



ROHDE & SCHWARZ

Test and Measurement
Division

Operating Manual

Baseband Fading Simulator

ABFS

1114.8506.02

Printed in the Federal
Republic of Germany

Supplement to Operating Manual Baseband Fading Simulator ABFS

Dear Customer,

Your Baseband Fading Simulator is equipped with a new firmware version. The new firmware offers the following extensions and improvements:

FSIM - FINE DELAY menu:

RF FREQUENCY CH1 Input value of RF frequency of channel 1.

IEC/IEEE-bus command : SOUR : FSIM : FDEL : CHAN1 : RF 100MHz

RF FREQUENCY CH2 Input value of RF frequency of channel 2.

IEC/IEEE-bus command : SOUR : FSIM : FDEL : CHAN2 : RF 100MHz

FSIM - MOVING DELAY menu:

RF FREQUENCY Input value of RF frequency.

IEC/IEEE-bus command : SOUR : FSIM : MDEL : CHAN : RF 100MHz

FSIM - BIRTH-DEATH menu:

RF FREQUENCY Input value of RF frequency.

IEC/IEEE-bus command : SOUR : FSIM : BIRT : CHAN : RF 100MHz

IEC/IEEE-bus commands:

[:SOURce] :FSIMulator:FDElay:CHANnel<1|2>:RF 5.0 MHz ... 8.5 GHz

This command sets the RF frequency of the selected channel in Fine Delay mode. The channel is selected via the numeric suffix in CHANnel.

Example: :SOUR : FSIM : FDEL : CHAN1 : RF 600 MHz *RST value is 100 MHz

[:SOURce] :FSIMulator:MDElay:CHANnel:RF 5.0 MHz ... 8.5 GHz

This command sets the RF frequency in Moving Delay mode.

Example: :SOUR : FSIM : MDEL : CHAN : RF 600 MHz *RST value is 100 MHz

[:SOURce] :FSIMulator:BIRTdeath:CHANnel:RF 5.0 MHz ... 8.5 GHz

This command sets the RF frequency in Birth-Death mode.

Example: :SOUR : FSIM : BIRT : CHAN : RF 600 MHz *RST value is 100 MHz

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Supplement to Data Sheet ABFS

Enhanced fading functions for WCDMA 3GPP with option ABFSB49

ABFSB49 extends the functionality of the baseband fading simulator ABFS to include WCDMA 3GPP channel simulation. It adds three new modes to the fading simulator so that all scenarios defined in 3GPP Release 99 can be simulated:

- In fine delay mode, fading simulator resolution is increased to 1 ns with up to four paths being available.
- In moving delay mode, two paths are simulated: for one path the delay remains constant, whereas for the other path the delay varies continuously.
- In birth-death mode, there are two paths changing delay in steps in accordance with the 3GPP channel model.

Specifications

The enhanced fading functions for WCDMA 3GPP are only available for the ABFS standard fading simulator, not for the second fading simulator (option ABFS-B2).

Modes	Standard fading, fine delay, birth-death
Setting time after RF frequency change	6 ms
Fine delay mode	
RF bandwidth	4.8 MHz
Number of paths	4
Profiles	Rayleigh, pure Doppler
Delay	25 ns to 1637 μ s
Delay resolution	1 ns
Moving delay mode	
RF bandwidth	4.8 MHz
Number of paths	2
Delay, path 1	0 to 1000 μ s (in 50 ns steps)
Delay, path 2	$\text{delay path1} + \frac{\text{delay variation}_{\text{pk-pk}}}{2} \cdot \sin \frac{2\pi t}{\text{variation period}}$
Delay variation (peak-peak)	150 ns to 50 μ s
Variation period	10 s to 500 s
Delay step size	<1 ns
Profiles	None
Birth-death mode	
Number of paths	2
Profiles	pure Doppler
Delay	5 μ s to 1000 μ s
Delay range (birth-death process)	-5 μ s to +5 μ s (not variable)
Delay grid	1 μ s (not variable)
Hopping dwell	100 ms to 5 s

Ordering Information

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Before putting the product into operation for the first time, make sure to read the following



Safety Instructions

Rohde & Schwarz makes every effort to keep the safety standard of its products up to date and to offer its customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. This product has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, Rohde & Schwarz 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 in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its operating manual and within its performance limits (see data sheet, documentation, the following safety instructions). Using the products requires technical skills and knowledge of English. It is therefore essential that the products be used exclusively by skilled and specialized staff or thoroughly trained personnel with the required skills. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation.

Symbols and safety labels

Observe operating instructions	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

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

Safety Instructions

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

Tags and their meaning

DANGER	This tag indicates a safety hazard with a high potential of risk for the user that can result in death or serious injuries.
WARNING	This tag indicates a safety hazard with a medium potential of risk for the user that can result in death or serious injuries.
CAUTION	This tag indicates a safety hazard with a low potential of risk for the user that can result in slight or minor injuries.
ATTENTION	This tag indicates the possibility of incorrect use that can cause damage to the product.
NOTE	This tag indicates a situation where the user should pay special attention to operating the product but which does not lead to damage.

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

Basic safety instructions

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

Safety Instructions

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

Safety Instructions

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



Por favor lea imprescindiblemente antes de la primera puesta en funcionamiento las siguientes informaciones de seguridad



Informaciones de seguridad

Es el principio de Rohde & Schwarz de tener a sus productos siempre al día con los standards de seguridad y de ofrecer a sus clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestra sección de gestión de la seguridad de calidad controla constantemente que sean cumplidas estas normas. Este producto ha sido fabricado y examinado según el comprobante de conformidad adjunto según las normas de la CE y ha salido de nuestra planta en estado impecable según los standards técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, deberá el usuario atenerse a todas las informaciones, informaciones de seguridad y notas de alerta. 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 solamente fue elaborado para ser utilizado en la industria y el laboratorio o para fines de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda ser dañada. El uso del producto fuera de sus fines definidos o despreciando las informaciones de seguridad del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del maluso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado dentro de las instrucciones del correspondiente manual del uso y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso de los productos hace necesarios conocimientos profundos y el conocimiento del idioma inglés. Por eso se deberá tener en cuenta de exclusivamente autorizar para el uso de los productos a personas péritas o debidamente minuciosamente instruidas con los conocimientos citados. Si fuera necesaria indumentaria de seguridad para el uso de productos de R&S, encontrará la información debida en la documentación del producto en el capítulo correspondiente.

Símbolos y definiciones de seguridad

Ver manual de instrucciones del uso	Informaciones para maquinaria con un peso de > 18kg	Peligro de golpe de corriente	¡Advertencia! Superficie caliente	Conexión a conductor protector	Conexión a tierra	Conexión a masa conductora	¡Cuidado! Elementos de construcción con peligro de carga electrostática

potencia EN MARCHA/PARADA	Indicación Stand-by	Corriente continua DC	Corriente alterna AC	Corriente continua/alterna DC/AC	El aparato está protegido en su totalidad por un aislamiento de doble refuerzo

Informaciones de seguridad

Tener en cuenta las informaciones de seguridad sirve para tratar de evitar daños y peligros de toda clase. Es necesario de que se lean las siguientes informaciones de seguridad concienzudamente y se tengan en cuenta debidamente antes de la puesta en funcionamiento del producto. También deberán ser tenidas en cuenta las informaciones para la protección de personas que encontrarán en otro capítulo de esta documentación y que también son obligatorias de seguir. En las informaciones de seguridad actuales hemos juntado todos los objetos vendidos por Rohde&Schwarz bajo la denominación de „producto“, entre ellos también aparatos, instalaciones así como toda clase de accesorios.

Palabras de señal y su significado

PELIGRO	Indica un punto de peligro con gran potencial de riesgo para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas.
ADVERTENCIA	Indica un punto de peligro con un potencial de riesgo mediano para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas .
ATENCIÓN	Indica un punto de peligro con un potencial de riesgo pequeño para el usuario. Punto de peligro que puede llevar hasta heridas leves o pequeñas
CUIDADO	Indica la posibilidad de utilizar mal el producto y a consecuencia dañarlo.
INFORMACIÓN	Indica una situación en la que deberían seguirse las instrucciones en el uso del producto, pero que no consecuentemente deben de llevar a un daño del mismo.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el ámbito de la comunidad económica europea. Pueden existir definiciones diferentes a esta definición. Por eso se debiera tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación 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 malinterpretaciones y tener por consecuencia daños en personas u objetos.

Informaciones de seguridad elementales

1. El producto solamente debe ser utilizado según lo indicado por el fabricante referente a la situación y posición de funcionamiento sin que se obstruya la ventilación. Si no se convino de otra manera, es para los productos R&S válido lo que sigue: como posición de funcionamiento se define principalmente la posición con el suelo de la caja para abajo , modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, utilizar solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar.
A menos que se especifique otra cosa en la hoja de datos, se aplicará una tolerancia de $\pm 10\%$ sobre el voltaje nominal y de $\pm 5\%$ sobre la frecuencia nominal.
2. En todos los trabajos deberán ser tenidas en cuenta las normas locales de seguridad de trabajo y de prevención de accidentes. El producto solamente debe de ser abierto por personal périto autorizado. Antes de efectuar trabajos en el producto o abrirlo deberá este ser desconectado de la corriente. El ajuste, el cambio de partes, la manutención y la reparación deberán ser solamente efectuadas por electricistas autorizados por R&S. Si se reponen partes con importancia para los aspectos de seguridad (por ejemplo el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Despues de cada recambio de partes elementales para la seguridad deberá ser efectuado un control de

Informaciones de seguridad

- seguridad (control a primera vista, control de conductor protector, medición de resistencia de aislamiento, medición de medición de la corriente conductora, control de funcionamiento).
3. Como en todo producto de fabricación industrial no puede ser excluido en general de que se produzcan al usarlo elementos que puedan generar alergias, los llamados elementos alergénicos (por ejemplo el níquel). Si se produjeran en el trato con productos R&S reacciones alérgicas, como por ejemplo urticaria, estornudos frecuentes, irritación de la conjuntiva o dificultades al respirar, se deberá consultar inmediatamente a un médico para averiguar los motivos de estas reacciones.
 4. Si productos / elementos de construcción son tratados fuera del funcionamiento definido de forma mecánica o térmica, pueden generarse elementos peligrosos (polvos de sustancia de metales pesados como por ejemplo plomo, berilio, níquel). La partición elemental del producto, como por ejemplo sucede en el tratamiento de materias residuales, debe de ser efectuada solamente por personal especializado para estos tratamientos. La partición elemental efectuada inadecuadamente puede generar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes al tratamiento de materias residuales.
 5. En el caso de que se produjeran agentes de peligro o combustibles en la aplicación del producto que debieran de ser transferidos a un tratamiento de materias residuales, como por ejemplo agentes refrigerantes que deben ser repuestos en periodos definidos, o aceites para motores, deberán ser tenidas en cuenta las prescripciones de seguridad del fabricante de estos agentes de peligro o combustibles y las regulaciones regionales para el tratamiento de materias residuales. Cuiden también de tener en cuenta en caso dado las prescripciones de seguridad especiales en la descripción del producto.
 6. Ciertos productos, como por ejemplo las instalaciones de radiación HF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. En vista a la protección de la vida en desarrollo deberían ser protegidas personas embarazadas debidamente. También las personas con un bypass pueden correr peligro a causa de la radiación electromagnética. El empresario está comprometido a valorar y señalar áreas de trabajo en las que se corra un riesgo de exposición a radiaciones aumentadas de riesgo aumentado para evitar riesgos.
 7. La utilización de los productos requiere instrucciones especiales y una alta concentración en el manejo. Debe de ponerse por seguro de que las personas que manejen los productos estén a la altura de los requerimientos necesarios referente a sus aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario lleva la responsabilidad de seleccionar el personal usuario apto para el manejo de los productos.
 8. Antes de la puesta en marcha del producto se deberá tener por seguro de que la tensión preseleccionada en el producto equivalga a la del la red de distribución. Si es necesario cambiar la preselección de la tensión también se deberán en caso dabo cambiar los fusibles correspondientes del producto.
 9. Productos de la clase de seguridad I con alimentación móvil y enchufe individual de producto solamente deberán ser conectados para el funcionamiento a tomas de corriente de contacto de seguridad y con conductor protector conectado.
 10. Queda prohibida toda clase de interrupción intencionada del conductor protector, tanto en la toma de corriente como en el mismo producto ya que puede tener como consecuencia el peligro de golpe de corriente por el producto. Si se utilizaran cables o enchufes de extensión se deberá poner al seguro, que es controlado su estado técnico de seguridad.
 11. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de distribución como interruptor. En estos casos deberá asegurar de que el enchufe sea de fácil acceso y nabejo (medida del cable de distribución aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para el corte de la red eléctrica. Si los productos sin interruptor están integrados en construcciones o instalaciones, se deberá instalar el interruptor al nivel de la instalación.

Informaciones de seguridad

12. No utilice nunca el producto si está dañado el cable eléctrico. Asegure a través de las medidas de protección y de instalación adecuadas de que el cable de eléctrico no pueda ser dañado o de que nadie pueda ser dañado por él, por ejemplo al tropezar o por un golpe de corriente.
13. Solamente está permitido el funcionamiento en redes de distribución TN/TT aseguradas con fusibles de como máximo 16 A.
14. 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. Si no tiene en consideración estas indicaciones se arriesga a que se originen chispas, fuego y/o heridas.
15. No sobrecargue las tomas de corriente, los cables de extensión o los enchufes de extensión ya que esto pudiera causar fuego o golpes de corriente.
16. En las mediciones en circuitos de corriente con una tensión de entrada de $U_{eff} > 30 \text{ V}$ se deberá tomar las precauciones debidas para impedir cualquier peligro (por ejemplo medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
17. En caso de conexión con aparatos de la técnica informática se deberá tener en cuenta que estos cumplan los requisitos de la EC950/EN60950.
18. Nunca abra la tapa o parte de ella si el producto está en funcionamiento. Esto pone a descubierto los cables y componentes eléctricos y puede causar heridas, fuego o daños en el producto.
19. Si un producto es instalado fijamente en un lugar, se deberá primero conectar el conductor protector fijo con el conductor protector del aparato antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
20. En caso de que los productos que son instalados fijamente en un lugar sean sin protector implementado, autointerruptor o similares objetos de protección, deberá la toma de corriente estar protegida de manera que los productos o los usuarios estén suficientemente protegidos.
21. Por favor, no introduzca ningún objeto que no esté destinado a ello en los orificios de la caja del aparato. No vierta nunca ninguna clase de líquidos sobre o en la caja. Esto puede producir corto circuitos en el producto y/o puede causar golpes de corriente, fuego o heridas.
22. Asegúrese con la protección adecuada de que no pueda originarse en el producto una sobrecarga por ejemplo a causa de una tormenta. Si no se verá el personal que lo utilice expuesto al peligro de un golpe de corriente.
23. Los productos R&S no están protegidos contra el agua si no es que exista otra indicación, ver también punto 1. Si no se tiene en cuenta esto se arriesga el peligro de golpe de corriente o de daños en el producto lo cual también puede llevar al peligro de personas.
24. No utilice el producto bajo condiciones en las que pueda producirse y se hayan producido líquidos de condensación en o dentro del producto como por ejemplo cuando se desplaza el producto de un lugar frío a un lugar caliente.
25. Por favor no cierre ninguna ranura u orificio del producto, ya que estas son necesarias para la ventilación e impiden que el producto se caliente demasiado. No pongan el producto encima de materiales blandos como por ejemplo sofás o alfombras o dentro de una caja cerrada, si esta no está suficientemente ventilada.
26. No ponga el producto sobre aparatos que produzcan calor, como por ejemplo radiadores o calentadores. La temperatura ambiental no debe superar la temperatura máxima especificada en la hoja de datos.

Informaciones de seguridad

27. Baterías y acumuladores no deben de ser expuestos a temperaturas altas o al fuego. Guardar baterías y acumuladores fuera del alcance de los niños. Si las baterías o los acumuladores no son cambiados con la debida atención existirá peligro de explosión (atención celulas de Litio). Cambiar las baterías o los acumuladores solamente por los del tipo R&S correspondiente (ver lista de piezas de recambio). Baterías y acumuladores son deshechos problemáticos. Por favor tirenlos en los recipientes especiales para este fin. Por favor tengan en cuenta las prescripciones nacionales de cada país referente al tratamiento de deshechos. Nunca sometan las baterías o acumuladores a un corto circuito.
28. Tengan en consideración de que en caso de un incendio pueden escaparse gases tóxicos del producto, que pueden causar daños a la salud.
29. Por favor tengan en cuenta que en caso de un incendio pueden desprenderse del producto agentes venenosos (gases, líquidos etc.) que pueden generar daños a la salud.
30. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptas para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (por ejemplo paredes y estantes).
31. Las asas instaladas en los productos sirven solamente de ayuda para el manejo que solamente está previsto para personas. Por eso no está permitido utilizar las asas para la sujecion en o sobre medios de transporte como por ejemplo grúas, carretillas elevadoras de horquilla, carros etc. El usuario es responsable de que los productos sean sujetados de forma segura a los medios de transporte y de que las prescripciones de seguridad del fabricante de los medios de transporte sean tenidas en cuenta. En caso de que no se tengan en cuenta pueden causarse daños en personas y objetos.
32. Si llega a utilizar el producto dentro de un vehículo, queda en la responsabilidad absoluta del conductor que conducir el vehículo de manera segura. Asegure el producto dentro del vehículo debidamente para evitar en caso de un accidente las lesiones u otra clase de daños. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Siempre queda en la responsabilidad absoluta del conductor la seguridad del vehículo y el fabricante no asumirá ninguna clase de responsabilidad por accidentes o colisiones.
33. Dado el caso de que esté integrado un producto de laser en un producto R&S (por ejemplo CD/DVD-ROM) no utilice otras instalaciones o funciones que las descritas en la documentación. De otra manera pondrá en peligro su salud, ya que el rayo laser puede dañar irreversiblemente sus ojos. Nunca trate de descomponer estos productos. Nunca mire dentro del rayo laser.



ROHDE & SCHWARZ
EC Certificate of Conformity



Certificate No.: 99037

This is to certify that:

Equipment type	Order No.	Designation
ABFS	1114.8506.02	Baseband Fading Simulator
ABFS-B1	1115.0009.02	Option: Noise Generator
ABFS-B2	1115.0309.02	Option: Second Fading Simulator
ABFS-B3	1115.0609.02	Option: Second Noise Generator

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

- relating to electrical equipment for use within defined voltage limits
(73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility
(89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN50081-1 : 1992
EN50082-2 : 1995

Affixing the EC conformity mark as from 1999

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

Munich, 1999-06-16

Central Quality Management FS-QZ / Becker

General Overview of Manuals

Operating Manual for Baseband Fading Simulator ABFS

This operating manual provides you with all the information necessary for putting into operation, manual and remote control as well as repair of Baseband Fading Simulator ABFS and also contains specifications of the instrument and available options.

The following options are described in this manual:

ABFS-B1 – Noise generator

ABFS-B2 – Second Fading simulator

ABFS-B3 – Second Noise generator

The contents of the chapters are as follows:

Data sheet	informs you about guaranteed specifications relating to functions and characteristics of the instrument and its options.
Chapter 1	contains all information about putting into operation (unpacking, connection to AC supply, switching on and off), functional testing and installation of the instrument, preset settings and views of the front and rear panel showing the controls and connectors needed for operation.
Chapter 2	presents a brief introduction and typical settings to users working with the ABFS for the first time.
Chapter 3	describes manual control of the Baseband Fading Simulator, for example calling up of menus, selection and editing of parameters, use of the list editor and the SAVE/RECALL function. This chapter also contains an overview of menus showing the functions available for the instruments and its options.
Chapter 4	describes the functions of the instrument and its options which can be activated manually via menus or by remote control (fading, noise generation, Memory Sequence, HOP CONTROL and general functions not directly related to signal generation).
Chapter 5	provides basic information on remote control, for example on the IEC/IEEE bus, RS-232-C interface, interface and device messages, command processing, status reporting system, etc.
Chapter 6	contains for each command system an overview and description of all commands available for the instrument and its options as well as an alphabetical list of all commands.
Chapter 7	includes programming examples for remote control.
Chapter 8	gives information on preventive maintenance, for example for keeping the exterior clean, storage, etc.
Chapter 9	contains the SCPI-specific and device-specific error messages displayed by the instrument.
Chapter 10	includes the index.

Service Manual Instrument for Baseband Fading Simulator ABFS

The service manual instrument for Baseband Fading Simulator ABFS provides information on the checking of rated characteristics, manual and electronic adjustment, repair (fault diagnosis, module replacement), and the fitting of options. Moreover, it includes documentation such as spare parts list, basic circuit diagram, block diagram, etc.

1 Putting into Operation

This chapter contains all information about putting into operation (unpacking, connection to AC supply, switching on and off), functional testing and installation of the instrument, preset settings and views of the front and rear panel showing the controls and connectors needed for operation.

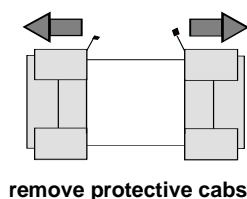
General Instructions

Before putting the ABFS into operation, please make sure that

- the covers of the casing are put on and screwed,
- the ventilation openings are free,
- no signal voltage levels exceeding the permissible limits are applied at the inputs,
- the outputs of the instrument are not overloaded or connected incorrectly.

If these points are not observed, the instrument might be damaged.

Unpacking the Instrument



- Take the instrument out of the shipping box and check whether the items listed in the packing list and in the lists of accessories are all included.
- Remove the two protective caps from the front and rear of the ABFS and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.

For further transport or shipment of the ABFS the original packing should also be used. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors.

Supply Voltage

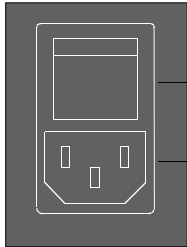
The ABFS can be operated at a.c. systems from 90 to 132 V and 180 to 265 V at system frequencies from 47 to 440 Hz. The power supply socket is situated at the rear of the instrument. The instrument automatically sets itself to the voltage applied within the permissible voltage ranges. It is not necessary to set the instrument to a certain supply voltage.

How to Ensure EMC

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

Switching On/Off the Instrument

Power switch at the rear of the instrument



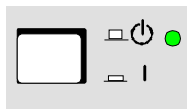
Power switch

Power supply socket

Switch on/off: ➤ Press power switch at the top (I) / bottom (0)

The power switch can remain switched on permanently. Switching off is only necessary when the instrument is to be completely disconnected from the mains.

On/Off switch at the front of the instrument



Standby check LED

Switch on: ➤ Press switch.

The instrument is ready for operation.

Switch off: ➤ Release switch.

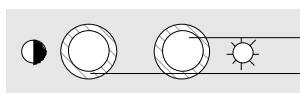
The instrument assumes the STANDBY mode.

Initial Status

Upon switching on, the instrument automatically assumes the status which was set when it was switched off.

If the instrument need not to be operated from the initial status any further, a defined default status should be established by pressing the [PRESET] key prior to further settings.

Setting Contrast and Brightness of the Display



Brightness control

Contrast control

Contrast and brightness of the display can be set by means of the contrast and brightness controls situated below the display.

RAM With Battery Back-Up

The ABFS has a static read-write memory (CMOS-RAM) with battery back-up, in which 50 different complete settings of the instrument can be stored (cf. Chapter 3, section "Storing and Calling of Instrument Settings"). In addition, all data and/or lists the user enters himself, such as for list mode or memory sequence, are stored in the RAM. Further, all data of the calibrations running within the instrument in the ABFS are stored in the RAM (cf. Chapter 4, section "Calibration" and Service Manual - Instrument).

A lithium battery with a service life of approx. 5 years serves to supply the RAM with power. When the battery is discharged, the data stored will be lost. Exchanging the battery is described in the Service Manual - Instrument.

Preset Setting

A defined setting status is achieved by pressing the [PRESET] key.

Preset Status:

Mode	1channel / 12path
Fading	switched off
AWGN	switched off
Memory Sequence	switched off
Hop Control	switched off
Protection of calibration data	Protection lock: unaltered
Settings stored	unaltered
Data, lists etc. stored	unaltered
IEC-bus address	unaltered
Beeper	unaltered

All parameters and circuit states, even those of operating modes which are not activated, are preset by means of Preset.

The presettings going beyond the above list can be seen from the menu representations as of Section 4 which each indicate the Preset setting status.

Functional Test

On switching on the instrument and permanently during operation, the ABFS carries out a self test. The ROM contents as well as the battery of the non-volatile RAM are checked on switching on the instrument and the RAM contents with every calling the memory. The most important instrument functions are automatically monitored during operation.

If an error is detected, the message "ERROR" is displayed in the status line. For further identification of the error, press the [ERROR] key. Thereupon a description of the error/s is displayed (cf. Chapter 9, section "Error Messages"). Return to the menu exited by pressing the [BACK] key.

If required, the self tests can be induced purposefully. Further, internal test points can be polled by the user and the results be read out and displayed. Cf. Service Manual Instrument.

Mounting into a 19" Rack

Caution: *Ensure free air inlet/outlet at the perforation of the side walls of the instrument in rack mounting.*

The ABFS can be mounted into a 19" rack by means of rack adapter ZZA-94 (stock no. 396.4905.00). The mounting instructions are attached to the adapter.

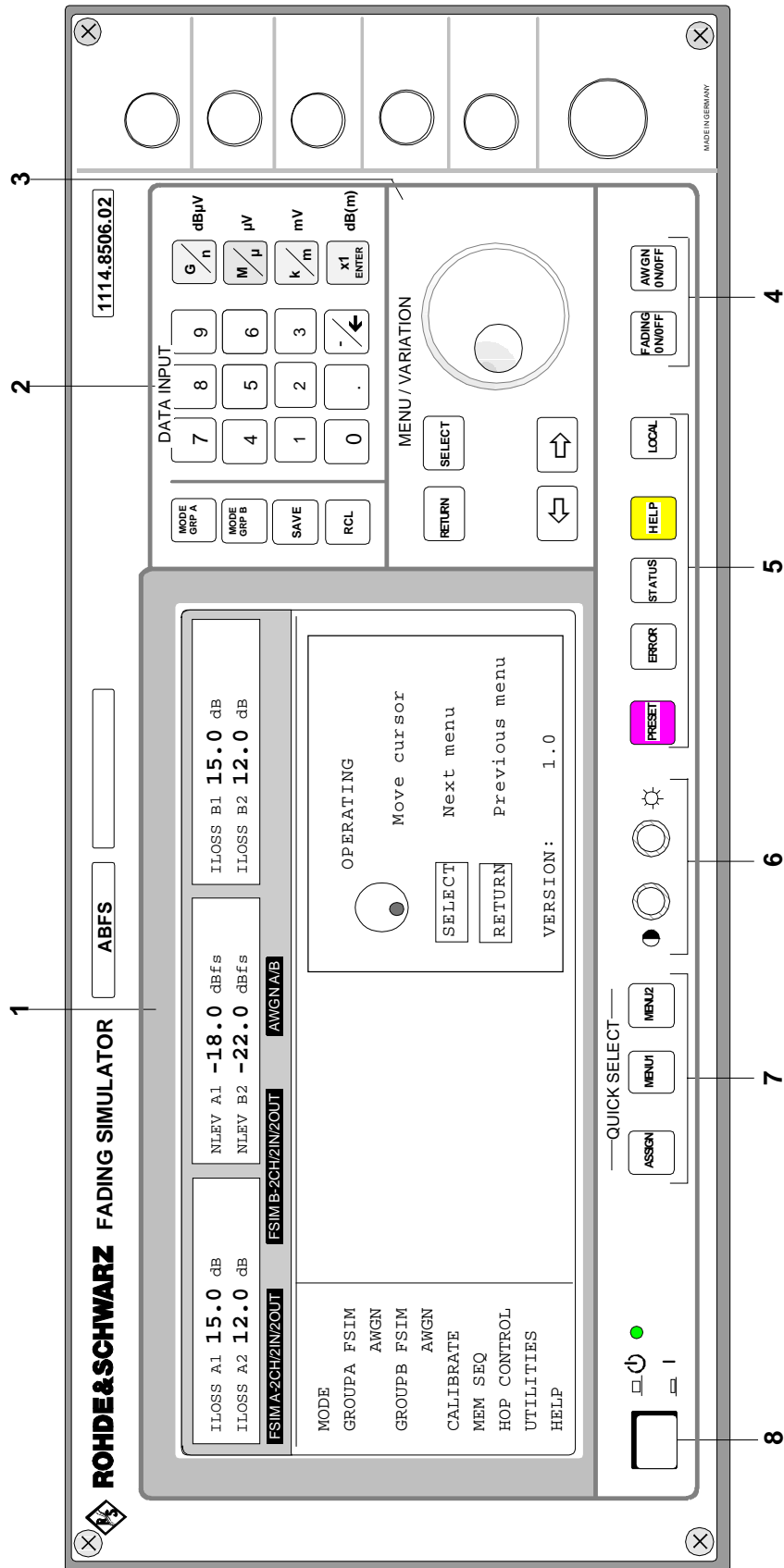


Fig. 1-1 Front panel view ABFS

Explanation of Front and Rear Panel

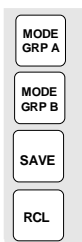
Elements of the Front Panel

1 Display

Cf. Chapter 3, section "Design of the Display".

2 DATA INPUT

Parameter field



As an alternative to menu control, the parameter keys can be used to switch over ABFS operating modes and signal paths. A graphic with the associated signal paths is displayed in the menu. Complete device settings may also be stored and called up.

MODE GRP A

MODE GRP B

Toggle key to change the operating mode of GROUP A or GROUP B of ABFS. After pressing the key, a window is opened in which the set signal paths are displayed in a graphic. The window is independent of the current menu control and menu hierarchy. The graphic is identical with that in the MODE menu.

SAVE Opens the storing of the current instrument setting. Memory selection is effected by entering a number (1 to 50) and is finished by means of the [ENTER] key.

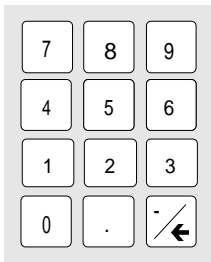
RCL Opens the calling of an instrument setting stored. Memory selection is effected by entering a number (1 to 50) and is finished by means of the [ENTER] key.

See as well Chapter 3,

Section "Use of [MODE GRP A] and [MODE GRP B]"

Section "Storing and Calling of Instrument Settings"

Numeric input field



Numeric values, decimal point and minus sign can be entered by means of the digital keys.,

0...9 Enters the digit.

• Enters the decimal point

-/← Enters the minus sign.

Deletes the last input (digit, sign or decimal point) - key [BACKSPACE].

See as well Chapter 3,

Section "Basic Operating Steps"

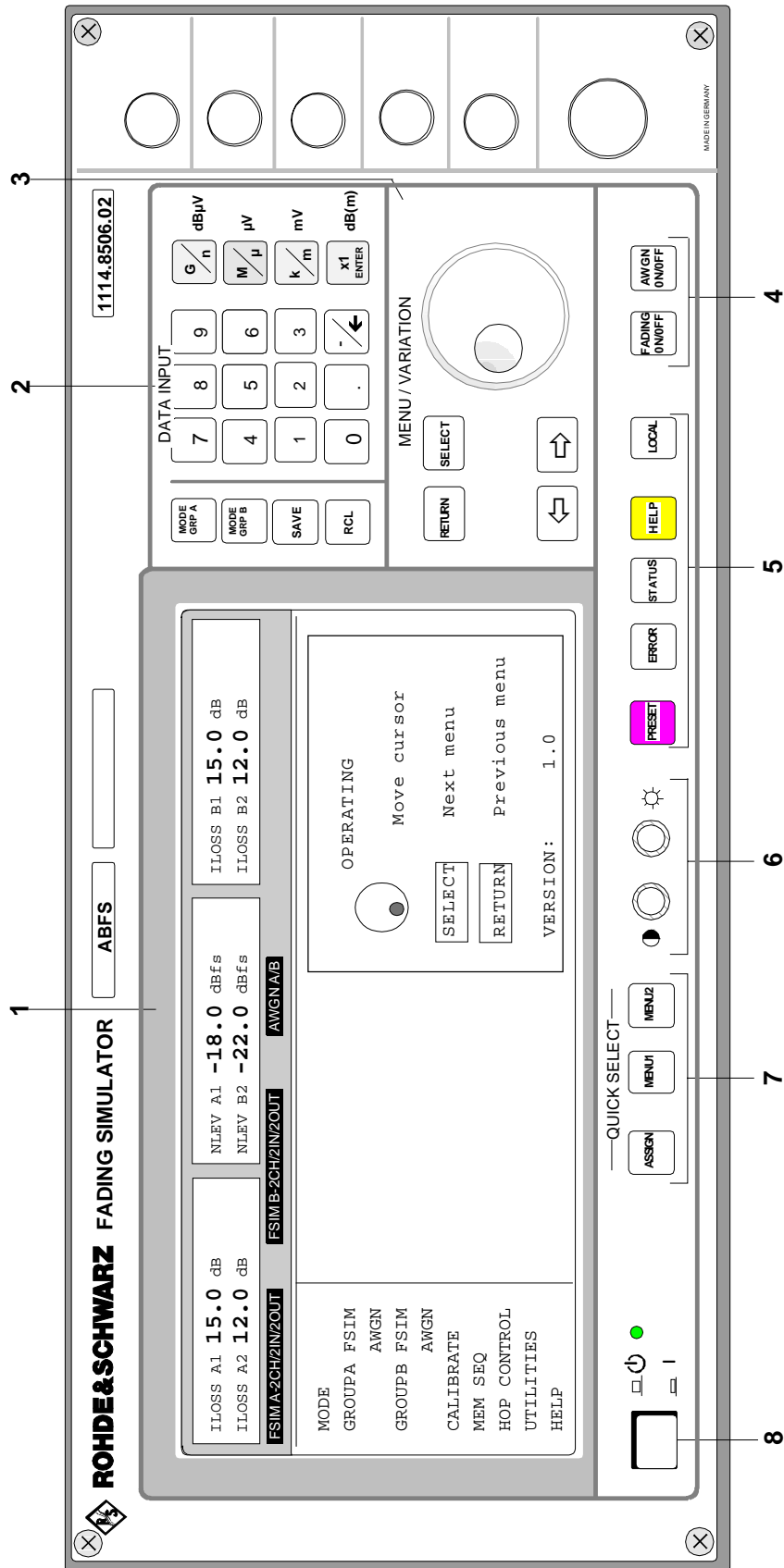
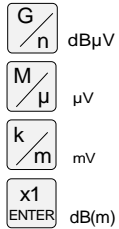


Fig. 1-1 Front panel view ABFS

2 DATA INPUT

Unit keys with enter function



The unit keys terminate the input of values and specify the multiplication factor for the respective basic unit. The basic units are displayed next to the input field while numbers are entered. In the case of level settings, the unit keys specify the unit.

G/n	dBμV	Selects giga/nano, with RF level dBμV, with LF level dBu.
M/μ	μV	Selects mega/micro, with level μV.
k/m	MV	Selects kilo/milli, with level mV.
1x		
Enter	dB(m)	Terminates entries in the basic unit and value inputs without unit. Selects with level dBm Selects with level offset and level step width dB.

See as well Chapter 3,

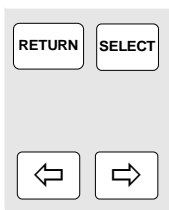
Section "Basic Operating Steps"

Section "Change Unit of Level"

In order to change to another level unit, simply press the unit key desired. Parameter LEVEL must be activated, e.g. by pressing the [LEVEL] key.

3 MENU/VARIATION

Menu keys



The menu keys access the menus and settings within the menus.

RETURN	Returns the menu cursor to the next higher menu level.
SELECT	Acknowledges the choice marked by the menu cursor
←	Moves the digit cursor to the left by one position in the marked value indication. Moves the menu cursor to the left by one position in a 1-out-of-n selection.
⇒	Moves the digit cursor to the right by one position in the marked value indication. Moves the menu cursor to the right by one position in a 1-out-of-n selection.

see as well Chapter 3

Section "Basic Operating Steps"

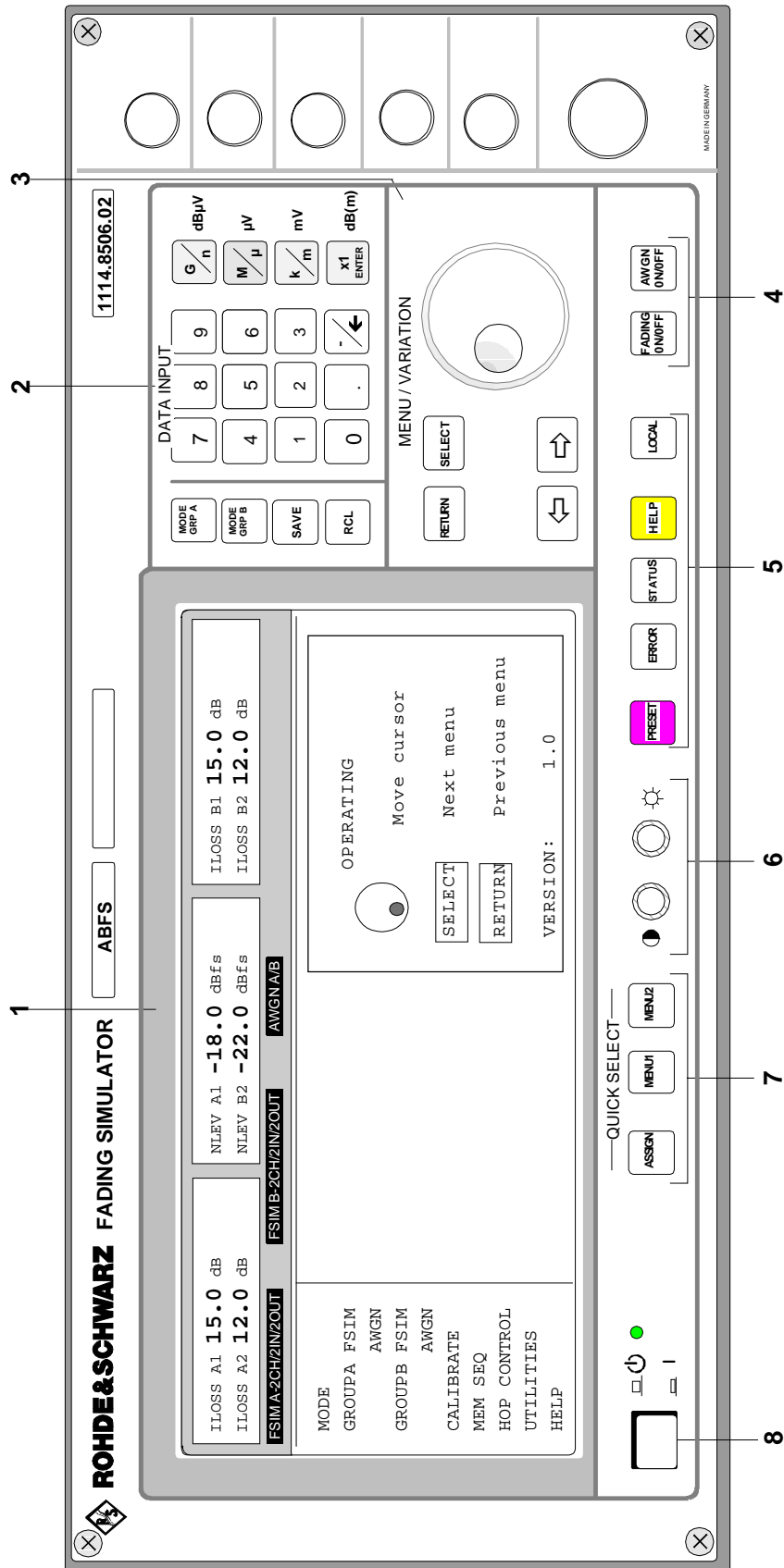
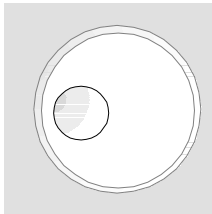


Fig. 1-1 Front panel view ABFS

3 MENU/VARIATION

Rotary knob



The rotary knob moves the menu cursor over the positions of a menu level to choose from or varies the value of a parameter. The variation is either effected in steps of one or in a step width that can be specified at will.

See as well Chapter 3 Section "Basic Operating Steps" Chapter 2, Section "Sample Setting for First Users"

4



FADING ON/OFF

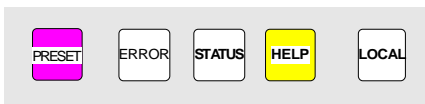
Switches all the fading simulators on or off.

AWGN ON/OFF

Switches all the noise generators on or off.

See as well Chapter 3, Section "Use of [FADING ON/OFF] and [AWGN ON/OFF] Keys"

5



PRESET

Establishes a defined instrument status.

ERROR*

Indicates error and caution messages.

STATUS*

Indicates the instrument status.

HELP*

Indicates context-sensitive auxiliary text.

LOCAL

Switches the instrument from the REMOTE mode (remote control) to the LOCAL mode (manual control).

See as well Chapter 1, Section "Preset Settings" Chapter 9, Section "Error Messages" Chapter 4, Section "Status" Section "The Help System" Section "Remote Control"

* Exit the menus using the [RETURN] key.

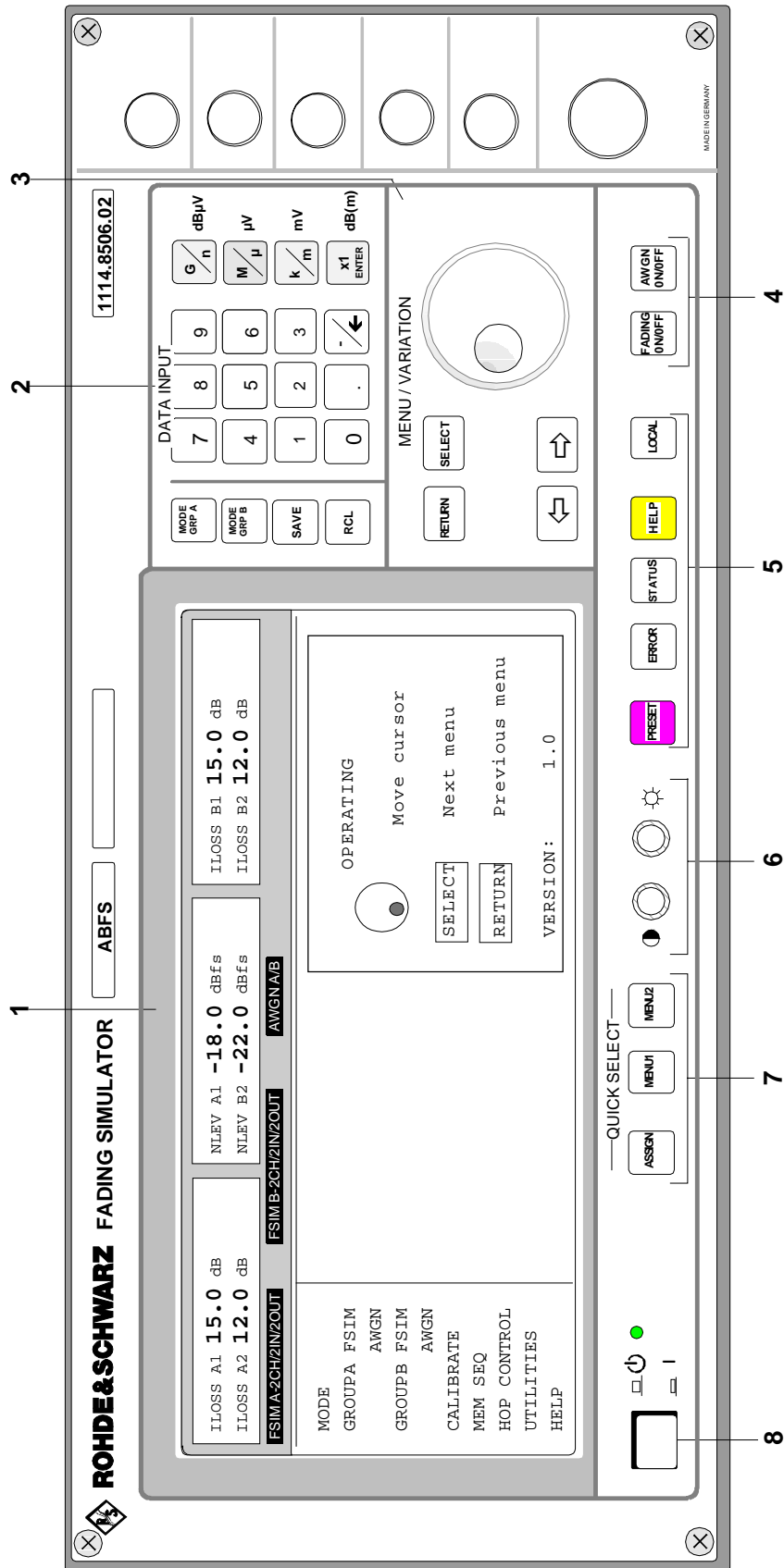
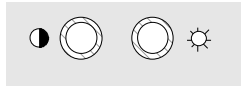


Fig. 1-1 Front panel view ABFS

6 BRIGHTNESS / CONTRAST

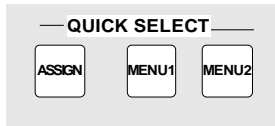


Brightness and contrast of the display can be set using the rotary knobs.

- Contrast
- ☀ Brightness

See as well Chapter 1, Section "Setting of Contrast and Brightness of the Display"

7 QUICK SELECT

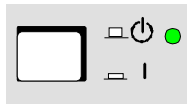


The menu-quick-selection keys permit fast access to two menus selected.

- ASSIGN Stores the current menu as menu1 when the MENU1 key is pressed afterwards or as menu2 when the MENU2 key is pressed afterwards.
- MENU1 Activates menu1 stored.
- MENU2 Activates menu2 stored.

See as well Chapter 3, Section "Basic Operating Steps"

8 ON/OFF SWITCH



The On/Off switch switches the instrument from the standby mode to the ready-for-operation status. Prerequisite: The power switch at the rear of the instrument must be switched on.

The LED is illuminated in the standby mode.

See as well Chapter 1, Section "Switching On/Off the Instrument" Section "Elements of the Rear Panel, Power Switch"

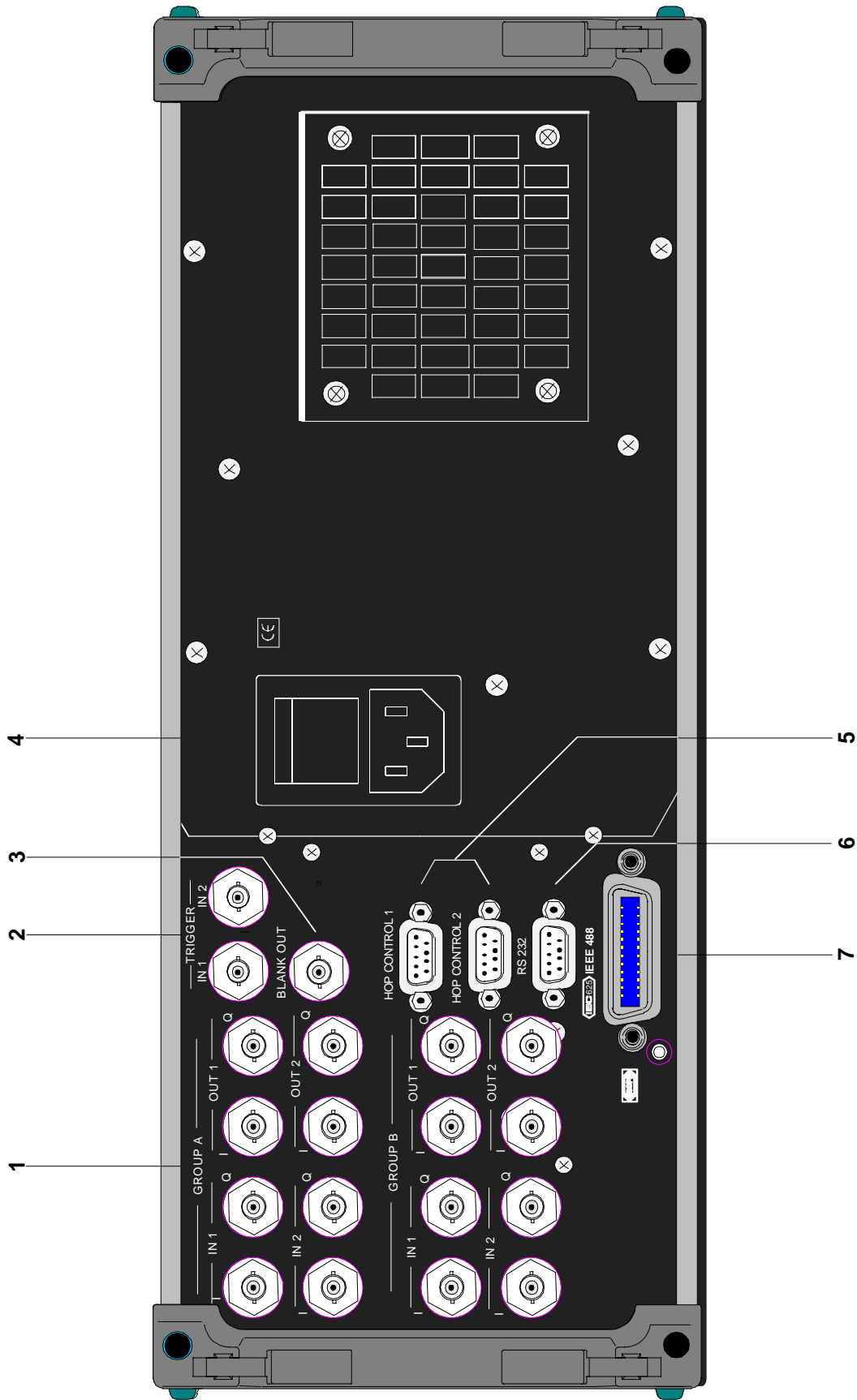
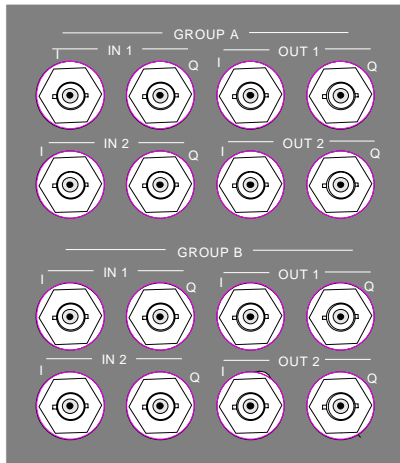


Fig. 1-2 Rear panel view ABFS

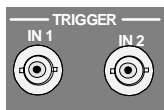
Elements of the Rear Panel

1 GROUP A / GROUP B



GROUP A
GROUP B Baseband inputs and outputs. The active inputs and outputs are displayed, depending on the selected operating mode and the options installed, in submenu MODE.
 Input/output resistance: 50 Ω.
 Nominal voltage: $U_s = 0.5\text{ V}$
 Max. permissible overvoltage: $\pm 5\text{ V}$

2 TRIGGER



TRIGGER
IN 1 Trigger Input
 HOP CONTROL 1.
 Level: TTL
IN 2 Trigger Input
 HOP CONTROL 2.
 Level: TTL

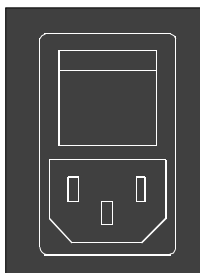
See as well Chapter 4, Section "HOP CONTROL"

3 BLANK OUT



BLANK OUT Output to blank out the frequency change of fading generators during HOP CONTROL.
 Level: TTL

4 POWER SWITCH



Power switch ON when pressed at the top ("I")
Power supply connector

See as well Chapter 1, Section "Supply voltage"
 Section "Switching On/Off the Instrument"

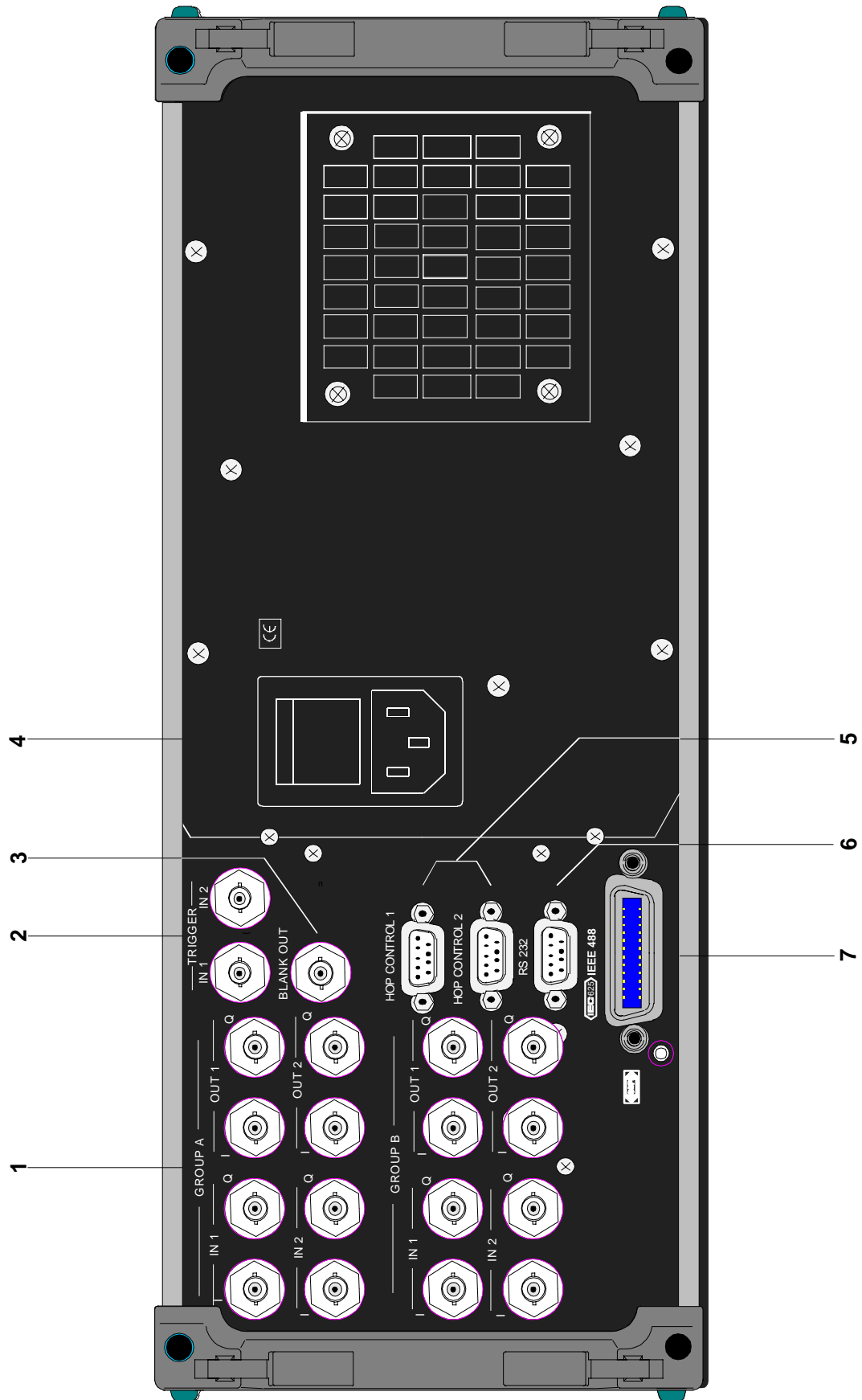
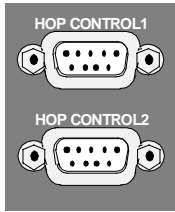


Fig. 1-2 Rear panel view ABFS

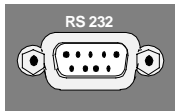
5 HOP CONTROL 1 / HOP CONTROL 2



HOP CONTROL 1
 HOP CONTROL 2 RS-232 HOP CONTROL interfaces. Transmission of a list index for selection of a HOP frequency for HOP CONTROL 1 or 2. In addition to trigger inputs TRIGGER IN 1 / IN 2 a trigger can also be activated as an option via the DSR line (pin 6).

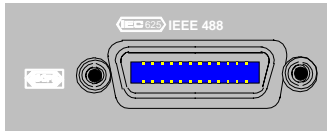
See as well Chapter 4, Section "HOP CONTROL"

6 RS 232



RS 232 RS-232-C interface, used for software update and remote control. The pin assignment corresponds to the pin assignment of a PC.

7 IEC / IEEE488



IEC 625/
 IEEE 488 IEC/IEEE bus (IEEE 488) Remote-control interface

See as well Chapter 5, Section "Interfaces"

2 Brief Introduction

This chapter provides information on the connection of ABFS and gives a short introduction with sample settings for first-time users. It thus allows a fast familiarization with the operation of the unit.

Connection of ABFS

ABFS is a fading simulator that utilizes the complex baseband signals I and Q. It does not comprise any signal source. It is located between the IQ source and RF upconverter in the baseband signal path (see Fig. 2-1).

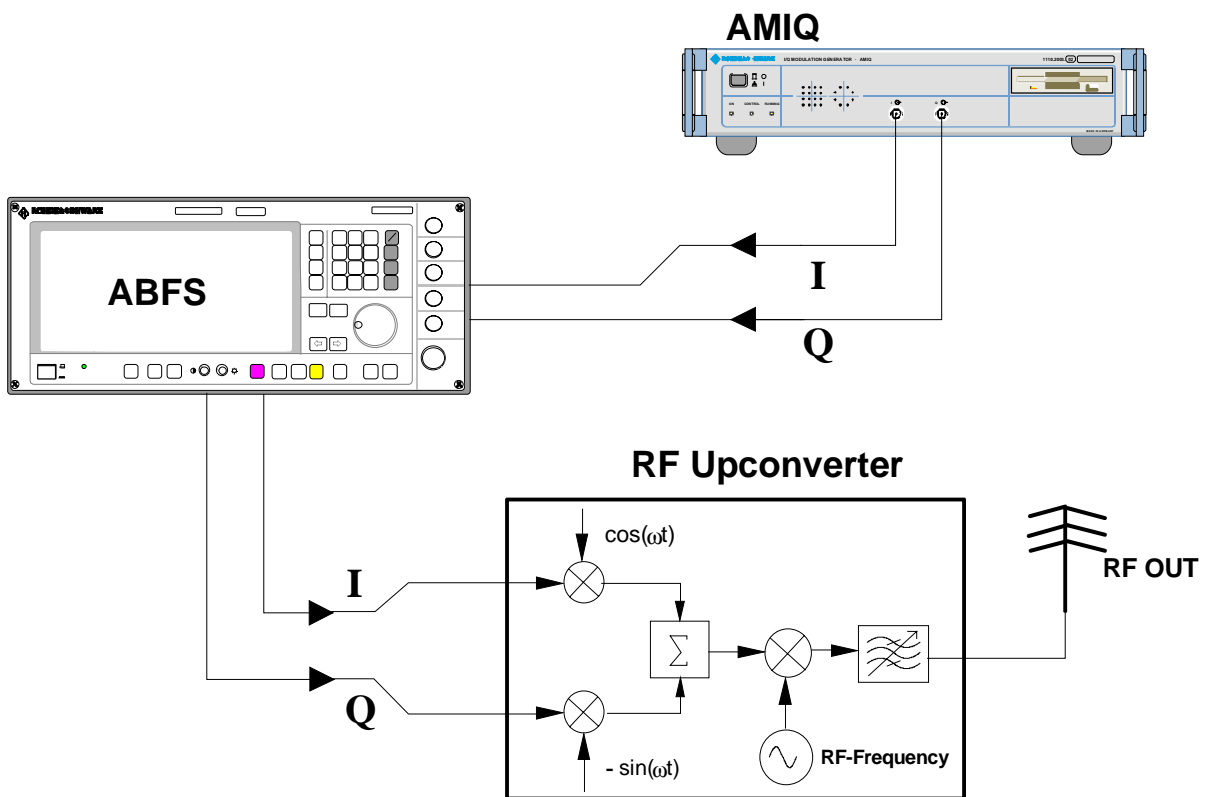


Fig. 2-1 Connection of Fading Simulator ABFS

AMIQ from Rohde & Schwarz is for use as an external source to generate modulation signals required for I/Q modulation. The generated signals are provided at the modulation outputs I and Q of AMIQ (front panel).

It is also possible to connect an IQ modulation source to ABFS other than AMIQ. The maximum rated input voltages must however be observed (see chapter 1, "Elements of the Rear Panel").

Sample Settings for First-Time Users

Fading a GSM signal

"GSM TYPICAL URBAN 12 Path" fading standard, RF carrier frequency = 904.5 MHz

First, the signal source (INPUT) and the upconverter (OUTPUT) are connected to ABFS. GROUP B connectors are available only if option ABFS-B2 (second fading group) has been fitted.

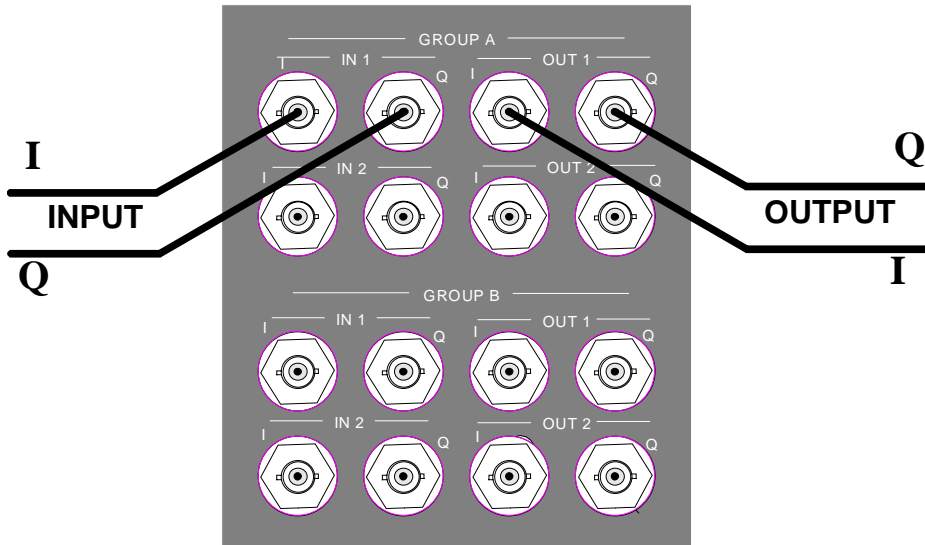




Fig. 2-2 Signal input/outputs on rear panel of ABFS

The fading mode can be set via the [MODE GRP A] toggle key. Press the [MODE GRP A] key until the 1CHANNEL 12 PATH mode is displayed for GROUP A, see Fig. 2-3).

Operating steps	Explanations
	Reset unit to defined state.
	Press key n-times until the FSIM A-1CH/1IN/1OUT fading mode is displayed in the status line.

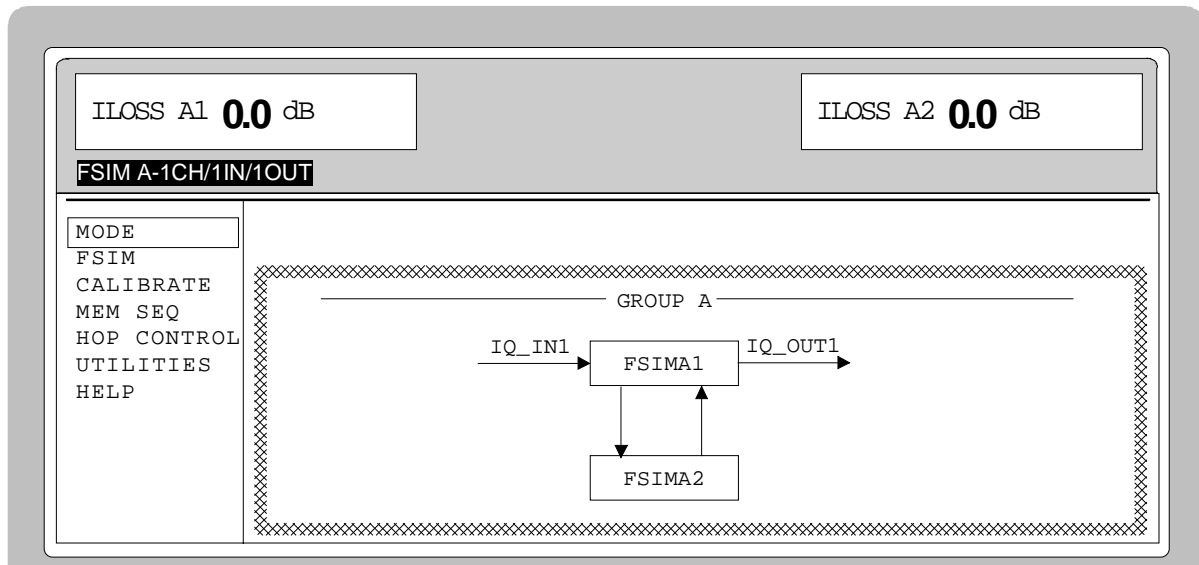
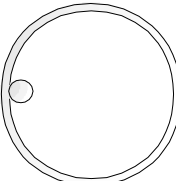

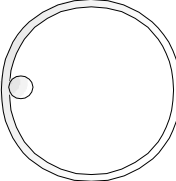

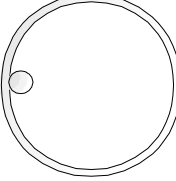

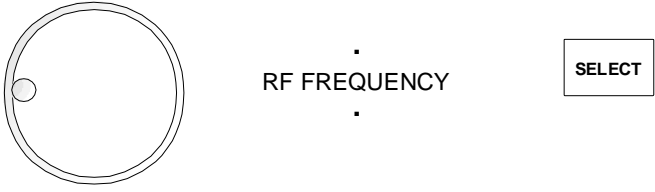
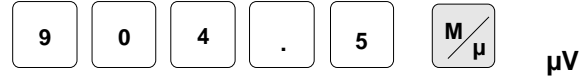
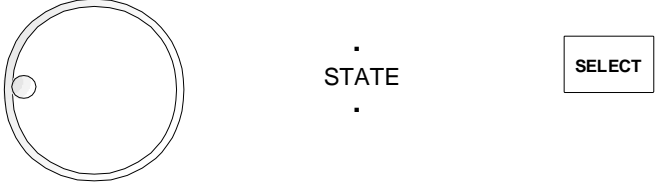
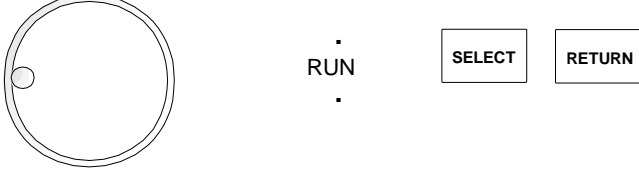


Fig. 2-3 Display for setting the fading mode

Setting the fading parameters

Operating steps		Explanations
<p>MENU / VARIATION</p>  <p style="text-align: center;">· FSIM ·</p> <p>MENU / VARIATION</p> 	<p>Select FSIM menu using the rollkey and press the SELECT key.</p> <p>The submenu is displayed.</p>	
<p>MENU / VARIATION</p>  <p style="text-align: center;">· STANDARD ·</p> <p>MENU / VARIATION</p> 	<p>Select STANDARD submenu and press the SELECT key.</p> <p>A selection of different fading standards is displayed.</p>	
<p>MENU / VARIATION</p>  <p style="text-align: center;">· GSM TYPICAL URBAN 3 ·</p> <p>MENU / VARIATION</p> 	<p>Select GSM TYPICAL URBAN 3 standard using the rollkey and press the SELECT key.</p> <p>The display returns to the FSIM menu and the parameters for the standard are set.</p>	

Operating steps	Explanations
<p>MENU / VARIATION MENU / VARIATION</p>  <p style="text-align: center;">. RF FREQUENCY .</p>	<p>Select RF-FREQUENCY using the rollkey and press the SELECT key.</p>
<p style="text-align: center;">DATA INPUT</p>  <p style="text-align: center;">9 0 4 . 5 M/μ μV</p>	<p>Enter an RF carrier frequency of 904.5 MHz. The cursor returns to the FSIM menu.</p>
<p>MENU / VARIATION MENU / VARIATION</p>  <p style="text-align: center;">. STATE .</p>	<p>Select STATE using the rollkey and press the SELECT key.</p> <p>The menu cursor marks the current 1-out-of-N selection.</p>
<p>MENU / VARIATION MENU / VARIATION</p>  <p style="text-align: center;">. RUN .</p>	<p>Select RUN using the rollkey and press the SELECT key. The cursor jumps to RUN.</p> <p>Press the RETURN key to again return to the FSIM menu.</p>

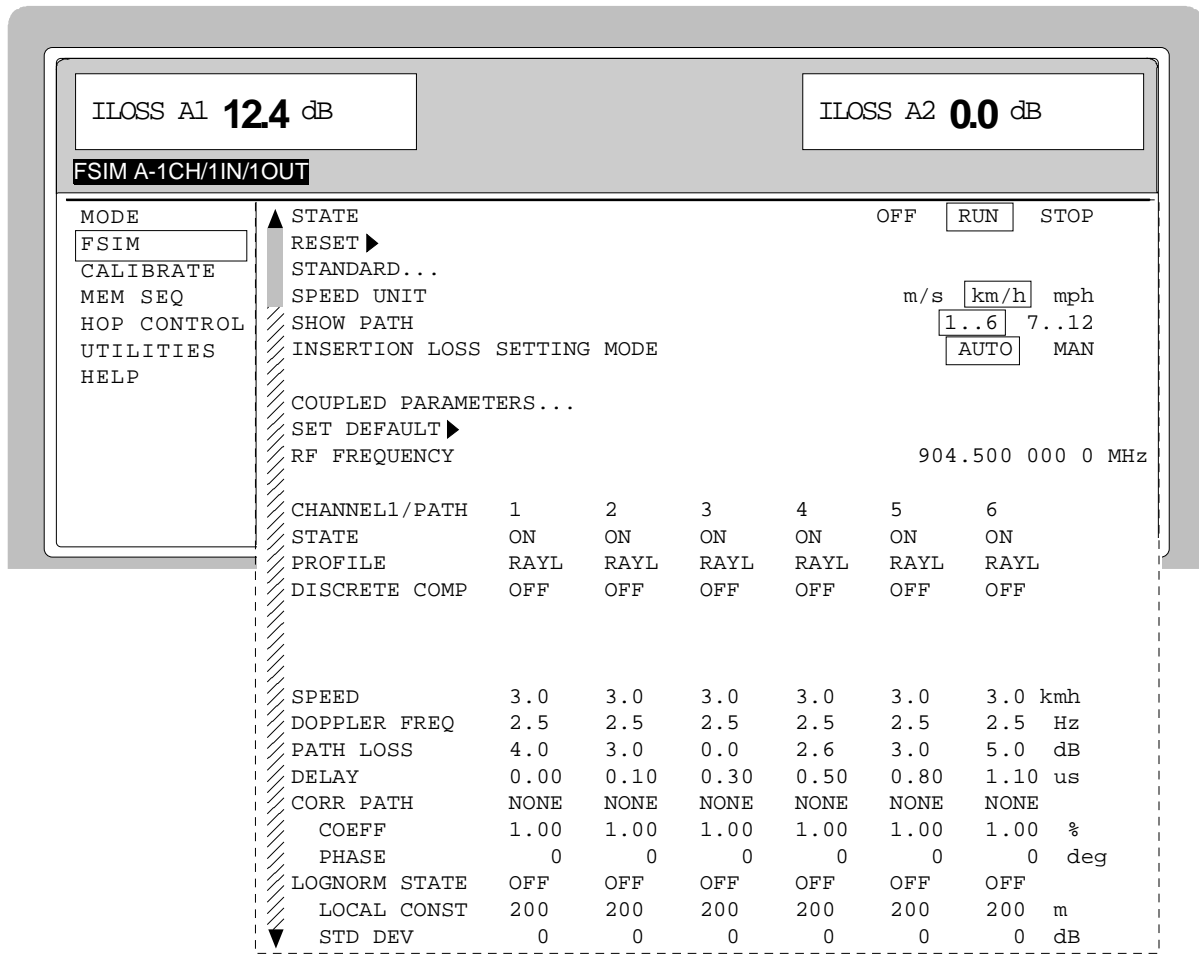


Fig. 2-4 Display for setting fading

3 Manual Operation

This chapter shows the design of the display and describes the manual control of the Baseband Fading Simulator, for example calling up of menus, selection and editing of parameters, use of the list editor and the SAVE/RECALL function. This chapter also contains an overview of menus showing the functions available for the instruments and its options.

It is useful to read the sample settings for first users in Chapter 2, "Short Tutorial".

Design of the Display

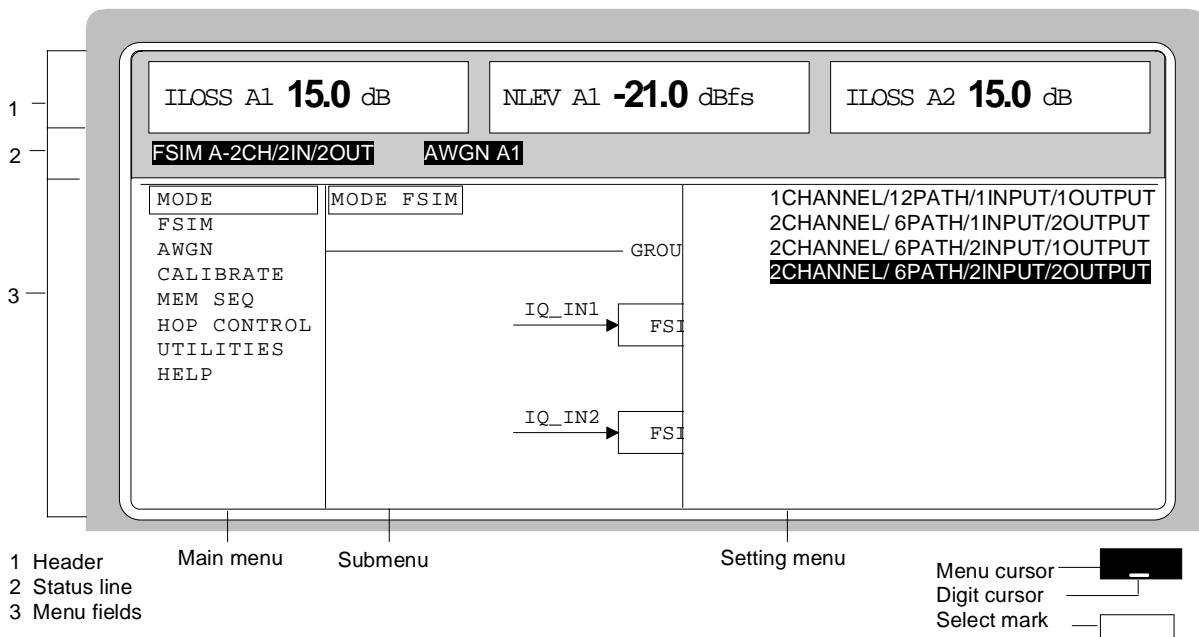


Fig. 3-1 Design of the display

(1) Header Depending on the operating mode set, the header indicates the different insertion losses for the individual channels (ILOSS = Insertion Loss). With options ABFS-B1/ABFS-B3 fitted, it also indicates the set noise level (NLEV = Noise Level).

(2) Status line The status line below describes operating mode and operating state of the instrument. Error messages and notes for caution are also displayed in the status line.

(3) Menu fields The indication fields below the header field are reserved for the menu representations. The image contents of these fields change as a function of the menu selected. The field at the left-hand display margin is occupied with the main menu, the topmost level of the menu structure. The main menu is always faded in. Each further field adjacent at the right contains submenus.

The field ending with the right-hand display margin shows the setting menu. In this menu all setting values and setting states connected with the menu selected are indicated. When accessing submenus, the higher-order menus remain in the display. The current menu path is evident through the select marks.

Menu cursor The menu cursor shows the user at which position in the menu he is. The position of the menu cursor is evident from the inverse notation of the term (white characters on a black background).

Digit cursor As an underscore, the digit cursor marks the position which can be varied by means of the rotary knob in a value indication.

Select mark The frame around a term marks current menus or valid settings in the setting menu.

Basic Operating Steps

To operate the instrument, menus are called in the display. All setting possibilities and the current setting status are evident from the menus. All settings can be made by accessing the menus.

Besides the menus, the keys [MODE GRP A] and [MODE GRP B] may also be used for making settings on the signal paths of GROUP A/B. Likewise, the fading simulators and the noise generators can be switched on and off not only via the menu but also by means of the keys [FADING ON/OFF] and [AWGN ON/OFF].

Calling the menus

Accessing the menus is effected using rotary knob [VARIATION], [SELECT] key and [RETURN] key.

Rotary knob Rotary knob [VARIATION] moves the menu cursor over the positions of a menu level to be selected.
If a scrollbar is visible at the left-hand margin of a menu, the menu is larger than the screen window. If the menu cursor is moved to the margin of the screen window, the covered lines become visible.

[SELECT] key The [SELECT] key acknowledges the selection marked by means of the menu cursor.

[RETURN] key The [RETURN] key

- returns the menu cursor to the next higher menu level; the menu cursor is shifted to the left into the preceding column of the menu structure,
- closes the display pages called using keys [STATUS], [HELP] and [ERROR] again.

Settings are accessed in the setting menu ending with the right-hand display margin.

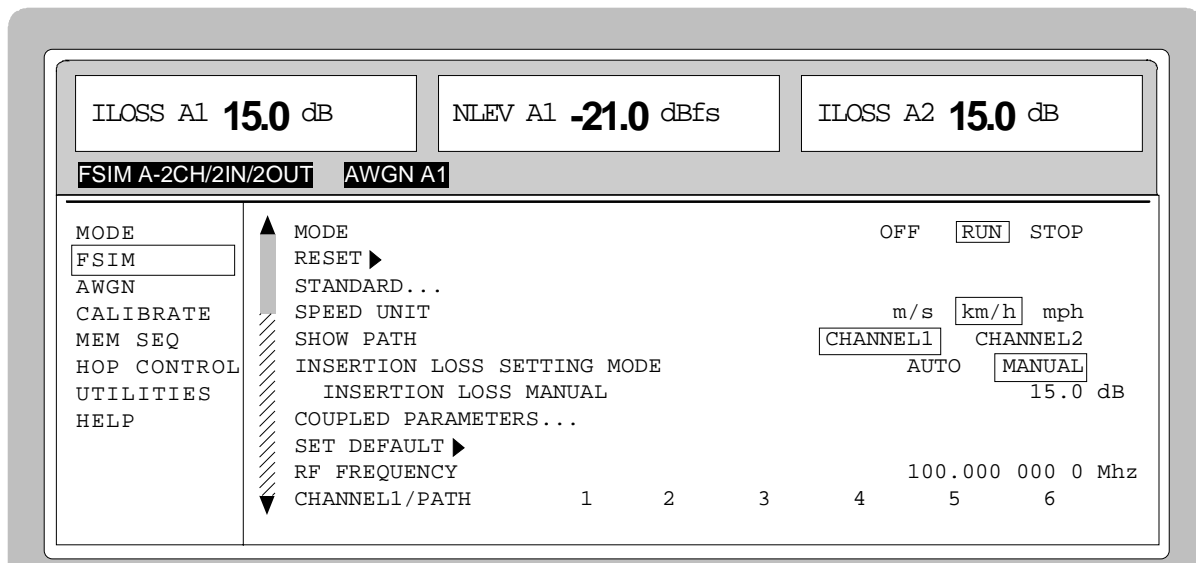


Fig. 3-2 Fading setting menu

Selection and Change of Parameters

- Select parameter** ➤ Set the menu cursor to the name of the parameter desired using the rotary knob, e.g. to INSERTION LOSS MANUAL in the FSIM setting menu, see Fig. 3-2.
- Change setting value** ➤ Via value input or by means of rotary knob.
- Via value inputs
- Press the first digit of the new value or minus sign.
The old value is deleted, the entry is indicated in the marked field.
 - Enter further digits.
 - Terminate the input using a unit key or, in the case of inputs in the base unit or in the case of inputs without unit, using the [1x/Enter] key.
The menu cursor wraps back to the appropriate parameter.
- Using rotary knob
- Press [SELECT] key.
The menu cursor changes from the parameter selected in the left-hand column of the setting menu to the setting value on the right, e.g. from INSERTION LOSS MANUAL to 15.0 dB, see Fig. 3-2.
 - Set the underscore to the position of the setting value to be varied using keys [⇒] [⇐].
 - Turn rotary knob.
The position underscored is varied in steps of 1.
- 1-out-of-n selection**
- Select parameter.
 - Press [SELECT] key.
The menu cursor changes from the parameter selected in the left-hand column of the setting menu to the current selection on the right, e.g. from SPEED UNIT to km/h, see Fig. 3-2.
 - Set the menu cursor to the position desired within the 1-out-of-n selection using the rotary knob or cursor keys [⇐] [⇒].
 - Press [SELECT] key.
The setting is made. The selection mark which has marked the setting valid up to now wraps to the new position.
 - Press the [RETURN] key.
The menu cursor wraps back to the respective parameter.
- Quick selection of a parameter**
- The quick selection of a parameter reduces the number of operating steps if several parameters are set successively. The menu cursor can directly be set further from line to line in the column of the setting values by pressing the [SELECT] key.
- The menu cursor wraps from the setting value of a parameter to the setting value of the parameter in the next line.
- The column of the setting values can be exited at each position by pressing the [RETURN] key.

Triggering Action

Lines in the setting menu which are marked with the "▶" symbol at the end of the line qualify an action which can be carried out. Instruction SET DEFAULT ▶ sets the default values of the path parameters.

- Triggering action**
- Set the menu cursor to the respective instruction.
 - Press the [SELECT] key.
The action is triggered.
While the action is carried out, the instruction remains framed by the selection mark.

Quick Selection of Menu (QUICK SELECT)

The keys [ASSIGN], [MENU1] and [MENU2] of the QUICK SELECT control field are used to call selected menus quickly by one keystroke.

- Store menus**
- Establish the desired operating status of the current menu.
 - Press [ASSIGN] key.
 - Press [MENU1] or [MENU2] key.
The current menu is stored as menu1 or menu2. That is to say, 2 menus can be stored in total.

- Call menus**
- Press [MENU1] or [MENU2] key.
Menu1 or menu2 stored is displayed. Exactly the operating status which was current at the point of time of storing is reconstructed.

Using Keys [MODE GRP A] and [MODE GRP B]

Besides the menus, the keys [MODE GRP A] and [MODE GRP B] may also be used for making settings on the signal paths of GROUP A/B.

- Key [MODE GRP A]
Key [MODE GRP B]**
- Press key [MODE GRP A] or [MODE GRP B].
The various operating modes or signal paths of the group are selected successively.

After pressing the key, a window is opened in which the set ABFS signal paths are displayed in a graphic. The window is independent of the current menu control and menu hierarchy. The graphic is identical with that in the MODE menu. The window is cleared automatically after 10 seconds. If a key is pressed while the signal paths are being displayed, the window will be cleared and operation via menus continues.

Using Keys [FADING ON/OFF] and [AWGN ON/OFF]

FADING and NOISE (AWGN Additive White Gaussian Noise) can be switched on and off not only in the menus but also by means of the keys [FADING ON / OFF] and [AWGN ON / OFF].

- | | |
|----------------------------|---|
| Key [FADING ON/OFF] | ➤ Press key [FADING ON/OFF].
Switching all fading simulators on or off. If fading is switched off, 0.0 dB will be indicated in the ILOSS displays. |
| Key [AWGN ON/OFF] | ➤ Press key [AWGN ON/OFF].
Switching all noise generators on or off. |

Correction of Input

Digits can be corrected by one of the following keys before the input is confirmed by the [Enter] key:

- | | |
|---|---|
| Key [-/←] | The backspace key deletes the value entered digit by digit. When the last digit is deleted, the previous value is displayed. |
| Key [RETURN] | Pressing the [RETURN] key deletes the entire entry and results in the previous value being indicated again.

For a subsequent new input in the setting menu, the digit of the new value is to be entered. |
| Key [MODE GRP A]/
Key [MODE GRP B] | If a selection is made by pressing the keys [MODE GRP A] or [MODE GRP B], a second press of the same key will delete the whole entry made. |

List Editor

The ABFS offers the facility of generating lists for automatic sequences of HOP mode and Memory Sequence. The lists consist of elements (pairs of values) which are defined by an index and at least one parameter per index. Each list is assigned a separate name and selected by means of this name. Access to the lists is made in the associated menus. For example, sequences of instrument settings can be accessed in the MEM SEQ menu. However, the lists are always generated and processed in the same way and the procedures are hence explained in detail in this section by the example of the Memory Sequence (Menu MEM SEQ).

Setting menus providing list processing are structured in two pages:

The first page, called OPERATION page in the following contains the general configuration parameters for processing a list. Further, the general list functions such as selecting and deleting the list as well as calling an editing mode are provided. The second page, the EDIT page, is automatically displayed when calling an edit function and serves to enter and modify the parameters of the list.

The OPERATION page has a similar arrangement with all list editors. As an example, the OPERATION page of the MEM SEQ menu is shown:

Menu selection: MEM SEQ

ILOSS A1 0.0 dB		ILOSS A2 0.0 dB	
FSIM A-2CH/2IN/2OUT			
MODE	MODE	<input type="checkbox"/> OFF	AUTO SINGLE STEP EXT_SINGLE EXT_STEP
FSIM	RESET SEQUENCE	▶	
AWGN	CURRENT INDEX	1	
CALIBRATE	SELECT LIST...	CURRENT LIST: MSEQ2	
MEM SEQ	DELETE LIST...		
HOP CONTROL	FUNCTION	FILL	INSERT DELETE EDIT/VIEW
UTILITIES			
HELP			

Fig. 3-3 OPERATION page of the MEM SEQ menu

The settings for MODE, CURRENT INDEX, etc. are irrelevant for the general description of the list editors and are described in Section "Memory Sequence".

The last three menu lines of the OPERATION page always exist and are reserved for selecting and deleting lists as well as for calling the edit functions (and hence the EDIT page).

SELECT LIST Opens a selection window in which a list can be selected from the existing lists or a new, empty list can be generated. In this line the active list is always displayed.

DELETE LIST Opens a selection window in which the list to be deleted can be selected.

FUNCTION Selection of the edit function for processing the lists. The EDIT page is automatically called through the selection.

- FILL Filling a list with elements.
- INSERT Insertion of elements into a list.
- DELETE Deletion of elements of a list.
- EDIT/VIEW Editing the single elements.

Select and Generate - SELECT LIST

SELECT LIST opens a selection window in which either an existing list can be selected or a new, empty list can be generated. By pressing the [RETURN] key, the selection window is closed without changing the setting.

- Select list
 - Mark the list desired using the rotary knob.
 - Press [SELECT] key.
 - The selected list is included in the instrument setting. The selection window is closed. The selected list is displayed under CURRENT.

- Generate list
 - Mark CREATE NEW LIST ► using rotary knob.
 - Press [SELECT] key.
 - A new empty list is automatically generated which can be filled using functions FILL or EDIT. The selection window is closed. The new list is displayed under CURRENT.

- No modification of the setting
 - Press [RETURN] key.

Selection: SELECT LIST

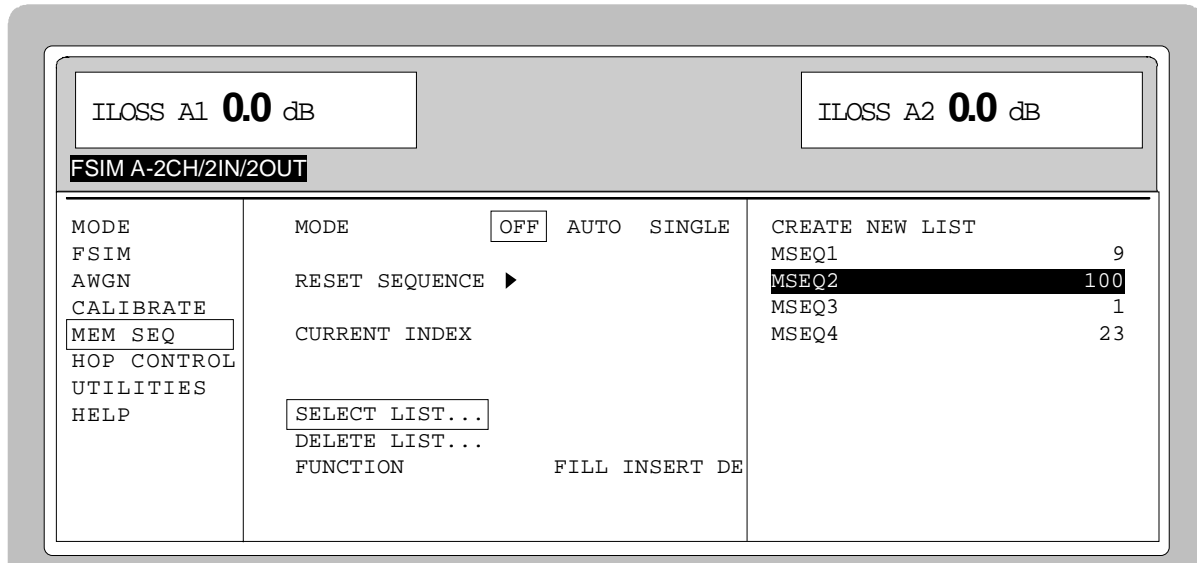


Fig. 3-4 SELECT-LIST selection window

CREATE NEW LIST ▶ Generating a new list. The name of the list cannot be selected freely in the case of manual control. A definite list name is automatically generated in the following form:

MSEQ<n>, with <n> ∈ {0..9}, e.g. MSEQ1 (with Memory Sequence)

In the case of HOP CTRL mode, HOP1 or HOP2 would be generated. If a list is created via IEC bus, an arbitrary list name can be given (cf. Section 5). Unrestricted access is also possible by means of the selection window.

MSEQ2 100

The list currently set is marked in the selection window by means of the selection mark, here MSEQ2. In addition to the list name, the length of the list is given, here 100 elements.

Deletion of Lists - DELETE LIST

DELETE LIST opens a selection window in which the list to be deleted can be selected. The lists are represented together with their name and their length. By pressing the [RETURN] key the selection window is exited without deleting a list.

- Delete list
- Mark desired list using the rotary knob.
 - Press [SELECT] key.
The prompt "enter [SELECT] to delete list/sequence?" is displayed
 - Press [SELECT] key.
The list is deleted. If the prompt is acknowledged with the [RETURN] key, however, the list is not deleted. The selection window is automatically closed due to the acknowledgment of the prompt.

Selection: DELETE LIST

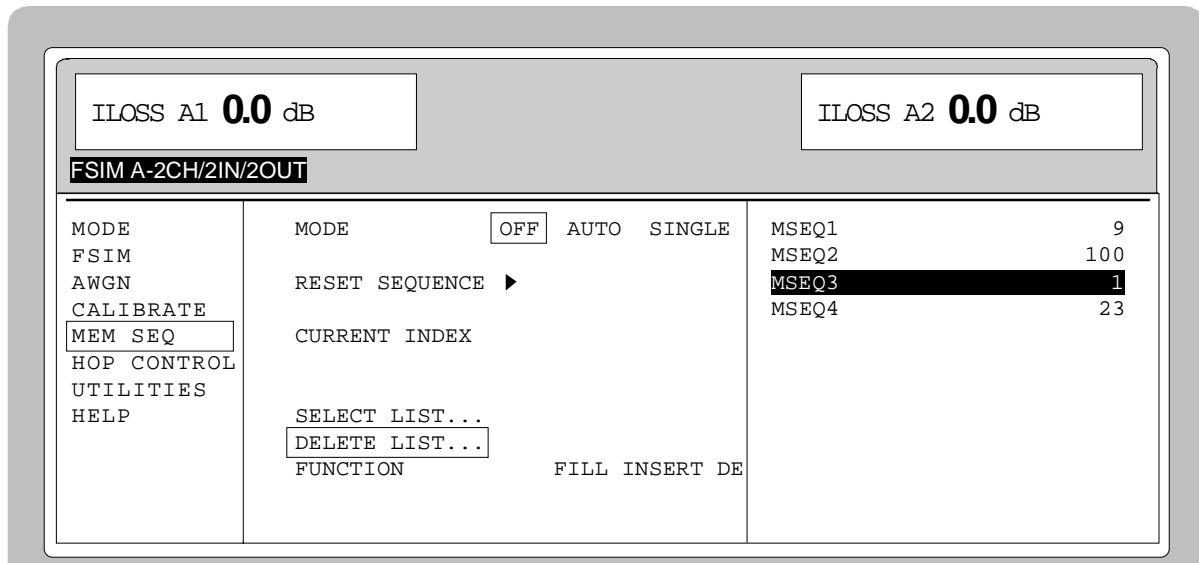


Fig. 3-5 DELETE-LIST selection window

Edition of Lists

Due to the selection of an edit mode on the OPERATION page the EDIT page is automatically activated. When the EDIT/VIEW function is selected, the largest possible section of the list is displayed (cf. Fig. 3-6). In the case of block functions FILL, INSERT and DELETE, an input window is additionally displayed (cf. Fig. 3-7 to Fig. 3-9).

Functions SELECT LIST and FUNCTION are available on the EDIT page as on the OPERATION page. Return to the OPERATION page is effected by pressing the [SELECT] key twice.

Single-value function EDIT/VIEW

By selecting the EDIT/VIEW function, the entire list can be viewed or modifications of single values be carried out.

If the cursor marks a value in the INDEX column of the list, the EDIT mode is exited by pressing the [RETURN] key. The menu cursor then marks FUNCTION again.

There is no separate function for storing the list. This means that every modification of the list is transferred to the internal data set and has an effect on exiting the EDIT/VIEW function.

Selection: FUNCTION EDIT/VIEW

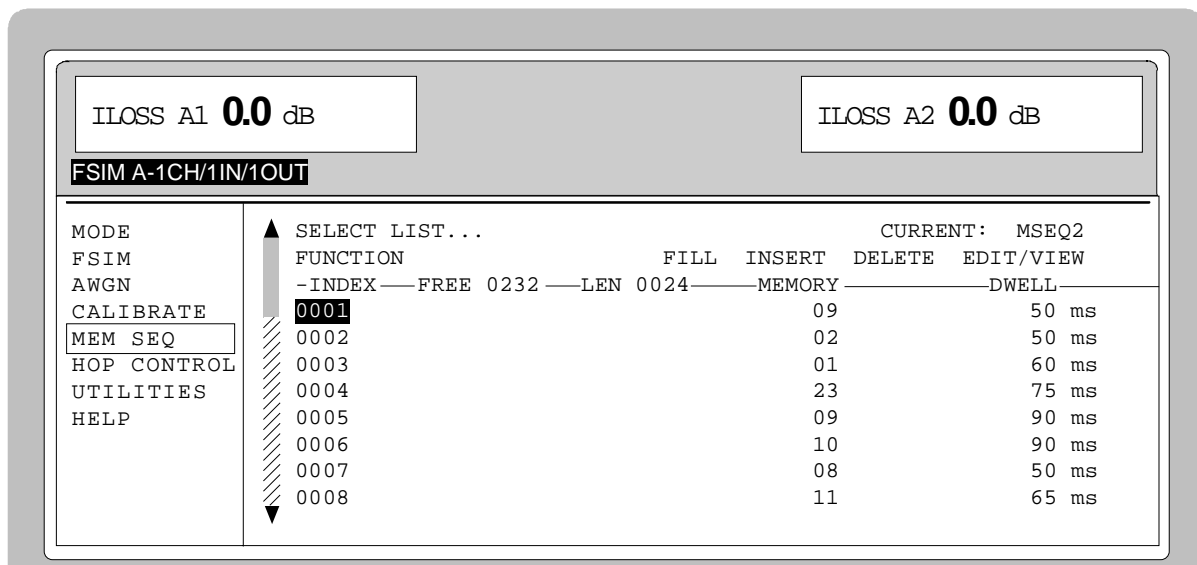


Fig. 3-6 Edit function EDIT/VIEW

INDEX	Position in the list.
FREE	Space available. FREE 0232 means that space for 232 parameter elements is available in the list memory in total.
LEN	Occupied space. LEN 0024 means that the current list occupies 24 elements in the list memory.
MEMORY	Identification of the column below. The number and name of parameter columns is different for the various list editors.
DWELL	

- Select parameter
 - Mark the index associated to the parameter using the rotary knob or directly enter the value of the index via the numeric keys.
 - Press [SELECT] key.
Parameter MEMORY is marked. If the second parameter DWELL is to be marked, press the [SELECT] key again.

- Modify parameter
 - Vary the value of the parameter selected using the rotary knob or enter the value directly using numeric keys.
 - Press the [ENTER] key or unit keys.
The value is included in the data set. The menu cursor marks the value of the next column. In the last column, the menu cursor then marks the next line of column MEMORY.
 - Press the [RETURN] key.
The menu cursor wraps back to the INDEX column. The EDIT mode is exited by repeatedly pressing the [RETURN] key (cf. Chapter 2, Section "Sample Settings for First Time Users").

Block function FILL

Using function FILL, a parameter, e.g. MEMORY, is overwritten with constant or linearly increasing/decreasing values within a defined range. The input window is exited by pressing the [RETURN] key without a modification being carried out.

If the filler range exceeds the end of the list, the list is automatically extended.

The list entry, in the example for MEMORY, with index [AT +n] is calculated as follows from the information AT, RANGE, starting value (MEMORY) and WITH INCREMENT:

$$\text{MEMORY[AT+n]} = \text{starting value (MEMORY)} + n \cdot \text{increment} \quad | \quad (0 \leq n \leq \text{RANGE1})$$

Selection: FUNCTION FILL

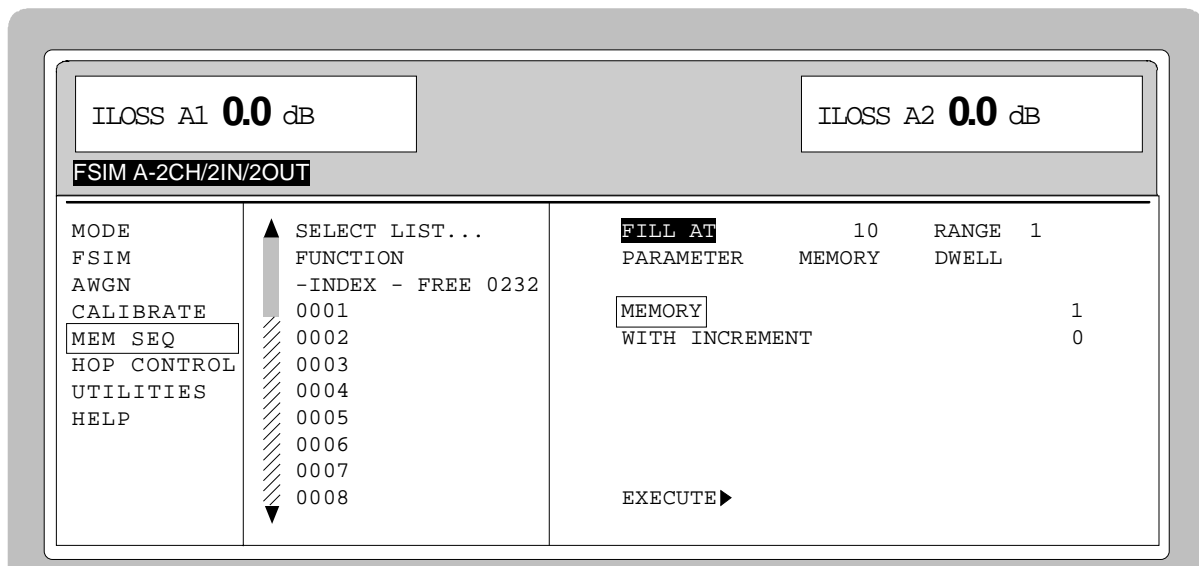


Fig. 3-7 Edit function FILL: input window

FILL AT	Setting the filling range. AT Lower limit (index) RANGE Number of the elements to be inserted
PARAMETER	Selection on which of the parameters the filling function is to have an effect. This menu option is eliminated if the list only includes elements with one parameter.
MEMORY oder DWELL	Input of the starting value for the parameter selected. This option is only displayed if a selection has been made under PARAMETER MEMORY or DWELL.
WITH INCREMENT	Input of the increment between two successive values. If 0 is entered as increment, a filling procedure with constant values is achieved. This option is only displayed if a selection has been made under PARAMETER MEMORY or DWELL.
EXECUTE ►	Starts the filling sequence. After the function has been executed, the input window is automatically exited. The current index points to the first element after the processed range.

Filling a list	<p>After selection of function FILL, the menu cursor marks FILL AT.</p> <ul style="list-style-type: none"> ➤ Press the [SELECT] key. The menu cursor marks the value at AT. ➤ Vary index value using the rotary knob or enter using the numeric keys and the [ENTER] key. ➤ Press the [SELECT] key. The menu cursor marks the value at RANGE. ➤ Vary value using the rotary knob or enter using the numeric keys and the [ENTER] key. ➤ Press the [SELECT] key. The menu cursor marks MEMORY or DWELL in input line PARAMETER. ➤ Select MEMORY using the rotary knob (if not yet marked) and press the [SELECT] key. The menu cursor marks the value in input line MEMORY. ➤ Vary starting value for column MEMORY using the rotary knob or enter using the numeric keys and the [ENTER] key. ➤ Press the [SELECT] key. The menu cursor marks the value in input line WITH INCREMENT. ➤ Vary the value of the increment desired using the rotary knob or enter using the numeric keys and the [ENTER] key. ➤ Press the [RETURN] key. ➤ Mark the action EXECUTE ► ➤ Press the [SELECT] key. The filling sequence is initiated. After the function has been carried out, the input window is automatically exited. The menu cursor marks FUNCTION. The EDIT page shows the end of the range that has been filled right now.
----------------	---

Block function INSERT

Function INSERT inserts the desired number of elements with constant or linearly increasing/de-creasing values before the element with the given starting index. All elements which had been stored from the starting index are shifted to the end of the range to be inserted.

Input is effected analogously to filling a list.

By pressing the [RETURN] key the input window is exited without a modification being effected. The menu cursor then marks FUNCTION.

The list entry, in the example for MEMORY, with index [AT +n] is calculated as follows from the information AT, RANGE, starting value (MEMORY) and WITH INCREMENT:

$$\text{MEMORY}[AT+n] = \text{starting value (MEMORY)} + n \cdot \text{Increment} \quad | \quad (0 \leq n \leq \text{RANGE}-1)$$

Selection: FUNCTION INSERT

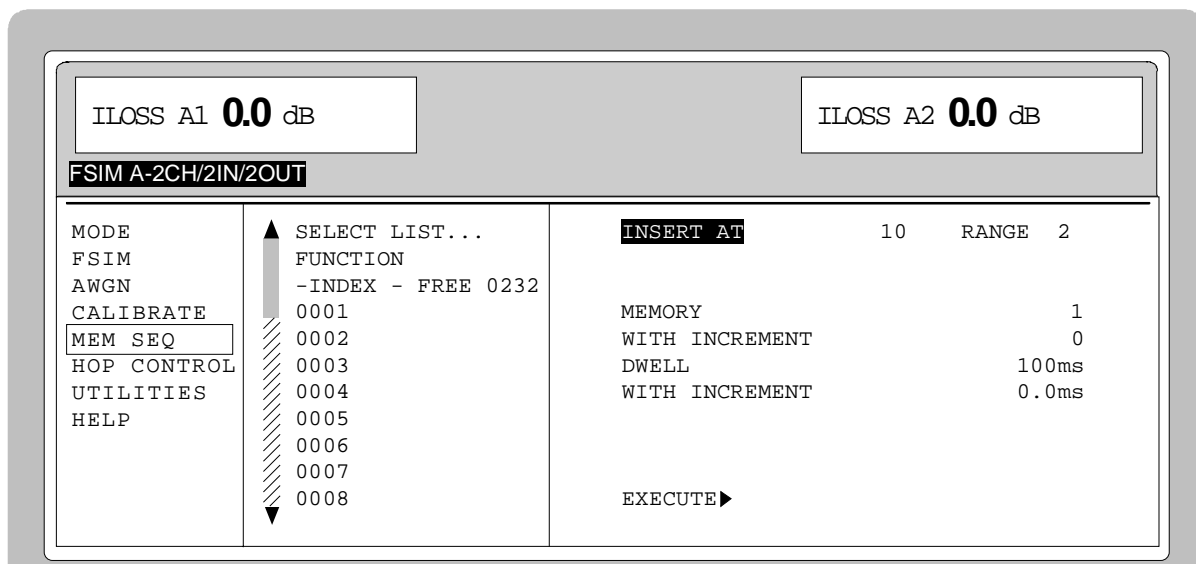


Fig. 3-8 Edit function INSERT: input window

INSERT AT Input of the starting index and the number of the elements to be inserted.
AT Starting index before which the insert operation is to be effective.
RANGE Number of the elements to be inserted.

MEMORY Input of the starting value for MEMORY.

DWELL Input of the starting value for DWELL.

WITH INCREMENT Input of the increment between two successive values for MEMORY or DWELL. If 0 is indicated as increment, constant values are achieved to be inserted RANGE times.

EXECUTE ► Starts the inserting sequence. After the function has been executed, the input window is automatically exited. The menu cursor marks FUNCTION. The EDIT page shows the beginning of the range that has moved forward.

Block function DELETE

Function DELETE deletes the elements of the range indicated. This does not leave a gap in the list but the remaining elements move forward. If the given range exceeds the end of the list, deletion until the end of the list is effected.

Input is analog to filling a list.

By pressing the [RETURN] key, the input window is exited without a modification being carried out. The menu cursor then marks FUNCTION.

Selection: FUNCTION DELETE

Fig. 3-9 Edit function DELETE: input window

DELETE AT Input of the block of the list to be deleted
 AT Lower limit (INDEX)
 RANGE Number of elements to be deleted.

EXECUTE ► Starts the deletion. After the function has been executed, the input window is automatically exited. The menu cursor marks FUNCTION. The EDIT page shows the beginning of the range that has moved forward.

SAVE/RECALL – Storing/Calling of Instrument Settings

50 complete instrument settings can be stored in memory locations 1 to 50.

Operating Steps	Explanations
<p style="text-align: center;">DATA INPUT</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 5px;">SAVE</div> <div style="border: 1px solid black; padding: 2px 5px;">1</div> <div style="border: 1px solid black; padding: 2px 5px;">2</div> <div style="border: 1px solid black; padding: 2px 5px;">x1 ENTER</div> </div>	<p>Store current instrument setting in memory location 12.</p>
<p style="text-align: center;">DATA INPUT</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 5px;">RCL</div> <div style="border: 1px solid black; padding: 2px 5px;">1</div> <div style="border: 1px solid black; padding: 2px 5px;">2</div> <div style="border: 1px solid black; padding: 2px 5px;">x1 ENTER</div> </div>	<p>Call instrument setting of memory location 12.</p>

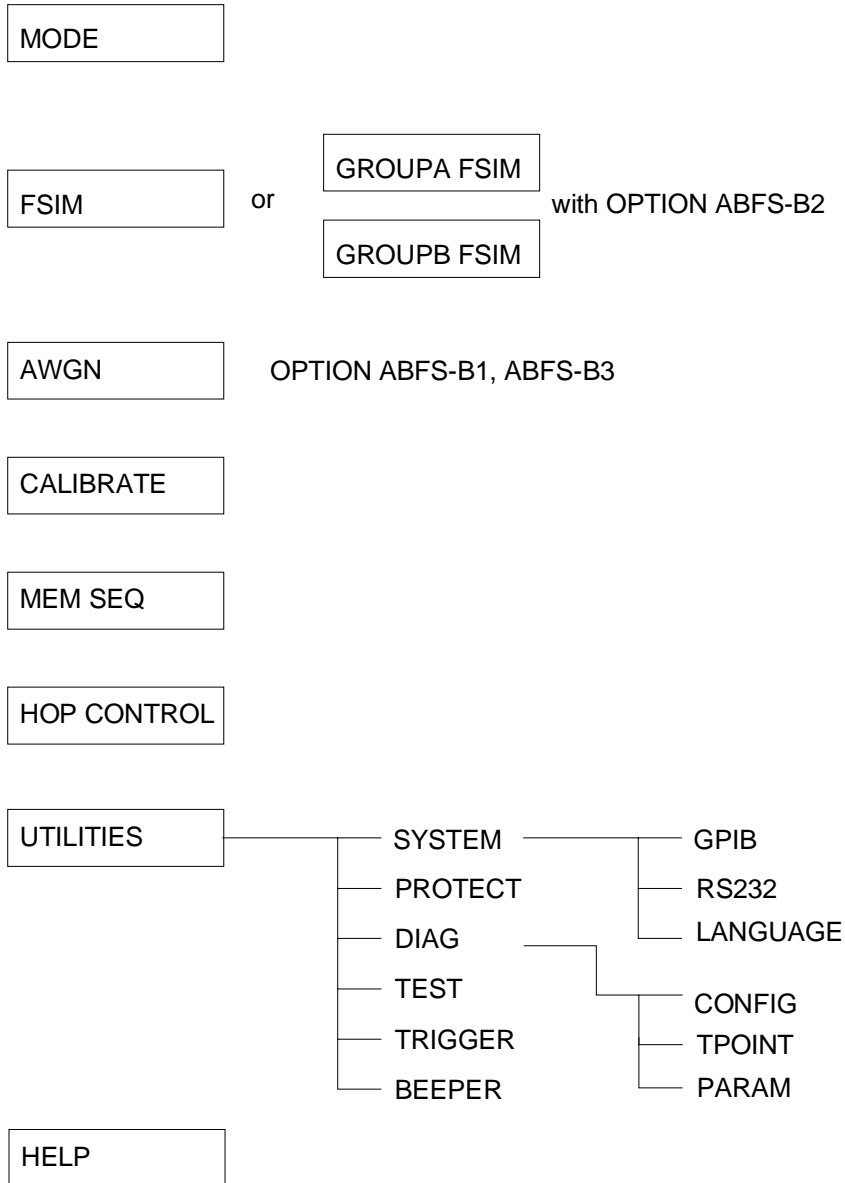
The digital display during a save or recall entry is faded in a window.

Memory location 0 has a special function. Here the instrument setting which was current prior to the last memory recall and prior to a preset setting is automatically stored. This permits the resetting of instrument settings which have inadvertently been deleted using Recall 0.

Store IEC-bus command: " *SAV 12 "

Call IEC-bus command: " *RCL 12 "

Menu Summary



4 Device Functions

The present chapter describes the functions and options of the unit. The functions can be called up manually via menus or via remote control and include fading, noise generation, HOP-CONTROL, memory sequence and general functions that are not directly related to signal generation. The subdivision of this chapter is according to the ABFS operating menu.

Fading Modes

Basic Units With 12 Paths

The different operating modes or signal paths of the fading channels can either be set directly via the MODE GRP A key or via the MODE menu. Fig. 4-1 shows the selection of operating modes in the MODE submenu of ABFS in its basic model configuration (without options ABFS-B1 / ABFS-B2 / ABFS-B3).

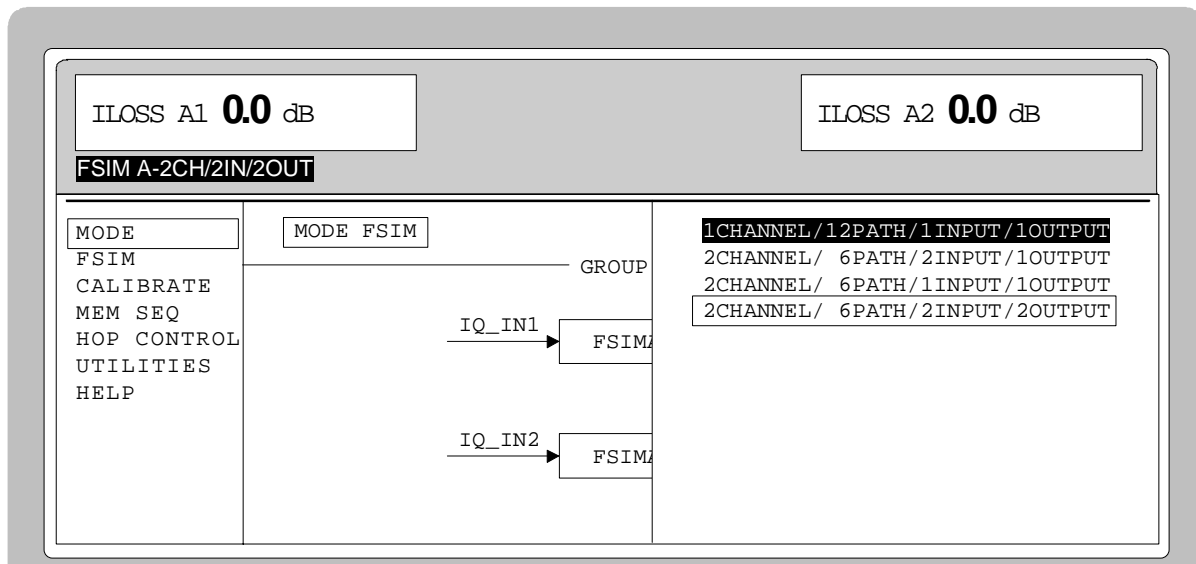


Fig. 4-1 Selection of operating modes in MODE submenu

In its basic configuration, ABFS comprises two fading modules that form a group of 12 fading channels. The channels can be combined to form the following operating modes:

- 1CHANNEL/12PATH/
1INPUT/1OUTPUT** One fading channel with 12 paths.
IEC/IEEE-bus command : SOUR:FSIM:CONF SISO
- 2CHANNEL/6PATH/
2INPUT/1OUTPUT** Two fading channels with 6 paths each and a common output.
IEC/IEEE-bus command : SOUR:FSIM:CONF DISO
Note: If option B49 is installed, this setting is not possible for the Moving Delay and Birth-Death operating modes !
- 2CHANNEL/6PATH/
1INPUT/2OUTPUT** Two fading channels with 6 paths each and a common input.
IEC/IEEE-bus command : SOUR:FSIM:CONF SIDO
Note: If option B49 is installed, this setting is not possible for the Moving Delay and Birth-Death operating modes !

**2CHANNEL/6PATH/
2INPUT/2OUTPUT**

Two fading channels with 6 paths each and a separate input and output per channel.

IEC/IEEE-bus command :SOUR:FSIM:CONF D1D0

Note: *If option B49 is installed, this setting is not possible for the Moving Delay and Birth-Death operating modes !*

When switching between the operating modes using the MODE GRP A key or the MODE menu, the different operating modes and their signal paths as well as their assignments to the respective inputs and outputs are displayed graphically. The operating mode is indicated in the status line. See Fig. 4-2.

Menu selection:MODE for basic unit

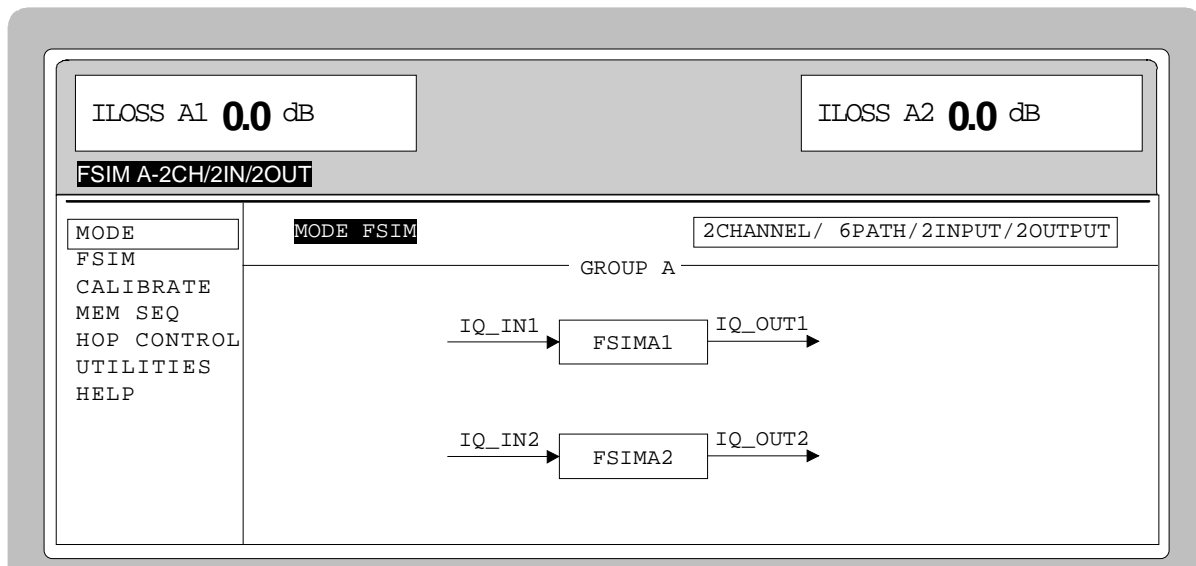


Fig. 4-2 Display of signal paths in the MODE submenu

Fading With Option ABFS-B2

With option ABFS-B2 fitted, another group comprising 12 transmission paths is available. Two separate groups (GROUP A and GROUP B) with 12 paths each are obtained but the individual paths of one group cannot be correlated with the paths of the other group (see correlation between paths). The operating modes or signal paths of a group are equivalent to the settings of the basic group and can either be set directly via the MODE GRP A and MODE GRP B keys or via the operating menu under MODE. The inputs and outputs are again shown graphically. Fig. 4-3 shows the MODE submenu of ABFS with built-in option ABFS-B2. The INSERTION LOSS for GROUP A is indicated on the left and the insertion loss for GROUP B on the right of the display.

Notes on IEC/IEEE-bus commands:

If a second fading group is available due to the presence of option ABFS-B2, all IEC/IEEE-bus commands relating to GROUP A and GROUP B only differ from each other by an identifier following the FSIMulator command, eg operating mode setting :

GROUP A FSIM: :SOURCE:FSIMulator[1]:CONFigure
 GROUP B FSIM: :SOURCE:FSIMulator2:CONFigure

Menu selection:MODE with option ABFS-B2

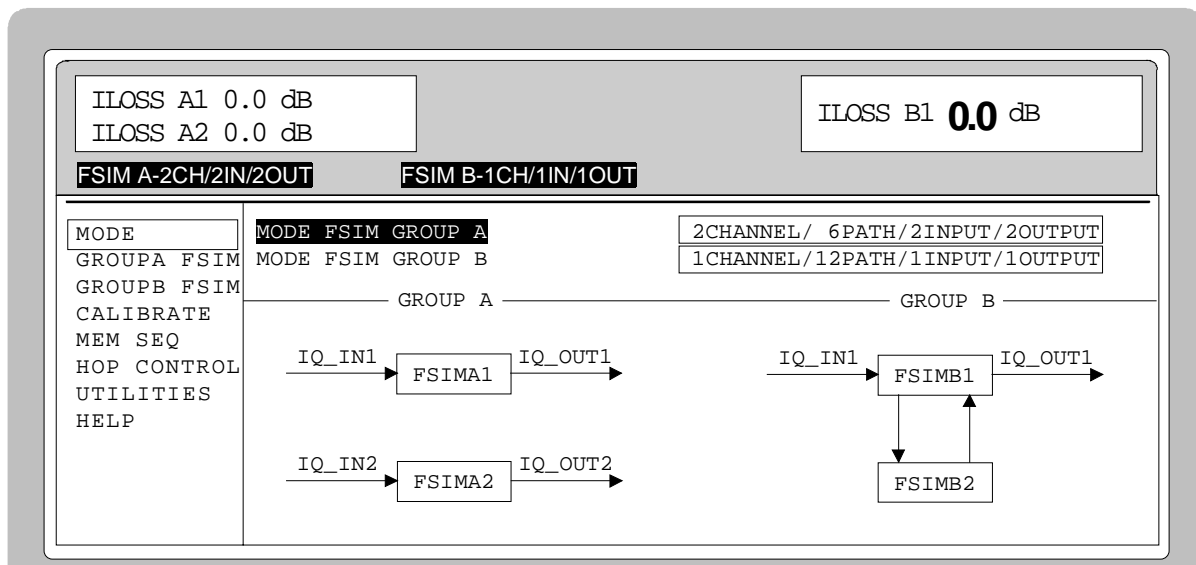


Fig. 4-3 MODE submenu with built-in option ABFS-B2

Fading Setting Parameters - Correlation Between Paths

The fading processes of different paths are normally independent of each other as far as statistics are concerned. However, it is possible to set a correlation of paths 1 to 6 together with paths 7 to 12 in pairs. Setting a correlation calls for synchronous signal processing so the user has to observe the following restrictions:

- Correlation is always reciprocal, ie if path 1 is correlated with 7, path 7 is also correlated with path 1 (CORR PATH).
- The following parameters of the two paths have to correspond with each other:
 - Fading profile PROFILE
 - Doppler parameter SPEED or DOPPLER FREQ

- Magnitude of correlation coefficient COEFF

- The following equation applies to the phase of the correlation coefficient (PHASE) and thus to the phase shift between the correlated paths:

$$\varphi_{12} = 360^\circ - \varphi_{21}$$

- The parameters for lognormal fading have to correspond with each other for correlated paths.

All these requirements necessary for the parameters due to the above restrictions are automatically set by ABFS.

Important: Once all the parameters are set signal processing must be synchronized by RESET and a subsequent RUN.

FSIM menu with option B49

If option B49 is installed, 4 fading modes are available. These can be reached via the following selection menu:



Fig. 4-4 FSIM selection menu with option B49 (option ABFS-B2 not installed)

<p>FSIM</p> <p>or</p> <p>GROUP A FSIM (with option ABFS-B)</p>	<p>Choice of operating modes for the fading simulator.</p> <p>STANDARD FAD "Normal" operating mode with 12 paths, 50 ns time resolution.</p> <p>FINE DELAY Operating mode with finer time resolution. Four paths are possible. The system bandwidth of these paths is restricted to 4.6 MHz; this is sufficient for 3GPP with 3.84 Msymb/s. The time resolution is 1 ns.</p> <p>MOVING DELAY Operating mode with 2 paths, one of which has a fixed delay and the other has a sinusoidally changing delay. This is in line with 3GPP test case 25.104-320, Annex B3.</p> <p>BIRTH-DEATH Operating mode with 2 paths, whose delays can be randomly modified within a time period.</p> <p>Note: <i>The operating modes FINE DELAY, MOVING DELAY and BIRTH-DEATH are only possible for Group A and only if the software option ABFS-B49 is installed.</i></p>
--	--

FSIM Menu (without option B49) /STANDARD FAD Menu (with option B49)

If the option B49 is not available, the menu for setting the fading parameters can be activated directly from the FSIM menu (basic configuration) or from the GROUP A FSIM and GROUP B FSIM menus (with option ABFS-B2 installed).

This menu is the same as the STANDARD FADING menu of option B49.

ILOSS A1 24.0 dB		ILOSS A2 0.0 dB	
FSIM A-1CH/1IN/1OUT STD			
MODE	STATE	OFF	RUN STOP
FSIM	RESET ▶		
AWGN	IGNORE RF CHANGES < 5%		OFF ON
CALIBRATE	STANDARD...		
MEM SEQ	SPEED UNIT	M/S km/h MPH	
HOP CONTROL	SHOW PATH	1..6 7..12	
UTILITIES	INSERTION LOSS SETTING MODE	AUTO MAN	
HELP	INSERTION LOSS MANUAL		24.00 dB
	COUPLED PARAMETERS...		
	SET DEFAULT ▶		
	RF FREQUENCY	100.000	000 0 MHz
CHANNEL1/PATH		1	2
STATE		ON	ON
PROFILE		PDOPP	PDOPP
DISCRETE COMP		ON	ON
POWER RATIO		0.00	
FREQ RATIO		+1.00	+1.00
CONST PHASE		0.0	0.0
SPEED		20.000	20.000
DOPPLER FREQ		6.7	6.7
PATH LOSS		0.0	3.0
SPEED		20.000	20.000
DOPPLER FREQ		6.7	6.7
PATH LOSS		0.0	3.0
DELAY		0.00	0.00
CORR PATH		NONE	NONE
COEFF		1.00	1.00
PHASE		0	0
LOGNORM STATE		OFF	OFF
LOCAL CONST		200.0	200.0
STD DEV		0	0

Fig. 4-5 FSIM menu (without ABFS-B49 and without ABFS-B2) / STANDARD FAD menu (with ABFS-B49)

STATE

Activates the fading simulation by starting (RUN) the fading process. The fading process is stopped by selecting STOP. After RESET the pseudo-noise generator used to generate the fading process in a defined initial state can be started by RUN.
 IEC/IEEE-bus commands : SOUR:FSIM:STAT ON
 : SOUR:FSIM:SEQ RUN

RESET ▶

Resets the pseudo-noise generator. Parameter STATE is automatically set to STOP after RESET. RESET also allows for a synchronization of the two fading options in two-channel mode with correlation switched on.
 IEC/IEEE-bus command : SOUR:FSIM:SEQ:RES

IGNORE RF CHANGES < 5% ►	<p>When enabled, frequency changes less than 5 % are ignored. That permits RF hopping faster than 3 ms.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:IGN:RFCH ON</p>
STANDARD	<p>Opens a window for selecting a defined setting of fading paths. The setting parameters correspond to the test regulations as stipulated in the mobile radio standards (eg GSM, CDMA, NADC). For standards TETRA TYPICAL URBAN and TETRA HILLY TERRAIN all six paths instead of the two are used with this parameter.</p> <p>With the same output signal applied, this yields a better residual carrier.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:STAN CDMA100</p>
SPEED UNIT	<p>Selection of the unit required for the speed of parameter SPEED.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:SPE:UNIT KMPH</p>
SHOW PATH	<p>Switchover between the indication of individual paths of a group. In case of 12-paths fading, switchover is between paths 1 to 6 and 7 to 12 and for 6-paths modes (2 channels) switchover is between CHANNEL 1 and CHANNEL 2.</p>
INSERTION LOSS SETTING MODE	<p>Selection of a setting mode for the insertion loss of the fading simulator.</p> <p>AUTO The insertion loss is set automatically and the value is shown in the display. Calculation is done under the following assumption:</p> <ul style="list-style-type: none"> - full-scale signal at input - typical crest factor of modulated signal <p>Note: signal clipping is possible.</p> <p>MAN The insertion loss can be set under INSERTION LOSS MANUAL.</p> <p>Note: strong signal clipping is possible.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:ILOS:SETT AUTO</p>
INSERTION LOSS MANUAL	<p>Setting of insertion loss for selected channel.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:CHAN:ILOS:MAN 10.0dB</p>
COUPLED PARAMETERS	<p>Opens a window to couple different parameters for all paths of a channel to facilitate operation. If a coupling is switched on, the current value of path 1 is assigned to all paths.</p> <p>The following parameters can be coupled:</p> <ul style="list-style-type: none"> - SPEED SETTING - CORR COEFF SETTING - LOCAL CONST SETTING - STD DEV SETTING <p>IEC/IEEE-bus command : SOUR:FSIM:COUP:SPE : SOUR:FSIM:COUP:CORR:COEF : SOUR:FSIM:COUP:LOGN:LCON : SOUR:FSIM:COUP:LOGN:CSTD</p>
SET DEFAULT ►	<p>Sets the default setting of the path parameters with path 1 switched on and all other paths switched off.</p> <p>IEC/IEEE-bus command : SOUR:FSIM:DEF</p>

RF FREQUENCY	Sets the RF frequency for selected channel. IEC/IEEE-bus command : SOUR:FSIM:CHAN1:RF 100MHz
CHANNEL 1/ PATH CHANNEL 2/ PATH	Indicates the paths for subsequent parameters. These parameters can be set individually for each path.
STATE	Switch-on/off of a path. If the cursor is placed onto a path, this path may be switched on or off by pressing one of the unit keys (toggle function). IEC/IEEE-bus command : SOUR:FSIM:PATH1:STAT ON
PROFILE	Selection of a fading profile.
	<p>pDOPP (Pure DOPpler) Simulation of a transmission path having a single direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by the parameters DOPPLER FREQ and FREQ RATIO. IEC/IEEE-bus command : SOUR:FSIM:PATH7:PROF PDOP</p> <p>RAYL (RAYLeigh) Simulation of a radio traffic area in which many strongly scattered partial waves are incident on a moving receiver. The resulting receiver amplitude is time-varying. The probability density of the magnitude of the receiver amplitude is indicated by a Rayleigh distribution. The fading spectrum is a classical Doppler spectrum. IEC/IEEE-bus command : SOUR:FSIM:PATH6:PROF RAYL</p> <p>RICE Simulation of a radio traffic area in which one strong direct wave (discrete component) is incident on a moving receiver in addition to many scattered partial waves. The probability density of the magnitude of the receiver amplitude is indicated by a Rayleigh distribution. The fading spectrum of an unmodulated signal is the classical Doppler spectrum overlapped with a discrete spectral line. IEC/IEEE-bus command : SOUR:FSIM:PATH4:PROF RICE</p> <p>CPHAS A radio traffic area without direct and random waves is generated for this fading type (no discrete and no static component). The path is multiplied by a constant "pointer" according to the path-specific parameter. IEC/IEEE-bus command : SOUR:FSIM:PATH3:PROF CPH</p>
DISCRETE COMP	Indication whether discrete component is switched on or off. IEC/IEEE-bus command : SOUR:FSIM:PATH4:DCOM:STAT ON
POWER RATIO	Entry value of power ratio between discrete component and distributed component with RICE fading switched on. If the POWER RATIO is modified, the sum power made up of the two components remains constant. IEC/IEEE-bus command : SOUR:FSIM:PATH6:PRAT 3

FREQ RATIO

Entry value of ratio of actual Doppler frequency shift to the Doppler frequency set with RICE or pDOPP fading switched on. The actual Doppler frequency shift depends on the simulated angle of incidence of the discrete component.

IEC/IEEE-bus command : SOUR:FSIM:PATH6:FRAT 1

ϕ / deg	0	90	180
FREQ RATIO	-1	0	+1

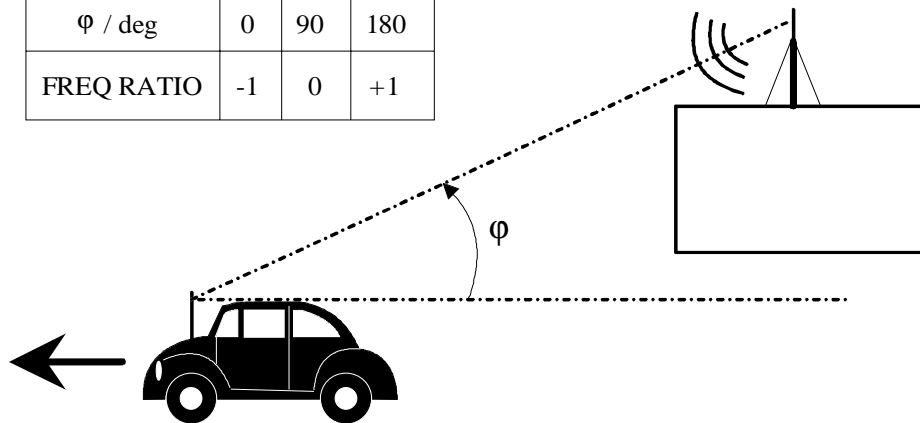


Fig. 4-6 Doppler frequency shift with moving receiver

CONST PHASE

Entry value of CONST PHASE with CPHAS fading switched on. The corresponding path is multiplied by this phase.

IEC/IEEE-bus command : SOUR:FSIM:PATH6:CPH 20.0

SPEED

Entry value of the speed v of the moving receiver. The Doppler frequency f_D (DOPPLER FREQ) is calculated from the speed and the frequency of the RF output signal f_{RF} . On changing the SPEED parameter, the DOPPLER FREQ parameter is automatically adjusted.

Setting range:

$$v_{\min} = \frac{0.03 \cdot 10^9 \text{ m/s}^2}{f_{RF}}$$

$$v_{\max} = \frac{479 \cdot 10^9 \text{ m/s}^2}{f_{RF}}$$

$$v_{\max} \leq 99999 \text{ km/h}$$

IEC/IEEE-bus command : SOUR:FSIM:PATH1:SPE 100

DOPPLER FREQ

Entry value of the magnitude of the maximum Doppler frequency shift (see FREQ RATIO).

On changing the Doppler frequency f_D , the SPEED parameter is automatically adjusted.

With $c = 2.998 \cdot 10^8 \text{ m/s}$ it is $\frac{v}{c} = \frac{f_D}{f_{RF}}$

IEC/IEEE-bus command : SOUR:FSIM:PATH2:FDOP 92.3

PATH LOSS	Entry value of attenuation in path. IEC/IEEE-bus command : SOUR:FSIM:PATH3:LOSS 3
DELAY	Entry value of signal delay in path. IEC/IEEE-bus command : SOUR:FSIM:PATH3:DEL 14.5
CORR PATH	Switch-on or off (NONE) of a correlation with the selected path. The correlation of paths 1 to 6 with paths 7 to 12 can only be set in pairs. If option ABFS-B2 is fitted, correlation of paths is only possible within a group. IEC/IEEE-bus command : SOUR:FSIM:PATH6:CORR:PATH 12
COEFF	Entry value of the magnitude of the complex correlation coefficient. IEC/IEEE-bus command : SOUR:FSIM:PATH6:CORR:COEF 0.5
PHASE	Entry value of the phase of the complex correlation coefficient. IEC/IEEE-bus command : SOUR:FSIM:PATH6:CORR:PHAS 180
LOGNORM STATE	Switch-on/off of lognormal fading. With lognormal fading set, an additional, rather slowly fluctuating amplitude of a moving receiver is simulated. Lognormal fading has a multiplying effect on the path loss. The multiplication factor is time-varying and has a logarithmic normal distribution. If a Rayleigh profile is set at the same time, this results in Suzuki fading. Hop mode is not possible when lognormal fading is active. (see HOP CONTROL) IEC/IEEE-bus command : SOUR:FSIM:PATH6:LOGN:STAT ON
LOCAL CONST	Entry value of area constant. The area constant L (LOCAL CONST) and the speed v of the moving receiver determine the limit frequency f_L of lognormal fading: $f_L = v / L$ The power density spectrum of an unmodulated carrier consists of a discrete spectral line at f_{RF} and a frequency-dependent continuous component described by: $S(f) = \text{const} \cdot e^{-0.5 \cdot \left(\frac{f - f_{RF}}{f_L} \right)^2}$ The lower limit of the range depends on the RF frequency f_{RF} . The following equation applies: $L_{\min} = \frac{12 \cdot 10^9 \text{ m / s}}{f_{RF}}$ IEC/IEEE-bus command : SOUR:FSIM:PATH6:LOGN:LCON 150
STD DEV	Entry value for standard deviation of lognormal fading. IEC/IEEE-bus command : SOUR:FSIM:PATH1:LOGN:CSTD 6

FINE DELAY Menu

With the FINE DELAY mode, a better time resolution for the time delay of the individual path can be achieved. Here, four paths are possible. Their system bandwidth is restricted to 4.6 MHz; this is sufficient for 3GPP with 3.84 Msymb/s. The time resolution is 1 ns.

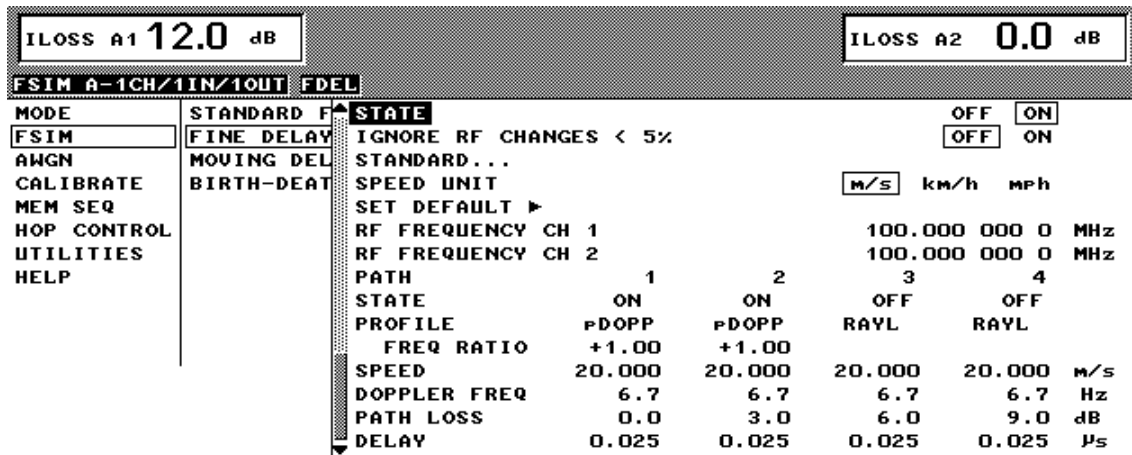


Fig. 4-7 FINE DELAY menu

- STATE** Enable / disable fine delay simulation.
IEC/IEEE-bus command : SOUR:FSIM:FDEL:STAT ON | OFF
- IGNORE RF** When enabled, frequency changes less than 5 % are ignored. That permits
CHANGES < 5% RF hopping faster than 3 ms.
IEC/IEEE-bus command : SOUR:FSIM:IGN:RFCH ON
- STANDARD** Opens a window for selecting a defined fading path setting.
Selection:
 - 3GPP_3.3.1_CASE1: SPEED: 3 km/h
 - Path 1: DELAY 25 ns
 - PATH LOSS 0 dB
 - Path 2: DELAY 1001 ns
 - PATH LOSS 10 dB
 - 3GPP_3.3.1_CASE2: SPEED: 3 km/h
 - Path 1: DELAY 25 ns
 - PATH LOSS 0 dB
 - Path 2: DELAY 1001 ns
 - PATH LOSS 0 dB
 - Path 3: DELAY 20025 ns
 - PATH LOSS 0 dB
 - 3GPP_3.3.1_CASE3: SPEED: 120 km/h
 - Path 1: DELAY 25 ns
 - PATH LOSS 0 dB
 - Path 2: DELAY 285 ns
 - PATH LOSS 3 dB
 - Path 3: DELAY 546 ns
 - PATH LOSS 6 dB
 - Path 4: DELAY 806 ns
 - PATH LOSS 9 dB
 - 3GPP_3.3.1_CASE4: SPEED: 3 km/h
 - Path 1: DELAY 25 ns
 - PATH LOSS 0 dB
 - Path 2: DELAY 1001 ns
 - PATH LOSS 0 dB

```
3GPP_3.3.1_CASE5: SPEED:      50 km/h
                  Path 1:    DELAY      25 ns
                              PATH LOSS  0 dB
                  Path 2:    DELAY     1001 ns
                              PATH LOSS  10 dB
```

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:STAN G3C1
```

Note: - The path delay corresponds to the delay in 3GPP 25.104-320, Appendix B3. However, a basic delay of 25 ns for the fading simulator is taken into account.

SPEED UNIT

Selects the speed unit for the SPEED parameter.

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:SPE:UNIT KMPH
```

SET DEFAULT ►

Sets the default setting for the path parameters where path 1 is enabled and the remaining paths are disabled.

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:DEF
```

PATH

Displays the path for the following parameters. These parameters are separately settable for every path.

STATE

Enables or disables a path. If the cursor is placed over the path, the path can be enabled or disabled by activating one of the unit keys (toggle function).

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:STAT ON |
OFF
```

PROFILE

Selects the fading profile. For an explanation, see Standard Fading. In this menu, only the following settings are possible:

pDOPP

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:PROF PDOP
```

RAYL (this setting is included for the 3GPP test cases.)

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:PROF RAYL
```

FREQ RATIO

Input value for the ratio of the Doppler frequency shift to the set Doppler frequency with FDOP fading (for an explanation, see Standard Fading).

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:FRAT 1
```

SPEED

Input value of the speed *v* of the moved receiver (for an explanation, see Standard Fading).

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:SPE 100
```

DOPPLER FREQ

Input value of the amount of the Doppler frequency shift (for an explanation, see Standard Fading).

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:FDOP 92.3
```

PATH LOSS

Input value of the path loss. Setting range: 0.0 dB to 50.0 dB.

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:LOSS 3
```

DELAY

Input value of the signal delay in the path. Setting range: 25 ns to 1637 μs

```
IEC/IEEE-bus command      : SOUR:FSIM:FDEL:PATH2:DEL 14.5E-6
```

MOVING DELAY Menu

In MOVING DELAY mode, the fading simulator simulates dynamic propagation conditions in accordance with 3GPP test case 25.104-320, Appendix B3.

Two paths are simulated; the delay of path 1 does not change, the delay of path 2 slowly moves back and forth in a sinusoidal manner. The two paths do not have a fading profile (non-fading) or a Doppler shift, but present the same level and the same phase.

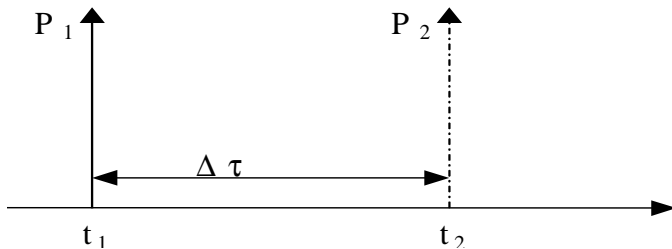


Fig. 4-1 Two paths for the MOVING DELAY menu

The delay of the moving path can be found according to the following equation:

$$\Delta\tau = \left(\text{DELAY_MEAN} + \frac{\text{DELAY_VARIATION}}{2} \left(1 + \sin\left(\frac{2\pi \cdot t}{\text{VARIATION_PERIOD}}\right) \right) \right)$$

In Appendix B3, the following values are suggested:

DELAY MEAN	= Delay path 1
DELAY VARIATION	5 μs
VARIATION PERIOD	157 s

For further tests, both the DELAY MEAN and the variation parameters can be modified. Moreover, the two paths can have different levels.

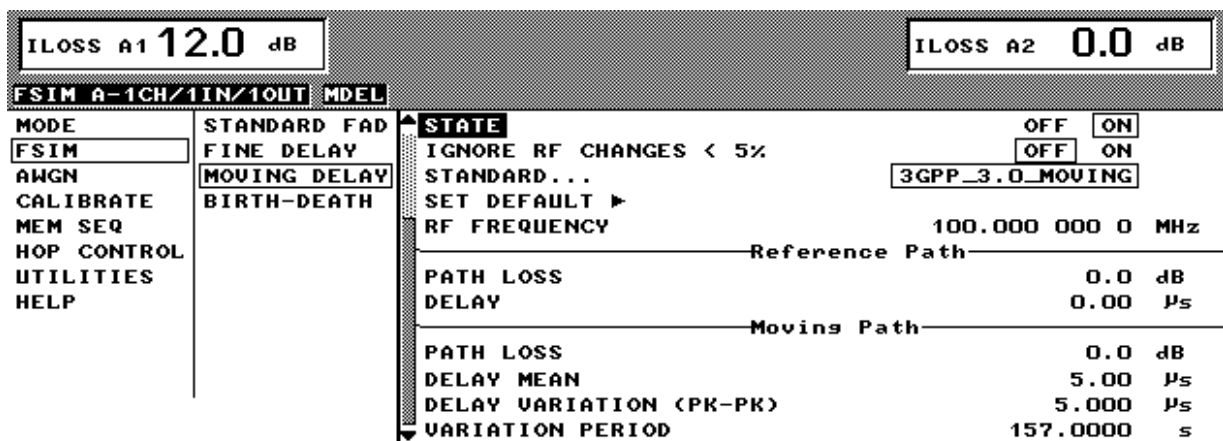


Fig. 4-8 MOVING DELAY

STATE Enable / disable the moving delay simulation.
 IEC/IEEE-bus command : SOUR:FSIM:MDEL:STAT ON | OFF

IGNORE RF CHANGES < 5% ►	When enabled, frequency changes less than 5 % are ignored. That permits RF hopping faster than 3 ms. IEC/IEEE-bus command : SOUR:FSIM:IGN:RFCH ON
STANDARD	Currently the same as SET DEFAULT.
SET DEFAULT ►	Sets the default settings for the path parameters. IEC/IEEE-bus command : SOUR:FSIM:MDEL:DEF
PATH	Displays the path for the following parameters. These parameters are separately settable for every path.
PATH LOSS	Input value of the path loss for the reference path. Setting range 0.0 dB to 50.0 dB. IEC/IEEE-bus command : SOUR:FSIM:MDEL:REF:LOSS 3
DELAY	Input value of the signal delay in the reference path. Setting range: 0.0 μ s to 1638 μ s IEC/IEEE-bus command : SOUR:FSIM:MDEL:REF:DEL 14.5E-6
PATH LOSS	Input value of the path loss for the moving path. Setting range 0.0 dB to 50.0 dB. IEC/IEEE-bus command : SOUR:FSIM:MDEL:MOV:LOSS 3
DELAY MEAN	Average delay value of the moving path. For further explanation, see above. Setting range: 0.25 μ s to 1637.8 μ s IEC/IEEE-bus command : SOUR:FSIM:MDEL:MOV:DEL:MEAN 12.5E-6
DELAY VARIATION (PK-PK)	Range of the delay variation for the moving path. The peak-to-peak value is set. For further explanation, see above. Setting range : 0.3 μ s to 100 μ s IEC/IEEE-bus command : SOUR:FSIM:MDEL:MOV:DEL:VAR 2.1E-6
VARIATION PERIOD	Speed of the delay variation. After a VARIATION PERIOD expires, a complete cycle is run through. Only for the moving path. Setting range : 10 s to 500 s IEC/IEEE-bus command : SOUR:FSIM:MDEL:MOV:VPER 13.4

BIRTH-DEATH Menu

In the BIRTH-DEATH mode, the fading simulator simulates dynamic propagation conditions according to 3GPP test case 25.104-320, Annex B4.

Here, 2 paths are simulated, which alternately appear (BIRTH) or disappear (DEATH) at random positions. The time positions lie within the array of [-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5] μ s. After a presettable time (HOPPING DWELL), a path disappears from a position and simultaneously emerges at another randomly chosen position. During this hop, the second path remains stable in its position. After a further HOPPING DWELL has expired, the second path changes its position, where this time, the first path remains in its position etc. Both paths never emerge at the same time position (see Fig. 4-10).

According to Appendix B4, every path has the same attenuation and phase and has no Doppler shift. These values can, however, be set in the BIRTH-DEATH menu for more comprehensive testing. The dwell time of 191 ms (according to 3GPP) can be changed in the range from 100 ms to 5 s.

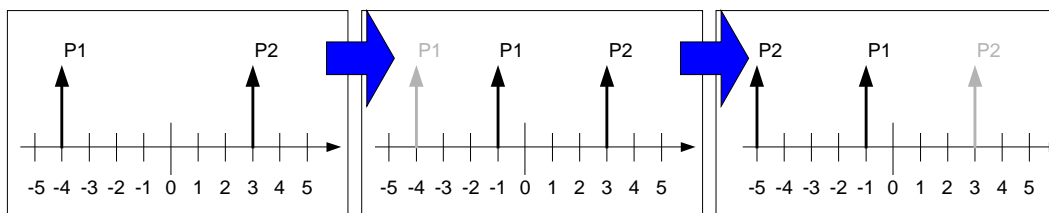


Fig. 4-9 Example of hopping sequence with BIRTH-DEATH fading

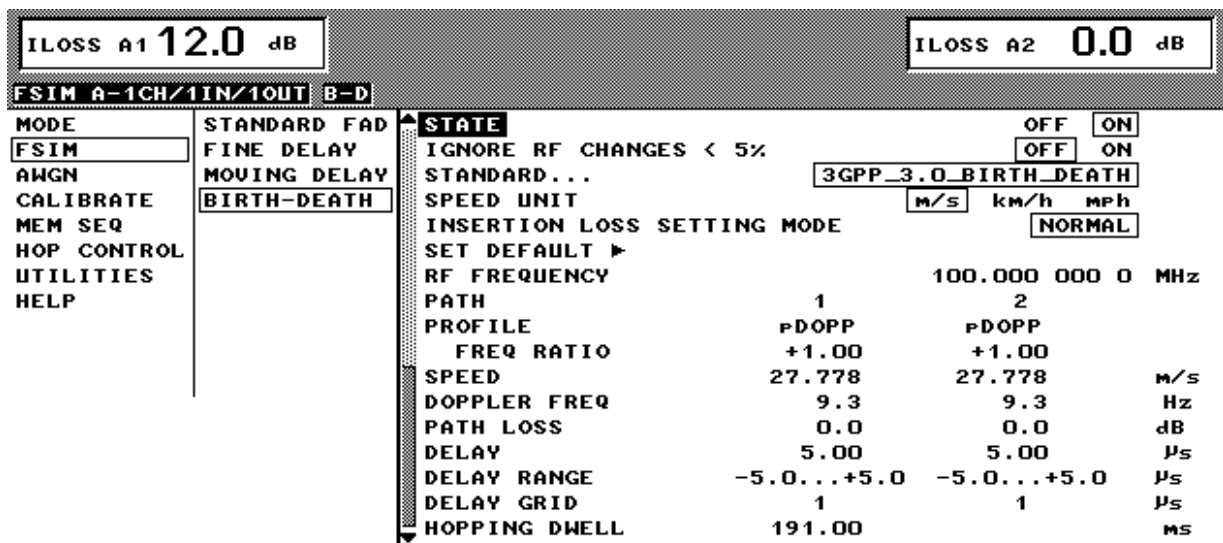


Fig. 4-10 BIRTH-DEATH menu

- STATE** Enables / disables the BIRTH-DEATH simulation.
IEC/IEEE-bus command : SOUR:FSIM:BIRT:STAT ON | OFF
- IGNORE RF CHANGES < 5%** When enabled, frequency changes less than 5 % are ignored. That permits RF hopping faster than 3 ms.
IEC/IEEE-bus command : SOUR:FSIM:IGN:RFCH ON
- STANDARD** Currently the same as SET DEFAULT.
- SPEED UNIT** Selects the speed unit for the SPEED parameter.
IEC/IEEE-bus command : SOUR:FSIM:BIRT:SPE:UNIT KMPH

INSERTION LOSS SETTING MODE	Selects the setting mode for the insertion loss of the fading simulator. For an explanation, see STANDARD FADING. IEC/IEEE-bus command : SOUR:FSIM:BIRT:ILOS:MODE NORM : SOUR:FSIM:BIRT:ILOS:MODE LACP
SET DEFAULT ►	Sets the default path parameters. IEC/IEEE-bus command : SOUR:FSIM:BIRT:DEF
PATH	Displays the path for the following parameters. These parameters are separately settable for every path.
PROFILE	Selects a fading profile. Only pDOPP is available; the setting of FREQ RATIO = 0 results in a non-fading path. pDOPP (pure DOPPler): A transmission path is simulated, which consists of a single direct connection from transmitter to moving receiver (discrete component). The Doppler frequency shift is determined by the DOPPLER FREQ and FREQ RATIO parameters. IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:PROF PDOP
FREQ RATIO	Input value for the actual Doppler frequency shift ratio. For an explanation, see STANDARD FADING. The setting of FREQ RATIO = 0 results in a non-fading path. IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:FRAT 1
SPEED	Input value of the speed v of the moving receiver. For an explanation, see STANDARD FADING. All entries in path 1 are also copied to path 2. IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:SPE 100
DOPPLER FREQ	Input value of the maximum Doppler frequency shift. For an explanation, see STANDARD FADING. All entries in path 1 are also copied to path 2. IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:FDOP 92.3
PATH LOSS	Input value of the path loss. Setting range 0.0 dB to 50.0 dB. IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH2:LOSS 3
DELAY	Input value of the basic signal delay in path 1. All entries in path 1 are also copied to path 2. Setting range: 5.0 μ s to 1000.0 μ s IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:DEL 1000 E-3
DELAY RANGE	The delay of both paths lies within this range. This parameter cannot be edited. For both channels: -5.0 μ s to +5.0 μ s
DELAY GRID	Time grid of the individual randomly appearing carriers. The carriers only have delays which lie within DELAY RANGE and which come to lie in the $n \cdot$ DELAY GRID (with -5 to +5). The parameter cannot be edited. Value = 1 μ s for both channels.
HOPPING DWELL	Dwell time until the next BIRTH-DEATH occurrence. After this dwell time, the next path randomly changes its delay time. Setting range: 100.0 ms to 5000.0 ms IEC/IEEE-bus command : SOUR:FSIM:BIRT:PATH1:HOPP:DWEL 1.2

**MODE Menu With Built-in Noise Generators
Option ABFS-B1 / Option ABFS-B3**

If ABFS is equipped with option ABFS-B1 as well as with option ABFS-B3, the number of noise generators available is one or two. The following combinations of options ABFS-B1/ABFS-B3 are possible with the basic unit and option ABFS-B2. The operating modes or signal paths are displayed in the MODE submenu of ABFS.

Table 4-1 Possible combinations of options with basic ABFS unit

	Option ABFS-B1 first noise source	Option ABFS-B2 second fading group	Option ABFS-B3 second noise source
Basic ABFS unit	X		
Basic ABFS unit	X		X
Basic ABFS unit		X	
Basic ABFS unit	X	X	X

Fig. 4-12 shows the ABFS basic unit with built-in option ABFS-B1. The ABFS-B1 noise source always follows FSIMA1 in the signal path, it is not possible to connect channel 2 with the noise generator in mode 2CHANNEL/6PATH/2INPUT/2OUTPUT, for example.

Basic ABFS unit with built-in option ABFS-B1 (one noise generator available)

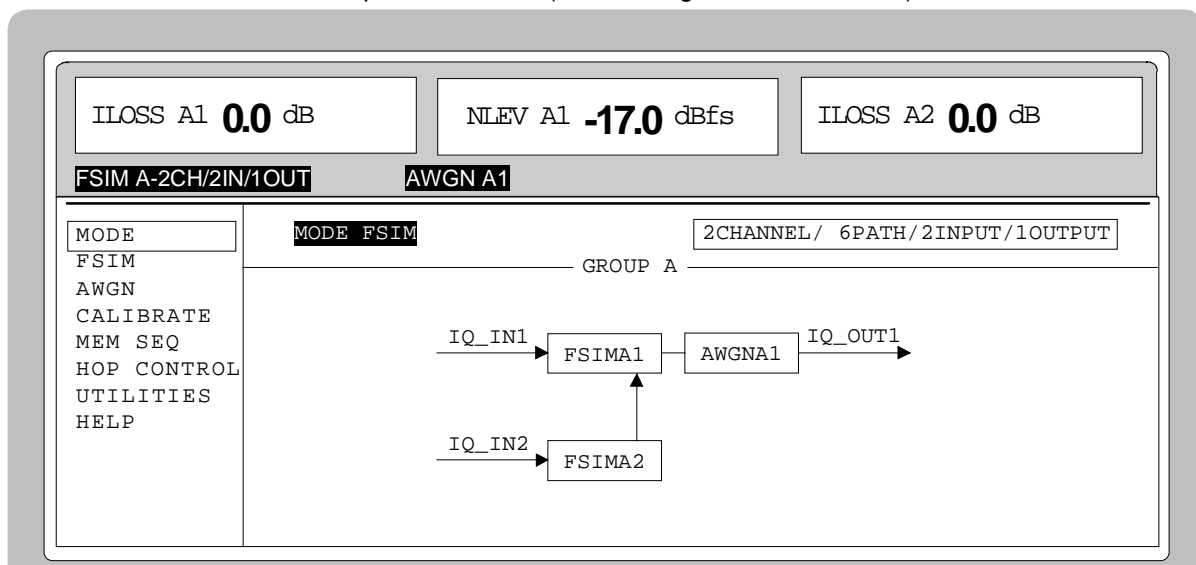


Fig. 4-12 MODE menu (option ABFS-B1 installed)

When a second noise source (option ABFS-B3) is fitted, it follows FSIMA2 in the signal path of the basic unit or FSIMB1 if a second fading group (option ABFS-B2) is fitted. See Fig. 4-13 and Fig. 4-14.

Basic ABFS unit with built-in options ABFS-B1 and ABFS-B3 (two noise generators)

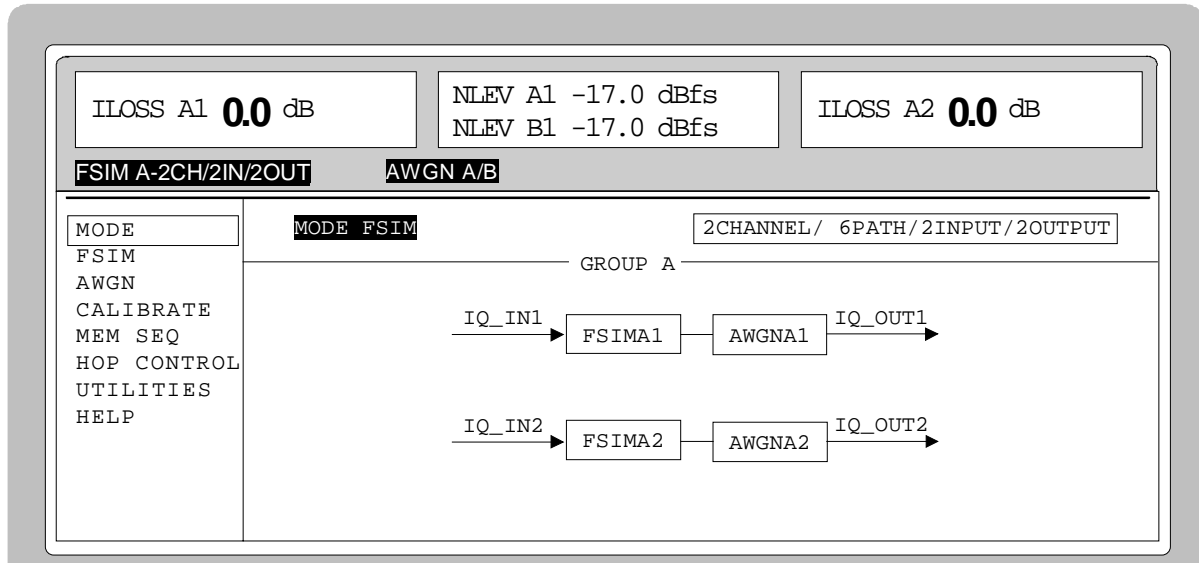


Fig. 4-13 MODE menu (options ABFS-B1 / ABFS-B2 installed)

Basic ABFS unit with built-in options ABFS-B1/ ABFS-B2 / ABFS-B3

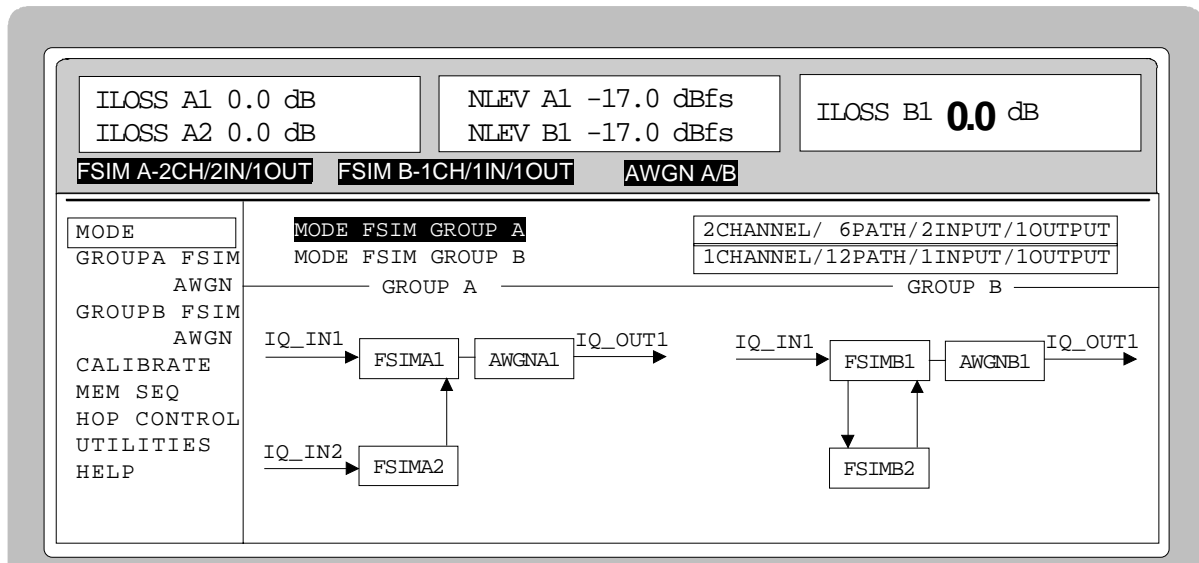


Fig. 4-14 MODE menu (options ABFS-B1 / ABFS-B2 / ABFS-B3 installed)

AWGN Menu

All noise generator settings can be found in the AWGN menu.

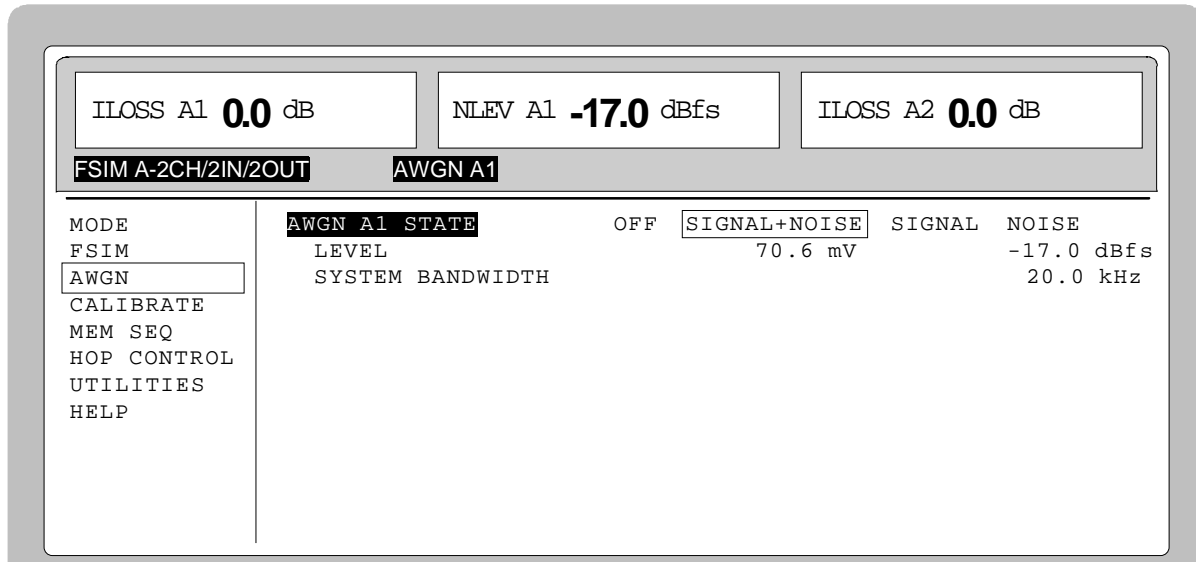


Fig. 4-15 AWGN menu

**AWGN A1 STATE
(OPTION ABFS-B1)**

Switch-on/off of corresponding noise source. The noise source is an AWGN signal (Additive White Gaussian Noise). The noise generator has the following modes:

**AWGN A2 STATE
AWGN B1 STATE
(OPTION ABFS-B3)**

- SIGNAL+NOISE** The fading signal is equipped with an AWGN signal (Additive White Gaussian Noise).
- SIGNAL** The noise generator remains in the signal path but no noise is added to the output signal.
- NOISE** Only the noise generator delivers its AWGN signal to the output, the input signal is not fed into the signal path.
- OFF** The noise generator is bypassed by means of a bypass circuit located in the signal path.

IEC/IEEE-bus command : SOUR:AWGN:STAT ON
: SOUR:AWGN:MODE SN

LEVEL

Entry value of noise power.

The noise power is entered in dBfs (dB under full scale). The noise power is the power in dBfs indicated in the header under NLEV.

Setting range: -14.0 dBfs to -50.0 dBfs

IEC/IEEE-bus command : SOUR:AWGN:SNR -22.0 dBfs

**SYSTEM
BANDWIDTH**

Entry value of system bandwidth.

The system bandwidth is the RF bandwidth by which the noise power is calculated. ABFS can set the bandwidth of the generated noise only in steps. The noise bandwidth is always set. It corresponds to at least the 1.4-fold of the system bandwidth but max. 10 MHz.

Setting range: 10 kHz to 10 MHz; resolution: three digits

IEC/IEEE-bus command : SOUR:AWGN:BAND 1.23 MHz

Calibration

The internal calibration of ABFS can be called up in the CALIBRATE menu. Moreover, an offset voltage can be entered for each input or output to compensate external DC offset voltages. The connection of the individual inputs and outputs is displayed in the CALIBRATE menu and depends on the relevant mode set.

If ABFS is equipped with options ABFS-B1, ABFS-B2 and ABFS-B3, the calibrations are also called up for these modules for which the module offset and partly IQ imbalance have to be calibrated.

All calibrations run internally. Calibration should be called up after a warm-up time of the unit of approx. 1 hour or after a temperature change of more than 5°C.

CALIBRATE Menu

All calibration settings can be found in the CALIBRATE operating menu.

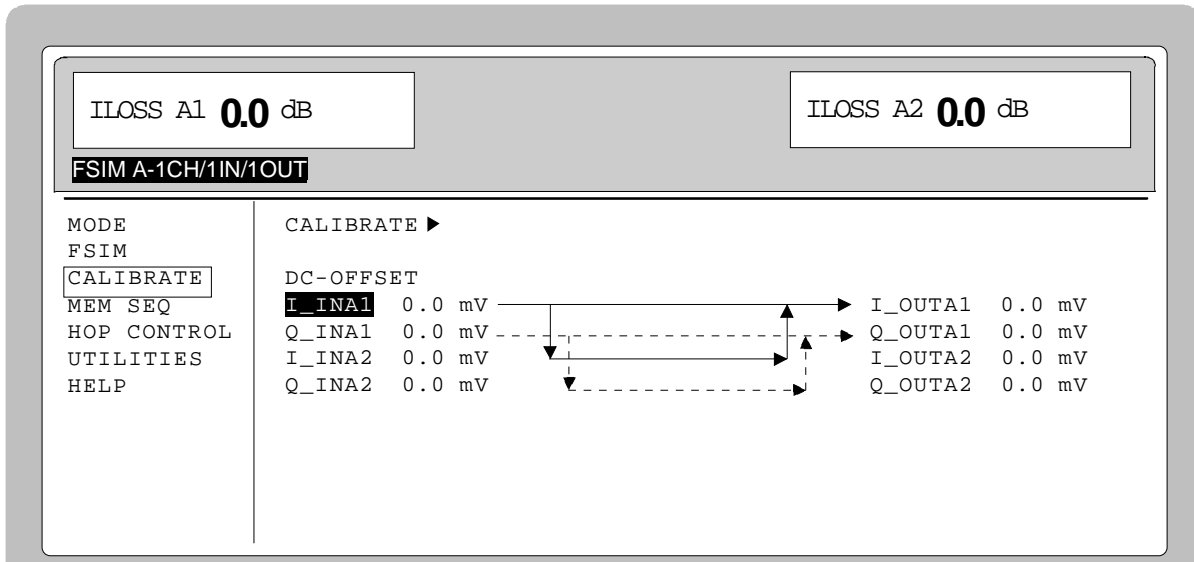


Fig. 4-16 CALIBRATE menu

CALIBRATE

Activate internal calibration.

Note: Calibration for warmed-up units only.

IEC/IEEE-bus command :CAL:FSIM?

DC-OFFSET

- I_INA1
- I_OUTA1
- Q_INA1
- Q_OUTA1
- ...

Entry of a user-defined offset voltage for the corresponding input or output. An external carrier residual can be minimized.

Setting range: -10.0 mV to +10.0 mV

IEC/IEEE-bus command :CAL:OFFS:I:INP2 5.1mV
:CAL:OFFS:Q:OUTP1 -2.3mV

Memory Sequence

In the memory sequence mode the unit automatically processes a list with stored device settings. Memory locations 1 to 50 are available. They are loaded with SAVE and their stored settings can either be called up individually using RECALL or automatically one after the other in the SEQUENCE mode.

The list is continuously processed from beginning to end starting with the index. The order of the memory sequence is selectable. A freely selectable dwell time can be assigned to each setting. The dwell time determines the duration of the setting. Its minimum value is 50 ms, maximum 60 seconds.

The list is subdivided into 3 columns: list index, memory location number (MEMORY) and dwell time (DWELL). The beginning of the list is assigned to index 1.

Table 4-2 Memory sequence; example of a list

Index	Memory	Dwell
001	09	50.0 ms
002	02	50.0 ms
003	01	75.0 ms
004	10	75.0 ms
...

Up to 10 sequence lists can be created. The total number of possible list elements is max. 256, ie a list can have 256 entries at max. or may have less entries if the several lists have been created.

Each list is identified by its unique name and can be selected under this name. For a detailed description for processing the lists see Chapter 3, Section "List Editor".

Modes (MODE)

The following modes are available:

- AUTO** Run from beginning to end of list including an automatic restart at the beginning. If another mode is switched on prior to AUTO mode, the run is continued from the current index.
IEC/IEEE-bus commands: :SYST:MODE MSEQ
:SYST:MSEQ:MODE AUTO
:TRIG:MSEQ:SOUR EXT
- SINGLE** Single run from beginning to end of list. When SINGLE is selected, the run is not yet started. The executable function EXECUTE SINGLE SEQUENCE ► by which the run can be started is displayed below the MODE line.
IEC/IEEE-bus commands: :SYST:MODE MSEQ
:SYST:MSEQ:MODE AUTO
:TRIG:MSEQ:SOUR SING
- STEP** Manual and stepwise list processing. When STEP is activated, an automatic run is stopped and the cursor is placed on the display value of CURRENT INDEX. The list can now be run through step by step from top to bottom using the rollkey.
IEC/IEEE-bus commands: :SYST:MODE MSEQ
:SYST:MSEQ:MODE STEP
:TRIG:MSEQ:SOUR SING
- EXT-SINGLE** Single run from beginning to end of list as described under SINGLE but triggered by an external trigger signal.
IEC/IEEE-bus commands: :SYST:MODE MSEQ
:SYST:MSEQ:MODE AUTO
:TRIG:MSEQ:SOUR EXT
- EXT-STEP** Step by step run by means of external trigger signal. Each trigger event triggers an individual step.
IEC/IEEE-bus commands: :SYST:MODE MSEQ
:SYST:MSEQ:MODE STEP
:TRIG:MSEQ:SOUR EXT
- OFF** Switch-off of memory sequence mode.
IEC/IEEE-bus command :SYST:MODE FIX

External Trigger

An external signal at the rear TRIGGER IN1 input triggers the memory sequence in modes EXT-SINGLE and EXT-STEP.

The polarity of the active trigger edge can be set in the UTILITIES - TRIGGER - EXT TRIG SLOPE menu.

Access to memory sequence mode is provided by the OPERATION and EDIT page of the MEM SEQ menu.

Menu selection: MEM SEQ

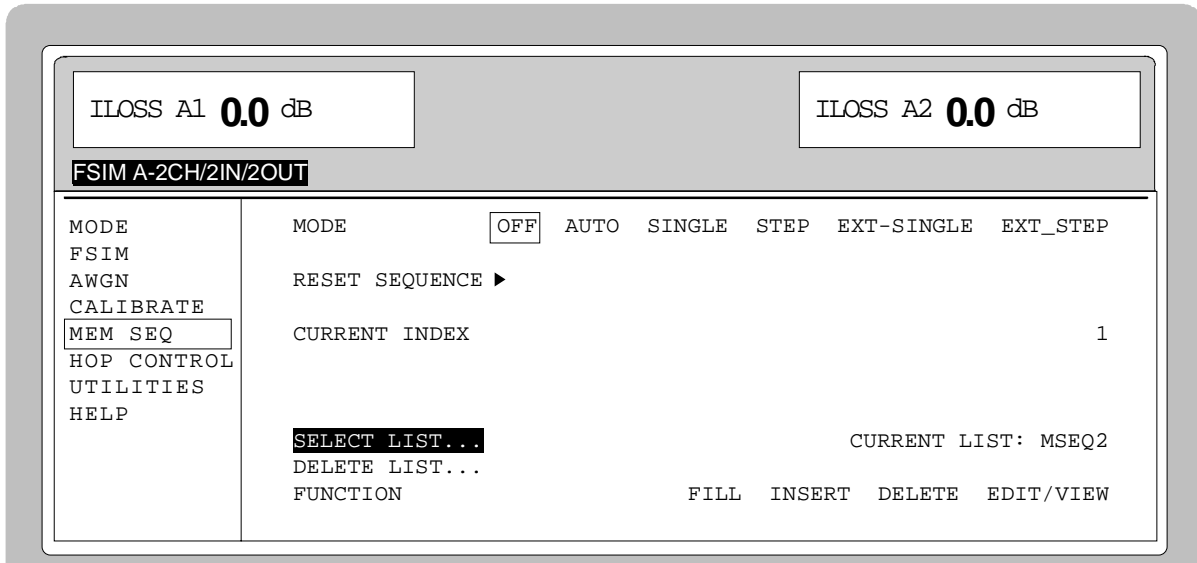


Fig. 4-17 MEM SEQ menu, OPERATION page

MODE	Selection of operating mode; setting the mode has an effect on the different IEC/IEEE-bus command systems (see above).
EXECUTE SINGLE SEQUENCE ▶	Starts the unique run of a memory sequence. This menu option can only be seen with MODE SINGLE selected. IEC/IEEE-bus command : TRIG:MSEQ
RESET SEQUENCE ▶	Return to beginning of list. IEC/IEEE-bus command : ABOR:MSEQ
CURRENT INDEX	Display of current list index. Setting value of current list index in MODE STEP mode.
SELECT LIST...	Selection of a list or creation of a new list (see Chapter 3, List Editor). IEC/IEEE-bus command : SYST:MSEQ:SEL "MSEQ1 "
DELETE LIST...	Deletion of a list (see Chapter 3, Section "List Editor"). IEC/IEEE-bus command : SYST:MSEQ:DEL "MSEQ2 "
FUNCTION	Selection of the editor function for processing a list (see Chapter 3, Section "List Editor"). IEC/IEEE-bus command : SYST:MSEQ

The second page of the MEM SEQ menu, the EDIT page, is activated automatically if one of the editing functions is selected in the FUNCTION line. The list executed in the SELECT LIST line as CURRENT LIST is indicated.

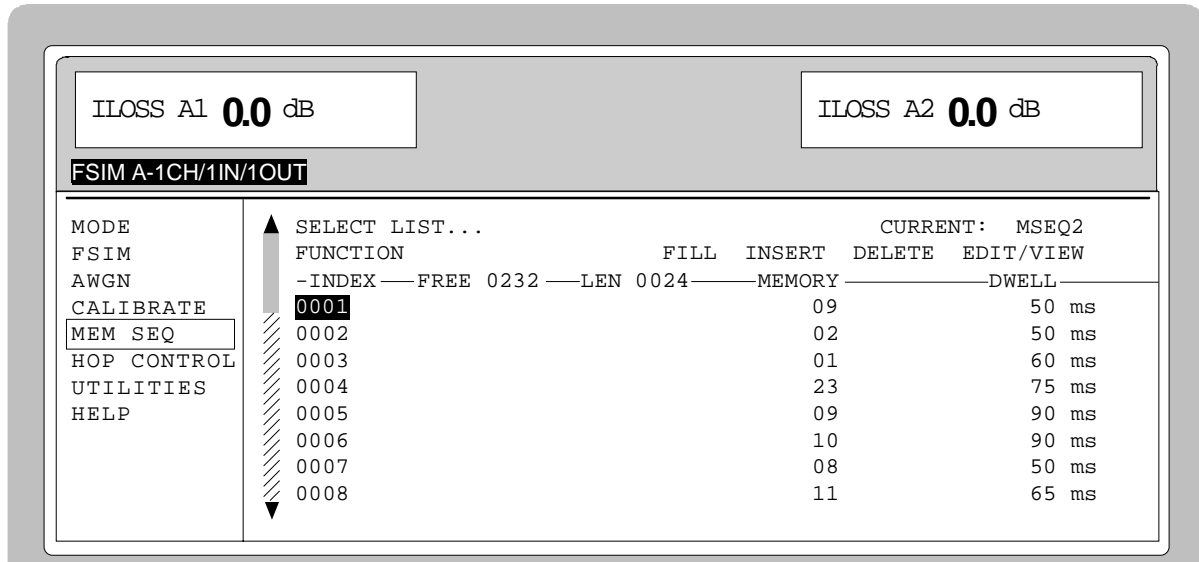


Fig. 4-18 MEM SEQ menu, EDIT page

- INDEX** Index of list.
- FREE** Indication of list entries that are still free.
- LEN** Length of current list.
- MEMORY** Parameter: memory location number; value range 1 to 50.
- DWELL** Parameter: dwell time; value range 50 ms to 60 sec, stepsize 1 ms.

HOP CONTROL

With the HOP mode of ABFS it is possible to simulate frequency hopping. In this mode, a sequence of fixed frequency points is scrolled through. Since a list index (= channel number) is transmitted via the serial hop interface (HOP CONTROL 1 and HOP CONTROL 2), a new fading frequency for the fading channel is selected from the HOP frequency lists.

The fading frequencies are RF carrier frequencies at which the IQ signal is modulated and transmitted. With manual operation, this carrier frequency is entered in the fading menu under RF - FREQUENCY.

ABFS has two hop interfaces, ie two different frequency lists can be processed at the same time. The frequency lists are assigned to the displayed frequency channels in the HOP CONTROL menu.

With option ABFS-B2 (second fading group) fitted, selection between fading channels B1/B2 or A2 is possible under menu item HOP CONTROL 2.

To maintain accurate timing, switchover of fading frequencies can be started following the transmission of the list index via a trigger signal. The variable transmission times of the RS232 HOP interfaces that are due to the baud rate as well as the different index lengths (SHORT_CODE or LONG_CODE) no longer have to be taken into account for the ABFS response time.

For transmitting the interrupt signals the two trigger lines (Trigger IN 1 and Trigger IN 2) at the rear of ABFS or the DSR lines (pin 6) of the two hop interfaces are available.

The polarity of the active trigger edge can be set in the UTILITIES - TRIGGER - EXT TRIG SLOPE menu. The interrupt inputs can be switched on or over by the software.

The fading output signal is switched off when the new fading frequency is calculated and set. This is indicated at the external BLANK connector. The polarity of the BLANK signal can be set in the UTILITIES - TRIGGER - BLANK POLARITY menu.

This setting is not permitted in the HOP mode. This is due to the long calculation time of a frequency change under LOGNORMAL fading. In the fading menu, the entry of the carrier frequency and the Doppler frequency depending on the carrier frequency are inhibited during active hopping.

HOP CONTROL Without Trigger Control

If trigger control is switched off in the HOP CONTROL menu (HOP TRIGGER OFF), the new fading frequency is sent to the corresponding fading modules immediately after reception of a list index. This frequency is set by the fading modules. The fading process is interrupted during the calculation and setting of the new fading parameters. The output signal is switched to 0 V. This is indicated at ABFS by means of the BLANK line. See Fig. 4-19 for more information.

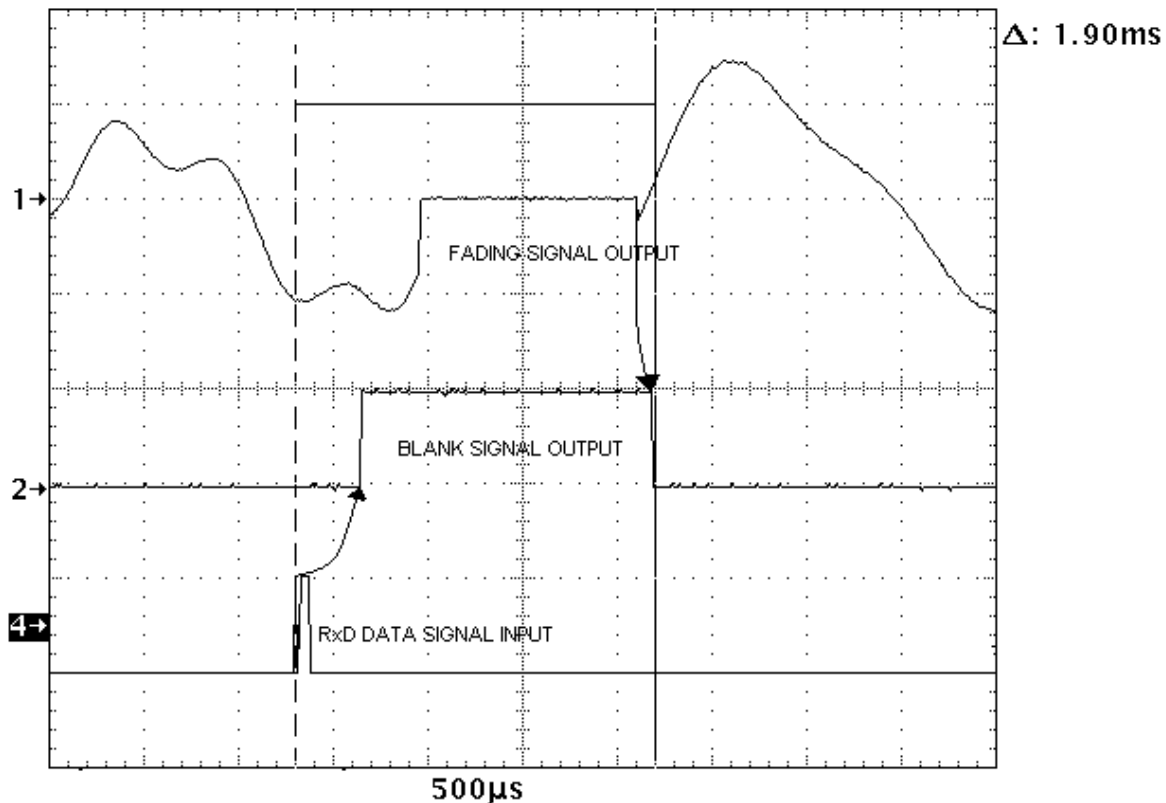


Fig. 4-19 Timing diagram during HOP CONTROL without trigger control

Signal 1 indicates the fading output signal.

Signal 4 corresponds to the RxD line of the hopping interface. It shows the data traffic on the RS 232 hop interface, 1 byte (list index) + 1 start and 1 stop bit at a transmission rate of 115200 b/s (approx. 90µs).

After reception of a new fading frequency ABFS implements a certain interval (approx. 100µs) during which the current fading profile can be processed. ABFS then activates the BLANK line (signal 2) and starts to calculate the new fading profile. The time required for the calculation and setting of the new fading parameters strongly depends on the number of paths activated and the fading profiles set. ABFS ensures that the output signal is active again not later than 3.5 ms after transmission of the list index.

HOP CONTROL With Trigger Control

To maintain accurate timing, frequency transmission to the modules can be started via an external trigger as soon as the transmission of the list index is completed.

The variable transmission times of the serial HOP CONTROL interfaces therefore need not be taken into account. The new frequency index can be sent to ABFS immediately after the trigger edge while the previous data record is transmitted to the modules. The serial interfaces have a data buffer of 16 bytes.

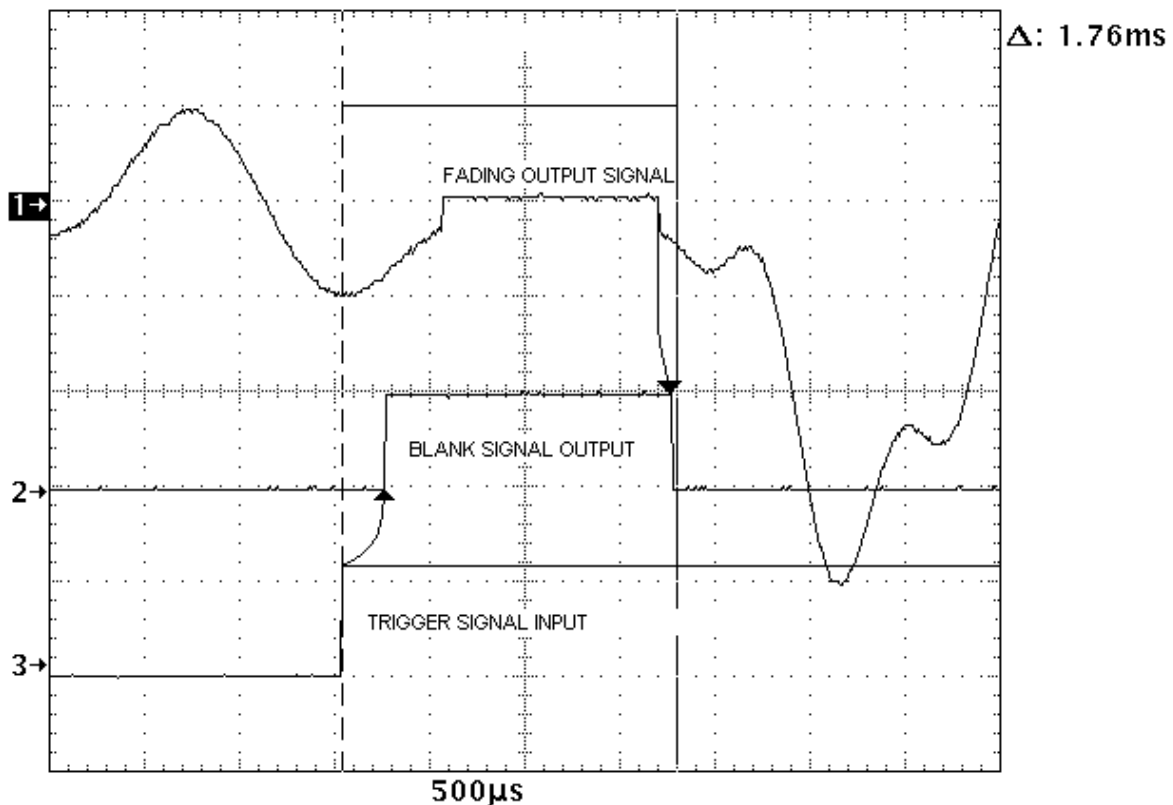


Fig. 4-20 Timing diagram during HOP CONTROL with trigger control

Signal 3 corresponds to the trigger signal, either TRIGGER IN1 / IN2 or DTR line (pin 6) of the hop interface HOP CONTROL 1 / HOP CONTROL 2

After reception of the trigger signal ABFS implements a certain interval (approx. 100µs) during which the current fading profile can be processed. ABFS then activates the BLANK line (signal 2) and starts to calculate the new fading profile. The time required for the calculation and setting of the new fading parameters strongly depends on the number of paths activated and the fading profiles set. ABFS ensures that the fading signal is active again not later than 3.5 ms after having triggered the trigger edge.

HOP CONTROL Menu

All settings regarding the HOP CONTROL function are located in the HOP CONTROL menu.

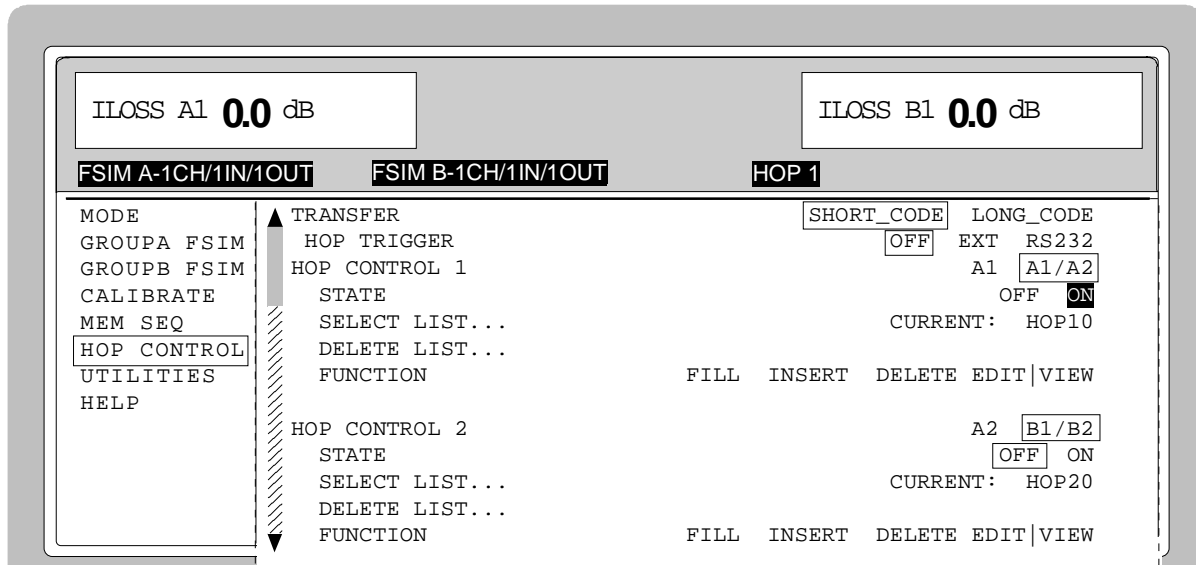


Fig. 4-21 HOP CONTROL menu

TRANSFER

Setting the size of the list index to be transmitted. For selecting the frequency from the corresponding HOP lists, 1 byte or 2 bytes can be transmitted.

- SHORT CODE 1 byte, for lists with up to 255 entries
- LONG CODE 2 bytes, for lists with up to 2000 entries

HOP TRIGGER

Selection of the trigger for the hop mode. The trigger can either be triggered via the external BNC trigger connectors Trigger IN 1 and IN 2 or via the DSR lines of the corresponding RS232 hop interface HOP CONTROL 1 / HOP CONTROL 2.

The DSR line (pin 6) offers the advantage that no additional trigger lines are needed so that a trigger can be activated via the DTR signal of the host. This setting is only possible for all the hop interfaces.

- OFF Trigger control off, frequency is immediately set after transmission of the list index.
- EXT Trigger control on, trigger source for:
 - HOP CONTROL 1: TRIGGER IN 1
 - HOP CONTROL 2: TRIGGER IN 2
- RS232 Trigger control on, trigger source for:
 - HOP CONTROL 1: DTR line pin 6 of HOP CONTROL 1
 - HOP CONTROL 2: DTR line pin 6 of HOP CONTROL 2
- IEC/IEEE-bus command :TRIG:HOP:STAT ON
 - :TRIG:HOP:SOUR EXT

HOP CONTROL 1

Indication of fading channels set with the frequency of HOP CONTROL 1. With option ABFS-B2 fitted (second fading group), the assignment of fading channels can be switched under HOP CONTROL 2, for HOP CONTROL 1 from A1/A2 to A2.

STATE	<p>Switch-on/off of HOP CONTROL 1. IEC/IEEE-bus command : SOUR:HOP:STAT ON</p>
SELECT LIST	<p>Selection of a list or creation of a new list (see Chapter 3, Section "List Editor"). IEC/IEEE-bus command : SOUR:HOP:SEL "HOP13"</p>
DELETE LIST	<p>Deletion of a list (see Chapter 3, Section "List Editor"). IEC/IEEE-bus command : SOUR:HOP:DEL "HOP12"</p>
FUNCTION	<p>Selection of the editor function for processing a list (see Chapter 3, Section "List Editor"). IEC/IEEE-bus command : SOUR:HOP:FREQ 540MHz , 1.2GHz , 1.9GHz , . . .</p>
HOP CONTROL 2	<p>Indication of fading channels set with the frequency of HOP CONTROL 2. With option ABFS-B2 fitted, the assignment of the channels of GROUP A and GROUP B can be switched over.</p> <p>HOP CONTROL 1 A1/A2 <-> A1 HOP CONTROL 2 B1/B2 <-> A2 IEC/IEEE-bus command : SOUR:HOP2:CONT A2</p>
STATE	<p>Switch-on/off of HOP CONTROL 2. IEC/IEEE-bus command : SOUR:HOP2:STAT ON</p>
SELECT LIST	<p>Selection of a list or creation of a new list (see chapter 3, List Editor). IEC/IEEE-bus command : SOUR:HOP2:SEL "HOP23"</p>
DELETE LIST	<p>Deletion of a list (see chapter 3, List Editor). IEC/IEEE-bus command : SOUR:HOP2:DEL "HOP22"</p>
FUNCTION	<p>Selection of the editor functions for processing a list (see chapter 3, List Editor). IEC/IEEE-bus command : SOUR:HOP2:FREQ 540MHz , 1.2GHz , 1.9GHz , . . .</p>

The second page of the HOP CONTROL menu, the EDIT page, is activated automatically if one of the editing functions of the FUNCTION line is selected. The list executed in the SELECT LIST line as CURRENT is indicated.

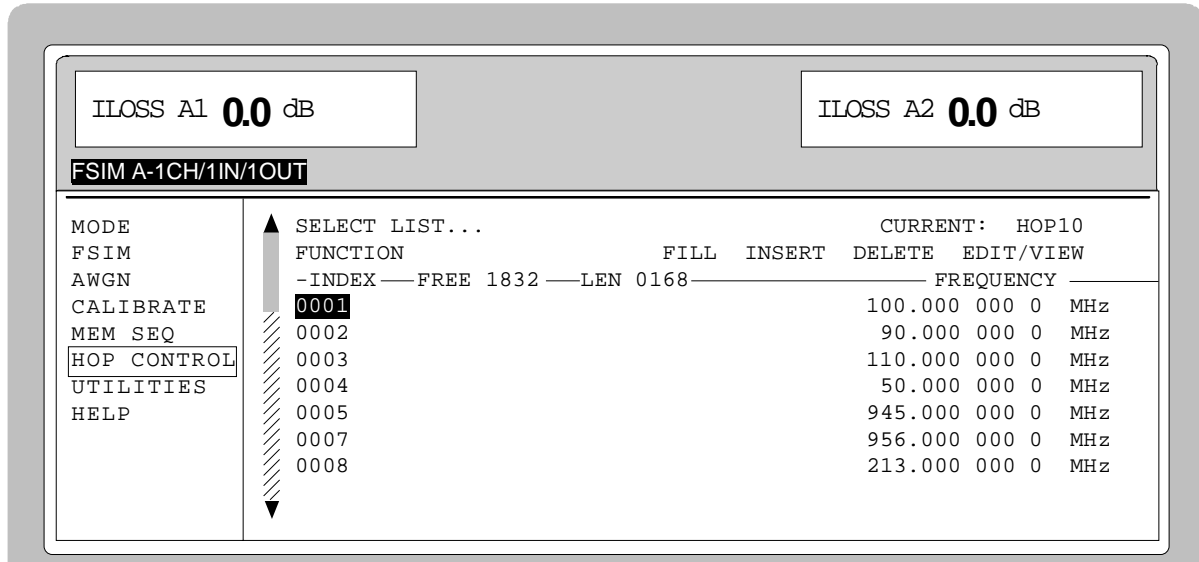


Fig. 4-22 HOP CONTROL menu, EDIT page

- INDEX** Index of list.
- FREE** Indication of list entries that are still free.
- LENGTH** Length of current list.
- FREQUENCY** Parameter: carrier frequency for fading channel selected under HOP CONTROL.

Utilities

The UTILITIES menu comprises submenus for general functions that are not directly related to signal generation.

IEC/IEEE-Bus Address (SYSTEM - GPIB)

The SYSTEM – GPIB submenu provides access to the remote control address. The setting range is from 0 to 30. Default address 28 is factory-set.

Menu selection: UTILITIES -SYSTEM -GPIB

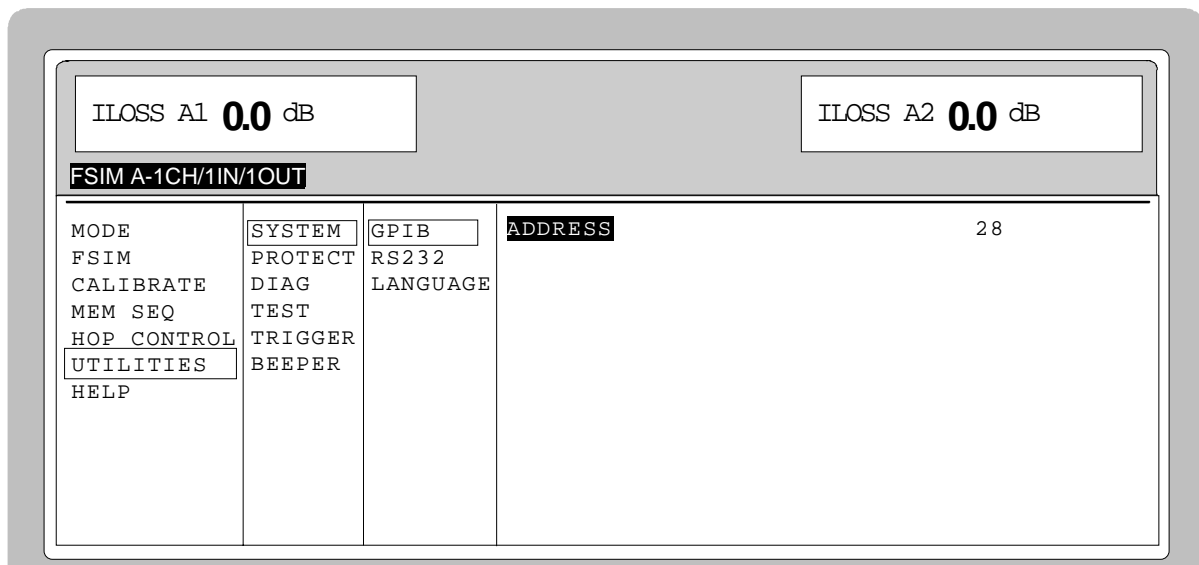


Fig. 4-23 UTILITIES - SYSTEM – GPIB menu

ADDRESS Entry value of IEC/IEEE-bus address.
 IEC/IEEE-bus command : SYST:COMM:GPIB:ADDR 28

Parameter of RS-232-C Interface (SYSTEM - RS232)

The SYSTEM-RS232 submenu provides access to the configuration of the RS-232-C interface and the hop interfaces. The pin assignment of the interfaces corresponds to that of a PC.

Menu selection: UTILITIES - SYSTEM - RS232

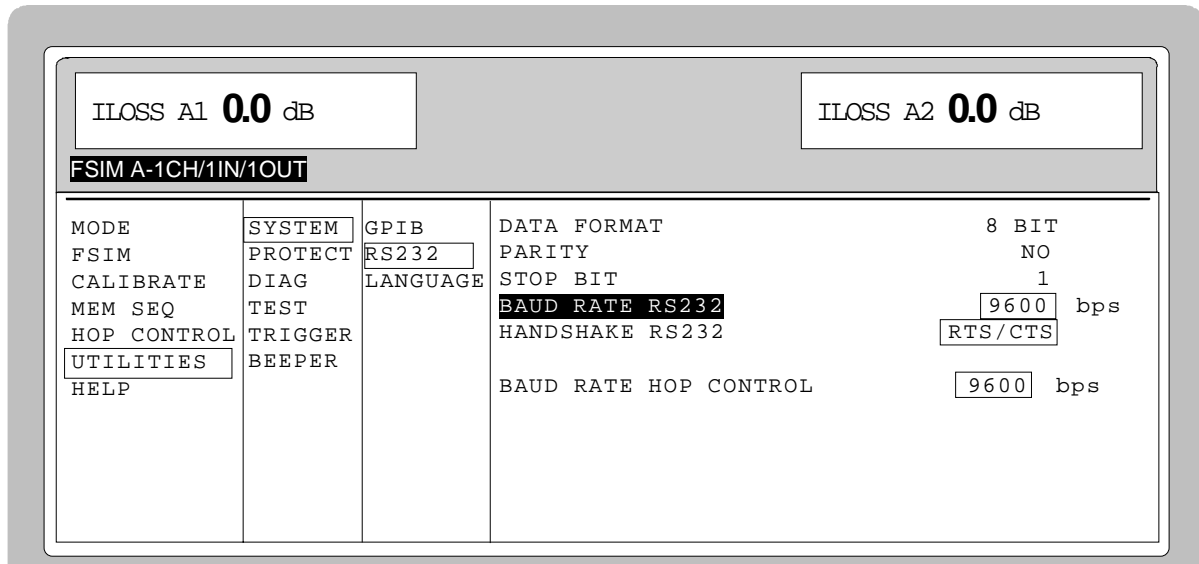


Fig. 4-24 UTILITIES - SYSTEM – RS232 menu

DATA FORMAT Display value of number of data bits. This value is fixed and cannot be modified.

PARITY Display value of parity . This value is fixed and cannot be modified.

STOP BIT Display value of number of stop bits. This value is fixed and cannot be modified.

BAUD RATE RS232 Selection of transmission rate for the RS-232-C interface .
IEC/IEEE-bus command :SYST:COMM:SER:BAUD 9600

Password Entry With Protected Functions (PROTECT)

Calibration and service functions are protected by a password. To undo the lock, enter the correct password, a 6-digit number, and then confirm the entry by pressing the [ENTER] key. The lock is automatically active after power-up of the unit.

Password 1 unlocks LOCK LEVEL 1.

Password 2 unlocks LOCK LEVEL 2.

Password 3 unlocks LOCK LEVEL 3. Entry of serial number and counts for POWER ON and operating hours is possible.

The UTILITIES – PROTECT menu provides access to undoing the lock for protected functions.

Menu selection: UTILITIES - PROTECT

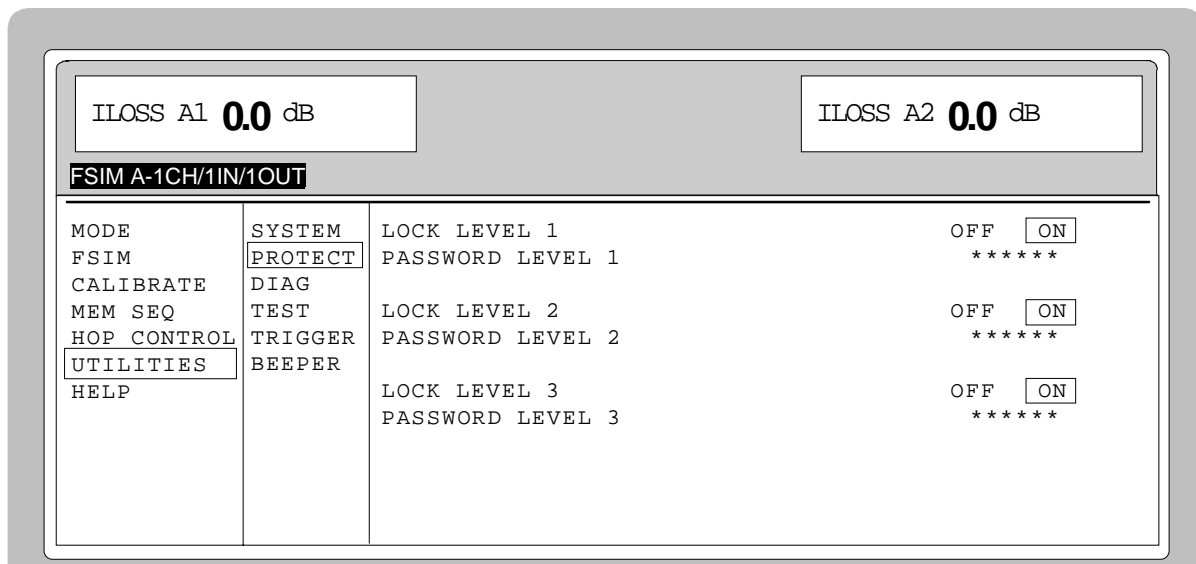


Fig. 4-25 UTILITIES - PROTECT menu (preset settings)

LOCK LEVEL x

Switch-on/off of lock.

ON Lock is switched on.

OFF Cursor automatically returns to entry of password.
Lock is switched off after entry of password.

IEC/IEEE-bus command :SYST:PROT1 ON

PASSWORD LEVEL x

Entry of password; entry is confirmed by pressing the [ENTER] key.

IEC/IEEE-bus command :SYST:PROT1 OFF, 123456

Display of Module Versions (DIAG-CONFIG)

The installed modules with their versions and modification indexes can be displayed for service purposes. The DIAG – CONFIG submenu provides access to the module display.

IEC/IEEE-bus command :DIAG:INFO:MOD?

Menu selection:UTILITIES - DIAG – CONFIG

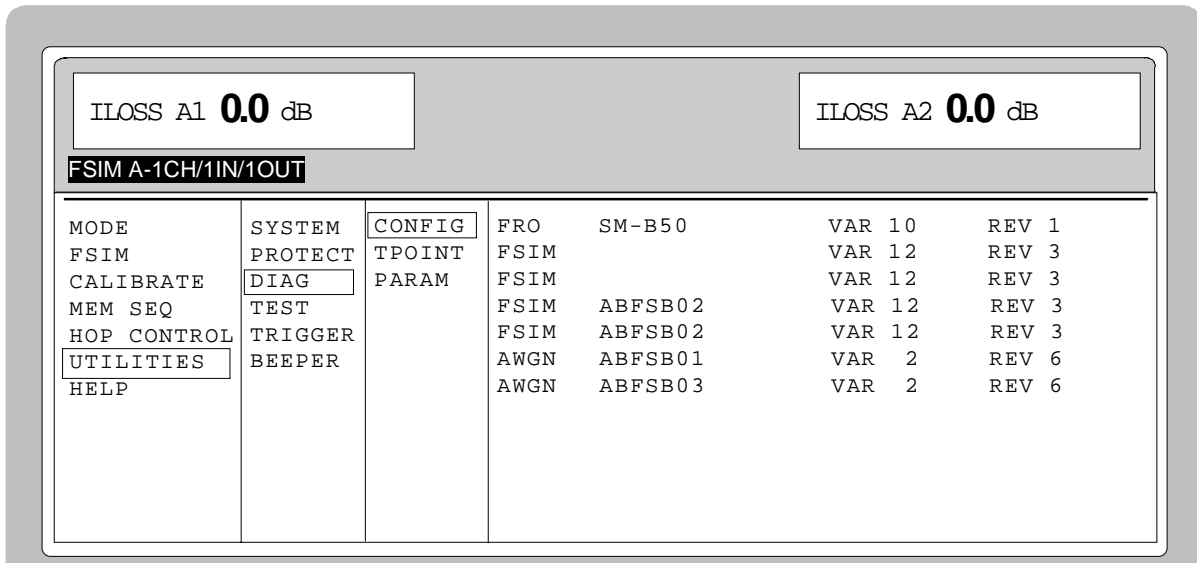


Fig. 4-26 UTILITIES - DIAG – CONFIG menu

Voltage Indication of Testpoints (DIAG-TPOINT)

The DIAG – TPOINT submenu provides access to internal testpoints. If a testpoint is switched on, a window with voltage indication is displayed in the header. For further information see service manual instrument.

Menu selection: UTILITIES - DIAG - TPOINT

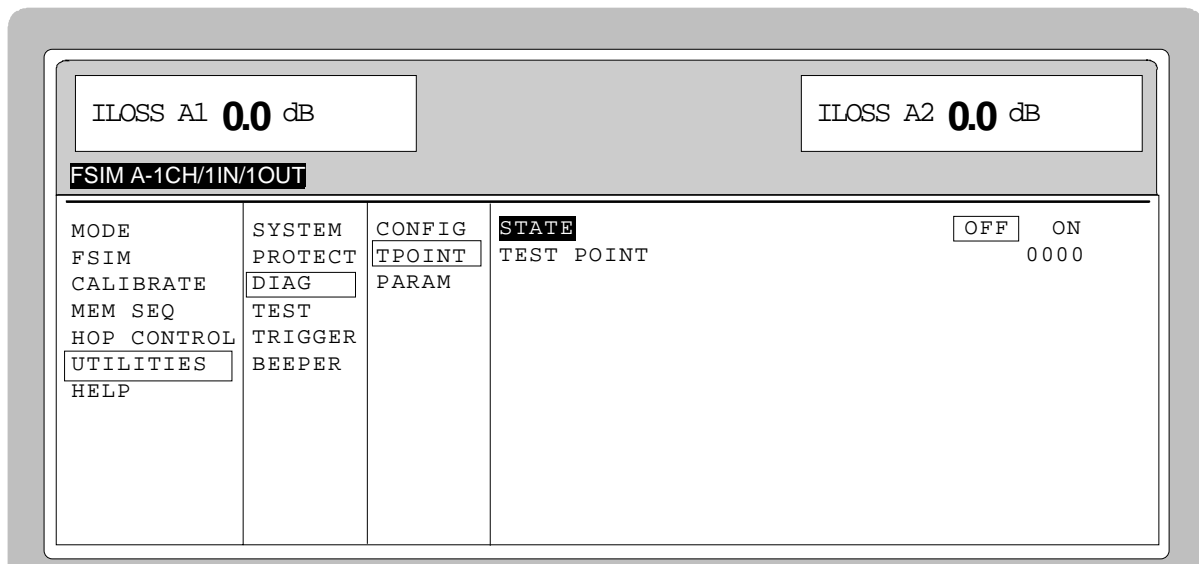


Fig. 4-27 UTILITIES - DIAG – TPOINT menu

STATE Switch-on/off of voltage indication in header.

TEST POINT Entry value of testpoint.
IEC/IEEE-bus command :DIAG:POINxx?

Indication of Service Data (DIAG - PARAM)

The DIAG – PARAM menu provides access to different parameters such as serial number, software version, counter of operating hours and attenuator switch cycles.

Menu selection: UTILITIES - DIAG - PARAM

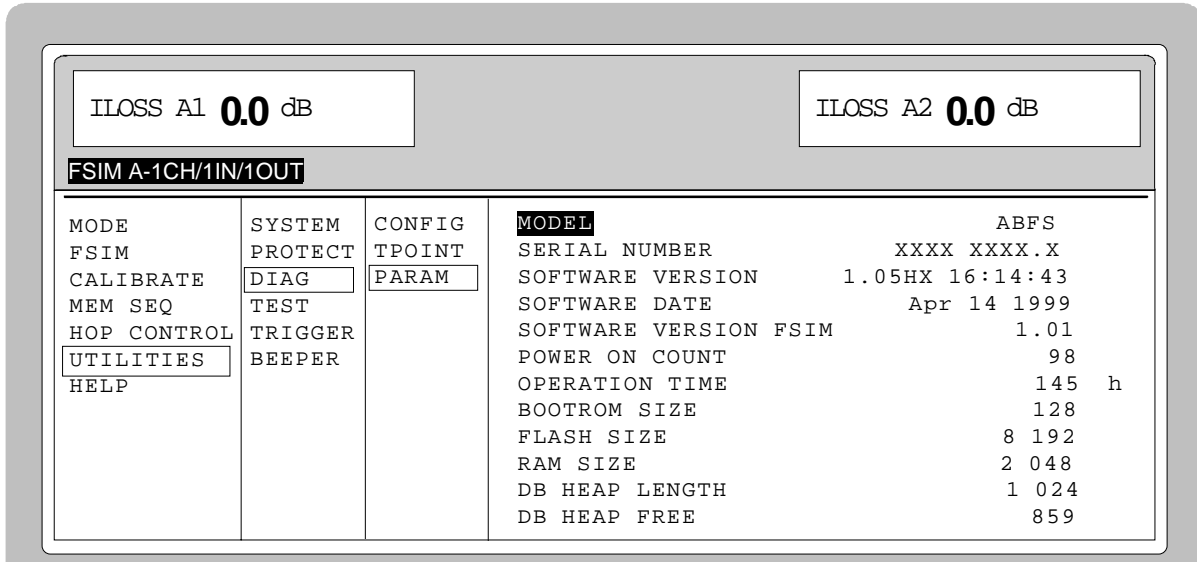


Fig. 4-28 UTILITIES - DIAG – PARAM menu

For IEC/IEEE-bus commands see Chapter 6, Section "DIAGnostic system" and Section "Common Commands; *IDN?".

Test (TEST)

On power-up, ABFS initiates a selftest which runs continuously during operation. The RAM and ROM contents are checked upon power-up. If an error is detected, a corresponding error message is output. The battery voltage of the non-volatile RAM is also checked upon power-up (TEST POINT 0007 = RAM batteries). Data storage is not ensured for voltage values below 2.5 V. A corresponding message is displayed.

The most important device functions are checked automatically during operation.

If a defective function occurs during the selftest, ERROR is displayed in the status line. To identify the error, press the [ERROR] key to call up the ERROR menu comprising all the error messages (see chapter 9, "Error messages"). The tests can also be called up via menu.

The UTILITIES – TEST menu provides access to the tests.

Menu selection: UTILITIES - TEST

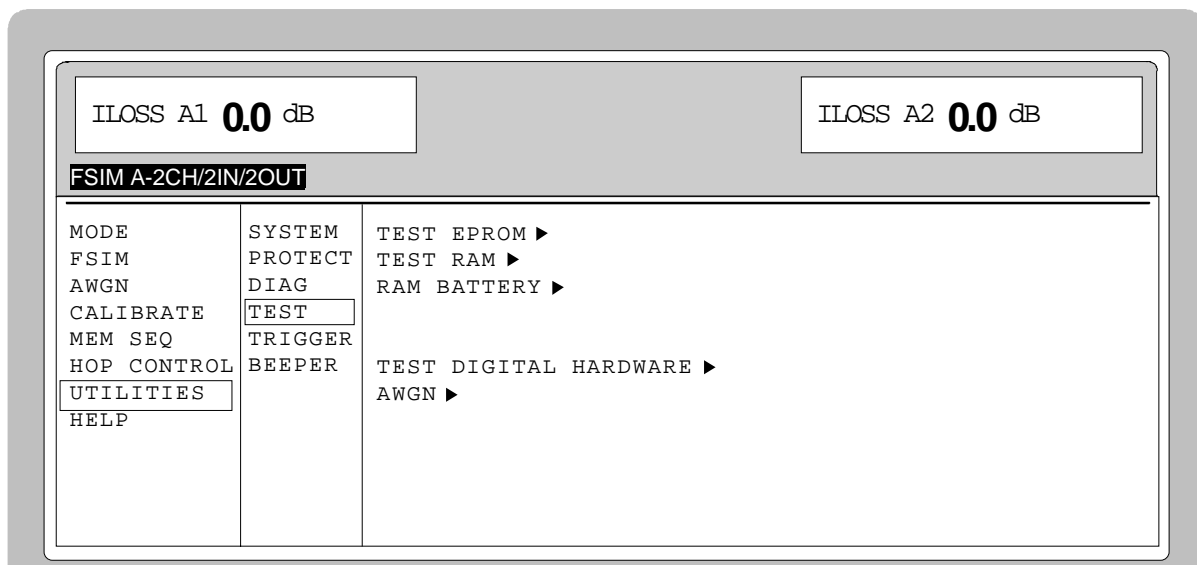


Fig. 4-29 UTILITIES – TEST menu

- | | |
|--------------------------------|---|
| TEST EPROM ► | Tests the EPROM. The result is displayed in a window.
IEC/IEEE-bus command : TEST:ROM? |
| TEST RAM ► | Tests the RAM. The result is displayed in a window.
IEC/IEEE-bus command : TEST:RAM? |
| RAM BATTERY ► | Tests the RAM battery. The result is displayed in a window.
IEC/IEEE-bus command : TEST:BATT? |
| TEST DIGITAL HARDWARE ► | Tests the digital hardware. The result is displayed in a window.
IEC/IEEE-bus command : TEST:FSIM? |
| AWGN ► | Tests the noise generator. The result is displayed in a window.
IEC/IEEE-bus command : TEST:NDSim? |

Set Trigger Inputs (TRIGGER)

The UTILITIES – TRIGGER menu provides access to settings relating to the TRIGGER input and the BLANK output.

For further information see Sections "HOP CONTROL" and "Memory Sequence".

Menu selection: UTILITIES - TRIGGER

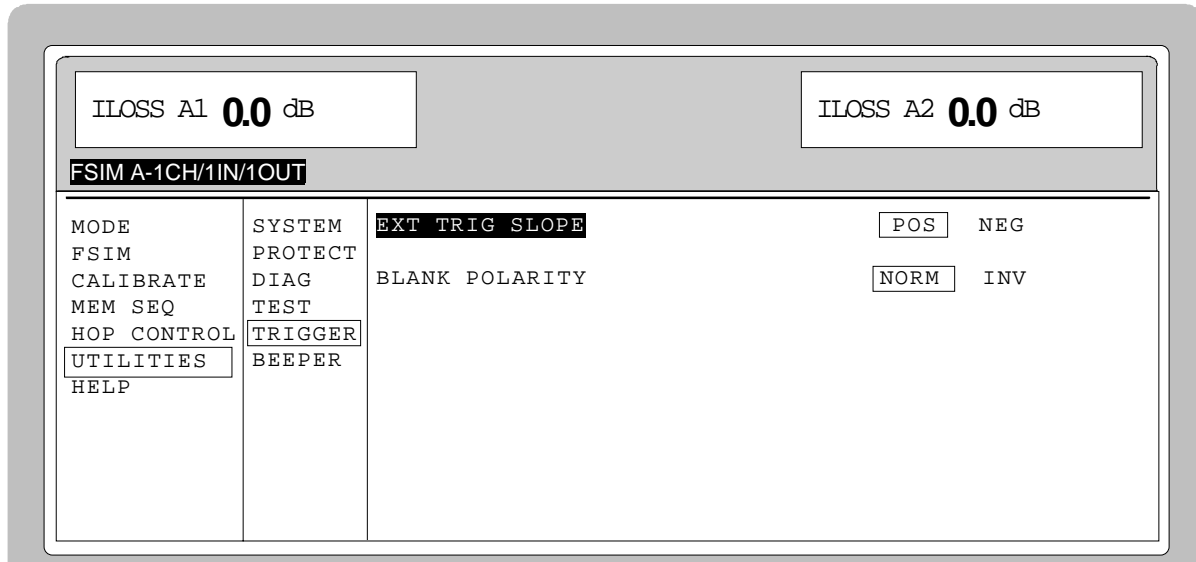


Fig. 4-30 UTILITIES – TRIGGER menu

EXT TRIG SLOPE

Selection of active edge of external trigger signal.

POS The unit triggers on the positive edge of the external signal.

NEG The unit triggers on the negative edge of the external signal.

IEC/IEEE-bus command :TRIG:SLOP POS

BLANK POLARITY

Selection of polarity for blank signal.

NORM If BLANK is active, the output signal is HIGH

INV Polarity is inverted.

IEC/IEEE-bus command :OUTP:BLAN NORM

Switch On/Off of Beeper

The beeper can be switched on/off via the UTILITIES – BEEPER menu.

Note: Preset does not change the current state (ON or OFF).

Menu selection: UTILITIES - BEEPER

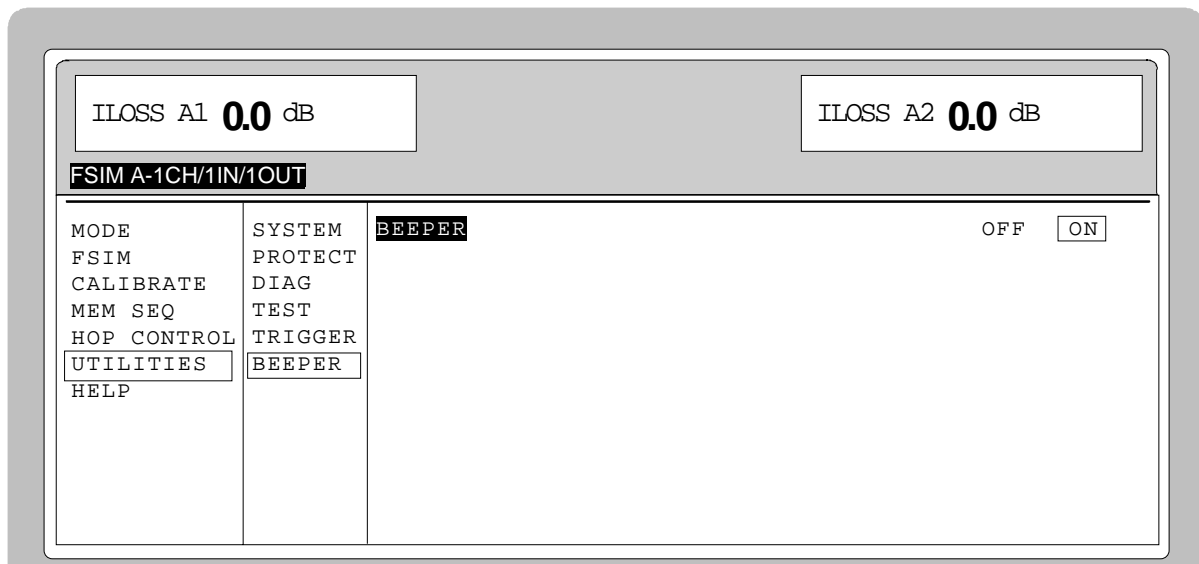


Fig. 4-31 UTILITIES – BEEPER menu

BEEPER

Switch-on/off of beeper.

IEC/IEEE-bus command :SYST:BEEP:STAT ON

Help System

ABFS has two help systems: one providing context-sensitive help that can be called up by the [HELP] key and provides information on the current menu. The other system can be accessed via the HELP menu and provides help texts that are displayed after the selection of a keyword. The keywords are listed in alphabetical order.

[HELP] key

The yellow [HELP] key can be pressed any time. The current setting menu is blanked out and the context-sensitive text is inserted. The help panel can be quit via the [RETURN] key.

HELP menu

After call-up of the HELP menu, access to all help texts is possible via an index. Operation is analog to menu operation.

- Place menu cursor to desired index using the rollkey.
- Press [SELECT] key.
- The information of the marked index is displayed.
- Press the [RETURN] key to quit the menu.

Status

The ABFS STATUS page gives an overview of all possible device settings. The settings are displayed in abbreviated form. The STATUS page is called up by pressing the [STATUS] key. A return to the previous menu is possible with the [RETURN] key. If ABFS is controlled via the IEC/IEEE bus, the menu too is replaced by the STATUS page.

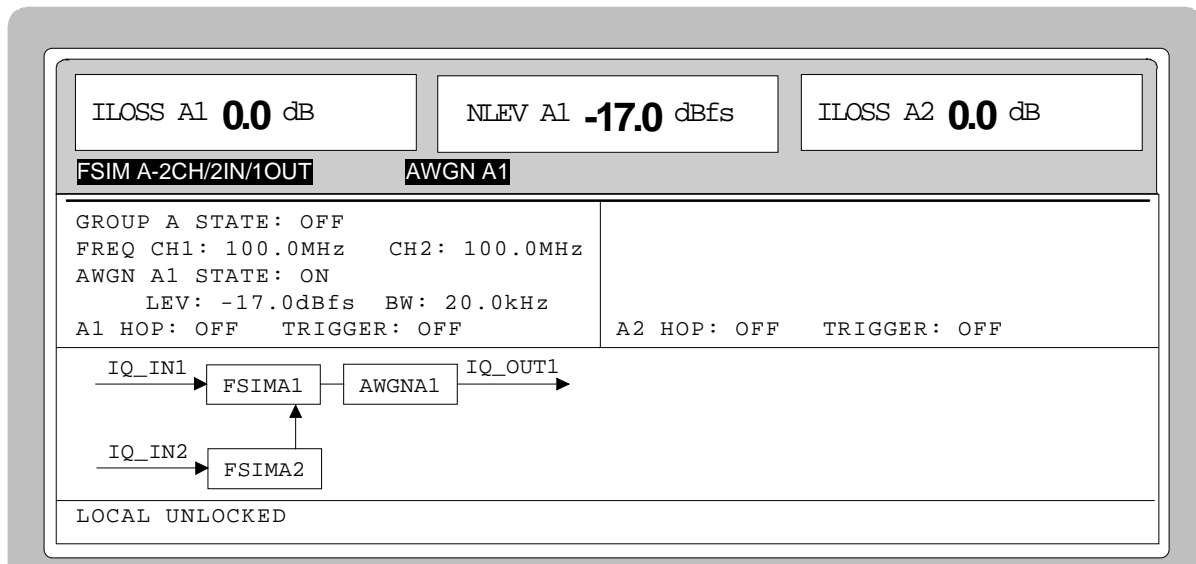


Fig. 4-32 STATUS page

5 Remote Control - Basic Information

This chapter provides basic information on remote control, for example on the IEC/IEEE-bus, RS-232-C-interface, interface and device messages, command processing, status reporting system, etc.

The instrument is equipped with an IEC/IEEE-bus interface according to standard IEC 625.1/IEEE 488.1 and two RS-232-C interfaces. The connectors are located at the rear of the instrument and permit to connect a controller for remote control. The instrument supports the SCPI version 1994.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers.

For this section it is assumed that the user has basic knowledge of IEC/IEEE-bus programming and operation of the controller. A description of the interface commands will be found in the relevant manuals.

The requirements of the SCPI standard regarding command syntax, error handling and configuration of the status registers are explained in detail in the respective sections. Tables provide a fast overview of the bit assignment of the status registers. The tables are complemented by a comprehensive description of the status registers.

A description of commands is given in chapter 6. Programming examples for the main functions will be found in chapter 7.

Brief Instructions

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions.

IEC/IEEE Bus

It is assumed that the IEC/IEEE-bus address, which is factory-set to 28, has not been changed.

1. Connect the instrument and the controller using the IEC/IEEE-bus cable.
2. Write and start the following program on the controller:

```
CALL IBFIND("DEV1", generator%)           Open port to instrument
CALL IBPAD(generator%, 28)                Transfer instrument address to controller
CALL IBWRT(generator%, "*RST;*CLS")      Reset instrument
CALL IBWRT(generator%, "SOUR:FSIM:STAT ON") Switch on fading simulation
```

The fading simulator is switched on.

3. To return to manual control, press the [LOCAL] key on the front panel.

RS-232-C Interface

It is assumed that the configuration of the RS-232-C interface of the unit has not yet been changed.

1. Connect the unit and the controller using the null modem cable.
2. Enter the following command on the controller to configure the controller interface:
mode com1: 9600, n, 8, 1
3. Create the following ASCII file on the controller:

*RST; *CLS	Switch instrument to remote control (RETURN)
:SOUR:FSIM:STAT ON	Reset instrument
	Switch on fading simulation

4. Transfer the ASCII file to the instrument via the RS-232-C interface. Enter the following command on the controller:
copy <filename> com1:
The fading simulator is switched on.
5. To return to manual control, press the [LOCAL] key on the front panel.

Switchover to Remote Control

On power-up, the instrument is always in the manual control mode ("LOCAL" state) and can be operated via the front panel.

The instrument is switched to remote control ("REMOTE" state) as follows:

IEC/IEEE-bus: when it receives an addressed command from the controller.
 RS-232-C interface: when it receives a carriage return <CR> (=0Dh) or a line feed <LF> (=0Ah) from the controller.

During remote control, operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via the IEC/IEEE bus. Switching from manual to remote control and vice versa does not affect the instrument settings.

Remote Control via IEC/IEEE Bus

Setting the Device Address

The IEC/IEEE-bus address of the instrument is factory-set to 28. It can be changed manually in the UTILITIES - SYSTEM – GPIB – ADDRESS menu or via the IEC/IEEE bus. Addresses 0 to 30 are permissible.

Manually:

- Call UTILITIES - SYSTEM – GPIB – ADDRESS menu
- Enter desired address
- Terminate input using the [1x/ENTER] key

Via IEC/IEEE-bus:

CALL IBFIND("DEV1", generator%)	Open port to instrument
CALL IBPAD(generator%, 28)	Transfer old address to controller
CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 20")	Set instrument to new address
CALL IBPAD(generator%, 20)	Transfer new address to controller

Indications during Remote Control

The remote control state is indicated by "IEC Remote" or "Local" being displayed on the STATUS page. In the REMOTE state, the STATUS page is always displayed.

"Locked" indicates that the [LOCAL] key is disabled, ie switchover to manual control can only be made via the IEC/IEEE bus. If "Unlocked" is displayed, switchover to manual control can be made with the [LOCAL] key.

Return to Manual Operation

Return to manual operation can be made via the front panel or the IEC/IEEE bus.

Manually: ➤ Press [LOCAL] key.

Note:

- Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.
- The [LOCAL] key can be disabled by the universal command LLO in order to prevent unintentional switchover. In this case, switchover to manual control is only possible via the IEC/IEEE bus.
- The [LOCAL] key can be enabled again by deactivating the REN control line of the IEC/IEEE bus.

Via IEC/IEEE bus:

```
...
CALL IBLOC(generator%)           Set instrument to manual control
...
```

Remote Control via RS-232-C Interface

Setting the Transmission Parameters

To enable error-free and correct data transmission, the parameters of the instrument and the controller should have the same setting. To prevent any problems during binary data transmission, the RS-232-C interface is permanently set for 8 data bits, no parity and 1 stop bit. This data format corresponds to the IEEE P1174 draft standard.

The baud rate and handshake can be manually changed in the UTILITIES – SYSTEM - RS232 menu.

- Call UTILITIES - SYSTEM - RS232 menu.
- Select desired baud rate and handshake.
- Terminate input using the [1x/ENTER] key.

Indications during Remote Control

The remote control state is indicated by "RS-232 Remote" or "Local" on the STATUS page. In the REMOTE state, the STATUS page is always displayed.

Return to Manual Operation

Return to manual operation can be made via the front panel.

➤ Press [LOCAL] key.

Note: Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.

Messages

The messages transferred via the data lines of the IEC/IEEE bus can be divided into two groups:

- **interfaces messages** and
- **device messages**

No interface messages are defined for the RS-232-C interface.

Interface Messages

Interface messages are transferred on the data lines of the IEC/IEEE bus, the ATN control line being active. They are used for communication between the controller and the instrument and can only be sent by a controller which has the IEC/IEEE-bus control. Interface commands can be subdivided into

- **universal commands** and
- **addressed commands.**

Universal commands act on all devices connected to the IEC/IEEE bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in the section "Interface Messages" below.

Some control characters are defined for the control of the RS-232-C interface see section "Interface Functions".

Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the IEC/IEEE bus, the ATN control line not being active. ASCII code is used. The device messages are largely identical for the two interfaces (IEC/IEEE bus and RS-232-C).

A distinction is made according to the direction in which device messages are sent on the IEC/IEEE bus:

- **Commands** are messages the controller sends to the instrument. They operate the device functions and request information.

Commands are subdivided according to two criteria:

1. According to the effect they have on the instrument:

Setting commands cause instrument settings such as reset of the instrument or setting the output level to 1 V.

Queries cause data to be provided for output(queries) on the IEC/IEEE bus, eg for device identification or polling of the active input.

2. According to their definition in standard IEEE 488.2:

Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as the management of the standardized status registers, reset and selftest.

Device-specific commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee.

- **Device responses** are messages the instruments sends to the controller in reply to a query. They may contain measurement results or information on the instrument status.

The structure and syntax of device messages are described in the following section.

Structure and Syntax of Device Messages

Introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The objective of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines identical functions of a device or of different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address identical functions with identical commands. The command systems are of a hierarchical structure. Fig. 5-1 illustrates this tree structure using a section of command system *SOURCE*, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.

SCPI is based on standard IEEE 488.2, ie it uses the same basic syntax elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined in greater detail than in standard IEEE 488.2 (see section "Responses to Queries").

Structure of Commands

Commands consist of a header and, in most cases, one or several parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg a blank). Headers may consist of several key words. Queries are formed by appending a question mark directly to the header.

Common commands

Common (device-independent) commands consist of a header preceded by an asterisk "*" and of one or several parameters, if any.

Examples: *RST RESET, resets the instrument
 *ESE 253 EVENT STATUS ENABLE, sets the bits of
 the event status enable register
 *ESR? EVENT STATUS QUERY, queries the
 contents of the event status register.

Device-specific commands

Hierarchy: Device-specific commands are of a hierarchical structure (see Fig. 5-1). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example: *SOURCE*
 This key word denotes the *SOURCE* command system.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: *SOURCE:FSIM:COUPLE:SPEED ON*

This command is at the fourth level of the *SOURCE* system.

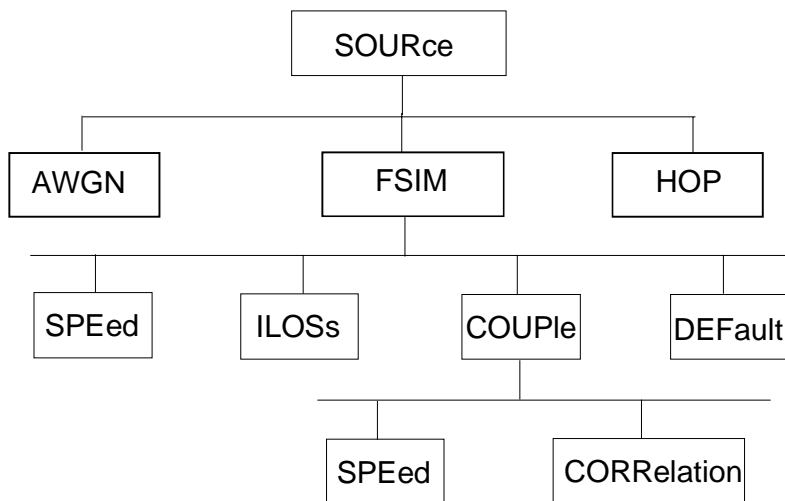


Fig. 5-1 Tree structure of SCPI command systems using the SOURce system as an example

Some key words occur at several levels within one command system. Their effect depends on the structure of the command, that is to say, at what position of the header of a command they are inserted.

Example: `:SOURce:FSIMulator:SPEEd:UNIT`
 This command contains the key word `SPEEd` at the third command level. It sets the speed unit.

Example: `:SOURce:FSIMulator:COUPLe:SPEEd`
 This command contains the key word `SPEEd` at the fourth command level. It couples the setting of `:FSIMulator:PATH<i>SPEEd` in all paths.

Optional key words:

Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked in the description by square brackets. The instrument must recognize the full command length for reasons of compatibility with the SCPI standard. Some commands can be considerably shortened by omitting optional key words.

Example: `[SOURce]:FSIMulator[:STATe]`
 This command switches the fading simulator on or off. The following command has the same effect:

`:FSIMulator ON`

Note: An optional key word must not be omitted if its effect is specified in greater detail by means of a numerical suffix.

Long and short form:

Key words have a long form and a short form. Either the long form or the short form may be entered, other abbreviations are not permissible.

Example: `STATus:QUESTionable:ENABle 1= STAT:QUES:ENAB 1`

Note: The short form is characterized by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serve the above purpose, the device itself does not make any difference between upper-case and lower-case letters.

Parameter: A parameter must be separated from the header by a "white space". If a command includes several parameters, they are separated by a comma ",". Some queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of these parameter types see section "Parameters".

Example: `SOURce:FSIMulator:COUPle:SPEEd ON`

Numerical suffix: If a device has several functions or features of the same kind, eg inputs, the desired function can be selected by appending a suffix to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example: `SOURce:FSIMulator2 ON`

This command selects Group B (= 2) from the fading simulator groups.

Structure of Command Lines

A command line may contain one or several commands. It is terminated by <New Line>, <New Line> with EOI or EOI together with the last data byte. QuickBASIC automatically produces EOI together with the last data byte.

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:

```
CALL IBWRT(generator%,
"SOURce:FSIMulator:SPEed:UNIT MPS;:SYSTem:MSEquence DWELL 20")
```

This command line contains two commands. The first command belongs to the SOURce system, the second command to the SYSTem system.

If successive commands belong to the same system and thus have one or several levels in common, the command line can be abbreviated. To this end, the second command (after the semicolon) is started with the level that lies below the common levels (see also Fig. 5-1). The colon following the semicolon must be omitted in this case.

Example:

```
CALL IBWRT(generator%,
"SOURce:FSIMulator:STATE ON;:SOURce:FSIM:SPEed:UNIT MPS")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. The two commands belong to the SOURce command system, subsystem FSIM, ie they have two common levels.

To abbreviate the command line, the second command is started with the level below SOURce:FSIM. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(generator%, "SOURce:FSIMulator:STATE ON;SPEed:UNIT MPS")
```

However, a new command line always has to be started with the complete path.

```
Example: CALL IBWRT(generator%, "SOURce:FSIMulator:STATE ON")
        CALL IBWRT(generator%, "SOURce:FSIMulator:SPEed:UNIT MPS")
```

Responses to Queries

For each setting command, a query is defined unless explicitly specified otherwise. The query is formed by adding a question mark to the setting command in question. Responses to queries to the SCPI standard are partly subject to stricter rules than responses to the IEEE 488.2 standard.

1. The requested parameter is transmitted without header.
Example: :SOURce:FSIMulator:ILOSS:SETting? Response: MAN
2. Maximum values, minimum values and all further quantities requested via a special text parameter are returned as numerical values.
Example: :RF? MAX Response: 99E9 for 99 GHz
3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set with the Unit command.
Example: :RF? Response: 1E6 for 1 MHz
4. Truth values (Boolean parameters) are returned as 0 (for Off) and 1 (for On).
Example: :SOURce:FSIMulator:STATE? Response: 1
5. Text (character data) is returned in a short form.
Example: :SOURce:FSIMulator:ILOSS:SETting? Response: MAN

Parameters

Most commands require a parameter to be specified. Parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The parameter type required for a given command and the permissible range of values are specified in the command description.

Numerical values Numerical values can be entered in any form, ie with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must be in the value range -32 000 to 32 000. The exponent is preceded by an "E" or "e". Specifying the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega, MOHM and MHz being also permissible), K (kilo), M (milli), U (micro) and N (nano). If no unit is entered, the basic unit is used.

Example: :SOURce:FSIMulator:CHANnel:RF 1.9 GHz =
:SOURce:FSIMulator:CHANnel:RF 1.9E9

Special numerical values The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.

In the case of a query, the numerical value is returned.

Example: Setting command: :SOURce:FSIMulator:CHANnel:RF MAXimum
Query: :SOURce:FSIMulator:CHANnel:RF? Response: 15

MIN/MAX MINimum and MAXimum denote the minimum and the maximum value.

DEF DEFault denotes a preset value stored in an EPROM. This value conforms to the default setting as called by the *RST command.

UP/DOWN UP/DOWN increases or decreases the numerical value by one step. The step width can be defined via an allocated step command for each parameter which can be set via UP/DOWN (see List of Commands, Chapter 6).

INF/NINF INFINITY, Negative INFINITY (NINF) represent the numerical values $-9.9E37$ or $9.9E37$, respectively. INF and NINF are only sent as device responses.

NAN Not A Number (NAN) represents the value $9.91E37$. NAN is only sent as a device response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. In the case of a query, 0 or 1 is returned.

Example: Setting command: :SOURce:FSIMulator:STATe ON
Query: :SOURce:FSIMulator:STATe? Response: 1

Text Text parameters follow the syntactic rules for key words, ie they can be entered using a short or a long form. Like any other parameter, they must be separated from the header by a "white space". In the case of a query, the short form of the text is returned.

Example: Setting command: :FSIMulator:ILOs:SETTING Manual
Query: :FSIMulator:ILOs:SETTING? Response: MAN

Strings

Strings must always be entered in inverted commas (' or ").

Example: `SYSTem:LANGUage "SCPI"` or
`:SYSTem:LANGUage 'SCPI'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command with a block data parameter has the following structure:

Example: `HEADer:HEADer #45168xxxxxxxx`

The data block is preceded by the ASCII character #. The next number indicates how many of the following digits describe the length of the data block. In the example, the four following digits indicate the length to be 5168 bytes. This is followed by the data bytes. During the transmission of the data bytes, all End or other control signs are ignored until all bytes are transmitted. Data elements comprising more than one byte are transmitted with the byte being the first which was specified by the SCPI command "FORMat:BOReR".

The format of the binary data within a block depends on the IEC/IEEE-bus command. The commands

```
:SOURce:HOP:FREQuency
:SYSTem:MSEQuence:DWELL
:SYSTem:MSEQuence:RCL
```

use the IEEE 754 format for double precision floating point numbers. Each number is represented by 8 bytes.

Example:

`a# = 125.345678E6`

`b# = 127.876543E6`

```
CALL IBWRT(generator%, "SOURce:FSIMulator:CHANnel<1>:RF
#216" + MKD$(a#) + MKD$(b#))
```

- '#' in the command string introduces the binary block,
- '2' indicates that 2 digits specifying the length will follow next,
- '16' is the length of the binary block (in bytes), here: 2 double precision floating point numbers of 8 bytes each.
- The binary data follow. Since the function IBWRT requires a text string, MKD\$ is used for type conversion.

The following ASCII format has the same effect:

```
CALL IBWRT(generator%, "SOURce:FSIMulator:CHANnel<1>:RF
125.345678E6, 127.876543E6")
```

Overview of Syntax Elements

Following is an overview of syntax elements.



The colon separates the key words of a command.
In a command line the separating semicolon marks the uppermost command level.



The semicolon separates two commands of a command line.
It does not alter the path.



The comma separates several parameters of a command.



The question mark forms a query.



The asterisk marks a common command.



Quotation marks introduce a string and terminate it.



ASCII character # introduces block data.



A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

Instrument Model and Command Processing

The instrument model shown in Fig. 5-2 was created with a view to the processing of IEC/IEEE-bus commands. The individual components work independently of each other and simultaneously. They communicate with each other by means of messages.

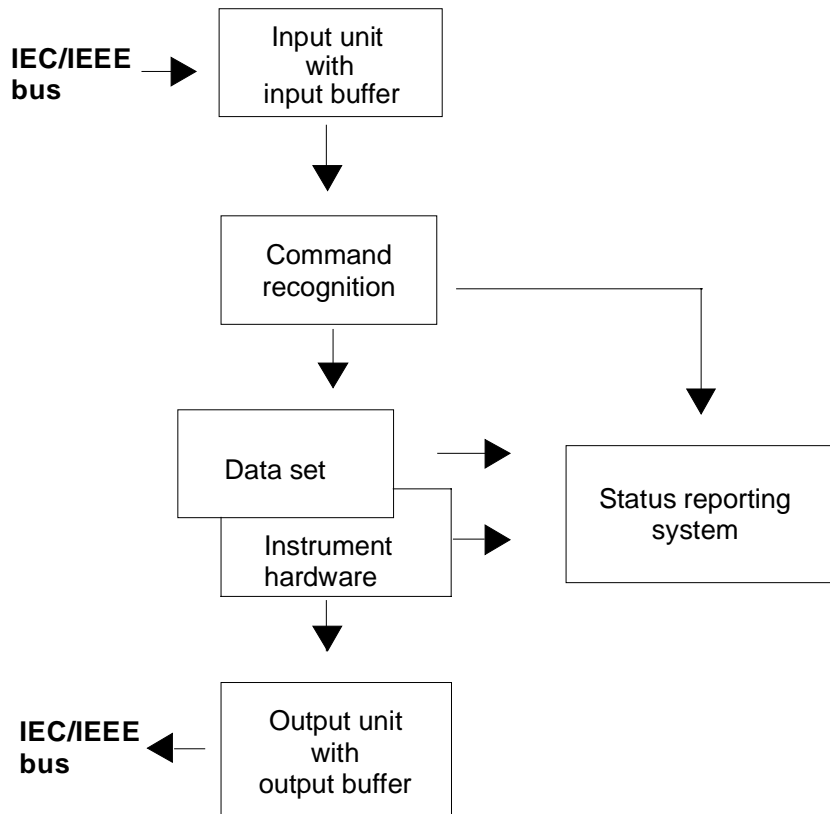


Fig. 5-2 Device model for remote control via the IEC/IEEE bus

Input Unit

The input unit receives commands character by character from the IEC/IEEE bus and stores them in the input buffer. The input buffer has a size of 256 characters. The input unit sends a message to the command recognition when the input buffer is full or when it receives a terminator, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.

If the input buffer is full, the IEC/IEEE-bus traffic is stopped and the data received up to then are processed. After this, the IEC/IEEE-bus traffic is continued. If, on receipt of a terminator, the input buffer is not full, the input unit can receive the next command during command recognition and execution. Receipt of a DCL command clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyzes the data from the input unit in the order the data are received. Only DCL commands are serviced with priority, whereas GET commands (Group Execute Trigger), for example, are processed only after the previously received commands. Each recognized command is immediately transferred to the data set but without being executed there at once.

Syntactic errors in commands are detected here and transferred to the status reporting system. The rest of a command line following a syntax error is further analyzed and processed as far as possible.

If the command recognition recognizes a terminator or a DCL command, it requests the data set to set the commands now also in the instrument hardware. After this, it is immediately ready to continue processing commands. This means that new commands can be processed while the hardware is being set ("overlapping execution").

Data Set and Instrument Hardware

The term "instrument hardware" is used here to designate the part of the instrument which actually performs the instrument functions: signal generation, measurement, etc. The controller is not included.

The data set is a detailed reproduction of the instrument hardware in the software.

IEC/IEEE-bus setting commands cause an alteration of the data set. The data set management enters the new values (eg frequency) into the data set but passes them on to the hardware only upon request by the command recognition. As this is only effected at the end of a command line, the sequence of setting commands in the command line is not relevant.

The data are only checked for compatibility among one another and with the instrument hardware immediately before they are transferred to the instrument hardware. If it is found that an execution is not possible, an "execution error" is signalled to the status reporting system. All alterations mad to the data set are cancelled, and the instrument hardware is not reset. Due to the delayed checking and hardware setting it is permissible however that impermissible instrument states are briefly set within a command line without an error message being produced. At the end of the command line, however, a permissible instrument state must be attained.

Before the data are passed on to the hardware, the settling bit in the STATus:OPERation register is set. The hardware makes the settings and resets the bit when the new state has settled. This procedure can be used for synchronization of command processing.

IEC/IEEE-bus queries cause the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit upon request. A detailed description of the structure and function is given in section "Status Reporting System".

Output Unit

The output unit collects the information requested by the controller and output by the data set management. The output unit processes the information in accordance with the SCPI rules and makes it available in the output buffer. The output buffer has a size of 256 characters. If the requested information exceeds this size, it is made available in portions without this being recognized by the controller.

If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit returns the error message "Query UNTERMINATED" to the status reporting system. No data are sent on the IEC/IEEE bus. The controller waits until it has reached its time limit. This procedure is specified by SCPI.

Command Sequence and Command Synchronization

As mentioned above, overlapping execution is possible for all commands. Likewise, the setting commands of a command line are not necessarily processed in the order in which they are received.

To ensure that commands are carried out in a specific order, each command must be sent in a separate command line, ie with a separate IBWRT() call.

To prevent overlapping execution of commands, one of commands *OPC, *OPC? or *WAI has to be used. Each of the three commands causes a certain action to be triggered only after the hardware has been set and has settled. The controller can be programmed to wait for the respective action to occur (see Table 5-1).

Table 5-1 Synchronization by means of *OPC, *OPC? and *WAI

Command	Action after the hardware has settled	Programming of controller
*OPC	Sets the operation-complete bits in the ESR	- Setting of bit 0 in the ESE - Setting of bit 5 in the SRE - Waiting for a service request (SRQ)
*OPC?	Writes a "1" into the output buffer	Addressing of instrument as a talker
*WAI	Continues the IEC/IEEE-bus handshake. The handshake is not stopped.	Sending of next command

An example of command synchronization will be found in section 7, "Programming Examples".

Status Reporting System

The status reporting system (see Fig. 5-4) stores all information on the current operating state of the instrument, for example that the instrument is carrying out an AUTORANGE, and on any errors that have occurred. This information is stored in status registers and in an error queue. The status registers and the error queue can be queried via the IEC/IEEE bus.

The information is of a hierarchical structure. The highest level is formed by the status byte (STB) register defined in IEEE 488.2 and the associated service request enable (SRE) mask register. The STB register receives information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated standard event status enable (ESE) mask register, and from the registers STATUS:OPERation and STATUS:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The status reporting system further comprises the IST flag ("Individual STATUS") with the parallel poll enable (PPE) register allocated to it. The IST flag, like the SRQ, combines the entire instrument state in a single bit. The function fulfilled by the PPE register for the IST flag corresponds to that fulfilled by the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. The output buffer is not part of the status reporting system but determines the value of the MAV bit in the STB register and is therefore shown in Fig. 5-4.

Structure of an SCPI Status Register

Each SCPI register consists of five parts each of 16 bits width which have different functions (see Fig. 5-3). The individual bits are independent of each other, ie each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATUS:OPERation register is assigned to the hardware status "Wait for trigger" for all five parts. Bit 15 (the most significant bit) is set to zero for all five parts. This allows the controller to process the contents of the register parts as positive integer.

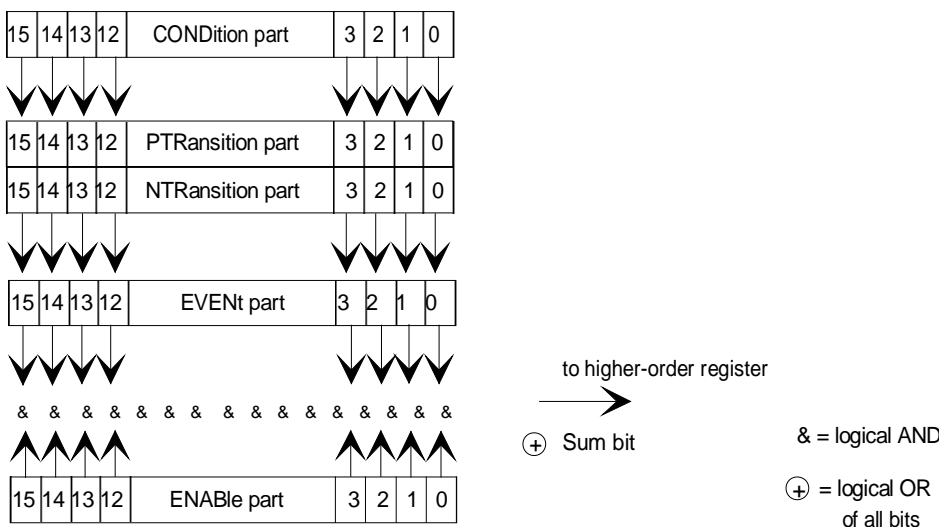


Fig. 5-3 Status register model

CONDition part	The CONDition part is directly written to by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can be read only but not written to or cleared. Reading does not affect it contents.
PTRansition part	The <u>P</u> ositive <u>T</u> ransition part acts as an edge detector. If a bit of the CONDition part changes from 0 to 1, the status of the associated PTR bit determines whether the EVENT bit is set to 1. PTR bit = 1: the EVENT bit is set. PTR bit = 0: the EVENT bit is not set. This part can be written to and read. Reading does not affect its contents.
NTRansition part	The <u>N</u> egative <u>T</u> ransition part likewise acts as an edge detector. If a bit of the CONDition part changes from 1 to 0, the status of the associated NTR bit determines whether the EVENT bit is set to 1. NTR bit = 1: the EVENT bit is set. NTR bit = 0: the EVENT bit is not set. This part can be written to and read. Reading does not affect its contents. With the above two edge register parts, the user can define what status transition of the CONDition part (none, 0 to 1, 1 to 0 or both) is to be stored in the EVENT part.
EVENT part	The EVENT part indicates whether an event has occurred since it was read the last time; it is the "memory" of the CONDition part. It indicates only those events that were passed on by the edge filters. The EVENT part is continuously updated by the instrument. This part can be read only. Upon reading, its contents is set to zero. In linguistic usage, the EVENT part is often treated as equivalent to the complete register.
ENABLE part	The ENABLE part determines whether the associated EVENT bit contributes to the sum bit (see below). Each bit of the EVENT part is ANDed with the associated ENABLE bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+'). ENABLE-Bit = 0: the associated EVENT bit does not contribute to the sum bit. ENABLE-Bit = 1: if the associated EVENT bit is "1", the sum bit is set to "1" as well. This part can be written to and read. Reading does not affect its contents.
Sum bit	As mentioned above, the sum bit is obtained from the EVENT part and the ENABLE part for each register. The result is entered as a bit of the CONDition part into the next higher register. The instrument automatically generates a sum bit for each register. It is thus ensured that an event, for example a PLL that has not locked, can produce a service request throughout all hierarchical levels.
Note:	<i>The service request enable (SRE) register defined in IEEE 488.2 can be taken as the ENABLE part of the STB if the STB is structured in accordance with SCPI. Analogously, the ESE can be taken as the ENABLE part of the ESR.</i>

Overview of Status Registers

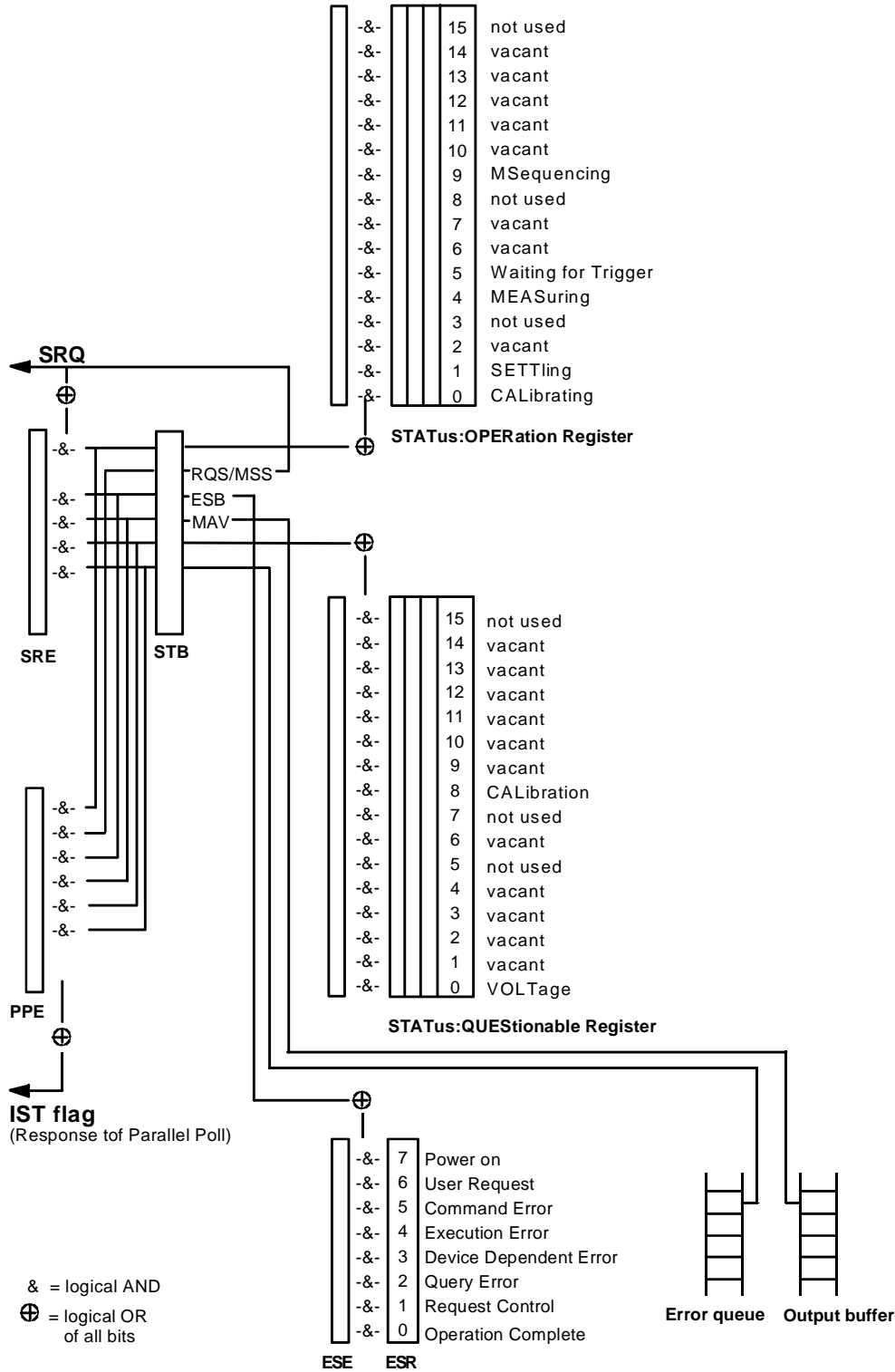


Fig. 5-4 Overview of status registers

Description of Status Registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The status byte is read using the command *STB? or a serial poll.

The STB is assigned an SRE. The SRE functionally corresponds to the ENABLE part of the SCPI registers. Each bit of the STB is assigned a bit of the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a service request (SRQ) is generated on the IEC/IEEE bus which triggers an interrupt in the controller (if the controller is configured correspondingly) and can be further processed there.

The SRE can be set using the command *SRE and read using the command *SRE?.

Table 5-2 Meaning of the bits used in the status byte

Bit No.	Meaning
2	<p>Error Queue Not Empty</p> <p>This bit is set if an entry is made in the error queue. If the bit is enabled by the SRE, each entry in the error queue generates a service request. Thus an error can be recognized and determined in greater detail by polling the error queue. The poll provides an informative error message. This procedure is recommended since it considerably reduces the problems involved in IEC/IEEE-bus control.</p>
3	<p>QUESTIONable Status sum bit</p> <p>This bit is set if an EVENT bit is set in the QUESTIONable status register and the associated ENABLE bit is set to 1. If the bit is set, this indicates a questionable instrument status which can be determined in greater detail by polling the QUESTIONable status register.</p>
4	<p>MAV bit (Message Available)</p> <p>This bit is set if a message is available in the output buffer which can be read. The bit can be used for the automatic reading of data from the instrument to the controller (see chapter 7, "Programming Examples").</p>
5	<p>ESB bit</p> <p>Sum bit of event status register. It is set if one of the bits of the event status register is set and enabled in the event status enable register. If the bit is set, this indicates a serious error which can be determined in greater detail by polling the event status register.</p>
6	<p>MSS bit (Master Status Summary bit)</p> <p>This bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable (SRE) register.</p>
7	<p>OPERation Status Register sum bit</p> <p>This bit is set if an EVENT bit is set in the OPERation status register and the associated ENABLE bit is set to 1. If the bit is set, this indicates that the instrument is just carrying out an action. The type of action can be determined by polling the OPERation status register.</p>

IST Flag and Parallel Poll Enable Register (PPE)

Analogously with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (see section "Parallel Poll") or using the command *IST?.

The parallel poll enable (PPE) register determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE. Unlike the SRE, bit 6 is used in this case. The IST flag results from the ORing of all results. The PPE can be set using the command *PRE and read using the command *PRE?.

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is already defined in IEEE 488.2. It can be compared with the EVENT part of an SCPI register. The event status register can be read using the command *ESR?.

The ESE is the associated ENABLE part. It can be set using the command *ESE and read using the command *ESE?.

Table 5-3 Meaning of the bits used in the event status register

Bit No.	Meaning
0	Operation Complete This bit is set on receipt of the command *OPC when all previous commands have been executed.
2	Query Error This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is errored and hence cannot be executed.
3	Device-Dependent Error This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
4	Execution Error This bit is set if a received command is syntactically correct but cannot be executed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
5	Command Error This bit is set if a command is received which is undefined or syntactically not correct. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue (see Chapter 9, Section "Error Messages").
6	User Request This bit is set when the [LOCAL] key is pressed, ie when the instrument is switched over to manual control.
7	Power On (AC supply voltage On) This bit is set on switching on the instrument.

STATus:OPERation Register

In the CONDition part, this register contains information on which actions the instrument is currently performing, and in the EVENt part information on what actions the instrument has performed since the register was last read. The register can be read using the commands STATus:OPERation:CONDition? and STATus:OPERation[:EVENT]?

Table 5-4 Meaning of the bits used in the STATus:OPERation register

Bit No.	Meaning
0	CALibrating This bit is set during the time the instrument performs a calibration.
1	SETTling This bit is set during the time a new status is settling after a setting command. The bit is set only if the settling time is longer than the command processing time.
4	MEASuring This bit is set during the time the instrument performs a measurement.
5	WAIT for TRIGGER This bit is set during the time the instrument waits for a trigger event.
9	MSEQuencing This bit is set during the time the instrument performs a memory sequence .

STATus:QUEStionable Register

This register contains information on questionable instrument states. These may occur, for example, if the instrument is operated outside specified values. The register can be read using the commands STATus:QUEStionable:CONDition? and STATus:QUEStionable[:EVENT]?

Table 5-5 Meaning of the bits used in the STATus:QUEStionable register

Bit –No.	Meaning
8	CALibration This bit is set if a calibration is not performed properly.

Use of Status Reporting System

To make effective use of the status reporting system, the information collected there must be transferred to the controller and further processed. There are several methods to this effect which are described in the following. For detailed examples see chapter 7, "Programming Examples").

Service Request, Making Use of Hierarchy Structure

Under certain conditions, the instrument can send a service request (SRQ) to the controller. The service request normally triggers an interrupt at the controller to which the control program can respond with corresponding actions. Fig. 5-4 shows that an SRQ is triggered if one or several of the bits 2, 3, 4, 5 and 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of another register, the error queue or the output buffer. By setting the ENABLE parts of the status registers accordingly, it is achieved that arbitrary bits of an arbitrary status register trigger an SRQ. To make use of the possibilities of the service request, all bits of the SRE and ESE enable registers should be set to "1".

Examples (see also Fig. 5-4 and chapter 7, "Programming Examples"):

Use of command *OPC to generate an SRQ

- Set bit 0 in the ESE (Operation Complete).
- Set bit 5 in the SRE (ESB).

The instrument generates an SRQ after completion of its settings.

The SRQ is the only way for the instrument to become active on its own. Each controller program should, therefore, set the instrument such that a service request is triggered in the event of a malfunction. The program should react appropriately to the service request. A detailed example of a service request routine is included in chapter 7, "Programming Examples".

Serial Poll

In a serial poll, just as with command *STB, the status byte of an instrument is queried. However, the query is implemented by means of interface messages and is therefore clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard method for different instruments to query the status byte. The method also works with instruments which do not adhere to SCPI nor to IEEE 488.2.

The QuickBASIC command for executing a serial poll is `IBRSP ()`. Serial polling is mainly used to obtain a fast overview of the states of several instruments connected to the IEC/IEEE bus.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, ie to set the data line allocated to each instrument to logically "0" or "1". Analogously to the SRE register, which determines under what conditions an SRQ is generated, there is a parallel poll enable (PPE) register, which is likewise ANDed with the STB bit by bit, with bit 6 being taken into account. The results are ORed, and the result of this is sent (possibly inverted) in response to a parallel poll by the controller. The result can also be queried without a parallel poll using the command `*IST`.

The instrument first has to be set for parallel polling by means of the QuickBASIC command `IBPPC()`. This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using `IBRPP()`.

The parallel-poll method is mainly used in order to find out quickly, after an SRQ, which instrument has sent the service request if there are many instruments connected to the IEC/IEEE bus. To this effect, the SRE and the PPE must be set to the same value. A detailed example on parallel polling will be found in chapter 7, "Programming Examples".

Query by Means of Commands

Each part of every status register can be read by means of a query. The queries to be used are included with the detailed description of the registers. In response to a query, a number is always returned which represents the bit pattern of the register queried. The number is evaluated by the controller program.

Queries are normally used after an SRQ to obtain more detailed information on the cause of the SRQ.

Error Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries to the error queue are detailed plain-text error messages which can be displayed in the Error menu by manual control or queried via the IEC/IEEE bus with the command `SYSTEM:ERROR?`. Each call of `SYSTEM:ERROR?` provides one entry from the error queue. If no more error messages are stored there, the instrument responds with 0, ie "No error".

The error queue should be queried by the controller program after each SRQ as the entries provide a more precise description of the cause of an error than the status registers. Especially during the test phase of a controller program the error queue should be queried regularly since errored commands from the controller to the instrument are also recorded in the error queue.

Reset Values of Status Reporting System

Table 5-6 lists the commands and events that cause a reset of the status reporting system. Except for *RST and SYSTem:PRESet, none of the commands has an effect on the functional settings of the instrument. It should be noted in particular that DCL also does not change instrument settings.

Table 5-6 Resetting of instrument functions

Event	Switching on of AC supply voltage		DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
	Power On Status Clear					
	0	1				
Clears STB, ESR	—	yes	—	—	—	yes
Clears SRE, ESE	—	yes	—	—	—	—
Clears PPE	—	yes	—	—	—	—
Clears EVENT parts of the registers	—	yes	—	—	—	yes
Clears ENABLE parts of all OPERATION and QUESTIONable registers, fills ENABLE parts of all other registers with "1"	—	yes	—	—	yes	—
Fills PTRansition parts with "1", clears NTRansition parts	—	yes	—	—	yes	—
Clears error queue	yes	yes	—	—	—	yes
Clears output buffer	yes	yes	yes	1)	1)	1)
Clears command processing and input buffer	yes	yes	yes	—	—	—

1) Each command which is the first in a command line, ie which directly follows the <PROGRAM MESSAGE TERMINATOR>, clears the output buffer.

Interfaces

IEC/IEEE-Bus Interface

The instrument is equipped with an IEC/IEEE-bus interface as standard. The connector to IEEE 488 is provided at the rear of the instrument. A controller for remote control can be connected via the interface. Connection is made using a shielded cable.

Characteristics of Interface

- 8-bit parallel data transmission
- Bidirectional data transmission
- Three-wire handshake
- High data transmission rate, max. 350 kbyte/s
- Up to 15 devices can be connected
- Maximum length of connecting cables 15 m (single connection 2 m)
- Wired OR if several instruments are connected in parallel

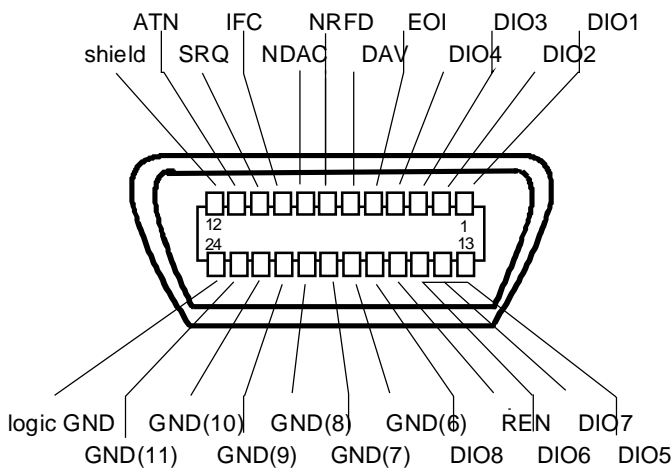


Fig. 5-5 Pin assignment of IEC/IEEE-bus interface

Bus Lines

1. Data bus with 8 lines DIO 1 to DIO 8

Transmission is bit-parallel and byte-serial in ASCII/ISO code. DIO1 is the least significant bit, DIO8 the most significant.

2. Control bus with 5 lines

- IFC** (Interface Clear):
Active LOW resets the interfaces of the instruments connected to the default setting.
- ATN** (Attention):
Active LOW signals the transmission of interface messages.
Inactive HIGH signals the transmission of device messages.
- SRQ** (Service Request):
Active LOW enables the instrument to send a service request to the controller.
- REN** (Remote Enable):
Active LOW enables switchover to remote control.
- EOI** (End or Identify):
This has two functions in conjunction with ATN:
ATN = HIGH Active LOW marks the end of a data transmission.
ATN = LOW Active LOW triggers a parallel poll.

3. Handshake bus with 3 lines

- DAV** (Data Valid):
Active LOW signals a valid data byte on the data bus.
- NRFD** (Not Ready For Data):
Active LOW signals that one of the devices connected is not ready to accept data.
- NDAC** (Not Data Accepted):
Active LOW as long as the instrument is accepting the data present on the data bus.

Interface Functions

Instruments which can be remote-controlled via the IEC/IEEE bus can be equipped with different interface functions. Table 5-7 lists the interface functions relevant for the instrument.

Table 5-7 Interface functions

Control character	Interface functions
SH1	Handshake source function (Source Handshake)
AH1	Handshake drain function (Acceptor Handshake)
L4	Listener function
T6	Talker function, ability to respond to serial poll
SR1	Service request function (Service Request)
PP1	Parallel poll function
RL1	Remote/local switchover function
DC1	Reset function (Device Clear)
DT1	Trigger function (Device Trigger)

Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the ATN (Attention) line being active LOW. These messages serve for communication between the controller and the instrument.

Universal Commands

Universal commands are in the code range 10 to 1F hex. They act on all instruments connected to the bus without addressing them before.

Table 5-8 Universal commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR\$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default state.
LLO (Local Lockout)	IBCMD (controller%, CHR\$(17))	Manual switchover to LOCAL is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR\$(24))	Ready for serial poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR\$(25))	End of serial poll.
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR\$(21))	End of parallel polling state.

Addressed Commands

Addressed commands are in the code range 00 to 0F hex. They only act on instruments addressed as listeners.

Table 5-9 Addressed commands

Command	QuickBASIC command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GET (Group Execute Trigger)	IBTRG (device%)	Triggers a previously active instrument function (eg a sweep). The effect of this command is identical to that of a pulse at the external trigger signal input.
GTL (Go to Local)	IBLOC (device%)	Transition to LOCAL state (manual control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configures the instrument for parallel polling. The QuickBASIC command additionally executes PPE / PPD.

RS-232-C Interface

Das Gerät ist serienmäßig mit einer RS-232-C-Schnittstelle ausgestattet. Der 9-polige Anschlußstecker befindet sich auf der Geräterückseite. Über die Schnittstelle kann ein Controller zur Fernsteuerung angeschlossen werden.

Characteristics of Interface

- Serial data transmission in asynchronous mode
- Bidirectional data transmission via two separate lines
- Selectable transmission rate from 120 to 15200 baud
- Logic 0 signal level from +3 V to +15 V
- Logic 1 signal level from –15 V to –3 V
- An external unit (controller) can be connected
- Software handshake (XON, XOFF)
- Hardware handshake

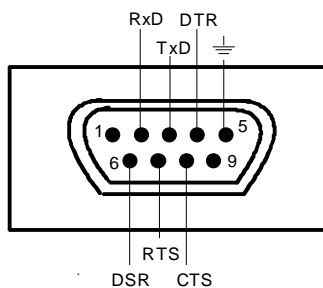


Fig. 5-6 Pin assignment of RS-232-C interface

Signal Lines

- RxD** (Receive Data):
Data line; transmission from external controller to instrument.
- TxD** (Transmit Data):
Data line; transmission from instrument to external controller.
- DTR** (Data terminal ready):
Output (logic zero = active). With DTR, the instrument indicates that it is ready to receive data. The DTR line controls the instrument's readiness for reception.
- GND:**
Interface ground, connected to instrument ground.
- DSR** (Data Set Ready):
(In the case of instruments with a VAR2 REV3 front module, the DSR line is used instead of the CTS line.)
- RTS** (Request To Send):
Output (logic 0 = active). With RTS, the instrument indicates that it is ready to receive data. The RTS line controls the instrument's readiness for reception.
- CTS** (Clear To Send):
Input (logic 0 = active). CTS informs the instrument that the opposite station is ready to receive data.

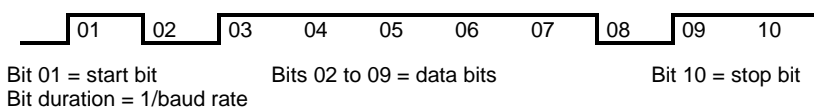
Transmission Parameters

To ensure error-free and correct data transmission, the transmission parameters on the instrument and the controller must have the same settings. The settings are made in the UTILITIES - SYSTEM - RS232 menu.

- Transmission rate (baud rate)** Eight different baud rates can be set on the instrument: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200.
- Data bits** Data transmission is in 8-bit ASCII code. The LSB (least significant bit) is transmitted as the first bit.
- Start bit** The transmission of a data byte is initiated with a start bit. The falling edge of the start bit indicates the beginning of the data byte.
- Parity bit** No parity bit is used.
- Stop bit** The transmission of a data byte is terminated by a stop bit.

Example:

Transmission of character A (41 hex) in 8-bit ASCII code:



Interface Functions

For interface control, a number of control characters defined from 0 to 20 hex of the ASCII code can be transmitted via the interface.

Table 5-10 Control characters for RS-232-C interface

Control character	Function
<Ctrl Q> 11 hex	Enable character output (XON)
<Ctrl S> 13 hex	Stop character output (XOFF)
Break (at least 1 character logic 0)	Reset instrument
0Dhex, 0Ahex	Terminator <CR><LF> Local/remote switchover

Handshake

Software handshake

The software handshake with the XON/XOFF protocol controls data transmission.

If the receiver (instrument) wishes to inhibit the input of data, it sends XOFF to the transmitter. The transmitter then interrupts data output until it receives XON from the receiver. The same function is also provided at the transmitter end (controller).

Note: *The software handshake is not suitable for the transmission of binary data. Here the hardware handshake is to be preferred.*

Hardware handshake

With a hardware handshake, the instrument signals its readiness for reception via the lines DTR and RTS. A logic 0 means "ready", a logic 1 means "not ready".

Whether or not the controller is ready for reception is signalled to the instrument via the CTS or the DSR line (see section "Signal Lines"). The transmitter of the instrument is switched on by a logic 0 and off by a logic 1. The RTS line remains active as long as the serial interface is active. The DTR line controls the instrument's readiness for reception.

Wiring between instrument and controller

Wiring between the instrument and the controller is by means of a null modem, ie the data, control and signalling lines have to be cross-connected. The wiring plan below applies to controllers with a 9-pin or 25-pin connector.

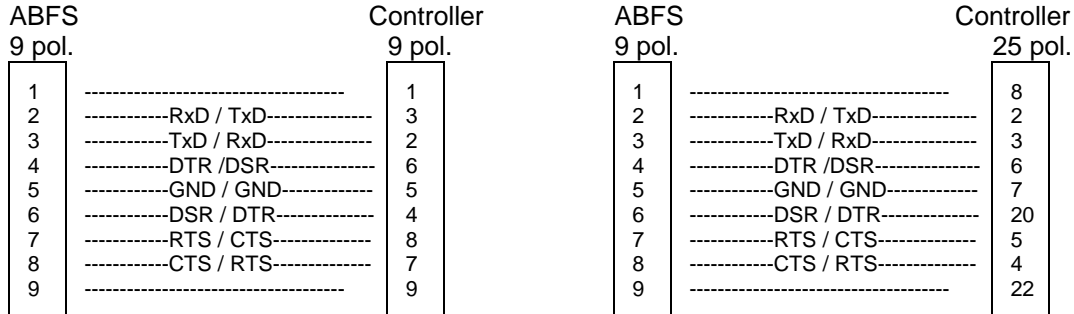


Fig. 5-7 Wiring of data, control and signalling lines for hardware handshake

6 Remote Control – Command Description

In the following sections, all commands implemented in the unit are first listed in a table according to the command system and are then described in detail. The notation is largely in line with the SCPI standard. Information on the SCPI conformity can be looked up in the alphabetical list at the end of the described commands.

For ease of orientation the corresponding IEC/IEEE-bus command for each setting is given in the description of manual control (chapter 4).

For a general introduction to remote control and a description of the status register see chapter 5. Chapter 7 contains programming examples for all important functions.

Note: *In contrast to manual control which is intended for optimum operating convenience remote control yields a predictable device status after a command. This means that after an attempt to combine incompatible settings, for example, the command is rejected and the device status remains unchanged without other settings being modified. Therefore, IEC/IEEE-bus control programs should always define an initial device status (eg with the *RST command) and then implement the required settings.*

Notation

Command table

Command:	The command column gives an overview of the commands and their hierarchical structure (see indentations).
Parameter:	The parameter column states the required parameters and their range of values.
Unit:	The unit column shows the basic unit of the physical parameters.
Remark:	This column indicates <ul style="list-style-type: none"> – whether the command has a query form, – whether the command is only in the form of a query, – whether the command is implemented in a specific device option only.

Indentations

The various levels of the SCPI command hierarchy are shown in the table by indentations to the right. The lower the level, the greater the indentation to the right. It should be noted that the complete notation of the command includes the higher levels too.

Example: :SOURce:FSIMulator:STATe is displayed in table as follows:

:SOURce	first level
:FSIMulator	second level
:STATe	third level

In the relevant manual, the command is shown in its full length. An example of each command and the default value (*RST), if any, can be found at the end of the corresponding manual.

Upper/lower case Upper/lower-case characters are used to denote long and short form notation of command keywords. The instrument does not differentiate between upper-case and lower-case characters.

Special characters | A selection of keywords with the same effect exists for several commands. These keywords are entered in the same line and are separated by a vertical stroke. Only one of these keywords has to be indicated in the header of the command. The effect of the command is independent of the relevant keyword entered.

Example: :SOURce
 :AWGN
 :BANDwith|:BWIDth

The two following commands bring about the same effect. They set the bandwidth of noise:

:SOURce:AWGN:BANDwith = SOURce:AWGN:BWIDth

A vertical bar in the notation of the parameters is used to separate alternative options and is to be seen as an "or". The effect of the command differs according to the parameter stated.

Example: Selection of parameters for the command

SOURce:AWGN:MODE SN | SIGNal | NOISe

- [] Keywords in square brackets may be omitted in compound headers (see chapter 5, section "Optional Keywords". For reasons of compatibility with the SCPI standard, the instrument must be able to recognize the full length of the command. Parameters in square brackets may also be optionally inserted into the command or omitted.
- { } Parameters in braces may be included in the command once, several times or not at all.

Common Commands

The common commands are based on the IEEE 488.2 (IEC 625.2) standard. A specific command has the same effect in different instruments. The header of these commands consist of an asterisk "*" followed by three letters. Many common commands concern the status reporting system described in detail in chapter 5.

Table 6-1 Common Commands

Command	Parameters	Unit	Remark
*CLS			No query
*ESE	0 to 255		
*ESR?			Query only
*IDN?			Query only
*IST?			Query only
*OPC			
*OPC?			Query only
*OPT?			Query only
*PRE	0 to 255		
*PSC	0 1		
*RCL	1 to 50		No query
*RST			No query
*SAV	1 to 50		No query
*SRE	0 to 255		
*STB?			Query only
*TRG			No query
*WAI			

***CLS**

CLEAR STATUS sets the status byte (STB), the Standard Event Status Register (ESR) and the EVENT part of the QUESTIONable and of the OPERATION Register to zero. The command has no effect on the enable and transition parts of the register. It clears the output buffer.

***ESE** 0 to 255

EVENT STATUS ENABLE sets the Event Status Enable Register to the defined value. Query *ESE? returns the contents of the Event Status Enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the contents of the Event Status register in decimal form (0 to 255) and then sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the identification of the unit.
 The response is for example: "Rohde&Schwarz, ABFS02,00000001, 1.04"
 02 = model identification
 00000001= serial number
 1,04 = firmware version

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flags in decimal form (0 | 1). The IST flag is the status bit sent during a parallel poll.

***OPC**

OPERATION COMPLETE sets bit 0 in the Event Status Register if all preceding commands have been processed. This bit may be used to trigger a service request.

***OPC?**

OPERATION COMPLETE QUERY returns a 1 if all preceding commands have been processed. Make sure that the IEC/IEEE-bus timeout is set long enough.

***OPT?**

OPTION IDENTIFICATION QUERY queries the options contained in the unit and returns a list of the built-in options. The options are separated by commas. Each option has its position in the response.

Table 6-2 Device response in case of OPT?

Position	Option
1	ABFS-B1 AWGN
2	ABFS-B2 second FSIM
3	ABFS-B3 second AWGN

Example of a device response: ABFS-B1,ABFS-B3

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets the Parallel Poll Enable register to the defined value. Query *PRE? returns the contents of the Parallel Poll Enable register in decimal form.

***PSC 0 | 1**

POWER ON STATUS CLEAR determines whether the contents of the ENABLE Registers is retained or cleared upon power-up.

*PSC = 0 causes the status registers to retain their contents. With adequate configuration of the ESE and SRE status registers, a service request may be triggered upon power-up.

*PSC ≠ 0 clears the registers.

The query *PSC? reads out the contents of the power-on-status-clear flag. The response may be 0 or 1.

***RCL** 1 to 50

RECALL calls up the device status stored under the given number by means of the ***SAV** command. 50 device states (1 to 50) can be stored by means of ***SAV**.

***RST**

RESET sets the device to a defined default state. The command corresponds to an activation of the [PRESET] key.

***SAV** 1 to 50

SAVE stores the current device state under the given number (see ***RCL**).

***SRE** 0 to 255

SERVICE REQUEST ENABLE sets the Service Request Enable Register to the defined value. Bit 6 (MSS mask bit) remains 0. This command determines the conditions under which a service request is triggered. The query ***SRE?** outputs the contents of the Service Request Enable Register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY outputs the contents of the status byte in decimal form.

***TRG**

TRIGGER triggers all actions waiting for a trigger event. Specific trigger events can be triggered via the command system TRIGger (see TRIGger System).

***WAI**

WAIT-to-CONTINUE allows processing of commands only after all preceding commands have been executed and all signals are settled (see **"*OPC"**).

ABORt System

The ABORt system comprises all the commands to abort triggered actions. After an abort the latter can immediately be retriggered. All commands trigger an event and have therefore no *RST value.

Command	Parameters	Default unit	Remark
:ABORt :MSEquence			No query

:ABORt:MSEquence

The command aborts a memory sequence (see :SYSTem:MSEquence) and sets the starting point.

Example: :ABOR:MSEQ

CALibration System

The CALibration system contains the commands for calibrating the unit and for setting the offset voltages of the inputs and outputs.

Command	Parameters	Default unit	Remark
:CALibration			
:FSIM			
[:MEASure]?			Query only
:NDSim			
[:MEASure]?			Query only
:OFFSet		V	
:I		V	
:INPut<i>	-10mV to 10mV		where i = [1] 2 (Group A) or i = 3 4 (Group B)
:OUTPut<i>	-10mV to 10mV	V	
:Q		V	
:INPut<i>	-10mV to 10mV		
:OUTPut<i>	-10mV to 10mV		

:CALibration:FSIM[:MEASure]?

This command triggers a calibration of fading simulators.

Example: :CAL:FSIM?

Response: 0 if ok., 1 if faulty

:CALibration:NDSim[:MEASure]?

This command triggers a calibration of noise generators (AWGN).

Example: :CAL:NDS?

Response: 0 if ok., 1 if faulty

:CALibration:OFFSet:I:INPut<i> -10mV to 10mV

A DC offset voltage to minimize the carrier residual, for example, can be set with this command.

Suffix i = [1] or 2 is used to set group A (FSIM1) and i = 3 or 4 to set group B (FSIM2).

Example: :CAL:OFFS:I:INP3 5.1mV

*RST value is 0

:CALibration:OFFSet:I:OUTPut<i> -10mV to 10mV

A DC offset voltage to minimize the carrier residual, for example, can be set with this command.

Suffix i = [1] or 2 is used to set group A (FSIM1) and i = 3 or 4 to set group B (FSIM2).

Example: :CAL:OFFS:I:OUTP3 5.1mV

*RST value is 0

FORMat System

This system contains the commands determining the format of the data returned to the controller by ABFS. All queries returning a list of numeric data or block data are concerned. Whenever this is applicable, a reference is made in the description of the commands.

Command	Parameters	Default unit	Remark
:FORMat [:DATA] :BORDER	ASCii PACKed NORMal SWAPPed		

:FORMat[:DATA] ASCii | PACKed

This command specifies the data format used by ABFS to return data. When data are transmitted from the controller to ABFS, the data format is automatically recognized by ABFS. In this case, the value specified here is irrelevant.

Note: *Settings made by the FORMat :DATA commands are only effective for commands for which this is stated in the command description.*

ASCii Numeric data are transmitted in plain text, separated by commas.

PACKed Numeric data are transmitted as binary block data. The format within binary data depends on the command and is described in chapter 5.

Example: :FORM:DATA ASC *RST value is ASCii

:FORMat:BORDER NORMal | SWAPPed

The command defines the order of bytes inside a binary block. This concerns only blocks that use the IEEE754 format (see chapter 5, "Block Data").

NORMal: For setting commands or queries, ABFS expects or sends the least significant byte of each IEEE754 floating point number. The most significant bit is sent last.

SWAPPed: For setting commands or queries, ABFS expects or sends the most significant byte of each IEEE754 floating point number. The least significant bit is sent last. For controllers based on a 80x86 processor this corresponds to the byte arrangement in the main memory. Conversion is therefore not required.

Example: :FORM:BORD NORM *RST value is NORMal

SOURCe:AWGN Subsystem

The AWGN subsystem comprises all commands for setting the noise generator for the fading signal (Additive White Gaussian Noise).

The AWGN modules (options ABFS-B1 and ABFS-B3) are controlled by this command.

Command	Parameters	Default unit	Remark
[:SOURce] :AWGN<i> :STATe :MODE :SNRatio :LEVel? :BANDwidth BWIDth	i = [1] 2 ON OFF SN SIGNal NOISe -17.0 to -50.0 10k to 10M	dBfs V Hz	not SCPI Query only

[:SOURce]:AWGN<i>

The following commands can be set separately for group A (i = 1 or without suffix) and group B (i = 2). The noise generator group A is selected with suffix <i>; group B (i = 2) is only available with option ABFS-B3.

Example: :SOUR:AWGN:STAT ON or :SOUR:AWGN1:STAT ON switch-on of group A

Example: :SOUR:AWGN2:STAT ON switch-on of group B

[:SOURce]:AWGN<i>:STATe ON | OFF

This command switches module AWGN on or off. For OFF, it is bypassed by means of the bypass circuit.

Example: :SOUR:AWGN:STAT ON *RST value is OFF

[:SOURce]:AWGN<i>:MODE SN | SIGNal | NOISe

This command switches the noise source or signal path on or off.

SN Signal + Noise: noise is added to signal.

SIGNal Only signal path is switched on.

NOISe Only noise generator is switched on.

Example: :SOUR:AWGN:MODE NOIS *RST value is SN

[:SOURce]:AWGN<i>:SNRatio -17.0 to -50.0 (dBfs)

This command sets the noise level in relation to the full-scale input level at a resolution of 0.1 dBfs.

Example: :SOUR:AWGN:SNR -22.2 *RST value is -14 dBfs

[[:SOURce]:AWGN<i>]:LEVel?

This command returns the absolute noise level in V.

Example: :SOUR:AWGN:LEV?

[[:SOURce]:AWGN<i>]:BANDwidth | BWIDth 10 kHz to 10 MHz

This command sets the bandwidth of noise.

Example: :SOUR:AWGN:BAND 1.23 MHZ

*RST value is 20 kHz

SOURce:FSIM Subsystem

The FSIM system contains the commands for the fading simulator.

Command	Parameters	Default unit	Remark
[:SOURce]			
:FSIMulator<k>			where <k>=[1] 2 (Group [A] B)
:CONFigure	SISO DISO SIDO DIDO		
[:STATe]	ON OFF		
:SEQuence	RUN STOP		
:RESet			
:IGNore			
:RFCHanges	ON OFF		
:STANdard	CDMA8 CDMA30 CDMA100 NADC8 NADC50 NADC100 GTU3 G6TU3 GTU50 G6TU50 GHT100 G6HT100 GRA250 GET50 GET100 PTU1 P6TU1 PTU50 P6TU50 PHT100 P6HT100 PRA130 PET50 PET100 TTU THT TET		
:SPEed			
:UNIT	MPS KMPH MPH		
:ILOSs			
:SETTing	AUTO MANual		
:COUPle			
:SPEed	ON OFF		
:CORRelation			
:COEFFicient	ON OFF		
:LOGNormal			
:LCONstant	ON OFF		
:CSTD	ON OFF		
:DEFault	(without)		
:CHANnel<i>	<i> = [1] 2		l=2 not for :FSIM:CONF SISO
:RF	1MHz to 99GHz		
:ILOSs?			Query only
:MANual	10 to 24dB		
:PATH<i>			<i> = 1 to 6 (7 to 12 only for :FSIM:CONF SISO)
:STATe	ON OFF	dB	
:PROFile	PDOPpler RAYLeigh RICE CPHase		
:DCOMponent			
:STATe	ON OFF		
:PRATio	-30.0 to +30.0 dB		
:FRATio	-1.0 to +1.0	dB	

Command	Parameters	Default unit	Remark
[:SOURce]			
:FSIMulator<k>	k = [1] 2		Group [A] B
:PATH<i>	<i> = 1 to 6 (12)		
:CPHase	0 to 360 DEG	DEG	
:SPEed	0.005 to 27 777 MPS		Depends on :FSIM:SPE:UNIT: MPS KMPH MPH
:FDOPpler	0.1 to 1600.0 Hz	Hz	
:LOSS	0 to 50.0 dB	dB	
:DELay	0 to 1638.0E-6s	s	
:CORRelation			
:PATH	0 7 to 12		
:COEFFicient	0 to 1.0		
:PHASe	0 to 359	DEG	
:LOGNormal			
:STATe	ON OFF		
:LCONstant	1 to 99 999		
:CSTD	0 to 12 dB	dB	

Only with option ABFS-B49

Command	Parameters	Default unit	Remark
[:SOURce]			
:FSIMulator			
:FDElay			Fine delay
[:STATe]	ON OFF		
:STANdard	G3C1 G3C2 G3C3 G3C4 G3C5		
:SPEed			
:UNIT	MPS KMPH MPH		
:DEFault	(none)		
:PATH<i>	<i> = [1] 2 to 4		
:STATe	ON OFF		
:PROFile	PDOPpler RAYLeigh		
:FRATio	-1.0 to +1.0		
:SPEed	0.005 MPS to 27 777 MPS		Depends on FSIM:SPE:UNIT: MPS KMPH MPH
:FDOPpler	0.1 Hz to 1600.0 Hz	Hz	
:LOSS	0 dB to 50.0 dB	dB	
:DElay	25 ns to 1637 us	s	
:MDElay			Moving delay
[:STATe]	ON OFF		
:DEFault	(none)		
:REFerence			
:LOSS	0 dB to 50.0 dB	dB	
:DElay	0 to 1638.0E-6	s	
:MOVing			
:LOSS	0 dB to 50.0 dB	dB	
:DElay		s	
:VPERiod	0.25 us to 1637.8 us	s	
:VPERiod	300 ns to 100 us	s	
:VPERiod	10 s to 500 s	s	
:BIRThdeath			
[:STATe]	ON OFF		
:SPEed			
:UNIT	MPS KMPH MPH		
:ILOSs			
:MODE	NORMal LACP		
:DEFault	(none)		
:PATH<i>	<i> = [1] 2		
:PROFile	PDOPpler		
:FRATio	-1.0 to +1.0		
:SPEed	0.005 MPS to 27 777 MPS		Depends on FSIM:SPE:UNIT: MPS KMPH MPH
:FDOPpler	0.1 Hz to 1600.0 Hz	Hz	
:LOSS	0 dB to 50.0 dB	dB	
:DElay	5 us to 1000 us	s	
:HOPPing			
	100 ms to 5.0 s	s	only PATH1

RST value is OFF [:SOURce]:FSIMulator<k>:STANdard CDMA8 | CDMA30 | to ..

This command selects the fading standard. All subsequent FSIM commands are set to a default value.

Parameters having a '6' after the first letter are compulsory in the 6-path mode (this mode is switched on if :FSIM:CONF DISO, SIDO or DIDO has been selected).

CDMA8, CDMA30, CDMA100	
NADC8, NADC50, NADC100	
GTU3, G6TU3, GTU50, G6TU50	GSM Typical Urban
GHT100, G6HT100	GSM Hilly Terrain
GRA250	GSM Rural Area
GET50, GET100	GSM Equal Test
PTU1, P6TU1, PTU50, P6TU50	DCS1800/PCS1900 Typical Urban
PHT100, P6HT100	DCS1800/PCS1900 Hilly Terrain
PRA130	DCS1800/PCS1900 Rural Area
PET50, PET100	DCS1800/PCS1900 Equal Test
TTU	Tetra Typical Urban
THT	Tetra Hilly Terrain
TET	Tetra Equal Test

Example: :SOUR:FSIM:STAN NADC50 *RST value is CDMA8

[:SOURce]:FSIMulator<k>:SPEed:UNIT MPS | KMPH | MPH

This command sets the unit for speed.

MPS	meters per second
KMPH	kilometers per hour
MPH	miles per hour

Example: :SOUR:FSIM:SPE:UNIT MPH *RST value is MPS

[:SOURce]:FSIMulator<k>:ILOSs:SETTing AUTO | MANual

This command sets the mode for the insertion loss of the fading simulator.

AUTO	The insertion loss is set automatically (caution: clipping is possible).
MANual	Manual setting of insertion loss is possible with the :FSIM:ILOS:MAN command.

Example: :SOUR:FSIM2:ILOS:SETT MAN *RST value is AUTO

[SOURce]:FSIMulator<k>:COUPle

The commands for coupling the settings for all paths are under this node. If the following coupling commands are set to ON, the change of the value in a path (path<i>) is considered in all other paths. If OFF is set to ON for the first time, all paths are set to the value of path 1.

[SOURce]:FSIMulator<k>:COUPle:SPEEd ON | OFF

This command couples the setting of :FSIMulator:PATH<i>:SPE in all paths.

Example: :SOUR:FSIM:COUP:SPE ON *RST value is OFF

[SOURce]:FSIMulator<k>:COUPle:CORRelation:COEFFicient ON | OFF

This command couples the setting of :FSIMulator:PATH<i>:CORRelation:COEFFicient in all paths.

Example: :SOUR:FSIM:COUP:CORR:COEF ON *RST value is OFF

[SOURce]:FSIMulator<k>:COUPle:LOGNormal:LCONstant ON | OFF

This command couples the setting of :FSIMulator:PATH<i>:LOGNormal:LCONstant in all paths.

Example: :SOUR:FSIM:COUP:LOGN:LCON ON *RST value is OFF

[SOURce]:FSIMulator<k>:COUPle:LOGNormal:CSTD ON | OFF

This command couples the setting of :FSIMulator:PATH<i>:LOGNormal:CSTD in all paths.

Example: :SOUR:FSIM:COUP:LOGN:CSTD ON *RST value is OFF

[SOURce]:FSIMulator<k>:DEFault

This command sets the default setting of the path parameters. Path 1 is switched on and the other paths are switched off. The command triggers an event and has therefore no *RST value and no query form.

Example: :SOUR:FSIM:DEF

[SOURce]:FSIMulator<k>:CHANnel<l>:RF 1.0 MHz to 99.0 GHz

This command sets the high frequency of the selected channel. Channel 2 (<l> = 2) is not available for :FSIM:CONF SISO.

Example: :SOUR:FSIM2:CHAN2:RF 1.9GHZ *RST value is 100 MHz

[[:SOURce]:FSIMulator<k>:CHANnel<l>:ILOSs?

The resulting insertion loss in dB of the selected channel is queried by this command. These values are also shown in the large ABFS display fields. Channel 2 (<l> = 2) is not available for :FSIM:CONF SISO. This command is a query and has therefore no *RST value.

Example: :SOUR:FSIM2:CHAN2:ILOS?

[[:SOURce]:FSIMulator<k>:CHANnel<l>:ILOSs:MANual 10.0 to 24.0 dB

This command sets the insertion loss of the fading simulator. (Caution: clipping is possible).

Example: :SOUR:FSIM:ILOS:MAN 13DB *RST value is 24.0 dB

[[:SOURce]:FSIMulator<k>:PATH<i>

The following commands can be set individually for each path. The path is selected with suffix <i>; depending on the configuration (:FSIM:CONF to) <i> has valid values from 1 to 6 (or from 1 to 12 in case of :FSIM:CONF SISO).

[[:SOURce]:FSIMulator<k>:PATH<i>:STATE ON | OFF

This command switches the selected path on or off.

Example: :SOUR:FSIM:PATH3:STAT ON *RST value is OFF

[[:SOURce]:FSIMulator<k>:PATH<i>:PROFile PDOPpler | RAYLeigh | RICE | CPHase

This command assigns a fading profile to the selected path.

PDOPpler Pure Doppler Profile

RAYLeigh Standard Rayleigh

RICE Standard Rice Profile

CPHase Constant Phase

Example: :SOUR:FSIM:PATH3:PROF RICE *RST value is RAYL

[[:SOURce]:FSIMulator<k>:PATH<i>:DCOMponent:STATe ON | OFF

This command switches the discrete components on or off. *RST value is OFF

Example: :SOUR:FSIM:PATH3:DCOM:STAT ON

[[:SOURce]:FSIMulator<k>:PATH<i>:PRATio -30 to +30 dB

This command sets the power ratio (only for RICE and LIST profile). The resolution is 0.1 dB.

Example: :SOUR:FSIM:PATH3:PRAT -20 *RST value is 0

[[:SOURce]:FSIMulator<k>:PATH<i>:FRATio -1.0 to +1.0

This command sets the frequency ratio of the Doppler shift. The resolution is 0.1.

Example: :SOUR:FSIM:PATH3:FRAT 0.5 *RST value is 1

[[:SOURce]:FSIMulator<k>:PATH<i>:CPHase 0 to 360 DEG

This command sets the phase for CPHAS fading.

Example: :SOUR:FSIM:PATH6:CPH 20.0 *RST value is 0

[[:SOURce]:FSIMulator<k>:PATH<i>:SPEed 0.005 to 27777 (in MPS (m/s))

This command sets the speed of the moving receiver. The unit is specified with the FSIM:SPEed:UNIT command and is not part of this command.

Example: :SOUR:FSIM:PATH3:SPE 10.0 *RST value is 20 MPS

[[:SOURce]:FSIMulator<k>:PATH<i>:FDOPpler 0.1 to 1600 Hz

This command indicates the Doppler frequency (coupled with vehicle speeds). The resolution is 0.1 dB.

Example: :SOUR:FSIM:PATH3:FDOP 100 *RST value is 6.7

[[:SOURce]:FSIMulator<k>:PATH<i>:LOSS 0 to 50.0 dB

This command sets the signal loss in the path. The resolution is 0.1 dB.

Example: :SOUR:FSIM:PATH3:LOSS 20 *RST value is 0

[[:SOURce]:FSIMulator<k>:PATH<i>:DELay 0 to 1638.0E-6S

This command sets the signal delay in the path. The resolution is 50 ns.

Example: :SOUR:FSIM:PATH3:DEL 123E-6 *RST value is 0

[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation

The commands for setting the correlation with another path are under this node.

[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation:PATH 0 | 7 to 12

This command defines the correlating path 7 to 12 for the path <i>. If no correlation is to occur, 0 is used.

Example: :SOUR:FSIM:PATH3:CORR:PATH 12 *RST value is 0

[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation:COEFFicient 0 to 1.0

This command sets the magnitude of the complex correlation coefficient. The resolution is 0.05.

Example: :SOUR:FSIM:PATH3:CORR:COEF 0.3 *RST value is 1

[[:SOURCE]:FSIMulator<k>:PATH<i>:CORRelation:PHASe 0 to 359 DEG

This command sets the phase of the complex correlation coefficient. The resolution is 1°.

Example: :SOUR:FSIM:PATH3:CORR:PHAS 180 *RST value is 0

[[:SOURCE]:FSIMulator<k>:PATH<i>:LOGNormal

The commands for setting Lognormal fading are under this node.

[[:SOURCE]:FSIMulator<k>:PATH<i>:LOGNormal:STATe ON | OFF

This command switches Lognormal fading on or off.

*RST value is OFF

Example: :SOUR:FSIM:PATH3:LOGN:STAT OFF

[[:SOURCE]:FSIMulator<k>:PATH<i>:LOGNormal:LCONstant 0 to 99 999 (m)

This command sets the terrain constant (local constant) in m. The unit is not part of this command. The resolution is 0.1 m.

Example: :SOUR:FSIM:PATH3:LOGN:LCON 50 *RST value is 200

[[:SOURCE]:FSIMulator<k>:PATH<i>:LOGNormal:CSTD 0 to 12.0 dB

This command sets the standard deviation of Lognormal fading. The resolution is 1 dB.

Example: :SOUR:FSIM:PATH3:LOGN:CSTD 2.0 *RST value is 0

[[:SOURCE]:FSIMulator:FDElay[:STATe] ON | OFF

This command switches fine delay fading simulation on or off.

Example: :SOUR:FSIM:FDEL ON

*RST value is OFF

[[:SOURCE]:FSIMulator:FDElay:STANdard G3C1 | G3C2 | G3C3

This command selects the fading standard for fine delay simulation.

G3C1 3GPP_3.0 Case 1

G3C2 3GPP_3.0 Case 2

G3C3 3GPP_3.0 Case 3

G3C4 3GPP_3.0 Case 4

G3C5 3GPP_3.0 Case 5

Example: :SOUR:FSIM:FDEL:STAN G3C1

*RST value is G3C1

[[:SOURCE]:FSIMulator:FDElay:SPEed:UNIT MPS | KMPH | MPH

This command sets the speed unit for fine delay simulation.

MPS m/s, meters per second

KMPH Km/h, kilometers per hour

MPH miles per hour

Example: :SOUR:FSIM:FDEL:SPE:UNIT MPH

*RST value is MPS

[[:SOURCE]:FSIMULATOR:FDELAY:DEFAULT

This command sets the default settings of the path parameters for fine delay simulation (as with *RST). The command triggers an event, and therefore has no *RST value and no query form.

Example: :SOUR:FSIM:FDEL:DEF

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>

The following commands are separately settable for every path. The path is selected with the suffix <i>, which has a valid range of 1 to 4.

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:STATE ON | OFF

This command switches the selected path for fine delay simulation on or off.

Example: :SOUR:FSIM:FDEL:PATH3:STAT ON *RST value is path 1, 2 ON; 3, 4 OFF

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:PROFILE PDOPpler | RAYLeigh

This command allocates a fading profile for fine delay simulation to the selected path.

PDOPpler Pure Doppler Profile

RAYLeigh Standard Rayleigh

Example: :SOUR:FSIM:FDEL:PATH3:PROF PDOP *RST value is RAYL

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:FRATIO -1.0 to +1.0

This command sets the frequency ratio for fine delay simulation. The resolution is 0.1.

Example: :SOUR:FSIM:FDEL:PATH3:FRAT 0.5 *RST value is 1

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:SPEED 0.005 to 27 777 (in MPS (m/s))

This command sets the speed of the moving receiver for fine delay simulation. The unit is set with the command FSIM:SPEED:UNIT and is not part of this command.

Example: :SOUR:FSIM:FDEL:PATH3:SPE 10.0 *RST value is 20 MPS

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:FDOPpler 0.1 Hz to 1600 Hz

This command presets the Doppler frequency for fine delay simulation (linked with vehicle speed). The resolution is 0.1 Hz.

Example: :SOUR:FSIM:FDEL:PATH3:FDOP 100 *RST value is 6.7

[[:SOURCE]:FSIMULATOR:FDELAY:PATH<i>:LOSS 0 dB to 50.0 dB

This command specifies the signal attenuation in the path for fine delay simulation. The resolution is 0.1 dB.

Example: :SOUR:FSIM:FDEL:PATH3:LOSS 20 *RST value is 0 (PATH1)
3 (PATH2)
6 (PATH3)
9 (PATH4)

[[:SOURce]:FSIMulator:FDElay:PATH<i>:DElay 25 ns to 1637 us

This command specifies the signal delay in the path for fine delay simulation.

Example: :SOUR:FSIM:FDEL:PATH3:DEL 123E-6 *RST value is 25 ns

[[:SOURce]:FSIMulator:MDElay[:STATe] ON | OFF

This command switches moving delay simulation on or off.

Example: :SOUR:FSIM:MDEL ON *RST value is OFF

[[:SOURce]:FSIMulator:MDElay:DEFault

This command sets the default settings of the path parameters for moving delay simulation (as with *RST). The command triggers an event and therefore has no *RST value and no query form.

Example: :SOUR:FSIM:MDEL:DEF

[[:SOURce]:FSIMulator:MDElay:REFerence:LOSS 0 dB to 50.0 dB

This command specifies the signal attenuation in the path for moving delay simulation. The resolution is 0.1 dB.

Example: :SOUR:FSIM:MDEL:REF:LOSS 20 *RST value is 0

[[:SOURce]:FSIMulator:MDElay:REFerence:DElay 0 s to 1638.0E-6 s

This command specifies the signal delay in the path for moving delay simulation.

Example: :SOUR:FSIM:MDEL:REF:DEL 123E-6 *RST value is 0

[[:SOURce]:FSIMulator:MDElay:MOVing:LOSS 0 dB to 50.0 dB

This command specifies the signal attenuation in the path for moving delay simulation. The resolution is 0.1 dB.

Example: :SOUR:FSIM:MDEL:MOV:LOSS 20 *RST value is 0

[[:SOURce]:FSIMulator:MDElay:MOVing:DElay:MEAN 0.25 us to 1637.8 us

This command specifies the mean delay of the moving path with moving delay simulation.

Example: :SOUR:FSIM:MDEL:MOV:DEL:MEAN 123E-6 *RST value is 5 us

[[:SOURce]:FSIMulator:MDElay:MOVing:DElay:VARiation 300 ns to 100 us

This command specifies the range of the delay variation for the moving path with moving delay simulation.

Example: :SOUR:FSIM:MDEL:MOV:DEL:VAR 123E-6 *RST value is 5 us

[[:SOURce]:FSIMulator:MDElay:MOVing:VPERiod 10 s to 500 s

This command specifies the speed of the delay variation with moving delay simulation.

Example: :SOUR:FSIM:MDEL:MOV:VPER 12 *RST value is 157 s

[[:SOURce]:FSIMulator:BIRThdeath[:STATe] ON | OFF

This command switches birth-death simulation on or off.

Example: :SOUR:FSIM:BIRT ON

*RST value is OFF

[[:SOURce]:FSIMulator:BIRThdeath:SPEEd:UNIT MPS | KMPH | MPH

This command sets the speed unit for birth-death simulation.

MPS m/s, meters per second

KMPH km/h, kilometers per hour

MPH miles per hour

Example: :SOUR:FSIM:BIRT:SPE:UNIT MPH

*RST value is MPS

[[:SOURce]:FSIMulator:BIRThdeath:ILOSs:MODE NORMAl | LACP

This command sets the insertion loss of the fading simulator for birth-death simulation.

NORMAl The insertion loss is fixed at 18 dB and is optimal for BER measurements.

LACP The insertion loss lies between 12 and 14 dB for a better signal/noise ratio, e.g. for adjacent channel measurements.

Example: :SOUR:FSIM:BIRT:ILOS:MODE LACP

*RST value is NORM

[[:SOURce]:FSIMulator:BIRThdeath:DEFault

This command sets the default settings of the path parameters for birth-death simulation (as with *RST). The command triggers an event and therefore has no *RST value and no query form.

Example: :SOUR:FSIM:BIRT:DEF

[[:SOURce]:FSIMulator:BIRThdeath:PATH<i>

The following commands are separately settable for every path. The path is selected with the suffix <i>, which has a valid range of 1 to 2.

[[:SOURce]:FSIMulator:BIRThdeath:PATH<i>:PROFile PDOPpler

This command allocates a fading profile for birth-death simulation to the selected path (currently, only PDOP may be set).

PDOPpler Pure Doppler Profile

Example: :SOUR:FSIM:BIRT:PATH2:PROF PDOP

*RST value is PDOP

[[:SOURce]:FSIMulator:BIRThdeath:PATH<i>:FRATio -1.0 to +1.0

This command sets the frequency ratio for birth-death simulation. The resolution is 0.1.

Example: :SOUR:FSIM:BIRT:PATH2:FRAT 0.5

*RST value is 1

[[:SOURce]:FSIMulator:BIRThdeath:PATH<i>:SPEEd 0.005 to 27 777 (in MPS (m/s))

This command sets the speed of the moving receiver for birth-death simulation. The unit is set with the command FSIM:SPEEd:UNIT and is not part of this command. The value may only be set in path 1 and is taken over for PATH2.

Example: :SOUR:FSIM:BIRT:PATH:SPE 10.0

*RST value is 27.778 MPS

SOURce:HOP Subsystem

This subsystem comprises the commands for setting the frequency of the fading simulator via a list (see :SOUR:FSIM:CHAN:RF). Up to 10 lists can be created. The number of entries into the list must not exceed 2000 however.

List processing is effected by means of the :TRIGger:HOP subsystem. It can also be defined that the list is not continuously used but used via a serial interface (RS232) with freely selectable access (:TRIG:HOP:SOUR).

Command	Parameters	Default unit	Remark
[:SOURce] :HOP :TRANsfer :HOP<i> :STATe :CONTRol :CATalog? :DELeTe :ALL :FREE? :FREQUency :POINts? :SElect	SCODE LCODE where i = [1] 2 ON OFF A2 B 'List name' (without) 1.0MHz to 99GHz {, 1.0MHz to 99GHz} Block data 'List name'	Hz	Query only No query Query only Query only

[:SOURce]:HOP:TRANsfer SCODE | LCODE

The command selects between a 1-byte transmission (max. 256 entries in the list) with short code and 2-byte transmission with long code. This command applies to serial interface (RS232) and to both hop systems.

Example: :SOUR:HOP:TRAN LCOD *RST value is SCODE

[:SOURce]:HOP<i>

The following commands can be set separately for hop system 1 (i = 1 or without suffix) and hop system 2 (i = 2). The HOP2:CONT command determines which fading simulator or which channel or which channels are controlled.

Example: :SOUR:FSIM ON or :SOUR:FSIM1 ON switch-on of group A

Example: :SOUR:FSIM2 ON switch-on of group B

[:SOURce]:HOP<i>:STATe ON | OFF

The command determines whether the frequency for the fading simulator is defined by the hop system (ON) or is via direct entry of the RF frequency (OFF) (in :SOUR:FSIM:CHAN:RF).

Example: :SOUR:HOP:STAT ON *RST value is OFF

[[:SOURce]:HOP<i>:CONTrol A2 | B

The command sets the assignment of fading channels to the hop systems. For HOP1 this is only one query (response A1 or A1A2) since the assignment is defined by the HOP2:CONT command. A1A2 or B1B2 concerns **both** channels of the corresponding fading simulator.

Example: :SOUR:HOP2:CONT B1B2 *RST value is A2

[[:SOURce]:HOP<i>:CATalog?

The command queries a list separated by comma of all available lists. This command is a query and has therefore no *RST value.

Example: :SOUR:HOP:CAT? Response: 'MYLIST', 'LIST1', 'LIST2'

[[:SOURce]:HOP<i>:DElete 'List name'

The command deletes the given list. *RST has no effect on data lists.

Example: :SOUR:HOP:DEL 'LIST2'

[[:SOURce]:HOP<i>:DElete:ALL

The HOP mode has to be switched off since a selected list may also be deleted by this command (:SOUR:HOP:STAT OFF). *RST has no effect on data lists.

Example: :SOUR:HOP:DEL:ALL

[[:SOURce]:HOP<i>:FREE?

The command queries two values. The first values indicates the available space for lists (in points), the second indicates the space already used (also in points). This command is a query and has therefore no *RST value.

Example: :SOUR:HOP:FREE? Response: 2400, 200

[[:SOURce]:HOP<i>:FREQuency 1.0 MHz to 99 GHz {, 1.0 MHz to 99 GHz} | Block data

The command fills the frequency list with values. Data can be given as lists of numbers of any length (separated by comma) or as a binary block data. In case of a block data transmission 8 (4) bytes are always interpreted as a floating-point number of double accuracy (see :FORMat:DATA command). *RST has no effect on data lists.

Example: :SOUR:HOP:FREQ 1.4GHz, 1.3GHz, 1.2GHz, to

[[:SOURce]:HOP<i>:FREQuency:POINts?

The command queries the length (in points) of the currently selected list. This command is a query and has therefore no *RST value.

Example: :SOUR:HOP:FREQ:POIN? Response: 327

[[:SOURce]:HOP<i>:SElect 'List name'

The command selects the given list. If a new list is to be created the name (maximum 8 letters) can be entered here. The list will then be created. *RST has no effect on data lists.

Example: :SOUR:HOP:SEL 'LIST1'

:STATus:OPERation:NTRansition 0 to 32767

The command (NegativeTRansition) sets the edge detectors of all bits of the STATus:OPERation register from 1 to 0 for the transitions of the CONDition bits.

Example: :STAT:OPER:NTR 0

:STATus:OPERation:ENABle 0 to 32767

The command sets the bits of the EnNABle register. This register selectively enables the individual events of the appropriate status event register for the sum bit in the status byte

Example: :STAT:OPER:ENAB 1

:STATus:PRESet

This command resets the edge detectors and ENABle parts of all registers to a defined value. All PTRansition parts are set to FFFFh, ie all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, ie a transition from 1 to 0 in a CONDition bit is not detected. The ENABle parts of STATus:OPERation and STATus:QUEStionable are set to 0, ie all events in these registers are not signalled.

Example: :STAT:PRES

:STATus:QUEStionable

The commands for the STATus:QUEStionable register are under this node.

:STATus:QUEStionable[:EVENT]?

Queries the contents of the EVENT register of the STATus:QUEStionable register. Reading the EVENT register clears it.

Example: :STAT:QUES:EVENT?

Response: 1

:STATus:QUEStionable:CONDition?

Queries the contents of the CONDition register of the STATus:QUEStionable register. Reading the CONDition register does not clear it.

Example: :STAT:QUES:COND?

Response: 2

:STATus:QUEStionable:PTRansition 0 to 32767

The command (Positive TRansition) sets the edge detectors of all bits of the STATus:QUEStionable register from 0 to 1 for the transitions of the CONDition bits.

Example: :STAT:QUES:PTR 32767

:STATus:QUEStionable:NTRansition 0 to 32767

The command (Negative TRansition) sets the edge detectors of all bits of the STATus:QUEStionable register from 1 to 0 for the transitions of the CONDition bits.

Example: :STAT:QUES:NTR 0

:STATus:QUEStionable:ENABle 0 to 32767

This commands sets the bits in the ENABLE register of the STATus:QUEStionable register. This part selectively enables the individual events of the appropriate EVENT part for the sum bit in the status byte.

Example: :STAT:QUES:ENAB 1

:STATus:QUEue [:NEXT]?

The command queries the entry that has been in the error queue for the longest time and thus deletes it. Positive error numbers denote device-specific errors, negative error numbers denote error messages specified by SCPI (see chapter 9). If the error queue is empty, 0 (No error) is returned. The command is identical with :SYSTem:ERRor?.

Example: STATus:QUEue:NEXT? Response: 221, "Settings conflict"

SYSTEM System

In this system, a number of commands for general functions, which are not immediately related to signal generation, are combined.

Command	Parameters	Default unit	Remark
:SYSTem			
:BEEPer			
:STATe	ON OFF		
:COMMunicate			
:GPIB			
:LTERminator	EOI STANdard		
[:SELF]			
:ADDRes	0 to 30		
:SERial			
:CONTRol			
:RTS	ON IBFull RFR		
:BAUD	1200 2400 4800 9600 19200 38400 57600 115200		
:PACE	XON NONE		
:HOP			
:BAUD	1200 2400 4800 9600 19200 38400 57600 115200		
:ERRor?			Query only
:KLOCK	ON OFF		
:MODE	FIXed MSEquence		
:MSEquence			
:CATalog?			Query only
:DELete	"Sequence name"		No query
:ALL		s	
:DWELI	50 ms to 60 s {,50 ms to 60 s}		
:FREE?			
:MODE	AUTO STEP		
[:RCL]	1 to 50 {,1 to 50}		
:POINts?			Query only
:SElect	"Sequence name"		No query
:PRESet			
:PROTect <i>	(where i = [1] 2 3)		
[:STATe]	ON OFF , Password		
:SECurity			
[:STATe]	ON OFF		
:SERRor?			Query only
:VERSion?			Query only

:SYSTem:BEEPer:STATe ON | OFF

The command switches the beeper on or off.

*RST value is OFF

Example: :SYST:BEEP:STAT OFF

:SYSTEM:COMMunicate

The commands for setting the remote-control commands are under this node.

:SYSTEM:COMMunicate:GPIB

The commands for checking the IEC/IEEE bus (GPIB = General Purpose Interface Bus) are under this node.

:SYSTEM:COMMunicate:GPIB:LTERminator EOI | STANdard

The command sets the delimiter identification mode. EOI only identifies a character that is transmitted with the EOI circuit message. STANdard also identifies LF (with or without EOI) as delimiter. The EOI mode is particularly suitable for binary block transmission where a character not representing the delimiter may accidentally have the value LF.

Example: :SYST:COMM:GPIB:LTER EOI *RST value is STAN

:SYSTEM:COMMunicate:GPIB[:SELF]:ADDRess 1 to 30

The command sets the IEC/IEEE-bus device address. *RST value is 28

Example: :SYST:COMM:GPIB:ADDR 1

:SYSTEM:COMMunicate:SERial

The commands for checking the serial interface are under this node. The interface is fixed to 8 data bits, no parity and 1 stop bit. These values cannot be changed. The unit represents a DTE (Data Terminal Equipment) in relation to the serial interface. Therefore, the controller must be connected via a modem bypass.

:SYSTEM:COMMunicate:SERial:BAUD 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200

The command sets the transmission rate (baud rate) both for the transmit and the receive direction. *RST has no effect on this parameter.

Example: :SYST:COMM:SER:BAUD 1200 *RST value is 9600

:SYSTEM:COMMunicate:SERial:CONTRol:RTS ON | IBFull | RFR

The command controls the hardware handshake. *RST has no effect on this parameter.

ON The RTS line is always active.

IBFull | RFR Input Buffer Full | Ready For Receiving.
The RTS line is activated if the unit is ready to receive data.

Example: :SYST:COMM:SER:CONT:RTS ON *RST value is RFR

:SYSTEM:COMMunicate:SERial:PACE XON | NONE

The command controls the software handshake. *RST has no effect on this parameter.

XON The unit sends XON and XOFF characters to control the data flow from the controller and responds correspondingly to these character from the controller.

Note: This setting may cause problems when binary data are to be transmitted. The RTS/CT handshake is strongly recommended.

NONE XON / XOFF handshake is not sent or evaluated.

Example: :SYST:COMM:SER:PACE NONE *RST value is NONE

:SYSTEM:COMMunicate:SERial:HOP:BAUD 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200

Control of the serial interface for the hop system of the fading simulator. The interface is fixed to 8 data bits, no parity and 1 stop bit. These values cannot be changed. The unit represents a DTE (Data Terminal Equipment) in relation to the serial interface. Therefore, the controller must be connected via a modem bypass.

The command sets the transmission rate (baud rate) both for the transmit and the receive direction. *RST has no effect on this parameter.

Example: :SYST:COMM:SER:HOP:BAUD 1200 *RST value is 9600

:SYSTEM:ERRor?

The command queries the entry that has been in the error queue for the longest time. Positive error numbers denote device-specific errors of the unit, negative error numbers denote error messages specified by SCPI (see chapter 9). If the error queue is empty, 0 (No parity) is returned. The command is identical with `STATus:QUEue:NEXT?`

Example: :SYST:ERR? Response: 221, "Settings conflict"

:SYSTEM:KLOCK ON | OFF

The command (Keyboard LOCK) locks the ABFS keyboard including the [LOCAL] (ON) key or unlocks it again (OFF).

Caution: If :SYSTEM:SECurity is ON, the keyboard cannot be enabled, ie :SYSTEM:KLOCK OFF will not be accepted. If the command is unlocked by switching to :SYSTEM:SECurity OFF, data will be lost.

Example: :SYST:KLOC ON *RST value is OFF

:SYSTEM:MODE FIXed | MSEQUence

The command sets the operating mode for of the unit.

FIXed The overall device state can only be switched using *RCL.

MSEQUence The unit successively sets the device states indicated under :SYSTEM:MSEQUence:RCL.

Example: :SYST:MODE FIX *RST value is FIX

:SYSTem:MSEquence

This command path can manage several memory sequences each of which consists of a list of device state numbers and a time list. If `:SYSTem:MODE` is switched to `MSEquence`, the device states stated in the selected list are set successively for the time stated in the time list. For further commands see Trigger System (`TRIGger:MSEquence to`) and `ABORt:MSEQ`.

:SYSTem:MSEquence:CATalog?

The command queries the available memory sequences. It returns a list, the list entries are separated by commas.

Example: `:SYST:MSEQ:CAT?` Response: "SEQ1", "DEMO", "SEQA"

:SYSTem:MSEquence:DELeTe "Sequence name"

The command deletes the memory sequence indicated.

Example: `:SYST:MSEQ:DEL "SEQ1"`

:SYSTem:MSEquence:DELeTe:ALL

The command deletes all memory sequences. The memory sequence mode must be switched off (`SYSTem:MODE FIXed`) since a selected sequence cannot be deleted.

Example: `:SYST:MSEQ:DEL:ALL`

:SYSTem:MSEquence:DWELI 50 ms to 60 s{,50 ms to 60 s}

For the memory sequence that has just been selected the command transmits a list indicating the time for which a device setting is kept before the unit proceeds to the next setting . If `DWELI` indicates only one parameter, every item of the device state list is set for the same time. `*RST` has no effect on the lists.

Example: `:SYST:MSEQ:DWEL 1s`

:SYSTem:MSEquence:FREE?

The command queries the available space for memory sequences. It returns two values. The first value indicates the free space available, the second the occupied space.

Example: `:SYST:MSEQ:FREE?` Response: 20, 236

:SYSTem:MSEquence:MODE AUTO | STEP

The command indicates the way the memory sequence is to be processed.

AUTO Each trigger event triggers a complete cycle of the memory sequence selected.

STEP Each trigger event only triggers one step in processing the memory sequence.

Example: `:SYST:MSEQ:MODE AUTO` *RST value is AUTO

:SYSTem:MSEquence[:RCL] 1 to 50 {,1 to 50}

The command transmits the list of device states to be assumed successively. The list contains integers denoting the states stored by means of *SAV. The device states are set successively using a simulated *RCL (thus the name of the list). The length of the list is not limited. The values of the lists are between 1 and 50 (number of memory locations that can be called). *RST has no effect on the lists.

Example: :SYST:MSEQ:RCL 30, 31, 32, 32, 32, 33

:SYSTem:MSEquence[:RCL]:POINts?

The command queries the length of the RCL list selected. The RCL list is user-defined and of variable length. The maximum length of the list can be queried by SYSTem:MSEquence:FREE? (addition of the two values).

Example: :SYST:MSEQ:RCL:POIN? Response: 17

:SYSTem:MSEquence:SElect "Sequence name"

The command selects a memory sequence. The name of the sequence may be an arbitrary character string of up to 8 letters. If there is no memory sequence of the name indicated, new lists can be created by means of this command.

Example: :SYST:MSEQ:SEL "SEQA"

:SYSTem:PRESet

The command triggers a device reset. It has the same effect as the PRESET key of the manual control or as the *RST command. This command triggers an event and has therefore no *RST value.

Example: :SYST:PRES

:SYSTem:PROTect1|2|3

The commands for disabling certain device functions are under this node. A list of all functions concerned can be found under the description of manual control (chapter 4, "Password entry with protected functions"). There are three protection levels that are differentiated by means of a suffix after PROTect. *RST has no effect on enabling/disabling device functions.

:SYSTem:PROTect1|2|3[:STATe] ON | OFF, Password

The command switches the protection level on or off. The passwords are 6-digit numbers. They are permanently stored in the firmware. The password for the first level is 123456.

ON disables the functions that belong to this protection level. A password need not be indicated.

OFF deactivates the disable if the correct password is indicated. Otherwise an error -224 "illegal parameter value" is generated and STATe remains ON.

Example: :SYST:PROT1:STAT OFF, 123456

:SYSTem:SECurity[:STATe] ON | OFF

The command switches the security state on or off.

ON The following command cannot be executed:
 :SYSTem:KLOCK OFF

OFF In the transition from ON to OFF all data existing in the unit except for the calibration data are deleted, especially all status registers, device states and lists.

This command has no effect on *RST and *RCL.

Example: :SYST:SEC:STAT ON

:SYSTem:SERRor?

This command returns a list of all errors existing at the time of the query. This list corresponds to the indication on the ERROR page with manual control (see chapter 9, Error messages).

Example: :SYST:SERR?

Response: -221, "Settings conflict", 153, "Input voltage out of range"

:SYSTem:VERSion?

The command returns the SCPI version number to which the device responds.

This command is a query and has therefore no *RST value.

Example: :SYST:VERS?

Response: 1994.0

TEST System

This system comprises the commands to execute selftest routines and to directly manipulate hardware modules (:TEST:DIRect). The selftests return a 0 if the test has been executed successfully, otherwise a value unequal to 0. All commands of this system do not have a *RST value.

Caution: *The commands under the node :TEST:DIRect directly act on the respective hardware module bypassing any security mechanisms. They are provided for service purposes and shall not be used by the user. Improper use may damage the module.*

Command	Parameters	Default unit	Remark
:TEST			
:DIRect			
:FSIM1M	Sub address, hex data string		
:FSIM2M	Sub address, hex data string		
:FSIM3M	Sub address, hex data string		
:FSIM4M	Subaddress, hex data string		
:NDSIM1M	Subaddress, hex data string		
:NDSIM2M	Subaddress, hex data string		
:NDSIM3M	Subaddress, hex data string		
:FSIM?			Query only
:NDSim?			Query only
:RAM?			Query only
:ROM?			Query only
:BATTery			
[:RAM]?			Query only

:TEST:DIRect

This node contains the commands acting on the corresponding hardware module by bypassing any security mechanisms. The commands under this node have no short form.

A subaddress (0 or 1) must be indicated as a parameter. The data are indicated as a <string> (ie, an ASCII character string enclosed in quotation marks), representing hexadecimal numbers. Thus, characters 0 to 9 A to F may occur in the character string.

Example: `:TEST:DIR:NDSim 0, "0010AF1F"`

Example of a query: `:TEST:DIR:NDSim? 0`

:TEST:DIRect:FSIM1M Subaddress, hex data string

The command acts on the first module of FSIM1 (Group A).

:TEST:DIRect:FSIM2M Subaddress, hex data string

The command acts on the second module of FSIM1 (Group A).

:TEST:DIRect:FSIM3M Subaddress, hex data string

The command acts on the first module of FSIM2 (Group B).

:TEST:DIRect:FSIM4M Subaddress, hex data string

The command acts on the second module of FSIM2 (Group B).

:TEST:DIRect:NDSIM1M Subaddress, hex data string

The command acts on the first module of NDSIM (AWGN).

:TEST:DIRect:NDSIM2M Sub address, hex data string

The command acts on the second module of NDSIM(AWGN) if it is used in group A.

:TEST:DIRect:NDSIM3M Subaddress, hex data string

The command acts on the second module of NDSIM (AWGN) if it is used in group B.

:TEST:FSIM?

The command triggers a test of the fading simulator or of the two fading simulators.

:TEST:NDSim?

The command triggers a test of the noise generator (AWGN) or of the two noise generators.

:TEST:RAM?

The command triggers at test of the RAM.

:TEST:ROM?

The command triggers a test of the EEPROM.

:TEST:BATTery[:RAM]?

The command triggers a test of the RAM battery voltage. The voltage should be at least 2.5 V.

TRIGger System

The TRIGger system contains the commands to select the trigger source and to configure the external trigger connector.

The trigger system of ABFS is a simplified implementation of the SCPI trigger system. Compared to SCPI, the TRIGger system shows the following differences:

- No INITiate command, the unit behaves as if INITiate:CONTInuous ON were set.
- There are two subsystems under TRIGger denoting the different parts of the unit (HOP, MSEQUence).

Command	Parameters	Default unit	Remark
:TRIGger			
:HOP			
:STATe	ON OFF		
:SOURce	SERial EXTernal		
:MSEQUence			
[:IMMEDIATE]	(without)		
:SOURce	SINGle EXTernal AUTO		
:SLOPe	POSitive NEGative		

:TRIGger:HOP

All the commands for triggering a hop sequence are under this node. The other parameters for the hop sequence are set in the [:SOURce]:HOP system.

:TRIGger:HOP:STATe ON | OFF

The command causes the hop sequence to run asynchronously (OFF) or synchronously (ON).

Example: :TRIG:HOP:STAT ON *RST value is OFF

:TRIGger:HOP:SOURce SERial | EXTernal

The command determines which event is used as trigger, if parameter ON is selected as trigger mode with the TRIG:HOP:STAT command. SERial is the serial interface (RS232) and EXTernal the trigger connector. If the serial interface is used, the DSR line triggers the trigger.

Example: :TRIG:HOP:SOUR EXT *RST value is SER

:TRIGger:MSEQUence

All the commands for triggering a memory sequence are under this node. The other parameters for the memory sequence are set in the :SYSTEM:MSEQUence system. The commands for halting the memory sequence are under the :ABORT system.

:TRIGger:MSEquence[:IMMediate]

The command immediately starts a memory sequence. It corresponds to the manual control command EXECUTE SINGLE in the MEM SEQ menu. This command is an event and has therefore no *RST value.

Example: :TRIG:MSEQ:IMM

:TRIGger:MSEquence:SOURce SINGLE | EXTernal | AUTO

The command defines the trigger mode. SCPI uses other designations for the parameters that are also accepted by the unit. These designations are to be preferred if compatibility is important. The following table gives an overview:

ABFS designation	SCPI designation	Command for manual control
AUTO	IMMediate	MODE AUTO
SINGle	BUS	MODE SINGLE or STEP
EXTernal	EXTernal	MODE EXT SINGLE or EXT STEP

AUTO The trigger is free-running ie the trigger requirement is permanently met. As soon as the selected list will have been finished it will be started again.

SINGle Triggering is effected by means of the IEC/IEEE-bus command :TRIGger:HOP:IMM. The list is executed once.

EXTernal Triggering is effected from the outside via the EXT.TRIG. connector or by the GET command via the IEC/IEEE-bus (see chapter 5). The list is executed once.

Example: :TRIG:MSEQ:SOUR AUTO *RST value is MPS

:TRIGger:SLOPe POSitive | NEGative

The command indicates whether the external trigger input responds to the positive or negative edge of the trigger signal.

Example: :TRIG:SLOP NEG *RST value is POSitiv

Command List

Command	Parameters	SCPI Info	Page
:ABORt:MESeQuence		not-SCPI	6.6
:CALibration:FSIM[:MEASure]?		not-SCPI	6.7
:CALibration:NDSim[:MEASure]?		not-SCPI	6.7
:CALibration:OFFSet:I:INPut<i>	-10mV...10mV	not-SCPI	6.7
:CALibration:OFFSet:I:OUTPut<i>	-10mV...10mV	not-SCPI	6.7
:CALibration:OFFSet:Q:INPut<i>	-10mV...10mV	not-SCPI	6.8
:CALibration:OFFSet:Q:OUTPut<i>	-10mV...10mV	not-SCPI	6.8
:DIAGnostic:INFO:MODules?			6.9
:DIAGnostic:INFO:OTIME?			6.9
:DIAGnostic:INFO:SDATE?			6.9
:DIAGnostic[:MEASure]:POINt<i>?			6.9
:FORMat[:DATA]	ASCIi PACKed		6.10
:FORMat:BORDer	NORMal SWAPped		6.10
[:SOURce]:AWGN<i>:STATe		not-SCPI	6.11
[:SOURce]:AWGN<i>:MODE		not-SCPI	6.11
[:SOURce]:AWGN<i>:SNRatio	-17.0...-50.0 (dBfs)	not-SCPI	6.11
[:SOURce]:AWGN<i>:LEVel?		not-SCPI	6.12
[:SOURce]:AWGN<i>:BANDwidth BWIDth	10 kHz...10 MHz	not-SCPI	6.12
[:SOURce]:FSIMulator<k>:CONFigure		not-SCPI	6.16
[:SOURce]:FSIMulator<k>[:STATe]	ON OFF	not-SCPI	6.16
[:SOURce]:FSIMulator<k>:SEQuence	RUN STOP	not-SCPI	6.16
[:SOURce]:FSIMulator<k>:SEQuence:RESet		not-SCPI	6.16
[:SOURce]:FSIMulator:IGNore:RFCHanges		not-SCPI	6.16
[:SOURce]:FSIMulator<k>:STANdard	CDMA8 CDMA30 CDMA100 NADC8 NADC50 NADC100 GTU3 GTU50 GHT100 GRA250 GET50 GET100 PTU1 PTU50 PTU100 PHT100 PRA130 PET50 PET100 TTU THT TET	not-SCPI	6.17
[:SOURce]:FSIMulator<k>:SPEed:UNIT	MPS KMPH MPH	not-SCPI	6.17
[:SOURce]:FSIMulator<k>:ILOSSs:SETTing	AUTO MANual	not-SCPI	6.17
[:SOURce]:FSIMulator<k>:COUPle:SPEed	ON OFF	not-SCPI	6.18
[:SOURce]:FSIMulator<k>:COUPle: CORRelation:COEFFicient	ON OFF	not-SCPI	6.18
[:SOURce]:FSIMulator<k>:COUPle:LOGNormal:LCONstant	ON OFF	not-SCPI	6.18
[:SOURce]:FSIMulator<k>:COUPle:LOGNormal:CSTD	ON OFF	not-SCPI	6.18
[:SOURce]:FSIMulator<k>:DEFault		not-SCPI	6.18
[:SOURce]:FSIMulator<k>:CHANnel<l>:RF	1.0 MHz...99.0 GHz	not-SCPI	6.18
[:SOURce]:FSIMulator<k>:CHANnel<l>:ILOSSs?		not-SCPI	6.19
[:SOURce]:FSIMulator<k>:CHANnel<l>:ILOSSs:MANual	10.0...24.0 dB	not-SCPI	6.19
[:SOURce]:FSIMulator<k>:PATH<i>:STATE	ON OFF	not-SCPI	6.19
[:SOURce]:FSIMulator<k>:PATH<i>:PROFile	PDOPpler RAYLeigh RICE CPHase	not-SCPI	6.19
[:SOURce]:FSIMulator<k>:PATH<i>:DCOMponent:STATe	ON OFF	not-SCPI	6.19
[:SOURce]:FSIMulator<k>:PATH<i>:PRATio	-30...+30 dB	not-SCPI	6.19
[:SOURce]:FSIMulator<k>:PATH<i>:FRATio	-1.0...+1.0	not-SCPI	6.20
[:SOURce]:FSIMulator<k>:PATH<i>:CPHase	0...360 DEG	not-SCPI	6.20

Command	Parameters	SCPI Info	Page
[[:SOURce]:FSIMulator<k>:PATH<i>:SPEed	0.005...27777 (in MPS; m/s)	not-SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:FDOPpler	0.1 ... 1600 Hz	not-SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:LOSS	0...50.0 dB	not-SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:DELay	0...1638.0 E-6S	not-SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation:PATH	0 7...12	not SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation:COEFFicient	0...1.0	not-SCPI	6.20
[[:SOURce]:FSIMulator<k>:PATH<i>:CORRelation:PHASe	0...359 DEG	not-SCPI	6.21
[[:SOURce]:FSIMulator<k>:PATH<i>:LOGNormal:STATe	ON OFF	not-SCPI	6.21
[[:SOURce]:FSIMulator<k>:PATH<i>:LOGNormal:LCONSTant	0...99 999 (in m)	not-SCPI	6.21
[[:SOURce]:FSIMulator<k>:PATH<i>:LOGNormal:CSTD	0...12.0 dB	not-SCPI	6.21
[[:SOURce]:FSIMulator:FDELay[:STATe]	ON OFF	not-SCPI	6.21
[[:SOURce]:FSIMulator:FDELay:STANDARD	G3C1 G3C2 G3C3	not-SCPI	6.21
[[:SOURce]:FSIMulator:FDELay:SPEed:UNIT	MPS KMPH MPH	not-SCPI	6.21
[[:SOURce]:FSIMulator:FDELay:DEFault		not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:STATE	ON OFF	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:PROFile	PDOPpler RAYLeigh	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:FRATio	-1.0...+1.0	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:SPEed	0.005...27777 (in MPS; m/s)	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:FDOPpler	0.1 ... 1600 Hz	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:LOSS	0...50.0 dB	not-SCPI	6.22
[[:SOURce]:FSIMulator:FDELay:PATH<i>:DELay	25ns...1637us	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay[:STATe]	ON OFF	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:DEFault		not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:REFerence:LOSS	0...50.0 dB	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:REFerence:DELay	0...1638.0 E-6S	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:MOVing:LOSS	0...50.0 dB	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:MOVing:DELay:MEAN	0.25us...1637.8us	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:MOVing:DELay:VARIation	300ns...100us	not-SCPI	6.23
[[:SOURce]:FSIMulator:MDELay:MOVing:VPERiod	10...500s	not-SCPI	6.23
[[:SOURce]:FSIMulator:BIRTHdeath[:STATe]	ON OFF	not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:ILOSS:MODE	NORMal LACP	not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:DEFault		not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:PROFile	PDOPpler	not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:FRATio	-1.0...+1.0	not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:SPEed	0.005...27777 (in MPS; m/s)	not-SCPI	6.24
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:FDOPpler	0.1 ... 1600 Hz	not-SCPI	6.25
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:LOSS	0...50.0 dB	not-SCPI	6.25
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:DELay	5us...1000s	not-SCPI	6.25
[[:SOURce]:FSIMulator:BIRTHdeath:PATH<i>:HOPPing:DWELl	100ms...5s	not-SCPI	6.25
[[:SOURce]:HOP:TRANSfer	SCODE LCODE	not-SCPI	6.26
[[:SOURce]:HOP<i>:STATe	ON OFF	not-SCPI	6.26
[[:SOURce]:HOP<i>:CONTrol	A2 B1B2	not-SCPI	6.27
[[:SOURce]:HOP<i>:CATalog?		not-SCPI	6.27
[[:SOURce]:HOP<i>:DELeTe	'List name'	not-SCPI	6.27
[[:SOURce]:HOP<i>:DELeTe:ALL		not-SCPI	6.27
[[:SOURce]:HOP<i>:FREE?		not SCPI	6.27

Command	Parameters	SCPI Info	Page
[:SOURce]:HOP<i>:FREQuency	1.0 MHz...99 GHz {, 1.0 MHz...99 GHz} Block data		6.27
[:SOURce]:HOP<i>:FREQuency:POINts?			6.27
[:SOURce]:HOP<i>:SElect	'List name'	not SCPI	6.27
:STATus:OPERation[:EVENT]?			6.28
:STATus:OPERation:CONDition?			6.28
:STATus:OPERation:PTRansition	0...32767		6.28
:STATus:OPERation:NTRansition	0...32767		6.29
:STATus:OPERation:ENABle	0...32767		6.29
:STATus:PRESet			6.29
:STATus:QUEStionable[:EVENT]?			6.29
:STATus:QUEStionable:CONDition?			6.29
:STATus:QUEStionable:PTRansition	0...32767		6.29
:STATus:QUEStionable:NTRansition	0...32767		6.29
:STATus:QUEStionable:ENABle	0...32767		6.30
:STATus:QUEue [:NEXT]?			6.30
:SYSTem:BEEPer:STATe	ON OFF		6.31
:SYSTem:COMMunicate:GPIB:LTERminator	EOI STANDard		6.32
:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	1...30		6.32
:SYSTem:COMMunicate:SERial:BAUD	1200 2400 4800 9600 19200 38400 57600 115200		6.32
:SYSTem:COMMunicate:SERial:CONTRol:RTS	ON IBFull RFR		6.32
:SYSTem:COMMunicate:SERial:PACe	XON NONE		6.33
:SYSTem:COMMunicate:SERial:HOP:BAUD	1200 2400 4800 9600 19200 38400 57600 115200		6.33
:SYSTem:ERRor?			6.33
:SYSTem:KLOCK	ON OFF		6.33
:SYSTem:MODE	FIXed MSEquence	not-SCPI	6.33
:SYSTem:MSEquence:CATalog?		not-SCPI	6.34
:SYSTem:MSEquence:DELeTe	'Sequence name'	not-SCPI	6.34
:SYSTem:MSEquence:DELeTe:ALL		not-SCPI	6.34
:SYSTem:MSEquence:DWELI	50 ms...60 s{,50 ms...60 s}	not-SCPI	6.34
:SYSTem:MSEquence:FREE?		not-SCPI	6.34
:SYSTem:MSEquence:MODE	AUTO STEP	not-SCPI	6.34
:SYSTem:MSEquence[:RCL]	1...50 {,1...50}	not-SCPI	6.35
:SYSTem:MSEquence[:RCL]:POINts?		not-SCPI	6.35
:SYSTem:MSEquence:SElect	"Sequence name"	not-SCPI	6.35
:SYSTem:PRESet			6.35
:SYSTem:PROTect1 2 3[:STATe]	ON OFF, Pass word	not-SCPI	6.35
:SYSTem:SECurity[:STATe]	ON OFF		6.36
:SYSTem:SERRor?		not-SCPI	6.36
:SYSTem:VERSion?			6.36
:TEST:DIRect:FSIM1M	Subaddress, hex data string		6.37
:TEST:DIRect:FSIM2M	Subaddress, hex data string		6.37
:TEST:DIRect:FSIM3M	Subaddress, hex data string		6.38
:TEST:DIRect:FSIM4M	Subaddress, hex data string		6.38
:TEST:DIRect:NDSIM1M	Subaddress, hex data string		6.38

Command	Parameters	SCPI Info	Page
:TEST:DIRect:NDSIM2M	Subaddress, hex data string		6.38
:TEST:DIRect:NDSIM3M	Subaddress, hex data string		6.38
:TEST:FSIM			6.38
:TEST:NDSim			6.38
:TEST:RAM?			6.38
:TEST:ROM?			6.38
:TEST:BATTery[:RAM]?			6.38
:TRIGger:HOP:STATe	ON OFF	not-SCPI	6.39
:TRIGger:HOP:SOURce	SERial EXTernal	not-SCPI	6.39
:TRIGger:MSEquence[:IMMediate]		not-SCPI	6.40
:TRIGger:MSEquence:SOURce	SINGle EXTernal AUTO	not-SCPI	6.40
:TRIGger:SLOPe	POSitive NEGative	not-SCPI	6.40

7 Remote Control - Programming Examples

The examples explain the programming of the instrument and can serve as a basis to solve more complex programming tasks.

QuickBASIC has been used as programming language. However, the programs can be translated into other languages.

Including IEC-Bus Library for QuickBasic

```
REM ----- Include IEC-bus library for quickbasic -----
'$INCLUDE: 'c:\qbasic\qbdecl4.bas'
```

Initialization and Default Status

The IEC bus as well as the settings of the instrument are brought into a defined default status at the beginning of every program. Subroutines "InitController" and "InitDevice" are used to this effect.

Initiate Controller

```
REM ----- Initiate Instrument -----
REM InitController
ieaddress% = 28                'IEC-bus address of the instrument
CALL IBFIND("DEV1", generator%) 'Open port to the instrument
CALL IBPAD(generator%, ieaddress%) 'Inform controller on instrument address
CALL IBTMO(generator%, 11)      'Response time to 1 sec
REM *****
```

Initiate Instrument

The IEC-bus status registers and instrument settings of the ABFS are brought into the default status.

```
REM ----- Initiate Instrument -----
REM InitDevice
CALL IBWRT(generator%, "*CLS")    'Reset status register
CALL IBWRT(generator%, "*RST")   'Reset instrument
CALL IBWRT(generator%, "FSIM ON") 'Switch on Fading
REM*****
```

Transmission of Instrument Setting Commands

Frequency and Standard are set in this example, furthermore the function is started.

```
REM ----- Instrument setting commands -----
CALL IBWRT(generator%, "FSIM:CHANNEL:RF 250E6") 'RF frequency 250 MHz
CALL IBWRT(generator%, "FSIM:STANDARD GTU3")   'Standard
CALL IBWRT(generator%, "FSIM:SEQUENCE RUN")
REM *****
```

Switchover to Manual Control

```
REM ----- Switch instrument over to manual control -----
CALL IBLOC(generator%) 'Set instrument to Local state
REM *****
```

Reading out Instrument Settings

The settings made in the example above are read out here. The abbreviated commands are used.

```
REM ----- Reading out instrument settings -----
Rffrequency$ = SPACE$(20) 'Provide text variables with 20 characters
CALL IBWRT(generator%, "FSIM:CHANNEL:RF") 'Request frequency setting

REM ----- Display values on the screen -----
PRINT "RF frequency: "; Rffrequency$,
REM *****
```

List Management

```

REM ----- Example of list management -----
CALL IBWRT(generator%, "HOP:SELECT "+CHR$(34)+"LIST1"+CHR$(34))
      'Select list "LIST1", is generated if necessary
CALL IBWRT(generator%, "HOP:FREQ 575MHz,235MHz,123MHz,456MHz,735MHz,333MHz")
      'Fill frequency list with values
CALL IBWRT(generator%, "HOP:STATE ON")
      'Switch over instrument to list mode
REM *****

```

Command synchronization

The possibilities for synchronization implemented in the following example are described in Chapter 5, Section "Command Order and Command Synchronization".

```

REM ----- Examples of command synchronization -----
REM Command AWGN:STATE ON has a relatively long execution time
REM (over 5s). It is to be ensured that the next command is only executed
REM when the noise generator is calculated.

REM ----- First possibility: Use of *WAI -----
CALL IBWRT(generator%, "AWGN:STATE ON; *WAI; :AWGN:SNRatio -20")

REM ----- Second possibility: Use of *OPC? -----
OpcOk$ = SPACE$(2)      'Space for *OPC? - Provide response
CALL IBWRT(generator%, "AWGN:STATE ON; *OPC?")
REM ----- here the controller can service other instruments -----
CALL IBRD(generator%, OpcOk$)      'Wait for "1" from *OPC?

REM ----- Third possibility: Use of *OPC
REM In order to be able to use the service request function in conjugation
REM with a National Instruments GPIB driver, the setting "Disable Auto
REM Serial Poll" must be changed to "yes" by means of IBCONF.

CALL IBWRT(generator%, "*SRE 32")      'Permit service request for ESR
CALL IBWRT(generator%, "*ESE 1")      'Set event-enable bit for
      'operation-complete bit
ON PEN GOSUB OpcReady      'Initialization of the service request routine
PEN ON
CALL IBWRT(generator%, "AWGN:STATE ON; *OPC")
REM Continue main program here.

OpcReady:
REM As soon as the noise generator is calculated, this subroutine is
REM activated
REM Program suitable reaction to the OPC service request.
ON PEN GOSUB OpcReady      'Enable SRQ routine again
RETURN
REM *****

```

Service Request

The service request routine requires an extended initialization of the instrument in which the respective bits of the transition and enable registers are set.

In order to be able to use the service request function in conjunction with a National Instruments GPIB driver, the setting "Disable Auto Serial Poll" must be changed to "yes" by means of IBCONF.

```

REM ---- Example of initialization of the SRQ in the case of errors -----
CALL IBWRT(generator%, "*CLS")          'Reset status reporting system
CALL IBWRT(generator%, "*SRE 168")      'Permit service request for STAT:OPER-,
                                        'STAT:QUES- and ESR register
CALL IBWRT(generator%, "*ESE 60")       'Set event-enable bit for command, exe-
                                        'cution, device-dependent and query error
CALL IBWRT(generator%, "STAT:OPER:ENAB 32767") 'Set OPERation enable bit
                                        'for all events
CALL IBWRT(generator%, "STAT:OPER:PTR 32767") 'Set appropriate OPERation
                                        'Ptransition bits
CALL IBWRT(generator%, "STAT:OPER:ENAB 32767") 'Set questionable enable bits
                                        'for all events
CALL IBWRT(generator%, "STAT:OPER:PTR 32767") ' Set appropriate questionable
                                        'Ptransition bits
ON PEN GOSUB Srq                        'Initialization of the service
                                        'request routine

PEN ON
REM Continue main program here
STOP                                    'End of program

```

A service request is then processed in the service request routine.

Note: The variables userN% and userM% must be pre-assigned usefully.

```

Srq:
REM ----- Service request routine -----
DO
  SRQFOUND% = 0
  FOR I% = userN% TO userM%              'Poll all bus users
    ON ERROR GOTO nouser                  'No user existing
    CALL IBRSP(I%, STB%)                 'Serial poll, read status byte
    IF STB% > 0 THEN                       'This instrument has bits set
                                          'in the STB

      SRQFOUND% = 1
      IF (STB% AND 16) > 0 THEN GOSUB Outputqueue
      IF (STB% AND 4) > 0 THEN GOSUB Failure
      IF (STB% AND 8) > 0 THEN GOSUB Questionablestatus
      IF (STB% AND 128) > 0 THEN GOSUB Operationstatus
      IF (STB% AND 32) > 0 THEN GOSUB Esrread
    END IF
  NEXT I%
nouser:
  NEXT I%
LOOP UNTIL SRQFOUND% = 0
ON ERROR GOTO error handling
ON PEN GOSUB Srq: RETURN                  'Enable SRQ routine again;
                                          'End of SRQ routine

```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

```

REM ----- Subroutines for the individual STB bits -----
Outputqueue:
Message$ = SPACE$(100)           'Reading the output buffer
                                  'Make space for response
CALL IBRD(generator%, Message$)
PRINT " Message in output buffer :"; Message$
RETURN

Failure:
ERROR$ = SPACE$(100)           'Read error queue
                                  'Make space for error variable
CALL IBWRT(generator%, "SYSTEM:ERROR?")
CALL IBRD(generator%, ERROR$)
PRINT "Error text :"; ERROR$
RETURN

Questionablestatus:
Ques$ = SPACE$(20)             'Read questionable status register
                                  'Preallocate blanks to text variable
CALL IBWRT(generator%, "STATus:QUESTionable:EVENT?")
CALL IBRD(generator%, Ques$)
IF (VAL(Ques$) AND 128) > 0 THEN PRINT "Calibration ?" 'Calibration is
                                  'questionable
RETURN

Operationstatus:
Oper$ = SPACE$(20)             'Read operation status register
                                  'Preallocate blanks to text variable
CALL IBWRT(generator%, "STATus:OPERation:EVENT?")
CALL IBRD(generator%, Oper$)
IF (VAL(Oper$) AND 1) > 0 THEN PRINT "Calibration"
IF (VAL(Oper$) AND 2) > 0 THEN PRINT "Settling"
IF (VAL(Oper$) AND 32) > 0 THEN PRINT "Wait for trigger"
RETURN

Esrread:
Esr$ = SPACE$(20)             'Read Event status register
                                  'Preallocate blanks to text variable
CALL IBWRT(generator%, "*ESR?") 'Read ESR
CALL IBRD(generator%, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN PRINT "Operation complete"
IF (VAL(Esr$) AND 4) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 8) > 0 THEN PRINT "Device dependent error"
IF (VAL(Esr$) AND 16) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 32) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 64) > 0 THEN PRINT "User request"
IF (VAL(Esr$) AND 128) > 0 THEN PRINT "Power on"
RETURN
REM *****

REM ----- Error routine -----
Error handling:
PRINT "ERROR"                 'Output error message
STOP                           'Stop software

```


8 Maintenance

The present chapter describes the measures that are necessary for maintaining, storing and packing the instrument.

The instrument does not need a periodic maintenance. What is necessary is essentially the cleaning of the outside of the instrument.

However, it is recommended to check the rated data from time to time.

Cleaning the Outside

The outside of the instrument is suitably cleaned using a soft, line-free dustcloth.

Caution! *Do not use solvents such as thinners, acetone and similar things in any case, because otherwise the front panel labeling or plastic parts will be damaged.*

Storing and Packing

The instrument can be stored at a temperature of -40°C to $+70^{\circ}\text{C}$. When stored for an extended period of time, the instrument should be protected against dust.

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

9 Error Messages

The present chapter contains the error messages (short-term and long-term messages) of the ABFS.

The ABFS displays error and caution messages in a different manner, depending on how long, for a short period of time or permanently, the cause exists.

Short-term message

The short-term message is displayed in the status line. Part of it overwrites the status indications and disappears after approx. 2 seconds or in the case of a new entry.

The instrument shows, e.g., short-term messages if the attempt is made to enter an overrange or if incompatible operating modes deactivate one another.

Long-term message

The long-term message is displayed in the status line by means of the message "WARNING" or "ERROR". Pressing the [ERROR] key calls the ERROR page in which the messages are entered. Several messages can be entered at the same time. The long-term message remains existing until there is no cause any more. The ERROR page is exited using the [RETURN] key.

The instrument displays, e.g., the long-term message "ERROR" if there is a hardware error or "WARNING" if overrange settings have been made.

- Notes:**
- An error message "ERROR" does not necessarily point to a defect instrument. There are various operating states which can cause an ERROR message. E. g. if the instrument is set to external reference but no external reference is connected.
 - Error -313 indicates the loss of calibration data and is also applicable in case of a cold start (key [PRESET] is pressed during switch-on). The calibration values can be restored with internal calibration routines. These routines are accessible via menu CALIBRATE (see section on calibration).

The ERROR page offers access to long-term messages if the [ERROR] key is pressed.

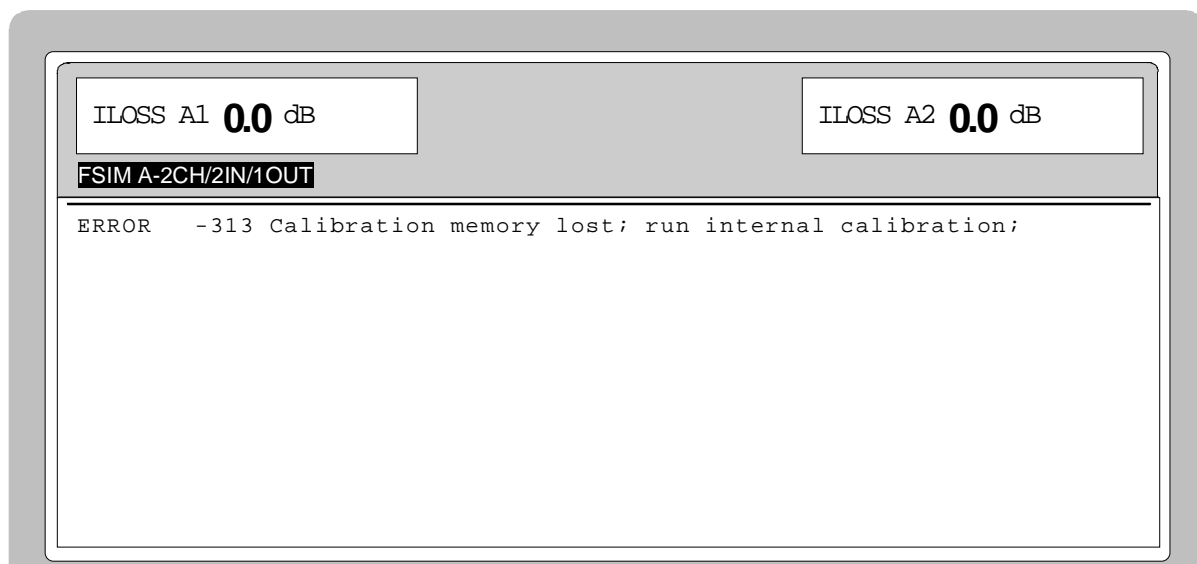


Fig. 9-1 ERROR-Seite

List of Error Messages

The following list contains all SCPI- and device-specific error messages for errors occurring in the instrument. The meaning of negative error codes is defined in SCPI, positive error codes mark device-dependent errors.

The lefthand column of the table below contains the error code. In the righthand column, the error text entered into the error/event queue and shown on the display is in bold type. Below the error text there is an explanation of the error.

SCPI-Specific Error Messages

No error

Error code	Error text with queue poll Explanation of error
0	No error This message is output if the error queue contains no entries.

Command Error – errored command; sets bit 5 in the ESR register

Error code	Error text with queue poll Explanation of error
-100	Command error The command is errored or invalid.
-101	Invalid character The command contains an invalid character. Example: A header contains an ampersand, "SOURCE&".
-102	Syntax error The command is invalid. Example: A command contains block data which the instrument does not accept.
-103	Invalid separator The command contains an illegal character instead of a terminator. Example: A semicolon after the command is missing.
-104	Data type error The command contains an invalid value information. Example: ON is entered instead of a numerical value for frequency setting.
-105	GET not allowed A Group Execute Trigger (GET) is entered within a command line.
-108	Parameter not allowed The command contains too many parameters. Example: The command SOURCE:FM:INTERNAL:FREQUENCY allows for a frequency entry only.
-109	Missing parameter The command contains too few parameters. Example: The command SOURCE:FM:INTERNAL:FREQUENCY requires a frequency entry.

Command Error, continued

Error code	Error text with queue poll Explanation of error
-112	Program mnemonic too long The header contains more than 12 characters.
-113	Undefined header The header is not defined for the instrument. Example: *XYZ is undefined for every instrument.
-114	Header suffix out of range The header contains an illegal numerical suffix. Example: SOURCE3 does not exist in the instrument.
-123	Exponent too large The absolute value of the exponent is larger than 32000.
-124	Too many digits The number contains too many digits.
-128	Numeric data not allowed The command contains a number which is not allowed at this position. Example: Command [SOURCE]:FSIMulator<k>:CONFigure requires the entry of a text parameter.
-131	Invalid suffix The suffix is invalid for this instrument. Example: nHz is not defined.
-134	Suffix too long The suffix contains more than 12 characters.
-138	Suffix not allowed A suffix is not allowed for this command or at this position of the command. Example: The command *RCL does not allow for a suffix to be entered.
-141	Invalid character data The text parameter either contains an invalid character or it is invalid for this command. Example: spelling mistake in parameter entry; [SOURCE]:FSIMulator<k>:CONFigure SIFO.
-144	Character data too long The text parameter contains more than 12 characters.
-148	Character data not allowed The text parameter is not allowed for this command or at this position of the command. Example: The command *RCL requires the entry of a number.
-158	String data not allowed The command contains a valid character string at a position which is not allowed. Example: Text parameter in inverted commas, eg [SOURCE]:FSIMulator<k>:CONFigure "SISO"
-161	Invalid block data The command contains errored block data. Example: An END message was received before the expected number of data was received.
-168	Block data not allowed The command contains valid block data at a position which is not allowed. Example: The command *RCL requires the entry of a number.
-178	Expression data not allowed The command contains a mathematical expression at a position which is not allowed.

Execution Error – error in the execution of a command; sets bit 4 in the ESR register

Error code	Error text with queue poll Explanation of error
-203	<p>Command protected The desired command could not be executed as it is protected by a password. Use the command <code>SYSTEM:PROTECT OFF, <password></code> to enable the desired command.</p>
-211	<p>Trigger ignored The trigger (GET, *TRG or trigger signal) was ignored because of the instrument timing control. Example: The instrument was not ready to answer.</p>
-221	<p>Settings conflict The settings of two parameters are conflicting. Example: MEM SEQ and HOP CONTROL cannot be switched on at the same time.</p>
-222	<p>Data out of range The parameter value is out of the permissible range of the instrument. Example: The command *RCL only permits entries between 0 and 50.</p>
-223	<p>Too much data The command contains too many data. Example: The instrument does not have sufficient memory space.</p>
-224	<p>Illegal parameter value The parameter value is invalid. Example: An invalid text parameter is entered, eg <code>TRIGGER:HOP:STATE AUTO</code></p>
-225	<p>Out of memory The available instrument memory space is exhausted. Example: An attempt was made to create more than 10 lists.</p>
-230	<p>Data corrupt or stale The data are incomplete or invalid. Example: The instrument has aborted a measurement.</p>
-240	<p>Hardware error The command cannot be executed because of a hardware fault of the instrument.</p>
-241	<p>Hardware missing The command cannot be executed because of hardware missing. Example: An option is not fitted.</p>
-255	<p>Directory full The list management cannot accept any more lists since the maximum number of lists has already been attained. Example: An attempt was made to create more than the allowed number of MEM SEQ lists.</p>

Device Specific Error - sets bit 3 in the ESR register

Error code	Error text with queue poll Explanation of error
-310	System error This error message suggests an error within the instrument. Please inform your R&S service center.
-311	Memory error Error in instrument memory.
-313	Calibration memory lost Loss of stored calibration data. The calibration data can be restored by means of internal routines (see chapter 4, section "Calibration").
-314	Save/recall memory lost Loss of the nonvolatile data stored with the command *SAV?.
-315	Configuration memory lost Loss of the nonvolatile configuration data stored by the instrument.
-330	Self-test failed The self-test could not be executed.
-350	Queue overflow This error code is entered into the error queue instead of the actual error code when the error queue is full. The code indicates that an error has occurred but has not been accepted. The error queue can accept 5 entries.
-360	Communication error An error has occurred during the transmission or reception of data on the IEC/IEEE bus or via the RS-232-C interface.

Query Error – error in data request; sets bit 2 in the ESR register

Error code	Error text with queue poll Explanation of error
-410	Query INTERRUPTED The query was interrupted. Example: After a query, the instrument receives new data before the response has been sent completely.
-420	Query UNTERMINATED The query is incomplete. Example: The instrument is addressed as a talker and receives incomplete data.
-430	Query DEADLOCKED The query cannot be processed. Example: The input and output buffers are full; the instrument cannot continue operating.

ABFS- Specific Error Messages

Device-dependent Error – device-specific error; sets bit 3 in the ESR register.

Error code	Error text in the case of queue poll Error explanation
180	Calibration failed Calibration could not be executed.
182	Calibration data missing Calibration data are missing in the device memory. The calibration data have to be generated first by an internal or external calibration or to be loaded into the device.
200	Cannot access hardware The data transmission to a module was unsuccessful.
201	Function not supported by this hardware revision A later version of certain parts of the instrument is necessary to execute the function selected.
241	No list defined There is no list defined..
243	Dwell time adjusted A dwell time given on a list cannot be processed by the unit. The setting was automatically adjusted.
257	Hop list index exceeds list range A list index which is not included in the Hop frequency list was transmitted
260	Invalid keyboard input ignored An invalid input via the keyboard is not considered.
265	This parameter is read only An attempt has been made to change a fixedly specified value.
270	Data output aborted Data output was aborted on the IEC/IEEE-bus. Example: The key [LOCAL] was pressed.
304	String too long A character string which is too long was received via the IEC bus. The names of lists may have a length of maximally seven letters.
305	Fill pattern too long; truncated More data have been entered with block function FILL in the list editor than the filling range (RANGE) set permits. The exceeding data are ignored.
306	No fill pattern specified An attempt was made to execute a filler function without having to indicate a filler pattern.

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