

R&S®FSQ-B71

Analog Baseband Input

Manual



1157.5047.12 – 04

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The following abbreviations are used throughout this manual:
R&S®FSQ-B71 is abbreviated as R&S FSQ-B71

Basic Safety Instructions

Always read through and comply with the following safety instructions!

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

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

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

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

Safety labels on products

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

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation	○	ON/OFF supply voltage
	Caution when handling heavy equipment	(○)	Standby indication
	Danger of electric shock	---	Direct current (DC)

Basic Safety Instructions

Symbol	Meaning	Symbol	Meaning
	Warning! Hot surface		Alternating current (AC)
	Protective conductor terminal		Direct/alternating current (DC/AC)
	Ground		Device fully protected by double (reinforced) insulation
	Ground terminal		EU labeling for batteries and accumulators For additional information, see section "Waste disposal/Environmental protection", item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section "Waste disposal/Environmental protection", item 2.
	Warning! Laser radiation For additional information, see section "Operation", item 7.		

Signal words and their meaning

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



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 information considered important, but not hazard-related, e.g. messages relating to property damage.

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

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

Operating states and operating positions

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

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of $\pm 10\%$ shall apply to the nominal voltage and $\pm 5\%$ to the nominal frequency, overvoltage category 2, pollution severity 2.
2. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). An installation that is not carried out as described in the product documentation could result in personal injury or even death.
3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

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

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a protective conductor contact and protective conductor.
3. Intentionally breaking the protective conductor either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
4. If there is no power switch for disconnecting the product from the AC supply network, or if the power switch is not suitable for this purpose, use the plug of the connecting cable to disconnect the product from the AC supply network. In such cases, always ensure that the power plug is easily reachable and accessible at all times. For example, if the power plug is the disconnecting device, the length of the connecting cable must not exceed 3 m. Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, the disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cables on a regular basis to ensure that they are in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.

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6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages $V_{rms} > 30$ V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC60950-1/EN60950-1 or IEC61010-1/EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

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

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2. Before you move or transport the product, read and observe the section titled "Transport".
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.
4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal/Environmental protection", item 1.
5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.
6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
7. Laser products are given warning labels that are standardized according to their laser class. Lasers can cause biological harm due to the properties of their radiation and due to their extremely concentrated electromagnetic power. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).
8. EMC classes (in line with EN 55011/CISPR 11, and analogously with EN 55022/CISPR 22, EN 55032/CISPR 32)
 - Class A equipment:
Equipment suitable for use in all environments except residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings
Note: Class A equipment is intended for use in an industrial environment. This equipment may cause radio disturbances in residential environments, due to possible conducted as well as radiated disturbances. In this case, the operator may be required to take appropriate measures to eliminate these disturbances.
 - Class B equipment:
Equipment suitable for use in residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings

Repair and service

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

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

Batteries and rechargeable batteries/cells

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

1. Cells must not be taken apart or crushed.
2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.
3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.
4. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
5. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.
6. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde & Schwarz type (see parts list) in order to ensure the safety of the product.
7. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.
2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.
3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

Waste disposal/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde & Schwarz customer service center.
2. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste, but must be collected separately.
Rohde & Schwarz GmbH & Co. KG has developed a disposal concept and takes full responsibility for take-back obligations and disposal obligations for manufacturers within the EU. Contact your Rohde & Schwarz customer service center for environmentally responsible disposal of the product.
3. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
4. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

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

Instrucciones de seguridad elementales

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

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

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

Instrucciones de seguridad elementales

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

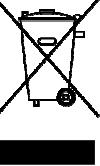
Tener en cuenta las informaciones de seguridad sirve para evitar en lo posible lesiones o daños por peligros de toda clase. Por eso es imprescindible leer detalladamente y comprender por completo las siguientes informaciones de seguridad antes de usar el producto, y respetarlas durante el uso del producto.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

Señalización de seguridad de los productos

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

Símbolo	Significado	Símbolo	Significado
	Aviso: punto de peligro general Observar la documentación del producto	○	Tensión de alimentación de PUESTA EN MARCHA / PARADA
	Atención en el manejo de dispositivos de peso elevado	(○)	Indicación de estado de espera (standby)
	Peligro de choque eléctrico	---	Corriente continua (DC)
	Advertencia: superficie caliente	~	Corriente alterna (AC)
	Conexión a conductor de protección	~	Corriente continua / Corriente alterna (DC/AC)
	Conexión a tierra	□	El aparato está protegido en su totalidad por un aislamiento doble (reforzado)
	Conexión a masa		Distintivo de la UE para baterías y acumuladores Más información en la sección "Eliminación/protección del medio ambiente", punto 1.

Instrucciones de seguridad elementales

Símbolo	Significado	Símbolo	Significado
	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)		Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos Más información en la sección "Eliminación/protección del medio ambiente", punto 2.
	Advertencia: rayo láser Más información en la sección "Funcionamiento", punto 7.		

Palabras de señal y su significado

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



Indica una situación de peligro que, si no se evita, causa lesiones graves o incluso la muerte.



Indica una situación de peligro que, si no se evita, puede causar lesiones graves o incluso la muerte.



Indica una situación de peligro que, si no se evita, puede causar lesiones leves o moderadas.



Indica información que se considera importante, pero no en relación con situaciones de peligro; p. ej., avisos sobre posibles daños materiales.

En la documentación del producto se emplea de forma sinónima el término CUIDADO.

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

Estados operativos y posiciones de funcionamiento

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

Instrucciones de seguridad elementales

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de $\pm 10\%$ sobre el voltaje nominal y de $\pm 5\%$ sobre la frecuencia nominal. Categoría de sobrecarga eléctrica 2, índice de suciedad 2.
2. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptos para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (p. ej. paredes y estantes). Si se realiza la instalación de modo distinto al indicado en la documentación del producto, se pueden causar lesiones o, en determinadas circunstancias, incluso la muerte.
3. No ponga el producto sobre aparatos que generen calor (p. ej. radiadores o calefactores). La temperatura ambiente no debe superar la temperatura máxima especificada en la documentación del producto o en la hoja de datos. En caso de sobrecalentamiento del producto, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

Seguridad eléctrica

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

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.
2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.
3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.
4. Si el producto no está equipado con un interruptor para desconectarlo de la red, o bien si el interruptor existente no resulta apropiado para la desconexión de la red, el enchufe del cable de conexión se deberá considerar como un dispositivo de desconexión.
El dispositivo de desconexión se debe poder alcanzar fácilmente y debe estar siempre bien accesible. Si, p. ej., el enchufe de conexión a la red es el dispositivo de desconexión, la longitud del cable de conexión no debe superar 3 m).
Los interruptores selectores o electrónicos no son aptos para el corte de la red eléctrica. Si se integran productos sin interruptor en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.
5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.

Instrucciones de seguridad elementales

6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).
7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.
8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.
9. En las mediciones en circuitos de corriente con una tensión $U_{eff} > 30$ V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.
12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.
14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.
15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.
16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.
17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.
18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.
2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".
3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados —los llamados alérgenos (p. ej. el níquel)—. Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.
4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación/protección del medio ambiente", punto 1.
5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.
6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.
7. Los productos con láser están provistos de indicaciones de advertencia normalizadas en función de la clase de láser del que se trate. Los rayos láser pueden provocar daños de tipo biológico a causa de las propiedades de su radiación y debido a su concentración extrema de potencia electromagnética. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).
8. Clases de compatibilidad electromagnética (conforme a EN 55011 / CISPR 11; y en analogía con EN 55022 / CISPR 22, EN 55032 / CISPR 32)
 - Aparato de clase A:
Aparato adecuado para su uso en todos los entornos excepto en los residenciales y en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.
Nota: Los aparatos de clase A están destinados al uso en entornos industriales. Estos aparatos pueden causar perturbaciones radioeléctricas en entornos residenciales debido a posibles perturbaciones guiadas o radiadas. En este caso, se le podrá solicitar al operador que tome las medidas adecuadas para eliminar estas perturbaciones.
 - Aparato de clase B:
Aparato adecuado para su uso en entornos residenciales, así como en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.

Reparación y mantenimiento

1. El producto solamente debe ser abierto por personal especializado con autorización para ello. Antes de manipular el producto o abrirlo, es obligatorio desconectarlo de la tensión de alimentación, para evitar toda posibilidad de choque eléctrico.
2. El ajuste, el cambio de partes, el mantenimiento y la reparación deberán ser efectuadas solamente por electricistas autorizados por Rohde & Schwarz. Si se reponen partes con importancia para los aspectos de seguridad (p. ej. el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Después de cada cambio de partes relevantes para la seguridad deberá realizarse un control de seguridad (control a primera vista, control del conductor de protección, medición de resistencia de aislamiento, medición de la corriente de fuga, control de funcionamiento). Con esto queda garantizada la seguridad del producto.

Baterías y acumuladores o celdas

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

1. No deben desmontarse, abrirse ni triturarse las celdas.
2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.
3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.
4. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.
5. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.
6. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).
7. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

Transporte

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

Instrucciones de seguridad elementales

2. Las asas instaladas en los productos sirven solamente de ayuda para el transporte del producto por personas. Por eso no está permitido utilizar las asas para la sujeción en o sobre medios de transporte como p. ej. grúas, carretillas elevadoras de horquilla, carros etc. Es responsabilidad suya fijar los productos de manera segura a los medios de transporte o elevación. Para evitar daños personales o daños en el producto, siga las instrucciones de seguridad del fabricante del medio de transporte o elevación utilizado.
3. Si se utiliza el producto dentro de un vehículo, recae de manera exclusiva en el conductor la responsabilidad de conducir el vehículo de manera segura y adecuada. El fabricante no asumirá ninguna responsabilidad por accidentes o colisiones. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Asegure el producto dentro del vehículo debidamente para evitar, en caso de un accidente, lesiones u otra clase de daños.

Eliminación/protección del medio ambiente

1. Los dispositivos marcados contienen una batería o un acumulador que no se debe desechar con los residuos domésticos sin clasificar, sino que debe ser recogido por separado. La eliminación se debe efectuar exclusivamente a través de un punto de recogida apropiado o del servicio de atención al cliente de Rohde & Schwarz.
2. Los dispositivos eléctricos usados no se deben desechar con los residuos domésticos sin clasificar, sino que deben ser recogidos por separado.
Rohde & Schwarz GmbH & Co.KG ha elaborado un concepto de eliminación de residuos y asume plenamente los deberes de recogida y eliminación para los fabricantes dentro de la UE. Para desechar el producto de manera respetuosa con el medio ambiente, diríjase a su servicio de atención al cliente de Rohde & Schwarz.
3. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.
4. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

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

Quality management and environmental management

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz Produktes entschieden. Sie erhalten damit ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unserer Qualitäts- und Umweltmanagementsysteme entwickelt, gefertigt und geprüft. Rohde & Schwarz ist unter anderem nach den Managementsystemen 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. This product has been manufactured using the most advanced methods. It was developed, manufactured and tested in compliance with our quality management and environmental management systems. Rohde & Schwarz has been certified, for example, according to the ISO 9001 and ISO 14001 management systems.

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 de ce produit ont été effectués selon nos systèmes de management de qualité et de management environnemental. La société Rohde & Schwarz a été homologuée, entre autres, conformément aux systèmes de management ISO 9001 et ISO 14001.

Engagement écologique

- Produits à efficience énergétique
- Amélioration continue de la durabilité environnementale
- Système de management environnemental certifié selon ISO 14001



Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

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1 Optional I/Q Baseband Input R&S FSQ-B71

The baseband input is used for direct measurement of complex baseband signals (normally modulation signals).

In the FFT Analyzer mode, measurements are performed by the R&S FSQ. The results are shown on the R&S FSQ display. Measurements in both the time domain and frequency domain are possible. Wherever possible, operation is the same as that for the Spectrum Analysis mode.

Alternatively you can also extract data: To do so, the R&S FSQ digitizes the analog input signals at a user-selectable sampling rate.

The samples can be transferred via IEC/IEEE bus or LAN interface to an external computer for analysis. They are not displayed (Baseband IQ Data Grabbing).

Baseband IQ data grabbing denotes the following:



The TRACE:IQ subsystem (see chapter 6.1) is used by an external computer via IEC/IEEE bus or LAN interface. That is, the R&S FSQ digitizes the signals applied at the baseband input, then filters, decimates and transfers them to the external computer, where they are further processed by a program (e.g. Matlab) to be written by the customer. No results are displayed by the R&S FSQ.

The user must explicitly select the sampling rate (thereby automatically selecting the filter bandwidth) and the data length.

The center frequency is always 0 Hz.

From firmware version 1.8x and higher, the baseband input can also be used with the options FS-K5, FS-K70, FS-K72, FS-K73, FS-K82 and FS-K84. For baseband functions of options not listed here, refer to the respective manual.

1.1 Functional description

(Refer to the block diagram on page 10)

The device under test, e.g. a complex modulation source, is connected to inputs I INPUT, UNBAL and Q INPUT UNBAL. By definition, I is the real part (in phase) and Q the imaginary part (quadrature phase).

Differential sources are connected to BAL HIGH and BAL LOW, the inverted signal being connected to BAL LOW.

There is an attenuator to -15 dB at the input. This means that higher input voltages are attenuated to <1 V so that the A/D converter is not overloaded. Voltages of ± 1 V can be measured at the 0 dB position. In sensitive measurement ranges, a preamplifier to $+30$ dB ensures adequate modulation of the A/D converter and thus a low noise figure.

The attenuator and preamplifier settings are permanently coupled to the setting of the **measurement range**.

RANGE	5.62 V	3.16 V	1.78 V	1 V	562 mV	316 mV	178 mV	100 mV	56.2 mV	31.6 mV
Attenuator	-15 dB	-10 dB	-5 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
Preamplifier	0 dB	0 dB	0 dB	0 dB	+5 dB	+10 dB	+15 dB	+20 dB	+25 dB	+30 dB

The attenuator and preamplifier have an impedance of 50Ω . The switchable $1 M\Omega$ input (or $1 K\Omega$ depending on the B71 module version) is reached by inserting a high-impedance 1:1 amplifier directly behind the input sockets. In this instance the maximum measurement range is 1.78 V.

At the *BALANCED OFF* position only the high input is through-connected and at the *BALANCED ON* position the difference between the high and the low inputs is through-connected for further processing.

The anti-aliasing lowpass filter follows. If required, it can be switched off (measurement bandwidth >30 MHz): *LOWPASS ON/OFF*.

If required, a dither signal can be added to the test signal, *DITHER ON/OFF*. This improves the linearity of the A/D converter at low modulation. For further details, refer to page 15.

The test signal (with dither signal if necessary) is sampled by a 14 bit A/D converter with 81.6 MHz.

The anti-aliasing filter is optimized for this fixed sampling rate.

The user must specify the sampling rate when data is extracted. It is user-definable but must be between 10 kHz and 81.6 MHz.

With the FFT Analyzer, the user never selects the sampling rate directly but always indirectly using other parameters (span, RBW, etc.). The firmware always selects the appropriate output sampling rate.

In both cases, the sampling rate is not reduced at the A/D converter but by means of digital signal processing using a resampler and subsequent integer decimation. Digital filters limit the signal before decimation to the bandwidth which can still be displayed without aliasing at the output sampling rate.

If the sampling rate is set too low for the test signal, the bandwidth of the signal is limited; but this does not result in aliasing (folding back of high frequencies to the useful band).

The bandwidths available for the given sampling rate are specified in the following table. Reference is made to the useful bandwidth, without limitation of the data (flat response of the digital filters).

This table is only relevant if data is extracted (Baseband IQ Data Grabbing).

With the FFT Analyzer, the sampling rate is calculated by the firmware. In this case, the interdependencies from Chapter “Using the I/Q baseband input in the FFT Analyzer” must be observed.

Table 1-1: Available bandwidths

Sampling rate from	to	Max. bandwidth I and Q in each case
81.6 MHz	>40.8 MHz	0.441 sample rate *)
40.8 MHz	>20.4 MHz	0.34 sample rate
20.4 MHz	>10.2 MHz	0.4 sample rate
10.2 MHz	>5.1 MHz	0.4 sample rate
5.1 MHz	>2.55 MHz	0.4 sample rate
2.55 MHz	>1.275 MHz	0.4 sample rate
1.275 MHz	>0.6375 MHz	0.4 sample rate
0.6375 MHz	>318.75 kHz	0.4 sample rate
318.75 kHz	>159.375 kHz	0.4 sample rate
159.375 kHz	>79.6875 kHz	0.4 sample rate
79.6875 kHz	>39.84375 kHz	0.4 sample rate
39.84375 kHz	>19.921875 kHz	0.4 sample rate
19.921875 kHz	10 kHz	0.4 sample rate

*) 36 MHz with LOWPASS ON

These bandwidths apply to I and Q, and are therefore the equivalent lowpass filter bandwidths.

The complex signal formed by I and Q is a bandpass signal having a center frequency of zero.

The bandpass filter bandwidth is twice the size of the lowpass filter bandwidth shown in the table.

The maximum bandpass filter bandwidth is therefore 72 MHz.

When data is extracted, the samples (I/Q data) are written with the selected sampling rate to a 16 Mword memory (16 Mword for both I and Q). The number of measurement values (samples) to be acquired is user-selectable.

The FFT Analyzer, however, selects the data volume automatically such that the data volume is always just large enough for the requirements of the user-selected measurement task. The "Capture both domains" mode is an exception; here the complete memory volume of 16 Mwords is filled.

With the trigger setting *IMMEDIATE* (corresponds to FREE RUN), sample acquisition begins directly following the request.

The trigger setting *EXTERNAL* supports synchronization of sample acquisition with an external trigger signal. The number of test points to be acquired before the trigger instant can be set.

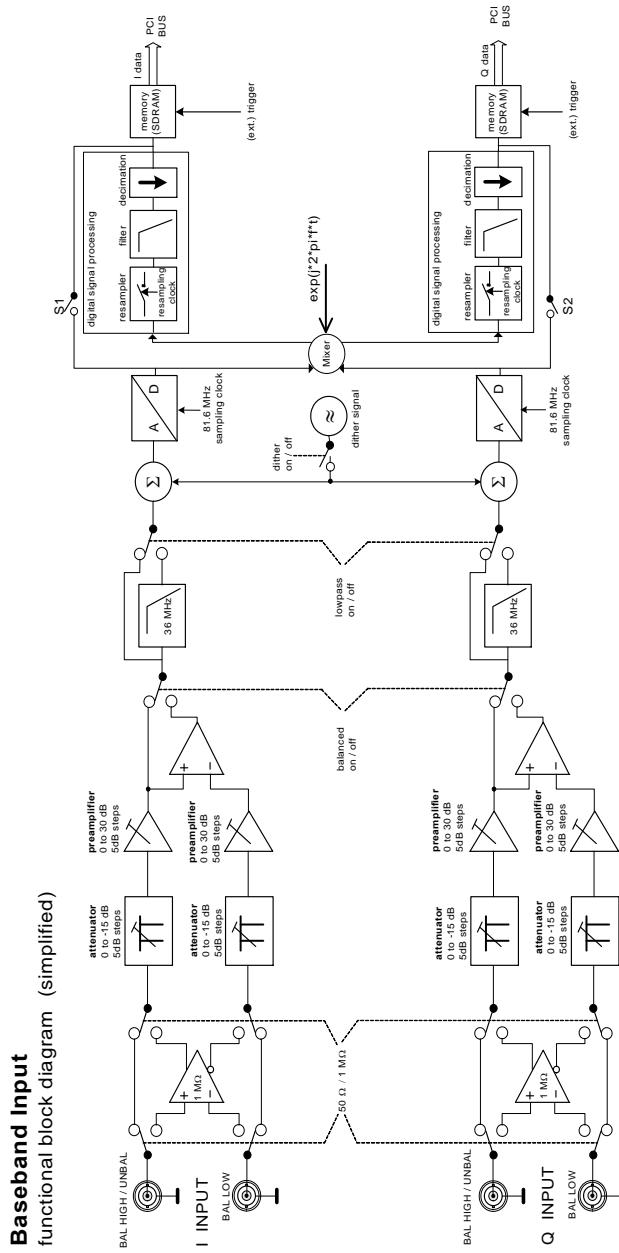
With the trigger setting *IFPOWER* (corresponds to I/Q LEVEL), sample acquisition begins as soon as the magnitude of the I/Q signal exceeds or falls below a selectable threshold. The number of test points to be acquired before the trigger instant can be set.

If data is extracted, the acquisition and output of I/Q samples are controlled using the commands of the TRACe:IQ subsystem.

In this case the measurement results are output in list form, with the list of I data and

the list of Q data immediately following each other in the output buffer. You can use the FORMAT command to choose between binary output (32 bit IEEE 754 floating-point numbers) and output in ASCII format. For further details, refer to chapter 6 onwards.

1.2 Functional block diagram



1.3 Error correction

The block diagram does not show the calibration sources and operator action for error correction.

The R&S FSQ automatically corrects all important parameters of the baseband input provided that a valid total calibration has been performed (total calibration status passed). Baseband input parameters corrected after total calibration

Offset:	Compensated for by means of a D/A converter before the A/D converters. This ensures that the modulation range of the A/D converters is retained even at high offset voltages (at high gain).
Gain:	Digitally corrected by a RAM with a correction table (lookup table) downstream of the A/D converters.
Frequency response:	Constant amplitude and group delay (linear phase) over the frequency are achieved by means of digital compensation filters.
Phase difference:	The delay difference (and thus the phase difference) between I and Q is compensated for by means of digital filters.
Trigger offset:	The different propagation delays (depending on the sampling rate and filters in the signal path) are automatically corrected so that the time reference between the test signal and an external trigger signal is retained.

1.4 Level display

The I/Q data specifies the voltages at the I/Q inputs at the sampling instants in volts. Generally speaking, the I/Q value pairs are regarded as complex numbers:

I = in phase = real part

Q = quadrature phase = imaginary part

The complex pointer represents a real signal in terms of magnitude and phase.

Relationship between RF and baseband:

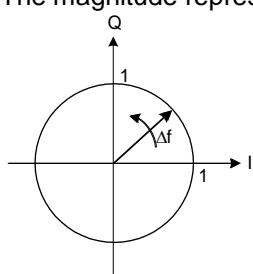
$$\text{Magnitude} = \sqrt{I^2 + Q^2} \quad \text{Phase} = \arctan\left(\frac{Q}{I}\right)$$

Example:

An unmodulated carrier (sinewave signal) is applied to the RF input and its frequency is Δf higher than the set receive frequency. The carrier has an rms voltage of 1 V. Following mixing into the complex baseband, a vector with a length of 1, which rotates with Δf , is obtained.

The following then applies to the I/Q data: $\text{Magnitude} = \sqrt{I^2 + Q^2} = 1$.

The magnitude represents the rms value of the RF signal.



The same signal represented in the baseband:

$$Q = 1V * \sin(2\pi\Delta f t)$$

$$I = 1V * \cos(2\pi\Delta f t)$$

They are two sinewave signals in phase quadrature with an rms voltage of 0.707 V and a peak voltage of 1 V.

In the 1 V measurement range, a peak voltage of 1 V can be measured in each instance at the I/Q inputs, which corresponds to an rms value of 0.707 V with sinewave signals. This means that a real signal with an rms value of 1 V can be displayed.

In the case of an identical RefLevel setting, the measurement range at the baseband input conforms to the measurement range of the RF input. The Ref Level at the RF input corresponds to the measurable rms value; the Ref Level at the baseband input corresponds to the peak value for both I and Q.

1.5 General operation

The following diagrams explain which settings must be made to allow the hardware to process the input signals correctly. The operating principle is the same for all operating modes; configuration, however, takes place at different locations.

The configurations for the baseband inputs are kept separate for the following operating modes:

- Baseband IQ Data Grabbing (extraction of data by means of IEC/IEEE bus or LAN interface, TRACE:IQ)
- FFT Analyzer
- every option which can use the baseband inputs

For configuration, the FFT Analyzer provides:

- a separate submenu (see chapter „SIGNAL SOURCE submenu of the FFT Analyzer”)
- or, alternatively, the submenu which can be called up using the SIGNAL SOURCE softkey in the SETUP menu (see chapter “SIGNAL SOURCE submenu of the FFT Analyzer”)

All options which can use the baseband inputs provide the following for configuration:

- the submenu, which can be called up using the SIGNAL SOURCE softkey in the SETUP menu (see chapter 2.5.6)

Please also refer to the operating manual for the respective option.

Note:

Both paths are always taken into consideration when data is extracted. The possibility of ignoring a path is only available in the FFT Analyzer (IQ PATH softkey).

1.5.1 Activation

Remote: INP:SEL AIQ | RF

Used to toggle the signal input on the R&S FSQ between RF and baseband (Analog I/Q).

1.5.2 Settings of the baseband inputs

Input impedance

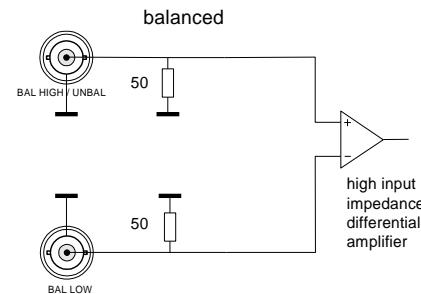
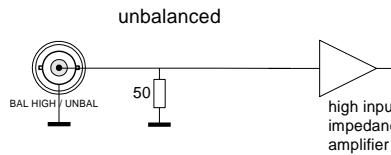
Remote: INP:IQ:IMP LOW | HIGH

LOW corresponds to 50Ω ; HIGH corresponds to $1 M\Omega$ or $1 K\Omega$ (depending on the B71 module version).

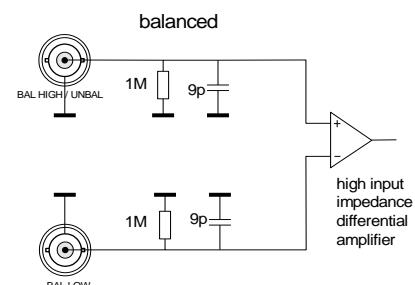
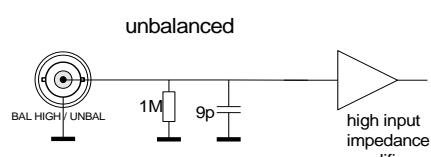
The default setting is LOW

Equivalent input circuit

50Ω



$1 M\Omega$



Differential input impedance for a floating source: $2 M\Omega +4.5 pF$



It should be remembered that at the 50Ω setting there is always a 50Ω DC path to ground, even when the input is switched to BALANCED.

Measurement mode

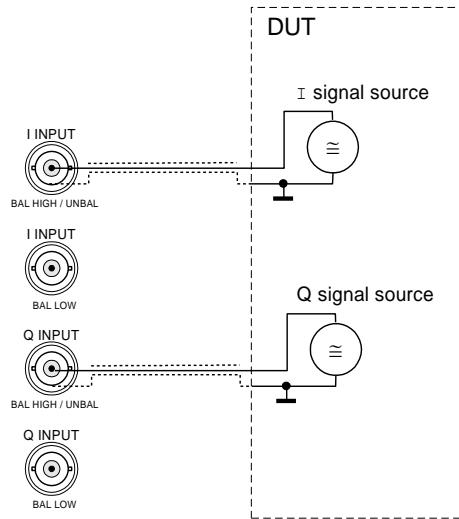
Remote: INP:IQ:BAL ON | OFF

Used to toggle the measurement mode between balanced (BALANCED ON) and referenced to ground (BALANCED OFF).

The default setting is ON.

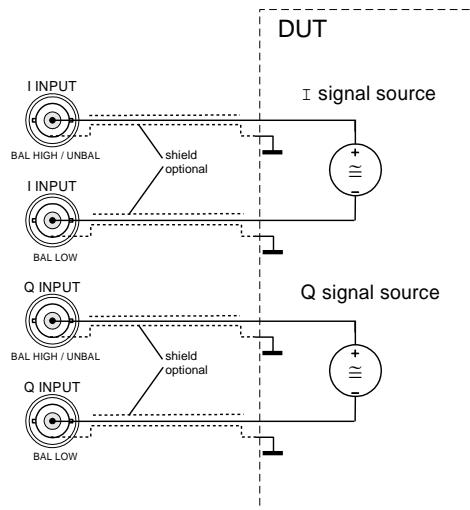
Connecting the signal sources (device under test)

BALANCED OFF



The connection to ground is run via the shield of the coaxial cable.

BALANCED ON



A connection to ground is not necessary.

Lowpass filter

Remote: IQ:LPAS ON | OFF

Used to switch the anti-aliasing filters upstream of the A/D converters on and off (cutoff frequency 36 MHz).

The default setting is ON.

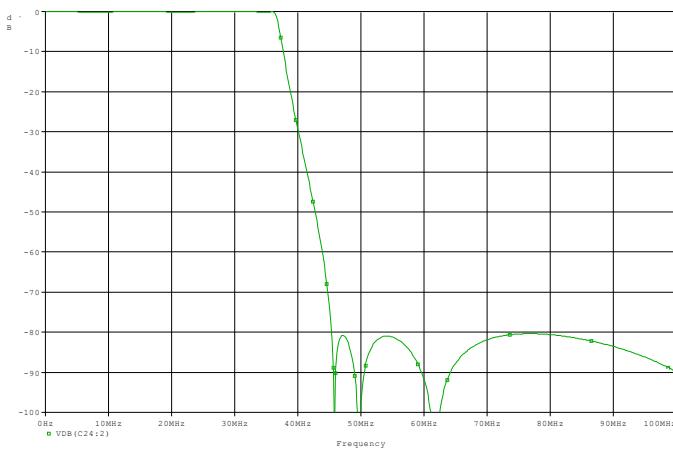


Figure 1-1: Anti-aliasing lowpass filter, typical frequency response

The filter prevents frequencies above the usable frequency range (>36 MHz) from being mixed into the usable frequency range (DC to 36 MHz) as a result of sampling (sampling frequency 81.6 MHz). It should therefore always be switched on. It should be remembered that, for example, harmonics and other spurious emissions of the device under test might be in the disallowed frequency range.



Amplitude response and phase response (or group delay) of the filter are compensated for up to 30 MHz.

With the filter switched off, amplitude response and phase response (or group delay) of the filter are compensated for up to 36 MHz. This setting is recommended only if the higher bandwidth is required. In this case, it is important to ensure that the spectrum of the device under test >45.6 MHz has adequately decayed since these spectral components appear in the useful band > 36 MHz.

Dithering

Remote: IQ:DITH ON | OFF

Used to switch the dither signal on and off. The dither signal is added to the useful signal by the A/D converter before sampling. The default setting is OFF.

The dither signal distinctly improves the linearity of the A/D converter at low signal levels (low modulation at the A/D converter) and thus the accuracy of the level displayed.

Note:

The dither signal is necessary only if the total AC voltage applied to the input (up to 36 MHz) is more than 46 dB less than the measurement range. The DC component is not taken into account.

The dither signal has no effect at a modulation higher than measurement range – 46 dB. A disadvantage, however, is that it might have to be removed from the spectrum as a result of post-processing (filters).

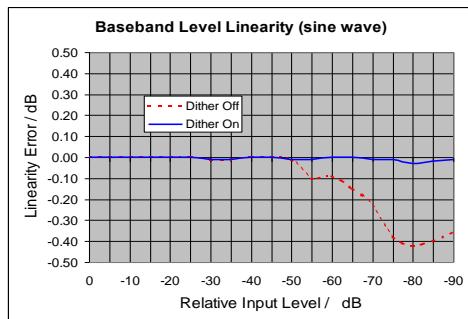


Figure 1-2: Typical linearity error with and without dither signal

Characteristics of the dither signal:

Band-limited noise, center frequency 38.93 MHz (in the I/Q spectrum), 3 dB bandwidth approx. 2 MHz, peak voltage 7 %, rms 1 % of modulation range of A/D converter.

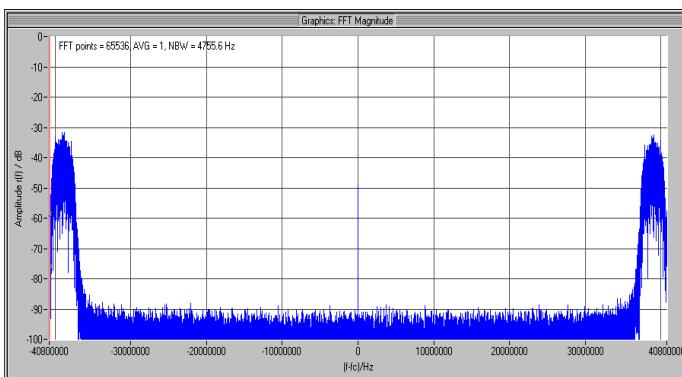


Figure 1-3: Dither signal, spectrum (complex FFT of I/Q data)

The entire spectrum is outside the usable frequency range (>36 MHz) and can therefore be removed by means of digital filters without affecting the useful signal. If data is extracted by means of IEC/IEEE bus or LAN interface, at lower sampling rates (<40.8 MHz) the dither signal will already have been removed by the internal digital filters and therefore no longer appears in the I/Q data.

In the FFT Analyzer the dither signal is almost completely removed by the internal digital filters.

Measurement range

Remote: VOLT:IQ:RANG 5.62|3.16|1.78|1|0.562|0.316 ...

The unit for input is volts.

The default setting is 1 V.

The measurement range specifies the measurable peak voltage, at the I and Q inputs in each case.

For example, voltages between –1 V and +1 V can be measured with a setting of 1 V.

With the BALANCED ON setting, the measurement range defines the measurable differential voltage.

The measurement range can be changed in steps of 5 dB.

Permissible settings:

- 0.0316 V
- 0.0562 V
- 0.1 V
- 0.178 V
- 0.316 V
- 0.562 V
- 1 V
- 1.78 V
- 3.16 V only with IMPEDANCE LOW (50Ω)
- 5.62 V only with IMPEDANCE LOW (50Ω)

Headroom: Typically 3 dB (with dither 2 dB); higher voltages can still be measured.

The A/D converter is overloaded when the headroom is exceeded. After the I/Q data has been read out, the overload display appears: IFOVL.

Triggering sample acquisition

Selecting the trigger source

Remote: TRIG:SOUR IMM | EXT | IFP

IMMEDIATE Activates cyclic data acquisition, i.e. there is no explicit triggering of the start of measurement. Sample acquisition starts immediately with the request for I/Q data.

EXTERNAL Activates triggering by means of a TTL signal at the EXT TRIGGER/GATE input socket on the rear panel of the instrument. Sample acquisition starts with the slope (see polarity) of the external trigger signal.

IFPOWER Activates triggering to the magnitude $\sqrt{I^2+Q^2}$ of the I/Q signal. The trigger threshold can be set in V (see trigger threshold).

Selecting the polarity (trigger slope)

Remote: TRIG:SLOP POS | NEG

Used to set the polarity of the trigger slope.

Sample acquisition starts after a positive or a negative slope of the trigger signal.

Selecting the trigger threshold

Remote: TRIG:LEV:IFP 0.7 [V]

Used to determine the threshold in volts for the IFPOWER trigger (triggering to the magnitude of the I/Q signal). Sample acquisition starts when the value exceeds (positive polarity) or drops below (negative polarity) the selected threshold.

2 Using the I/Q baseband input in the FFT Analyzer

The FFT Analyzer provides a convenient way of analyzing the signals at the analog baseband input in both the time domain and the frequency domain. This does not require an external computer. The R&S FSQ is used to process the data and to display the results.

Many of the functions belonging to the Spectrum Analysis mode are also available in the FFT Analyzer. Operation is largely based on that of the Spectrum Analysis mode.

In contrast to the Spectrum Analysis mode, the FFT Analyzer does not determine the spectrum using the sweep principle but instead by performing a FFT (Fast Fourier Transform) on the input data. For this reason, some parameter interdependencies are completely different. There are also a number of new setting options, such as the window functions.

In the FFT Analyzer, a distinction is made between the two operating modes Time Domain and Frequency Domain (corresponding to the operating modes Zero Span and Span > 0 of the basic unit).

They differ with respect to signal processing and the internal parameter interdependencies.

2.1 Operating principle of the FFT Analyzer

This chapter contains a brief description of the signal processing steps for the two operating modes of the FFT Analyzer.

The processing sequence depends on several parameters which are only relevant for the FFT Analyzer:

- Is the Time Domain or Frequency Domain mode active?
- Which input signal am I expecting (IQ-PATH parameter, see page 44)?
 - I+jQ mode: Signals at the I and Q input are regarded as components of a complex signal.
 - I ONLY mode: A signal at the I input is regarded as a single, real signal. A signal at the Q input is ignored.
 - Q ONLY mode: A signal at the Q input is regarded as a single, real signal. A signal at the I input is ignored.
- Is the CAPTURE BOTH DOMAINS mode active?
This mode allows measurements with completely different configurations to be performed repeatedly using data which needs to be acquired once only. Initial acquisition of the data must, however, be performed directly to the memory. In the first step, the samples of both the I and Q input are always recorded regardless of the input signal setting.
- How large is the span in the Frequency Domain mode?
If the span is larger than 27.5 MHz, initial acquisition of the data must once again be performed directly to the memory.

The input signals are processed in the following sequence corresponding to the functional block diagram on page 10:

1. Provision of the appropriate input impedance (50Ω or $1 M\Omega / 1 K\Omega$).
2. Different attenuation of signal depending on the REFERENCE LEVEL. Both inputs do, however, always experience the same level of attenuation.
3. Different amplification of signal depending on the REFERENCE LEVEL. Both inputs do, however, always experience the same level of gain.
4. Adaptation of the measurement mode (balanced / referenced to ground). Has the same effect on both inputs.
5. Activation of analog anti-aliasing filter or not. Has the same effect on both inputs.
6. Possible addition of shaped dither signal.
7. Sampling of both paths at constant 81.6 MHz.
8. The I and Q samples are then written directly to the memory, but only if this is necessary. Bypassing of switch S1 and S2 using the signal processing block.
9. The samples from both the I and Q input are passed on to the mixer. They either come from the current data acquisition process (i.e. directly from the two A/D converters) or are read out of the two memories if the samples were written directly to these memories beforehand, e.g. because the CAPTURE BOTH DOMAINS mode is active.
Reading out of the raw data and all subsequent signal processing steps can also be triggered by a manual or automatic RECALC process (see page 64). Signal processing starts here for every RECALC process.
10. The samples pass through the complex mixer. The mixer has a complex input and output. Depending on the IQ PATH setting, the mixer performs the following internal processes:
 - I + J*Q mode: The samples from the I input are passed on to the real part of the mixer input and the samples from the Q input to the imaginary part.
 - I ONLY mode: The samples from the I input are passed on to the real part of the mixer input. The samples from the Q input are discarded. The imaginary part of the mixer input is instead set to zero.
 - Q ONLY mode: The samples from the Q input are passed on to the real part of the mixer input. The samples from the I input are discarded. The imaginary part of the mixer input is instead set to zero.
11. The resulting real or complex signal at the mixer input is multiplied in the mixer by a complex rotating phasor. This causes a shift in the frequency domain which is directly proportional to the rotational frequency of the rotating phasor. The rotational frequency can also be 0 Hz; there is then no shift. The rotational frequency is calculated automatically by the firmware on the basis of the measurement settings. The output signal of the mixer is normally complex. If the input signal was real and has not been mixed, it remains real.

The next processing steps are different for the two operating modes Time Domain and Frequency Domain.

2.1.1 Operating principle in the Time Domain mode

The resampler processing block is not active in the Time Domain mode.

An identical digital lowpass filter in both signal paths allows only low-frequency signal components to pass. However, these signal components had a completely different frequency position prior to mixing. The mixing process should have shifted the frequency domain of interest to the range around 0 Hz. It is not attenuated by the filter.

In the Time Domain mode, the filter always has a Gaussian characteristic. Its bandpass filter bandwidth (twice the cutoff frequency) corresponds to the RESOLUTION BANDWIDTH (RBW) selected by the user.

The filter also performs integer decimation. With small filter bandwidths, the effect of decimation may be greater than with large filter bandwidths. The output sampling rate for small and medium RBWs is always approx. 20 times that of the selected RBW; with very large RBWs the output sampling rate drops to approx. twice that of the selected RBW.

The two filtered signals are then stored in the memory. The output sampling rate of the signal processing block determines the period during which the memory is completely full. As a result, the maximum observation time in the Time Domain mode usually depends on the selected RBW. If, however, CAPTURE BOTH DOMAINS and SINGLE SWEEP are active, the acquisition time is always max. 0.16 seconds (16 Mwords / 81.6 MHz minus settling time) irrespective of the RBW since the data is initially recorded in the memory without decimation. See Chapter "Setting the bandwidths and sweep time – BW key, softkey SWT MANUAL".

The data is then read out of the memory for analysis. This cannot be performed until data acquisition and processing has been completed. Unlike the zero-span mode in the Spectrum Analysis mode, the result trace is therefore not continuously plotted on the display in the case of long observation times. Instead, the trace only appears after the observation time has elapsed. With very large data volumes (i.e. large RBW and/or long observation time), the data is read out in blocks and, as a result, the trace is plotted bit by bit.

The read-out measurement data can be analyzed in a number of different ways:

MAGNITUDE diagram: The magnitude of the measurement data is plotted over time. This roughly corresponds to the zero-span mode in the Spectrum Analysis mode.

VOLTAGE diagram: The real and imaginary part of the read-out measurement data is plotted. If the mixer was not active, this corresponds to the operating principle of a digital single-channel or dual-channel storage oscilloscope. If, however, the mixer was active, the information contained in this diagram will not be conclusive.



The upper and lower diagram display the real part and the imaginary part of the selected complex or real input signal AFTER the input signal has passed through the signal processing modules. The two diagrams DO NOT normally represent the I and Q inputs.

A Gaussian filter is always used for Time Domain measurements. The user-definable window functions from the Frequency Domain mode are completely irrelevant here.

2.1.2 Operating principle in the Frequency Domain mode

The resampler processing block is active in the Frequency Domain mode. It performs fractional resampling of the sampling rate. Combined with the subsequent integer decimation in the digital filters, this allows the output sampling rate to be varied steplessly over a very broad range.

An identical digital lowpass filter (approximately rectangular in form) in both signal paths removes high-frequency signal components. Only slightly more than the span selected by the user is allowed through unchanged. The mixing process should have shifted the center of the selected span to the frequency 0 Hz.

This permits the largest possible decimation (here integer decimation) to be performed following filtering, i.e. the sampling rate is reduced.

The two filtered signals are then stored in the memory. The output sampling rate of the signal processing block determines the period during which the memory is completely full. This gives rise to the interdependencies and minimum/maximum values described in chapter "Setting the bandwidths and sweep time – BW key". Other values apply in the CAPTURE BOTH DOMAINS mode since the acquisition time is max. 0.16 seconds (16 Mwords / 81.6 MHz minus settling time). In this mode, data is always initially recorded in the memory without decimation.

The samples are then read out of the memory. They are multiplied using the selected window function. A complex FFT transforms the data from the time domain to the frequency domain.

The FFT results can be analyzed in a number of different ways:

- MAGNITUDE diagram: Only the magnitude of the FFT results is displayed. This is therefore similar to the Spectrum Analysis mode of the R&S FSQ.
- MAGNITUDE PHASE diagram: The upper diagram corresponds to the upper MAGNITUDE diagram. The phase information is, however, also displayed in the lower diagram. The phase trace only provides conclusive information if a single measurement (SINGLE SWEEP) was performed, or if a periodic signal is analyzed in the CONTINUOUS SWEEP using a trigger.
- REAL IMAG diagram: The real and imaginary parts of the FFT results are displayed on a linear scale. These can also be negative. This diagram is generally of little relevance. As with the MAGNITUDE PHASE diagram, a single measurement should be performed or, alternatively, a trigger should be used.

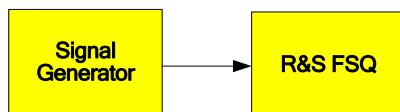
2.2 Measurement examples for the FFT Analyzer

This chapter explains operation of the FFT Analyzer using typical measurements as examples. Chapter "Instrument functions of the FFT Analyzer" contains a detailed explanation of the basic operating steps, e.g. selecting menus and setting parameters. The layout of the screen and the information displayed on the screen are also described.

The following examples start with the FFT Analyzer in its default state. The default state is set by pressing the PRESET key or the PRESET FFT key. The full default setup is described in Chapter "Default settings of the FFT Analyzer – PRESET FFT key".

2.2.1 Measurement example 1 – Spectrum of a GSM signal in the complex baseband

Test setup:



Settings on the signal generator (e.g. R&S SMIQ or R&S SMU)

Frequency: not relevant, because the baseband output is used

Level: not relevant, because the baseband output is used

Modulation: GSM standard; PRBS data is used

The I baseband output of the signal generator is connected to the I baseband input of the R&S FSQ. The Q baseband output of the signal generator is connected to the Q baseband input of the R&S FSQ. With asymmetrical cabling, the "unbalanced" inputs of the R&S FSQ must be used.

Measurements with the FFT analyzer

1. Set the R&S FSQ to its default state:
 - Press the PRESET key.
2. Change to the FFT Analyzer:
 - Press the FFT hotkey.
3. Configure the baseband input:
 - Press the SIGNAL SOURCE softkey.
 - Select the appropriate input impedance using the IQ INPUT softkey (the input impedance depends on the signal generator).
 - Use the BALANCED softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
4. Set the span to 1 MHz:

- Press the SPAN key and enter 1 MHz.
5. Set the resolution bandwidth to 10 kHz:
 - Press the BW key, then the RES BW MANUAL softkey and enter 10 kHz.
 6. Switch on averaging:
 - Press the TRACE key and then the AVERAGE softkey.

You can see the typical spectrum of a GSM signal (see Figure 2-1). The center frequency is 0 Hz. Positive and also negative frequencies are shown. This is meaningful, because the spectrum of a complex input signal is in most cases not symmetrical to 0 Hz.

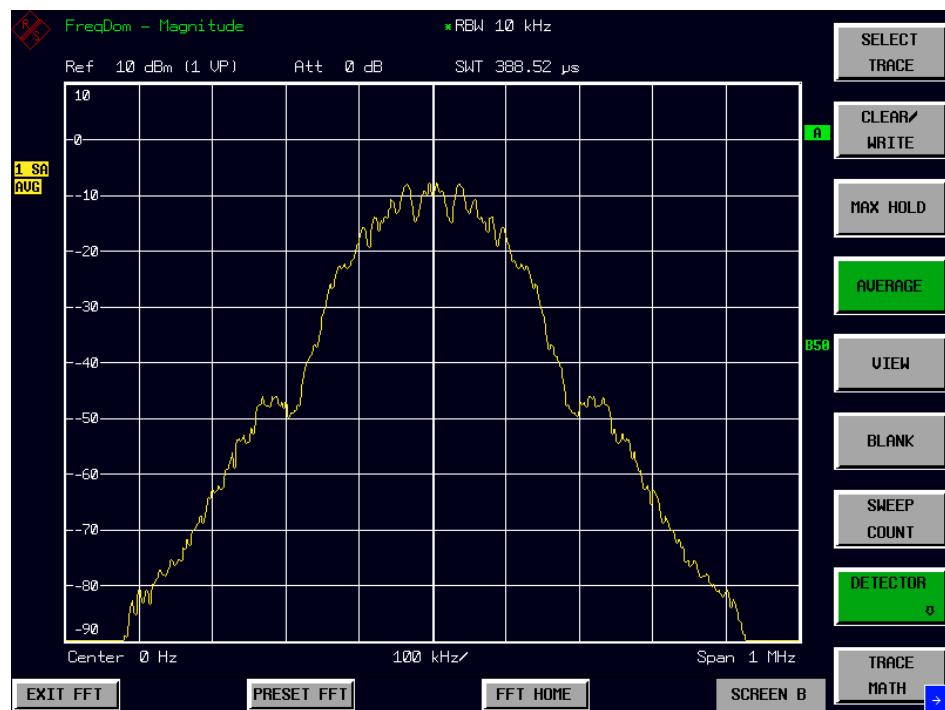


Figure 2-1: Typical spectrum of a GSM signal (PRBS data is used)

We want to generate a complex rotating phasor now.

7. Switch the signal generator to bit pattern "11111..." or "00000....":
 - Operator interactions depend on the signal generator used.
Important: Differential coding must be used.
8. Use the marker to measure the frequency and the level of the rotating phasor:
 - Press the MKR \Rightarrow key, then the PEAK softkey.

You can see (Figure 2-2) the spectrum of a complex rotating phasor. Its frequency is a quarter of the GSM symbol frequency of 270.833 kHz (=67.708 kHz). You can read the frequency and the level of the rotating phasor in the marker information field.

A complex rotating phasor is defined as:

$$s(t) = e^{j \cdot \varpi \cdot t} = \cos(\varpi \cdot t) + j \cdot \sin(\varpi \cdot t)$$

with a positive or negative ω , which determines the direction of rotation and the frequency.

The above formula can be rewritten as:

$$\sin(\varpi \cdot t) = \frac{1}{2j} \cdot (e^{j \cdot \varpi \cdot t} - e^{-j \cdot \varpi \cdot t})$$

and

$$\cos(\varpi \cdot t) = \frac{1}{2} \cdot (e^{j \cdot \varpi \cdot t} + e^{-j \cdot \varpi \cdot t})$$

A sine or cosine can be split into two complex rotating phasors. We will need this fact later.

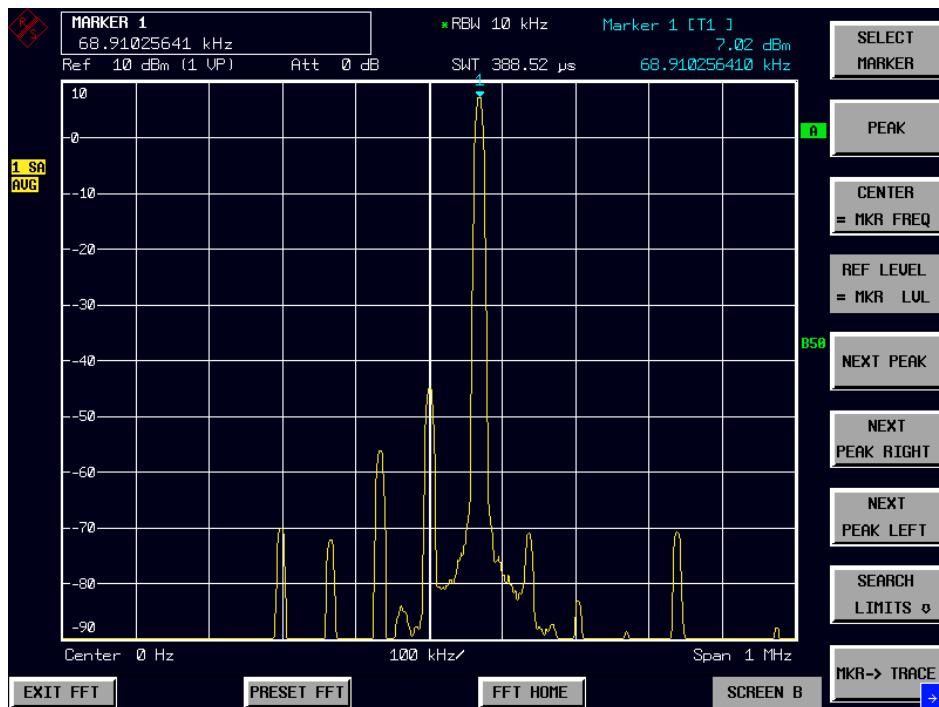


Figure 2-2: Spectrum with pattern "11111..." or "00000..." used.



In the spectrum you can see a small DC offset around 0 Hz and a few harmonics at multiples of 67.708 kHz.

We now want to generate a complex rotating phasor with the opposite direction of rotation:

9. Switch the signal generator to alternating bit pattern "10101..."
- Operator interactions depend on the signal generator used.
Important: Differential coding must be used.
10. Use the marker to measure the frequency and the level of the rotating phasor:
- Press the MKR \Rightarrow key, then the PEAK softkey.

Now you can see () the spectrum of the same complex rotating phasor, but with the opposite direction of rotation. The level measured by the marker stays the same.

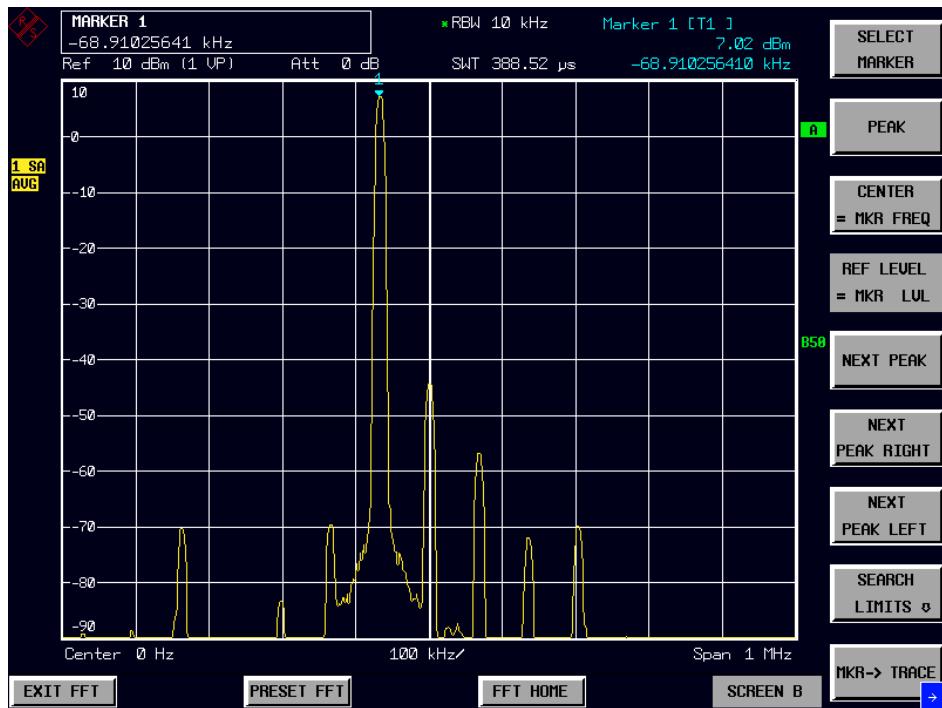


Figure 2-3: Spectrum with pattern "101010..." used.

11. Switch from a complex to a real input signal:

Disconnect the cable from the Q input of the R&S FSQ.

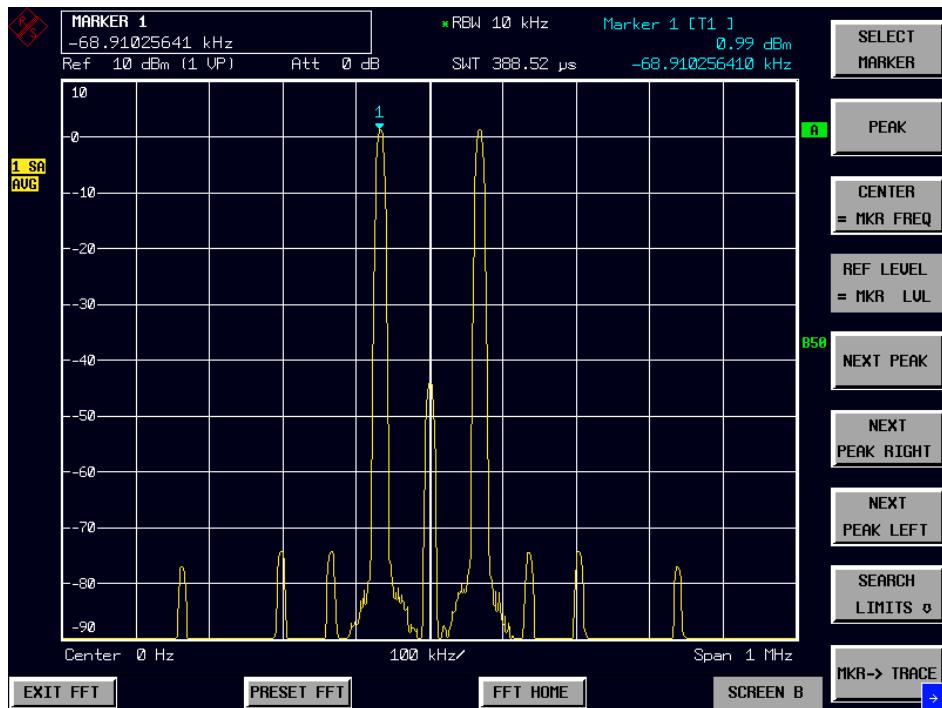


Figure 2-4: Spectrum after disconnecting the Q signal. Misconfiguration of the FFT analyzer!

You can see (Figure 2-4) the complex spectrum of a real carrier. The level of the carrier measured by the marker is 6 dB smaller now. This is because half of the input power is now missing (one cable disconnected). Due to the complex FFT, the remaining power is additionally split into equal shares on a rotating phasor with a negative frequency and another one with a positive frequency.

Expressed mathematically: $\cos(\varpi \cdot t) = \frac{1}{2} \cdot (e^{j \cdot \varpi \cdot t} + e^{-j \cdot \varpi \cdot t})$

Conclusion: When measuring real signals, you should not use the configuration $I+j^*Q$.

We remove the current misadjustment to get the correct spectrum of the signal applied to the I input:

12. Switch to real input signals:

- Press the HOME FFT hotkey, then SIGNAL SOURCE, then IQ PATH, then I ONLY

13. Use the marker to measure the frequency and the level of the rotating phasor:

- Press the MKR \Rightarrow key, then the PEAK softkey.

The FFT analyzer omits the range of negative frequencies due to the selection of real input signals. The spectrum of a real signal is symmetrical to 0 Hz.

The correct level is now shown in the range of positive frequencies (see Figure 2-5). The level is now half of the level in Figure 2-5

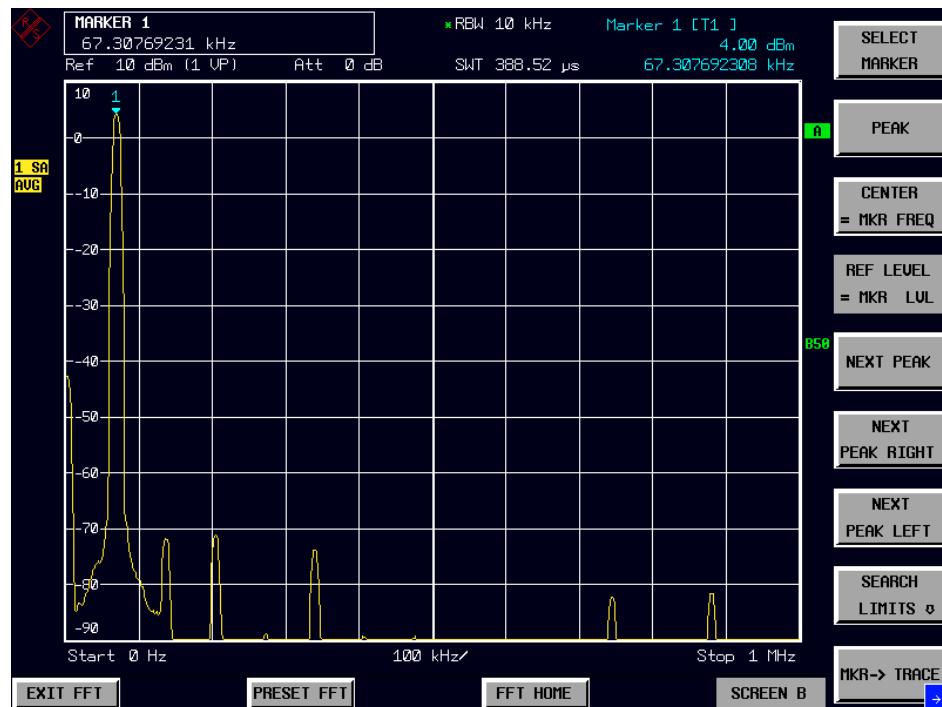
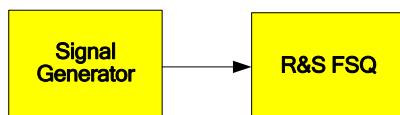


Figure 2-5: Spectrum after switching to real input signals.

2.2.2 Measurement example 2 – Function of the RECALC softkey

This measurement example shall demonstrate the application possibilities of the RECALC function. We are using it in this example to measure the phase difference between the sine oscillations at the I and Q input. As in the previous example, a complex phasor is used as the input signal.

Test setup:



Settings on the signal generator (e.g. R&S SMIQ or R&S SMU)

- Frequency: not relevant, because the baseband output is used
- Level: not relevant, because the baseband output is used
- Modulation: GSM standard; "1111..." or "0000...." pattern is used

The I baseband output of the signal generator is connected to the I baseband input of the R&S FSQ. The Q baseband output of the signal generator is connected to the Q baseband input of the R&S FSQ. With asymmetrical cabling, the "unbalanced" inputs of the R&S FSQ must be used.

Measurements with the FFT analyzer

1. Set the R&S FSQ to its default state:
 - Press the PRESET key.
2. Change to the FFT analyzer:
 - Press the FFT hotkey.
3. Configure the baseband input:
 - Press the SIGNAL SOURCE softkey.
 - Select the appropriate input impedance using the IQ INPUT softkey (the input impedance depends on the signal generator).
 - Use the BALANCED softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
4. Initiate capturing of data:
 - Press the SWEEP key, then the SINGLE SWEEP softkey.

The memory was now filled completely with sampled data of the signals applied to the I and Q inputs (because the CAPTURE BOTH DOMAINS softkey was active).

All following measurements of this measurement example are completely based on this data, since the RECALC or the RECALC AUTO softkeys will be used each time. You could already disconnect both cables now or connect a new device under test.

5. Switch on the automatic RECALC:
 - Press the SWEEP key, then the NEXT hardkey, then the RECALC AUTO softkey.

We already know the frequency of the rotating phasor from the previous measurement example. It is $270.8333 \text{ kHz} / 4 = 67.708 \text{ kHz}$.

6. Set the span to 200 Hz and the center frequency to 67.708 kHz:
 - Press the SPAN key and enter 200 Hz.
 - Press the FREQ key and enter 67.708 kHz.
7. Switch on the phase information:
 - Press the HOME FFT hotkey, then FREQUENCY DOMAIN, then the MAGNITUDE PHASE softkey.
8. Measure the phase of the signal applied to the I input:
 - Press the HOME FFT hotkey, then SIGNAL SOURCE, then the I-ONLY softkey.
 - Press the MKR key. Then enter 67.708 kHz.

In the marker information field you can read the phase of the sine wave applied to the I input (see Figure 2-6).

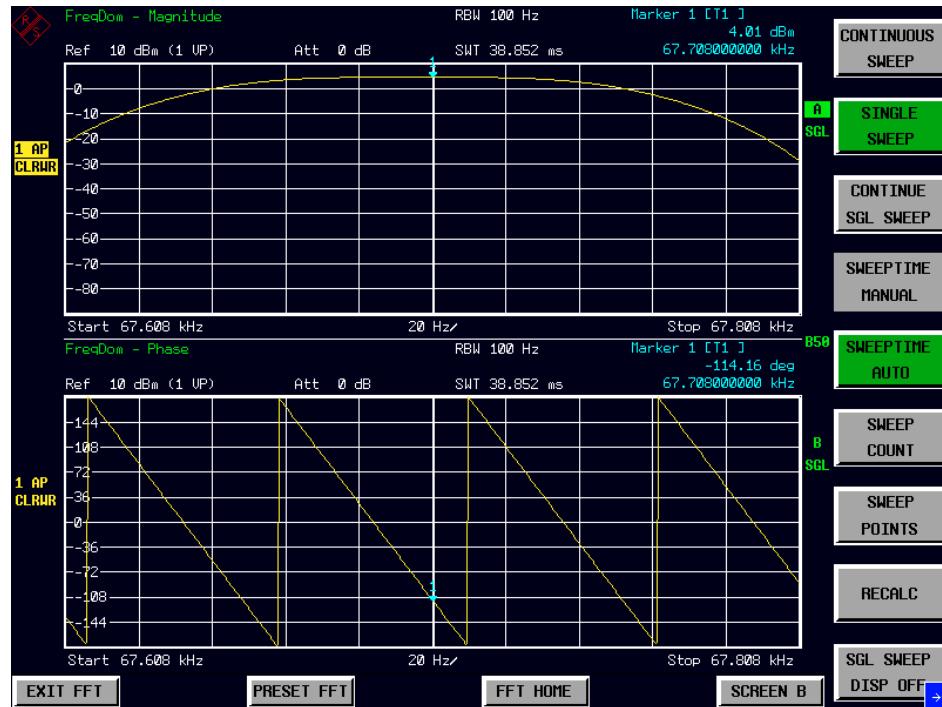


Figure 2-6: Example of the measurement of the phase of the sine wave applied to the I input.

9. Measure the phase of the signal applied to the Q input:
 - Press the HOME FFT hotkey, then SIGNAL SOURCE, then the Q-ONLY softkey.

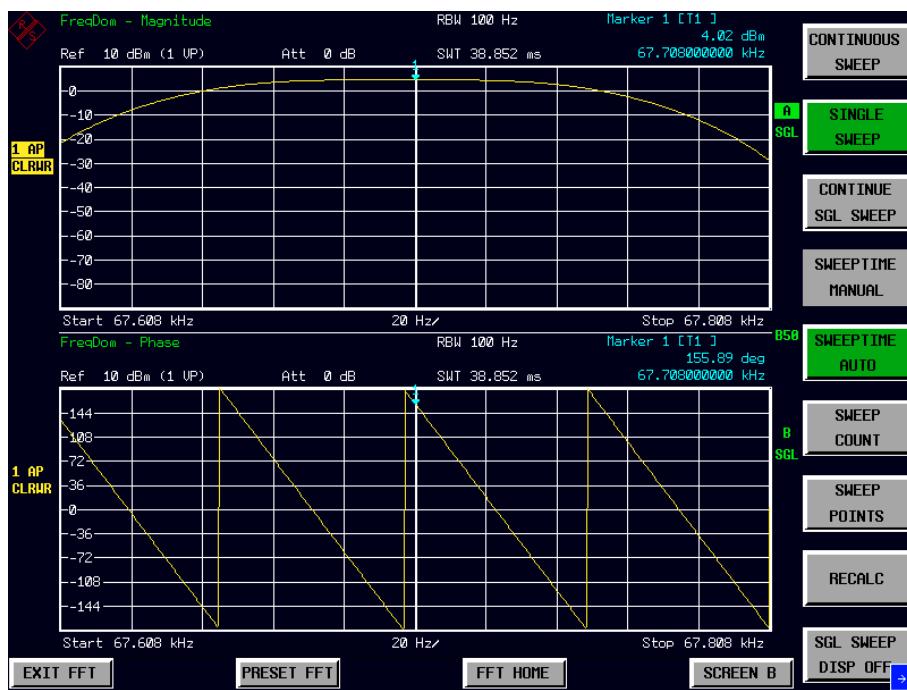


Figure 2-7 Example of the measurement of the phase of the sine wave applied to the Q input.

In the marker information field you can read the phase of the sine wave applied to the Q input (see Figure 2-7).

The phase difference between the I and the Q input is $155.89^\circ - (-114.16^\circ) = 270.05^\circ = -89.95^\circ$.

Now we want to observe both signals in the time domain:

10. Switch to time domain. Show both signals simultaneously:

- Press the HOME FFT hotkey, then SIGNAL SOURCE, then the I+j*Q softkey.
- Press the HOME FFT hotkey, then TIME DOMAIN, then the VOLTAGE softkey.

11. Switch off the mixer and set up the sweep time:

- Press the FREQ key, then enter 0 Hz.
- Press the SWEEP key, then enter 20 μ s.

12. Search for the maximum of the signal applied to the I input:

- Press the MKR key. The marker searches for the maximum of the trace of the I input automatically. The other marker is automatically moved synchronously on the trace of the Q input.

At the found maximum, you can see (Figure 2-8) a zero crossing of the sine wave applied to the Q input. The phase difference is therefore again about -90° .

Note:

This measurement in the time domain does not reach the accuracy of the previous one in the frequency domain. It should only show that you can also switch between time domain and frequency domain when using CAPTURE BOTH DOMAINS and RECALC

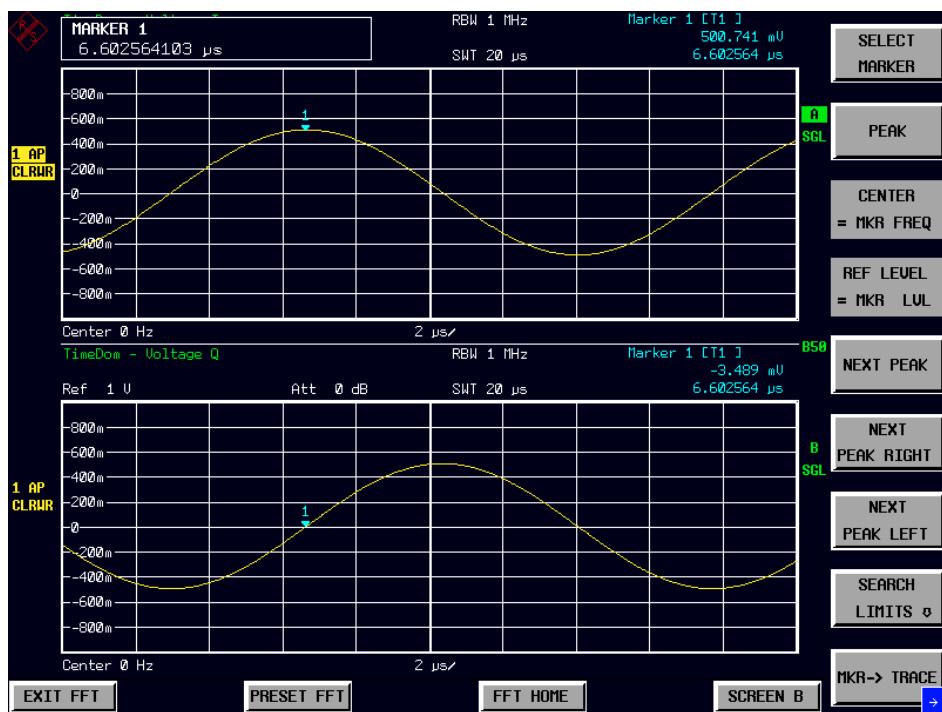


Figure 2-8: Both signals shown simultaneously in the time domain.

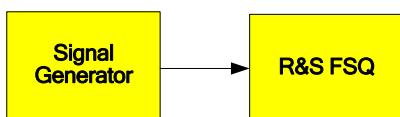
2.3 Measurements on AM signals

This measurement example is based on the corresponding measurement example given in the R&S FSQ operating manual. Refer to chapter 2 onwards for details on the technical background.

In this example, an AM signal with a frequency of 100 MHz has been measured. If, however, the signal has a very low intermediate frequency, it will not be possible to measure this signal using the RF input (insufficient LO suppression). The analog baseband input in combination with the FFT Analyzer provides almost exactly the same possibilities for analyzing this low IF signal.

2.3.1 Measurement example 1 – Displaying the AF of an AM signal in the time domain

Test setup:



Settings at the signal generator (e.g. R&S SMIQ or SMU)

- Frequency: 10 MHz
- Level: 0 dBm
- Modulation: 50 % AM, 1 kHz AF

The RF output of the signal generator is connected to the I baseband input of the R&S FSQ. With asymmetrical cabling, the "unbalanced" I input must be used.

Measurements with the FFT Analyzer

1. Set the R&S FSQ to its default state:
 - Press the PRESET key.
2. Change to the FFT Analyzer:
 - Press the FFT hotkey.
3. Configure the baseband input:
 - Press the SIGNAL SOURCE softkey.
 - Select the appropriate input impedance using the IQ INPUT softkey (the input impedance depends on the signal generator).
 - Use the BALANCED softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
 - Press the IQ PATH softkey and then the I ONLY softkey to select the I input only.
4. Set the center frequency and then set the span to 0 Hz:
 - Press the FREQ key and enter 10 MHz.
 - Press the SPAN key and enter 0 Hz.
5. Set the reference level to a peak voltage of 0.562 V and the display range to linear.
 - Press the AMPT key and enter 0.562 V.
 - Press the RANGE LINEAR softkey.
6. Switch to SINGLE SWEEP to obtain a static image:
 - Press the SWEEP key and then the SINGLE SWEEP key.

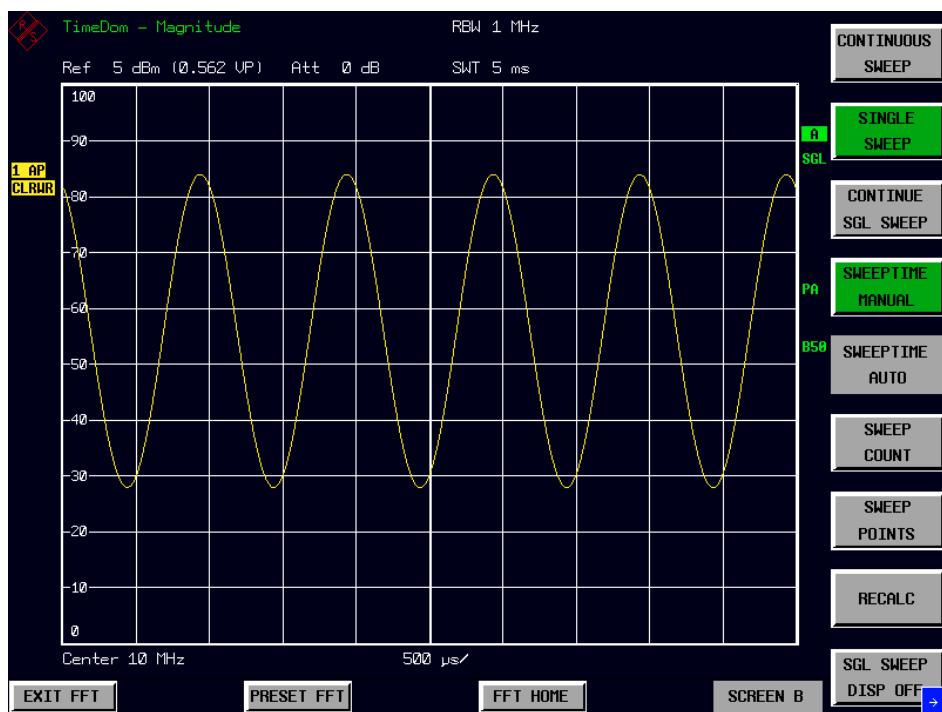
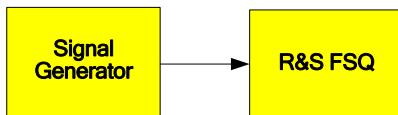


Figure 2-9: Measuring the 1 KHz AF-signal, which modulated the carrier

The display shows the demodulated AF signal. In the FFT Analyzer, however, there is no means of triggering the video signal or monitoring the modulated signal (because signal processing is done off-line).

2.3.2 Measurement example 2 – Measuring the modulation depth of an AM carrier in the frequency domain



Settings at the signal generator (e.g. R&S SMIQ or SMU)

- Frequency: 10 MHz
- Level: -30 dBm
- Modulation: 50% AM, 1 kHz AF

The RF output of the signal generator is connected to the I baseband input of the R&S FSQ. With asymmetrical cabling, the "unbalanced" I input must be used.

2.3.3 Measurements with the FFT Analyzer:

1. Set the R&S FSQ to its default state:
 - Press the PRESET key.
2. Change to the FFT Analyzer:

- Press the FFT hotkey.
3. Configure the baseband input:
 - Press the SIGNAL SOURCE softkey.
 - Select the appropriate input impedance using the IQ INPUT softkey.
 4. Use the BALANCED softkey to set the measurement mode (balanced / referenced to ground).
 - Press the IQ PATH softkey and then the I ONLY softkey to select the I input only.
 5. Set the center frequency and then set the span to 5 kHz:
 - Press the FREQ key and enter 10 MHz.
 - Press the SPAN key and enter 5 kHz.
 6. Set the reference level to a peak voltage of 0.178 V.
 - Press the AMPT key and enter 0.178 V.
 7. Activate the marker function for measuring the AM modulation depth.
 - Press the MEAS key.
 - Press the MODULATION DEPTH softkey.

The R&S FSQ automatically sets a marker on the carrier signal in the center of the diagram and one delta marker each on the upper and lower AM sidebands. The FFT Analyzer calculates the AM modulation depth from the level differences of the delta markers relative to the main marker and outputs the numeric value in the marker information field („MDEPTH 50.158%“).

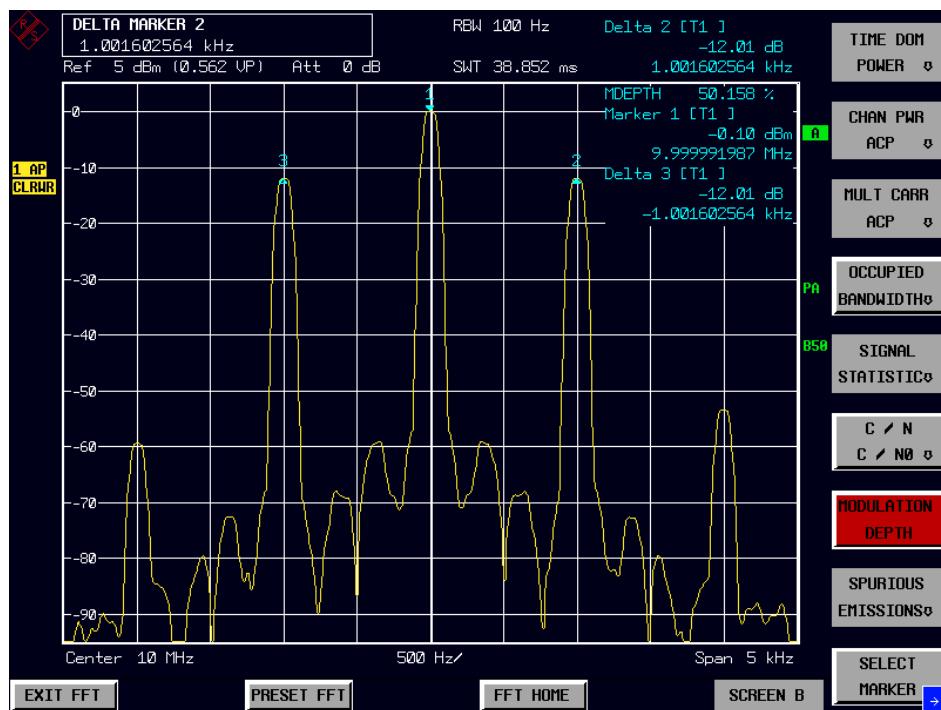


Figure 2-10: Measuring the AM modulation depth in the frequency domain

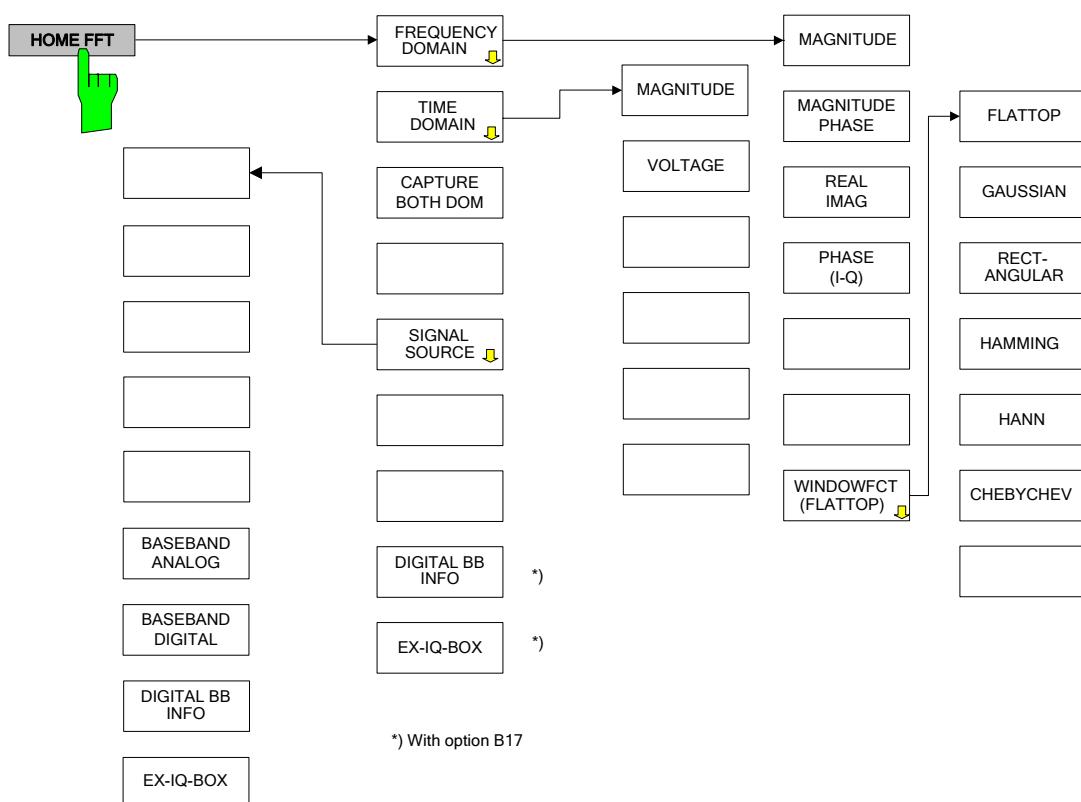
2.4 Manual operation of the FFT Analyzer:

The FFT Analyzer is operated in largely the same way as the R&S FSQ.

The most significant differences are as follows:

- Negative frequencies can now also be set for certain parameters (Center Frequency, Start Frequency, etc.).
- Other interdependencies exist between frequency resolution, measurement time and frequency span.

2.4.1 Overview of menus



2.5 Instrument functions of the FFT Analyzer

All the FFT analyzer functions and their uses are described in this chapter. The order in which the menu groups are described follows that of the procedures for configuring and starting measurements:

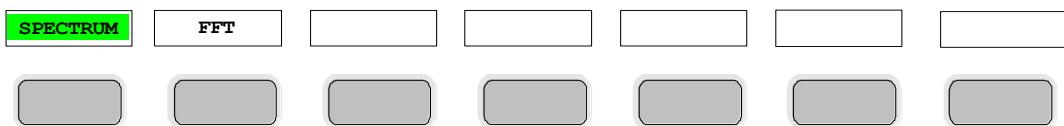
- Resetting the instrument – PRESET key
- Setting the operating mode – hotkey bar
- Setting the measurement parameters – FREQ, SPAN, AMPT, BW, SWEEP, TRIG, TRACE and CAL keys

- Selection and configuration of the measurement function – MKR, MKR->, MKR FCTN, MEAS and LINES keys

2.5.1 Selecting the operating mode – HOTKEY bar

The R&S FSQ has seven keys ("hotkeys") below the display to allow fast selection of the various operating modes. These keys may have different functions depending on the available instrument options.

The illustration below shows how the hotkey bar may look if the instrument is in the Spectrum Analysis mode and not yet in the FFT Analyzer mode.



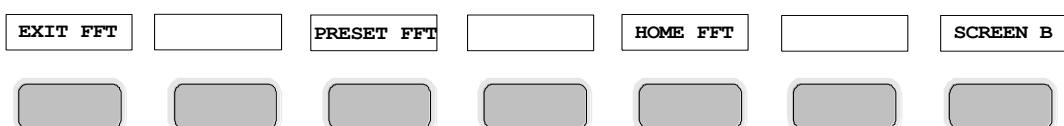
SPECTRUM The SPECTRUM hotkey switches the R&S FSQ to the Spectrum Analysis mode.

Remote: INST:SEL SAN

FFT The FFT hotkey switches the R&S FSQ to the FFT Analyzer mode.

Remote: INST:SEL FAN

Pressing the FFT key activates the FFT Analyzer mode and the hotkey bar has the following appearance:



EXIT FFT The EXIT FFT hotkey switches the R&S FSQ back to the Spectrum Analysis mode. There is no Remote for this function. Every Remote which is used to switch to a different operating mode has the same effect.

PRESET FFT The PRESET FFT hotkey sets the FFT Analyzer to a predefined state. See Chapter "Default settings of the FFT Analyzer – PRESET FFT key".

Remote: SENS:FFT:PRES

HOME FFT The HOME FFT hotkey opens the main menu of the FFT Analyzer.

SCREEN A Real split-screen mode is not possible in the FFT Analyzer. Although in the FFT Analyzer there are measurements with a split screen, these measurements cannot display the results of two completely independent measurements. The SCREEN A / SCREEN B hotkey can only be used in measurements that automatically display split-screen diagrams. Marker operations and the configuration of the diagram axes can be switched between the upper diagram (SCREEN A) and the lower one (SCREEN B) with this hotkey.

2.5.2 Default settings of the FFT Analyzer – PRESET FFT key

The PRESET FFT key sets the FFT Analyzer to a predefined default state.

Remote: SENS:FFT:PRES

Pressing the PRESET FFT key sets the default settings in the FFT Analyzer as shown in Table 2-1.

Table 2-1: Default settings of the FFT Analyzer

Parameter	Setting
Operating mode (Mode)	FFT Analyzer
FFT Analyzer mode	Frequency Domain, Magnitude diagram
Capture Both Domains	On
Window function	Flattop
Center frequency	0 Hz
Center frequency step	0.1 * span
Frequency span (Span)	72 MHz
Reference level (Ref Level)	1.0 V Peak
Level range	100 dB log
Level unit	dBm
Resolution bandwidth (Res BW)	auto
Span / RBW	50
Sweep	cont
Sweep count	0
Sweep points	625
Trigger	free run
Trace 1	clr write
Trace 2/3	blank
Detector	auto peak
Trace Math	off
Freq Offset	0 Hz
Ref Level Offset	0 dB
Ref Level Position	100 %
Grid	abs
Cal Correction	on
Input	AIQ
Measurement mode I/Q balanced / unbalanced	balanced
Input impedance HIGH / LOW	Low (50 Ω)
Type of signal at baseband input (IQ Path)	I+jQ
Baseband input dither signal ON / OFF	Off
Baseband input analog lowpass filter 36 MHz On / Off	On

2.5.3 Main menu of the FFT Analyzer

This softkey main menu appears on the right-hand side of the display immediately after the FFT Analyzer mode is started or whenever the HOME FFT hotkey is pressed.

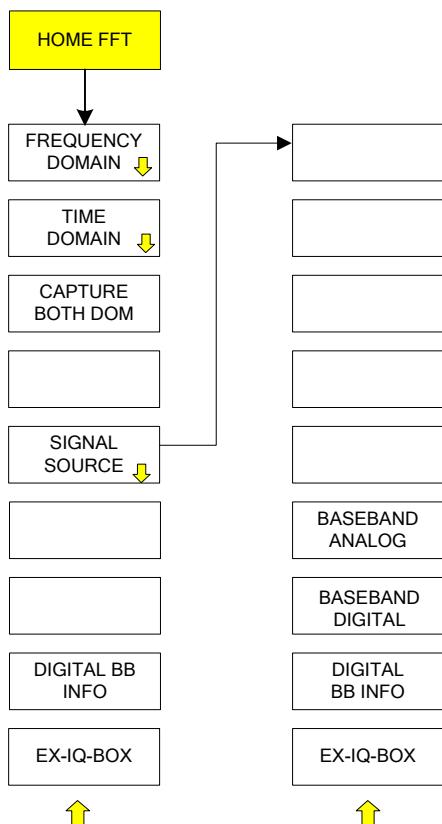
Since firmware version V3.85, it is possible to set the type of baseband input signal (menu SETUP) and the center frequency in the range of 0 to 35 MHz (I only, Q only) or -35 MHz to 35 MHz ($I+j*Q$).

This function is supported in all applications but FS-K30 and FS-K40.

The PRESET settings are:

- signal path: $I+j*Q$
- center frequency: 0 Hz

Remote: INP:IQ:TYPE IQ | I | Q



FREQUENCY DOMAIN The FREQUENCY DOMAIN softkey opens a submenu in which various types of spectrum measurements can be selected. The softkey activates the Frequency Domain mode and deactivates the Time Domain mode.

Note:

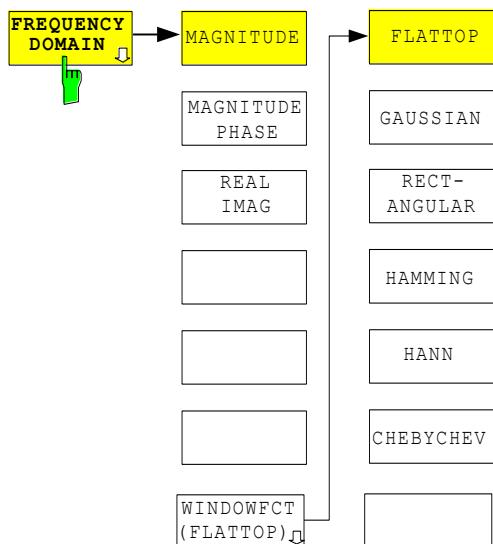
The Frequency Domain mode can also be activated by entering a SPAN larger than 0 Hz (see chapter "Setting the frequency span – SPAN key").

Remote SENS:FREQ:SPAN 10MHz

TIME DOMAIN	The TIME DOMAIN softkey opens a submenu in which various types of time-domain measurements can be selected. The softkey activates the Time Domain mode and deactivates the Frequency Domain mode.
	Note: The Time Domain mode can also be activated by entering a SPAN of 0 Hz (see Chapter "Setting the frequency span – SPAN key").
	Remote: SENS:FREQ:SPAN 0Hz
CAPTURE BOTH DOM	The CAPTURE BOTH DOM softkey (short for "capture both domains") has a toggle function. Function active: In single sweep mode, the entire I/Q data memory is always filled with unfiltered raw data first. By using the RECALC and RECALC AUTO softkeys in the SWEEP menu, this data can then be analyzed as often as required using different instrument settings. This is possible in both the time and frequency domain, hence the name of the softkey. Function not active: Data acquisition is optimized for the currently selected measurement task. This means that the observation time is only as long as necessary. As a result, measurements are generally performed more quickly, unless the measurement settings force data to be written directly to the memory. If the function is not active and the data rate can be reduced prior to writing the data to the memory, this will permit a longer observation time and a better frequency resolution.
	Remote: SENS:FFT:CAPT ON
SIGNAL SOURCE	The SIGNAL SOURCE softkey opens a submenu in which the properties of the input signal and the way in which the signal is to be processed can be defined.
	Remote: -
ADJUST REF LVL	The ADJUST REF LVL softkey performs one-off adaptation of the attenuation/gain to the baseband inputs. Overloading is then avoided, but the modulation range is utilized as fully as possible.
	Remote: SENS:FFT:PRES:RLEV

2.5.4 Frequency Domain submenu of the FFT Analyzer

This submenu appears when the FREQUENCY DOMAIN softkey in the main menu of the FFT Analyzer is pressed.



The first three softkeys are used to select the display mode for the measured spectrum. The softkey changes color when selected. Pressing a different softkey toggles the selection. The displayed spectrum range depends primarily on the parameters SPAN / CENTER FREQUENCY and START FREQUENCY / STOP FREQUENCY. The frequency resolution is determined using the parameter RESOLUTION BANDWIDTH (RBW). The selected window function determines the filter shape and the shape factor. The window function and the RBW together determine the data acquisition time (i.e. SWEEP TIME) which is automatically selected internally.

MAGNITUDE If the MAGNITUDE softkey is selected, only the magnitude of the spectrum is displayed as the result. The functions which are also used in the spectrum analysis mode (e.g. in the MEAS menu) and which require a level trace can be applied to this trace.

Remote: CALC:FORM MAGN

MAGNITUDE PHASE If the MAGNITUDE PHASE softkey is selected, the magnitude of the spectrum and its phase information are displayed as the result.

Note:

This option should only be selected for single measurements or when using a trigger with periodic signals. It should be noted that scaling of the phase information can be controlled using a special submenu (PHASE SETTINGS) opened with the AMPT key.

Remote: CALC:FORM MPH

REAL IMAG If the REAL IMAG softkey is selected, the real and imaginary parts of the spectrum are displayed as the result. The results are displayed on a linear scale.

Note:

This option should only be selected for single measurements or when using a trigger with periodic signals.

A number of measurements (e.g. from the menu opened with the MEAS key) are not permitted in this display mode.

Remote: CALC:FORM RIM

**PHASE
(I-Q)** Softkey PHASE activates the phase difference measurement between two scalar input signals connected to input I and input Q. Select signal source I Only to get the phase difference I-Q and Q Only for Q-I.

This function is only available if BOTH DOMAIN is switched on and if signal source is not set to $I+j^*Q$.

Remote: CALC:FORM DPH

**MAGN PHASE
(I-Q)** Softkey MAGN PHASE activates the phase difference/magnitude difference measurement between two scalar input signals connected to input I and input Q. Select signal source I Only to get the phase difference I-Q and Q Only for Q-I. The upper window (Screen A) shows the phase difference. The lower window (Screen B) shows the magnitude difference.

This function is only available if BOTH DOMAIN is switched on and if signal source is not set to $I+j^*Q$.

Remote: CALC:FORM DMPH



The WINDOWFCT softkey (short for "window function") opens a submenu in which the window function for the FFT input data can be selected. The input data for the FFT is multiplied by the selected window function. This suppresses leakage effects (but not in the case of the rectangular window).

The softkey also indicates the type of window function currently active.



The window function is completely irrelevant in the Time Domain mode.

Selecting a different window function changes the filter shape of the resolution filter, e.g.:

- shape factor: ratio of –60 dB bandwidth to –3 dB bandwidth
- sidelobe fall-off
- attenuation of highest sidelobe

The equivalent noise bandwidth remains constant when the window function is changed. This is achieved by adapting the acquisition time (referred to as SWEETIME in the Spectrum Analysis mode of the FFT Analyzer).



In the FFT Analyzer, the equivalent noise bandwidth is used as the entry for RESOLUTION BANDWIDTH.

FLATTOP

The FLATTOP softkey selects a "flattop" window function. It provides optimum amplitude accuracy. It is therefore the default setting. It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

Remote: SENS:WIND:TYPE FLAT

GAUSSIAN

The GAUSSIAN softkey selects a "Gaussian" window function.

It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

Remote: SENS:WIND:TYPE EXP

RECT- ANGULAR

The RECTANGULAR softkey selects a "rectangular" window function. The input data is then not weighted differently but instead remains unchanged. This type of window function is also referred to as "boxcar window" or "transient window".

It should be used for brief transient signals (no data is lost).

It should be used in cases where only frequency resolution is an important factor.

It is otherwise unsuitable since leakage is not suppressed.

Remote: SENS:WIND:TYPE RECT

HAMMING

The HAMMING softkey selects a "Hamming" window function.

Note:

It is not suitable for measurements with a wide dynamic range.

Remote: SENS:WIND:TYPE HAMM

HANN

The HANN softkey selects a "Hann" window function (sometimes also referred to as "Hanning").

It is sometimes used for measurements on noise-like signals.

Remote: SENS:WIND:TYPE HANN

CHEBYCHEV

The CHEBYCHEV softkey selects a "Chebychev" window function. It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

Remote: SENS:WIND:TYPE CHEB

Table 2-2: Window function data

	ENBW (bins)	BW3dB (bins)	BW3dB / ENBW	BW6dB (bins)	BW6dB / ENBW	Shape factor = BW60dB/BW3dB	Highest sidelobe (dB)	sidelobe fall off (dB / decade)
Flattop	3.89	3.85	0.99	4.73	1.22	2.4	-90	0
Hann	1.50	1.45	0.97	2.02	1.35	9.1	-31.5	60
Hamming	1.36	1.32	0.97	1.83	1.35	70.7	-42.6	20
Rectangular	1.00	0.89	0.89	1.21	1.21	707	-13.3	20
Gaussian	2.26	2.13	0.94	3.00	1.32	4.4	-87.6	20
Chebychev	2.03	1.95	0.96	2.72	1.34	3.84	-110	0

Explanation of the table values:

- The equivalent noise bandwidth of a filter is the bandwidth which an ideal, rectangular filter would need to have to allow the same power to pass if white noise is applied at the input.
- The value BW_{3dB} / ENBW indicates the factor by which the measured 3 dB bandwidth is smaller than the selected RBW (which is defined by the equivalent noise bandwidth). If, for example, a Hann window and an RBW of 10 kHz are used, a 3 dB bandwidth of approx. 9.7 kHz will be measured with the N DB DOWN measurement.
- The values of the highest sidelobe and of the sidelobe fall-off are important if measurements are to be performed with the widest possible dynamic range. The flattop, Gaussian and Chebychev windows are ideal for such measurements. The flattop and Chebychev windows have sidelobes with more or less constant attenuation.
- The shape factor is a measure of the shape of a window or filter. It is defined as the ratio of 60 dB bandwidth to 3 dB bandwidth. Small values are to be aimed for. The rectangular window and Hamming window do not perform well here.

Interdependency between observation time and window function:

In the FFT Analyzer, the equivalent noise bandwidth is used as the entry for RESOLUTION BANDWIDTH (RBW). This is because the FFT has an equivalent noise bandwidth of exactly one bin if the rectangular window function is used. The frequency resolution of the FFT for this window is 1 Hz if the observation time is 1 second. RBW and observation time (here referred to as SWEETIME SWT, although no sweep principle is actually applied) are reciprocal.

The equation $\Delta f = RBW = \frac{1}{SWT}$ applies in the case of a rectangular window.

However, leakage effects occur which make the rectangular window unusable for the majority of applications. If a window function is then used to reduce these leakage effects, the data is slowly attenuated toward zero at the beginning and end of the observation time. The effective observation time drops as a result and the frequency resolution in turn becomes poorer. The FFT then has a noise bandwidth which is one relative equivalent noise bandwidth larger than if a rectangular window of the same length is used (see the Table 2-2).

$$ENBW_{rel}(window) = \frac{ENBW(window)}{ENBW(rectangular)}$$

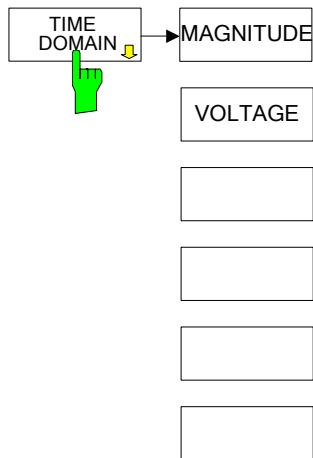
This problem can be solved by increasing the observation time by multiplying it by the relative equivalent noise bandwidth ENBW_{rel} of the window function:

The equations $SWT = \frac{ENBW_{rel}}{RBW}$ and $RBW = \frac{ENBW_{rel}}{SWT}$ apply for all windows.

Changing the window function therefore changes the observation time. However, changing the SPAN does not change the observation time, which is in complete contrast to the Spectrum Analysis mode.

2.5.5 Time Domain submenu of the FFT Analyzer

This submenu appears when the TIME DOMAIN softkey in the main menu of the FFT Analyzer is pressed.



The observation time is determined by the parameter SWEEP TIME (SWT). The parameter RESOLUTION BANDWIDTH (RBW) determines the filter bandwidth. The parameter CENTER FREQUENCY determines the frequency which is to be exactly at the center of the filter and is not attenuated. This is achieved internally by means of frequency conversion (multiplication by a complex rotating phasor).

MAGNITUDE If the MAGNITUDE softkey is selected, the magnitude of the input signal (which may be offset with respect to frequency and then filtered by lowpass filters) over time is displayed as the result.

Using the IQ PATH softkey (in the SIGNAL SOURCE menu), it is possible to decide whether both paths or just one path of the baseband input is to be through-connected.

Remote: CALC:FORM MAGN

VOLTAGE

If the VOLTAGE softkey is selected, the real and imaginary parts of the input signal (which may be offset with respect to frequency and then filtered by lowpass filters) over time are displayed as the result. The diagram is split into two parts and shows the real and imaginary part on a linear scale.

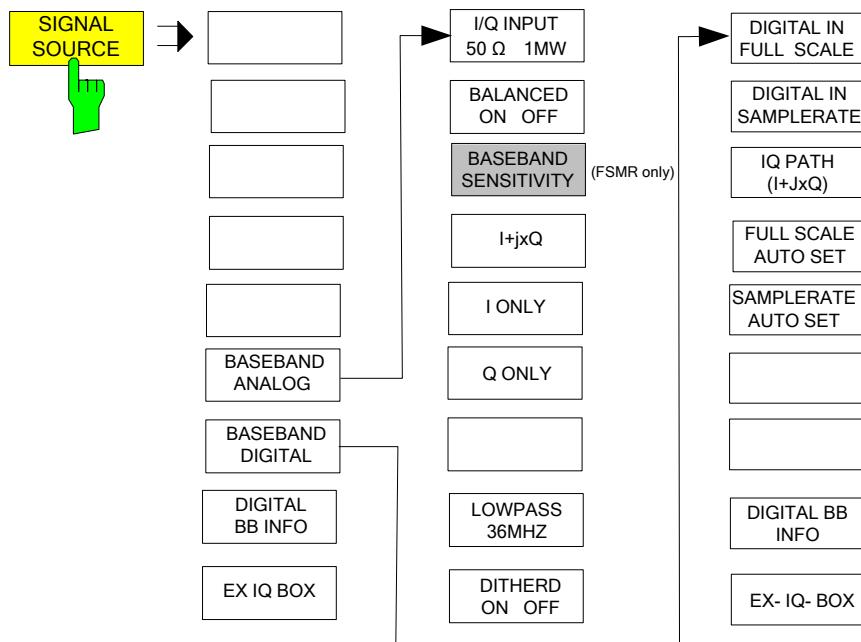
If no mixing takes place (CENTER FREQUENCY = 0 Hz), the following applies:

- With IQ PATH = $I + j*Q$: The real part and imaginary part of the result corresponds to the voltage characteristic at the I input and Q input.
- With IQ PATH = I ONLY: The real part of the result corresponds to the voltage characteristic at the I input. The imaginary part is zero.
- With IQ PATH = Q ONLY: The real part of the result corresponds to the voltage characteristic at the Q input. The imaginary part is zero.

Remote: CALC:FORM VOLT

2.5.6 SIGNAL SOURCE submenu of the FFT Analyzer

This submenu appears when the SIGNAL SOURCE softkey in the main menu of the FFT Analyzer is pressed.



The way in which the FFT Analyzer is to process the input signals can be defined in this menu.

A similar menu for configuring the baseband input can also be opened by pressing the SETUP hardkey.

BASEBAND ANALOG

The BASEBAND ANALOG softkey switches on the baseband input.
The default setting is baseband input OFF.

Remote: INP:SEL AIQ

I/Q INPUT 50 Ω - 1 MΩ	The I/Q INPUT 50Ω - 1MΩ softkey toggles the input impedance of the baseband inputs. The default setting is 50 Ω. Remote: INP:IQ:IMP LOW HIGH
BALANCED ON OFF	The BALANCED ON - OFF softkey switches the inputs to balanced (BALANCED ON) or referenced to ground (BALANCED OFF). The default setting is ON. Remote: INP:IQ:BAL ON OFF
I+JxQ	The I+JxQ softkey causes the FFT Analyzer to regard the signals at the I and Q input as components of a complex signal. This is the standard setting for the analysis of signals with complex modulation. Remote: INP:IQ:TYPE IJQ
I ONLY	The I ONLY softkey causes the FFT Analyzer to regard the signal at the I input as a single, real signal. The signal at the Q input is ignored. This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the I input. Remote: INP:IQ:TYPE I
Q ONLY	The Q ONLY softkey causes the FFT Analyzer to regard the signal at the Q input as a single, real signal. The signal at the I input is ignored. This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the Q input. Remote: INP:IQ:TYPE Q
LOWPASS 36MHZ	The LOWPASS 36MHZ ON / LOWPASS 36MHZ OFF softkey is used to toggle the analog anti-aliasing lowpass filters of the baseband inputs. The setting has the same effect on both inputs. See also page 14. Remote: SENS:IQ:LPAS:STAT ON OFF
DITHER ON OFF	The DITHER ON / DITHER OFF softkey is used to add a shaped dither signal to both inputs. See page 15 in cases where this is advisable. Remote: SENS:IQ:DITH:STAT ON OFF
BASEBAND DIGITAL	The softkey BASEBAND DIGITAL opens a menu to configure the digital baseband input. The default setting is baseband input OFF. The baseband input is switched off when its application is closed. Remote: INP:SEL AIQ DIQ RF

DIGITAL IN FULL SCALE	The softkey DIGITAL IN FULL SCALE opens a dialog to define the voltage corresponding to the maximum input value of the digital baseband input (value 7FFF hex). The default is 1 Volt. The FULL SCALE AUTO SET function is switched off if the full scale value is manually configured.
Note:	This softkey is only available for R&S FSQ-B17.
DIGITAL IN SAMPLE RATE	The softkey DIGITAL IN SAMPLE RATE defines the input date sample rate read by the digital baseband input. The default value is 81.6 MHz. The SAMPLE RATE AUTO SET function is switched off if the input data sample rate is manually configured.
Note:	This softkey is only available for R&S FSQ-B17.
FULL SCALE AUTO SET	Dependent on the capability of the digital base band signal source the I/Q data's sample rate and/or the full scale value are passed to the LVDS input interface of the analyzer. The analyzer automatically adjusts the related input parameters (DIGITAL IN FULL SCALE and DIGITAL IN SAMPLE RATE) if the AUTO SET functions for the Digital Input Full Scale Value or the Digital Input Sample Rate are active.
SAMPLE RATE AUTO SET	A conflict between the received values (full scale, sample rate) and the instrument's supported parameter ranges is indicated by a red colored "BDI" enhancement label at the right side of the grid. The same happens if the AUTO SET function is active but the sending device does not support this feature. The related AUTO SET function has to be switched off and the parameter has to be manually configured in that case.
Note:	This softkey is only available for R&S FSQ-B17.
	Remote: INP<1 2>:DIQ:RANG:AUTO ON OFF INP<1 2>:DIQ:SRAT:AUTO ON OF
DIGITAL BB INFO	The softkey DIGITAL BB INFO opens a window to display the status information of the connected digital baseband device (input or output). Dependent on the capability of the digital base band signal source the I/Q data's sample rate and/or the full scale value are passed to LVDS input interface of the analyzer and displayed in the Digital Baseband Info table. The analyzer automatically adjusts the related input parameters (DIGITAL IN FULL SCALE and DIGITAL IN SAMPLE RATE) if the AUTO SET functions are switched on.
Note:	This softkey is only available for R&S FSQ-B17.

DIGITAL BASEBAND INFO		
	INPUT	OUTPUT
Connected Device	AMU200A	-----
Serial Number	100266	
Port	Out A	
Full Scale	-----	
Sampling Rate	38.7 MHz	
Max Transfer Rate	100 MHz	
Connection Protocol	passed	
PRBS Test Deskewing	not yet started	

Figure 2-11: R&S AMU200 used as a Digital Baseband Signal Source

The dialog lists the following items:

- **Connected Device:**
The name of the connected device
- **Serial Number:**
The serial number of the connected device
- **Port Name:**
The port name of the connected device
- **Full Scale Value:**
The full scale value of the I/Q data sent by the connected device. "----" indicates this information is not sent by the connected device. FULL SCALE AUTO SET can not be used in that case and you have to manually configure this instrument setting. "**auto**" indicates an active AUTO SET function.
A warning appears if the value exceeds the allowed range of the analyzer.
- **Sample Rate:**
The sample rate of the I/Q data sent by the connected device. "----" indicates this information is not sent by the connected device. SAMPLE RATE AUTO SET can not be used in that case and you have to manually configure this instrument setting. "**auto**" indicates an active AUTO SET function.
A warning appears if the value exceeds the allowed range of the analyzer.
- **Max Transfer Rate:**
The Maximum interface clock rate to transfer the I/Q data using the B17 connection.
- **Connection Protocol:**
Indicates the state of the connection protocol. The analyzer is able to communicate with the sending/receiving device.
- **PRBS Test Deskewing:**
An alignment process is started when the B17 input or output is connected to a digital baseband source/sink. The current state of this process is listed here. Possible indications are "not yet started", "failed" or "passed".

Figure 2-11 shows the result of an R&S AMU200A connected to the analyzer's digital baseband input. The sample rate of the I/Q data is 38.7 MHz. The Full Scale Value is not sent by the AMU and therefore the digital input full scale value has to be manually set. The connection protocol was successfully passed and the self alignment process was not yet started (cable connected in analyzer mode).

DIGITAL BASEBAND INFO		
Connected Device	INPUT	OUTPUT
Serial Number	AMU200A	-----
Port	100266	
Full Scale	Out A	
Sampling Rate	-----	
Max Transfer Rate	38.7 MHz	auto
Connection Protocol	100 MHz	
PRBS Test Deskewing	passed	
	passed	

Figure 2-12: R&S AMU200, connection with analyzer established

In Figure 2-12 the self alignment was successfully finished and indicated with "passed".

DIGITAL BASEBAND INFO		
Connected Device	INPUT	OUTPUT
Serial Number	ExBox	-----
Port	100064	
Full Scale	IQ OUT	
Sampling Rate	-----	
Max Transfer Rate	100 MHz	auto
Connection Protocol	-----	
PRBS Test Deskewing	passed	
ExIQ-Box PLL	passed	
	locked	

Figure 2-13: The R&S Ex-IQ-Box connected to the digital baseband input

An additional PLL status line is available, if an Ex-IQ-Box is connected (see Figure 2-13).

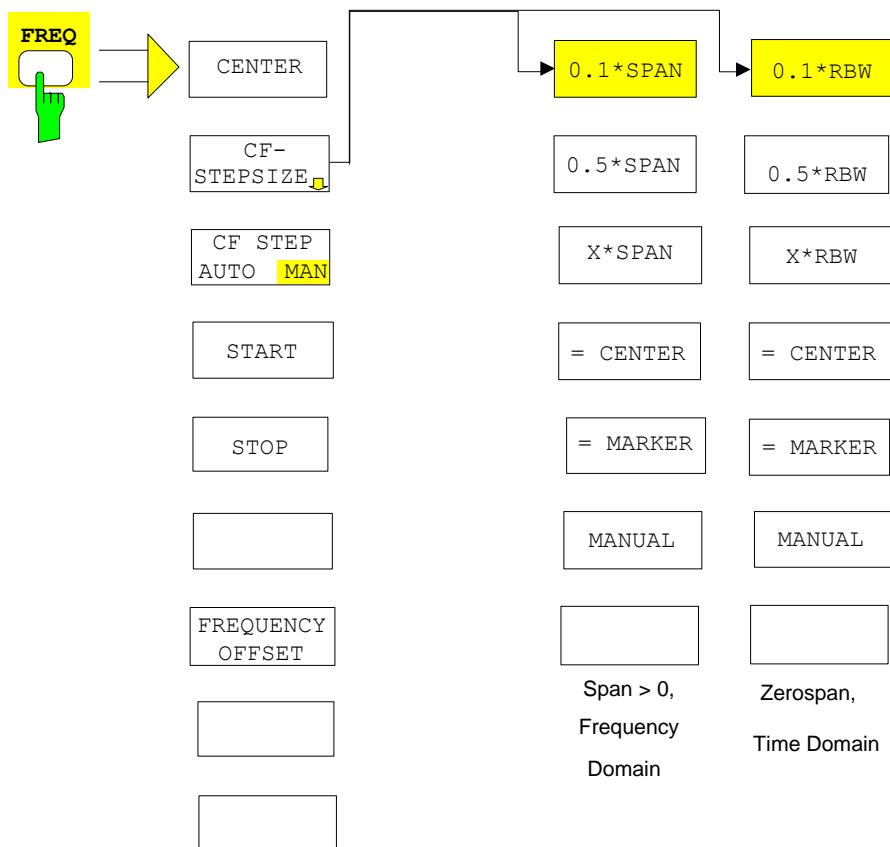
DIGITAL BASEBAND INFO		
Connected Device	INPUT	OUTPUT
Serial Number	-----	ExBox
Port		100064
Full Scale		IQ IN
Sampling Rate		0.223607 V
Max Transfer Rate		100 MHz
Connection Protocol		-----
PRBS Test Deskewing		passed
EX-IQ-Box PLL		done
		locked

Figure 2-14: The R&S Ex-IQ-Box connected to the digital baseband output

```
Remote: INP<1 | 2>:DIQ:CDEV?
OUTP<1 | 2>:DIQ:CDEV?
STAT:QUES:DIQ:COND?
```

- EX IQ BOX** The softkey opens a dialog to configure an R&S EX-IQ-Box connected to the digital baseband Input or Output.

2.5.7 Selecting the frequency and frequency span – FREQ key



The functionality and structure of the menu tree which is opened by pressing the FREQ hardkey are largely the same as that for the Spectrum Analysis mode.

One significant difference is that the FFT Analyzer also allows negative frequencies to be entered in the case of complex input signals. However, only positive frequencies are possible for real input signals.

The functionalities CF-STEP SIZE = CENTER and CF-STEP SIZE = MARKER are disabled for the FFT Analyzer.

CENTER The CENTER softkey opens a window in which the center frequency can be entered.

The permissible entry ranges for the center frequency are as follows:

- For the frequency domain (Frequency Domain, Span > 0):
- For IQ PATH = I + jQ (complex signal):
 $-36 \text{ MHz} + \text{Minspan}/2 \leq f_{\text{center}} \leq +36 \text{ MHz} - \text{Minspan}/2$
- For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 $\text{Minspan}/2 \leq f_{\text{center}} \leq +36 \text{ MHz} - \text{Minspan}/2$
- For the time domain (Time Domain, Span = 0):
- For IQ PATH = I + jQ (complex signal):
 $-36 \text{ MHz} \leq f_{\text{center}} \leq 36 \text{ MHz}$
- For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 $0 \text{ Hz} \leq f_{\text{center}} \leq 36 \text{ MHz}$

fcenter Center frequency
 Minspan Smallest selectable span > 0 Hz (10 Hz)

Remote: FREQ:CENT 10MHz

START The START softkey activates manual entry of the start frequency.

The permissible entry ranges for the start frequency are as follows:

For the frequency domain (Frequency Domain, Span > 0):

For IQ PATH = I + jQ (complex signal):
 -36 MHz ≤ fstart ≤ +36 MHz - Minspan

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 0 ≤ fstart ≤ +36 MHz - Minspan

For the time domain (Time Domain, Span = 0):

For IQ PATH = I + jQ (complex signal):
 -36 MHz ≤ fstart ≤ 36 MHz

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 0 Hz ≤ fstart ≤ 36 MHz

If the entered start frequency is greater than the stop frequency, the stop frequency is set to start frequency + minspan.

fstart Start frequency

Minspan Smallest selectable span > 0 Hz (10 Hz)

Remote: FREQ:STAR 2MHz

STOP The STOP softkey activates entry of the stop frequency.

The permissible entry ranges for the stop frequency are as follows:

For the frequency domain (Frequency Domain, Span > 0):

For IQ PATH = I + jQ (complex signal):
 -36 MHz + Minspan ≤ fstop ≤ +36 MHz

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 Minspan ≤ fstop ≤ +36 MHz

For the time domain (Time Domain, Span = 0):

For IQ PATH = I + jQ (complex signal):
 -36 MHz ≤ fstop ≤ 36 MHz

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
 0 Hz ≤ fstop ≤ 36 MHz

If the entered stop frequency is less than the start frequency, the start frequency is set to stop frequency - minspan.

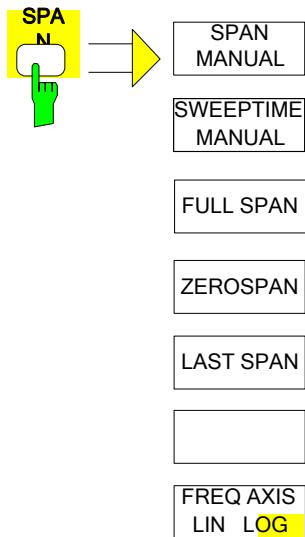
fstop Stop frequency

Minspan Smallest selectable span > 0 Hz (10 Hz)

Remote: FREQ:STOP 20MHz

The other softkeys are not explained here. Their functionality in the FFT Analyzer is the same as in the R&S FSQ. An explanation is given from chapter 4 onwards of the R&S FSQ operating manual.

2.5.8 Setting the frequency span – SPAN key



The SPAN key opens a menu which contains the various options for setting the frequency span (Frequency Domain mode).

In the frequency domain (Span > 0), entry of the span (SPAN MANUAL softkey) is activated automatically. In the time domain (Span = 0), entry of the sweep time (SWEETIME MANUAL softkey) is activated automatically.

The functionality and structure of the menu tree is largely the same as that for the Spectrum Analysis mode.

The FREQ AXIS LIN / FREQ AXIS LOG functionality is, however, not available for the FFT Analyzer. A linear frequency axis is always selected.

**SPAN
MANUAL** The SPAN MANUAL softkey activates manual entry of the frequency span, whereby the center frequency is kept constant wherever possible. CENTER FREQUENCY is adapted automatically only if the new span projects beyond the permissible ranges. This is indicated on the display.

For the frequency domain (Frequency Domain, Span > 0), the permissible entry range for the frequency span is:

For IQ PATH = I + jQ (complex signal):
Minspan < fspan ≤ 72 MHz

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal)
Minspan < fspan ≤ 36 MHz

Entering a span of 0 Hz activates the Time Domain mode. In this mode, 0 Hz is the only permissible value for SPAN.

Entering a span > 0 Hz activates the Frequency Domain mode.

fspan Frequency span (Span)

Minspan Smallest selectable span (10 Hz)

Remote: FREQ:SPAN 2MHz

**SWEEPTIME
MANUAL** The SWEEPTIME MANUAL softkey activates manual entry of the sweep time in the Time Domain mode (Span = 0). If the span is greater than 0, the softkey is not available as the observation time is selected internally by the firmware.

The softkey with the same label in the submenu opened by pressing the SWEEP hardkey has the same functionality. See Table 2-3 for the permissible values of the SWEEPTIME parameter.

Remote: SWE:TIME 1ms

FULL SPAN The FULL SPAN softkey sets the frequency span to the largest possible span in the FFT Analyzer. If the Time Domain mode is currently active, the mode also switches over to Frequency Domain.

The span and center frequency are then as follows:

For IQ PATH = I + jQ (complex signal):

SPAN = 72 MHz, i.e. -36 MHz to +36 MHz.

CENTER FREQUENCY = 0 Hz

For IQ PATH = I ONLY or IQ PATH = Q ONLY (real signal):

SPAN = 36 MHz, i.e. from 0 Hz to +36 MHz

CENTER FREQUENCY = 18 MHz

Remote: FREQ:SPAN:FULL

ZERO SPAN The ZERO SPAN softkey sets the frequency span to 0 Hz. As a result, the mode of the FFT Analyzer changes to Time Domain.

The x-axis becomes the time axis, whereby the gridlines each correspond to 1/10 of the current sweep time (SWT).

Remote: FREQ:SPAN 0Hz

LAST SPAN If the frequency span has been changed, pressing the LAST SPAN softkey restores the previous setting on the instrument. In this way, it is possible to switch between an overview measurement (FULL SPAN) and a detailed measurement (manually selected center frequency and span).

Note:

The last span value is restored if and only if the span is > 0, i.e. the time domain is not selected automatically.

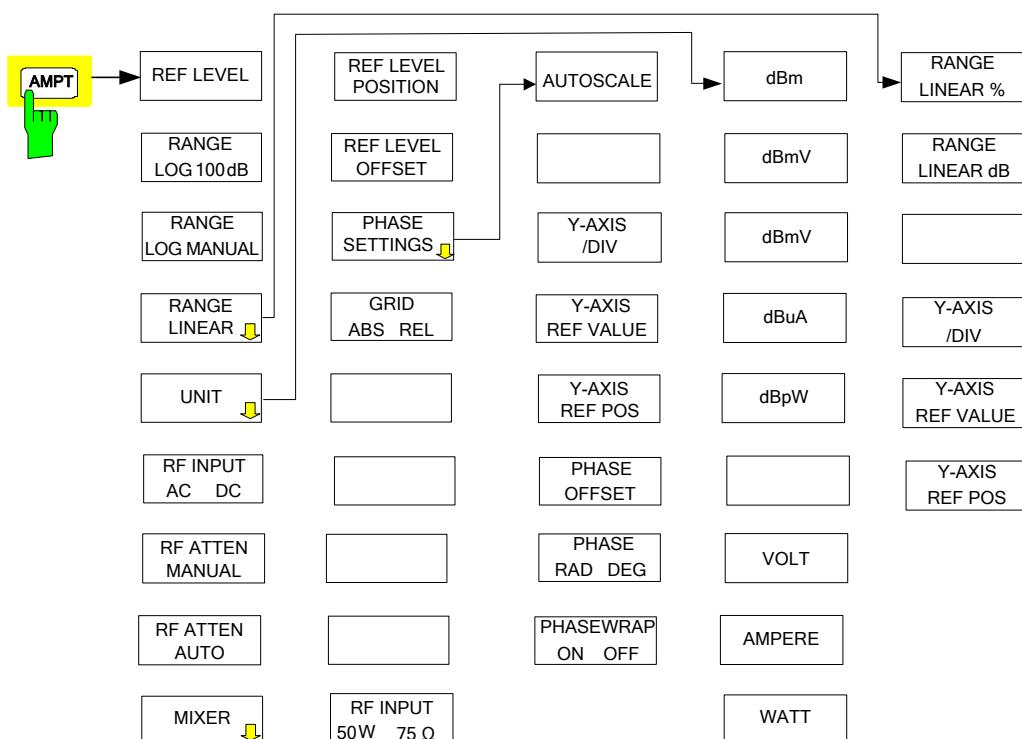
Remote: -

2.5.9 Setting the level display and configuring the diagrams – AMPT key

The AMPT key opens a submenu in which the reference level (REF LEVEL) and various properties of the result diagrams can be configured. REF LEVEL can be entered immediately since the entry dialog is opened automatically as soon as the AMPT key is pressed.

The menu tree is largely based on that of the Spectrum Analysis mode. Only a few functions are deactivated for the FFT Analyzer. The submenu for configuring the phase diagram is, however, new.

Note. If the analog baseband input is used, the reference level should not be specified as the RMS power but rather as the applied peak voltages. See also Chapter REF LEVEL softkey and Chapter "Level display".



REF LEVEL The REF LEVEL softkey activates entry of the reference level. If the baseband input is used, this level is expected at the input as the maximum voltage and not as the RMS input power (this is intended to avoid overloading of the A/D converter). The value is therefore entered in "volt peak". The level in the diagram label is specified in dBm, however, since the limit values in the mobile radio standards are also specified in dBm. 1 volt peak corresponds to 10 dBm.

The following values are permissible:

- 0.0316 V
- 0.0562 V
- 0.1 V
- 0.178 V
- 0.316 V
- 0.562 V

1 V
 1.78 V
 3.16 V only with IMPEDANCE LOW (50 Ω)
 5.62 V only with IMPEDANCE LOW (50 Ω)

See also Chapter (REF LEVEL softkey) and Chapter “Level display”.

Remote: SENS:VOLT:IQ:RANGE 1 or
 DISP:WIND:TRAC:Y:RLEV 1

RANGE LOG	The RANGE LOG 100 dB softkey sets the level display range to 100 dB.
100 dB	Remote: DISP:WIND:TRAC:Y:SPAC LOG DISP:WIND:TRAC:Y 100DB
RANGE LOG MANUAL	The RANGE LOG MANUAL softkey activates manual entry of the level display range. Display ranges from 10 to 200 dB in 10 dB steps are permitted. Invalid entries are rounded to the nearest permissible value. The default setting is 100 dB. Remote: DISP:WIND:TRAC:Y:SPAC LOG DISP:WIND:TRAC:Y 120DB
RANGE LINEAR	The RANGE LINEAR softkey switches the display range of the analyzer over to linear scaling and opens the submenu for selecting % or dB as the diagram labeling. The display in % is selected the first time the display range is switched over to linear scaling (see RANGE LINEAR dB softkey). Remote: DISP:WIND:TRAC:Y:SPAC LIN
RANGE LINEAR %	The RANGE LINEAR % softkey switches the display range of the analyzer to linear scaling. The horizontal gridlines are labeled in %. The grid has decadic division. Markers are displayed in the selected unit and delta markers in % referred to the voltage value at the position of marker 1. Remote: DISP:WIND:TRAC:Y:SPAC LIN
RANGE LINEAR dB	The RANGE LINEAR dB softkey switches the display range of the analyzer to linear scaling. The horizontal gridlines are labeled in dB. Markers are displayed in the selected unit and delta markers in dB referred to the power at the position of marker 1. Remote: DISP:WIND:TRAC:Y:SPAC LDB
Y-AXIS /DIV	With linear scaling, the Y-AXIS/DIV softkey is used to determine the value range which is to correspond to the distance between two horizontal gridlines. The entire displayed value range is therefore equivalent to 10 times the selected value. The softkey is only available in the following display modes: <ul style="list-style-type: none">• REAL IMAG in the Frequency Domain mode• VOLTAGE in the Time Domain mode The setting always affects both subdiagrams in the same way. Remote: DISP:WIND:TRAC:Y:PDIV 10

**Y-AXIS
REF-VALUE** The Y-AXIS REF-VALUE softkey determines the reference value of the diagram at the reference position. The gridlines are arranged on the basis of this reference value.

The softkey is only available in the following display modes:

- REAL IMAG in the Frequency Domain mode
- VOLTAGE in the Time Domain mode

The setting always affects both subdiagrams in the same way.

Remote: DISP:WIND:TRAC:T:RVAL 1

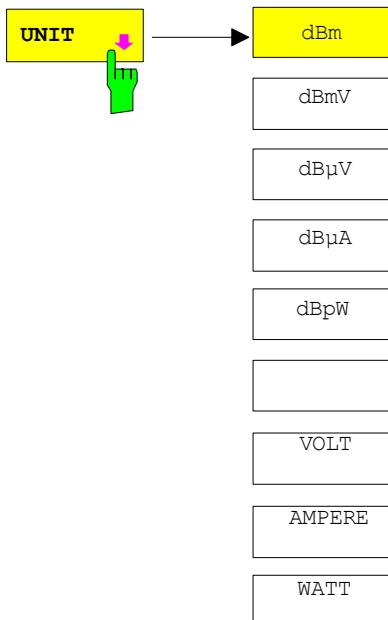
**Y-AXIS
REF-POS** The Y-AXIS REF-POS softkey is used to control the location of the reference position within the grid from 0% to 100%. The default value is 50%.

The softkey is only available in the following display modes:

- REAL IMAG in the Frequency Domain mode
- VOLTAGE in the Time Domain mode

The setting always affects both subdiagrams in the same way.

Remote: DISP:WIND:TRAC:Y:POS



The UNIT softkey opens a submenu in which the desired unit for the level axis can be selected.

In the default setting, the level is displayed over 1 milliwatt (= dBm). The input impedance, which is ALWAYS assumed to be 50Ω can be used for conversion to other units. As a result, it is possible to convert the units dBm, dBmV, dB μ V, dB μ A, dBpW, V, A and W directly.

Remote: CALC:UNIT:POW DBM

**RF INPUT
AC/DC** The RF INPUT AC/DC softkey is deactivated if the baseband input is used.

RF ATTEN MANUAL	The RF ATTEN MANUAL softkey is deactivated if the baseband input is used.
RF ATTEN AUTO	The RF ATTEN AUTO softkey is deactivated if the baseband input is used.
MIXER LEVEL	The MIXER LEVEL softkey is deactivated if the baseband input is used.
	AMPT side menu:
REF LEVEL OFFSET	<p>The REF LEVEL OFFSET softkey activates entry of an arithmetic level offset. This is added to the measured level irrespective of the selected unit. The y-axis scaling is changed accordingly.</p> <p>The setting range is ± 200 dB in 0.1 dB steps.</p> <p>Remote: DISP:WIND:TRAC:RLEV:OFFS -10dB</p>
PHASE SETTINGS	<p>The PHASE SETTINGS softkey opens a submenu in which the scaling of the phase diagram can be configured. The softkey and the submenu are therefore only available for the MAGNITUDE PHASE measurement in the Frequency Domain mode.</p> <p>Note: The AUTOSCALE, PHASE OFFSET, PHASE RAD/DEG and PHASEWRAP ON/OFF softkeys always affect the phase diagram. The other softkeys of this submenu can have an effect on either the upper or lower diagram, depending on the position of the SCREEN A/B hotkey.</p>
AUTOSCALE	<p>The AUTOSCALE softkey performs one-off scaling of the phase diagram so that the current trace fully utilizes the value range.</p> <p>Remote: DISP:WIND2:TRAC:Y:SCAL:AUTO ONCE</p>
Y-AXIS /DIV	<p>The Y-AXIS/DIV softkey is used to determine the value range which is to correspond to the distance between two horizontal gridlines. The entire displayed value range is therefore equivalent to 10 times the selected value. With manual entry, the unit selected using the PHASE RAD / PHASE DEG softkey applies (only for the phase diagram).</p> <p>Remote: -</p>
Y-AXIS REF-VALUE	<p>The Y-AXIS REF-VALUE softkey determines the reference value of the diagram at the reference position. The gridlines are arranged on the basis of this reference value. The unit selected using the PHASE RAD / PHASE DEG softkey applies (only for the phase diagram).</p> <p>Remote: DISP:WIND2:TRAC:Y:RVAL 20DEG</p>
Y-AXIS REF-POS	<p>The Y-AXIS REF-POS softkey is used to control the location of the reference position within the grid from 0% to 100%. The default value is 50%.</p> <p>Remote: DISP:WIND2:TRAC:Y:RPOS 50</p>
PHASE OFFSET	<p>The PHASE OFFSET softkey determines a constant phase value which is added to the overall phase trace. This allows a test point to be assigned to a desired phase value.</p>

The unit selected using the PHASE RAD / PHASE DEG softkey applies.

Remote: SENS:CORR:OFFS:PHAS 10DEG

PHASE RAD DEG The PHASE RAD / PHASE DEG softkey switches the unit of the phase trace between radians and degrees.

Remote: CALC:UNIT:ANGL RAD

PHASEWRAP ON OFF The PHASEWRAP ON / PHASEWRAP OFF softkey activates/deactivates the phase trace limitation to the value range between -180° and $+180^\circ$ / $-\pi$ to π .

Remote: CALC2:FORM PHAS
CALC2:FORM UPHAS

GRID ABS/REL LEVEL The GRID ABS/REL LEVEL softkey is deactivated if the baseband input is used.

2.5.10 Setting the bandwidths and sweep time – BW key

The BW key opens a menu in which the resolution bandwidth (RBW) and sweep time (SWT) which determine the measurement are set. The RBW can be coupled to the span (stop frequency minus start frequency, SPAN) or can be freely defined by the user. The automatic coupling is set by pressing the RES BW AUTO softkey. The coupling ratio is selected using the COUPLING RATIO softkey.

The RES BW MANUAL softkey activates direct entry of the RBW. There is then no coupling to the SPAN.

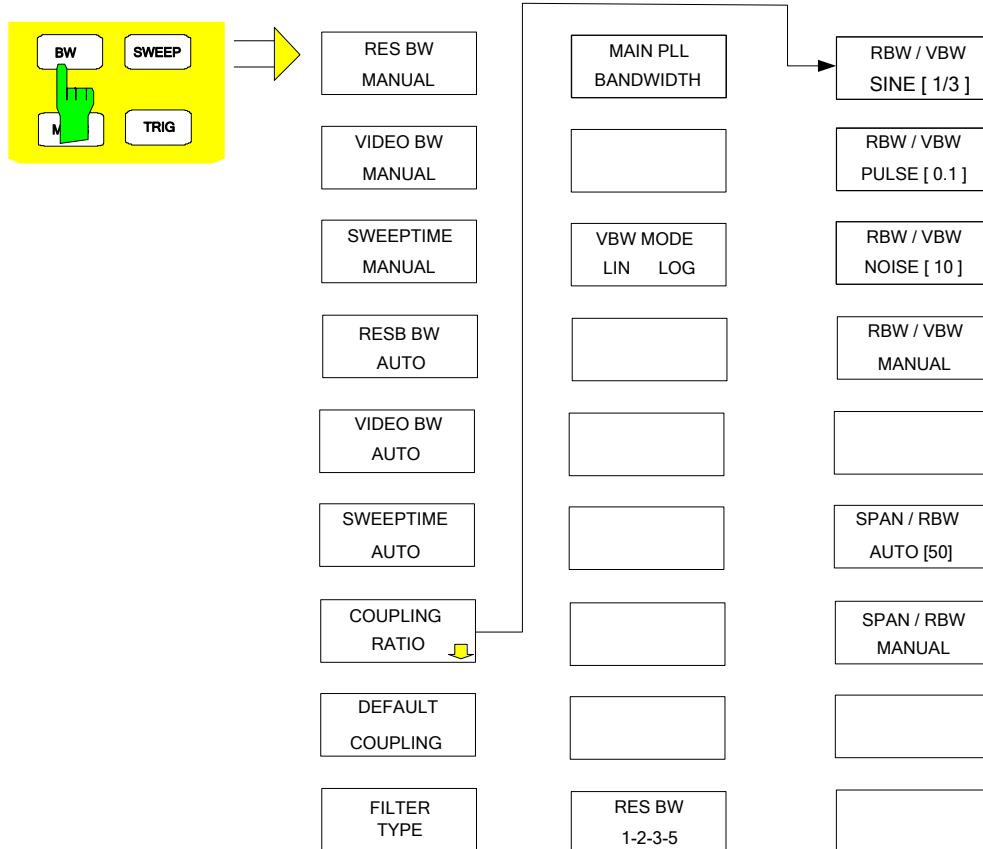
In the FFT Analyzer, digital filters are used as the resolution filters only in the Time Domain mode. In this mode, the FFT Analyzer therefore provides the same resolution bandwidths as in the Spectrum Analysis mode.

An FFT with preselectable windowing of the data is used in the Frequency Domain mode. The resolution bandwidths can be selected both in the usual steps and in fine intermediate steps (RES BW 1-2-3-5 softkey).

The FFT Analyzer does not support video filters (VBW). The averaging of consecutive traces can be used instead.



The FFT filters, which can be selected in the Spectrum Analysis mode using the FILTER TYPE softkey, should not be confused with the FFT Analyzer. This softkey is deactivated in the FFT Analyzer.



RES BW MANUAL

The RES BW MANUAL softkey activates manual entry of the resolution bandwidth.

The following applies in the Frequency Domain mode:

- The resolution bandwidth can be set in steps of 1, 2, 3, 5 and 10 or in steps of 0.1 Hz, depending on the setting of the RBW 1-2-3-5 softkey. The nominal values for the resolution bandwidths are the equivalent noise bandwidths of the resolution filters and NOT the 3 dB bandwidths.
- The largest possible RBW is always 20 MHz.
- For CAPTURE BOTH DOMAINS active and/or a span greater than 27.5 MHz, the smallest possible RBW is 25 Hz, or rounded up to 30 Hz.
- Otherwise the smallest attainable RBW is equal to 0.1 Hz times the relative ENBW of the set window function, depending on the position of RES BW 1-2-3-5, rounded up or not. For the relative ENBW, see **Fehler! Verweisquelle konnte nicht gefunden werden..**
- Also applicable, however, is a maximum ratio of the span to RBW, which cannot be exceeded. Ratios that are too extreme can be rejected by the firmware.

The following applies in the Time Domain mode:

- The resolution bandwidth can always be selected in steps of 1, 2, 3, 5 and 10 between 10 Hz and 20 MHz (s. Table 2-3). The nominal values for the resolution bandwidths are the 3 dB bandwidths which are familiar from the Spectrum Analysis mode.

If necessary, the RBW is rounded to the nearest possible value when the Frequency Domain mode is switched over to the Time Domain mode.

When bandwidths are entered manually, the value is always rounded to the nearest possible bandwidth; if bandwidths are entered using the rotary knob or the UP/DOWN keys, the value is scrolled up and down in steps.

A green asterisk (*) appears on the display field to indicate that the resolution bandwidth has been entered manually.

Remote: BAND 1MHz

**VIDEO BW
MANUAL** The VIDEO BW MANUAL softkey is deactivated in the FFT Analyzer mode. Use the TRACE AVERAGE function instead.

**SWEETIME
MANUAL** The SWEETIME MANUAL softkey activates manual entry of the sweep time. It is only available in the Time Domain mode.

In the Frequency Domain mode, the sweep time is preset by selecting the window function and frequency resolution. It is therefore not possible to change the sweep time.

In time domain mode (Span = 0 Hz), the sweep times (which may range from 1 μ s to max. 16000 s) can be selected in steps of max. 5% of the sweep time. When sweep times are entered manually, the FFT Analyzer always rounds to the nearest possible sweep time; if sweep times are entered using the rotary knob or the UP/DOWN keys, the FFT Analyzer scrolls the sweep time up and down in steps.

Refer also to Table 2-3 for the sweep times. In the FFT Analyzer, the maximum sweep time depends on the selected RESOLUTION BANDWIDTH and the CAPTURE BOTH DOMAINS function.

Remote: SWE:TIME 10ms

Table 2-3: Maximum sweep times for the Time Domain mode

Maximum SWEETIME for Time Domain	CAPTURE BOTH DOMAIN S = OFF	CAPTURE BOTH DOMAINS = ON
RBW = 10Hz	16000.0000 s	Not available
RBW = 20Hz	16000.0000 s	
RBW = 30Hz	16000.0000 s	
RBW = 50Hz	16000.0000 s	
RBW = 100Hz	8000.0000 s	
RBW = 200Hz	4000.0000 s	
RBW = 300Hz	2500.0000 s	
RBW = 500Hz	1600.0000 s	
RBW = 1KHz	800.0000 s	
RBW = 2KHz	400.0000 s	
RBW = 3KHz	250.0000 s	
RBW = 5KHz	160.0000 s	
RBW = 10KHz	80.0000 s	
RBW = 20KHz	40.0000 s	
RBW = 30KHz	25.0000 s	
RBW = 50KHz	16.0000 s	
RBW = 100KHz	8.6000 s	
RBW = 200KHz	4.5000 s	
RBW = 300KHz	2.8000 s	
RBW = 500KHz	1.6000 s	
RBW = 1MHz	0.8000 s	
RBW = 2MHz	0.6000 s	
RBW = 3MHz	0.6000 s	
RBW = 5MHz	0.4000 s	
RBW = 10MHz	0.4000 s	
RBW = 20MHz	0.4000 s	

NOTICE

Very large volumes of data will be recorded if the values for both RBW and SWEETIME are large. The trace will then be plotted block by block.

RES BW AUTO The RES BW AUTO softkey is only available in the frequency domain (Span > 0 Hz). The softkey is not visible in the time domain.

It couples the resolution bandwidth to the selected frequency span (SPAN). If the frequency span is changed, the resolution bandwidth is adjusted automatically.

Automatic coupling of the resolution bandwidth to the frequency span is always recommended if a resolution bandwidth setting is desired which is suitable for the measurement task and in proportion to the selected span.

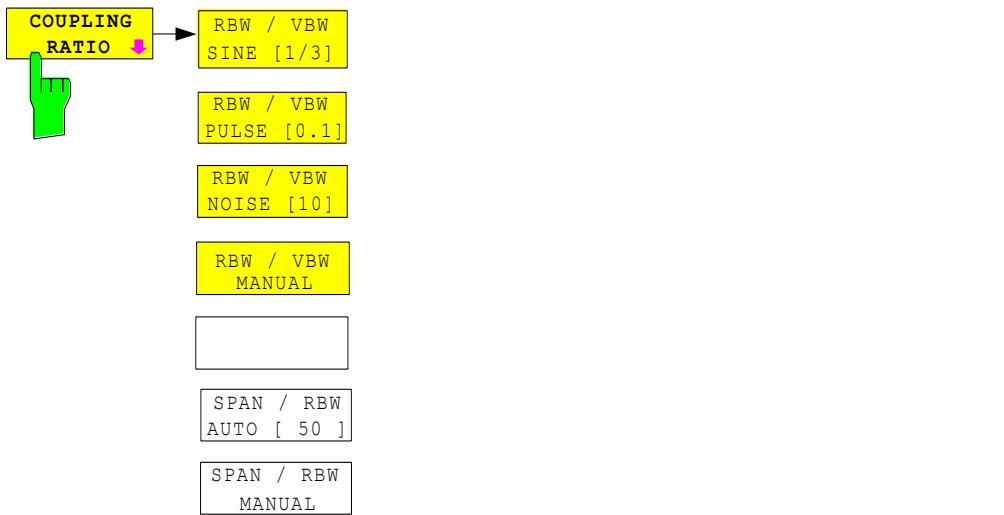
The coupling ratio is set in the COUPLING RATIO submenu.

Remote: BAND:AUTO ON

VIDEO BW The VIDEO BW AUTO softkey is not available in the FFT Analyzer mode because a video filter is not supported.

SWEEPTIME The SWEEPTIME AUTO softkey is only available in the frequency domain (SPAN > 0 Hz) and is always selected there because it is not possible to select the SWEEPTIME manually.

The softkey is not visible in the time domain because the SWEEPTIME can only be selected manually.



The COUPLING RATIO softkey opens a submenu in which the coupling ratio can be selected. In the FFT Analyzer this is only the ratio of SPAN and RBW.

In the default state, i.e. when the COUPLING RATIO softkey is not active (not highlighted), the ratio of span to resolution bandwidth (SPAN/RBW) is 50 (corresponds to SPAN / RBW AUTO [50]).

It is only possible to select one of the SPAN / RBW softkeys if RBW AUTO is selected.

RBW / VBW SINE [1/0] The RBW/VBW SINE softkey is deactivated in the FFT Analyzer mode.

RBW/VBW PULSE [...] The RBW/VBW PULSE softkey is deactivated in the FFT Analyzer mode.

RBW / VBW NOISE [10] The RBW/VBW NOISE softkey is deactivated in the FFT Analyzer mode.

RBW / VBW MANUAL The RBW/VBW MANUAL softkey is deactivated in the FFT Analyzer mode.

SPAN/RBW AUTO [50]	The SPAN/RBW AUTO softkey sets the following coupling ratio: Resolution bandwidth = Frequency span/50 This coupling ratio corresponds to the default setting. Remote: BAND:RAT 0.02 It is only possible to select this softkey if RBW AUTO is active.
SPAN / RBW MANUAL	The SPAN/RBW MANUAL softkey activates entry of the coupling ratio of frequency span and resolution bandwidth. The ratio of frequency span to resolution bandwidth can be set between 1 and 10000. Remote: BAND:RAT 0.1 It is only possible to select this softkey if RBW AUTO is active.
DEFAULT COUPLING	The DEFAULT COUPLING softkey sets all coupling functions to their default state (AUTO); in the FFT Analyzer this only applies to SPAN/RBW. In addition, the SPAN/RBW ratio in the COUPLING RATIO submenu is set to 50. Remote: BAND:AUTO ON
FILTER TYPE	The FILTER TYPE softkey is deactivated in the FFT Analyzer mode. Only filters which have a Gaussian characteristic and the selected 3 dB bandwidth are available for time domain measurements. An FFT with user-selectable window function is always used for frequency domain measurements. BW – NEXT menu: The MAIN PLL BANDWIDTH softkey is deactivated in the FFT Analyzer mode.
MAIN PLL BANDWIDTH	The MAIN PLL BANDWIDTH softkey is deactivated in the FFT Analyzer mode.
VBW MODE LIN LOG	The VBW MODE LIN/LOG softkey is deactivated in the FFT Analyzer mode because no video filter is supported.
RES BW 1-2-3-5	The RES BW 1-2-3-5 softkey is only available in the Frequency Domain mode. When activated, the RESOLUTION BANDWIDTH can only be changed in steps of 1, 2, 3, 5 and 10 (which is also always the case in the Time Domain mode). However, this softkey is also used to activate manual entry of freely selected bandwidths in the Frequency Domain mode. The values must then be entered by means of the RES BW MANUAL softkey, or are derived from the SPAN if the automatic coupling function is activated. If the values are in the permissible range, they are rounded to 0.1 Hz and accepted. If the system is switched back to the mode with the bandwidth steps or to the Time Domain mode, the RESOLUTION BANDWIDTH is rounded to the nearest permissible value. Remote: SENS:BWID:RESO:STEP:MODE LIN SENS:BAND:RESO:STEP:MODE L1235

2.5.11 Setting the sweep – SWEEP key

The SWEEP key is used to select the frequency sweep type.

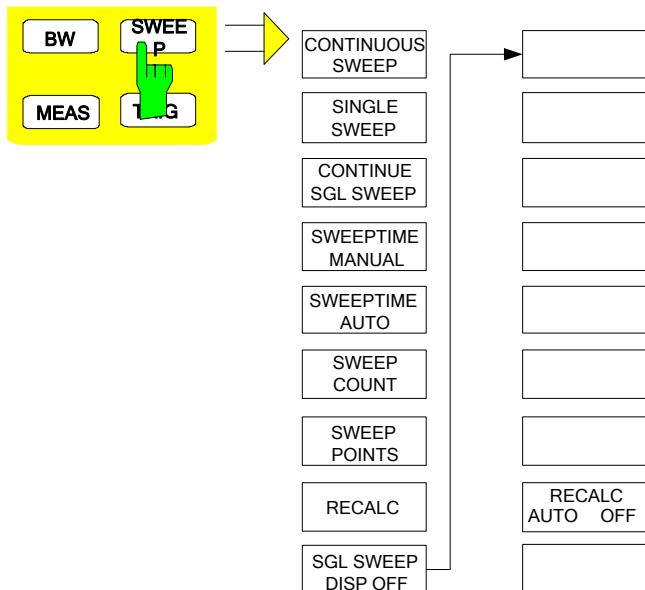


: The term "sweep" is used here (and also at other points in the description of the FFT Analyzer) although no "sweep" principle is performed in a frequency analysis. The term is based on the Spectrum Analysis mode of the R&S FSQ and the softkey labels used in this mode.

The sweep time used for the FFT is also shown at the top of the screen in the middle of the display (e.g. as "SWT = 10 ms"). This is, however, not the time required for a complete measurement process. If CAPTURE BOTH DOMAINS is active, data acquisition is initially performed for 0.16 seconds for a SINGLE SWEEP and then only a small proportion of the data is usually used for calculating the FFT. The overall measurement process is made up of the times for data acquisition, for filtering and decimation of the data, for calculation of the FFT and for displaying the results.

However, the displayed SWEEPTIME only indicates which time domain is covered by the input data of the FFT.

SWEEP menu



The SWEEP key opens a menu in which the frequency sweep (sweep mode) is configured.

The CONTINUOUS SWEEP, SINGLE SWEEP and SGL SWEEP DISP OFF softkeys are selection switches. Only one of these switches can be active at any one time.

Most of the softkeys do not need to be explained in this chapter because their functionality is identical to that in the Spectrum Analysis mode. Please refer to chapter 4 of the R&S FSQ operating manual.

The SWEEPTIME MANUAL and SWEEPTIME AUTO softkeys behave in a different way. The two softkeys are also in the menu which is opened by pressing the BW key.

Their function is explained in Chapter “Setting the bandwidths and sweep time – BW key”.

The two softkeys RECALC and RECALC AUTO / RECALC OFF are specially intended for the FFT Analyzer:

RECALC The RECALC softkey is deactivated and cannot be used if the CAPTURE BOTH DOMAINS measurement mode is not active.

The RECALC softkey can only be operated if the CAPTURE BOTH DOMAINS measurement mode is active, the FFT Analyzer is in the SINGLE SWEEP mode and measurement data has already been acquired.

The data stored in the memory (always sampled for 0.16 s at 81.6 MHz) is reanalyzed according to the current instrument settings each time the RECALC softkey is pressed. Data acquisition is not performed again. Any trigger settings, e.g. EXTERN or I/Q LEVEL, are ignored, i.e. reanalysis is performed immediately.

The instrument settings which can be adjusted are, for example:

Time Domain / Frequency Domain

measurement display mode (MAGNITUDE, VOLTAGE, etc.)

RBW, SPAN, WINDOWFCT, CENTER FREQUENCY, SWEETIME

type of detector

IQ PATH: I + jQ, I ONLY, Q ONLY

RECALC AUTO OFF The RECALC AUTO / RECALC OFF softkey is deactivated and cannot be used if the CAPTURE BOTH DOMAINS measurement mode is not active.

If the softkey is set to OFF, the RECALC softkey must be pressed each time recorded data is to be analyzed using modified measurement settings.

If, however, the softkey is set to AUTO, the firmware automatically triggers a RECALC whenever the adjustable parameters are changed manually.

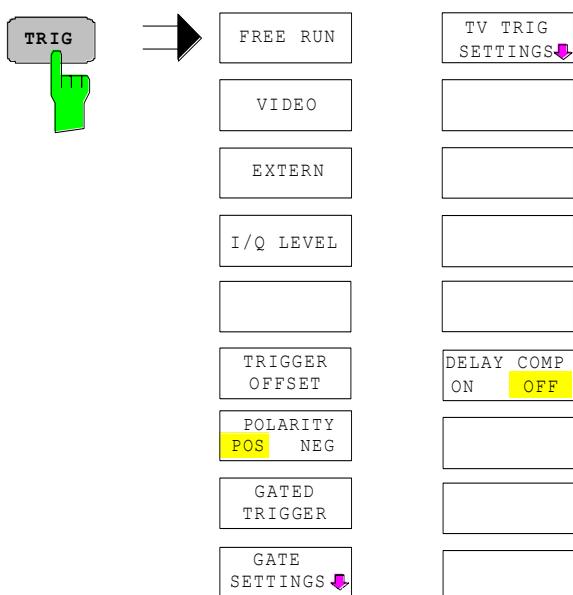
However, as soon as one of the critical parameters has been changed (see the description of the RECALC softkey), the automatic RECALC is not performed and, like the RECALC softkey, the RECALC AUTO / OFF softkey is also temporarily deactivated. Press the SINGLE SWEEP key to start a new data acquisition process.

2.5.12 Triggering the sweep – TRIG key

The TRIG key opens a menu for setting the various trigger sources and selecting the polarity of the trigger. The associated softkeys are highlighted to indicate that the trigger mode is active.

The enhancement label TRG is displayed on the screen to indicate that a trigger mode other than FREE RUN is set.

TRIGGER menu



FREE RUN

The FREE RUN softkey activates the free-running measurement, i.e. there is no explicit triggering of the start of measurements. When one measurement has been completed, another is started immediately.

FREE RUN is the default setting of the FFT Analyzer.

Remote: TRIG:SOUR IMM

VIDEO

The VIDEO softkey is deactivated in the FFT Analyzer mode.

EXTERN

The EXTERN softkey activates triggering by means of a TTL signal at the EXT TRIGGER/GATE input socket on the rear panel of the instrument. It has the same functionality as in the Spectrum Analysis mode.

Remote: TRIG:SOUR EXT

I/Q LEVEL

The I/Q LEVEL softkey activates triggering to the magnitude of the I/Q signal and determines the trigger threshold in volts. Sample acquisition starts when the value exceeds (positive polarity) or drops below (negative polarity) the selected threshold.

Here too, the IQ PATH setting is taken into account, which means the I or Q input may be ignored.

The following applies to the bandwidth within which the magnitude of the I/Q signal is measured:

With CAPTURE BOTH DOMAINS inactive:

Frequency domain measurement: the bandwidth is slightly smaller than the set span, but no more than about 19 MHz

Time domain measurement: the bandwidth is the set RBW

With CAPTURE BOTH DOMAINS active:

Frequency domain measurement: the bandwidth is always about 19 MHz

Time domain measurement: the bandwidth is the set RBW

Only in FFT Analyzer mode is the bandwidth symmetric around the set center frequency.

Remote: TRIG:LEV:IFP 0.7

TRIGGER OFFSET

The TRIGGER OFFSET softkey activates entry of a time offset between the trigger signal and the start of the sweep.

Triggering is delayed (entry > 0) or advanced (entry < 0) by the entered time relative to the trigger signal. The time can be entered in the value range –100 ms to 50 s (default: 0 s).

Remote: TRIG:HOLD 10US

POLARITY POS NEG

The POLARITY POS/NEG softkey determines the polarity of the trigger slope.

Measurement starts after a positive or a negative slope of the trigger signal. The selected setting is highlighted accordingly.

The setting applies to all trigger types except FREE RUN.

The default setting is POLARITY POS.

Remote: TRIG:SLOP POS

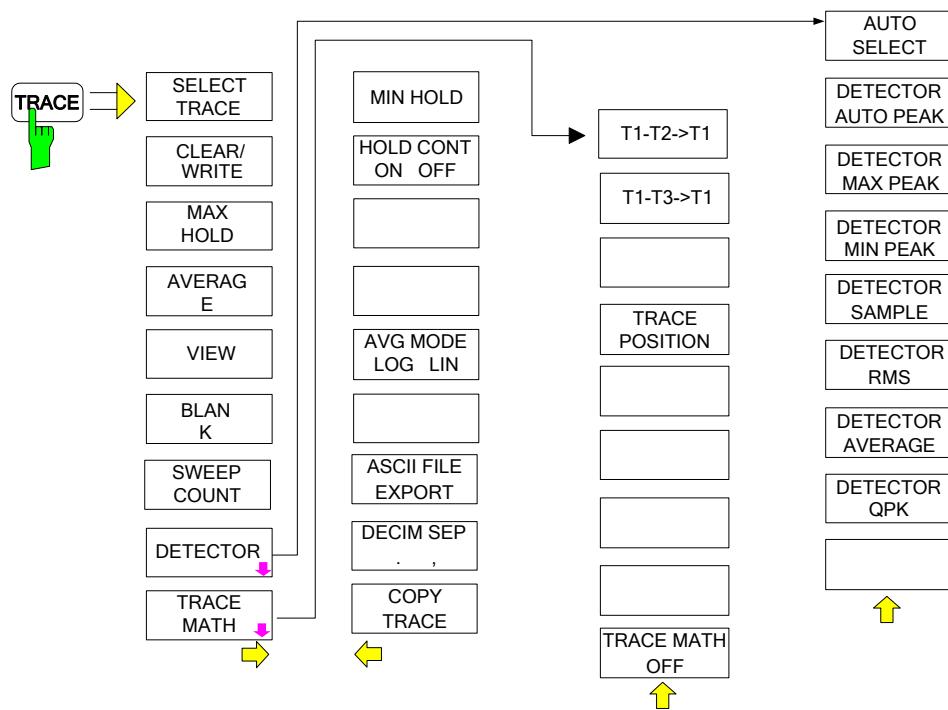
GATED TRIGGER GATE SETTINGS

The GATED TRIGGER softkey and the functions of the associated submenu and of the GATE SETTINGS softkey are not available in the FFT Analyzer mode.

DELAY COMP ON OFF

The DELAY COMP ON/OFF softkey is not available in the FFT Analyzer mode. Group delay compensation for the resolution filters with active external trigger is always active.

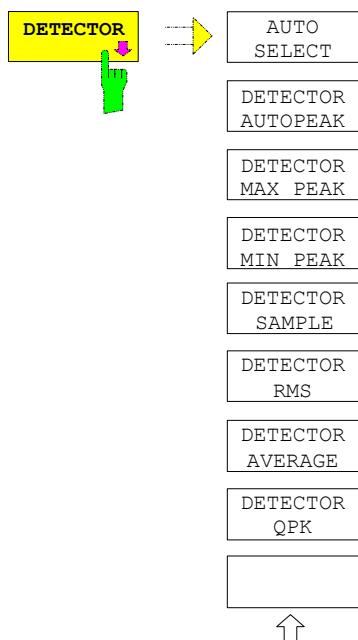
2.5.13 Selecting and setting the traces – TRACE key



Many of the softkeys in this menu do not need to be described in detail here because their functionality is identical to that in the Spectrum Analysis mode. Please refer to chapter 4 of the R&S FSQ operating manual.

Only those softkeys whose functions differ in the FFT Analyzer and Spectrum Analysis modes are described below:

- ASCII FILE EXPORT** The ASCII FILE EXPORT softkey saves the active trace to a disk in ASCII format.
 Remote: FORM ASC;
 MMEM:STOR:TRAC 1, 'TRACE.DAT'



The DETECTOR softkey opens a submenu for selecting the detector for the selected trace. The softkey is highlighted if the detector is not selected using AUTO SELECT.

The detector can be selected separately for each trace. The AUTO SELECT mode sets the appropriate detector for each trace display type (Clear Write, Max Hold or Min Hold).

With split-screen FFT Analyzer diagrams, the selected detector always applies to both diagrams.

The softkeys for the detectors are selection switches; only one of these switches can be active at any one time.

AUTO SELECT The AUTO SELECT softkey (= default setting) selects the most suitable detector according to the selected trace display type (Clear Write, Max Hold and Min Hold).

Display type	Detector
Clear/Write	Auto Peak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

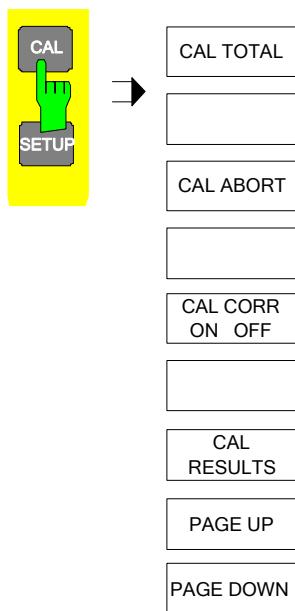
The detector which is active for the trace in question is identified in the respective trace display field by means of the following designations:

Detector	
Auto Peak	AP
Max Peak	PK
Min Peak	MI
Average	AV
RMS	RM
Sample	SA

Remote: DET:AUTO ON

DETECTOR AUTOPEAK	The DETECTOR AUTOPEAK softkey activates the autopeak detector. This is possible irrespective of the SWEEPPOINTS parameter. Remote: DET APE
DETECTOR MAX PEAK	The DETECTOR MAX PEAK softkey activates the maximum peak detector. It is recommended if pulse-like signals are to be measured. Remote: DET POS
DETECTOR MIN PEAK	The DETECTOR MIN PEAK softkey activates the minimum peak detector. The minimum peak detector makes weak sinewave signals clearly visible in noise. The pulse signals are suppressed in composite signals consisting of sinewave and pulse signals. Remote: DET NEG
DETECTOR SAMPLE	The DETECTOR SAMPLE softkey activates the sample detector. It is used if uncorrelated signals such as noise are to be measured. The power can be determined for weighting and for the log amplifier by means of fixed correction factors. Remote: DET SAMP
DETECTOR RMS	The DETECTOR RMS softkey activates the RMS detector. It is not available in the Frequency Domain mode in the FFT Analyzer. The RMS detector always supplies the signal power irrespective of the signal shape. To do so, the mean square of all sampled level values is formed during the sweep of a pixel. The sweep time thus determines the number of averaged values and with increasing sweep time better averaging is obtained. The RMS detector is therefore an alternative means of averaging over several sweeps (see TRACE AVERAGE). Remote: DET RMS
DETECTOR AVERAGE	The DETECTOR AVERAGE softkey activates the average detector. It is not available in the Frequency Domain mode. Unlike the RMS detector, the average detector supplies the linear average of all level values during the sweep of a pixel. Remote: DET AVER
DETECTOR QPK	The DETECTOR QPK softkey is not available in the FFT Analyzer mode.

2.5.14 Correction data acquisition – CAL key



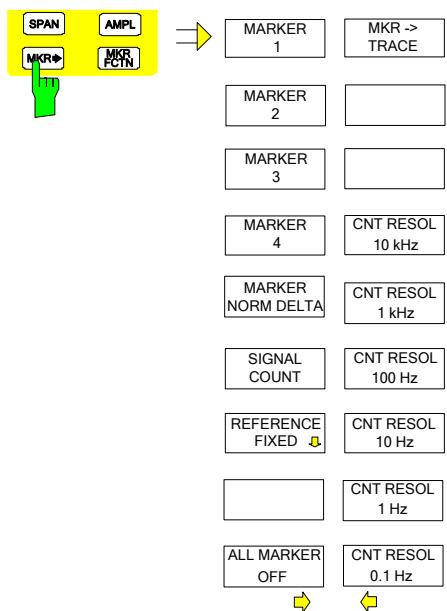
The CAL key opens a menu containing the available functions for the acquisition, display and activation of data used for system error correction.

The CAL TOTAL key starts correction data acquisition for the entire instrument. Correction data will also be calculated for the B71 module (if this module is installed in the instrument). This improves the accuracy of the FFT Analyzer. When correction data acquisition has been completed, press the PRESET FFT softkey, for example, and then the CAL CORR ON / OFF softkey to view the effects of the DC offset.

The softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the Spectrum Analysis mode. Please refer to chapter "Recording the Correction Data of R&S FSQ – CAL Key" of the R&S FSQ operating manual.

Technical details regarding correction data can also be found in Chapter "Error correction".

2.5.15 Markers and delta markers – MKR -> key



Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the Spectrum Analysis mode. Please refer to chapter “Change of Settings via Markers – MKR -> Key” of the R&S FSQ operating manual.

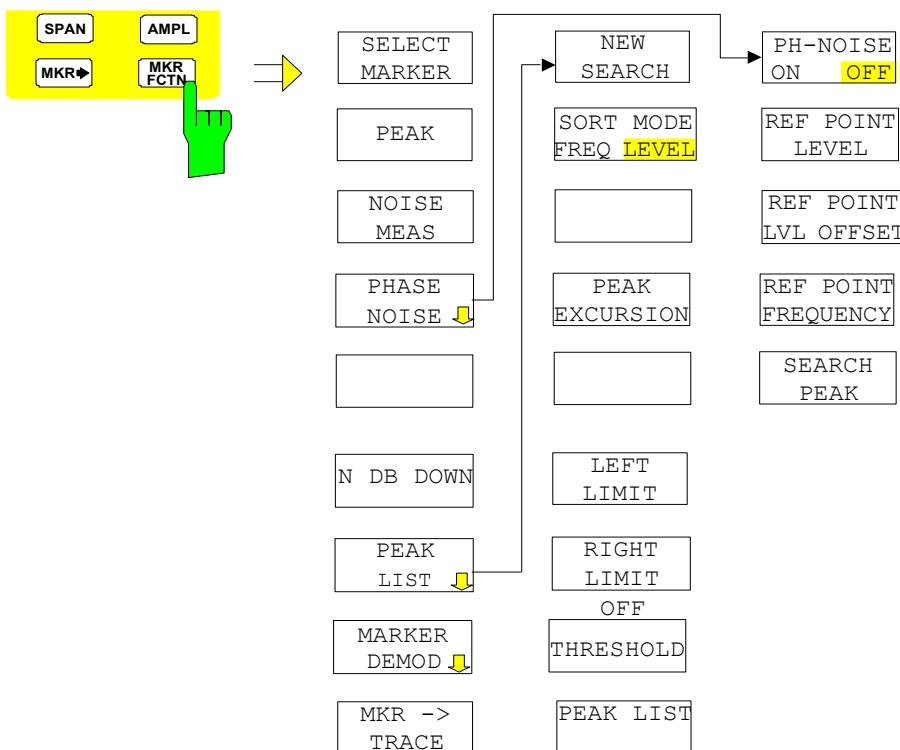
Only those softkeys whose functions differ in the FFT Analyzer and Spectrum Analysis modes are described below:

Special features are the new split-screen diagrams REAL IMAG, VOLTAGE and MAGNITUDE PHASE. On these diagrams, it is not possible to move markers separately on each trace; these markers are in fact marker pairs which are coupled to each other. The values of both markers are displayed, however.

SIGNAL COUNT The SIGNAL COUNT softkey is deactivated in the FFT Analyzer mode. The softkeys for setting the counter accuracy in the side menu are therefore also unnecessary and are deactivated.

REFERENCE FIXED The REFERENCE FIXED softkey is deactivated in the FFT Analyzer mode, except for Frequency Domain MAGNITUDE .

2.5.16 Marker functions – MKR FCTN key



Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the Spectrum Analysis mode. Please refer to chapter “Marker Functions – MKR FCTN Key” of the R&S FSQ operating manual.

Only those softkeys whose functions differ in the FFT Analyzer and Spectrum Analysis modes are described below:

Please note that, similar to other functions, negative frequencies (both as entries and as results) are also possible in the FFT Analyzer.

The following should be noted with regard to the NOISE MEAS and PHASE NOISE softkeys:

The measurements are also possible in the FFT Analyzer. However, various restrictions apply. For example:

- not all detectors are available
- no video filter is available
- no split screen is available

Special features are the new split-screen diagrams REAL IMAG, VOLTAGE and MAGNITUDE PHASE. On these diagrams, it is not possible to move markers separately on each trace; these markers are in fact marker pairs which are coupled to each other. The values of both markers are displayed, however.

In split-screen diagrams, the marker always operates (search for peak, etc.) in the diagram currently selected by the SCREEN A / SCREEN B hotkey; the other marker automatically moves in sync.

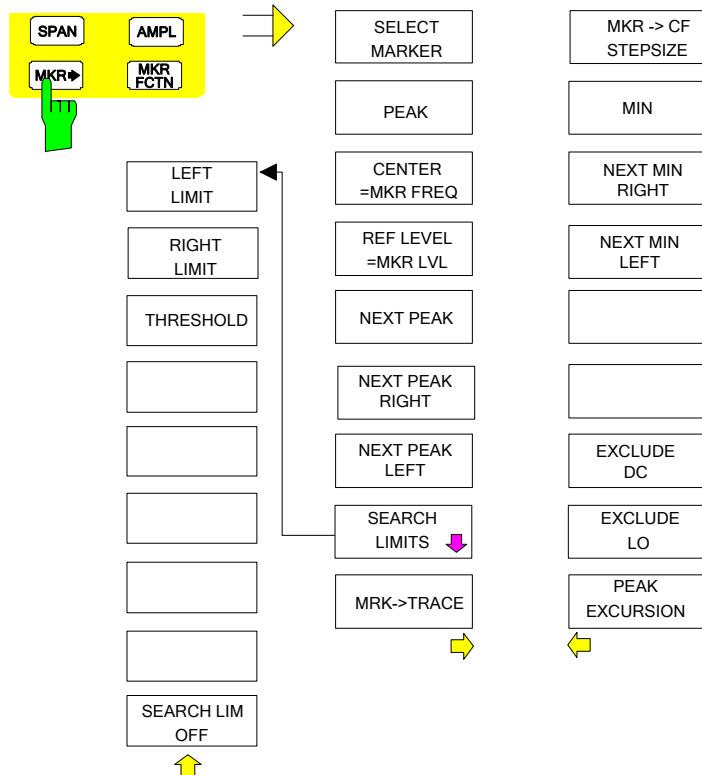
N dB DOWN The function is identical to that in the Spectrum Analysis mode. When the 3 dB bandwidths of the FFT-analyzer's resolution filters are measured in the Frequency Domain mode, the value that is returned is not exactly the same as the value that was set as the RESOLUTION BANDWIDTH. This is due to the fact that the equivalent noise bandwidths are entered as the RBW in the Frequency Domain mode in the FFT Analyzer. See also the explanations of the window functions in Chapter "Frequency Domain submenu of the FFT Analyzer".

The function is disabled in the following display modes:

- time domain – VOLTAGE
- frequency domain – REAL IMAG
- frequency Domain MAG PHASE

MARKER DEMOD The MARKER DEMOD softkey is deactivated in the FFT Analyzer mode. It is not possible to demodulate and monitor AM or FM signals.

2.5.17 Changing instrument settings with markers – MKR ⇒ key



Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the Spectrum Analysis mode. Please refer to (see chapter „Change of Settings via Markers – MKR -> Key“) of the R&S FSQ operating manual.

Only those softkeys whose functions differ in the FFT Analyzer and Spectrum Analysis modes are described below:

Please note that, similar to other functions, negative frequencies (both as entries – e.g. search limits – and as results) are also possible in the FFT Analyzer.

Functions which are available in the Spectrum Analysis mode only when SPAN is > 0, are also available only in Frequency Domain mode in the FFT Analyzer.

The restriction that applies to the PEAK softkey in the MKR FCTN menu also applies to all marker search functions (MIN, NEXT MIN RIGHT, NEXT MIN LEFT, NEXT PEAK RIGHT, NEXT PEAK LEFT, NEXT PEAK, PEAK):

With split-screen diagrams, you can use the SCREEN A / SCREEN B hotkey to select between the two diagrams.

REF LEVEL = MKR LVL

The REF LEVEL = MKR LVL softkey is deactivated in the FFT Analyzer mode.

Frequency Domain: MAGNITUDE or MAGNITUDE PHASE

Time Domain: MAGNITUDE.

EXCLUDE LO

The EXCLUDE LO softkey is deactivated in the FFT Analyzer mode. The EXCLUDE DC softkey performs a similar function.

EXCLUDE DC

In the FFT Analyzer, the EXCLUDE DC softkey performs the function of the EXCLUDE LO softkey. The function can only be activated in the Frequency Domain mode.

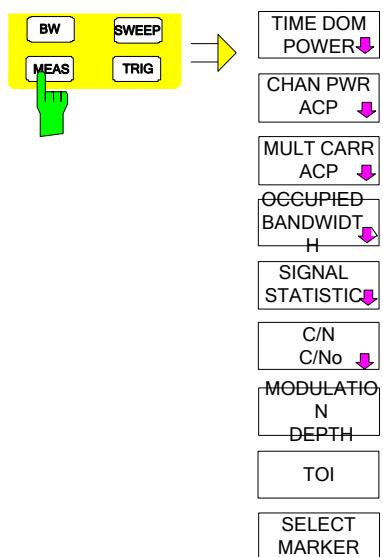
The following therefore applies if the function is active:

The frequency 0 Hz is excluded from the search to ensure that, e.g. with the peak function, the marker does not move to the DC component at 0 Hz in the case of span settings which include this frequency. The minimum frequency to which the marker moves is $\geq 2 \times$ resolution bandwidth (RBW). The largest negative frequency with a complex input signal is $-2 * \text{resolution bandwidth}$.

If the function is deactivated, the search is not restricted to a specific range. The frequency 0 Hz is included in the marker search functions.

Remote: CALC:MARK:LOEX ON

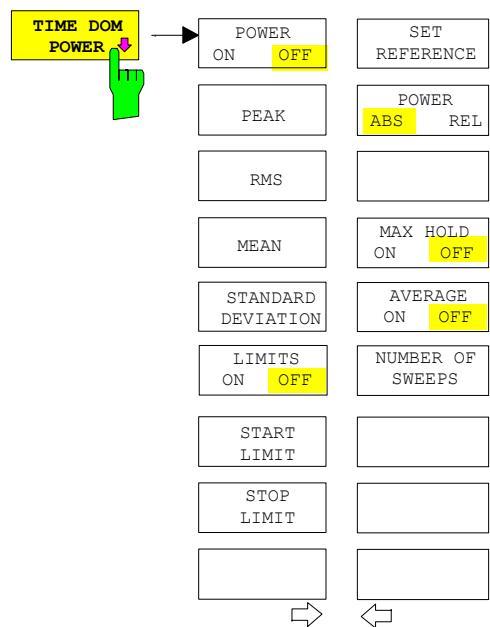
2.5.18 Power measurements – MEAS key



The following measurements are possible:

- power in the time domain (TIME DOM POWER)
- occupied bandwidth (OCCUPIED BANDWIDTH)
- signal/noise power (C/N, C/No)
- amplitude distribution (SIGNAL STATISTIC)
- modulation depth (MODULATION DEPTH)
- third-order intercept (TOI)

The above-mentioned measurements are performed alternately.



The TIME DOM POWER softkey activates measurement of the power in the time domain and opens the submenu for configuring the power measurement.

The submenu allows selection of the type of power measurement (rms or mean power), the settings for max hold and averaging as well as the definition of limits.

The range of the power measurement can be restricted by defining limits.

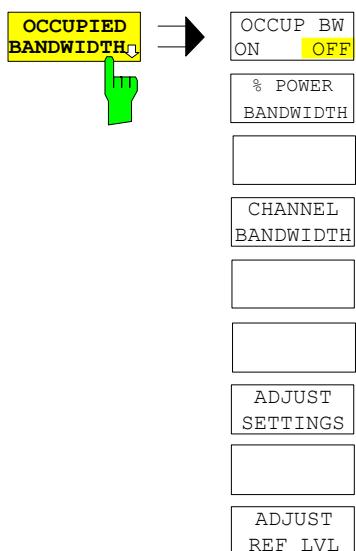


The measurement is only available in the MAGNITUDE measurement in the time domain (span = 0).

The FFT Analyzer does not provide any channel filters other than filters with Gaussian characteristic.

Please refer to chapter "Power Measurement in Time Domain" of the R&S FSQ operating manual for detailed explanations of the individual softkeys in the submenus.

CHAN PWR	The CHAN PWR ACP softkey and the functionalities of the associated submenu are not available in the FFT Analyzer mode.
MULT CARR	The MULT CARR ACP softkey and the functionalities of the associated submenu are not available in the FFT Analyzer mode.



The OCCUPIED BANDWIDTH softkey activates measurement of the occupied bandwidth on the basis of the current configuration and opens the submenu for configuring the measurement. The softkey is only available for the frequency domain (span > 0); it changes color when the measurement is activated.

In the spectrum display mode, the "Occupied Bandwidth" measurement determines the bandwidth that contains a predefined percentage of power of the displayed frequency range (% PoWeR BANDWIDTH softkey).

The FFT Analyzer does not provide all detectors or any video filter.

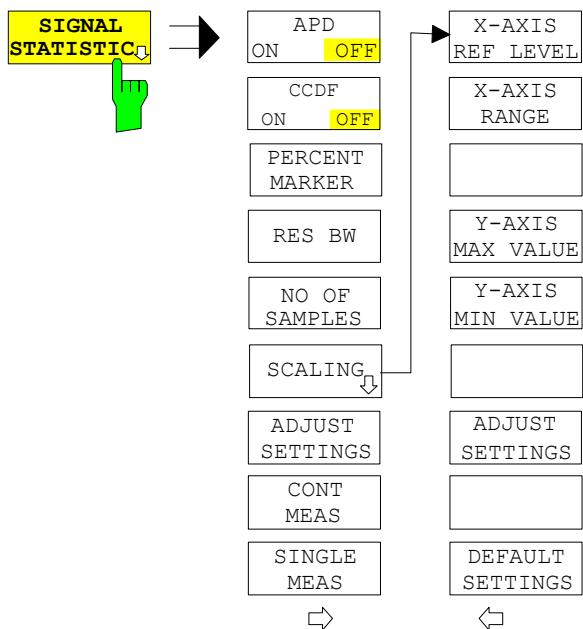
The occupied bandwidth is output on the marker display field and indicated in the trace by means of temporary markers.



The function is only available on a level trace in the frequency domain (span > 0). It is disabled in the REAL IMAG display mode.

The measurement is performed on the trace on which marker 1 is located. In order to analyze a different trace, marker 1 must be moved to a different trace using SELECT TRACE in the MKR menu.

Please refer to chapter „submenu MEAS OCCUPIED BANDWIDTH“ of the R&S FSQ operating manual for detailed explanations of the individual softkeys in the submenus.



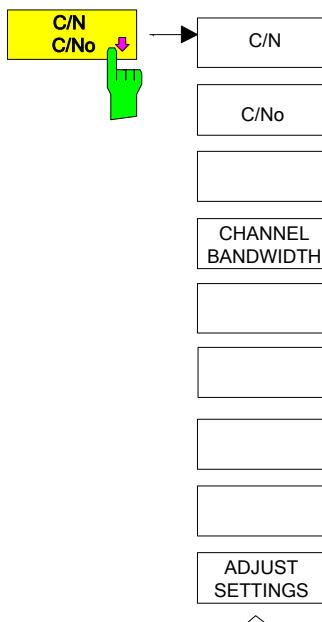
The SIGNAL STATISTIC softkey opens a submenu for measuring the amplitude distribution. The softkey is only available for the time domain.

Special features of this measurement:

- The I and the Q input are sampled. The settings I ONLY and Q ONLY are not allowed!
- The set center frequency is ignored. The center frequency is always 0 Hz for this measurement.
- The RBW can be set between 10 kHz and 60 MHz.
- Rectangular filters are used instead of filters with a Gaussian characteristic.

Measurement of either the amplitude probability distribution (APD) or the complementary distribution (CCDF) can be selected in this submenu. Only one of the amplitude distribution functions can be selected at any one time.

Please refer to Please refer to chapter „submenu MEAS SIGNAL STATISTIC“ of the R&S FSQ operating manual for detailed explanations of the individual softkeys in the submenus.



The C/N, C/No softkey opens the submenu for configuring measurement of the signal/noise ratio.

Measurement either without bandwidth reference (C/N) or with bandwidth reference (C/No) can then be selected in the submenu. It is also possible to select the bandwidth of the measurement channel and to adapt the frequency span (SPAN) accordingly.



The measurements are only available in the frequency domain (span > 0). The MAGNITUDE display mode must be active.

In the FFT Analyzer, the function is identical to that in the Spectrum Analysis mode.



Not all detectors are available; there is no video filter.

Please refer to chapter “Measurement of Carrier/Noise Ratio C/N and C/No” of the R&S FSQ operating manual for detailed explanations of the individual softkeys in the submenus.

The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carrier might be too low if the flattop window function is not selected.

```

Remote: CALC:MARK:FUNC:POW:SEL CN
        CALC:MARK:FUNC:POWEr:RES? CN
        CALC:MARK:FUNC:POWEr:SE CN0
        CALC:MARK:FUNC:POWEr:RES? CN0
        CALC:MARK:FUNC:POWEr OFF
  
```

MODULATION DEPTH The MODULATION DEPTH softkey activates measurement of the AM modulation depth. An AM carrier is required on the screen for this function to operate correctly.

Note:

The measurements are only available in the frequency domain (span > 0). The MAGNITUDE or MAGNITUDE PHASE display mode must be active.

In the FFT Analyzer, the function is identical to that in the Spectrum Analysis mode. Please refer to chapter "Measurement of Carrier/Noise Ratio C/N and C/N0" of the R&S FSQ operating manual.

The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carriers might be too low if the flattop window function is not selected.

Remote: CALC:MARK:FUNC:MDEP ON | OFF
CALC:MARK:FUNC:MDEP?RESULT?

TOI The TOI softkey is used to trigger measurement of the third-order intercept.

The measurements are only available in the frequency domain (span > 0). The MAGNITUDE or MAGNITUDE PHASE display mode must be active.

In the FFT Analyzer, the function is identical to that in the Spectrum Analysis mode. Please refer to (s. chapter "Measurement of Carrier/Noise Ratio C/N and C/N0").

The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carriers might be too low if the flattop window function is not selected.

Remote: CALC:MARK:FUNC:TOI ON;
CALC:MARK:FUNC:TOI:RES?

2.5.19 Setting limit lines and display lines – LINES key

The function of the limit lines and display lines is identical to that in the Spectrum Analysis mode. Please refer to chapter „Setting limit lines and display lines – LINES key“ for a detailed description of each softkey.

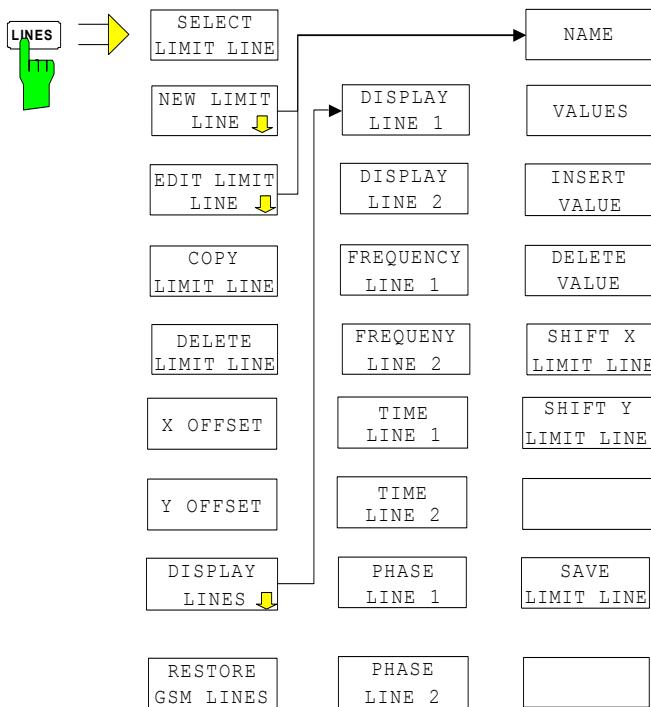
Special features of the FFT Analyzer are:

Limit lines are not available for the REAL IMAG frequency domain measurement or the VOLTAGE time domain measurement. With the MAGNITUDE PHASE frequency domain measurement, limit lines can only be applied to the magnitude.

The state and position of the lines are stored separately for the Time Domain and Frequency Domain modes. This means that the previous lines are restored when the mode is changed.

As in the Spectrum Analysis mode, the display lines are not always available:

- frequency lines only available in frequency domain
- time lines only available in time domain
- phase lines only available for measurements with phase display



New softkeys are:

PHASE LINE 1 The PHASE LINE 1/2 softkeys activate/deactivate phase lines 1/2 and activate entry of the line position.

PHASE LINE 2 The phase lines mark the selected phases in the measurement window.

Entries are made in the currently selected phase unit.

The line is adapted automatically if the unit is changed using the PHASE RAD/DEG softkey in the AMPT menu.

The line will, however, not be adapted automatically if the phase offset is changed using the PHASE OFFSET softkey in the AMPT menu.

Note:

The softkeys are only available in the frequency domain for the MAGNITUDE PHASE measurement.

Remote: CALC:PLIN1:STAT ON
 CALC:PLIN1 120DEG
 CALC:PLIN2:STAT ON
 CALC:PLIN2 140deg

2.5.20 Configuring the screen display – DISP key

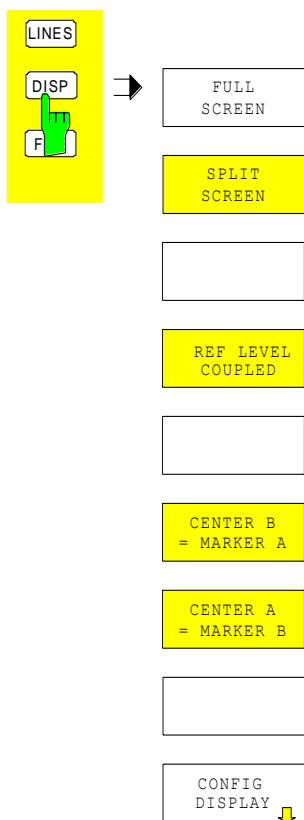
The DISPLAY menu is used both to configure the diagram display on the screen and to select the desired display elements and colors.

In the FFT Analyzer, two measurement windows are not designed to be completely decoupled from each other, i.e. they are not intended to behave like two completely independent instruments (SPLIT SCREEN operation).

Although there are measurements with a split screen, they draw their data from the same measurement.

For this reason, all softkeys which are required for SPLIT SCREEN are disabled.

The submenu of the CONFIG DISPLAY softkey behaves in the same way as in the Spectrum Analysis mode. Please refer chapter “Setting limit lines and display lines – LINES key“ for details.



2.6 Digital Down Converter for low carrier frequency using Baseband Inputs

The R&S FSQ-B71 Option (baseband input) is capable of mixing signals from low carrier frequencies (e.g. low IF signals) towards baseband. The allowed center frequency range is -35 MHz to +35 MHz. Both real-valued and complex-valued signals are supported.

The baseband signal is sampled, mixed from desired center frequency towards baseband and resampled towards the desired sample rate (cf. R&S FSQ-B71 functional description).

2.6.1 Limitation of center frequency range depending on signal bandwidth:

Center frequency and sample rate are adjustable independently, though there are some restrictions to take care of:

The lower limit of the center frequency depends on the sideband suppression that is needed for a particular measurement application. To avoid overlap of the two sidebands of a real-valued signal, the theoretical lower limit of the intermediate frequency is **half the signal bandwidth**.

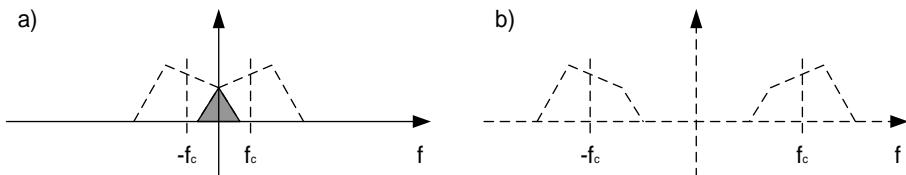


Figure 2-15: Dependency between signal bandwidth and carrier frequency

The carrier frequency f_c in Fig. Figure 2-15 a) is lower than half the signal bandwidth, resulting in sideband overlap. The carrier frequency f_c in Fig. 1 - b) is high enough to separate the two sidebands.

In practice, the intermediate frequency must be increased for lower sideband crosstalk (limited filter edge steepness). All spectral components of the opposite sideband must be above the decimation filter stop band frequency. Thus, the center frequency must be higher than **0.5 x (stop band frequency + 0.5 x signal bandwidth)**. The stop band frequency depends on the desired output sample rate and is specified in the following table:

Sampling rate from	Sampling rate to	Decimation filter stop band frequency
81.6 MHz	>40.8 MHz	0.53 sample rate
40.8 MHz	>20.4 MHz	0.42 sample rate
20.4 MHz	>10.2 MHz	0.53 sample rate
10.2 MHz	>5.1 MHz	0.53 sample rate
5.1 MHz	>2.55 MHz	0.53 sample rate
2.55 MHz	>1.275 MHz	0.53 sample rate
1.275 MHz	>0.6375 MHz	0.53 sample rate
0.6375 MHz	>318.75 kHz	0.53 sample rate
318.75 kHz	>159.375 kHz	0.53 sample rate
159.375 kHz	>79.6875 kHz	0.53 sample rate
79.6875 kHz	>39.84375 kHz	0.53 sample rate
39.84375 kHz	>19.921875 kHz	0.53 sample rate
19.921875 kHz	10 kHz	0.53 sample rate

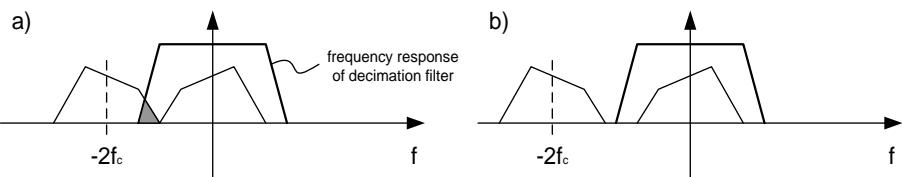


Figure 2-16: Unwanted part of the opposite sideband real valued signals

In the signal shown in Figure 2-16 a) an unwanted part of the opposite sideband remains after decimation filtering, while Figure 2-16- b) depicts a decimation filtered signal free from sideband crosstalk.

The upper limit of the carrier frequency is specified by the available baseband input bandwidth. The entire signal spectrum must fit into the baseband input bandwidth, so the carrier frequency may not exceed

$$\pm 0.5 \times (\text{baseband input bandwidth} - \text{signal bandwidth})$$

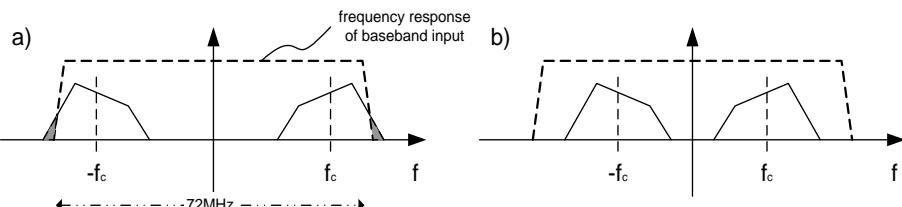


Figure 2-17: Signal bandwidth exceeds baseband input bandwidth of option FSQ-B71.

In Figure 2-17- a) the signal spectrum is cut, because it exceeds the baseband input bandwidth of Figure 2-17- b) shows a signal fitting entirely into the baseband input bandwidth.

2.6.2 Signal bandwidth limitation for real-valued input signals

A theoretical upper bandwidth limit for an input signal on the lowest possible intermediate frequency
(= 0.5 x signal bandwidth) is given by **the half of the baseband input bandwidth**

3 Using the I/Q baseband input in the options



This chapter does NOT refer to the FFT Analyzer.

The baseband input is also available in the options FS-K5, FS-K7, FS-K8, FS-K70, FS-K72, FS-K73, FS-K76, FS-K77, FS-K82, FS-K83 and FS-K84. The following section describes those softkeys used to control the baseband input which are identical in all of the named options, as well as any other characteristics which are common to all options. Baseband functions of options not listed here can be found in the respective manual.

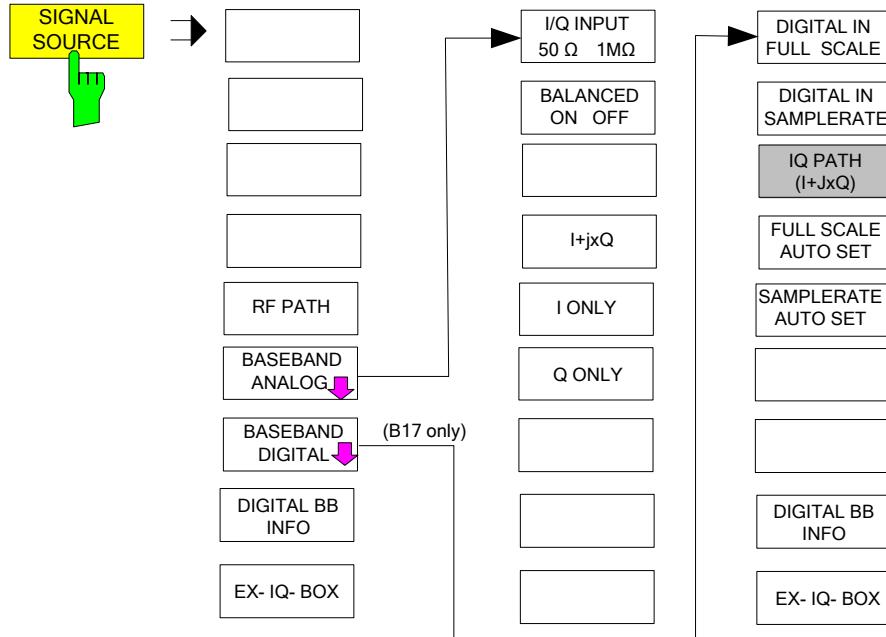
This chapter does NOT refer to the FFT Analyzer. The FFT Analyzer is dealt with in chapter “Using the I/Q baseband input in the FFT Analyzer”.

The individual application measurements that can be performed with the baseband input are described separately for each application.

The applications themselves are described in the respective manuals.

3.1 Switching on and configuring the I/Q baseband input

The *SIGNAL SOURCE* softkey in the *SETUP* menu opens the menu for switching on and configuring the baseband inputs.





Both the I and Q path are always taken into consideration in the options. The possibility of ignoring a path is only available in the FFT Analyzer (IQ PATH softkey).

RF PATH The softkey RF PATH selects the RF Input Path of the analyzer. This softkey is not available for the FFT analyzer mode.

Remote: INP:SEL RF

BASEBAND ANALOG The BASEBAND ANALOG softkey switches on the baseband input. The default setting is *baseband input OFF*.

Remote: INP:SEL AIQ

I/Q INPUT 50 Ω - 1 MΩ The I/Q INPUT 50Ω - 1MΩ softkey toggles the input impedance of the baseband inputs.

The default setting is 50 Ω.

Remote: INP:IQ:IMP LOW | HIGH

BALANCED ON OFF The BALANCED ON - OFF softkey switches the inputs to balanced (BALANCED ON) or referenced to ground (BALANCED OFF).

The default setting is ON.

Remote: INP:IQ:BAL ON | OFF

I+JxQ The I+JxQ softkey causes the FFT Analyzer to regard the signals at the I and Q input as components of a complex signal. This is the standard setting for the analysis of signals with complex modulation.

Remote: INP:IQ:TYPE IJQ

I ONLY The I ONLY softkey causes the FFT Analyzer to regard the signal at the I input as a single, real signal. The signal at the Q input is ignored.

This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the I input.

Remote: INP:IQ:TYPE I

Q ONLY The Q ONLY softkey causes the FFT Analyzer to regard the signal at the Q input as a single, real signal. The signal at the I input is ignored.

This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the Q input.

Remote: INP:IQ:TYPE Q

LOWPASS 36MHZ The LOWPASS 36MHZ ON / LOWPASS 36MHZ OFF softkey is used to toggle the analog anti-aliasing lowpass filters of the baseband inputs. The setting has the same effect on both inputs. See also page 14.

Remote: SENS:IQ:LPAS:STAT ON

DITHER ON OFF	The DITHER ON / DITHER OFF softkey is used to add a shaped dither signal to both inputs. See page 15 in cases where this is advisable. Remote: SENS:IQ:DITH:STAT ON
BASEBAND DIGITAL	The softkey BASEBAND DIGITAL opens a menu to configure the digital baseband input. This menu is described in chapter 2.5.6 The default setting is baseband input OFF. The baseband input is switched off when its application is closed. Remote: INP:SEL AIQ DIQ RF
DIGITAL BB INFO	The softkey DIGITAL BB INFO opens a window to display the status information of the connected digital baseband device (input or output).
EX IQ BOX	The softkey opens a dialog to configure an R&S EX-IQ-Box connected to the digital baseband Input or Output. If the baseband input is active, the enhancement label B50 (input impedance 50 Ω) or B1M (input impedance 1 MΩ) is displayed at the right of the diagram. The lowpass filter of the baseband input cannot be switched off and dithering cannot be switched on within the applications. When the baseband input is active, it is also not possible to make the following settings in the named options (unlike in the <i>FFT Analyzer</i> mode):
	<ul style="list-style-type: none"> • center frequency (irrelevant) • RF attenuation (automatically derived from reference level) • resolution and video bandwidth (irrelevant) <p>When setting the I/Q baseband input, note the following for softkeys REF LEVEL and REF LEVEL OFFSET. These softkeys are located in the AMPT menu.</p>
REF LEVEL	In the baseband, the reference level is entered in volt peak. The level in the diagram label is specified in dBm, however, since the limit values in the mobile radio standards are also specified in dBm. 1 volt peak corresponds to 10 dBm. The following values are permissible:
	0.0316 V 0.0562 V 0.1 V 0.178 V 0.316 V 0.562 V 1 V 1.78 V 3.16 V only with IMPEDANCE LOW (50 Ω) 5.62 V only with IMPEDANCE LOW (50 Ω)
	Remote: SENS:VOLT:IQ:RANGE

- REF LEVEL** By entering an adequate reference level offset (to compensate for the output amplifier of a base station or mobile phone not available in the measurement path), the values can be shifted to the appropriate range.
OFFSET The y-axis scaling is changed accordingly.
The setting range is ± 200 dB in 0.1 dB steps.

Remote: DISP:WIND:TRAC:RLEV:OFFS -10dB

3.2 Application FS-K5

When the baseband input is active, the following measurements can be performed with application FS-K5 (GSM and EDGE):

PHASE/FREQ ERROR (GSM)
MODULATION ACCURACY (EDGE)
POWER VS TIME
and
AUTO LEVEL&TIME

The following measurements are disabled:

CARRIER POWER
MODULATION SPECTRUM
TRANSIENT SPECTRUM
SPURIOUS

3.3 Application FS-K7

When the baseband is active, all measurements can be performed with application FS-K7 (FM demodulator).

3.4 Application FS-K8

When the baseband input is active, the following measurements can be performed with application FS-K8 (Bluetooth):

OUTPUT POWER
MODULATION CHAR
INIT CARR FREQ TOL
CARR FREQ DRIFT

The following measurements are disabled:

TX SPEC ACP

3.5 Application FS-K70

When the baseband is active, all measurements can be performed with application FS-K70 (vector signal analysis).

3.6 Applications FS-K72 and FS-K73

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K72/K74 (3G FDD BS) and FS-K73 (3G FDD MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
STATISTICS

3.7 Applications FS-K76 and FS-K77

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K76 (TD-SCDMA BTS) and FS-K77 (TD-SCDMA MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
POWER VS TIME
STATISTICS

3.8 Applications FS-K82 and FS-K83

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K82 (CDMA 2k BS) and FS-K83 (CDMA 2k MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
SIGNAL STATISTIC

3.9 Applications FS-K84 and FS-K85

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K84 (1xEVDO BS) and FS-K85.

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
SIGNAL STATISTIC

4 Remote control commands

For remote control, the FFT Analyzer mode mainly uses the commands of the Spectrum Analyzer mode (frequency and time domain). For limitations on the availability of commands, see section "[Manual Operation](#)". All specific expansions of the IQ Baseband FSQ-B71 option are described in the following section.

4.1 Option identification

***OPT?**

OPTION IDENTIFICATION QUERY queries the options contained in the instrument and returns a list of installed options. The individual options are separated by commas.

Position	Option	
1		Reserved
2	B4	OCXO
3		Reserved
4	B6	TV and RF Trigger Reserved
5		FSE: Vector analysis Reserved
6		Reserved
7	B9	Tracking Generator 3.6 GHz / can be I/Q-modulated
8		Reserved
9		Reserved
10	B12	Tracking Generator Attenuator 0 to 70 dB
11 to 13		Reserved
14		Reserved
15 to 18		Reserved
19	B21	Ext. Mixer Reserved
20 to 22		Reserved
23	B25	Electronic Attenuator
24 to 46		Reserved
47	FSQ-B71	Baseband Input

4.2 CALCulate subsystem

4.2.1 CALCulate:FORMAT subsystem

The CALCulate:FORMAT subsystem determines the postprocessing and conversion of measured data. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

CALCulate<1|2>:FORMAT

This command defines the display of traces.

Parameters

MAGNitude Display of magnitude.

This parameter is available in both the frequency and time domains.

RIMag Display of real and imaginary component of spectrum.

This parameter is available only in the frequency domain.

MPHase Display of magnitude and phase of spectrum.

This parameter is available only in the frequency domain.

VOLTage Display of voltage.

This parameter is available only in the time domain.

PHASE Display of phase with limitation to ± 180 deg or $. \pm \pi$ (PHASE WRAP).

This parameter is available only in the phase diagram.

UPHASE Display of phase without limitation to ± 180 deg or $. \pm \pi$ (PHASE UNWRAP). This parameter is available only in the phase diagram.

Example

CALC:FORM MPH

Display of magnitude/phase diagram

Characteristics

*RST value: MAGNitude

SCPI: conforms to standard

The availability of the parameters depends on the FREQUENCY DOMAIN/TIME DOMAIN setting

4.2.2 CALCulate:MARKer subsystem

The CALCulate:MARKer subsystem controls the marker functions in the instrument. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

CALCulate<1|2>:MARKer<1...4>:LOExclude

This command switches the suppression of the DC component on or off during maximum search. This function is available only in the FFT Analyzer mode in the frequency domain display.

This setting is valid for all markers and delta markers in all measurement windows

Parameters

ON | OFF

Example

```
CALC:MARK:LOEX OFF
```

Characteristics

*RST value: ON

SCPI: device-specific

The numeric suffix under CALCulate<1 | 2> and the numeric suffix under MARKer<1 . . . 4> are irrelevant.

4.2.3 CALCulate:PLINe subsystem

The CALCulate:PLINe subsystem controls the display lines in the phase diagram in the FFT Analyzer mode. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

CALCulate<1|2>:PLINe<1|2>

This command defines the position of the display lines in the phase diagram (phase line).

The lines mark the specified phases in the measurement window. Phase lines are available only in the frequency domain of the magnitude/phase display when the FFT Analyzer mode is active.

Parameters

-36000 to 36000s

Example

```
CALC2:PLIN2 10ms
```

Characteristics

*RST value: - (STATe to OFF)

SCPI: device-specific

CALCulate<1|2>:PLINe<1|2>:STATe

This command switches the display lines in the phase diagram on or off. Phase lines are available only in the frequency domain of the magnitude/phase display when the FFT Analyzer mode is active.

Parameters

ON | OFF

Example

```
CALC2:PLIN2:STAT ON
```

Characteristics

*RST value: OFF

SCPI: device-specific

4.2.4 CALCULATE:UNIT subsystem

The CALCULATE:UNIT subsystem defines the units of the phase in the FFT Analyzer mode.

CALCulate<1|2>: UNIT:ANGLE

This command selects the unit of the phase in the magnitude/phase diagram.

Parameters

DEG | RAD

Example

```
CALC2:UNIT:ANGL RAD
```

Characteristics

*RST value: DEG

SCPI: device-specific

4.3 DIAGnostic subsystem

The DIAGnostic subsystem contains the commands that support instrument diagnostics for service, maintenance and repair. According to the SCPI standard, these commands are all device-specific.

DIAGnostic<1|2>:SERVice:IQ:CALibration:DESTination

The calibration signals (DC Cal signal and Pulse Cal signal) can be switched to only one input at a time. This command switches the calibration signal to the I or Q path.

HIGH selects the positive and LOW the negative input. The negative input is through-connected only in the Balanced setting. The calibration signals are always positive. An inverted signal therefore appears in the output data when a signal is being fed to the negative input (LOW).

The DC Cal signal voltage is set using the command diag:serv:iq:cal:dc, and the frequency of the Pulse Cal signal is set using the command diag:serv:iq:cal:puls:prat.

Parameters

- IHIGH Feed calibration signal to positive I path.
- ILOW Feed calibration signal to negative I path.
- QHIGH Feed calibration signal to positive Q path.
- QLOW Feed calibration signal to negative Q path

Example

```
DIAG:SERV:IQ:CAL:DEST QHIG
```

Characteristics

*RST value: IHIGH

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:CALibration:DC

This command selects the voltage for the DC Cal signal in volts.

Parameters

- 0 | 0.1 | 0.178 | 0.316 | 0.562 | 1.0

Example

```
DIAG:SERV:IQ:CAL:DC 0.316
```

Characteristics

*RST value: 0

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:CALibration:PULSe:PRATe

This command sets the frequency of the Pulse Cal signal.

Parameters

10 kHz | 62.5 kHz | 80 kHz | 100 kHz | 102.4 kHz | 200 kHz | 500 kHz | 1 MHz | 2 MHz
| 4 MHz

Example

```
DIAG:SERV:IQ:CAL:PULS:PRAT 80KHZ
```

Characteristics

*RST value: 62.5 kHz

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:INPut

This command selects the baseband signal source.

Parameters

IQ	The female I and Q connectors of the FSQ are the baseband signal sources.
GND	The baseband inputs are internally connected to ground.
CALDc	The baseband signal source is the DC Cal signal. The voltage of this signal can be set with diag:serv:iq:cal:dc.
CALPulse	The baseband signal source is the Pulse Cal signal. The frequency of this signal can be set with diag:serv:iq:prat.

Example

```
DIAG:SERV:IQ:INP CALD
```

Characteristics

*RST value: IQ

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.4 DISPlay subsystem

The DISPlay subsystem controls the scaling of measurement data on the screen.

The measurement window is selected via WINDow1 (SCREEN A) or WINDow2 (SCREEN B).

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:AUTO

This command adapts the diagram limits to the current measurement results. The value range depends on the selected display.

Parameters

ONCE

Example

```
DISP:WIND2:TRAC:Y:SCAL:AUTO ONCE
```

Characteristics

*RST value: -

SCPI: device-specific

This command is an event, so it has neither an *RST value nor a query.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision

This command defines the scaling of the y-axis.

Parameters

<numeric_value>

Example

```
DISP:WIND2:TRAC:Y:PDIV 20deg
```

'Sets the scaling of the y-axis to 20 deg/ DIV

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffix under TRACe <1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel

This command defines the reference level or the measurement range of the baseband input.

If the reference level offset is <> 0, the specified value range of the reference level is changed by the offset.

I/Q data acquisition (TRAC:IQ:STAT ON):

RF input: The limits, units and dependencies specified in the FSQ manual apply.

The unit and value range depends on the setting made with CALCulate:UNIT.

Baseband input: Use the command SENS:VOLT:IQ:RANG:UPP to set the gain.

FFT Analyzer:

In the FFT Analyzer mode, volt peak is generally used as the unit. The setting can also be made with SENS:VOLT:IQ:RANG:UPP in this case. The value range of the baseband input depends on the input impedance. The measurement range is defined as the measurable peak voltage (positive and negative).

Input impedance	Value range / Volt (5 dB steps)
Low (50 Ω)	0.0316; 0.0562; 0.1; 0.178; 0.316; 0.562; 1; 1.78; 3.16; 5.62
High (1 MΩ or 1KΩ)	0.0316; 0.0562; 0.1; 0.178; 0.316; 0.562; 1; 1.78

Parameters

-130 dBm to 30 dBm

Example

```
INST:SEL FANAL
'FFT Analyzer mode
DISP:WIND1:TRAC:Y:RLEV 0.1
'sets the reference level to 0.1 volt peak
```

Characteristics

*RST value: -20 dBm for TRAC:IQ
 1 V peak for FFT Analyzer mode

SCPI: conforms to standard

The numeric suffix under WINDOW<1...2> and the numeric suffix under TRAC<1...3> are irrelevant.

DISPlay[:WINDOW<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel:OFFSet

This command defines the reference level offset.

Parameters

-200 dB to 200 dB

Example

```
DISP:WIND1:TRAC:Y:RLEV:OFFS -10dB
```

Characteristics

*RST value: 0 dB

SCPI: conforms to standard

The numeric suffix under WINDOW<1...2> and the numeric suffix under TRACe<1...3> are irrelevant.

DISPlay[:WINDOW<1|2>]:TRACe<1...3>:Y[:SCALe]:RPOsition

This command defines the position of the reference value for the y-axis.

Parameters

0 to 100 PCT

Example

DISP:WIND2:TRAC:Y:RPOS 30PCT" 'shifts the reference value to 30 %

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffix under TRACe <1...3> is irrelevant.

DISPlay[:WINDOW<1|2>]:TRACe<1...3>:Y[:SCALe]:RVALue

This command defines the reference value for the y-axis of the measurement diagram.

Parameters

<numeric_value>

Example

DISP:WIND2:TRAC:Y:RVAL 10deg

'sets the reference value to 10 deg

Characteristics

*RST value: 0

SCPI: device-specific

The numeric suffix under TRACe <1...3> is irrelevant.

4.5 INPut subsystem

The INPut subsystem controls the characteristics of the instrument inputs. The numeric suffix is irrelevant for the FFT Analyzer mode.

INPut<1|2>:IQ:BALanced[:STATe]

This command toggles the baseband inputs between balanced and unbalanced.

Parameters

ON Inputs balanced

OFF Inputs unbalanced

Example

INP:IQ:BAL ON

Characteristics

*RST value: OFF

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:IQ:IMPedance

This command selects the impedance of the baseband inputs.

Parameters

LOW Input impedance 50 Ω

HIGH Input impedance 1 MΩ or 1 KΩ, depending on the version of the B71 module

Example

INP:IQ:IMP HIGH

Characteristics

*RST value: LOW

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:IQ:TYPE

This command defines the input signal path used. It is available only in the FFT Analyzer mode.

Parameters

I Real signal I only

Q Reall signal Q only

IQ Complex signal I+j*Q

Example

INP:IQ:TYPE IQ

'Selection of 'I+j*Q'

Characteristics

*RST value: IQ

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:SELect

This command switches the baseband inputs on (AIQ) or off (RF). *This command is not available in the FFT Analyzer mode.*

Parameters

AIQ | RF

Example

```
INP:SEL AIQ
```

Characteristics

*RST value: RF

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.6 INSTRument subsystem

The INSTRument subsystem selects the instrument operating mode either by means of text parameters or by means of permanently assigned numbers.

INSTRument:NSELect

This command enables you to switch between operating modes by entering numeric values.

Parameters

- 1: Spectrum Analysis mode
- 22: FFT Analyzer mode

Example

```
INST:NSEL 1  
'Switches to the analyzer mode
```

Characteristics

*RST value: 1

SCPI: conform

INSTRument[:SElect]

This command enables you to switch between operating modes by entering the name of the preferred mode

Parameters

- SANalyzer: Spectrum Analysis mode
- FANalyzer FFT Analyzer mode

Example

```
INST SAN  
'Switches the instrument to SPECTRUM.
```

Characteristics

*RST value: SANalyzer

SCPI: conform

4.7 SENSe subsystem

4.7.1 SENSe:BANDwidth subsystem

This subsystem controls the setting of the analyzer filter bandwidths. The two commands BANDwidth and BWIDth are identical. The numeric suffix is irrelevant for the FFT Analyzer mode.

[SENSe<1|2>:]BANDwidth[BWIDth[:RESolution]:STEP:MODE]

This command controls the rounding of the settable bandwidth in the FFT Analyzer mode (in the frequency domain). With L1235, it is limited to steps of 1/2/3/5/10; with LIN, it is rounded to 0.1 Hz.

Parameters

LIN | L1235

Example

BAND:STEP:MODE L1235

Characteristics

*RST value: L1235

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.7.2 SENSe:CORRection subsystem

The SENSe:CORRection subsystem controls how correction factors are calculated into the measurement results.

[SENSe<1|2>:]CORRection:OFFSet:PHASe

This command sets a reference value for the phase display in the FFT analyzer mode.

Parameters

<numeric_value.>

Example

CORR:OFFS:PHAS 10deg

'includes a phase offset of 10 deg

Characteristics

*RST value: 0 dB

SCPI: device-specific

4.7.3 SENSe:FFT subsystem

The SENSe:FFT subsystem controls the FFT analyzer.

[SENSe<1|2>:]FFT:CAPTure

This command controls how data is captured in the FFT Analyzer mode. While the highest measurement speed is attained with OFF, ON and Single Sweep allow switching between the time and frequency domains even after the measurement without further data capture being necessary.

Parameters

ON | OFF

Example

```
FFT:CAPT ON
```

Characteristics

*RST value: ON

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]FFT:CAPTure:AUTO

This command controls the automatic recalculation of measurement results after changing the instruments parameter. This function is only available for BOTH DOMAIN OFF and SINGLE SWEEP.

Parameters

ON | OFF

Example

```
FFT:CAPT:AUTO ON
```

Characteristics

*RST value: OFF

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]FFT:CAPTure:CALCulate

This command restarts the analysis of captured data with new parameter settings, e.g. resolution bandwidth, window function or domain. This function is only available for BOTH DOMAIN OFF and SINGLE SWEEP.

This recalculation is automatically done, if FFT:CAPT:AUTO is switched ON.

Example

```
FFT:CAPT:CALC
```

Characteristics

*RST value: -

SCPI: device-specific

This command is an event and therefore has no *RST value and no query.
The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]FFT:PRESet[:DEViCe]

This command sets the FFT Analyzer mode to the default state. This default state is identical with the setting in effect after PRESET.

Example

```
SENS :FFT :PRES
'sets the FFT Analyzer mode to the default state
```

Characteristics

*RST value: -

SCPI: device-specific

This command is an event, so it has neither an *RST value nor a query.
The numeric suffix <1|2> is irrelevant with this command.

4.7.4 SENSe:IQ subsystem

This subsystem controls settings for the baseband input.

[SENSe<1|2>:]IQ:DITHer[:STATe]

This command inserts a 2 MHz-wide noise signal at 42.67 MHz into the signal path of the baseband input. When measuring data with TRAC:IQ subsystem it appears in the spectrum at 38.92 MHz.

Parameters

ON | OFF

Example

```
IQ:DITH ON
```

Characteristics

*RST value: OFF

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]IQ:LPASs[:STATe]

This command inserts a 36 MHz filter into the I and Q paths of the baseband input.

Parameters

ON | OFF

Example

```
IQ:LPAS OFF
```

Characteristics

*RST value: ON

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.7.5 SENSe:VOLTage subsystem

This subsystem controls the amplitude settings of the baseband input.

[SENSe<1|2>]:VOLTage:IQ:RANGE[:UPPer]

This command defines the measurement range of the baseband input. The value range depends on the input impedance. The measurement range defines the measurable peak voltage (positive and negative).

Input impedance	Range of values / Volt (5 dB steps)
Low (50 Ω)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78; 3.16; 5.62
High (1 MΩ or 1 kΩ)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78

Parameters

<numeric_value>

Example

```
VOLT:IQ:RANGE 0.1
```

Characteristics

*RST value: 1

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>]:VOLTage:IQ:RANGE:OFFSet

This command defines the reference level offset for the baseband input. In the FFT Analyzer mode, the command DISP:WIND:TRAC:Y:SCAL:RLEV:OFFS can also be used.

Parameters

-200 dB to 200 dB

Example

```
VOLT:IQ:RANG:OFFS -20dB
```

'sets the reference level offset for the baseband input to -20 dB

Characteristics

*RST value: 0 dB

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.7.6 SENSe:WINDOW subsystem

This subsystem controls the evaluation in the FFT Analyzer mode.

SENSe<1|2>:WINDOW:TYPE

This command selects the type of the window function for the FFT input data in the spectrum display (span > 0).

Parameters

FLATtop	"Flattop" type
EXPonential	"Gaußian" type
HAMMING	"Hamming" type
HANNing	"Hann" type
RECTangular	"Rectangular" type
CHEBychev	"Chebychev" type

Example

```
WIND:TYPE HAMM
```

Characteristics

*RST value: -

SCPI: device-specific

The numeric suffix <1|2> is irrelevant with this command.

4.8 TRACe:IQ subsystem

The commands of this subsystem are used to measure and output I/Q data. For this purpose, a measurement memory is provided with a capacity of 16 Mword each for I and Q data. The number of samples to be acquired can be set. The sample rate can be selected in the range from 10 kHz to 81.6 MHz.

All trigger sources except VIDeo are available for triggering. The number of test points captured prior to triggering can be set for all available sources except FREE RUN (for FREE RUN, this value can always be assigned with 0).

The measurement results are output in list form, with the list of I data and the list of Q data immediately following each other in the output buffer. You can use the FORMAT command to choose between binary output (32-bit IEEE 754 floating-point numbers) and output in ASCII format.

The subsystem commands can be used in two ways:

1. Measurement and result retrieval in one command:
This method causes the shortest delay between measurement and sample output, but requires that the control computer be actively waiting for the instrument to respond.
2. Setting of the instrument, starting of the measurement with "INIT" and querying of the result list at the end of the measurement:
With this method, the control computer can be used during the measurement for other activities, which is at the expense of the additional time required for synchronization by means of a service request.

TRACe<1|2>:IQ:DATA?

This command starts a measurement with the setting specified by TRAC:IQ:SET and immediately returns the list of frequency-response corrected measurement results. The number of measurement results depends on specifications for the TRAC:IQ:SET command; the output format depends on the setting made via the FORMat subsystem and via TRAC:IQ:DATA:FORM

Note:

This command requires that all requested measurement data be completely retrieved before the instrument accepts any further commands

Example

```
TRAC:IQ:STAT ON
'switches on I/Q data capturing
INP:IQ:SEL AIQ
'selects baseband input
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096
'configures the measurement:
'filter type:      Normal
'RBW:              10 MHz
'sample rate:       32 MHz
'trigger source:    External
'trigger slope:     Positive
'pretrigger samples: 0
'# of samples:      4096
```

```

FORMAT REAL,32
'defines the format of the response data
TRAC:IQ:DATA
'starts the measurement and outputs the results

```

Returned values:

Irrespective of the output format selected, the data is scaled linearly with *Volt* as the unit and corresponds to the voltage at the RF input of the instrument.

ASCII format (FORMAT ASCII):

In this case, the command returns a comma-separated list (comma separated values or CSV) of the measured voltage values in floating-point format. The number of returned data here is 2 * the number of samples, the first half containing the I values and the second half the Q values.

Note:

If the volume of sampled values is >512 k = 524288 sampled values, the data is transferred in logical blocks of 512 k. See below.

Binary format (FORMAT REAL,32):

In this case, the command returns binary data (definite length block data as defined in IEEE 488.2), in which the samples are arranged in sequential lists of I and Q data in 32-bit IEEE 754 floating-point numbers. The return string has the following structured:

```
#44096<I-value1><I-value2>...<I-value512k><Q-value1><Q-value2>...<Q-value512k>
```

where

#4	number of places occupied by the following number of data bytes (here: 4)
4096	number of following data bytes (# of DataBytes, here: 4096)
<I-value x>	4-byte floating-point I value; maximum number: 512 k
<Q-value y>	4-byte floating-point Q value; maximum number: 512 k

The number of I and Q values can be calculated as follows:

$$\# \text{ of } I - \text{Data} = \# \text{ of } Q - \text{Data} = \frac{\# \text{ of } \text{DataBytes}}{8}$$

The offset of the Q data in the output buffer can thus be calculated as follows:

$$Q - \text{Data} - \text{Offset} = \frac{(\# \text{ of } \text{DataBytes})}{2} + \text{LengthIndicatorDigits}$$

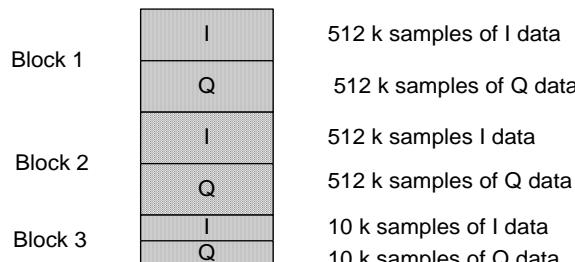
where LengthIndicatorDigits is the number of characters of the length specification (including '#'). The preceding example (#41024...) thus yields a value of 6 for LengthIndicatorDigits and an offset of 512 + 6 = 518 for the Q data in the output buffer where LengthIndicatorDigits is the number of characters of the length specification (including '#'). The preceding example (#44096...) thus yields a value of 6 for LengthIndicatorDigits and an offset of 2048 + 6 = 2054 for the Q data in the output buffer.

Blockwise transfer if the amount of data exceeds 512 k words:

If the volume of sampled values is >512 k = 524288 sampled values, the data is transferred in logical blocks of 512 k. All transferred blocks except the last one have a data length of exactly 512 k words.

The following example shows the data structure for 1058816 I data and 1058816 Q data of the sampled values. Since the block length is limited to 512 k, three blocks are required for data transfer:

512 k	(=524288) samples of I data of Block 1
512 k	(=524288) samples of Q data of Block 1
512 k	(=524288) samples of I data of Block 2
512 k	(=524288) samples of Q data of Block 2
10 k	(=10240) samples of I data of Block 3
10 k	(=10240) samples of Q data of Block 3



Block transfer structure for 1034 k samples = 1058816 samples

Characteristics

*RST value: -

Note:

The following minimum buffer sizes are recommended for the response string when querying I/Q data with TRAC:IQ:SET set to *RST.

ASCII format: 10 kbyte
Binary format: 2 kbyte

SCPI: device-specific

TRACe<1|2>:IQ:DATA:FORMAT

This command controls the I/Q data output format (for command TRAC:IQ:DATA?):

Parameters

COMPatible alternately transferring 512k I data and 512k Q data
IQBLock transferring all I data first and then all Q data
IQPair transferring I/Q data in pairs

Example

TRAC:IQ:DATA:FORM IQP

Characteristics

*RST value: COMP

SCPI: device specific

TRACe<1|2>:IQ:DATA:MEMORY?

This command allows you to read previously captured (and frequency-response-corrected) I/Q data from memory by specifying the offset of the beginning of the capture and the number of samples. Thus, a data record can be read in smaller portions after being initially captured. The maximum number of measurement results available depends on specifications for the TRACe:IQ:SET command; the output format depends on the setting made via the FORMAT subsystem.

Note:

This command requires that all requested measurement data be completely retrieved before the instrument accepts any further commands.

Parameters

<offset samples> Offset of the values to be output relative to the beginning of the captured data. Value range: 0 to <# of samples> - 1, where <# of samples> is the value specified for the TRACe:IQ:SET command.

<# of samples> Number of samples to be output. Value range: 1 to <# of samples> - <offset samples> where <# of samples> is the value specified for the TRACe:IQ:SET command

Example

```

TRAC:IQ:STAT ON
'switches on I/Q data capture
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,100,4096
'configures the measurement: 'filter type: Normal
'RBW: 10 MHz
'sample rate: 32 MHz
'trigger source: External
'trigger slope: Positive
'pretrigger samples: 100
'# of samples: 4096
INIT;*WAI
'Starts the measurement and waits for the operation to be completed FORMat
REAL,32
'Defines the format of response data Read out results:
TRAC:IQ:DATA:MEM? 0,2048
'reads in 2048 I/Q values starting from beginning of capture
TRAC:IQ:DATA:MEM? 2048,1024
'reads in 1024 I/Q values starting from half the captured data
TRAC:IQ:DATA:MEM? 100,512
'reads in 512 I/Q values starting from trigger time (<pretrigger samples> was 100))

```

Characteristics

*RST value: OFF

SCPI: device-specific

Returned values:

Irrespective of the output format selected, the data is scaled linearly with V as the unit and corresponds to the voltage at the RF input of the instrument. The structure of the return buffer matches that of the TRACe : IQ : DATA? command.

TRACe<1|2>:IQ:SET

This command defines the default settings of the hardware for I/Q data capture.

The sample rate, trigger setting and the capture length are thus set.

Parameters

<filter type>:	NORMAL not relevant for baseband input
<rbw>:	3MHz not relevant for baseband input
<sample rate>:	Sampling rate of data capture Value range: 10 kHz to 81.6 MHz
<trigger mode>:	Selection of the trigger source used for I/Q measurement.
Permissible values:	IMMEDIATE EXTERNAL IFPOWER
<trigger slope>:	Trigger slope used.
Permissible values:	POSITIVE NEGATIVE
<pretrigger samples>:	Number of samples captured prior to trigger time. Value range: -16744447 (= -2 ²⁴ +513) to 65023 (= 64*1024 – 513); where negative values correspond to trigger delay.

Note:

Always enter the value 0 if <trigger mode> = IMMEDIATE.

<# of samples>:	Number of samples to be output. Value range: 1 to 16 776 704 (16*1024*1024 – 512)
-----------------	--

Example

```
TRAC:IQ:SET NORM,3MHz,32MHz,EXT,POS,0,2048
```

'reads 2048 I/Q values starting from the trigger time.

sample rate: 32 MHz

trigger: external slope: positive

```
TRAC:IQ:SET NORM,3MHz,4MHz,EXT,POS,1024,512"reads 512 I/Q values  
starting from 1024 measurement points prior to the trigger time.
```

sample rate: 4 MHz

trigger: external

slope: positive

Characteristics

*RST value: NORM,3MHz,32MHz,IMM,POS,0,128

SCPI: device-specific

Note:

For this setting, the following minimum buffer sizes are recommended for the

response string when using the TRAC:IQ:DATA? command:
ASCII format: 10 kbyte
binary format: 2 kbyte

TRACe<1|2>:IQ:SRATE

This command sets the sample rate for I/Q data capture. This means that the sampling rate can also be changed later on without affecting the other settings

Parameters

10.0 kHz to 81.6 MHz (value range)

Example

```
TRAC:IQ:SRAT 4MHz
```

Characteristics

*RST value: 32 MHz

SCPI: device-specific

TRACe<1|2>:IQ[:STATe]

This command enables or disables I/Q data capture.

Parameters

ON|OFF

Note:

I/Q data capture is not compatible with other measurement functions.

Therefore, all other measurement functions are disabled when I/Q data capture is enabled.

Likewise, traces cannot be displayed in this mode. All traces are therefore set to "BLANK".

Finally, the split-screen mode is automatically disabled when the function is enabled.

Example

```
TRAC:IQ ON  
'enables I/Q data capture
```

Characteristics

*RST value: OFF

SCPI: device-specific

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