK menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

Recalling a previously stored spectrogram

- Press the RECALL SPECTROGRAM softkey.  
The R&S FSH opens a dialog box to select a file that contains the spectrogram data. The file extension for spectrogram data is \*.spm.
- Select the file you need with the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
The R&S FSH loads the spectrogram and shows the data in the display.



In general you can do the same things on a recalled spectrogram as in the spectrogram recording mode, e.g. customize the display to your needs.

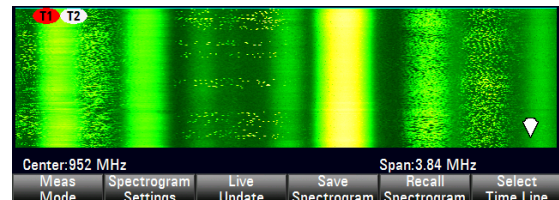
In addition to that functionality, it is possible to view not only the spectrum that belongs to the currently selected spectrogram frame, but also the spectrums of all frames that are in the memory of the R&S FSH.

#### Working with time lines in playback mode

To find a particular point in time and display the corresponding spectrum you can use two time lines:

When entering the playback mode the R&S FSH displays two time lines in the spectrogram.

The first time line (T1) corresponds to an absolute time value, the second (T2) is a time relative to the first time line. Both time lines are positioned on the most recent spectrogram line at the top of the result display.



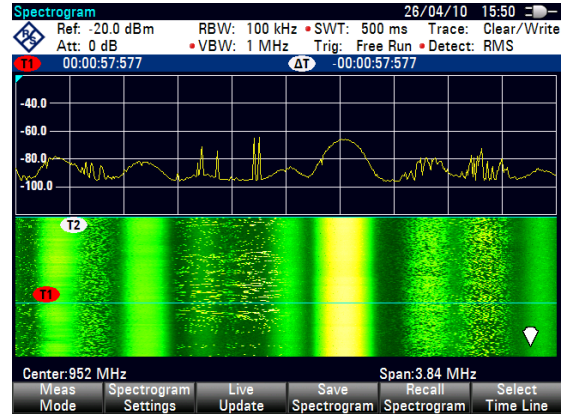
You can now select a specific spectrogram frame that is in the memory of the R&S FSH.

- Press the SELECT TIME LINE softkey.  
The R&S FSH opens an input field to define the position of the first time line (T1).
- Enter a number with the number keys, or position the time line using the rotary knob or the cursor keys.  
Entering 0 sets the time line marker on the most recent frame. The maximum value that you can enter is 1024 (the maximum number of frames the R&S FSH can store in its memory).

Note that not all frames are visible on the screen. If a frame is part of the history outside the visible area, the time line is also not visible and you have to scroll through the spectrogram to be able to see it again.

The upper window will display the spectrum of the frame at the time line position. By moving the time line you can thus browse through the history of spectra stored in memory.

In the marker information field, the R&S FSH shows the time stamp of the time line. The time stamp of the first time line T1 is always referred to the top-most frame (e.g. a time stamp of 00:00:50:000 means that the data was measured 50 seconds prior to the top-most frame).



- Press the SELECT TIME LINE softkey again.

The R&S FSH opens an input field to define the position of the second time line (T2).

- Enter a number with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key.

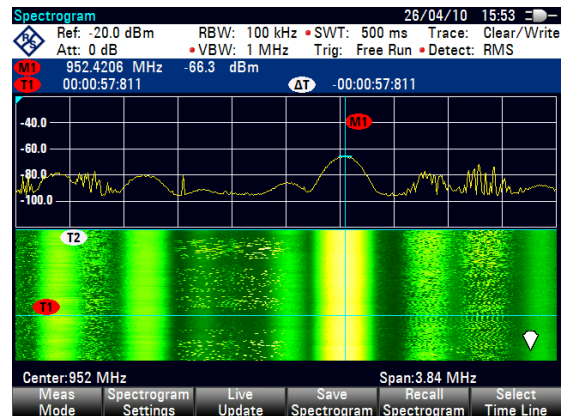
The R&S FSH positions the second time line on the selected frame. Again it shows the time stamp of the time line in the marker information field (ΔT value). For the second time line (T2), the information is relative to the first one (T1). This means that the time stamp of the second time line can be negative, if you have set it on a frame above the first time line.

If you scroll the time line through the frames of the spectrogram with the rotary knob or the cursor keys, the R&S FSH will show the spectrum corresponding to the selected frame in the upper window of the display.

You can use the spectrogram playback for a detailed analysis of the signal levels over time and compare signal details in the spectrum result display, e.g. with the help of markers.

In addition to the time line (horizontal marker), you can also use (vertical) markers in the spectrogram.

With the help of the marker and the time line, you are able to find the exact moment when a specific event has occurred in the spectrum.



- Press the MARKER key.  
The R&S FSH activates a marker and sets it on the peak level of the currently displayed spectrum.
- Use the rotary knob or the cursor keys to move the marker on the horizontal axis to the frequency you want to analyze, or enter the frequency directly with the number keys.

- Press the SELECT TIME LINE softkey and browse through the spectrums using the rotary knob or the cursor keys until the spectrum of interest is displayed in the upper window.  
The time stamp of the selected time line gives you a precise indication on when the event shown in the spectrum occurred.

For more information on marker functionality, see

- [Using Markers](#) on page 44

**Switching back to active spectrogram recording**

To resume recording of a new spectrogram

- Press the LIVE UPDATE softkey at any time you are in playback mode.  
The R&S FSH switches back to performing live measurements.

## 4.13 Two-port Measurements with the Tracking Generator

Only for R&S FSH with tracking generator (order number 1309.6000.14, 1309.6000.24, 1309.6000.18 or 1309.6000.28).

The R&S FSH can be supplied with an optional tracking generator to measure the transmission of two-ports or the reflection coefficients of one-ports and two-ports. The tracking generator outputs a signal at the current R&S FSH frequency. The nominal output level can be selected from 0 dBm to -50 dBm in 1 dB steps.

Two-port transmission can be determined directly by connecting the input of the DUT to the output of the tracking generator and the DUT's output to the R&S FSH's RF input. A bridge is required to measure the reflection coefficient, as included in the R&S FSH4 model, catalogue number 1309.6000.24 and the R&S FSH8, catalogue number 1309.6000.28. With current VSWR measuring bridges, the R&S FSH can carry out measurements in both the forward and backward directions. A two-port measurement object can thus be measured for impedance at the input and at the output and for the transmission in both directions.

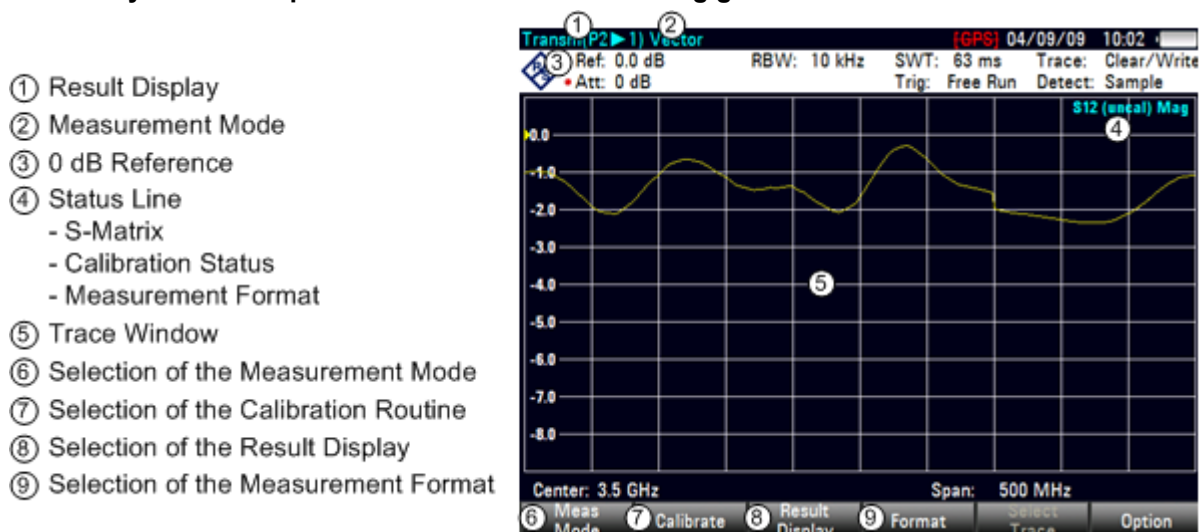
Due to the calibration technique used, the R&S FSH's measurement accuracy is high for both transmission measurements and reflection measurements. The R&S FSH offers scalar calibration methods as standard; i.e. with transmission and reflection measurements, the magnitudes are corrected. Vector calibration methods and measurements (option R&S FSH-K42) are possible for increasing the dynamic range and the measurement accuracy. The operation of vector measurements primarily differs in the expanded calibration routines. In addition, the R&S FSH-K42 option offers additional measurement functions for determining the phase, the group delay and the electrical length of a DUT.

- Press the MODE key.
- Press the NETWORK ANALYZER softkey.

The R&S FSH turns on the tracking generator and switches to its softkey menu. However, the frequency and level settings from the spectrum analyzer mode are not changed.

The softkey menu for the network analysis includes the softkeys for selecting measurement mode (scalar or vector, only available in devices with VSWR bridge), calibrating the transmission measurement (CALIBRATE TRANSMISSION FWD / REV) and reflection (CALIBRATE REFLECTION PORT 1 / 2). Calibration is necessary because the tracking generator output level does not exactly match the values specified in the table and it is frequency-dependent. If transmission measurements are performed on a two-port, the calibration takes the transmission characteristics of the test setup and the frequency response of the tracking generator into account and corrects the measurement with the correction data that has been obtained. When a reflection measurement is to be performed, during calibration the R&S FSH measures the reflection coefficient at a short and at an open on the bridge. These two measurements provide the correction data for reflection measurements.

Screen layout for two-port measurements with tracking generator:



When the tracking generator is switched on, the status line indicates (Uncal). This indicates that tracking generator measurements are uncalibrated. The level axis is in the relative unit dB. Apart from the level values, the 0 dB reference is also displayed. This corresponds to a reference level of 0 dBm in the spectrum analyzer mode (= nominal output level of the tracking generator).

When the tracking generator is on, measurement parameters like bandwidth or the frequency range are selected with the appropriate keys as in the spectrum analyzer mode. When the MEAS key is pressed, the softkey menu for the tracking generator is displayed.

Before calibration, the output level of the tracking generator, the frequency range you want and the appropriate reference level should be set because calibration is only valid for the calibrated frequency range and reference. Changing these parameters after calibration invalidates calibration.



The calibration remains valid if the start frequency, stop frequency, center frequency and span are subsequently changed within the calibrated frequency range. In this case, the R&S FSH interpolates the correction data between the reference points of the calibration. The R&S FSH retains the calibration values but displays (Interp) in the status line to indicate a possible increase in measurement uncertainty.

With an integrated VSWR bridge (models R&S FSH4, order number 1309.6000.24 and R&S FSH8, order number 1309.6000.28) the R&S FSH can measure the match at both the input and the output of a DUT and the transmission from input to output and vice versa (2-port capability). For this purpose, it internally switches the tracking generator to each of the required N-connectors, which are labelled port 1 and port 2 for this purpose.



In spectrum analysis mode, port 1 is used as the RF input.

### 4.13.1 Scalar Measurements

In devices which are not equipped with a VSWR bridge (Models R&S FSH4, order number 1309.600.14 and R&S FSH8, order number 1309.600.18), the generator output switching option is absent. These devices can therefore measure only the transmission from the tracking generator output (= port 2) to the RF input (= port 1) (TRANSMISSION REVERSE PORT 2 -> PORT 1). These devices also measure only the transmitted power (scalar measurement). The phase response cannot be measured by means of the measurement object.

Calibration is therefore available, regardless of the device model, in different versions:

- **Full Two-Port**

Reference measurements are performed for transmission and reflection measurement at both measurement ports (ports 1 and 2). This means that all measurements in “Network” mode are performed with maximum accuracy. The indication (Cal) shows in the status line. With regards to subsequent measurements at the DUT, this calibration method is the most flexible. However, it is also the most time-consuming, because all calibration standards (Open, Short, Load, Through) must be connected to both ports, which requires a total of seven measurement steps.

- **Reflection Port 1**

Performs vector reference measurements for later measurement of match or reflection at port 1. In this case, calibration requires the calibration standards to be connected to a single RF connector (3 measurement steps).

- **Transmission Fwd**

Performs vector reference measurements for the transmission from port 1 to port 2.

- **Transmission Rev**

Performs vector reference measurements for the transmission from port 2 to port 1.

- **Reflection Port 2**

Performs vector reference measurements for later measurement of match or reflection at port 2.

- **Normalize ...**

When selecting a normalization, a single reference measurement is made at the corresponding port or between both ports. By means of this reference measurement, for example, the frequency and phase response of a connected measurement cable can be compensated accurately enough without having to carry out a time-consuming full calibration.



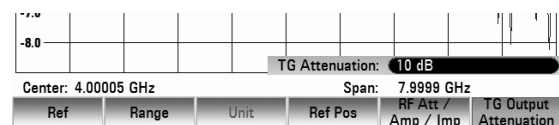
In SCALAR mode and in instrument models without the VSWR bridge, only the NORMALIZE calibration type is provided.



With an SD memory card inserted, you can toggle between internal memory and the memory card with the INTERNAL/SD-CARD softkey.

#### Setting the output level:

- Press the AMPT key.
- Press the TG OUTPUT ATTENUATION softkey.  
The input field to set the output level opens.



You set the output level by selecting an attenuation value (0 dB to 40 dB). If you select 0 dB, the output level will be 0 dBm. If you select 40 dB, the output level will be -40 dBm.

- Set the attenuation level you need with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key.



## 4.13.2 Vector Measurement

Vector measurements are possible only with an R&S FSH4/8 with tracking generator and integrated VSWR bridge (order number 1309.6000.24 or 1309.6000.28) that is equipped with option R&S FSH-K42 (vector reflection and transmission measurement) and in conjunction with accessories R&S FSH-Z28 or R&S FSH-Z29 (calibration standards).

When performing vector measurements, the R&S FSH analyzes both magnitude and phase of the receive signal, thus correcting the influence it has on the measurement result by means of the complex correction values obtained from the calibration types with correct phase. Reference is made to the calibration standards used (through connection and 50  $\Omega$  termination).

Compared to scalar measurement, the vector transmission measurement yields higher measurement accuracy and dynamic range. One of the main benefits of vector measurements is that it also lets you determine the phase, group delay and electrical length of a DUT. These measurement formats are possible only after calibration has been performed, else they are unavailable.

For vector measurements, the following calibration types are available.

- **Full Two Port**

Both test ports are calibrated for a complete set of measurements (input reflection (S11), forward transmission (S21), reverse transmission (S12) and output reflection (S22)). The calibration routine therefore requires the connection of the standards load, open and short to both test ports, and a through connection of the test ports. The influences of the test setup and of the isolation between the test ports are thereby determined and taken into account in the subsequent measurement of the device under test.

While this method is the most time-consuming during calibration, it does provide the greatest accuracy for all measurements at both test ports without recalibration and is thus the most flexible.



The instrument is delivered with a full two port calibration (factory calibration). This does not, however, take into account the influence of the actual test setup (cabling). Thus all measurements are possible, even without further calibration, however, the accuracy is limited because the actual test setup is not taken into account. For this reason, the instrument indicates "(Uncal)" in the status line. To achieve the best possible measuring accuracy, we recommend that the calibration is repeated with the test setup in use.

---

- **Reflection Port 1**

Test port 1 is calibrated for the reflection measurement (S11). The calibration routine requires the calibration standards open, short and load to be connected one after another.



The instrument is delivered with a full two port calibration (factory calibration). If, after calibration of the reflection at port 1, other measurements (Transmission Fwd / Rev, Reflection Port 2) are selected, the R&S FSH uses the appropriate calibration data from the factory calibration. The measurements are thus possible but only with limited accuracy because the test setup in use is not taken into account. For this reason, the instrument indicates "(Uncal)" in the status line.

---

- **Transmission Fwd (Port 1 ►2)**

Forward transmission (S21) is calibrated. The calibration routine requires a through connection as well as the connection of the calibration standards open and short to Port 1. The influences of test setup and the isolation between the test ports are thereby determined and taken into account in the subsequent measurement of the device under test.



The instrument is delivered with a full two port calibration (factory calibration). If, after calibration of the forward transmission, other measurements (Transmission Rev, Reflection Port 1 / Port 2) are selected, the R&S FSH uses the appropriate calibration data from the factory calibration. The measurements are thus possible but only with limited accuracy because the test setup in use is not taken into account. For this reason, the instrument indicates "(Uncal)" in the status line.

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- **Transmission Rev (Port 2 ►1)**

Reverse transmission (S12) is calibrated. The calibration routine requires a through connection as well as the connection of the calibration standards open and short to Port 2. The influences of the test setup and of the isolation between the test ports are thereby determined and taken into account in the subsequent measurement of the device under test.



The instrument is delivered with a full two port calibration (factory calibration). If, after calibration of the forward transmission, other measurements (Transmission Rev, Reflection Port 1 / Port 2) are selected, the R&S FSH uses the appropriate calibration data from the factory calibration. The measurements are thus possible but only with limited accuracy because the test setup in use is not taken into account. For this reason, the instrument indicates "(Uncal)" in the status line.

---

- **Reflection Port 2**

Test port 2 is calibrated for the reflection measurement (S22). The calibration routine requires the calibration standards open, short and load.



The instrument is delivered with a full two port calibration (factory calibration). If, after calibration of the reflection at port 1, other measurements (Transmission Fwd / Rev, Reflection Port 2) are selected, the R&S FSH uses the appropriate calibration data from the factory calibration. The measurements are thus possible but only with limited accuracy because the test setup in use is not taken into account. For this reason, the instrument indicates "(Uncal)" in the status line.

---

- **Normalize Reflection Port 1 (Short)**

Test port 1 is calibrated for the reflection measurement (S11). The calibration routine requires only the calibration standard short. In the subsequent measurement, the isolation between the test ports is not taken into account, a possible cross-talk between the test ports in the test setup is not eliminated.



For the selection of other measurements, the same applies as for Reflection Port 1.

---

- **Normalize Reflection Port 2 (Short)**

Test port 2 is calibrated for the reflection measurement (S22). The calibration routine requires only the calibration standard short. In the subsequent measurement, the isolation between the test ports is not taken into account, a possible cross-talk between the test ports in the test setup is not eliminated.



For the selection of other measurements, the same applies as for Reflection Port 2.

---

### 4.13.3 Measuring the Transmission of Two-Port DUTs

To perform a transmission measurement, connect the input of the DUT to the generator output and the DUT's output to the RF input of the R&S FSH. The R&S FSH measures the magnitude of the DUT's transmission.

The measurements of the operating sequences below are performed on a two-port filter with a center frequency of 2060 MHz and a bandwidth of approx. 11 MHz. The measurement example starts with the R&S FSH in its default setting.

#### Setting the frequency range:

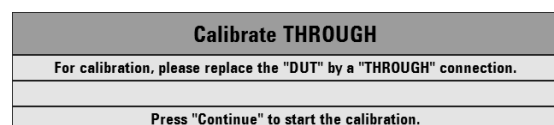
- Press the PRESET key.
- Press the MODE key.
- Press the NETWORK ANALYZER softkey.  
The R&S FSH displays the tracking generator menu. As calibration has not yet been performed, the R&S FSH displays (uncal) in the status line.
- Press the FREQ key.  
The frequency menu and the input field to set the center frequency open.
- Enter the center frequency of 2060 MHz with the number keys.
- Confirm the entry with the unit keys.  
The R&S FSH now sets a center frequency of 2060 MHz.
- Press the SPAN key.  
The span menu and the input field to define the span open.
- Enter the span of 50 MHz with the number keys.
- Confirm the entry with the unit keys.  
The R&S FSH is now set up to perform the measurements on the filter.

#### 4.13.3.1 Scalar Transmission Measurement

- Press the MEAS key.
- Press the MEAS MODE softkey.
- Select the SCALAR menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
The R&S FSH is now ready to perform scalar transmission measurements.

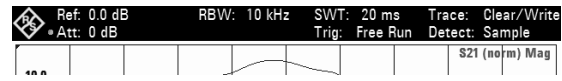
#### Calibrating the measurement

- Press the CALIBRATE softkey.
- Select the NORMALIZE TRANSMISSION FWD (PORT1⇒2) menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the CALIBRATE softkey.  
To perform the calibration, the R&S FSH asks you to connect its RF input to the tracking generator output.
- Connect the RF input of the R&S FSH directly to the tracking generator output without the DUT.



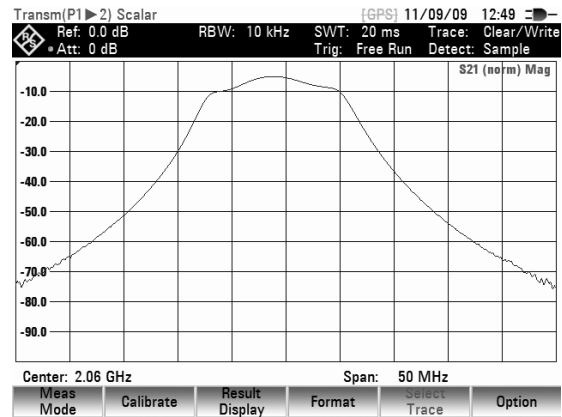
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).



- Connect the DUT between the RF input and the generator's output.

The R&S FSH displays the transmission magnitude. You can now look for exact measurement results with, for example, markers.



The calibration for transmission measurements remains valid until you change the center frequency or the span to such an extent that the new span falls outside the calibrated frequency range. The status line again says (Uncal) if the calibration is no longer valid.

If you change the reference is changed after the calibration, you must anticipate greater measurement uncertainty. The R&S FSH retains the calibration data but displays (Interp) in the status line to indicate a possible increase in measurement uncertainty (< 0.3 dB).

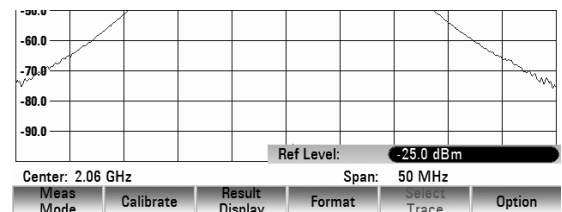
Changing any other of the parameters like bandwidth, detector, sweep time or measurement range has no effect on measurement accuracy. You can therefore change these parameters after the calibration without reducing the accuracy of the results.

You can save calibration data like other data sets after you have performed the calibration. That means that you can simply load the data set containing the calibration data and then perform measurements without calibrating the R&S FSH first.

**Measurement on amplifiers**

With measurements on amplifiers, the reference must be shifted so that the amplifier's transmission function can be seen on the screen. An increase of the reference level corresponds to an increase of the input attenuation. The R&S FSH provides a reference setting for this purpose. The position of the 0 dB reference can be shifted to positive or negative values.

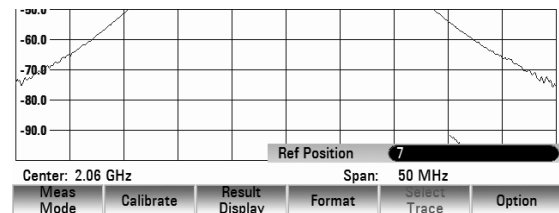
- Press the AMPT key.
- Press the REF LEVEL softkey.
- Set the reference with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key or the REF LEVEL softkey.



When performing measurements on amplifiers, make sure not to overload the R&S FSH. The risk of an overload is eliminated as long as the trace is within the display area on the screen (with REF POSITION = 10 dB).

You can also shift the reference without increasing the input attenuation – for example, in order to move the trace to the center of the screen. You can do this with the REFPOS function. The values 0 to 10 indicate the horizontal lines from bottom to top (with 0 = bottom line, 10 = uppermost line). The value 5 indicates the line in the center of the diagram.

- Press the AMPT key.
- Press the REFPOS softkey.
- Set the reference position with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key or the REFPOS softkey.



### 4.13.3.2 Vector Transmission Measurement

Vector measurements are possible only with an R&S FSH4/8 with tracking generator and integrated VSWR bridge (order number 1309.6000.24 or 1309.6000.28) that is equipped with option R&S FSH-K42 (vector reflection and transmission measurement) and in conjunction with accessories R&S FSH-Z28 or R&S FSH-Z29 (calibration standards).

#### Switching on vector measurement:

- Press the MODE key.
- Press the NETWORK ANALYZER softkey.
- Select the VECTOR menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
The R&S FSH is now ready to perform scalar transmission measurements.

#### Calibrating the measurement

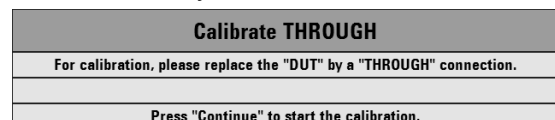
Before calibrating the R&S FSH, you have to set the center frequency and span you need. If set later, the calibration is not valid and you have to recalibrate the R&S FSH.



The calibration remains valid if the start frequency, stop frequency, center frequency and span are subsequently changed within the calibrated frequency range. In this case, the R&S FSH interpolates the correction data between the reference points of the calibration. The R&S FSH retains the calibration values but indicates a possible increase in measurement uncertainty by displaying (Interp) in the status line.

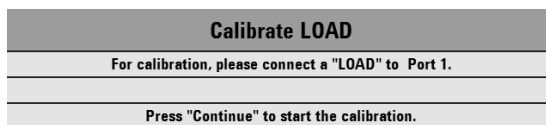
- Press the MEAS key.
- Press the CALIBRATE softkey.
- Select the TRANSMISSION FWD (PORT1⇨2) menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the CALIBRATE softkey.

To perform the calibration, the R&S FSH asks you to connect its RF input to the tracking generator output.



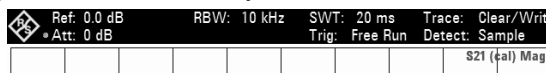
- Connect the RF input of the R&S FSH directly to the tracking generator output without the DUT.
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

Next, the R&S FSH asks you to terminate the output of the tracking generator into 50 Ω (LOAD).



- Connect the generator output to a 50 Ω termination
- Press the CONTINUE softkey to resume the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).



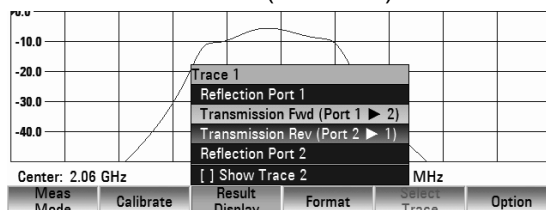
### 4.13.3.3 Setting the Result Display

The R&S FSH can show different measurement results. In the result display menu, you can choose from

- the reflection at port 1 (REFLECTION PORT 1)
- the reflection at port 2 (REFLECTION PORT 2)
- the transmission in forward direction (TRANSMISSION FWD (Port 1 ►2))
- the transmission in reverse direction (TRANSMISSION REV (Port 2 ►1))

In its default state, the R&S FSH displays the transmission in reverse direction (Port 2 ►1).

- Press the RESULT DISPLAY softkey.
- Select the result display menu item you want with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the RESULT DISPLAY softkey



The R&S FSH now displays the selected measurement result on the screen.

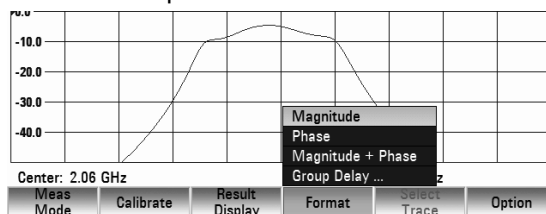
### 4.13.3.4 Selecting the Measurement Format

After you have selected the result display, you can view different aspects of the results. The number of available measurement formats depends on the measurement mode and result display you have selected previously.

#### Measuring the Transmission Magnitude

Connect the DUT between the tracking generator output and the RF input.

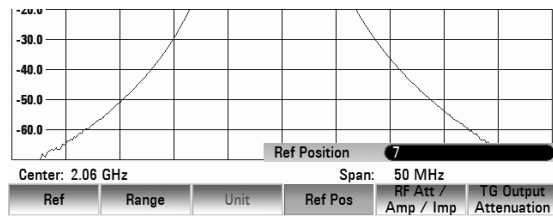
- Press the FORMAT softkey.
- Select the MAGNITUDE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.



The R&S FSH shows the currently selected measurement format in the status line (S21 (Cal) Mag in case of the transmission magnitude).

You can now adjust the reference position for better viewing results.

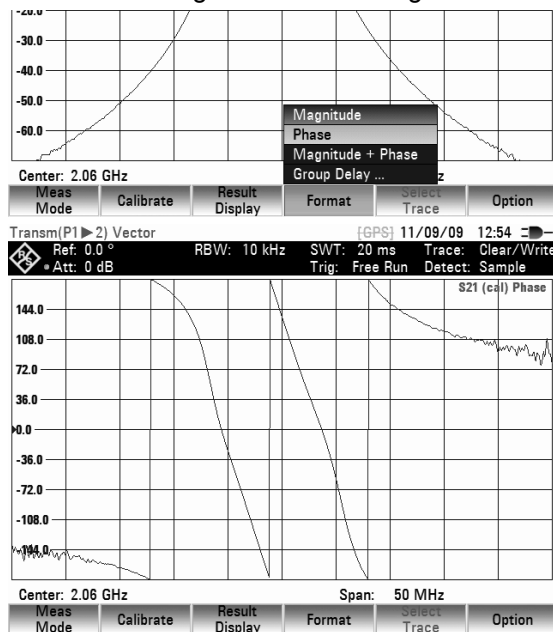
- Press the AMPT key
- Press the REF POS softkey
- Set the reference position with the number keys, the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the REFPOS softkey.



**Measuring the Transmission Phase**

Transmission phase measurements are available for models with an integrated VSWR bridge.

- Press the FORMAT softkey.
- Select the PHASE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.



The R&S FSH displays the DUT's phase characteristic as a function of the frequency.

The R&S FSH shows the currently selected measurement format in the status line (S21 (Cal) Phase in case of the transmission phase).

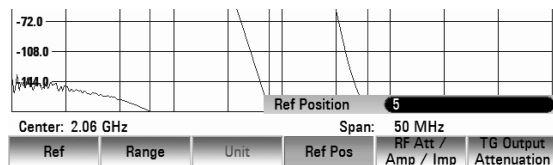
In the default scaling, the phase can only have values between -200° and +200°.

**Note:**

*In the diagram's default scaling of -200° to +200°, the trace will be shown correctly only if the phase difference between two adjacent test points is less than 180°.*

You can now adjust the reference position for better viewing results, for example to move the trace to the center of the screen.

- Press the AMPT key.
- Press the REF POS softkey.
- Set the reference position with the number keys, the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the REF POS softkey.



**Measuring the Electrical Length When Measuring Transmission (Models with Integrated VSWR Bridge only)**

Measurement of the electrical length is available for models with an integrated VSWR bridge.

The electrical length is calculated from the phase delay

$$\tau_{\Phi} = \frac{\Delta\Phi}{2\pi f}$$

where  $\Delta\Phi$  designates the phase deviation over the entire frequency range.

The electrical length is derived by

$$l_{\Phi} = \tau_{\Phi} c_0$$

where  $c_0$  = velocity of light.



The result for the electrical length is correct only if the phase difference between two adjacent test points does not exceed 180°.

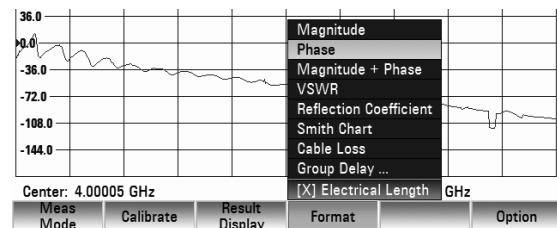


By definition, the electrical length is calculated from the vacuum velocity of light and the differential group delay  $\tau_g$  (see above). Here, the group delay is replaced by the phase delay for two reasons:

- An electrical length needs to be specified only for non-dispersive DUTs in which phase delay and group delay match.
- Due to the significantly wider aperture, the measurement certainty is an order of magnitude higher in the phase delay measurement than in the group delay measurement.

- Press the FORMAT softkey.
- Select the ELECTRICAL LENGTH menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

The R&S FSH displays the electric length it has calculated.



### 4.13.3.5 Supplying DC voltage to active DUTs (models with integrated VSWR bridge only)

By using the R&S FSH, DC voltage can be supplied to active DUTs such as amplifiers, through the integrated bias connectors (BIAS 1 and BIAS 2) via the RF cable. The DC voltage is fed in from a suitable external power supply (max. 600 mA/max. 50 V). To measure the antenna coupling of mobile radio base stations, the DC voltage must be supplied to two tower-mounted amplifiers (TMA). This is done by applying a suitable voltage at the BIAS 1 and BIAS 2 BNC inputs of the VSWR bridge.

## 4.13.4 Measuring the Reflection

### 4.13.4.1 Scalar Reflection Measurement

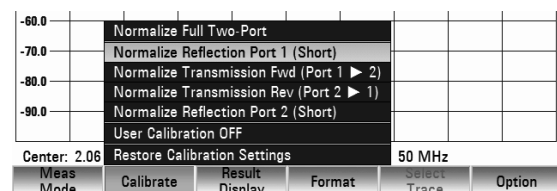
When performing scalar reflection measurements, you have to calibrate the R&S FSH before starting the measurement in order to get valid results. For successful calibration, you have to connect an open or a short at the point where the measurement takes place. If you insert a cable between the DUT and the bridge, you need to perform the calibration at the measurement end of the cable

- Press the MEAS MODE softkey.
- Select the SCALAR menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

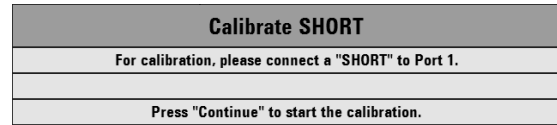
#### Calibrating the measurement

Before calibrating the R&S FSH, you have to set the center frequency and span you need. If set later, the calibration is not valid and you have to recalibrate the R&S FSH.

- Press the CALIBRATE softkey.
- Select the NORMALIZE REFLECTION PORT 1 (SHORT) menu item with the rotary knob or the cursor keys.



To perform the calibration, the R&S FSH asks you to connect a short to the measurement input.



- Connect a short to the measurement input of the bridge.
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

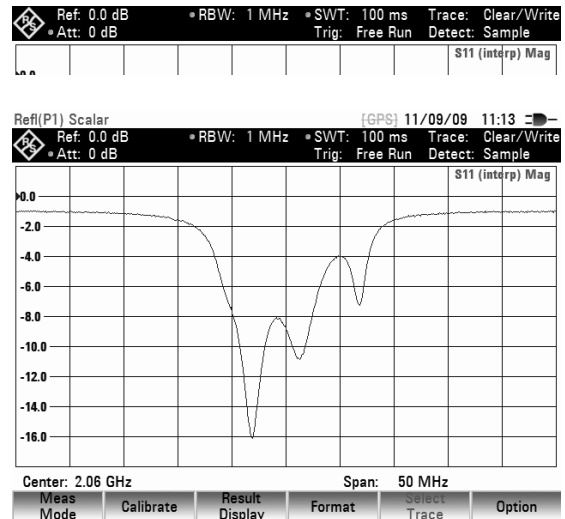


**Calibration with an open**

Instead of a SHORT, the R&S FSH can be calibrated with an OPEN. As the R&S FSH only measures the magnitude of the reflected voltage, it cannot distinguish between a SHORT and an OPEN. However, calibration with a SHORT increases measurement accuracy because the R&S FSH takes the average of the calibration values for the SHORT and the OPEN.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).

- Connect the DUT to the measurement port of the VSWR bridge.
- The R&S FSH displays the return loss of the DUT.

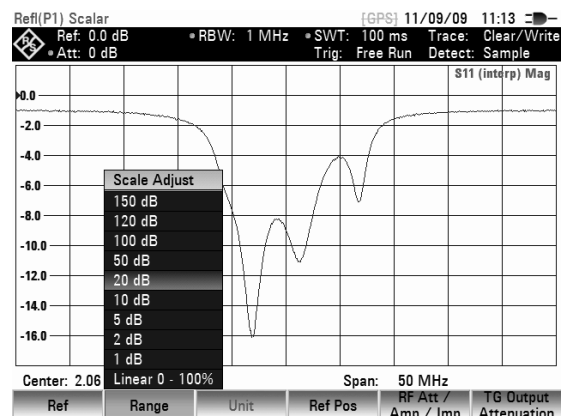


**Entering the display range**

- Press the AMPT key.
- Press the RANGE softkey.

The submenu for selecting the display ranges will open. The available display units depend on the selected reflection measurement format: return loss in dB, linear in %, standing wave ratio (VSWR), reflection coefficient (REFL COEFF (ROH)) and reflection coefficient (REFL COEFF (mROH)). Select the desired display unit by using the cursor keys or rotary knob.

The R&S FSH displays the reflection coefficient of the DUT.





### Automatic scaling

In the case of return loss and linear display, scaling is directly selected. In the case of all other units, a window for selecting the display range scaling opens. You can select a display range by using the cursor keys or the rotary knob.

Confirm the selection by pressing the ENTER key or the RANGE softkey.

The calibration for reflection measurements remains valid until you change the center frequency or the span to such an extent that the new span falls outside the calibrated frequency range. The status line again says (Uncal) if the calibration is no longer valid.

If you change the reference is changed after the calibration, you must anticipate greater measurement uncertainty. The R&S FSH retains the calibration data but displays (Interp) in the status line to indicate a possible increase in measurement uncertainty.

Changing any other of the parameters like bandwidth, detector, sweep time or measurement range has no effect on measurement accuracy. You can therefore change these parameters after the calibration without reducing the accuracy of the results.

You can save calibration data like other data sets after you have performed the calibration. That means that you can simply load the data set containing the calibration data and then perform measurements without calibrating the R&S FSH first.

#### 4.13.4.2 Vector Measurement of Reflection

Vector measurements are possible only with an R&S FSH4/8 with tracking generator and integrated VSWR bridge (order number 1309.6000.24 or 1309.6000.28) that is equipped with option R&S FSH-K42 (vector reflection and transmission measurement) and in conjunction with accessories R&S FSH-Z28 or R&S FSH-Z29 (calibration standards).

Unlike scalar measurements, the R&S FSH corrects the waveform reflected by the DUT according to magnitude and phase by means of the correction values obtained from calibration. In addition to calibration with open circuit and/or short circuit, calibration with a 50  $\Omega$  termination is necessary. Thus, the characteristics of the VSWR bridge (directivity and impedances) no longer affect the measurement result. Rather, the decisive factor is the quality of the calibration parameters open circuit, short circuit and 50  $\Omega$  termination. Vector measurement therefore yields higher dynamic range and thus accuracy. Due to the higher dynamic range, the display ranges for the VSWR and VSWR 1 – 1.5 and VSWR 1 – 1.1 have been expanded. As a result, extremely well matched DUTs can be measured more accurately and at a higher display resolution. However, a major advantage of the vector measurement is the capability to display the complex test results in a Smith chart. This allows for a much more detailed look at the DUT characteristics than with the reflection magnitude display as return loss, reflection coefficient or VSWR. Moreover, the vector reflection measurement allows you to determine the phase, the group delay and the electrical length of a DUT. The specified measurement formats become available only after calibration has been performed. With vector measurements, the R&S FSH sets the bandwidths (resolution BW and video BW) to a fixed, unchangeable value. It invariably uses the sample detector as a detector. All other measurement parameters can be set as with scalar measurement.

- Press the MEAS MODE softkey.
- Select the VECTOR menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

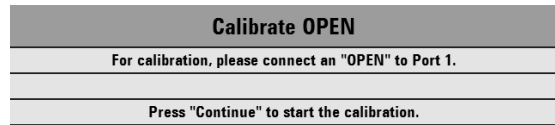
#### Calibrating the measurement

Before calibrating the R&S FSH, you have to set the center frequency and span you need. If set later, the calibration is not valid and you have to recalibrate the R&S FSH.

- Press the CALIBRATE softkey.
- Select the REFLECTION PORT 1 menu item with the rotary knob or the cursor keys

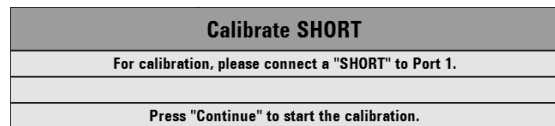
- Confirm the selection with the ENTER key or the CALIBRATE softkey.

To perform the calibration, the R&S FSH asks you to connect an open circuit to the measurement input.



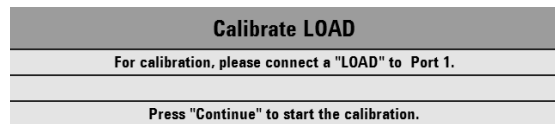
- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into an open circuit (Open).
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

After finishing the open circuit calibration, the R&S FSH ask you to terminate the measurement port into a short circuit.



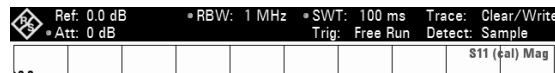
- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into a short circuit (SHORT).
- Press the CONTINUE softkey to resume the calibration.

In the third stage of the calibration, the R&S FSH asks you to connect a 50 Ω termination to the measurement port.



- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into a 50 Ω termination (LOAD)
- Press the CONTINUE softkey to resume the calibration.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).



The calibration for reflection measurements remains valid until you change the center frequency or the span to such an extent that the new span falls outside the calibrated frequency range. The status line again says (Uncal) if the calibration is no longer valid.

If you change the reference is changed after the calibration, you must anticipate greater measurement uncertainty. The R&S FSH retains the calibration data but displays (Interp) in the status line to indicate a possible increase in measurement uncertainty.

Changing any other of the parameters like bandwidth, detector, sweep time or measurement range has no effect on measurement accuracy. You can therefore change these parameters after the calibration without reducing the accuracy of the results.

You can save calibration data like other data sets after you have performed the calibration. That means that you can simply load the data set containing the calibration data and then perform measurements without calibrating the R&S FSH first.

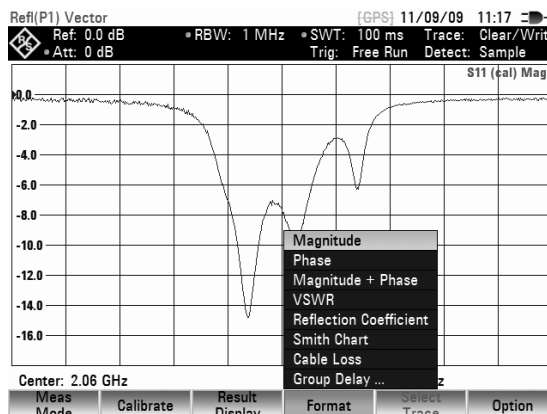
### 4.13.4.3 Selecting the Measurement Format

#### Measuring the Reflection Magnitude

Connect the DUT to the test port of the VSWR bridge.

- Press the FORMAT softkey.
- Select the MAGNITUDE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

The R&S FSH shows the return loss magnitude in the upper area of the display.



Refer to "[Scalar Reflection Measurement](#)" for more information on how to set the display unit and the scaling of the display.

#### Measuring the Reflection Phase

- Press the FORMAT softkey.
- Select the PHASE menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the FORMAT softkey.

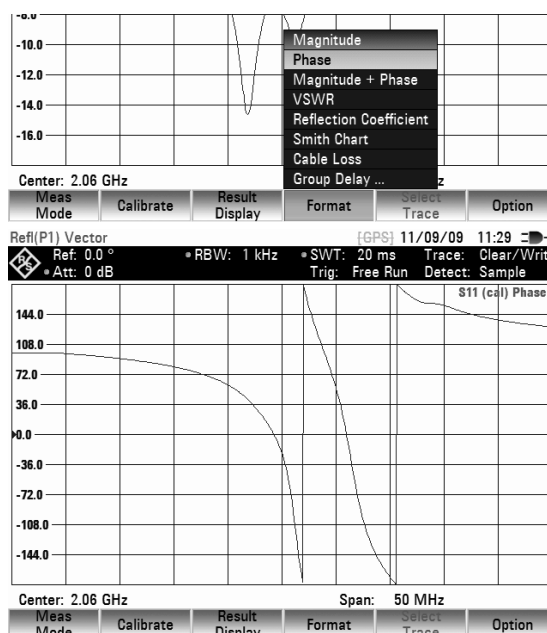
The R&S FSH displays the DUT's phase characteristic as a function of the frequency.

The status line says S11 (Cal) Phase.

In the default setting, the phase can only have values between  $-200^\circ$  and  $+200^\circ$ .

**Note:**

*In the diagram's default scaling of  $-200^\circ$  to  $+200^\circ$ , the trace will be shown correctly only if the phase difference between two adjacent test points is less than  $180^\circ$ .*

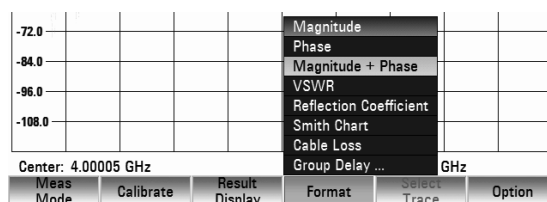


For additional information on the scaling of the phase measurement, see section "Measuring the transmission phase".

Refer to "[Vector Transmission Measurement](#)" for more information on how to set the scaling of the display.

#### Measuring the Reflection Magnitude and Phase Simultaneously

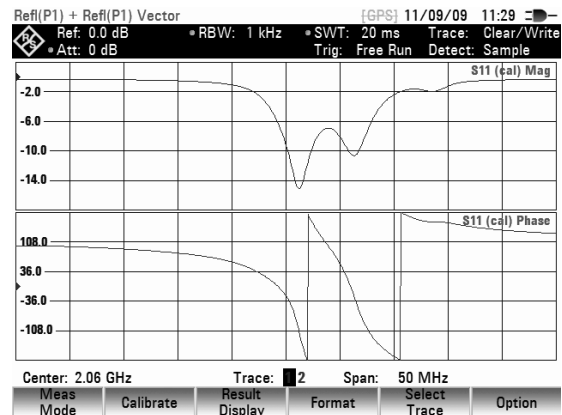
- Press the FORMAT softkey.
- Select the MAGNITUDE + PHASE menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.



The R&S FSH now shows the results as two traces in two diagrams.

In the upper diagram the R&S FSH shows the magnitude of the reverse attenuation. In the lower diagram it shows the phase curve of the DUT as functions of frequency.

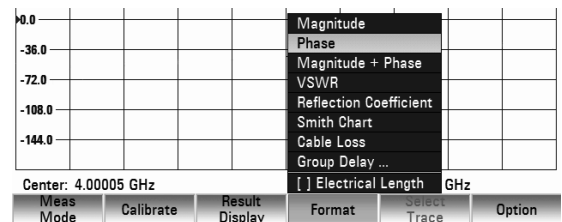
The status line of trace 1 say S11 (Cal) Mag and the status line of trace 2 says S11 (Cal) Phase).



**Selecting other Measurement Formats**

In addition to the magnitude and phase, the R&S FSH can display the following measurement formats:

- VSWR
- Reflection Coefficient
- Smith Chart
- Cable Loss
- Group Delay
- Electrical Length
- Press the FORMAT softkey.
- Select one of the measurement formats from the menu.
- Confirm the selection with the ENTER key or the FORMAT softkey.



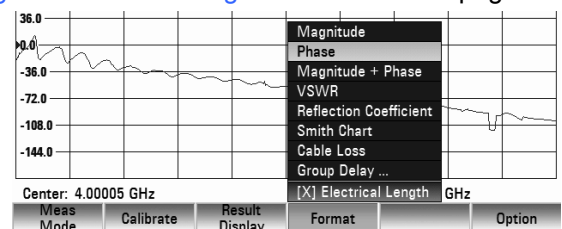
The R&S FSH displays the selected format.

- In case of the VSWR format it shows the Voltage Standing Wave ratio in a cartesian diagram. The VSWR is the ratio of the maximum voltage and the minimum voltage that occur in an electrical transmission line.
- In case of the Reflection Coefficient format it shows the ratio of the amplitude of a reflected wave and that of the incidental wave that occur in an electrical transmission line.
- In case of the Smith Chart format it shows the Smith Chart. For details on handling the Smith Chart refer to "[Displaying the Reflection in the Smith Chart](#)" on page 104
- In case of the Cable Loss format it shows the attenuation vs frequency provided by a cable.
- In case of the Group Delay format it describes the propagation time of a wave through a device.
- In case of the Electrical Length it shows the Electrical Length of a DUT. For details on this measurement format refer to "[Measuring the Electrical Length When Measuring Transmission](#)" on page 98

**Measuring the Electrical Length when Measuring Reflection**

For more information see "[Measuring the Electrical Length When Measuring Transmission](#)" on page 98

- Press the FORMAT softkey.
- Select the ELECTRICAL LENGTH menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

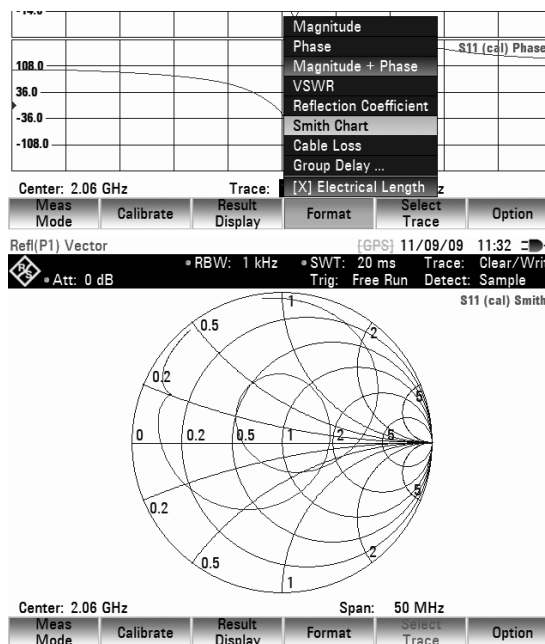


The R&S FSH shows the calculated electrical length on the display.

**Displaying the Reflection in the Smith Chart**

- Press the FORMAT softkey.
- Select the SMITH CHART menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

The R&S FSH shows the reflection of the DUT in the Smith chart.



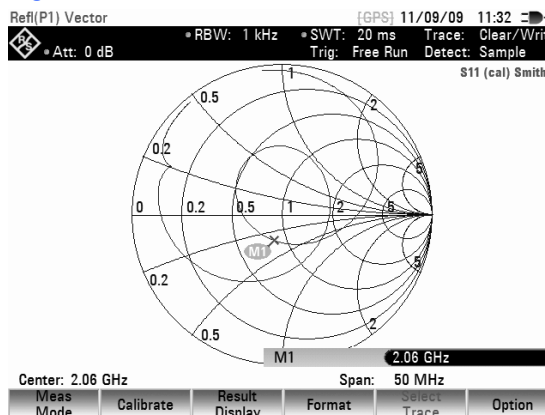
**Using the markers in the Smith chart:**

Like scalar measurements, the Smith chart provides all marker functions (marker, delta marker, multi-marker). The Smith chart also provides additional marker formats for vector reflection measurements. For more information on marker functionality, refer to "Using Markers".

- Press the MARKER key.  
The marker menu opens and the R&S FSH activates a marker.
- Shift the marker on the complex reflection curve with the rotary knob or the cursor keys.
- Alternatively, you can enter a marker position with the number keys.

By default, the R&S FSH shows marker values in numeric format with the marker frequency and complex resistance in  $\Omega$ , with complex resistance = (real component)+j(imaginary component).

If you want to display the complex reflection factor, for example, you can modify the marker format accordingly.



**Selecting the marker format**

- Press the MKR key.
- Press the MARKER MODE softkey.
- Select one of the available marker formats with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MARKER MODE softkey.

You can choose one of the following marker formats:

- 'dB Magn + Phase (Rho)' outputs the marker value for the reflection factor in complex magnitude phase format, where the magnitude is converted to dB.
- 'Lin Mag + Phase (Rho)' outputs the marker value for the reflection factor in complex magnitude phase format, where the magnitude is linearly converted to a percent value.

- 'Real + Imag (Rho)' outputs the marker value for the reflection factor in complex format with real and imaginary components.
- 'R+jX' shows the marker value for the impedance in complex format with real and imaginary components. In addition, the imaginary component of the impedance is converted to inductance or capacitance and displayed, with the marker frequency and sign taken into account.
- 'G+jB' shows the marker value for the admittance in complex format with real and imaginary components. In addition, the imaginary component of the admittance is converted to inductance or capacitance and displayed, with the marker frequency and sign taken into account.
- '(R+jX/Z0)' displays the marker value for the standardized impedance in complex format with real and imaginary components.
- '(G+jB/Z0)' displays the marker value for the standardized admittance in complex format with real and imaginary components.

### Defining the reference impedance

By default, the Smith chart is standardized to an impedance of 50  $\Omega$ . In other words, the matching point in the center of the Smith chart corresponds exactly to 50  $\Omega$ . However, reflection measurements using suitable matching networks and calibration standards can also be carried out in systems with different impedance values. In this case, you can adjust the reference impedance for the Smith chart as you need.

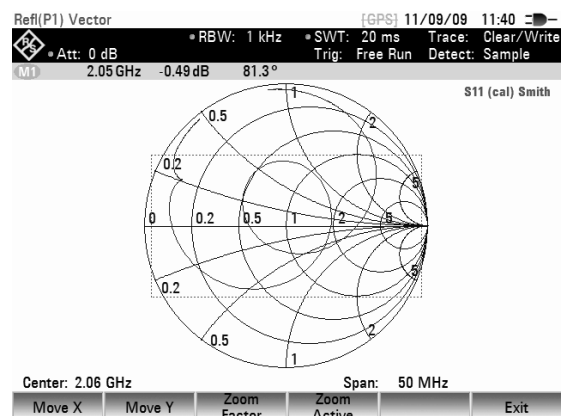
- Press the MKR key.
- Press the MARKER MODE key.
- Select the REF IMPEDANCE 50  $\Omega$  menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the MARKER MODE softkey.  
The R&S FSH opens a dialog box to enter the reference impedance.

You can enter any value between 1 m $\Omega$  and 10 k $\Omega$ .

### Zooming in on parts of the Smith chart

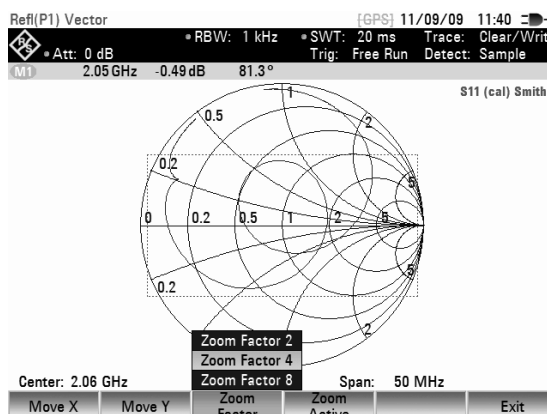
To get a better look at the measurement results, you can use the zoom function to enlarge any part of the Smith chart.

- Press the TRACE key.
- Press the ZOOM softkey.  
The R&S FSH opens the zoom menu. A zoom window appears in the Smith chart.  
The window's size and position are variable.
- You can deactivate the zoom at any time by pressing the EXIT softkey.  
The R&S FSH has several zoom factors that define the size of the zoom window.





- Press the ZOOM FACTOR softkey.  
Zoom factors 2, 4 and 8 are available.
- Select the zoom factor from the menu with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the ZOOM FACTOR softkey.  
Possibly you'd like to see a particular part of the Smith chart after zooming in on it.  
By default, the R&S FSH zooms in on the center of the Smith chart.

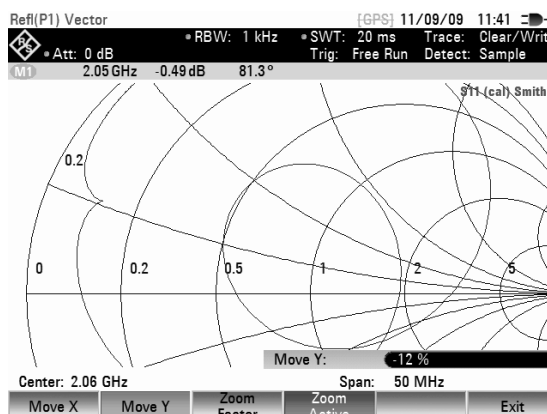


The center of the Smith chart is also the reference point for shifting the zoom window vertically and horizontally. The amplitude of the shift is a percentage and ranges from -50% to +50% for both vertical and horizontal directions.

The equation  $x = y = 0\%$  corresponds to the center of the Smith chart.

- Press the MOVE X softkey.
- Enter a value between -50% and 50% with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key or the MOVE X softkey.  
The R&S FSH shifts the window in the direction you have specified.
- Press the MOVE Y softkey.
- Enter a value between -50% and 50% with the number keys, the rotary knob or the cursor keys.

- Confirm the entry with the ENTER key or the MOVE Y softkey.  
The R&S FSH shifts the window in the direction you have specified.  
Now that you have defined the zoom factor and position of the zoom window, you can activate the zoom.
- Press the ZOOM ACTIVE softkey.  
The R&S FSH now zooms in on the area covered by the zoom window. You can fine-adjust the position of the zoom window with the MOVE X and MOVE Y softkeys as described.



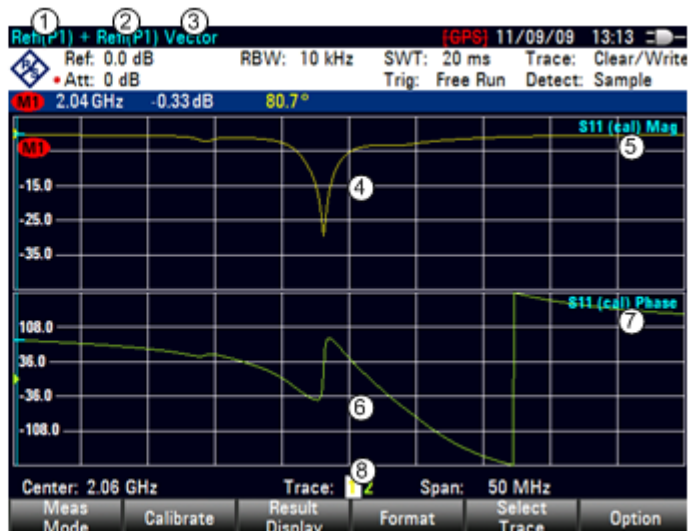
- You can deactivate the zoom at any time by pressing the ZOOM ACTIVE softkey.

### 4.13.5 Performing Measurements in Dual Trace Mode

When performing vector measurements, it is possible to perform and display two measurements simultaneously. After activating this function, the R&S FSH shows the two traces on two separate screens. This allows you to view any combination of two vector measurement formats on the display. Note that the Magnitude + Phase measurement format is an exception to this rule (see "[Measuring the Reflection Magnitude and Phase](#)" on page 103). This format counts as one trace. To display the magnitude and phase as two separate traces, assign the Phase format to trace 1 and the Magnitude format to trace 2.

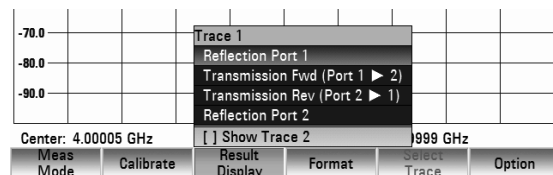
Screen Layout in Dual Trace Mode

- ① Result Display Trace 1
- ② Result Display Trace 2
- ③ Measurement Mode
- ④ Trace Window 1
- ⑤ Trace Information Trace 1:
  - S-Matrix
  - Calibration Status
  - Measurement Format
- ⑥ Trace Window 2
- ⑦ Measurement Format Trace 2
- ⑧ Active Trace Indicator



➤ Press the RESULT DISPLAY softkey. The menu shows all measurements available for the currently selected measurement mode. By default, only one trace, and therefore only one screen, is active.

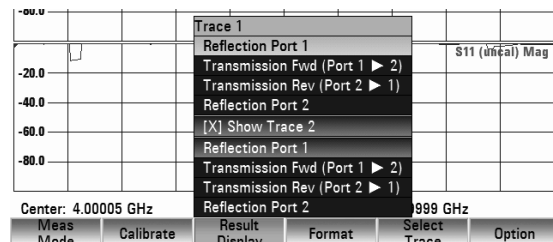
- Select the SHOW TRACE 2 menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the RESULT DISPLAY softkey.



The R&S FSH splits the screen. The upper screen shows trace 1, the bottom screen shows trace 2. You can configure both screens as you like.

To indicate the dual trace mode is active, an [X] is in front of the SHOW TRACE 2 menu item.

In addition, the menu of the RESULT DISPLAY softkey expands. It now shows the available vector measurements that can be applied to trace 2.



After activating the second trace, trace 1 is always the active trace. Only the active trace can be configured, while the other is passive.

- To activate trace 2, press the SELECT TRACE softkey in the trace menu. When pressing the SELECT TRACE softkey, the R&S FSH switches between trace 1 and 2. The trace indicator shows the currently active trace:

**Trace: 1 2**

After selecting trace 2, you can set the measurement parameters for trace 2, while the first trace is passive.

You can also use the Trace Memory using the SHOW softkey in the TRACE menu. Restoring a saved trace is possible only for the currently active trace (i.e. screen 1 or screen 2). Refer to section Trace Memory on page 43 for further information on how to use the trace memory.

### 4.13.6 Working with Channel Tables in Network Analyzer Mode

The R&S FSH allows you to use channel tables in Network Analyzer mode.

- Press the **FREQ** key.
- Press the **CHANNEL TABLE** softkey.  
The R&S FSH opens the list of channel tables loaded into the R&S FSH via R&S FSH4View.
- Select the desired channel table with the rotary knob or the cursor keys and switch it on with the **SELECT** softkey.  
The R&S FSH scans the channel table for the channels with the lowest and highest frequencies and sets those as the start and stop frequency.

You can define channel tables using the R&S FSH4View software and load them into the spectrum analyzer. The R&S FSH can store more than 100 different channel tables that can be activated from the front panel as required. The maximum number of channel tables may be reduced if transducer factors, cable models, limit values or data sets are stored simultaneously (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

Refer to the manual of the R&S FSH4View software for information on how to create channel tables.

### 4.13.7 Using Limit Lines in Network Analyzer Mode

When working with the magnitude format in the network analyzer, you can use limit lines to set limits for level characteristics on the display that must not be exceeded.

You can create and edit limit lines with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of limit lines the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see "[Saving and Loading Instrument Settings and Measurement Results](#)" in this manual).

For information on how to work with limit lines, see

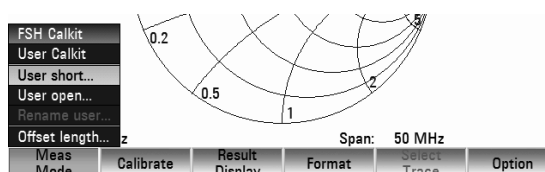
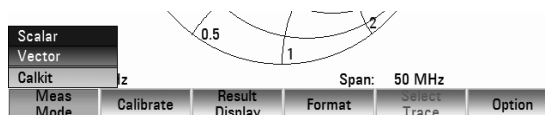
- [Using Limit Lines](#) on page 54

### 4.13.8 Selecting the Calibration Standards

Optionally, the calibration standards R&S FSH-Z28 and R&S FSH-Z29 are available for the R&S FSH. The open and short calibration standards each have an electrical length of 5.27 mm. To eliminate the phase error that would result, the electrical length for the S11 measurement is corrected as standard. Standards other than R&S calibration standards can also be used. This is conditional on the difference in the electrical lengths of the open and short being as close to zero as possible. A length difference introduces an additional phase error. The R&S FSH can also post-correct a phase shift due to other cables and adapters that are used for S11 and S21 measurements.

#### Operating sequence

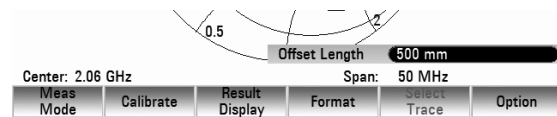
- Press the **MEAS MODE** softkey.
- Select the **CALKIT...** menu item with the rotary knob or the cursor keys.
- Confirm the selection with the **ENTER** key or the **MEAS MODE** softkey.  
A second menu to specify the calibration standard opens.
- Select the **USER SHORT** or **USER OPEN** menu item with the rotary knob or the cursor keys
- Confirm the selection with the **ENTER** key or the **MEAS MODE** softkey.



The **USER SHORT** menu item opens an input field to specify the electrical length of the short.

The USER OPEN menu item opens an input field to specify the electrical length of the open.

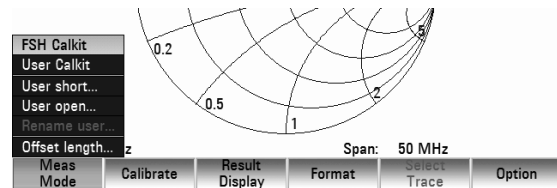
- Enter the electrical length of the calibration standard you are using with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key.



The R&S FSH now takes the electrical length of the calibration standard into account for phase measurements and in the Smith chart.

If you are using the calibration standards R&S FSH-Z28 or R&S FSH-Z29, proceed as follows.

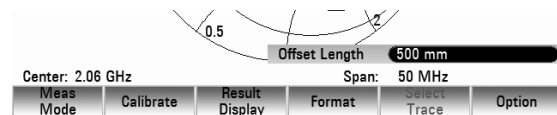
- Press the MEAS MODE softkey.
- Select the FSH CALKIT menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.



If you want to take phase correction for additional cables and adapters into account, proceed as follows.

- Select the OFFSET LENGTH... menu item with the rotary knob or the cursor keys.
  - Confirm the selection with the ENTER key or the MEAS MODE softkey.
- An input field to enter the offset length opens.

- Enter an offset length with the number keys, the rotary knob or the cursor keys.

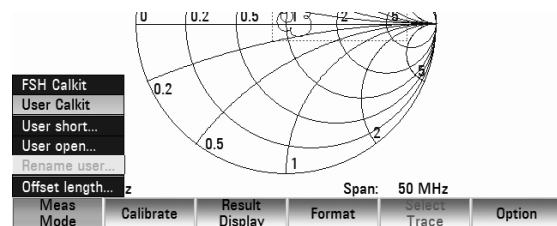


The R&S FSH now takes the additional electrical length into account for phase measurements and in the Smith chart.

You can give a name to the USER calibration standard. The R&S FSH then shows the name of the USER calibration standard that you have entered in the R&S FSH status display so that you can, for example, document the settings when the measurement is documented.

- Select the RENAME USER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

The R&S FSH opens the entry window for the name of the USER standard.



- Enter a name with the number keys.
- Confirm the entry with the ENTER key.

After selecting the user standard, the R&S FSH shows the name of the user calibration standard in the R&S FSH status display

## 4.14 Vector Voltmeter

The Vector Voltmeter functionality is available for the R&S FSH4/8 with tracking generator and integrated VSWR bridge (order number 1309.6000.24 or 1309.6000.28) that is equipped with option R&S FSH-K45 (vector voltmeter)

Vector voltmeters are very popular and are used for simple reflection measurements ( $S_{11}$ ) and transmission measurements ( $S_{21}$ ). The signal source generates an unmodulated sinewave signal (single frequency).

Typical applications are:

- Adjustment of the electrical length of cables by using an  $S_{11}$  measurement
- Testing of the antenna elements of a phase-controlled antenna-array relative to a reference antenna ( $S_{21}$  measurement)

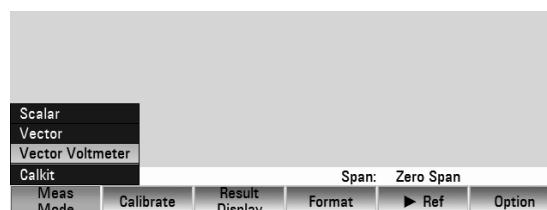
Owing to the Vector Voltmeter function, an R&S FSH with VSWR bridge (models 1309.6000.24 and 1309.6000.28) can replace a vector voltmeter, plus it makes the signal source that is usually required superfluous.

### 4.14.1.1 Reflection Measurements ( $S_{11}$ )

#### Operating sequence

- Press the MODE key.
- Press the NETWORK ANALYZER softkey.
- Press the MEAS MODE softkey.

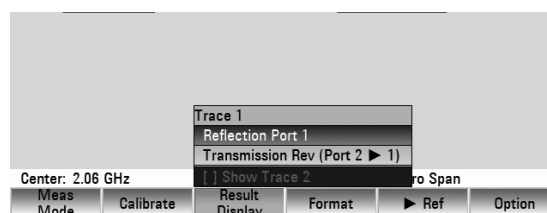
The R&S FSH opens the measurement function menu.



- Select the menu item VECTOR VOLTMETER with the cursor keys or the rotary knob and confirm the selection with the ENTER key or the MEAS MODE softkey.

The R&S FSH turns on the tracking generator and goes into the ZERO SPAN mode. The frequency and level settings from the spectrum analyzer mode are retained.

- Press the RESULT DISPLAY softkey and select REFLECTION PORT 1 from the menu with the cursor keys or the rotary knob. Confirm the selection with the ENTER key or the RESULT DISPLAY softkey.



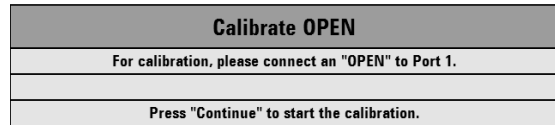
#### Calibrating the Measurement

You have to calibrate the test setup before you can perform measurements. For successful calibration, you have to connect an open, a short and a 50  $\Omega$  terminating impedance at the point where the measurement takes place. If you insert a cable between the DUT and the bridge, you need to perform the calibration at the measurement end of the cable

Before calibrating the R&S FSH, you have to set the center frequency and span you need. If set later, the calibration is not valid and you have to recalibrate the R&S FSH.

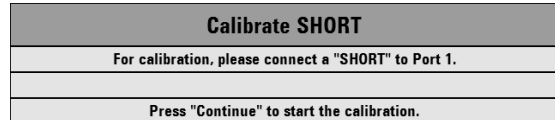
- Press the CALIBRATE softkey.
- Select the REFLECTION PORT 1 menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the CALIBRATE softkey.

To perform the calibration, the R&S FSH asks you to connect an open circuit to the measurement input.



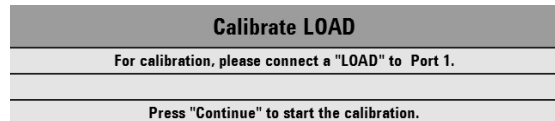
- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into an open circuit (Open).
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

After finishing the open circuit calibration, the R&S FSH ask you to terminate the measurement port into a short circuit.



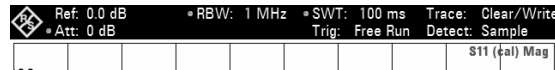
- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into an short circuit (Open).
- Press the CONTINUE softkey to resume the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

In the third stage of the calibration, the R&S FSH asks you to connect a 50 Ω termination to the measurement port.

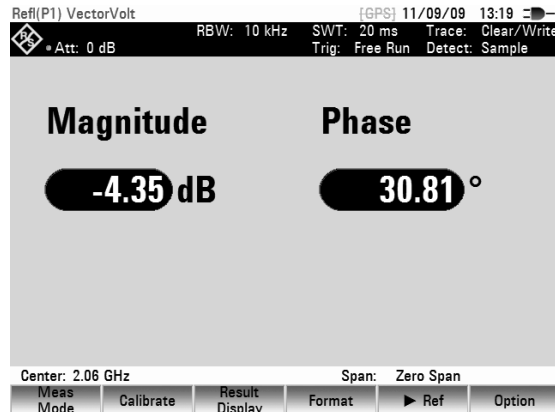


- Terminate the measurement input of the VSWR bridge or the end of the measurement cable into a 50 Ω termination (LOAD).
- Press the CONTINUE softkey to resume the calibration.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).



If calibration has been completed successfully, the R&S FSH displays the numerical values for the return loss and for the phase of the DUT.



The calibration for reflection measurements remains valid until you change the center frequency. The status line again says (Uncal) if the calibration is no longer valid.

Changing any other of the parameters like sweep time has no effect on measurement accuracy. You can therefore change these parameters after the calibration without reducing the accuracy of the results.

You can save calibration data like other data sets after you have performed the calibration. That means that you can simply load the data set containing the calibration data and then perform measurements without calibrating the R&S FSH first.

**Entering the display unit**

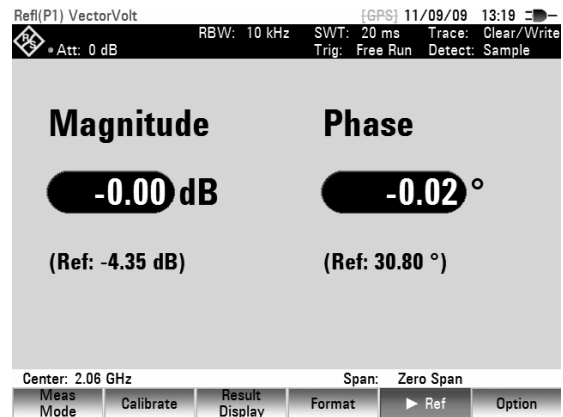
- Press the AMPT key.
- Press the RANGE softkey.  
The R&S FSH opens the menu for selecting the unit that is displayed. The following display units are available for reflection measurements: return loss in dB, linear in %, VSWR, reflection coefficient (REFL COEFF (ROH)), and reflection coefficient (REFL COEFF (mROH)).
- Select the unit you need with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the RANGE softkey.



In the Vector Voltmeter mode, the display ranges have no effect on the numerical values.

If you perform measurements on different DUTs whose results you'd like to compare, you can save the current results as reference values.

- Press the REF ► softkey.  
The R&S FSH saves the results that it got prior to pressing the softkey as the reference results for future measurements.  
After activating the reference measurement, the R&S FSH shows the results as relative values instead of absolute values. The results are therefore calculated from the reference and the current measurement results.



For better orientation, the R&S FSH always shows the reference results below the measurement results.

The unit for reference measurements is always dB.

Relative measurements are possible only for the return loss (dB) format. If a unit other than dB has already been selected, the R&S FSH automatically switches to the return loss display.

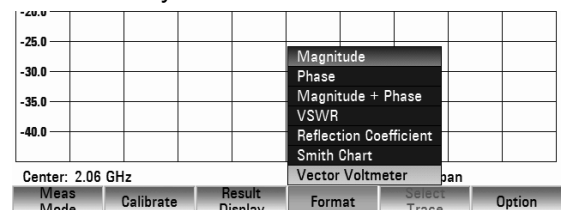
In addition to the magnitude and phase, you can choose one of the following measurement formats:

- Magnitude +Phase
- VSWR
- Reflection Coefficient
- Smith Chart

For more information on the available measurement formats, refer to "[Selecting the Measurement Format](#)".

- Press the FORMAT softkey.
- Select one of the available menu items with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

Depending on the measurement mode that has been selected, the R&S FSH displays corresponding trace.



Proceed as follows to return to the Vector Voltmeter display:

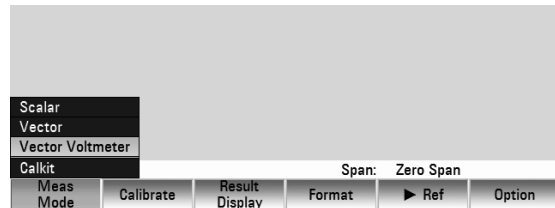
- Press the FORMAT softkey.

- Select the VECTOR VOLTMETER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

**4.14.1.2 Transmission Measurements (S<sub>21</sub>)**

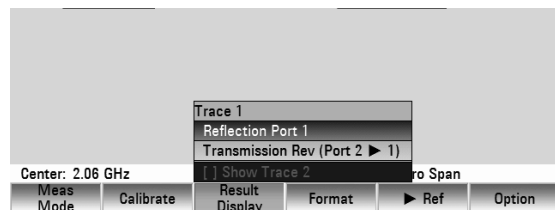
- Press the MODE key.
- Press the NETWORK ANALYZER softkey.
- Press the MEAS MODE softkey.  
The R&S FSH opens the measurement function menu.

- Select the VECTOR VOLTMETER menu item VECTOR VOLTMETER with the rotary knob or the cursor keys



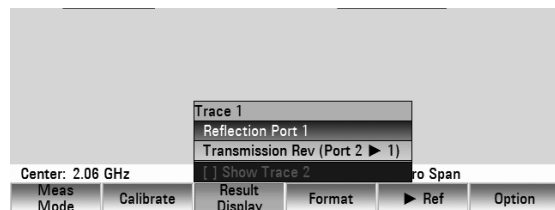
- Confirm the selection with the ENTER key or the MEAS MODE softkey.

- Press the RESULT DISPLAY softkey and select REFLECTION PORT 1 from the menu with the cursor keys or the rotary knob. Confirm the selection with the ENTER key or the RESULT DISPLAY softkey.



The R&S FSH activates the tracking generator and switches to zero span mode (time domain). The frequency and level settings from the spectrum analyzer mode are retained.

- Press the RESULT DISPLAY softkey
- Select the REFLECTION PORT 1 menu item from with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the RESULT DISPLAY softkey.



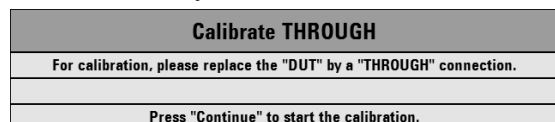
**Calibrating the measurement**

You have to calibrate the test setup before you can perform measurements. For successful calibration, you have to apply a through connection between the tracking generator output and the RF input and a 50 Ω terminating impedance at the tracking generator output. Instead of a through connection, it is also possible to use a reference DUT.

Before calibrating the R&S FSH, you have to set the center frequency and span you need. If set later, the calibration is not valid and you have to recalibrate the R&S FSH.

- Press the CALIBRATE softkey.
- Select the TRANSMISSION REV (PORT 2 ▶ 1) menu item with the rotary knob or the cursor keys
- Confirm the selection with the ENTER key or the CALIBRATE softkey.

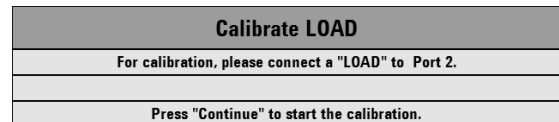
To perform the calibration, the R&S FSH asks you to connect the RF output to the input of the tracking generator (through connection).





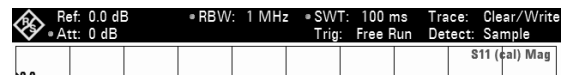
- Start the calibration by pressing CONTINUE.  
You can abort the calibration at any stage with the CANCEL softkey.
- Connect the RF output directly to the generator input without the DUT. If necessary you can also connect the RF output to a reference DUT.
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

In the second stage of the calibration, the R&S FSH asks you to connect a 50  $\Omega$  termination to the measurement port.

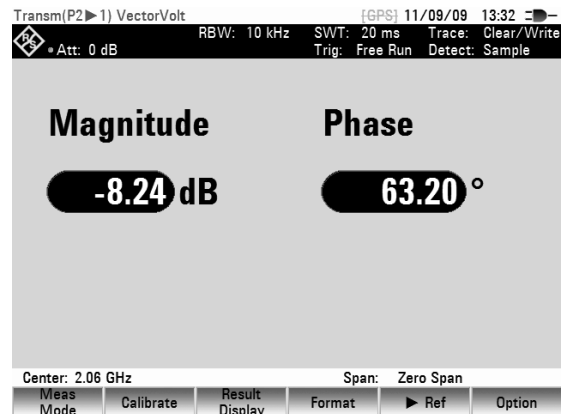


- Terminate the tracking generator output into a 50  $\Omega$  termination (LOAD).
- Press the CONTINUE softkey to resume the calibration.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).



If calibration has been completed successfully, the R&S FSH displays the numerical values for the transmission loss and for the phase of the DUT.



The calibration for transmission measurements remains valid until you change the center frequency. The status line again says (Uncal) if the calibration is no longer valid.

Changing any other of the parameters like sweep time has no effect on measurement accuracy. You can therefore change these parameters after the calibration without reducing the accuracy of the results.

You can save calibration data like other data sets after you have performed the calibration. That means that you can simply load the data set containing the calibration data and then perform measurements without calibrating the R&S FSH first.

### Entering the display unit

- Press the AMPT key.
- Press the RANGE softkey.  
The R&S FSH opens the menu for selecting the unit that is displayed. The following display units are available for transmission measurements: transmission loss in dB and linear in %.
- Select the unit you need with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the RANGE softkey.



In the Vector Voltmeter mode, the display ranges have no effect on the numerical values.

If you perform measurements on different DUTs whose results you'd like to compare, you can save the current results as reference values.

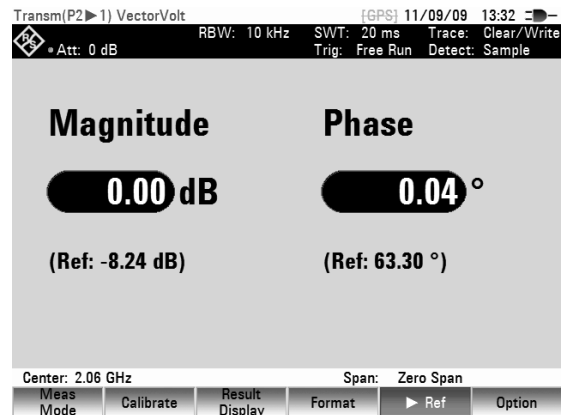
- Press the REF ► softkey.  
The R&S FSH saves the results that it got prior to pressing the softkey as the reference results for future measurements.

After activating the reference measurement, the R&S FSH shows the results as relative values instead of absolute values. The results are therefore calculated from the reference and the current measurement results.

For better orientation, the R&S FSH always shows the reference results below the measurement results.

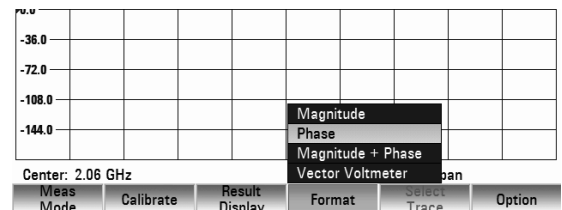
The unit for reference measurements is always dB.

Relative measurements are possible only for the transmission loss (dB) format. If a unit other than dB has already been selected, the R&S FSH automatically switches to the return loss display.



In Vector Voltmeter mode, you can display the magnitude and phase in the time domain either separately or combined.

- Press the FORMAT softkey.
- Select the desired display mode with the cursor keys or the rotary knob.
- Terminate the selection with the ENTER key or the FORMAT softkey.



Depending on the measurement format that you have selected, the R&S FSH displays the magnitude, the phase or both in the time domain.

Proceed as follows to return to the Vector Voltmeter display:

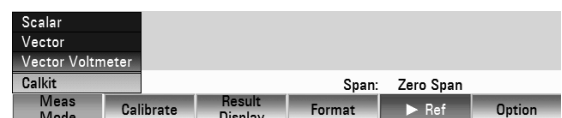
- Press the FORMAT softkey.
- Select the VECTOR VOLTMETER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the FORMAT softkey.

### 4.14.1.3 Selecting a calibration standard

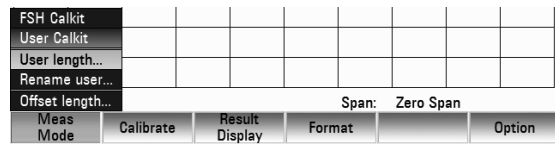
Optionally, the calibration standards R&S FSH-Z28 and R&S FSH-Z29 are available for the R&S FSH. The open and short calibration standards each have an electrical length of 5.27 mm. To eliminate the phase error that would result, the electrical length for the S11 measurement is corrected as standard. Standards other than R&S calibration standards can also be used. This is conditional on the difference in the electrical lengths of the open and short being as close to zero as possible. A length difference introduces an additional phase error. The R&S FSH can also post-correct a phase shift due to other cables and adapters that are used for S11 and S21 measurements.

#### Operating sequence

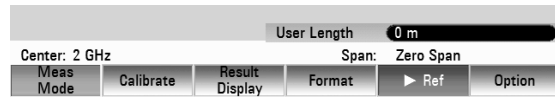
- Press the MEAS MODE softkey.
- Select the CALKIT menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
A second menu to specify the calibration standard opens.



- Select the USER LENGTH menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
An input field to change the user length opens.



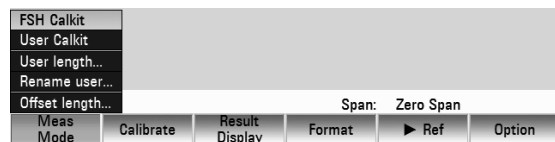
- Enter the electrical length of the calibration standard you are using with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key.



The R&S FSH now takes the electrical length of the calibration standard into account for phase measurements and in the Smith chart.

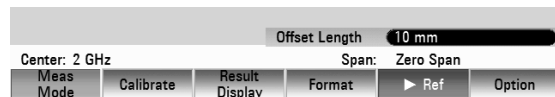
If you are using the calibration standards R&S FSH-Z38 or R&S FSH-Z39, proceed as follows.

- Press the MEAS MODE softkey.
- Select the FSH CALKIT menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.



If you want to take phase correction for additional cables and adapters into account, proceed as follows.

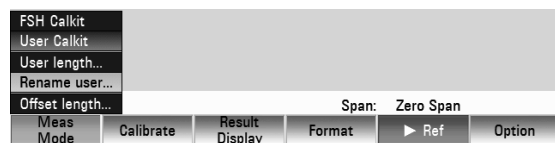
- Select the OFFSET LENGTH... menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
An input field to enter the offset length opens.
- Enter an offset length with the number keys, the rotary knob or the cursor keys.



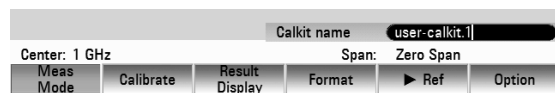
The R&S FSH now takes the additional electrical length into account for phase measurements and in the Smith chart.

You can give a name to the USER calibration standard. The R&S FSH then shows the name of the USER calibration standard that you have entered in the R&S FSH status display so that you can, for example, document the settings when the measurement is documented.

- Select the RENAME USER menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS MODE softkey.  
The R&S FSH opens the entry window for the name of the USER standard.



- Enter a name with the number keys.
- Confirm the entry with the ENTER key.



After selecting the user standard, the R&S FSH shows the name of the user calibration standard in the R&S FSH status display

## 4.15 Cable Measurements

(Only for R&S FSH with tracking generator and internal VSWR-Bridge (catalogue number 1309.6000.24 or 1309.6000.28) and installed option R&S FSH-K41 (Distance-To-Fault Measurements) in conjunction with R&S FSH-Z20 or R&S FSH-Z32x (RF cable) and R&S FSH-Z28 or R&S FSH-Z29 (calibration standards).)

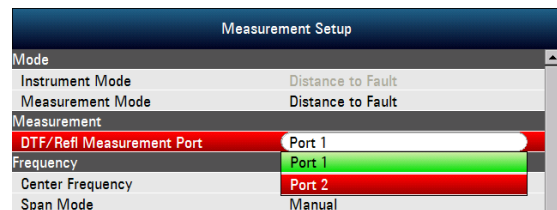
Measurements to determine the characteristics of cables to the antenna are key tasks when transmission equipment is being installed or maintained. Cable damage or bad connections have an adverse effect on the efficiency of the transmitter system. In conjunction with a tracking generator and the option "Distance-To-Fault Measurement" (DTF, R&S FSH-K41), the R&S FSH can locate cable faults and determine their distance from the measurement plane.

The only inputs required are the cable type and the approximate length. Using these parameters, the R&S FSH measures the distance to any faults and the degree of mismatch. It is easy to define the cable characteristics with the supplied R&S FSH4View software package and to transfer them to the R&S FSH. Up to 100 cable types can be stored by the R&S FSH.

The R&S FSH measures the sum of the tracking generator signal and the signal reflected by the cable under test in the frequency domain. Depending on the phase of the signal reflected at a fault relative to the generator signal there is either reinforcement or cancellation. Because of this effect there is ripple on the received sum signal in the frequency domain. The R&S FSH fast Fourier transforms the received signal to the time domain. Using the characteristic data of the cable under test, the R&S FSH directly calculates how far the reflections have travelled from the fault. The magnitude of the fault is given by the height of the reflection at a certain distance.

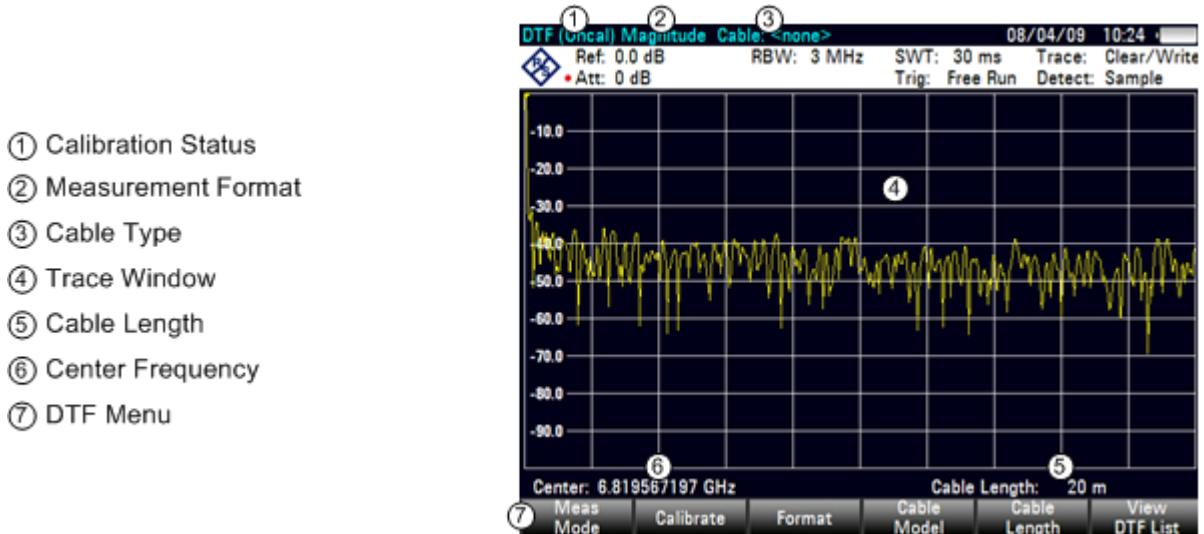
### Test setup

- Connect the RF measurement cable (R&S FSH-Z20 or R&S FSH-Z32x) either to PORT 1 or PORT 2 of the R&S FSH.
- Press the MODE key.
- Press the DISTANCE TO FAULT softkey.  
The R&S FSH activates the "Distance To Fault" operating mode.
- Press the MEAS MODE key.
- Select the DTF/REFLECTION PORT menu item with the rotary knob or the cursor keys and press ENTER.
- Depending on the port you have connected the cable to, select either Port 1 or Port 2 from the dropdown menu.



You can also select the Spectrum or Reflection measurement mode. In Spectrum mode, the R&S FSH shows the spectrum without a prior mode switch. In Reflection mode it shows the  $S_{11}$  parameter. Both modes are well suited for a quick check if there are any interfering signals that may impair results before you start the measurement.

Screen layout for cable measurements:



To perform distance-to-fault measurements, the R&S FSH needs to “know” the type of cable and its approximate length.

The cable type must be known to determine the speed of propagation and so the distance to any fault along the cable. The attenuation of the cable must be known to determine the size of the fault correctly. The R&S FSH automatically sets the span according to the approximate length of the cable.

#### 4.15.1 Cable Selection

You can create and edit frequency-dependent cable models with the R&S FSH4View software and load them into the R&S FSH via the USB or the LAN interface. The number of cable models the R&S FSH can store in its memory depends on the number of other data sets on the R&S FSH (see ["Saving and Loading Instrument Settings and Measurement Results"](#) in this manual).

For more information on how to create and edit cable models refer to the R&S FSH4View manual.

If the distance to a cable fault is to be located precisely, it is essential to use the appropriate cable model. If not, the R&S FSH will not be able to correctly determine the distance of the fault from the measurement plane and the magnitude of the reflection at the fault.

##### Selecting a cable model from a predefined list

- Press the CABLE MODEL softkey.  
The R&S FSH displays the list of cable models.
- Select the cable model you need with the rotary knob or the cursor keys.
- Confirm the selection with the SELECT softkey.  
The R&S FSH returns to the DTF measurement function and shows the selected cable type on the display.

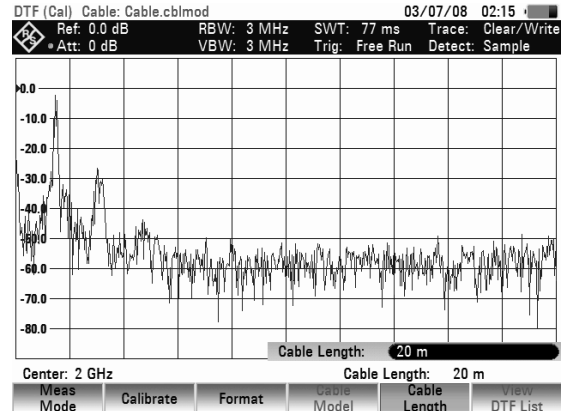
##### Preselecting the cable length

The R&S FSH uses the cable length to determine the optimal span for the measurement. The longer the cable under test is, the smaller the span used by the R&S FSH. The R&S FSH also calculates the cable attenuation from the selected cable model and the length setting so that the magnitude of the reflection at the fault is measured correctly. If the graphics display mode is selected for the results, the R&S FSH scales the x axis so that it represents the total length of the cable.

If the entered cable length is less than the actual cable length, the R&S FSH does not display the faults of the complete cable. A reflection at the end of the cable will not be shown. However, deliberately entering a cable length that is too short is a good way of increasing distance-to-fault accuracy for a fault that is near to the measurement plane. If the entered cable length is greater than the actual length, the

measured values for lengths beyond the cable length are useless because they are caused by multiple reflections. If the length of the cable is not known precisely, it is best to enter a length that is about 20 % to 50 % greater than the best estimate of the cable length.

- Press the CABLE LENGTH softkey.
  - The R&S FSH opens the corresponding input field and displays the current length setting in meters or feet. You can set the unit in the "Instrument Settings" dialog box. Refer to the Quick Start Guide for more information.
  - The default length unit is meter.
- Enter the cable length you need with the number keys, the rotary knob or the cursor keys.
- Confirm the entry with the ENTER key.
  - The R&S FSH adjusts the span accordingly.



The minimum cable length is 3 meters (about 10 feet). This value is determined by the maximum frequency range of the R&S FSH. You can enter a maximum cable length of 1500 m (about 5000 feet). The maximum cable length that is suitable for measurements depends on the cable attenuation. Since the test signal must be routed twice through the cable, the signal reflected at the cable end arrives with twice the cable attenuation in attenuated form at the input of the power divider. Dynamic range decreases with increasing cable length.

If the cable attenuation exceeds 10 dB, the R&S FSH outputs a warning indicating that the cable attenuation is too high. It also indicates the maximum recommended cable length for obtaining accurate results.

- Press the CONTINUE softkey to accept the entry.

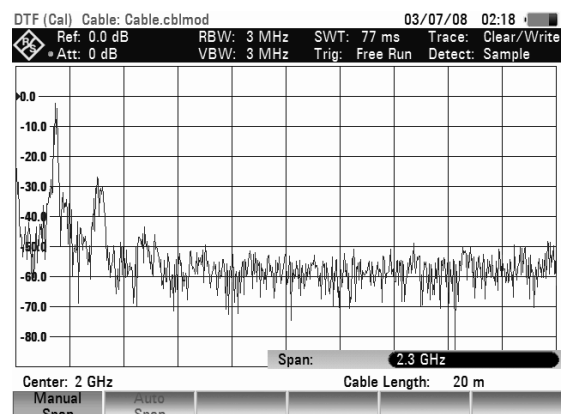
## 4.15.2 Selecting the Frequency Range

In the default setting, the R&S FSH automatically selects the frequency range around the center frequency on the basis of the cable length and cable model. The R&S FSH selects a frequency range that enables maximum length resolution.

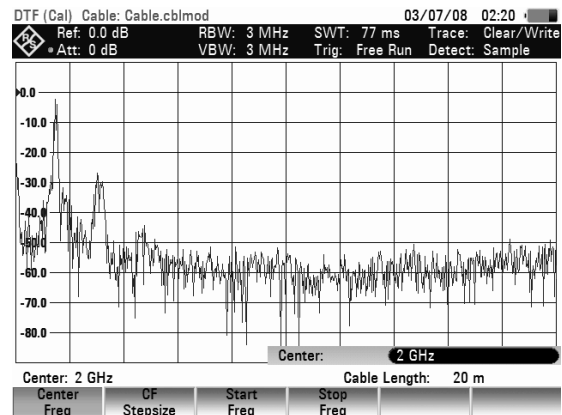
Short cables in particular may then exceed the specified frequency range of the cable. Therefore, the R&S FSH allows you to define the frequency range in which the distance-to-fault measurement is carried out. However, the length resolution of the measurement is reduced by using smaller frequency ranges.

When setting the frequency range, make sure to set the span first, then the center frequency. This prevents a message from being output stating that the desired center frequency cannot be set for the span currently being used for the distance-to-fault measurement.

- Press the SPAN key.
  - The R&S FSH displays the span menu for the DTF measurement. If the AUTO SPAN softkey is active, the R&S FSH sets the span for the best length resolution. If the required span is too large for the current center frequency, the R&S FSH sets the center frequency to the smallest possible frequency.
- Press the MANUAL SPAN key.
- Set the span you need with the number keys, the rotary knob or the cursor keys.



- Confirm the entry with the ENTER key or the MANUAL SPAN softkey.  
The minimum span you can set is either 1/10 of the span automatically set by the R&S FSH in the case of AUTO SPAN or 200 MHz (whichever is smaller). Spans larger than the ones set by the R&S FSH with AUTO SPAN are not allowed.
- Press the FREQ key.
- Enter the center frequency you need with the number keys, the rotary knob or the cursor keys.



- Confirm the entry with the ENTER key or the CENTER FREQ softkey.

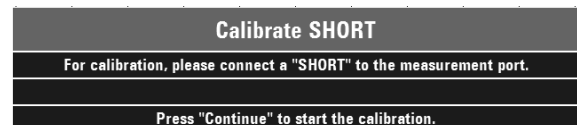
### 4.15.3 Calibrating the Test Setup

When performing scalar reflection measurements, you have to calibrate the R&S FSH before starting the measurement in order to get valid results. For successful calibration, you have to connect a short at the output of the 1 m measurement cable. You can use an open instead of the short, but have to expect greater measurement uncertainties because an open is not defined as precisely as a short.



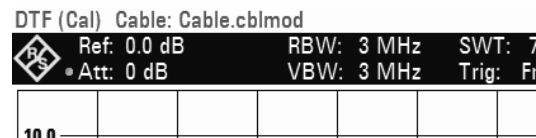
The reference plane must be the output of the 1 m measurement cable; i.e. the measurement cable may not be dispensed with. If the output of the VSWR bridge is used as the reference plane, the DTF results are useless.

- Press the CALIBRATE softkey.
- Select the DTF ONLY menu item with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the CALIBRATE softkey.  
The R&S FSH asks you to terminate the measurement cable with a SHORT.



- Connect the SHORT to the output of the measurement cable.
- Press the CONTINUE softkey to start the calibration.
- You can abort the calibration at any time by pressing the CANCEL softkey.

After it has finished the calibration routine, the R&S FSH shows the message **Calibration done!** for a short time. The status line now says (Cal).

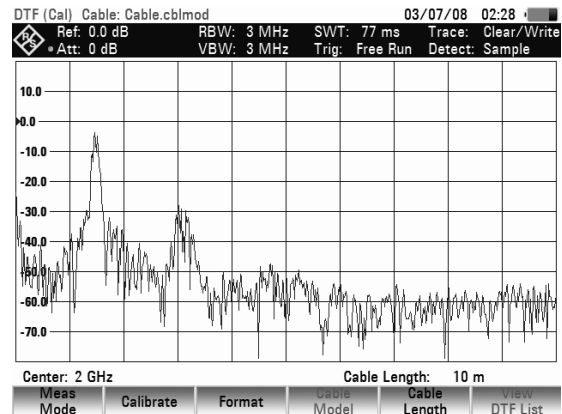


#### Note on Calibration:

Calibration is performed over the entire R&S FSH frequency range. This eliminates the need for recalibration when a different cable length is selected. The calibration data are saved in the R&S FSH's internal memory so that calibration remains effective when switchover is made to another operating mode or the instrument is switched off. As a precondition for calibration to remain valid, however, the instrument temperature must not change by more than 5 °C after calibration.

- Unscrew the SHORT from the measurement cable.
- Connect the cable under test to the measurement cable.

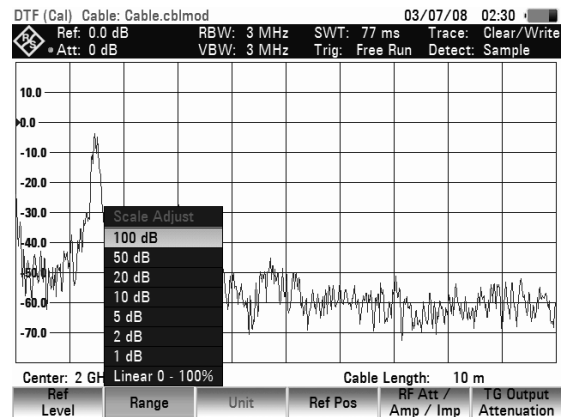
The R&S FSH displays the reflections produced in the cable under test.



#### To select the display unit:

- Press the AMPT key.
- Press the RANGE softkey.
 

The R&S FSH opens the display range menu. The available units depend on the measurement format: return loss in dB, linear in %, standing wave ratio (VSWR), reflection coefficient (ROH) and reflection coefficient (mROH). Select the display unit you want by using the cursor keys or the rotary knob.



The R&S FSH can also list any cable faults. It displays the return loss and distance from the measurement plane of all reflections that exceed a settable threshold.

- Press the VIEW DTF LIST softkey.
 

The R&S FSH opens the threshold input field and also displays a table that contains all reflections that are above the threshold sorted according to distance from the measurement plane.
- Set the threshold using the cursor keys (5 dB steps), the rotary knob (1 dB steps) or the number keys.
- You can return to the graphics display mode by pressing the VIEW DTF LIST at any time.

### 4.15.4 Measurement Formats in DTF Mode

You can choose the measurement format for cable measurements. On the R&S FSH, three formats are available:

- Magnitude
 

By default, the R&S FSH shows the magnitude of the cable fault. The magnitude of the fault is described by the height of the reflection at a certain distance.
- VSWR
 

The VSWR shows the Voltage Standing Wave Ratio in a cartesian diagram. The VSWR is the ratio of the maximum voltage and the minimum voltage that occur in an electrical transmission line.
- Reflection Coefficient
 

The Reflection Coefficient shows the ratio of the amplitude of a reflected wave and that of the incidental wave that occur in an electrical transmission line.



- Press the FORMAT softkey.
- Select the measurement format you want with the rotary knob or the cursor keys.
- Confirm your selection with the ENTER key or the FORMAT softkey.  
The R&S FSH adjusts and updates its display accordingly.

## 4.16 Measurements Using the Power Sensor

For highly accurate power measurements, you can connect one of the power sensors that are available for the R&S FSH. The R&S FSH provides a special interface at its top to connect the power sensors.

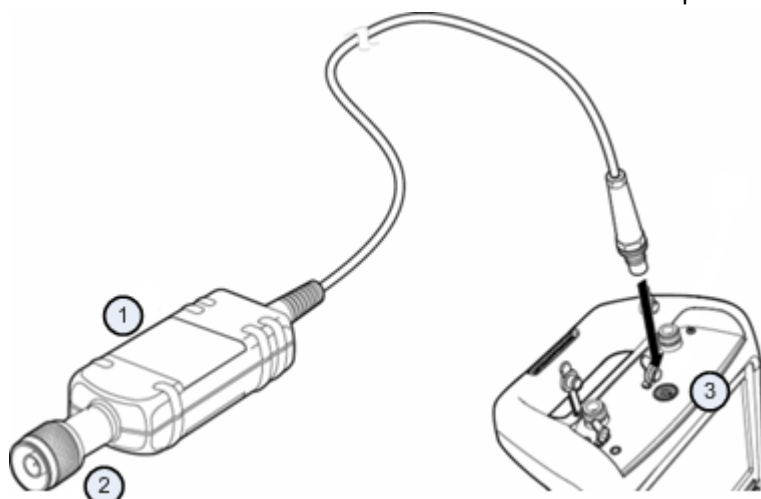
### 4.16.1 Measuring the Power with a Power Sensor

The power sensors R&S FSH-Z1 and R&S FSH-Z18 (order numbers 1155.4505.02 and 1165.1909.02) measure the power in the frequency range from 10 MHz to 8 GHz and 18 GHz respectively. This means that you can measure both sine signals and modulated signals precisely over a large dynamic range.

The power sensor function turns the R&S FSH into a wideband power meter. It then always measures the power of the whole signal from 10 MHz to 8 GHz or 18 GHz. In most cases the signal shape has no effect on the measurement.

#### 4.16.1.1 Connecting the Power Sensor

The R&S FSH controls and powers the power sensors R&S FSH-Z1 and -Z18 via a special interface. Connect the power sensor cable to the R&S FSH's power sensor interface and screw it into position. You can then connect the DUT to the N-connector of the power sensor.



- 1 Power Sensor R&S FSH-Z1 or R&S FSH-Z18
- 2 Power Sensor connector (Device Under Test)
- 3 Interface for Power Sensor

### NOTICE

#### Risk of damage to the power sensor

The continuous power applied to the power sensor's input must not exceed 400 mW (26 dBm). Higher input powers may destroy the sensor. Short ( $\leq 10 \mu\text{s}$ ) power peaks up to 1 W (30 dBm) are however permissible.

An attenuator pad must be used to ensure that the maximum permissible power for the sensor is never exceeded when measurements are made on high-power transmitters.

### 4.16.1.2 Performing Measurements

- Press the MODE key.
- Press the POWER METER softkey  
The R&S FSH activates the mode for power measurements.

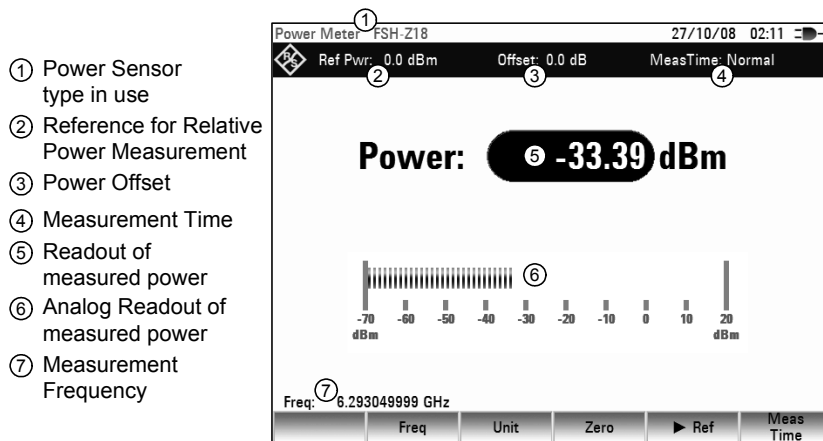
If the R&S FSH recognizes a power sensor, it sets up a connection via the interface and after a few seconds shows the measured power.

If no power sensor has been connected or is not connected appropriately, the R&S FSH shows nothing.

If there are communication problems between the R&S FSH and the power sensor, the R&S FSH displays one of the following error messages that indicate the possible cause.

Message	Cause	Remedy
Error in zeroing: signal at sensor	A signal was present at the power sensor when zeroing was performed.	Unscrew the power sensor from the device under test and repeat zeroing.
Warning: Input overloaded	The power at the input of the power sensor exceeds the permitted power (23 dBm = 200 mW).	Reduce the power at the sensor input.
Power sensor hardware error	Communication error between the R&S FSH and the power sensor.	Unscrew the sensor from the R&S FSH and check the connectors. If the problem persists, contact a Rohde & Schwarz service center.
Power sensor error	The power sensor signals an error to the R&S FSH.	Contact a Rohde & Schwarz service center.
Unknown power sensor model connected	The R&S FSH cannot identify the device connected to the power sensor interface.	

#### Screen layout for power-sensor measurements:



The power sensor has a memory containing frequency-dependent correction values. Therefore the highest accuracy is reached for signals whose frequency is known.

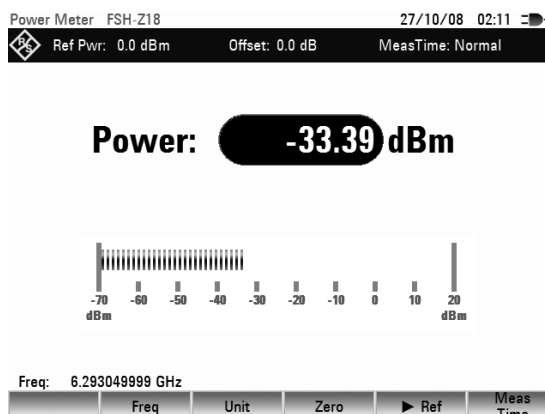
Note that if the R&S FSH switches over to the power measurement mode from another operating mode, it uses the center frequency set in that mode as the frequency for the power sensor.

If you want to perform measurements on another known signal, the power sensor can be “told” what the center frequency is via the frequency entry mode (FREQ softkey).

- Press the **FREQ** softkey.

The frequency value entry box opens.

- Enter the frequency you want with the number keys.
  - Confirm the entry with one of the unit keys.
- The R&S FSH transfers the new frequency to the power sensor which then corrects the measured power readings.

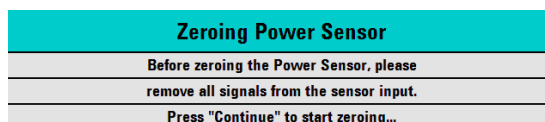


### Zeroing the Power Sensor

Offset voltages and currents have most effect on the power readout when low powers are being measured. Zeroing is used to compensate for these offsets. The power sensor zeroes itself automatically when instructed to do so.

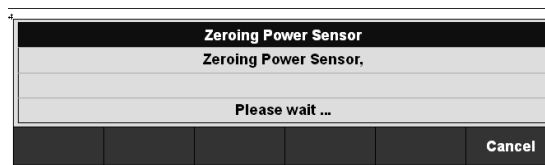
Do not apply power during the zeroing process, as the power sensor cannot distinguish between external powers and internal offsets.

- Press the **ZERO** softkey.
- The R&S FSH asks you not to apply any signals to the power sensor during the zeroing process.



- Disconnect the power sensor from any signal sources.
- Press the **CONTINUE** softkey to start zeroing..
- Press **CANCEL** to abort zeroing (for example if you cannot disconnect the signal source).

The R&S FSH immediately starts power sensor zeroing. While zeroing is in progress, the R&S FSH shows the message "Zeroing power sensor, please wait..".



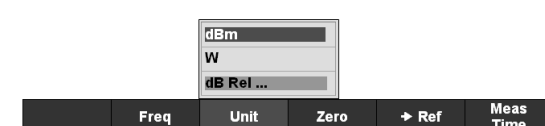
When zeroing is over, the R&S FSH shows the message "Power sensor zero OK" and switches back to the softkey menu for the power sensor.



### Selecting the Unit for the Power Readout

The R&S FSH can display measured power in relative units (dBm) or in absolute units (W, mW, μW, nW and pW). A reference level in dB is also provided by the R&S FSH.

- Press the **UNIT** softkey.
- A submenu to select the unit opens.
- Select the unit you want with the rotary knob or the cursor keys.
  - Confirm the selection with the **ENTER** key or the **UNIT** softkey.



### Setting the Reference Level

If you have selected the unit dB Rel, the R&S FSH opens an input field to set the reference level.

- Enter the reference level with the number keys.
- Confirm the entry with one of the unit keys.

Alternatively, you can set the current level reading as the reference level.

- Press the ►REF softkey.  
The R&S FSH adjusts the reference level to the currently measured power level.  
It then displays the measured level relative to the reference level in dB. The unit is automatically set to dB Rel...
- The R&S FSH shows the currently set reference level in the diagram header.



In the REFERENCE value entry box, the reference level can be adjusted with the rotary knob or the cursor keys or corrected by making a numeric entry.

- Confirm the reference level with the ENTER key or by pressing the ►REF softkey.

### Setting the Averaging Time

The averaging time determines for how long the signal will be measured. The longer the averaging time, the more stable the display, particularly if signals are at the lower end of the measurement range or are noisy. You can perform "Short", "Normal" or "Long" averaging.

Stationary sine signals with a high level (> -40 dBm) require only a short measurement time to produce stable, accurate results. "Short" averaging is recommended to obtain a high repetition rate for the measurement. Use "Normal" averaging to increase the stability of the display for signals with low levels or for modulated signals. The "Long" mode is recommended for signals with very low power levels (<-50 dBm to <-60 dBm).

The R&S FSH-Z1 averages out the noise most effectively and the effect of noise on the measurement is minimal.

- Press the MEAS TIME softkey.
- Select the measurement time you want to use with the rotary knob or the cursor keys.
- Confirm the selection with the ENTER key or the MEAS TIME softkey.

### Taking Additional Loss or Gain into Account

At high powers that cause the R&S FSH-Z1's maximum input level to be exceeded or at very low levels that are below the R&S FSH minimum sensitivity, the R&S FSH can take additional loss or gain between the DUT and the power sensor into account. These are defined in terms of an offset in dB relative to the measured level. A positive offset corresponds to a loss and a negative offset to a gain.

- Press the AMPT key.
- Press the REF OFFSET softkey.  
The value entry box for the reference offset opens.



- Enter the required offset with the number keys, the rotary knob or the cursor keys
- Confirm the entry with the ENTER key or the REF OFFSET softkey.

The offset is taken into account in the power or level display.  
The R&S FSH shows the current offset in the diagram header.

### 4.16.2 Measuring Forward and Reflected Power

With the directional power sensors R&S FSH-Z14 and R&S FSH-Z44 (order numbers 1120.6001.02 and 1165.2305.02) you can measure the power in both directions.

When you connect the directional power sensor between the source and the load, the R&S FSH measures the power from source to load (forward power) and from load to source (reverse power).

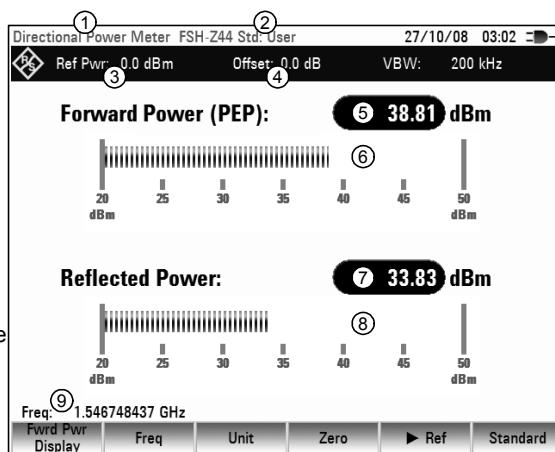
The ratio between forward and reverse power is a measure of the load matching. The R&S FSH displays it as the return loss or standing wave ratio.

The power sensors for the R&S FSH have an asymmetrical design. Therefore, they have to be inserted into the test setup in such a way that the "Forward" arrow on the sensor (1⇒2) points toward the load (= in the direction of the power flux).

- Press the MODE key.
- Press the POWER METER softkey  
The R&S FSH activates the mode for power measurements.

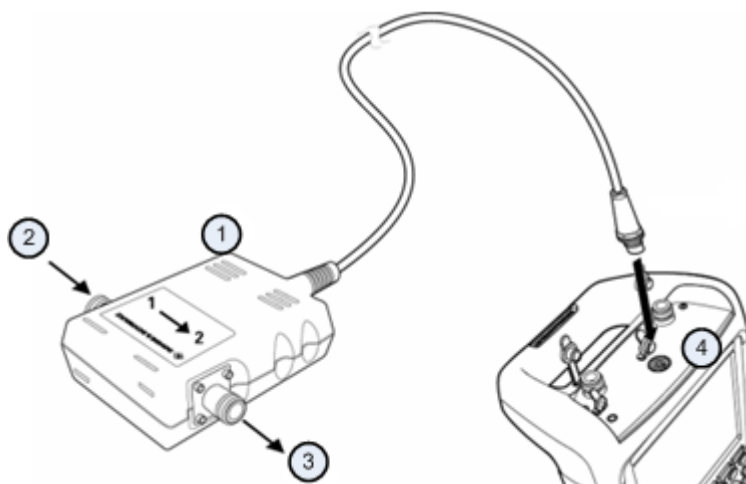
#### Screen layout of the power meter mode with a directional power sensor

- ① Power Sensor type in use
- ② Transmission Standard
- ③ Reference for Relative Power Measurement
- ④ Power Offset
- ⑤ Readout of forward power (dBm, W or dB, relative)
- ⑥ Analog readout of forward power
- ⑦ Readout of matching value (VSWR or Return Loss)
- ⑧ Analog readout of matching value
- ⑨ Measurement Frequency



#### 4.16.2.1 Connecting the Directional Power Sensor

The R&S FSH controls and powers the power sensors R&S FSH-Z14 and –Z44 via a special interface. Connect the power sensor cable to the R&S FSH's power sensor interface and screw it into position. The sensor is connected between the source and the load.



- 1 Directional Power Sensor R&S FSH-Z44
- 2 Source
- 3 Load
- 4 Power sensor socket

When measuring high powers, pay strict attention to the following instructions to avoid personal injury and to prevent the power sensor from being destroyed.

**CAUTION**

**Danger of skin burns or damage to the instrument**

- Never exceed the permissible continuous power.
- See diagram on the rear of the sensor for the permissible continuous power.
- Turn off the RF power to connect the sensor.
- Screw the RF connectors tightly.

After connecting the directional power sensor, the R&S FSH should recognize the power sensor and start the measurement. If not, it may show an error message.

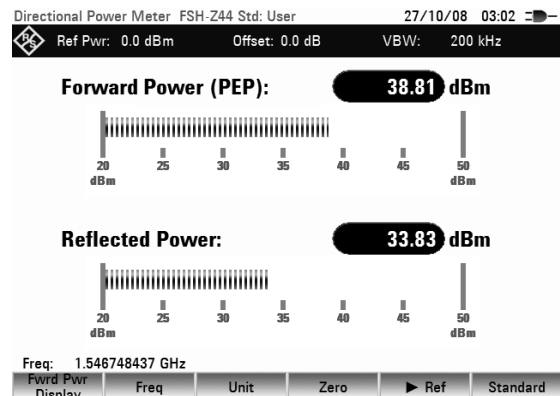
For more information see "[Connecting the Power Sensor](#)".

**4.16.2.2 Performing Measurements with the Directional Power Sensor**

The power sensors contain frequency-dependent correction values. This means that the highest accuracy is reached for signals whose frequency is known. When the R&S FSH switches to the power measurement mode from another operating mode, it transfers its current center frequency to the power sensor.

If a signal at another frequency is to be measured, the new center frequency can be transferred to the power sensor by entering the frequency (FREQ softkey).

- Press the MEAS key.
- Press the FREQ softkey.  
An input field to define the frequency opens.
- Enter the frequency you want with the number keys.
- Confirm the entry with one of the unit keys.  
The R&S FSH transfers the new frequency to the power sensor which corrects the measured power values accordingly.



**Zeroing the Power Sensor**

For more information see "[Zeroing the Power Sensor](#)".

**Setting the Power Measurement Weighting**

For forward power display, the R&S FSH provides both average power and peak envelope power. Use the FWRD PWR DISPLAY softkey in the Power Sensor menu to switch between the two.

- Press the FWRD PWR DISPLAY softkey.
- Select PEAK ENVELOPE from the menu using the



rotary knob or the cursor keys.

- Confirm your selection with the ENTER key or by pressing the FWRD PWR DISPLAY softkey.  
The currently set weighting mode is highlighted in green.

- Select the desired weighting mode using the rotary knob or the cursor keys.
- Confirm your choice with the ENTER key or the FWRD POWER DISPLAY softkey.  
The R&S FSH displays the set weighting under the heading forward power on the screen:

Forward power (AVG) = average power  
Forward power (PEP) = peak envelope power

**Selecting the Unit for the Power Readout**

The R&S FSH displays the measured forward power as a logarithmic level value in dBm (relative value) or as a linear value in W or mW (absolute value). Moreover, a reference level can be defined relative to which the R&S FSH indicates the level difference in dB. Load matching is indicated as return loss in dB or as voltage standing wave ratio (VSWR). In addition, the absolutely reflected power can be displayed in W, or the reflected level in dBm.

- Press the UNIT softkey.  
The menu for selecting the units for forward power and reflected power display opens.
- Using the rotary knob or the cursor keys, select the unit for the power readout.

For the forward power, the following units can be selected:

- dBm
- W
- dB REL

For the reflected power or the reflection, the following units can be selected:

- dBm
- W
- VSWR
- dB (return loss)

- Confirm the parameter with the ENTER key or the FWRD POWER DISPLAY softkey.

When the dB REL... unit is selected, an entry box for the reference level opens.

- Enter the reference level (REFERENCE) using the number keys and terminate the entry with the appropriate unit, or change the reference level using the rotary knob or the cursor keys.

The current level reading can be defined as the reference level simply by pressing the ->REF softkey.





- Press the ->REF softkey.  
The R&S FSH accepts the currently measured level as the reference level and displays the measured level difference relative to the reference level in dB. The unit (UNIT) is automatically set to dB REL...

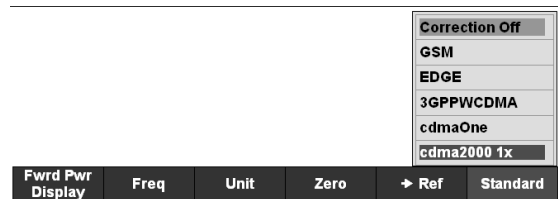
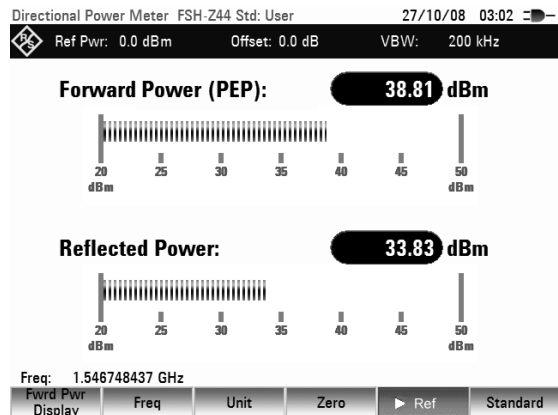
The reference level is displayed in the upper left corner of the screen (in this case: Ref: -4.8 dBm).

The reference level can be adjusted in the REFERENCE entry box by means of the rotary knob, the cursor keys or the number keys.

- Confirm the reference level with the ENTER key or the ->REF softkey.
- To switch off the relative measurement to absolute values, press the FWRD PWR DISPLAY softkey.
- Select the Forward Power... parameter.
- Select dBm or Watt for forward power indication.

To ensure that true results are output when measuring modulated signals, the R&S FSH offers the possibility of taking correction values into account for a number of common transmission standards.

- Press the STANDARD softkey.  
A menu to select a standard opens.
- Select the required standard with the rotary knob or the cursor keys.
- Confirm with the selection with the ENTER key or the STANDARD softkey.  
The R&S ZVH takes the selected standard into account. The currently active standard is displayed in the display header.



**Taking Additional Attenuation into Account**

When the directional power sensor is connected to a test point not directly but via a cable, the influence of cable attenuation can be taken into account. For this purpose, the cable attenuation for the measurement frequency in question is to be entered, i.e. as a positive dB value if the power and matching are to be measured at the source and the cable is connected between the source and the power sensor, and as a negative dB value if the power and matching are to be measured at the load and the cable is connected between the load and the power sensor. The directional power sensor then corrects the power and matching values to produce the results that would have been obtained if it had been directly connected to the test point.

- Press the AMPT key.
- Press the REF OFFSET softkey.  
The value entry box for the reference offset opens.
- Enter the desired offset using the rotary knob, the cursor keys or the number keys and confirm the entry with the ENTER key.  
The selected offset is displayed in the middle at the top of the screen and is taken into account in the power (level) and matching results.



If high powers are applied that exceed the maximum input level of the R&S FSH-Z14 or R&S FSH-Z44, a directional coupler or an attenuator has to be connected ahead of the power sensor. In such cases, the coupling attenuation of the directional coupler or the attenuation value of the attenuator are to be entered as positive dB values (see above) into the R&S FSH to ensure true measured power readout. In both cases, a termination or an attenuator of sufficient power-handling capacity has to be connected to the power sensor at the load end. The matching readout is irrelevant in such case since it is likewise corrected by taking into account the attenuation value of the termination or attenuator (see measurement via cable).

## 4.17 Field-Strength Measurement with Isotropic Antenna

When used together with the R&S TS-EMF isotropic antenna (Order No. 1158.9295.13), the R&S FSH can determine the resultant field strength in the frequency range from 30 MHz to 3 GHz. The antenna has three orthogonal elements for measuring the resultant field strength. The R&S FSH triggers the three antenna elements one after the other via the probe power socket and calculates the resultant field strength ( $E_r$  = resultant field strength) from the results of the three individual measurements:

$$E_r = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The transducer factors for each antenna element and the cable loss of the antenna cable are compensated in the measurement. If an extension cable such as the R&S TS-EMFZ2 (1166.5708.02) is used, the additional cable loss can be taken into account by using transducer factors. The transducer factors are antenna-specific and are supplied together with the TS-EMF antenna. Transducers are loaded into the R&S FSH by means of the R&S FSH4View control software (see also "Measuring with Transducer Factors" in this chapter). In order to activate the measurement with the isotropic antenna, a transducer factor file with the extension \*.isotrd must be selected.

### Connecting the Antenna to the R&S FSH

The isotropic antenna includes factory-attached cables. The RF cable with the N coaxial plug is connected to the input of the R&S FSH. The control cable for switching between the X, Y and Z axes with the 9-pin D-Sub plug is connected with the R&S RSH probe power socket by using the supplied adapter cable.

- Press the MEAS MODE key.  
The R&S FSH will open the measurement mode menu.
- Select ISOTROPIC ANTENNA from the menu with the cursor keys or rotary knob to activate the use of an isotropic antenna. Confirm the selection with the ENTER key or the MEASURE softkey.  
The activation of the isotropic antenna influences all relevant measurements.  
  
Before displaying final measurement results, the R&S FSH performs a measurement for each of the three antenna axes so that the update rate of the trace decreases accordingly.

### Note:

*If the connected accessory is an isotropic antenna from R&S, the use of an isotropic antenna is automatically activated.*

**To use transducer factors for the isotropic antenna:**

- Press the AMPT key.  
The R&S FSH opens the amplitude menu.

**Note:**

*The TRANSDUCER softkey enables you to activate the transducer factor for the isotropic antenna. The corresponding files have the extension \*.isotrd. As soon as a transducer factor with that filename extension is selected, the R&S FSH will automatically activate the isotropic antenna measurement.*

- Press the TRANSDUCER softkey  
The R&S FSH opens the menu for selecting the transducers.
- Select a filename with extension \*.isotrd with the cursor keys or the rotary knob and confirm with the TRANSDUCER softkey or the ENTER key.

Do the following to compensate the antenna extension cable:

- Select the SELECT SECONDARY TRANSDUCER item from the Transducer menu.  
The R&S FSH will display the list of transducer factors available in the instrument with the unit dB.
- Select the appropriate transducer factor for the antenna by using the rotary knob or cursor keys and activate with the SELECT softkey.

## 4.18 Measuring with Transducer Factors

The frequency-dependent transducer factor of transducers and antennas can be directly considered in the measurement result. A transducer factor consists of a numeric values and a unit. The R&S FSH corrects the level values of the trace by the values of the transducer. At the same time, the unit of the transducer is assigned to the level axis. When field-strength measurements are performed with the aid of antennas, for instance, the electrical field strength is directly indicated in dB $\mu$ V/m on the R&S FSH. A transducer factor can also be used to correct a frequency-dependent attenuation, e.g. of a cable between DUT and RF input of the R&S FSH.

More than 100 transducer factors with 60 reference values each can be stored internally. The maximum number of transducer factors may be reduced if cable models, channel tables, limit lines, or data sets are stored simultaneously (see "Saving and Loading Instrument Settings and Measurement Results" in this chapter).

Interpolation between the values is performed with the aid of a modified spline algorithm. Even if only relatively few values such as maxima, minima and turning points are available, this algorithm can easily simulate the correction factors of common transducers. Two transducers can be switched on at a time. The second transducer must be assigned the unit dB. The R&S FSH adds the two transducers to a total transducer.

Transducer factors are defined with the aid of control software FSH4View. They are transferred from the PC to the instrument via LAN or the USB interface.

Units supported for transducer factors:

- dB
- dB $\mu$ V/m
- dB $\mu$ A/m
- W/m<sup>2</sup>

The unit dB does not change the unit set on the R&S FSH. It can be used, for instance, to compensate for frequency-dependent loss and gain at the input of the R&S FSH. The units dB $\mu$ V/m and dB $\mu$ A/m convert the output power of an antenna into electric or magnetic field strength. The unit W/m<sup>2</sup> is used to calculate and display the power flux density.

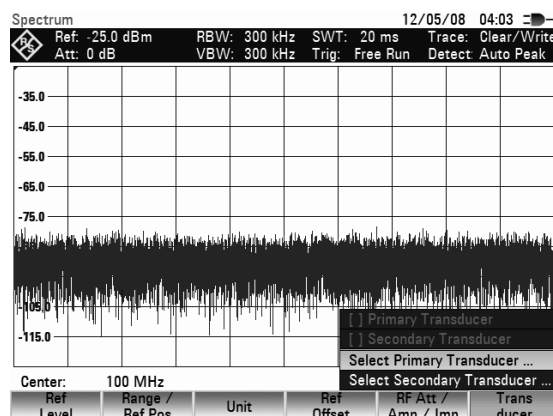
For example, to compensate for the cable loss between the transducer and the RF input, the R&S FSH can use two transducers at the same time. One of them must have the unit dB, however, i.e. it must correspond to one loss or gain value.

### Operating sequence:

- Press the AMPT key.
- Press the TRANSDUCER softkey.  
The softkey menu for operation of transducer factors is displayed on the screen.

### Note:

Transducer factors are not available for measurements with the tracking generator or the Power Sensors. The TRANSDUCER softkey is therefore interactive.



Two transducer factors can be selected with the menu entries SELECT PRIMARY TRANSDUCER and SELECT SECONDARY TRANSDUCER. [ ] PRIMARY TRANSDUCER and [ ] SECONDARY TRANSDUCER are used to switch the selected transducer factors on and off.

Press the SELECT PRIMARY TRANSDUCER softkey.

The R&S FSH displays a list of transducer factors available in the unit. The cursor is on the active transducer factor (line highlighted). If no transducer is active, the cursor is on the first item in the list.

- Select the desired transducer factor with the rotary knob or the cursor keys and switch it on with the SELECT softkey.

**Note:**

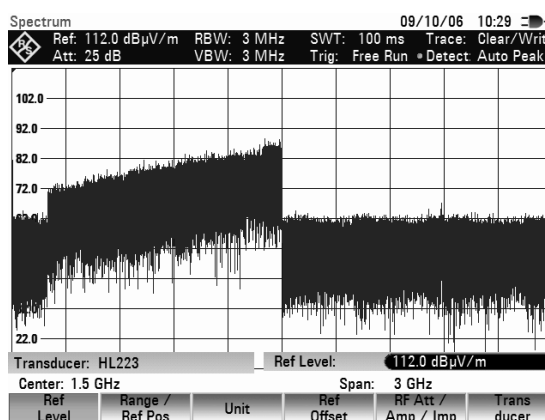
*With an inserted SD card, switch between internal memory and memory card by pressing the INTERNAL/SD-CARD softkey.*

- Quit the transducer menu with the EXIT softkey.

If a transducer is switched on, the R&S FSH shows the selected transducer after the AMPT key is pressed.

The complete name of the selected transducer is also displayed in the status line (press the SETUP key and scroll down the list), or in the list of transducer factors (entry highlighted in red).

The example (Fig. right) shows the transducer factor of the R&S HL223 antenna, which is defined as between 200 MHz and 1300 MHz. The R&S FSH therefore displays the noise in this frequency range as a function of frequency incremented by the transducer factor. Outside the transducer range, the R&S FSH sets the transducer factor at zero, i.e. measurements in this range do not yield conclusive results.



A second transducer factor can be selected with the SELECT SECONDARY TRANSDUCER softkey, which is then added to the first, as soon as the menu entry . [ ] SELECT SECONDARY TRANSDUCER is marked with an X. The unit of the second transducer factor must always be the relative unit dB as otherwise an addition would not be useful. When SELECT SECONDARY TRANSDUCER is selected, the R&S FSH offers only the transducer factors stored in the instrument with dB as the unit.

### 4.18.1 Unit for Measurements with Transducers

If the unit of the transducer is dB, the units dBm, dBmV or dBμV remain unchanged. The linear units Volt and Watt are not permissible. They are deactivated in the units menu.

If the unit of the transducer is dBμV/m or dBμA/m, this unit is also used for the R&S FSH level display. This means that both the level axis of the diagram and the level at the marker position are assigned the unit of the transducer. If dBμV/m is selected as the transducer unit, switchover to absolute level indication in V/m is possible.

Switchover to V/m level indication:

- Press the AMPT key.
- Press the UNIT softkey.
- In the UNIT menu, select V by means of the rotary knob or the cursor keys and confirm with the ENTER key or by pressing the UNIT softkey again.

If a transducer with the unit dBμA/m is switched on, no other unit can be selected in the AMPT menu. Level indication is entirely in dBμA/m.

## 4.18.2 Reference Level Settings for Measurements with Transducers

The transducer shifts the trace by its value as a function of frequency. Positive transducer values increase the level, negative values reduce it. To ensure that the trace is always within the diagram, the R&S FSH adjusts the reference level accordingly. The reference level is shifted by the maximum transducer value in the positive or negative direction.

## 4.18.3 Frequency Range of Transducer

If the set frequency range is wider than the span in which a transducer is defined, the R&S FSH assumes the transducer values outside the defined range to be zero.

## 4.18.4 Data Sets Containing Transducer Factors

The R&S FSH stores data sets together with any transducer factors that may have been active for the measurement in question. When such a data set is recalled, the associated transducer factor(s) are switched on as well. Transducer factors recalled as part of a data set do however not appear in the list of transducer factors.

## 4.19 Code Domain Measurements on 3GPP FDD Signals

Equipped with the software application R&S FSH-K44, you can perform measurements on WCDMA signals in accordance to the 3GPP standard with your R&S FSH.

When starting a measurement, the R&S FSH first records a section of the signal that lasts approximately 1.2 ms (or about 2 WCDMA slots). It then scans the recorded signal section for the start of a WCDMA slot. Upon detection of the start of a slot, the R&S FSH starts the code domain measurement for that slot.

The R&S FSH performs various measurements on the slot in general as well as measurements on specific channels.

Measurements on the slot include the power level, Error Vector Magnitude (EVM), the Code Domain Error and the Frequency Error. To get sufficient measurement accuracy, it is necessary to synchronize the reference frequency of the base station and the R&S FSH via the EXT REF IN input.

To obtain sufficient measurement accuracy, it is necessary to feed the reference frequency of the R&S FSH base station at the EXT REF IN input.

In addition, you can analyze the following channel types in more detail:

- Common Pilot Channel (CPICH)

**Note:**

This channel is required by the channel configuration; without it, synchronization is not possible.

- Primary Common Control Physical Channel (P-CCPCH)
- Primary Synchronization Channel (P-SCH)
- Secondary Synchronization Channel (S-SCH)

For the CPICH and P-CCPCH channels the R&S FSH measures the power level and the  $E_c/I_0$ . For the P-SCH and S-SCH channels, the R&S FSH measures the power level.

### Operation

- Press the MODE key
- Press the DIG MOD ANALYZER key
- Select 3GPP WCDMA BTS and confirm the selection with the ENTER key.

The R&S FSH starts the code domain analysis and displays the softkeys of the Digital Modulation Analyzer.



## 4.19.1 Reading the Result Summary

The Result Summary shows various measurement results in numerical form.

### Screen Layout of the Result Summary display

① Result Display

② Standard

③ General Settings

④ Global Results

⑤ Channel Results CPICH / P-SCH

⑥ Channel Results P-CCPCH / S-SCH

⑦ Synchronization State:  
- green font: SYNC OK  
- red font: SYNC failed

⑧ 3GPP WCDMA Menu

Global Results for Frame 0:	
Total Power	-64.0 dBm
Carrier Freq Error	-58.92 Hz
Active Channels: 2	
Channel Results List:	
CPICH (15 kbps, Cod 5)	P-CCPCH (15 kbps, C 1)
Power	-69.6 dBm
Ec/Io	-5.5 dB
Symbol EVM rms	6.9 %
P-SCH Power	-72.8 dBm
	S-SCH Power
	-73.1 dBm

### 4.19.1.1 General Settings

The general settings show some general information about the measurement.

- Center Frequency  
Shows the current center frequency of the R&S FSH.
- Scrambling Code  
Shows the currently used scrambling code
- Transducer  
If you use a transducer, this field shows the type of transducer currently in use.

### 4.19.1.2 Global Results

In the upper part of the table, the R&S FSH shows measurement result concerning the composite signal. These results evaluate the total signal over the period of one slot.

- Total Power  
Shows the total power of the signal in dBm.  
To calculate the Total Power, the R&S FSH averages the complete evaluated 3GPP FDD frame.
- Carrier Frequency Error  
The Carrier Frequency Error is the frequency error relative to the center frequency. The unit of the Frequency Error is Hz.
- Active Channels  
Shows the number of active channels.

### 4.19.1.3 Channel Results

In the lower part of the table, the R&S FSH shows measurement results concerning specific channels.

- CPICH ([ksp/s], Code #) Power  
Shows the power of the CPICH in dBm.
- CPICH ([ksp/s], Code #) Ec / Io  
Shows the ratio of the power of the pilot channel to the total power of the signal. Therefore this value shows the usable part of the signal.
- CPICH ([ksp/s], Code #) Symbol EVM rms  
Shows the averaged (root mean square) EVM on symbol level of the CPICH.
- P-CCPCH ([ksp/s], Code #) Power  
Shows the power of the P-CCPCH in dBm.
- P-CCPCH ([ksp/s], Code #) Ec / Io  
Shows the ratio of the power of the control channel to the total power of the signal. Therefore this value shows the usable part of the signal.
- P-CCPCH ([ksp/s], Code #) Symbol EVM rms  
Shows the averaged (root mean square) EVM on symbol level of the P-CCPCH.
- P-SCH ([ksp/s], Code #) Power  
Shows the power of the P-SCH in dBm.
- S-SCH ([ksp/s], Code #) Power  
Shows the power of the S-SCH in dBm.

## 4.19.2 Configuring the Measurement

### 4.19.2.1 Specifying the Scrambling Code

To demodulate a 3GPP signal, you have to know the primary and secondary scrambling code of the base station. You can either enter the scrambling code manually or let the R&S FSH automatically determine the scrambling code.

#### Manual entry of the primary scrambling code

- Press the SCRAMBLING CODE softkey
- Select the SET CODE MANUAL menu item.  
Specify the primary scrambling code of the base station and confirm with the ENTER key or the SCRAMBLING CODE softkey.



After specifying the primary scrambling code, the R&S FSH prompts you to enter the secondary scrambling code.

- Specify the secondary scrambling code of the base station and confirm it with the ENTER key or the SCRAMBLING CODE softkey.



In most cases, the secondary scrambling code has the value '0'.

After you have entered the correct values for frequency, reference level and scrambling code and have selected the correct antenna diversity, the R&S FSH synchronizes to the 3GPP signal of the base station.

In the Result Summary, **SYNC OK** is displayed and the R&S FSH updates the measurement results.

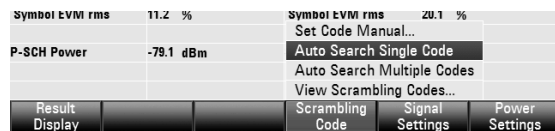
If the synchronization was not successful, the Result Summary shows the **SYNC NOT FOUND** tag.

If you don't know the scrambling code, the R&S FSH can automatically determine the scrambling code of one or more 3GPP base stations. Two different modes are available for this purpose:

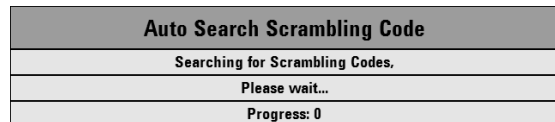
- Auto Search Single Code  
The R&S FSH determines the scrambling code of the base station with the highest signal level.
- Auto Search Multiple Codes  
The R&S FSH can determine the scrambling codes of up to eight 3GPP base stations together with the CPICH power. The automatic scrambling-code search assumes that the value of the secondary scrambling code is 0.

**Auto Search Single Code mode**

- Press the SCRAMBLING CODE softkey.
- Select the AUTO SEARCH SINGLE CODE menu item. Confirm the selection with the ENTER key or the SCRAMBLING CODE softkey.



The R&S FSH starts searching for the scrambling codes. The status of the search is output in a message box. The search should take about 22 seconds. As soon as it has found a scrambling code, the R&S FSH synchronizes to the 3GPP signal of that base station.



If the R&S FSH cannot detect any scrambling codes, a message shows in the display.

In the Result Summary, **SYNC OK** is displayed and the R&S FSH updates the measurement results.

**Auto Search Multiple Code Mode**

- Press the SCRAMBLING CODE softkey.
- Select the AUTO SEARCH MULTIPLE CODE menu item. Confirm the selection with the ENTER key or the SCRAMBLING CODE softkey.

The R&S FSH starts searching for the scrambling codes. The status of the search is output in a message box. The search should take about 50 seconds. As soon as it has found a scrambling code, the R&S FSH synchronizes to the 3GPP signal with the highest level.

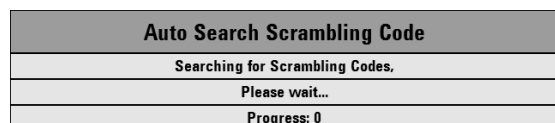
If the R&S FSH cannot detect any scrambling codes, a message shows in the display.

In the Result Summary, SYNC OK is displayed and the R&S FSH updates the measurement results.

- Press the SCRAMBLING CODE softkey.
- Select the AUTO SEARCH MULTIPLE CODE menu item. Confirm the selection with the ENTER key or the SCRAMBLING CODE softkey.



The R&S FSH starts searching for the scrambling codes. The status of the search is output in a message box. The search should take about 50 seconds. As soon as it has found a scrambling code, the R&S FSH synchronizes to the 3GPP signal with the highest level.



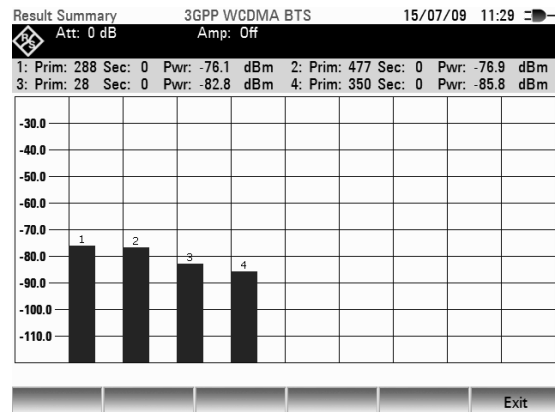
If the R&S FSH cannot detect any scrambling codes, a message shows in the display.

In the Result Summary, **SYNC OK** is displayed and the R&S FSH updates the measurement results.

**Viewing the found scrambling codes:**

- Press the SCRAMBLING CODE softkey.
- Select the VIEW SCRAMBLING CODES menu item. Confirm the selection with the ENTER key or the SCRAMBLING CODE softkey.

The R&S FSH shows all primary and the corresponding secondary scrambling codes that it found during the search in descending order. In addition, the powers of the corresponding CPICH channels is shown in numerical and graphical form.

**4.19.2.2 Signal Settings**

By default, the R&S FSH does measurements on base stations with one antenna. For base stations with two antennas, you have to specify the antenna to synchronize to.

- Press the SIGNAL SETTINGS softkey.
- Select the ANTENNA SETTINGS menu item. Confirm the selection with the ENTER key or the SCRAMBLING CODE softkey.



- In the submenu, select ANTENNA #1.

The R&S FSH synchronizes to the CPICH of antenna 1.

The procedure to select antenna 2 is the same.

To measure base stations with one antenna, select the menu item ANTENNA DIVERSITY OFF.



To successfully synchronize, the center frequency, reference level and scrambling code have to be set correctly.

## 4.20 Code Domain Measurements on CDMA2000 Signals

Equipped with the measurement application R&S FSH-K46, you can perform Pilot channel and EVM measurements on the forward link of CDMA2000 signals in accordance to the 3GPP2 standard with your R&S FSH.

Equipped with the measurement application R&S FSH-K46E, you can perform Code Domain Power measurements on the forward link of CDMA2000 signals in accordance to the 3GPP2 standard with your R&S FSH.

### Starting the measurement

- Press the MODE key
- Press the DIG MOD ANALYZER key
- Select CDMA2000 BTS and confirm the selection with the ENTER key.

The R&S FSH starts the code domain analysis and displays the softkeys of the Digital Modulation Analyzer.

When starting a measurement, the R&S FSH first records a section of the signal that lasts approximately 27 ms (or about 1 Sync Frame Period). If the instrument is in a triggered mode (external or GPS trigger), it then searches for the start of the PN code in the vicinity of the PN offset you have entered. If you are using the automatic PN Offset, the R&S FSH performs a full search for the PN offset and reports the PN found. For a "free run" situation, the R&S FSH searches for the start of the PN sequence over the entire signal length.

The R&S FSH performs various general measurements over one PCG (power control group) as well as measurements on specific channels. It then shows the results in one of three formats:

- tabular form in the "Result Summary" display,
- scrollable table form in the "Code Domain Channel Table", or
- graphical form in the "Code Domain Power" result display.

To get highest measurement accuracy, it is necessary to synchronize the reference frequency of the R&S FSH with the base station via the EXT REF IN input or with an optional GPS receiver.

### 4.20.1 Reading the Result Summary

The Result Summary shows various hardware settings, CDMA2000 standard settings and measurement results in numerical form.

#### Screen layout of the Result Summary display

① Result Display

② Standard

③ General Settings

④ Sync State + GPS Information

⑤ Global Results

⑥ Channel Results

⑦ CDMA2000 Menu

Result Summary - CDMA2000			
Center:	893.97 MHz	Ref Level:	-20.0 dBm
Channel:	799	Att:	0.0 dBm
Band:	cdma2k(800)	Preamp:	Off
		Base SF:	64
		PN Offset:	0
GPS: Lat. 48° 7' 39.924"N Long. 11° 36' 42.642"E Alt. 571.9 m		GPS 16/02/10 09:41	
SYNC OK			
Global Results for PCG 0			
Total Power:	-25.39 dBm	Active Channels:	9
Rho:	1.000	Composite EVM:	2.20 %
Carrier Freq. Error:	-73.7 Hz	Peak to Average:	8.97 dB
Channel Results List			
Pilot Channel Power (Code 0)		Sync Channel Power (Code 32)	
Absolute:	-32.40 dBm	Absolute:	-38.11 dBm
Relative to Total:	-7.01 dB	Relative to Total:	-12.72 dB

### 4.20.1.1 General Settings

The General Settings section shows an assortment of hardware settings and general CDMA2000 settings.

- Center  
Current center frequency of the R&S FSH.  
For measurements, this has to be the center frequency of the signal you want to measure.
- Channel  
Number of the channel you are currently analyzing.  
The number depends on the selected band (bandclass).
- Band  
Name of the bandclass you are currently using.

#### Selecting the bandclass

- Press the **FREQ** hardkey.
- Press the **FREQ MODE** softkey.
- Select the **CHANNEL** menu item with the rotary knob or the cursor keys.
- Confirm the selection with the **ENTER** key or the **FREQ MODE** softkey.  
The R&S FSH opens a dialog box to select a CDMA2000 channel table or bandclass.
- Select the table you need with the rotary knob or the cursor keys.
- Confirm the selection with the **SELECT** softkey.  
The R&S FSH now applies the channel table to future measurements.

Stat	Name	Size	Date	Time
	\Public\Channel Tables\...			
cdma2k_0	(800 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_1	(1900 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_10	(Sec 800 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_11	(400 MHz Europe PAMR).chntab	1 kB	27/01/2010	04:21
cdma2k_12	(800 MHz PAMR Band).chntab	1 kB	27/01/2010	04:21
cdma2k_13	(2.5 GHz IMT-2000 Ext).chntab	1 kB	27/01/2010	04:21
cdma2k_14	(US PCS 1.9GHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_15	(AWS Band).chntab	1 kB	27/01/2010	04:21
cdma2k_16	(US 2.5GHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_18	(700 MHz Pbi Safety).chntab	1 kB	27/01/2010	04:21
cdma2k_19	(Lower 700 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_2	(TACS Band).chntab	1 kB	27/01/2010	04:21
cdma2k_3	(JTACS Band).chntab	1 kB	27/01/2010	04:21
cdma2k_4	(Korean PCS Band).chntab	1 kB	27/01/2010	04:21
cdma2k_5 20k	(450 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_5 25k	(450 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_6	(2 GHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_7	(Upper 700 MHz Band).chntab	1 kB	27/01/2010	04:21
cdma2k_8	(1800 MHz Band).chntab	1 kB	27/01/2010	04:21

- Ref Level  
The reference level is the level the R&S FSH expects on its RF input. The R&S FSH uses this value to determine the internal settings for attenuation and preamplifier.

Set the Ref Level to the expected maximum peak level of the CDMA2000 signal.

To obtain the greatest possible dynamic range, the lowest reference level possible must be set.

The R&S FSH will be overloaded by the measurement signal, if its maximum level exceeds the reference level.

Because the R&S FSH's resolution bandwidths are implemented digitally after the A/D converter, depending on the resolution bandwidth you have selected, the signal level at the A/D converter can be higher than the level indicated by the trace in Spectrum mode.

If you are not sure about the maximum level of the signal, do the following:

To prevent the A/D converter from being overloaded, the signal must be measured at the widest resolution bandwidth (3 MHz) and video bandwidth (3 MHz) with the peak detector (in Spectrum mode). The trace maximum then determines the optimal reference level.

This is especially important if you measure in a scenario with more than one active CDMA2000 channel near the channel you want to measure (+/- 6 MHz).

If you do the Ref Level setting in Spectrum mode and afterwards switch to CDMA2000 mode, the Ref Level value is applied in the CDMA2000 mode.

- Att

Current RF attenuation inside the R&S FSH.

Refer to chapter "[Setting the Amplitude Parameters](#)" for more information on RF attenuation.

- Preamp

Current state of the preamplifier (on / off).

Refer to chapter "[Setting the Amplitude Parameters](#)" for more information on preamplification.

- Base SF

Current Base Spreading factor (Base SF).

Take care of setting the base spreading factor of the code domain to either 64 or 128. If you set the base spreading factor to 64 for channels with a base spreading factor of 128 (code class 7), an alias power may be displayed in the Code Domain Power result display, because of the ambiguity of the Hadamard Matrix. An alias power is a displayed code power, where no power would be if the spreading factor was correct.

- Code Order

Current code order. You can set the code order either to BitReverse or Hadamard order.

Hadamard order means that there's no distinction between channels. The R&S FSH shows codes in ascending order regardless of the channel that it belongs to.

BitReverse order means that the R&S FSH combines codes of a channel if a channel consists of more than one code. When using BitReverse order, the codes of a channel are next to one another. In this way you can see the total power of a concentrated channel.

- Sweep

Current sweep mode.

You can select between

- Single: data is captured and results are displayed one at a time.
- Continuous: data is captured and results are displayed continuously.

- Trigger

Current trigger mode.

Refer to chapter "[Trigger](#)" for more information on trigger modes.

- External Reference

Shows whether the external reference is active or not.

- SYNC NOT FOUND / SYNC OK

Indicates whether synchronization was successful or not.

- Position

Shows the current position if you have connected a GPS receiver and have activated the GPS receiver. If not, this field stays empty. Refer to the Quick Start Guide for details.

- PN Offset

Current Pseudo Noise (PN) Offset of the base station.

The standard uses the PN Offset to distinguish between base stations. The PN offset determines the offset in the circulating PN sequence in multiples of 64 chips with reference to the event second clock trigger.

The PN Offset only has a function in External or GPS trigger mode.

### 4.20.1.2 Global Results

In the global results, the R&S FSH shows measurement results of the composite signal. These results evaluate the total signal over the period of one Power Control Group (PCG).

- **Total Power**  
Total power of the signal in dBm in the 1.23 MHz bandwidth around the center frequency.
- **Rho**  
According to the CDMA2000 standard, Rho is the normalized, correlated power between the measured and the ideally generated reference signal. When you measure Rho, the CDMA2000 standard requires that only the pilot channel be supplied.
- **Tau**  
According to the CDMA2000 standard, Tau shows the timing error of the signal. The maximum offset is specified at 10  $\mu$ s.
- **Carrier Frequency Error**  
Shows the frequency error in relation to the current center frequency of the R&S FSH  
  
The absolute frequency error is the sum of the frequency error of the R&S FSH and that of the device under test. Frequency differences between the transmitter and receiver of more than 1.0 kHz impair synchronization of the Code Domain Power measurement. If at all possible, the transmitter and the receiver should be synchronized.  
  
Concerning uncertainty of the reference frequency of the GPS receiver, refer to the data sheet.
- **Active Channels**  
Number of currently active channels
- **Composite EVM**  
Shows the composite Error Vector Magnitude (EVM) in %. The EVM is the root of the ratio of the mean error power (root mean square) to the power of an ideally generated reference signal.  
  
An EVM of 0 % means a perfect signal.
- **Peak to Average**  
Shows the difference between the peak power and the average power of the signal (crest factor).

### 4.20.1.3 Channel Results

In the lower part of the table, the R&S FSH shows measurement results of specific channels.

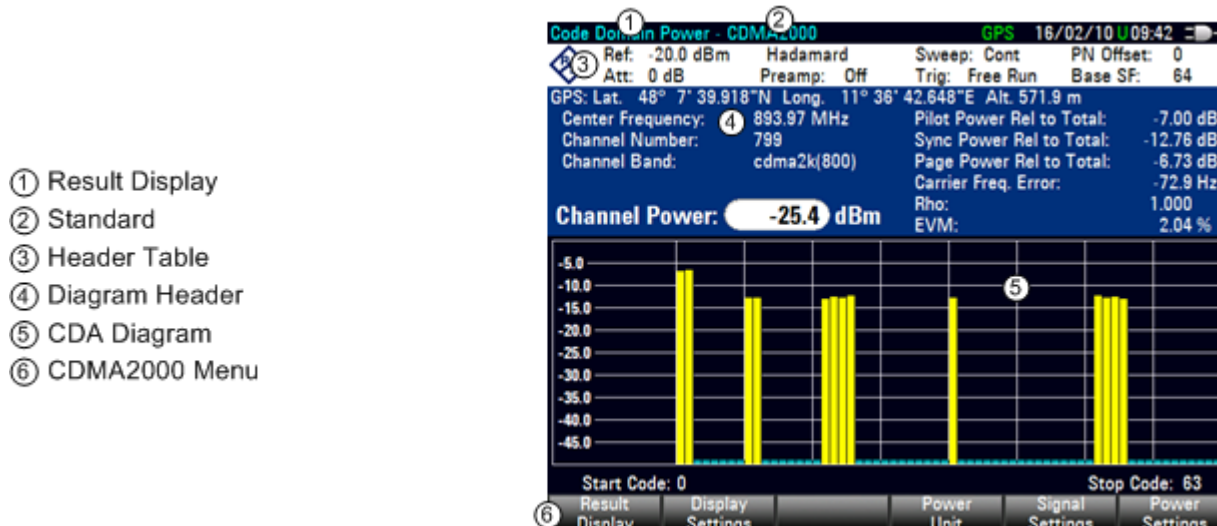
The pilot channel always occupies code 0 and the synchronization channel always occupies code number 32.

- **Pilot Channel Power (Code 0) Absolute**  
Absolute power of the pilot channel (PICH) in dBm.
- **Pilot Channel Power (Code 0) Relative**  
Relative power of the pilot channel (PICH) in dB. The reference power is either the total power or the pilot power, depending on your selection (see "[Changing the reference power](#)").
- **Sync Channel Power (Code 32) Absolute**  
Absolute power of the synchronization channel (SYNC) in dBm.
- **Sync Channel Power (Code 32) Relative**  
Relative power of the synchronization channel (SYNC) in dB. The reference power is either the total power or the PICH, depending on your selection (see "[Changing the reference power](#)").



### 4.20.2 Measuring the Code Domain Power

Screen Layout of the Code Domain Power result display



- ① Result Display
- ② Standard
- ③ Header Table
- ④ Diagram Header
- ⑤ CDA Diagram
- ⑥ CDMA2000 Menu

#### Header Table

The header table shows an assortment of settings already described in the section about the Result Summary result display. Refer to that section for a description of the table header.

#### Diagram Area

The Code Domain Power result display shows the measurement results in graphic form. It shows the power of all codes in the signal. In the graph, each bar represents one (Walsh) code.

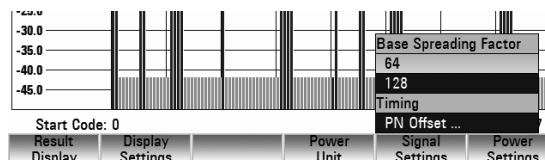
The displayed codes have different colors. The color of the code depends on the state of the channel it belongs to.

- Yellow: active code (channels)
- Turquoise: inactive (code channels)

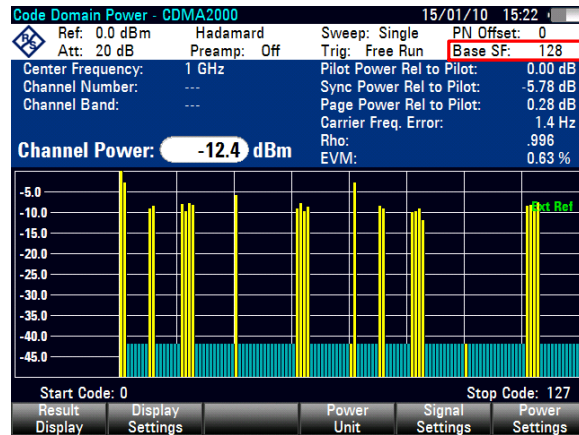
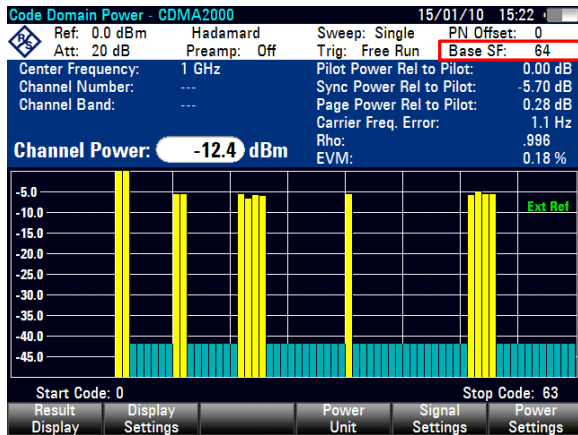
The number of codes depends, in addition to the signal constellation itself, on the base spreading factor you have set in the Signal Settings menu.

#### Setting the base spreading factor

- Press the MEAS hardkey.
- Press the SIGNAL SETTINGS softkey.
- In the menu, select either 64 or 128 as base spreading factor with the cursor keys or the rotary knob and confirm your selection with the ENTER key or the SIGNAL SETTINGS softkey.



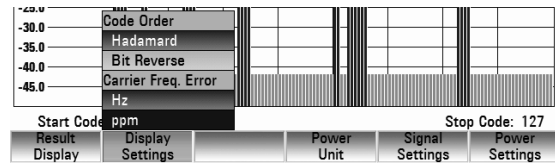
A base spreading factor of 64 results in a display of 64 codes on the x-axis (0 to 63), a base spreading factor of 128 in a display of 128 codes on the x-axis (0 to 127).



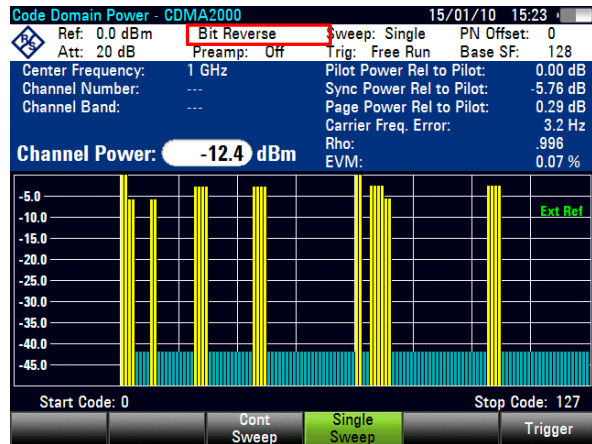
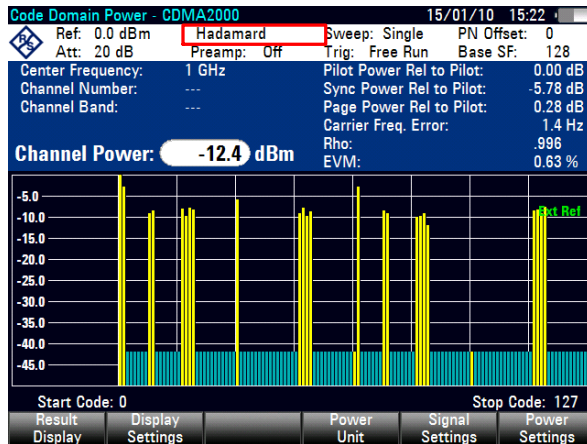
By default, the R&S FSH displays the codes in BitReverse order. In this order you can see at first glance the codes that belong to the same channel. If you want to see the codes in ascending order, you have to change the code order to Hadamard order. The codes used for one specific channel are then spread over the horizontal axis.

**Changing the code order**

- Press the MEAS hardkey.
- Press the DISPLAY SETTINGS softkey.
- In the menu, select the Hadamard item with the cursor keys or the rotary knob. Confirm the selection with the ENTER key or the DISPLAY SETTINGS softkey.



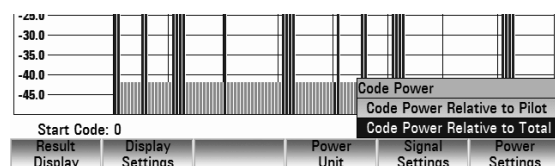
The R&S FSH now displays the codes in ascending order.



The y-axis represents the power of the signal. The power of the codes is relative either to the total power of the signal or relative to the power of the pilot channel (PICH).

**Changing the reference power**

- Press the MEAS hardkey.
- Press the POWER SETTINGS softkey.
- Depending on the display you want to see, select either CODE POWER RELATIVE TO PILOT or CODE POWER RELATIVE TO TOTAL with the cursor keys or the rotary knob.
- Confirm your selection with the ENTER key or the POWER SETTINGS softkey.



By default, the R&S FSH displays the power in the unit dBm. You can change the unit in the Power Unit menu.

**Changing the PN Offset**

Each signal is spread with a Walsh code of length 64 or 128 and a pseudo-random noise code (PN code) of length  $2^{15}$ . Each BTS sector in the network is assigned a PN offset in steps of 64 chips..

If you use an external or GPS sync trigger, you have to adjust the PN Offset according to the base station / sector you are measuring.

- Press the MEAS hardkey.
- Press the SIGNAL SETTINGS softkey.
- Select the PN OFFSET menu item with the rotary knob or the cursor keys. Confirm with the SIGNAL SETTINGS softkey or the ENTER key.
- In the input field that opens, enter the PN Offset you need (between 0 and 511).

**Synchronizing with a base station using a GPS receiver**

If you use a GPS receiver while performing measurements on a base station, you can synchronize the sweep via the GPS receiver.

- Press the SWEEP key.
- Press the TRIGGER softkey.
- Select GPS Sync from the menu and confirm your selection with the ENTER key or the TRIGGER softkey.

### 4.20.3 Reading the Code Domain Channel Table

The application also provides a code domain channel table display. The channel table shows various parameters and measurement results on channel level.

Screen layout of the Code Domain Channel table result display

① Result Display

② Standard

③ Header Table

④ Sync State + GPS Information

⑤ Channel Table

Code Domain Channel Table - CDMA2000 GPS 16/02/10 09:42

Center: 893.97 MHz    Ref Level: -20.0 dBm    Sweep: Continuous

Channel: 799    Att: 0.0 dBm    Trigger: Free Run

Band: cdma2k(800)    Preamp: Off

Base SF: 64

PN Offset: 0

GPS: Lat. 48° 7' 39.918"N Long. 11° 35' 42.654"E Alt. 571.9 m ④ SYNC OK

Channel Type	Walsh Ch.SF	Symb. Rate (ksps)	RC	Status	Power Abs. (dBm)	Power Rel. to Total (dB)
PICH	0.64	19.2	0	⑤ Active	-32.39	-7.01
CHAN	1.64	19.2	0	Active	-32.10	-6.73
CHAN	8.64	19.2	1	Active	-38.17	-12.79
CHAN	9.64	19.2	1	Active	-38.12	-12.74
CHAN	17.32	38.4	1	Active	-38.15	-9.74
CHAN	18.32	38.4	1	Active	-38.11	-9.73
CHAN	19.32	38.4	1	Active	-38.71	-9.74
CHAN	20.32	38.4	1	Active	-37.28	-9.75
SYNC	32.64	19.2	0	Active	-38.14	-12.76
CHAN	2.64	19.2	0	Inactive	-74.38	-49.00
CHAN	3.64	19.2	0	Inactive	-74.38	-49.00
CHAN	4.64	19.2	0	Inactive	-74.38	-49.00
CHAN	5.64	19.2	0	Inactive	-74.38	-49.00
CHAN	6.64	19.2	0	Inactive	-74.38	-49.00

Result Display    Display Settings    Power Unit    Signal Settings    Power Settings

#### 4.20.3.1 Header Table

The header table shows an assortment of settings already described in the sections above. Refer to those sections for a description of the table header.

#### 4.20.3.2 Global Results

The global results section shows a number of key measurement results for easy reference. These measurement results include total power, composite EVM and PN found (for Auto PN Offset).

#### 4.20.3.3 Channel Table

The channel table is made up out of seven columns and a number of rows that depend on the number of channels.

The columns show the following information

- Channel Type

Type of channel. (---) indicates an inactive channel. The following channels can be detected:

Channel Type	Channel
F-PICH	Pilot channel (displayed as PICH)
F-SYNC	Synchronization channel (displayed as SYNC)

All other channel types are not automatically differentiated and named as "CHAN".

- Walsh Ch.SF

Channel number including the spreading factor (in the form <Channel>.<SF>).

- Symb. Rate (ksps)

Symbol rate that the channel is transmitted with (9.6 ksps to 307.2 ksps).

- RC

Radio configuration. The RC is a predefined physical layer configuration for the transmit signal. It defines the physical channel configuration based upon a specific channel data rate. In the current CDMA2000 Standard nine RCs are defined in the forward link.

- Status  
Status display. Unassigned codes are identified as inactive channels.
- Power Abs (dBm)  
Absolute power of the channel in dBm.
- Power Rel to PICH [Total] (dB)  
Relative power of the channel in dB. The reference channel is the PICH or the total signal, depending on the reference power you have selected.

#### 4.20.4 Spectrum Overview

The Spectrum Overview result display shows the spectrum of the signal you are currently measuring. The screen layout and contents are the same as those in spectrum analyzer mode. The Spectrum Overview result display provides an overview only; you can only set the resolution bandwidth and the span while using this result display.

You can use this result display as a quick display of the frequency and power level of the CDMA2000 signal without switching the operating modes of the R&S FSH. For a detailed analysis of the spectrum, you should switch to the spectrum analyzer mode.

#### 4.20.5 PN Scanner

If you are measuring over-the-air (OTA) signals, you can use the PN scanner result display that shows the PN offset and the corresponding power. In order to be able to determine the PN offsets of the base station you are scanning, you have to apply a trigger to the R&S FSH from a GPS device such as the optional GPS receiver.

Note that the PN scanner result display shows the detected base station PN offsets as well as the relative powers of these base stations. Above the display, the PN offsets are listed in a table.

## 4.21 Measurements on 1xEV-DO Signals

Equipped with the measurement application R&S FSH-K47, you can perform Pilot channel and EVM measurements on the forward link of 1xEV-DO signals in accordance to the 3GPP2 standard with your R&S FSH.

### Starting the measurement

- Press the MODE key
- Press the DIG MOD ANALYZER softkey
- Select 1xEVDO BTS and confirm the selection with the ENTER key.

The R&S FSH starts the 1xEV-DO measurement application. In the default mode, it also starts measuring right away.

After you have started the measurement, the **Error! Unknown document property name.** first records a section of the signal that lasts approximately 27 ms (or about 1 Sync Frame Period). If the instrument is in a triggered mode (external or GPS trigger), it then searches for the start of the PN code in the vicinity of the PN offset you have entered. If you are using the automatic PN Offset, the R&S FSH performs a full search for the PN offset and reports the PN found. For a "free run" situation, the R&S FSH searches for the start of the PN sequence over the entire signal length.

The R&S FSH performs various general measurements over one slot as well as measurements on specific channels. It then shows the results in tabular form in the "Result Summary" display,

To get highest measurement accuracy, it is necessary to synchronize the reference frequency of the R&S FSH with the base station via the EXT REF IN input or with an optional GPS receiver.

### 4.21.1 Reading the Result Summary

The Result Summary shows various hardware settings, 1xEV-DO standard settings and measurement results in numerical form.

#### Screen layout of the Result Summary display

Result Summary		1xEVDO BTS		GPS	24/09/10 12:18
Center:	1.93 GHz	Ref Level:	3.0 dBm	Sweep:	Cont
Channel:	0	Att:	15.0 dB	Trigger:	GPS Sync
Band:	cdma2k(1900)	Preamp:	Off		
		PN Offset:	5		
GPS: Lat. 48° 7' 38.508"N Long. 11° 38' 43.272"E Alt. 584.4 m SYNC OK					
Global Results					
Total Power:	-11.76 dBm	Peak to Average:	11.02 dB		
Carrier Freq Error:	1.3072 kHz	PN Found:	5		
		Tau:	55.59 µs		
		Traffic Activity:	75.00 %		
Channel Results					
	Pwr Absolute:	Pwr Rel to Total:	Pwr Rel to Pilot:	EVM:	Rho:
Pilot:	-10.95 dBm	-9.52 dB	0.00 dB	1.75 %	1.000
MAC:	-9.86 dBm	-7.19 dB	2.34 dB		
Data:	-10.95 dBm	-1.57 dB	7.96 dB		
Result Display		Display Settings		Signal Settings	

- 1 Type of result display
- 2 Standard
- 3 General settings
- 4 Synchronization and GPS information
- 5 Global results
- 6 Channel results
- 7 1xEV-DO softkey menu

### 4.21.1.1 General Settings

The General Settings section shows an assortment of hardware settings and general 1xEVDO settings.

- Center

Current center frequency of the R&S FSH.

For measurements, this has to be the center frequency of the signal you want to measure.

If you change the center frequency with the rotary knob or the cursor keys, the stepsize by default is 1.25 MHz. You can change the stepsize in the frequency menu.

- Press the **FREQ** key.
- Press the **CF STEPSIZE** softkey.
- Select the **MANUAL...** menu item or the **=CENTER** menu item.

The R&S FSH opens an input field to define a CF stepsize.

If you have selected the **=CENTER** menu item, the R&S FSH sets the stepsize equal to the current center frequency, i.e. that each step doubles the center frequency.

- Channel

Number of the channel you are currently analyzing.

The number depends on the selected band (bandclass).

- Band

Name of the bandclass you are currently using.

#### Selecting the bandclass

- Press the **FREQ** hardkey.
- Press the **FREQ MODE** softkey.
- Select the **CHANNEL** menu item with the rotary knob or the cursor keys.
- Confirm the selection with the **ENTER** key or the **FREQ MODE** softkey.

The R&S FSH opens a dialog box to select a 1xEVDO channel table or bandclass.

- Select the table you need with the rotary knob or the cursor keys.
- Confirm the selection with the **SELECT** softkey.

The R&S FSH now applies the channel table to future measurements.

- Ref Level

The reference level is the level the R&S FSH expects on its RF input. The R&S FSH uses this value to determine the internal settings for attenuation and preamplifier.

Set the Ref Level to the expected maximum peak level of the 1xEVDO signal.

To obtain the greatest possible dynamic range, the lowest reference level possible must be set.

The R&S FSH will be overloaded by the measurement signal, if its maximum level exceeds the reference level.

Because the R&S FSH's resolution bandwidths are implemented digitally after the A/D converter, depending on the resolution bandwidth you have selected, the signal level at the A/D converter can be higher than the level indicated by the trace in Spectrum mode.

Select Channel Table					16/02/10 10:09
Stat	Name	Size	Date	Time	
<	\Public\Channel Tables\				▲
	cdma2k_0 (800 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_1 (1900 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_10 (Sec 800 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_11 (400 MHz Europe PAMR).chntab	1 kB	27/01/2010	04:21	
	cdma2k_12 (800 MHz PAMR Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_13 (2.5 GHz IMT-2000 Ext).chntab	1 kB	27/01/2010	04:21	
	cdma2k_14 (US PCS 1.9GHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_15 (AWS Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_16 (US 2.5GHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_18 (700 MHz P1 Safety).chntab	1 kB	27/01/2010	04:21	
	cdma2k_19 (Lower 700 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_2 (TACS Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_3 (JTACS Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_4 (Korean PCS Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_5 20k (450 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_5 25k (450 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_6 (2 GHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_7 (Upper 700 MHz Band).chntab	1 kB	27/01/2010	04:21	
	cdma2k_8 (1800 MHz Band).chntab	1 kB	27/01/2010	04:21	

Free: 15 MB

Select    Sort/Show    Internal/SD-Card    Exit

If you are not sure about the maximum level of the signal, do the following:

To prevent the A/D converter from being overloaded, the signal must be measured at the widest resolution bandwidth (3 MHz) and video bandwidth (3 MHz) with the peak detector (in Spectrum mode). The trace maximum then determines the optimal reference level.

This is especially important if you measure in a scenario with more than one active 1xEVDO channel near the channel you want to measure (+/- 6 MHz).

If you do the Ref Level setting in Spectrum mode and afterwards switch to 1xEVDO mode, the Ref Level value is applied in the 1xEVDO mode.

- Att  
Current RF attenuation inside the R&S FSH.  
Refer to chapter "[Setting the Amplitude Parameters](#)" for more information on RF attenuation.
- Preamp  
Current state of the preamplifier (on / off).  
Refer to chapter "[Setting the Amplitude Parameters](#)" for more information on preamplification.
- PN Offset  
Current pseudo noise (PN) offset of the base station.  
The standard uses the PN offset to distinguish between base stations. The PN offset determines the offset in the circulating PN sequence in multiples of 64 chips with reference to the even second GPS clock.  
The PN Offset only has a function in External or GPS trigger mode.  
In the default mode, the R&S FSH automatically looks for the PN offset. However, you can also set the PN offset manually.
  - Press the MEAS key.
  - Press the SIGNAL SETTINGS softkey.
  - Select the MANUAL menu item.  
The R&S FSH opens an input field to set the PN offset.
  - Enter the PN offset.
- Sweep  
Current sweep mode.  
You can select between
  - Single: data is captured and results are displayed one at a time.
  - Continuous: data is captured and results are displayed continuously.
- Trigger  
Current trigger mode.  
Refer to chapter "[Trigger](#)" for more information on trigger modes.
- External Reference  
Shows whether the external reference is active or not.
- SYNC NOT FOUND / SYNC OK  
Indicates whether synchronization was successful or not.
- GPS Position  
Shows the current position if you have connected a GPS receiver and have activated the GPS receiver. If not, this field stays empty. Refer to the Quick Start Guide for details.



### 4.21.1.2 RF Power Results

The RF power results show measurement results of the composite signal. These results evaluate the total signal over the period of one frame.

- **Total Power**  
Total power of the signal in dBm in the 1.23 MHz bandwidth around the center frequency.
- **Pilot Power**  
Power of the pilot channel.  
The result is an average over the time that the channel is active in the measured slot.
- **MAC Power**  
Pilot of the MAC channel.  
The result is an average over the time that the channel is active in the measured slot.
- **Data Power**  
Power of the data channels in the signal.  
The result is an average over the time that the channel is active in the measured slot.
- **Traffic Activity**  
Percentage of traffic slots with data.
- **PN Found**  
The PN offset found during auto PN offset operation.

### 4.21.1.3 Signal Quality Results

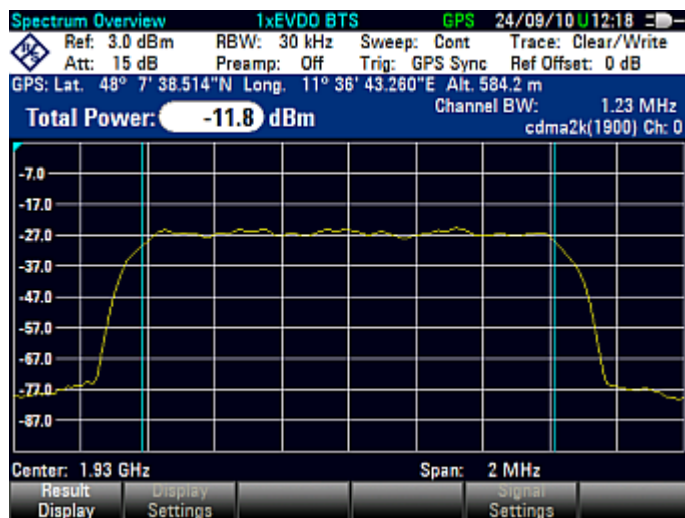
- **Rho Pilot**  
Quality parameter Rho of the pilot channel.  
Rho is specified in the CDMA2000 standard. It is the normalized, correlated power between the measured signal and an ideal reference signal. The standard requires that only the pilot channel is measured to get the results for Rho.
  - **EVM Pilot**  
Error vector magnitude (EVM) of the pilot channel in %.  
The EVM is the root of the ratio of the mean error power (root mean square) to the power of an ideal reference signal.  
An EVM of 0 % means a perfect signal.
  - **Tau**  
Tau is specified in the CDMA2000 standard. It shows the timing error of the signal. The maximum offset is specified at 10  $\mu$ s.
  - **Carrier Frequency Error**  
Shows the frequency error in relation to the current center frequency of the R&S FSH.  
The absolute frequency error is the sum of the frequency error of the R&S FSH and that of the device under test. Frequency differences between the transmitter and receiver of more than 1.0 kHz impair synchronization of the 1xEVDO measurement. If at all possible, the transmitter and the receiver should be synchronized.  
Concerning uncertainty of the reference frequency of the GPS receiver, refer to the data sheet.  
You can display the carrier frequency error with the unit Hz or ppm.
- Press the MEAS key.

- Press the DISPLAY SETTINGS softkey.
- Select the HZ or PPM menu item.  
The R&S FSH shows the carrier frequency error in the unit you have selected.
- Peak to Average  
Shows the difference between the peak power and the average power of the signal (crest factor).

### 4.21.2 Spectrum Overview

The Spectrum Overview result display shows the spectrum of the signal you are currently measuring. The screen layout and contents are the same as those in spectrum analyzer mode. The Spectrum Overview result display provides an overview only; you can only set the resolution bandwidth and span while in this mode. For detailed spectral analysis, you should switch to the spectrum analyzer mode. You can use this result display as a quick display of the frequency and power level of the 1xEVDO signal without switching the operating modes of the R&S FSH.

- Press the RESULT DISPLAY softkey.
- Select the RESULT SUMMARY menu item.



## 4.22 Saving and Loading Instrument Settings and Measurement Results

The R&S FSH's settings and measurement results can be saved to the internal memory and recalled at a later date. Using the R&S FSH4View software package, these data sets can also be saved to a PC from the R&S FSH or downloaded onto the R&S FSH from a PC.

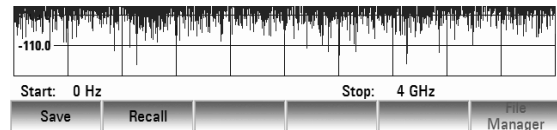
Results and settings, including the measurement function, are always saved en bloc so that when the results are recalled the measurement context is clear. The R&S FSH can store at minimum 100 data sets which are assigned a unique name.

Data sets for scalar transmission and reflection measurements can be stored along with their calibration data. When such data sets are recalled, therefore, measurements can be performed without prior calibration. Saving a data set with calibration data, however, requires twice as much memory space as without it, i.e. a data set with calibration data takes up the space required for two data sets without calibration data. This reduces the maximum number of data sets that can be stored by the number of data sets stored with calibration data.

If cable models, channel tables, limit lines or transducer factors are stored simultaneously, the maximum number of data sets will be reduced. In addition, the size of the data sets can vary as a function of the selected measurement function. A complete data set uses approx 100 kB of memory.

The R&S FSH provides a total internal storage space of approx 20 MB. In addition data sets, cable models, channel tables, limit lines and transducer factors can be stored on a SD card. Thus the amount of data sets that can be stored depends only on the size of the SD card in use.

- Press the SAVE/RECALL key.  
The R&S FSH opens the file manager.



### 4.22.1 Saving Results

- Press the SAVE softkey.  
The R&S FSH opens the "Save Dataset" dialog box.

The **Name** entry box, which is highlighted in red, also suggests a name for the data set (DATASET.003) which can be accepted by pressing the ENTER key.

For the sake of simplicity, the R&S FSH also saves the data set when the SAVE softkey under the suggested name is pressed twice.

The remaining *free memory* size (**Free xx MB**) is also displayed in the dialog box.



The default file name for datasets is "Dataset###.set" with a new number in ascending order for each new dataset. The file extension for datasets is \*.set.

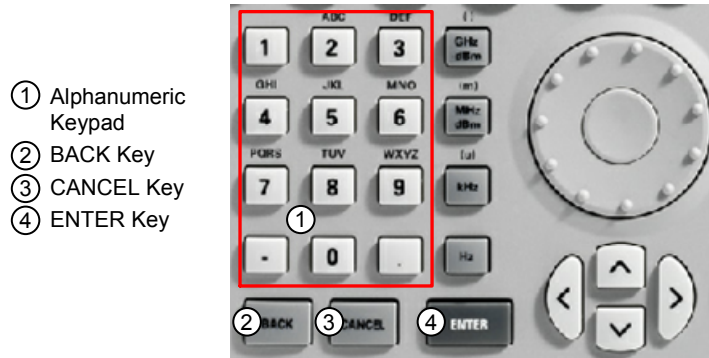
If you enter another name, the R&S FSH uses that name and assigns a new number to the file name if you save the data set the next time.

Consecutive data set names can then be assigned by simply saving with SAVE or ENTER.

The names of the data sets already stored can be displayed one after the other using the BACK key. This allows, for example, to store new results under the name of a previous data set (for example Antenna.000), but with a new extension. The R&S FSH displays the old name together with the first unassigned extension, e.g. Antenna.001. No new name has to be entered.

### 4.22.2 Entering a Data Set Name

A new name can be entered with the numeric keypad. The letter assignment for the keypad is the same as that for a mobile phone



If the R&S FSH is expecting a letter entry, it automatically assigns the letters above the keys to the keys in the alphanumeric keypad. The keys have a multiple assignment. Enter the letter you want by pressing the key in question the appropriate number of times.

- Using the alphanumeric keypad enter a name for the data set and terminate the entry with the ENTER key.  
The data set is saved to the R&S FSH's internal memory under the name that has been given.

### 4.22.3 Loading Measurement Results

Previously saved measurement results and settings can be recalled with the R&S FSH's recall function.

- Press the RECALL softkey.  
The R&S FSH opens a list of all the data sets that have been saved.  
The red selection bar indicates the last data set to have been saved.  
Using the cursor keys, you can position the selection bar at the top or bottom of the page. This means fast scrolling if many data sets have been saved in the R&S FSH's memory.  
The softkey INTERNAL / SD CARD selects either the internal memory of the FSH or the SD card as the storage medium for the data set.  
You can quit the menu by pressing the EXIT softkey. The R&S FSH returns to its previous settings.

Recall Dataset		09/10/06 08:42		
Stat	Name	Size	Date	Time
Public	Dataset000.set	40 kB	28/04/2006	11:48
	Dataset001.set	18 kB	22/05/2006	21:25
	Dataset002.set	18 kB	22/05/2006	21:56
	Dataset003.set	75 kB	09/10/2006	05:54
	Dataset004.set	75 kB	09/10/2006	05:55
	Dataset005.set	75 kB	09/10/2006	06:01

Free: 27 MB

View   Recall   Sort/Show   Internal/SD-Card   Exit

#### Previewing data sets

- Using the rotary knob or the cursor keys select a data set.
- Preview the data set by pressing the RECALL softkey.  
The R&S FSH shows a preview of the selected data set. The preview is like a screenshot of the last measurement that was done with the settings corresponding to that data set.  
The settings corresponding to the dataset, however, are not yet activated.

- Use the rotary knob to scroll through and preview all available data sets. The currently active data set is displayed below the measurement screen. In addition to the trace, the R&S FSH also shows the settings of that particular measurement.

**Loading data sets**

- Press the ACTIVATE softkey to load the settings of the data sets or the EXIT softkey to quit previewing the data sets. If you choose to activate a data set, the R&S FSH loads the settings corresponding to that particular data set to perform future measurements. If you choose to exit the preview of data sets, the R&S FSH returns to the file manager ('Recall Data Sets' dialog).

**4.22.4 Quick Recall of Instrument Settings**

The R&S FSH allows quick access to previously saved datasets by linking a particular dataset to one of the softkeys.

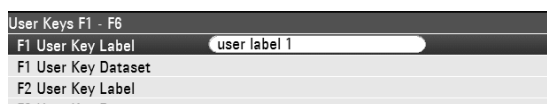
**Assigning a dataset to one of the softkeys:**

- Press the SETUP key. The R&S FSH opens the setup menu.
- Press the USER PREFERENCE softkey. The R&S FSH opens the User Preference Setup menu.



In this menu you can customize the name of one of the softkeys F1 to F6 and assign a dataset to a specific softkey for quick access to that dataset. By default, the name of the label is USER-PREF 1 to USER-PREF 6.

- Using the cursor keys or the rotary knob, select one of the User Key Labels F1 to F6. Confirm your selection with the ENTER key. Customize the name of the softkey by entering a new one with the alphanumeric keys, e.g. 'user label 1'.

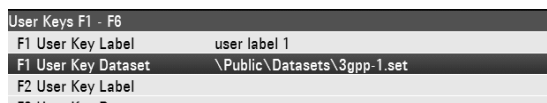


The first word of the key label is displayed in the first row of the label, the rest in the second row. If a label is too long to be displayed, it is truncated. If you enter no label, the softkey will be inactive.

- Using the cursor keys or the rotary knob, select the User Key Dataset corresponding to the customized User Key Label F1 to F6. Confirm your selection with the ENTER key. The R&S FSH opens the file manager and displays a list of available datasets.

- Select the dataset you want to assign to the softkey using the cursor keys or the rotary knob and confirm your selection with the SELECT softkey.

The R&S FSH returns to the User Preference Setup menu. The dataset is now assigned to the softkey.



**Recalling a dataset:**

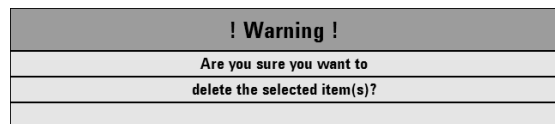
- Press the USER key.
- Press one of the softkeys F1 to F6 in the menu. Note that the label of the softkeys depends on the settings made in the User Preference Setup menu. The R&S FSH immediately activates the dataset assigned to that softkey.



**4.22.5 Deleting Data Sets**

Previously saved data sets can be deleted individually.

- Press the SAVE/RECALL key.
- Press the FILE MANAGER softkey. The R&S FSH opens the file manager.
- In order to delete a single dataset, press the SELECT ACTION softkey. Select DELETE and the dataset currently under the cursor is deleted after your confirmation.
- In order to delete multiple data sets, the respective data sets have to be marked first.
- Press the MARK softkey to mark files for deletion
- Select the data set you'd like to delete using the rotary knob or the cursor keys. Mark the data sets with the ENTER key. The selected data sets should be checked in the STATUS column.
- Repeat the selection by moving the cursor with the rotary knob or the cursor key and marking more data sets with the ENTER key.
- Press the SELECT ACTION softkey.
- Select the DELETE menu item and confirm with the ENTER key or the SELECT ACTION softkey. Before deleting the data set, the R&S FSH shows a warning message that you need to confirm. When confirming the deletion process the R&S FSH deletes the selected data sets from its memory.



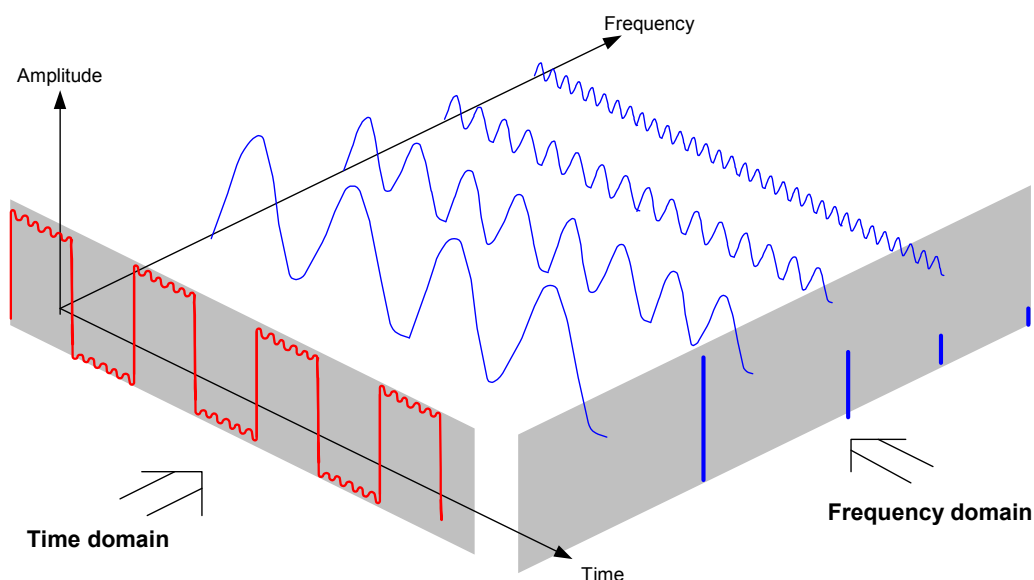
## 4.23 How a Spectrum Analyzer Works

Basically, an RF signal can either be analyzed in the time domain or in the frequency domain.

In the time domain, how the signal varies with time can be observed on an oscilloscope, for example. In the frequency domain, a spectrum analyzer can be used to display the frequency components of a signal.

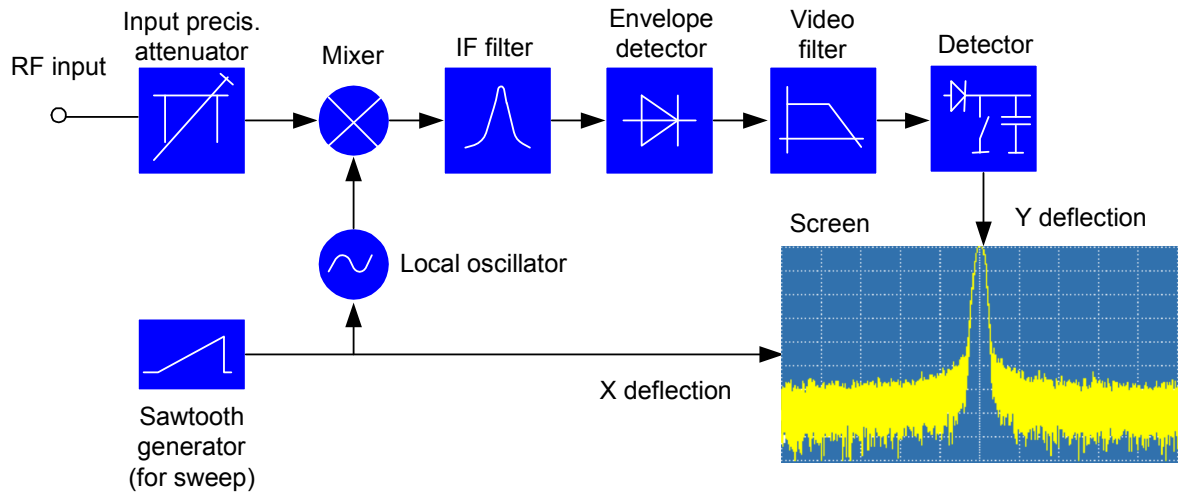
Both modes are essentially equivalent because applying the Fourier transform to any signal converts it into its spectral components. However, depending on the signal characteristic to be measured, one method is usually more appropriate than the other. Just by glancing at an oscilloscope, it is possible to tell whether a measurement signal is a sine signal, a squarewave with a certain on/off ratio or a sawtooth. However, it is not at all obvious what the harmonic content of the signal is or if low-level signals are superimposed. This is easy to see with a spectrum analyzer.

The following Fig. shows the theoretical basis of the two measurement techniques. In the time domain, an oscilloscope is showing a section of a signal which is approximately a squarewave. The same signal viewed with a spectrum analyzer shows a line spectrum, i.e. the fundamental and harmonics.



The periodic squarewave in the time domain can be Fourier transformed to the frequency domain. In the case of a squarewave there is a fundamental (= frequency of the squarewave) and its odd harmonics. Using a narrow bandpass filter, the spectrum analyzer makes measurements in the frequency domain. Only at frequencies where there is a signal is there a reading which gives the amplitude of the frequency component.

The block diagram below shows how a spectrum analyzer works.



The precision attenuator at the input of the spectrum analyzer adjusts the level of the measurement signal to the level range that the mixer can handle without overdriving it. The precision attenuator at the input of the R&S FSH is adjustable in 10 dB steps from 0 dB to 30 dB and is directly coupled to the reference level setting.

The mixer converts the RF input signal to a fixed IF. Conversion is usually performed in several stages to an IF for which good narrowband IF filters are available. The R&S FSH4 has three mixing stages with the IFs 4856 MHz, 831.4 MHz and 21.4 MHz. Up to 3.6 GHz, the R&S FSH8 uses the same IFs as the R&S FSH4. Between 3.6 GHz and 8 GHz, it uses a first IF at 8856 MHz, which it converts to the second IF of 831.4 MHz with the aid of the second local oscillator. As of the second IF, the signal path for the two ranges is identical.

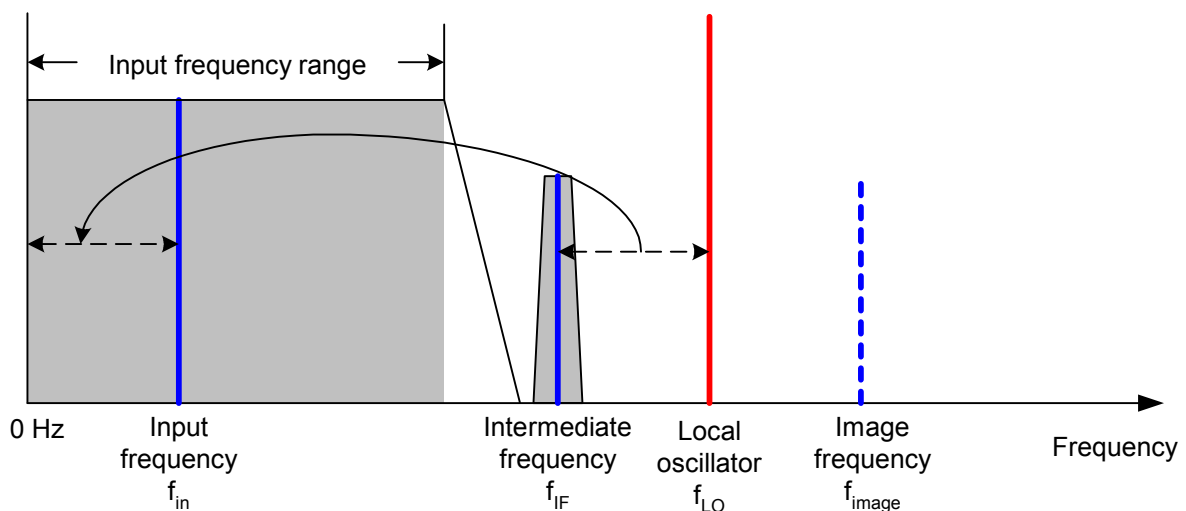
A local oscillator that can be tuned from 4.8 GHz to 8.4 GHz is used in the R&S FSH4 for conversion to the first IF so that a certain input frequency is converted to the first IF. The further conversions are performed by single-frequency oscillators.

The frequency of the local oscillator determines the input frequency at which the spectrum analyzer performs measurements:

$$f_{in} = f_{LO} - f_{IF}$$

The first mixer produces the sum frequency  $f_{LO} + f_{in}$  (= image frequency  $f_{image}$ ) as well as the difference frequency  $f_{LO} - f_{in}$ .

The image frequency is rejected by the bandpass at the IF so that it does not interfere with the subsequent frequency conversions.





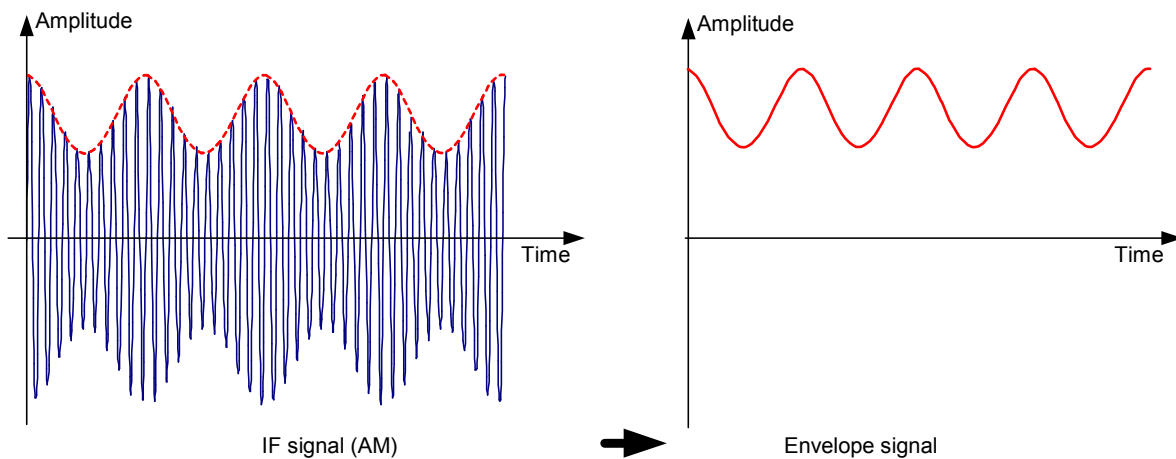
The first local oscillator is tuned with a sawtooth which simultaneously acts as the x deflection voltage for the display. In practice, synthesizer technology is used to generate the frequency of the first local oscillator and for a digital display.

The instantaneous sawtooth voltage therefore determines the input frequency of the spectrum analyzer.

The bandwidth of the IF filter at the IF determines the bandwidth that is used for measurements. Pure sine signals are passed by the IF filter characteristics. This means that signals closer together than the bandwidth of the IF filter cannot be resolved. This is why the bandwidth of the IF filter in a spectrum analyzer is referred to as the resolution bandwidth. The R&S FSH has resolution bandwidths from 1 kHz to 1 MHz.

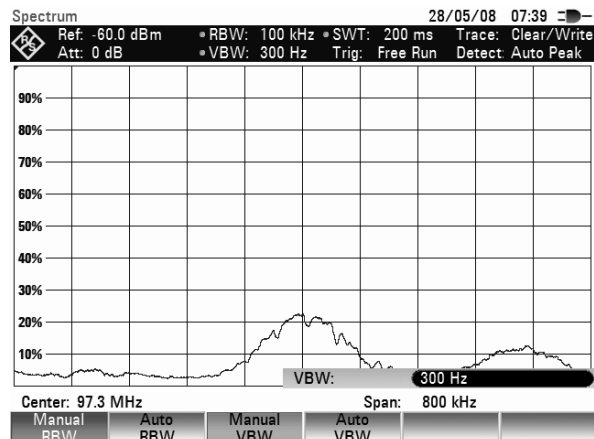
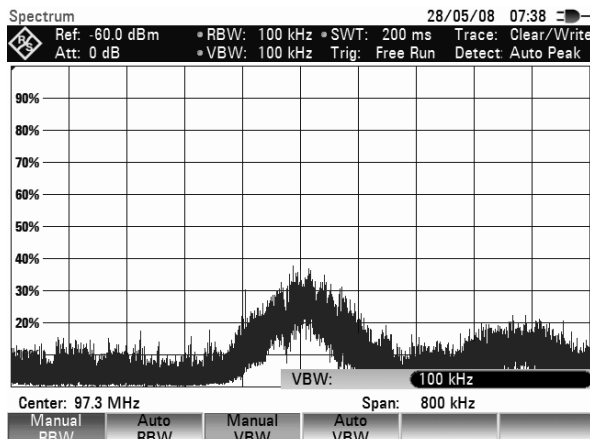
The bandlimited IF is passed to the envelope detector. The envelope detector removes the IF from the signal and outputs its envelope. The output signal from the envelope detector is referred to as the video signal. As it has been demodulated, it only contains amplitude information. The phase information is lost.

With RF sine signals, the video signal is a DC voltage. With AM signals the video signal contains a DC component whose amplitude corresponds to the carrier power and an AC component whose frequency is equal to the modulation frequency, provided the modulation frequency is inside the resolution bandwidth.



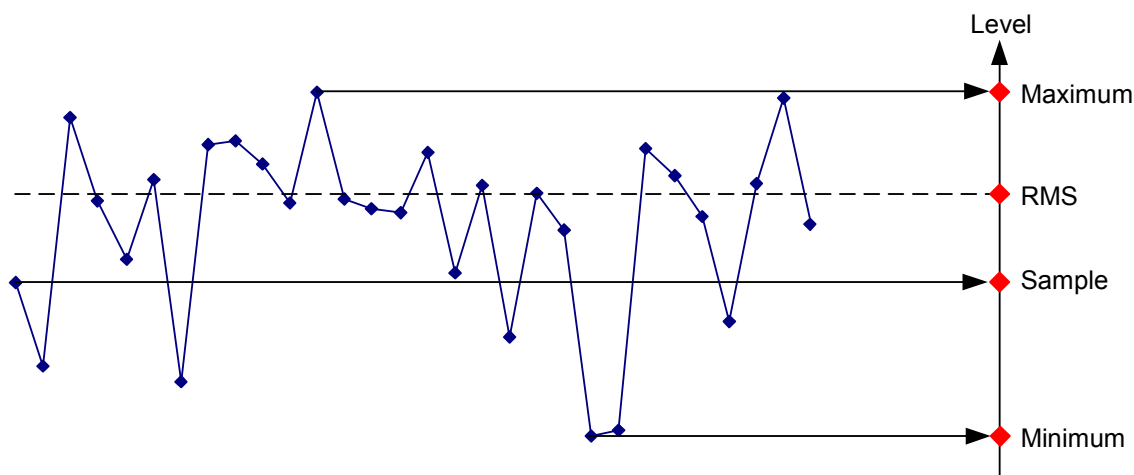
The video filter comes after the envelope detector. The filter is a lowpass with an adjustable cutoff frequency which limits the bandwidth of the video signal. It is particularly useful when sine signals are to be measured in the vicinity of the spectrum analyzer's intrinsic noise. The sine signal produces a video signal that is a DC voltage. At the IF, however, the noise is distributed over the whole bandwidth or, in the case of the video signal, over half the bandwidth of the resolution filter. By selecting a narrow video bandwidth relative to the resolution bandwidth, the noise can be suppressed, while the sine signal to be measured (= DC) is not affected.

The Figs. below show a weak sine signal. In the first Fig., it is measured with a large video bandwidth and in the second with a narrow video bandwidth.



Limiting the video bandwidth smoothes the trace considerably. This makes it much easier to determine the level of the measured signal.

The detector comes after the video filter. The detector combines the measured spectrum so that it can be represented as one pixel in the trace. The R&S FSH uses 301 pixels to form the trace, i.e. the whole measured spectrum has to be represented using just 301 pixels. Common types of spectrum analyzer detectors are the peak detector (PEAK), the sample detector (SAMPLE) and the RMS detector (RMS). An Auto Peak detector which simultaneously displays the maximum peak and the minimum peak is usually also provided. The Fig. below explains how these detectors work.



The Fig. above shows 30 measured values which are represented by a single pixel. The peak detector determines and displays the maximum measured value. The Auto Peak detector takes the maximum and minimum and displays them together. This gives a good indication of the level variation over the measured values represented by a single pixel. The RMS detector is used by the spectrum analyzer to determine the RMS value of the measured values. It is therefore a measure of the spectral power represented by a pixel. The sample detector takes an arbitrary measurement value and displays it (in the Fig. above, the first). The other measured values are ignored.

On the basis of the operating principles of detectors, a few recommendations can be made as to their use.

- It is best to use the Auto Peak detector or the peak detector for spectrum analysis over large frequency ranges. This ensures that all signals are displayed.
- The RMS detector is recommended for power measurements on modulated signals. However, the display range should be chosen so as not to exceed 100 times the bandwidth of the signal or the resolution bandwidth, whichever is larger.
- The sample detector or the RMS detector (preferred) should be used for noise measurements. Only these two detectors are capable of measuring noise power correctly.
- When measurements are made on sine signals, the level display does not depend on the detector. However, if you use the RMS detector or the sample detector, ensure that the span is not too great. Otherwise, the displayed levels of sine signals may be lower than their true value.

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