

# R&S® SMW200A

## Vector Signal Generator

### User Manual



1175.6632.02 – 10

This document describes the R&S®SMW200A, stock no. 1412.0000.02 and its options:

- R&S®SMW-B10
- R&S®SMW-B13/-B13T
- R&S®SMW-B20
- R&S®SMW-B22
- R&S®SMW-B81/-B82/-B83/-B84
- R&S®SMW-B90
- R&S®SMW-B93
- R&S®SMW-B103/-B106
- R&S®SMW-B112/-B120/-B131/-B140/-B140N
- R&S®SMW-B203/-B206
- R&S®SMW-B212/-B220
- R&S®SMW-K16
- R&S®SMW-K18
- R&S®SMW-K22/-K23/-K24
- R&S®SMW-K61
- R&S®SMW-K62
- R&S®SMW-K75
- R&S®SMW-K76
- R&S®SMW-K511/-K512
- R&S®SMW-K522
- R&S®SMW-K739

This manual describes firmware version FW 3.20.390.xx and later of the R&S®SMW200A.

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The following abbreviations are used throughout this manual: R&S®SMW200A is abbreviated as R&S SMW, R&S®SGS100A is abbreviated as R&S SGS, R&S®WinIQSIM2™ is abbreviated as R&S WinIQSIM2, R&S®VISA is abbreviated as R&S VISA, R&S®SMU200A is abbreviated as R&S SMU, R&S®EX-IQ-BOX is abbreviated as R&S EX-IQ-BOX, Linux® is abbreviated as Linux.

# Basic Safety Instructions

## Always read through and comply with the following safety instructions!

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

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

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

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

## Safety labels on products

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

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

## Basic Safety Instructions

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

### Signal words and their meaning

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



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



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

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

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

## Basic Safety Instructions

### Operating states and operating positions

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

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

### Electrical safety

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

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

## Basic Safety Instructions

6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages  $V_{rms} > 30$  V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC 60950-1 / EN 60950-1 or IEC 61010-1 / EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

## Operation

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

## Basic Safety Instructions

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

### Repair and service

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

## Basic Safety Instructions

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

### Batteries and rechargeable batteries/cells

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

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

### Transport

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



## Instrucciones de seguridad elementales

### Waste disposal/Environmental protection

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

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

## Instrucciones de seguridad elementales

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

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

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















## Instrucciones de seguridad elementales

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

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

### Señalización de seguridad de los productos

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

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

## Instrucciones de seguridad elementales

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

### Palabras de señal y su significado

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



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



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



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



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

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

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

### Estados operativos y posiciones de funcionamiento

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

## Instrucciones de seguridad elementales

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

### Seguridad eléctrica

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

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

## Instrucciones de seguridad elementales

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

## Instrucciones de seguridad elementales

### Funcionamiento

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

## Instrucciones de seguridad elementales

### Reparación y mantenimiento

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

### Baterías y acumuladores o celdas

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

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

### Transporte

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

## Instrucciones de seguridad elementales

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

### Eliminación/protección del medio ambiente

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

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



# Quality management and environmental management

Certified Quality System  
**ISO 9001**

Certified Environmental System  
**ISO 14001**

## Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz Produktes entschieden. Sie erhalten damit ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unserer Qualitäts- und Umweltmanagementsysteme entwickelt, gefertigt und geprüft. Rohde&Schwarz ist unter anderem nach den Managementsystemen ISO9001 und ISO 14001 zertifiziert.

## Der Umwelt verpflichtet

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

## Dear customer,

You have decided to buy a Rohde&Schwarz product. This product has been manufactured using the most advanced methods. It was developed, manufactured and tested in compliance with our quality management and environmental management systems. Rohde&Schwarz has been certified, for example, according to the ISO9001 and ISO 14001 management systems.

## Environmental commitment

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

## Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests de ce produit ont été effectués selon nos systèmes de management de qualité et de management environnemental. La société Rohde&Schwarz a été homologuée, entre autres, conformément aux systèmes de management ISO 9001 et ISO 14001.

## Engagement écologique

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



# Customer Support

## Technical support – where and when you need it

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

## Up-to-date information and upgrades

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

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# 1 Preface

The R&S SMW is a new high-performance signal generator developed to meet demanding customer requirements. Offering excellent signal characteristics, wide signal bandwidth and straightforward and intuitive operation, the signal generator makes signal generation fast and easy.

## 1.1 Key Features

Outstanding key features of the R&S SMW are:

- Frequency range from 100 kHz to 3/6/12.75/20/31.8/40 GHz
- Optional second RF path with 100 kHz up to 3/6/12.75/20 GHz
- Up to 160 MHz I/Q modulation bandwidth (in RF) with internal baseband
- Options for all important digital communications standards
- Versatile configuration: from single-path vector signal generator to multichannel MIMO receiver tester
- Optional integrated fading simulator with up to 160 MHz bandwidth
- Ideal for MIMO, multistandard radio, or LTE-Advanced applications thanks to up to eight signal sources and up to 16 fading channels
- Implementation of all key MIMO fading scenarios such as 2x2, 3x3, 4x4, 8x2, and 2x(2x2) using a single instrument
- Internal digital adding of baseband signals, even with frequency and level offset
- Excellent signal quality for high accuracy in spectral and modulation measurements
- Intuitive operation via touchscreen with block diagram as key element
- Graphical signal monitoring at practically every point in the signal flow
- SCPI macro recorder and code generator for generating executable remote control code from manual operating steps (for MATLAB®, CVI, etc.)

For a detailed specification, refer to the data sheet.

## 1.2 About this Manual

This User Manual describes general instrument functions, the operation of the instrument and settings common to all firmware options. The settings specific to the firmware options are described in the corresponding user manuals.

The main focus of this manual is on the signal generation capabilities of the instrument and the tasks required to achieve them. The following topics are included:

- **Welcome to the R&S SMW**  
Introduction to and getting familiar with the instrument, including introduction to the signal generation principles.

- **Getting Started**  
Information that you have received as a printed book together with your instrument
- **Signal Routing and System Configuration**  
The concept and the advantages of system configuration, including the multiple routing possibilities, configuration settings, and examples.
- **Configuring the Internal Baseband Source**  
Descriptions of the individual generation modes, including configuration settings and task descriptions
- **Simulating Fading, Adding Noise and Predistortions, and Impairing the Signal**  
Descriptions of the noise generation, signal impairment and digital predistortion, including configuration settings and task descriptions
- **Applying I/Q Vector Modulation**  
Descriptions of the configuration settings
- **Configuring the Signal in the RF Domain**  
Descriptions of the individual operation modes, including configuration settings and task descriptions
- **Monitoring Signal Characteristics**  
The concept of real-time graphic display and the baseband power level surveillance function
- **File and Data Management**  
Description of general functions to handle data files and work with the file system of the instrument
- **General Instrument Functions**  
Description of the general instrument settings and functions
- **Network and Remote Operation**  
Information on setting up the instrument in a network and operating it remotely.
- **Remote Commands**  
Remote commands required to configure and perform measurements in a remote environment, sorted by tasks  
Remote commands required to set up the environment and to perform common tasks on the instrument, sorted by tasks  
Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Maintenance**  
Information on tasks required to maintain the operability of the instrument
- **Troubleshooting and Error Messages**  
Hints and tips on how to handle errors
- **Appendix**  
Extensive reference information on remote control, hardware interfaces, etc.
- **Glossary**  
List of often used terms and abbreviations
- **List of Commands**  
Alphabetical list of all remote commands described in the manual
- **Index**

## 1.3 Documentation Overview

The user documentation for the R&S SMW consists of the following parts:

- Getting started, printed manual
- Online help system on the instrument, incl. tutorials
- User manuals and online manual, see the product page
- Service manual, provided on the internet for registrated users
- Instrument security procedures, see the product page
- General safety instructions, printed brochure
- Release notes, see the product page (download > firmware)
- Data sheet and brochures, see the product page (download > brochures and data sheets)
- Application notes, provided on the internet



You find the user documentation on the R&S SMW product page mainly at:

<http://www.rohde-schwarz.com/product/SMW200A.html> > "Downloads" > "Manuals"

Additional download paths are stated directly in the following abstracts of the documentation types.

### Getting Started

Introduces the R&S SMW and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc.

### Online Help and Tutorials

The **online help** offers quick, context-sensitive access to the information needed for operation and programming. It contains the description for the base unit and the software options.

The **tutorials** offer guided examples and demonstrations on operating the R&S SMW.

### User Manual and Online Manual

Separate manuals are provided for the base unit and the software options:

- **Base unit** manual  
Contains the description of the graphical user interface, an introduction to remote control, the description of all SCPI remote control commands, programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- **Software option** manuals  
Describe the specific functions of an option. Basic information on operating the R&S SMW is not included.

The **online manual** provides the contents of the user manual for immediate display on the internet.

**Service Manual**

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS).

**Instrument Security Procedures**

Deals with security issues when working with the R&S SMW in secure areas.

**Data Sheets and Brochures**

The data sheet contains the technical specifications of the R&S SMW. Brochures provide an overview of the instrument and deal with the specific characteristics, see <http://www.rohde-schwarz.com/product/SMW200A.html> > "Download" > "Brochures and Data Sheets".

**General Safety Instructions**

Contains basic safety instructions in English, Spanish, German and French.

**Release Notes**

Describes the firmware installation, new and modified features and fixed issues according to the current firmware version. You find the latest version at:

<http://www.rohde-schwarz.com/product/SMW200A.html> > "Downloads" > "Firmware"

**Application Notes, Application Cards, White Papers, etc.**

These documents deal with special applications or background information on particular topics, see <http://www.rohde-schwarz.com/appnotes>.

## 1.4 Conventions Used in the Documentation

### 1.4.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.

Convention	Description
File names, commands, program code	File names, commands, coding samples and screen output are distinguished by their font.
<i>Input</i>	Input to be entered by the user is displayed in italics.
<a href="#">Links</a>	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

## 1.4.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

## 1.4.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic test situations.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

## 2 Welcome to the R&S SMW

The R&S SMW is a new high-performance signal generator developed to meet demanding customer requirements. Offering excellent signal characteristics, wide signal bandwidth and straightforward and intuitive operation, the signal generator makes signal generation fast and easy.

This user manual contains a description of the provided functionality, including remote control operation. The latest version is available for download at the product homepage (<http://www2.rohde-schwarz.com/product/SMW200A.html>).

### 2.1 Introduction to the Signal Generation

This section introduces the signal generation concept and explains the basic terminology used throughout this documentation.

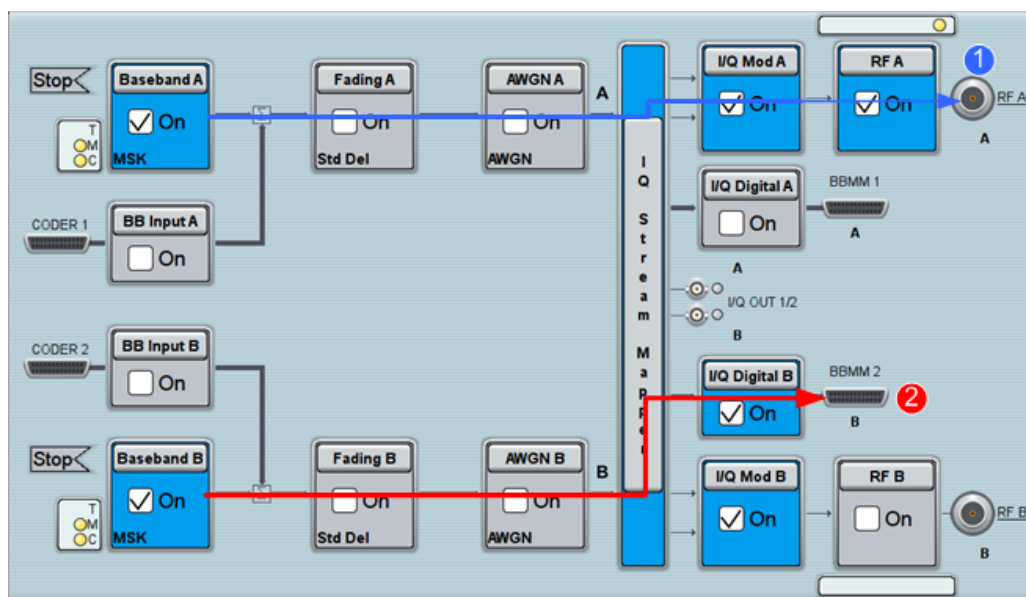
#### Signal Flow

The R&S SMW is equipped with a large touchscreen that displays the block diagram, indicates the current state of the functional blocks, and allows you to monitor and revise the signal flow. The signal processing flow follows the logical left-to-right direction, where the active functional blocks influence the generated signal.

#### Signal Path

The [Figure 2-1](#) illustrates the term signal path.

In the default instrument state (**Standard mode**), the block diagram of a fully equipped R&S SMW displays two signal paths. A signal path describes the chain of functional blocks from the baseband block to the RF output, for example the blocks "Baseband A", "Fading A", "AWGN A", "I/Q Mod A" and "RF A". Throughout this documentation, the upper processing chain is denoted as first signal path or as path A.



**Figure 2-1: Explanation of the terms "signal path"**

- 1 (blue) = first signal path; analog output signal
- 2 (red) = second signal path; digital output signal

Compare the signal processing in both paths on [Figure 2-1](#). In the first path, the output signal is an analog signal modulated on a radio frequency (RF). The second signal path is digital one. The digital baseband signal is routed to the digital output interface; the output signal is not modulated on an RF.

In [Advanced mode](#), however, the block diagram represents the signal flow more abstract; not all functional blocks are dedicated to a signal path (see also [Figure 2-3](#)).

### The Baseband and RF Domains

The processing blocks from the baseband source up to the I/Q modulator build the baseband domain. The signal in the baseband domain is fully digital and is converted to analog in the RF section of the instrument or if an analog output of the baseband signal is required. On the block diagram, you can recognize the signal by the used line weight: the digital signal is indicated with thick lines, whereas the analog signal is represented by thin lines.

The [Figure 2-2](#) illustrates the baseband and the RF domains.

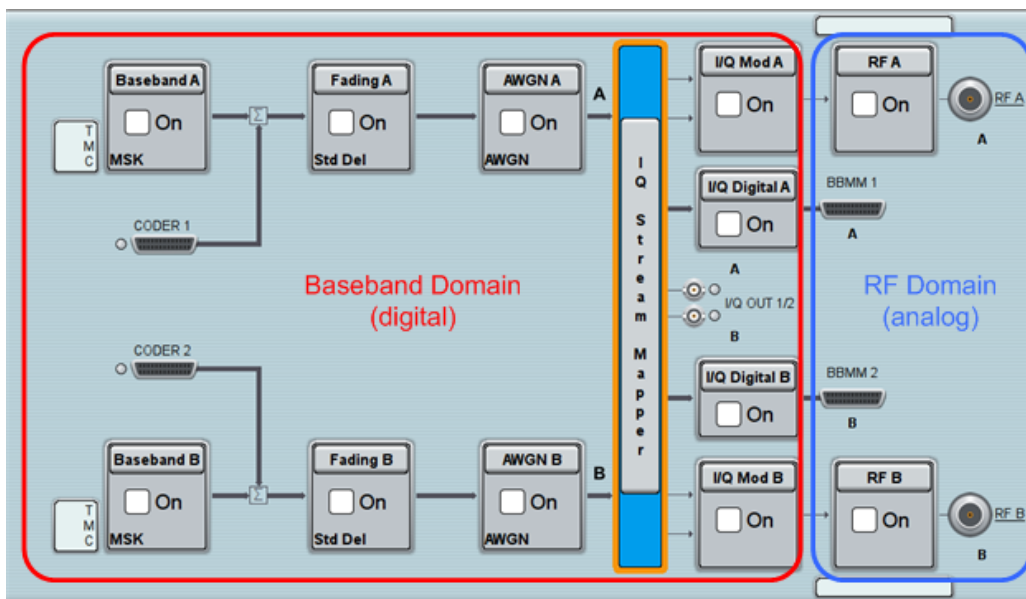


Figure 2-2: The "borders" of baseband and RF domains

### Baseband Signal (Basebands), I/Q Streams, RF Signal

The Figure 2-3 depicts the main terms used to denote the signal at the different processing stages. The output signals of the "Baseband" blocks are referred as "baseband signals" or "basebands". The signals at the end of the baseband domain are called "streams" (input and output signals of the "I/Q Stream Mapper"). The RF modulated output signal is denoted as RF signal.

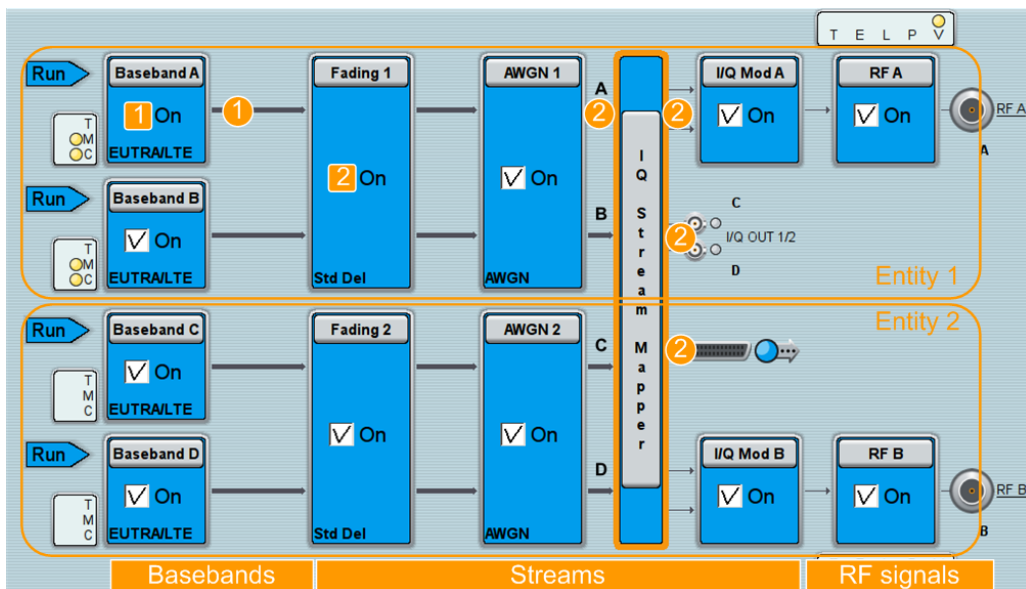


Figure 2-3: Explanation of the terms "baseband signal", "stream" and "entity"



- 1 (square) = baseband signal source
- 2 (square) = fading simulator; the representation is highly abstract and does not depict the actual signal processing and signal flow
- 1 (circle) = Baseband signals or basebands
- 2 (circle) = Streams
- Entity 1/2 = two self-contained independent systems, consisting of their own baseband part with possible fading simulator and noise generator and an RF part

The [Figure 2-3](#) is an example of an [Advanced mode](#) configuration with two entities, [Entity 1](#) and [2](#), and also shows the functional blocks belonging to each of them.

## 2.2 Overview of the Instrument Functions and the Related Description

The embedded context sensitive help systems ensures that you receive the help content related to the element you are currently interacting with. The table of contents, the index and the find functions supports you to find out the information if you are using the documentation in printable form. In particular in printed documents, you may find it helpful to use this section and get familiar with the structure of this description.

The section briefly introduces the provided functions, extends the overview provided in [Chapter 1.2, "About this Manual"](#), on page 25, explains the structure of the description, and helps you to find out the information related to a front panel key, a functional block, or other interactive element of the user interface.

This description follows the decisions you likely take when you consider a new test setup or a signal generation task, starting from selecting of a suitable configuration and deciding upon necessary external equipment. The description then respects the signal generation functions along the signal generation flow. It begins with the signal source and signal in the baseband domain, followed by the I/Q modulation and the functions affecting the signal in the RF domain (see [Figure 2-2](#)).

### Signal Routing and System Configuration

The R&S SMW supports versatile MIMO configurations and a flexible way to define the signal source, the signal routing, and the way the signal is output from the instrument. A selected "Taskbar > System Config > System Configuration" influences the signal processing and reflects not only on the displayed block diagram but also in the provided settings.

Therefore, the description begins with [Chapter 4, "Signal Routing and System Configuration"](#), on page 120. The scope of this section is:

- The explanation of the signal routing possibilities of the instrument
- The description of the provided "System Configuration" settings
- The overview of the instrument input and output signals and description of the settings provided by the "Baseband Input", "I/Q Analog" and "I/Q Digital" blocks.

### Configuring the Internal Baseband Source

The "Baseband" block is the access point to the functions of the internal baseband signal source.

The R&S SMW offers various possibilities for generating digitally modulated signals in compliance with the definitions of digital standards or with user-defined characteristics. The range of software options for this is being extended continuously.

The scope of [Chapter 5, "Configuring the Internal Baseband Source"](#), on page 212 is:

- The "Baseband" block and its functions for generation of digitally modulated signals, the arbitrary waveform generator, the multi-carrier continuous wave generation
- The functions accessed via the "AWGN" block
- Theoretical and background information on the characteristics and handling of baseband signals.

The functionality of the "Fading" block builds a major part of the signal processing in the baseband domain. However, the corresponding description is not a scope of this user manual.

For a description, see the user manual "Fading Simulator".

For comprehensive information on each of the provided software options, refer to the corresponding user manual. The user manuals of all supported digital standards are provided on the <http://www.rohde-schwarz.com/product/SMW200A.html>

### Applying I/Q Vector Modulation and Impairing the Signal

The "I/Q Mod" functional block is the access point to the functions of the I/Q modulator. You can define the input signal, influence the modulation parameters, and impair the generated signal. For details, see [Chapter 7, "Applying I/Q Vector Modulation"](#), on page 399.

### Configuring the Signal in the RF Domain

In the R&S SMW, you can further modify the RF characteristics of the generated I/Q signal (the signal at the outputs of the I/Q modulator). The "RF" block provides access to the group of the related settings.

Available are different functions, like signal generation in CW mode, in list and sweep mode, applying of analog modulations, accessing the reference and local oscillators settings, or applying user corrections and power control. Refer to [Chapter 8, "Configuring the Signal in the RF Domain"](#), on page 408 for detailed description.

### Monitoring Signal Characteristics

To learn how to use the built-in graphic functionality ("Taskbar > Graphics (wave icon)") and other functions provided for control and surveillance functions, see the [Chapter 9, "Monitoring Signal Characteristics"](#), on page 526.

### File and Data Management

The front panel key SAVE/RCL provides direct access to the functions for storing and loading of complete instrument settings. Refer to [Chapter 10, "File and Data Management"](#), on page 571 to get familiar with the instrument's file system, the further file management-related function, and the description of the HCPY key.

## General Instrument Functions

The general instrument functions are settings which do not directly affect signal generation. You access most of these settings via the front panel keys or the menus in the taskbar and not by the function blocks in the block diagram.

The scope of [Chapter 11, "General Instrument Functions"](#), on page 608 is:

- the main functions of several front panel keys, like PRESET, SETUP, USER, INFO
- the most function provided in the "Taskbar > System Configuration > Setup" menu

## Network and Remote Control Operation

The focus of the previous sections is the manual operation of the R&S SMW from the touchscreen. You can operate the R&S SMW also from an external controller, tablet PC or via remote control commands.

Refer to [Chapter 12, "Network and Remote Control Operation"](#), on page 649 for a description of the prerequisites, the related instrument settings and for background information on the remote control and remote operation topics.

The main scope of this section is:

- The function provided in the "Taskbar > System Configuration > Setup > Remote Access Setting" dialog
- The SCPI recording function accessed via the context-sensitive menu
- The function of the LOCAL front panel key

## Remote Control Commands

Where applicable, the description of the provided functions and parameters includes a link to the associated SCPI command. The comprehensive description of the provided commands for remote control is provided in [Chapter 13, "Remote Control Commands"](#), on page 714.

## Troubleshooting and Error Messages

The R&S SMW indicates error situations or occurred problems by error messages. For information on how to use the INFO key, on how to query detailed error information and description of the error messages, refer to [Chapter 15, "Troubleshooting and Error Messages"](#), on page 1095.

## 3 Getting Started

This section contains the information you have received as a printed book together with your instrument. The information is provided again to enable you to search throughout the complete description. If you are already familiar with the described topics, consider the provided information as not relevant.

### 3.1 Preparing for Use

- [Putting into Operation](#)..... 36
- [Linux Operating System](#).....43
- [Connecting USB Devices](#).....44
- [Setting Up a Network \(LAN\) Connection](#).....45
- [Configuring the Initial Instrument Settings](#)..... 48

#### 3.1.1 Putting into Operation

This section describes the basic steps to be taken when setting up the R&S SMW for the first time.

---

#### **WARNING**

##### **Risk of injury and instrument damage**

The instrument must be used in an appropriate manner to prevent electric shock, fire, personal injury, or damage.

- Do not open the instrument casing.
  - Read and observe the "Basic Safety Instructions" at the beginning of this manual, in addition to the safety instructions in the following sections. Notice that the data sheet may specify additional operating conditions.
- 

#### **NOTICE**

##### **Risk of instrument damage**

Note that the general safety instructions also contain information on operating conditions that will prevent damage to the instrument. The instrument's data sheet may contain additional operating conditions.

---

**NOTICE****Risk of electrostatic discharge (ESD)**

Electrostatic discharge (ESD) can cause damage to the electronic components of the instrument and the device under test (DUT). ESD is most likely to occur when you connect or disconnect a DUT or test fixture to the instrument's test ports. To prevent ESD, use a wrist strap and cord and connect yourself to the ground, or use a conductive floor mat and heel strap combination.

For details refer to the basic safety instructions included at the front of the manual.

**NOTICE****Risk of instrument damage during operation**

An unsuitable operating site or test setup can cause damage to the instrument and to connected devices. Ensure the following operating conditions before you switch on the instrument:

- All fan openings are unobstructed and the airflow perforations are unimpeded. The minimum distance from the wall is 10 cm.
- The instrument is dry and shows no sign of condensation.
- The instrument is positioned as described in the following sections.
- The ambient temperature does not exceed the range specified in the data sheet.
- Signal levels at the input connectors are all within the specified ranges.
- Signal outputs are correctly connected and are not overloaded.

**3.1.1.1 EMI Suppression**

Electromagnetic interference (EMI) may affect the measurement results.

To suppress generated Electromagnetic Interference (EMI),

- Use suitable shielded cables of high quality. For example use double-shielded RF and LAN cables.  
**Note:** USB cables are of varying and often poor quality. Therefore, check the quality of each individual USB cable as described in the service manual.
- Always terminate open cable ends.
- Use the cable R&S SMU-Z6 for connection to the DIG I/Q interfaces of the instrument. The required cable is available under part number 1415.0201.02.
- Note the EMC classification in the data sheet

**3.1.1.2 Unpacking and Checking the Instrument**

Check the equipment for completeness using the delivery note and the accessory lists for the various items. Check the instrument for any damage. If there is damage, immediately contact the carrier who delivered the instrument. Make sure not to discard the box and packing material.

**Packing material**

Retain the original packing material. If the instrument needs to be transported or shipped at a later date, you can use the material to protect the control elements and connectors.

**NOTICE****Risk of damage during transportation and shipment**

Insufficient protection against mechanical and electrostatic effects during transportation and shipment can damage the instrument.

- Always make sure that sufficient mechanical and electrostatic protection is provided.
- When shipping an instrument, the original packaging should be used. If you do not have the original packaging, use sufficient padding to prevent the instrument from moving around inside the box. Pack the instrument in antistatic wrap to protect it from electrostatic charging.
- Secure the instrument to prevent any movement and other mechanical effects during transportation.

The **carrying handles** at the front and side of the casing are designed to lift or carry the instrument. Do not apply an excessive external force to the handles.

Observe the information on transporting heavy instruments in the basic safety instructions included at the front of the printed manual.

**3.1.1.3 Accessory List**

The instrument comes with the following accessories:

- Power cable
- Getting Started printed manual

**3.1.1.4 Placing or Mounting the Instrument**

The R&S SMW is designed for use under laboratory conditions, either on a bench top or in a rack using the standard rack mount kit.

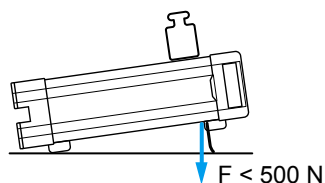
**Bench Top Operation**

If the R&S SMW is operated on a bench top, the surface should be flat. The instrument can be used in horizontal position, standing on its feet, or with the support feet on the bottom extended.

**⚠ CAUTION****Risk of injury if feet are folded out**

The feet may fold in if they are not folded out completely or if the instrument is shifted. This may cause damage or injury.

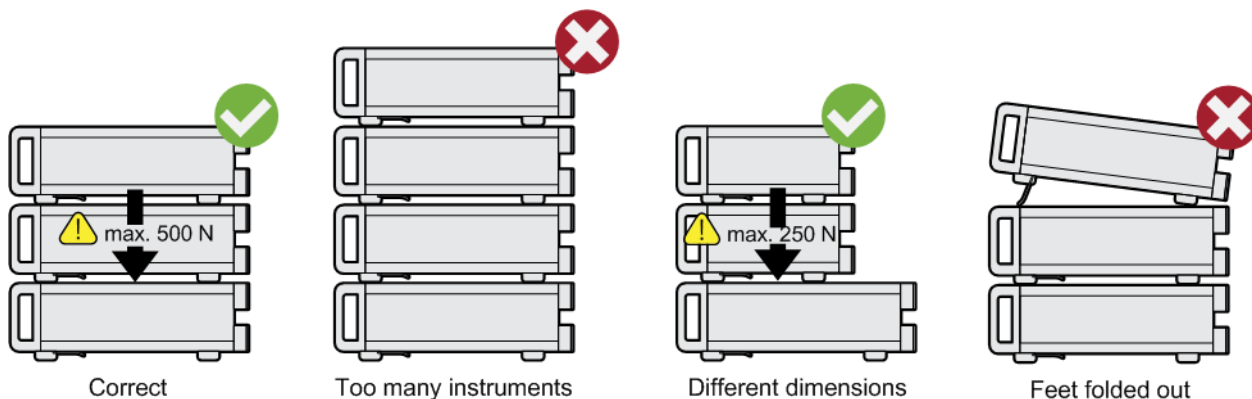
- Fold the feet completely in or completely out to ensure stability of the instrument. Never shift the instrument when the feet are folded out.
- When the feet are folded out, do not work under the instrument or place anything underneath.
- The feet can break if they are overloaded. The overall load on the folded-out feet must not exceed 500 N.

**⚠ CAUTION****Risk of injury and instrument damage if stacking instruments**

A stack of instruments may tilt over and cause injury. Furthermore, the instruments at the bottom of the stack may be damaged due to the load imposed by the instruments on top.

Observe the following instructions when stacking instruments:

- Never stack more than three instruments with the same dimensions (width and length). If you need to stack more than three instruments, install them in a rack.
- The overall load imposed on the lowest instrument must not exceed 500 N.
- All instruments should have the same dimensions (width and length). If you need to stack smaller instruments on the top, the overall load imposed on the lowest instrument must not exceed 250 N.
- If the instruments have foldable feet, fold them in completely.



## Rackmounting

The R&S SMW can be installed in a rack using a rack adapter kit (Order No. see data sheet). The installation instructions are part of the adapter kit.

### NOTICE

#### Risk of instrument damage in a rack

An insufficient airflow can cause the instrument to overheat, which may disturb the operation and even cause damage.

Make sure that all fan openings are unobstructed, that the airflow perforations are unimpeded, and that the minimum distance from the wall is 10 cm.

### 3.1.1.5 Switching the Instrument On and Off



You can leave the AC power on permanently. Switching off is required only if the instrument must be disconnected from all power supplies.

The R&S SMW is equipped with an AC power supply connector, that can be operated with different AC power voltages. Once it is connected, the instrument automatically adjusts to the given voltage. Refer to the data sheet for the requirements of voltage and frequency. There is no need to set the voltage manually or change fuses. The **AC SUPPLY AND POWER SWITCH** is at the rear of the unit.

#### To connect the AC supply

- ▶ Connect the R&S SMW to the AC power source using the supplied power cable.

**Note:** The instrument is assembled in compliance with the specifications for safety class EN61010. It may only be connected to an outlet that has a ground contact.

#### To start up the instrument

1. **Connect the instrument to the AC supply.**



2. To turn on the power, press the main power switch to position I (On).

The instrument is supplied with AC power.

After booting, the instrument is in standby or ready state. The state depends on the state of the POWER ON/STANDBY key at the front panel of the instrument when the instrument was switched off for the last time.





### Warm-up time for OCXO

When the instrument is switched on, the OCXO requires an extended warm-up time (see data sheet). No warm-up time is required when starting from standby mode.

### To switch between standby and ready state

- ▶ Press the POWER ON/STANDBY key briefly.

In ready state, the LED is green. All modules are power-supplied and the R&S SMW initiates its startup procedure. The instrument is ready for operation. In standby state, the LED is orange. The standby power mode keeps the power switch circuits and the oven-controlled crystal oscillator OCXO active. In this state, it is safe to switch off the AC power and disconnect the instrument from the power supply.

### Start-up and booting

The instrument boots the operating system and starts the instrument firmware. If the previous session was terminated regularly, the instrument uses the last setup with the relevant instrument settings.

Once the start-up procedure has been terminated, the instrument is ready for operation.



Press the PRESET key to return the instrument to its defined reset/preset state, if the current setup is no longer relevant.

To customize the start settings, like to recall previously stored settings, use the SAVE/RCL function or define the USER key for recalling a user preset file.

### To shut down the Instrument

To shut down the R&S SMW, proceed as follows.

## NOTICE

### Risk of losing data

If you switch off the running instrument using the rear panel switch or by disconnecting the power cord, the instrument loses its current settings. Furthermore, program data may be lost.

Press the ON/STANDBY key first to shut down the application properly.

1. Press the POWER ON/STANDBY key.  
The current setup is saved, the operating system shuts down and the instrument set to standby state  
The POWER ON/STANDBY LED must be orange.
2. To turn the power off, press the main power switch to position 0 (Off).  
None of the front-panel LEDs should be on.



### Switching off the AC power

You can leave the AC power on permanently. Switching off is required only if the instrument must be disconnected from all power supplies.

#### 3.1.1.6 Function Check

When the instrument is switched on, it automatically monitors the main functions.

A detected fault is indicated by an "Error" message displayed in the "Info" line of the instrument together with a brief error description. For an in-depth identification of the error, press the "Info" button. In response, a description of the errors is displayed. For more information, refer to the "Troubleshooting and Error Messages" section in the user manual.

In addition to the automatic monitoring, the R&S SMW offers the following capabilities to assure correct functioning:

- **Internal Adjustments**  
Select the "System Config > Setup > General > Internal Adjustments" to access the dialog for performing and configuring the adjustments settings.
- **Selftest**  
A selftest is provided for service purposes ("System Config > Setup > Maintenance > Self Test").
- **Test points**  
If required for service purposes, internal test points can be queried. These tests are protected test procedures, which can be accessed if protection level 2 is disabled. The corresponding procedure is described in the Service Manual.

#### 3.1.1.7 Default Settings

When the instrument is switched on, it is not the preset state that is active, but the state that was set before the instrument was switched off. It is recommended that you use the PRESET function to return the instrument to its defined preset state every time a new configuration is required or the current setup is no longer relevant.

The R&S SMW offers a four-stage preset concept:

- **Preset of one individual parameter**  
The selective preset on a parameter basis is triggered over the "Preset this parameter" function in the context menu
- **Preset of the settings belonging to a digital standard or associated with one dialog**  
Most of the dialog boxes provide a special "Set to Default" function that resets the settings associated to the corresponding dialog. This function is available for all digital modulation settings and in the "Custom Digital Mod" dialog. These settings are identical to the settings called up using the PRESET key.
- **Preset of the instrument to a predefined state**  
The PRESET key calls up a defined instrument setup. All parameters and switching states are preset (also the states of inactive operating modes). The default instrument settings provide a reproducible initial basis for all other settings. How-

ever, functions that concern the integration of the instrument into a measurement setup are not changed, for example reference oscillator source settings.

- Preset of the instrument to its factory settings  
The instrument can also be forced to load its default factory settings, except that the security settings are not affected. To access the corresponding dialog box, select the "Taskbar > System Config > Setup > Settings > Factory Preset" function.



For more information and an overview of the settings affected by the factory preset function, see [Chapter 10.2, "Restoring the \(Default\) Instrument Configuration"](#), on page 574.

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User-defined instrument states can be stored and called up using the "Setup > Save/Recall" function or the SAVE/RCL key.

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### 3.1.1.8 Checking the Supplied Options and Licenses

The instrument may be equipped with both hardware and firmware options. To check whether the installed options correspond to the options indicated on the delivery note, proceed as follows:

1. Press the SETUP key.
2. Select "Instrument Assembly > Hardware Config" and "Software / Options".  
A list with hardware and firmware information is displayed.
3. Check the availability of the hardware options as indicated in the delivery note.  
For an overview of the available options, refer to the instrument specifications provided on the <http://www.rohde-schwarz.com/product/SMW200A.html>.

See also [Chapter 14.2.8, "Requesting Instrument Configuration and Specifications"](#), on page 1091.

## 3.1.2 Linux Operating System

The instrument uses an embedded Linux operating system, optimally adapted to the signal generator.



### Accessing the Operating System

No access to the operating system is required for normal operation.  
All necessary system settings can be made in the "Setup" dialog.

---

The R&S SMW provides an internal hard disk drive. The hard disk holds the operating system, the firmware, and the stored data. The folder `/var/user` and all subfolders can be used to store user data.

### Accessing the File System

Data transfer is possible via a memory stick connected to a USB interface. The memory stick and the hard disk are accessed via the "SAVE/RCL > File Manager" function.

The instrument also supports two standard methods to access the file system from a remote client:

- FTP (file transfer protocol)
- File sharing according to the SAMBA/SMB (server message block) protocol.

Both methods allow you the access to the folder `/var/user/share`.



#### Default password

The FTP and SAMBA file access use the user "instrument" with default password "instrument".

It is highly recommended that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network!

See [Chapter 11.5.4, "Password Management"](#), on page 641.

### 3.1.3 Connecting USB Devices

The USB interfaces on the front and rear panels of the R&S SMW allow you to connect USB devices directly to the instrument. This number can be increased as necessary by using USB hubs. Due to the large number of available USB devices, there is almost no limit to the expansions that are possible with the R&S SMW.

The following list shows various USB devices that can be useful:

- Memory stick for easy transfer of data to/from a computer (for example firmware updates)
- Keyboard or mouse to simplify the entry of data, comments, file names, etc.
- Power sensors of the NRP-Zxx family

All USB devices can be connected to or disconnected from the instrument during operation.

#### Connecting a USB storage device

When a USB storage device like a memory stick, a CD-ROM drive, or a hard disk is connected, it is detected automatically. The device is made available as a new drive (`/usb`). The name of the drive is manufacturer-dependent.

#### Connecting a keyboard

A keyboard is detected automatically when it is connected. The default keyboard layout is English – US.

Use the "Setup > User Interface > Keyboard Settings" dialog to configure the keyboard properties, see [Chapter 3.1.5.2, "Setting the Keyboard Language"](#), on page 50.

### Connecting a mouse

A mouse is detected automatically when it is connected.

## 3.1.4 Setting Up a Network (LAN) Connection

The R&S SMW is equipped with a network interface and can be connected to an Ethernet LAN (local area network). Provided the appropriate rights have been assigned by the network administrator, the interface can be used, for example:

- To transfer data between a controller and the instrument, for example to run a remote control program.  
See [Chapter 12, "Network and Remote Control Operation"](#), on page 649.
- To access or operate the instrument from a remote computer using the Ultr@VNC program (or a similar tool, like another VNC client or any Web browser supporting Java)
- To transfer data from a remote computer and back, for example using network folders

This section describes how to configure the LAN interface. It includes the following topics:

- [Chapter 3.1.4.1, "Connecting the Instrument to the Network"](#), on page 45
- [Chapter 3.1.4.3, "Assigning the IP Address"](#), on page 47
- [Chapter 3.1.4.2, "Using Computer Names \(Hostnames\)"](#), on page 46



### Accessing Operating System

No access to the operating system is required for normal operation.

All necessary system settings can be made in the "Setup" dialog.

---

#### 3.1.4.1 Connecting the Instrument to the Network

There are two methods to establish a LAN connection to the instrument:

- A non-dedicated network (Ethernet) connection from the instrument to an existing network
- A dedicated network connection (Point-to-point connection) between the instrument and a single computer

In both cases, a computer name or an IP address has to be assigned to the instrument and the computer, see [Chapter 3.1.4.3, "Assigning the IP Address"](#), on page 47.

## To set up a network (LAN) connection

### NOTICE

#### Risk of network failure

Before connecting the instrument to the network or configuring the network, consult your network administrator. Errors may affect the entire network.

- ▶ Connect the instrument to the network or to a single PC.

If the instrument is connected to the LAN, the operating system automatically detects the network connection and activates the required drivers.

By default, the instrument is configured to use dynamic TCP/IP configuration and to obtain the whole address information automatically.

### NOTICE

#### Risk of network connection failure

Network cables and cable connectors of poor quality may cause network connection failures.

If the network connection to the instrument fails, check the network infrastructure and contact your network administrator.

For details, see section "Troubleshooting and Error Messages".

### 3.1.4.2 Using Computer Names (Hostnames)

In a LAN that uses a DNS server (Domain Name System server), each PC or instrument connected in the LAN can be accessed via an unambiguous computer name (*hostname*) instead of the IP address. The DNS server translates the hostname to the IP address. This is especially useful when a DHCP server is used, as a new IP address may be assigned each time the instrument is restarted.



#### Changes in Hostname Syntax

From FW version 3.20.200.xxx and later the syntax of the computer name slightly changes, according to recent conventions of Rohde & Schwarz. For comparison, the following explanation shows the previous syntax in parentheses.

Note also, that a *Factory Preset* resets the computer name. Depending on the installed firmware version, the computer name may change compared to the past.

Each instrument is delivered with an assigned computer name, that remains permanent as long as it is not explicitly changed.

The default computer name follows the syntax `SMW200A-<serial number>` (previous syntax: `rssmw200a<serial number>`), where:

- `SMW200A` is the short name of your instrument, as stated on the front panel.

- <serial number> is the individual serial number of the instrument. You can find the serial number at the rear panel of instrument, see [Figure 3-3](#). It is the third part of the device ID printed on the bar code sticker .

**Example:**

The default hostname of an R&S SMW with a serial number 100007 is SMW200A-100007 (previous name `rssmw200a100007`).

**To query and change a computer name**

1. Press the SETUP key and select "Remote Access > Network".  
The "Network Settings" dialog opens.  
The computer name is displayed under "Hostname".
2. Press the SETUP key, select "Security > Protection", and enable the "Protection Level 1".  
The default password is 123456.  
The parameter "Hostname" in the "Network Settings" dialog is now enabled for configuration.
3. Change the "Hostname".

**3.1.4.3 Assigning the IP Address**

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

- If the network supports dynamic TCP/IP configuration using the Dynamic Host Configuration Protocol (DHCP), the whole address information can be assigned automatically.
- If the network does not support DHCP, the instrument tries to obtain the IP address via Zeroconf (APIPA) protocol. If this attempt does not succeed or if the instrument is set to use alternate TCP/IP configuration, the addresses must be set manually.

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

**NOTICE****Risk of network errors!**

Connection errors can affect the entire network.

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the instrument to the LAN.

Contact your network administrator to obtain a valid IP address.

**To assign the IP address manually on the instrument****Use computer names to identify the instrument**

In networks using a DHCP server, it is recommended that you address the instrument by its unambiguous computer name, see [Chapter 3.1.4.2, "Using Computer Names \(Hostnames\)"](#), on page 46.

1. Press the SETUP key and select "Remote Access > Network".

The "Network Settings" dialog opens.

2. Select "Address Mode > Static".

3. Select the "IP Address" and enter the IP address, for example *192.168.0.1*.

The IP address consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.

4. Select the "Subnet Mask" and enter the subnet mask, for example *255.255.255.0*.

The subnet mask consists of four number blocks separated by dots. Every block contains 3 numbers in maximum.

**To assign the IP address manually on the computer**

- ▶ Obtain the necessary information from your network administrator. If you use more than one LAN connector, you need separate address information for each connector.

For information on how to perform the configurations, refer to the documentation of the operating system the computer uses.

### 3.1.5 Configuring the Initial Instrument Settings

This section describes how to set up the R&S SMW initially.

#### 3.1.5.1 Setting the Date and Time

The R&S SMW uses an internal real time clock to determine the date and time. The instrument records the time whenever you create or modify files on your instrument or

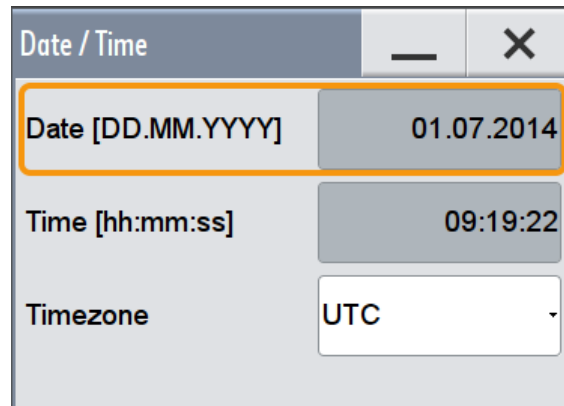


you use timed licenses. By default, the instrument is set to the UTC timezone, but you can select the timezone according to your location.

You can get the current date and time as follows:

#### To open the "Date and Time" dialog box

1. Press the SETUP key.
2. Select "Maintenance > Date / Time".



The date and time are protected settings. Disable protection level 1 to access them.

#### To change the date and time

1. Press the SETUP key, select "Security > Protection", and enable the "Protection Level 1".  
The default password is 123456.
2. Select "Setup > Maintenance > Date / Time" and adjust the settings.
3. Close the dialogs.

The instrument adopts the new date and time.

#### To select the timezone

1. Press the SETUP key.
2. Select "Setup > Maintenance > Timezone".
3. Select continent and city of your location.  
**Tip:** By typing the first letter, you can quickly navigate through the lists to find the desired destination.
4. Close the dialogs.

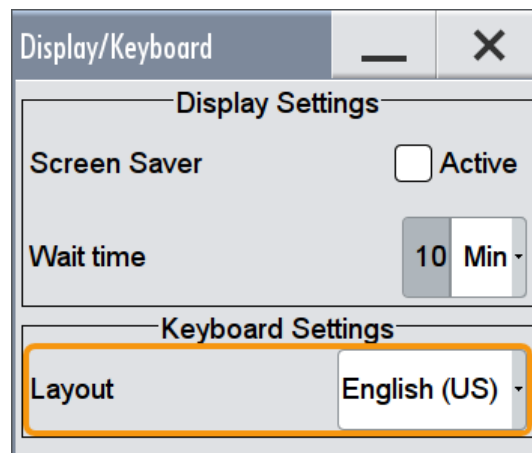
The instrument adjusts the time according to the selected location.

### 3.1.5.2 Setting the Keyboard Language

You can select the language of the external keyboard connected to the instrument.

#### To adjust the keyboard settings

1. Press the SETUP key.
2. Select "User Interface > Keyboard".



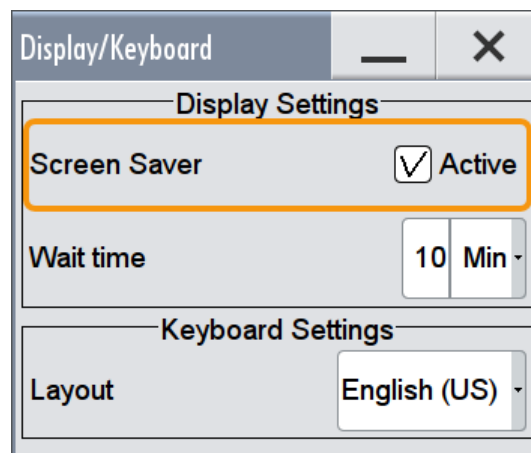
3. If necessary, toggle the "Keyboard Layout".  
The dialog closes and the changes take effect immediately.

### 3.1.5.3 Setting the Screen Saver

The R&S SMW provides a feature to automatically activate a screen saver after a user-defined period of time. The screen saver is activated if no entries are made from the front panel after the selected response time (key and rotary knob).

#### To activate the screen saver

1. Press the SETUP key.
2. Select "User Interface > Display"
3. In the "Display Settings" area, set the "Screen Saver" to "Active".



4. Define the "Wait Time" in minutes.

The screen saver is activated after the defined period of time.

To reactivate the display, simply tap the screen or press a key on the front panel.

#### To deactivate the screen saver

- ▶ In the "Display Settings" area of the "Display/Keyboard Settings" dialog box, disable the "Screen Saver" state.

### 3.1.5.4 Adjusting User Interface Appearance

You can adjust the transparency of the opened dialogs.

1. Select "System Config > Setup > User Interface > Appearance".
2. If required, enable "Alpha Settings (inactive dialogs)".

The dialog closes and the changes take effect immediately.

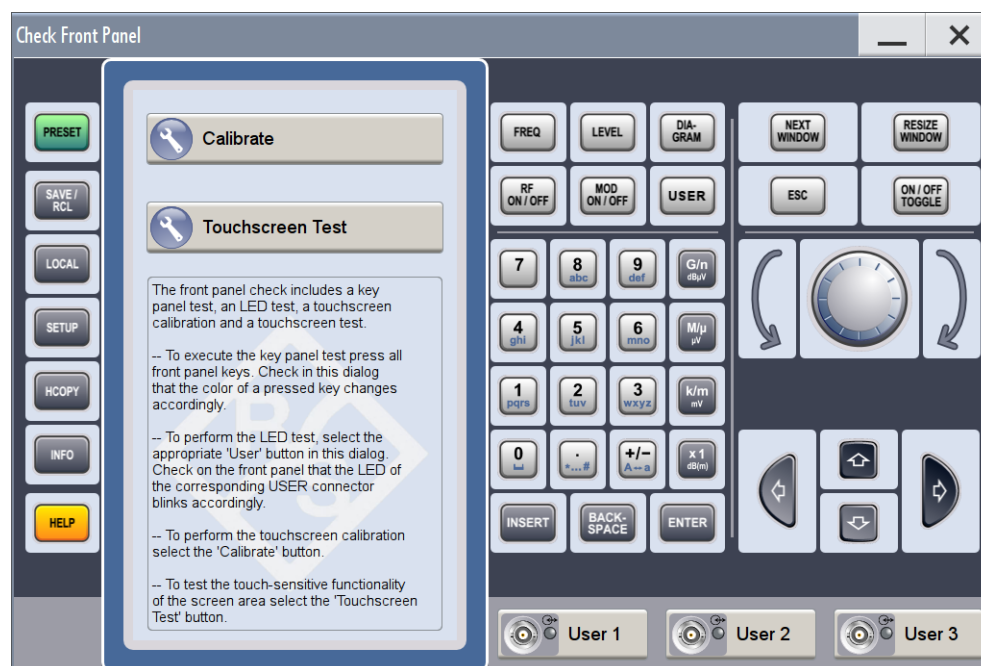
### 3.1.5.5 Calibrating the Touchscreen

When the instrument is delivered, the touchscreen is initially calibrated. However, if an instrument is mounted on the topmost or on the bottommost shell in a rack, a parallax error may occur. See also "[Rackmounting](#)" on page 40.

#### To calibrate the touchscreen for preventing a parallax error

1. Press the SETUP key.
2. Select the "Maintenance > Check Front Panel".

The "Check Front Panel" opens.



3. Select "Calibrate".

The instrument performs the calibration process.

4. Do not abort the calibration.

The instrument completes the calibration process automatically and returns to the "Check Front Panel" dialog.

## 3.2 Instrument Tour

The following topics will help you get familiar with the instrument and perform the first steps:

- [Front Panel Tour](#)
- [Rear Panel Tour](#)

This section explains the control elements and the connectors of the R&S SMW with the aid of the front and rear views. Specifications of interfaces can be found in the data sheet.

### 3.2.1 Front Panel Tour

This section provides an overview of the control elements on the front panel of the R&S SMW. Most of the connectors are placed on the rear panel and are described in [Chapter 3.2.2, "Rear Panel Tour"](#), on page 59. The user interface can be displayed on a remote PC station used to manually remote control the instrument.

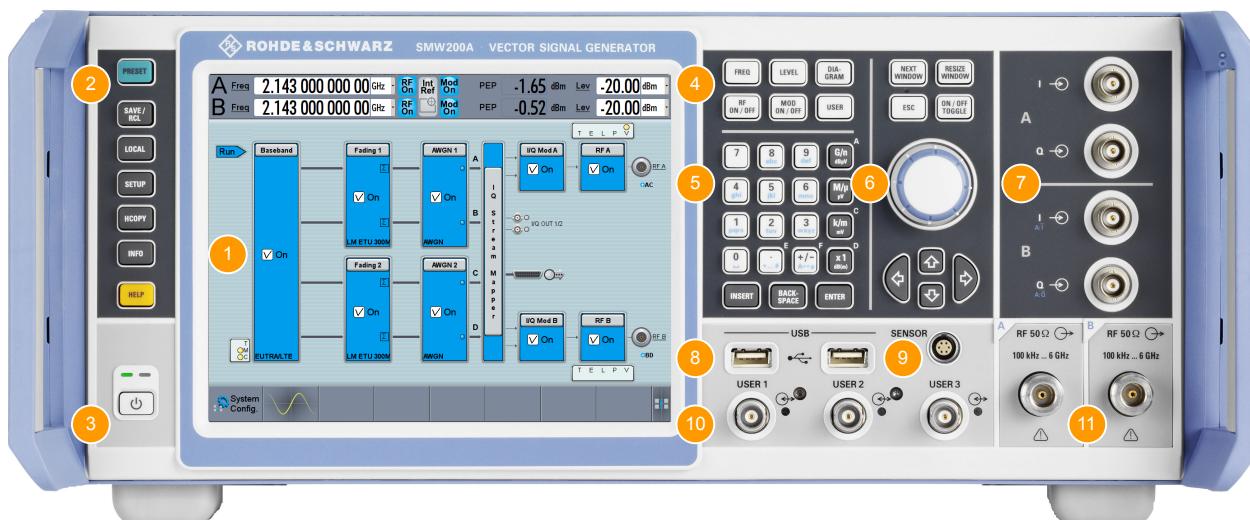


Figure 3-1: Front panel view

- 1 = Touchscreen
- 2 = Utility keys
- 3 = POWER ON/STANDBY
- 4 = Function keys
- 5 = Keypad
- 6 = Navigation controls
- 7 = I/Q input connectors
- 8 = USB connectors
- 9 = SENSOR connector
- 10 = USER input/output connectors
- 11 = RF A/RF B output connectors

## NOTICE

### Instrument damage caused by cleaning agents

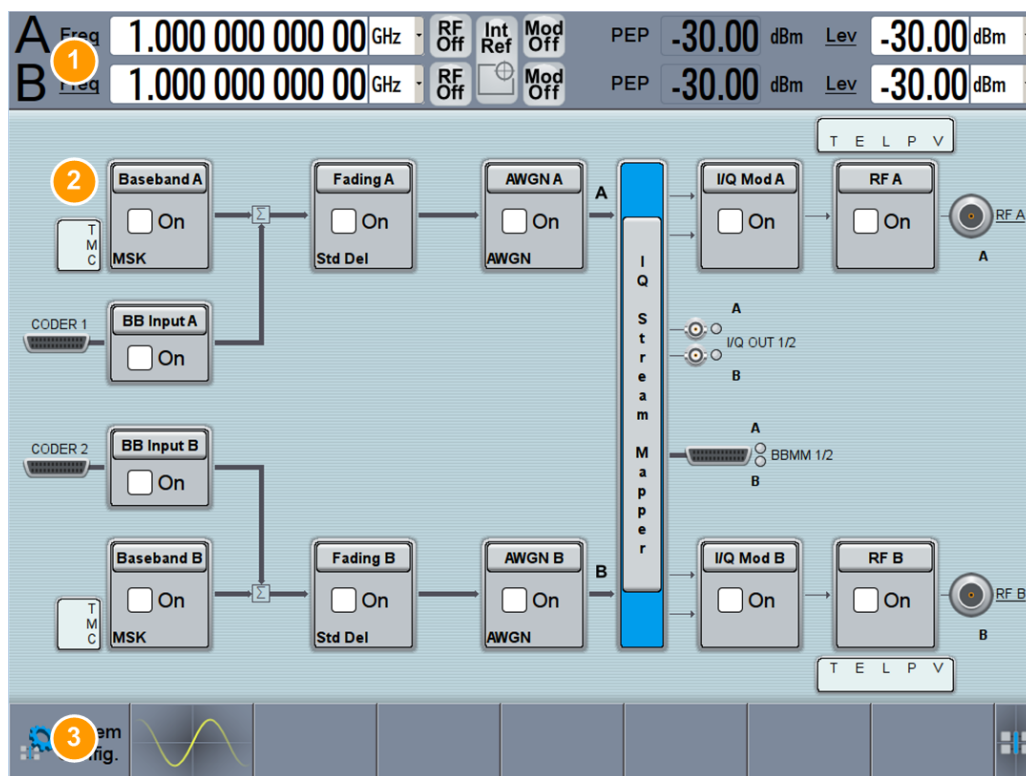
Cleaning agents contain substances that may damage the instrument. For example, cleaning agents that contain a solvent may damage the front panel labeling, plastic parts, or the display.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

### 3.2.1.1 Touchscreen

The block diagram and the most important settings are displayed on the screen on the front panel. Additionally, the screen display provides status and setting information and allows you to quickly reconfigure the signal flow. The screen is touch-sensitive, offering an alternative means of user interaction for quick and easy handling of the instrument.



**Figure 3-2: Touchscreen elements**

- 1 = Status bar (frequency and level display)
- 2 = Block diagram
- 3 = Taskbar/softkey bar

A touchscreen is a screen that is touch-sensitive. It reacts in a specified way when a particular element on the screen is tapped by a finger. Any user interface element that can be clicked on by a mouse pointer can also be tapped on the screen to trigger the same behavior. Using the touchscreen, the following tasks (among others) can be performed by the tap of your finger (see also [Chapter 3.3, "Trying Out the Instrument"](#), on page 64):

- Changing a setting
- Selecting new settings
- Scrolling through the list of parameters
- Saving or recalling settings
- Routing the signal flow
- Opening and closing dialogs



To imitate a right-click by mouse using the touchscreen, for example to open a context-sensitive menu for a specific item, press and hold the screen for about 1 second.

### 3.2.1.2 Keys

#### Utility Keys

The utility keys cause the R&S SMW to return to a defined instrument state and provide information on the instrument and assistance.

For more information, refer to [Chapter 11, "General Instrument Functions"](#), on page 608.

**Table 3-1: Utility Keys**

Utility Key	Assigned functions
PRESET	Sets the instrument to a defined state
SAVE/RCL	Saves and loads instrument setting Accesses the file manager
LOCAL	Switches from remote control to local (manual) control
SETUP	Accesses the general instrument settings
HCOPY	Opens the "Hardcopy" dialog for storing the current display in a file
INFO	Displays status messages, error messages, and warnings
HELP	Displays context-sensitive help text

#### POWER ON/STANDBY

The POWER ON/STANDBY key switches the instrument from the standby to the ready state or vice versa.

- In the ready state, the LED is green. The instrument is ready for operation.
- In the standby state, the LED is orange. The standby power mode keeps the power switch circuits and the oven-controlled crystal oscillator OCXO active. In this state, it is safe to switch off the AC power and disconnect the instrument from the power supply.

#### Function Keys

Function keys provide access to most common generator settings and functions.

A detailed description of the corresponding functions is provided in the user manual.

**Table 3-2: Function keys**

Function key	Assigned functions
FREQ	Activates frequency entry. <sup>1)</sup>
LEVEL	Activates level entry. <sup>1)</sup>
DIAGRAM	Brings the block diagram to the foreground. Active dialogs are minimized.
RF ON/OFF	Switches the RF output on and off. <sup>2)</sup>
MOD ON/OFF	Switches the modulations on and off. <sup>2)</sup>

Function key	Assigned functions
USER	Key with a customizable function. You can define the action to be executed.
<b>Function execution</b> (in navigation controls area)	
ON/OFF TOGGLE	<ul style="list-style-type: none"> <li>• Switches highlighted elements or a function block on and off.</li> <li>• Switches between two or more settings, e.g. items of selection lists. At the end of a list, the cursor is set on the first entry again.</li> </ul>

<sup>1)</sup> The entry field that was active last is activated. Press the key again to activate the entry field of the other path.

<sup>2)</sup> Current status is displayed in the "Status bar". The key switches all RF signals/modulations off; Press the key again to restore the last active status.

### Keypad

The keypad is used to enter alphanumeric parameters, including the corresponding units. It contains the following keys:

**Table 3-3: Keys on the keypad**

Type of key	Description
Alphanumeric keys	Enter numbers and (special) characters in edit dialog boxes.
Decimal point	Inserts a decimal point "." at the cursor position.
Sign key	Changes the sign of a numeric parameter. In the case of an alphanumeric parameter, inserts a "-" at the cursor position.
Unit keys (G/n dB $\mu$ V, M/ $\mu$ $\mu$ V, k/m mV and x1 dB(m))	<p>These keys add the selected unit to the entered numeric value and complete the entry.</p> <p>In the case of level entries (e.g. in dB) or dimensionless values, all units have the value "1" as multiplying factor. Thus, they have the same function as an ENTER key.</p>
INSERT key	Toggles between insert and overwrite mode
ESC key	<p>Closes all kinds of dialog boxes, if the edit mode is not active. Quits the edit mode, if the edit mode is active. In dialog boxes that contain a "Cancel" button it activates that button.</p> <p>For "Edit" dialog boxes the following mechanism is used:</p> <ul style="list-style-type: none"> <li>• If data entry has been started, it retains the original value and closes the dialog box.</li> <li>• If data entry has not been started or has been completed, it closes the dialog box.</li> </ul>
BACKSPACE key	If an alphanumeric entry has already been started, this key deletes the character to the left of the cursor.
ENTER key	<p>Has the same effect as pressing the rotary knob</p> <ul style="list-style-type: none"> <li>• Concludes the entry of dimensionless entries. The new value is accepted.</li> <li>• With other entries, this key can be used instead of the default unit key.</li> <li>• In a dialog box, selects the default or focused element.</li> <li>• Calls the next dialog level.</li> <li>• Confirms and closes open input windows.</li> </ul>



## Navigation Controls

The navigation controls include a rotary knob, navigation keys, and the display keys. They allow you to navigate within the display or within dialog boxes.

### Rotary Knob

The rotary knob has several functions:

- Increments (clockwise direction) or decrements (counter-clockwise direction) the instrument parameter at a defined step width in the case of a numeric entry.
- Moves the selection, e.g. to a function block in the block diagram
- Shifts the selection bar within focused areas (e.g. lists).
- Acts like the ENTER key, when it is pressed.

### Navigation Keys

The navigation keys can be used alternatively to the rotary knob to navigate through dialog boxes, diagrams, or tables.

**Table 3-4: Navigation Keys**

Type of key	Description
UP/DOWN Key	The UP and the DOWN key does the following: <ul style="list-style-type: none"> <li>• In a numeric edit dialog box, increase or decrease the instrument parameter.</li> <li>• In a list, scroll forward and backward through the list entries.</li> <li>• In a table, move the selection bar vertically.</li> <li>• In windows or dialog boxes with vertical scroll bar, move the scroll bar.</li> </ul>
LEFT/RIGHT Key	The LEFT and the RIGHT key does the following: <ul style="list-style-type: none"> <li>• In an alphanumeric edit dialog box, move the cursor.</li> <li>• In a list, scroll forward and backward through the list entries.</li> <li>• In a table, move the selection bar horizontally.</li> <li>• In windows or dialog boxes with horizontal scroll bar, move the scroll bar.</li> </ul>

### Display Keys

The display keys arrange different windows on the display.

**Table 3-5: Display keys**

Display key	Assigned functions
NEXT WINDOW	Toggles between the active dialogs
RESIZE WINDOW	Adjusts the size of the active dialog to use the whole height of the display.
ESC	Closes all kinds of dialog boxes, if the edit mode is not active. Quits the edit mode, if the edit mode is active. In dialog boxes that contain a "Cancel" button it activates that button.  For "Edit" dialog boxes the following mechanism is used: <ul style="list-style-type: none"> <li>• If data entry has been started, it retains the original value and closes the dialog box.</li> <li>• If data entry has not been started or has been completed, it closes the dialog box.</li> </ul>

### 3.2.1.3 Connectors

The RF and I/Q connectors and various others interface connectors are located on the front panel.

#### I, Q

I and Q inputs for external analog modulation signal directly fed into the I/Q modulator. One pair of I and Q inputs are available per installed RF path.

For more information, see [Chapter 4.3.2, "Overview of the Baseband Signal Sources"](#), on page 129

#### USB

USB (universal serial bus) interfaces of type A (host USB).

- Connection of peripherals such as mouse or keyboard
- Connection of memory stick for file transmission
- Firmware update

**Note:** Further USB interface type A (host USB) and a USB interface type B (device USB for data transmission) are available on the rear panel.

See also [Chapter 3.1.3, "Connecting USB Devices"](#), on page 44.

#### SENSOR

Connector for R&S NRP-Zxx sensors.

The R&S SMW supports the use of R&S NRP-Zxx power sensors in various ways including as a simple power viewer.

A power sensor is connected by inserting the male connector. To disconnect, pull the connector by its sleeve. You cannot disconnect the sensor simply by pulling at the cable or the rear part of the connector.

See also [Chapter 8.9.4.1, "NRP-Z Power Viewer"](#), on page 515 and [Chapter 8.9.3, "User Correction"](#), on page 505.

#### USER 1, 2, 3

Multipurpose connectors. The input/output signal has to be defined, for example "Global Trigger", "Global Clock", etc.

The [Table 3-6](#) lists the signals assigned to the USER 1, 2, 3 connectors in the default instrument state.

**Table 3-6: Default configuration of the USER 1, 2, 3 connectors**

Connector	Direction	Default assigned signal
USER 1	Output	Baseband A Marker 1
USER 2	Output	Baseband A Marker 2
USER 3	Input	Global Trigger 1

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active

See also [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612 and [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

### RF A, RF B

Outputs for RF signal of path A and path B.

**NOTICE!** Maximum Input Levels. Do not overload the RF output. The maximum permissible back-feed is specified in the data sheet.

The connector type depends on the installed frequency option, see [Table 3-7](#).

*Table 3-7: Overview of RF connector types depending on the frequency range*

Required option	Connector type
RF A: R&S SMW-B103/-B106 RF B: R&S SMW-B203/-B206	N female
RF A: R&S SMW-B112 RF B: R&S SMW-B212	Test port adapter, PC 3.5 mm female
RF A: R&S SMW-B120 RF B: R&S SMW-B220	Test port adapter, PC 3.5 mm female
RF A: R&S SMW-B131/-B140/-B140N	Test port adapter, PC 2.92 mm female

**NOTICE!** Risk of RF connector and cable damage. Excessive tightening of the connectors can damage the cables and connectors. Too weak tightening leads to inaccurate results.

Always use an appropriate torque wrench suitable for this type of connector and apply the torque specified in the application note [1MA99](#).

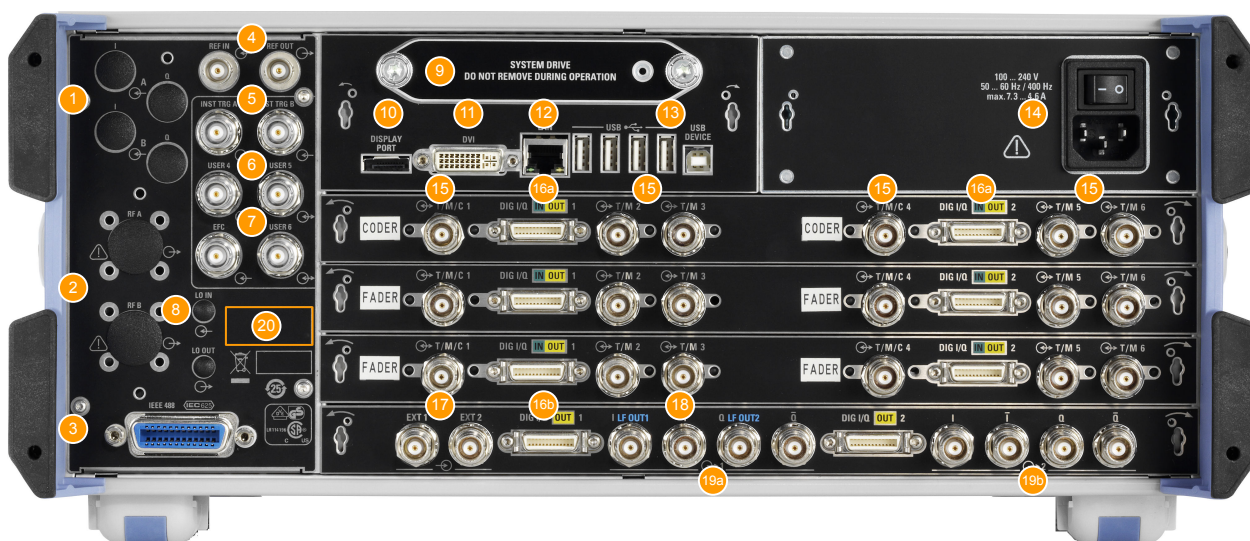
If your instrument is equipped with a test port adapter, refer also to [1MA100](#).

The application notes are available on the Internet and provide additional information on care and handling of RF connectors.

Rohde & Schwarz offers appropriate torque wrenches for various connectors. For ordering information see the R&S SMW data sheet or product brochure.

## 3.2.2 Rear Panel Tour

This section provides an overview of the connectors on the rear panel of the instrument. For technical data of the connectors, refer to the data sheet.



**Figure 3-3: Rear panel view**

- 1, 2 = Connectors for use in a rack
- 3 = IEC 625/IEEE 488 connector
- 4 = REF IN/ REF OUT connectors
- 5 = INST TRIG A/B connectors
- 6 = USER 4, 5, 6 connectors
- 7 = EFC connectors
- 8 = LO IN, LO OUT connectors
- 9 = SYSTEM DRIVE
- 10, 11 = DISPLAY PORT/DVI connectors
- 12 = LAN connectors
- 13 = USB connectors
- 14 = AC power supply connection and main power switch
- 15 = T/M/C1,4 and T/M2,3,5,6 connectors on each CODER and FADER boards
- 16, 16a = DIG IQ IN/OUT connectors on each CODER and FADER boards; DIG IQ OUT connectors on BBMM board
- 17 = EXT 1, 2 connectors
- 18 = LF OUT 1, 2 connectors
- 19a, b = I/Q OUT, I/Q BAR OUT connectors
- 20 = Serial number (last 6 digits in the string 1412.0000.02-<serial number>)

### 3.2.2.1 Connectors

#### I, Q

Rear panel connectors, recommended for use of the instrument in a 19" rack.

See also "[Rackmounting](#)" on page 40.

#### RF A / RF B

Rear panel connectors for the 1st RF path (option R&S SMW-B81/-B83) and the 2nd RF path (option R&S SMW-B82/-B84). These options are recommended for use of the instrument in a 19" rack.

See also "[Rackmounting](#)" on page 40.

**IEC 625/IEEE 488**

GPIO-bus interface for remote control of the instrument.

The IEC 625 interface is in compliance with IEEE488 and SCPI. A computer for remote control can be connected via this interface. To set up the connection, a shielded cable is recommended.

**Note:** To avoid electromagnetic interference (EMI) caused by open lines, always terminate any connected IEC-bus cable with an instrument or a controller.

See also [Chapter D.1, "GPIO-bus Interface"](#), on page 1162 and [Chapter 12, "Network and Remote Control Operation"](#), on page 649.

**REF IN/ REF OUT**

Input/output for external reference signal. The external reference is used for both paths.

See also [Chapter 8.5, "Reference Oscillator"](#), on page 422.

**INST TRIG A/B**

Input for external trigger of sweeps and list mode.

See also [Chapter 8.7, "Varying the RF Signal in List or Sweep Mode"](#), on page 437.

**USER 4, 5, 6**

Multipurpose connectors. The input/output signal has to be defined, for example "Pulse In/Gen A/B", "Signal Valid A/B", "Sync A/B", or "Video A/B".

The [Table 3-8](#) lists the signals assigned to the USER 4, 5, 6 connectors in the default instrument state.

*Table 3-8: Default configuration of the USER 4, 5, 6 connectors*

Connector	Direction	Default assigned signal
USER 4	Input	Global Trigger 2
USER 5	Output	No Signal (Blank) A
USER 6	Not used	None

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active

See also [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612 and [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

**EFC**

Input connector for an EFC signal (external frequency control).

**LO IN, LO OUT**

Local oscillator input and output for phase-coherent RF signal; require option R&S SMW-B90.

- LO IN: Input of phase coherence signal
- LO OUT: Output of phase coherence signal

**NOTICE!** Protection of mechanical components. To avoid damage of the SMA connectors it is essential to limit the tightening torque to 60 Ncm. Use an adequate 8 mm torque wrench and not an ordinary open-end wrench.

See also [Chapter 8.6, "Local Oscillator Coupling"](#), on page 428.

### SYSTEM DRIVE

Hard disk drive (HDD) or solid-state drive (SSD); the SSD requires option R&S SMW-B93.

With respect to security concerns the hard disk can be removed from the instrument, but it is bound to the specific R&S SMW. Therefore, it cannot be exchanged between different instruments.

**NOTICE!** Risk of instrument damage and data loss. During operation the instrument is accessing the hard disk. Removing the hard disk while operating leads to data loss or even instrument damage.

Do not remove the hard disk during operation.

### DISPLAY PORT/DVI

Provided for future use.

### LAN

The LAN interface can be used to connect the R&S SMW to a local network for remote control, remote operation, and data transfer.

For details, see [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45.

### USB

The rear panel provides 4 more female USB Type A connectors to connect devices like a keyboard, a mouse, a memory stick, or a power sensor R&S NRP-Zxx, connected with an appropriate cable R&S NRP-Z3/Z4.

Furthermore, a female USB DEVICE connector (USB Type B) is provided, for example for remote control.

See also [Chapter 3.1.3, "Connecting USB Devices"](#), on page 44.

### AC SUPPLY AND POWER SWITCH

The AC power supply connector and the main power switch are located in a unit on the rear panel of the instrument.

Main power switch function:

- Position 1: The instrument is in operation.
- Position 0: The entire instrument is disconnected from the AC power supply.

For details, refer to [Chapter 3.1.1.5, "Switching the Instrument On and Off"](#), on page 40.

### T/M/(C)

Multipurpose input/output connectors. Each coder and fader board is equipped with one TRIGGER/MARKER/CLOCK and two TRIGGER/MARKER connectors. The input/output signal has to be defined, for example "Trigger", "Clock", etc.

The [Table 3-9](#) lists the configuration of the local connectors in the default instrument state.

**Table 3-9: Default configuration of the T/M/(C) connectors on the CODER boards**

Connector	Direction	Default assigned signal	Remark
T/M/C 1	Output	Clock	Local clock signal for the particular baseband
T/M 2	Input	Trigger	Local trigger signal for the particular baseband
T/M 3	Output	Marker 3	Marker output signal from the particular baseband

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active

See also [Chapter 5.3.1.1, "Data, Clock and Control Signals and Sources in the Baseband"](#), on page 216 and [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

### DIGITAL IQ IN/OUT

Connectors for the input/output of a digital I/Q signal from and to an R&S instrument, like a signal generator, signal analyzer, the R&S EX-IQ-BOX, or the R&S®CMW500 Radio Communication Tester in fading applications.

Each fader board is equipped with one bidirectional interface. The coder boards are equipped with one DIG IQ IN interface each and the BBMM (Baseband main module) board - with one or two DIG IQ OUT interfaces.

The interfaces require the options listed in [Table 3-10](#) (for details see the data sheet).

**Table 3-10: Overview of the required options**

Location of the interface	Designation	Required option
DIG IQ IN on the coder boards	CODER 1/2 IN/OUT	R&S SMW-B10
DIG IQ IN/OUT on the fader boards	FADER 1/2/3/4 IN/OUT	R&S SMW-B14, Fading Simulator
DIG IQ OUT on the BBMM board	BBMM 1/2 OUT	R&S SMW-B13/-B13T and R&S SMW-K18, Digital Baseband Output

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active

### EXT 1, 2

Input for external analog modulation signals. The instrument is equipped with two separate inputs, which both can be used for path A and path B.

See also [Chapter 8.8.2, "Modulation Signals"](#), on page 473.

### LF OUT 1/2

Output for internal LF generator signal.

**Note:** The output of the internal LF signal and the analog I/Q signal use the same physical connectors (LF OUT 1/2 and I/Q OUT 1). These signals cannot be output at the same time.

See also data sheet and [Chapter 8.8.2, "Modulation Signals"](#), on page 473.

#### **I/Q OUT, I/Q BAR OUT 1,2 LF OUT 1/2**

Direct output or differential output for the analog I/Q signal. Output of differential signal requires option R&S SMW-K16.

#### **Note:**

Throughout the user documentation, the notations DIFF I OUT and I OUT BAR are used interchangeably.

See also [Chapter 4.8, "I/Q Analog Output Settings"](#), on page 173.

## 3.3 Trying Out the Instrument

This chapter introduces the most important functions and settings of the R&S SMW step by step. The complete description of the functionality and its usage is given in the R&S SMW user manual. Basic instrument operation is described in [Chapter 3.5, "Instrument Control"](#), on page 104.

See also:

- ["To start a tutorial in an interactive step-by-step mode"](#) on page 116

#### **Prerequisites**

- The instrument is set up, connected to the power supply, and started up as described in [Chapter 3.1, "Preparing for Use"](#), on page 36.
- Throughout this description, the term base unit describes a R&S SMW equipped with the options R&S SMW-B10, R&S SMW-B13, and R&S SMW-B103.

For the first signal generation tasks, you use the internal baseband and reference signal, so you do not need any additional signal source. More complex signal generation tasks, however, require an instrument equipped with additional options and/or external signals. Each task description lists its prerequisites.



The screenshots in this description show a fully equipped instrument. Consider that, the block diagram displayed on your particular instrument may differ from the one used in the example.

The instrument is manually operated via the touchscreen. Try out the following:

- [Generating an Unmodulated Carrier](#).....65
- [Generating a Digitally Modulated Signal](#).....67
- [Triggering the Instrument with an External Signal](#)..... 69
- [Enabling and Configuring a Marker Signal](#).....75
- [Routing the Signal through the Instrument and Defining the Output Connectors](#)... 76
- [Verifying the Generated Signal with the Graphics Display](#).....81

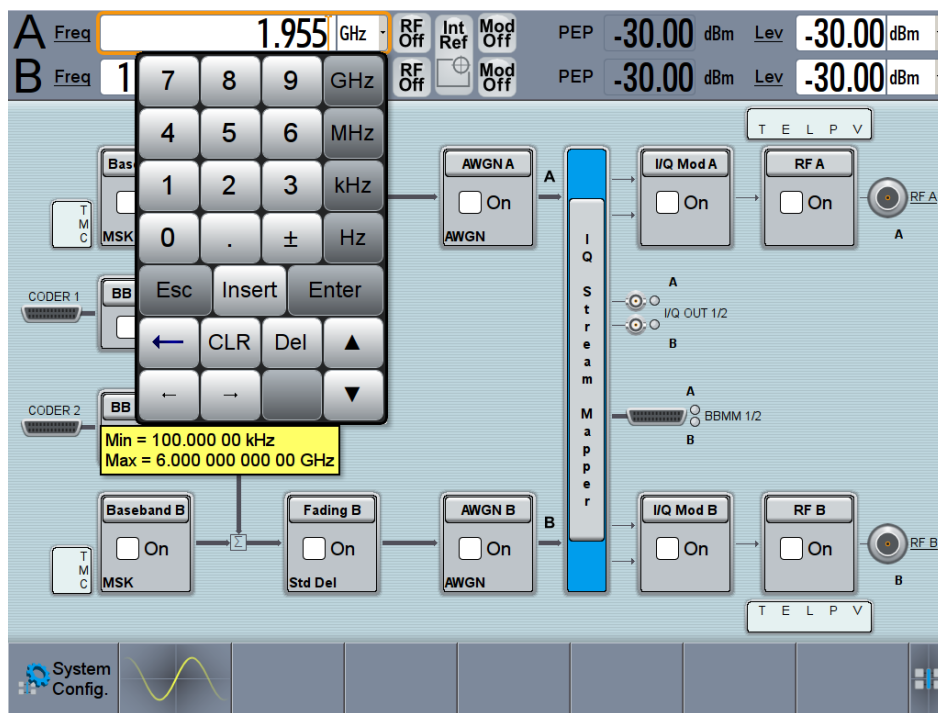


- [Saving and Recalling Settings](#)..... 84
- [Generating an EUTRA/LTE Signal](#).....86
- [Using the System Configuration Capabilities for MIMO Setups](#).....90

### 3.3.1 Generating an Unmodulated Carrier

We start out by generating a simple unmodulated signal. The R&S SMW in this example can be a base unit in its minimal configuration.

1. On the R&S SMW front panel, press the PRESET key to start out in a defined instrument configuration.
2. Set the frequency:
  - a) On the "Status Bar", tap the "A Freq" field.
  - b) On the on-screen keypad, enter 1.955 and press the "GHz" key.



The on-screen key pad closes and the frequency value is displayed.

3. On the "Status Bar", tap the "Lev" field and enter the level in the same way.



4. Select "Block Diagram > RF A Block > On" to enable the output of the generated unmodulated signal.

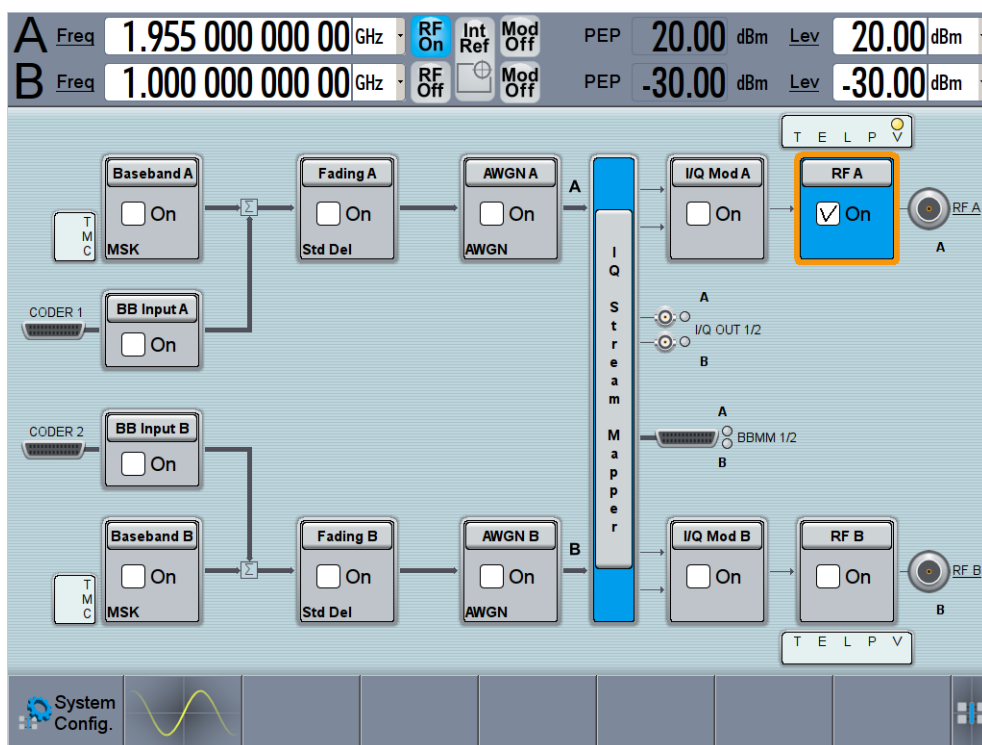
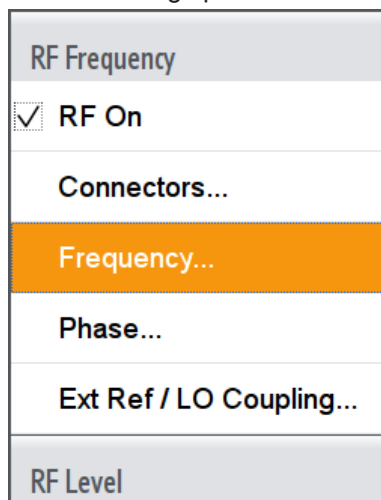


Figure 3-4: Block diagram: Generating an unmodulated signal

**Tip:** Alternative way to access the instrument functions. To fulfill the same task, you can use other hot spots in the block diagram, the provided functions under the "RF" block or the function front panel keys.

Try out the following:

- on the "Status Bar" and in the block diagram, tap the underlined labels **Freq**, **Lev** and **RF A**.
- Or:
- select "Block Diagram > RF A" block, navigate through the context menu, and use the settings provided in the "Frequency" and "Level" dialog.



To enable signal generation, enable the "RF On".

Or:

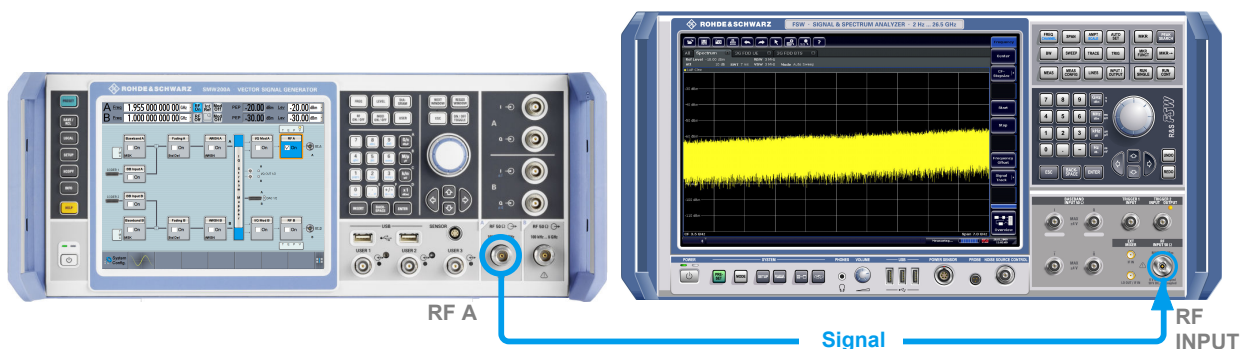
- use the FREQ, LEVEL, and RF ON/OFF key on the front panel.

See also [Chapter 3.5, "Instrument Control"](#), on page 104.

The 1.95 GHz signal is output at the RF A connector at the front panel of the R&S SMW.



Connect RF A of the R&S SMW to a signal analyzer, for example R&S®FSW, to display the generated signal.



**Figure 3-5: Simplified test setup**

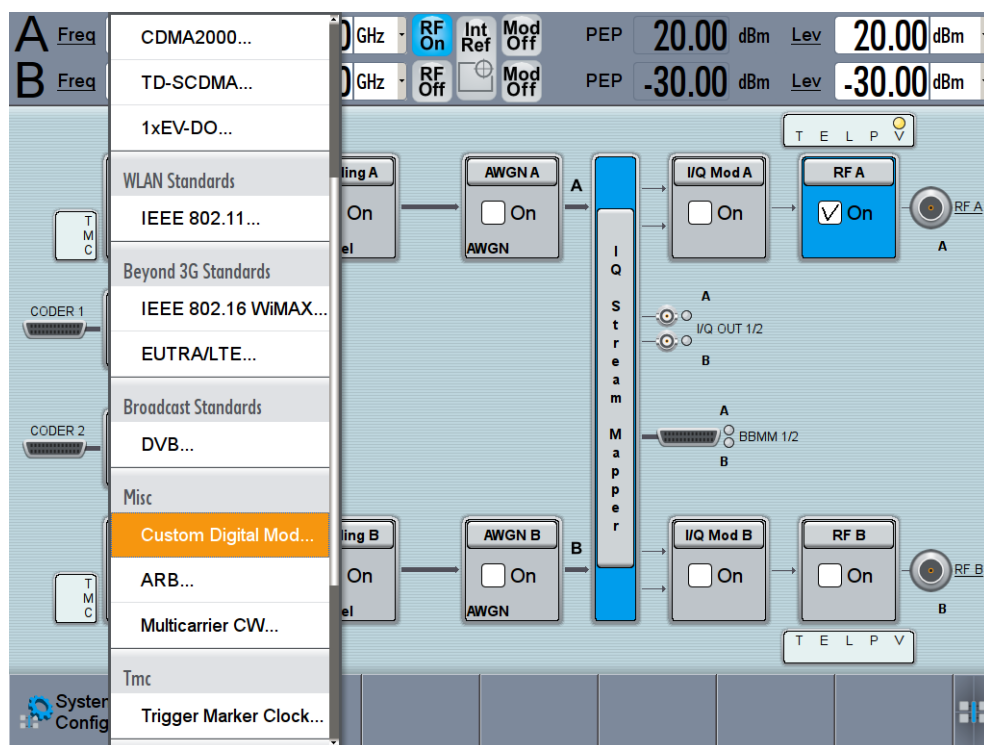
For the required settings of the signal analyzer, refer to its user manual or its online help.

### 3.3.2 Generating a Digitally Modulated Signal

This example shows you how to generate a simple WCDMA-3GPP (QPSK 45° Offset) signal with the help of the "Custom Digital Modulation" functionality. The minimum requirement for R&S SMW in this example is a base unit.

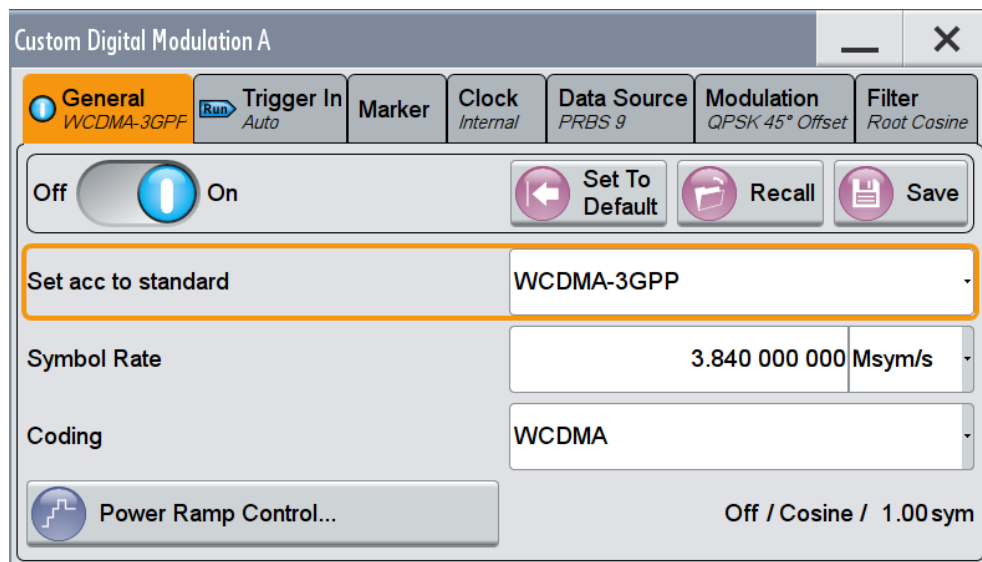
The initial situation is not the instrument's preset state but rather the configuration described in [Chapter 3.3.1, "Generating an Unmodulated Carrier"](#), on page 65.

1. In the block diagram, select "Baseband A" and navigate to the section "Misc > Custom Digital Mod...".



The "Custom Digital Modulation" dialog opens.

2. In the "Custom Digital Modulation" dialog, select "General > Set acc to standard > WCDMA-3GPP".
3. Select "General > State > On" to enable signal generation.



4. Select the "Modulation" tab and observe the used "Modulation Type".

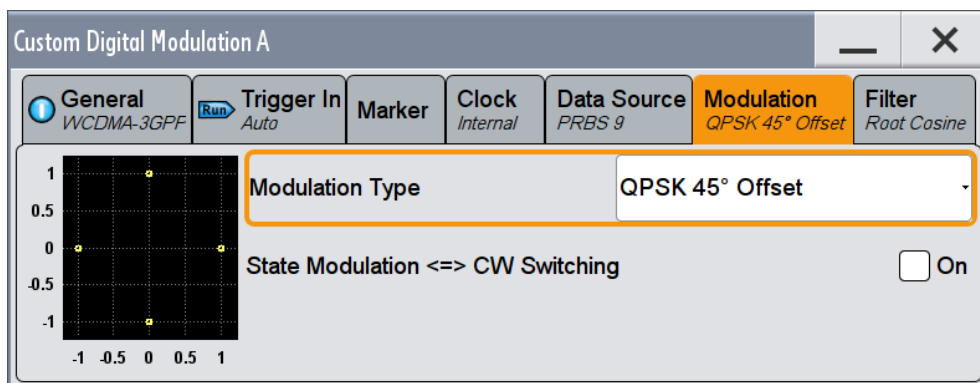


Figure 3-6: Display of the used modulation type

The instrument activates automatically "I/Q Mod A", uses the internal trigger and clock signals, and generates a WCDMA-3GPP signal, modulated with a QPSK 45° Offset modulation.

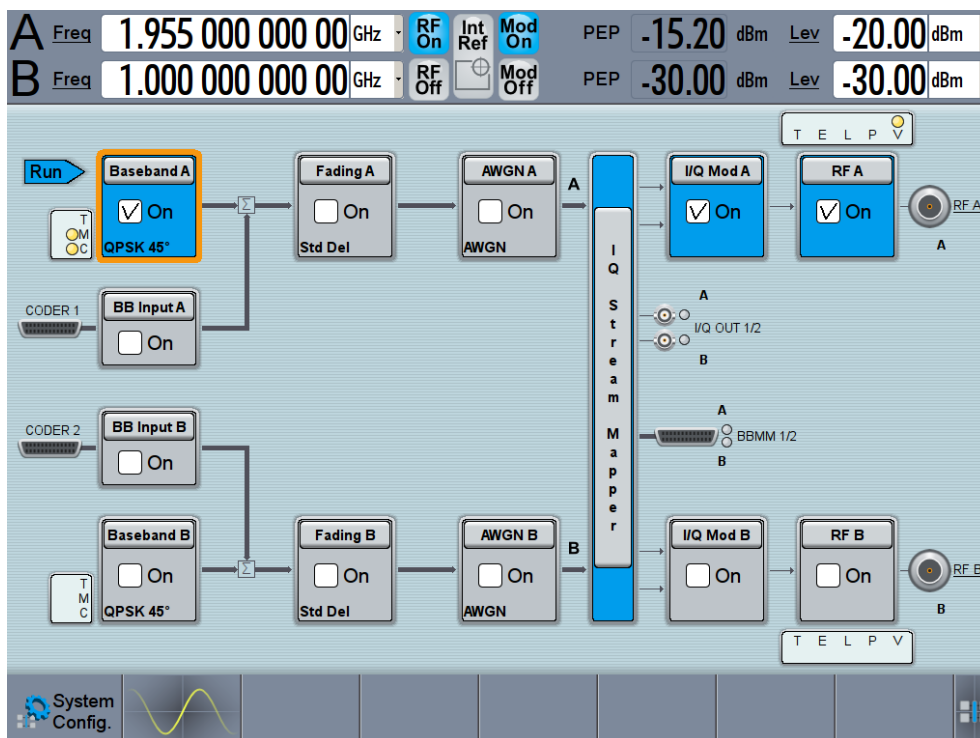


Figure 3-7: Block diagram: Generating a digitally modulated signal

### 3.3.3 Triggering the Instrument with an External Signal

The example configurations are rather theoretical cases, because you rarely use the R&S SMW as a stand-alone instrument. Usually, the instrument would be connected to a device under test (DUT) and/or other measurement equipment. As a rule, whenever a test setup requires two or more devices, provide them with a common reference frequency. Some test setups require control of the signal generation start and an exact

generation start time, determined by a defined trigger event, e.g. by triggering the instrument internally or externally from the DUT.

This example illustrates the general principle of external triggering and extends the configuration performed in [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67 by the configuration of the required trigger signal and connector settings.



In this example, we use the global USER connectors. Alternatively, you can achieve the same configuration goal with the local [T/M/\(C\)](#) connectors.

This test setup requires one signal analyzer, like the R&S®FSW, as additional equipment.

### To start the signal generation in Baseband A synchronous to an external global trigger signal

The configuration requires three main steps with the following goals:

1. Observe the current connector configuration and define an input connector for the external global trigger signal.  
See ["To verify the current connector configuration"](#) on page 70
2. Configure Baseband A to use this external global trigger signal as trigger source.  
See ["To \(re\)configure the trigger settings"](#) on page 73
3. Connect the instrument and the external trigger source.  
See ["To connect the instrument and the external trigger source"](#) on page 74

### To verify the current connector configuration

The R&S SMW is equipped with multi purpose bi-directional local T/M/(C) connectors and global USER connectors. Because the signal direction, input or output, and the signal mapping are configurable, it is recommended that you check the current configuration before cabling or further instrument's configurations.

1. To display *an overview* of the current mapping of the logical signals to the connectors, perform one of the following:
  - In the block diagram, select the Trigger/Marker/Clock status LEDs on the left side of the "Baseband" block.



- Select "Baseband > Trigger Marker Clock".

Trigger Marker Clock

Baseband A Baseband B

	Logical Signal	Connector	Find
Trigger Source	Internal		
Clock Source	Internal		
Clock Output		T/M/C 1	...
Marker 1	On/Off Ratio	User 1, T/M 2	...
Marker 2	On/Off Ratio	User 2, T/M 3	...
Marker 3	On/Off Ratio		

Diagram Legend

- T=Trigger =Common to all Basebands
- M=Marker
- C=Clock
- =Signal is available at Output Connector
- =Signal Source is external

Local Connector Settings...

Global Connector Settings...

The instrument uses its internal trigger and clock signals, and the default mapping of the marker signals to the connectors.

- To access the related connector settings, perform one of the following:
  - select "Global Connector Settings"
  - tap the connector name, for example select the connector "User 1, T/M 2"

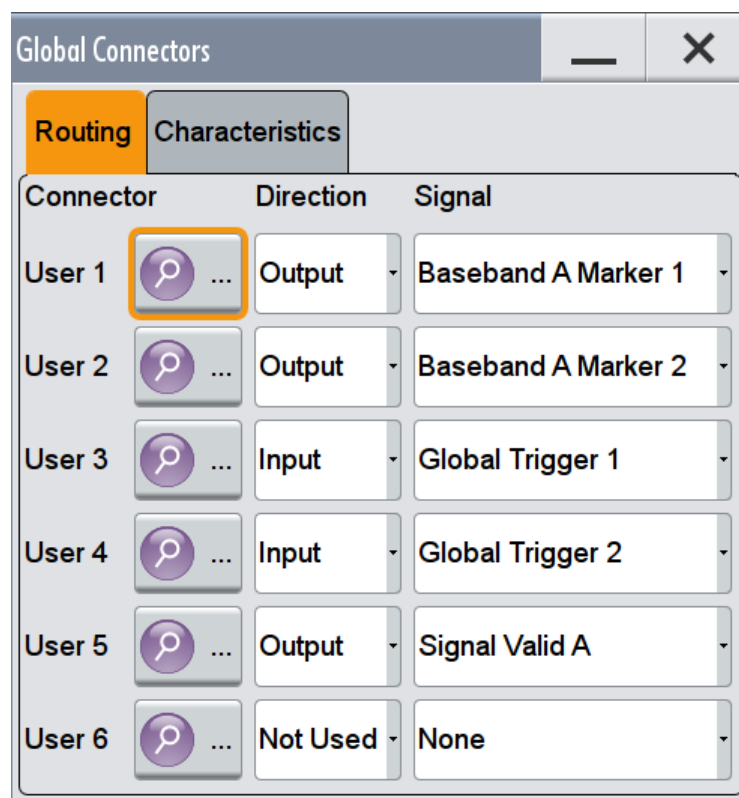


Figure 3-8: Signal mapping to the global connectors

The "Global Connectors" dialog displays the current connectors configuration. The settings are configurable, but in this example we use the default mapping.

- Alternatively, select "Block Diagram > Baseband > Misc > Custom Digital Mod", select the "> Trigger In" tab and select "Local Connector Settings" or "Global Connector Settings".

In the current mapping, the three global connectors **USER 1, 2, 3** on the front panel are configured as follows:

- "Marker 1/2" are output at the USER 1/2 connectors
- the USER 3 connector is an input for the "Global Trigger 1" signal.

Check the front panel of the R&S SMW. The USER 1/2 LEDs are yellow; the USER 3 LED is green.



#### Find the physical location of each connector

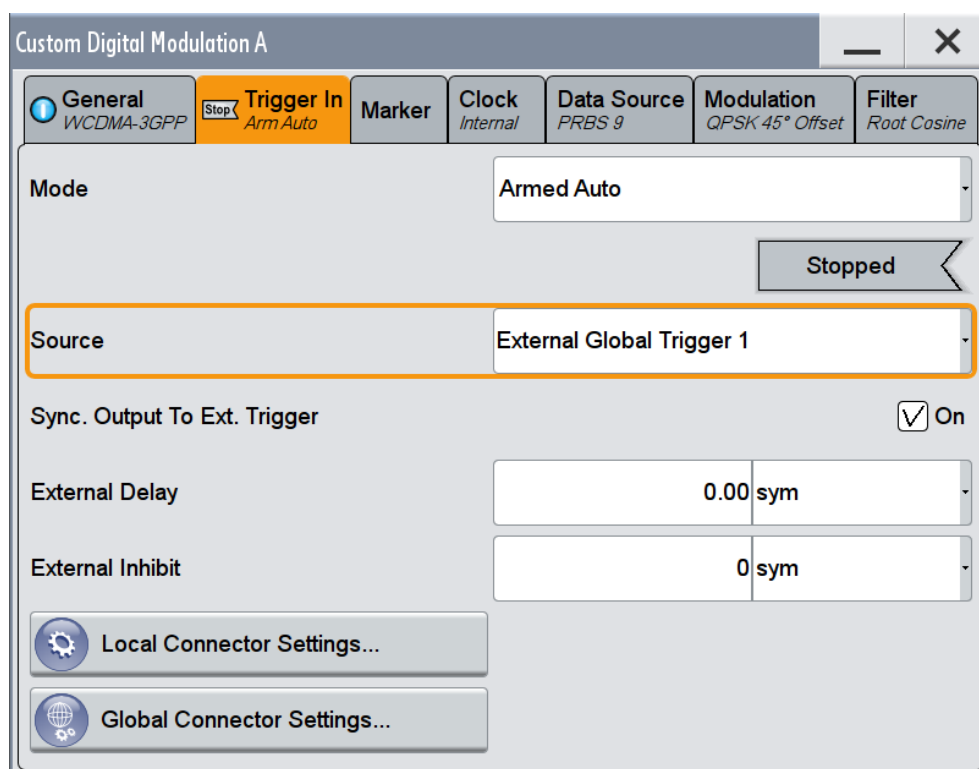
Use the built-in "Trigger Marker Clock > Find" function to display the location of the selected connector. A blinking LED on the front/rear panel also indicates the selected connector.



### To (re)configure the trigger settings

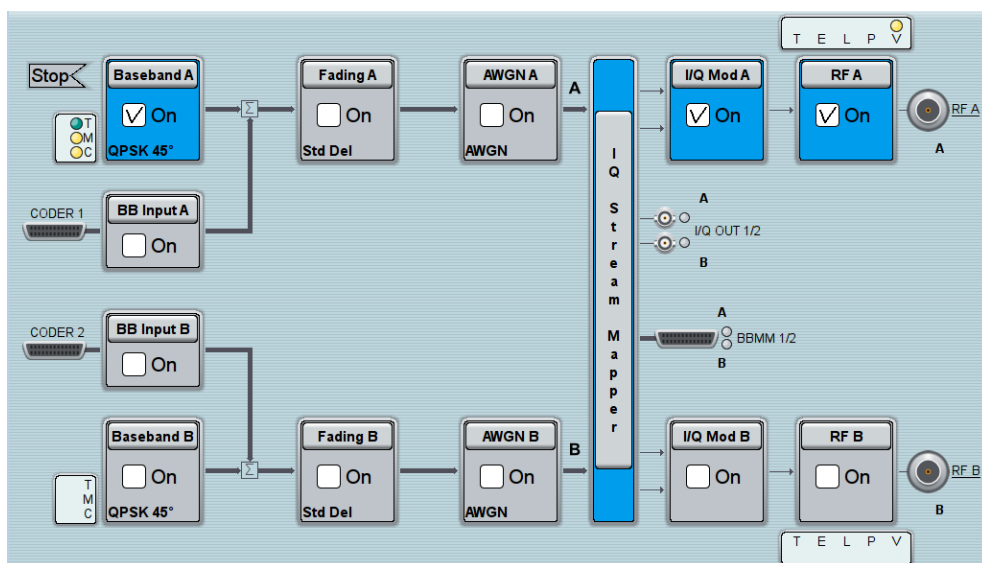
We assume that the instrument is configured as described in [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67 and the default connector mapping is maintained (see [Figure 3-8](#)).

1. In the block diagram, select "Baseband > Misc > Custom Digital Mod > Trigger In".
2. Select the following settings:
  - a) "Mode > Armed Auto"
  - b) "Source > External Global Trigger 1".



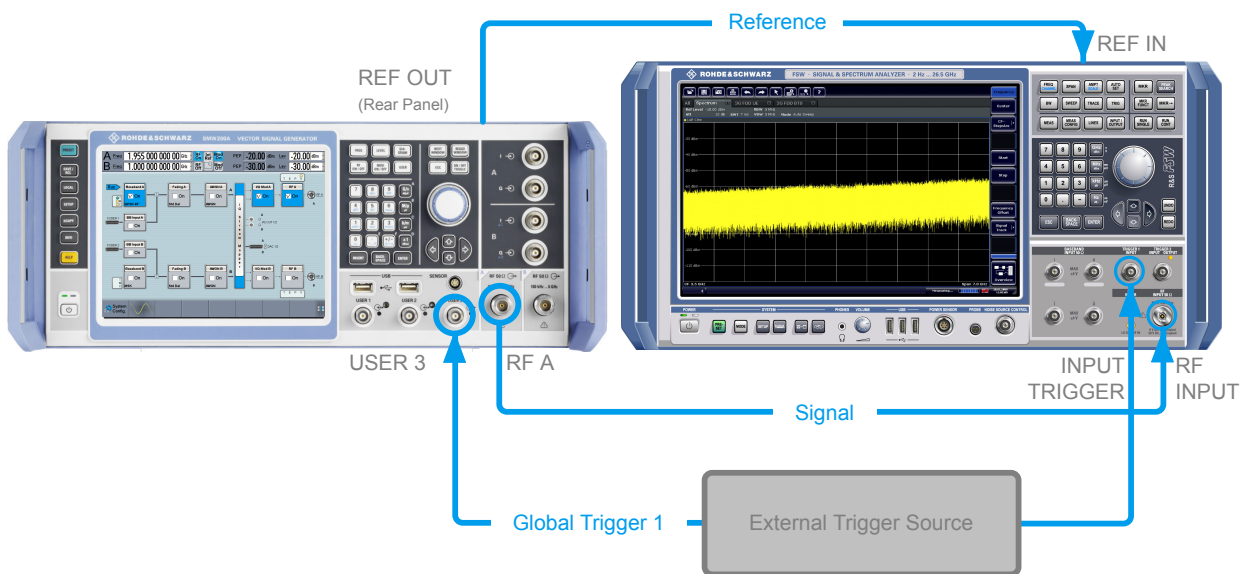
The instrument expects an external global trigger event. In this current configuration (see [Figure 3-8](#)), the "Global Trigger 1" signal has to be supplied at the input connector USER 3.

The Trigger/Marker/Clock status LEDs in the block diagram confirm that an external trigger signal is selected; the signal generation is however stopped.



**To connect the instrument and the external trigger source**

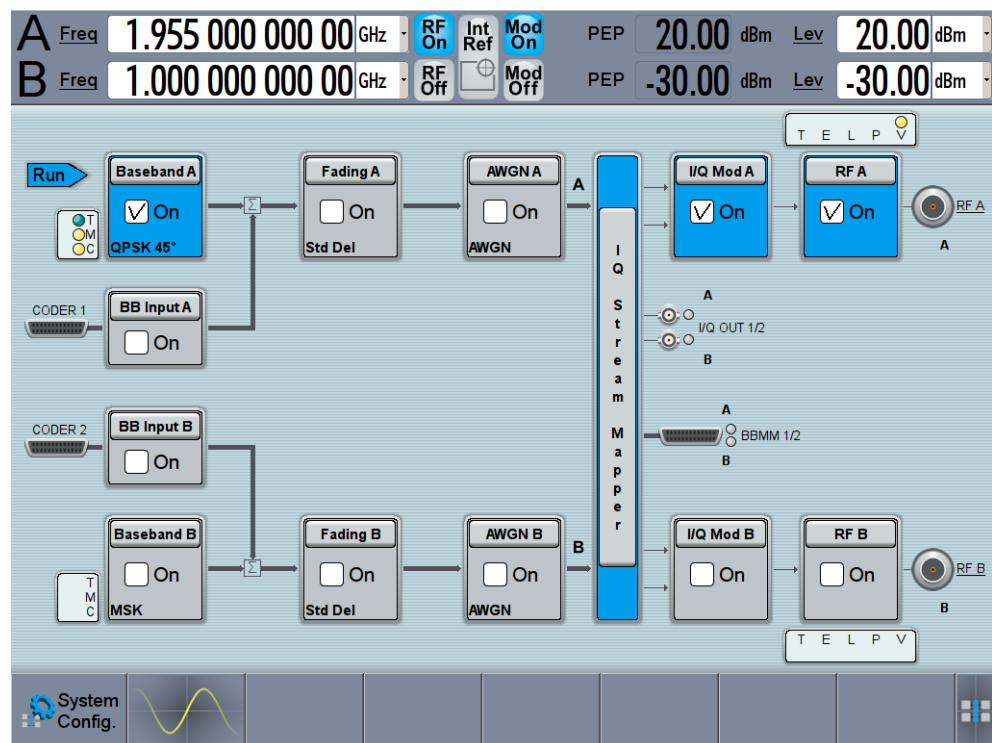
1. Use a suitable cable to connect the external trigger source to the USER 3 connector of the R&S SMW, see [Figure 3-9](#).



**Figure 3-9: Simplified representation of a test setup\*\***

\*\* = the figure depicts the cabling as a general principle; in a particular test setup not all connections are required at the same time

The [Figure 3-9](#) depicts the location of the connectors and explains the connection as principle. In practice, you would rather "substitute" the analyzer by a DUT, like a base station (BS). The DUT is the source for the reference signal and sends for example a frame trigger signal to the R&S SMW, the R&S SMW acts still as the signal source.



2. Use suitable cables to connect the **RF A/B** and **REF OUT** connectors of the R&S SMW to the signal analyzer or the DUT.

Upon the receiving of an external trigger event, the R&S SMW starts the signal generation and then generates a continuous signal. An "Arm" stops the signal generation. A subsequent trigger event causes a restart of the signal generation.



To learn more about this topic, refer to:

- [Chapter 5.3.1.3, "Baseband Trigger Signals"](#), on page 226
- [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612

### 3.3.4 Enabling and Configuring a Marker Signal

Test setups often require that an external device is synchronized to the generated data stream. For this purpose, the R&S SMW can output marker signals (or markers) additionally to the generated signal. The R&S SMW provides several regular marker signals and marker signals specific to the firmware option. With suitable marker settings for instance, you can mark slot or frame boundaries or mark the start of a particular modulation symbol.

This example extends further the configurations performed in [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67. We assume a default connector mapping (see [Figure 3-8](#)).



In this example, we use the global USER connectors. Alternatively, you can achieve the same configuration goal with the local **T/M/(C)** connectors.

This test setup requires one oscilloscope, like the R&S®RTO, as additional equipment.

1. In the block diagram, select "Block Diagram > Baseband > Misc > Custom Digital Mod > Marker".
2. Select "Marker Mode > Marker 1 > Pulse" and "Divider = 2".

Generated is a periodic marker with marker frequency of 1.92 MHz. The signal is output at the USER 1 connector of the R&S SMW (see [Figure 3-8](#)).

3. Use a suitable cable to connect the USER 1 connector of the R&S SMW to the monitoring instrument, for example oscilloscope like R&S®RTO, see [Figure 3-10](#).



**Figure 3-10: Simplified representation of a test setup for signal monitoring\*\***

\*\* = the figure depicts the cabling as a general principle

4. Use a suitable cable to connect the **I OUT** connector of the R&S SMW to the monitoring instrument.



To learn more about this topic, refer to [Chapter 5.3.1.2, "Regular Marker Output Signals"](#), on page 223.

### 3.3.5 Routing the Signal through the Instrument and Defining the Output Connectors

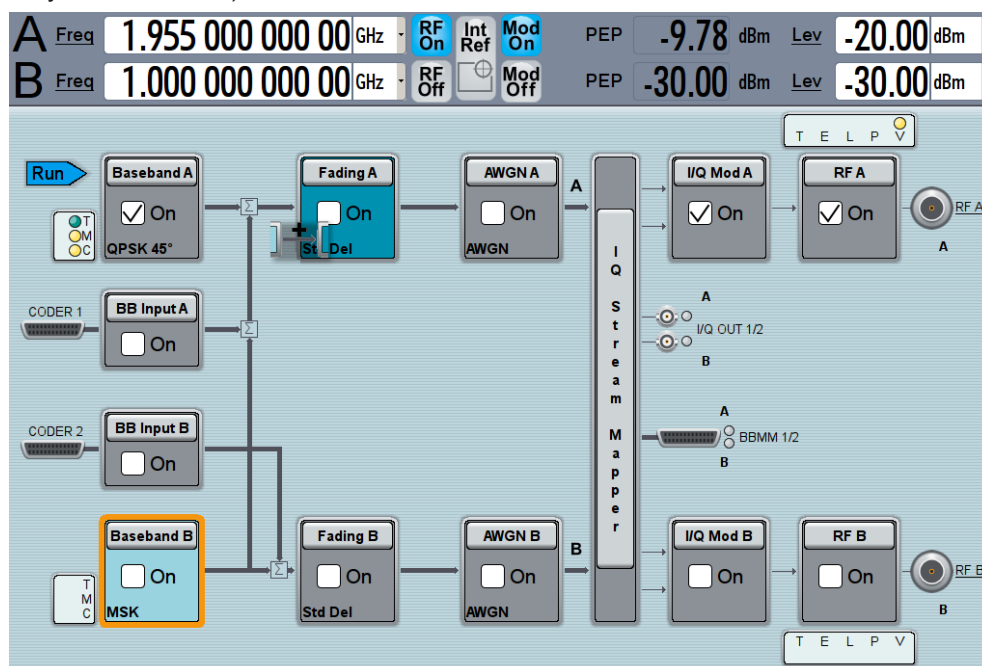
This section emphasizes on the signal routing capabilities in the default state of the instrument (standard system configuration mode). The R&S SMW provides the "I/Q Stream Mapper" function to route and distribute each of the generated I/Q signals (streams) to any of the available output connectors.

In the provided example, you use the R&S SMW to generate two baseband signals, apply a baseband frequency shift, weight them and add them. You then route the generated stream and define the output connector. The initial situation is the configuration described in [Chapter 3.3.3, "Triggering the Instrument with an External Signal"](#), on page 69.

The minimum requirement for the instrument in this example is an R&S SMW equipped with the options 2xR&S SMW-B10, R&S SMW-B13T, and 2xR&S SMW-B103.

### To configure a composed baseband signal

1. In the first baseband, generate a WCDMA-3GPP signal as described in [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67.
2. To route the signal from "Baseband B" block to the first signal path, use one of the alternatives:
  - In the block diagram, select "Baseband B" block and drag&drop it to the first path ("Fading A" block or "AWGN A" block depending on the options installed on your instrument).



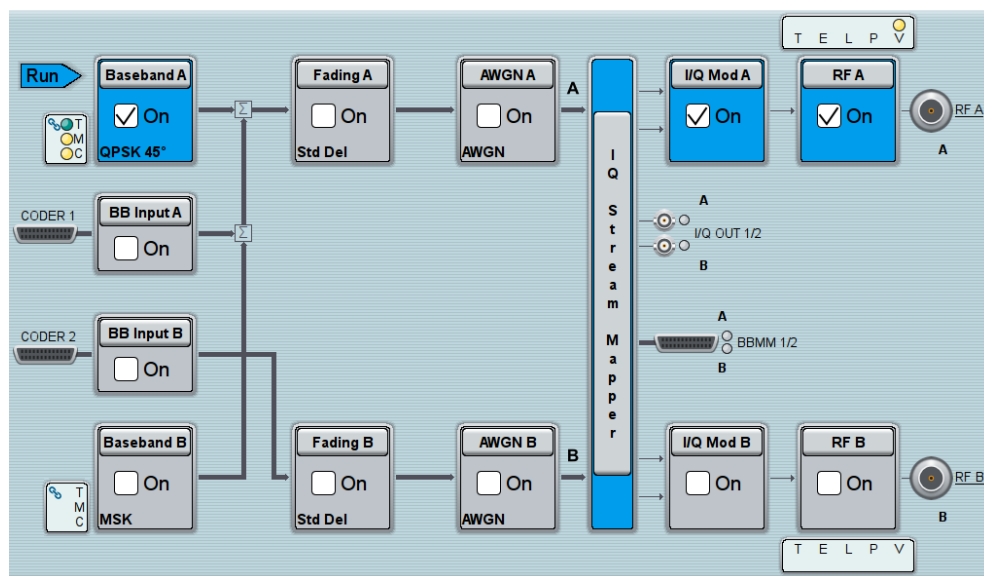
Select the "Fading B" block and drag&drop it to the "Baseband B" block.

- In the block diagram, select "Baseband B" block, navigate in the context menu, and select "Signal Routing > route to path A".

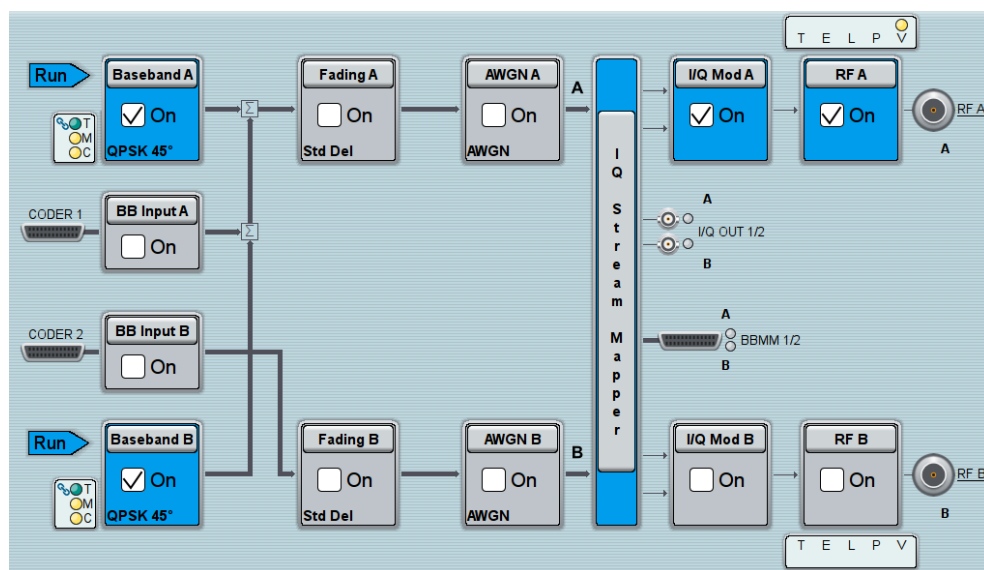
**Signal Routing**

- route to path B
- route to path A
- route to path A and B

The block diagram displays the routing.



- In the block diagram, select "Baseband B > Misc > Custom Digital Mod...", select "Set acc. to standard > 3GPP FDD" and enable "Custom Digital Modulation > State > On".



4. To apply frequency and power offsets to the signals, select "Baseband B > Baseband Offsets".
  - a) Enter "Baseband A > Frequency Offset > 5 MHz".
  - b) Enter "Baseband B > Frequency Offset > -5 MHz".
  - c) Enter "Baseband B > Path Gain > -30 dB".
  - d) Close the "Baseband Offsets" dialog.

Baseband Offsets			
	Frequency Offset /Hz	Phase Offset /°	Gain /dB
Baseband A	-5 000 000.00	0.00	0.000
BB Input A	0.00		0.000
BB Input B	0.00		0.000
Baseband B	5 000 000.00	0.00	-30.000

The symbols  $\Delta f$  and  $\Delta$  in the block diagram confirm that the signals are added weighted with a frequency offset on both paths and a path gain on path B.

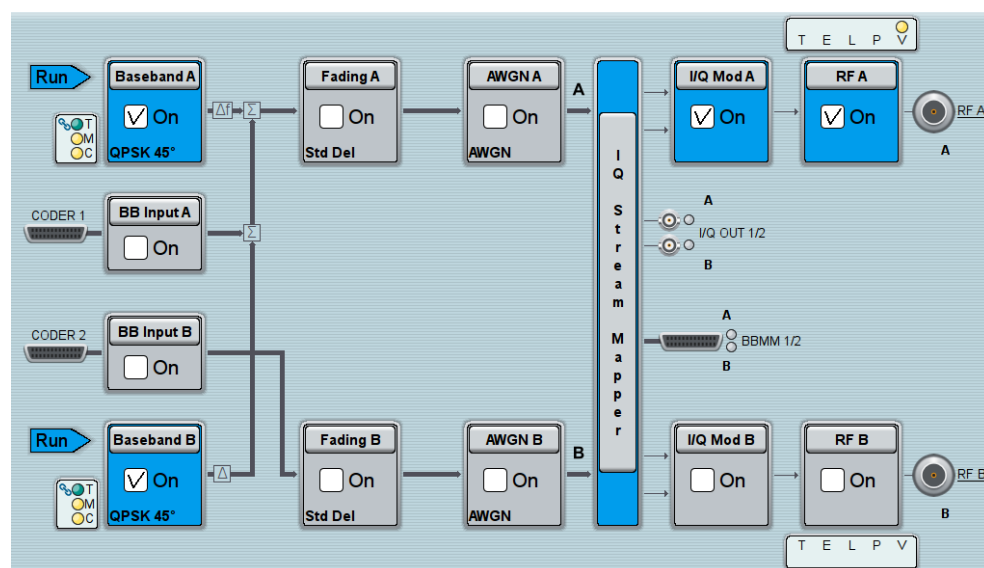



Figure 3-11: Block diagram: Generating a composed signal (Stream A)

To enable simultaneous signal generation in both basebands, the R&S SMW couples the trigger settings in the available basebands. The trigger settings enabled in "Baseband A" apply automatically to the "Baseband B".

The symbol  confirms that common trigger settings are applied.

### To map the I/Q stream and define the output connector

The term stream describes the signal at the input of the "I/Q Stream Mapper" up to the output connectors of the instrument.

1. In the block diagram, select the "I/Q Stream Mapper" block.

The "System Configuration > I/Q Stream Mapper" dialog displays the current (default) distribution and mapping of the I/Q streams to the output connectors as a mapping matrix.

	Frequency Offs /Hz	Phase Offs °	RF A	RF B	I/Q OUT 1	I/Q OUT 2	BBMM 1	BBMM 2
Stream A	0.00	0.00	ⓘ		ⓘ		ⓘ	
Stream B	0.00	0.00		ⓘ		ⓘ		ⓘ
Combination			Single	Single	Single	Single	Single	Single

Stream A is routed to all the available output connectors: the analog RF A and I/Q OUT 1 connectors, and the digital I/Q output connectors DIG I/Q OUT ("BBMM 1").

2. To reconfigure the mapping, tap a matrix entry, for example disable the output of Stream A on the BBMM 1 interface.

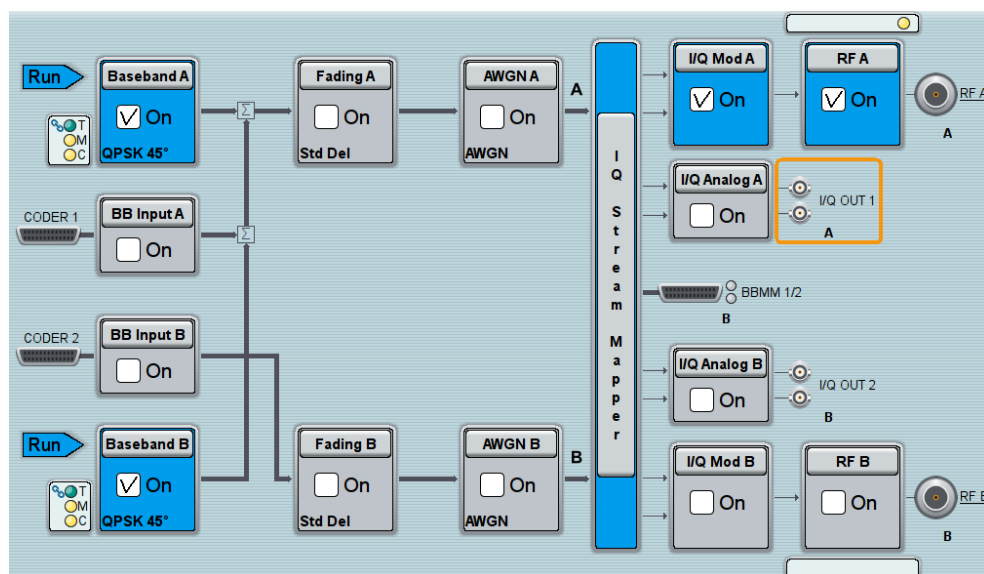
With the "I/Q Stream Mapper" you route the streams; the outputs are, however, not necessarily activated.

**Tip:** How to access the settings of the input and output interfaces.

In the block diagram, the blocks related to the input and output interfaces can be folded for a better overview.

If the block diagram does not show the "I/Q Analog" block, tap the corresponding connector icon, i.e. "I/Q Out 1/2", to unfold the settings.





The generated composed signal (Stream A) is output at the analog RF A connector and routed to the I/Q OUT 1 connector. The block diagram confirms this routing and displays the letter "A" next to the symbols of the output connectors. Consider however that the I/Q OUT 1/2 connectors are disabled.



To learn more and to explore the whole range of routing capability, refer to [Chapter 4, "Signal Routing and System Configuration"](#), on page 120.

### 3.3.6 Verifying the Generated Signal with the Graphics Display

It is often useful to check the spectra of the configured signals, before you enable the RF output of the instrument.

The R&S SMW provides a build-in function to represent the generated signal on a graphical signal display. We demonstrate this feature by showing the characteristics at one particular point of the signal processing chain. You can, however, display the signal characteristics at other different stages.

This example shows you how to use this graphical display to verify the generated signal. Use the signal generated in [Chapter 3.3.5, "Routing the Signal through the Instrument and Defining the Output Connectors"](#), on page 76.

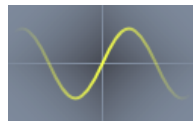
#### To access the graphical signal display functionality

- ▶ Perform one of the following:

- a) select "Taskbar > System Configuration > Graphics"



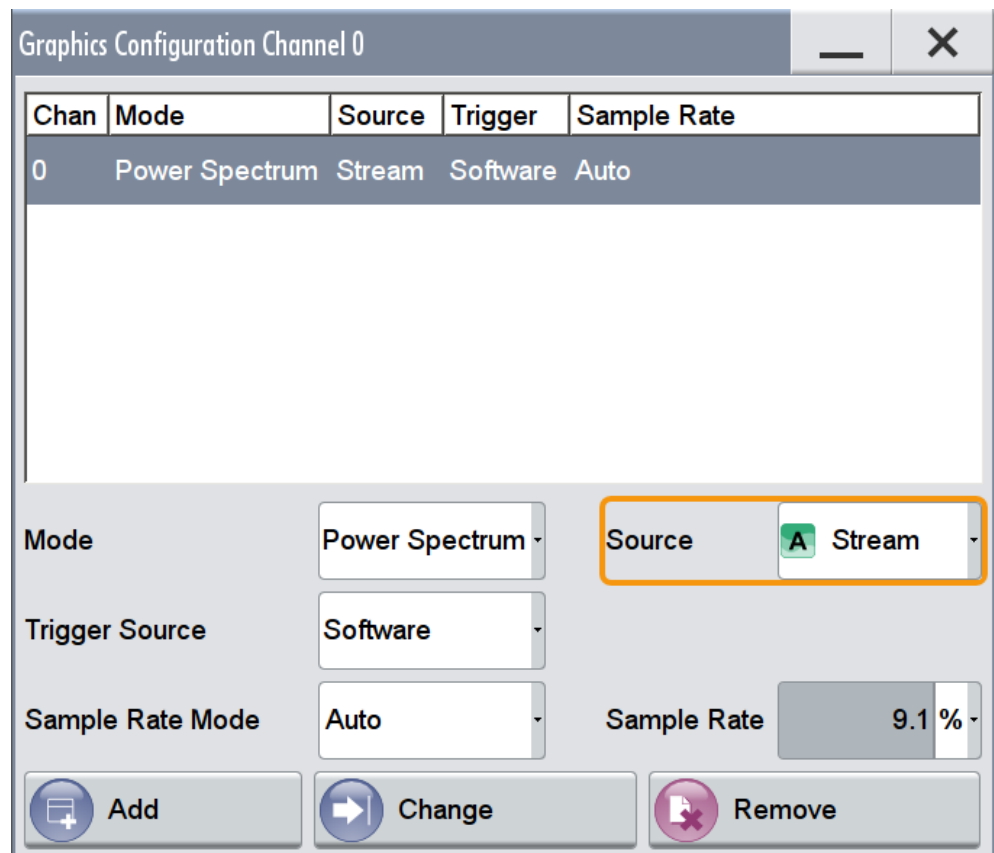
- b) on the "Taskbar", tap the wave icon.



The "Graphics Configuration" dialog opens.

**To visualize the sum signal**

1. In the "Graphics Configuration" dialog, select "Mode > Power Spectrum".
2. Select "Source > A Stream".
3. Select "Add" to enable signal display.

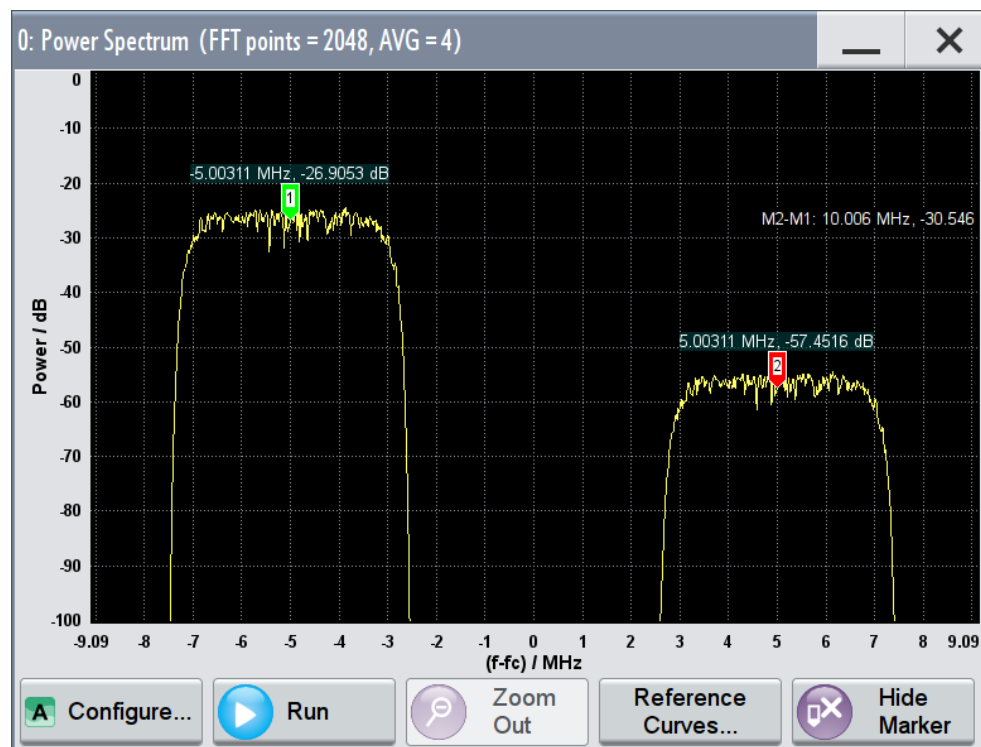


A new thumbnail (minimized view) indicating the active diagram appears in the "Taskbar".



4. Press the thumbnail graphic.

The graphic enlarges and the diagram is displayed in a normal size

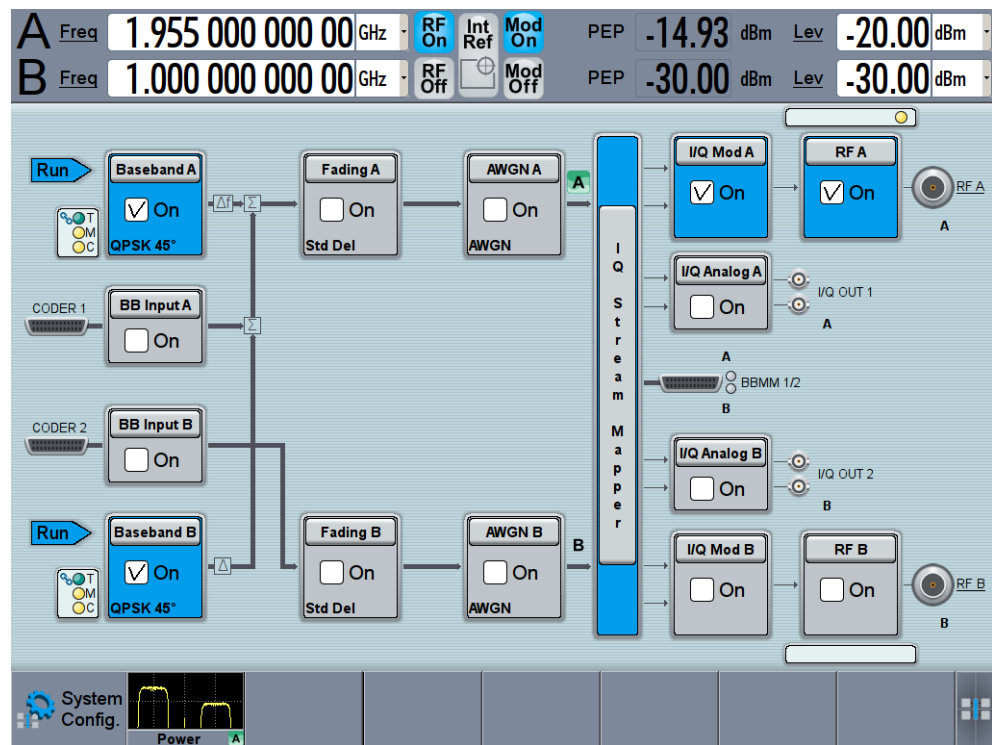


The "Power Spectrum" displays two signals, both 3GPP FDD signals are frequency shifted and the right one is also attenuated.

5. To retrieve more information, zoom in the spectrum and select "Show Marker" to measure the distance between the two signals.  
In principle, the zoom in function works like the two-finger pinching for magnifying images on your cell phone.
6. In the "Power Spectrum" dialog, select "Configure" to return to the "Graphics Configuration" dialog.  
Close the "Graphics Configuration" dialog.

This action has no effect on the configured graphics but on the dialog itself.

The block diagram displays the current signal routing. It indicates that frequency and power offsets are enabled and displays the acquisition points for the real time diagrams minimized in the "Taskbar".



See also [Chapter 9, "Monitoring Signal Characteristics"](#), on page 526.

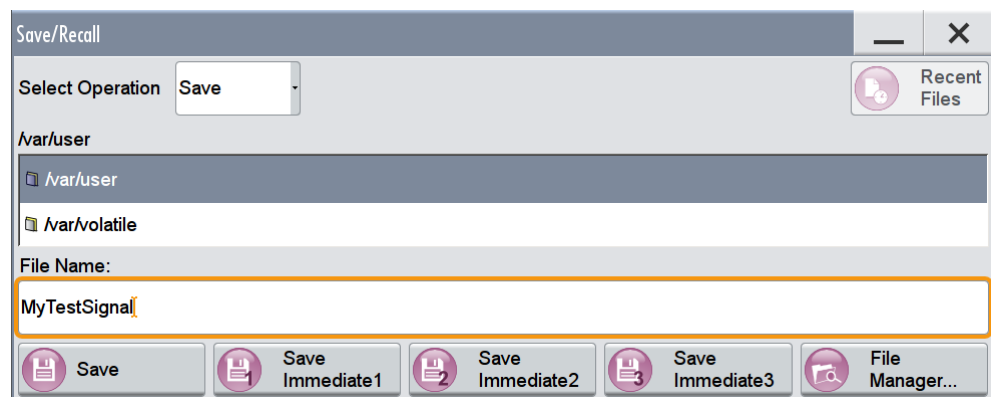
### 3.3.7 Saving and Recalling Settings

To restore the results of our measurements later, we store the instrument settings to a file.

#### To save the instrument settings to a file

We assume, a test configuration as described in [Chapter 3.3.5, "Routing the Signal through the Instrument and Defining the Output Connectors"](#), on page 76.

1. Press the SAVE/RCL key on the front panel.
2. In the "Save/Recall" dialog box, select "Select Operation > Save".  
Tap the "File Name", use the on-screen keyboard, and enter *MyTestSignal*.



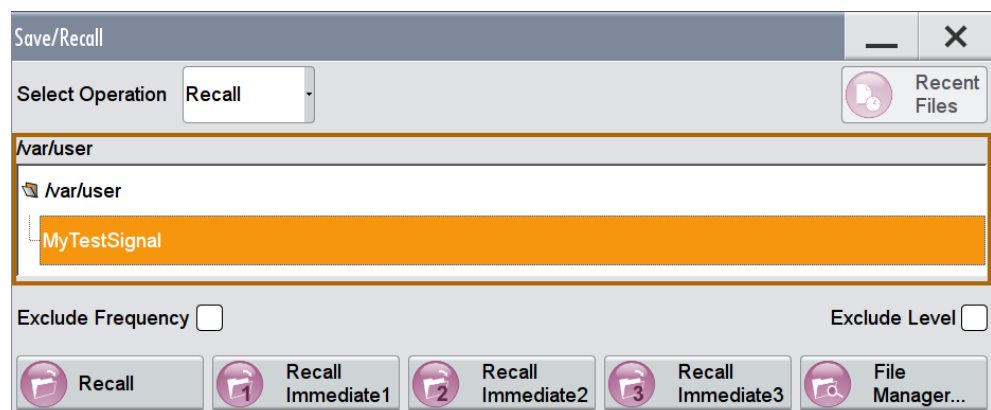
3. Tap the "Save" button.

The file `MyTestSignal.savrcl.txt` is stored in the default directory `/var/user`.

### To load stored instrument settings

You can restore the settings to the instrument at any time using the settings file.

1. Press the PRESET button to restore the default instrument settings so you can check that the stored user settings are restored afterwards.
2. Press the SAVE/RCL key.
3. In the "Save/Recall" dialog, select "Recall" operation.  
Navigate to the directory the file is stored in and select the `MyTestSignal` file.



4. Tap the "Recall" button.

All instrument settings are restored and the display should resemble [Figure 3-11](#), which shows the instrument display right before the settings were stored.

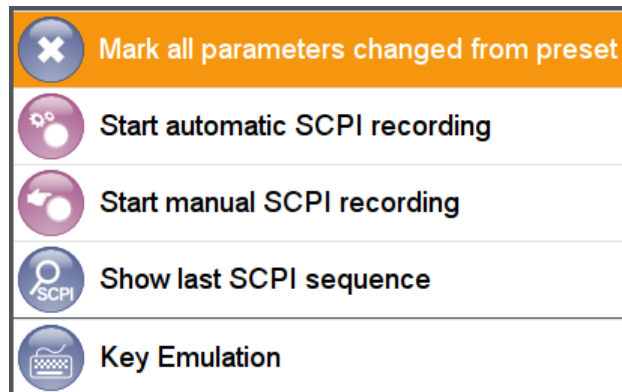


### How to display all parameters with values different to their preset values

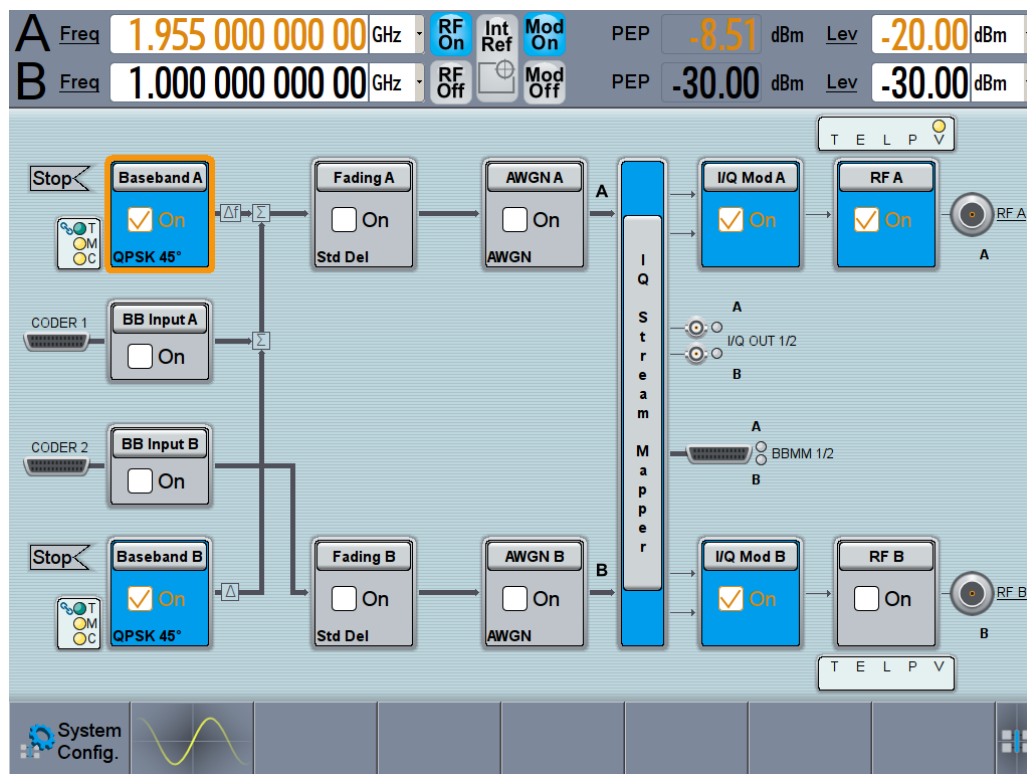
When you load a file to your instrument, you may do not have enough information on the changed settings. In such case, it is useful to visualize all parameters that have been changed from their default state.

Try out the following:

- Tap and hold on an empty space in the block diagram to access the context sensitive menu.
- Select "Mark all parameters changed from preset".



- All changed parameters are highlighted.



See also [Chapter 10, "File and Data Management"](#), on page 571.

### 3.3.8 Generating an EUTRA/LTE Signal

The main application field of the R&S SMW is the generation of digital signals in accordance with several telecommunication and wireless standards, like WCDMA, EUTRA/LTE or WLAN, to name a few. This example uses the digital standard

EUTRA/LTE to introduce the way you can access and interact with the instrument and experience the advantages provided by the additional options.

The minimum requirement for R&S SMW in this example is a base unit equipped with the additional option R&S SMW-K55 Digital Standard EUTRA/LTE.

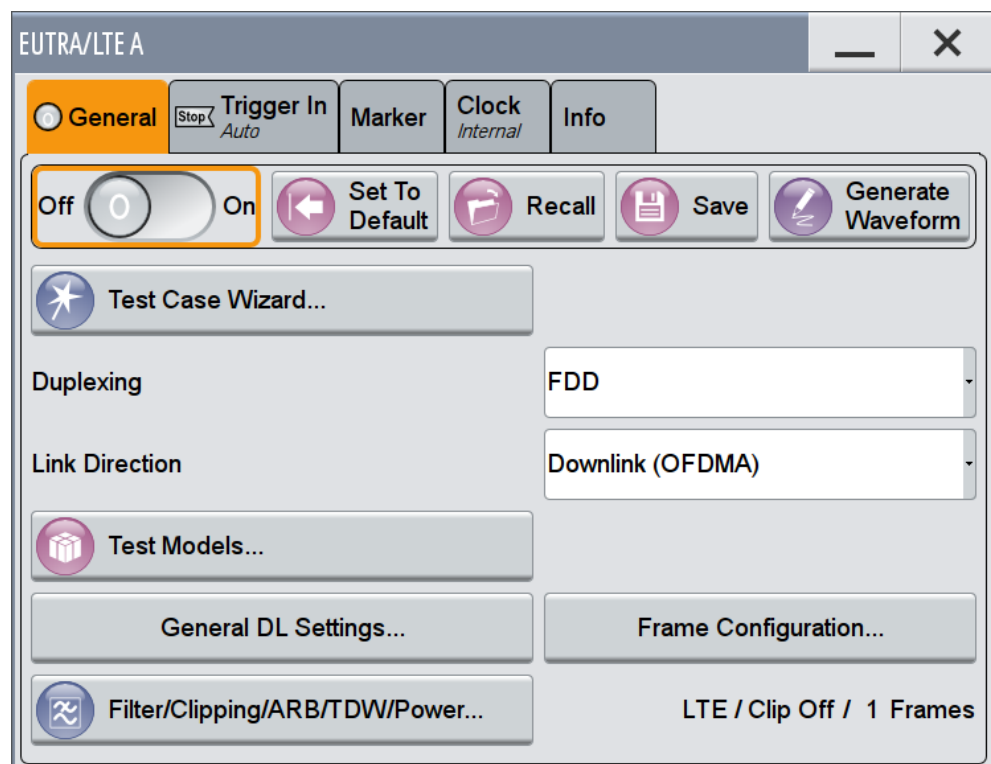
### To generate a downlink test signal

The main focus of the following example is not on the R&S SMW capabilities and the features provided by the firmware option. The example aims rather to help you get familiar with the settings and configuration principle common for the digital standards.

We use one of the provided EUTRA Test Models (E-TM) to show how to generate a test signal upon a quick selection.

1. On the R&S SMW front panel, press the PRESET key to start out in a defined instrument configuration.
2. In the block diagram, select "Baseband > Beyond 3G Standards > EUTRA/LTE".

The EUTRA/LTE dialog appears and displays the general settings provided for the digital standard.



As in the user interfaces of all digital standards, the "EUTRA/LTE" dialog is divided into several tabs. The "General" tab comprises the primary settings of the standard, the functions for storing and recalling settings and provides access to further functions and dialogs, like the "Filter" settings. The "Trigger In", "Marker" and "Clock" tabs comprise the settings related to the corresponding function.

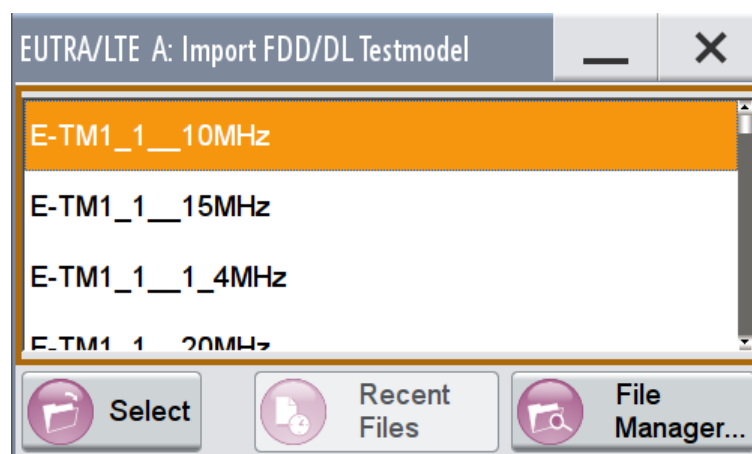
The more complex the digital standard itself is, the more comprehensive the further dialog and tab structure. The start dialog of each digital standard, however, follows a repeating dialog structure that comprises the tabs "General", "Trigger In", "Marker" and "Clock". (See also [Chapter 3.5.2.4, "Additional Display Characteristics"](#), on page 109).

**Tip:** To display the dialog in its maximal height, press the RESIZE WINDOW key on the front panel.

3. In the "EUTRA/LTE General" tab, select "Test Models".

The Test Models is a function for quick selection and settings adjustment according to one of the various EUTRA Test Models (E-TM).

A standard "File Select" function enables you to select form files with predefined settings.



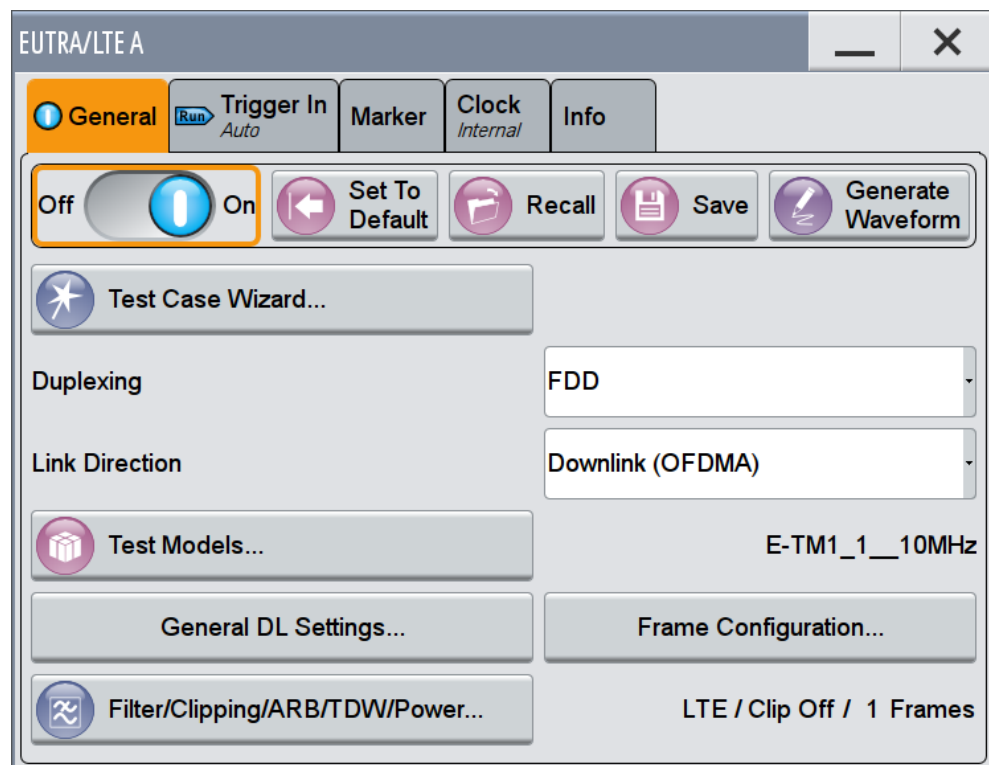
**Tip:** On the front panel, press the HELP key to retrieve detailed information on the current settings and on the contents of the predefined files.

4. Navigate to a file, for example to the E-TM1\_1\_\_10MHz (an E-TM1.1 test model with 10 MHz channel bandwidth) and confirm with "Select".

The dialog closes automatically and the user interface confirms the name of the selected file.

5. In the "EUTRA/LTE > General" tab, select "State > On".

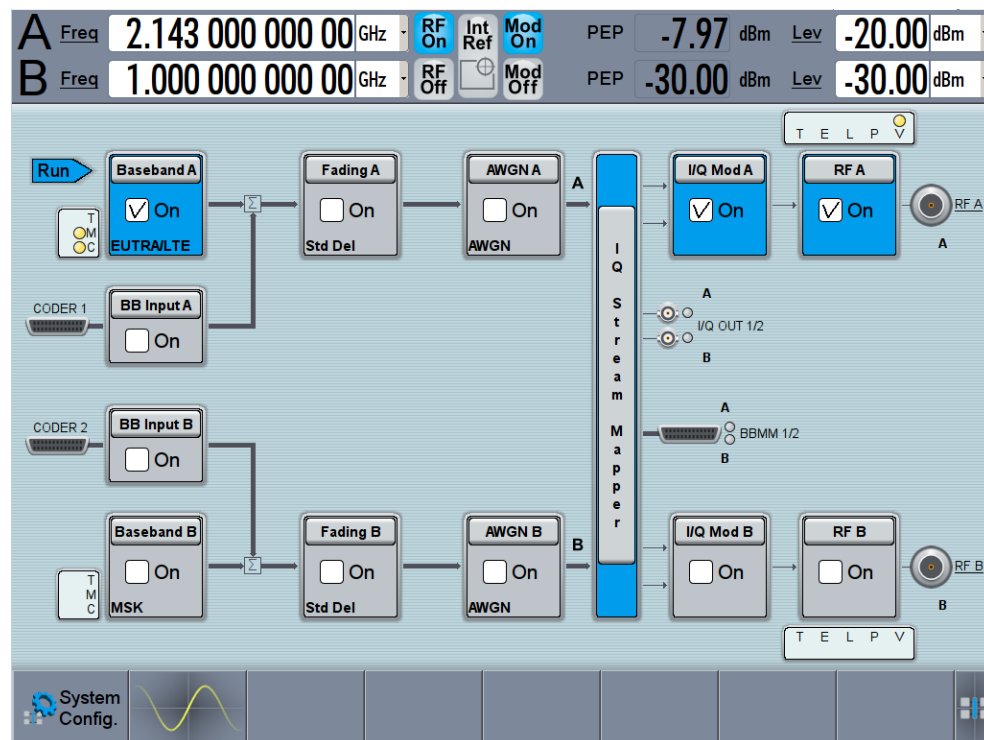




Close the dialog.

- On the "Status Bar", tap the "Freq" and "Lev" fields and enter new values, for example  $2.1432\text{ GHz}$  and  $-20\text{ dBm}$ .

Select "RF A > On".



The instrument generates an EUTRA/LTE test signal with the selected channel bandwidth, frequency, and level.



With these first steps, you have gained an impression of the provided functionality.

For a comprehensive description of the full range of capabilities, refer to the user manual "EUTRA/LTE Digital Standard for R&S SMW200A".

### 3.3.9 Using the System Configuration Capabilities for MIMO Setups

The R&S SMW supports versatile MIMO configurations and provides comfortable functions to simplify the definition and signal routing for MIMO test setups and configuration involving several instruments. For complex routing scenarios, the "System Configuration" functionality is the start and central configuration point. Within one dialog, you can configure complex configurations with up to 8 Tx or Rx antennas or up to two stand-alone 2x2 MIMO systems, e.g. 8x2 MIMO or LTE-A Carrier Aggregation with 2x2 MIMO.

This example does not cover the whole range of the "System Configuration" capabilities but delivers an insight into the topic. The example shows how to use coupled baseband sources and select a suitable fading and baseband configuration to generate an EUTRA/LTE signal in 2x2 MIMO configuration.



To learn more and to explore the whole range of capability provided by the "System Configuration" function, in particular how to connect and configure external devices, refer to [Chapter 4, "Signal Routing and System Configuration"](#), on page 120.

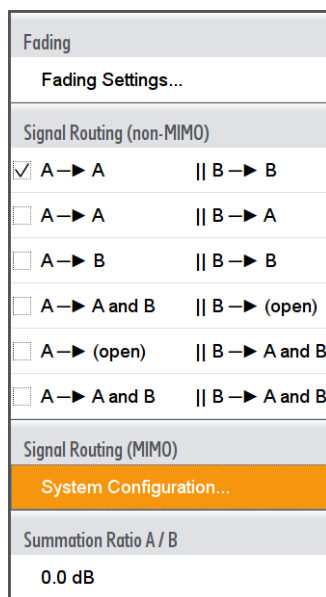
The instrument in this example is a R&S SMW equipped with two signal paths: two baseband options R&S SMW-B10, two options Fading Simulator R&S SMW-B14, option Fading MIMO R&S SMW-K74, one R&S SMW-B13T, frequency options R&S SMW-B10x/-B20x and two options R&S SMW-K55 Digital Standard EUTRA/LTE.

**To access the "System Configuration" function**

1. Perform one of the following:
  - a) On the "Taskbar", select "System Config > System Configuration"

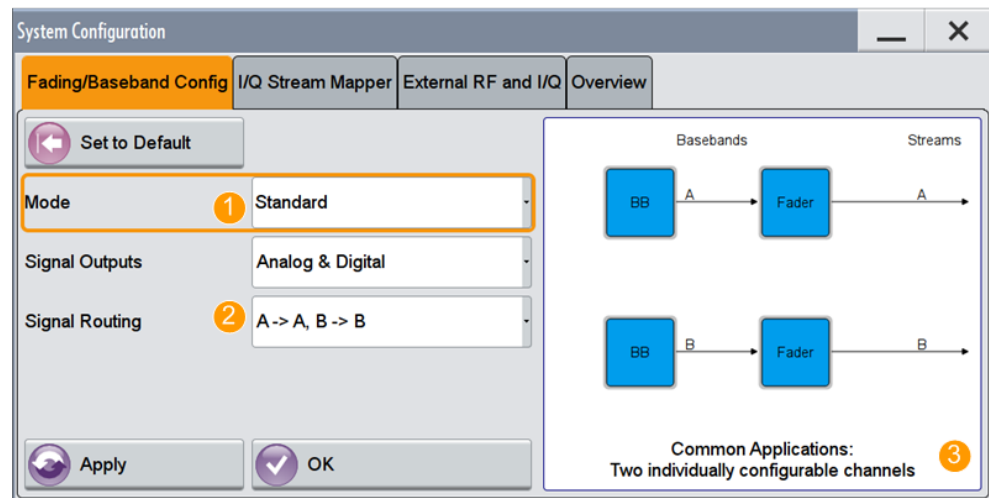


- b) In the block diagram, select "Fading > MIMO > System Configuration"



- c) In the block diagram, select "I/Q Stream Mapper" and select the "Fading/Baseband Configuration" tab.

The "System Configuration > Fading/Baseband Configuration" dialog displays the current signal routing. The instrument works in the default "Standard" mode.



**Figure 3-12: System Configuration in the default "Standard Mode"**

- 1 = standard or advanced mode; the last is required for configuration of complex LxMxN MIMO scenarios
- 2 = current signal routing
- 3 = simplified preview diagram with a description of the common application for the particular configuration

2. Open "System Configuration > I/Q Stream Mapper" to obtain an overview of the current distribution and mapping of the I/Q streams to the output connectors, see also "[To map the I/Q stream and define the output connector](#)" on page 80.
3. Open "System Configuration > External RF and I/Q Instruments" to gain information on the current setup.

The tab comprises the additional settings provided to simplify the configuration of connected instruments, like configuring the connectors, establishing a connection to the instruments, or controlling these instruments.

In this test setup no further instruments are connected.

### To enable a 2x2 MIMO configuration (1x2x2 Fading and Baseband Configuration)

1. In the "System Configuration > Fading/Baseband Configuration" dialog, select "Mode > Advanced" and enable the following settings:
  - a) "Entities (Users, Cells) > 1", "Basebands (Tx Antennas) > 2", "Streams (Rx Antennas) > 2"
  - b) Select "BB Source Config > Coupled Sources"
  - c) Observe the signal routing displayed on the preview diagram. Does it match with the expected signal routing?
  - d) Select "Apply" to confirm the configuration.

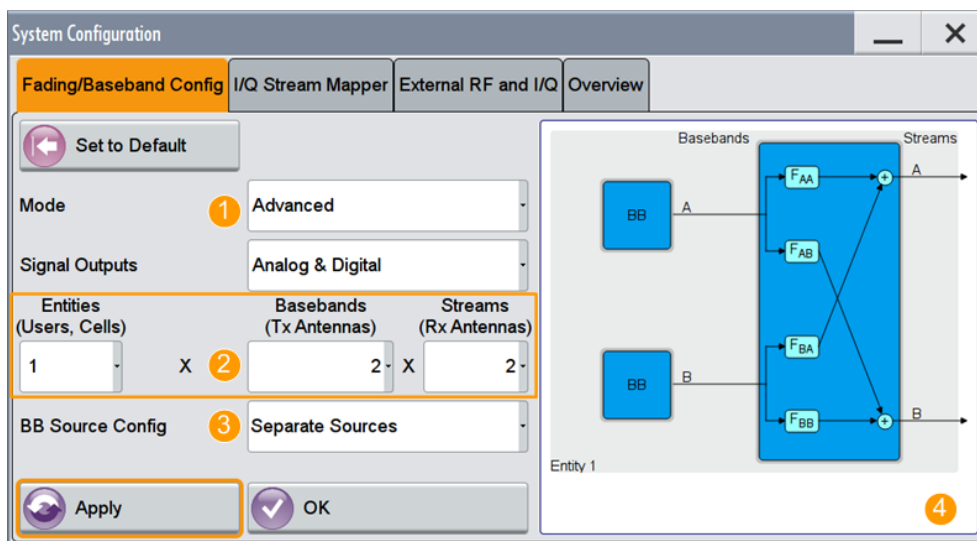


Figure 3-13: System Configuration in the "Advanced Mode" (1x2x2 configuration)

1 = advanced mode, required for configuration of complex LxMxN MIMO scenarios

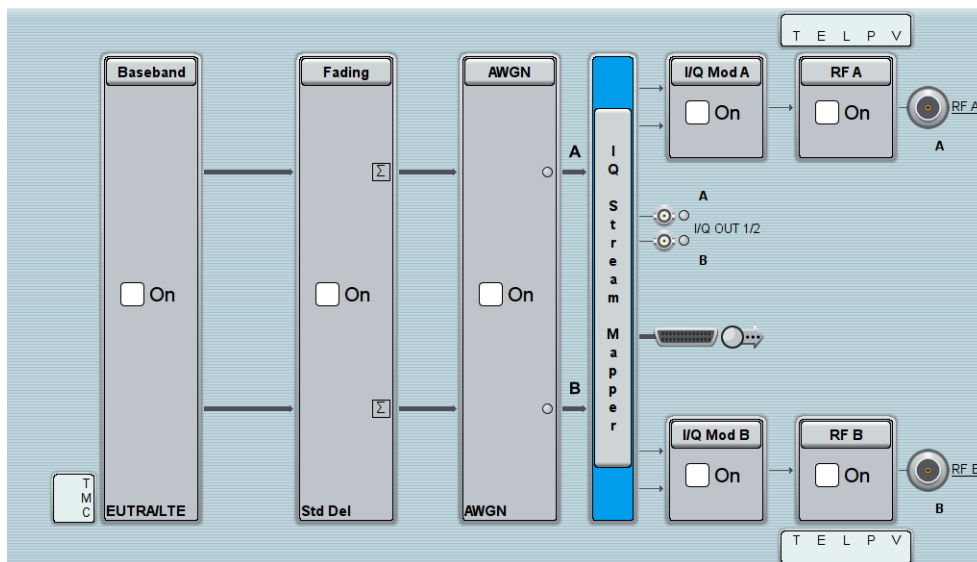
2 = current signal routing; 2x2 MIMO configuration

3 = separated and coupled baseband sources

4 = simplified preview diagram of the particular configuration

2. Leave all further settings, i.e. the "I/Q Stream Mapper" settings, at their default values and close the "System Configuration" dialog.

The block diagram displays the selected configuration.

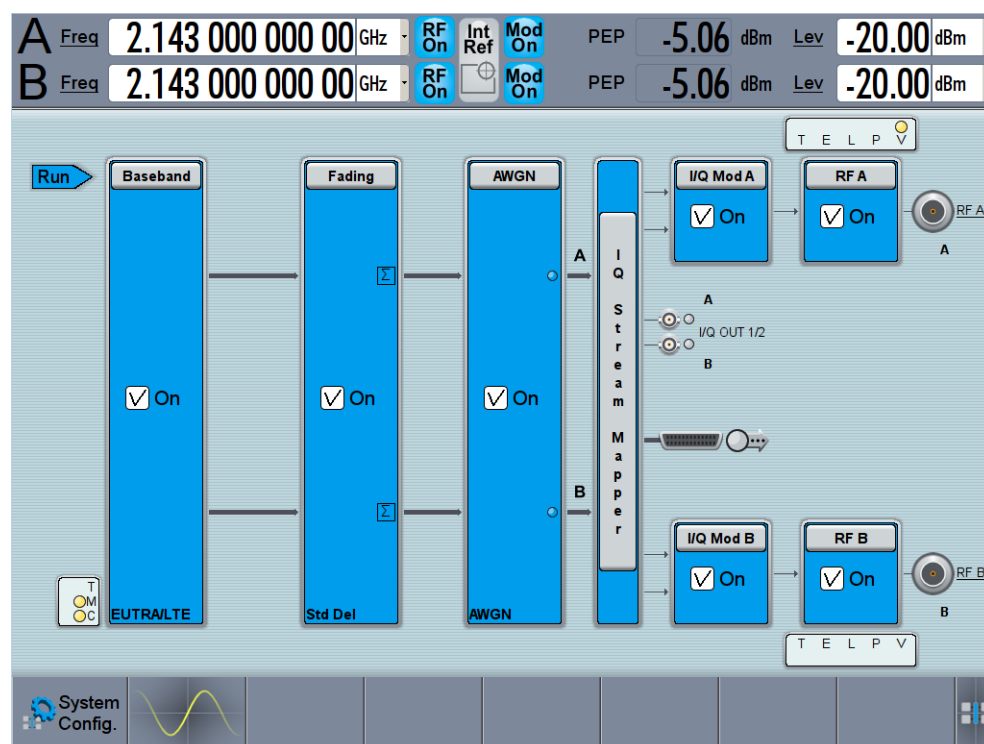


**To generate an EUTRA/LTE signal in the 2x2 MIMO scenario**

1. In the block diagram, select "Baseband > EUTRA/LTE", select "State > On", and close the dialog.

In coupled baseband source mode, the R&S SMW takes over the baseband signal configuration. The instrument adjusts the settings in the basebands automatically, for example the mapping of the transmitting antennas to the basebands.

2. In the block diagram, select "Fading > On".  
The default "Standard Delay" fading profile is applied.
3. On the "Status Bar", set the same frequency and level settings for both paths:
  - a) "A Freq = B Freq = 2.1432 GHz"
  - b) "Lev (A) = Lev (B) = -20 dBm"
4. In the block diagram, select "RF A > On" and "RF B > On".



The R&S SMW generates a realistic EUTRA/LTE downlink signal with 10 MHz channel bandwidth, though without any scheduled data.



To enable the generation of scheduled data, further configurations are required; these configurations are, however, outside the scope of this description.

For further information, refer to the user manual "EUTRA/LTE Digital Standard for R&S SMW200A".

## 3.4 System Overview

This section helps you to get familiar with the R&S SMW. It provides an introduction to the general concept of the instrument with a sample of the possible application fields as well as a description of the main blocks in the signal generation flow.

For information on how to access functions and interact with the R&S SMW, refer to [Chapter 3.5, "Instrument Control"](#), on page 104.

### 3.4.1 Brief Introduction to the Instrument's Concept

The R&S SMW combines up to two independent signal generators in one instrument and offers unrivaled RF and baseband characteristics. Due to its *modular design*, the instrument can be optimally adapted to the requirements of different applications. Both RF paths can be equipped with one of the available frequency options with different upper frequency limit. The baseband section of the R&S SMW is fully digital. It contains the hardware for generating and processing I/Q signals in realtime or generating signals with an arbitrary waveform generator.

#### 3.4.1.1 Possible Ways to Operate the Instrument

There are three ways to operate the R&S SMW:

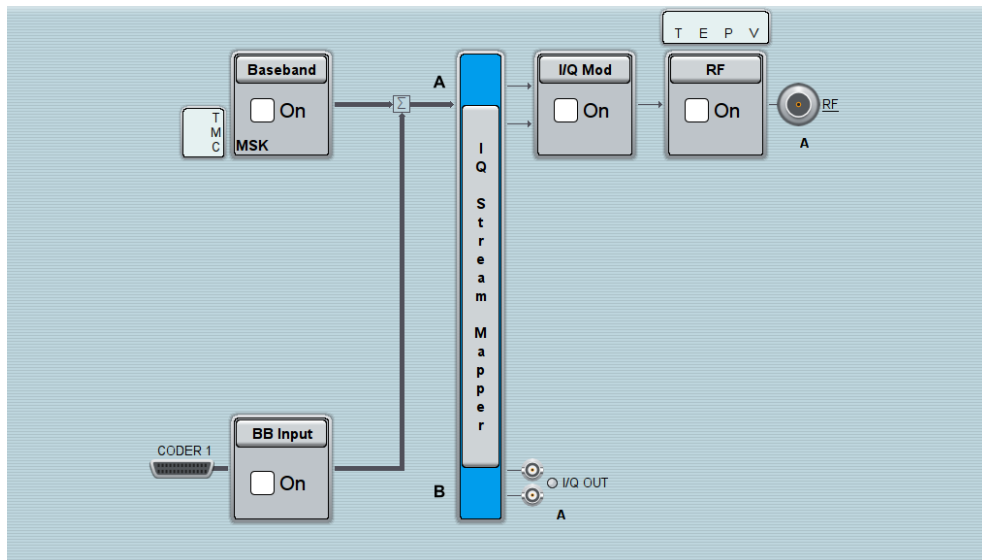
- **Manual operation:**  
Use the touchscreen, hard keys and rotary knobs, or an optional mouse and/or keyboard. The principles of manual operation are explained in [Chapter 3.5, "Instrument Control"](#), on page 104.
- **Remote control:**  
Create programs to automatize repeating settings, tests and measurements. The instrument is connected to a computer running the program.  
This way of operation is described in [Chapter 12, "Network and Remote Control Operation"](#), on page 649.
- **Remote operation from a computer:**  
Remote monitoring and control of the instrument from a connected computer is based on the common cross-platform technology VNC (Virtual Network Computing). On the remote computer, any standard web browser (supporting Java) or a dedicated VNC client (like Ultr@VNC) can be used. See also [Chapter 3.5.7, "Remote Operation over VNC"](#), on page 119.

#### 3.4.1.2 The Signal Flow at a Glance

The R&S SMW is equipped with a large touchscreen, that displays a block diagram. The block diagram represents the signal flow and the general stages the signal generation goes through. Depending on the options the R&S SMW is equipped with, the appearance of the block diagram changes.

The following examples do not cover all possible cases but aim to introduce the way the block diagram depicts the installed options.

- An example of a base unit, equipped with one signal path (R&S SMW-B10, R&S SMW-B13, and R&S SMW-B103/-B106)



- Two examples of a fully equipped instrument, one in the default instrument state and a second one in an advanced configuration with more abstract representation.
  - In this "classic" representation, the block diagram displays all blocks for that the required hardware and software options are fitted. The block diagram shows the signal flow as it is.

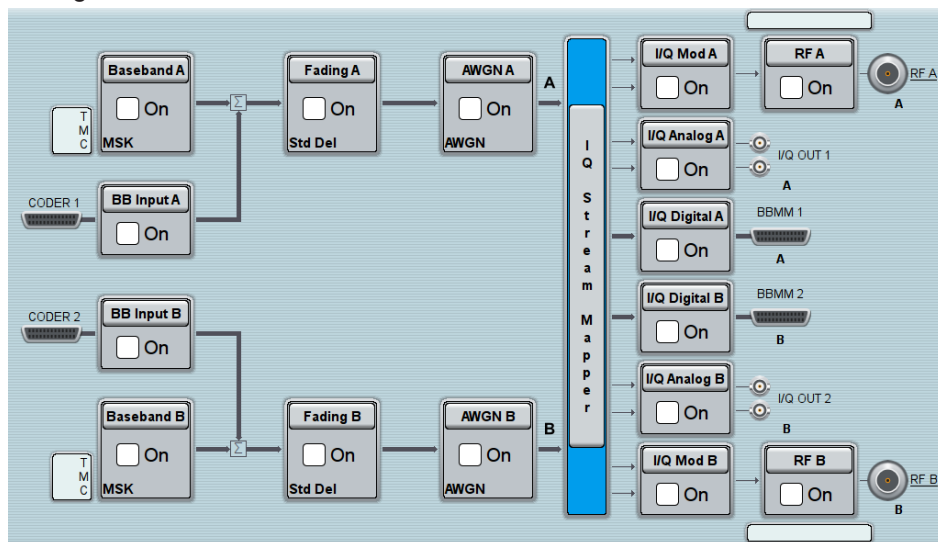


Figure 3-14: Block diagram of a fully equipped two path instrument (default)

- The block diagram depicting a 4x4 MIMO scenario with coupled baseband sources is a more abstract representation. Each stage of the signal generation is still represented by a functional block but the signal routing is displayed in a conceptual manner.



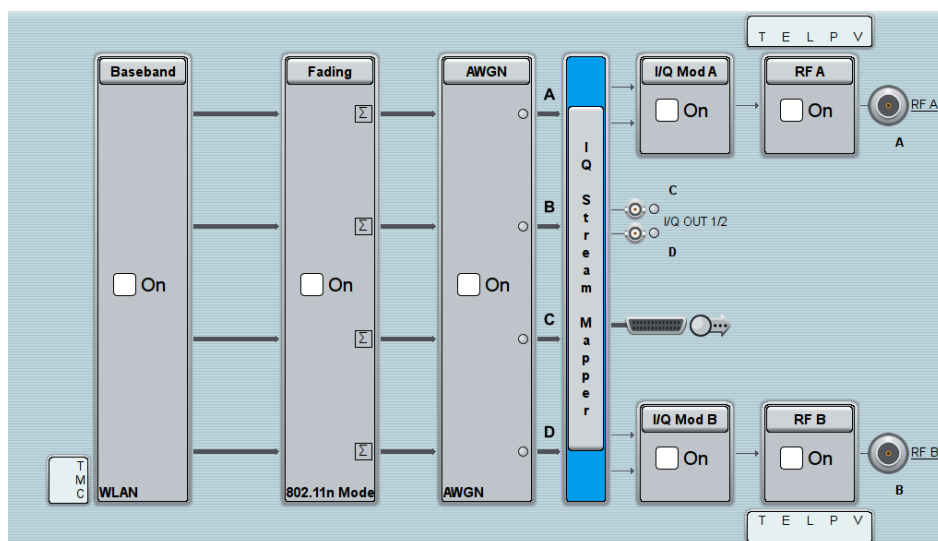


Figure 3-15: Block diagram of a fully equipped two path instrument (4x4 MIMO configuration)

For more examples, see also [Chapter 3.4.2, "Applications Examples of the R&S SMW"](#), on page 100.

**The cross-reference between the installed options and the displayed settings**



Throughout this description, a fully equipped instrument is assumed (see [Figure 3-14](#)). For detailed information on available options, refer to the R&S SMW data sheet and the R&S SMW configuration guide. Up-to-date information is available at the R&S SMW homepage on the internet <http://www.rohde-schwarz.com/product/smw200a.html>.

The [Table 3-11](#) is an excerpt of the available options and lists only the options required to *display* a functional block in the block diagram.

For exact information on the available options, and on the minimum requirements and the interdependencies between the provided options, refer to the R&S SMW data sheet.

**Table 3-11: Required options per functional block (excerpt)**

Functional block	Required option
"Baseband A"	R&S SMW-B10
"Baseband B"	Second option R&S SMW-B10
"BB Input A"	Included in R&S SMW-B10
"BB Input B"	Included in second option R&S SMW-B10
"Fading A"	R&S SMW-B14
"Fading B"	Second option R&S SMW-B14

Functional block	Required option
"AWGN A"/"AWGN B"	At least one option R&S SMW-K62
"I/Q Stream Mapper"	-
"I/Q Mod A"	R&S SMW-B103/-B106
"I/Q Mod B"	R&S SMW-B203/-B206
"I/Q Analog A"	R&S SMW-B13
"I/Q Analog B"	R&S SMW-B13T
"I/Q Digital A"	R&S SMW-K18
"I/Q Digital B"	Second option R&S SMW-K18
"RF A"	R&S SMW-B103/-B106
"RF B"	R&S SMW-B203/-B206

### 3.4.1.3 Internal Baseband Source ("Baseband" Blocks)

The "Baseband" block represents the source of the baseband signals (basebands).

This functional block is the access point to:

- *The internal baseband generator*  
The baseband generator contains modules for real time signal generation (Custom Digital Modulation) and an arbitrary waveform generator (ARB).  
One or two baseband generators can be fitted in an R&S SMW and operated separately.
- *The available digital standards*  
Generation of digital signals in accordance with the supported standards requires additional software options. For example, option R&S SMW-K55 generates signals according to the EUTRA/LTE standard, option R&S SMW-K42 signals to 3GPP FDD standard.
- *The signal routing (in the standard "classic" mode)*  
Signals from the baseband generators can be routed between the available paths, and added (possibly with frequency, phase and power offsets).

### 3.4.1.4 Digital Baseband Input and Output ("BB Input" and "I/Q Digital" Blocks)

The "BB Input" and the "I/Q Digital" blocks are the access point to the settings of the digital interfaces.

The R&S SMW is - depending on SW and HW options - able to receive digital baseband signals and to output digital baseband signals. A fully equipped instrument provides eight configurable digital interfaces. Depending on the configuration, the available digital interfaces may be used as up to six inputs or up to six outputs.

The digital baseband inputs and outputs can be used together with other Rohde&Schwarz instruments, like signal generators, signal analyzers, the digital interface module R&S®EX-IQ-BOX, or the R&S®CMW500 Radio Communication Tester. A

Rohde&Schwarz signal generator for instance may serve as digital signal source in test configuration requiring more than two baseband sources. A test setup with the R&S®CMW500 Radio Communication Tester is suitable for testing under fading conditions.

The "BB Input" block is the access point to the settings of:

- *The external digital I/Q signals*  
The external digital I/Q signals are further processed in the baseband section (e.g. fading, addition of noise)
- *The signal routing (in the standard "classic" mode)*  
The external and internal baseband signals can be routed and added (possibly with frequency, phase and power offsets).

The "I/Q Digital" block is the access point to the settings of:

- The digital I/Q output signals
- The digital I/Q impairments

#### 3.4.1.5 Fading Simulator ("Fading" Blocks)

The "Fading" block is displayed only in instruments equipped with the option R&S SMW-B14, Fading Simulator. This block controls the fading module and, in standard mode, the signal routing at the output of this module.

The fading simulator functionality enables you to simulate real time fading effects on the baseband signal. Provided the instrument is equipped with the required options, up to 20 dynamic fading paths in a SISO mode (Single Input Single Output, i.e. non-MIMO mode) and up to 20 paths per MIMO channel in MIMO mode can be created simultaneously.

The fading extension options provide even more functionality, for example:

- Second option R&S SMW-B14 permits also real two-channel fading irrespective of the RF carrier spacing of the two channels
- The option R&S SMW-K71 comprises the 3GPP dynamic fading configurations moving propagation and birth-death propagation, and the fine delay fading configurations offering enhanced delay resolution
- The option R&S SMW-K72 extends the statistic functions and is required for additional fading profiles and some of the predefined test scenarios
- The option R&S SMW-K74 enables the simulation of MIMO scenarios with up to 8 transmitting or 8 receiving antennas.

#### 3.4.1.6 Additional White Gaussian Noise ("AWGN" Blocks)

The "AWGN" block is displayed only in instruments equipped with at least one option R&S SMW-K62. This block controls the additional white Gaussian noise generator (AWGN). An additive white noise is required for measurements of mobile radio base stations.

### 3.4.1.7 "I/Q Stream Mapper" Block

As one of the access points to the system configuration settings, the "I/Q Stream Mapper" provides direct access for configuring the distribution and mapping of the generated I/Q streams to the available output connectors, to the analog RF and I/Q output and to the digital I/Q output connectors.

### 3.4.1.8 I/Q Modulator ("I/Q Mod" Blocks)

The "I/Q Mod" blocks represent the I/Q modulators.

These functional blocks are the access point to:

- The I/Q modulation of the internal baseband signal
- The I/Q modulation of an external analog wideband signal (single ended or differential)
- The analog I/Q impairments

### 3.4.1.9 Analog I/Q Output ("I/Q Analog" Blocks)

The "I/Q Output" block represents the analog I/Q output connectors.

This block is the access point to the settings of:

- The analog I/Q output signals  
The generated signal can be output as single ended or differential analog signal.
- The analog I/Q impairments

### 3.4.1.10 RF and Analog Modulations ("RF" Blocks)

The "RF" block represents the RF settings of the instrument.

This block is the access point to:

- RF frequency and level settings, as well as the reference frequency, local oscillator, user correction, etc.
- The analog modulations
- The list and sweep modes

## 3.4.2 Applications Examples of the R&S SMW

Due to its modular design, the R&S SMW can be optimally adapted to the requirements of different applications:

- Generation of digitally modulated signal  
The main field of application of the R&S SMW is the generation of digitally modulated signals. The R&S SMW generates a digitally modulated signal in several ways: using the internal baseband generator, using the externally applied digital baseband signals or in an analog wideband I/Q operation.
- Generation of test signals for diversity tests and MIMO scenarios

The R&S SMW enables you to generate test signals in versatile MIMO configuration for which several signal generators were previously required.

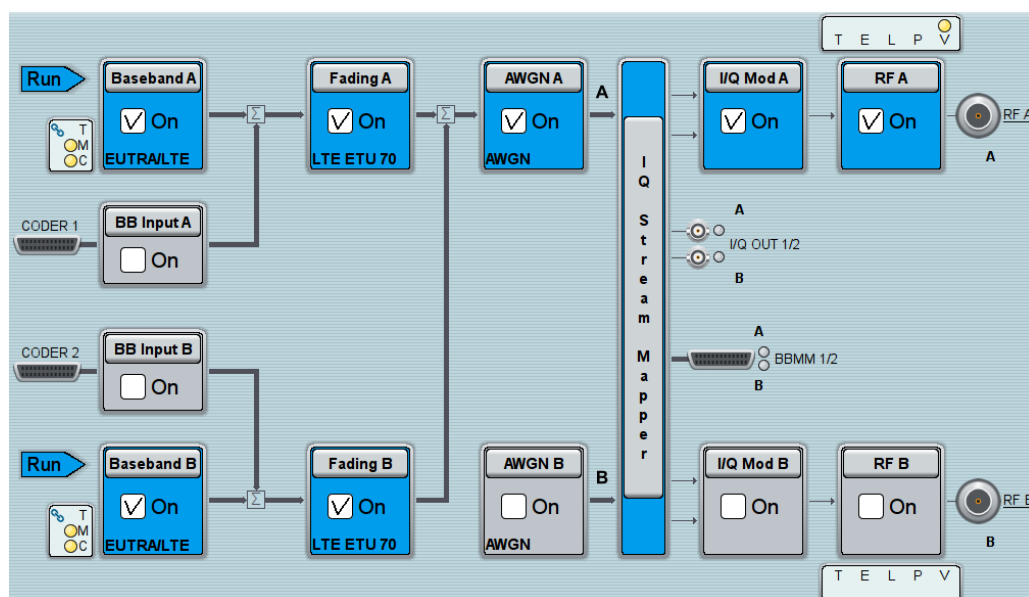
- Generation of a wanted signal and an interfering signal for receiver tests
- Addition of real time signals of different standards, for example EUTRA/LTE and 3GPP FDD
- Generation of signals with up to 160 MHz signal bandwidth, for example for WLAN IEEE 802.11ac signals
- Generation of fading scenarios, e.g for test setups involving R&S SMW and R&S®CMW

A few examples are given in the following:

- Tx Diversity Test (MISO scenario)..... 101
- Rx Diversity Test (SIMO scenario)..... 101
- Generation of Signals for Testing of WCDMA Handover (Two Cells)..... 102
- Generation of an EUTRA/LTE 8x2 MIMO Signal for UE Tests..... 102
- Generation of an LTE Test Signal with Carrier Aggregation and 2x2 MIMO each Component Carrier..... 103
- Generation of a WLAN 802.11ac signal with 160 MHz..... 104

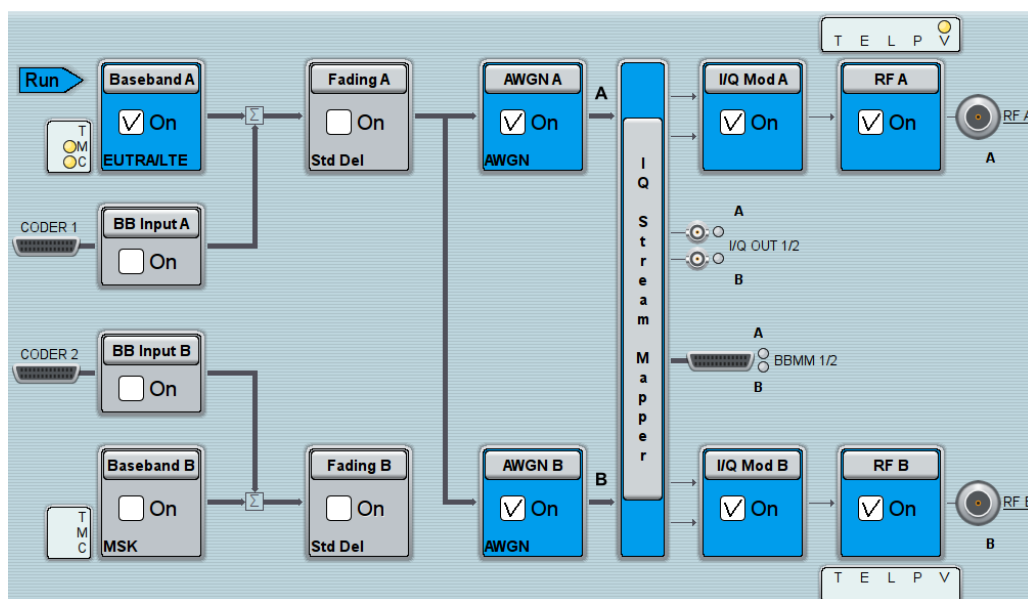
### 3.4.2.1 Tx Diversity Test (MISO scenario)

The block diagram in this example depicts the generation of a test signal using both internal baseband generators and 1 RF output (RF A).



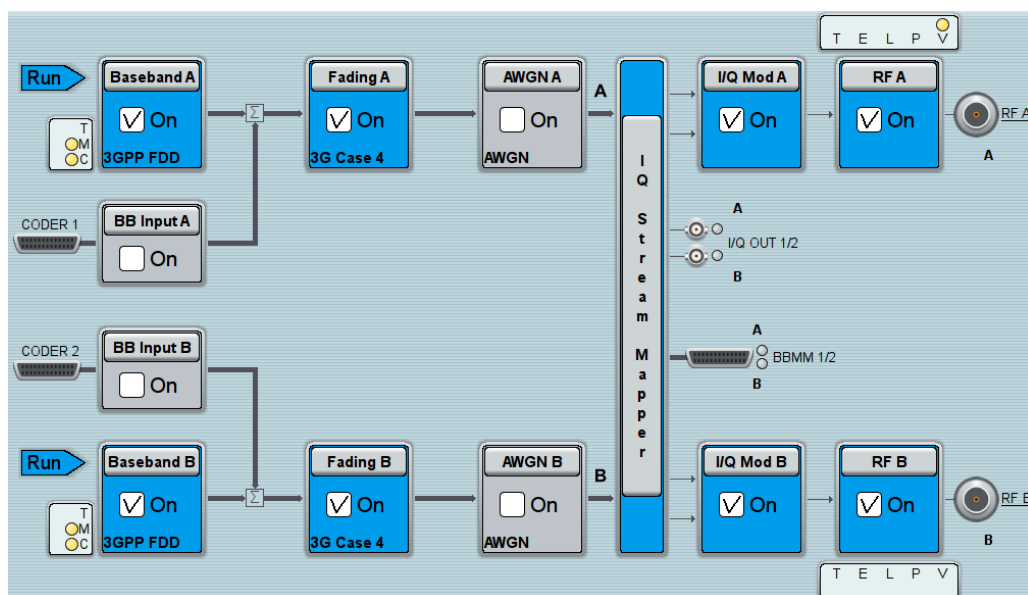
### 3.4.2.2 Rx Diversity Test (SIMO scenario)

The block diagram in this example depicts the generation of a test signal using one internal baseband generator (Baseband A) and distributing the signal to both RF outputs.



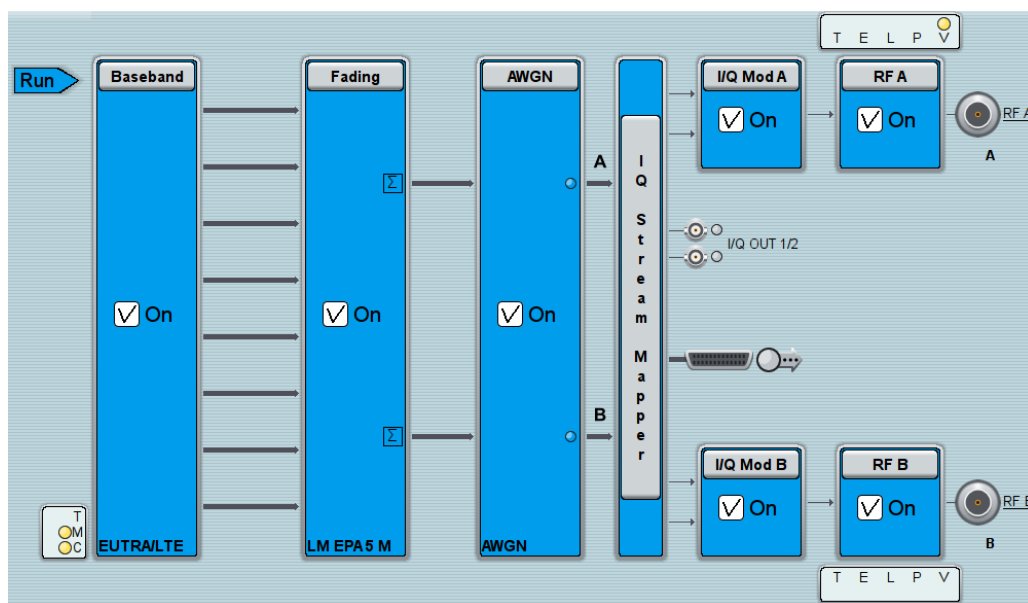
### 3.4.2.3 Generation of Signals for Testing of WCDMA Handover (Two Cells)

The block diagram in this example depicts the generation of a test signal using both internal baseband generators and both RF outputs, for example for handover tests. The R&S SMW acts as two independent generators in one instrument.



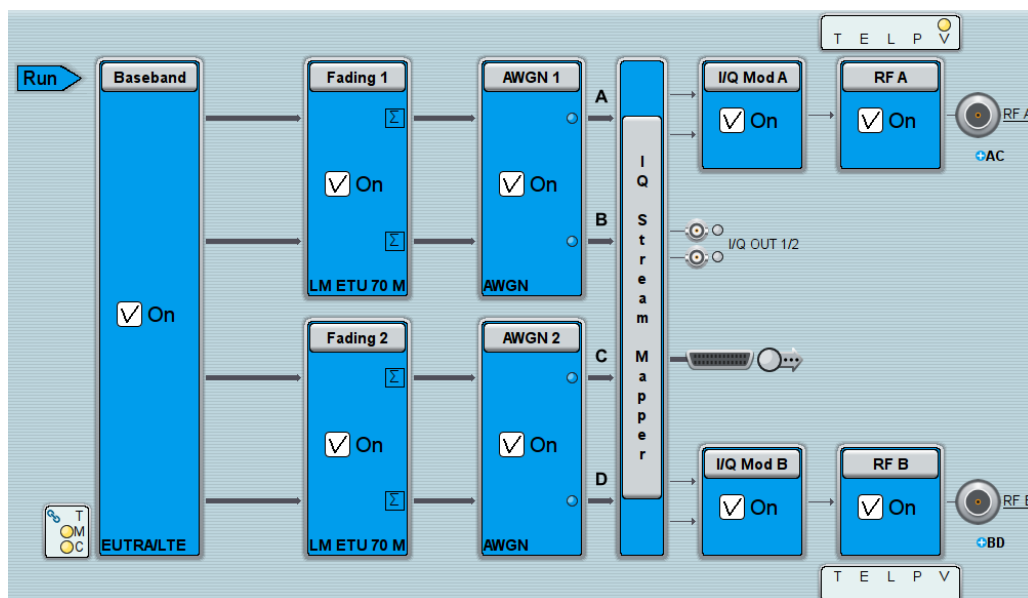
### 3.4.2.4 Generation of an EUTRA/LTE 8x2 MIMO Signal for UE Tests

The block diagram in this example depicts the generation of an EUTRA/LTE test signal in a 8x2 MIMO scenario, for example for UE tests. The instrument uses a coupled internal baseband source to generate all required baseband signals.



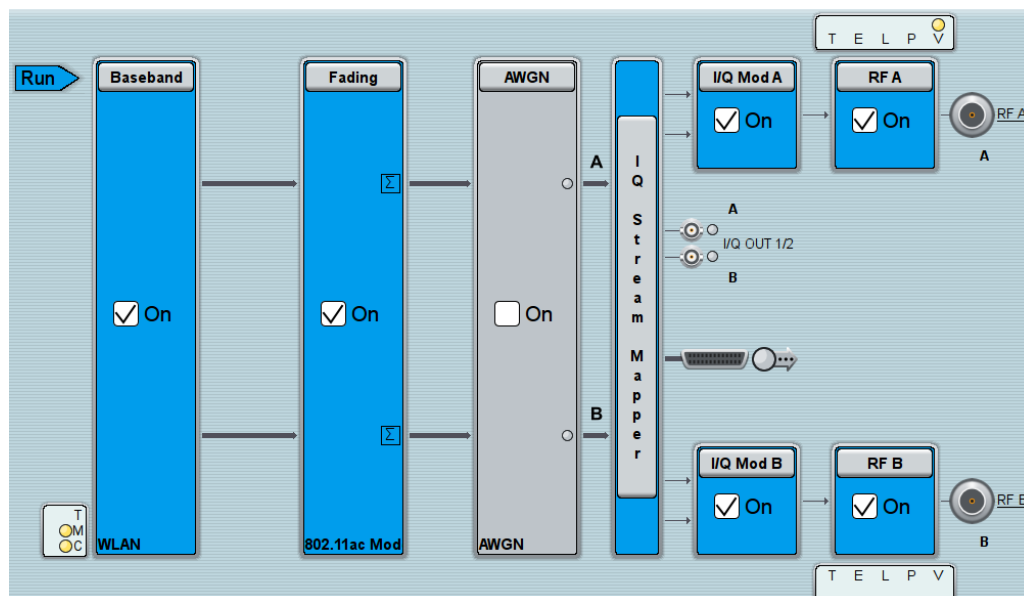
### 3.4.2.5 Generation of an LTE Test Signal with Carrier Aggregation and 2x2 MIMO each Component Carrier

The block diagram in this example depicts the generation of an EUTRA/LTE test signal with two component carriers (intra-band carrier aggregation) and 2x2 MIMO fading each, for example for UE tests. The instrument uses a coupled internal baseband source and both RF outputs.



### 3.4.2.6 Generation of a WLAN 802.11ac signal with 160 MHz

The block diagram in this example depicts the generation of a WLAN 802.11ac test signal with 160 MHz bandwidth in a 2x2 MIMO scenario. The instrument uses a coupled internal baseband source and both RF outputs.



## 3.5 Instrument Control

This chapter provides an overview on how to work with the R&S SMW. It describes what kind of information is displayed in the diagram area, how to operate the R&S SMW via the touchscreen, the front panel keys and other interaction methods, and how to use the online help.

This section describes the manual operation of the R&S SMW. For an overview of alternative ways, refer to [Chapter 3.4.1.1, "Possible Ways to Operate the Instrument"](#), on page 95.

### 3.5.1 Means of Manual Interaction

The R&S SMW provides the following means of manual interaction, which you can use alternatively or complementary:

- **Touchscreen:**  
This is the most direct interaction way. Use your finger to set parameters in dialog boxes, enter data, and much more. Most of the control elements and actions on the screen are based on the standard operating system concept.  
Tapping the screen works like clicking mouse buttons:
  - Tap = click: Selects a parameter or provokes an action.
  - Touch and hold = right-click: Opens a context-sensitive menu.

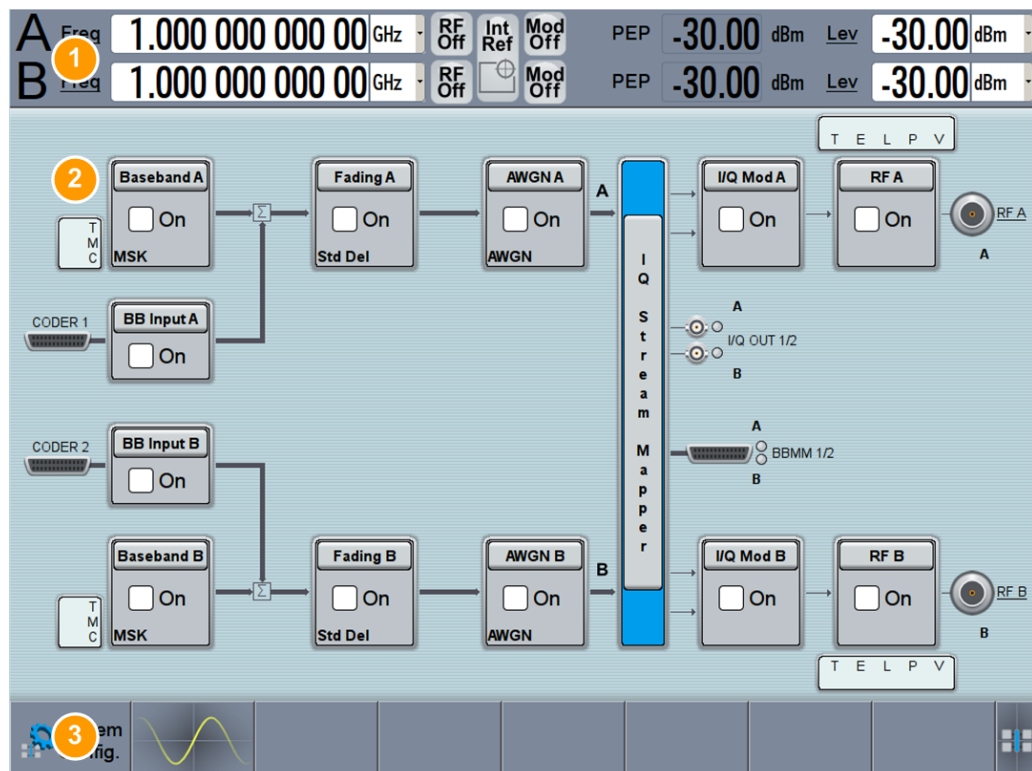


- Touch and drag = drag&drop:  
Moves a window (dialog or graphic) by dragging it to a new position on the screen, or  
Routes a signal by selecting a block and dragging to the destination block, or  
Resizes a window (dialog or graphic) by dragging an edge or a corner of a window to the destination size
- Two-finger pinching = zoom in:  
Zooms in a graphical display as it works on your cell phone
- Function keys and rotary knobs:  
The front panel provides nearly all functions and controls to operate the instrument in the classic ways, without touchscreen.
- Optional mouse and/or keyboard:  
These devices work like known from PCs. The navigation keys on the front panel correspond to the keys on the keyboard.

The usage of the touchscreen and navigation keys is described in detail in the following sections.

### 3.5.2 Understanding the Display Information

The screen display of the R&S SMW shows all main settings and generator states, divided into three main operation areas:



- 1 = Status bar
- 2 = Block diagram
- 3 = Taskbar/softkey bar

The labeled operation areas are explained in detail in the following sections.

- [Chapter 3.5.2.1, "Status Bar"](#), on page 106
- [Chapter 3.5.2.2, "Block Diagram"](#), on page 106
- [Chapter 3.5.2.3, "Taskbar"](#), on page 108

See also [Chapter 3.5.2.4, "Additional Display Characteristics"](#), on page 109 for additional information.

### 3.5.2.1 Status Bar

The status bar in the header of the display indicates the frequency and level settings of the RF output signal, containing offset and peak envelope power (PEP).



- 1 = Frequency display  
 2 = Status buttons  
 3 = Level display

The main characteristics of the RF signal, frequency and level, are displayed continuously and can be set. Status buttons indicate key parameters that are set for the output signal. Most of the status buttons are virtual keys you can use to open a corresponding menu or dialog.

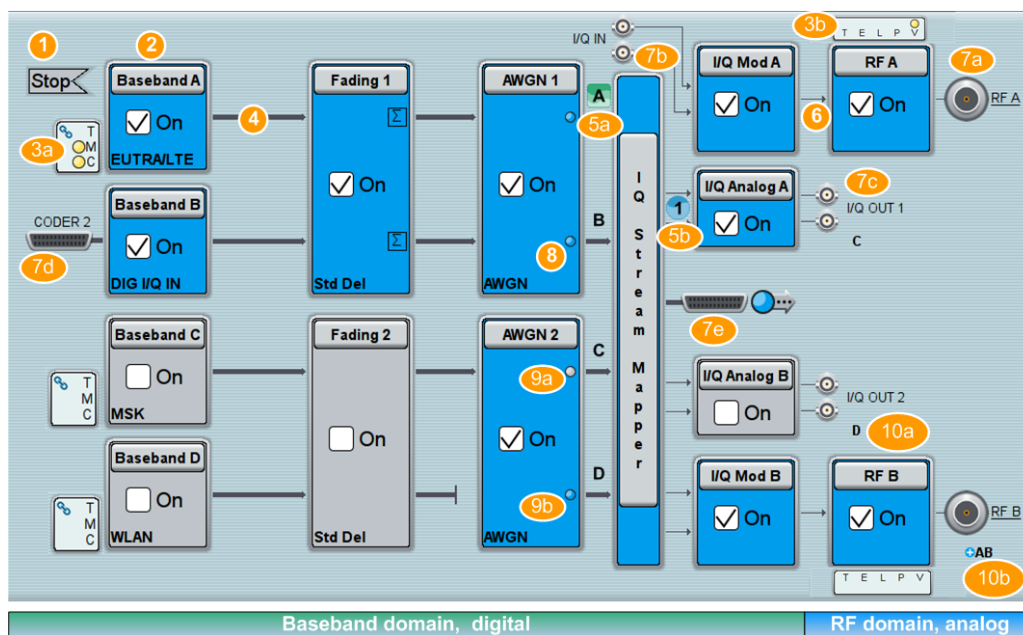


Underlined names, such as Freq, Lev, or RF A (in the block diagram) are also touch-sensitive. By touching them, you can execute a setting or access the dialog or menu.

For an overview of the status buttons and their functionality, refer to [Chapter C, "Elements and Controls of the Graphical User Interface"](#), on page 1145.

### 3.5.2.2 Block Diagram

The block diagram shows the current configuration and the signal flow in the generator with the aid of function blocks, connected by signal lines. The following figure displays almost all the elements that can appear in the block diagram. However, it does not necessarily represent a useful configuration.



- 1 = Status indicator
- 2 = Functional block
- 3a / 3b = Control signal block
- 4 = Signal line (digital)
- 5a / 5b = Graphics indicator
- 6 = Signal line (analog)
- 7a / 7b / 7c / 7d / 7e = Connector icons (RF, analog, digital)
- 8 = Stream indicator
- 9a / 9b = Stream status indicator (On/Off)
- 10a / 10b = Stream indicator (Single, Add)

Starting from left up to the "Stream Mapper", you can see the functional blocks provided in the baseband domain. After the stream mapper, the analog section contains the digital to analog conversion and modulation to RF.

Legend	Item	Description
1	Status indicator	Indicates whether the signal is running or waiting for a trigger.
2	Functional block	Represents a basic task in signal generation. The push button provides access to any number of associated actions to accomplish the task. The On/Off (checkbox) and the block label quickly activates the basic task.
3	Control signal block	Indicates information on the control signals like signal content, input or output and provides quick access to the corresponding configuration dialog. A dedicated control block is displayed for each baseband (3a) and RF block (3b).
4, 6	Signal lines (digital/ analog)	Show the currently configured signal flow. <ul style="list-style-type: none"> <li>• Thick lines represent the digital I/Q streams, see (4) in the figure above</li> <li>• Thin lines represent the analog signals (6)</li> </ul>
5	Graphics indicator	Denotes that the signal is displayed graphically (5a /5b).

Legend	Item	Description
7	Connector Icons	Represent the interfaces for signal input and output. <ul style="list-style-type: none"> <li>RF signal connector output (7a); (icons vary depending on the frequency)</li> <li>Analog I/Q signal connector input (7b)</li> <li>Analog I/Q signal connector output (7c)</li> <li>Digital I/Q signal connector input (7d)</li> <li>Digital I/Q signal connector output (7e)</li> </ul>
8	Stream indicators	Show the input streams at the I/Q stream mapper.
9	Stream status indicators	Show the status of a stream (On/Off)
10	Stream indicators	Indicates the output streams that are routed to the corresponding connectors, and the way the streams are internally processed: <ul style="list-style-type: none"> <li>Single One stream mapped on the connector (9a).</li> <li>Add More than one stream are routed to a connector (9b).</li> </ul>

### 3.5.2.3 Taskbar

The "Taskbar" contains labeled softkeys and minimized views (thumbnails) of active graphics and dialogs.

Initially, it shows the permanently assigned softkeys. The softkey with the sine wave denotes that no signal is activated for graphical representation.



Figure 3-16: Taskbar in default state

Whenever you open a settings or graphics dialog, it is automatically assigned to the "Taskbar". The softkeys shown in the following figure represent the variants.



Figure 3-17: Taskbar fully assigned

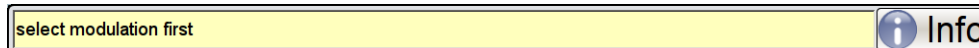
- 1 = System configuration
- 2 = Remote control connections
- 3 = R&S NRP-Zxx power sensors
- 4 = Graphics
- 5 = Dialogs
- 6 = Diagram / More

1	System Config	Provides access to general system configurations like setup, display, or remote. <b>Note:</b> The warning symbol signifies a permanent error message. It replaces the default symbol, as shown in <a href="#">Figure 3-16</a> .
2	Remote	Shows the established remote connections when the instrument is remotely controlled. <b>Tip:</b> An indicator in the status bar shows the current remote control status.
3	NRP-Zxx	Shows a connected external power sensor. The softkey is labeled on a blue background when it is active.
4	Graphics	Shows that a signal is represented graphically.
5	Dialogs	Shows a dialog as a thumbnail, the dialog name, and the name of signal channel.
6	Diagram / More	The diagram icon as shown in <a href="#">Figure 3-16</a> minimizes all dialogs indicated on the screen. The block diagram is in the foreground. <b>Note:</b> The "More" softkey indicates that more dialogs are open than can be displayed in the taskbar. Use this softkey to open a selection list with the remaining active dialogs, as well as the "Diagram" function.

### 3.5.2.4 Additional Display Characteristics

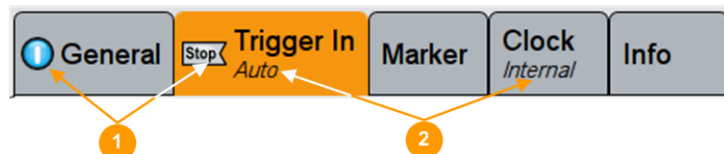
The following section provides a short insight on the indication of the screen in general, and significant elements that you see under specific operating modes, in dialogs or settings. They are described in detail in the User Manual in the appropriate chapters.

- **Appearance of active elements**
  - *Active* elements like On/Off switches, state buttons, blocks and symbols have a **blue** background
  - *Selected* elements such as blocks and connectors in the block diagram are highlighted **orange**.
  - *Inactive* elements are **gray**
- **On-Screen keypads**  
As additional means of interacting with the instrument without having to connect an external keyboard, either a numerical or alphanumerical on-screen keypad appears when you activate an entry field (see [Chapter 3.5.4, "Entering Data"](#), on page 112).
- **Info Line**  
The "Info line" shows brief status information and error messages. It appears above the "Taskbar" when an event generates a message.



- **Key parameters indicated in tab labels**

Most dialogs are divided into tabs with logically grouped parameters. The tab label expresses the content and may also contain status indicators or the set value of a key parameter.



1 = Status indicators  
 2 = Key parameter values

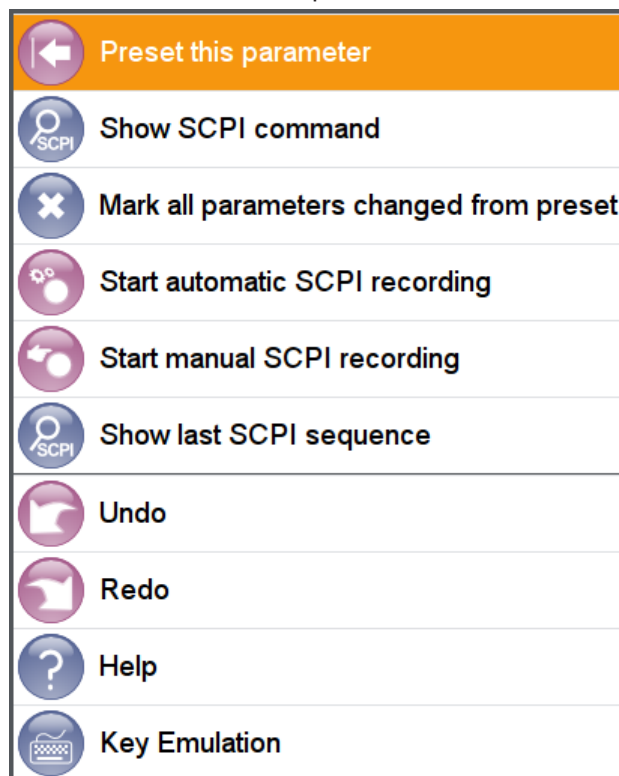
- **Scroll bar handle**

An arrow icon that appears when you touch a scroll bar helps you to scroll in a dialog or list.



- **Context-sensitive menus**

Within the entire screen display, including single parameters, you can access context-sensitive menus that provide some additional functions.



### 3.5.3 Accessing the Functionality

All functionalities are provided in dialog boxes as known from computer programs. You can control the instrument intuitively with the touchscreen. This section provides an overview of the accessing methods.

For most tasks, there are at least 2 alternative methods to perform them:

- Using the touchscreen
- Using other elements provided by the front panel, for example the keypad, rotary knob, or arrow and position keys

The instrument's functions and settings can be accessed by selecting one of the following elements:

- System and function keys on the front panel of the instrument
- Taskbar/softkeys on the touchscreen
- Context-sensitive menus for specific elements on the touchscreen
- Elements on the status bar in the touchscreen
- Displayed setting on the touchscreen, that means block diagram and all settings available in dialogs.

#### To open a dialog box

- ▶ Perform one of the following actions:
    - Tap the required block, and then the menu entry.
    - Tap the minimized view (thumbnail) on the taskbar.
- Some of the Utility keys access a dedicated dialog, too.

#### To minimize a dialog box

- ▶ Tap the "Minimize" icon in the upper right corner.

#### To close a dialog box

- ▶ Tap the "Close" icon in the upper right corner.  
Or:  
Press the ESC key on the front panel.

#### To select an option in a dialog box

- ▶ Tap the required option.

#### To select an option in a list

If many options are available - for example, for the trigger mode - the options are provided in a list. The current selection is shown on the list button.

- ▶ Tap in the list, scroll in the list and then tap the required option.  
Or:  
Use the rotary knob  
Or:

Use ON/OFF/TOGGLE key to select the succeeding option

Or:

Use the front panel keys:

- a) Press the LEFT and RIGHT arrow keys to navigate to the list button.
- b) Press the ENTER key to open the list.
- c) Press the UP ARROW and DOWN ARROW keys to navigate to the required option in the list.
- d) Press the ENTER key to select the marked option.

### 3.5.4 Entering Data

Some parameters have their own key on the front panel.

For data input in dialog boxes, the touchscreen provides an on-screen keypad to enter numeric values and units. For text input, the on-screen keyboard with English layout is used.

Data can be entered in dialog boxes using one of the following methods:

- Using the touchscreen, via the online keyboard or keypad
- Using other elements provided by the front panel, for example the keypad, rotary knob, or navigation keys  
The rotary knob acts like the ENTER key when it is pressed.
- Using a connected external keyboard

#### Correcting an entry

1. Using the arrow keys, move the cursor to the right of the entry you want to delete.
2. Press the BACKSPACE key.
3. The entry to the left of the cursor is deleted.
4. Enter your correction.

#### Completing the entry

- ▶ Press the ENTER key or the rotary knob.

#### Aborting the entry

- ▶ Press the ESC key.  
The dialog box is closed without changing the settings.



### 3.5.4.1 Entering Numeric Parameters

#### To enter values with the on-screen keypad

If a field requires numeric input, the keypad provides only numbers. The provided units correspond to the units of the parameter.

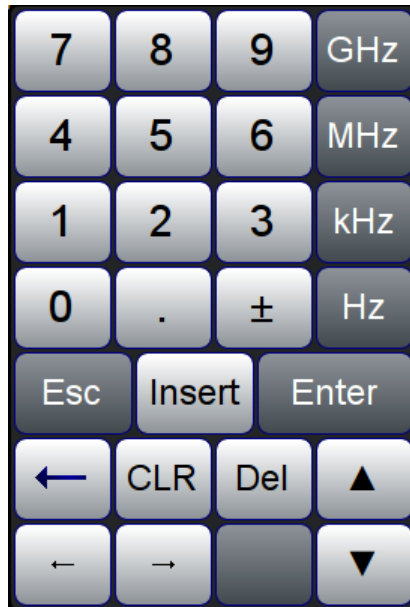


Figure 3-18: Example of a keypad for frequency parameter

1. Enter the numeric value.
2. Tap the unit button to complete the entry.  
The unit is added to the entry.
3. If the parameter does not require a unit, confirm the entered value by pressing "Enter".

#### To enter values by using the front panel controls

1. Change the currently used parameter value by using the rotary knob (small steps) or the UP or DOWN keys (large steps).
2. If the parameter does not require a unit, confirm the entered value by pressing the ENTER key or any of the unit keys.  
The editing line is highlighted to confirm the entry.

If you edit numeric data in tables, the entry field must be in edit mode: Press ENTER, or the rotary knob to activate the edit mode.

### 3.5.4.2 Entering Alphanumeric Parameters

If a field requires alphanumeric input, you can use the on-screen keyboard to enter numbers and (special) characters (see [Figure 3-19](#)).



Figure 3-19: On-screen keyboard

The interaction with the on-screen keyboard is as tipping on a connected keyboard.

### 3.5.4.3 Undo and Redo Actions

Accessed via the context-sensitive menus, "Undo" allows you to restore one or more actions on the instrument. Depending on the available memory, the "Undo" steps may restore all actions.



"Redo" restores a previously undone action.

## 3.5.5 Getting Information and Help

In some dialog boxes, graphics are included to explain the way a setting works. For further information, you can use the following sources:

- Tooltips give the value range of the parameter.
- The context help provides functional description on a setting.
- The general help explains a dialog box, provides instructions, and general information.
- The tutorials are interactive examples and demonstrations on how to perform specific tasks.

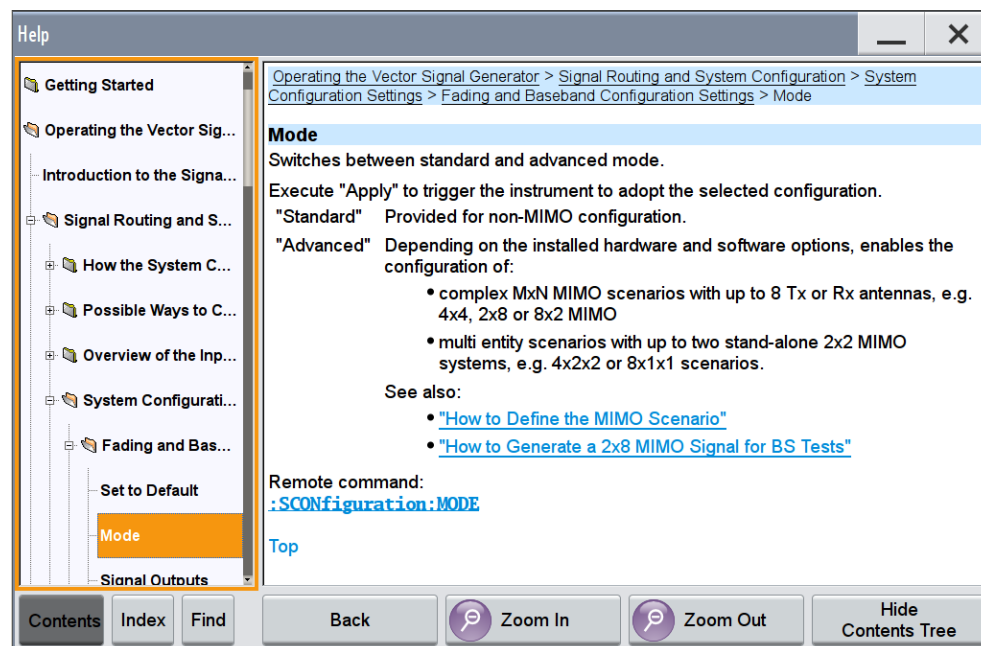
#### To access the tutorials

- ▶ Follow the instructions in [Chapter 3.5.5.1, "Using the Tutorials"](#), on page 116.

### To display context help

- ▶ To access a help topic, perform one of the following:
  - a) Tap and hold the parameter for which you need information and tap "Help" in the context menu.
  - b) Tap the parameter and press the HELP key.

The "Help" dialog opens. You can browse the help for further information.



### Contents of the help dialog box

The help dialog box covers two main areas:

- "Contents" - contains a table of help contents
- "Topic" - contains a specific help topic

The help system also provides an "Index" and a "Find" area, and "Zoom" functions that are accessed via the corresponding buttons.

### To open general help

- ▶ Press the yellow HELP key on the front panel.

If a dialog box is opened, the help topic for the current tab is shown. Otherwise the "Contents" page appears.

### Navigating in the table of contents and in the help topics

1. To move through the displayed contents entries, tap on an entry and scroll or use a connected mouse or the UP/DOWN keys.  
Entries with a plus sign contain further entries.
2. To display a help topic, tap on the topic name or double click on the topic name or press the ENTER key.

3. To follow a cross-reference, tap on the link text.
4. To return to the previous page, select "Back".  
This function scrolls back all steps you have performed before.
5. Use the "scroll bars" to shift the visible section of content shown.
6. To maximize the "Topics" area, tap the "Hide Contents Tree" button to hide the contents tree.

### Using the Index

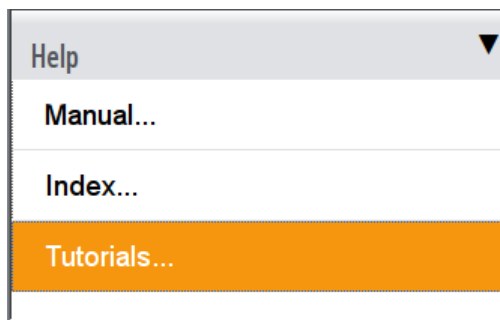
1. Select the "Index" button in the task bar.
2. Enter the first characters of the topic you are interested in.  
The entries starting with these characters are displayed.
3. Tap on the index entry.  
The corresponding help topic is displayed.

#### 3.5.5.1 Using the Tutorials

A set of tutorials is embedded in the software. The tutorials are interactive examples and demonstrations on how to perform specific tasks.

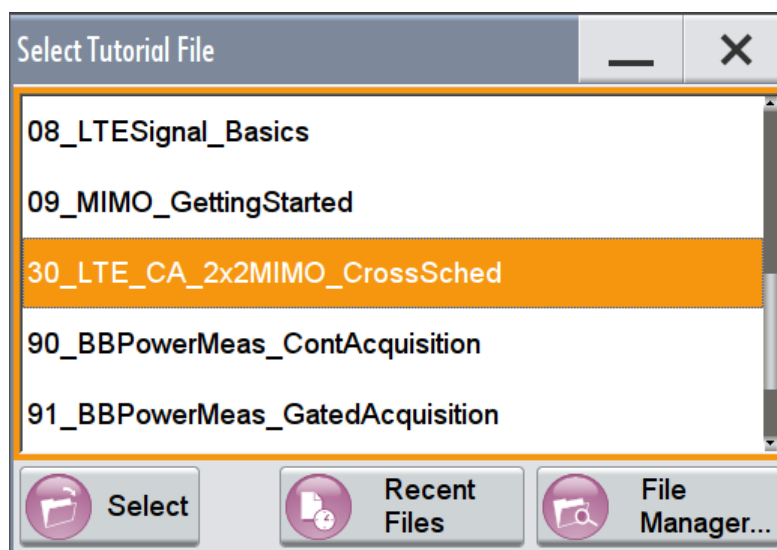
#### To start a tutorial in an interactive step-by-step mode

1. Press the SETUP key on the front panel.
2. Scroll-down in the list, tap on the "Help" section to expand it and tap on "Tutorials".

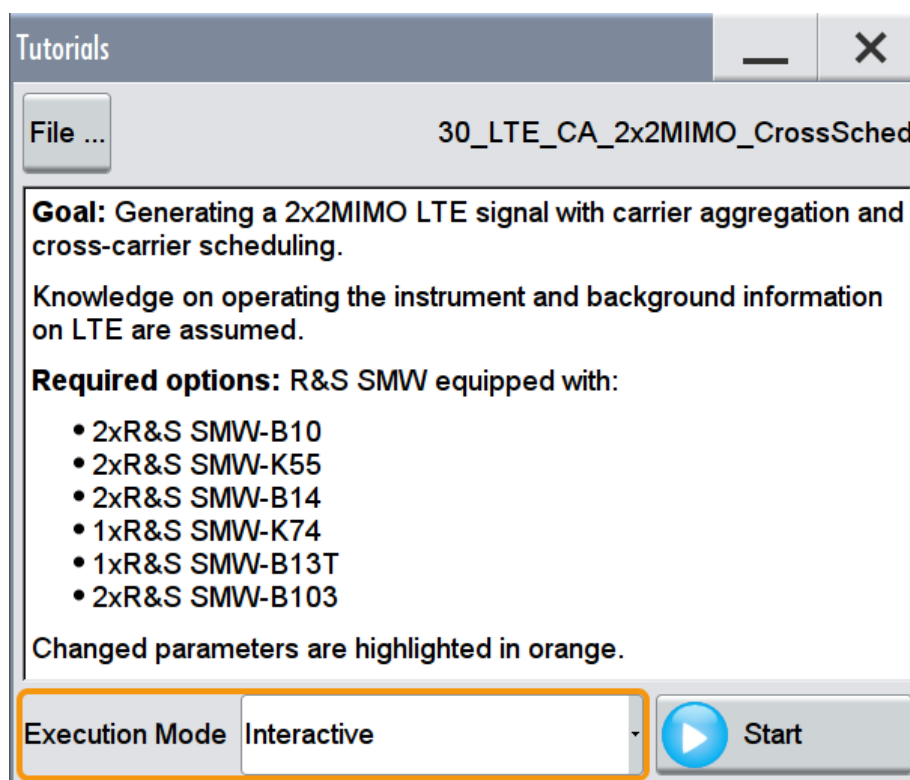


The "Tutorials" dialog opens.

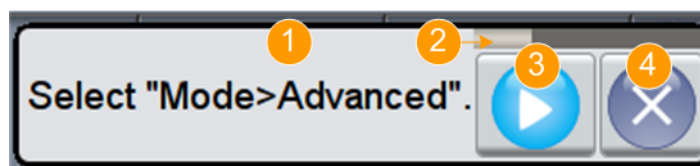
3. Select "File > Load Predefined Tutorial".



4. Tap on a tutorial from the list and confirm with "Select".  
If the file contains a description, it is displayed.



5. Use the default mode, that is "Execution Mode > Interactive".
6. Tap on the "Start" button.
7. Observe the information displayed in the "Info" line (bottom of the display).



- 1 = Information on the performed action
- 2 = Progress bar
- 3 = "Next Step": confirms the execution of the step
- 4 = "Stop": terminates the tutorial

8. To execute a subsequent step, select the "Next Step" button.

A blinking cursor indicates the block or parameter affected by the step.



The instrument performs the configurations step-by-step and expects your confirmation. Dialogs are opened and closed; changed parameters are highlighted in orange.

Additional information is displayed in the "Info" line.

### To stop the tutorial

The demonstration can be terminated at any time.

- ▶ Select the "Stop" button.

The demonstration stops.



You may reopen the "Tutorials" dialog and start another file or exit the tutorial mode.

### To use the demonstration mode

1. Start the tutorials as described in ["To start a tutorial in an interactive step-by-step mode"](#) on page 116.
2. In the "Tutorials" dialog, select "Execution Mode > Auto (Looped) 3 sec".

The configurations are performed automatically; your interaction is not required. Dialogs are opened and closed; changed parameters are highlighted in orange. Additional information is displayed in the "Info" line.

See also:

- [Chapter E, "Available Tutorial Files"](#), on page 1164
- The application sheet "RS\_SMW\_CreatingTutorials\_AppSheet", available for download from the R&S website, on the R&S SMW [product page](#).

### 3.5.6 Remote Control

In addition to working with the R&S SMW interactively, located directly at the instrument, it is also possible to operate and control it from a remote PC.

The R&S SMW supports various methods for remote control:

- Connecting the instrument to a (LAN) network (see [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45)
- Using the LXI browser interface in a LAN network
- Connecting a PC via the IEC-bus (IEEE 488) interface
- Remote control via the USB interface



For remote control over LAN or USB, you can use the R&S VISA (Virtual Instrument Software Architecture) library provided for download at the Rohde & Schwarz website <http://www.rohde-schwarz.com/rsvisa>.

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How to configure the remote control interfaces is described in [Chapter 12, "Network and Remote Control Operation"](#), on page 649.

### 3.5.7 Remote Operation over VNC

The VNC is an application which can be used to access and control the instrument from a remote computer through a LAN connection. While the instrument is in operation, the instrument screen contents are displayed on the remote computer, and VNC provides access to all applications, files, and network resources of the instrument. Thus, remote operation of the instrument is possible.



#### Instrument control from a remote computer

To access the basic utility functions of the R&S SMW, perform a right mouse click on the block diagram and select "Key Emulation".

A key panel to the right of the block diagram gives access to the utility functions provided by the front panel keys.

---

The VNC is an add-on program, included in operating system Linux/Unix, and available as a free-of-charge download on the internet.

For more information, refer to [Chapter 12.17, "How to Set Up Remote Operation via VNC"](#), on page 704.

## 4 Signal Routing and System Configuration

The R&S SMW provides multiple routing possibilities and simplifies the definition of versatile MIMO configurations.

Provided the instrument is equipped with the required options, R&S SMW can:

- Process the internally generated digital baseband signal
- Process an external digital signal
- Vector modulate baseband signals, irrespectively of the signal source
- Impair, distort by noise, and apply fading to digital baseband signals.

Generally, the processing of the generated baseband signal involves a modulation on the selected radio frequency (RF) and output at the RF connectors. However, the digital baseband signal can also be output directly, or converted and output as an analog I/Q signal.

To support you in your configuration tasks, the R&S SMW provides the "System Configuration" dialog. The main focus of this section is the "System Configuration" settings. This section also introduces the concept of the signal routing possibilities and covers the settings provided for the adjustment of the input and output analog and digital signals.



The information in the following sections assumes a fully equipped R&S SMW.

The following information is not relevant if your instrument is not fully equipped. In particular if it is equipped with one signal path or it is without a Fading Simulator.

### 4.1 How the System Configuration Function Supports You in Your Task

The R&S SMW vector signal generator is an instrument with outstanding characteristics that can serve a wide range of test cases. Irrespective of your current use case, the decision process on how to fulfill the task with the R&S SMW and what kind of configurations are necessary, undergoes the same main phases.

The "System Configuration" settings and capabilities support the decision and the configurations in these main phases. It helps you for instance to define MIMO configurations, to route the signal through the instrument, and to connect and control external instruments.

#### 4.1.1 Finding Out the System Configuration for a Current Test Case

##### Prerequisites

The provided instrument settings guide you throughout the decision process and support you configuring even the connected external instruments. It is, however, still



required that you are familiar with the instrument's capability so that you can evaluate if and which additional instruments are required in the current test setup.

### **General workflow for finding out the suitable system configuration for a current use case**

The general workflow comprises the main phases listed below. The "System Configuration" helps you in phase 3, 4 and 5.

1. Analyzing the use case/test case and deciding whether the test setup requires external instruments, either as a baseband source or as an RF frontend.  
In general, a test setup that requires more than two Rx antennas requires additional instruments.  
**Tip:** Compare your current test case with the example scenarios listed in [Table 4-1](#).  
The table provides information on the required fading and baseband configuration, the used baseband source, the required output interfaces, and a summary of the additionally required instruments.
2. Connecting and cabling the instruments.  
In the common case, all instruments use the same reference frequency signal and are connected to a LAN or the external instruments are connected via USB to the R&S SMW.
3. Configuring the signal flow by selecting the suitable fading and baseband configurations and deciding whether coupled or separate baseband sources are necessary.  
The most powerful way is to rely on the [Fading and Baseband Configuration Settings](#).  
See also [Chapter 4.2, "Possible Ways to Configure the Signal Flow"](#), on page 124.
4. Distributing and mapping the I/Q streams to the required output interfaces.  
See [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137.
5. Establishing connection to the external instruments.  
See [Chapter 4.4.3, "External RF and I/Q Settings"](#), on page 139  
You can also manually configure the correct input and output interfaces the R&S SMW expects the signal from or outputs the signal at.  
See [Chapter 4.3, "Overview of the Input and Output Signals and Interfaces"](#), on page 127.
6. Configuring the baseband signal, enabling fading, and defining the signal to noise ratio (SNR), if required.  
Adjusting the RF frequency and further required settings.
7. Starting the signal generation.

For step-by-step descriptions, see [Chapter 4.9, "How to Connect External Instruments and Configure the Signal Flow"](#), on page 178.

#### 4.1.2 From a test scenario to the required system configuration

The information in [Table 4-1](#) provides a cross-reference between a test scenario and the required configuration. The "System Configuration > Fading/Baseband Settings" dialog serves the opposite way, that is it provides a short description and an example of the common application or test scenario of the selected configuration.

**Table 4-1: Overview of important test scenarios and their system configuration**

Test scenario	Short description/application	Fading and Baseband Configuration	Baseband Source Configuration	Required output signals per instrument	Required additional instruments
LTE 4x4 MIMO	User equipment (UE) or base station (BS) tests <a href="#">More</a>	1x4x4	Coupled	<ul style="list-style-type: none"> <li>RF A, RF B</li> <li>analog I/Q 1/2 OUT or BBMM 1/2 OUT</li> </ul>	2xR&S SGS or 2xR&S SGT
LTE 2x8 MIMO Beamforming	TD-LTE BS test, e.g. Beamforming tests <a href="#">More</a>	1x2x8	Coupled	<ul style="list-style-type: none"> <li>RF A, RF B</li> <li>analog I/Q 1/2 OUT</li> </ul> or <ul style="list-style-type: none"> <li>RF A, RF B</li> <li>BBMM 1/2 OUT</li> <li>FAD 3/4/1/2 OUT</li> </ul>	<ul style="list-style-type: none"> <li>1xR&amp;S SMW + 4xR&amp;S SGS</li> </ul> or <ul style="list-style-type: none"> <li>6xR&amp;S SGT</li> </ul>
LTE 8x2 MIMO UE tests	TD-LTE UE tests	1x8x2	Coupled	RF A, RF B	-
LTE-A carrier aggregation with 2x2 MIMO	UE test with two component carriers (carrier aggregation) and 2x2 MIMO each	2x2x2	Coupled	intra-band <ul style="list-style-type: none"> <li>RF A, RF B</li> </ul> inter-band <ul style="list-style-type: none"> <li>RF A, RF B</li> <li>analog I/Q 1/2 OUT or BBMM 1/2 OUT</li> </ul>	intra-band <ul style="list-style-type: none"> <li>-</li> </ul> inter-band <ul style="list-style-type: none"> <li>2xR&amp;S SGS or 2xR&amp;S SGT</li> </ul>
LTE-A intra-band carrier aggregation with 2x2 MIMO	Test with four component carriers (carrier aggregation) and 2x2 MIMO each	4x2x2	Coupled	RF A, RF B	intra-band <ul style="list-style-type: none"> <li>-</li> </ul> inter-band <ul style="list-style-type: none"> <li>2xR&amp;S SGT</li> </ul>
LTE-A Rel. 11 fel-CIC	Further enhanced inter-cell interference coordination (fel-CIC) tests	3x2x2	Coupled per Entity	RF A, RF B	
LTE Intra-band carrier aggregation with 4x4 MIMO	Test with two component carriers and 4x4 MIMO each	2x4x4	Coupled/ Coupled per Entity	RF A, RF B	2xR&S SGT
LTE Multi-User	PUCCH Test with 4 UEs according to TS 36.141	1x4x2	Separate	RF A, RF B	-
WCDMA Type 3i	One wanted cell and two interfering cells, each with Rx diversity according to TS 34.121	1x3x2	Separate	RF A, RF B	-
DC-DB-HSDPA with 2x2 MIMO	Two WCDMA cells with 2x2 MIMO each	2x2x2	Separate	RF A, RF B analog I/Q 1/2 OUT or BBMM 1/2 OUT	2xR&S SGS or 2xR&S SGT

Test scenario	Short description/application	Fading and Baseband Configuration	Baseband Source Configuration	Required output signals per instrument	Required additional instruments
WLAN 802.11ac with 160 MHz	WLAN 802.11ac with 160 MHz and 4 Tx antennas (without dyn. fading)	4x1x1	Coupled	RF A, RF B analog I/Q 1/2 OUT or BBMM 1/2 OUT	2xR&S SGS or 2xR&S SGT
WLAN 802.11ac with 80 MHz	WLAN 802.11ac with 80 MHz and 3x3 MIMO	1x3x3	Coupled	RF A, RF B analog I/Q 1/2 OUT or BBMM 1/2 OUT	R&S SGS or 2xR&S SGT
MSR (Multi Standard Radio)	Multi Standard Radio with up to 4 individual carriers (e.g. GSM, WCDMA, LTE, etc.) within one frequency band (without dyn. fading) <a href="#">More</a>	1x4x4 with "Fading > Bypass If Fading Off > On" or 4x1x1	Separate	RF A, RF B	-
MSR (Multi Standard Radio)	Multi Standard Radio with 8 individual carriers (e.g. GSM, WCDMA, LTE, etc.) within one frequency band (without fading)	8x1x1	Coupled	RF A	-
WCDMA UE Tests	Tests with three WCDMA UEs	3x1x2	Separate	RF A, RF B BBMM 1/2 OUT FAD 3/4 OUT	4xR&S SGT
WCDMA Handover	Two WCDMA cells	2x1x1	Separate	RF A, RF B	-
WCDMA/LTE mixed scenarios	BS/UE tests with LTE 2x2 MIMO and WCDMA 2x2 MIMO	2x2x2	Coupled per Entity	RF A, RF B BBMM 1/2 OUT	2xR&S SGT

For a step-by-step description of how to perform the different steps, refer to [Chapter 4.9, "How to Connect External Instruments and Configure the Signal Flow"](#), on page 178.

The [Table 4-2](#) lists examples of test scenarios that utilize the fading functionality of the instrument.

Table 4-2: Example of scenarios for signaling tests

Test scenario	Short description/application	Fading and Baseband Configuration	Baseband Source Configuration	Required Input/output signals per instrument	Required additional instruments
LTE-A carrier aggregation with 2x2 MIMO and signaling	UE test with two component carriers (carrier aggregation) and 2x2 MIMO each	2x2x2	Coupled	Input: CODER 1/2 IN Output: BBMM 1/2 OUT	1xR&S CMW
LTE 4x4 MIMO with signaling	UE or BS tests with signaling Input signal from R&S CMW required	1x4x4	Coupled	Input: CODER 1/2 IN Output: BBMM 1/2 OUT	1xR&S CMW

### The meaning of the short form representations of the fading and baseband configurations

Throughout this description, the fading and baseband configurations are represented in a short form that follows the predefined structure

<#Entity>x<#Basebands>x<#Streams> (LxMxN). The last two blocks are identical with the standard convention used to describe a MxN MIMO system.

#### Example:

The abbreviation 1x8x2 is a representation of an one-entity 8x2 MIMO system; a 2x2x2 configuration is a scenario with two entities with a 2x2 MIMO system each.

## 4.2 Possible Ways to Configure the Signal Flow

The R&S SMW provides different possibilities for configuring the signal flow. This section gives an overview of the available alternatives, starting with the simple manual configuration, to the automatically assisted routing for complex signal scenarios. Select the routing method most fitting to your needs and workflow.

For complex routing scenarios, like MIMO configuration and especially configuration involving several instruments, use the "System Configuration" functionality as the start and central configuration point.

### 4.2.1 Using the Signal Routing Settings and the Block Diagram

The following methods are provided in [Standard mode](#) and are suitable for the configuration of non-MIMO signal routing tests scenarios.

#### Signal Routing

This is an easy method for a simple signal routing task involving routing and summing of the baseband signals up to the output of the "Fading" block. The available routing possibilities are grouped in the "Signal Routing" sections of the corresponding block.

The signal routing influences:

- The signal flow of the baseband sources
- The routing of the output fading signal for the non-MIMO cases.

The provided settings are sufficient for standard test configurations with Tx or Rx diversity measurements with two antennas.

Refer to [Chapter 4.5, "Signal Routing Settings"](#), on page 155 for detailed description of the provided settings.

### Drag&Drop blocks

Basically, this functionality achieves the same effect as the signal routing settings but extends it with the possibility to route the generated streams to any of the digital and analog output connectors of the instrument. In other words, it covers the complete baseband domain including the functionality of the [I/Q Stream Mapper](#).

- To route the baseband signal, select the corresponding block ("Baseband A/B" or "BB Input A") and drag it to the block of the signal it should be routed through, e.g. "Fading A/B". The allowed routing possibilities are highlighted. The block diagram shows the resulting signal flow.
- To map a stream, select the "AWGN" block and drag it to the connector of the stream it should be output at, e.g. BBMM 2. If the associated block is hidden, it unfolds.  
Open the "I/Q Stream Mapper" to verify the routing.
- To break up the routing, perform the reverse operation, i.e. select the "Fading A/B" block and drop it to the corresponding "Baseband A/B" or "BB Input A" block.

## 4.2.2 Using the System Configuration Capabilities

### Fading/Baseband Configuration

Another way to configure the signal routing of the baseband signal and the fading block is to use the "System Configuration > Fading/Baseband Configuration" settings. The configuration settings are provided for two modes, for the standard non-MIMO configuration and for the advanced MIMO configuration respectively.

- The "Standard" fading and baseband configuration settings are a more detailed representation of the "Fading > Signal Routing" settings. The dialog provides some additional description, e.g. the common application of the current configuration.
- The "Advanced" fading and baseband configuration is required for the configuration of complex  $L_x M_x N$  MIMO scenarios.

For any allowed system configuration, the R&S SMW configures the signal flow **automatically upon just four parameters:**

- Number of Entities (Users, Cells, etc),
- Number of Tx and Rx antennas and
- The decision whether coupled or separated baseband sources are used
- Kind of generated signals, analog, digital, or multiplexed digital signals.

In this way, within one dialog you can configure complex configurations with:

- Up to 8 Tx or Rx antennas
- Up to four stand-alone 2x2 MIMO systems, e.g. 8x2 MIMO or LTE-A Carrier Aggregation with 2x2 MIMO
- Up to 8 SISO systems

See also [Table 4-1](#).

For any selected fading and baseband configuration, the dialog displays on-the-fly a simplified preview diagram of the signal routing. The selected configuration is applied after executing the "Apply" function; the configuration influences the signal flow up to the I/Q stream mapper.

Refer to [Chapter 4.4, "System Configuration Settings"](#), on page 131 for detailed description of the provided settings.

### Coupled or Separate Baseband Sources

To simplify the configuration of the baseband signal in some MIMO test scenarios, you can enable the R&S SMW to combine the available resources into a single baseband block and to generate the required number of Tx antennas out of it. The configuration of the various Tx antennas is performed in a common dialog.

Depending on the currently selected baseband source, in particular when using coupled or coupled per entity basebands, not all digital standards are available. Coupled mode is supported by the "EUTRA/LTE" and "IEEE802.11 WLAN" digital standards, enabled in the "ARB" and with an external digital baseband signal.

- **Advantages of the coupled baseband sources**

Using coupled baseband sources is recommended for complex test scenarios and enabled if a scenario requires the signal of more than one cell, Tx antenna or entity.

In coupled mode, the instrument takes over the baseband signal configuration, adjusts the settings of all required basebands/entities automatically, and applies suitable trigger settings.

Coupling external digital baseband signals accelerates the configuration and provides better overview by combining the settings within one central dialog.

- **Separate baseband sources**

Separate baseband sources have to be used in test scenarios involving:

- A mixture of internally generated and externally supplied baseband signals
- A mixture of internally generated signals according to different digital standards.

### I/Q Stream Mapper

Irrespective of the used signal routing method, it is possible to reconfigure the distribution and mapping of the I/Q streams to the output connectors.

Depending on the installed hardware options and the enabled "System Configuration > Fading/Baseband Configuration", up to *eight logical I/Q streams*, stream A to stream H, may be generated. The R&S SMW offers a flexible mapping functionality of these streams to the provided output connectors.

By default, the first two streams are mapped to the RF outputs. The stream mapping of all other streams depends on the current configuration, in particular the number of output streams, number of [multiple entity](#) systems, whether the fading simulator is bypassed or not, etc. We recommend that you observe the stream mapping before performing further configurations.

Refer to [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137 for detailed description of the provided settings.

See also [Figure 4-1](#).

### External RF and I/Q Instruments

The MIMO test scenarios with more than two Rx antennas require the signal at both RF outputs and up to six additional RF signals. The instrument generates the required signal and routes it to the available output connectors as defined with one of the routing possibilities. Which logical information, i.e. which **stream**, is output at which connector is defined by the "IQ Stream Mapper" (see ["I/Q Stream Mapper"](#) on page 126).

The I/Q analog and/or digital output signal has to be processed by an additional instrument. The R&S SMW provides additional settings to configure the output connectors, to establish the connections to the connected RF instruments and to control them.

Refer to [Chapter 4.4.3, "External RF and I/Q Settings"](#), on page 139 for detailed description on the provided settings and to [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185 for step-by-step description on how to connect and configure slave instruments.

## 4.3 Overview of the Input and Output Signals and Interfaces

Designed as a signal generator with various application fields, the R&S SMW uses a hardware concept that enables you to define and customize most of the input and output signals and interfaces. Depending on the selected fading and baseband configuration, the digital interfaces can be used as input or output connectors; the different logical settings of the same physical interface are grouped in different dialogs.

### Logical signals, streams and channels at the interfaces

This section provides **background information** and introduction to the topics. The description is divided in parts that follow the logical decision process when configuring the instrument. It supports the manual configuration for simple test scenarios.

The settings provided in the "System Configuration" dialog guide you throughout this decision process automatically. For complex routing scenarios, like MIMO configuration and especially configuration involving several instruments, it is recommended to use the ["System Configuration"](#) functionality as a start and central configuration point.

For an overview of the interfaces and their characteristics, refer to:

- [Chapter 4.3.2, "Overview of the Baseband Signal Sources"](#), on page 129
- [Chapter 4.3.3, "Overview of the Baseband and RF Output Signals"](#), on page 131

- [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207

### 4.3.1 Physical Location of the Input and Output Interfaces

This section focuses on the input and output interfaces of the instrument. For a detailed overview of all front and rear panel connectors, see [Chapter 3.2, "Instrument Tour"](#), on page 52.

#### Naming conventions for the input and output interfaces and "Find Connector" function

The R&S SMW is a highly modular instrument that can be equipped with different combinations of hardware and software options. To increase the serviceability of the instrument, the design of the different hardware board is similar. However, this similarity together with the customizable connectors direction and user definable signals may cause cabling and configuration faults. To simplify the cabling and to minimize this error source, it is important to clearly identify the interfaces in any possible hardware and system configuration.

The instrument provides the following two methods for identifying the connectors:

- A connector naming rule that follows the predefined structure `<Board Name> <Number> <Direction>`, e.g. CODER 2 IN, BBMM 2 OUT, etc.
- A built-in [Find Connector](#) function, that indicates the selected connector on the instrument's rear panel with a blinking LED.



The short and long connector names (e.g. COD 2 IN and CODER 2 IN or "Coder 2 IN") are used interchangeably.

- The [Figure 4-1](#) shows the *digital interfaces* on the instrument's rear panel together with the associated GUI term (highlighted in orange color).



*Figure 4-1: Location of the digital input and output interfaces (part view of the rear panel of a fully equipped instrument)*

- The [Figure 4-2](#) shows the *analog output interfaces* on the instrument's rear panel together with the associated GUI term (highlighted in orange color).



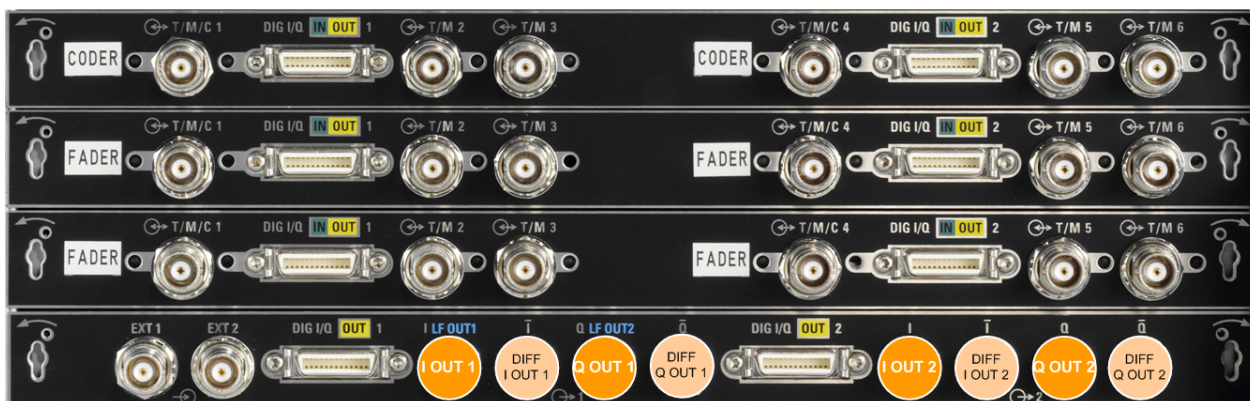


Figure 4-2: Location of the analog output interfaces (part view of the rear panel of a fully equipped instrument)

### Direction of the digital interface

Each of the six connectors serves as an input or an output connector. The selected fading and baseband configuration automatically predefines the direction of the required connectors (see "[System Configuration LxMxN](#)" on page 134).



If you change these predefined settings, cross-check the direction of the digital interface before you connect an external instrument.

See:

- "[To find out the correct connector](#)" on page 180 and "[Indication of the digital interface status](#)" on page 129
- "[To find out the connector's direction](#)" on page 180 (if you operate the instrument remotely)

### Indication of the digital interface status

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active

## 4.3.2 Overview of the Baseband Signal Sources

The [Table 4-3](#) gives an overview of the *possible* input signals and the connectors they are supplied at. Any one of the specified input signals can be processed by the I/Q modulator and output at the RF outputs.

Table 4-3: Physical input signals

Input Signal	Connector	GUI Element	Refer to
Internal digital baseband signal	-	"Baseband"	<a href="#">Chapter 5, "Configuring the Internal Baseband Source"</a> , on page 212
External digital signal	COD 1/2 FAD 1/2	"BB Input"	<a href="#">Chapter 4.6, "Digital Baseband Input Settings"</a> , on page 159
External analog <ul style="list-style-type: none"> <li>Wideband</li> <li>Differential (in the first signal path)</li> </ul>	<ul style="list-style-type: none"> <li>I IN, Q IN</li> <li>I IN BAR, Q IN BAR</li> </ul>	"I/Q Mod"	<a href="#">Chapter 7, "Applying I/Q Vector Modulation"</a> , on page 399

### Input interface for the external digital baseband signal

As shown in [Table 4-3](#), the instrument is equipped with **up to four digital interfaces**, the CODER 1/2 and the FADER 1/2 connectors, that can be used as input for digital signals. These digital interfaces provide direct communication with other Rohde&Schwarz instruments, like signal generators, the external digital signal interface module R&S®EX-IQ-BOX or the R&S®CMW500 Radio Communication Tester in fading applications.

See also

- [Chapter 4.9.11, "How to Connect an R&S EX-IQ-BOX"](#), on page 199
- [Chapter 4.9.9, "How to Connect an R&S®CMW500 Radio Communication Tester for Fading Applications"](#), on page 195

### Application examples of the externally supplied digital baseband signal

Provided the instrument is equipped with the required options, in particular with at least two coder boards, the externally applied signals can be used for and further processed as follows:

- Used as a stand-alone baseband source and processed separately, e.g. subsequently faded, detuned, or loaded with noise or directly applied to the I/Q modulator
- Used as a user-specific wanted signal or interference signals to the internally generated signals
- Routed to one or to all the signal paths, added to the internally generated baseband signal possibly also frequency shifted
- Used as a baseband source for digital signals in test setups requiring more than four baseband signals (Tx antennas) or entities

### Input Interface for the External Analog Signal

The R&S SMW provides also an input interface for an external analog (wideband or differential) I/Q signal; the external signal is fed directly to the I/Q Modulator. For description of the related connectors and settings, see [Chapter 7, "Applying I/Q Vector Modulation"](#), on page 399 and [Table 7-1](#).

### 4.3.3 Overview of the Baseband and RF Output Signals

Usually, the generated baseband signal is modulated on the RF frequency and output at the RF connectors. For MIMO configurations with more than two Rx antennas, however, the two RF output signals are not sufficient. For such of configurations or for test setups in which the R&S SMW is used as a baseband signal source or as a pure fading simulator, the instrument provides also connectors to output the baseband signal. As shown in [Table 4-4](#), the R&S SMW outputs the digitally modulated signal directly or converted to an analog I/Q baseband output signal. The analog baseband signal can be output single ended or differential (non-inverted); an RF envelope signal can be generated, too.

The [Table 4-4](#) shows the possible output connectors with the corresponding kind of signal. Which logical information, i.e. which **stream**, is output at which connector is defined by the "I/Q Stream Mapper" (see [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137).

**Table 4-4: Physical output signals**

Type	Output Signal	Connector	GUI Element	Refer to
RF	RF signal	RF	"RF"	<a href="#">Chapter 8, "Configuring the Signal in the RF Domain"</a> , on page 408
BB	Digital signal	BBMM 1/2 FAD 3/4/1/2	"I/Q Digital"	<a href="#">Chapter 4.7, "I/Q Digital Output Settings"</a> , on page 166
	Analog signal <ul style="list-style-type: none"> <li>• Single ended</li> <li>• Differential</li> <li>• RF Envelope</li> </ul>	<ul style="list-style-type: none"> <li>• I OUT, Q OUT</li> <li>• I OUT BAR, Q OUT BAR</li> <li>• I OUT, I OUT BAR</li> </ul>	"I/Q Analog"	<a href="#">Chapter 4.8, "I/Q Analog Output Settings"</a> , on page 173

## 4.4 System Configuration Settings

The "System Configuration" dialog is the central point for the configuration of the signal flow. The provided settings assist you to fulfill your configuration tasks, like changing the selected MIMO mode e.g. from 2x2 MIMO to 4x4 MIMO or support you by connecting new devices to the baseband outputs.

The settings in this dialog comprise the fading configuration, the baseband source configuration, the mapping, and the processing of the generated I/Q streams, and the configuration of the related setting of instruments connected to the RF and I/Q connectors.



For a step-by-step description of how to use the provided settings, refer to [Chapter 4.9, "How to Connect External Instruments and Configure the Signal Flow"](#), on page 178 .

### Required options

The equipment layout for the generation of complex signals ([Advanced mode](#)) includes:

- 2 options Baseband Generator (R&S SMW-B10)

- (incl. one digital interfaces CODER 1/2 per installed option)
- Up to four options Fading simulator (R&S SMW-B14)  
(incl. one digital interfaces FADER 1/2/3/4 per installed option)
- Option MIMO Fading (R&S SMW-K74)
- Optional option Higher-Order MIMO (R&S SMW-K75)
- Optional option Multiple Entities (R&S SMW-K76)
- Optional option [Slow IQ](#) (R&S SMW-K551)

#### 4.4.1 Fading and Baseband Configuration Settings

Access:

- ▶ Use one of the following:
  - select "Taskbar > System Config > System Configuration > Fading/Baseband Config"
  - select "Block Diagram > Fading > System Configuration > Fading/Baseband Config"
  - select "Block Diagram > I/Q Stream Mapper > System Configuration > Fading/Baseband Config"
  - on the instrument front panel, press SETUP and select "System Configuration > Fading/Baseband Config"

The dialog comprises the settings required to configure the signal routing up to the "I/Q Stream Mapper". A *preview diagram* shows a detailed view of the signal processing for the currently selected configuration, together with a short description of the possible application of this configuration.

The screenshot shows the "System Configuration" dialog with the "Fading/Baseband Config" tab selected. The "Mode" is set to "Advanced". Under "Signal Outputs", "Analog & Digital" is selected. The "Entities (Users, Cells)" is set to 2, "Basebands (Tx Antennas)" is set to 2, and "Streams (Rx Antennas)" is set to 2. The "BB Source Config" is set to "Coupled Sources per Entity". The "Preview Diagram" on the right shows two entities, Entity 1 and Entity 2. Entity 1 has two basebands (A and B) connected to four fading blocks (F\_AA, F\_AB, F\_BA, F\_BB) which then connect to two streams (A and B). Entity 2 has two basebands (C and D) connected to four fading blocks (F\_CC, F\_CD, F\_DC, F\_DD) which then connect to two streams (C and D). Below the diagram, it says "Common Applications: LTE-A Carrier Aggregation (2CCs) with 2x2 MIMO".

If you are familiar with other Rohde&Schwarz signal generators, e.g. the R&S SMU or R&S AMU, you might expect that the block diagram also displays a detailed view of the

signal routing as it is done on the preview diagram. Consider, however, that if in "Fading/Baseband Configuration > Mode > Standard" this behavior is assured, for higher MIMO modes in "Mode > Advanced" the block diagram is rather an abstract representation of the configuration.

Refer to [Chapter 4.10.1, "Representation of the Signal Flow in the Block Diagram"](#), on page 202 for more information.



This section focuses on the settings available in the "System Configuration" dialog. For further details about the fading functionality, refer to the User Manual "Fading Simulator".

For step-by-step description on how to use the provided settings, refer to [Chapter 4.9.3, "How to Define the MIMO Scenario"](#), on page 181.

<a href="#">Set to Default</a> .....	133
<a href="#">Mode</a> .....	133
<a href="#">Signal Outputs</a> .....	134
<a href="#">Signal Routing</a> .....	134
<a href="#">System Configuration LxMxN</a> .....	134
L <a href="#">Entities (Users, Cells)</a> .....	135
L <a href="#">BB Signals (Tx Antennas)</a> .....	135
L <a href="#">Streams (Rx Antennas)</a> .....	136
<a href="#">Baseband Source Configuration</a> .....	136
<a href="#">Apply</a> .....	136
<a href="#">Ok</a> .....	136

### Set to Default

Presets the signal routing in the baseband section and the fading configuration to the default state.

Remote command:

`:SCONfiguration:PRESet` on page 772

### Mode

Switches between standard and advanced mode.

Execute "Apply" to trigger the instrument to adopt the selected configuration.

"Standard"	Provided for non-MIMO configuration.
"Advanced"	Depending on the installed hardware and software options, enables the configuration of: <ul style="list-style-type: none"> <li>• Complex MxN MIMO scenarios with up to 8 Tx or Rx antennas, e.g. 4x4, 2x8, or 8x2 MIMO</li> <li>• <a href="#">multiple entity</a> scenarios with up to four stand-alone 2x2 MIMO systems, e.g. 4x2x2 scenarios</li> <li>• Up to 8 <a href="#">SISO</a> systems, e.g. 8x1x1 scenarios</li> </ul>

See also:

- [Chapter 4.9.3, "How to Define the MIMO Scenario"](#), on page 181
- [Chapter 4.9.7, "How to Generate a 2x8 MIMO Signal for BS Tests"](#), on page 192

Remote command:

`:SCONfiguration:MODE` on page 772

### Signal Outputs

Defines whether an analog and digital or digital only signal is generated.

"Analog&Digital"

In this default mode, the instrument generates signals with high data rate.

Generated streams can be mapped to the analog connectors (RF/I/Q OUT) and to the digital I/Q interfaces (BBMM/FAD).

"Digital Only/Digital Only Multiplexed"

(requires option R&S SMW-K551)

R&S SMW can generate digital signals with reduced speed, depending on the device connected to the digital I/Q interfaces.

The supported configuration and mapping of the generated streams to the digital I/Q interfaces depends on the selected mode:

- In "Digital Only" mode, up to 4 streams can be mapped to the digital I/Q interfaces.
- In "Digital Only Multiplexed" mode, the multiplexed streams are mapped to the digital I/Q interfaces BBMM 1/2; the mapping is fixed.

See user manual R&S®SMW-K551 Generation of Digital "Slow IQ" Signals.

Remote command:

`:SCONfiguration:OUTPut:MODE` on page 773

### Signal Routing

Defines the signal routing in *non-MIMO Standard mode*. In a fully equipped instrument, the following configurations are available:

- A->A, B->B
- A->A, B->A
- A->B, B->B
- A->A and B, A->A and B
- B->A and B, B-> (open)
- A-> (open), B->A and B

The preview diagram displays the signal routing for the selected configuration.

Execute "Apply" to trigger the instrument to adopt the current configuration.

Remote command:

`:SCONfiguration:FADing` on page 773

### System Configuration LxMxN

In *Advanced mode*, the signal routing, i.e. the fading/baseband configuration LxMxN is determined by three parameters, "Entities", "BB Signals", and "Streams". The available configurations depend on the installed hardware and software options (see data sheet).

**Note:** The RF outputs are disabled, if you apply new [System Configuration LxMxN](#) and/or change the [Baseband Source Configuration](#).

**Entities (Users, Cells) ← System Configuration LxMxN**

Defines the number of entities to be generated.

An entity is a *self-contained independent system*, consisting of its own baseband part with possible fading simulator and noise generator as well as an RF part. An example of an entity is a user/mobile station or a cell/base station in one digital standard (e.g. 3GPP FDD, EUTRA/LTE, etc.). The R&S SMW can generate the signals of up to 8 entities.

The [Table 4-5](#) shows the interdependency between the number of entities (L), the number of baseband signals (M) and the number of streams (N).

**Table 4-5: Available value ranges and allowed combinations**

Number of Entities (L)	Number of Basebands (Tx Antennas) (M)	Number of Streams (Rx Antennas) (N)	Baseband Source Configuration
1	1 to 4	1 to 4	Separate, Coupled
1	8	1, 2	Coupled
1	1, 2	8	Separate, Coupled
2	1, 2	1 to 4	Separate, Coupled/Coupled per Entity
2	1 to 4	1, 2	Coupled/Coupled per Entity
3 .. 4	1, 2	1, 2	Coupled/Coupled per Entity
5 .. 8	1	1	Coupled

See also "[To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings](#)" on page 181.

**Tip:** Use the "System Configuration > Overview" tab to visualize the current stream mapping to the output interfaces.

Remote command:

See `:SCONfiguration:FADing` on page 773

**BB Signals (Tx Antennas) ← System Configuration LxMxN**

Defines the number of baseband signals or Tx antennas to be simulated per entity. If one entity is enabled, the R&S SMW can generate the signal of up to 8 Tx antennas simultaneously (see [Table 4-5](#)).

Configurations with "BB Signals (Tx Antennas) > 4" are enabled only with internal baseband signal.

**Note:** Error message: "The selected configuration is not fully supported by the current firmware".

Some baseband and fading configurations require that the R&S SMW is equipped with hardware and software options or the selected configuration is not yet fully supported.

For more information, refer to the instrument's data sheet.

Remote command:

See [:SCONfiguration:FADing](#) on page 773

### Streams (Rx Antennas) ← System Configuration LxMxN

Defines the number of streams or Rx antennas to be generated per entity. If one entity is enabled, the R&S SMW can generate the signal of up to 8 Rx antennas simultaneously (see [Table 4-5](#)).

Remote command:

See [:SCONfiguration:FADing](#) on page 773

### Baseband Source Configuration

Determines whether coupled or separated baseband sources are used (see "[Coupled or Separate Baseband Sources](#)" on page 126).

**Note:** The RF outputs are disabled, if you apply new [System Configuration LxMxN](#) and/or change the [Baseband Source Configuration](#).

"Separated"      The signal in each baseband can be and has to be configured separately.

Separated baseband sources are required, whenever the test scenario involves:

- A mixture of internally generated and externally supplied baseband signals
- A mixture of internally generated signals according to different digital standards

"Coupled/Coupled per Entity"

All required baseband signals are generated out of the same baseband source. This mode is supported by the "EUTRA/LTE" and "IEEE802.11 WLAN" digital standards, by the "ARB" and by applying external digital baseband signals.

Using coupled baseband sources is recommended for complex test scenarios. These modes are enabled if a [System Configuration LxMxN](#) with  $L > 1$  and/or  $M > 1$  is selected.

In LxMxN configuration with  $L > 1$ , the baseband sources can also be coupled per entity.

Remote command:

[:SCONfiguration:BASEband:SOURce](#) on page 774

### Apply

Triggers the instrument to adopt the selected configuration.

**Note:** The RF outputs are disabled, if you apply new [System Configuration LxMxN](#) and/or change the [Baseband Source Configuration](#).

Remote command:

[:SCONfiguration:APPLY](#) on page 774

### Ok

Applies the configuration and exits the dialog.



Remote command:

:SCONfiguration:APPLY on page 774

#### 4.4.2 I/Q Stream Mapper Settings

- ▶ To access this dialog box, use one of the following:
  - select "Block Diagram > I/Q Stream Mapper"
  - select "Taskbar > System Config > System Configuration > I/Q Stream Mapper"
  - select "Block Diagram > Fading > System Configuration > I/Q Stream Mapper"
  - on the instrument front panel, press SETUP and select "System Configuration > I/Q Stream Mapper"

	Frequency Offs /Hz	Phase Offs P	RF A	RF B	I/Q OUT 1	I/Q OUT 2	BBMM 1	BBMM 2	FAD 3	FAD 4
Stream A	-20 000 000.00	0.00	↓				↓			
Stream B	0.00	0.00		↓				↓		
Stream C	-20 000 000.00	0.00			↓		↓		↓	
Stream D	0.00	0.00				↓		↓		↓
Combination			Single	Single	Single	Single	Add	Add	Single	Single

Figure 4-3: Example: I/Q Stream Mapper settings in a LxMxN configuration with four streams

The dialog provides the settings for routing of the signal streams to the available output connectors, the analog RF and I/Q output, and the digital I/Q output connectors.

Meaning of the background colors:

- **Yellow:** Streams mapped to the RF, I/Q and the BBMM connectors can be added, possibly also frequency and phase shifted. At the BBMM connectors, streams can also be output multiplexed.
- **Grey:** The stream mapping to the FADER connectors is fixed. Only single streams can be mapped to the FADER connectors; frequency offset cannot be applied.  
If, however, R&S SMBV or R&S SGT instruments are connected to the FADER connectors and they are remotely controlled by the R&S SMW, the selected frequency offset is applied to the RF signal of these instruments.

The settings are displayed in form of a stream matrix, where:

- The number of rows is equal to the number of the generated streams ("System Configuration > Fading/Baseband Configuration > Advanced Mode" and selected [Entities \(Users, Cells\)\\*Streams \(Rx Antennas\)](#))

- The column display only the available digital output interfaces ("System Configuration > External RF and I/Q > Direction > Out").

<a href="#">f<sub>offset</sub>, MHz</a> .....	138
<a href="#">Phase, deg</a> .....	138
<a href="#">Map Stream X to Connector</a> .....	138
<a href="#">Combination Mode</a> .....	139

### **f<sub>offset</sub>, MHz**

Sets an absolute frequency offset; streams routed to the RF, I/Q OUT and BBMM connectors are shifted in the frequency domain.

Frequency offset is also applied to R&S SMBV and R&S SGT instruments connected to the FADER outputs.

**Tip:** Use this parameter:

- To shift the used frequency band in the RF frequency section without modifying the RF settings
- To separate streams in the frequency domain, if these streams are added and routed to the same output connector

**Note:** The parameters "Baseband Offset" and "Frequency Offset" have different impact.

Both parameters shift the signal in the frequency domain, but only the  $f_{\text{offset}}$  affects the calculation of the "Doppler Shift".

If the fading simulator is used, do not apply a "Baseband Offset" but do use the "Frequency Offset" instead.

See also:

- "Fading Simulation" user manual, description of the parameter "Dedicated Frequency".
- "[Combination Mode](#)" on page 139.

Remote command:

`:SCONfiguration:OUTPut:MAPPING:STReam<st>:FOFFset` on page 776

### **Phase, deg**

Sets the phase offset of the corresponding stream.

Remote command:

`:SCONfiguration:OUTPut:MAPPING:STReam<st>:POFFset` on page 776

### **Map Stream X to Connector**

The mapping of the generated streams to the output connectors is represented as a stream matrix. A blue circle at a matrix element routes the selected stream to the corresponding connector.

To map more than one stream to an output connector, enable the [Combination Mode](#).

The stream mapping to the FADER connectors is fixed.

Remote command:

`:SCONfiguration:OUTPut:MAPPING:RF<ch>:STReam<st>:STATe` on page 775

`:SCONfiguration:OUTPut:MAPPING:IQOutput<ch>:STReam<st>:STATe`

on page 775

`:SCONfiguration:OUTPut:MAPPING:BBMM<ch>:STReam<st>:STATe`

on page 775

`:SCONfiguration:OUTPut:MAPPING:FADer<ch>:STReam<st>:STATe?`

on page 775

### Combination Mode

Defines the way the streams are internally processed if multiple streams are routed to the same physical connector.

**Tip:** Use the parameter  $f_{\text{offset}}$ , MHz to shift the frequency bands of the streams in the frequency domain.

"Single"	One stream can be routed to several connectors but only one stream can be mapped on each connector.
"Add"	If more than one stream are routed to the same RF, I/Q OUT or BBMM connector, they are added equally weighted.
"Mux"	(requires option R&S SMW-K551) Enables stream multiplexing at the digital connectors. The exact parameters are defined in the "Digital I/Q Output" dialog. <b>Tip:</b> This mode is useful to output the generated signals of a higher-order MIMO configuration at less digital connectors. The connected instrument must support stream multiplexing. See <a href="#">Chapter 4.7, "I/Q Digital Output Settings"</a> , on page 166  See user manual R&S®SMW-K551 Generation of Digital "Slow IQ" Signals.

Remote command:

`:SCONfiguration:OUTPut:MAPPING:RF<ch>:MODE` on page 775

`:SCONfiguration:OUTPut:MAPPING:IQOutput<ch>:MODE` on page 775

`:SCONfiguration:OUTPut:MAPPING:BBMM<ch>:MODE` on page 775

`:SCONfiguration:OUTPut:MAPPING:FADer<ch>:MODE?` on page 775

## 4.4.3 External RF and I/Q Settings

A fully equipped R&S SMW can deliver up to 8 independent I/Q streams but can modulate only two of them to the RF domain using the internal RF paths. The remaining streams can be output at the analog or digital I/Q interfaces and led to the connected external RF signal generators. With the settings in the "External RF and I/Q" tab, you can control these external devices from the R&S SMW, if the required remote control connections (LAN or USB) are established additionally to the I/Q connections.

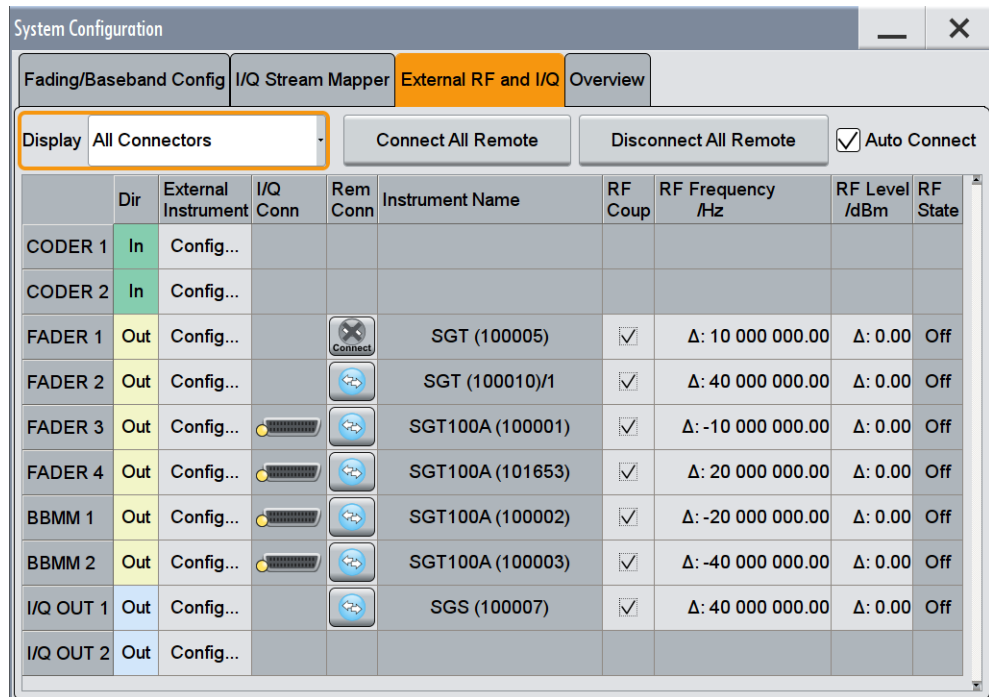


A LAN or USB connection between the external instruments and the R&S SMW is a prerequisite to control them from the instrument.

All instruments must use a common reference frequency signal, either from an external common reference source or using the distributed reference frequency of the R&S SMW.

► To access this dialog:

- Select "Taskbar > System Config > System Configuration > External RF and I/Q" or
- On the instrument front panel, press SETUP and select "System Configuration > External RF and I/Q".



The dialog provides an overview of all available I/Q input and output connectors and comprises the settings necessary to establish the connection to the external instruments. Displayed is an overview of the currently connected external instruments together with relevant information like the connection status and the RF level and frequency these external instruments shall use.

The dialog provides access to some additional short information on each of the connected instruments. It also provides a find function for an easy localization of the selected connector on the instrument front and/or rear panel.

For step-by-step description on how to use the provided settings, refer to:

- [Chapter 4.9.5, "How to Cable the Instruments in MIMO Test Setups"](#), on page 184
- [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185
- [Connections Configuration and Connection Status Overview Settings](#)..... 140
- [External Instrument Configuration Settings](#).....146

#### 4.4.3.1 Connections Configuration and Connection Status Overview Settings

<a href="#">Display</a> .....	141
<a href="#">Auto Connect</a> .....	141
<a href="#">Connect/Disconnect All Remote</a> .....	141
<a href="#">Connector Name</a> .....	142

Direction.....	142
External Instrument.....	143
I/Q Connection.....	143
Remote Connection Status.....	144
Instrument Name.....	144
RF Couple.....	145
(Delta) RF Frequency/ RF Level.....	145
RF State.....	145

### Display

Filters the displayed connectors upon one of the following criteria:

#### "All Connectors"

No filter is applied.

#### "Mapped Connectors"

Displayed are only the connectors to which a stream is mapped (see ["Map Stream X to Connector"](#) on page 138).

**Note:** To prevent faults, use this filter before you further configure the external instruments.

#### "Input Connectors/Output Connectors"

Filters the display according to connector direction.

Remote command:

`:SCONfiguration:EXTernal:DISPlay` on page 778

### Auto Connect

With enabled auto connect function, the instrument automatically detects connected external instruments and (re)establish the required connection.

If the "Auto Connect > Off", however, after a startup you have to revise the test setup and perform the following:

- Check whether the necessary connections to the external instruments are still existing.
- Prove that the remote control of this instrument is required.
- Trigger the [Connect All Remote](#) function.

Remote command:

`:SCONfiguration:EXTernal:ACONnect` on page 778

### Connect/Disconnect All Remote

Triggers the instrument to:

- Establish the connections to all configured [External Instrument](#)
- To disconnect all existing connections.

The status of each connection is displayed and can be toggled with the parameter [Remote Connection Status](#).

#### Note:

External instruments connected to the R&S SMW are preset (`:DEVice:PRESet`) whenever:

- The connection to the external instrument is established or terminated ("Connect/ Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMW is preset (PRESET).

To ensure that the connections to the external instruments will be automatically established after instrument's start up, enable the parameter [Auto Connect](#).

See also:

- [Chapter 4.9.5, "How to Cable the Instruments in MIMO Test Setups"](#), on page 184
- [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185.

Remote command:

`:SCONfiguration:EXTernal:REMOte:CONNect[:ALL]` on page 778

`:SCONfiguration:EXTernal:REMOte:DISConnect[:ALL]` on page 778

### Connector Name

Displays the connector name.

The dialog lists the connectors, required for the current "Fading and Baseband Configuration".

See also:






- [Chapter 4.3.1, "Physical Location of the Input and Output Interfaces"](#), on page 128
- [Chapter 4.4.1, "Fading and Baseband Configuration Settings"](#), on page 132





### Direction

Displays the connector direction as a color coded field, where:

- the direction is determined by the selected "Fading and Baseband Configuration"
- the color is determined by the configuration in the "I/Q Stream Mapping" dialog.

The following table gives an overview of the possible combinations and explains the used designations.

Connector	Direction/ Color	Enabled in the "Fading and Baseband Configuration"	Enabled in the "I/Q Stream Mapping"
CODER		Yes	-
	Input Grey	Not used	-
FADER		Yes	-
		Yes	Yes
		Yes	Not used
		Not used	Not used

Connector	Direction/ Color	Enabled in the "Fading and Base- band Configuration"	Enabled in the "I/Q Stream Mapping"
BBMM		Yes	Yes
		Yes	Not used
I/Q OUT		Yes	Yes
		Yes	Not used

Remote command:

:SCONfiguration:EXTernal:CODer<ch>:DIRection? on page 779

:SCONfiguration:EXTernal:FADer<ch>:DIRection? on page 779

:SCONfiguration:EXTernal:BBMM<ch>:DIRection? on page 779

:SCONfiguration:EXTernal:IQOutput<ch>:DIRection? on page 779

### External Instrument

Accesses a dialog with settings that help you to establish the connection to the external instruments, see [Chapter 4.4.3.2, "External Instrument Configuration Settings"](#), on page 146.

#### Note:

Each external instrument must be connected via a LAN or USB to the R&S SMW.



All instruments must use a common reference frequency signal, either from an external common reference source or using the distributed reference frequency of the R&S SMW.


See also:

- [Chapter 4.9.5, "How to Cable the Instruments in MIMO Test Setups"](#), on page 184
- [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185.

### I/Q Connection

Indicates the status of the I/Q connection of the digital interfaces.

Indication		Designation
A green LED and an icon		The DIG I/Q interface is used as an input connector
A yellow LED and an icon		The DIG I/Q interface is used as an output connector

Indication		Designation
An icon without an LED		An external instrument is connected to the DIG I/Q interface, but no direction is specified
No icon displayed		No connection

Remote command:

[:SCONfiguration:EXTernal:CODer<ch>:IQConnection:STATe?](#) on page 779

[:SCONfiguration:EXTernal:FADer<ch>:IQConnection:STATe?](#) on page 779

[:SCONfiguration:EXTernal:BBMM<ch>:IQConnection:STATe?](#) on page 779

### Remote Connection Status

Indicates the status of the remote connection. A click on the status indicator, toggles the remote connection status.

To connect/disconnect all external instruments, use the functions [Connect/Disconnect All Remote](#).

#### Note:

External instruments connected to the R&S SMW are preset ([:DEVice:PRESet](#)) whenever:

- The connection to the external instrument is established or terminated ("Connect/Disconnect All Remote" or "Rem. Conn > On/Off")
- The R&S SMW is preset (PRESET).

**Note:** An active "Rem. Conn." and an "RF State > On" do not necessary mean that an I/Q stream is mapped to this connector!

Use the "System Configuration > External Rf and I/Q > Display > Mapped Connectors" filter to list only the connectors with a mapped I/Q stream.

Remote command:

[:SCONfiguration:EXTernal:FADer<ch>:RCONnection:STATe?](#) on page 779

[:SCONfiguration:EXTernal:FADer<ch>:REMote:DISConnect](#) on page 785

[:SCONfiguration:EXTernal:BBMM<ch>:RCONnection:STATe?](#) on page 779

[:SCONfiguration:EXTernal:BBMM<ch>:REMote:DISConnect](#) on page 785

[:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?](#)

on page 779

[:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect](#)

on page 785

[:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?](#) on page 785

[:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO?](#) on page 785

[:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?](#) on page 785

### Instrument Name

Displays useful information on the connected external instrument, like the instrument designation and the RF path the RF settings are coupled to.

Remote command:

[:SCONfiguration:EXTernal:CODer<ch>:INAME?](#) on page 779

[:SCONfiguration:EXTernal:FADer<ch>:INAME?](#) on page 779

[:SCONfiguration:EXTernal:BBMM<ch>:INAME?](#) on page 780

[:SCONfiguration:EXTernal:IQOutput<ch>:INAME?](#) on page 780



[:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?](#) on page 785  
[:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO?](#) on page 785  
[:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?](#) on page 785

### RF Couple

If enabled, this parameter couples all major RF setting (like the "RF Frequency", the "RF Level" and the "RF State") of the external instrument to the R&S SMW.

The R&S SMW acts as a "master", i.e the external instruments synchronize their settings and the RF A output state to the R&S SMW. You can apply delta frequency and level offset to the signal.

Remote command:

[:SCONfiguration:EXTernal:FADer<ch>:RF:COUPling](#) on page 780  
[:SCONfiguration:EXTernal:BBMM<ch>:RF:COUPling](#) on page 780  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPling](#) on page 780

### (Delta) RF Frequency/ RF Level

With enabled "RF Coupled" parameter, sets a delta frequency and level value. The RF Frequency of the external instrument is calculated as follows:

$$RF_{ExtInstr} = RF_{A_{R\&S\ SMW}} + \Delta_{Freq}$$

In uncoupled mode, sets the RF frequency and RF level of the external instrument.

Remote command:

[:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency](#) on page 780  
[:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQuency](#) on page 780  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency](#) on page 780  
[:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency:OFFSet](#) on page 781  
[:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQuency:OFFSet](#) on page 781  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency:OFFSet](#) on page 781  
[:SCONfiguration:EXTernal:FADer<ch>:RF:POWer](#) on page 781  
[:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer](#) on page 781  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer](#) on page 781  
[:SCONfiguration:EXTernal:FADer<ch>:RF:POWer:OFFSet](#) on page 781  
[:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer:OFFSet](#) on page 781  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet](#) on page 781

### RF State

With enabled "RF Coupled" parameter, displays the RF output state of the connected external instrument. The parameter is coupled to the state of the RF output of the R&S SMW.

In uncoupled mode, enables/disables the RF output in the external instrument.

Remote command:

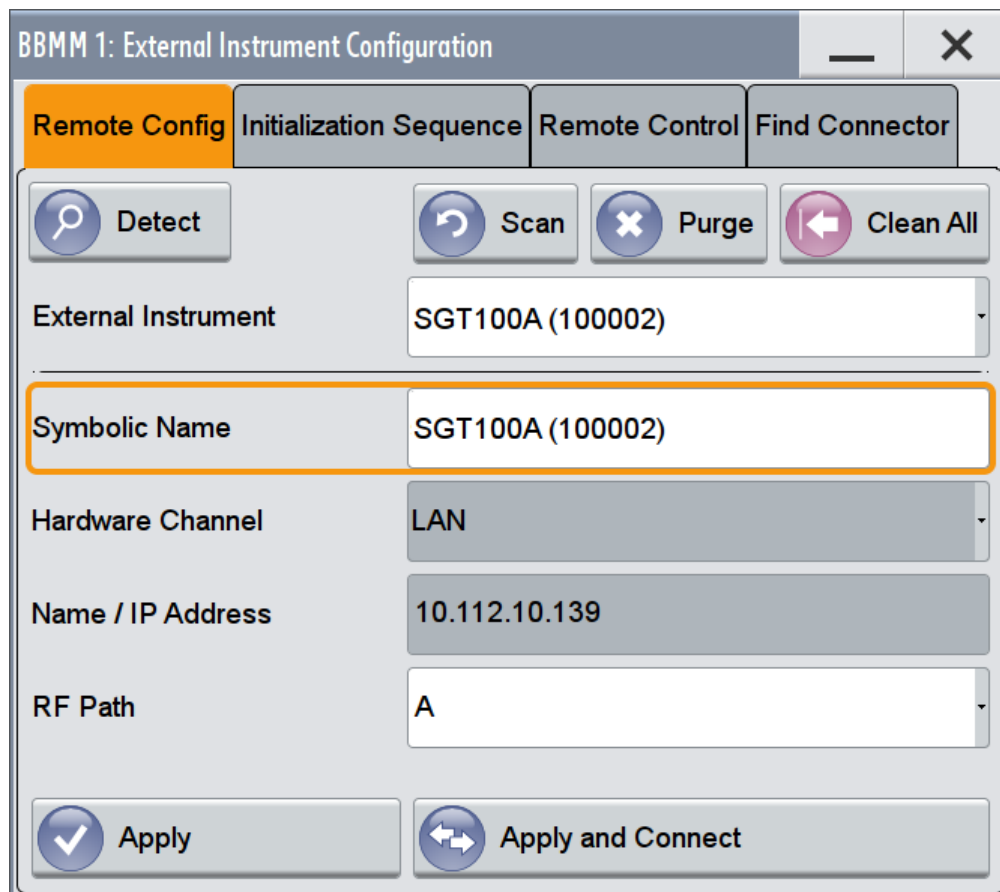
[:SCONfiguration:EXTernal:FADer<ch>:RF:STATe](#) on page 782  
[:SCONfiguration:EXTernal:BBMM<ch>:IQConnection:STATe?](#) on page 779  
[:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe](#) on page 782

4.4.3.2 External Instrument Configuration Settings

To access this dialog:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector and select "External Instruments > Config ...".

The "<Dig. Conn. Name>: External Instrument Configuration" dialog opens and displays the "External Instrument Configuration > Remote Config" settings.



**Settings:**

Remote Config Settings.....	146
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Remote Control Settings.....	151
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**Remote Config Settings**

Detect/Scan.....	147
Purge/Clean.....	147
Select Instrument.....	147

Symbolic Name.....	148
Hardware Channel.....	148
Name / IP Address.....	148
RF Path.....	148
Apply.....	148
Apply and Connect.....	149

### Detect/Scan

If you connect an external instrument, you can fill in the required information in the "External Instrument Configuration" dialog manually or use one of the provided "Detect/Scan" functions. Both functions consider connections via the supported interfaces, USB or LAN.

The parameter [Select Instrument](#) lists the pool of available instruments.

**Note:** The first initialization of an instrument connected to a network may last several minutes. During their initialization, instruments are not detected by the detect/scan function.

"Detect"                Searches for external instruments connected to this particular digital interface of the R&S SMW.

Remote command:

[:SCONfiguration:EXTernal:FADer<ch>:REMote:DETECT?](#) on page 784

[:SCONfiguration:EXTernal:BBMM<ch>:REMote:DETECT?](#) on page 784

"Scan"                 Scans the network for connected supported instruments, like R&S SMW, R&S SGS, R&S SGT, R&S SMBV, R&S SMU, R&S SMATE, and R&S SMJ.

**Note:** The scan function searches throughout the entire network and may last several minutes.

Remote command:

[:SCONfiguration:EXTernal:REMote:SCAN](#) on page 782

[:SCONfiguration:EXTernal:REMote:SCAN:STATe?](#) on page 782

### Purge/Clean

Triggers the instrument to purge at once all other connections except the configured and the currently selected one. This allows you to retrieve a new pool of valid instruments.

The clean function removes all configured settings from the "External RF and I/Q".

Remote command:

[:SCONfiguration:EXTernal:REMote:PURGe](#) on page 787

[:SCONfiguration:EXTernal:REMote:CLEan](#) on page 787

### Select Instrument

Lists all available instruments, found by the [Detect/Scan](#) function.

To connect an external instrument, use one of the following:

- Enable "Select Instrument > New" and configure the settings manually
- Select "Select Instrument", navigate through the pool of available instruments, and select the required. The required settings are retrieved and updated automatically.

Select "None" to disable the connection.

Execute "Apply" to confirm the settings.

Remote command:

:SCONfiguration:EXTernal:REMote:LIST? on page 783  
:SCONfiguration:EXTernal:REMote:ADD on page 783  
:SCONfiguration:EXTernal:FADer<ch>:REMote:ISElect on page 784  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:ISElect on page 784  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISElect on page 784

### Symbolic Name

Sets the alias name of the instrument.

Remote command:

:SCONfiguration:EXTernal:REMote:ADD on page 783  
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 785

### Hardware Channel

Selects the hardware channel (USB or LAN) used by the remote channel to the external instrument.

Remote command:

:SCONfiguration:EXTernal:REMote:ADD on page 783  
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 785

### Name / IP Address

Displays/sets the IP address or hostname of the connected external instrument.

Remote command:

:SCONfiguration:EXTernal:REMote:ADD on page 783  
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 785

### RF Path

In a two-path instrument, determines the RF output to be used.

Remote command:

:SCONfiguration:EXTernal:REMote:ADD on page 783  
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO? on page 785  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO? on page 785

### Apply

Confirms the settings and displays the external instrument in the "External RF and I/Q" dialog.

Remote command:

:SCONfiguration:EXTernal:FADer<ch>:REMote:ISElect on page 784

:SCONfiguration:EXTernal:BBMM<ch>:REMote:ISElect on page 784

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISElect on page 784

### Apply and Connect

Confirms the settings and triggers the connection establishment. In the connected instruments, the status of this active remote connection is displayed by the "Remote" indication.

Remote command:

:SCONfiguration:EXTernal:FADer<ch>:REMote:ISElect on page 784

:SCONfiguration:EXTernal:FADer<ch>:REMote:CONNECT on page 785

:SCONfiguration:EXTernal:BBMM<ch>:REMote:ISElect on page 784

:SCONfiguration:EXTernal:BBMM<ch>:REMote:CONNECT on page 785

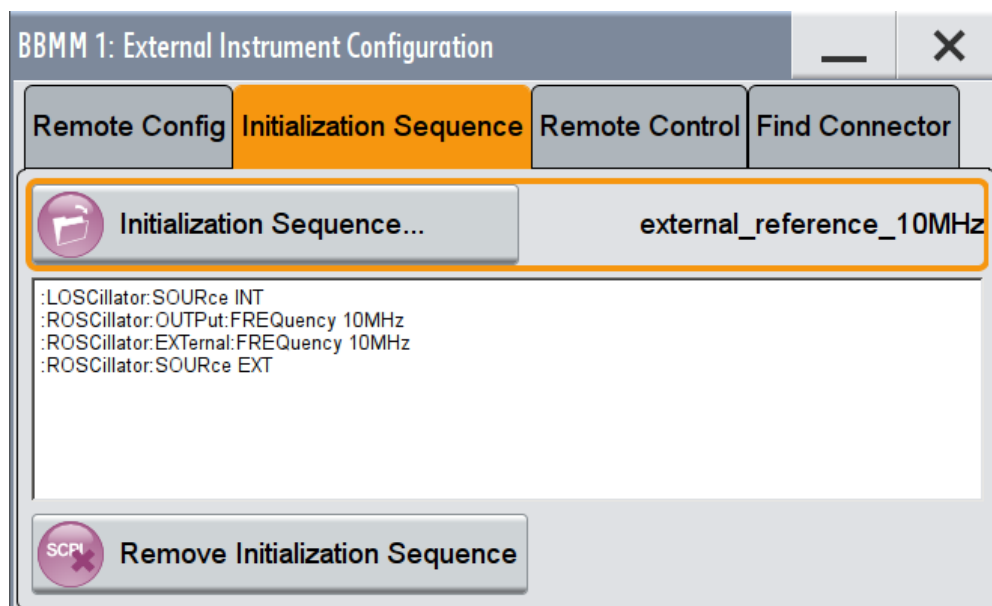
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISElect on page 784

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNECT on page 785

### Initialization Sequence Settings

To access this dialog:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector and select "External Instruments > Config ...".
3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Initialization Sequence".



The dialog displays the content of a loaded initialization sequence for remote control of the connected external instrument from the R&S SMW.

<a href="#">Initialization Sequence</a> .....	150
<a href="#">Remove Initialization Sequence</a> .....	151

### Initialization Sequence

Accesses the standard "File Select" dialog for loading an existing initialization file (extension \*.iec).

Use the "Predefined Settings" function to access a predefined initialization file or navigate to a user defined one.

When you establish the connection to an external instrument, i.e. [Remote Connection Status](#) is active, the R&S SMW performs the following:

- Sends the command `:DEvice:PRESet`
- Sends the content of the initialization sequence file to reconfigure the external instrument

If required, perform further settings and configuration of the external instruments.

**Tip:** Try out also the following:

- Send individual SCPI commands or a sequence of SCPI commands to the connected instruments or define your own initialization sequence and load the file  
See "[To create a remote control sequence or modify the initialization sequence](#)" on page 191
- If you are configuring the R&S SMW remotely from a controller, try out to remote control the connected R&S SGS/R&S SGT via the R&S SMW.  
See:
  - [Example "Controlling the R&S SMW and external RF instruments with the same application program"](#) on page 768
  - [Example "Connecting an external instrument and sending SCPI commands to it"](#) on page 771

Remote command:

`:SCONfiguration:EXTernal:REMote:INITialization:USER:CATalog?`  
on page 786

`:SCONfiguration:EXTernal:REMote:INITialization:PREDefined:CATalog?` on page 786

`:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:USER:FILE` on page 786

`:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:PREDefined:FILE` on page 787

`:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:FILE?`  
on page 787

`:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:USER:FILE` on page 786

`:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:PREDefined:FILE` on page 787

`:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:FILE?`  
on page 787

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:USER:FILE on page 786

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:PREDefined:FILE on page 787

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE? on page 787

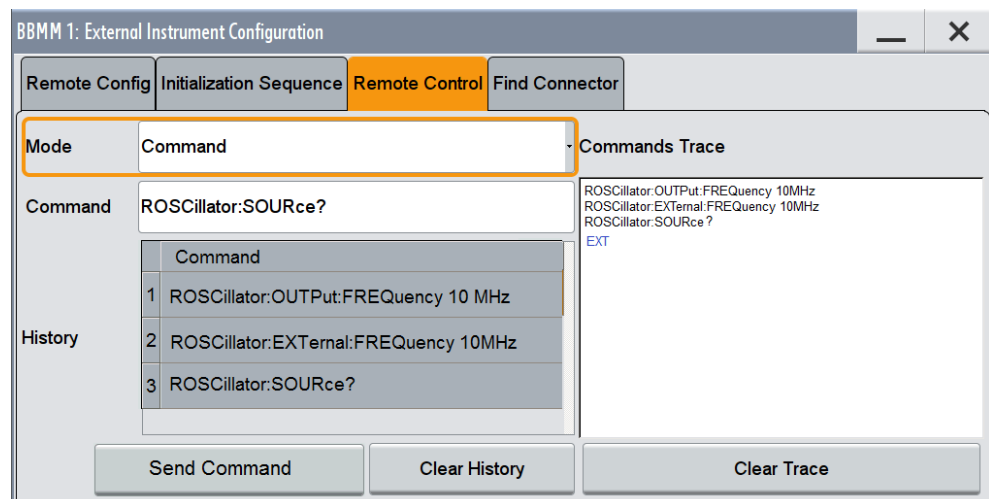
### Remove Initialization Sequence

Deletes the loaded sequence.

### Remote Control Settings

To access this dialog:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector and select "External Instruments > Config ...".
3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Remote Control".



In this dialog, you can send individual SCPI commands or a sequence of SCPI commands to the connected instruments.

The sent commands and their results are displayed in the "Command Trace" field, as long as the trace is not deleted "Clear Trace". The sent commands are also listed in the "History" list. As long as this history list is not deleted ("Clear History"), you can select a command from the list and send it again.

See also:

- ["To create a remote control sequence or modify the initialization sequence"](#) on page 191
- [Example "Controlling the R&S SMW and external RF instruments with the same application program"](#) on page 768.

Mode.....	152
Command, Send Command.....	152
File, Sequence, Send Sequence.....	152
History, Clear History.....	152
Commands Trace, Clear Trace.....	152

**Mode**

You can send a single command ("Command") or a command sequence ("Sequence") to the connected instrument.

**Command, Send Command**

Entry field for the SCPI commands.

You can enter a new command or select a previously sent command from the "History".

If the remote connection is active, select "Send Command" to execute the command.

Remote command:

`:SCONfiguration:EXTernal:BBMM<ch>:REMote:SEND` on page 788

`:SCONfiguration:EXTernal:FADer<ch>:REMote:SEND` on page 788

`:SCONfiguration:EXTernal:IQOutput<ch>:REMote:SEND` on page 788

**File, Sequence, Send Sequence**

Accesses the standard "File Select" dialog for loading of user defined files with extension \*.iec.

The provided navigation possibilities in the dialog are self-explanatory.

When a file is selected, its name and content are displayed, and the first command is selected. You can send the commands one by one ("Send Command") or send the entire sequence at once ("Send Sequence").

After a command is sent, the next command from the sequence is selected.

See also:

- ["To create a remote control sequence or modify the initialization sequence"](#) on page 191
- ["Initialization Sequence"](#) on page 150
- [Chapter 10.5.1, "File Select Settings"](#), on page 586.

**History, Clear History**

List of the sent commands.

As long as this history list is not cleared ("Clear History"), you can select a command from the list and send it again.

**Commands Trace, Clear Trace**

List of the sent commands and their results, where the results are displayed in blue color.

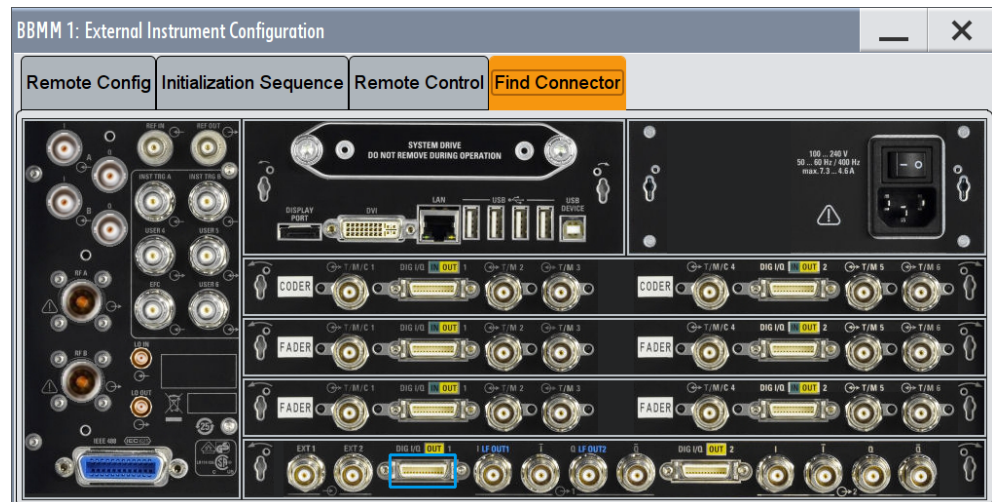
To delete the trace, select "Clear Trace".



## Find Connector

To access this dialog:

1. Select "Taskbar > System Config > System Configuration > External RF and I/Q".
2. Navigate to the required connector and select "External Instruments > Config ...".
3. In the "<Dig. Conn. Name>: External Instrument Configuration" dialog, select "Find Connector".



The dialog displays the location of the selected connector.

The "Find Connector" function triggers the instrument to identify the connector on the rear panel. The LED next to the selected connector blinks.

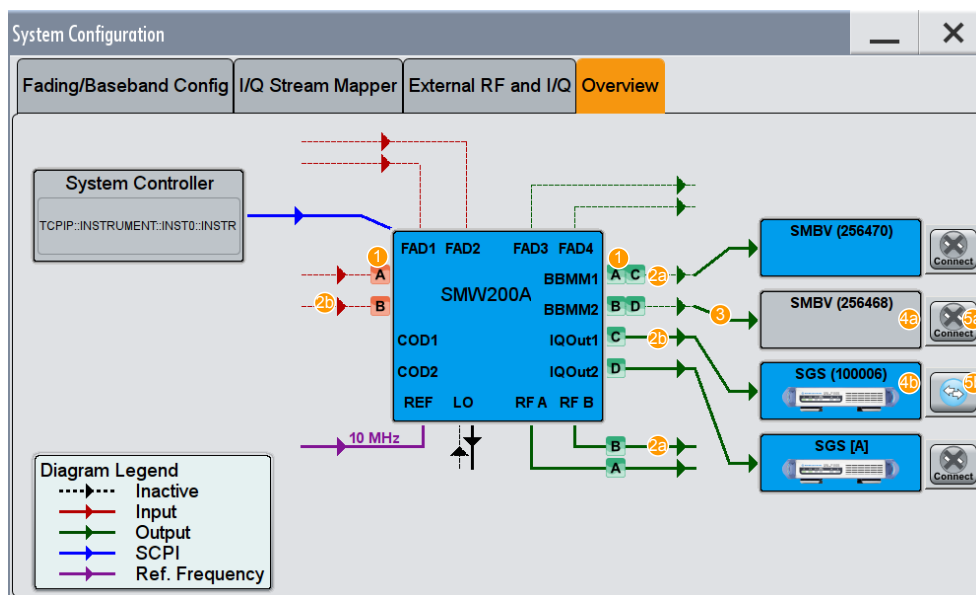
See also [Chapter 4.3.1, "Physical Location of the Input and Output Interfaces"](#), on page 128.

## 4.4.4 Overview

- ▶ To display an *interactive* overview diagram of the current configuration, select "System Configuration > Overview".

The overview tab shows information on:

- Current stream mapping to the output interfaces, see [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137.
- Connected controller (external PC).
- Connections for remote control of connected external I/Q and RF devices, [Chapter 4.4.3, "External RF and I/Q Settings"](#), on page 139
- Input and output signals, like:
  - LO coupling or used external reference frequency.
  - Connected external baseband source to the digital input interface.



- 1 = I/Q streams mapped to the interfaces
- 2a = state indication for the RF and digital/analog IQ outputs: active
- 2b = state indication for the RF and digital/analog IQ outputs: inactive
- 3 = external instrument configured in the "External RF and I/Q" dialog
- 4a = grey background color: deactivated RF outputs of the external instrument
- 4b = blue background color: activated RF outputs of the external instrument
- 5a = remote connection state indicator: existing physical connection with disabled status
- 5b = remote connection state indicator: external instrument connected to and operated from the R&S SMW

Compare the overview representation with the example configuration in [External RF and I/Q Settings](#).

**Hotspots for fast access to the required settings**

Several of the displayed elements are hotspots. Select one of the elements listed in [Table 4-6](#) to access the related dialog.

**Table 4-6: Hotspots in the "Overview" tab**

GUI element	Dialog	Refer to
"System Controller"	"Remote Access Settings"	See <a href="#">Chapter 12.4.6, "Active Connections Settings"</a> , on page 668
"COD 1/2" or the associated Stream	"Baseband Input Settings"	See <a href="#">Chapter 4.6, "Digital Baseband Input Settings"</a> , on page 159
"IQ OUT1/2" or the associated Stream	"I/Q Analog Outputs"	See <a href="#">Chapter 4.8, "I/Q Analog Output Settings"</a> , on page 173
"BBMM 1/2" "FAD 3/4" or the associated Stream	"I/Q Digital Outputs"	See <a href="#">Chapter 4.7, "I/Q Digital Output Settings"</a> , on page 166

GUI element	Dialog	Refer to
"FAD 1/2" or the associated Stream	Depends on the current configuration and whether the digital interface acts as input or as output: "Baseband Input Settings" "I/Q Digital Outputs"	See <a href="#">Chapter 4.6, "Digital Baseband Input Settings"</a> , on page 159 See <a href="#">Chapter 4.7, "I/Q Digital Output Settings"</a> , on page 166
"RF A/B" or the associated Stream	"I/Q Modulator"	See <a href="#">Chapter 7.3, "I/Q Modulator Settings"</a> , on page 400
Icon of a connected external Instrument	"External Instrument Configuration"	See <a href="#">Chapter 4.4.3.2, "External Instrument Configuration Settings"</a> , on page 146
"REF"	"Ext. Reference"	See <a href="#">Chapter 8.5, "Reference Oscillator"</a> , on page 422
"LO"	"LO Coupling"	See <a href="#">Chapter 8.6, "Local Oscillator Coupling"</a> , on page 428

## 4.5 Signal Routing Settings

In [Standard mode](#), the signal routing settings are a routing possibility suitable for straightforward non-MIMO configuration configurations. If you are familiar with other Rohde&Schwarz signal generators, e.g. the R&S SMU or R&S AMU, these settings provide a convenient way to configure the signal flow. Consider, however, that the number of the possible configurations is rather limited. To experience the whole routing performance of the instrument, use the more advanced configurations (see [Chapter 4.4, "System Configuration Settings"](#), on page 131).



### Other possibilities to configure the signal flow

The "Signal Routing" settings are just one of several methods you may use to configure the signal flow and route the signal throughout the instrument. Refer to [Chapter 4.2, "Possible Ways to Configure the Signal Flow"](#), on page 124 for an overview of all other ways and their common application fields.

In the default state of the instrument, i.e. in **"System Configuration > Mode = Standard"**, the baseband internal and external signals can be routed as defined in the [Table 4-7](#).

As shown in the table:

- The internal baseband signal can be introduced into path A, path B or both
- The external baseband signal of the first input module "BB Input A" can be fed into path A, path B or both
- The second baseband input module "BB Input B" is firmly connected to signal path B

- If internal signals from one or two paths are generated at the same time, all signals in each path are summed.

**Table 4-7: Possible baseband signal routing combinations (default instrument state)**

Block in the block diagram	To path A	To path B	To path A and B
"Baseband A"	X	X	X
"Baseband B"	X	X	X
"BB Input A"	X	X	X
"BB Input B"		X	



### Interdependency between the "Signal Routing" settings and the "System Configuration" settings

The signal routing settings are enabled for the following configurations:

- "System Configuration > Mode = Standard"
- "System Configuration > Mode = Advanced" with maximum two "Separate Baseband Sources", e.g. in 1x2x2, 2x1x1 or 2x1x2 configurations  
See also ["The meaning of the short form representations of the fading and baseband configurations"](#) on page 124.

For an overview of the signal routing possibilities of the faded baseband signal, refer to [Chapter 4.4.1, "Fading and Baseband Configuration Settings"](#), on page 132.

**Example: Baseband and fading signal routing in standard mode**

The Figure 4-4 shows an example of the signal flow for the following signal routing settings:

- "Baseband A > Signal Routing > route to path A and B"
- "Baseband B > Signal Routing > route to path A and B"
- "BB Input A > Signal Routing > route to path A and B"
- "BB Input B > Signal Routing > route to path B"
- "Fading > System Configuration > Mode = Standard > System Configuration > A to A and B, B to A and B"

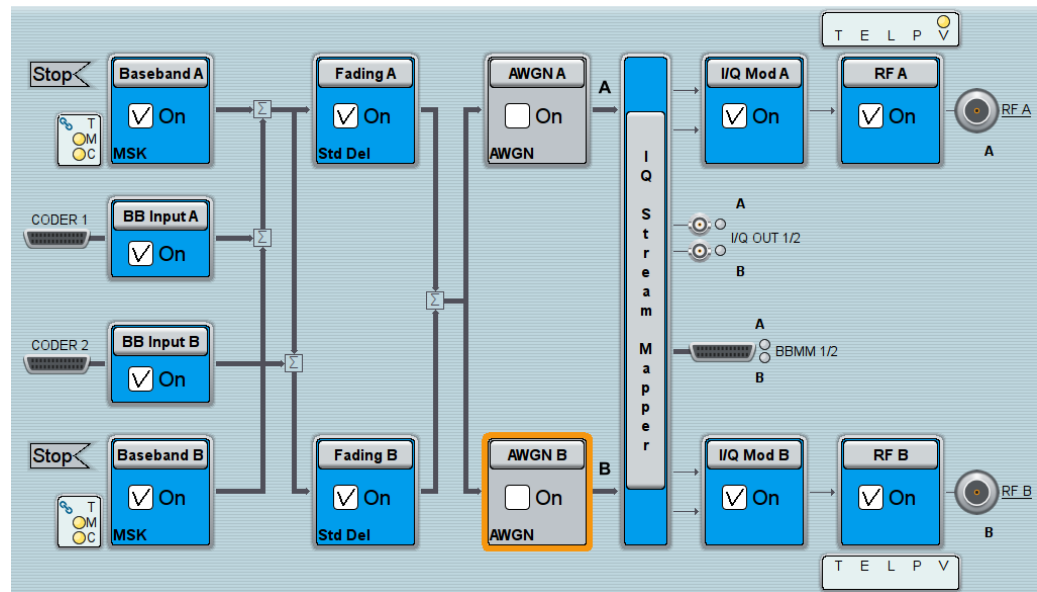


Figure 4-4: Example: Baseband and fading signal routing in standard mode

**Example: Routing the signal of baseband A to the RF B output**

The Figure 4-5 shows an example of the signal flow for the following settings:

- "IQ Stream Mapper > Stream A to RF B"
- "Baseband A > State > On"
- "RF B > State On"

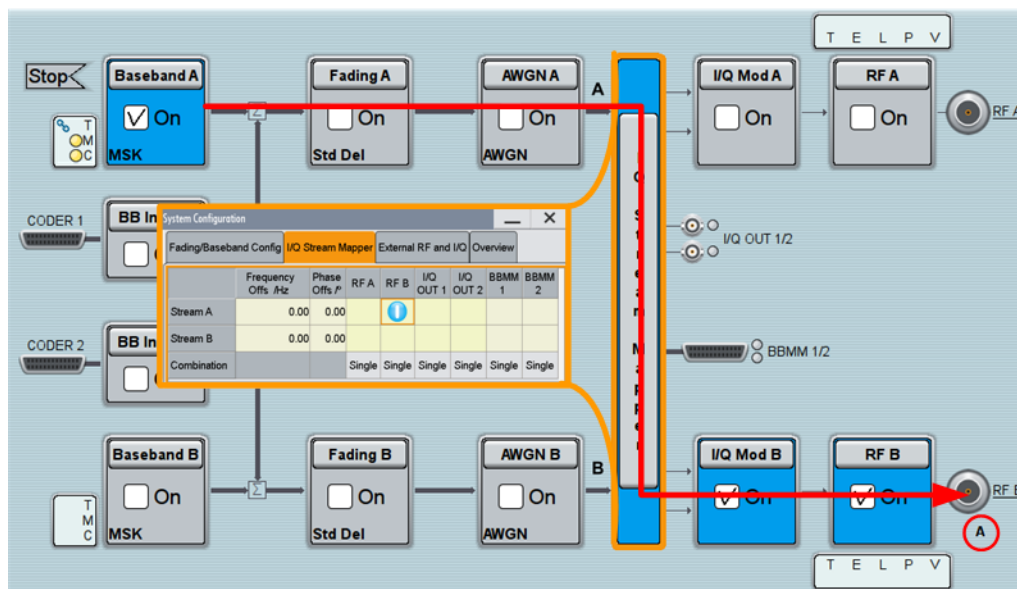


Figure 4-5: Example: Routing the signal of baseband A to the RF B output

- ▶ To access the required "Signal Routing" settings, use one of the following:
  - "Baseband A/B > Signal Routing"
  - "BB Input A/B > Signal Routing"
  - "Fading > Signal Routing"
  - "Taskbar > System Config > Mode = Standard > System Configuration"

**Signal Routing**

route to path A

route to path B

route to path A and B

**Signal Routing**

<input checked="" type="checkbox"/> A → A	<input type="checkbox"/> B → B
<input type="checkbox"/> A → A	<input type="checkbox"/> B → A
<input type="checkbox"/> A → B	<input type="checkbox"/> B → B
<input type="checkbox"/> A → A and B	<input type="checkbox"/> B → A and B
<input type="checkbox"/> A → A and B	<input type="checkbox"/> B → (open)
<input type="checkbox"/> A → (open)	<input type="checkbox"/> B → A and B

**Signal Routing**

Defines the way the baseband signal (internally generated or externally provided) is routed in the instrument. When routing more than one signals to the same path, the signals are summed.

"Route to path A"

The internal or external baseband signal is routed to path A.

"Route to path B"

The internal or external baseband signal is routed to path B.

"Route to path A and B"

The internal or external baseband signal is routed to both paths.

Remote command:

[ :SOURce<hw> ] :BB:ROUTE on page 813

[ :SOURce<hw> ] :BBIN:ROUTE on page 813

## 4.6 Digital Baseband Input Settings

The R&S SMW provides interfaces to feed an **external digital baseband signal** into the signal path.

**Required Options**

The equipment layout for applying an external baseband signal includes

- Option Baseband Generator (R&S SMW-B10) per required input (incl. one digital interfaces CODER 1/2 per installed option)
- Up to two options Fading simulator (R&S SMW-B14) (incl. one digital interfaces FADER 1/2 per installed option)

For exact information, refer to the instrument specification (data sheet).

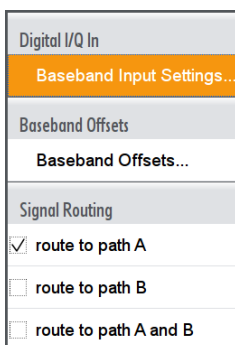
**To access and configure the "Baseband Input" settings**

The "BB Input" block provides access to the settings for signal routing, frequency offset and path gain, as well as to the available configuration parameters of the external signal.

The digital baseband input interfaces CODER 1/2 IN and FADER 1/2 IN are located on the R&S SMW rear panel, see [Figure 4-1](#).

In the default instrument state, the block diagram displays the CODER 1/2 connector in an unfolded state. The digital input interfaces are inactive (grey LEDs).

1. To display the "BB Input" block if the connectors are folded, select the symbol "CODER 1/2"



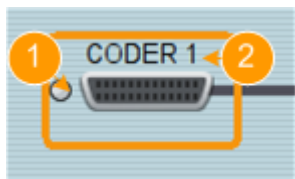


Figure 4-6: Representation of the digital baseband input interface

1 = digital input interface state: grey = inactive; blue = active  
2 = connector name

2. To access the routing settings, select "BB Input > Signal Routing" and select the required signal switching.  
See [Chapter 4, "Signal Routing and System Configuration"](#), on page 120.
3. To access the frequency offset and path gain settings, select "BB Input > Baseband Offsets".  
See [Chapter 5.10, "Shifting and Boosting the Baseband Signal"](#), on page 366.
4. To access the dialog box for configuring the external signal input depending on the current "System Configuration > Fading/Baseband Configuration", select one of the following:
  - "BB Input > Digital I/Q In > Baseband Input Settings"
  - "Baseband > Digital I/Q In > Baseband Input Settings"

The "Baseband Input Settings" dialog provides settings necessary to define the used connector, to adjust the signal parameters, like the sample rate, the baseband input level and to perform simple signal monitoring.

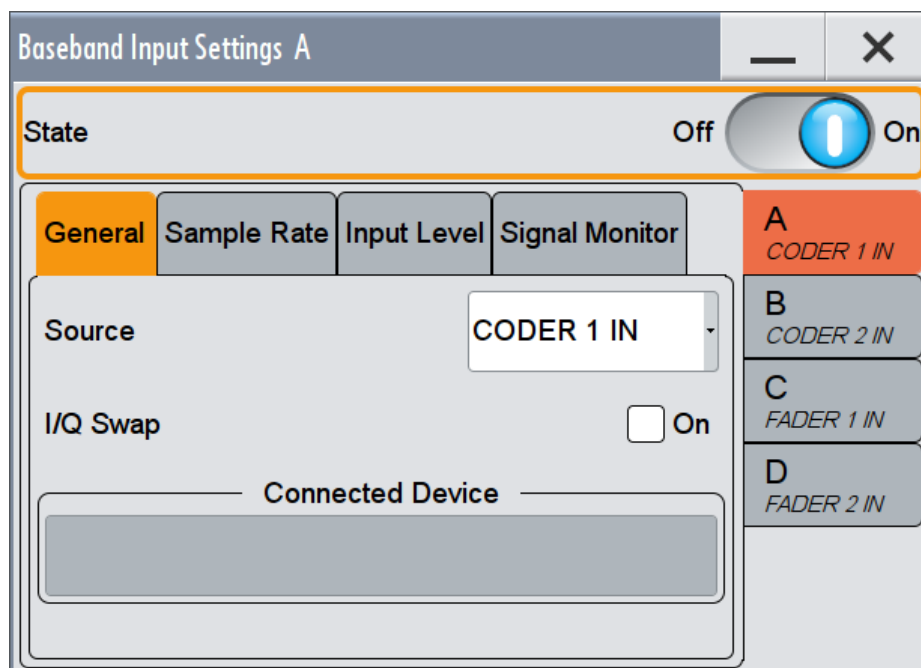


Figure 4-7: Example: "Baseband Input Settings" in 2x2x2 System Configuration



If the current instrument configuration uses **Coupled sources**, the dialog consists of up to four side tabs, whereas the number of tabs corresponds to the number of selected **BB Signals (Tx Antennas)**. The tab name displays the baseband the settings are related to and the connector the digital input signal is provided at.

5. To enable the input signal:
  - select "BB Input > On" or
  - select "BB Input > Baseband Input Settings > State > On".

The remote commands required to define these settings are described in [Chapter 13.18.4, "SOURce:BBIN Subsystem"](#), on page 951.

### 4.6.1 General Settings

State.....	161
Source.....	161
I/Q Swap.....	161
Connected Device.....	161

#### State

Switches On/Off the feeding of the selected external digital signals into the baseband.

Remote command:

`[ :SOURce<hw> ] :BBIN:STATe` on page 952

#### Source

Defines the connector used as an external signal source. Available are all digital input connectors, as defined with "System Configuration > External RF and I/Q > Direction > Input" (see "[Direction](#)" on page 142).

Remote command:

`[ :SOURce<hw> ] :BBIN:DIGital:SOURce` on page 953

#### I/Q Swap

Activates swapping of the I and Q signal components, see "[I/Q Swap](#)" on page 403.

**Tip:** The I/Q swap is required in test setups, like for example, if an external CDMA2000® or 1xEV-DO signal is added to an internally generated baseband signal.

See also:

- description "CDMA2000® incl. EV-DV Digital Standard for R&S SMW"
- description "1xEV-DO Rev. A, Rev. B Digital Standard for R&S SMW"

Remote command:

`[ :SOURce<hw> ] :BBIN:IQSWap [ :STATe ]` on page 953

#### Connected Device

If the connection to the external device is properly established and signal transmission is active, this parameter displays information on the instrument connected to the DIG I/Q interface:

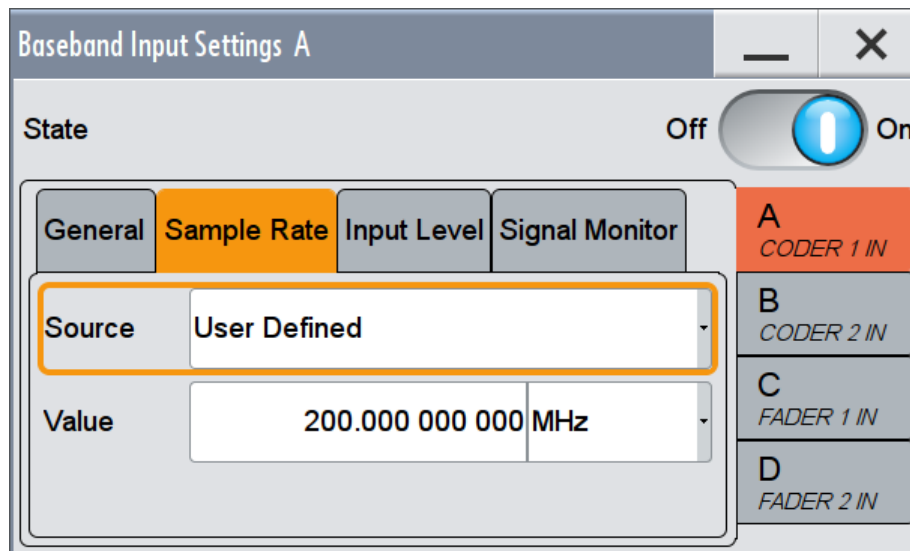
- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

Remote command:

[ :SOURce<hw> ] :BBIN:CDEvice? on page 956

### 4.6.2 Sample Rate Settings

- ▶ To access this dialog, select "BB Input > Digital I/Q In > Baseband Input Settings > Sample Rate".



Sample Rate Source..... 162  
 Sample Rate Value..... 163

#### Sample Rate Source

Selects whether the sample rate is estimated based on the digital input signal or is defined by the user (see also [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207).

"User Defined" The sample rate is as defined the entry field value.

**Note:** An I/Q data clock is not necessary but the external signal source (typically a second R&S Instrument) and the receiving R&S Instrument have to be synchronized, i.e they have to use common external reference signal.

"Digital I/Q In" (for CODER 1/2 connectors)

Estimates the sample rate based on the applied I/Q data clock and displays the resulting value in the value field. The I/Q data clock signal is fed via the digital I/Q input.

**Note:** Estimation works best if the sample rate is close to the user defined value.

Remote command:

[ :SOURce<hw> ] :BBIN:SRATe:SOURce on page 953

**Sample Rate Value**

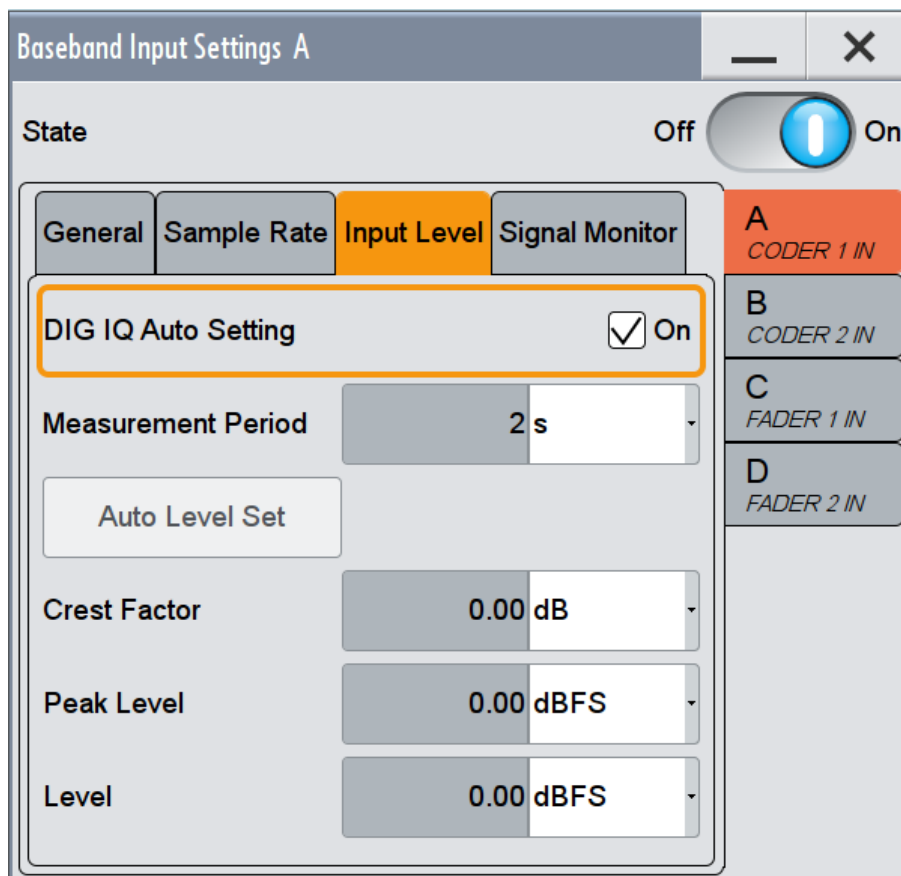
Sets the sample rate of the external digital baseband input signal. The max. sample rate depends on the connected transmitting device.

Remote command:

[ :SOURce<hw> ] :BBIN:SRATe [ :ACTual ] on page 954

**4.6.3 Input Level Settings**

- ▶ To access this dialog, select "BB Input > Digital I/Q In > Baseband Input Settings > Input Level".



DIG IQ Auto Setting..... 164  
 Measurement Period..... 164  
 Auto Level Set..... 164  
 Crest Factor..... 164  
 Peak Level..... 164  
 Level..... 164

**DIG IQ Auto Setting**

Activates an automatic adjustment of the baseband input signal.

The R&S SMW receives PEP, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Remote command:

`[ :SOURce<hw> ] :BBIN:DIGital:ASETting:STATe` on page 954

**Measurement Period**

(for CODER 1/2 connectors)

Sets the recording duration for measuring the baseband input signal by "Auto Level Set".

**Note:** For accurate level measurements, the measurement period should be set to a time value that is long enough to capture several periods of the input signal.

Remote command:

`[ :SOURce<hw> ] :BBIN:MPERiod` on page 954

**Auto Level Set**

(for CODER 1/2 connectors)

Starts measuring the input signal for estimating the crest factor, the peak power, and the RMS power of the input signal.

See also ["Fulfilling the prerequisites for a correct signal processing of the externally supplied digital baseband signal"](#) on page 209.

Remote command:

`[ :SOURce<hw> ] :BBIN:ALEVel:EXECute` on page 954

**Crest Factor**

Indicates the crest factor of the external baseband signal.

See also [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207.

Remote command:

`[ :SOURce<hw> ] :BBIN:CFACTOR` on page 955

**Peak Level**

Indicates the peak level of the external baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

See also [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207.

Remote command:

`[ :SOURce<hw> ] :BBIN:POWER:PEAK` on page 955

**Level**

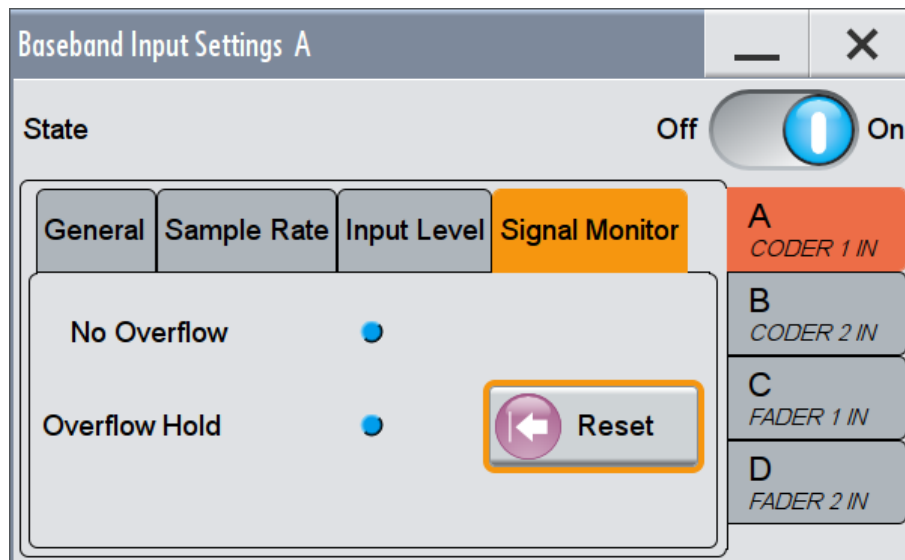
Indicates the estimated RMS level acquired with "Auto Level Set".

Remote command:

[ :SOURce<hw> ] :BBIN:POWer:RMS? on page 955

#### 4.6.4 Signal Monitoring Settings

- ▶ To access this dialog, select "BB Input > Digital I/Q In > Baseband Input Settings > Signal Monitor".



Signal Monitoring..... 165

##### Signal Monitoring

The R&S SMW monitors constantly the input signal (Crest Factor and Peak Level) and indicates an overflow status, if the entered "Peak Level" (in dB full scale) value does not correspond with the real value.

**Note:** The overflow status is indicated as long as the "Peak Level" value is not corrected.

To avoid overflow effects, enable automatic measurement with the "Auto Level Set" function.

**"Overflow/No Overflow"**

Indicates whether the input is overloaded or not. An additional indication is displayed in the block diagram close to the corresponding connector.

Remote command:

`[ :SOURce<hw> ] :BBIN:OLOad:STATe?` on page 955

**"Overflow Hold"**

Indicates an overload since the last reset for evaluating the measurement.

To reset the state, select "Reset", start a new measurement with the "Auto Level Set" function or change the value of one of the monitored parameters.

Remote command:

`[ :SOURce<hw> ] :BBIN:OLOad:HOLD:STATe?` on page 956

**"Reset"**

Resets the "Overload Hold" indication.

Remote command:

`[ :SOURce<hw> ] :BBIN:OLOad:HOLD:STATe?` on page 956

## 4.7 I/Q Digital Output Settings

### Required Options

The equipment layout for output of digital I/Q signal includes:

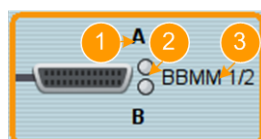
- Option Baseband Generator (R&S SMW-B10) per signal path and Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)
- Up to two options Digital Baseband Output (R&S SMW-K18) per required output
- Up to four options Fading simulator (R&S SMW-B14) (incl. one digital interface FADER 3/4(1/2) per installed option)

For exact information, refer to the instrument specification (data sheet).

### To access and configure the "I/Q Digital Output" settings in "System Configuration > Mode > Standard"

The digital output connectors BBMM 1/2 OUT are located on the R&S SMW rear panel, see [Figure 4-1](#).

In the default instrument state ([Standard mode](#)), the block diagram displays the BBMM 1/2 OUT connector in a folded state. The digital output interfaces are inactive (grey LEDs).



*Figure 4-8: Representation of the digital output interface in standard mode*

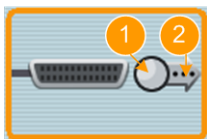
- 1 = mapped I/Q stream
- 2 = digital output interface state: grey = inactive; blue = active
- 3 = digital output connector name

1. Select the BBMM 1/2 OUT connector to unfold the "I/Q Digital" block.
2. To (re)route the I/Q streams to the digital outputs, select the "I/Q Stream Mapper" block.
3. To enable the baseband signal at the digital outputs, select "Block Diagram > I/Q Digital A or B > I/Q Digital On".
4. To access the dialog box for configuring the digital output signal, select "I/Q Digital > I/Q Digital Outputs".

#### To access and configure the "I/Q Digital Output" settings in "System Configuration > Mode > Advanced"

The digital output connectors BBMM 1/2 OUT and FADER 3/4 OUT are located on the R&S SMW rear panel, see [Figure 4-1](#).

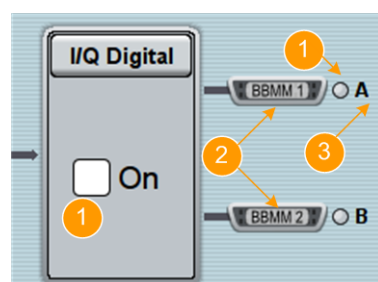
In [Advanced mode](#), the block diagram displays all digital output interfaces as one common connector symbol in folded state. The digital output interfaces are inactive (grey LED).



**Figure 4-9: Representation of the digital output interface in advanced mode**

- 1 = digital output interface state: grey = inactive; blue = active
- 2 = more settings indication; select to unfold detailed information

1. Select the connector icon to unfold the settings and retrieve more information on the mapped streams and configured connectors.



- 1 = digital output interface state: grey = inactive; blue = active
- 2 = digital connector name
- 3 = mapped I/Q streams

**Note:** The number of the displayed digital output interfaces corresponds to the number of enabled [Streams \(Rx Antennas\)](#) in the "System Configuration > Fading/ Baseband Configuration" dialog.

2. To (re)route the I/Q streams to the digital outputs, select the "I/Q Stream Mapper" block.

- To enable the baseband signal at the digital outputs, select "Block Diagram > I/Q Digital > I/Q Digital On".
- To access the dialog box for configuring the digital output signal, select "I/Q Digital > I/Q Digital Outputs".

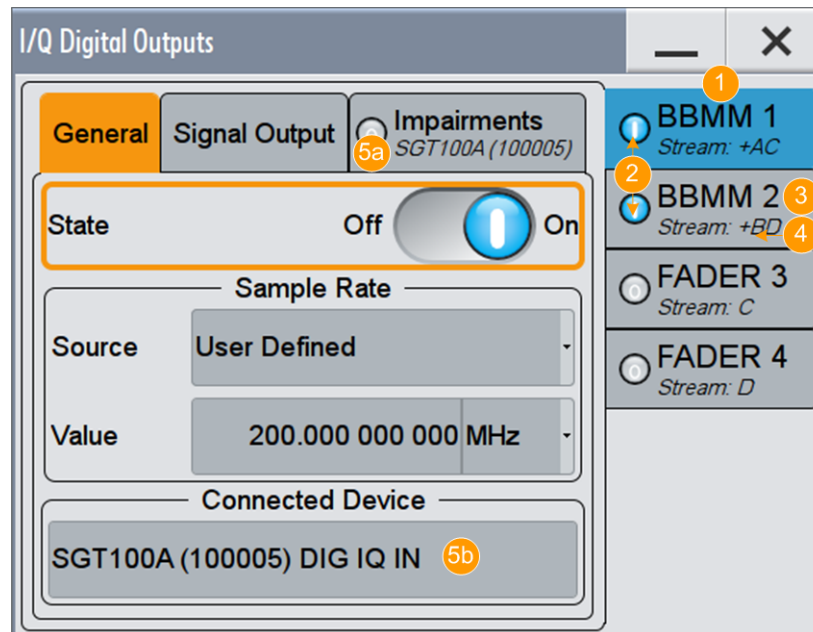


Figure 4-10: I/Q Digital Outputs: Understanding the displayed information

- 1 = Side tabs; one per digital output
- 2 = State of the digital output
- 3 = Digital output interface name
- 4 = Mapped I/Q stream(s)
- 5a, 5b = Indicates the connected instrument

Using the "I/Q Stream Mapper" you defined which stream is routed to which output connector. The settings provided in the "I/Q Digital Outputs" dialog enable you to define how each stream is output at the digital output interface, for example digitally impaired or not.

If a R&S SGT is connected to the digital interface, digital impairments like for example intended I/Q delays are applied in the connected instrument.

Refer to [Chapter 6.3, "Impairing the Signal"](#), on page 390 for description of the impairments functionality.

In [Advanced mode](#), the dialog consists of more than one side tabs, whereas the number of tabs corresponds to the number of available digital output interfaces. The tab name displays the output interface the settings are related to and an overview information on the streams mapped to the particular connector.

- To configure the connected external instruments, use the "Taskbar > System Config > System Configuration > External RF and I/Q" dialog.



### 4.7.1 General Settings

If R&S SGT is connected to the DIG I/Q OUT of the R&S SMW, the several parameters set automatically.

State.....	169
Sample Rate Source.....	169
Sample Rate Value.....	169
Connected Device.....	169

#### State

Switches On/Off the digital I/Q output signals.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM < ch > : STATe` on page 986

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer < ch > : STATe` on page 986

#### Sample Rate Source

Selects whether the sample rate is estimated based on the digital signal or is defined by the user.

"User Defined" Enables you to define the sample rate in the entry field value. An I/Q data clock is not necessary.

"Digital I/Q Out"

Estimates the sample rate based on the applied I/Q data clock and displays the resulting value in the value field.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM < ch > : SRATe : SOURce` on page 987

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer < ch > : SRATe : SOURce` on page 987

#### Sample Rate Value

Sets or displays the sample rate of the digital I/Q output signal. The maximal sample rate depends on the connected receiving device.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM < ch > : SRATe` on page 987

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer < ch > : SRATe` on page 987

#### Connected Device

If the connection to the external device is properly established and signal transmission is active, this parameter displays information on the instrument connected to the DIG I/Q interface:

- Name and serial number of the connected instrument
- The transmitter sample rate, if supported by the transmitter

Remote command:

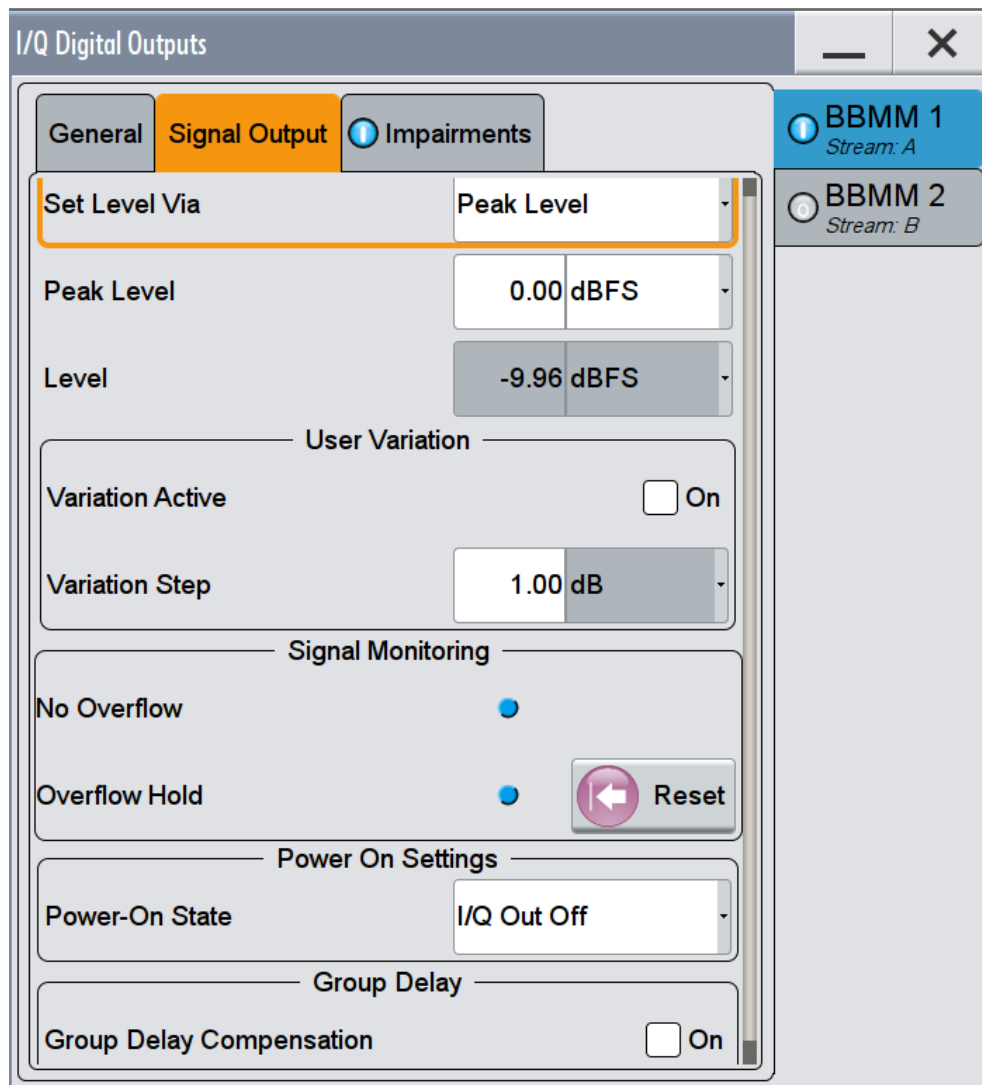
`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM < ch > : CDEvice?` on page 987

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer < ch > : CDEvice?` on page 987

### 4.7.2 Signal Output Settings

- ▶ To access this dialog, select "I/Q Digital > I/Q Digital Settings > Signal Output".

If R&S SGT is connected to the DIG I/Q OUT of the R&S SMW, "User Variation" and "Group Delay Compensation" settings are not available.



Signal Output.....	170
User Variation.....	171
Signal Monitoring.....	171
Power-On State.....	172
Group Delay Compensation.....	172

#### Signal Output

Comprises the level settings of the output signal. The signal level is expressed as a peak or RMS level value.

If R&S SGT is connected to the DIG I/Q OUT of the R&S SMW, the level parameters are set automatically.

**Note:** The "Level" display always refers to both signal components, i.e.  $SQR(I^2+Q^2)$ .

"Set Level Via" Selects whether the signal level is expressed as a peak or as RMS level value.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM <ch> : POWer : VIA` on page 988

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer <ch> : POWer : VIA` on page 988

"Peak Level" Enters the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM <ch> : POWer : PEP` on page 988

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer <ch> : POWer : PEP` on page 988

"Level" Enters the RMS level of the output signal.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM <ch> : POWer : LEVel` on page 988

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer <ch> : POWer : LEVel` on page 988

### User Variation

If the rotary knob is used to adjust the level values, the step width can be defined. The configured step width applies with activated variation.

If R&S SGT is connected to the DIG I/Q OUT of the R&S SMW, "User Variation" is disabled.

"Variation Active"

Enables the user-defined step width.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM <ch> : POWer : STEP : MODE` on page 988

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer <ch> : POWer : STEP : MODE` on page 988

"Variation Step"

Sets the user defined step width.

Remote command:

`[ :SOURce ] : IQ : OUTPut : DIGital : BBMM <ch> : POWer : STEP [ : INCRement ]`

on page 989

`[ :SOURce ] : IQ : OUTPut : DIGital : FADer <ch> : POWer : STEP [ : INCRement ]`

on page 989

### Signal Monitoring

The R&S SMW monitors constantly the output signal and indicates overflow, if the digital signal is clipped. Overload can occur if the level of the output signal, or the noise level (AWGN) are too high.

**"Overflow/No Overflow"**

Indicates whether the I/Q output signal is clipped or not. An additional indication is displayed in the block diagram close to the corresponding connector.

## Remote command:

`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:OFLow:STATe?` on page 989

`[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:OFLow:STATe?` on page 989

**"Overflow Hold"**

Indicates an overload since last reset for evaluating the measurement.

To reset the state, select "Reset", start a new signal generation, or change the output level.

## Remote command:

`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:OFLow:HOLD:STATe?` on page 990

`[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:OFLow:HOLD:STATe?`

on page 990

**"Reset"** Resets the "Overload Hold" indication.

## Remote command:

`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:OFLow:HOLD:RESet` on page 990

`[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:OFLow:HOLD:RESet` on page 990

**Power-On State**

Selects the state which the I/Q digital output connectors are to resume after the instrument is switched on.

**"I/Q Out Off"** On power-on, the output is deactivated.

**"Previous Setting"**

Resumes the state that was active before the last switch off.

## Remote command:

`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:PON` on page 986

`[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:PON` on page 986

**Group Delay Compensation**

(enabled for BBMM 1/2 OUT connectors and connected R&S EX-IQ-BOX)

If you evaluate digital signals, enable this parameter so that the instrument compensates the group delay response of the internal digital filters.

Remote command:

[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:GDElay:CState on page 989

## 4.8 I/Q Analog Output Settings

### Required Options

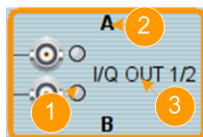
The equipment layout for output of analog I/Q signal includes:

- Option Baseband Generator (R&S SMW-B10) per signal path and Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T) Incl. output the baseband signal at the single ended outputs
- Option Differential Analog I/Q Outputs (R&S SMW-K16) per signal path

### To access and configure the "I/Q Analog Output" settings

The analog output connectors I/Q OUT 1/2 are located on the R&S SMW rear panel, see [Figure 4-2](#).

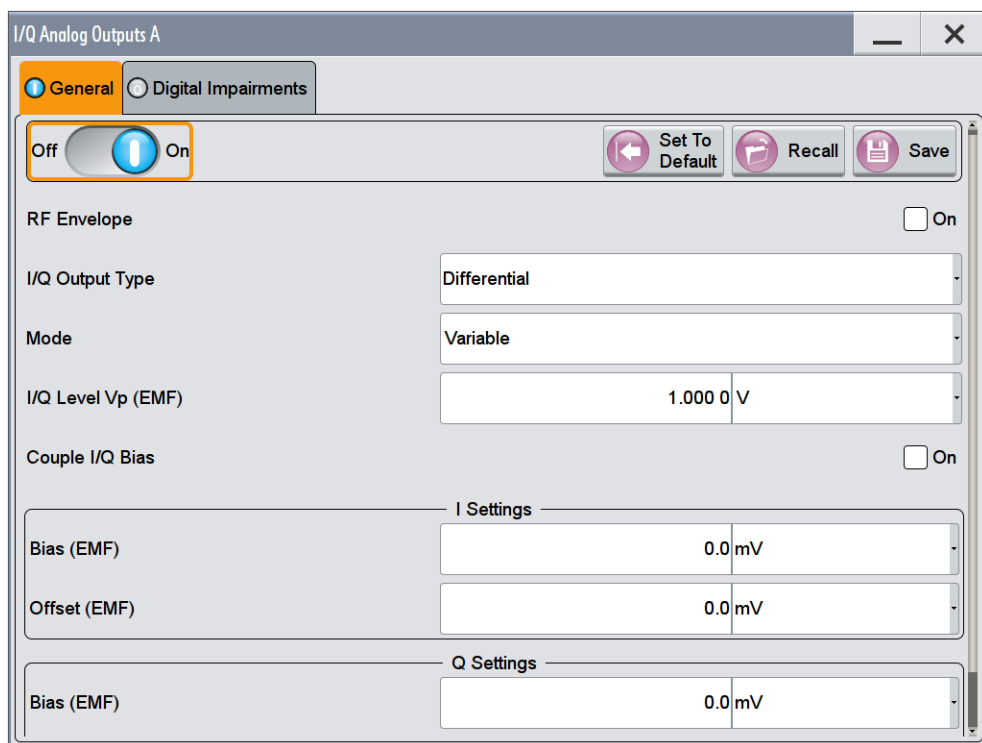
The block diagram displays the I/Q OUT 1/2 connector in a folded state. The analog output connectors are inactive (grey LEDs).



**Figure 4-11: Representation of the analog output interface**

1 = analog output interface state: grey = inactive; blue = active  
 2 = mapped I/Q stream  
 3 = analog output connector name

1. Select the I/Q OUT 1/2 connector to unfold the "I/Q Analog" block.
2. To (re)route the signal to the analog outputs, select the "I/Q Stream Mapper" block.
3. To enable the baseband signal at the analog outputs, select "Block Diagram > I/Q Analog A or B > I/Q Analog On".
4. To access the dialog box for configuring the analog output signal, select "I/Q Analog > I/Q Analog Settings > General".



The dialog comprises the settings necessary to enable a single ended or differential analog output signal, to enable and generate an RF envelope signal, and to add digital impairments to the signal.

See also [Chapter 6.3, "Impairing the Signal"](#), on page 390.

5. To configure connected external instruments, use the "Taskbar > System Config > System Configuration > External RF and I/Q" dialog.

The differential analog I/Q outputs require option R&S SMW-K16.

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

### 4.8.1 General Analog I/Q Output Settings

State.....	175
Set to Default.....	175
Save/Recall.....	175
RF Envelope.....	175
I/Q Output Type.....	176
Mode.....	176
I/Q Level Vp EMF.....	176
Couple I/Q Bias.....	177
Bias (EMF).....	177
Offset (EMF).....	177

**State**

Enables/disables the analog I/Q output.

**Note:** By default, these output connectors are deactivated.

Remote command:

[\[:SOURce<hw>\]:IQ:OUTPut:ANALog:STATe](#) on page 982

**Set to Default**

Calls the default settings. The values of the main parameters are listed in the following table.

Parameter	Value
"State"	Not affected by the "Set to Default"
"RF Envelope"	Off
"I/Q Output Type"	Single Ended
"I/Q Level V <sub>p</sub> (EMF)"	1 V
"Bias (EMF)"	0 V

Remote command:

[\[:SOURce<hw>\]:IQ:OUTPut\[:ANALog\]:PRESet](#) on page 982

**Save/Recall**

Accesses the "Save/Recall" dialog, that is the standard instrument function for storing and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

See also [Chapter 10, "File and Data Management"](#), on page 571.

Remote command:

[\[:SOURce<hw>\]:IQ:OUTPut\[:ANALog\]:SETTing:CATalog?](#) on page 982

[\[:SOURce<hw>\]:IQ:OUTPut\[:ANALog\]:SETTing:STORe](#) on page 983

[\[:SOURce<hw>\]:IQ:OUTPut\[:ANALog\]:SETTing:LOAD](#) on page 983

[\[:SOURce<hw>\]:IQ:OUTPut\[:ANALog\]:SETTing:DELeTe](#) on page 983

**RF Envelope**

In instruments equipped with option R&S SMW-K540, enables the output of a control signal that follows the RF envelope. This control signal is provided for power amplifiers envelope tracking testing. The signal is output at the I OUT and I BAR OUT connectors.

The envelope tracking (ET) is a method used by the modern power amplifiers (PA) to improve their efficiency, especially when amplifying high crest factor RF signals. With envelope tracking, the PA estimates, i.e. "tracks", the RF signal and varies the supply voltage at the end amplifying stage synchronous to the changes in the RF signal.

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

Remote command:

```
[ :SOURce<hw> ] : IQ : OUTPut [ : ANALog ] : ENVELOpe : STATE
```

### I/Q Output Type

Selects the type of output signal.

The provided parameters in the dialog depend on the selected output mode.

- "Differential"
- If "RF Envelope > On"  
The inverted envelope signal E BAR is output at the I BAR OUT connectors.
  - If "RF Envelope > Off"  
The analog I/Q signal components are output at the I/Q BAR OUT connectors.
- "Single Ended"
- If "RF Envelope > On"  
The envelope signal E is output at the I OUT connectors.
  - If "RF Envelope > Off"  
Single ended output at the I/Q OUT connectors.

You can define a bias between the output signal and ground.

Remote command:

```
[ :SOURce<hw> ] : IQ : OUTPut [ : ANALog ] : TYPE on page 983
```

### Mode

Selects the mode for setting the outputs, independent or together.

- "Fixed" The I/Q signal components settings are fixed to the value listed in [Table 4-8](#).

**Table 4-8: I/Q Settings in "Mode = Fixed"**

"I/Q Output Type"	"I/Q Level Vp (EMF)"	"Bias (EMF)"	"Offset (EMF)"
"Single ended"	1 V	0 V	0 V
"Differential"	2 V	0 V	0 V

- "Variable" (R&S SMW-K16)  
Enables modification of the I/Q signal components settings.

Remote command:

```
[ :SOURce<hw> ] : IQ : OUTPut [ : ANALog ] : MODE on page 984
```

### I/Q Level Vp EMF

Sets the output voltage for both signal components.

See [Chapter 6.3.3, "Analog and Digital Impairments Settings"](#), on page 393.

**Table 4-9: Maximum I/Q level and overall output voltage**

"I/Q Output Type"	Value range "I/Q Level Vp (EMF)"	Maximum overall output voltage $V_{EMFmax}$
"Single ended"	20 mV to 2 V	"I/Q Level Vp (EMF)" + "Bias (EMF)" $\leq$ 4 V
"Differential"	40 mV to 4 V	$0.5 \cdot \text{"I/Q Level Vp (EMF)" +  "Bias (EMF)"  + 0.5 \cdot \text{"Offset (EMF)"}$ $\leq$ 4 V



Remote command:

`[ :SOURce<hw> ] :IQ:OUTPut:LEVel` on page 984

### Couple I/Q Bias

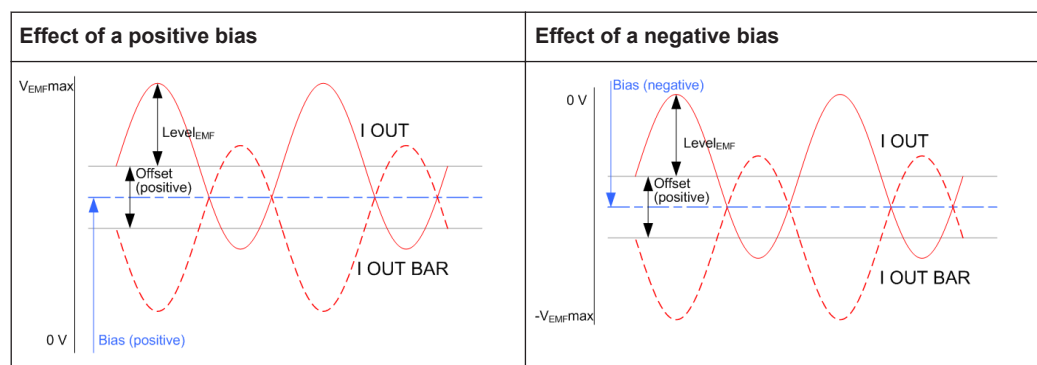
In "Variable Mode", activates/deactivates coupling of bias setting of the I-signal and Q-signal component. With activated coupling, the settings of the I-signal component automatically apply to the Q-signal component as well.

Remote command:

`[ :SOURce<hw> ] :IQ:OUTPut [ :ANALog ] :BIAS:COUPling [ :STATe ]` on page 983

### Bias (EMF)

If a bias is enabled, a DC voltage is superimposed upon the I or Q signal.



In "Single Ended" mode, this parameter defines the bias between the output signal and ground.

See [Table 4-9](#) for an overview of the maximum overall voltage values.

Use this parameter to define the operating point of a DUT.

Remote command:

`[ :SOURce<hw> ] :IQ:OUTPut [ :ANALog ] :BIAS:I` on page 984

`[ :SOURce<hw> ] :IQ:OUTPut [ :ANALog ] :BIAS:Q` on page 984

### Offset (EMF)

Sets an offset between the inverting and the non-inverting output.

The value range is dynamically adjusted as defined in [Table 4-9](#).

The selected offset is set half in the positive and half in the negative direction.

Effect of a positive offset	Effect of a negative offset
<p>A positive offset is set with half of the value in positive direction at the non-inverting outputs, in negative direction at the inverting outputs, respectively.</p>	<p>A negative offset is set with half of the value in negative direction at the non-inverting outputs, in positive direction at the inverting outputs, respectively.</p>

#### Example: Effect of a positive offset on the I signal component

"I Offset" = 100.0 mV

The offsets of the two output connectors are as follows:

- offset at I OUT = 50.0 mV
- offset at I BAR OUT = -50.0 mV

Remote command:

`[ :SOURce<hw> ] :IQ:OUTPut [ :ANALog ] :OFFSet:I` on page 985

`[ :SOURce<hw> ] :IQ:OUTPut [ :ANALog ] :OFFSet:Q` on page 985

## 4.9 How to Connect External Instruments and Configure the Signal Flow

This section gives examples on how to select the required system configuration and to configure the signal flow through the instrument, how to connect external instruments to the R&S SMW, how to configure them, and how to define the input and output signals.

### General workflow

The general workflow described in "[General workflow for finding out the suitable system configuration for a current use case](#)" on page 121. The [Figure 4-12](#) is a graphical representation of this workflow.

The graphic depicts the main phases for connecting and configuring the R&S SMW and the external instruments. This illustration is a simplified diagram that *highlights* the configuration stages performed in the "System Configuration" dialog.

For relevant information on the configuration of the baseband source signal or using the Fading Simulator and the AWGN generator, see:

- [Chapter 5, "Configuring the Internal Baseband Source"](#), on page 212
- [Chapter 4.6, "Digital Baseband Input Settings"](#), on page 159
- user manual "Fading Simulator"

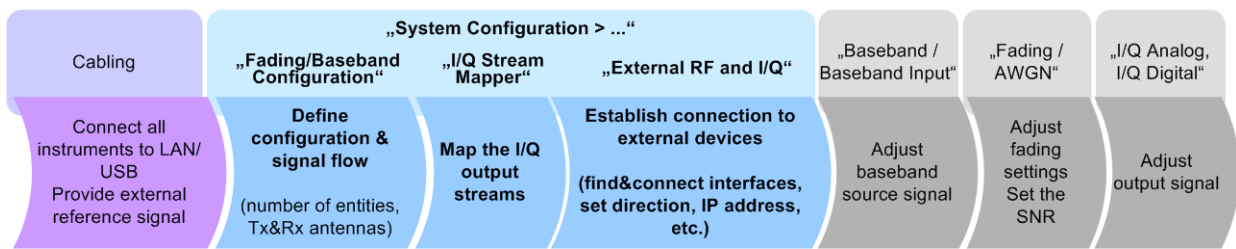


Figure 4-12: General configuration stages and the steps performed in the "System Configuration" dialog

The illustration depicts the steps in general and is intended to explain the configuration in principle.

For a step-by-step description of how to perform the different steps, see:

- [How to Find Out the Suitable System Configuration for Your Current Test Case](#) ..... 179
- [How to Find out where the Input/Output Interface is Located](#)..... 180
- [How to Define the MIMO Scenario](#).....181
- [How to Route the I/Q Streams to the Output Interfaces](#).....183
- [How to Cable the Instruments in MIMO Test Setups](#)..... 184
- [How to Connect and Configure External RF and I/Q Instruments](#)..... 185
- [How to Generate a 2x8 MIMO Signal for BS Tests](#).....192
- [How to Generate a Multi-Standard Radio Test Signal](#)..... 193
- [How to Connect an R&S®CMW500 Radio Communication Tester for Fading Applications](#).....195
- [How to Apply an External Digital Baseband Signal](#)..... 197
- [How to Connect an R&S EX-IQ-BOX](#).....199
- [How to Perform Further Configurations](#)..... 201

#### 4.9.1 How to Find Out the Suitable System Configuration for Your Current Test Case

For conceptual information on the workflow, refer to "[General workflow for finding out the suitable system configuration for a current use case](#)" on page 121.

1. Select a system configuration form the test cases listed in [Table 4-1](#).  
The table provides a cross-reference between a test scenario and the required configuration.
2. Select "Taskbar > System Configuration > Fading/Baseband Settings":
  - Follow the instructions in "[To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings](#)" on page 181.
  - Observe the preview diagram in the "Fading/Baseband Settings" dialog.

This diagram provides a short description and an example of the common application or test scenario of the selected configuration.

For description of the further steps, see:

- [Chapter 4.9.3, "How to Define the MIMO Scenario"](#), on page 181

- [Chapter 4.9.4, "How to Route the I/Q Streams to the Output Interfaces"](#), on page 183

See also:

- [Chapter 4.9.5, "How to Cable the Instruments in MIMO Test Setups"](#), on page 184
- [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185

## 4.9.2 How to Find out where the Input/Output Interface is Located

See:

- ["To find out the correct connector"](#) on page 180
- ["To find out the connector's direction"](#) on page 180

### To find out the correct connector

1. Select "Taskbar > System Configuration > External RF and I/Q".
2. In the overview table, navigate to the connector an external instrument has to be connected to (e.g. BBMM 1) and select "External Instruments > Config".
3. In the "External Instrument Configuration" dialog, select "Find Connector".

A blinking LED on the rear of the instrument indicates the connector's position.



**Tip:** Cross-check whether this digital interface is defined as input or output, before you connect the external instrument.

### To find out the connector's direction

The directions of the digital interfaces located at the FADER boards are configurable parameter. Depending on the test set up, each of these connectors may serve as an input or an output connector but not at the same time.

To find out the currently selected connector's direction and the currently defined connectors, proceed as follows:

1. Select "Taskbar > System Configuration > External RF and I/Q".
2. In the overview table, navigate to the required connector and observe the value of the parameter "Direction".

### 4.9.3 How to Define the MIMO Scenario

See:

- ["To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings"](#) on page 181
- ["To define the baseband signal"](#) on page 182

#### To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings

The configuration of complex MIMO scenarios undergoes the same steps. We use the configuration of a 1x4x4 MIMO scenario with coupled sources as example to explain the principle.

See also [Chapter 4.9.1, "How to Find Out the Suitable System Configuration for Your Current Test Case"](#), on page 179.

Proceed as follows:

1. To access the "Fading/Baseband Configuration" settings, use one of the following:
  - select "Taskbar > System Config > System Configuration"
  - select "Block Diagram > I/Q Stream Mapper > System Configuration > Fading/Baseband Configuration"
  - select "Block Diagram > Fading > MIMO > System Configuration".

The "Fading/Baseband Configuration" settings are divided into two modes, the standard mode for more simple non-MIMO configurations and the advanced mode for complex MxN MIMO setups.

2. In the "Fading/Baseband Configuration" tab, enable "Mode > Advanced" and enable the required configuration.
  - a) Define the number of "Entities"
  - b) Define the number of "BB Signals (Tx Antennas)" and "Streams (Rx Antennas)"

**Tip:** Use the provided preview diagram and description to simplify the decision process.

3. If required, adjust the "Baseband Source Configuration".

For example, to enable the instrument to calculate the required signals and streams out of one baseband signal source, select "BB Source Config > Coupled Sources"

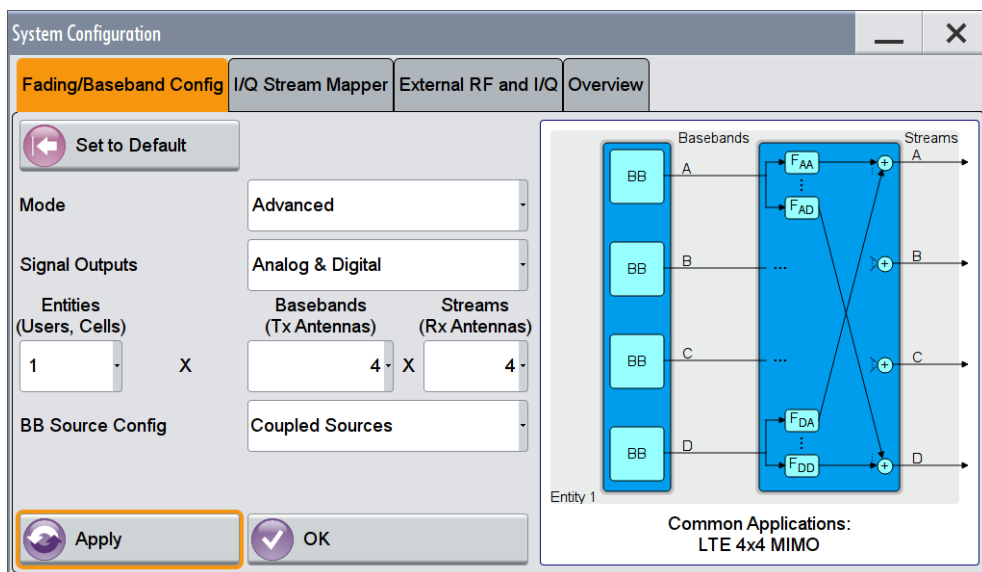


Figure 4-13: Configuration example ("Fading/Baseband Configuration > 1x4x4" and "Coupled Baseband Sources")

- Execute "Apply" to trigger the instrument to adopt the signal routing.

The block diagram displays the configured signal routing.

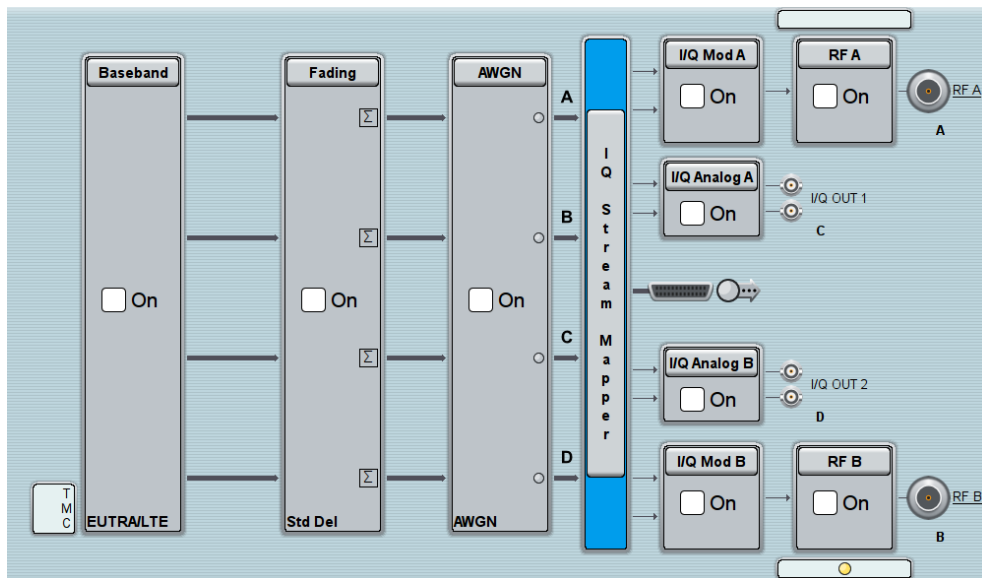


Figure 4-14: Signal routing example ("Fading/Baseband Configuration > 1x4x4" and "Coupled Baseband Sources")

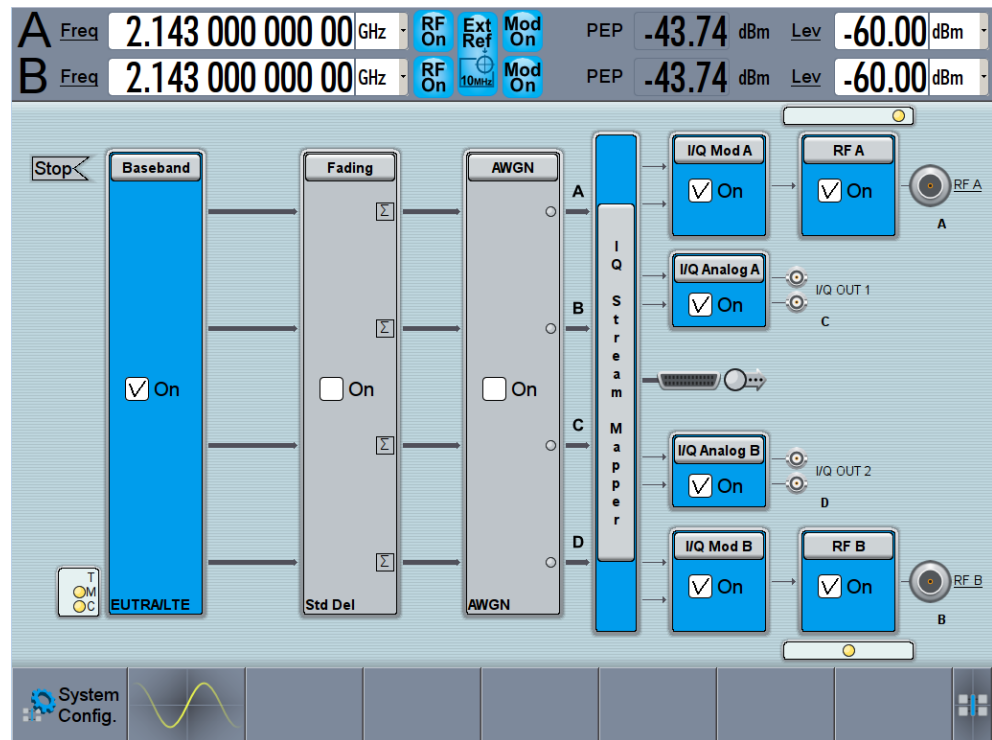
**To define the baseband signal**

To generate an EUTRA/LTE signal, use the following general steps:

1. Select "Baseband > EUTRA/LTE".
2. Configure the settings as required.

For example, enable "EUTRA/LTE > Link Direction > Downlink" and select a "DL Test Model > E-TM1.1 5MHz"

3. Select "EUTRA/LTE > State > On" to enable signal generation.
4. In the status bar, select "Frequency A = Frequency B = 2.1432 GHz" and "Lev A = Lev B = -60 dBm".
5. Select "RF A > On" and "RF B > On".



#### 4.9.4 How to Route the I/Q Streams to the Output Interfaces

This example shows how to enable the instrument to output the EUTRA/LTE 1x4x4 MIMO signal at both RF outputs and both I/Q analog outputs.

1. Select "Block Diagram > I/Q Stream Mapper".
2. In the stream to connector mapping matrix, tap on a crossing cell to enable the routing of the selected stream to the corresponding connector.  
For example, enable "Stream A > RF A", "Stream B > RF B", "Stream C > I/Q OUT 1" and "Stream D > I/Q OUT 2".

**Tip:** To route more streams to one output connector, in the "I/Q Stream Mapper" dialog and for the particular connector, select "Combination> Add" and select the streams to be routed to it.

	Frequency Offs /Hz	Phase Offs /°	RF A	RF B	I/Q OUT 1	I/Q OUT 2	BBMM 1	BBMM 2	FAD 3	FAD 4
Stream A	-20 000 000.00	0.00	ⓘ				ⓘ			
Stream B	0.00	0.00		ⓘ				ⓘ		
Stream C	-20 000 000.00	0.00			ⓘ		ⓘ		ⓘ	
Stream D	0.00	0.00				ⓘ		ⓘ		ⓘ
Combination			Single	Single	Single	Single	Add	Add	Single	Single

### 4.9.5 How to Cable the Instruments in MIMO Test Setups

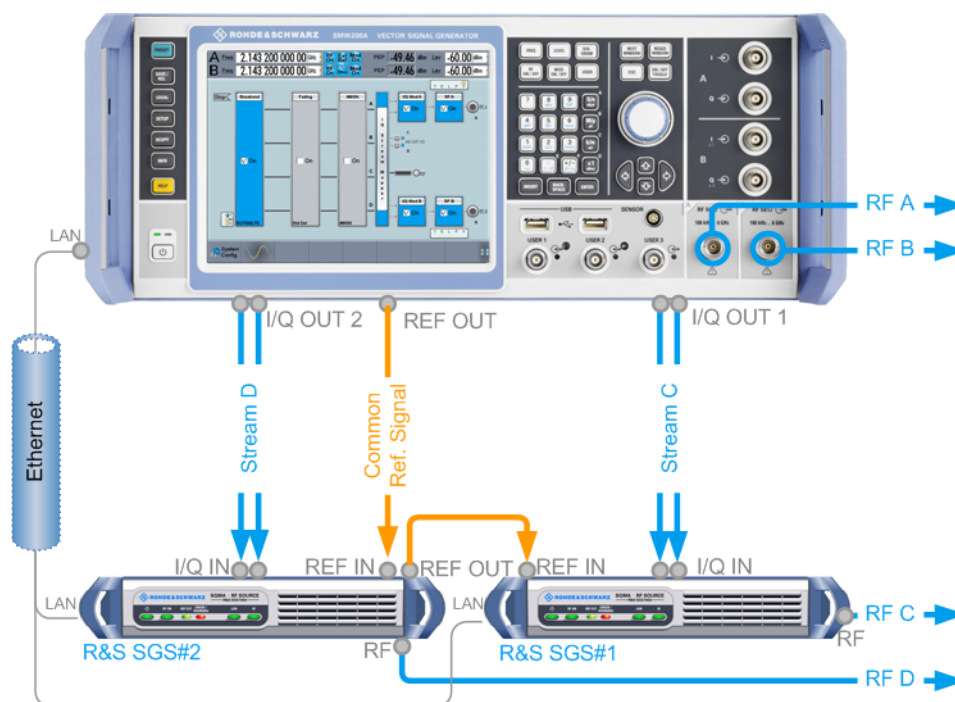
The MxN MIMO test setups with more than two Rx antennas (N>2) require the signal of at least three antennas. The R&S SMW generates the required signal and outputs two of the antennas signals at the RF outputs. The others signals can be routed to the provided analog and digital I/Q connectors and then processed by a connected instrument, like an RF frontend. Several RF frontend instruments can serve as extended RFs for the R&S SMW, for example R&S SGS, R&S SGT, or R&S SMBV.

The [Figure 4-15](#) shows a 1x4x4 MIMO test setup with two R&S SGS connected to the analog I/Q outputs of the R&S SMW.

For how to connect instruments to the DIG I/Q OUT interfaces, see [Figure 4-17](#).



How to Connect External Instruments and Configure the Signal Flow



**Figure 4-15: Example of test setup: 1x4x4 MIMO with R&S SMW and 2xR&S SGS connected to the I/Q OUT 1/2.**

blue circle = front panel connector

grey circle = rear panel connector

Refer to "To connect and configure RF instruments to the I/Q analog interface" on page 186 for a description of how to configure the R&S SMW.

#### 4.9.6 How to Connect and Configure External RF and I/Q Instruments

See:

- "To connect and configure RF instruments to the I/Q analog interface" on page 186
- "To connect and configure RF instruments to the I/Q digital interface" on page 189
- "To create a remote control sequence or modify the initialization sequence" on page 191

You have already selected a MIMO scenario and have mapped the I/Q stream to the output interfaces, see:

- "To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings" on page 181
- Chapter 4.9.4, "How to Route the I/Q Streams to the Output Interfaces", on page 183

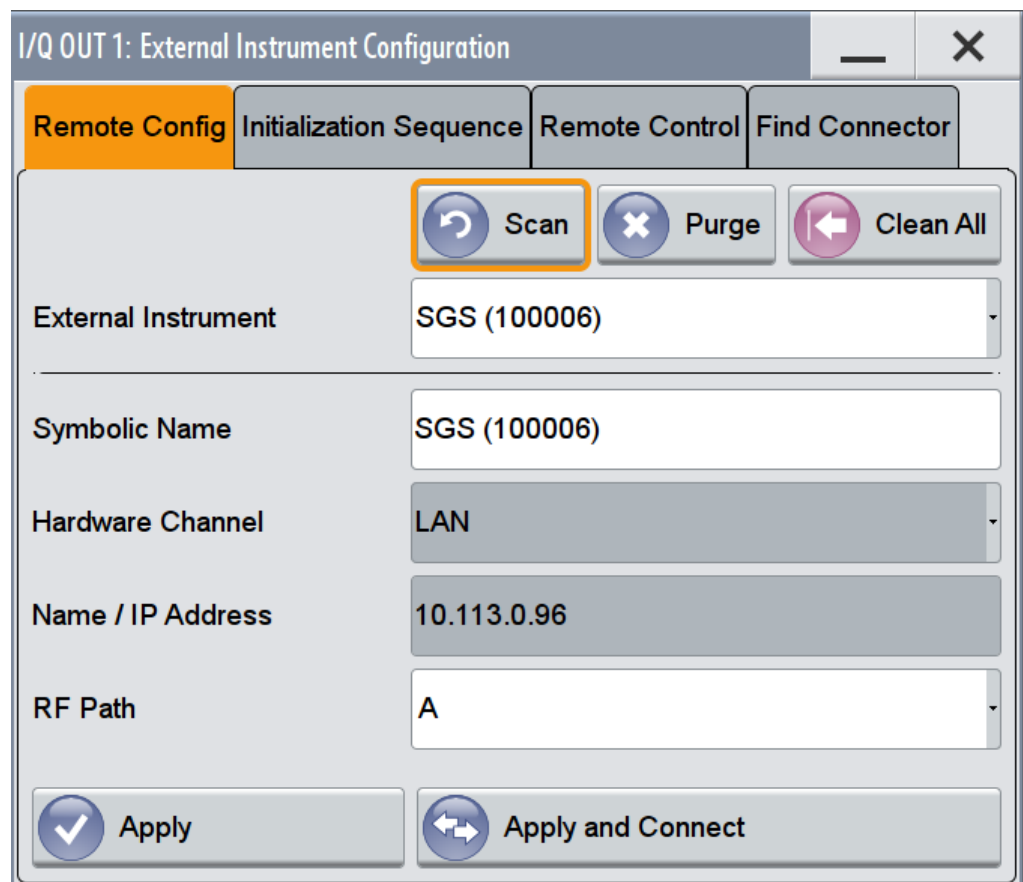
**To connect and configure RF instruments to the I/Q analog interface**

In this example, we assume a "Fading/Baseband Configuration > 1x4x4 MIMO" and the following stream mapping: Stream A and B are output at RF A and B; stream C and D at I/Q OUT 1/2 respectively.

The test setup uses the analog I/Q outputs and requires two additional instruments, 2xR&S SGS (see [Figure 4-15](#)). To connect and configure each of the R&S SGS to the I/Q OUT 1/2 interfaces, proceed as follows:

1. Perform one of the following:
  - Connect the R&S SMW and the external instruments to the LAN
  - Connect the external instruments to the USB connector of the R&S SMW.
2. Supply all instruments with common frequency reference signal:
  - Use an external common frequency source
  - Distribute the reference frequency of the R&S SMW to the external instruments.

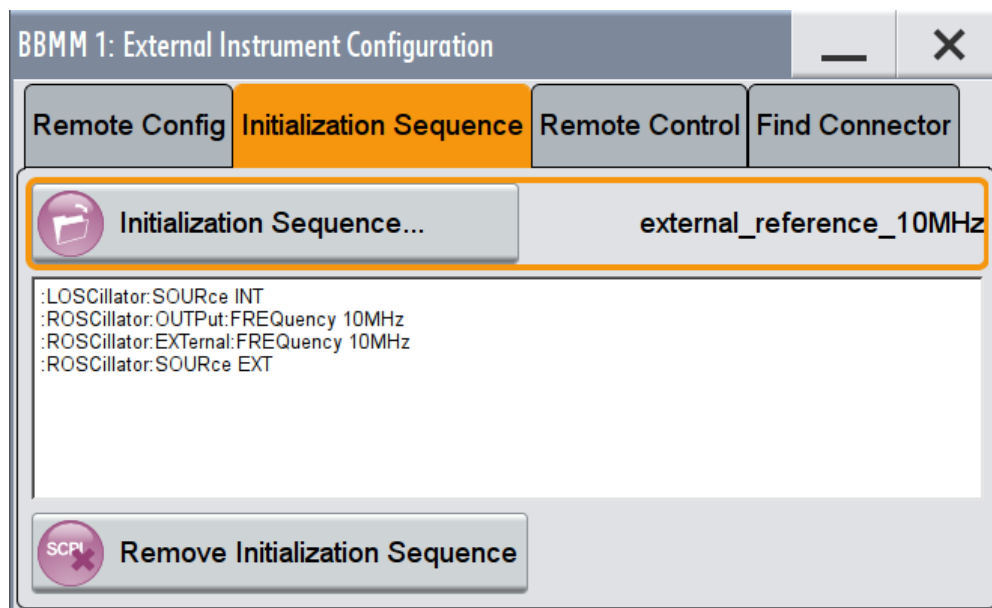
See [Chapter 8.5, "Reference Oscillator"](#), on page 422.
3. Use suitable cables and connect the external instruments to the I and Q connectors (I/Q OUT 1) of the R&S SMW.  
See also ["To find out the correct connector"](#) on page 180.
4. Select "Block Diagram > I/Q OUT 1/2" to unfold the "I/Q Analog" block  
**Note:**  
Per default, the analog I/Q outputs are disabled.
5. Select "I/Q Analog > State > On", to enable the analog I/Q outputs with their default settings.
6. Open the "Taskbar > System Config > System Configuration > External RF und I/Q" dialog and select "I/Q OUT1 > External Instrument > Config".
7. In the "I/Q OUT 1: External Instrument Configuration" dialog, select "Detect".  
The R&S SMW searches through the LAN and the USB connections and updates the dialogs with the retrieved information, like "IP Address", or "Instrument Name".



8. Select "Apply".

The "System Config > System Configuration > External RF und I/Q" dialog displays the settings of the connected external instrument.

9. You can disable "RF Couple" state and adjusts the RF settings manually. In a MIMO setup however, it is useful to use the coupled settings, because a MIMO setup typically requires the same RF frequency at all antennas.
10. Perform the previous steps to connect and configure the second R&S SGS.
11. Select "I/Q OUT 1 > External Instrument > Config".
  - a) Select "External Instrument Configuration > Initialization Sequence".
  - b) Select "Initialization Sequence > Predefined Settings" and select the predefined initialization file `external_reference_10MHz`.



**Tip:** Try out also "To create a remote control sequence or modify the initialization sequence" on page 191.

- In the "System Config > System Configuration > External RF und I/Q" dialog, select the "I/Q OUT 1 > Rem Conn" icon to toggle the state and establish the remote connection to the instrument.

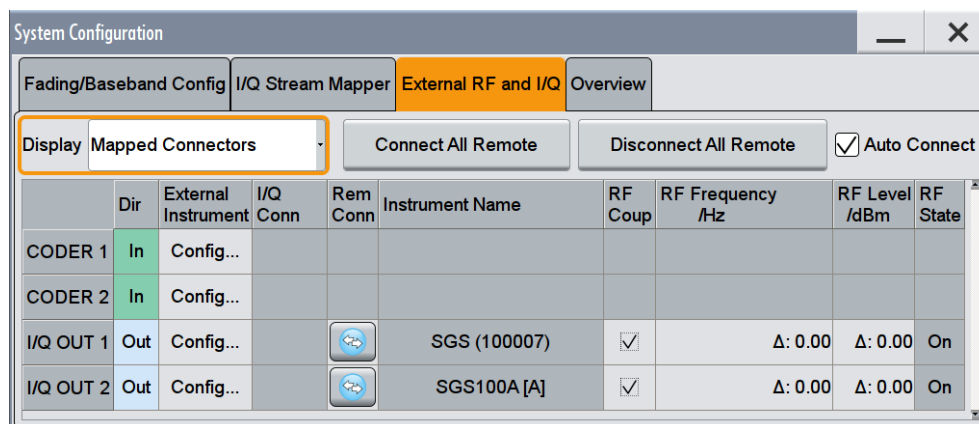


Figure 4-16: Example: Connecting external instruments to the I/Q OUT 1/2 of the R&S SMW (2x R&S SGS)

The R&S SMW:

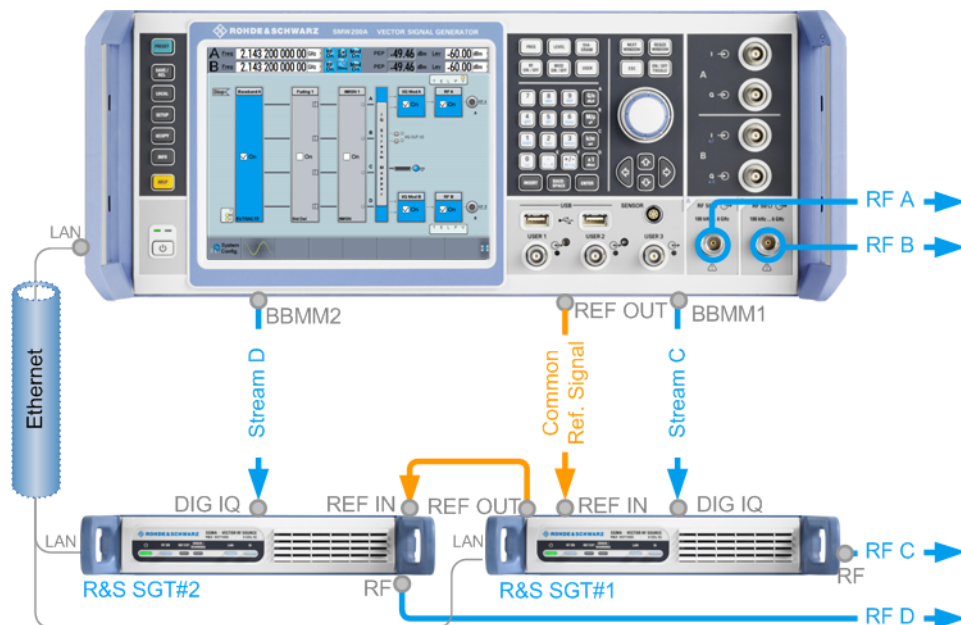
- Sends a `:DEV:PRES` command to the connected external instrument(s)
- Triggers the external instrument to execute the configuration defined in the initialization sequence file
- Adjusts the RF settings of the external instrument, e.g. applies the same RF frequency at both RF outputs and at the RF outputs of the external instruments.

### To connect and configure RF instruments to the I/Q digital interface

In this example, we assume a "Fading/Baseband Configuration > 1x4x4 MIMO" scenario and the following stream mapping: Stream A and B are output at RF A and B; stream C and D at BBMM 1/2.

The test setup uses the digital I/Q outputs and requires two additional instruments, for example 2xR&S SGT.

1. Connect two R&S SGT to the BBMM 1/2 interfaces, see [Figure 4-17](#).



**Figure 4-17: Example of test setup: 1x4x4 MIMO with R&S SMW and 2xR&S SGT connected to the BBMM1/2.**

blue circle = front panel connector

grey circle = rear panel connector

2. Follow the steps described in "[To connect and configure RF instruments to the I/Q analog interface](#)" on page 186.
  - a) In the "System Config > System Configuration > External RF und I/Q", enable "Auto Connect > On".
  - b) Use the predefined initialization file `initialize_SGT`

The "System Configuration > External RF and I/Q" dialog confirms a correct and successful configuration by means of active "Rem Conn" status and active "I/Q Conn" status indication.

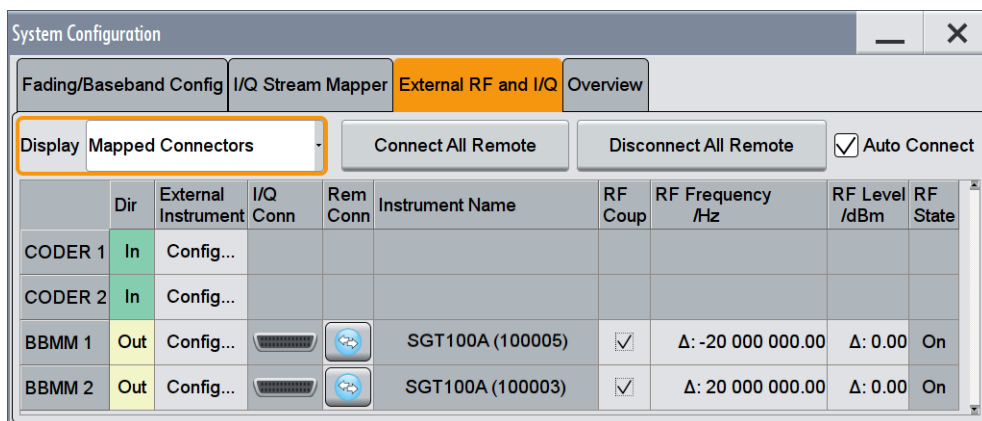
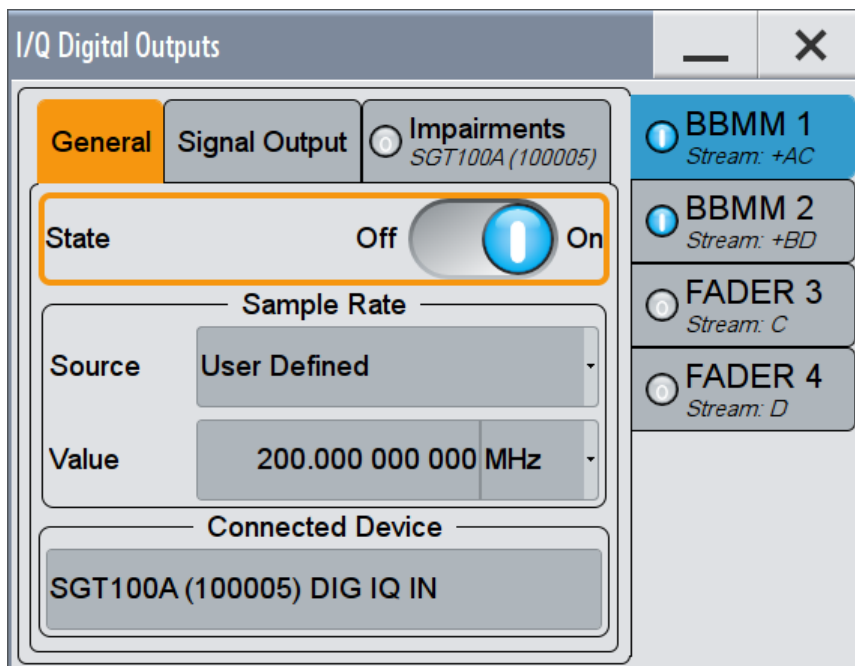
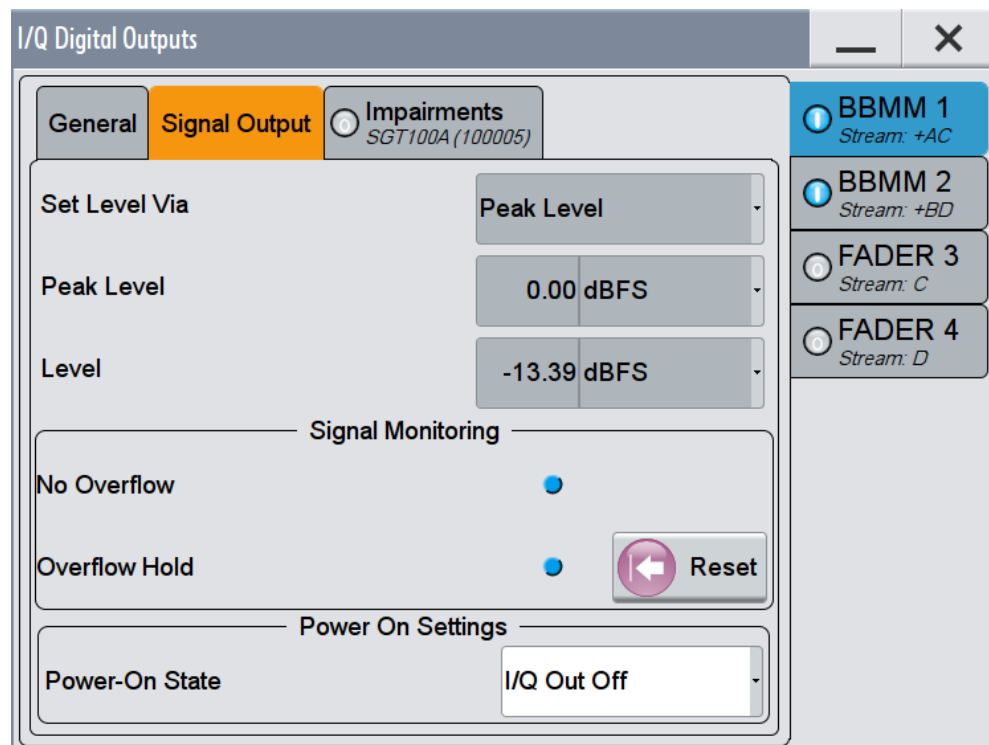


Figure 4-18: Example: Connecting external instruments to the BBMM 1/2 of the R&S SMW (2xR&S SGT)

- In the block diagram, select "I/Q Digital".



The dialog confirms the selected configuration. The settings are retrieved and set to fit to the connected R&S SGT.



#### To create a remote control sequence or modify the initialization sequence

You have connected and configured external instruments to the R&S SMW as described in ["To connect and configure RF instruments to the I/Q analog interface"](#) on page 186.

To create an SCPI sequence or your own initialization sequence and send it to a R&S SGS connected to the I/Q OUT 1 interface, proceed as follows:

1. On a remote computer, open the Notepad or other similar tool and write a sequence of SCPI commands.
2. Store the SCPI sequence in a file with file extension `*.iec`.
3. Use one of the standard file transfer methods and transfer the file to the user directory `/var/usb/` of the R&S SMW.  
See [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595.
4. Select "System Config > System Configuration > External RF und I/Q".
5. Select "I/Q OUT 1 > External Instrument > Config"
6. Select "External Instrument Configuration > Remote Control":
  - a) Select "Mode > Sequence".
  - b) Select "File" and select the `*.iec` file from the user directory `/var/usb/`.
  - c) Select "Send Sequence".
7. Alternatively, select "External Instrument Configuration > Initialization Sequence".
  - a) Select "Remove Initialization Sequence".

- b) Select "Initialization Sequence" and select the \*.iec file from the user directory /var/usb/.

See also:

- [Example "Controlling the R&S SMW and external RF instruments with the same application program"](#) on page 768
- [Example "Connecting an external instrument and sending SCPI commands to it"](#) on page 771

#### 4.9.7 How to Generate a 2x8 MIMO Signal for BS Tests

Refer to [Table 4-1](#) to find out the suitable system configuration and the required additional instruments for this particular test.

There are two suitable test setups:

- A test setup with one R&S SMW and six R&S SGT  
See ["Test setup with R&S SMW and 6xR&S SGT"](#) on page 192
- A test setup with multiplexed digital output signals

See user manual R&S®SMW-K551 Generation of Digital "Slow IQ" Signals.

##### Test setup with R&S SMW and 6xR&S SGT

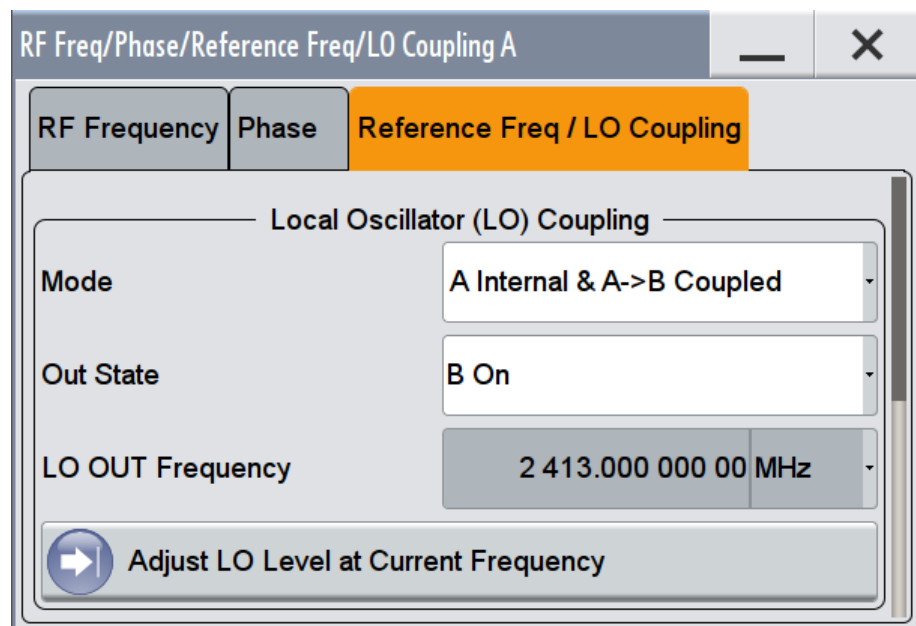
This test setup is a logical extension of the 1x4x4 test case.

Follow the instructions provided in the sections listed below but connect six R&S SGT instruments instead:

1. Connect all 8 instruments to a LAN.
2. Connect the six R&S SGT to the DIG I/Q OUT interfaces of the R&S SMW (see [Figure 4-17](#) for explanation of the principle)
3. Distribute the *internal reference frequency* of R&S SMW to the other instruments. Connect the instruments in a *daisy chain*.
4. Perform the configurations described in:
  - [Chapter 4.9.3, "How to Define the MIMO Scenario"](#), on page 181
  - [Chapter 4.9.4, "How to Route the I/Q Streams to the Output Interfaces"](#), on page 183
  - ["To connect and configure RF instruments to the I/Q digital interface"](#) on page 189
5. If a beamformed signal is required, activate the local oscillator (LO) of the R&S SMW and distribute the *LO signal* to the other instruments ( instead of the reference frequency):



- a) In the R&S SMW, select "RF > Reference Frequency/LO Coupling", select "LO Coupling Mode > A Internal& A->B Coupled" and enable "Out State > B On".



See also ["To configure LO coupling with cascaded instruments to achieve phase coherence"](#) on page 434.

- b) Disconnect the cable for the REF OUT connector and connect it to the LO OUT connector of the R&S SMW.

The connected instruments are reconfigured automatically so that they use the supplied local oscillator signal.

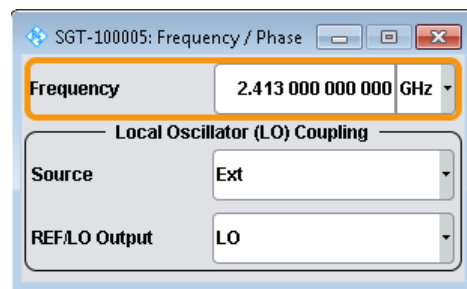


Figure 4-19: Example: Automatically configured settings in the connected external instrument

All connected instruments generate signals with the same RF frequency.

#### 4.9.8 How to Generate a Multi-Standard Radio Test Signal

Refer to [Table 4-1](#) to find out the suitable system configuration and the required additional instruments for this particular test.

This example shows how to configure the instrument to generate two wanted signals, an LTE and a 3GPP FDD uplink signals, and two strong interfering signals, a CW inter-

ferer and an LTE modulated interferer. The wanted signals are routed to the RF A output and the interfering to RF B.



You can also use the ARB generator and generate the signal of up to 8 SISO systems ("System Configuration > 8x1x1").

See [Chapter 5.5.3.1, "ARB General Settings"](#), on page 292.

1. Press the PRESET key.
2. Select "System Configuration" and configure:
  - a) An 1x4x4 MIMO scenario with "BB Source Config > Separate Sources"
 

See ["To simulate complex MxN MIMO scenarios using the "Fading and Baseband Configuration" settings"](#) on page 181.
  - b) Select "I/Q Stream Mapper" and route the streams as follows:

System Configuration										
Fading/Baseband Config		I/Q Stream Mapper		External RF and I/Q		Overview				
	Frequency Offs /Hz	Phase Offs /°	RF A	RF B	I/Q OUT 1	I/Q OUT 2	BBMM 1	BBMM 2	FAD 3	FAD 4
Stream A	-30 000 000.00	0.00	⬇				⬇			
Stream B	0.00	0.00	⬇					⬇		
Stream C	7 500 000.00	0.00		⬇					⬇	
Stream D	17 500 000.00	0.00		⬇						⬇
Combination			Add	Add	Single	Single	Single	Single	Single	Single

See also [Chapter 4.9.4, "How to Route the I/Q Streams to the Output Interfaces"](#), on page 183.

The instrument couples automatically the trigger settings in all four basebands (see ["Simultaneous signal generation start in several instruments"](#) on page 233).

3. Select "Fading > Bypass If Fading Off > On" to bypass the fading simulator.
 

The basebands are routed unchanged to the next processing block.
4. In "Baseband A", define the first wanted signal, for example an uplink FDD LTE signal with the default settings.
 

See also ["To define the baseband signal"](#) on page 182
5. In "Baseband B", define the second wanted signal, for example an uplink FDD 3GPP FDD signal with the default settings.
6. In "Baseband C", define the unmodulated (CW) interferer, for example use the "MCCW" settings and enable a signal carrier CW signal.
7. In "Baseband D", define the modulated interferer, for example an uplink FDD LTE signal with the 1.4 MHz channel bandwidth.

8. Select "Frequency A = Frequency B = 1.95 GHz"
9. Select "Level A = -100 dBm" and "Level B = 0 dBm"
10. Select "Baseband A > Baseband Offsets > Baseband A > Gain = -30 dB" to boost the second wanted signal.
11. Select "RF A > On" and "RF B > On".

**Tip:** Use the built-in graphical display to verify the power spectrum of the generated signals, see [Chapter 9.1.4, "How to Verify the Generated Signal with the Graphics Display"](#), on page 540.

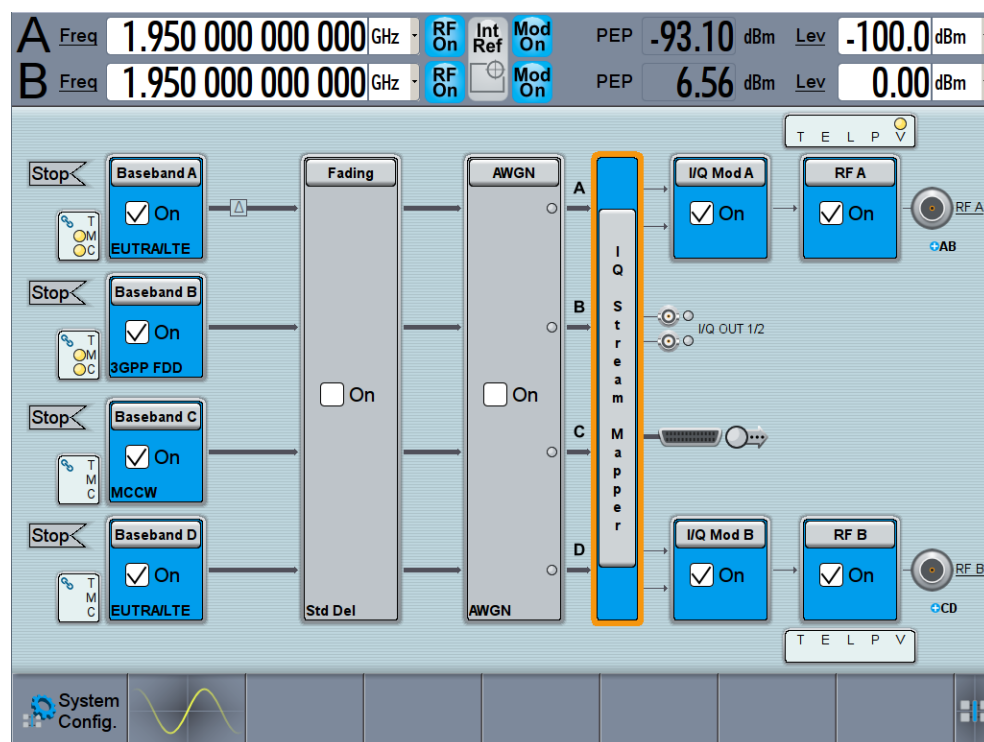


Figure 4-20: Example: Generation of two wanted and two interfering signals

#### 4.9.9 How to Connect an R&S®CMW500 Radio Communication Tester for Fading Applications

You can use R&S SMW to superimpose fading on the baseband signal generated by an R&S®CMW500. The R&S SMW must be connected to the digital I/Q interface of the R&S®CMW500.

The [Table 4-10](#) lists the stream mapping for this configuration; the table entries show the stream to interface mapping in the order the related boards are located on the instrument's rear panel.

Table 4-10: Overview of the stream mapping

Digital Interface	Direction	Stream	Digital Interface	Direction	Stream
CODER 1	Input	Stream to Baseband A	CODER 2	Input	Stream to Baseband B
FADER 1	Input	Stream to Baseband C	FADER 2	Input	Stream to Baseband D
FADER 3	Output	Stream C	FADER 4	Output	Stream D
BBMM 1	Output	Stream A	BBMM 2	Output	Stream B

The Figure 4-21 shows a 1x2x2 MIMO setup with two downlink paths using the connectors DIG IQ 1 to 4 of the R&S®CMW500. In this example, the R&S SMW is synchronized to a 10-MHz reference signal provided by the R&S®CMW500. The R&S®CMW500 also provides the R&S SMW with its trigger signal.

All connections between R&S SMW and the R&S®CMW500 are established via the rear panels of the instruments.

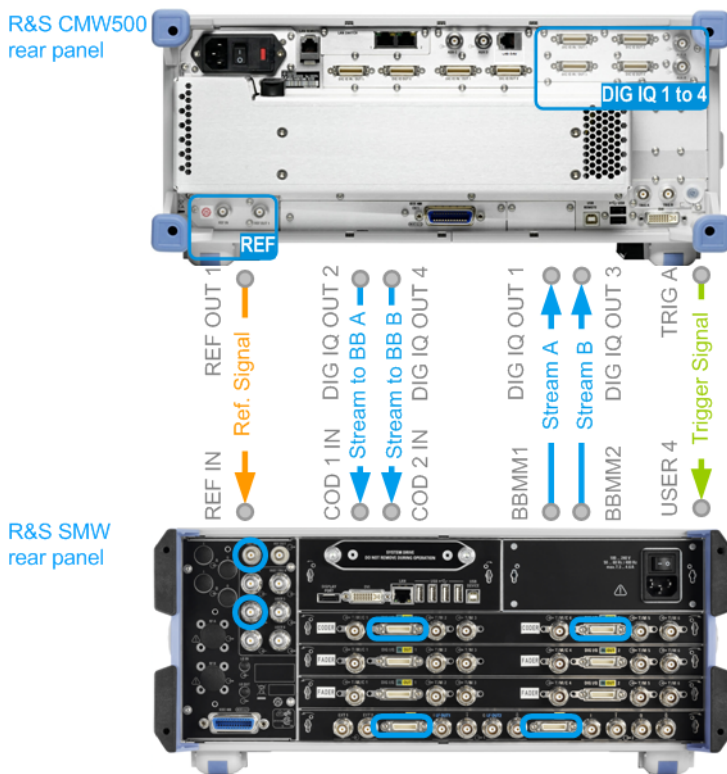


Figure 4-21: Example of test setup: 1x2x2 MIMO with 1xR&S SMW and 1xR&S CMW500 connected to the DIG I/Q interfaces

#### 4.9.10 How to Apply an External Digital Baseband Signal

See:

- "To provide an external digital signal to the instrument" on page 197
- "To apply an external analog signal directly to the I/Q modulator" on page 198
- "To apply an external differential analog signal directly to the I/Q modulator" on page 199

##### To provide an external digital signal to the instrument



A digital signal must be provided. The instrument displays an error message if no signal is applied at the digital input connector.

The external signal source, typically a second R&S instrument, and the receiving instrument have to be synchronized, i.e. they have to use a common reference signal.

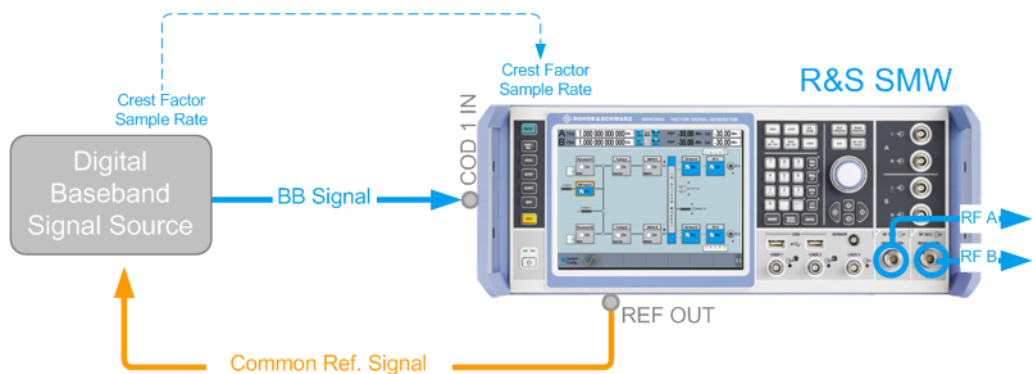


Figure 4-22: Example of test setup (simplified)

The procedure describes the configuration in the *default state of the instrument*, i.e. "System Config > Fading/Baseband Configuration > Mode > Standard".

In "Mode > Advanced" and with coupled baseband sources the steps differ.

1. Connect the external digital signal source to one of the digital input interfaces of the instrument, e.g. the CODER 1 IN.
2. If the "BB Input" block is not displayed in the block diagram, select the input symbol "CODER 1".
3. Select "BB Input > Signal Routing" and adjust the required signal switching.
4. Select "BB Input > Baseband Offsets" and adjust the frequency offset and the path gain settings, if required.
5. In the "Baseband Input Settings > Sample Rate" dialog, adjust the sample rate source and value.
6. In the "Baseband Input Settings > Input Level Settings" dialog adjust the "Crest Factor", "Peak Level" and "Level" values of the external input signal in one of the following ways:

- a) Find these values out and enter them manually
- b) Set appropriate "Measurement Period" and trigger "Auto Level Set".  
To ensure accurate level measurements, select a measurement period that is long enough to capture several periods of the input signal.
- c) Enable "DIG IQ Auto Settings"  
The R&S SMW receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

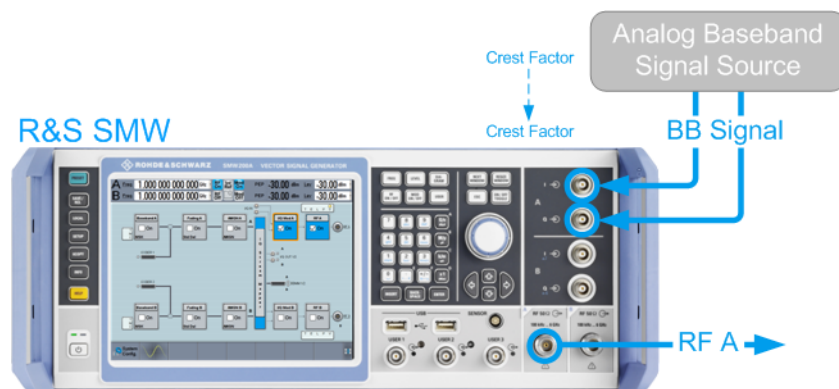
Based on these values, the internal gain control adjusts the input signal gain to achieve an optimal dynamic range.

**Tip:** Achieving correct signal leveling with external baseband signals requires one measurement per each baseband source with an appropriate measurement time. Perform the same steps in the other basebands, if an external digital signal is fed to the other digital input connectors.

7. In the "Baseband Input Settings" dialog, configure the other settings as required.
8. Select "Baseband Input Settings > General > State > On" to enable the processing of the external digital signal.
9. Open "Baseband Input Settings > Signal Monitoring" and monitor the signal overflow status.

#### To apply an external analog signal directly to the I/Q modulator

An external analog wideband signal has to be fed at the I/Q input connectors (see [Table 4-3](#)). The signal is used as an input signal for the I/Q modulator.



**Figure 4-23: Example of test setup (simplified)**

1. To configure the input signal source of the I/Q modulator, select "I/Q Mod > I/Q Mod In > Analog Wideband I/Q In".
2. To access the dialog box for configuring the I/Q modulator settings, select "I/Q Mod > I/Q Settings > I/Q Modulator".  
Refer to [Chapter 7, "Applying I/Q Vector Modulation"](#), on page 399 for a description of the settings.
3. In the "I/Q Modulator" dialog, select "General > Analog Wideband I/Q Input > Crest Factor" and adjust the crest factor and gain values.

4. To impair the analog signal, adjust the "I/Q Modulator > Impairments" settings (see also [Chapter 6.3, "Impairing the Signal"](#), on page 390).
5. Select "I/Q Mod > On" or "I/Q Mod > I/Q Modulator > General > State > On" to enable the processing of the external analog signal.

#### To apply an external differential analog signal directly to the I/Q modulator

1. Select "I/Q Mod > I/Q Settings > Source > Differential Analog I/Q Input".
2. Follow the steps described in ["To apply an external analog signal directly to the I/Q modulator"](#) on page 198.

### 4.9.11 How to Connect an R&S EX-IQ-BOX

Transmission of digital I/Q signals to a device under test (DUT) requires that the signals are adjusted to the type of interface, including its physical properties, and to the corresponding transmission protocol. While Rohde & Schwarz instruments generally communicate via a company-wide standardized transmission protocol that is based on LVDS, many different interfaces and communication protocols have evolved in digital I/Q transmission.

To meet many of these variants in a convenient way, you can use the R&S EX-IQ-BOX as a downstream converter. The R&S EX-IQ-BOX is a configurable digital interface module, designed to convert digital I/Q signals of the Rohde & Schwarz instruments into *User Defined* or *Standardized* signal formats. This is done by so-called breakout boards, which adjust the signal physically. See the R&S EX-IQ-BOX Operating Manual for information on the breakout boards and their pin assignment.

See:

- ["Basic Test Setup with the R&S EX-IQ-BOX"](#) on page 199
- ["To set up the R&S EX-IQ-BOX and R&S DigIConf"](#) on page 200
- ["To connect an R&S EX-IQ-BOX operating in transmitter mode to the instrument"](#) on page 200

#### Basic Test Setup with the R&S EX-IQ-BOX

The [Figure 4-24](#) shows the cabling of a basic test set up with the R&S SMW, a connected R&S EX-IQ-BOX and a DUT. The R&S EX-IQ-BOX is configured via USB by the digital interface configuration software R&S DigIConf, running on a PC. The R&S EX-IQ-BOX operates in transmitter mode from the R&S SMW to the DUT.

How to Connect External Instruments and Configure the Signal Flow

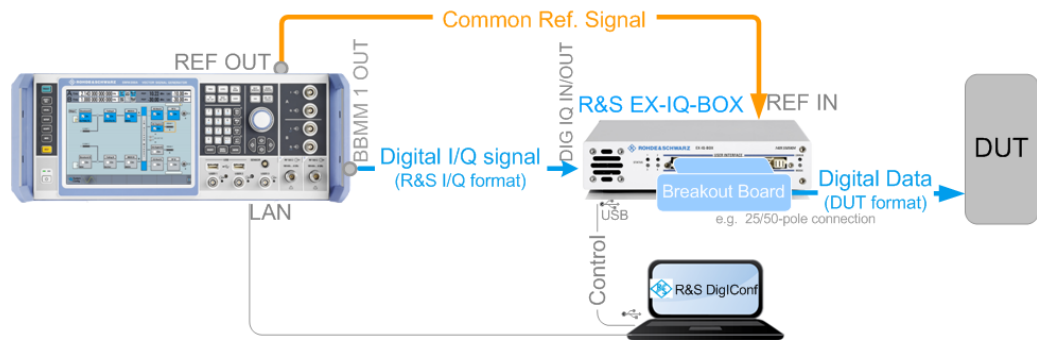


Figure 4-24: Basic test setup with R&S SMW and an R&S EX-IQ-BOX operating in transmitter mode



This section describes how to configure a basic setup with the R&S SMW and R&S EX-IQ-BOX, including the cabling, installing the configuration software, and connecting the instruments.

For more information, refer to the R&S EX-IQ-BOX Operating Manual.

#### To set up the R&S EX-IQ-BOX and R&S DigiConf

1. Disconnect all R&S EX-IQ-BOX instruments from controller PC.
2. Download the setup file `DigiConf_x.xx.xxx.exe` from the R&S website: <http://www.rohde-schwarz.com/product/EX-IQ-Box.html>
3. Install the configuration software R&S DigiConf on the controller PC.
4. Plug the required breakout board to the user interface of the R&S EX-IQ-BOX.
5. Connect the R&S EX-IQ-BOX to the AC supply.
6. Connect the USB cable between the USB IN of the R&S EX-IQ-BOX and the PC.
7. Start R&S DigiConf.

The application starts. The main view of R&S DigiConf shows the connected R&S EX-IQ-BOX.

#### To connect an R&S EX-IQ-BOX operating in transmitter mode to the instrument

1. Connect the required cable to the DIG I/Q IN connector of the R&S EX-IQ-BOX to the BBMM 1 OUT connector of the R&S SMW.  
See [Figure 4-24](#).

The R&S SMW recognizes this external digital signal interface module automatically and indicates a labeled symbol of the R&S EX-IQ-BOX at the "Block Diagram > I/Q Digital" block.

R&S DigiConf also indicates a separate function block with information on the R&S SMW, the currently used interfaces, and the signal flow.

2. Select "Block Diagram > I/Q Digital > Sample Rate > Source > Digital IQ IN".
3. Adjust further required settings.



See also ["To match the crest factors and coordinate the signal parameters of connected instruments"](#) on page 201.

4. To access information on the recognized R&S EX-IQ-BOX components, select "Setup > Hardware Config > Baseband Assembly".  
For more information, refer to the R&S EX-IQ-BOX Operating Manual.



See user manual R&S®SMW-K551 Generation of Digital "Slow IQ" Signals.

#### 4.9.12 How to Perform Further Configurations

##### To match the crest factors and coordinate the signal parameters of connected instruments

To obtain correct signal level at the RF outputs of the connected instrument, the instrument settings of the generators have to be coordinated.

If you use the settings provided in the dialog "System Configuration > External RF and I/Q", the R&S SMW automatically adjusts all necessary settings at the connected instruments; you can skip this description.

This procedure explains how to query the expected peak level of the RF instrument performing the upconverting task and set the corresponding output settings in the R&S SMW, *if you configure the instruments manually*.



We assume, that the instruments are connected properly, among others:

- the RF upconverter is connected to the I/Q OUT 1 outputs of the R&S SMW
- At least one stream is mapped to this analog I/Q output, e.g. Stream C
- The instruments use common reference frequency.

For description of the assisted configuration, see ["To connect and configure RF instruments to the I/Q analog interface"](#) on page 186.

*For manual configuration*, proceed as follows:

1. Lets assume, that the RF upconverter uses a peak level of 0.5 V at its analog I/Q inputs.
2. In the R&S SMW, select "Block Diagram > I/Q Analog > I/Q Analog Outputs" and set:
  - a) "I/Q Out Type = Single Ended"
  - b) "Set Level Via = Peak Level"
  - c) "Peak Level" = 0.5 V
3. In the "Block Diagram > I/Q Analog > I/Q Analog Outputs" dialog, query the "Crest Factor" value of the output signal.

4. Enter this crest factor value at the I/Q output signal at the upconverting instrument, e.g. R&S SGS:
  - a) select "SGMA GUI > Block Diagram > I/Q Settings > Wideband > On"
  - b) set the "Crest Factor" to the Crest Factor at the I/Q outputs of the R&S SMW.
5. In the R&S SMW, select "Block Diagram > I/Q Analog > On" to enable the I/Q output.

The signal parameters are coordinated. Perform further settings (like "RF > On", etc.) as required.

## 4.10 Reference

This section provides reference and background information.

### 4.10.1 Representation of the Signal Flow in the Block Diagram

This section delivers an insight into the possible representations in the block diagram. The description follows a standard mode to advanced MIMO configurations order. As the examples show, the more complex the scenario and the higher the MIMO mode, the more abstract the representation.

Together with the examples, the description lists short information with the required options. For comprehensive information about all available options with their prerequisites and requirements, as well as an overview of the possible configuration, refer to the instrument's specification (data sheet).

#### 4.10.1.1 Main Differences Between the Standard and the Advanced Modes

The [Table 4-11](#) summarizes the main differences between the two modes.

See also:

- [Chapter 4.10.1.2, "Configurations in Standard Mode"](#), on page 203
- [Chapter 4.10.1.3, "Configurations in Advanced Mode"](#), on page 204

Table 4-11: Main differences

Criteria	Standard mode	Advanced mode
Required options	-	Several required options
Signal routing	User defined Signals can be added, frequency and/or phase shifted as well as power boosted	Fixed up to the "I/Q Stream Mapper" Selected upon a predefined "Baseband and Fading Configuration"
Signal flow representation on the block diagram	As it is (WYSIWYG)	Abstract The more complex the scenario and the higher the MIMO mode, the more abstract the representation

### 4.10.1.2 Configurations in Standard Mode

The term *Standard Mode* refers to the "System Configuration > Mode > Standard" setting and is used as an abbreviation/synonym of it throughout this documentation.

This mode corresponds to the former Rohde&Schwarz signal generators capabilities, like those of an R&S SMU or R&S AMU base unit, without the MIMO Fading option R&S SMU/AMU-K74. The representation of the block diagram is "classic", as it is in the former instruments. The block diagram displays all blocks for that the required hardware and software options are installed and shows the **signal flow as it is**, without any level of abstraction.

Table 4-12: Overview of the possible configuration in standard mode and representation in the block diagram

Required Baseband Options	Block Diagram
<p><b>Instrument with RF Section Only, One or Two Paths</b>                      Examples of possible applications of this configuration are</p> <ul style="list-style-type: none"> <li>• A setup with external ARBs and high RF frequency (e.g. RF = 20 GHz)</li> <li>• The instrument is used as RF frontend for the 3<sup>rd</sup> and for the 4<sup>th</sup> antenna in a 4x4 MIMO system realized with another R&amp;S SMW</li> </ul>	
-	<p><b>Instrument with Baseband Section, Digital Input Interfaces and without Fading Simulator</b>                      The external and internal signals can be added, frequency and/or phase shifted as well as power boosted.</p>

Required Baseband Options	Block Diagram
1xR&S SMW-B10	
<p><b>Instrument with Fading Simulator without MIMO Extension</b> The signals at the output of the fading blocks can be added.</p>	
1xR&S SMW-B10 + 1xR&S SMW-B14	

**4.10.1.3 Configurations in Advanced Mode**

Throughout this documentation, the term *Advanced Mode* is used as an abbreviation of the "System Configuration > Mode > Advanced". This mode is available in instruments equipped with the required hardware and software options.

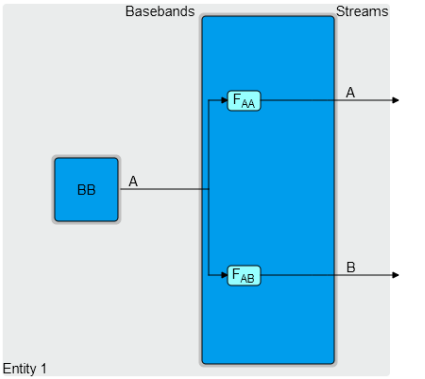
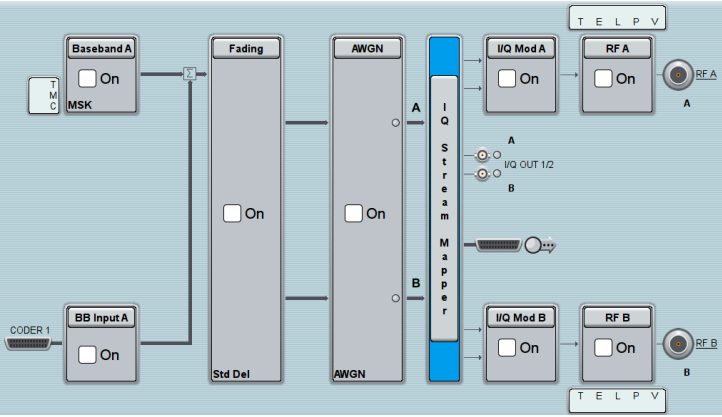
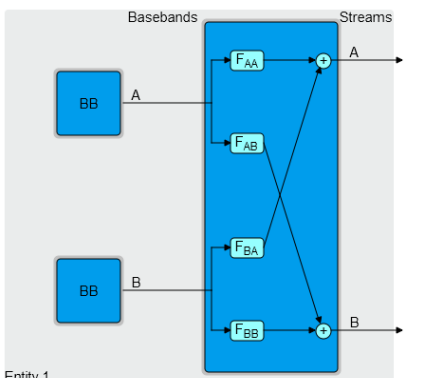
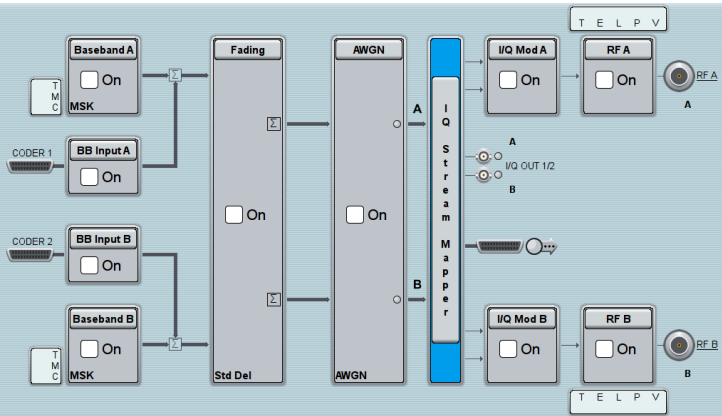
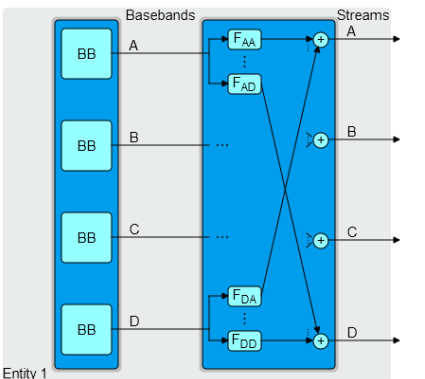
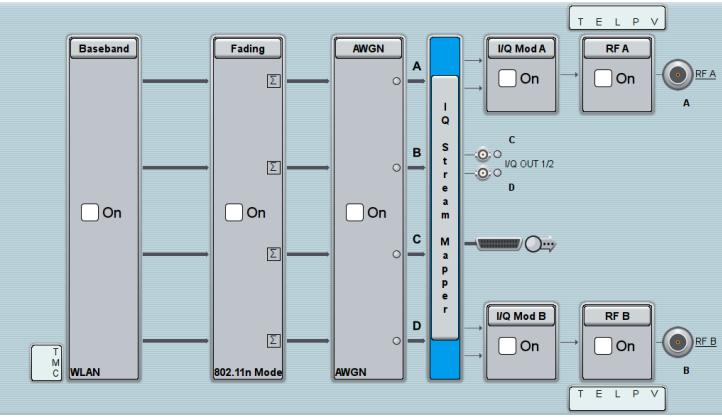
The advanced mode extends the *Standard mode* with MIMO configurations like 2x2 MIMO, higher MIMO modes (e.g. 4x4, 2x8 and 8x2 MIMO), or multiple entity modes (e.g. 2x2x2, 4x2x2 or 8x1x1 configurations).

All examples in this section require the options listed in "[Required options](#)" on page 131.

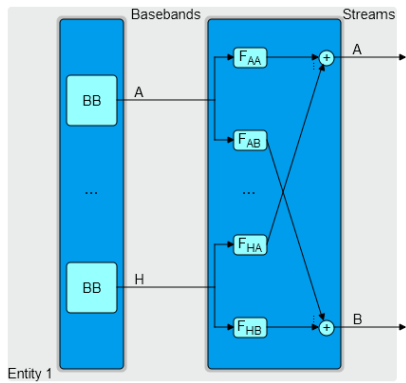
In advanced mode, **the signal routing is fixed.**

The [Table 4-13](#) shows the representation of the selected fading and baseband configuration on the preview diagram ("System Configuration > Fading/Baseband Configuration") and on the block diagram. As the examples show, the more complex the scenario (e.g. multiple entity) and the higher the MIMO mode ( $M, N > 2$ ), the more abstract the representation.

Table 4-13: Overview of the possible configuration in advanced mode with representation in the block diagram

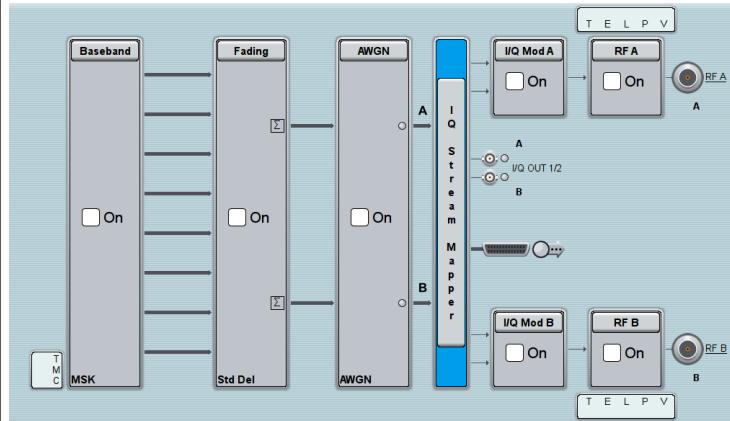
Preview Diagram	Block Diagram
<b>Single Entity and 1xN or 2xN MIMO Configuration</b>	
 <p>Entity 1</p>	 <p>SIMO/Rx diversity, i.e. one baseband source</p>
 <p>Entity 1</p>	 <p>Double source MIMO, i.e. two individual baseband sources</p>
<b>Single Entity and 3xN or 4xN MIMO Configuration</b>	
 <p>Entity 1</p>	 <p>4x4 MIMO with coupled baseband sources</p>
<b>Single Entity and 8x1 or 8x2 MIMO Configuration</b>	

Preview Diagram



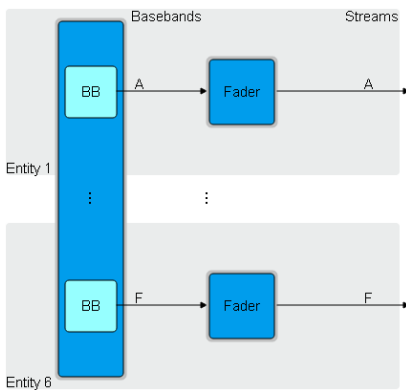
Entity 1

Block Diagram



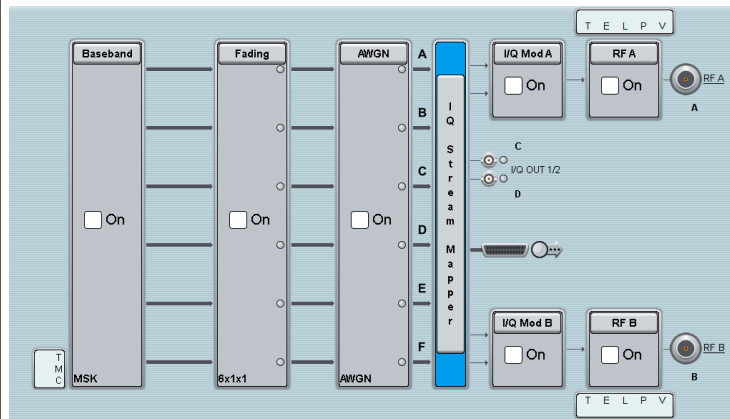
8x2 MIMO, coupled source

Multiple Entity in Lx1x1 Configuration



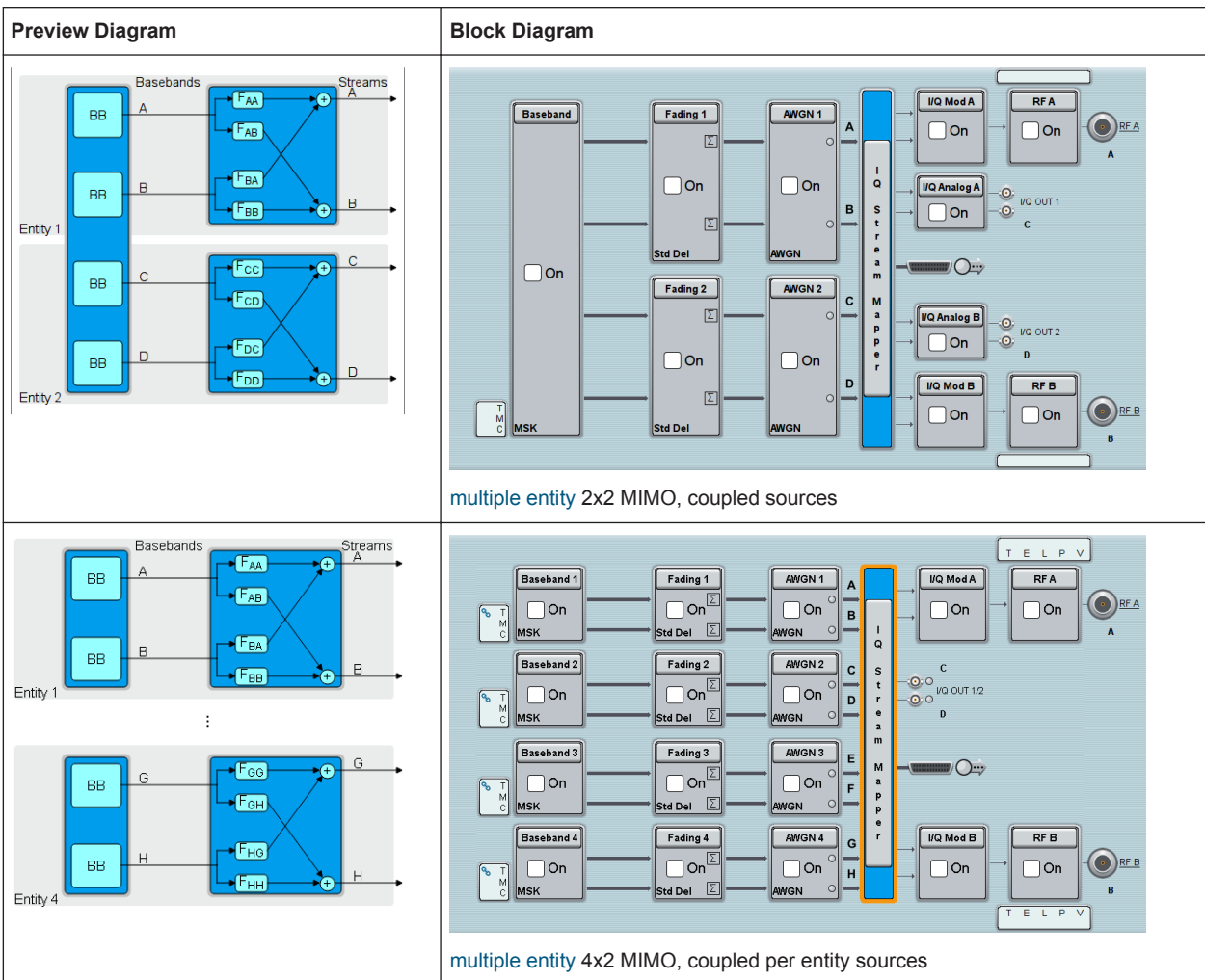
Entity 1

Entity 6



6x1x1 multiple entity SISO

Multiple Entity in 2x2x2 and 4x2x2 Configuration



### 4.10.2 Important Signal Parameters and Interface's Characteristics

The correct signal processing of the externally supplied input signals in the instrument and the correct processing of the output signal in the subsequently connected instrument require information of some signal parameters, like sampling rate, crest factor and signal level, expressed as peak or as RMS level value.

#### Sample rate

The sample rate of the digital input and output signal can be defined manually or automatically retrieved from the input and estimated for the output signal.

#### Crest factor

According to its definition, the crest factor gives the difference in level between the peak level and RMS level value in dB (see Figure 4-25).

The R&S SMW uses the crest factor to calculate the power levels, that is the instrument compensates the RMS levels of the externally supplied signal by the crest factor.

For example, the crest factor of the externally fed analog signal is important for the calculation of the RF output power.

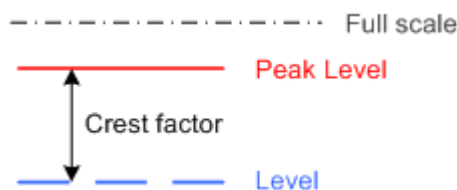


Figure 4-25: Relation between the level settings

Test setups often involve an up-converter connected to the analog or digital I/Q connectors of the generator or feeding of external signal to the digital input of the R&S SMW. As a rule, whenever an I/Q signal is transferred between two instrument, *the crest factor and the peak levels of the two involved instruments have to be coordinated*. Proper signal settings and correct results are ensured if the peak level and crest factor values at the I/Q outputs of the "source" instrument (e.g. the R&S SMW) and the I/Q inputs of the up-converter are equal.

In the R&S SMW, level values are represented as relative to a full scale (see [Figure 4-25](#)).



#### Where to find the necessary values?

- Dialog "BB Input", see [Chapter 4.6, "Digital Baseband Input Settings"](#), on page 159
- Dialog "Digital I/Q Out", see [Chapter 4.7, "I/Q Digital Output Settings"](#), on page 166
- Dialog "Analog I/Q Out", see [Chapter 4.8, "I/Q Analog Output Settings"](#), on page 173
- Dialog "Setup > System > Baseband Powers", see [Chapter 9.2, "Querying Information on the Baseband Power Levels"](#), on page 553
- Dialog "Fading > Insetion Loss Config./ Coupled Parmeters > Insetrion Loss" See the user manual "Fading Simulator".

#### Why the instrument monitors the signal internally and how to avoid overflow

The R&S SMW constantly monitors the input and output digital signal and indicates an overflow status.

- Overflow of the **input signal** (Crest Factor and Peak Level) is indicated if the entered "Peak Level" (in dB full scale) value does not correspond to the real value  
**Tip:** The overflow status is indicated as long as the signal level is not reduced and the peak level value corrected. Trigger "Auto Level Set" to collect the required values and adjusts the settings automatically.
- Overflow of the **output signal** is indicated if the digital signal is clipped, i.e. if the level of the output signal, or the noise level (AWGN) are too high.



### 4.10.2.1 Specific Characteristics of the Digital I/Q Interface

#### What is a "digital channel" and how are the channels distributed to the basebands

The external digital signals supplied at the DIG I/Q interfaces of the instrument may contain more than one, possibly even multiplexed, digital channels. The R&S SMW processes each of these digital channels as a separate signal. Over the settings provided at the user interface, you can route the available digital channels of each of the digital interface to one of the baseband blocks.



Do not mistake the term *channel* used here with the terms [Fading channel](#) or signal path.

For a description of the required settings, see [Source](#).

#### Fulfilling the prerequisites for a correct signal processing of the externally supplied digital baseband signal

The [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207 emphasizes why and which signal parameters are important for the correct internal signal processing of externally supplied signals in the R&S SMW. This section focuses on the way these requirements are fulfilled and explains how the instrument deals with signals deviating from the expected values:

- **Crest factor, peak level and RMS level**

These values can be adjusted in one of the following ways:

- Adjusted manually

If you have knowledge about these values, it is best to enter them directly (see ["Crest Factor"](#) on page 164)

- Estimated automatically by the internal measurement function

Use the function [Auto Level Set](#) to trigger the R&S SMW to measure the input signal, estimate the peak level and RMS level and calculate the crest factor out of them.

**Tip:** For a correct signal leveling:

- 1) enable an appropriate measurement time
- 2) perform one measurement for each baseband source
- 3) set the measurement period to a time value that is long enough to capture several periods of the input signal.

- Determined automatically

The R&S SMW can receive the values from the connected transmitter.

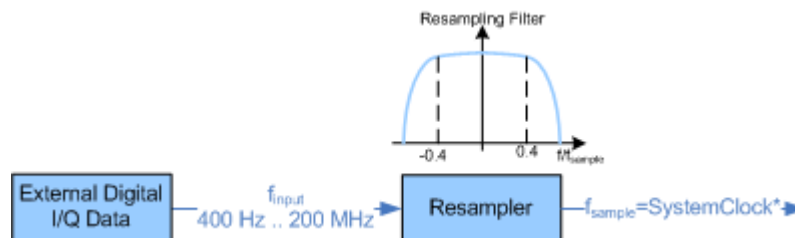
If the external digital signal source is a second Rohde & Schwarz instrument, it signals the peak level and the RMS level of the signal over the digital input interface. To enable the R&S SMW to receive these values, enable the parameter [DIG IQ Auto Setting](#).

In the second automatic way, the R&S SMW adjusts the corresponding input fields with the measured/received values. The internal gain control mechanism uses

these received values to adjust the input signal gain to achieve an optimal dynamic range.

- **Sample Rate**

External input signals with sample rates different than the system clock are resampled, as illustrated on [Figure 4-26](#).



**Figure 4-26: Resampling principle of external digital baseband signals**

\* = max. sample rate (200 MHz or 100 MHz) depends on connected device

The R&S SMW can process digital signals with sample rate from 400 Hz to 200 MHz. The internal signal processing is based on a sample rate with a maximum value (200 MHz or 100 MHz) that depends on the capabilities of the connected transmitting/receiving device.



### Estimating or defining the sample rate

The sample rate of the signal at the digital interface can be determined with one of the following methods:

- **User-defined sample rate**  
Provide both the external signal source and the receiving instrument with a common external reference signal and set the sample rate value.
- **Estimated sample rate**  
Enable the instrument to evaluate the received I/Q data clock

- **Maximum modulation bandwidth**

A baseband signal with a sample rate that is smaller than the used system clock is interpolated (see [Figure 4-26](#)). The resulting modulation bandwidth is calculated as  $Sample\ Rate * 0.8$ , i.e. with a sample rate of exactly 200 MHz, the modulation bandwidth is 160 MHz.

#### 4.10.2.2 Specifics of the Analog I/Q Interfaces

The R&S SMW outputs the digitally modulated signal not only directly but also converted to an analog I/Q baseband output signal. The R&S SMW outputs the analog baseband signal single ended or differential (non-inverted); an RF envelope signal can be generated, too.

#### Differential output signal

The *differential output* provides symmetrical signals for differential inputs of DUTs without the need of additional external electric network. To achieve an optimal and balanced operating point of these inputs, ensure the correct adjustment of the used DC

voltage ("Bias") and the offset ("Offset") between inverting and non-inverting output. Refer to the descriptions [Bias \(EMF\)](#) and [Offset \(EMF\)](#) for a description of the effect of these parameters.

## 5 Configuring the Internal Baseband Source

The R&S SMW is a vector signal generator with internal signal generation and real-time functionality and with integrated arbitrary waveform generator.

The instrument enables you to generate various digital modulation signals in accordance with the definitions in the corresponding specifications or with user-definable characteristics. Signals are generated in real-time or played from a data store with external and internal data. The instrument provides an interface for the loading of externally computed modulation signals in form of waveform files.

### Overview of the signal generation modes

The R&S SMW can generate the signal in the following ways:

- **Generating digital modulated signals according to various digital standards**  
Provided the instrument is equipped with the required firmware options, the instrument can generate digital standards in accordance with the corresponding specifications.  
The required options are specified in the description of the respective digital standard (see the corresponding user manual).  
See also [Chapter 5.2, "Generating Signals According to Digital Standards"](#), on page 214.
- **Generating a real-time signal**
  - While utilizing the *internal* signal generator, the R&S SMW generates the digital modulation signals with user-definable characteristics in real time.  
See also [Chapter 5.4, "Generating Custom Digital Modulated Signals"](#), on page 252.
  - If the required options are installed, *externally supplied real-time* baseband signals can be added to the internally generated signals.  
See also [Chapter 4.6, "Digital Baseband Input Settings"](#), on page 159.
- **Playing a waveform**  
The R&S SMW is equipped with an Arbitrary Waveform Generator (ARB) used to generate test signals and to process waveform files. Waveforms are files with settings provided for repeatable tests with the same test signal. Irrespectively of the way these waveform files are generated, they are always played from the instrument. That is, the signal calculation is performed in advance and the instrument reacts as a player.
  - *Externally* computed waveform files, like for example files generated with the signal generation software R&S WinIQSIM2, can be loaded in the instrument over the LAN, USB, or the GPIB interface.
  - The instrument provides different functions to generate waveforms *Internally*. Some of the digital standards firmware options provide the possibility to store the current signal settings into a waveform file. These waveform files can be loaded in and processed as multi-carrier or multi-segment signal by the ARB generator (see also [Chapter 5.5, "Using the Arbitrary Waveform Generator \(ARB\)"](#), on page 287).  
Multi-carrier waveforms consisting of carriers modulated by different baseband signals can be configured and created internally (see also [Chapter 5.7, "Gener-](#)

ating Multi Carrier Signals", on page 340). Such multi-carrier waveform files are required to simulate complex multi-carrier scenarios with different baseband signals, e.g. CDMA2000, 3GPP FDD, or signals in accordance with the LTE Advanced specifications.

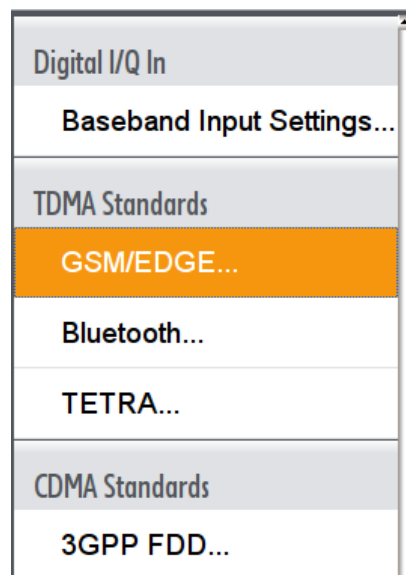
Provided the instrument is equipped with the corresponding option, it is also possible to generate multi-carrier waveforms consisting of unmodulated carriers (see also [Chapter 5.8, "Generating Multi-Carrier Continuous Wave Signal"](#), on page 357).

## 5.1 How to Access the Functions in the Baseband Domain



To access the functions of the baseband generator

1. In the block diagram, select the corresponding "Baseband" block and navigate through the context menu.



The "Baseband" block comprises all functions and settings concerning the baseband signal. These include all generation modes, as described in the ["Overview of the signal generation modes"](#) on page 212.

2. The signal generation is not started immediately.  
To activate the baseband generator: in the block diagram, select the corresponding "Baseband" block and set "Baseband > On".

A short designation indicates the digital standard or modulation currently selected. The designation DIG I/Q IN indicates that the instrument uses the external digital baseband signal, see [Chapter 4.6, "Digital Baseband Input Settings"](#), on page 159.

For information, see:

- [Chapter 5.4, "Generating Custom Digital Modulated Signals"](#), on page 252
- [Chapter 5.5, "Using the Arbitrary Waveform Generator \(ARB\)"](#), on page 287

- [Chapter 5.8, "Generating Multi-Carrier Continuous Wave Signal"](#), on page 357
- The description of the digital standards
- [Chapter 5.10, "Shifting and Boosting the Baseband Signal"](#), on page 366

## 5.2 Generating Signals According to Digital Standards

The R&S SMW generates digital signals in accordance with the specifications of the main communication and radio standards only if the corresponding firmware options are installed.

This section lists the supported standard-compliant digital signals.

### **GSM/EDGE, EDGE Evolution**

This digital standard requires an instrument equipped with the GSM/EDGE and EDGE Evolution options R&S SMW-K40/-K41.

The GSM/EDGE, EDGE Evolution options provide functionality to generate signals in accordance with the GSM/EDGE standard, based on the GMSK and 8PSK modulation, and in accordance with the EDGE Evolution standard with simulation of higher order modulations.

For details, see the R&S SMW GSM/EDGE user manual.

### **Bluetooth® Enhanced Data Rate/Low Energy**

This digital standard requires an instrument equipped with the Bluetooth® Enhanced Data Rate option R&S SMW-K60.

The Bluetooth® Enhanced Data Rate option provides functionality to generate signals in accordance with the Bluetooth Specification 2.1+EDR and the latest Bluetooth Low Energy specification.

For details, see the R&S SMW Bluetooth EDR user manual.

### **TETRA Release 2**

This digital standard requires an instrument equipped with the TETRA Release 2 option R&S SMW-K68.

The TETRA Release 2 option provides functionality to generate signals in accordance with the standard Terrestrial Trunked Radio Release 2 (TETRA2).

For details, see the R&S SMW TETRA Release 2 user manual.

### **3GPP FDD incl. enhanced MS/BS tests, HSPA, HSPA+**

This digital standard requires an instrument equipped with the 3GPP FDD incl. enhanced MS/BS tests, HSPA, HSPA+ options R&S SMW-K42/-K83.

These options provide functionality to generate signals in accordance with the WCDMA standard 3GPP FDD.

For details, see the R&S SMW 3GPP FDD user manual.

**CDMA2000®**

This digital standard requires an instrument equipped with the CDMA2000 option R&S SMW-K46.

The CDMA2000 option provides functionality to generate signals in accordance with the CDMA2000 standard 3GPP2 C.S0002-C, version 1.0 (release C).

For details, see the R&S SMW CDMA2000 user manual.

**TD-SCDMA and TD-SCDMA enhanced features**

This digital standard requires an instrument equipped with the TD-SCDMA and TD-SCDMA enhanced features options R&S SMW-K50/-K51.

The TD-SCDMA options provide functionality to generate signals in accordance with the TD-SCDMA (3GPP TDD LCR) standard.

For details, see the R&S SMW TD-SCDMA user manual.

**1xEV-DO Rev. A and Rev. B**

This digital standard requires an instrument equipped with the 1xEV-DO Rev. A and Rev. B options R&S SMW-K47/-K87.

The 1xEV-DO options provide functionality to generate signals in accordance with the CDMA2000 1xEV-DO (Evolution-Data Optimized), Rev. A and Rev. B standard.

For details, see the R&S SMW 1xEV-DO Rev. A Rev. B user manual.

**IEEE 802.11a/b/g/n, IEEE 802.11ac**

This digital standard requires an instrument equipped with the IEEE 802.11a/b/g/n and IEEE 802.11ac options R&S SMW-K54/-K86.

These options provide functionality to generate signals in accordance with the Wireless LAN standards IEEE 802.11a/b/g/n/ac/p/j.

For details, see the R&S SMW IEEE 802.11a/b/g/n/ac user manual.

**IEEE 802.16 WiMAX™**

This digital standard requires an instrument equipped with the IEEE 802.16 WiMAX option R&S SMW-K49.

The IEEE 802.16 WiMAX option provides functionality to generate signals in accordance with the IEEE 802.16 standard WiMAX.

For details, see the R&S SMW WiMAX user manual.

**EUTRA/LTE Release 8, Release 9, Release 10 and Release 11**

This digital standard requires an instrument equipped with the EUTRA/LTE options R&S SMW-K55/-K69/-K81/-K84/-K85/-K112.

These options provide functionality to generate signals in accordance with the 3GPP standard EUTRA/LTE Release 8, Release 9, Release 10, and Release 11.

For details, see the R&S SMW EUTRA/LTE user manual.

### **NFC/EMV**

This digital standard requires an instrument equipped with the NFC/EMV option R&S SMW-K89.

The NFC/EVM option provides functionality to generate signals in accordance with the short-range wireless connectivity technology NFC-A/B/F and the EMV standard.

For details, see the R&S SMWNFC A/B/F user manual.

### **DVB-H/T**

This digital standard requires an instrument equipped with the DVB-H/T option R&S SMW-K52.

The DVB-H/T option provides functionality to generate signals in accordance with the DVB-H (Digital Video Broadcasting - Transmission System for Handheld Terminals) standard.

For details, see the R&S SMW DVB-H/T user manual.

## **5.3 Common Functions and Settings in the Baseband Domain**

Basic signal generation settings that are common to many generation tasks, regardless of the selected baseband source or digital standard, are described here. If you are performing a specific signal generation task, like generating a signal according to a digital standard, be sure to check the specific description for settings that may deviate from these common settings.

### **5.3.1 Basics on Signals, Modulation Types and Filters Used the Baseband Domain**

This section provides general information on common topics and basic principles.

#### **5.3.1.1 Data, Clock and Control Signals and Sources in the Baseband**

This section describes the common characteristics of the signals used for generating the baseband signal for all standards, irrespectively of the used generating mode (see "[Overview of the signal generation modes](#)" on page 212). The selection in the dialogs at any given time depends on the parameter and standard concerned and is clear from the selection list offered in the dialog. Some parameters are therefore not available in certain cases.

Characteristics which are uniquely specific to particular standards are described in the corresponding user manual.



For the generation of modulation signals, the instrument uses the following input signals:

- [Internal Modulation Data](#)
- ["External Modulation Data"](#) on page 218
- [Clock Signals](#)
- [Control Signals](#)

### Signal Sources

The data, the clock and the trigger signals can be both internally generated and supplied from an external source. Control signals however are always generated internally.

Depending on the current configuration, the internally generated data and marker signals are output on one or several connectors. For a detailed description of the output capabilities of the instrument and of how to configure the required connectors, refer to [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

### Internal Modulation Data

The R&S SMW uses the following internal modulation data sources:

- **Data lists**

Data lists are externally or internally created binary lists with modulation data. The instrument provides standard file select function for loading of existing data lists, creating internally new data lists or editing an existing one. Internally, data lists are created in the dedicated "Data List" editor (see [Chapter 5.4.3.7, "Data List Editor"](#), on page 267). A separate file is created for each list and stored on the instrument's hard disk. The file name is user-defined; the file extension is `*.dm_iqd`.

The maximum length of a data list is determined by the size of the data list memory (see data sheet). There is no restriction on the number of lists that can be stored. Settings for file handling, like transferring external data lists to the instrument, or renaming of folders and files, are accessed via the standard "File Manger" function (see also [Chapter 10, "File and Data Management"](#), on page 571).
- **Data patterns**

Simple data patterns such as binary 0 ("All 0") strings or 1 ("All 1") strings or variable bit strings with a maximum length of 64 bits can be used as internal modulation data.
- **PRBS data**

The PRBS generators deliver pseudo-random binary sequences of differing length and duration. They are known as maximum length sequences, and are generated with the aid of ring shift registers with feedback points determined by the polynomial.

The pseudo-random sequence from a PRBS generator is uniquely defined by the register number and the feedback. The [Table 5-1](#) describes the available PRBS generators.

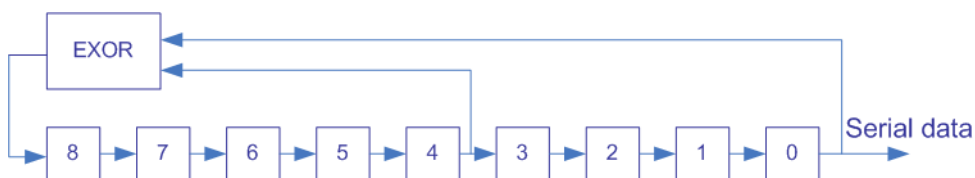
For PRBS15 and PRBS23, a CCITT V.52-compliant data inversion is performed in the feedback path automatically.

**Table 5-1: Overview of PRBS generators**

PRBS generator	Length in bits	Feedback to	GUI selection
9-bit	$2^9 - 1 = 511$	Registers 4, 0	PRBS 9/PN9
11-bit	$2^{11} - 1 = 2047$	Registers 2, 0	PRBS 11/PN11
15-bit	$2^{15} - 1 = 32767$	Registers 1, 0	PRBS 15/PN15
16-bit	$2^{16} - 1 = 65535$	Registers 5, 3, 2, 0	PRBS 16/PN16
20-bit	$2^{20} - 1 = 1048575$	Registers 3, 0	PRBS 20/PN20
21-bit	$2^{21} - 1 = 2097151$	Registers 2, 0	PRBS 21/PN21
23-bit	$2^{23} - 1 = 8388607$	Registers 5, 0	PRBS 23/PN23

**Example:**

By way of example, the diagram on [A 9-bit PRBS generator](#) shows a 9-bit generator with feedback to registers 4 and 0 (output). The generated serial data is converted internally, e.g 2 Bit/Symbol if QPSK is used.

**Figure 5-1: A 9-bit PRBS generator**

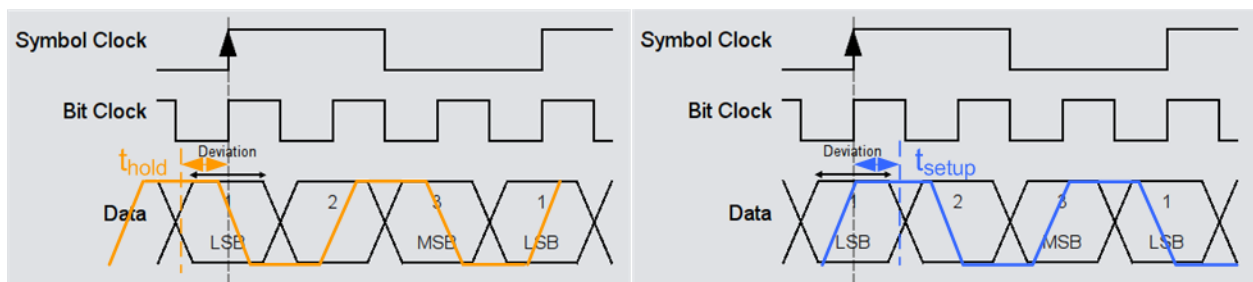
Related settings:

- [Chapter 5.4.3.3, "Data Source"](#), on page 256
- [Chapter 5.4.3.7, "Data List Editor"](#), on page 267
- [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269
- Data Source selection in the dialogs of the firmware options

**External Modulation Data**

The R&S SMW can generate custom digitally modulated signal form external serial data source.

For proper synchronization, the instrument requires a reference (externally supplied) symbol clock signal to generate a bit clock out of it. The active edge of both, the symbol clock and the bit clock, is configurable. Positive and negative timing deviations between the clock and the data signals are indicated and automatically corrected.



**Figure 5-2: Timing deviations ( $t_{hold}$  and  $t_{setup}$ ) between the clock and the data signals**

$t_{hold}$  = "Timing Deviation < 0", i.e. the data signal is received ahead of the clock signal; the data is held and output synchronous to the clock signal

$t_{setup}$  = "Timing Deviation > 0", i.e. the clock signal is received ahead of the data signal; the processing is held until the data is received

See also ["Synchronizing data signals and clock signals"](#) on page 221.

The external data signal and the external clock signal have to be supplied via the connectors listed in:

- [Table 5-2](#)
- [Table 5-4](#), local connectors

**Table 5-2: Input connectors for the external serial data**

Connector	Location	GUI Selection
T/M 2 T/M 5	Local connector on the coder board	To configure the connector: <ul style="list-style-type: none"> <li>• "Custom. Dig. Mod &gt; Clock Settings &gt; Local Connectors &gt; Direction &gt; Input"</li> <li>• "Custom. Dig. Mod &gt; Clock Settings &gt; Local Connectors &gt; Signal &gt; Data"</li> </ul> To enable the data source: <ul style="list-style-type: none"> <li>• "Custom. Dig. Mod &gt; Data Source &gt; Data Source &gt; External Serial"</li> </ul>

The instrument can process the external serial data in both, the least significant bit (LSB first) or most significant bit (MSB first), bit orders.

For information on the maximum data rate for serial data processing, see the data sheet.

See also [Chapter 5.4.3.3, "Data Source"](#), on page 256

## Clock Signals

The instrument requires an internal or an external clock reference for generating the timing pulse:

- **Internal clock reference**

The instrument uses its internal clock reference.

The internally generated symbol clock signal can be output at the local T/M/(C) connectors. The [Table 5-3](#) gives an overview.

**Table 5-3: Output connectors for the reference clock signal**

Connector	Location	GUI Selection
T/M(C)	Local connectors on each board	To configure the connector: <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Local Connectors &gt; Direction &gt; Output"</li> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Local Connectors &gt; Signal &gt; Symbol Clock"</li> </ul> To enable the clock source <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Clock Source &gt; Internal"</li> </ul>

- **External clock reference**

An external clock has to be supplied via the connectors listed in [Table 5-4](#).

**Table 5-4: Input connectors for the external reference clock signal**

Connector	Location	GUI Selection
T/M/C 1/4	Local connector on each coder board	To configure the connector: <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Local Connectors &gt; Direction &gt; Input"</li> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Local Connectors &gt; Signal &gt; Clock"</li> </ul> To enable the clock source <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Clock Source &gt; External Local Clock"</li> </ul>
USER	Global connectors	To configure the connector: <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Global Connectors &gt; Signal &gt; Global Clock 1, 2"</li> </ul> To enable the clock source <ul style="list-style-type: none"> <li>"Custom. Dig. Mod/Digital Standard &gt; Clock Settings &gt; Clock Source &gt; External Global Clock 1/2"</li> </ul>



The signals provided at the global and local connector are configurable. However, there is a limitation on the number and the type of signals that are configured simultaneously, see [Chapter 11.2.1.5, "Internal Resources for the Trigger, Marker, Clock and Control Signals"](#), on page 615.

### Internal and external clock synchronization

When the external clock reference is selected, the internal clock is synchronized to it. Internally, the instrument interprets the rising edge as the active edge. Because the active edge of the external clock signal is configurable ("Global/Local Connector Settings > Clock Input Slope"), the active rising edge of the internal clocks are synchronized with either the rising or the falling edge of the external clock reference.



### Proper synchronization

The correct synchronization of the clock synthesizer requires that a special procedure is maintained. Refer to ["To apply an external clock signal"](#) on page 273 for a description of the required steps.

### Synchronizing data signals and clock signals

When selecting data signals and clock signals, the following operating modes are possible:

- External clock and internal data  
I.e. the modulation data is generated internally; the clock synchronization can be based on the rising edge or the falling edge according to the configuration. Refer to the data sheet for information about the maximum permissible multiple symbol clock.  
See also ["Internal Modulation Data"](#) on page 217.
- Internal clock and internal data  
The synchronization is always based on the clock's positive edge.
- External or internal clock and external serial data  
The clock synchronization can be based on the rising edge or the falling edge of the internal clock and the external symbol clock.  
From the externally supplied symbol clock, the instrument generates the bit clock from the and uses it for reading the serial data. The active edge of the bit clock is configurable.  
See also ["External Modulation Data"](#) on page 218.  
If the internal clock is used, the R&S SMW and the instrument acting as a data source have to be connected to a common reference frequency.

Related settings:

- [Chapter 5.3.2.3, "Clock Settings"](#), on page 248
- [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612
- Clock settings in the dialogs of the firmware options

### Control Signals

The following control signals are processed in the R&S SMW:

- "Burst Gate" for power ramping
- "Level Attenuation" for power ramping
- "CW/Mod" for controlling the CW (continuous wave) mode

A dedicated internal "Control Data Editor" is provided for defining the control signals. Refer to [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269 for a description on the provided settings.

### Continuous Wave Mode

The "CW" signal turns off digital modulation. The signal is output in unmodulated form.

The CW/Mod control signal is generated internally and is output at one of the T/M/(C) local connectors.

### Power Ramping and Level Attenuation

The R&S SMW uses the two control signals "Burst Gate" and "Lev\_Att" to trigger the power ramping and level attenuation functions.

The instrument internally generates control signals as configured in [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269; the signals can be output on the T/M/(C) local connectors.

- *Burst gate control signal*  
The "Burst Gate" signal is a rectangular pulse signal with variable low and high periods. Signal generation is restricted to the gate high periods. If the power ramping function is enabled, each transition between two gate periods of the "Burst Gate" signal triggers the generation of a ramp. Further settings define the form and the steepness of this ramp, see ["Impact of the Power Ramping Settings on the Generated Signal"](#) on page 222.
- *Level attenuation control signal*  
The "Lev\_Att" signal is a rectangular pulse signal with variable low and high periods. Level attenuation is applied, if the "Lev\_Att" signal is high. If level attenuation is enabled, the modulation signal level is attenuated by a defined value.

Refer to [Chapter 5.4.3.6, "Power Ramp Control Settings"](#), on page 265 for a description of the provided settings for level attenuation and power ramping.



#### Possible applications

- Use the "Level Attenuation" function to simulate radio stations located at various distances.
- Use the "Power Ramp" function if it is necessary to control the RF output signal envelope synchronously, e.g. by the generation of TDMA signals.

Both the GSM/EDGE and the TD-SCDMA firmware options are equipped with embedded power ramping function. In the GSM/EDGE standard for example, a maximum of 7 different level attenuation values can be defined and allocated separately to the 8 slots independently of one another.

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#### Impact of the Power Ramping Settings on the Generated Signal

The [Figure 5-3](#) explains the power ramping function in principle. The "Burst Gate" signal defines the start of the rising and falling edges of the envelope of the output signal, and the "Lev Att" signal defines the start and end of level attenuation. The signal level during the attenuation period is a configurable value.

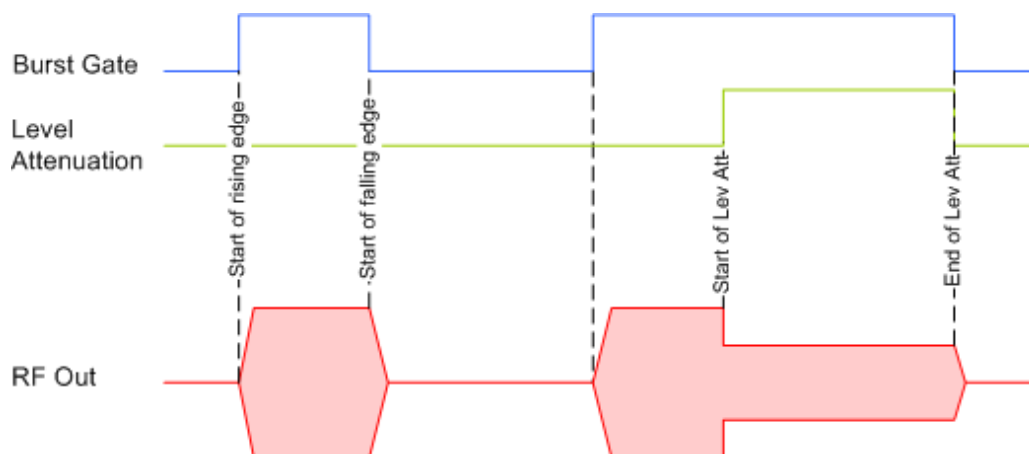


Figure 5-3: Signal behavior when power ramping and level attenuation are enabled

Several parameters are provided for precise definition of the form and the steepness of ramp. The Figure 5-4 depicts the impact of the provided settings.

- Ramp function: defines the shape of the rising and falling edges
- Ramp time: defines the duration of the rising and the falling ramp
- Rise/fall delay: offsets the falling edge of the envelope at the beginning/end of a burst

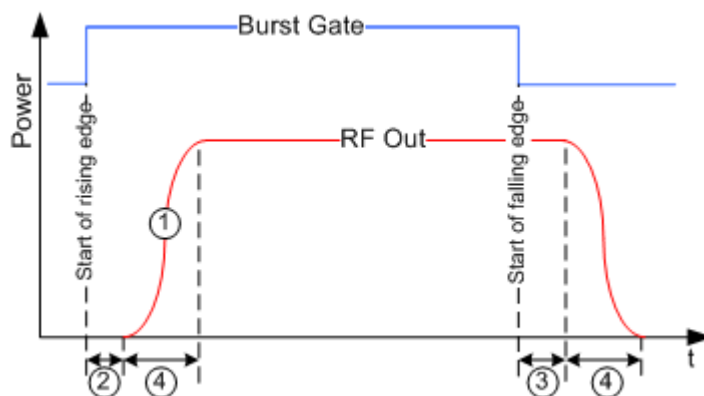


Figure 5-4: Impact of the ramp settings

- 1 = "Ramp Function"
- 2, 3 = "Rise Delay", "Fall Delay"
- 4 = "Ramp Time"

### 5.3.1.2 Regular Marker Output Signals

The R&S SMW can add *additional signals* to the generated signal. Marker signals (or markers) are digital signals which can be used to synchronize external devices to the generated data stream. With suitable marker settings for instance, a slot clock or frame clock can be selected or the start of a particular modulation symbol can be marked.



Three marker output signals are available in each baseband. All marker signals can be output at the provided connectors but not always at the same time (see [Chapter 11.2.1.5, "Internal Resources for the Trigger, Marker, Clock and Control Signals"](#), on page 615). The mapping of the marker output signal to the output connector is configurable.

**Table 5-5: Mapping of the marker signals to the output connectors**

Baseband	Marker	Connector type	Connector name	Connector direction
Baseband A/B/C/D	Marker 1, 2 and 3	Local connector	T/M 1/2/3	Output
		Global connectors	USER 1/2/3/4/5/6	Output

Related settings:

- [Chapter 5.3.2.2, "Marker Settings"](#), on page 247
- [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612
- Marker settings in the dialogs of the firmware options

### Marker Modes

The marker mode is a characteristic for the shape and the periodicity of the marker. The R&S SMW provides several different modes to define different marker signals. Most of them are specific for each of the firmware options. This section focuses only on the general commonly available marker signals.

Generally, the marker signal can change from "On" (high) to "Off" (low) state or vice versa after some period of time. The instrument provides various ways to describe the marker signal. Use the method that best suits your needs.

### Marker Mode Restart

The generated marker signal is a single "On" pulse. The rising edge of this pulse is generated at the signal generation start as well as at each subsequent signal restart time. This marker can be used to monitor the effects of the selected trigger, e.g. trigger causing restarts of the signal generation.

### Marker Mode Pulse

Periodic marker with consecutive On and Off periods of equal length. The first On period starts at the beginning of the first generated sample/symbol. The marker frequency is defined by a "Divider". The frequency is derived as follows:

<Frequency> = "Symbol/Sample Rate" / "Divider", respectively

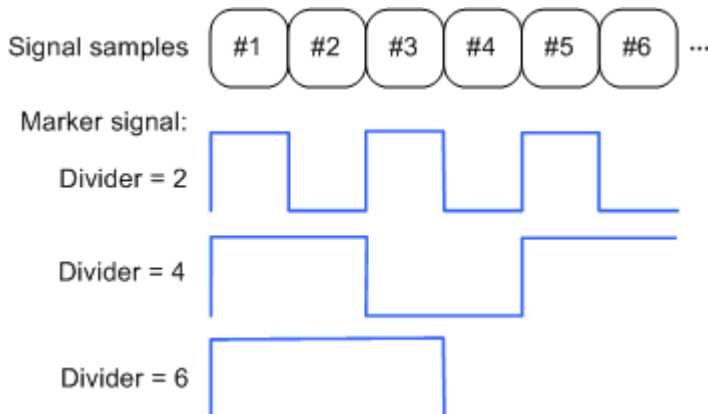
<Frequency> = "Sampling Frequency" / "Divider".



**Example:**

Symbol Rate = 1 Msym/s, Divider = 2

The marker frequency is 500 kHz, corresponding to a marker period of 2 us. Each On and Off period has a length of 1 us, corresponding to one symbol period. With a divider of 4 (6, 8 ...), the length of each On and Off period is increased to 2 (3, 4, ...) symbol periods.

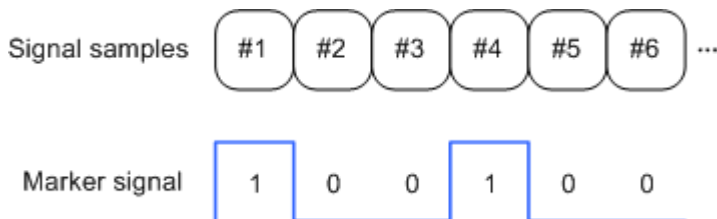


**Marker Mode Pattern**

Periodic marker where each period is defined by a bit pattern with a maximum length of 64 bits. A "1" ("0") in the pattern denotes an On (Off) signal segment with a duration of one sample/symbol period.

**Example:**

In the following example, the marker signal is defined by a pattern 100100...



**Marker Mode ON/OFF Ratio**

Similar to "Pulse" but with independent lengths of the On and Off periods. The length of the periods is entered as a number of symbols/sample periods.

**Example:**

In the following example, the marker signal is defined by an "On Time" = 1 and "Off Time" = 2.

**Marker Mode CList**

This is not one of the most common modes.

The instrument generates a marker signal that is defined in the selected control list. The R&S SMW provides a graphical interface for convenient definition of control signals among others also for the marker signals.

**Delaying Marker Signals**

In all the examples listed in "[Marker Modes](#)" on page 224, the marker starts at the beginning of the first generated sample/symbol (sample/symbol no. 1). It is possible though to delay the start of the marker by an integer number of symbols/sample periods.

**5.3.1.3 Baseband Trigger Signals**

The R&S SMW provides several trigger modes, different trigger sources, and some additional trigger settings to suppress or delay the trigger events. This section provides an overview of the provided baseband trigger settings and the impact of the trigger settings on the signal generation.

The current signal generation status ("Running" or "Stopped") is continuously displayed in the corresponding dialog, indicated in the header of the tab and in the block diagram of the instrument. This indication is important when an external trigger is applied.

Refer to [Chapter 8.7.1, "Signal Generating and Triggering in the Sweep and List Modes"](#), on page 439 for information on the trigger signals used in the RF domain.

**Trigger**

The trigger signals are internally generated or externally supplied signals which start signal generation at a particular point in time. However, signal generation can also take place without triggering. In this case, the signal generation starts immediately after the modulation is enabled.

### Trigger event

A trigger event is caused by the received trigger signal. Another possibility to provoke a trigger event is to execute trigger manually. The "Arm" function stops the signal generation until subsequent trigger event occurs.

### Trigger Sources

The provided trigger sources are divided into two main groups, internally generated or externally supplied trigger signals.

- Internal ("Internal" and "Internal Baseband A/B")  
Internal trigger signals are generated by the instrument itself and can be used independently per baseband or routed from one to the other. This feature is useful, if the signal generation start in the basebands has to be synchronized.
- External ("External Global Trigger 1/2", "External Local Trigger", "External Global Clock 1/2", "External Local Clock")  
External trigger signal is generated by an external trigger source.
  - An external *local* trigger/clock signal is dedicated to the baseband board this signal is supplied at (i.e. the board the local T/M/(C) connector is located).  
An external *local* trigger/clock signal can be internally routed and used for synchronous triggering of all other basebands.
  - An external *global* trigger/clock signal can be supplied to one or simultaneously to all the basebands. The latter possibility is the recommended solution, if common triggering of all basebands and synchronous generation start are required.

The instrument expects the trigger signal at one of the T/M/(C) or USER connectors. Refer to [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612 for information on how to configure the required settings; see also [Figure 11-1](#).



The trigger mode setting, the selection of the trigger source and the setting of a delay and trigger suppression in the case of external triggering are carried out independently for each of the basebands or, if there is [coupled trigger settings](#), jointly for all basebands.

However, the polarity and impedance characteristics of the external signals supplied at the USER connectors are identical for all basebands using this signal.

A signal which marks the trigger event can be output at the T/M/(C) connectors.

Related settings:

- [Chapter 5.3.2.1, "Trigger Settings"](#), on page 242
- [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612
- Trigger settings in the dialogs of the firmware options

### Impact of the Trigger Modes on the Signal Generation

A trigger event affects the signal generation in different way, depending on the selected trigger mode. The [Table 5-6](#) gives an overview of the provided trigger modes and their impact.

**Table 5-6: Impact of the trigger events on the generated signal**

"Trigger Mode"	Signal generation mode <sup>1</sup>	Trigger event "Exec. Trigger" or "External" trigger signal	Trigger event "Arm"
"Auto"	Continuous	-	-
"Retrigger"	Continuous	Initial start Restart	-
"Armed_auto"	Continuous	Initial start Restart	Stop
"Armed_retrigger"	Continuous	Initial start Restart	Stop
"Single"	Single length determined by "Trigger Signal Duration"	Initial start Restart	-

<sup>1)</sup> The instrument generates a continuous signal or a single signal.

- Single signal generation means that the signal generation stops after one cycle. That is, after the signal with signal length determined by the "Trigger Signal Duration" has been generated.
- Continuous transmission means that the signal is generated repeatedly without delay and until the data generation is stopped explicitly. However, any parameter change within the processing chain (baseband, fading simulator, or stream mapping) causes a signal generation restart.

The following is a list of the trigger modes together with their short description and an example of their impact on the generated signal. The provided examples are intended to show the triggering mechanism in principle. To simplify the description, an internal trigger event ("Execute Trigger") is used; an external trigger event has the same effect on the signal generation. In the examples on the figures below, the instrument's processing time is ignored.

- Single  
The instrument starts the signal generation only when a trigger event occurs. The signal is generated once and its signal length is determined by the "Trigger Signal Duration".  
Every subsequent trigger event causes a restart.

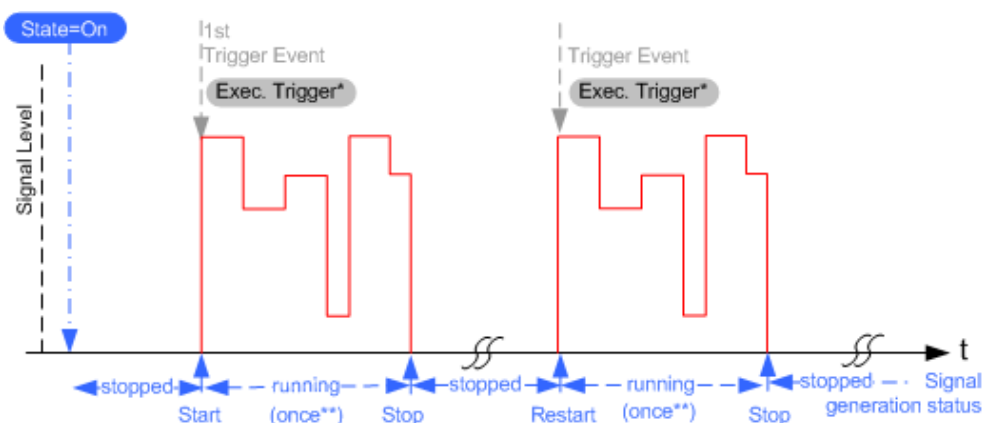


Figure 5-5: Trigger Mode Single

\*\* = the signal is generated once to the length specified with "Trigger Signal Duration"

- Auto

In auto trigger mode, the instrument generates a continuous signal.

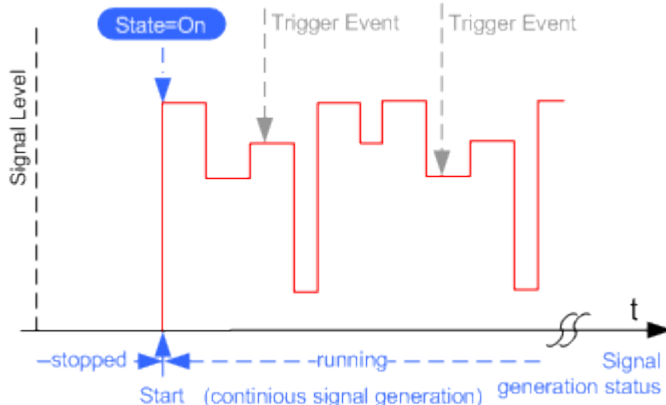


Figure 5-6: Trigger Mode Auto

- Retrigger

The instrument generates a continuous signal. With enabled retrigger, a new trigger event aborts the current generation cycle and restarts the signal generation from the beginning.

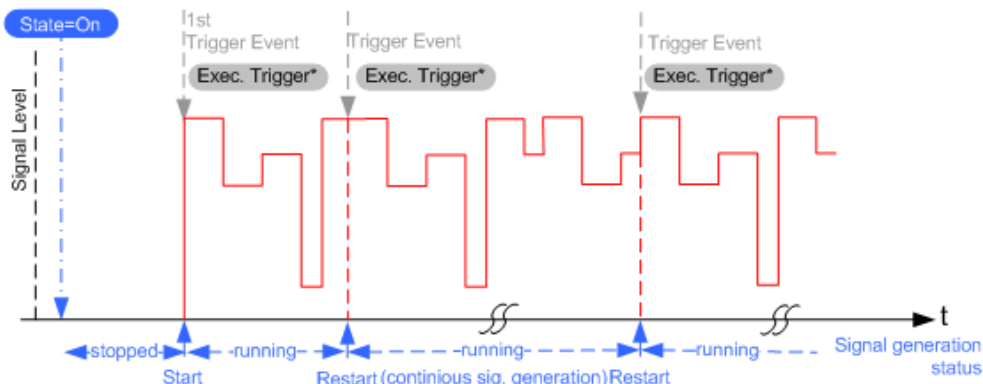


Figure 5-7: Trigger Mode Retrigger

Compare the shape and the length of the red curve in single mode and in retrigger mode. The first part of the curve in retrigger mode is shorter, i.e the signal generation is interrupted due to the subsequent trigger event.

- **Armed Auto**  
The instrument starts the signal generation only when a trigger event occurs and then generates a continuous signal. An "Arm" stops signal generation. A subsequent trigger event causes a restart of the signal generation.

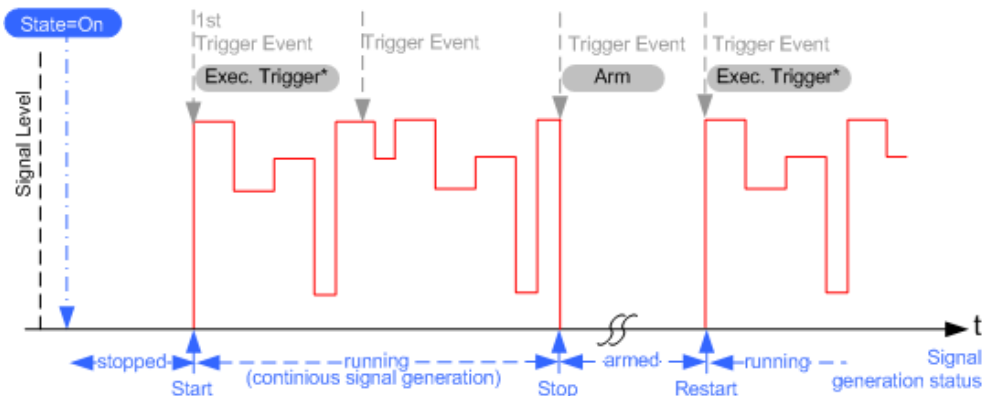


Figure 5-8: Trigger Mode Armed Auto

- **Armed Retrigger**  
The instrument starts the signal generation only when a trigger event occurs and then generates a continuous signal. Every subsequent trigger event causes a restart of the signal generation. An "Arm" stops the signal generation. A subsequent trigger event causes a restart.

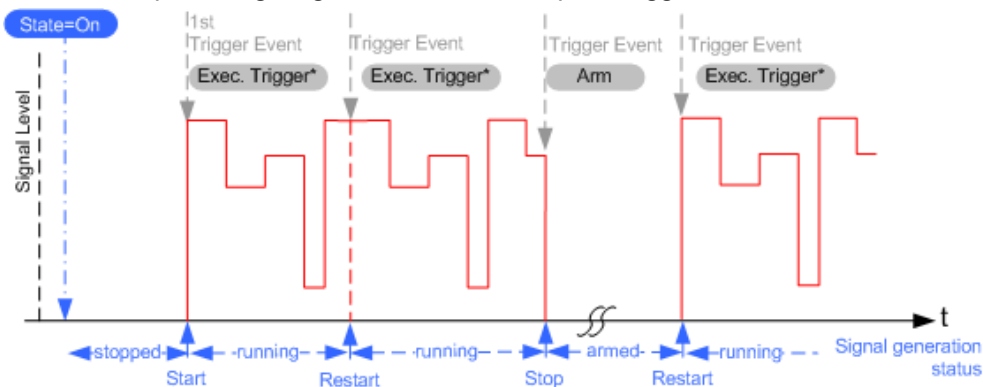


Figure 5-9: Trigger Mode Armed Retrigger

**Impact of the Additional Trigger Settings**

The R&S SMW provides a set of settings to configure the behavior upon receiving of a trigger signal, like suppressing trigger events, delaying the instrument's response on them or adjusting the signal calculation start time in relation to the trigger event.

### Avoiding accidental trigger events

The following trigger settings enhance the flexibility of the trigger system and can help to avoid accidental trigger events.

- "Threshold Trigger Input"  
Defines the voltage level of the trigger signal where the R&S SMW generates a trigger event. Trigger signals below the trigger threshold are ignored.
- "Trigger Input Slope"  
Specifies the edge (rising or falling edge) of the trigger signal that is to provide the trigger event.
- "Impedance Trigger Input"  
Specifies the input impedance of the trigger signal.

### Starting the signal generation with the first sample

By default, the instrument starts the signal calculation simultaneously with the receiving of the external trigger event. Because of the instrument's processing time, the first samples are cut off and no signal is output.

This default behavior however can cause problems if short signal sequences are generated. To overcome this problem, the instrument provides the special parameter "Sync. Output to External Trigger". If this parameter is disabled, the signal output begins after elapsing of the processing time and starts with sample 0, i.e. the complete signal is output (compare both figures in [Table 5-7](#)).

**Table 5-7: Impact of the parameter "Sync. Output to External Trigger"**

"Sync. Output to External Trigger = On"	"Sync. Output to External Trigger = Off"
<p>Recommended for long signal sequences. The output signal is synchronous to the trigger event after elapsing of the internal processing time.</p>	<p>Recommended for triggering of short signal sequences with signal duration comparable with the processing time of the instrument</p>

### Suppressing and delaying trigger events

The main focus of the following features is the mobile communication standards.

- "(External) Trigger Delay"  
You can apply a definable number of symbols to delay the **start** trigger event of an externally supplied or routed from the other path trigger signals

This feature is useful to:

- Simulate the time delay between a base station signal and a user equipment signal, for example during base station tests
- Compensate for known propagation delays or a timing offset in the test setups
- Enable a time delay between the generated baseband signals
- "(External) Trigger Inhibit"
 

You can suppress the effect of a restarted trigger signal in the "Retrigger" trigger mode for a definable number of symbols.

During base station tests for example, this feature enables the trigger suppression for a definable number of frames and yet the signal can still be generated synchronously. In each frame, the base station generates a trigger which would cause a signal generation restart every time but for the suppression.

#### Example:

A trigger delay of 1000 samples means that after a trigger event, any subsequent trigger signal is ignored for the space of 1000 samples.

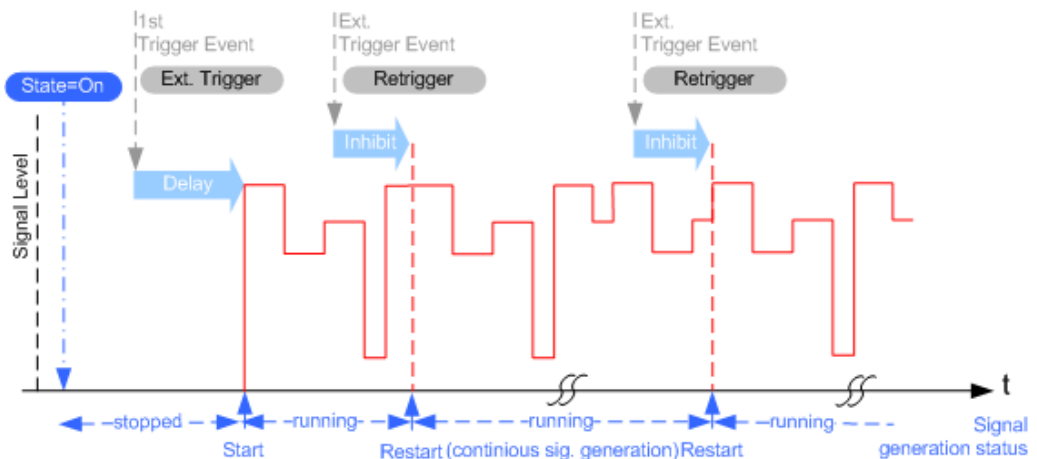


Figure 5-10: Trigger Delay and Trigger Inhibit in Trigger Mode Retrigger

#### Specifying delay and inhibit values in time units

The [Suppressing and delaying trigger events](#) introduces the concept of delaying and suppressing trigger events.

The delay and inhibit values are expressed in the units of the generated signal but you can also define the exact delay or inhibit period directly as a time value (e.g. in seconds).



**Example:**

This example is based on an ARB signal with 1 MHz clock frequency ("Baseband > ARB > Clock Frequency = 1 MHz").

Step 1: Enable the following settings:

- "ARB > Trigger In > Mode > Armed Auto"
- "ARB > Trigger In > Source > External Global Trigger 1"
- "ARB > Trigger In > External Delay Unit > Samples"
- "ARB > Trigger In > External Delay = 100 Samples"

The parameter "Actual External Delay = 100 us" displays the time delay in seconds.

Step 2: Enable the following settings:

- "ARB > Trigger In > External Delay Unit > Time"
- "ARB > Trigger In > Specified External Delay = 10 us"  
Logically, the "Actual External Delay" changes to 10 us.

Step 3:

- Switch to "ARB > Trigger In > External Delay Unit > Samples".

The value of "ARB > Trigger In > External Delay" is 10 Samples.

Step 1	Step 2	Step 3
External Delay Unit: Sample External Delay: 100.00 Samples Actual External Delay: 100.0000 µs External Inhibit: 0 Samples	External Delay Unit: Time Specified External Delay: 10.0000 µs Actual External Delay: 10.0000 µs External Inhibit: 0 Samples	External Delay Unit: Sample External Delay: 10.00 Samples Actual External Delay: 10.0000 µs External Inhibit: 0 Samples



This principle applies for any external triggering and triggering via the other paths.

## Receiving and Providing Trigger Signals

In test setups that require the signal of two or more instruments and/or basebands it is required that:

- The signal generation starts at a defined moment
- The signal generation starts simultaneously (or with an exactly defined delay) in all involved instruments and/or basebands.

### Simultaneous signal generation start in several instruments

Using the same trigger on several instruments is useful to synchronize the transmitted and received signals.

As a basic rule, whenever a test scenario involves two or more instruments and/or a simultaneous signal generation is required, connect all instruments to a common external trigger source.

For a step-by-step description, see [Chapter 3.3.3, "Triggering the Instrument with an External Signal"](#), on page 69.

### Simultaneous signal generation start in all basebands

The R&S SMW supports you to trigger all basebands simultaneous in the following cases:

- In system configuration with [Coupled sources](#)  
See "[Coupled or Separate Baseband Sources](#)" on page 126
- In configuration that involves signal routing with signal addition, like:
  - Any [MIMO](#) configuration  
See [Chapter 4.2.2, "Using the System Configuration Capabilities"](#), on page 125
  - Routing and summing of [Baseband](#) and/or [Streams](#) signals before and after the "Fading" blocks  
See [Chapter 4.2.1, "Using the Signal Routing Settings and the Block Diagram"](#), on page 124
  - Routing and summing of [Streams](#) in the "I/Q Stream Mapper"  
See "[I/Q Stream Mapper](#)" on page 126
- In instruments equipped with 2xR&S SMW-B10, 1xR&S SMW-B14 and R&S SMW-B13T.

To enable simultaneous signal generation in all basebands in any of these cases, the R&S SMW couples automatically the trigger settings in all available basebands. It is sufficient to adjust the trigger settings, like trigger source and trigger mode in one of the basebands; the R&S SMW applies them automatically to all other. An arm or a restart trigger event applies to all basebands, too. You can still apply different delay to each of the triggers individually.

**Example:**

This example shows schematically the distribution of the trigger signal in instrument with the following configuration:

- "System Configuration > Entity = 1", 4x4 MIMO configuration (1x4x4) and "Baseband Source Config > Separate".
- "Baseband A > ... > Trigger In > Trigger Source > Ext. Global Trigger 1"  
Each of the "Baseband B/C/D" adopts the same trigger source automatically.

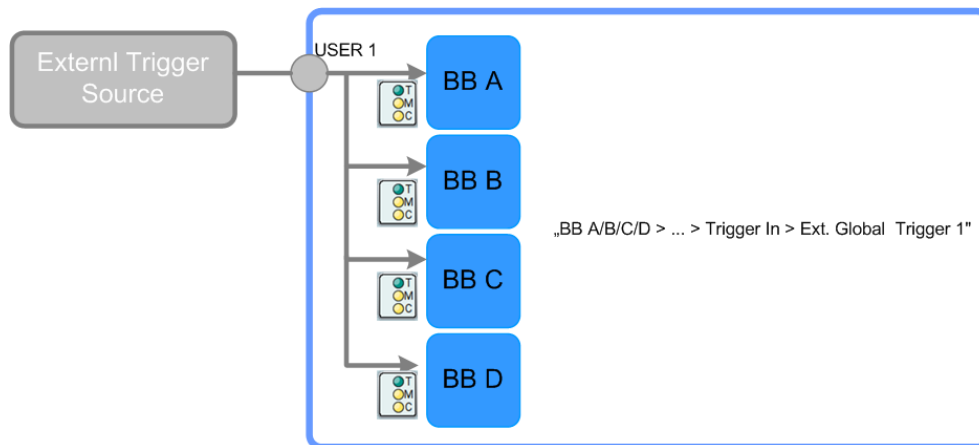


Figure 5-11: Distribution of the external trigger signal in the coupled trigger settings mode

- "Baseband A > ... > Trigger In > Trigger Mode > Retrigger"  
The "Baseband B/C/D" adopt the same trigger mode automatically.

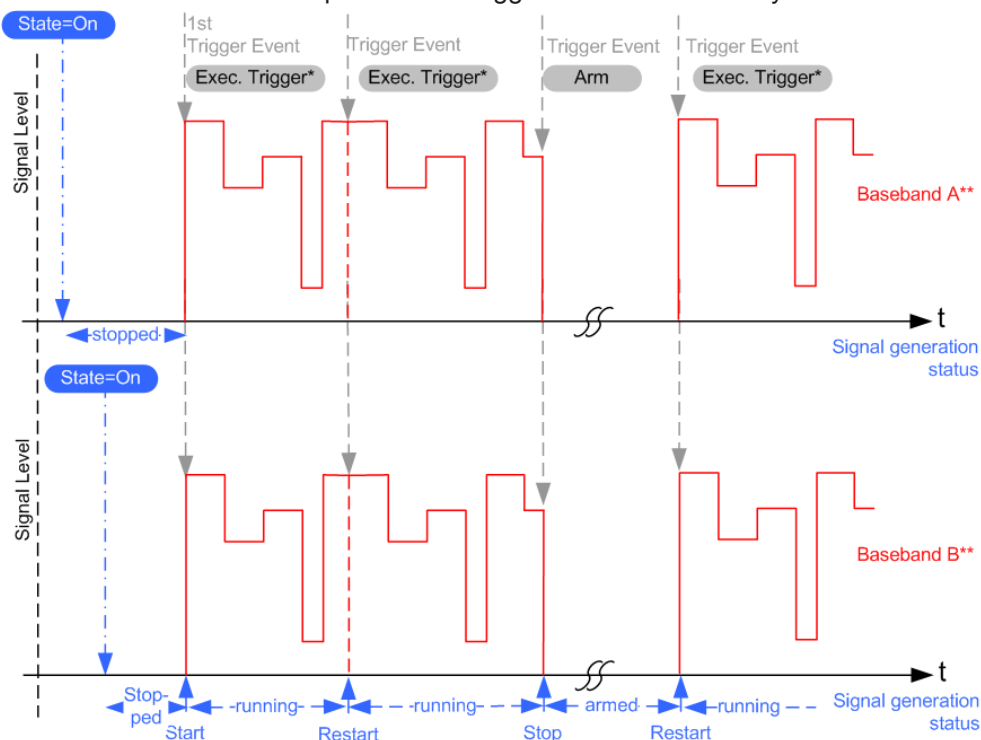


Figure 5-12: Simultaneous triggering of two basebands in coupled trigger settings mode

\*\* = this example assumes identical basebands and shows only the first two of them

The signal generation starts simultaneous in all basebands but you can still delay the basebands compared to each other.

In test setups that require the signal of two or more baseband sources but that do *not use the advantages of the coupled trigger setting*, trigger the baseband sources from a common trigger source. Use for example an external trigger source or to distribute the internal trigger signal of one of the basebands to the other.

For a step-by-step description, see [Chapter 5.3.3.2, "How to Trigger the Baseband Sources with a Common Signal"](#), on page 250.

#### 5.3.1.4 Supported Modulation Types

The R&S SMW supports a range of predefined digital and analog modulation types. This section focuses on the possibility to digitally modulate the baseband signal. The analog modulation methods provided for shifting the frequency bandwidth of the RF signal are described in [Chapter 8.8, "Analog Modulations"](#), on page 471.

In the communication techniques, the commonly used digital modulation schemes are based on keying. From the several existing keying techniques, this instrument supports ASK (amplitude shift keying), FSK (frequency shift keying), PSK (phase shift keying), and QAM (quadrature amplitude modulation). The digital modulation procedure is described by mapping, i.e. by the assignment of I and Q values (PSK and QAM) or frequency shifts (FSK) to every modulation symbol. The resulting modulated signal is graphically represented by a constellation diagram, in that each possible symbol is represented by a discrete point on a complex plane. The number of used bits per symbol is a modulation parameter. The exact position of the symbols on the constellation diagram is determined by the used coding and can be influenced by additionally applied rotation.

Most of the provided modulation schemes are implemented according to a communication standard. The QAM procedures 16QAM, 32QAM, 64QAM for instance have been produced in accordance with ETSI standard ETS 300429 for digital video broadcasting (DVB). The QAM procedures 256QAM and 1024QAM are not specified in this standard, but have been produced according to the same basic principles.

In the case of all FSK procedures, the you can set the symbol rate  $f_{\text{SYMB}}$  up to a maximum value (see data sheet). The frequency deviation (FSK deviation) of the MSK modulation is permanently set to  $\frac{1}{4}$  of the symbol rate.

In addition to the common modulation schemes, a variable FSK modulation with definable deviation per symbol is available and for even greater flexibility, a user defined modulation mapping can be applied (see ["User mapping"](#) on page 236).

##### Predefined modulation types

Refer to [Chapter 5.4.5.1, "Predefined Modulation Types"](#), on page 279 for an overview of the available modulation types.

##### User mapping

A user defined modulation mapping file can also be selected as modulation mapping source. The user modulation mapping file must have extension `*.vam` and can be cre-

ated with the Rohde & Schwarz software tool mapping wizard. The mapping wizard (mapwiz) is a tool from Rohde & Schwarz designed for editing modulation schemes (for example QPSK, 32QAM). Its main purpose is the assignment of logical symbol numbers to constellation points and the selection of modulation-specific parameters. Beyond this, it supports the creation of nearly any arbitrarily chosen constellation diagram. The output of mapwiz is a mapping file (\*.vam) that can be imported to a R&S SMW. The program was developed on a 32-bit Microsoft Windows platform under MATLAB. For more information, refer to the description "Introduction to "mapwiz" Mapping Editor" at the Rohde & Schwarz webpage.

The remote commands required to define the modulation settings are described in [Chapter 13.18.3.2, "SOURCE:BB:DM Subsystem"](#), on page 815.

Related settings:

- [Chapter 5.4.3.4, "Modulation Settings"](#), on page 261

#### 5.3.1.5 Supported Coding Schemes

Coding is a technique used to improve the signal properties and signal reception and is required only when using some types of modulation. In general, the coding schemes are applied before modulation, i.e. the modulation symbols are coded directly before I and Q values or frequency shifts are assigned. Hence, the applied coding is directly related to the selected modulation methods and explains why coding schemes are not freely combinable with modulation methods.

Refer to [Chapter 5.4.5.2, "Common Coding Algorithms"](#), on page 283 for overview on the available coding combinations. This section also defines the modulation types for which the various coding procedures can be used.

Related settings:

- ["Coding"](#) on page 255

#### 5.3.1.6 Supported Baseband Filters

In the wireless transmission technique, filters are applied to shape the baseband signal before it is modulated on the RF. The selected baseband filter type and shape affect the output stream, especially while generating broadband signals. If the filter is too narrow, it cuts the signal. If the filter is too wide, the signal could be distorted by some unwanted signals.

To fulfill wide range of requirements, the R&S SMW offers a wide selection of predefined baseband filters. The predefined filters are designed for the special spectrum characteristics of the different communication standards. However, depending on the selected filter form one or more filter parameters are provided for even more precise adjustment of the filter characteristic. You can select for example more steeper edges or change the transition bandwidth. For more information on the provided settings, refer to ["Impact of the Filter Parameters"](#) on page 238.

The selection of user defined filter offers even more flexibility. The later is a useful interface while filters with complex or proprietary form are required. For more information, refer to ["User filter"](#) on page 238.

### Predefined baseband filters

Refer to [Chapter 5.4.5.3, "Predefined Baseband Filters"](#), on page 285 for an overview of the available baseband filters.

### User filter

The user filter file must have extension `*.vaf` and can be created with the Rohde & Schwarz software tool filter wizard.

The filter wizard (filtwiz) is a tool from Rohde & Schwarz designed for creating filter files that can be imported on a R&S SMW. Its main purpose is the conversion of user-defined finite impulse response (FIR) filters into the filter format (`*.vaf`). Beyond this filt wiz provides designs for standard filters, e.g. Root Raised Cosine, Gaussian.

The program was developed on a 32-bit Microsoft Windows platform under MATLAB.

For more information, refer to the description "Introduction to "filtwiz" Filter Editor" at the Rohde & Schwarz webpage.

The remote commands required to define the filter settings are described in [Chapter 13.18.3.2, "SOURCE:BB:DM Subsystem"](#), on page 815 and the corresponding section in the User Manual of each firmware option.

Related settings:

- [Chapter 5.4.3.5, "Filter Settings"](#), on page 263
- Filter settings in the dialogs of the firmware options

### Impact of the Filter Parameters

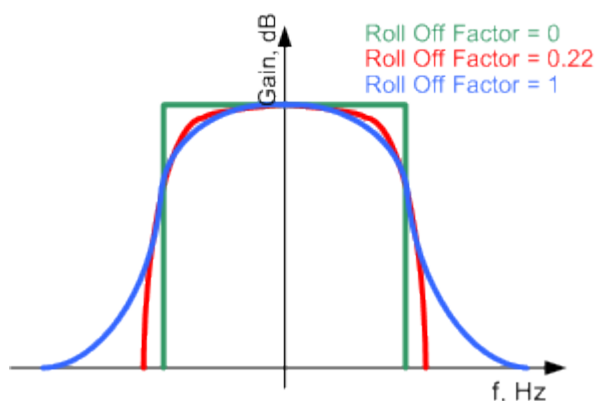
The following is a simple description of the filter parameters and the way they affect the main filter characteristics. Changing filter parameters is an effective way to ensure that the entire bandwidth of the desired signal is allowed to pass and adjust the filter form to reach the spectrum mask requirements

#### Cut Off Frequency

The cut-off frequency or corner frequency is a filter characteristic that defines the frequency at the 3 dB down point. This frequency is bound to the transition band; here the filter characteristic changes from the passband to the stopband, where the signal is suppressed.

#### Rolloff Factor

The rolloff factor is a measure for the excess bandwidth compared to the ideal bandwidth of a "brick like" filter. The roll off factor affects the steepness of the filter flanks. A "Rolloff Factor" = 0 would result in the steepest theoretically possible flanks ; values near to 1 make the flanks more flat.



### Passband

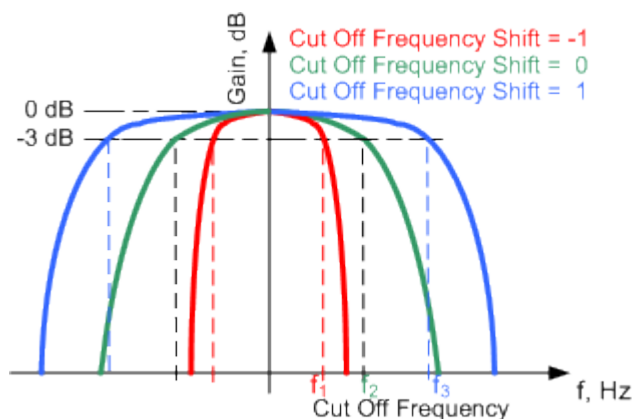
The passband describes the frequency span that the filter passes unchanged. The total passband of a filter is given as follows:

$$\text{Bandwidth} = (1 + \text{"Roll Off Factor"}) * \text{"Symbol Rate"}$$

### Cut Off Frequency Shift

The "Cut Off Frequency Shift" affects the cut-off frequency in the way that the filter flanks are "moved" and the passband increases by "Cut Off Frequency Shift" \* "Sample Rate":

$$\text{Cut Off Frequency} = (1 + \text{"Cut Off Frequency Shift"}) * \text{"Sample Rate"}$$



- A "Cut Off Frequency Shift" = -1 results in a very narrow-band filter
- Increasing the value up to 1 makes the filter more broad-band
- By "Cut Off Frequency Shift" = 0, the -3 dB point is at the frequency determined by the half of the selected "Sample Rate".

#### 5.3.1.7 Methods for Optimizing the Crest Factor

Communication standards utilizing higher order modulation techniques or using multiple carrier and complex signals consisting of the signals of more than one digital stan-

ard can feature a high crest factor. The signals of some digital standards can have high crest factors also particularly with many channels and long sequences.

The **crest factor** represents the ratio of the peak voltage value to the RMS voltage value, i.e. the peak to average ratio (**PAR**). The higher the crest factor and the resulting dynamics of a signal, the greater the requirement for a power amplifier fed by the signal to be linear. A high crest factor arises for instance, when in a multi carrier signal the carriers feature an identical start phase. This is based on the fact that the carriers are periodically superposed that leads to high peak voltages in relation to the RMS voltage values.

High crest factors entail two basic problems:

- The nonlinearity of the power amplifier (compression) causes intermodulation which expands the spectrum (spectral regrowth).
- Since the level of the D/A converter is relative to the maximum value, the average value is converted with a relatively low resolution. This leads to a high quantization noise.

Both effects increase the adjacent-channel power.

### Direct approaches

At the individual signal generation stages, the R&S SMW offers different direct approaches aimed to reduce the crest factor. While the corresponding parameters are enabled, the implemented algorithms ensure minimizing the crest factor or achieving of predefined target crest factor by applying of automatic settings. Methods of reducing the crest factor differ regarding both the optimization achievable and the time required for computation.

The provided crest factor reduction methods include:

- Internal calculation of optimized carrier phases for the individual carriers in a multi carrier signal
- Automatic calculation of the carrier start phases in a multi-carrier continuous wave signal

### Applying clipping and filtering

Another common and simple approach for achieving a lower PAR is the combination of clipping and filtering. In several of the firmware options, like 3GPP FDD or CDMA2000, the instrument provides the possibility to enable baseband clipping and to select the baseband filter and, when applicable, to adjust the filter characteristics.

- **Clipping** is a technique that applies a wanted distortion to the signal. The principle includes specifying a threshold, finding out the signal peaks once the defined limits are exceeded and clipping them off. The level limit is specified as a percentage of the highest peak value. Because clipping is done before filtering, the procedure does not influence the spectrum. The error vector magnitude (EVM) however increases.

The instrument offers two clipping modes:

– **Vector | I + q |**

The clipping limit is related to the amplitude | I + q |. The I and Q components are mapped together, the angle is retained.



– **Scalar  $|I| + |Q|$**

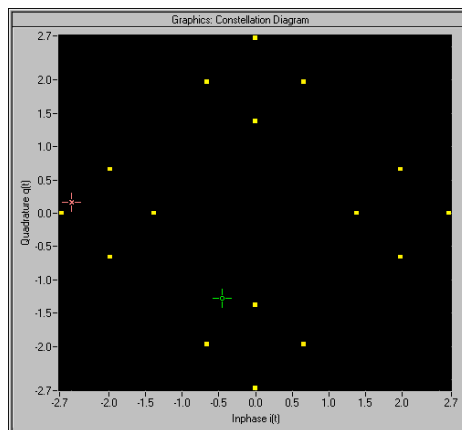
The clipping limit is related to the absolute maximum of all the I and Q values  $|I| + |Q|$ . The I and Q components are mapped separately, the angle changes.

However, signal clipping not only changes the peak value but also the average value and the effect on the crest factor is unpredictable.

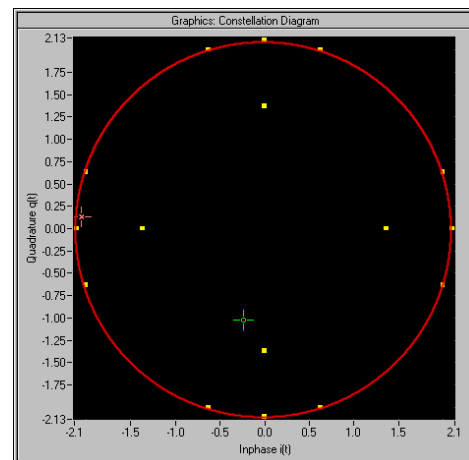
**Example:**

The following figures demonstrate the effect of the clipping on the crest factor for typical scenarios.

Enabled is clipping with vector mode ( $|I+Q|$ ), using a signal configuration with 2 active channels.



Constellation diagram of the signal without clipping, shows the level mapping



Constellation diagram with clipping level 80%, vector mode ( $|I+Q|$ ) The circle emphasizes the changed constellation points

- **Filtering** is applied subsequently. The used filters are specially designed so that they filter out the distortion.

### 5.3.2 Common Settings

The start dialog of each digital standard follows a repeating dialog structure that comprises the tabs "General", "Trigger In", "Marker" and "Clock".

The "General" tab comprises the primary settings of the standard, the functions for storing and recalling settings. It also provides access to further functions and dialogs, like the "Filter" settings.

The "Trigger In", "Marker" and "Clock" tabs comprise the settings related to the corresponding function.

In the following, we use the "Custom Digital Modulation" dialog to explain the provided common settings. The related remote-control commands are listed in the order "Custom Digital Modulation", "ARB", "Multi Carrier CW".



This section focuses on the available settings.

For more information refer to:

- [Chapter 5.3.1.3, "Baseband Trigger Signals"](#), on page 226.
- [Chapter 5.3.1.2, "Regular Marker Output Signals"](#), on page 223
- ["Clock Signals"](#) on page 219



#### **Routing and Enabling a Trigger**

The provided trigger signals are not dedicated to a particular connector but can be mapped to one or more globally shared USER or local T/M/(C) connectors.

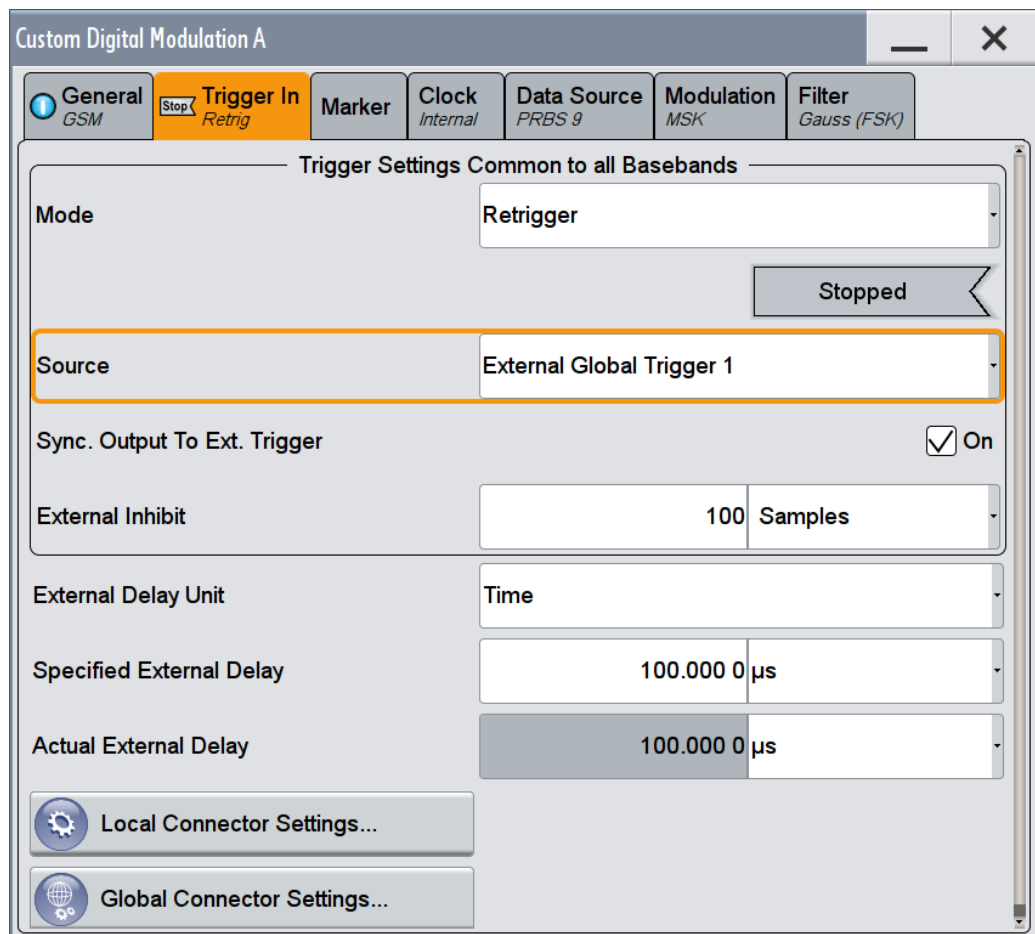
Use the [Local and Global Connector Settings](#) to configure the signal mapping as well as the polarity, the trigger threshold and the input impedance of the input connectors.

To route and enable a trigger signal, perform the following *general steps*:

- Define the signal source and the effect of a trigger event, i.e. select the "Trigger In > Mode" and "Trigger In > Source"
- Define the connector, USER or T/M/(C), the selected signal is provided at, i.e. configure the [Local and Global Connector Settings](#).


#### **5.3.2.1 Trigger Settings**

This tab comprises the settings for selecting and configuring the trigger, like trigger source, mode, and delay, and to arm or trigger an internal trigger manually. The current signal generation status is displayed in the header of the tab together with information on the enabled trigger mode. As in the "Marker" and "Clock" tabs, this tab provides also access to the settings of the related connectors.



### Trigger Settings Common to All Basebands

To enable simultaneous signal generation in all basebands, the R&S SMW couples the trigger settings in the available basebands in any instrument's configuration involving signal routing with signal addition (e.g. MIMO configuration, routing and summing of basebands and/or streams).

The icon  indicates that common trigger settings are applied.

You can access and configure the common trigger source and trigger mode settings in any of the basebands. An arm or a restart trigger event applies to all basebands, too. You can still apply different delay to each of the triggers individually.

### Trigger Mode ← Trigger Settings Common to All Basebands

Selects a regular trigger signal: "Auto", "Retrigger", "Armed\_Auto", "Armed\_Retrigger", or "Single".

Refer to "[Impact of the Trigger Modes on the Signal Generation](#)" on page 227 for a detailed description of the provided trigger modes.

Remote command:

`[ :SOURce<hw> ] :BB:DM [ :TRIGger ] :SEquence` on page 829

`[ :SOURce<hw> ] :BB:ARBitrary [ :TRIGger ] :SEquence` on page 879

`[ :SOURce<hw> ] :BB:MCCW [ :TRIGger ] :SEquence` on page 925

**Trigger Signal Duration ← Trigger Settings Common to All Basebands**

Enters the length of the signal sequence to be output in the "Single" trigger mode.

Use this parameter to deliberately output part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:SLENgth` on page 830

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:SLUNit` on page 881

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:SLENgth` on page 924

**Running/Stopped ← Trigger Settings Common to All Basebands**

For enabled modulation, displays the status of signal generation for all trigger modes.

- "Running"  
The signal is generated; a trigger was (internally or externally) initiated in triggered mode.
- "Stopped"  
The signal is not generated and the instrument waits for a trigger event.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:RMODe?` on page 831

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:RMODe?` on page 880

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:RMODe?` on page 923

**Arm ← Trigger Settings Common to All Basebands**

Stops the signal generation until subsequent trigger event occurs.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:ARM:EXECute` on page 831

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:ARM:EXECute` on page 881

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:ARM:EXECute` on page 922

**Execute Trigger ← Trigger Settings Common to All Basebands**

For internal trigger source, executes trigger manually.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:EXECute` on page 831

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:EXECute` on page 881

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:EXECute` on page 922

**Trigger Source ← Trigger Settings Common to All Basebands**

Selects trigger source (see also "[Trigger Sources](#)" on page 227 ).

The polarity, the trigger threshold, and the input impedance of the input connectors can be configured in the "Global Connector Settings" and "Global Connector Settings" dialog.

See [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

"Internal"           The trigger event is executed by "Execute Trigger".

"Internal (Baseband A/B)"

The trigger event is provided by the trigger signal from the other basebands.

**"External Global Trigger 1 / 2"**

The trigger event is the active edge of an external trigger signal provided and configured at the global USER connectors.

**"External Global Clock 1 / 2"**

The trigger event is the active edge of an external clock signal provided and configured at the global USER connectors.

**"External Local Trigger"**

The trigger event is the active edge of an external trigger signal provided and configured at the local T/M/(C) connector.

With coupled trigger settings, the signal has to be provided at the T/M/C 1/2/3 connectors.

**"External Local Clock"**

The trigger event is the active edge of an external clock signal provided and configured at the local T/M/C connector.

With coupled trigger settings, the signal has to be provided at the T/M/C 1 connector.

**Remote command:**

`[ :SOURce<hw> ] :BB:DM:TRIGger:SOURce` on page 830

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:SOURce` on page 880

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:SOURce` on page 924

**Sync. Output to External Trigger ← Trigger Settings Common to All Basebands**

For external trigger signal, enables/disables output of the signal synchronous to the external trigger event. For a detailed description of the impact of this parameter, see ["Impact of the Additional Trigger Settings"](#) on page 230.

**Remote command:**

`[ :SOURce<hw> ] :BB:DM:TRIGger:EXTErnal:SYNChronize:OUTPut`

on page 831

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger[:EXTErnal]:SYNChronize:OUTPut`

on page 881

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:EXTErnal:SYNChronize:OUTPut`

on page 922

**External Trigger Inhibit ← Trigger Settings Common to All Basebands**

For external trigger signal or trigger signal from the other path, sets the duration with that any following trigger event is suppressed. In "Retrigger" mode for example, a new trigger event does not cause a restart of the signal generation until the specified inhibit duration does not expire.

For more information, see ["Impact of the Additional Trigger Settings"](#) on page 230.

**Remote command:**

`[ :SOURce<hw> ] :BB:DM:TRIGger[:EXTErnal]:INHibit` on page 834

`[ :SOURce<hw> ] :BB:DM:TRIGger:OBASeband:INHibit` on page 833

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger[:EXTErnal]:INHibit` on page 884

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OBASeband:INHibit` on page 883

`[ :SOURce<hw> ] :BB:MCCW:TRIGger[:EXTErnal]:INHibit` on page 925

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:OBASeband:INHibit` on page 923

**External Delay Unit**

Determine whether the trigger delay is expressed in samples or directly defined as a time period (seconds).

To specify the delay, use the [\(External\) Trigger Delay/Specified Trigger Delay](#)

The parameter [Actual Trigger Delay](#) displays the delay converted in time.

See also ["Specifying delay and inhibit values in time units"](#) on page 232.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:DElay:UNIT` on page 833

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:DElay:UNIT` on page 883

**(External) Trigger Delay/Specified Trigger Delay**

The name of the parameter and the units the delay is expressed in, changes depending on the parameter [External Delay Unit](#).

Delays the trigger event provided by:

- The external trigger source
- The other path
- The other basebands (internal trigger), if common trigger settings are used.

Use the settings to:

- Synchronize the instrument with the device under test (DUT) or other external devices
- Postpone the signal generation start in the basebands compared to each other

For more information, see:

- ["Impact of the Additional Trigger Settings"](#) on page 230
- ["Specifying delay and inhibit values in time units"](#) on page 232

The parameter [Actual Trigger Delay](#) displays the delay converted in time.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger [ :EXternal ] :DElay` on page 833

`[ :SOURce<hw> ] :BB:DM:TRIGger:OBASeband:DElay` on page 832

`[ :SOURce<hw> ] :BB:DM:TRIGger [ :EXternal ] :TDElay` on page 833

`[ :SOURce<hw> ] :BB:DM:TRIGger:OBASeband:TDElay` on page 832

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger [ :EXternal ] :DElay` on page 883

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OBASeband:DElay` on page 882

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger [ :EXternal ] :TDElay` on page 883

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OBASeband:TDElay` on page 882

`[ :SOURce<hw> ] :BB:MCCW:TRIGger [ :EXternal ] :DElay` on page 925

`[ :SOURce<hw> ] :BB:MCCW:TRIGger:OBASeband:DElay` on page 923

**Actual Trigger Delay**

Displays the time (in seconds) an external trigger event or a trigger event from the other path is delayed with.

See also ["Specifying delay and inhibit values in time units"](#) on page 232.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger [ :EXternal ] :RDElay?` on page 834

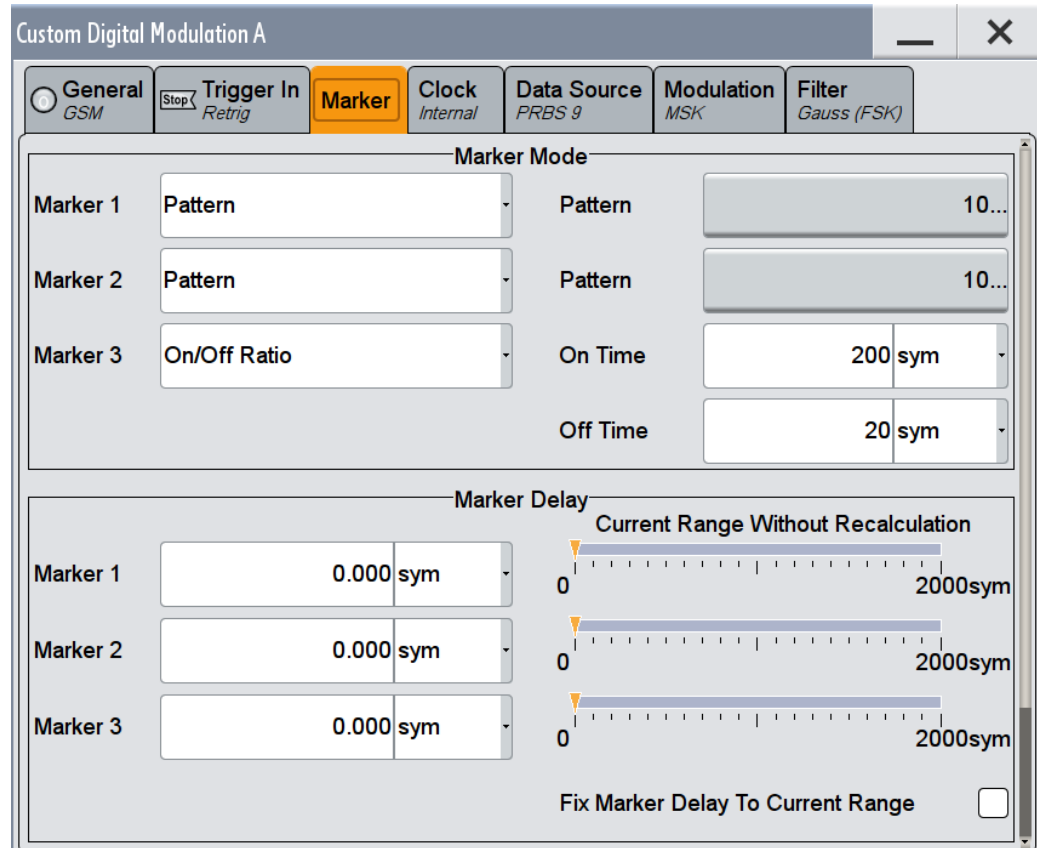
`[ :SOURce<hw> ] :BB:DM:TRIGger:OBASeband:RDElay?` on page 832

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger [ :EXternal ] :RDElay?` on page 884

`[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OBASeband:RDElay?` on page 882

### 5.3.2.2 Marker Settings

This tab provides access to the settings necessary to select and configure the marker output signal, like the marker mode or marker delay settings.



#### Marker Mode

Basic marker configuration for up to three marker channels. The contents of the dialog change with the selected marker mode.

Use the settings to define the shape and periodicity of the markers. See [Chapter 5.3.1.2, "Regular Marker Output Signals"](#), on page 223 for description of the regular marker signals.

The instrument routes the generated marker signals to the selected output connectors, see [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

"CList"            A marker signal as defined in the selected control list.

Remote command:

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:MODE` on page 834

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 836

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?`  
on page 837

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:PATtern` on page 836

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:OFFTime` on page 836

`[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:ONTime` on page 836

ARB: see **"Marker Mode"** on page 301

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:MODE on page 927

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVider on page 928

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?  
on page 928

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:PATtern on page 927

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:ONTime on page 927

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:OFFTime on page 927

### Marker x Delay

Defines the delay between the marker signal at the marker outputs relative to the signal generation start.

"Marker x"            For the corresponding marker, sets the delay as a number of symbols.

Remote command:

[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:DELay on page 835

[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OUTPut<ch>:DELay on page 886

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:DELay on page 926

"Current Range without Recalculation"

Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and the signal.

Move the setting mark to define the delay.

Remote command:

[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:DELay:MAXimum? on page 835

[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut<ch>:DELay:MINimum? on page 835

[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MINimum?  
on page 887

[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?  
on page 887

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:DELay:MINimum?  
on page 926

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut<ch>:DELay:MAXimum?  
on page 926

"Fix marker delay to current range"

Restricts the marker delay setting range to the dynamic range.

Remote command:

[ :SOURce<hw> ] :BB:DM:TRIGger:OUTPut:DELay:FIXed on page 835

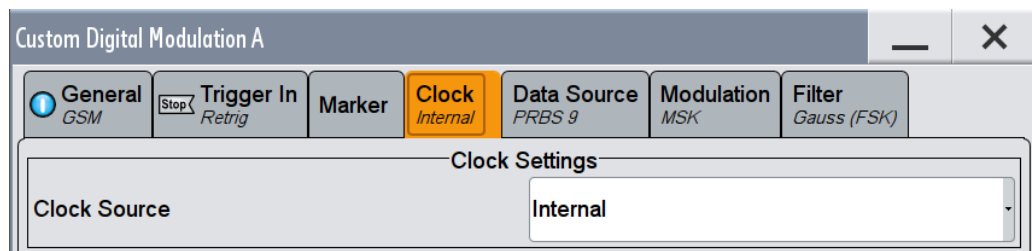
[ :SOURce<hw> ] :BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed on page 886

[ :SOURce<hw> ] :BB:MCCW:TRIGger:OUTPut:DELay:FIXed on page 926

### 5.3.2.3 Clock Settings

This tab provides access to the settings necessary to select and configure the clock signal, like the clock source and clock mode.





### Clock Source

Selects the clock source (see "Clock Signals" on page 219).

"Internal" The instrument uses its internal clock reference.

"External Global Clock 1/2"  
The instrument expects an external clock reference at the configured global USER connector.

"External Local Clock"  
The instrument expects an external clock reference at the local T/M/C connector.

Remote command:

`[ :SOURce<hw> ] :BB:DM:CLOCK:SOURce` on page 837

`[ :SOURce<hw> ] :BB:ARbitrary:CLOCK:SOURce` on page 887

`[ :SOURce<hw> ] :BB:MCCW:CLOCK:SOURce` on page 928

### Clock Mode

Enters the type of externally supplied clock; the symbol clock is derived internally.

Remote command:

`[ :SOURce<hw> ] :BB:DM:CLOCK:MODE` on page 837

`[ :SOURce<hw> ] :BB:ARbitrary:CLOCK:MODE` on page 888

`[ :SOURce<hw> ] :BB:MCCW:CLOCK:MODE` on page 929

### Clock Multiplier

Enters the multiplication factor for clock type "Multiple".

Remote command:

`[ :SOURce<hw> ] :BB:DM:CLOCK:MULTIplier` on page 837

`[ :SOURce<hw> ] :BB:ARbitrary:CLOCK:MULTIplier` on page 888

`[ :SOURce<hw> ] :BB:MCCW:CLOCK:MULTIplier` on page 929

### Measured External Clock

Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:

`:CLOCK:INPut:FREQuency?` on page 738

#### 5.3.2.4 Local and Global Connector Settings

Each of the "Trigger In", "Marker" and "Clock" dialogs as well as the "Trigger Marker Clock" dialog provides a quick access to the related local and global connector settings.

For more information, refer to the description R&S SMW User Manual, section "Local and Global Connectors".

### 5.3.3 How to Use the Trigger Settings for Simultaneous Signal Generation

In test setups that require the signal of two or more instruments and/or basebands it is required that:

- The signal generation starts at a defined moment
- The signal generation starts simultaneously (or with an exactly defined delay) in all involved instruments and/or basebands.

This section explains how to fulfill these tasks with the provided trigger settings.

For background information, see ["Receiving and Providing Trigger Signals"](#) on page 233.

#### 5.3.3.1 How to Trigger Several Instruments with a Common Signal

Using the same trigger event on several instruments is useful to synchronize the transmitted and received signals. Some test cases also require that you control the signal generation start and determine the exact generation start time by a defined trigger event. The signal generation start can be controlled for example by triggering the instrument internally or externally from the DUT.

For a step-by-step description, see [Chapter 3.3.3, "Triggering the Instrument with an External Signal"](#), on page 69.

#### 5.3.3.2 How to Trigger the Baseband Sources with a Common Signal

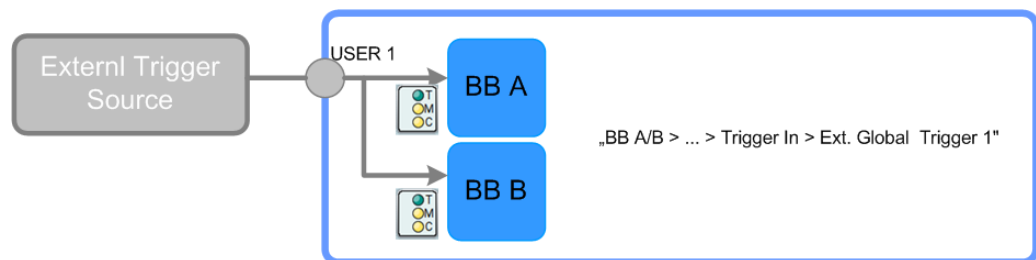
The R&S SMW supports you to trigger all basebands simultaneous and couples automatically the trigger settings in all available basebands (see ["Simultaneous signal generation start in several instruments"](#) on page 233).

In test setups that require the signal of two or more baseband signals but that do *not use the advantages of the coupled trigger settings*, you can trigger the baseband generators from a common trigger source. A common trigger source can be an external trigger source or the internal trigger signal of one baseband that is distributed to the other basebands.

Use one of the following possibilities.

##### To use the external global trigger signal of the instrument

An external *global* trigger/clock signal can be supplied to one or simultaneously to all the basebands.



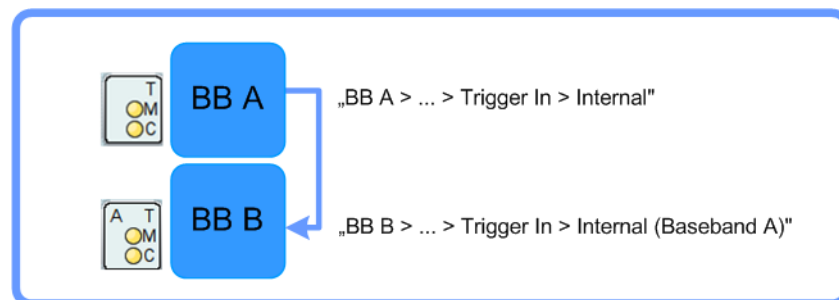
To trigger commonly all basebands and to assure a synchronous generation start with the global trigger/clock signal, proceed as follows:

- ▶ Enable the same trigger source in each of the basebands.  
For example, select "Trigger In > Source > External Global Trigger 1".

The instrument spreads the provided external trigger signal to all basebands.

### To use the internal trigger signal of the instrument

Internal trigger signals are generated by the instrument self and can be used independently per baseband or routed from one to the other.

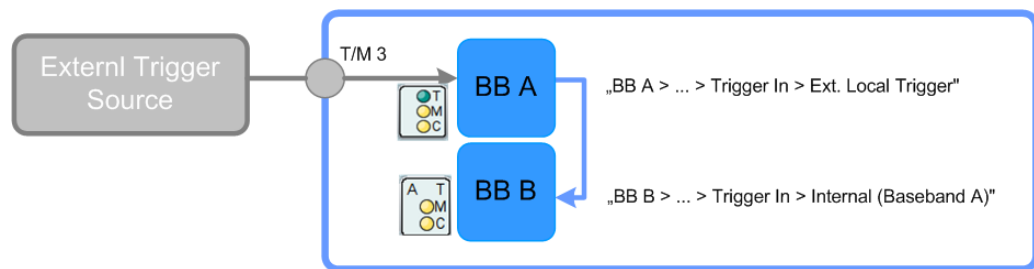


To use this feature to synchronize the signal generation start in the basebands, proceed as follows:

1. In the first baseband enable:
  - a) "Baseband > Cust Dig Mod > Trigger In > Mode > Armed Auto"
  - b) "Baseband > Cust Dig Mod > Trigger In > Source > Internal"
2. In the second baseband enable:
  - a) "Baseband B > Cust Dig Mod > Trigger In > Mode > Armed Auto"
  - b) "Baseband B > Cust Dig Mod > Trigger In > Source > Internal (Baseband A)"

### To use the external local trigger signal of the instrument

An external *local* trigger/clock signal is dedicated to the baseband board this signal is supplied at (i.e. the board the local T/M/(C) connector is located).



To route internally this signal and to use it for synchronous triggering of all other basebands, proceed as follows:

1. Configure one of the local connectors T/M 2,3 as input for the external local trigger signal:
  - a) "Baseband > Cust Dig Mod > Trigger In > Local Connector Settings"
  - b) In the "Local Connectors" dialog, enable "T/M 3 > Direction > Input" and "Signal > Trigger"
2. In the first baseband enable:
  - a) "Baseband > Cust Dig Mod > Trigger In > Mode > Armed Auto"
  - b) "Baseband > Cust Dig Mod > Trigger In > Source > External Local Trigger"
3. In the second baseband enable:
  - a) "Baseband B > Cust Dig Mod > Trigger In > Mode > Armed Auto"
  - b) "Baseband B > Cust Dig Mod > Trigger In > Source > Internal (Baseband A)"
4. Use a suitable cable and connect the external trigger source to the T/M 3 connector of the R&S SMW.

See ["To find out the physical location of the connector on the front/rear panel of the instrument"](#) on page 626.

The connector is located at the rear of the instrument, on the left part of the top-most CODER board.

## 5.4 Generating Custom Digital Modulated Signals

The R&S SMW can generate digital modulation signals with user-definable characteristics. The baseband filtering and the symbol rate can be set within wide limits.

### 5.4.1 Required Options

The equipment layout for generating the digital modulation signals includes

- Option Baseband Generator (R&S SMW-B10) per signal path
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)

## 5.4.2 About the Custom Digital Modulation

An introduction to the supported filter, modulation, and coding schemes is provided in:

- [Chapter 5.3.1.6, "Supported Baseband Filters"](#), on page 237
- [Chapter 5.3.1.4, "Supported Modulation Types"](#), on page 236
- [Chapter 5.3.1.5, "Supported Coding Schemes"](#), on page 237.

### Interdependency between selected modulation type and coding scheme and handling of conflicting settings

The applied coding is directly related to the selected modulation methods. The available coding schemes listed in [Chapter 5.4.5.2, "Common Coding Algorithms"](#), on page 283 are not freely combinable with modulation methods.

Obviously, having selected a modulation procedure, not every combination of the further modulation parameters "Symbol Rate" and "Coding" is possible. These restrictions inevitably result in conflicting settings if you change a parameter and leads to a prohibited combination.

An inappropriately change of a parameter triggers a settings conflict. A conflicting setting is indicated by a message on the "Info" line in the display. Although the R&S SMW displays the selected settings, the generated modulation signal does not correspond to this display. The displayed message disappears when a conflict-free setting is selected.

Refer to [Chapter 15, "Troubleshooting and Error Messages"](#), on page 1095 for a list of the possible settings conflicts and messages in digital modulation.

## 5.4.3 Custom Digital Modulation Settings

To access the dialog box:

- ▶ Select "Baseband > Custom Dig Mod".

The "Custom Digital Modulation" dialog enables direct selection of the data source, standard, symbol rate, coding, modulation type and filter.

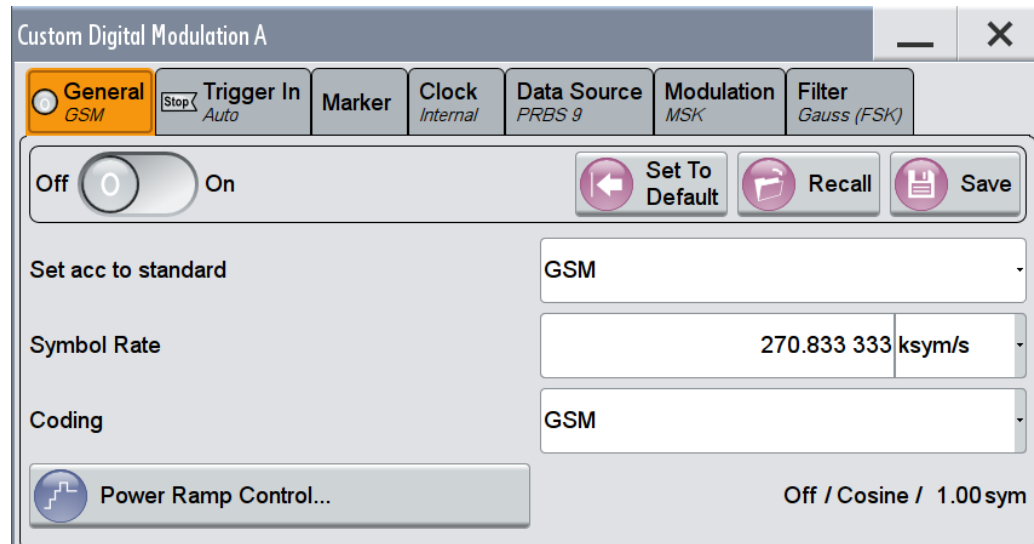
The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name.

The remote commands required to define these settings are described in [Chapter 13.18.3.2, "SOURce:BB:DM Subsystem"](#), on page 815.

- [General Settings](#)..... 254
- [Trigger, Marker and Clock Setting](#)..... 255
- [Data Source](#)..... 256
- [Modulation Settings](#)..... 261
- [Filter Settings](#)..... 263
- [Power Ramp Control Settings](#)..... 265
- [Data List Editor](#)..... 267
- [Control and Marker Lists Editor](#)..... 269

### 5.4.3.1 General Settings

This tab provides access to the default and the Save/Recall settings, as well as to a quick selection of a digital modulation according to predefined communication standard, adjusting the symbol rate and the coding.



State.....	254
Set To Default.....	254
Save/Recall.....	254
Set according to Standard.....	255
Symbol Rate.....	255
Coding.....	255
Power Ramp Control.....	255

#### State

Enables/disables digital modulation. Switching on digital modulation turns off all other digital standards.

The digital modulation is generated in real time (no precalculated signal), and therefore while the digital modulation is enabled, all parameter changes directly affect the output signal.

Remote command:

[ :SOURce<hw> ] :BB:DM:STATe on page 818

#### Set To Default

Calls default settings. The values are listed in [Table 5-8](#).

Remote command:

[ :SOURce<hw> ] :BB:DM:PRESet on page 818

#### Save/Recall

Accesses the "Save/Recall" dialog, that is the standard instrument function for storing and recalling the complete dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

See also [Chapter 10, "File and Data Management"](#), on page 571.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SETTing:CATalog?` on page 822

`[ :SOURce<hw> ] :BB:DM:SETTing:DELeTe` on page 823

`[ :SOURce<hw> ] :BB:DM:SETTing:LOAD` on page 822

`[ :SOURce<hw> ] :BB:DM:SETTing:STORe` on page 822

### Set according to Standard

Selects a predefined communication standard. A subset of parameters is automatically adjusted: "Modulation Type", "Symbol Rate", "Filter" and "Coding".

A subsequent modification of one of the parameters, sets the standard to "User". Use the "Save/Recall" function to store and recall customized settings.

Refer to [Table 5-9](#) for an overview of the available standards and the associated settings of the modulation parameters.

Remote command:

`[ :SOURce<hw> ] :BB:DM:STANdard` on page 819

### Symbol Rate

Selects the symbol rate. The value range of this parameter depends on the selected modulation type; the range is automatically redefined. The instrument generates an error message if the selected symbol rate is outside of the redefined range and sets the symbol rate to the maximum allowed value for the new modulation.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SRATe` on page 819

### Coding

Selects the coding (see [Chapter 5.3.1.5, "Supported Coding Schemes"](#), on page 237).

The dialog offers only the coding settings that are permissible for the selected modulation type. All other coding methods are grayed out. A subsequent modification to a modulation type for which the selected coding is not available, automatically disables the coding ("Coding = Off").

Remote command:

`[ :SOURce<hw> ] :BB:DM:CODing` on page 825

### Power Ramp Control

Accesses the power ramp control dialog, see [Chapter 5.4.3.6, "Power Ramp Control Settings"](#), on page 265.

## 5.4.3.2 Trigger, Marker and Clock Setting

These tabs provide standard settings.

For detailed description, see:

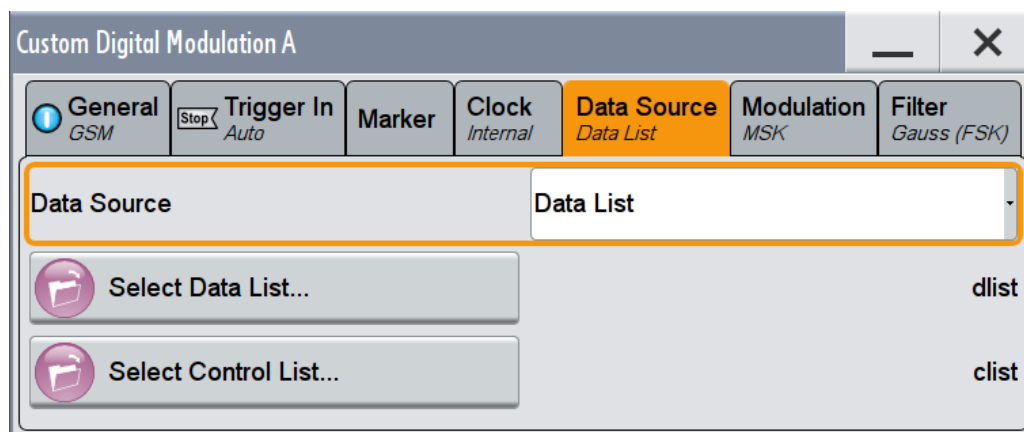
- [Chapter 5.3.2.1, "Trigger Settings"](#), on page 242

- Chapter 5.3.2.2, "Marker Settings", on page 247
- Chapter 5.3.2.3, "Clock Settings", on page 248
- Chapter 5.3.2.4, "Local and Global Connector Settings", on page 249

### 5.4.3.3 Data Source

This tab provides access to the settings necessary to select and configure the data source, like access to data and list editors or direct selection of PRBS data.

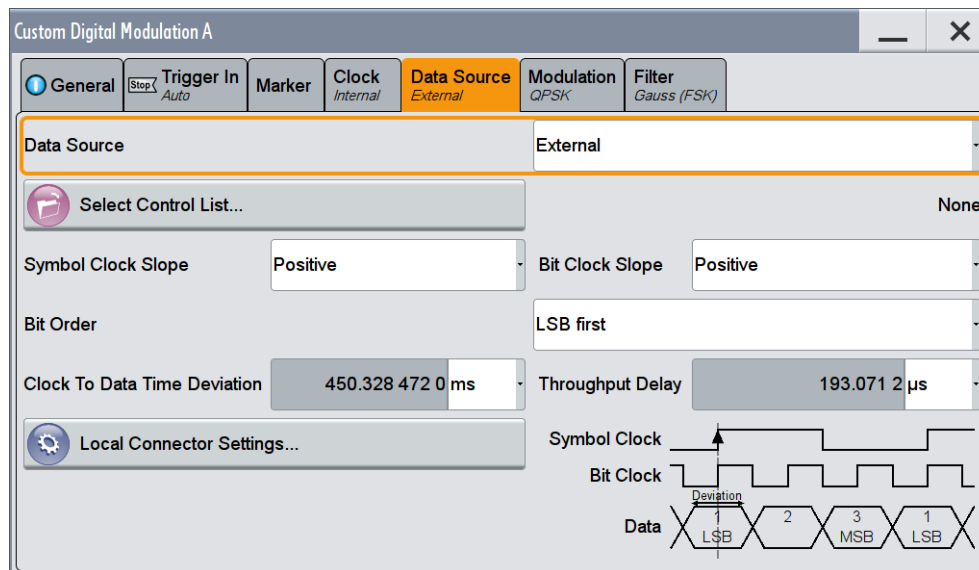
For an overview of the supported data sources, refer to Chapter 5.3.1.1, "Data, Clock and Control Signals and Sources in the Baseband", on page 216.



#### To access the extern serial data settings

Provide the external serial data and clock signals at the connectors listed in Table 5-2.

1. In the "Custom Digital Modulation > Data Source" dialog, select "Data Source > External".





2. If higher order modulation is required, select for example "Modulation > Modulation Type > PSK > QPSK".

Data Source.....	257
Select Data List.....	257
Select Control List.....	258
Symbol Clock Slope/Clock Slope.....	258
Bit Clock Slope.....	258
Receiver State.....	259
Bit Order.....	259
Clock to Data Time Deviation.....	260
Throughput Delay.....	260
Local Connector Settings.....	260
Graphical illustration of the timing ratios between the data and clock signals.....	261

### Data Source

Selects the data source (see [Chapter 5.3.1.1, "Data, Clock and Control Signals and Sources in the Baseband"](#), on page 216).

The following data sources are available:

"All 0, All 1"      A sequence containing 0 data or 1 data is internally generated

"PRBS, PRBS Type"

Selects internally generated PRBS data in accordance with the IUT-T. Use the parameter "PRBS Type" to define the length.

Remote command:

`[ :SOURce<hw> ] :BB:DM:PRBS [ :LENGth ]` on page 820

"Pattern"      Use the "Pattern" box to define a bit pattern with a maximum length of 64 bits.

"Data List"

Binary data from data lists are used, see [Select Data List](#).

Remote command:

`[ :SOURce<hw> ] :BB:DM:DLISt:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:DLISt:SElect` on page 839

"External"      An externally supplied serial data is used, see ["External Modulation Data"](#) on page 218.

Data and clock signals have to be supplied at the corresponding connectors.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SOURce` on page 819

### Select Data List

Accesses the standard "Select List" dialog to select an existing data list or to create a new one.

Data lists can be generated externally or internally in the data editor.

- Select the "Select Data List > navigate to the list file \*.dm\_iqd > Select" to select an existing data list.

- Use the standard "File Manager" function to transfer external data lists to the instrument.
- Use the "New" and "Edit" functions to create internally new data list or to edit an existing one, see [Chapter 5.4.3.7, "Data List Editor"](#), on page 267.

See also [Chapter 5.4.4.2, "How to Create and Assign a Data List"](#), on page 275

Remote command:

`[ :SOURce<hw> ] :BB:DM:DLISt:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:DLISt:SElect` on page 839

`[ :SOURce<hw> ] :BB:DM:DLISt:COpy` on page 841

`[ :SOURce<hw> ] :BB:DM:DLISt:DElete` on page 839

### Select Control List

Accesses the standard "Select List" dialog to select an existing control list or to create a new one.

Control lists can be generated externally or internally in the "Control and Marker Lists" editor.

- Select the "Select Control List > navigate to the list file \*.dm\_iqc > Select" to select an existing control list.
- Use the standard "File Manager" function to transfer external lists to the instrument.
- Use the "New" and "Edit" functions to create internally new list or to edit an existing one, see [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269.

Irrespectively on the way they are created, control lists are not automatically used (see ["How to assign and activate control signals from a control list"](#) on page 275).

Remote command:

`[ :SOURce<hw> ] :BB:DM:CLISt:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:CLISt:SElect` on page 839

`[ :SOURce<hw> ] :BB:DM:CLISt:COpy` on page 841

`[ :SOURce<hw> ] :BB:DM:CLISt:DElete` on page 839

### Symbol Clock Slope/Clock Slope

("Data Source > External")

A higher bit modulation external serial data requires a reference symbol clock signal to generate a bit clock out of it.

This parameter sets the active edge of the symbol clock, as set with the parameter [Clock Input Slope](#).

To set the active edge of the bit clock, use the parameter [Bit Clock Slope](#).

Observe the impact of this parameter on the preview graphic.

See also ["External Modulation Data"](#) on page 218.

Remote command:

`[ :SOURce ] :INPut:USER:CLOCK:SLOPe` on page 793

### Bit Clock Slope

("Data Source > External")

Sets the active edge of the bit clock.

Timing deviations between the clock and the data signals, that are smaller than  $\pm 1/16$  of the clock period, are:

- Automatically corrected
- Indicated with the parameter [Clock to Data Time Deviation](#)

Observe the impact of this parameter on the preview graphic.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SMODulation:CLOCK:SLOPe:BIT` on page 821

### Receiver State

Indicates the current state of the receiver of the external data. The displayed information is useful in erroneous situations.

"Off"	Indicates that the baseband is not active.
"Operational"	Indicates a normal operation; the data is received with the expected data rate.
"Overflow"	Data rate is too high for correct processing; symbols have been lost. This indication is displayed as long as the signal is not restarted. <b>Tip:</b> Try out the following: <ul style="list-style-type: none"> <li>• Check the data rate of the input signal.</li> <li>• Provide the data source and the R&amp;S SMW with a common external reference signal. See <a href="#">Chapter 8.5, "Reference Oscillator"</a>, on page 422.</li> <li>• Provide an external clock signal to the R&amp;S SMW. See <a href="#">"Clock Source"</a> on page 249.</li> <li>• Avoid reflections on the data and clock lines. The R&amp;S SMW may interpret reflections on the data and clock lines as extra clock edges.</li> </ul>
"Underflow"	Data rate is too low or data is missing; zero symbols have been inserted. This indication is displayed as long as the signal is not restarted. <b>Tip:</b> Try out the following: <ul style="list-style-type: none"> <li>• Check that the data and clock cables are connected to R&amp;S SMW.</li> <li>• Check the data rate of the input signal.</li> <li>• Provide the data source and the R&amp;S SMW with a common external reference signal. See <a href="#">Chapter 8.5, "Reference Oscillator"</a>, on page 422.</li> <li>• Provide an external clock signal to the R&amp;S SMW. See <a href="#">"Clock Source"</a> on page 249.</li> <li>• Check the value of the parameter <a href="#">Local Connector Settings &gt; Threshold Clock</a>. If the configured threshold is higher than the signal's "high" voltage, the signal is not detected.</li> </ul>

Remote command:

`[ :SOURce<hw> ] :BB:DM:SMODulation:RCVState?` on page 821

### Bit Order

("Data Source > External")

Sets the bit order, **LSB** or **MSB** first, used to process the externally supplied higher bit modulation serial data.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SMODulation:BOReDer` on page 820

### Clock to Data Time Deviation

("Data Source > External")

Indicates timing deviations between the clock and the data signals. Timing deviations that are smaller than  $\pm 1/16$  of the clock period are automatically corrected.

See also "[External Modulation Data](#)" on page 218.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SMODulation:CDTDeViation` on page 820

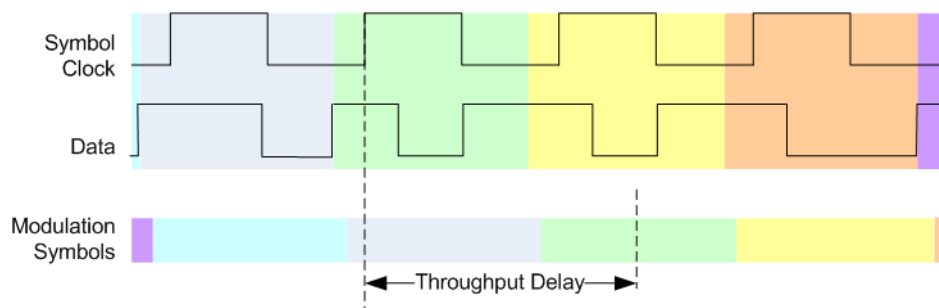
### Throughput Delay

("Data Source > External")

Indicates the time delay between the active clock edge for the external data and the center of the modulation symbol (associated with this data item) on the RF connectors, see [Figure 5-13](#).

#### Example:

- "Data Source > External"
- Modulation with 3 bits per symbol
- "Symbol Clock Slope > Positive", i.e. the active edge of the symbol clock is the rising edge
- Clock active edge falls at the center of the first bit of each symbol



**Figure 5-13: Throughput Delay (symbols indicated by different colors)**

In this particular case, the throughput delay is the time between the center of the modulation symbol at the RF output and the center of the first bit in each symbol in the external data.

Remote command:

`[ :SOURce<hw> ] :BB:DM:SMODulation:THROughput:DELaY?` on page 821

### Local Connector Settings

Access the settings of the local connectors, see [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

**Graphical illustration of the timing ratios between the data and clock signals**

A graph illustrates the timing relation, depending on the selected:

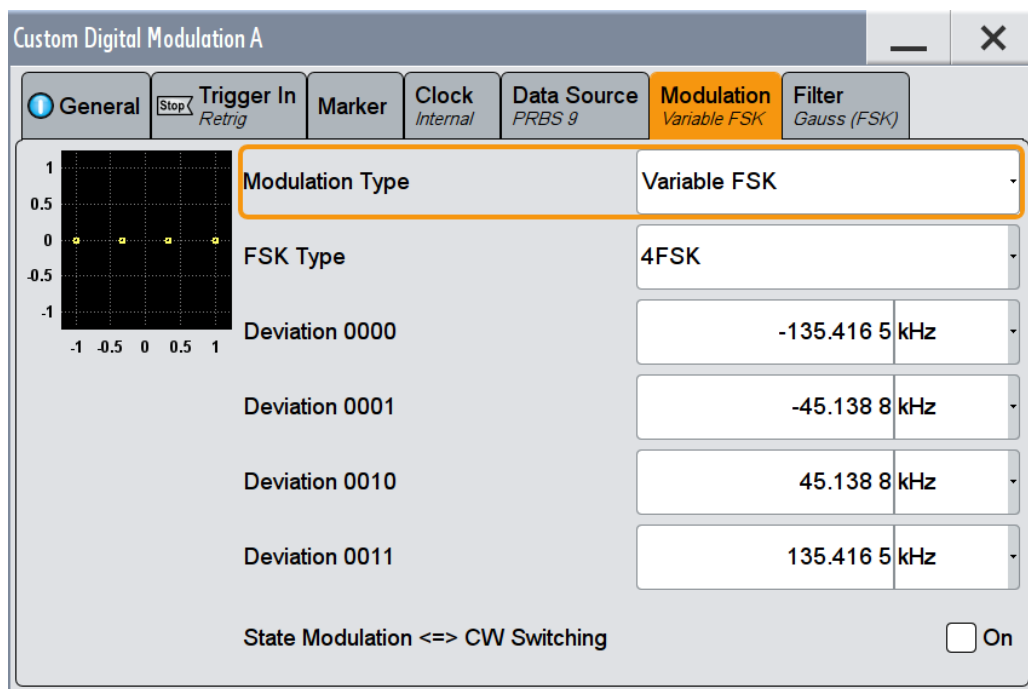
- Bit Clock Slope
- Symbol Clock Slope/Clock Slope
- Bit Order

**5.4.3.4 Modulation Settings**

This tab provides access to the modulation settings, e.g modulation type, FSK deviation, or modulation depth. The dialog shows the theoretical constellation diagram of the selected modulation.



This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to [Chapter 5.3.1.4, "Supported Modulation Types"](#), on page 236.



Modulation Type.....261

Load User Mapping.....262

ASK Depth.....262

FSK Deviation.....262

Angle Alpha.....262

FSK Type.....263

Deviation xxxx.....263

State Modulation <=> CW Switching.....263

**Modulation Type**

Selects a modulation type. The associated symbol mapping is displayed.

If the selected "Coding" is not allowed with the configured modulation type, the value of the parameter [Coding](#) is set to "Off".

Refer to [Table 5-10](#) for an overview of the allowed combinations.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FORMat` on page 825

### Load User Mapping

Accesses the "Select List File User Mapping" dialog to select the mapping table (see ["User mapping"](#) on page 236). The dialog provides all standard file management functions.

Remote command:

`[ :SOURce<hw> ] :BB:DM:MLIST:SElect` on page 839

`[ :SOURce<hw> ] :BB:DM:MLIST:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:MLIST:DElete` on page 839

### ASK Depth

Sets the modulation depth  $m$  for ASK modulation.

$$m = (Amplitude_{max} - Amplitude_{min}) / (Amplitude_{max} + Amplitude_{min})$$

Remote command:

`[ :SOURce<hw> ] :BB:DM:ASK:DEPTH` on page 826

### FSK Deviation

Sets the frequency deviation for FSK modulation. The range of values depends on the selected [Symbol Rate](#) (see data sheet).

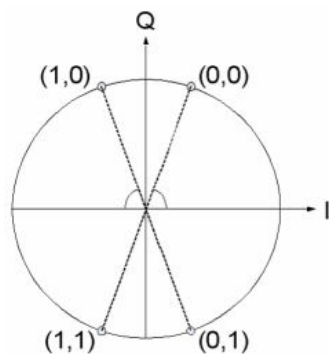
Whenever "MSK" is selected, the deviation corresponds to 1/4 of the symbol rate and cannot be changed.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FSK:DEVIation` on page 826

### Angle Alpha

For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.



Remote command:

[ :SOURce<hw> ] :BB:DM:AQPSk:ANGLE on page 825

### FSK Type

(Variable FSK only)

Selects the FSK modulation type for selection "Variable FSK".

Available are 4FSK, 8FSK and 16FSK.

Remote command:

[ :SOURce<hw> ] :BB:DM:FSK:VARiable:TYPE on page 827

### Deviation xxxx

(Variable FSK only)

Sets the deviation of the associated symbol. The number of symbols depends on the selected modulation type. The value of each symbol is indicated in binary format.

Remote command:

[ :SOURce<hw> ] :BB:DM:FSK:VARiable:SYMBOL<ch0>:DEVIation on page 826

### State Modulation <=> CW Switching

Enables/disables switching between the digitally modulated and an unmodulated (CW) signal.

Remote command:

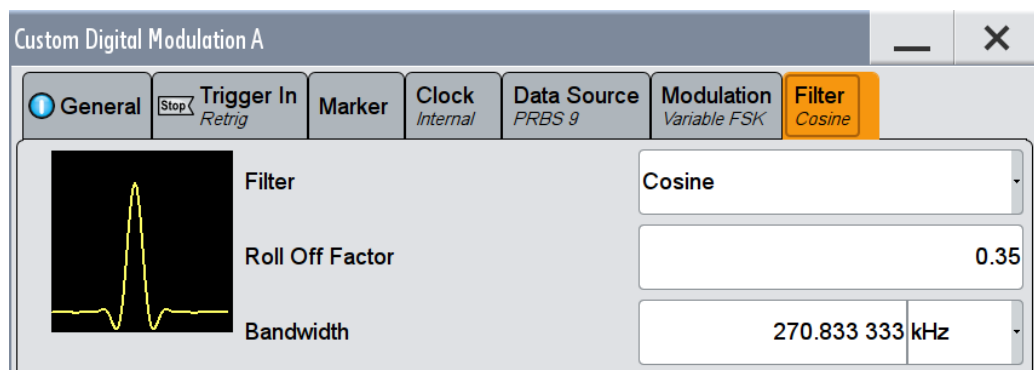
[ :SOURce<hw> ] :BB:DM:SWITching:STATe on page 827

## 5.4.3.5 Filter Settings

This tab provides access to the filter settings, like filter type and if available further filter settings. A simplified diagram shows the filter characteristic of the selected filter.



This section focuses on the available settings. For background information on how the settings affect the signal and the filter characteristics, refer to [Chapter 5.3.1.6, "Supported Baseband Filters"](#), on page 237.



Filter.....	264
Filter Parameter.....	264
Cut Off Frequency Factor.....	264
Bandwidth.....	264
Load User Filter.....	264

**Filter**

Selects the baseband filter.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FILTer:TYPE` on page 823

**Filter Parameter**

Sets the corresponding filter parameter.

The filter parameter offered ("Roll Off Factor" or "B x T") depends on the currently selected filter type.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:APCO25` on page 823

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:COsine[:ROLLoff]` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:GAUSSs` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:PGAuss` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:RCOSine` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:SPHase` on page 824

**Cut Off Frequency Factor**

(available for filter parameter Lowpass and APCO25 (LSM) only)

Sets the value of the cutoff frequency factor. The cutoff frequency of the filter can be adjusted to reach spectrum mask requirements.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:LPASSs` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:LPASSEVM` on page 824

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:APCO25Lsm:GAUSSs` on page 823

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:APCO25Lsm:LOWPass` on page 823

**Bandwidth**

Determines the bandwidth of the cosine filter, so that the function in  $H(f) = 0$  is fulfilled for  $f \geq (1 + RollOff) * Bandwidth / 2$ .

Remote command:

`[ :SOURce<hw> ] :BB:DM:FILTer:PARAmeter:COsine:BANDwidth` on page 823

**Load User Filter**

Calls the dialog "Select User Filter" for selecting a user-defined filter file with extension \* .vaf (see "User filter" on page 238). The dialog provides access to the standard file management functions, like store, load, delete.

Remote command:

`[ :SOURce<hw> ] :BB:DM:FLISt:SElect` on page 839

`[ :SOURce<hw> ] :BB:DM:FLISt:CATalog?` on page 838

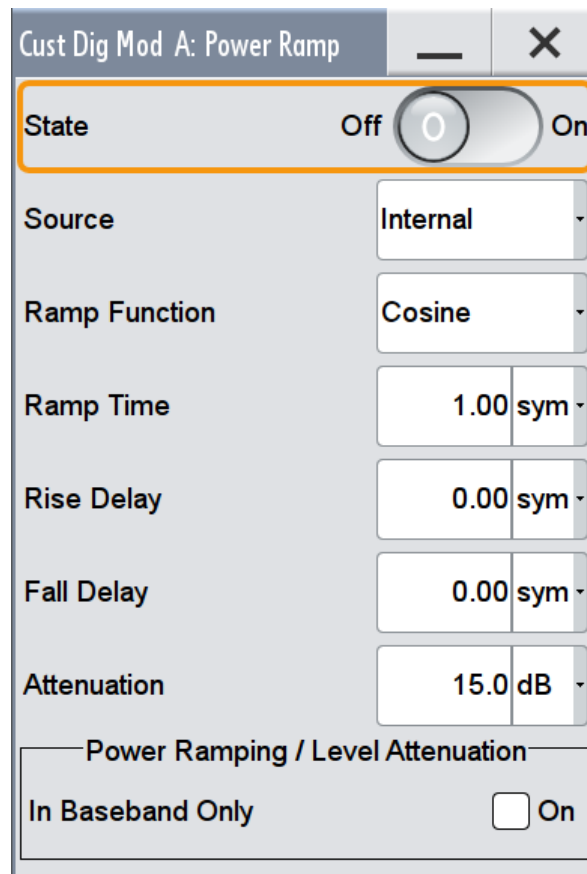
`[ :SOURce<hw> ] :BB:DM:FLISt:DElete` on page 839



### 5.4.3.6 Power Ramp Control Settings

To access this dialog:

- ▶ Select "Baseband > Custom Digital Modulation > General > Power Ramp Control".



The dialog provides access to the settings used to configure the power ramping, like the source for the necessary control signals "Burst" and "Lev\_Att", the form of the ramp function and the applied attenuation (see also "Power Ramping and Level Attenuation" on page 221).



Power ramping is possible up to a symbol rate of 5 MHz. A higher symbol rate disables the power ramping automatically and an error message is output.

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Ramp Function.....	266
Ramp Time.....	266
Rise Delay.....	266
Fall Delay.....	266
Attenuation.....	266
In Baseband Only.....	267

**State**

Enables/disables power ramping.

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp [ :STATe ] on page 829

**Source**

Defines the source for the power ramp control signals.

"Internal"            The control signals as defined in the internal control list are used for control purposes.  
See also [Chapter 5.4.4.1, "How to Create and Assign a Control List"](#), on page 273.

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp :SOURce on page 827

**Ramp Function**

Selects the ramp function that describes the shape of the rising and falling edges during power ramp control, see [Figure 5-4](#).

"Linear"              The transmitted power rises and falls linear fashion.

"Cosine"              The transmitted power rises and falls with a cosine-shaped edge, resulting in a more favorable spectrum than the "Linear" setting.

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp :SHAPE on page 828

**Ramp Time**

Enters the power ramping rise time and the fall time for a burst. The setting is expressed in symbols. See also [Figure 5-4](#).

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp :TIME on page 828

**Rise Delay**

Sets the offset in the rising edge of the envelope at the start of a burst, see [Figure 5-4](#).

A positive value delays (the envelope length decreases) and a negative value causes an advance (the envelope length increases). The setting is expressed in symbols.

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp :RDElay on page 828

**Fall Delay**

Sets the offset in the falling edge of the envelope at the end of a burst, see [Figure 5-4](#).

A positive value delays (the envelope length increases) and a negative value causes an advance (the envelope length decreases). The setting is expressed in symbols.

Remote command:

[ :SOURce<hw> ] :BB:DM:PRAMp :FDElay on page 828

**Attenuation**

Determines the level by that the average signal level is attenuated during the signal attenuation period, during the time the "Lev\_Att" signal is high. See also [Figure 5-3](#).

For information about the required control signal LEV\_ATT, refer to "[Power Ramping and Level Attenuation](#)" on page 221.

Remote command:

`[ :SOURce<hw> ] :BB:DM:PRAMp:ATTenuation` on page 828

### In Baseband Only

Restricts power ramping to the baseband signal.

"Off"	Level attenuation is affected via the attenuator stages in the RF section; only the remaining part is attenuated in the baseband. The signal is issued at the RF output with the defined level values.
"On"	Level attenuation is affected in the baseband only.

#### Note:

This setting is mandatory in the following cases:

- When only the baseband signal is issued at the I/Q outputs. It is thus ensured that, with power ramping active, this signal is output with the defined level values.
- In case of two-path instruments, when one baseband signal is applied to two RF paths. The RF paths having separate frequency and level settings, the remaining attenuation to be effected in the baseband would have to be different for the two paths and is therefore not possible.

Remote command:

`[ :SOURce<hw> ] :BB:DM:PRAMp:BBONly [ :STATe ]` on page 829

### 5.4.3.7 Data List Editor

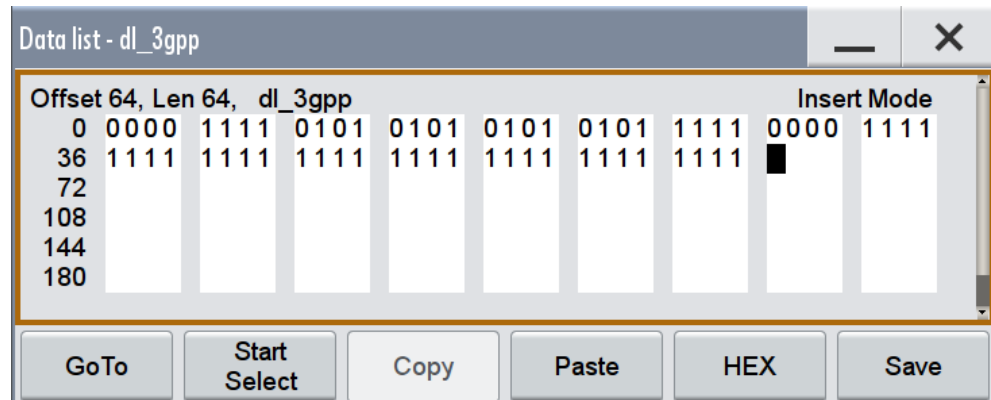
The R&S SMW provides the following ways to create a data list file:

- to use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see "[To create a data list manually](#)" on page 275
- To use the tag-oriented format and create a data list file, see "[To create a data list using tag file format](#)" on page 908
- To use SCPI commands and create a file in binary format, see "[To create a data list in binary format](#)" on page 909

To access the "Data List Editor" dialog:

1. Select "Baseband > Custom Dig Mod > Data Source > Data List"
2. Select "Select Data List"
3. Navigate to the required directory, select "New", and enter a file name.

For example, use the directory `/var/user/` and enter "File Name" = `dl_3gpp`



The "Data List Editor" is a list of binary values with a maximum length of  $2^{31}$  bits. This value corresponds to a file size of approx. 268 Mbyte.

To increase readability, the bits are displayed in groups of four. The current cursor position, the length of the list and the list file name are displayed above the list. The offset starts with the value 0 which corresponds to the bit position on the left side of the first row, i.e. the beginning of the list. On the left edge of the editor, the last three offset positions are specified at the beginning of the row.

An existing list can be edited in the insert or replace mode.

SCPI command:

[\[:SOURCE<hw>\]:BB:DM:DLIST:SElect](#) on page 839

[\[:SOURCE<hw>\]:BB:DM:DLIST:DATA](#) on page 843

[\[:SOURCE<hw>\]:BB:DM:DLIST:DATA:APPend](#) on page 843

The buttons below the binary list simplify the editing. The following table lists the provided functions.

GUI Element	Description
"GoTo"	Opens the entry window for the bit position. The cursor marks the bit at the selected position.
"Start Select" / "Undo Select"	Defines the current cursor position as the start position for the range to be selected. To define the stop position, select "GoTo > Go To Offset" and define the offset. Selecting "Undo Select" deactivates the selected range.
"Copy", "Cut", "Paste"	Standard copy, cut, and paste functions
"Hex"	Switchover to hexadecimal display. Each four bits group is displayed as a hexadecimal value: To increase readability, the hexadecimal values in turn are displayed in pairs of two. The hex functions are automatically assigned to the numeric keys at the front panel.
"Save"	Stores the changes made to the Data List file selected for editing.

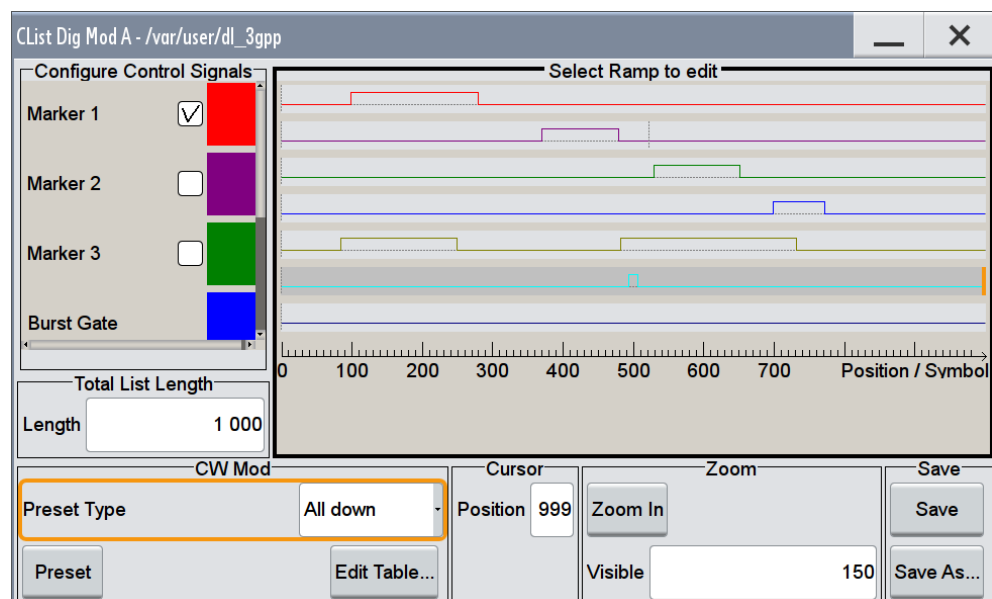
### 5.4.3.8 Control and Marker Lists Editor

The R&S SMW provides the following ways to create a file containing control signals:

- To use the tag-oriented format and create a control list file, see ["To create a control list using tag file format"](#) on page 907
- To use SCPI commands and create a file in binary format, see ["To create a control list in binary format"](#) on page 907
- to use the dedicated "Control Data Editor" and create a file in ASCII format and with extension \*.dm\_iqc.  
The "Control Data Editor" is described in this section. Refer to ["To create a control list in ASCII format manually"](#) on page 274 for step-by-step instructions.

To access the "Control Data Editor":

1. Select "Baseband > Custom Dig Mod > Data Source".
2. Select "Select Control List"
3. Navigate to the required directory, select "New", and enter a file name.  
For example, use the directory `/var/user/` and enter "File Name" = `dl_3gpp`
4. In the "File Name" field, enter the name of the new control list, for example `dl_3gpp`.
5. Select "Edit".



The dedicated internal "Control Data Editor" is an intuitive graphical interface provided for defining and managing of:

- Marker signals
- Control signals, like the CW, Hop, Burst Gate, and Lev\_Att control signals (see also ["Control Signals"](#) on page 221)

A separate file with the file extension `*.dm_iqc` is created for each defined control signal and held on the instrument's hard disk. Control lists created with the editor are files in an ASCII file format.

In the "Control Data Editor" dialog, the available marker and control signals are displayed color-coded. The "Select Ramp to Edit" is a graphical display of the signal characteristics. To define the ramp for the individual markers or control signals, tap on the desired position or use the provided support functions "<Signal> Table" and "Cursor Position". To simplify the settings, use the predefined preset ramp characteristics in the "<Signal> Preset Type" section. The scaling of the x-axis is always adapted to the overall length of the control list to provide constant overview of all defined ramps. For detailed representation, zoom the displayed area around the current cursor position.

In the "Configure Control Signal" section, a status check box indicates whether the individual marker or control signal is assigned or enabled (see [Chapter 5.4.4.1, "How to Create and Assign a Control List"](#), on page 273).

SCPI command:

`[ :SOURce<hw> ] :BB:DM:CLIST:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:CLIST:SElect` on page 839

<a href="#">Configure Control Signal</a> .....	270
<a href="#">Select Ramp to Edit</a> .....	270
<a href="#">Total List Length</a> .....	271
<a href="#">Preset Type</a> .....	271
<a href="#">Cursor Position</a> .....	271
<a href="#">Positions Control Signal</a> .....	271
<a href="#">Zoom/Visible</a> .....	272
<a href="#">Save/Save As</a> .....	272

### Configure Control Signal

Displays the color the marker/control signal has been assigned.

The status check box indicates whether the individual marker or control signal is assigned or enabled (see [Chapter 5.4.4.1, "How to Create and Assign a Control List"](#), on page 273).

Remote command:

n.a.

### Select Ramp to Edit

Graphical representation for editing of the marker/control signals.

Refer to [Chapter 5.4.4.1, "How to Create and Assign a Control List"](#), on page 273 for an overview of the editing capabilities of the display.

Remote command:

`{ [TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1 }`

on page 896

`[ :SOURce<hw> ] :BB:DM:CLIST:DATA` on page 842

**Total List Length**

Enters the length of the definition range of the control list in bits. The starting value is always bit 0. The entire definition range is displayed, i.e. the bit scale is adapted to the entry. If the definition range is decreased, the ramps outside the range are lost.

When used, the control list is always repeated over the length of the definition range if the length of the data list exceeds the length of the control list.

**Tip:** With long control lists, it is useful to zoom the displayed area around the current cursor position ("Zoom in").

Remote command:

{CONTROL LENGTH: ControlLength} on page 894

**Preset Type**

Triggered with "Preset", presets for the ramp characteristic of the selected control signal as defined with the "Preset Type".

"All Up, All Down "

Continuously high/low marker/control signal.

"Ramp Up, Ramp Down"

A ramp from low to high or from high to low is configured in the center of the displayed signal area; ramp position can be later shifted as required.

"Ramp Up/Down, Ramp Down/Up"

Created is a ramp sequence of low to high and high to low transitions, respectively high to low, and low to high transitions. The ramps are symmetrically distributed around the center of the displayed signal area but be later shifted as required.

Remote command:

n.a.

**Cursor Position**

Displays/enters the cursor position in the graphical display

If the entered value exceeds the selected length of the definition range, the length is adjusted automatically.

Remote command:

n.a.

**Positions Control Signal**

Select "Edit Table" to access a dialog with representation of the ramps of the selected signal in table form.

Dig Mod A Positions - CW Mod		
	Ramp Position	Ramp State
1	0	Low
2	13	High
3	1050	Low
4	2169	High
5	3500	Low
6		

Accept

The bit position is specified in the "Ramp Position" column, the high or low signal status in the "Ramp State" column. Use the last blank row to enter new ramps.

To apply the changes, press "Accept".

Remote command:

n.a.

#### Zoom/Visible

Zooms the displayed area of the control list. The designation of the button changes from "Zoom in" to "Zoom out".

With long control lists, it might be helpful to display only a part of the control list. In such cases, set the "Visible/Bits Visible" to determine the number of symbols/bits to be displayed and select "Zoom" to focus the displayed area around the current "Cursor Position".

Ramps outside the displayed area are not lost by zooming.

Remote command:

n.a.

#### Save/Save As

Stores the changes in the selected control list file or in a new file.



Remote command:  
n.a.

#### 5.4.4 How to Generate Custom Digitally Modulated Signals and Create Data and Control Lists

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings, see [Chapter 5.4.3, "Custom Digital Modulation Settings"](#), on page 253.

##### To generate a digitally modulated signal

- ▶ To generate a simple 3GPP digitally modulated signal, follow the instructions in [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67.

##### To apply an external clock signal



##### Internal and external clock synchronization

The correct synchronization of the internal clock synthesizer requires that the following procedure is maintained.

---

1. Supply the instrument with the external clock, i.e. connect the external reference clock source to the suitable instrument's connector.
2. If required, adjust the corresponding connector settings.
3. Adjust the "Symbol Rate".  
The selected symbol rate must not deviate from the symbol rate of the external signal by more than 2% (see also data sheet).
4. Enable "Clock Source External"

##### 5.4.4.1 How to Create and Assign a Control List

The R&S SMW provides the following ways to create a file containing control signals:

- To use the dedicated [Control and Marker Lists Editor](#) and create a file in ASCII format and with extension `*.dm_iqc`, see ["To create a control list in ASCII format manually"](#) on page 274
- To use the tag-oriented format and create a control list file, see ["To create a control list using tag file format"](#) on page 907
- To use SCPI commands and create a file in binary format, see ["To create a control list in binary format"](#) on page 907

### To create a control list in ASCII format manually

Use the intuitive build in [Control and Marker Lists Editor](#) dialog:

1. To open the "Control Data Editor", select "Baseband > Custom Dig Mod > Data Source > Select Control List" and select an existing file or use "New" to create a new one.

If the selected file is an existing one, the dialog shows the used settings. If a new file has been created, the control list is empty.

2. Adjust the control signals as required.
  - a) In the graphic editor "Select Ramp to Edit", select the color-coded trace of the required signal.
  - b) Tap at a position where a ramp is required. The number of ramps per marker is not limited.
  - c) To remove a ramp, place the cursor at the desired ramp position and press the BACKSPACE key.
  - d) For faster marker and control signal definition, use the predefined ramp functions ("Preset Type") and apply them with "Preset".
  - e) If required, readjust the ramps with the help of the "Edit Table" function.
  - f) Define the "Total List Length".
  - g) To display only a part of the control list, set the "Visible/Bits Visible" to determine the number of symbols/bits to be displayed and select "Zoom" to focus the displayed area around the current "Cursor Position".  
Ramps outside the displayed area are not lost by zooming.

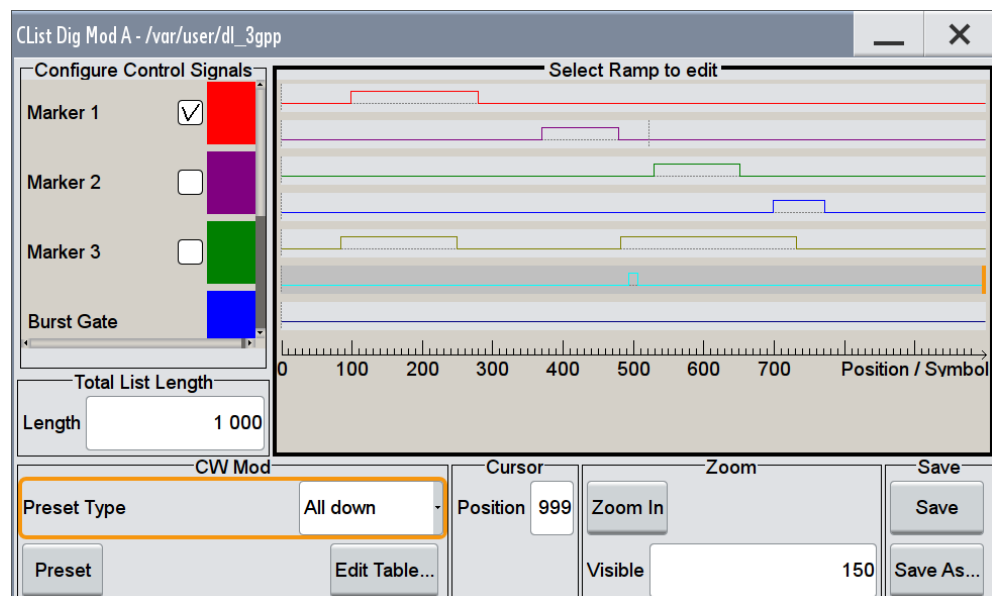


Figure 5-14: Example of control list settings

3. Select "Save" or "Save As" and store the used settings as a control list file.

The created file is an ASCII file with the extension `*.dm_iqc`

Enable the instrument to use the control list, e.g. for the marker and/or other control signals.

Enabled control signals are indicated as active in the "Configure Control Signal" section.

#### How to assign and activate control signals from a control list

Irrespectively on the way they are created, generated control lists are not automatically used.

To use a marker/control signal from a control list and to output this signal at the local connector, perform the following:

1. To enable the R&S SMW to use the control list for marker output 2 and output this signal at the T/M 2 connector:
  - a) select "Baseband > Custom Digital Modulation > Marker > Marker 2 Mode > CList".
  - b) select "Baseband > Custom Digital Modulation > Marker > Local Connector Setting" and select "T/M 2 > Direction = Output", "T/M 2 > Signal = Marker A2".
2. To enable the R&S SMW to use the Burst Gate and Level Attenuation control signals as defined in a control list and output one of them at the T/M 3 connector:
  - a) select "Baseband > Custom Digital Modulation > Power Ramp Control > Source > Internal"
  - b) select "Baseband > Custom Digital Modulation > Marker > Local Connector Setting" and select "T/M 3 > Direction = Output", "T/M 3 > Signal = Lev Att A".

#### 5.4.4.2 How to Create and Assign a Data List

The R&S SMW provides the following ways to create a data list file:

- To use the dedicated [Data List Editor](#) and create a file with extension `*.dm_iqd`, see ["To create a data list manually"](#) on page 275
- To use the tag-oriented format and create a data list file, see ["To create a data list using tag file format"](#) on page 908
- To use SCPI commands and create a file in binary format, see ["To create a data list in binary format"](#) on page 909

##### To create a data list manually

Use the intuitive build in [Data List Editor](#) dialog:

1. To access the "Data List Editor":
  - a) select "Baseband > Custom Dig Mod > Data Source > Data List"
  - b) select "Select Data List"
  - c) navigate to the required directory, select "New", and enter a file name.  
For example, use the directory `/var/user/` and enter "File Name" = `dl`

The "Data List Editor" opens; the data list is empty.

2. Enter a sequence of 0 and 1, for example *01110101*.

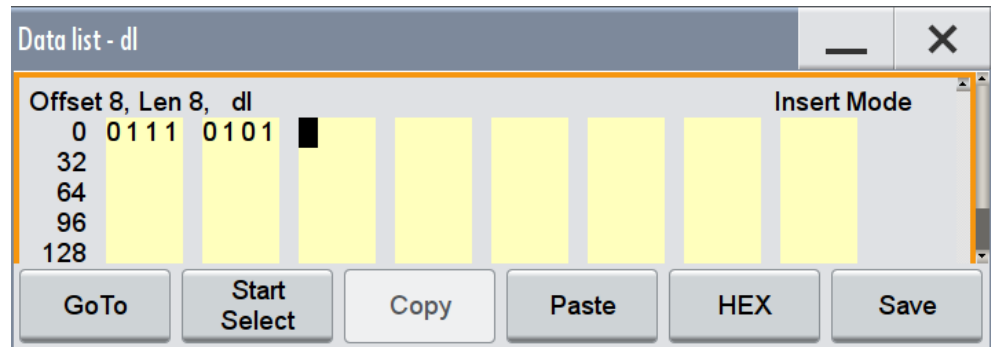


Figure 5-15: Example of data list

3. Select "Save" and store the used settings as a data list file.  
The instrument stores the `dl.dm_iqd` file in the `/var/user/` directory.

### How to assign and activate data lists

Irrespectively on the way they are created, generated data lists are not automatically used.

1. To enable the R&S SMW to use the data list as data source for the custom digital modulation:
  - a) select "Baseband > Custom Digital Modulation > Data Source > Data List"
  - b) select "Select Data List"
  - c) navigate through the file system, select the file, and confirm with "Select".
2. To enable the R&S SMW to use the data list as data source for any of the digital standards:
  - a) Select the "Data List Name" in the individual dialog.  
For example, for "Baseband > 3GPP FDD > Basestations > BS1 > Channel Table > P-CCPCH > Data = Data List"
  - b) Select "DList = None".
  - c) Navigate through the file system, select the file, and confirm with "Select".

## 5.4.5 References

Table 5-8: Custom Digital Modulation default values

Parameter	Value
State	Not affected
Data Source	PRBS 9
Standard	GSM
Symbol Rate	270.833 ksymb/s
Coding	GSM

Parameter	Value
Modulation Type	MSK
Filter	Gauss (FSK)
Filter Parameter BxT	0.3
Trigger	Mode Auto, Source Internal
Clock	Source Internal
<b>Power Ramp Control</b>	
Attenuation	15 dB
Ramp Time	1 symbol
Ramp Function	Cosine
Fall Delay	0
Rise Delay	0
Source	Internal
State	Off

Table 5-9: Communication standards with their predefined settings

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
APCO Phase1 C4FM	4FSK, Deviation 1.8 KHz	4.8 ksym/s	APCO25, roll off = 0.2	APCO25(FSK)	APCOPH1C4fm
APCO Phase1 CQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 0.2, BW = 4.8 KHz	APCO25(PSK)	APCOPH1CQpsk
APCO Phase2 H-CPM	4FSK, Deviation 3 KHz	6 ksym/s	APCO25 (H-CPM)	APCO25(FSK)	APCOPH2HCpm
APCO Phase2 H-DQPSK	pi/4-DQPSK	6 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(PSK)	APCOPH2HDQpsk
APCO Phase2 H-D8PSK Wide	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(8PSK)	APCOPH2HD8PSKW
APCO Phase2 H-D8PSK Narrow	pi/8-D8PSK	4 ksym/s	Cosine, roll off = 1, BW = 5 KHz	APCO25(8PSK)	APCOPH2HD8PSKN
APCO Phase1 LSM	pi/4-DQPSK	4.8 ksym/s	APCO25 (LSM), Gauss Cut Off = 2.04 KHz, Low-pass Cut Off = 6.2 KHz	APCO25(PSK)	APCOPH1Lsm
APCO Phase1 WCQPSK	pi/4-DQPSK	4.8 ksym/s	Cosine, roll off = 1, BW = 7.2 KHz	APCO25(PSK)	APCOPH1Wcqpsk
Bluetooth	2FSK, Deviation 160.0 kHz	1.0 Msym/s	Gauss, B*T = 0.5	OFF	BLUetooth
DECT	2FSK, Deviation 288.0 kHz	1.152 Msym/s	Gauss, B*T = 0.5	OFF	DECT
ETC (ARIB STD T55)	ASK, ASK Depth 100%	1.024 Msym/s	Split Phase, B*T = 2.0	OFF	ETC

Standard	Modulation	Symbol Rate	Filter	Coding	Parameter for SCPI command
GSM	MSK	270.833333 ksym/s	Gauss, B*T = 0.3	GSM	GSM
GSM EDGE	8PSK EDGE (3pi/8 8PSK)	270.833333 ksym/s	Gauss linear	OFF	GSMEdge
NADC	pi/4 DQPSK	24.3 ksym/s	Root Cosine, alpha = 0.35	NADC	NADC
PDC	pi/4 DQPSK	21.0 ksym/s	Root Cosine, alpha = 0.50	PDC	PDC
PHS	pi/4 DQPSK	192.0 ksym/s	Root Cosine, alpha = 0.50	PHS	PHS
TETRA	pi/4 DQPSK	18.0 ksym/s	Root Cosine, alpha = 0.35	TETRA	TETRa
WCDMA 3GPP	QPSK 45° Offset	3.84 Msym/s	Root Cosine, alpha = 0.22	WCDMA 3GPP	w3GPP
TD-SCDMA	QPSK 45° Offset	1.28 Msym/s	Root Cosine, alpha = 0.22	OFF	TCSCdma
cdma2000 Forward	QPSK	1.2288 Msym/s	cdmaOne + Equalizer	cdma2000	CFORward
cdma2000 Reverse	Offset QPSK	1.2288 Msym/s	cdmaOne	cdma2000	CREVerse
Worldspace	QPSK	1.84 Msym/s	Root Cosine, alpha = 0.40	OFF	WORLdspace
TFTS	pi/4 DQPSK	22.1 ksym/s	Root Cosine, alpha = 0.40	TFTS/ TETRA	TFTS

Table 5-10: Permissible coding combinations for modulation symbols and modulation type

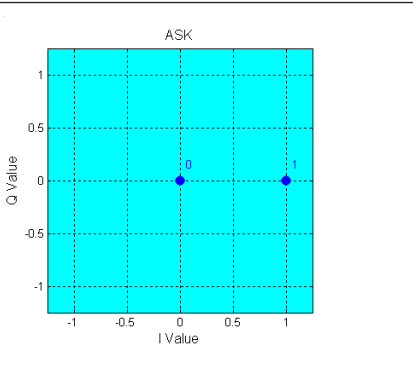
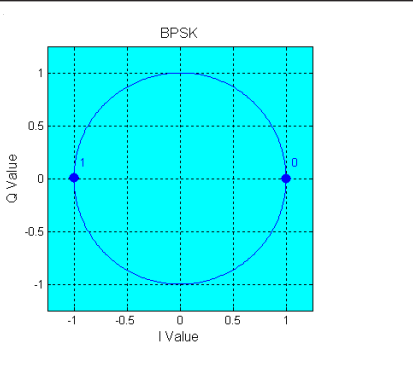
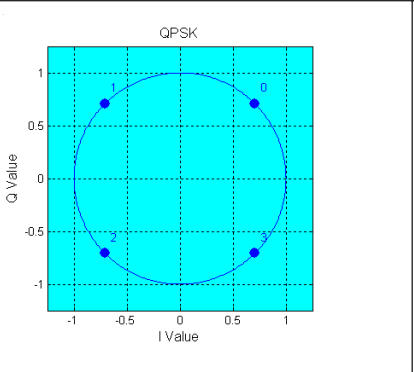
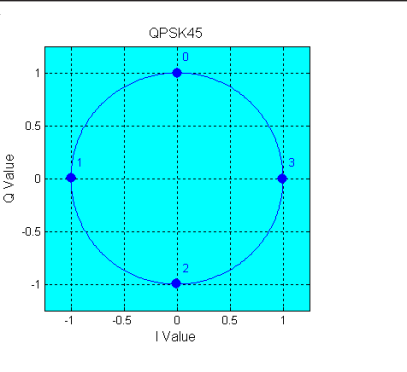
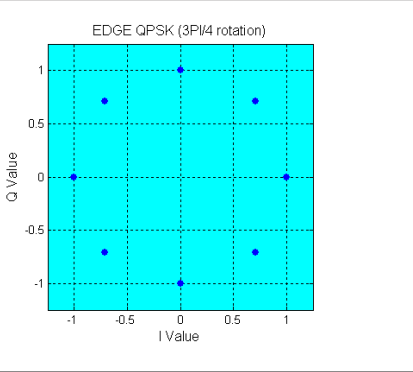
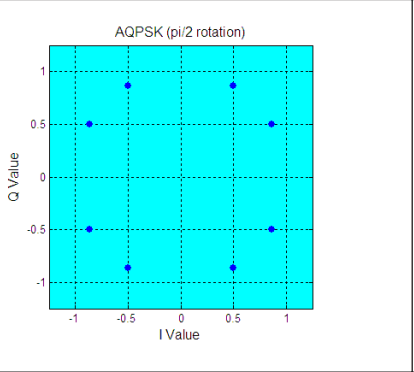
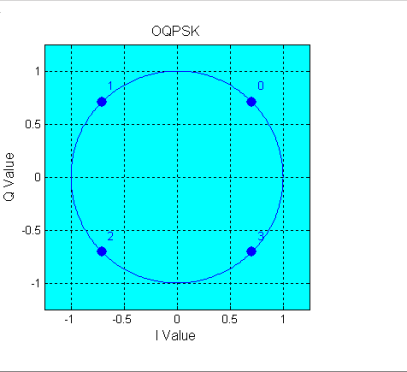
	OFF	Differ- ential	Phase Diff.	Diff. +Gray	Gray	GSM	NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT	TFTS/ TETRA	INMARSAT, ICO, WCDMA, cdma2000	VDL	APCO25 (FSK)	APCO25 (8PSK)
ASK	X	X		X	X							
BPSK	X	X		X	X							
pi/2 DBPSK	X				X							
QPSK	X	X		X	X				X			
QPSK EDGE	X											
QPSK45° Off- set	X	X		X	X							
Pi/4 QPSK	X	X			X							
Pi/4 DQPSK	X				X		X	X				
8PSK	X	X		X	X					X		

	OFF	Differ- ential	Phase Diff.	Diff. +Gray	Gray	GSM	NADC, PDC, PHS, TETRA, APCO25 (PSK), PWT	TFTS/ TETRA	INMARSAT, ICO, WCDMA, cdma2000	VDL	APCO25 (FSK)	APCO25 (8PSK)
AQPSK	X	X		X	X							
OQPSK	X	X		X	X							
8PSK_EDGE	X											
PI/8 D8PSK	X				X							X
MSK	X	X		X	X	X						
2FSK	X	X		X	X	X						
4FSK	X	X		X	X					X		
8FSK	X	X		X	X							
16FSK	X	X		X	X							
16QAM	X	X	X	X	X							
16QAM EDGE	X											
32QAM	X	X	X	X	X							
32QAM EDGE	X											
64QAM	X	X	X	X	X							
128QAM	X	X	X	X	X							
256QAM	X	X	X	X	X							
1024QAM	X	X	X	X	X							

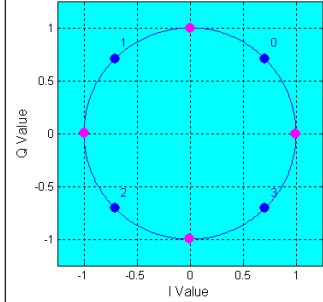
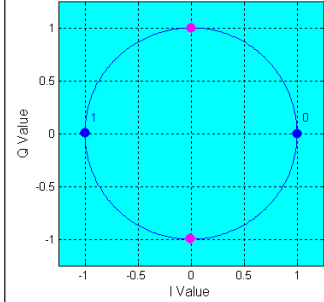
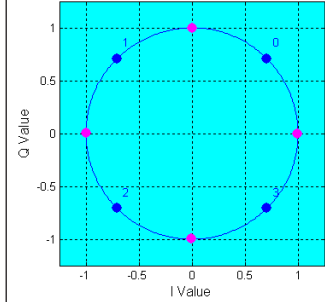
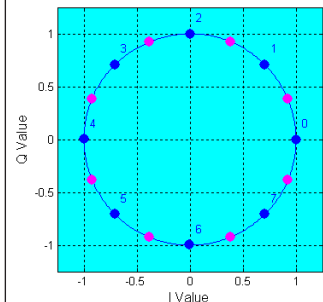
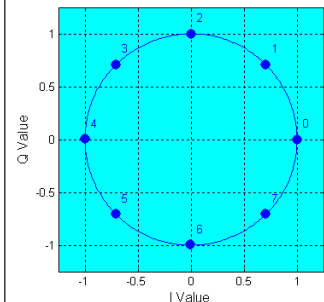
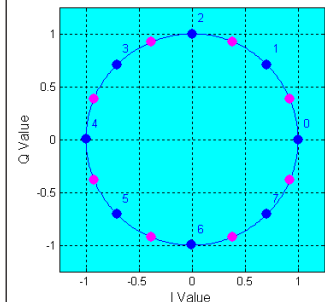
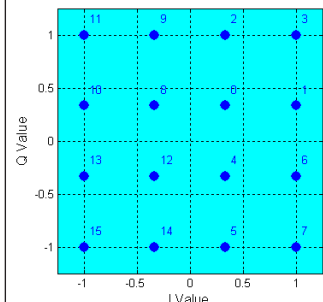
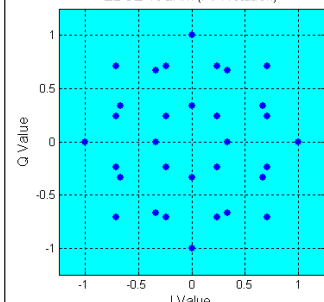
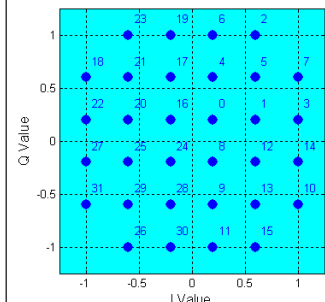
#### 5.4.5.1 Predefined Modulation Types

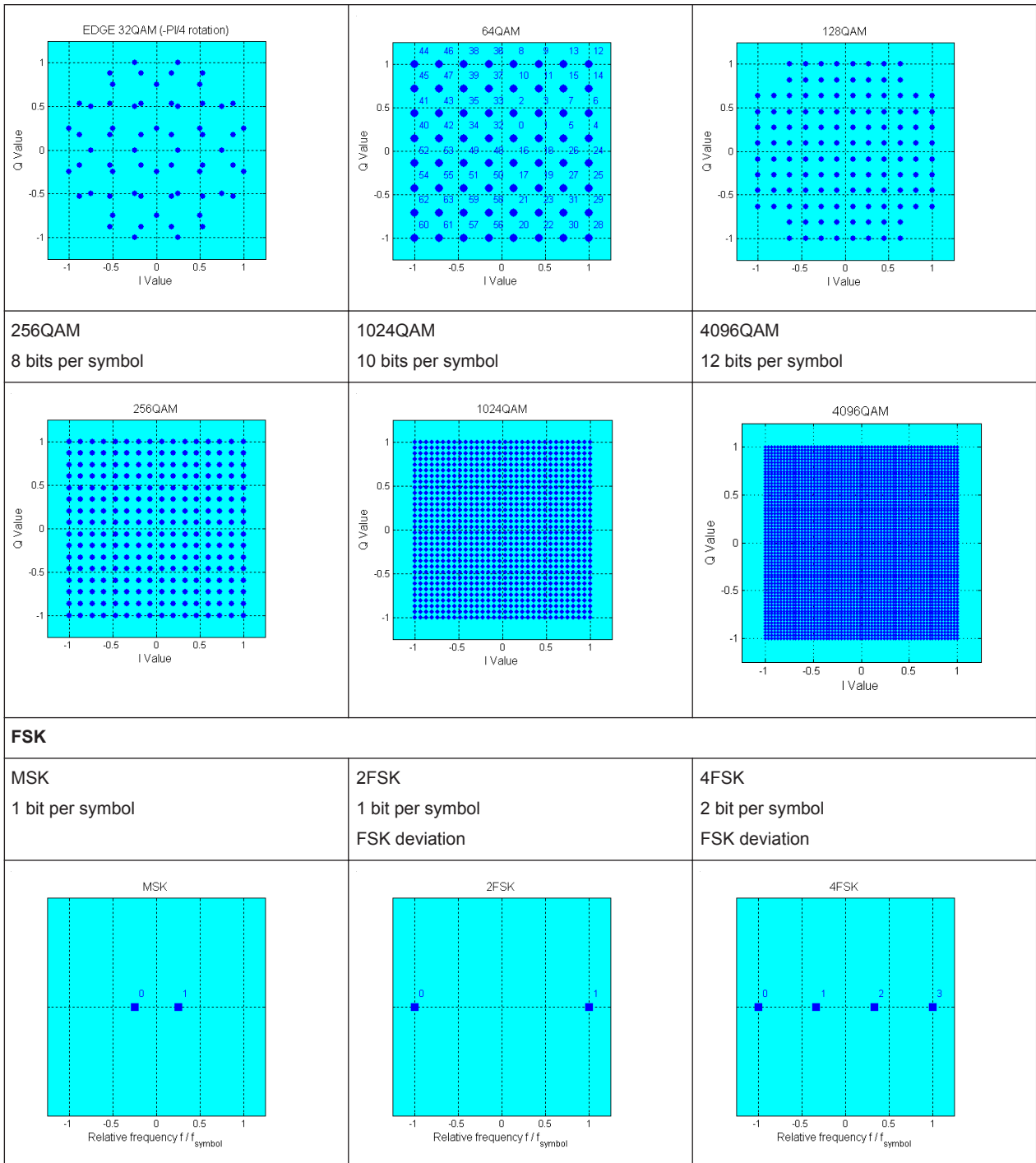
The [Table 5-11](#) shows the modulation types that are available, together with the associated parameters. The mapping for the selected modulation type is displayed in graphical form.

Table 5-11: Modulation type and associated mapping

<p><b>ASK</b> 1 bit per symbol</p> 		
<p><b>PSK</b></p>		
<p><b>BPSK</b> 1 bit per symbol</p> 	<p><b>QPSK</b> 2 bits per symbol</p> 	<p><b>QPSK 45° Offset</b> 2 bits per symbol, 45° rotation</p> 
<p><b>QPSK EDGE</b> 2 bits per symbol, 3pi/4 rotation</p> 	<p><b>AQPSK</b> 2 bits per symbol, pi/2 rotation</p> 	<p><b>OQPSK</b> 2 bits per symbol, Q offset</p> 
<p><b>pi/4-QPSK</b> 2 bits per symbol pi/4 rotation</p>	<p><b>pi/2-DBPSK</b> 1 bit per symbol Differential coding, pi/2 rotation</p>	<p><b>pi/4-DQPSK</b> 2 bits per symbol Differential coding, pi/4 rotation</p>



 <p>PI/4 QPSK</p>	 <p>PI/2 DBPSK</p>	 <p>PI/4 DQPSK</p>
<p>pi/8-D8PSK 3 bits per symbol Differential coding, pi/8 rotation</p>	<p>8PSK 3 bits per symbol</p>	<p>8PSK EDGE (3pi/8 8PSK) 3 bits per symbol Edge coding, 3pi/8 rotation</p>
 <p>PI/8 D8PSK</p>	 <p>8PSK</p>	 <p>3PI/8 8PSK</p>
<p><b>QAM</b></p>		
<p>16QAM 4 bits per symbol</p>	<p>16QAM EDGE 4 bits per symbol, pi/4 rotation</p>	<p>32QAM 5 bits per symbol</p>
 <p>16QAM</p>	 <p>EDGE 16QAM (PI/4 rotation)</p>	 <p>32QAM</p>
<p>32QAM EDGE 5 bits per symbol, -pi/4 rotation</p>	<p>64QAM 6 bits per symbol</p>	<p>128QAM 7 bits per symbol</p>



### 5.4.5.2 Common Coding Algorithms



In the notation used below,  $a_n$  denotes the  $n^{\text{th}}$  input symbol and  $b_n$  denotes the correspondingly coded output symbol. Individual bits in the symbols from the LSB (least significant bit) to the MSB (most significant bit) are denoted by  $a_{0n}$ ,  $a_{1n}$ , etc. The same applies to the output symbols.

Common coding types are listed in [Table 5-12](#).

**Table 5-12: Common coding algorithms**

Coding	Coding algorithm	Applicable for K bit/symbol
"None"	$b_n = a_n$	$k = 1 \dots 8$
"Differential"	$b_n = (a_n + b_{-1}) \text{ modulo } 2^k$	$k = 1 \dots 7$
"Differential + Gray"	Gray coding with additional differential coding	$k = 1 \dots 7$
"GSM"	$d_n = \text{NOT} (d_n \text{ EXOR } d_{-1})$	$k = 1$
"Phase differential coding" <sup>1)</sup>	$b_{1n} = [\text{NOT} (a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{1n} \text{ EXOR } b_{1(n-1)})] \text{ OR } [(a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{1n} \text{ EXOR } b_{0(n-1)})]$ $b_{0n} = [\text{NOT} (a_{1n} \text{ EXOR } a_{0n}) \text{ AND } (a_{0n} \text{ EXOR } b_{0(n-1)})] \text{ OR } [(a_{1n} \text{ EXOR } a_{0(n-1)}) \text{ AND } (a_{0n} \text{ EXOR } b_{1(n-1)})]$	

<sup>1)</sup> "Phase differential coding" INMARSAT and PHASE DIFF correspond to system standards Inmarsat-M and DVB according to ETS 300 429. The INMARSAT coding can generally be used for modulation types with 2 bits/symbol, such as QPSK.

#### Examples

The following examples illustrate how some of the different common coding schemes combined with a modulation method influence the signal.

**Example: Differential coding for QPSK modulation with K = 2 bit/symbol**

Decimal display; the value range for modulation symbols is  $a_n = \{0, 1, 2, 3\}$

According to [Table 5-12](#) and for  $k = 2$ , the recursive coding is defined as  $b_n = (a_n + b_{-1}) \text{ modulo } 4$

Depending on the state of a preceding modulation symbol  $b_{-1}$ , the coded modulation symbol  $b_n$  is obtained for example from modulation symbol  $a_n = 2$  as follows:

$b_{-1}$	0	1	2	3
$b_n$	2	3	0	1

With differential coding, the assignment of modulation symbols  $a_n$  (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

**Table 5-13: Phase difference for QPSK**

Modulation symbol $a_n$	00	01	10	11
Phase difference	0°	90°	180°	270°

**Example: Differential coding for modulation type pi/4DQPSK**

With differential coding switched on at the same time, the obtained constellation diagram for pi/4DQPSK is similar to that of 8PSK. Phase shifts are however assigned to the individual modulation symbols. The [Table 5-14](#) shows the assignment of modulation symbols  $a_n$  (binary indication: MSB, LSB) to phase shifts of the I/Q vector in relation to the selected coding.

**Table 5-14: Phase shifts for pi/4DQPSK**

Modulation symbol $a_n$	00	01	10	11
"Coding = OFF"	+ 45°	+ 135°	- 135°	- 45°
"Coding = NADC, PDC, PHS, TETRA, or APCO25 (PSK)"	+ 45°	+ 135°	- 45°	- 135°
"Coding = TFTS"	- 135°	+ 135°	- 45°	+ 45°

**Example: Gray and differential coding for 8PSK modulation**

When this coding scheme is used, the gray coding according to the gray code is performed prior to the differential coding. The later uses the recursive coding algorithm quoted above (see [Table 5-12](#)). The assignment of modulation symbols  $a_n$  (binary indication: MSB, LSB) to the phase differences shown in the following table is generated:

**Table 5-15: Differential coding according to VDL<sup>1)</sup>**

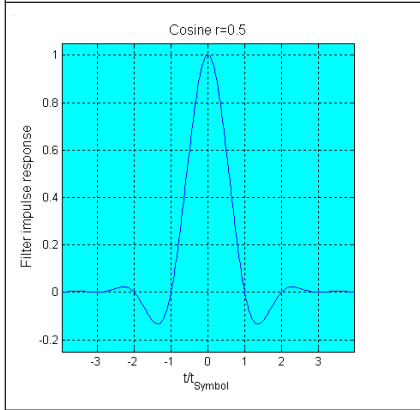
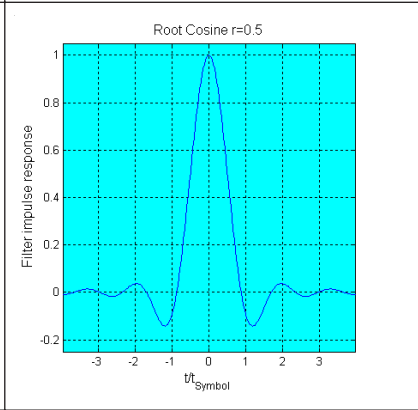
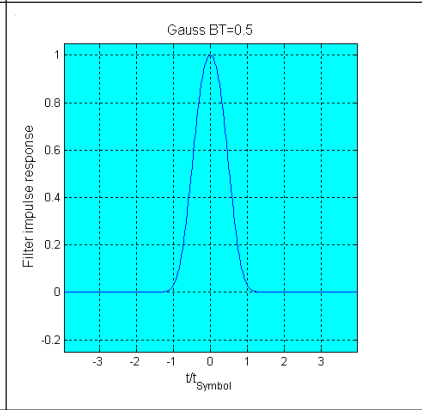
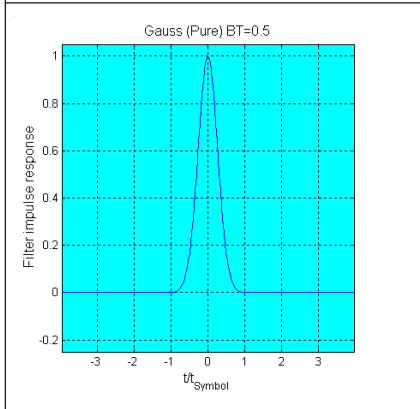
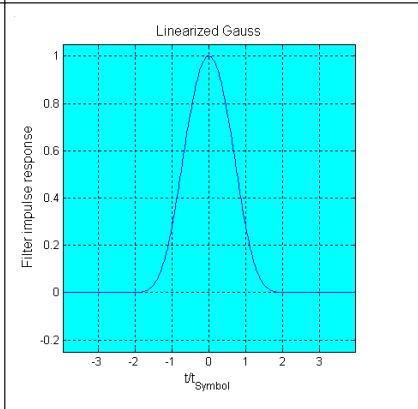
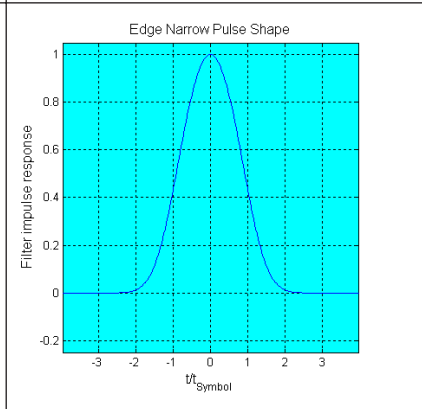
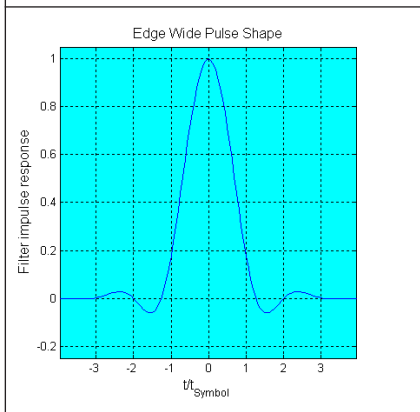
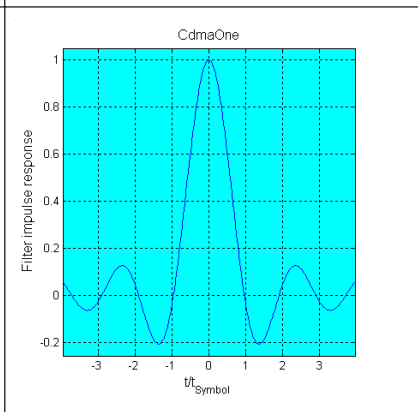
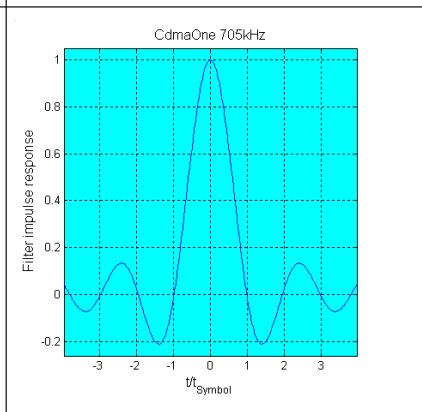
Modulation symbol $d_n$	000	001	010	011	100	101	110	111
Phase difference	0°	45°	135°	90°	270°	315°	225°	180°

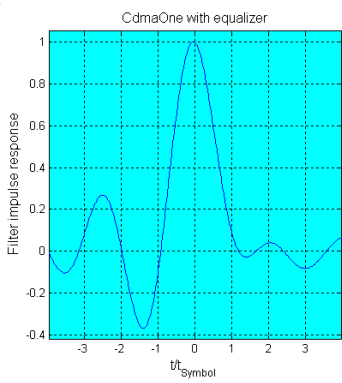
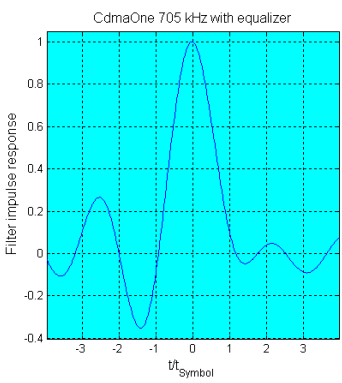
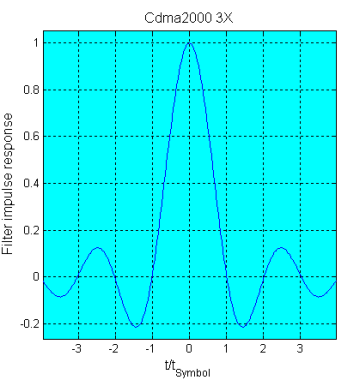
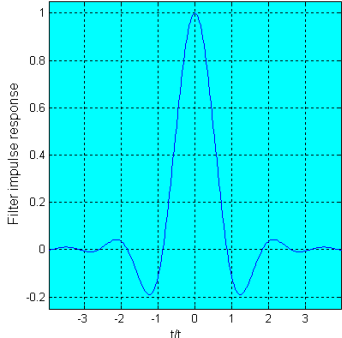
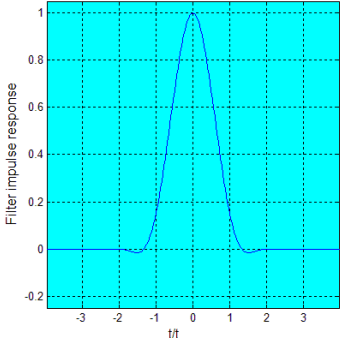
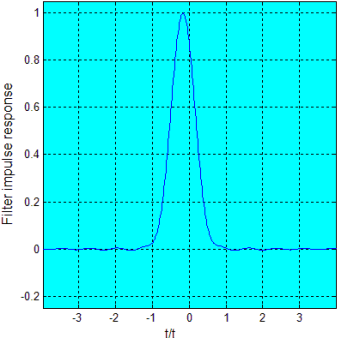
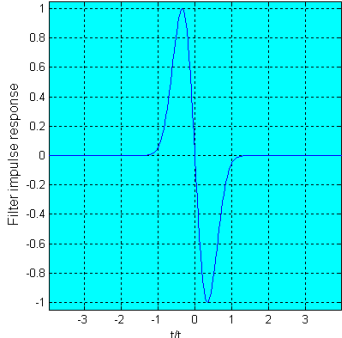
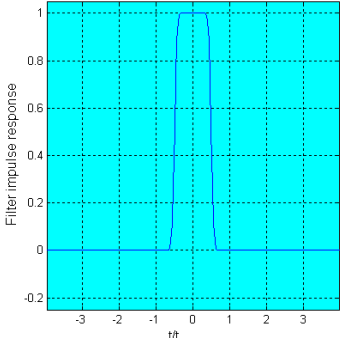
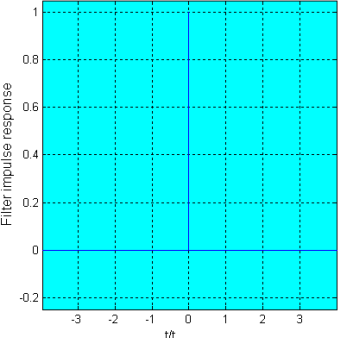
<sup>1)</sup> "Differential coding according to VDL" can be used for modulation types with 3 bits/symbol, e.g. 8PSK.

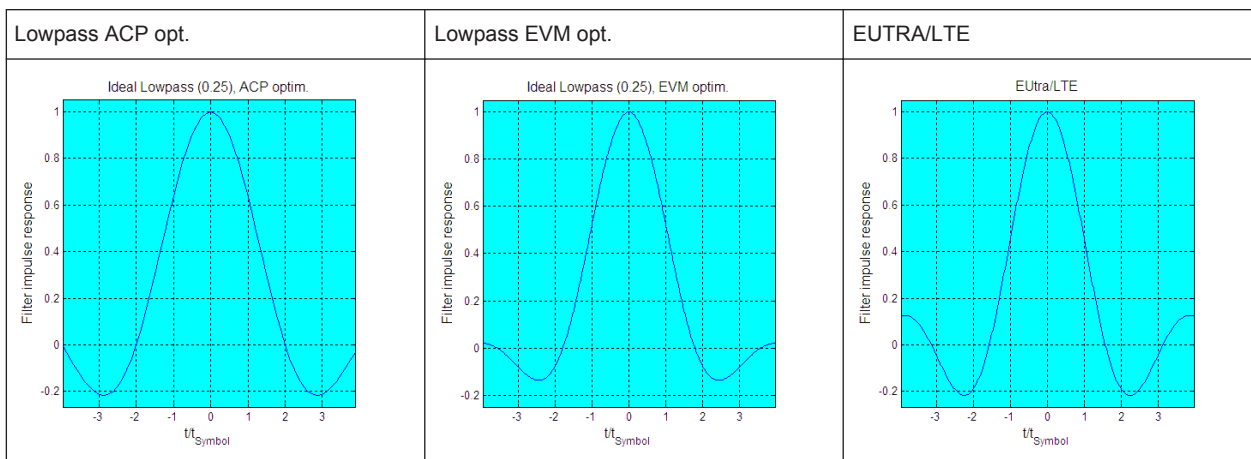
### 5.4.5.3 Predefined Baseband Filters

The Table 5-16 shows the filters that are available, together with their associated parameters. The filter characteristic is displayed in graphical form.

**Table 5-16: Overview of the baseband filters**

<p>Cosine Roll Off Factor Bandwidth</p>	<p>Root Cosine Roll Off Factor</p>	<p>Gauss (FSK) B x T</p>
		
<p>Pure Gauss B x T</p>	<p>Gauss Linearized</p>	<p>Edge Narrow Pulse Shape</p>
		
<p>Edge Wide Pulse Shape</p>	<p>cdmaOne</p>	<p>cdmaOne 705 kHz</p>
		

<p>cdmaOne + Equalizer</p> 	<p>cdmaOne 705 kHz + Equalizer</p> 	<p>cdma2000 3X</p> 
<p>APCO25 Roll Off Factor</p>	<p>APCO25 (H-CPM)</p>	<p>APCO25 (LSM) Gauss Cut Off Frequency Gauss Cut Off Frequency</p>
<p>APCO25 r=0.5</p> 	<p>APCO H-CPM</p> 	<p>APCO LSM</p> 
<p>Split Phase BxT</p>	<p>Rectangular</p>	<p>Dirac</p>
<p>Splitphase BT=0.5</p> 	<p>Rectangular</p> 	<p>Dirac</p> 



## 5.5 Using the Arbitrary Waveform Generator (ARB)

The Arbitrary Waveform Generator (ARB) is an I/Q modulation source forming an integral part of the R&S SMW. The ARB allows the playback and output of any externally calculated modulation signals in the form of waveform files. The ARB can also generate multi-carrier or multi-segment signals from the waveform files.

### 5.5.1 Required Options

The equipment layout for processing of waveform files includes:

- Option Baseband Generator (R&S SMW-B10) per signal path  
Arbitrary Waveform Generator is incorporated in the Baseband Generator
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)
- Corresponding Digital Standard option (R&S SMW-K2xx) per signal path  
Required to process a waveform file generated by the signal generation software R&S WinIQSIM2.  
For example, if you purchase option Digital Standard EUTRA/LTE R&S SMW-K255, you can process EUTRA/LTE waveform files generated by R&S WinIQSIM2.

Depending on the connectors the waveform is output at, the following options are required:

- output at the RF connector requires suitable RF frequency option (R&S SMW-B1xx/-B2xx)
- output at the I/Q OUT connectors requires option Differential Analog I/Q Out (R&S SMW-K16) per signal path
- output at the DIG IQ OUT connectors requires option Digital Baseband Out (R&S SMW-K18) per signal path

## 5.5.2 About the ARB

This section provides background information on the ARB functionality and the impact of the provided settings.

For a description of the multi-carrier, multi-segment and multi-carrier continuous wave functions, refer to:

- [Chapter 5.7, "Generating Multi Carrier Signals"](#), on page 340
- [Chapter 5.6, "Generating Multi-Segment Waveform Files"](#), on page 310
- [Chapter 5.8, "Generating Multi-Carrier Continuous Wave Signal"](#), on page 357

### 5.5.2.1 Waveform Files Sources

In ARB mode, the R&S SMW uses ARB waveform files to obtain the digital IQ data of the baseband signal. The R&S SMW can replay any waveform file stored on a network drive but it can also generate and replay simple waveforms for test purposes.

A waveform is a file with specified file format containing raw IQ samples. The IQ values are calculated in advance and stored as waveform files with a predefined extension \* .wv. When created by the R&S SMW, the instrument inserts a tagged waveform header at the beginning of each created ARB file. For more information, refer to [Chapter 13.18.3.4, "Waveform, Data and List Format"](#), on page 888.

Depending on whether the R&S SMW creates the waveform files itself or not, two waveform files sources can be distinguished:

- **Internally generated waveforms**  
The ARB generator enables the calculation and the generation of multi-segment and multi-carrier waveform files as well as the built-in function to create a test waveform (e.g. a sine or rectangle signal) and keep it as a file or in the RAM. Several digital standards provide the special function "Generate Waveform File" and enable the calculation and storage of the signal as a waveform file that can be afterwards processed by the ARB generator.
- **Externally generated waveforms**  
The ARB can also process externally generated waveform files e.g. the waveform files generated on a PC by the Windows software package R&S WinIQSIM2, the software R&S ARB Toolbox, the R&S SMW-K300/-K301 Pulse Sequencer software or signals calculated using a mathematical program such as Matlab. For more information also on the required options, refer to the Rohde&Schwarz web site at <http://www.rohde-schwarz.com>. See also the Application Note 1MA28, "IQWizard - I/Q Signal Measurement and Conversion".  
The externally generated waveform files can be loaded into the instrument via one of the available interfaces (USB, LAN or GPIB). Usually, the waveform file is stored on one of the network drives which are accessible for the operating system.

### 5.5.2.2 ARB Test Signals

The following test signals are available:

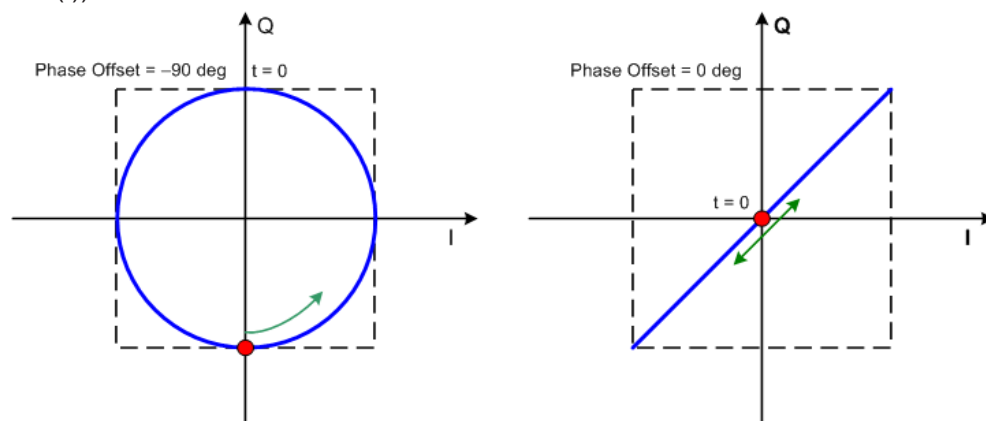
- **Sine Test Signal:** Two sinewave signals with a selectable (but equal) number of samples per period and equal frequencies. When the generation is triggered, the



number of samples per period, together with the frequency of the test signal, determines the ARB clock frequency: "Clock Frequency" = "Frequency" \* "Samples per Period".

**Note:** Because the resulting clock rate must not exceed the maximum ARB clock rate (see data sheet), the number of sample values is automatically restricted depending on the selected frequency.

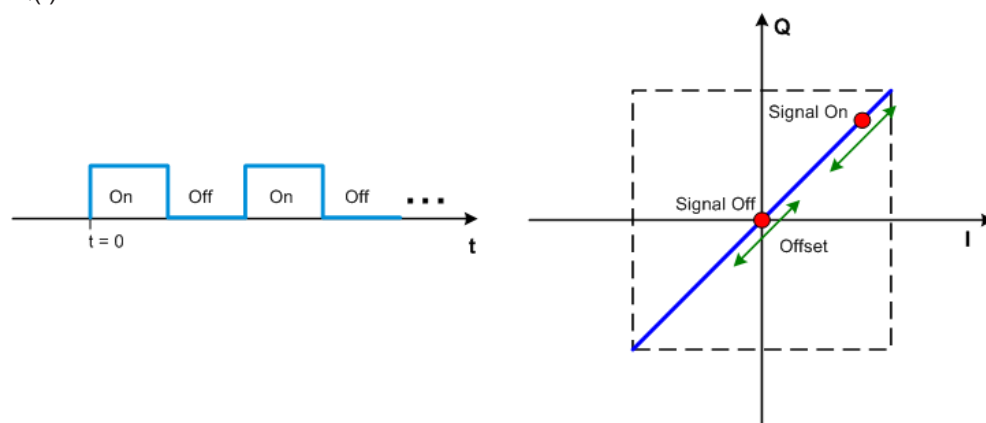
The first sine signal is mapped on the I samples, the second on the Q samples. The two signals differ by a selectable phase offset. For a  $-90$  deg offset, the result is a unit vector in the I/Q plane, rotating counter-clockwise and starting at  $I = 0, Q = -1$ . For a  $0$  deg offset, the I and Q samples are on the diagonal of a unit square ( $I(t) = Q(t)$ ).



In general the I/Q samples are located on a deformed circle which is confined to the dashed square in the upper diagrams.

- **Rect Test Signal:** Rectangle signal with selectable but equal On and Off periods and amplitude. The period is defined by the selected frequency:  $\langle \text{Period} \rangle = 1 / \text{"Frequency"}$ .

The signal is mapped on both the I and Q samples. This results in two distinct points in the I/Q plane. The "Offset DC" shifts both points along the diagonal  $I(t) = Q(t)$ .



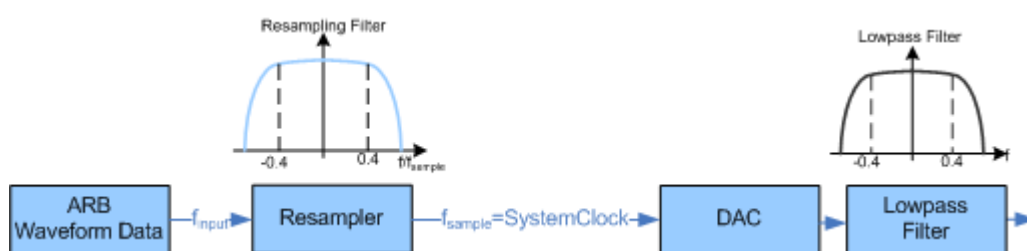
- **Const I/Q Test Signal:** Continuous test signal with constant IQ and constant Clock Frequency of 10 KHz. The values for each I and Q components are selectable but constant. They are defined as a decimal number, which is decimal-to-binary converted internally. The signal is provided as a 16-bit wide digital signal for both I and Q channels.

Converted to analog, the signal is output directly at the BNC connectors I and Q outputs of the instrument.

### 5.5.2.3 Waveform Sample Rate

The Arbitrary Waveform Generator includes a resampling unit that interpolates the input samples to reach a target digital output I/Q sample rate before digital-to-analog conversion (DAC). The input sample rate  $f_{input}$  is retrieved from the waveform (the default sample rate tag) or is defined by the corresponding parameter in the ARB user interface.

The [Figure 5-16](#) depicts the stages involved in the processing and resampling of a waveform in the ARB.



**Figure 5-16: Processing of the waveform files in the ARB**

The R&S SMW uses a 200 MHz system clock and a sample rate of max 200 MSamples/s.

#### Impact of the Resampling Lowpass Filter

As illustrated in [Figure 5-16](#), the lowpass filter in the resampling stage is distortion-free for signals with the following maximum baseband bandwidth:

$$BasebandBandwidth_{max}, \text{ MHz} = 0.4 \times f_{input}$$

An externally created waveform file has to provide a sample rate  $f_{input}$  that is high enough for perfect signal reconstruction. For distortion-free resampling the lower bound of the required sample rate  $f_{input}$  is then calculated as follows:

$$f_{input} \geq BasebandBandwidth / 0.4$$

A modulation signal with a sample rate  $f_{input} = 200 \text{ MHz}$  ensures the  $BasebandBandwidth_{max} = 80 \text{ MHz}$ . After the DAC, this signal features a  $RFBandwidth_{max} = 2 \times 0.4 \times f_{input} = 160 \text{ MHz}$ .

#### Impact of the Oversampling Factor

Waveforms generated by the R&S WinIQSIM2 software can be optimized by choosing a suitable integer oversampling factor.

In comparison with conventional ARB generators that often assume oversampling factors of 4, the ARB generator of the R&S SMW requires low oversampling factors, but still provides excellent signal quality in terms of EVM and ACP.

A reduced sample rate saves significantly the amount of memory or allows an increased signal cycle time, and vice versa.

#### 5.5.2.4 Impact on the Enabled Number of Marker Signals on the Waveform Length

The R&S SMW provides the possibility to define marker signals, that are sent to the marker outputs in synchronicity with the I/Q output signals. Marker signals can be either predefined or subsequently defined.

The I/Q data and marker data are located in separate memory areas of the SDRAM and can be independently configured whereas each marker signal requires one bit of the available memory size. Sometimes, it is useful to generate a modulation signal without extra marker signals to increase the maximum waveform length.

The following example explains the dependency between the number of enabled marker signals, the available memory size, and the resulting waveform length.

##### **Example: Calculating the maximum waveform length**

The calculation in this example is based on an instrument equipped with option R&S SMW-B10 (256 Msamples).

- Total Memory Size = 256 MB
- Required Memory Size (per complex sample) = 32 bits + 3 bits = 35 bits = 4.375 bytes, where:
  - The raw I/Q samples are stored as 16-bit values;  
That is, for I/Q data =  $2 \times 16 \text{ bits} = 32 \text{ bits}$  (16 bits per I/Q channel)
  - Each software defined marker requires 1 bit;  
That is, for 3 enabled markers =  $3 \times 1 \text{ bit} = 3 \text{ bits}$
- Maximum Waveform Length (with 3 markers) =  $256 \text{ MB} / 4.375 \text{ bytes} = 58 \text{ Msamples}$
- Theoretical Maximum Waveform Length (no markers) =  $256 \text{ MB} / 4 \text{ bytes} = 64 \text{ Msamples}$

Hence, a memory size of 256 MB yields a maximum waveform length of 58 Msamples if three markers are enabled. The maximum waveform length increases to 64 Msamples, if the internal hardware markers are used, and the complete memory is available for I/Q data.

The minimum length of a waveform is 512 samples. A waveform shorter than this value is automatically repeated until it reaches the minimum length.

### 5.5.3 ARB Settings

- ▶ To access the dialog box, select "Baseband > ARB".

The "ARB" dialog enables direct selection of the waveform file to be processed, the selection of a test signal or access to the multi-segment and multi-carrier settings.

If the current instrument configuration uses [Coupled sources](#), you can assign waveforms to all available basebands.

The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name.

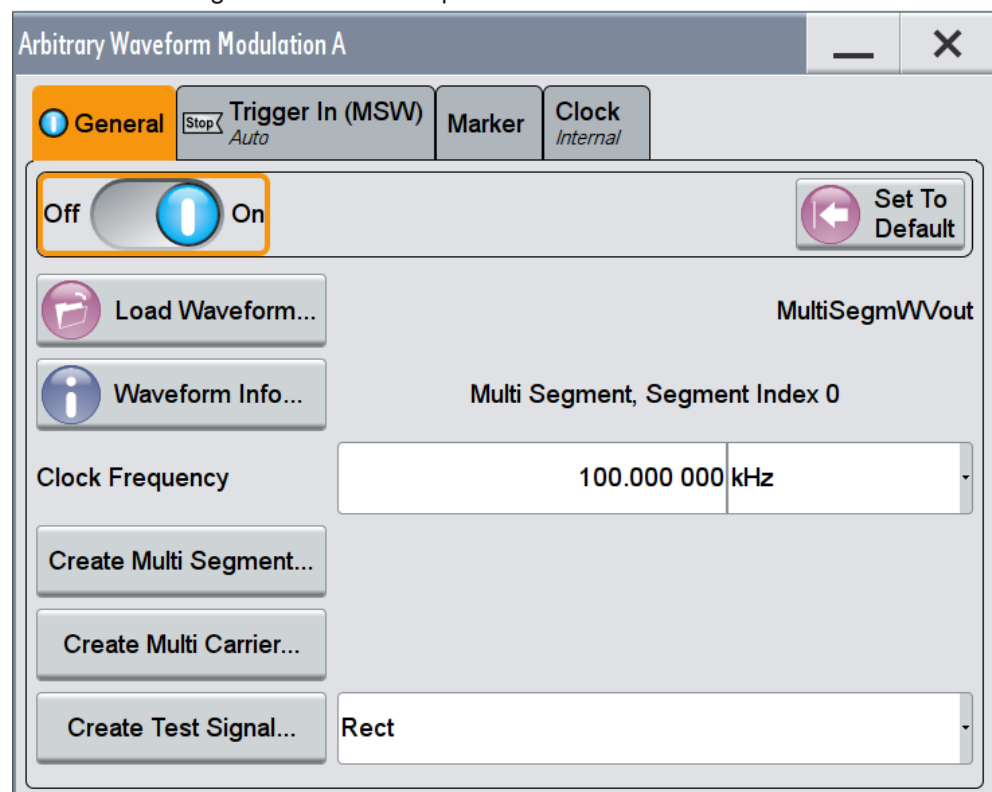
The remote commands required to define these settings are described in [Chapter 13.18.3.3, "SOURce:BB:ARbitrary Subsystem"](#), on page 844.

### 5.5.3.1 ARB General Settings

This tab provides access to the default ARB settings, selecting a waveform file and enabling the ARB generator.

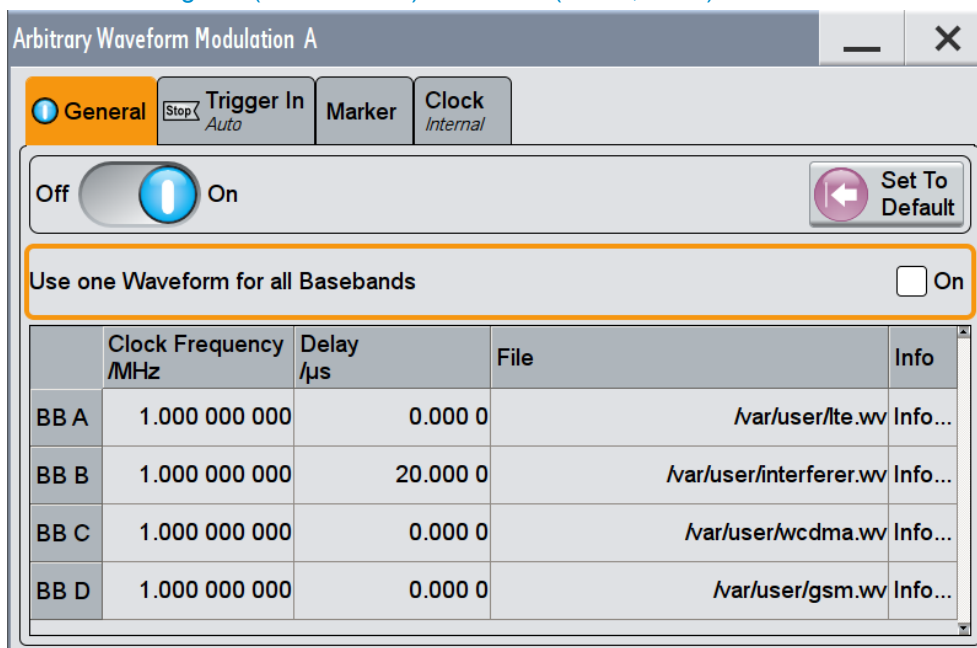
Further settings depend on selected "System Configuration" and waveform type:

- If a single segment waveform is used, the tab provides also settings for configuring the test signal and access to the settings for calculating a multi-segment or a multi-carrier waveform.
- If a multi-segment waveform is loaded, the tab expands and displays the dedicated section "Multi Segment Waveform Options".



This section comprises the settings necessary to configure the segment to be output and adjust the trigger for the switch between the segments of the multi-segment waveform. The parameters displayed depend on the selected trigger source. The provided parameters are identical with the parameters in the section "Next Segment Trigger In" in the "Trigger" tab; for information see [Chapter 5.6.3.5, "Next Segment Trigger In Settings"](#), on page 327.

- If the current instrument configuration uses **Coupled sources**, the dialog displays a table with of up to 8 rows, where the number of rows corresponds to the number of selected **BB Signals (Tx Antennas)** or **Entities (Users, Cells)**.



State.....293

Set To Default.....294

Use one Waveform for all basebands.....294

Waveforms table.....294

Load Waveform/File.....294

Waveform Info.....295

Clock Frequency.....295

Delay.....295

Create Multi Segment.....296

Create Multi Carrier.....296

Create Test Signal.....296

**State**

Enables/disables ARB modulation. Switching on the ARB generator turns off all the other digital standards and digital modulation types in the same signal path.

The output is based on the waveform file that is loaded. The name of the waveform file is displayed next to "Load Waveform". When a multi-segment waveform is loaded, the display expands and lists more settings, grouped in the "Multi Segment Waveform Options" section.

**Note:** No or empty waveform file.

If no waveform file is loaded, as in the default state, "None" is displayed next to "Load Waveform" and the ARB modulator cannot be powered up. An error message indicates that no or empty waveform file is selected.

If no waveform file is loaded, the ARB modulator remains off. Select a waveform file, before switching on the ARB.

Remote command:

[\[:SOURce<hw>\]:BB:ARBitrary:STATe](#) on page 853

### Set To Default

Calls default settings (see [Table 5-17](#)).

**Table 5-17: ARB Default Settings**

Parameter	Value
State	Off
Clock Freq.	1 MHz
Trigger Mode	Auto
Trigger Source	Internal
Marker State	Off
Marker Mode	Unchanged
Clock Source	Internal

Remote command:

[\[:SOURce<hw>\]:BB:ARBitrary:PRESet](#) on page 853

### Use one Waveform for all basebands

If the current instrument configuration uses [Coupled sources](#), you can:

- Assign different waveforms to the available basebands ("BB A .. H")
- Use the same waveform for all basebands ("BB All"); the waveform selected for the first baseband ("BB A") is used.

To select the waveforms, use the parameter [File](#).

Remote command:

[\[:SOURce<hw>\]:BB:ARBitrary:COUPled:STATe](#) on page 859

### Waveforms table

If the current instrument configuration uses [Coupled sources](#), the dialog displays a table with of up to 8 rows, where the number of rows corresponds to the number of selected [BB Signals \(Tx Antennas\)](#) or [Entities \(Users, Cells\)](#).

The waveforms table consists of one row only, if the parameter [Use one Waveform for all basebands](#) is enabled.

Following parameters are available per baseband:

- [Clock Frequency](#)
- [Delay](#)
- [File](#)
- [Waveform Info](#)

### Load Waveform/File

Accesses the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

The waveform files are files with predefined file extension \*.wv. When a file is selected, the dialog displays short information about the selected waveform.

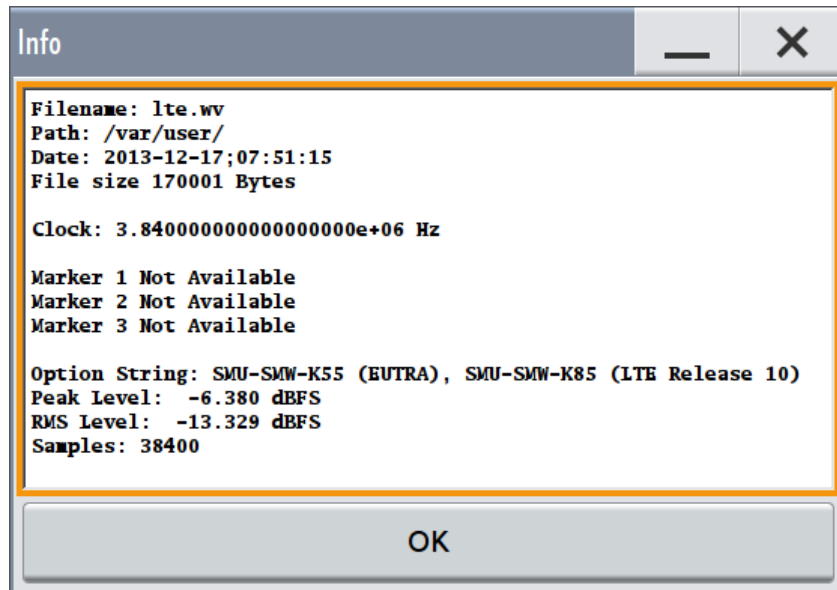
Enable the ARB generator ("ARB > State > On") to trigger the instrument to load and process the selected waveform file.

Remote command:

`[ :SOURce<hw> ] :BB:ARBitrary:WAVeform:SELEct` on page 857

### Waveform Info

Opens a dialog with detailed information about the currently selected waveform. The display depends on whether the selected waveform file is a multi-segment one or not. All parameters are read-only.



Remote command:

For non-multi segment waveform files, use the `Tag` commands (see [Chapter 13.18.3.4, "Waveform, Data and List Format"](#), on page 888).

### Clock Frequency

Displays or sets the ARB output clock rate.

The value of this parameter is set to the clock rate defined in the loaded waveform file (`{CLOCK}` tag). The value can be changed afterwards.

**Note:** The clock frequency must match the value of the externally applied clock source.

Remote command:

`[ :SOURce<hw> ] :BB:ARBitrary:CLOCK` on page 859

### Delay

When [Coupled sources](#) are used, all basebands are triggered with a common trigger signal.

Enable a time delay to delay the waveform processing of a particular baseband.

Remote command:

```
[ :SOURce<hw> ] :BB:ARBitrary:COUPled:TRIGger:DELay:OFFSet  
on page 860
```

#### **Create Multi Segment**

Accesses the dialog for creating multi-segment waveforms (see [Chapter 5.6, "Generating Multi-Segment Waveform Files"](#), on page 310).

#### **Create Multi Carrier**

Accesses the dialog for creating multi-carrier waveforms (see [Chapter 5.7, "Generating Multi Carrier Signals"](#), on page 340).

#### **Create Test Signal...**

Selects the form of the test signal and accesses the dialog with further settings. A choice between a sinusoidal, rectangular, or test signal with constant I/Q is provided.

See the corresponding section for a detailed description of the parameters for the selected test signal:

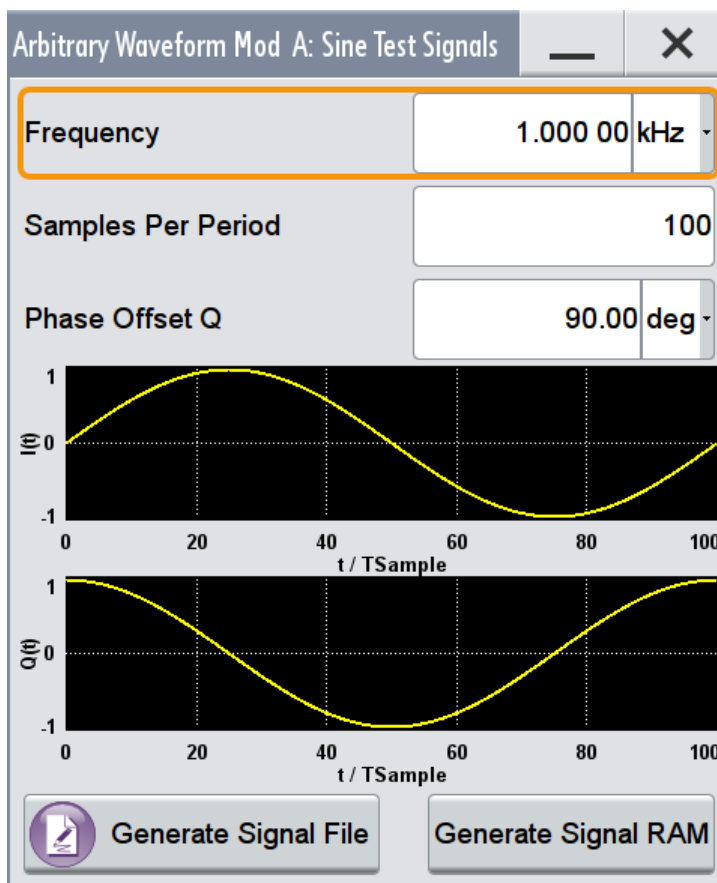
- [Chapter 5.5.3.2, "Sine Test Signals"](#), on page 297
- [Chapter 5.5.3.3, "Rectangular Test Signal"](#), on page 299
- [Chapter 5.5.3.4, "Constant IQ Test Signal"](#), on page 300

Generation of test signals is possible in configurations with separated baseband sources ("System Configuration > Fading/Baseband Config > BB Source Configuration > Separated").



5.5.3.2 Sine Test Signals

- ▶ To access the "Sine Test Signals" dialog, select "Baseband > ARB > General > Create Test Signal > Sine" and press "Create Test Signal".



This dialog provides settings for configuration of a sinusoidal test signal. A sine wave is generated on the I path, and a sine wave of the same frequency but phase-shifted is generated on the Q path. For more information, refer to [Chapter 5.5.2.2, "ARB Test Signals"](#), on page 288.

The dialog displays the characteristic of the currently selected signal.

<a href="#">Frequency</a> .....	297
<a href="#">Samples per Period</a> .....	298
<a href="#">Phase Offset Q</a> .....	298
<a href="#">Generate Signal HD</a> .....	298
<a href="#">Generate Signal RAM</a> .....	298

**Frequency**  
Enters the frequency of the test signal.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:FREQuency` on page 855

#### **Samples per Period**

Enters the number of sample values required from the sine wave per period.

The maximum allowed value is determined by the maximum ARB clock rate (see data sheet) and the selected frequency.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:SAMPles` on page 855

#### **Phase Offset Q**

Enters the phase offset of the sine-wave signal on the Q channel relative to the sine-wave signal on the I channel.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:PHASe` on page 855

#### **Generate Signal HD**

Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:CREate:NAMEd` on page 856

#### **Generate Signal RAM**

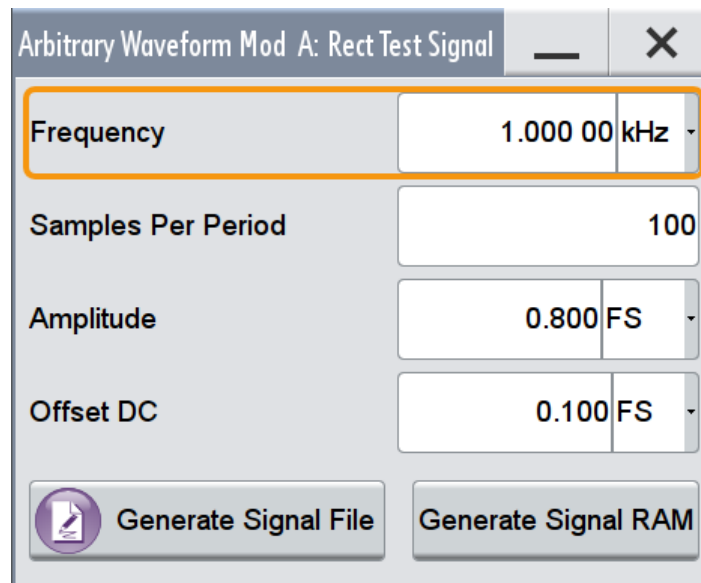
Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

Remote command:

[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:CREate on page 856

### 5.5.3.3 Rectangular Test Signal

- ▶ To access the "Rect Test Signals" dialog, select "Baseband > ARB > General > Create Test Signal > Rect" and press "Create Test Signal".



This dialog provides settings for configuration of a rectangular test signal. A rectangular test signal with a duty factor of 0.5 is created. Amplitude and offset are adjustable. Both paths, I and Q, use the same signal. For more information, refer to [Chapter 5.5.2.2, "ARB Test Signals"](#), on page 288.

Frequency.....	299
Samples per Period.....	299
Amplitude.....	300
Offset DC.....	300
Generate Signal HD.....	300
Generate Signal RAM.....	300

#### Frequency

Enters the frequency of the test signal.

Remote command:

[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:RECTangle:FREQuency on page 854

#### Samples per Period

Enters the number of sample values required for the rectangular signal per period.

The maximum allowed value is determined by the maximum ARB clock rate (see data sheet) and the selected frequency.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:RECTangle:SAMPles` on page 854

### Amplitude

Enters the digital amplitude of the rectangular wave. The abbreviation FS means full scale.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:RECTangle:AMPLitude` on page 854

### Offset DC

Enters a DC component.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:RECTangle:OFFSet` on page 854

### Generate Signal HD

Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:RECTangle:CREate:NAMed`  
on page 856

### Generate Signal RAM

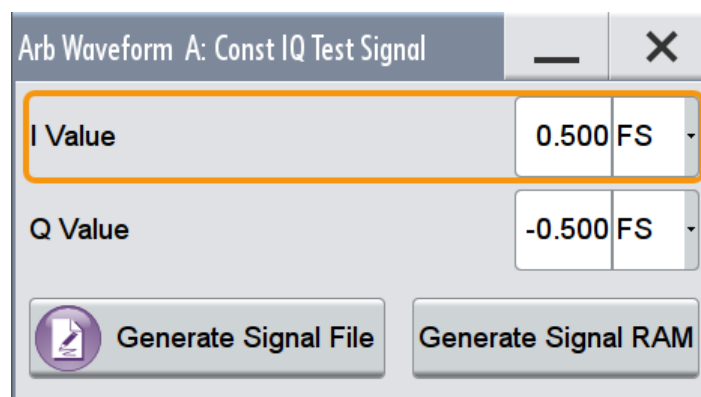
Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:SINE:CREate` on page 856

#### 5.5.3.4 Constant IQ Test Signal

- ▶ To access the "Rect Test Signals" dialog, select "Baseband > ARB > General > Create Test Signal > Const IQ" and press "Create Test Signal".



This dialog provides settings for configuration of a continuous test signal with constant IQ. The I and Q values for each path are adjustable but constant. For more information, refer to [Chapter 5.5.2.2, "ARB Test Signals"](#), on page 288.

Converted to analog, the signal is output directly at the I and Q connectors of the instrument.

I Value, Q Value.....	301
Generate Signal HD.....	301
Generate Signal RAM.....	301

#### I Value, Q Value

Enters the value for the I respectively Q component of the test signal.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:CIQ:I` on page 853

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:CIQ:Q` on page 853

#### Generate Signal HD

Generates a signal and saves it as a waveform file on the hard disk. Use the standard "File Select" function to store this file

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:CIQ:CREate:NAMed` on page 856

#### Generate Signal RAM

Generates a signal and uses it as output straight away. The instrument stores the file with a predefined name.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TSIGnal:CIQ:CREate` on page 856

### 5.5.3.5 Trigger, Marker and Clock Setting

These tabs provide standard settings.

For detailed description, see:

- [Chapter 5.3.2.1, "Trigger Settings"](#), on page 242
- [Chapter 5.3.2.2, "Marker Settings"](#), on page 247
- [Chapter 5.3.2.3, "Clock Settings"](#), on page 248
- [Chapter 5.3.2.4, "Local and Global Connector Settings"](#), on page 249

The following settings are specific to the ARB dialog.

#### Marker Mode

Basic marker configuration for up to three marker channels. The contents of the dialog change with the selected marker mode.

Use the settings to define the shape and periodicity of the markers. See [Regular Marker Output Signals](#) for description of the regular marker signals.

**Note:** The marker trace in the waveform file remains unchanged in any case. It is not overwritten, even if something else than Unchanged has been selected.

The instrument routes the generated marker signals to the selected output connectors, see [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612.

"Unchanged" The marker signal remains unchanged as defined in the waveform file.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:MODE](#) on page 884

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:PULSe:DIVider](#) on page 886

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?](#) on page 886

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:PATtern](#) on page 885

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:OFFTime](#) on page 885

[\[:SOURce<hw>\]:BB:ARbitrary:TRIGger:OUTPut<ch>:ONTime](#) on page 885

## 5.5.4 How to Generate and Play Waveform Files

This section provides step-by-step instructions on configuring and using the provided settings. For details on individual functions and settings see [Chapter 5.5.3, "ARB Settings"](#), on page 291.

Some test cases do not require a real time generation of signal according to a digital standard. For these test cases, the replay of a previously generated waveform is sufficient. In such cases, you can generate the required test waveform file in one of the following ways:

- Internally,
  - With the built-in "Generate Waveform File" function, see [Chapter 5.5.4.2, "How to Create Waveform Files with the Built-In "Generate Waveform File" Function"](#), on page 303
  - With the "Create ARB Test Signal" function, see [Chapter 5.5.4.1, "How to Create and Store ARB Test Signals"](#), on page 302
- Externally, for example:
  - With the free of charge software R&S WinIQSIM2, see [Chapter 5.5.4.4, "How to Create a Waveform File Generated with the R&S WinIQSIM2 and Load it in the ARB"](#), on page 304
  - With the software R&S ARB Toolbox
  - With the R&S SMW-K300/-K301 Pulse Sequencer software
  - Calculated using a mathematical program such as Matlab, see ["How to Manually Create a Waveform Using Tag File Format"](#) on page 902.

Provided the R&S SMW is equipped with the required option, you can load this waveform file and subsequent process it with the instrument.

This section provides examples on the internal waveform file generation and on the external generation with the R&S WinIQSIM2.

### 5.5.4.1 How to Create and Store ARB Test Signals

If your test case requires a simple sine or square test file, consider to use the provided ARB test signals.

1. Select "Baseband > ARB"
2. Select "Create Test Signal > Sine".
3. Adjust the "Sine Test Signal" settings as required.
4. Select "Generate Signal File", navigate through the directory tree (e.g. `/var/user/`), enter a file name (e.g. `sine_waveform`) and select "Save".  
The R&S SMW stores the generated waveform file and automatically loads it in the ARB.
5. Select "ARB > State > On".  
The R&S SMW processes the waveform file.

#### 5.5.4.2 How to Create Waveform Files with the Built-In "Generate Waveform File" Function

Several digital standards provide the special function "Generate Waveform File". This function enables the calculation and storage of the signal as a waveform file that can be afterwards played by the ARB generator.

##### To generate an EUTRA/LTE waveform file

1. Select "Baseband > EUTRA/LTE"
2. Adjust the settings as required, for example:
  - a) select "Link Direction > Downlink"
  - b) select a predefined test model, "Test Setups/Models > E-TM1\_1\_\_10MHz"
3. Enable "EUTRA/LTE > State > On".
4. Select "Generate Waveform File", navigate through the directory tree (e.g. `/var/user/`), enter a file name (e.g. `lte_waveform`) and select "Save".  
The R&S SMW stores the generated waveform file `lte_waveform.wv` under the selected directory `/var/user/`.  
To process the waveform file, load it in the ARB (see [Chapter 5.5.4.3, "How to Load and Play Waveform Files"](#), on page 303).

#### 5.5.4.3 How to Load and Play Waveform Files

Irrespectively on the way a waveform file is generated, you can transfer it on the instrument, load it in the ARB and play it.

##### To load and play a waveform file

1. Transfer an externally created waveform file to the instrument, see [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595
2. Select "Baseband > ARB"

3. Select "Load Waveform File", navigate to the directory the file is stored in, select the waveform file (e.g. /var/user/lte\_waveform) and execute "Select".  
The "ARB" dialog confirms that the waveform file is loaded.
4. Select "ARB > State > On".  
The R&S SMW processes the waveform file.

#### 5.5.4.4 How to Create a Waveform File Generated with the R&S WinIQSIM2 and Load it in the ARB

The following is an example on how to use the R&S WinIQSIM2 to generate an EUTRA/LTE waveform and load it in the ARB of the R&S SMW.

The workflow consists of three main steps, each described in a separate step-by-step instruction:

- Configuring the connection between the R&S WinIQSIM2 and the R&S SMW
- Generating of a waveform file with the required settings
- Transferring the waveform file to and paying it with the R&S SMW.



This section does not describe the R&S WinIQSIM2 but focuses only the task-related settings.

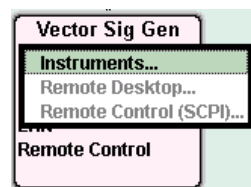
For more information on configuration and working with the R&S WinIQSIM2, refer to description "Software Manual R&S WinIQSIM2".

#### To configure the R&S SMW as destination instrument in the R&S WinIQSIM2

In this example, we assume that the R&S WinIQSIM2 is installed on a remote controller. This remote controller is connected over LAN to the R&S SMW.

The general instrument settings of the destination instrument affect various functions, like, the maximum size of the file the waveform is stored in. It is recommended that you configure the destination instrument before you generate the waveform with the R&S WinIQSIM2.

1. In the R&S WinIQSIM2, select "File > New" to preset the software to a defined state.
2. In the block diagram, select "Vector Sig Gen > Config > Instruments".

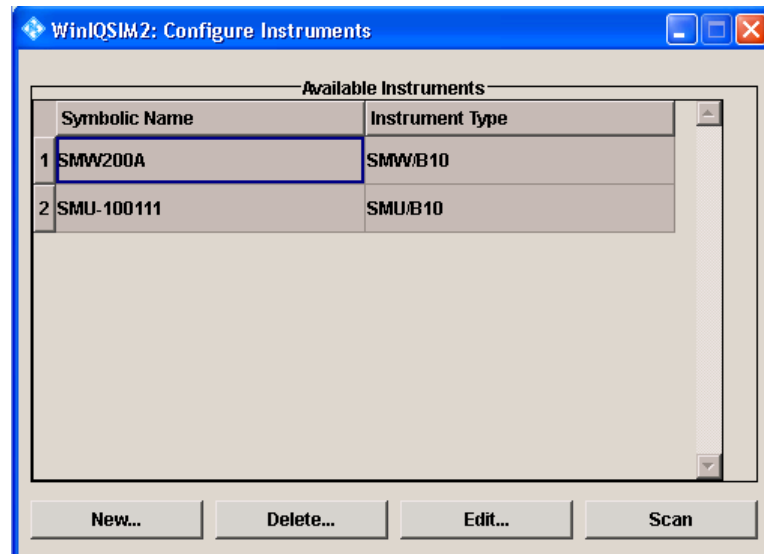


The "Configure Instruments" dialog opens. The list of configured instruments is empty.

3. Select "Configure Instruments > Scan".

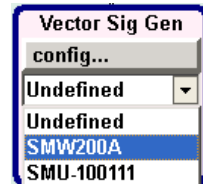


The software scans the network for connected and active instruments.



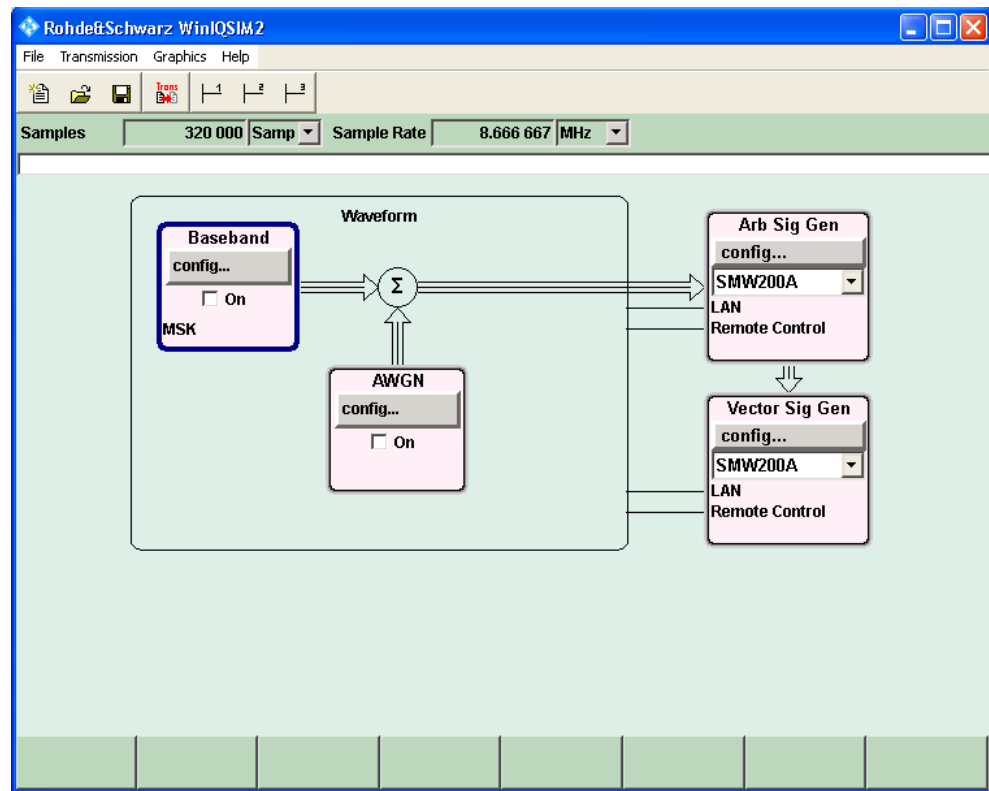
Alternatively, use the "New" function to add the R&S SMW manually to the list of instruments.

4. Close the dialog.
5. In the block diagram, select "Vector Sig Gen" block and select the R&S SMW from the list.



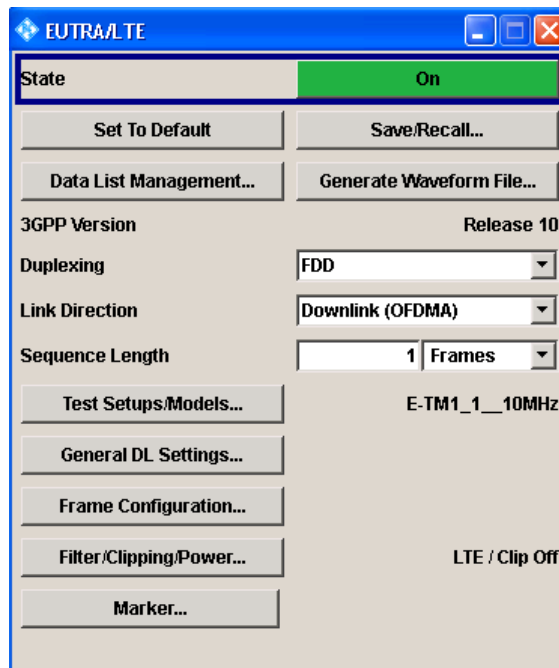
6. In the block diagram, select "Arb Sig Gen" block and select the R&S SMW from the list.

The two lines to the "Vector Sig Gen" and "Arb Sig Gen" blocks on the block diagram confirm that a remote connection to the R&S SMW is established.

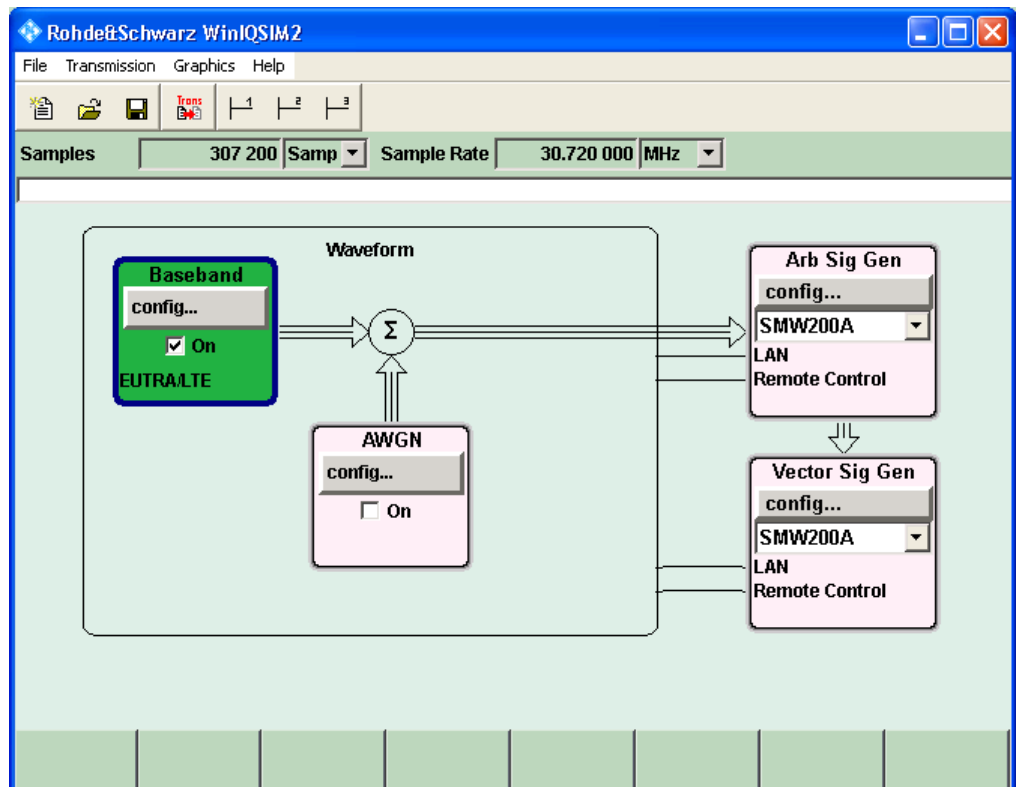


### To generate a waveform file with the R&S WinIQSIM2

1. In the R&S WinIQSIM2, select "Block diagram > Baseband > Config. > EUTRA/LTE".
2. Adjust the settings as required, for example:
  - a) select "Link Direction > Downlink"
  - b) select a predefined test model, "Test Setups/Models > E-TM1\_1\_\_10MHz"
3. Enable "EUTRA/LTE > State > On".

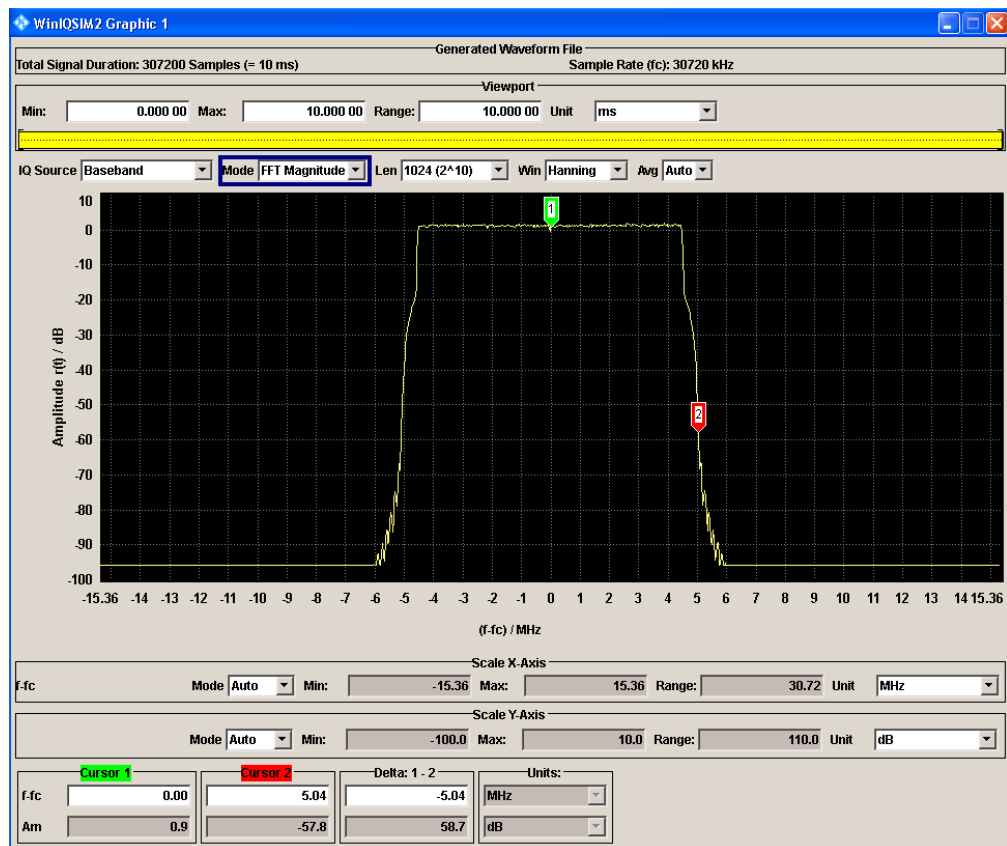


The R&S WinIQSIM2 calculates the signal and displays important signal parameters, like the used "Sample Rate" and "Number of Samples".





Use "Graphics > Graphic 1 (Complete)" view to retrieve more information on the generated signal.

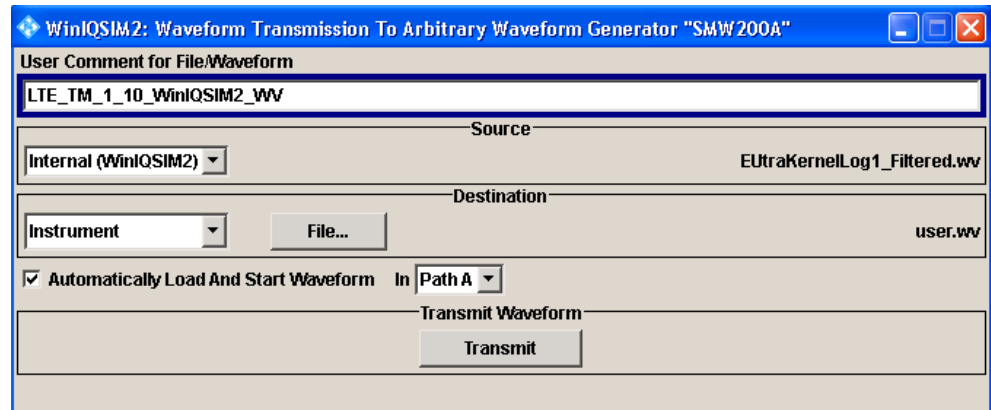


The display confirms the expected EUTRA/LTE 10 MHz spectrum.

### To transfer the generated file to the R&S SMW

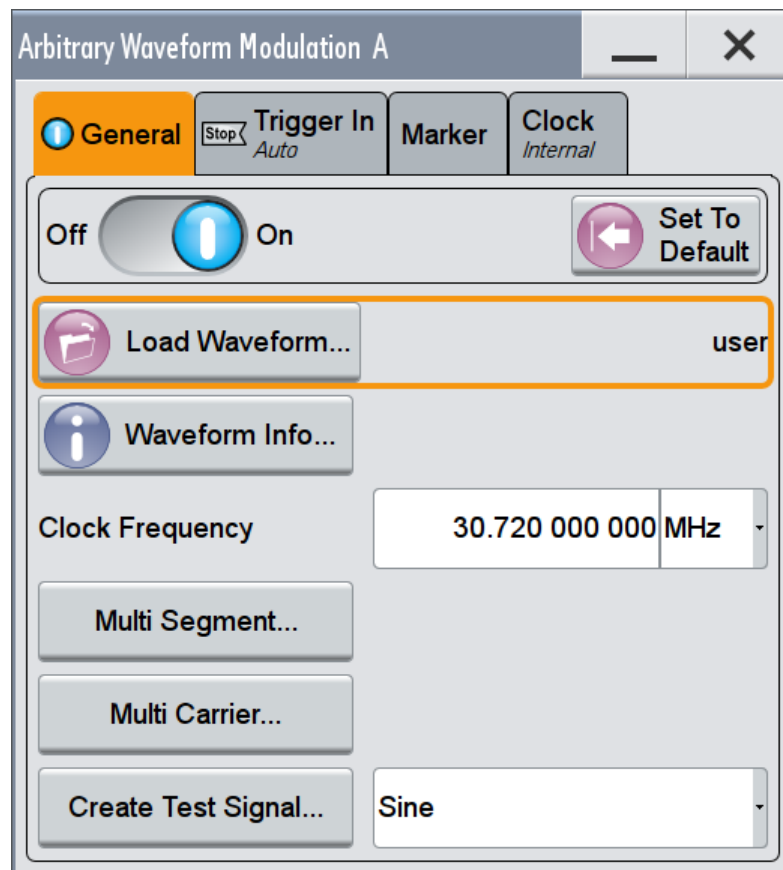
1. In the R&S WinIQSIM2, select "Transmission > Transmit".
2. In the "Waveform Transmission to Arbitrary Waveform Generator" dialog, select:
  - a) "Source > Internal (WinIQSIM2)"
  - b) "Destination > Instrument" and define the file name the transmitted file is stored as.
  - c) Enable "Automatically Load and Start Waveform > On" and select the required baseband, e.g. "Path A"
  - d) Add a comment to the waveform.
  - e) Select "Transmit".

Using the Arbitrary Waveform Generator (ARB)



The waveform is transmitted to the default directory of the R&S SMW.

3. In the R&S SMW, select "Baseband > ARB".



The dialog confirms that the ARB is enabled and plays the transmitted waveform.

## 5.5.5 References

### R&S Waveform File Format

The header of the generated I/Q data files consists of "tags" which are enclosed in braces { }. During data export, the header information is written to a \*.wv file.

For detailed description on all available tags and for information on how to query them or to create waveforms manually, refer to [Chapter 13.18.3.4, "Waveform, Data and List Format"](#), on page 888.

## 5.6 Generating Multi-Segment Waveform Files

Modern chip technologies implement several communication standards within one chip and rise special verification and test requirements. To fulfill the requirements of these test systems and to enable rapid alternation between different waveforms with differing test signals, the R&S SMW provides the functionality to generate multi-segment waveform files.

This section introduces the concept of the multi-segment waveform files, together with description of the provided settings and some typical configuration examples.

Generation of multi-segment waveform files is possible in configurations with separated baseband sources ("System Configuration > Fading/Baseband Config > BB Source Configuration > Separated").

### 5.6.1 Required Options

See [Chapter 5.5.1, "Required Options"](#), on page 287.

Multi-segment waveform files require the corresponding Digital Standard options (R&S SMW-K2xx) of all included standards.

### 5.6.2 About the Multi-Segment Waveforms

A multi-segment waveform is a composed signal that contains several multiple independent waveforms called segments. Each segment is an independent waveform that can be output with its own marker and clock settings.

The [Figure 5-17](#) shows the principle of building a multi-segment waveform.

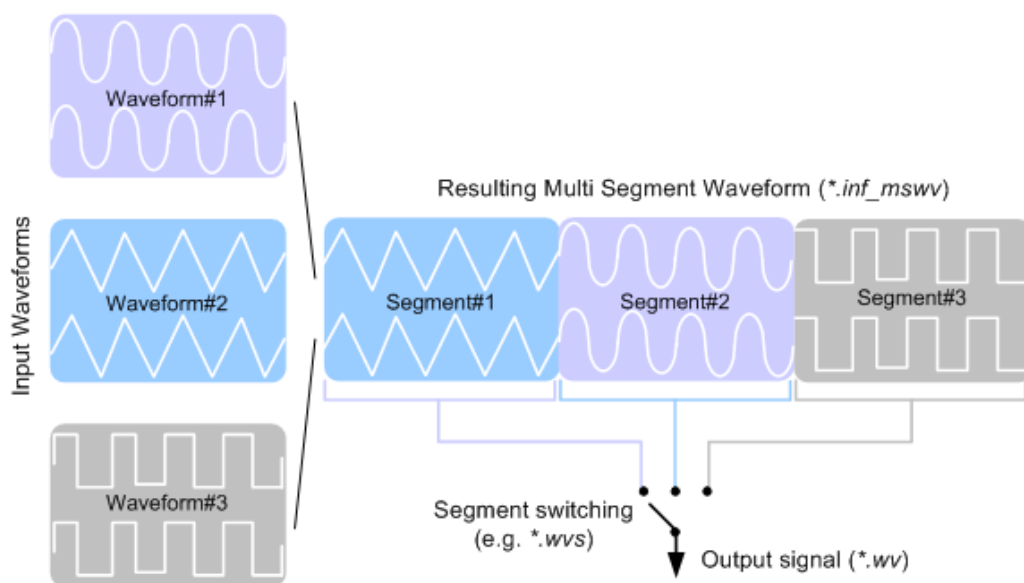


Figure 5-17: ARB Multi-Segment Waveform Concept

It is also possible to create and output a blank segment, i.e. segments containing a zero signal.

Typical applications for the multi-segment mode are described in section [Chapter 5.6.4, "How to Create and Work with the Multi-Segment Waveform Files"](#), on page 331.

### 5.6.2.1 Multi-Segment Waveforms Processing

Processing of the waveform is triggered by the "Create" or "Create and Load" function. To process the waveform, the instrument loads the entire multi-segment waveform into the memory. It is therefore possible to alternate between the individual waveforms without delay due to loading. You can define the output order of the segments, as well as the segment intended to be output at any given moment.

When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day. You can also acquire information about the waveform in the dedicated "Waveform Info" dialog.

### 5.6.2.2 The ARB Sequencer Mode

If high switch over speeds is required, the test signals can be continuously scrolled through with the aid of an external trigger or by applying a predefined "Play List". The R&S SMW provides the possibility not only to define a sequence of different segment but also to determine whether a segment is played once or repeated several times and to adjust the transition between the segments.

For the correct and fast processing and for seamless transition between the multiple waveforms, segments with a common sample rate are required. If the combined waveforms features different sample rates, they have to be adapted to a common sample

rate by resampling. Another advantage of this procedure is the scaling of the instantaneous amplitude of the various waveforms to a common RMS level.

### 5.6.2.3 File Concept

To provide flexible configuration, the building of a composed multi-segment waveform file involves different stages; by completing of each of them, the R&S SMW creates and stores a dedicated file. The following files are used:

- **Configuration list:** is a dedicated file with details on how a multi-segment waveform is made up from different waveforms, the level and the clock rate settings, and the file name. The file extension is `*.inf_mswv`.  
You can create any number of configurations as a basis for defining further multi-segment waveforms.
- **Output file:** is the created output multi-segment waveform file. The R&S SMW stores it under a user definable name; as with the standard waveforms, the used file extension is `*.wv`. The instrument appends additional information to the header of the composed waveform file, e.g. user comments.
- **Sequencing list:** are files created in the "Multi Segment Waveform Sequencing" dialog, i.e. when the ARB sequencer mode is used (see [Chapter 5.6.2.2, "The ARB Sequencer Mode"](#), on page 311).  
The sequencing list file has an extension `*.wvs` and is automatically assigned to but independent from the multi-segment file. By default, both files have the same name and are located in the same file directory. You can create more than one sequencing list file per multi-segment waveform file.  
The sequencing list file carries information only about the segment number, the corresponding waveform file names are retrieved from the assigned multi-segment waveform file. That is, the same sequencing list file can be reused for different multi-segment waveform files with the same number of segments.  
Changes and recalculations of a multi-segment waveform file cause a recheck whether the assigned sequencing list files are still valid. A message is displayed to inform about necessary corrections in the "play list".

### 5.6.2.4 Impact of the Marker Settings

The general purpose of the marker signal is the triggering of the DUT (device under test) and the synchronization with other measurement instruments.

For better flexibility, the instrument provides several possibilities to define marker signals:

- **Segment markers**  
Because the multiple segments are stand alone waveforms, they can already carry marker signals. You can define how the instrument processes these available marker signals. The instrument can ignore them or use them in the composed multi-segment waveform.
- **Additional segment restart and sequence restart markers**  
Additional marker signal can be defined to restart the multi-segment sequence or to restart each of the multiple segments. A marker output configured and defined



for one of these purposes overwrites markers that use the same output connector and that are defined in the individual waveforms.

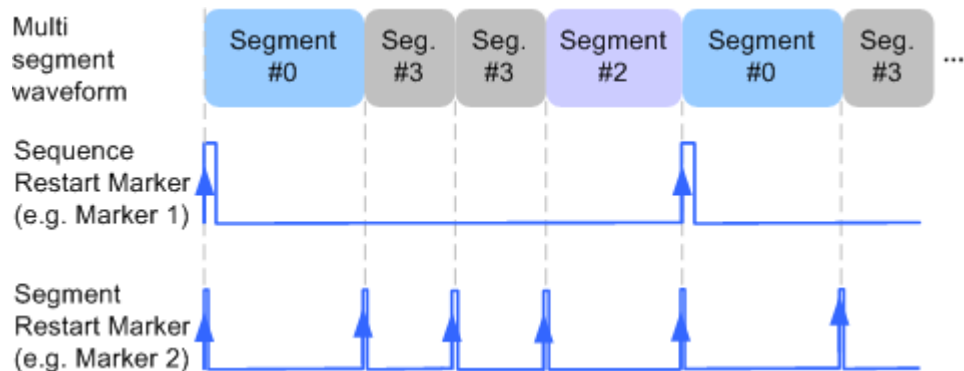


Figure 5-18: Example of marker signals

The segment begin is defined by the low-high slope of the marker. This applies for switching between two segments as well as if there is a segment replay.

- General marker signals for the composed multi-segment waveform  
The "ARB" dialog provides also access to the standard marker settings. Settings other than "unchanged" overwrite existing marker in the waveforms or markers defined for the multi-segment waveform.

The [Figure 5-19](#) shows schematically how the instrument evaluates the priorities of the different marker signals, if multiple marker signals are mapped to the same connector.

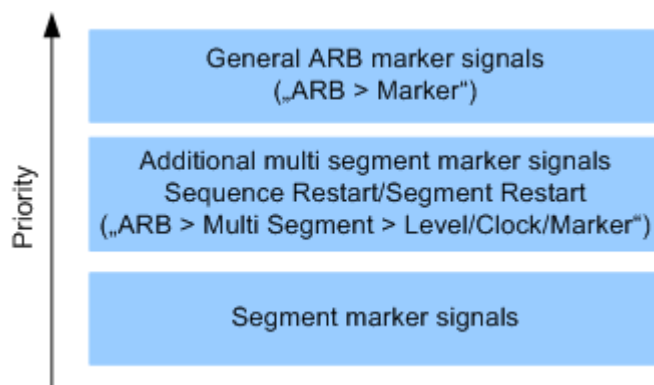


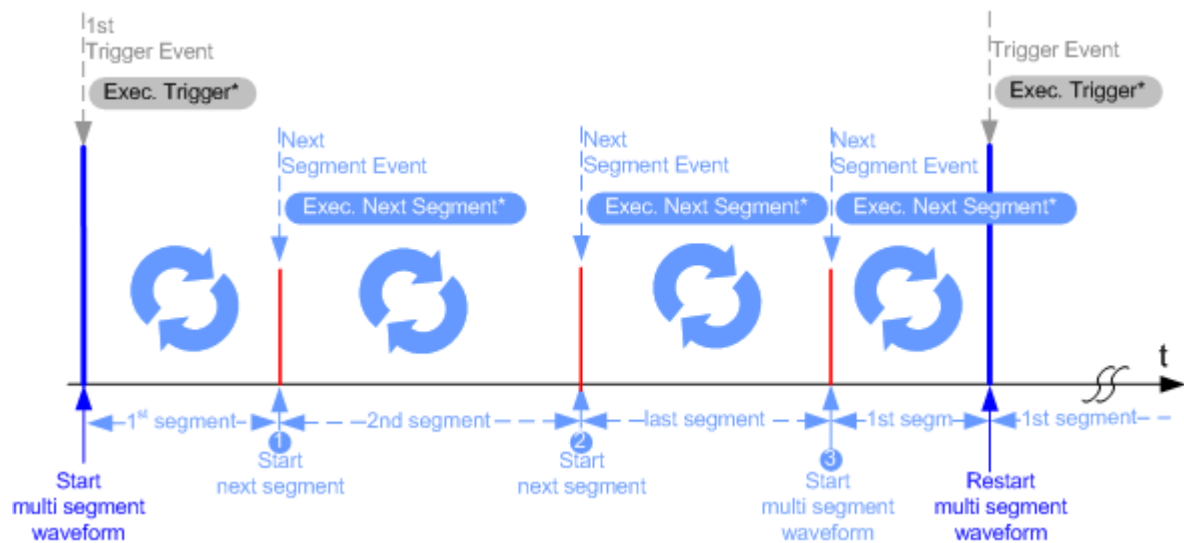
Figure 5-19: Marker priority used by assigning of marker signals to a hardware connector

### 5.6.2.5 Impact of the Trigger Settings and Next Segment Settings

The ARB dialog is equipped with the standard (regular) trigger settings. These settings are provided for triggering of the composed multi-segment waveform as a **sequence**, i.e. as one file. The functions provided in the "Trigger" tab and their effect are described in [Chapter 5.3.1.3, "Baseband Trigger Signals"](#), on page 226.

This section focuses on the additional settings provided for triggering of the individual segments building the composed multi-segment waveform. These settings are enabled and visible only if a multi-segment waveform is loaded for processing. The settings are grouped in the "Multi Segment Waveform Options/Next Segment Trigger In" section.

The Figure 5-20 illustrates how trigger events affect the processing of the multi-segment waveforms.



**Figure 5-20: Principle of segment triggering**

- \* = To simplify the description, an internal next segment trigger event ("Exec. Next Segment") and an internal trigger event ("Execute Trigger") are used; an external trigger event has the same effect on the signal generation.
- 1, 2 = Any next segment trigger event (internal or external) causes a switch over to the subsequent available segment in the waveform. The currently output segment (segment file name and segment index) is indicated at "Current Segment".
- 3 = When the last segment of the multi-segment waveform is output, the sequence starts again with the output of the first segment after the subsequent trigger event. Hence, a sequence of external next segment trigger events can be used to cyclically output the segments in the multi-segment file.

### Defining Next Segment Source

As with the standard trigger system, provided are the following two sources for the next segment signal:

- **Internal:** the switch over to the subsequent segment is triggered manually with the "Execute Next Segment" function.  
To trigger a switch over to any segment within the multi-segment waveform, change the value of the parameter "Segment".
- **External:** the instrument expects a trigger event ("Global Next Segment") on one of the two provided and configured USER connectors.

### Defining the Subsequent Segment

By default, the instrument replays the segments in incremental order, e.g. Segment#1, Segment#2, etc. If other order is required, use one of the following possibilities to define the segment to be played next:

- **Next Segment:** defines the subsequent segment while triggering the segments manually, i.e. by "Next Segment Source > Internal"
- **Sequencing List:** the subsequent segment is defined in the selected play list.

### Defining the Transition between the Segments

The R&S SMW provides the parameter "Next Segment Mode" to define the transition to the subsequent segment (see the graphs in [Transition examples](#)).

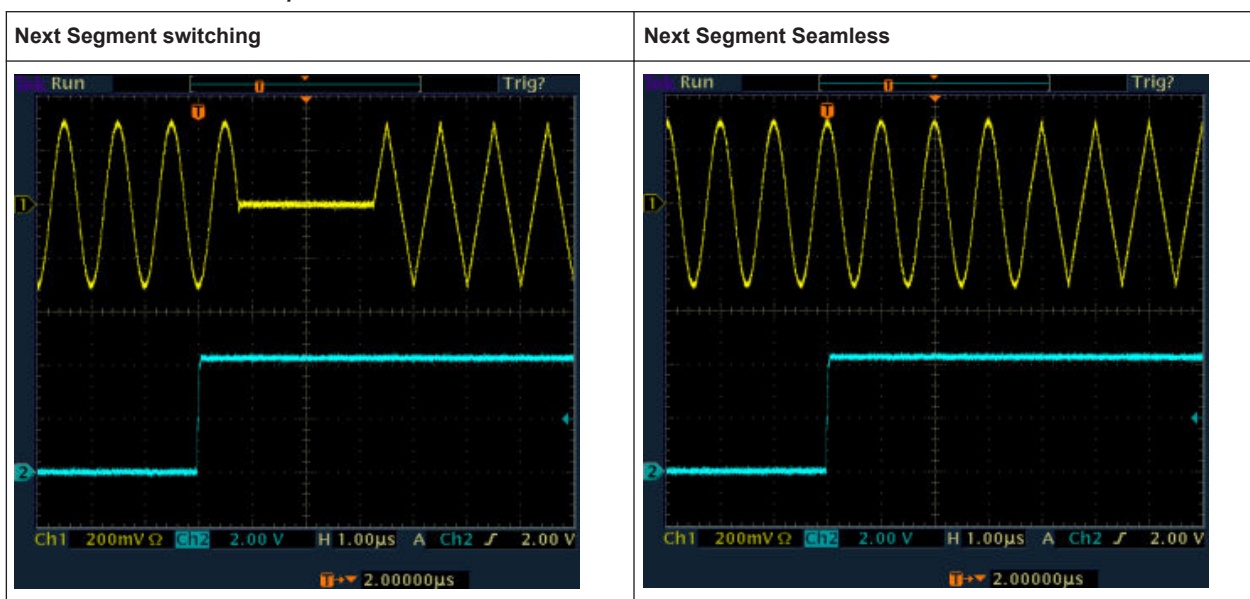
- **Next Segment:** by receiving a Next Segment Event, the ARB aborts immediately the playing of the current waveform and starts playing the next segment waveform (see [Table 5-18](#)).
- **Next Segment Seamless:** by receiving a Next Segment Event, the ARB completes the processing of the current waveform before starting the next segment waveform (see [Table 5-18](#)).

Use this setting to avoid signal gaps and wrap-around problems. Seamless transition requires segments with equal clock rates.

Another way to generate a multi-segment signal without signal gaps between the segments is to use the provided ARB sequencer mode (see [Chapter 5.6.3.4, "Multi-Segment Waveform Sequencing"](#), on page 323).

The [Table 5-18](#) shows two examples of the transition from a sine-wave signal segment to a sawtooth segment (1 channel, upper curve) in the case of next segment external triggering. The left graphic displays an abrupt transition; the right graphic, the **seamless** transition case.

Table 5-18: Transition examples



### Understanding the Trigger Examples


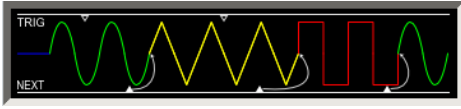
A simplified diagram in the ARB dialog is intended to explain the effect of the triggering on the signal processing. The currently enabled settings for trigger and next segment mode are considered.



The curves plotted in the dialog are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and the next segment settings more clearly.

- The triangle on the top line denotes a trigger event. A filled triangle on the bottom line denotes a next segment event.
- A green sine wave (or other shape) over a full period indicates one replay cycle of a segment. A shorter example signal indicates a replay cycle which was interrupted, e.g. due to a next segment event (compare the two graphics in [Table 5-19](#)).

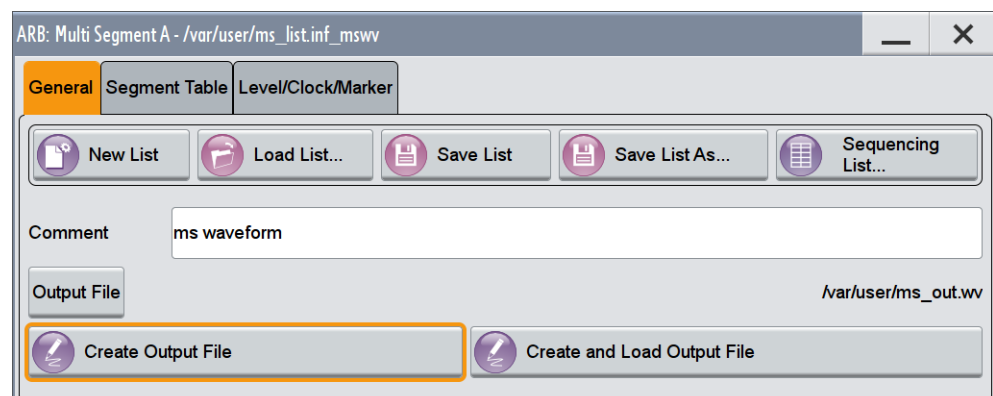
Table 5-19: Trigger examples in the "ARB" dialog

"Next Segment Mode = Next Segment"	"Next Segment Mode = Next Segment Seamless"
	

### 5.6.3 Multi-Segment Settings

1. To access the dialog box, select "Baseband > ARB > General > Create Multi Segment".

The "ARB: Multi Segment" dialog enables direct assignment of waveforms to the multiple segments, adjusting the clock, level, and marker settings of the composed waveform and selecting the output file.



For description on the provided settings, refer to:

[Chapter 5.6.3.1, "Setting for Handling the Multi-Segment Files and Output File Settings"](#), on page 317,

[Chapter 5.6.3.2, "Segment Table"](#), on page 319 and

[Chapter 5.6.3.3, "Level / Clock / Marker Settings"](#), on page 321

2. Select "ARB: Multi Segment > General > Create and Load Output File" to store and load current multi-segment file.
3. Select "Multi Segment > Sequencing List" to access the settings for configuring a sequencing "Play List" for fast automatic processing of the multi-segment waveform.

For a description of the provided settings, refer to [Chapter 5.6.3.4, "Multi-Segment Waveform Sequencing"](#), on page 323.

4. Select "Baseband > ARB > General".  
The "Load Waveform" confirms that the current multi-segment file is loaded (file name as defined with "Output File").
5. Select "Baseband > ARB > Trigger In (MSW)".  
For a description of the provided settings, refer to [Chapter 5.6.3.5, "Next Segment Trigger In Settings"](#), on page 327.
6. Select "Baseband > ARB > General > State > On" to process the configured multi-segment waveform.

The remote commands required to define these settings are described in [Chapter 13.18.3.3, "SOURCE:BB:ARbitrary Subsystem"](#), on page 844.

### 5.6.3.1 Setting for Handling the Multi-Segment Files and Output File Settings

To access the dialog box:

1. Select "Baseband > ARB > General > Create Multi Segment".  
The "General" tab comprises standard functions for file handling, like selecting and loading of files, or determining the output file name.  
The provided settings depend on the current waveform. The "Sequencing List" function for instance requires that the current "Sequence Table" contains more than one segment.
2. Perform one of the following:
  - Select "New List" to create a multi-segment waveform file
  - Select "Load List" to load an existing one
3. Add a comment and select "Output File" to define the file name the multi-segment waveform is created at.

<a href="#">New List</a> .....	317
<a href="#">Load List</a> .....	318
<a href="#">Save List/Save List As</a> .....	318
<a href="#">Sequencing List</a> .....	318
<a href="#">Comment</a> .....	318
<a href="#">Output file</a> .....	318
<a href="#">Create/Create and Load</a> .....	318

#### **New List**

Accesses the standard "Create Multi Segment Waveform List" function to enter the name of the new file.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:SElect` on page 869

### Load List

Accesses the standard "File Select" function to select the configuration file to be edited.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:CATalog?` on page 866

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:SElect` on page 869

### Save List/Save List As...

Saves the current entries of the [Segment Table](#) in a configuration list (file), including the level mode, clock mode, segment marker mode, and output file name settings.

See also [Chapter 5.6.2.3, "File Concept"](#), on page 312.

Consider also the following remote control commands:

- To define the configuration file (`*.inf_mswv`) used by the calculation of the output file:
  - `[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CREate`
  - `[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CLOad`
- To define the file name of the output waveform file (`*.wv`):
  - `[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:OFILe`

Remote command:

n.a.

### Sequencing List

Accesses the dedicated dialog for configuring the associated play lists, see [Chapter 5.6.3.4, "Multi-Segment Waveform Sequencing"](#), on page 323.

Remote command:

n.a.

### Comment

Adds a comment to the composed multi-segment file.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:COMMent` on page 867

### Output file

Accesses the standard "File Select" dialog function and requests the file name for the multi-segment waveform to be calculated.

An output file name is required for further processing of the multi-segment waveform:

- For the internal storage triggered by the "Save List" function
- For the calculation and creation of the multi-segment waveform, triggered by the "Create" or "Create and Load" function.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:OFILe` on page 868

### Create/Create and Load

- "Create"

- Creates a multi-segment waveform using the current entries in the [Segment Table](#).
- "Create and Load"  
Creates a multi-segment waveform and loads it in the ARB generator.

The R&S SMW stores the multi-carrier waveform as file with file name as specified with parameter [Output file](#).

Depending on the configuration of the multi-carrier waveform, calculation takes some time. Use the "Abort" function, to interrupt the calculation.

Remote command:

To define the configuration file (\*.inf\_mswv) used by the calculation of the output file:

`[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CREate`

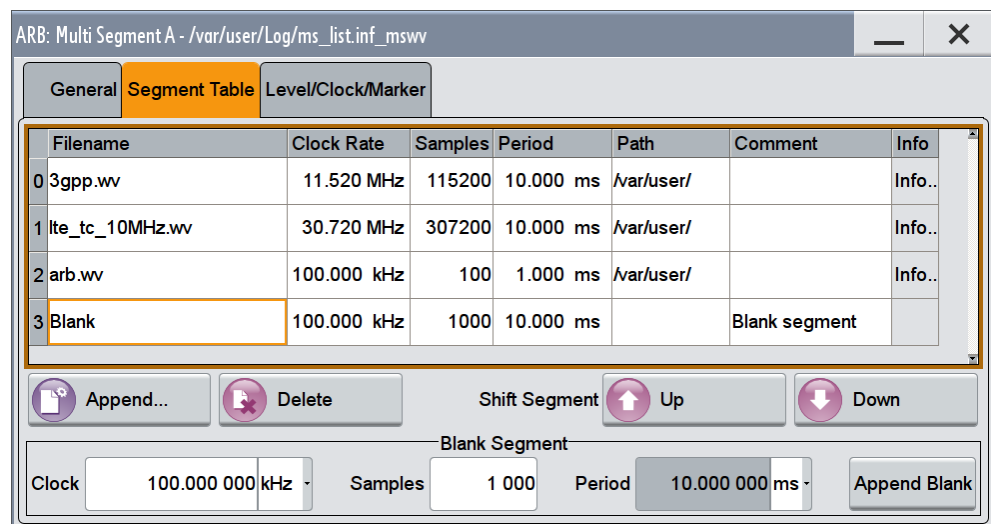
Or `[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CLOad`

To define the file name of the output waveform file (\*.wv):

`[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CONFigure:OFILe`

### 5.6.3.2 Segment Table

- To access the dialog box, select "Baseband > ARB > General > Multi Segment".
- In the "ARB: Multi Segment > General" dialog, select an existing list.
- Select "ARB: Multi Segment > Segment Table".
- Select "Append" to add *existing* waveform segments.
- Select "Append Blank" to add a blank segment and configure the "Blank Segment Settings" as required.



This section explains the settings, necessary to create and adjust the contents of the multi-segment file.

[Multi Segment Table, Append/Delete/Shift Seg.](#)..... 320  
[Blank Segment](#)..... 320

**Multi Segment Table, Append/Delete/Shift Seg.**

The table lists the individual waveforms (segments) of the selected multi-segment waveform. The information about the segments is retrieved from the tags of the corresponding waveform files.

*Table 5-20: GUI Elements in the Multi-Segment Table*

Function	Description
"Segment#"	Indication of segment index. Within the manual and remote control configuration, this segment index indicates the segment explicitly. <b>Tip:</b> Use the segment index for example to define the subsequent sequence to be output in Next Segment Mode "Next Segment" or "Next Segment Seamless".
"Waveform"	Indication of the waveform file name of the segment.
"Clock Rate"	Indication of the clock rate of the selected waveform.
"Samples"	Indication of the number of samples in the segment.
"Period"	Indication of the segment duration.
"Path"	Indication of the location of the waveform file used for the corresponding segment.
"Comment"	Indication of the possible comment contained in the waveform.
"Info"	Opens a dialog with detailed information about the currently selected waveform.

"Append" Opens the standard "File Select" dialog for navigation to and selection of the waveform file to be added on the end of the existing list. Only non-multi segment waveforms can be loaded.

"Delete" Removes the selected entry from the table. The waveform file itself is however not deleted.

"Shift Seg.# Up/Down" Rearranges the segments, i.e. moves the selected segment up and down.

Remote command:

[\[:SOURCE<hw>\]:BB:ARbitrary:WSEgment:CONFigure:SEGment:CATalog?](#)  
on page 868

[\[:SOURCE<hw>\]:BB:ARbitrary:WSEgment:CONFigure:SEGment:APPend](#)  
on page 868

[\[:SOURCE<hw>\]:BB:ARbitrary:WSEgment:CONFigure:DELete](#) on page 867

**Blank Segment**

Comprises the settings of a blank segment. A blank segment is a zero signal with defined clock rate and number of samples.



"Clock Rate" Selects the clock rate of the blank segment.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CONFigure:BLANk:APPend`  
on page 866

"Samples" Selects the number of samples for the blank segment.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CONFigure:BLANk:APPend`  
on page 866

"Period" Displays the resulting period for the blank segment.

"Append Blank" Adds the blank segment to the multi-segment file.

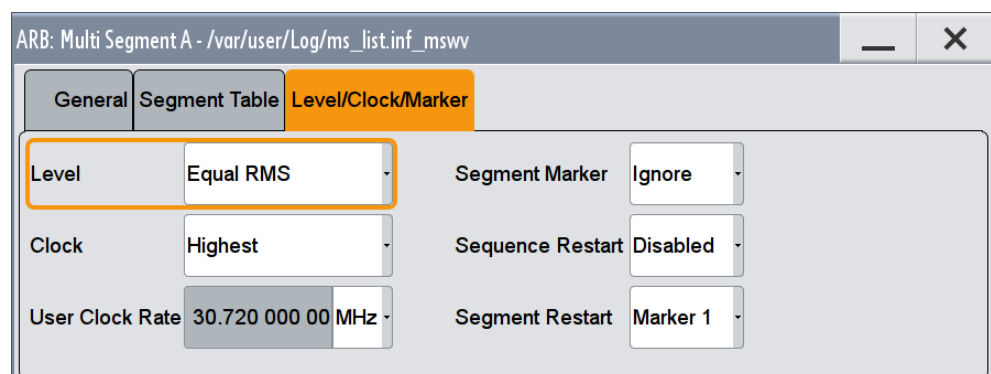
Blank"

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:WSEgment:CONFigure:BLANk:APPend`  
on page 866

### 5.6.3.3 Level / Clock / Marker Settings

1. To access the dialog box, select "Baseband > ARB > General > Multi Segment".
2. In the "ARB: Multi Segment > General" dialog, select an existing list.
3. Select "ARB: Multi Segment > Segment Table" and configure the segments.
4. Select "ARB: Multi Segment > Level/Marker/Clock".



The "Level/Marker/Clock" tab provides the parameters necessary to adjust the level, marker and clock settings for the selected multi-segment waveform file.

Level.....	322
Clock.....	322
User Clock Rate.....	322
Segment Marker.....	322
Sequence Restart.....	323
Segment Restart.....	323

**Level**

Defines the way the instrument determines the output level of each of the multiple waveforms.

- "Unchanged" Concerning the level settings, the segments are output exactly as defined in the individual files. The "Level" display applies only to the segment with the highest RMS value. Sometimes, the remaining segments are output at a lower level than the displayed value.
- "Equal RMS" Segments are output so that all segments have the same RMS value. The "Level" display applies to all segments.

Remote command:

```
[ :SOURce<hw> ]:BB:ARbitrary:WSEgment:CONFigure:LEVel[:MODE]
```

on page 868

**Clock**

Defines the way the instrument determines the clock rate of each of the multiple waveforms.

- "Unchanged" Each segment is output with the clock rate defined in its waveform file.  
**Note:** Segments with equal clock rates are required for "Next Segment Mode > Next Segment Seamless".
- "Highest" All segments are output at the highest available clock rate.  
**Note:** Trade-off between fast switch over and computing time. This mode provides short switch over times between segments. However, the computing time increases because the individual segments are resampled.
- "User" All segments are output at the clock rate defined by the parameter "User Clock".  
This mode is a trade-off between fast switch over and computing time, too.

Remote command:

```
[ :SOURce<hw> ]:BB:ARbitrary:WSEgment:CONFigure:CLOCK:MODE
```

on page 867

**User Clock Rate**

Defines the sample rate used for multi-segment waveform output, if "Clock Mode > User" is selected.

Remote command:

```
[ :SOURce<hw> ]:BB:ARbitrary:WSEgment:CONFigure:CLOCK on page 867
```

**Segment Marker**

Defines the way the marker information within the separate segments is processed, see also [Chapter 5.6.2.4, "Impact of the Marker Settings"](#), on page 312.

- "Ignore" The marker information carried in the individual segment waveform files is not considered.
- "Take Over" The output waveform file contains the marker information as configured in the individual waveform files.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:MARKer:MODE`  
on page 865

#### Sequence Restart

Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also [Chapter 5.6.2.4, "Impact of the Marker Settings"](#), on page 312.

"Disable" No additional marker is generated.

"Marker 1, 2, 3"  
Generates a restart marker signal at the beginning of the first segment of the complete multi-segment sequence.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:MARKer:FSEgment`  
on page 865

#### Segment Restart

Enables/disables the generation of an extra restart marker in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered, see also [Chapter 5.6.2.4, "Impact of the Marker Settings"](#), on page 312.

"Disable" No additional marker is generated.

"Marker 1, 2, 3"  
Generates a restart marker signal at the beginning of each segment. The segment begin is defined by the low-high slope of the marker signal. This applies for switching between two segments and if there is a segment replay.

Remote command:

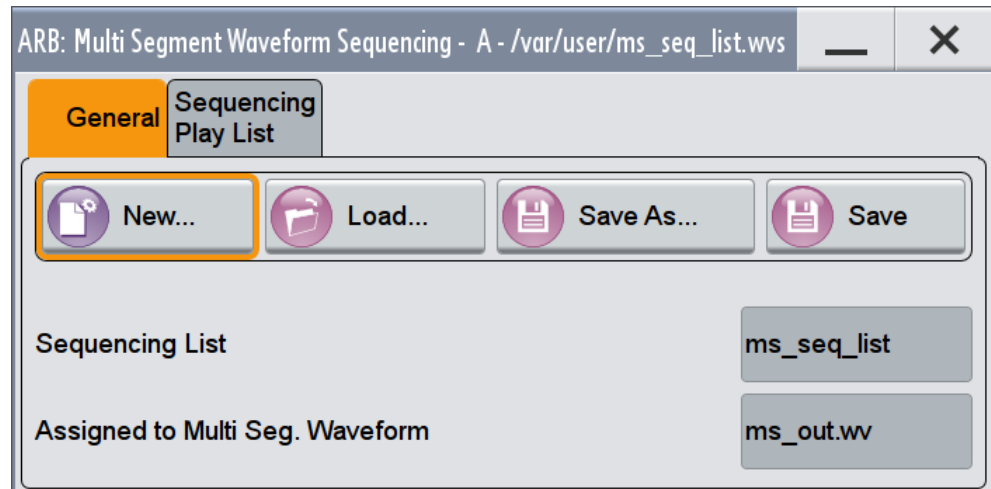
`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:CONFigure:MARKer:ESEgment`  
on page 865

### 5.6.3.4 Multi-Segment Waveform Sequencing

Access:

1. Select "Baseband > ARB > General > Multi Segment".
2. In the "ARB: Multi Segment > General" dialog, select an existing list.
3. Select "ARB: Multi Segment > Segment Table" and configure a waveform with more than one segment.
4. Select "ARB: Multi Segment > Level/Marker/Clock" and adjust the clock settings so that all segments use the same clock rate.
5. In the "ARB: Multi Segment > General" dialog, select "Sequencing List..."

6. Select "New" or "Load" to load a sequencing list file.

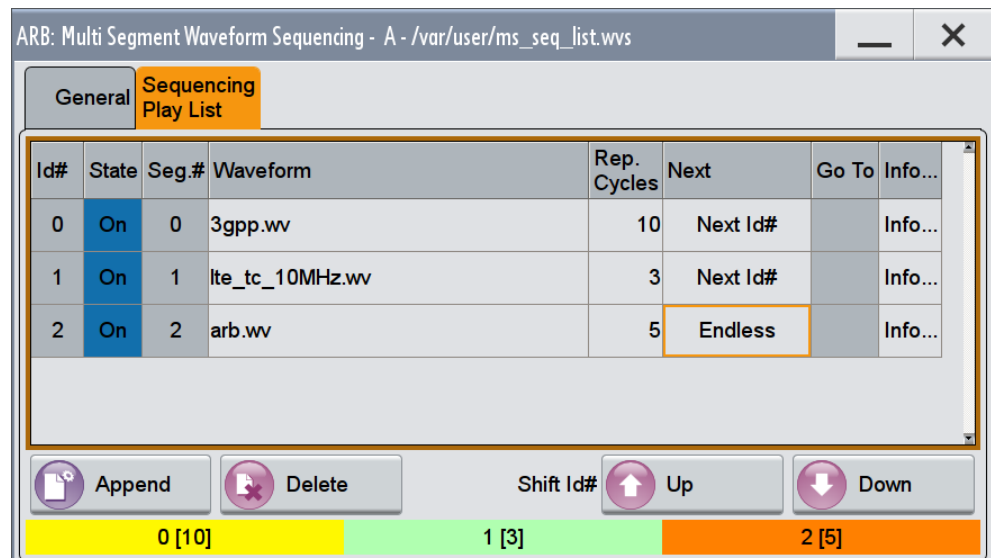


7. Select "ARB: Multi Segment Waveform Sequencing > Sequencing Play List" to create a "play list".

A new sequencing list contains no information.

8. Use the "Append/Delete" and "Up/Down" functions to configure the order the segments are processed.

The user interface shows the configured play list in form of a "Sequencing Graphic".



Refer to "[Sequencing Play List Settings](#)" on page 326 for description of the provided settings.

9. Select "ARB: Multi Segment Waveform Sequencing > General > Save" to store the "play list".
10. Select "ARB: Multi Segment > General > Create and Load Output File" to store and load current multi-segment file.

11. To enable the instrument to use the configured "play list", select "ARB > Next Segment Waveform Options > Next Segment Mode > Sequencer".



All segments in a "play list" must have the same clock rate.

### General Settings

Provided are the following settings:

New/Load Sequencing List.....	325
Save/Save As Sequencing List.....	325
Sequencing List.....	325
Assigned to Multi Seg. Waveform.....	325

### New/Load Sequencing List

Accesses the standard "Select Sequencing List" function to define the name of the new play list file or select of an existing one.

Remote command:

`[ :SOURce<hw> ] :BB:ARBitrary:WSEgment:SEquence:SElect` on page 863

### Save/Save As Sequencing List

Saves the current entries of the table in a play list file. Play list files have the file extension \*.wvs.

The default file name of the play list file is the same as the multi-segment waveform file name, but it can be changed.

### Sequencing List

Displays the name of the selected sequencing list file, i.e. the file with the "play list" settings (see [Chapter 5.6.2.3, "File Concept"](#), on page 312).

Remote command:

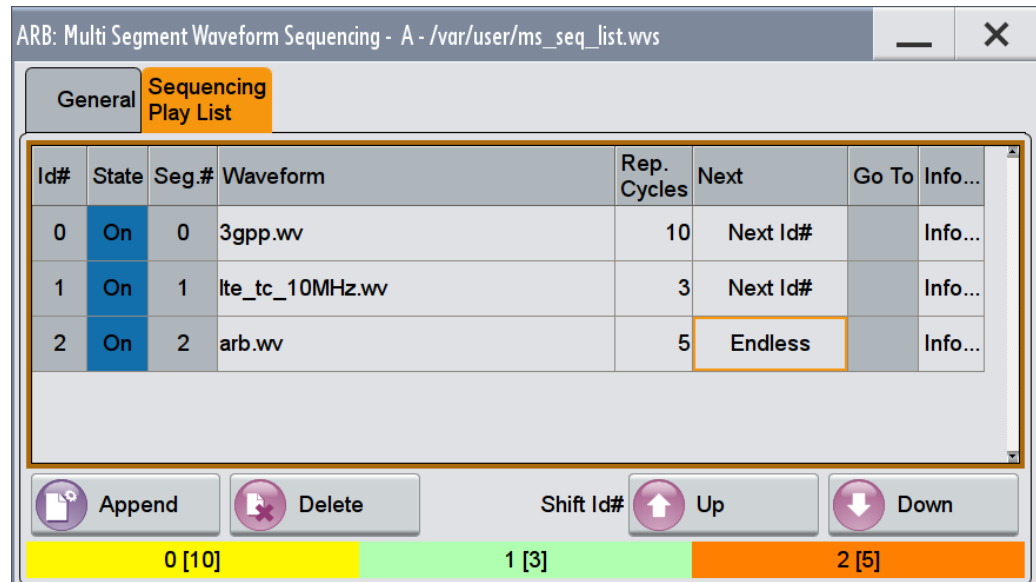
n.a.

### Assigned to Multi Seg. Waveform

Displays the name of the multi-segment waveform file the current sequencing list file is assigned to.

Remote command:  
n.a.

### Sequencing Play List Settings



Provided are the following settings:

#### Sequencing Play List

The "Sequencing Play List" table defines the sequence order the waveform file segments are processed and how many times each of them is repeated.

"Id#"	Indicates the row number.
"State"	Enables/disables the selected row. Only active segments are processed.
"Segment#"	Indicates the segment index. The sequencing list file carries information only about the segment index, the corresponding file names are retrieved from the assigned multi-segment waveform file.
"Waveform"	Indicates the waveform file mapped to the corresponding segment. The file name is retrieved from the assigned multi-segment waveform file. Available are only waveform files from the pool of segments of the selected multi-segment waveform file.
"Repetition Cycles"	Sets the number of times the selected segment is cyclically repeated before the next segment in the sequence is processed.
"Info"	Opens a dialog with detailed information about the currently selected waveform.

Remote command:

See ["Append"](#) on page 327

#### **Next ← Sequencing Play List**

Determines the action after completing the current one, like for instance which segment is processed after the processing of the current one is finished.

"Next Id#"	The next active segment in the play list is processed.
"Blank"	After the processing of the current segment is completed, the signal output is stopped until a signal restart like a retrigger signal is received. A restart signal causes a complete restart of the sequencing play list.
"Endless"	The current segment is replayed until a signal restart like a retrigger signal is received and the complete sequencing play list is restarted. Only active segments are considered.
"Goto Id#"	Determines the row number of the segment to be processed next. This feature is limited to the first 32 rows.

#### **Append ← Sequencing Play List**

Inserts a new row at the end of the sequencing play list table.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:WSEgment:SEquence:SElect](#) on page 863

[\[:SOURce<hw>\]:BB:ARbitrary:WSEgment:SEquence:APPend](#) on page 864

#### **Delete ← Sequencing Play List**

Deletes the selected row.

#### **Shift Id# Up/Down ← Sequencing Play List**

Rearranges the rows, i.e. moves the selected row up and down.

#### **Sequencing Graphic**

Displays the play list graph according to the current configuration.

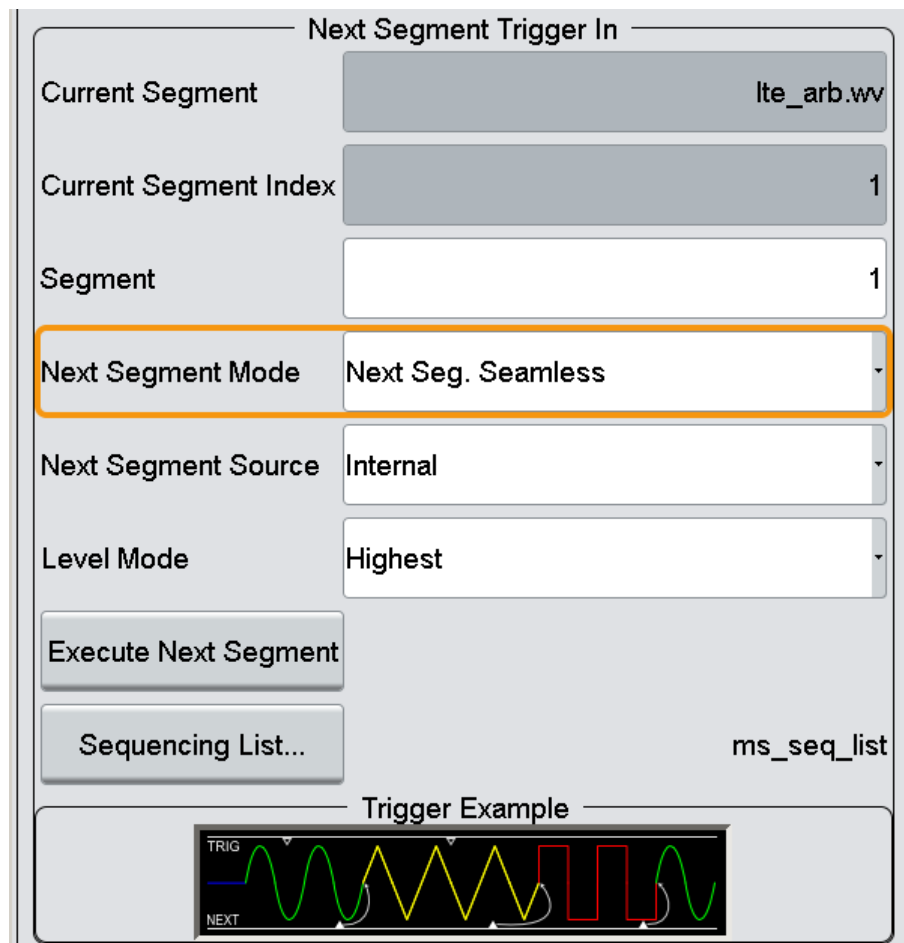
The graph shows the segment sequence, the segment number, and the number of times, the segment is repeated; considered are only the active segments.

### **5.6.3.5 Next Segment Trigger In Settings**

The "Next Segment Trigger" settings are enabled only if a multi-segment waveform is loaded into the ARB.

1. Enable a multi-segment waveform and load it in the ARB, see [Chapter 5.6.3, "Multi-Segment Settings"](#), on page 316.

2. Select "Baseband > ARB > Trigger In (MSW)".



The "Next Segment Trigger In" section comprises the settings necessary to adjust the trigger for switching between the segments of a multi-segment waveform. The parameters displayed depend on the selected trigger source.

Current Segment/Current Segment Index.....	328
Segment.....	329
Next Segment Mode.....	329
Next Segment Source.....	330
Level Mode.....	330
Execute Next Segment.....	330
Sequencing List.....	330
Trigger Example.....	331

**Current Segment/Current Segment Index**

Indicates the waveform segment (segment file name and index) that is output.

Remote command:

[ :SOURce<hw> ] :BB:ARBbitrary:WSEGment? on page 862

[ :SOURce<hw> ] :BB:ARBbitrary:WSEGment:NAME? on page 862



**Segment**

Selects the waveform segment to be output after the segment indicated as "Current Segment". This parameter determines the start segment when switching on the ARB and enables switching over to any other segment.

The following events cause a switch over:

- An external next segment trigger event
- An internal segment trigger, that is a change in the segment index in the "Segment" field

Use the parameter [Next Segment Mode](#) to define whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around). The subsequent trigger event after the last segment causes the first segment to be output again.

For more information, see [Chapter 5.6.2.5, "Impact of the Trigger Settings and Next Segment Settings"](#), on page 313.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:NEXT` on page 862

**Next Segment Mode**

Defines the way the **switch over between the segments** in a multi-segment waveform is executed.

The regular trigger mode for starting the waveform generation and **triggering the whole multi-segment sequence** is set with the parameters in the "ARB > Trigger" tab. The segment currently being output is displayed at "Current Segment". The "Trigger Example" graph displays schematically the waveform output, depending on the activated trigger and the next segment settings.

For background information, refer to [Chapter 5.6.2.5, "Impact of the Trigger Settings and Next Segment Settings"](#), on page 313.

For detailed information on how the regular trigger signal affects the multi-segment waveform processing in combination with the different values for "Next Segment Mode", refer to [Chapter 5.6.5, "Reference to Triggering of Multi-Segment Waveforms"](#), on page 337.

**Note:** The seamless switch over and the sequencer mode require segments with equal sample rate.

**"Same Segment"**

The processing of the multi-segment waveform file is similar to the processing of a non-multi segment waveform, i.e. there is no switching to consecutive segment upon the receiving of a trigger event. To trigger switching between the segments, change the segment index in the "Segment" field.

**"Next Segment"**

The current segment ceases to be output when a trigger event for a new segment occurs, and the new segment starts to be output after a system-imposed signal gap.

**"Next Segment Seamless"**

The new segment is not output until the whole of the current segment has been output (wrap around), i.e. the signal transition is seamless.

"Sequencer" The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (\*.wvs) assigned to the multi-segment waveform file. This "play list" is defined in the [Multi-Segment Waveform Sequencing](#) dialog.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:TRIGger:SMODE` on page 865

#### Next Segment Source

Determines whether the next segment is switched upon receiving of an external trigger signal or upon executing of software next segment trigger (see [Figure 5-20](#)).

This parameter is disabled, if a sequencing play list is enabled.

"Internal" Switch over to any segment is triggered manually with the "Execute Next Segment" function.

"Global Next Segment 1/2"

The trigger event for switching to the next segment is input as configured on one of the USER connectors (see [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612).

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEGment:NEXT:SOURce` on page 863

#### Level Mode

Sets how the instrument levels the individual segments in a multi-segment signal. The parameter is important, if waveforms with different crest factors are used.

"Highest" All segments are output at the highest available crest factor.

"Unchanged" Each segment is output with the crest factor defined in its waveform file.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEGment:LMODE` on page 863

#### Execute Next Segment

For "Next Segment Source = Internal", triggers manually switch over to the subsequent segment in the multi-segment file. The subsequent segment can be any segment within the multi-segment file and is defined by the parameter "Segment"

This parameter is disabled, if a sequencing play list is enabled.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:WSEGment:NEXT:EXECute` on page 863

#### Sequencing List

Opens a dialog box for defining the "play lists", see [Chapter 5.6.3.4, "Multi-Segment Waveform Sequencing"](#), on page 323.

Remote command:

[ :SOURce<hw> ] :BB:ARbitrary:WSEgment:SEquence:SElect on page 863

### Trigger Example

Displays an example of a multi-segment waveform. The currently enabled trigger and next segment mode are considered. After the instrument is switched on, the graph of the last loaded waveform is displayed.

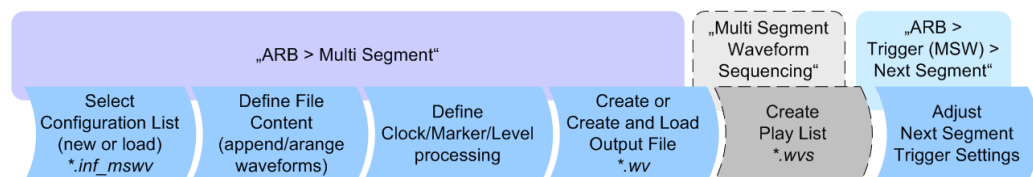
**Note:** The curves plotted in this dialog box are textbook examples, "not measured" waveforms. They are intended to visualize the trigger and next segment settings more clearly.

Remote command:

n.a.

## 5.6.4 How to Create and Work with the Multi-Segment Waveform Files

This section provides step-by-step instructions on how to configure and use the multi-segment settings. The [Figure 5-21](#) shows the essential stages of multi-segment waveform configuration, together with the corresponding user interface dialogs and if applicable, the corresponding file extensions. Perform the necessary settings, enable the signal generation, and provide trigger signal.



**Figure 5-21: Basic workflow for generation of multi-segment waveforms**

### Generating a multi-segment waveform file (basic workflow)

1. In the "ARB > Multi Segment > General" dialog, select "New List" to create empty list.
2. Use the "ARB: Multi Segment > Segment Table > Append" function to add two or more waveform files.
3. In the "ARB: Multi Segment > Level/Clock/Marker" dialog, adjust the "Level", "Clock", and "Segment Marker" settings.
4. Select the "ARB > Multi Segment > General > Output File" and enter file name.
5. Select "ARB > Multi Segment > General > Save List" to store the configuration file.
6. Select "ARB > Multi Segment > General > Create" or "Create and Load" to create and load the multi-segment waveform.
7. Select "ARB > Multi Segment > General > State > On".

**Tip:** Try out the built-in tutorial.



The following description emphasizes on the settings required to fulfill the particular task or achieve the desired performance; standard basic settings are not discussed. All provided examples use the example segment sequence as shown on [Figure 5-22](#).

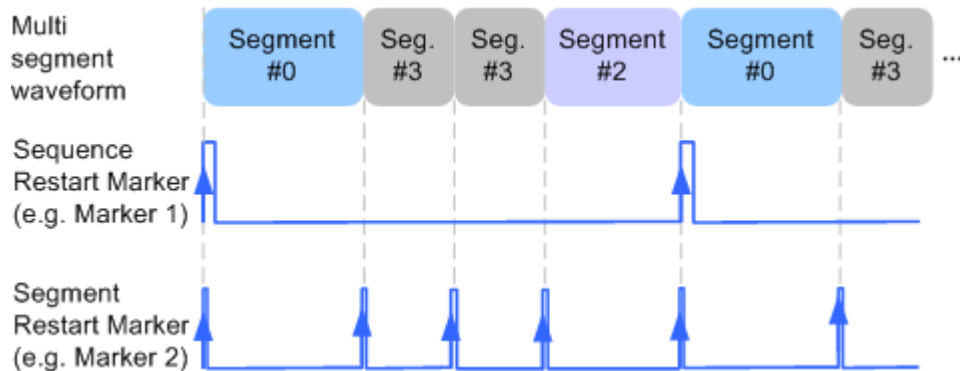


Figure 5-22: Example: multi-segment sequence with marker signals

See how to:

- ["To apply a manual segment switch to the output segments in the required order"](#) on page 332
- ["To generate a multi-segment signal without signal interruptions"](#) on page 333
- ["To enable an external triggering for high-speed switch over"](#) on page 334
- ["To configure a multi-segment sequence using the play list function"](#) on page 335
- ["To add marker signals"](#) on page 336

#### To apply a manual segment switch to the output segments in the required order

When testing DUTs using different test signals, it may be necessary to switch dynamically and flexibly between any of the test signals, for instance depending on the outcome of the previous test. The following settings enable flexible dynamic switch over between the segments in a multi-segment waveform.

We assume, that a multi-segment sequence composed of 4 segments (Seg#0, Seg#1, Seg#2 and Seg#3) is created and loaded in the ARB (see ["Generating a multi-segment waveform file \(basic workflow\)"](#) on page 331). The required output order of the segments is Seg#0, Seg#3 [2], Seg#2. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched on.

1. Select "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Mode = Next Segment"  
The transition between the segments is abrupt.
2. To enable manual next segment triggering, select "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Source = Internal"
3. To enable manual triggering, select "ARB > Trigger In (MSW) > Mode = Armed Auto" and "ARB > Trigger In (MSW) > Source = Internal"

- Execute "ARB > Trigger In (MSW) > Execute Trigger" to trigger the signal generation.

The "ARB > Trigger In (MSW) > Next Segment Trigger In" settings display the currently output segment: "Current Segment Name = Seg#0" and "Current Segment Index = 0". Seg#0 is output continuously.

- Set "ARB > Trigger In (MSW) > Next Segment Trigger In > Segment = 3" to output the second segment in the sequence order.

The parameter "ARB > Trigger In (MSW) > Next Segment Trigger In > Current Segment Index" changes to segment index 3. Seg#3 is output continuously.

- Execute "ARB > Trigger In (MSW) > Execute Trigger" to restart Seg#3.

- Set "ARB > Trigger In (MSW) > Next Segment Trigger In > Segment = 2" to output the third segment in the sequence order.

Seg#2 is output continuously.

To switch over to Seg#0, change the "ARB > Trigger In (MSW) > Next Segment Trigger In > Current Segment Index", etc.

**Tip:** The ARB sequencer mode provides the necessary settings to achieve the same goal in a more convenient way, see ["To configure a multi-segment sequence using the play list function"](#) on page 335



#### Faster flexible dynamic switch over

When using Creating a **remote control** via an external computer, the following settings enable switching times of approx. 20 ms for segments with the same sample rate and approx. 200 ms for segments with different sample rates:

- "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Mode = Next Segment"
- "ARB > Trigger In (MSW) > Trigger Mode = Auto"
- "ARB > Trigger In (MSW) > Trigger Source = Internal"

#### To generate a multi-segment signal without signal interruptions

Testing receivers requires a continuous output of different test signals without interrupting the signal. The test signals then produce a complex total signal with no signal gaps on switch over. Control procedures can use a simulated back channel of the receiver (trigger line or remote control).



Switching times depend on the length of the segment currently being output, because switch over to the next segment does not take place until the current segment comes to an end.

To overcome wrap-around problems and generate multi-segment signal without signal gaps between the segments, consider the following settings:

- Enable "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Mode = Next Segment Seamless"

2. Select "ARB > Trigger In (MSW) > Trigger Mode = Auto"
3. Select "ARB > Trigger In (MSW) > Trigger Source = Internal"
4. A segment ("Current Segment") is output continuously as long as the value of the parameter "Segment" is not changed. Change the value of the parameter "ARB > Trigger In (MSW) > Next Segment Trigger In > Segment" to select the segment index to be processed after completing the current one.
5. The seamless transition between the segments requires waveforms with equal clock rate.  
If the waveforms feature different sample rates, select "ARB > Multi Segment > Level/Clock/Marker > Clock Mode = Highest" or "Clock Mode = User" to resample the waveforms.

#### To enable an external triggering for high-speed switch over

To test DUTs/chips using different test signals at high throughput requires fast switch over (for instance when testing ATE devices during manufacture).

We assume, that the required multi-segment sequence is created and loaded in the ARB (see ["Generating a multi-segment waveform file \(basic workflow\)"](#) on page 331). The segments are *output in incremental order*. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched on. An external global or local trigger source is connected to the instrument and the corresponding connectors are configured.

The following settings enable **switching times of approx. 5 us** and the test signals are scrolled through with the aid of an external trigger signal:

1. Select "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Mode = Next Segment".
2. Select "ARB > Trigger In (MSW) > Next Segment Trigger In > Next Segment Source = Global Next Trigger 1".
3. Do not change the displayed segment index (parameter "ARB > Trigger In (MSW) > Next Segment Trigger In > Segment").
4. Enable "ARB > Trigger > Trigger Mode = Auto"
5. Select "ARB > Trigger > Trigger Source = External Global/Local Trigger"
6. If the waveforms in the multi-segment file feature different sample rates, select "ARB > Multi Segment > Level/Clock/Marker > Clock Mode = Highest" or "Clock Mode = User" to resample the waveforms.

The switch over between the segments is triggered by receiving of an external trigger event. The segments are output in incremental order, i.e. Seg#0, Seg#1, etc. The currently processed segment ("Current Segment") is output continuously as long as a new trigger event is received. A new trigger event aborts the output of the current segment immediately and starts the processing of the next one in the sequence.

**Tip:** To output the segments in any order, use the ARB sequencer mode, see ["To configure a multi-segment sequence using the play list function"](#) on page 335.

Refer to [Chapter 11.2.6, "How to Enable Signals and Perform Signal to Connector Mapping"](#), on page 626 for general description on the configuration of the trigger and connector settings.

### To configure a multi-segment sequence using the play list function

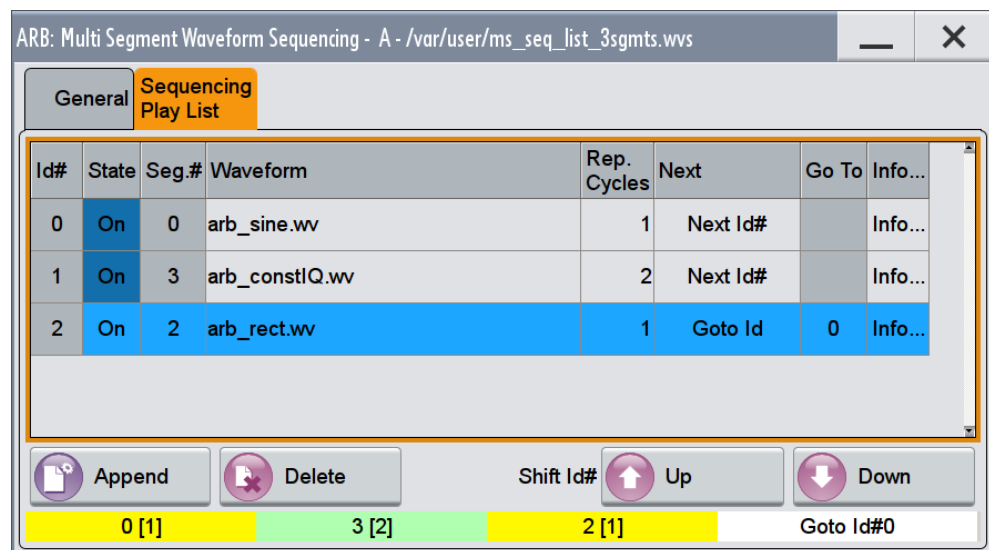


The ARB Sequencer mode requires waveform files with equal clock rate!

We assume, that a multi-segment sequence composed of four segments (Seg#0, Seg#1, Seg#2 and Seg#3) is created and loaded in the ARB (see ["To apply a manual segment switch to the output segments in the required order"](#) on page 332). The required output order of the segments is Seg#0, Seg#3 [2], Seg#2. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched on.

The following settings show an example of how to configure this segment output order with the help of the ARB sequencing function.

1. In the "ARB > Multi Segment" dialog, load the previously created list and execute "Create and Load".
2. Select "ARB > Multi Segment > General > Sequencing List".  
The "Multi Segment Waveform Sequencing" dialog opens. A new play list is created and assigned to the current multi-segment waveform file.
3. Select "ARB: Multi Segment Waveform Sequencing > Sequencing Play List" and use the "Append" function to add new rows to the list and configure the settings as follows:
  - a) Id#0: Seg#0, "Rep. Cycles = 1", "Next = Next Id#"
  - b) Id#1: Seg#3, "Rep. Cycles = 2", "Next = Next Id#"
  - c) Id#2: Seg#2, "Rep. Cycles = 1", "Next =Goto Id", "Go To = 0" (creates a loop to the first segment in the sequence)



4. Select "ARB: Multi Segment Waveform Sequencing > General > Save List" to store the configured play list.
5. To enable the instrument to use this play list, select "ARB > Trigger (MSW) > Next Segment Trigger In > Next Segment Mode > Sequencer".
6. Select "ARB > Trigger (MSW) > Trigger Mode = Armed Auto"
7. Select "ARB > Trigger (MSW) > Trigger Source = Internal"

The segments are played back (output) as defined in the sequencing list, i.e. the switch over to the next segment is performed automatically according to the rules and segment order defined in the "Sequencing Play List".

#### To add marker signals

We assume, that a multi-segment sequence composed of the segments Seg#0 [1], Seg#3 [2], Seg#2 [1] is created and loaded in the ARB (see ["To configure a multi-segment sequence using the play list function"](#) on page 335). The multi-segment sequence starts with Seg#0 and this segment is output once. The instrument is operated manually, the ARB generator is in active state, and the instrument output is switched on.

To add marker signals at the beginning of each segment and at the beginning of the sequence (see [Figure 5-22](#)), two additional marker signals, "Marker 2" and "Marker 1", are enabled and inserted into the multi-segment waveform.

1. Select "ARB > Marker > Marker Mode > Marker 1/Marker2 = Unchanged" to enable taking over of the marker signals defined inside the multi-segment sequence. If required, adjust the marker delay settings.
2. Select the "Block Diagram > Trigger/Marker/Clock" and map the "Logical Signals > Marker 1/Marker 2" to the desired connectors ("Global Connectors > User x > Direction = Output" and "Signal = Baseband Marker 1/Baseband Marker 2")
3. In the "ARB > Multi Segment > Level/Clock/Marker" dialog, select "Segment Marker = Ignore"



4. Enable "Level/Clock/Marker > Sequence Restart = Marker 1"
5. Enable "Level/Clock/Marker > Segment Restart = Marker 2"

An extra restart marker signal is generated at the beginning of each segment and the beginning of the waveform. These restart markers *overwrite* the existing Marker 1 and Marker 2 trace signals defined in the waveforms of the individual segments.

### 5.6.5 Reference to Triggering of Multi-Segment Waveforms

Signal generation of multi-segment waveforms takes place differently according to the trigger selected in the "ARB > Trigger In" section. The sections provide a detailed explanation of the effect of a trigger event on the multi-segment waveform processing, depending on the enabled "Next Trigger Mode". Refer to [Chapter 5.6.2.5, "Impact of the Trigger Settings and Next Segment Settings"](#), on page 313 for background information.

#### 5.6.5.1 Triggering in "Next Trigger Mode = Same Segment"

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

**Table 5-21: Waveform triggering: "Next Trigger Mode = Same Segment", "Trigger Source = Internal"**

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Trigger events are ignored. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Retrigger"	Output starts at once and the segment is generated continuously, a trigger event causes a restart. If the segment is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Retrigger"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs.

### 5.6.5.2 Triggering in "Next Trigger Mode = Next Segment"

Depending on the trigger setting, the segment selected under "Segment" is output either immediately or after a trigger event. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

**Table 5-22: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = Internal"**

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
"Single"	Output starts after the first trigger event. The segment is then generated once. Further trigger events cause a restart. If the segment index is changed in "Segment", the new segment is not output until a trigger occurs.

**Table 5-23: Waveform triggering: "Next Trigger Mode = Next Segment", "Trigger Source = External"**

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to outputting the subsequent segment, following a system-imposed signal gap. If the segment index is changed in "Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap. The subsequent trigger event after the last segment causes the first segment to be output again.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Further trigger events are ignored. Each next segment trigger event switches over to outputting the subsequent segment, following a system-imposed signal gap. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.
"Single"	Output starts after the first trigger event. The segment is then generated once. Each trigger event (re-)starts the segment; each next segment trigger event switches over to outputting the subsequent segment. If the segment is changed in "Segment", signal output is not stopped. The new segment is not output until a trigger occurs. The subsequent trigger event after the last segment causes the first segment to be output again.

For description of the "Retrigger" and "Armed\_Retrigger" trigger modes, see [Table 5-21](#).

### 5.6.5.3 Triggering in "Next Trigger Mode = Next Segment Seamless"

The segment selected under "Segment" is output. This mode is only available if all segments have the same sample rate.

**Table 5-24: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = Internal"**

"Trigger Mode"	Description
"Auto"	Output starts at once and the segment is generated continuously. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.
"Single"	Output starts at once and the segment is generated continuously. Each trigger event (re-)starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", the new segment is output seamlessly after the output of the current segment is complete.

**Table 5-25: Waveform triggering: "Next Trigger Mode = Next Segment Seamless", "Trigger Source = External"**

"Trigger Mode"	Description
"Armed_Auto"	Output starts after the first trigger event. The segment is then generated continuously. Each trigger event (re-)starts the segment; each next segment trigger event switches over to outputting the subsequent segment once the output of the current segment has been completed. If the segment is changed in "Segment", signal output is stopped and the new segment is not output until a trigger occurs.

For description of the "Retrigger" and "Armed\_Retrigger" trigger modes, see [Table 5-21](#).

### 5.6.5.4 Triggering in "Next Trigger Mode = Sequencer"

The waveform files are processed according to the order and repetition cycles defined in the special sequencing list file (\*.wvs) assigned to the multi-segment waveform file.

## 5.7 Generating Multi Carrier Signals

To simulate complex multi-carrier scenarios with different baseband signals, the R&S SMW provides the possibility to generate multi-carrier waveforms. These waveforms can consist of up to 512 carriers, each modulated by the same or by different user-selectable baseband signal.

The multi-carrier waveform is a practical solution for the generation of a complex broadband signal, for example:

- Multi-carrier waveforms build from the signals of *different* communication standards (e.g. CDMA2000 or 3GPP FDD)
- Multi-carrier waveforms composed of several signals from the *same* communication standard as this is the case with LTE Advanced.

Generation of multi-segment waveform files is possible in configurations with separated baseband sources ("System Configuration > Fading/Baseband Config > BB Source Configuration > Separated").

### 5.7.1 Required Options

See [Chapter 5.5.1, "Required Options"](#), on page 287.

Multi-carrier waveform files require the corresponding Digital Standard options (R&S SMW-K2xx) of all included standards.

### 5.7.2 About the Multi-Carrier Waveforms

This chapter provides background information on the ARB functionality for generating of multi carrier signals and the impact of the provided settings. Refer to [Chapter 5.7.4, "How to Use the Multi-Carrier Function"](#), on page 355 for information on how to use the provided settings to configure a multi carrier signal.

The multi-carrier waveforms are convenient way to configure the broadband test signals required for transmitter or receiver tests. Even complex multi-carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Because the multi-carrier files are processed by the ARB generator, the composed waveform file must be created before it is loaded to and played by the ARB. The R&S SMW stores the created multi-carrier waveform file under user definable name; as with the single carrier waveforms, the used file extension is \*.wv. The instrument appends additional information to the header of the composed waveform file. When the created waveform is loaded, the graphical interface displays information on clock rate, number of samples and creation day.

### General principle for composing the multi carrier signal

The following is a list of the general steps used for composing the multi carrier signal:

- In the default mode, the up to 512 carriers are equally spaced and centered toward the RF frequency or baseband DC line, respectively.  
The carrier spacing is adjustable within the total available bandwidth. The total RF bandwidth of the composed multi carrier signal may not exceed 160 MHz (see data sheet).
- Another possibility is to define the center frequency of each of the carrier individually, see also [Chapter 5.7.2.1, "Defining the Carrier Frequency"](#), on page 341.
- Each carrier can be separately defined in terms of power, phase and modulated input signal.  
To define the leveling of the composed multi carrier signal, use the parameter [Power Reference](#)
- Optionally, crest factor optimization can be applied (see [Chapter 5.7.2.2, "Optimizing the Crest Factor"](#), on page 342).
- After all multi-carrier processing steps are completed, the instrument calculates the resulting peak and RMS power over the total signal and enters the values in the waveform file.

#### 5.7.2.1 Defining the Carrier Frequency

There are two ways to define the carrier frequency of the individual carriers in the multi carrier signal.

- Enabling the **arbitrary carrier frequency** distribution and specifying the carrier frequency of each carrier individually.
- Using the built-in **equidistant carrier spacing** distribution function, i.e. enabling the carriers to be equally spaced and centered toward the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.

The maximum carrier spacing is calculated as a function of the available total bandwidth and the selected number of carriers as follows:

$$\text{Max Carrier Spacing} = \text{Total bandwidth} / (\text{Number of Carriers} - 1)$$

To avoid wrap-around problems, the effective applied carrier spacing can be slightly modified.

The value of the carrier spacing is rounded in that way that the carrier closest to the center RF frequency shows no phase jump assuming that the carrier is unmodulated.

- For odd number of carriers:

$$\text{RoundedCarrierSpacing} = 1 / \text{OutputSignalDuration} * \text{round}(\text{CarrierSpacing} * \text{OutputSignalDuration})$$

- For even number of carriers:

$$\text{RoundedCarrierSpacing} = 2 / \text{OutputSignalDuration} * \text{round}(0.5 * \text{CarrierSpacing} * \text{OutputSignalDuration})$$

The R&S SMW provides the parameter [Mode](#) for this purpose.

### 5.7.2.2 Optimizing the Crest Factor

An introduction to the topic is provided in [Chapter 5.3.1.7, "Methods for Optimizing the Crest Factor"](#), on page 239. This section focuses on the settings provided for and related to the multi carrier signals.

The R&S SMW provides a crest factor reduction in form of an automatic optimization upon selected values for the following parameters:

- **Crest factor optimization mode:** determines whether the phase settings are selectable or internally calculated to fulfill a requirement for the crest factor value.
- **Clipping:** reduces the peak power of the resulting multi carrier signal according to the input parameter "Target Crest Factor"  
The resulting clipped peak power is defined by sum of the RMS level of the unclipped multi carrier signal and the input parameter "Target Crest Factor".  
Because clipping reduces also the RMS level, the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor".
- **Target Crest Factor:** determines the desired crest factor. A value above the crest factor of the unclipped multi carrier signal has no effect.
- **Filter Cut Off Frequency:** determines the filter parameter of the final lowpass filter.  
When the cut-off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multi carrier signal. However, it may also increase the resulting crest factor.

### 5.7.3 Multi-Carrier Settings

- ▶ To access the dialog box, select "Baseband > ARB > General > Create Multi Carrier".

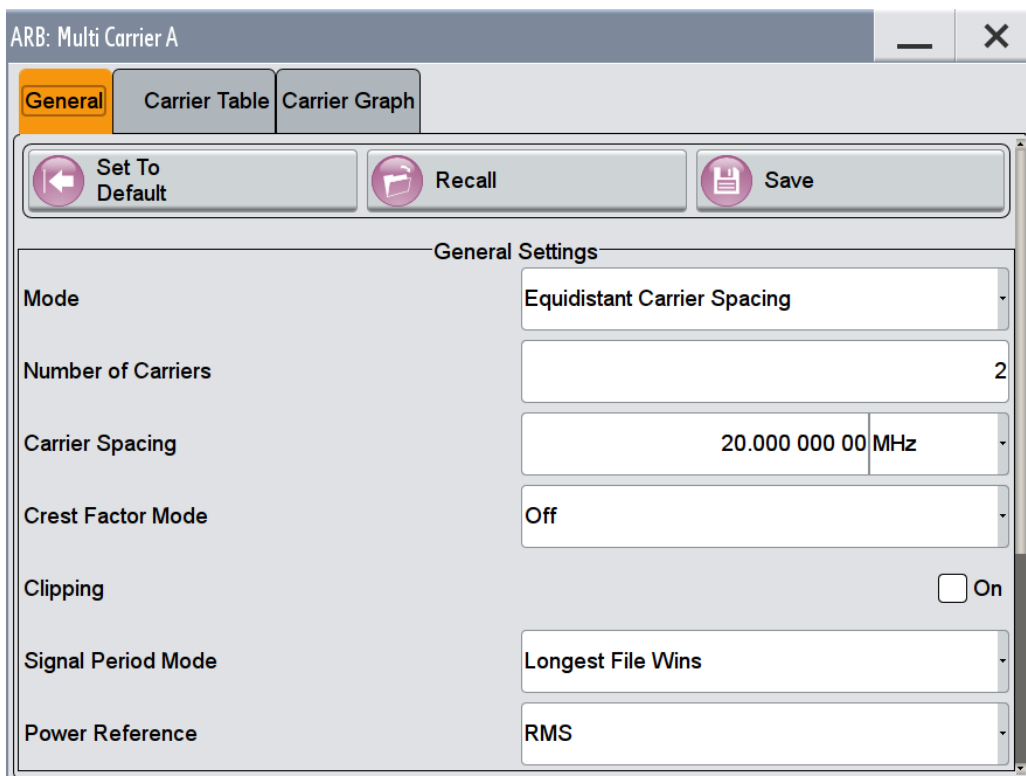
The "ARB: Multi Carrier" dialog enables direct configuration of the carrier distribution around the center frequency and adjusting some parameters for improving the signal characteristics.

The dialog is divided into several tabs. In each case, the current setting is displayed in the tab name. The tab "Carrier Table" enables the selection of the waveform files to be processed. Use the "Carrier Graph" to visualize the configured signal.

The remote commands required to define these settings are described in [Chapter 13.18.3.3, "SOURce:BB:ARbitrary Subsystem"](#), on page 844.

#### 5.7.3.1 General Settings

This tab provides access to the default settings, selecting the output waveform file and enabling the generation, and the configuration of the carrier distribution.



Set to Default..... 343

Save/Recall Frame..... 344

Mode..... 344

Number of Carriers..... 344

Carrier Spacing..... 344

Crest Factor Mode..... 345

Clipping..... 345

Target Crest Factor..... 345

Filter Cut Off Frequency..... 345

Signal Period Mode..... 346

Signal Period..... 346

Power Reference..... 346

Output Settings..... 348

    L File..... 349

    L Clock Rate..... 349

    L File Size..... 349

Create/Create and Load..... 349

**Set to Default**

Calls the default settings.

Parameter	Value
Number of Carriers	1
Carrier Spacing	0 MHz

Parameter	Value
Crest Factor Mode	Off
Signal Period Mode	Longest file wins

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:PRESet` on page 869

### Save/Recall Frame

Accesses the standard "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the complete dialog-related settings. Refer to [Chapter 10.4, "Storing and Recalling Instrument Settings"](#), on page 580 for a detailed description.

The multi-carrier settings are stored as files with the predefined file extension `*.arb_multcarr`. The file name and the directory they are stored in are user-definable.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:SETTING:CATalog?` on page 869

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:SETTING:LOAD` on page 869

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:SETTING:STORe` on page 870

### Mode

Selects the way the carriers are distributed within the available bandwidth.

"Equidistant Carrier Spacing"

Sets an equidistant carrier spacing distribution, i.e. the carriers are equally spaced and centered toward the RF frequency. The carrier frequencies are automatically calculated depending on the selected number of carriers and the carrier spacing.

"Arbitrary Carrier Frequency"

Enables the specification of the carrier frequency of each carrier individually.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier:MODE` on page 870

### Number of Carriers

Sets the number of carriers for the multi-carrier waveform. By default the multi-carrier table lists 1 carrier. A maximum of 512 carriers can be configured and activated.

When the number of carriers is increased, the multi-carrier table is extended by adding further lines at the end of the table. If these carriers already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

See also [Chapter 5.7.2.1, "Defining the Carrier Frequency"](#), on page 341.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier:COUNT` on page 870

### Carrier Spacing

Sets the frequency spacing between adjacent carriers of the multi-carrier waveform.



The carriers are arranged symmetrically around the RF carrier and the maximum carrier spacing is limited to:

**"Carrier Spacing" = Total baseband bandwidth / ("Number of Carriers" - 1)**, where the total baseband bandwidth is specified in the data sheet.

For more information, see [Chapter 5.7.2.1, "Defining the Carrier Frequency"](#), on page 341.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:CARRier:SPACing` on page 870

### Crest Factor Mode

Selects the mode for optimizing the crest factor by calculating the carrier phases. For more information, refer to [Chapter 5.7.2.2, "Optimizing the Crest Factor"](#), on page 342.

The following modes are available:

- |            |  |
|------------|--|
| "Off"      | There is no automatic setting for minimizing or maximizing the crest factor. The "Phase" setting as defined in the carrier table is in use.    |
| "Minimize" | The crest factor is minimized by internally calculating optimized carrier phases. The Phase setting displayed in the carrier table is invalid. |
| "Maximize" | The crest factor is maximized by internally calculating optimized carrier phases. The Phase setting displayed in the carrier table is invalid. |

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:CFACTOR:MODE` on page 871

### Clipping

Switches the baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the input parameter "Target Crest Factor". For more information, refer to [Chapter 5.7.2.2, "Optimizing the Crest Factor"](#), on page 342.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:CLIPping[:STATe]` on page 872

### Target Crest Factor

Sets the value of the desired crest factor, if baseband clipping is enabled.

A "Target Crest Factor" above the crest factor of the unclipped multi carrier signal has no effect. For more information, refer to [Chapter 5.7.2.2, "Optimizing the Crest Factor"](#), on page 342.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:CLIPping:CFACTOR` on page 872

### Filter Cut Off Frequency

Sets the cut-off frequency of the final lowpass filter, if baseband clipping is enabled.

When the cut-off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multi carrier signal. This process may increase the resulting crest factor. See also [Chapter 5.7.2.2, "Optimizing the Crest Factor"](#), on page 342.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:CLIPping:CUToff` on page 872

### Signal Period Mode

Defines the way the resulting signal period of the multi-carrier waveform is calculated. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF). Use the "Carrier Table > Info" function to obtain information on the sample rate and file length data of each carrier.

**Note:** Wrap-around and timing problems can occur when I/Q signals of different length are used. Thus, demodulation of a carrier can be difficult or even impossible. We recommend that you consider the timing when creating the input I/Q files or to adjust the signal duration to the carrier which is then demodulated (in this case, the other carriers are for interfering the signal only). These problems do not arise with signals of the same standard (e.g. 3GPP).

The following modes are available:

"Longest File Wins"

The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

"Shortest File Wins"

The resulting signal period is defined by the shortest I/Q file in the carrier table. Only the first part of longer I/Q files is used.

"User"

The signal period is set manually ([Signal Period](#)). Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

"Least Common Multiple"

The output file duration is the least common multiple of all input file durations.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:TIME:MODE` on page 873

### Signal Period

Sets the signal period in Signal Duration Mode "User". Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

Remote command:

`[ :SOURCE<hw> ] :BB:ARbitrary:MCARrier:TIME` on page 871

### Power Reference

Defines the way the individual carriers in a composed multi carrier signal are leveled. The difference between the provided modes is especially important if signals with different crest factors are composed together into a multi carrier signal.

"RMS" The individual carriers are leveled based on their RMS power and the configured "Carrier Gain".

**Example:**

A multi carrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multi carrier signal, the *RMS power* of the second carrier signal will be 3 dB lower than the RMS power of the first carrier signal.

"Peak" The individual carriers are leveled based on their peak power and the configured "Carrier Gain".

#### Example:

A multi carrier signal is composed from two waveform files.

First carrier "Gain" = 0 dB

Second carrier "Gain" = -3 dB

In the resulting multi carrier signal, the *peak power* of the second carrier signal will be 3 dB lower than the peak power of the first carrier signal.

#### Example: Multi carrier signal composed of waveforms with different crest factor

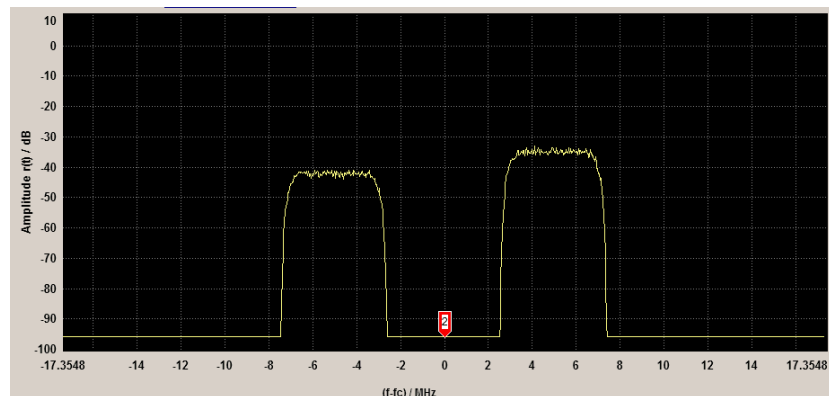
A multi carrier signal is composed from two waveform files with the following characteristics:

3GPP FDD signals with the same "Sample Rate" but *different "Crest Factors"*.

"Peak" = 0 dBFS

"Carrier Gain" = 0 dB

State	Carrier Freq [MHz]	Gain [dB]	Phase [deg]	Delay [ns]	File	Info	!!!
0 On	-5.000 000	0.00	0.00		0 /var/user/lte1	Info...	
1 On	5.000 000	0.00	0.00		0 /var/user/lte2	Info...	



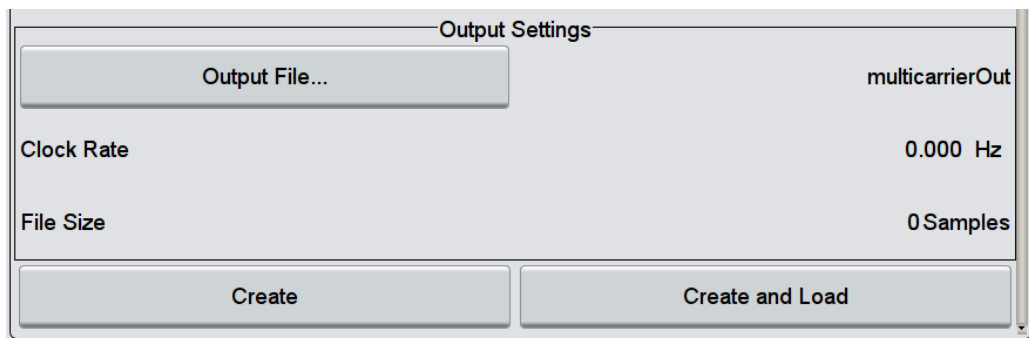
The Peak values of the carrier signals are equal, the RMS values are different.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:POWer:REFerence` on page 873

#### Output Settings

The output settings indicate the name, the file size, and the clock rate of the currently calculated multi-carrier output file.

**File ← Output Settings**

Accesses the standard "File Select" function to specify the output file name of the multi-carrier waveform to be calculated. As with normal waveforms, the file extension is \*.wv.

To trigger the calculation and storage of this multi-carrier waveform, select "Create" or "Create and Load".

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:OFILe` on page 873

**Clock Rate ← Output Settings**

Displays the resulting sample rate at which the multi-carrier waveform is output by the ARB generator. The output clock rate depends on the number of carriers, carrier spacing, and input sample rate of the leftmost or rightmost carriers.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CLOCK?` on page 874

**File Size ← Output Settings**

Displays the resulting number of samples of the multi-carrier waveform.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:SAMPles?` on page 871

**Create/Create and Load**

Creates a multi-carrier waveform defined by the multi-carrier table and general setting entries. If the calculation is triggered by the "Create and Load" function, the instrument creates the waveform and loads it in the ARB generator.

This multi-carrier waveform is stored with file name specified in "Output File". Depending on the configuration of the multi-carrier waveform, calculation may take some time. To stop the calculation, use the "Abort" function.

Remote command:

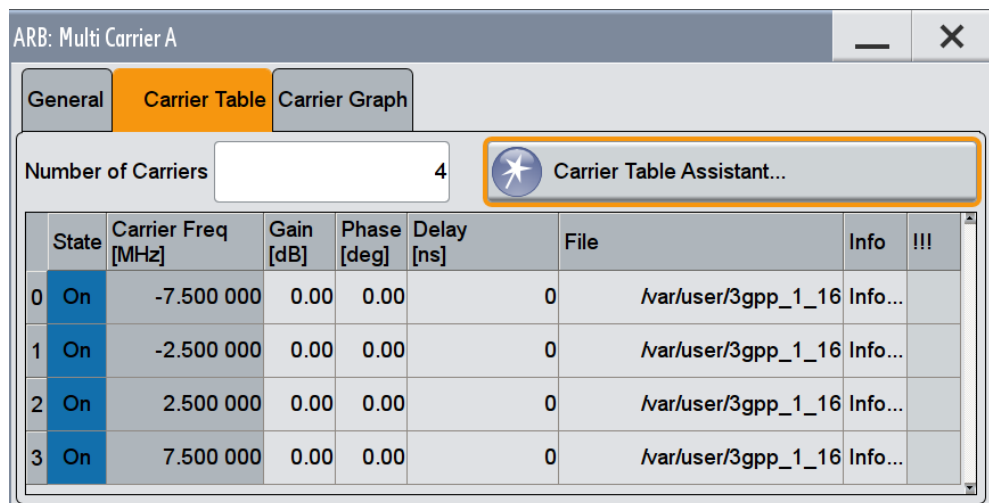
`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CREate` on page 874

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CLoad` on page 873

**5.7.3.2 Carrier Table Settings**

1. To access the dialog, select "Baseband > ARB > General > Multi Carrier".

2. Select "ARB: Multi Carrier > Carrier Table"



This tab comprises the settings of the individual carriers. A selectable carrier range can be set with the aid of the optional "Carrier Table Assistant". The settings of all available carriers are displayed in table form. Previously applied assistant settings can be further refined. The number of lines corresponds to the number of carriers.



The phase/deg settings are only valid if optimization of the crest factor is disabled ("Crest Factor Mode" = Off).

Use the "Carrier Graph" tab to visualize the selected multi-carrier configuration.

Number of Carriers.....	350
No.....	350
State.....	351
Carrier Freq [MHz].....	351
Gain.....	351
Phase.....	351
Delay.....	351
File.....	351
Info.....	351
!!!.....	351

**Number of Carriers**

Defines the number of carriers of the multi-carrier waveform.

This parameter is identical to the one in the "General Setting" section.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier:COUNT` on page 870

**No**

Indicates the carrier index ranging from 0 to (number of carriers -1).

Individual carriers can be set using the remote control commands by specifying the index in the parameter CARR.

**State**

Switches On/Off a carrier.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:STATe` on page 874

**Carrier Freq [MHz]**

Sets the carrier frequency.

**Note:** The carrier frequency can only be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:FREQuency`  
on page 874

**Gain**

Sets the gain of a carrier.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:POWer` on page 875

**Phase**

Sets the starting phase of a carrier.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:PHASe` on page 875

**Delay**

Sets the starting delay of a carrier.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:DELay` on page 875

**File**

Accesses the standard "File Select" function for selecting the input file with the I/Q signal to be modulated onto the carrier.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:FILE` on page 876

**Info**

Indicates the sample rate, number of I/Q value pairs (number of samples), and the resulting signal period of the selected I/Q input file.

Remote command:

n.a.

**!!!**

Indicates an occurred conflict by means of a warning triangle. A conflict arises when the carriers overlap and is also indicated in the header of the "Carrier Table" tab.

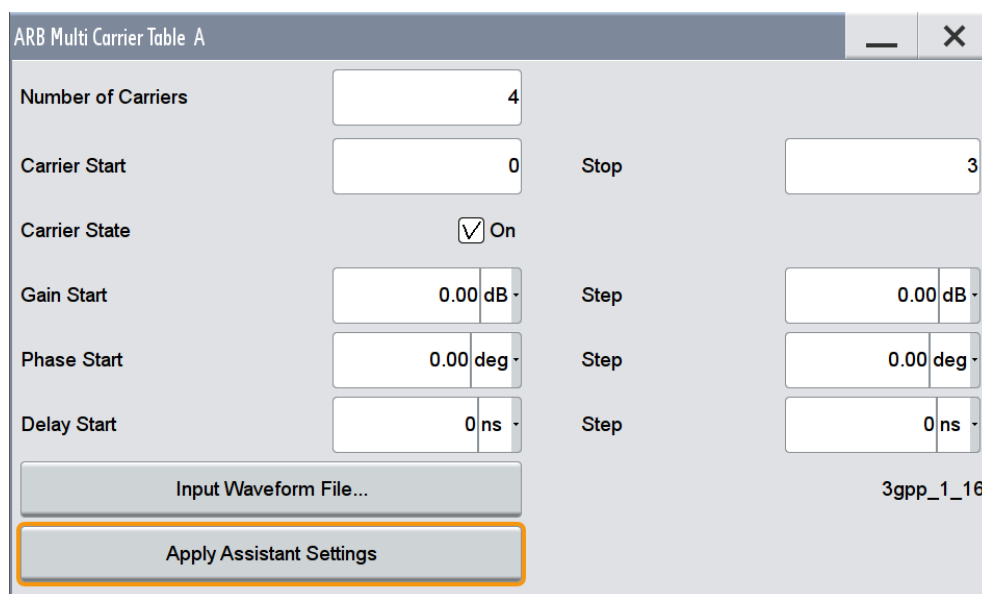
Remote command:

```
[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:CARRier<ch>:CONFLICT?
```

on page 876

### 5.7.3.3 Carrier Table Assistant

1. To access the dialog, select "Baseband > ARB > General > Multi Carrier".
2. Select "ARB: Multi Carrier > Carrier Table > Carrier Table Assistant"



The "Carrier Table Assistant" dialog enables the configuration of a selectable subset of carrier. The provided settings are an optional way to create a multi-carrier scenario within a specified carrier range.

<a href="#">Carrier State</a> .....	352
<a href="#">Carrier Start/Start</a> .....	353
<a href="#">Gain Start</a> .....	353
<a href="#">Gain Step</a> .....	353
<a href="#">Phase Start</a> .....	353
<a href="#">Phase Step</a> .....	353
<a href="#">Delay Start</a> .....	353
<a href="#">Delay Step</a> .....	354
<a href="#">Input Waveform File</a> .....	354
<a href="#">Apply Assistant Settings</a> .....	354

#### Carrier State

Switches the carriers in the range "Carrier Start" to "Carrier Stop" on/off.



Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:STATe` on page 876

### Carrier Start/Start

Defines the start/stop index of the carrier range to which the assistant settings are intended to apply.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:START` on page 876

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:STOP` on page 876

### Gain Start

Sets the gain of the carrier marked by "Carrier Start".

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:POWer[:START]`

on page 877

### Gain Step

Sets the step width that is used to increment the gain.

The resulting carrier gain in the carrier table equals:

$$\text{Gain} = \text{"Gain Start"} + n * \text{"Gain Step"}$$

where *n* ranges from 0 to ("Carrier Stop" - "Carrier Start").

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:POWer:STEP`

on page 877

### Phase Start

Sets the phase of the carrier marked by "Carrier Start".

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:PHASe[:START]`

on page 878

### Phase Step

Sets the step width that is used to increment the phase.

The resulting phase in the carrier table equals:

$$\text{Phase} = \text{"Phase Start"} + n * \text{"Phase Step"}$$

where *n* ranges from 0 to ("Carrier Stop" - "Carrier Start")

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRier:POWer:STEP`

on page 877

### Delay Start

Sets the delay of the carrier marked by "Carrier Start".

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRIER:DElay[:START]`  
on page 879

#### Delay Step

Sets the step width that is used to increment the delay

The resulting delay in the carrier table equals:

$Delay = "Delay\ Start" + n * "Delay\ Step"$ ,

where n ranges from 0 to ("Carrier Stop" – "Carrier Start").

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRIER:DElay:STEP`  
on page 878

#### Input Waveform File

Accesses the standard "File Select" function for selecting the input file with the I/Q signal to be modulated onto all carriers of the selected carrier range.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRIER:FILE` on page 879

#### Apply Assistant Settings

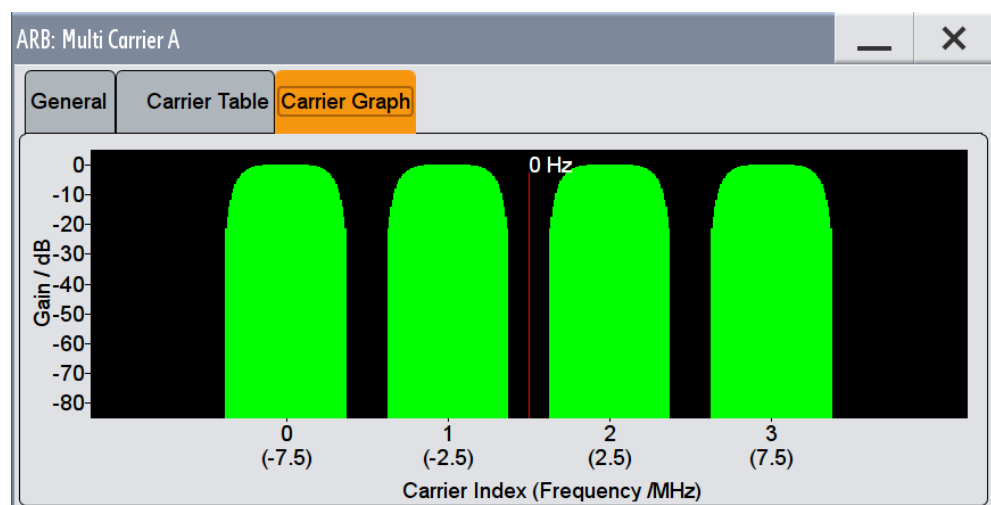
Transfers the assistant settings to the carrier table.

Remote command:

`[ :SOURce<hw> ] :BB:ARbitrary:MCARrier:EDIT:CARRIER:EXECute`  
on page 879

### 5.7.3.4 Carrier Graph

1. To access the dialog, select "Baseband > ARB > General > Multi Carrier".
2. Select "ARB: Multi Carrier > Carrier Graph"



The carrier graph is a graphical representation of the current multi-carrier configuration in the frequency domain.

The height of the bars corresponds to the selected gain of each individual carrier. The bandwidth of the carriers signals is indicated by the width of the bars.

#### 5.7.4 How to Use the Multi-Carrier Function

This section provides step-by-step instructions on how to configure and use the multi-carrier settings.

##### To create a multi-carrier waveform file (general workflow)

Perform the following general steps:

1. To configure the general settings, select "Baseband A/B > ARB > General"
2. To configure the carrier table select "ARB > Multi Carrier > Carrier Table"
3. To enter the file name of the multi-carrier waveform, select "ARB > Multi Carrier > Output File"
4. To save and load multi-carrier waveform, select "ARB > Multi Carrier > Create or Create and Load")

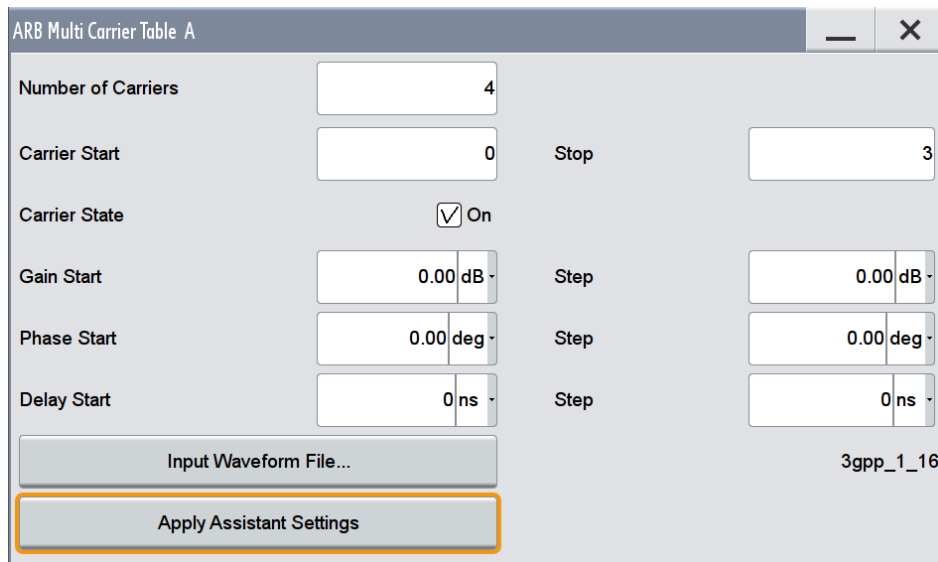
##### To generate a multi carrier signal for standard transmitter test

High power amplifiers of multi-carrier base stations face increased requirements in terms of linearity and acceptable intermodulation performance.

To set up a standard transmitter test, proceed as follows:

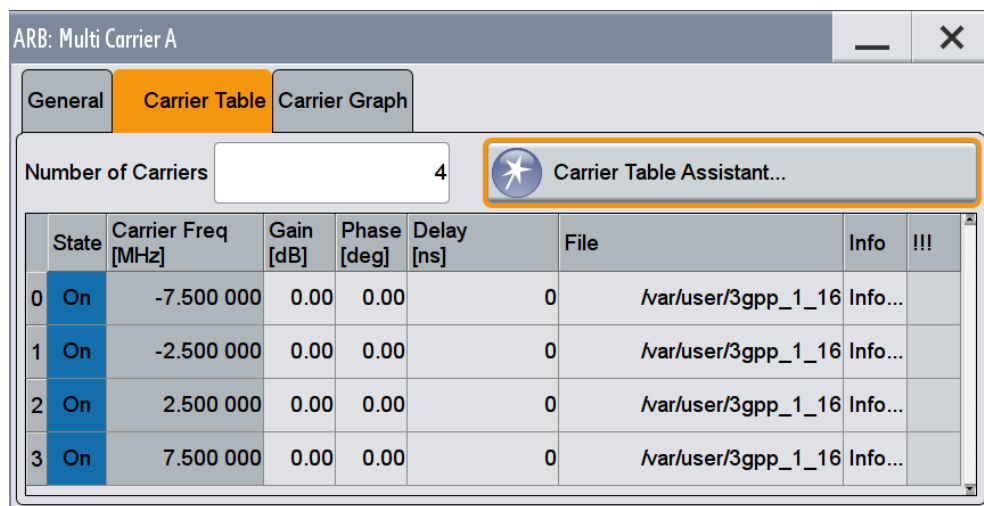
1. Select "Baseband > 3GPP FDD" dialog and perform the following:
  - a) select "3GPP FDD > Basestations > Test Setups/Models"
  - b) select "3GPP FDD: Downlink/Test Model > Test\_Model\_1\_16channels".
  - c) Confirm with "Select".
2. To enable signal generation, select "3GPP FDD > General > ON".
3. To create a 3GPP ARB file, select "3GPP FDD > Generate Waveform". Select the path and enter the name of the waveform file to be generated, for example 3gpp\_1\_16.
4. Confirm with "Save"
5. To set up a multi-carrier scenario with 4 carriers and a carrier spacing of 5 MHz, select "Baseband > ARB > Multi Carrier" and perform the following:
  - a) In the "General" dialog, select "Number of Carriers = 4" and "Carrier Spacing = 5 MHz".
  - b) To load the generated waveform file to all 4 carriers, select "Carrier Table > Carrier Table Assistant" and select "Carrier Start = 0" and "Carrier Stop = 3".

- c) To load the generated waveform file to all 4 carriers, select "ARB Multi Carrier Table > Input Waveform File", navigate to the generated waveform file 3gpp\_1\_16, and select it.
- d) Select "ARB Multi Carrier Table > Carrier State > On".

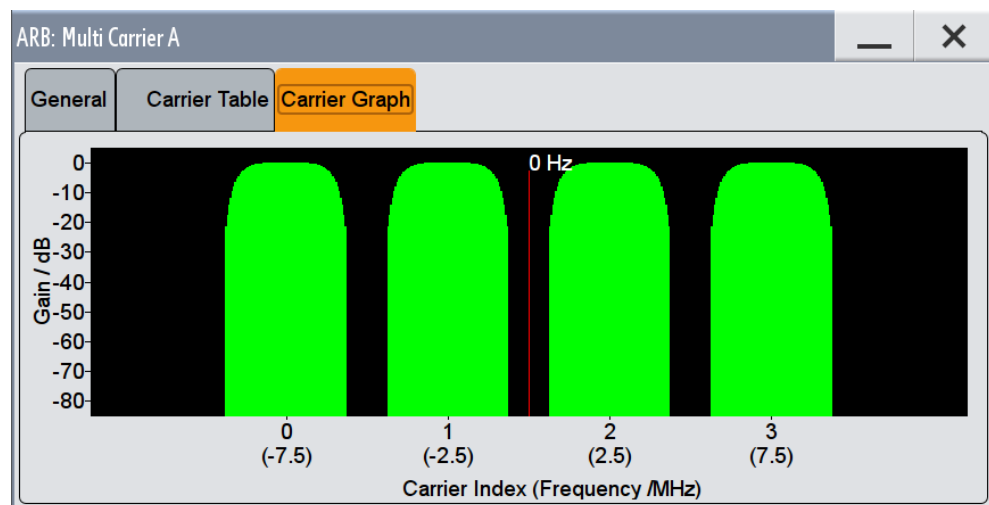


- e) Select "ARB Multi Carrier Table > Apply Assistant Settings" and close the dialog.

The "ARB: Multi Carrier > Carrier Table" dialog confirms the configuration.



- 6. Select "ARB: Multi Carrier > Carrier Graph" to visualize the configuration.



7. Select "ARB: Multi Carrier > General > Output File" and enter the name of the output file, for example 4x5MHz\_3gpp\_1\_16.
8. To trigger signal calculation and to load the waveform in the ARB generator, select "ARB: Multi Carrier > General > Create/Create and Load" function.
9. Select "ARB > General > Load Waveform" and confirm that the generated multi-carrier waveform is used.
10. Select "ARB > State > On" to enable the ARB generator.

## 5.8 Generating Multi-Carrier Continuous Wave Signal

The multi-carrier continuous wave (MCCW) is a firmware option that enables the R&S SMW to calculate up to 8192 continuous wave signals.

### 5.8.1 Required Options

The equipment layout for processing of waveform files includes

- Option Baseband Generator (R&S SMW-B10) per signal path
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)
- Option Multi-Carrier CW (R&S SMW-K61) per signal path

### 5.8.2 About the MCCW

The R&S SMW can calculate and generate a multi-carrier continuous wave signal build form up to 8192 unmodulated carriers. The carrier offset and the power level of the carriers are user-definable. The provided settings allow individual configuration of each carrier as well as the joint configuration of subset of carriers. Automatic start phase setting is provided to minimize the crest factor.

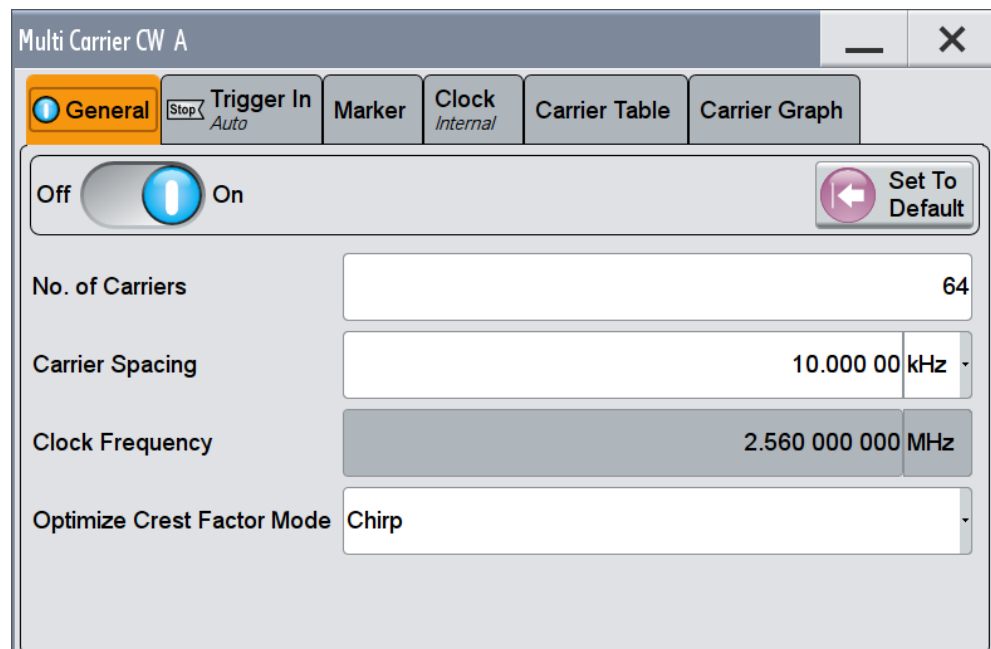
The multi-carrier CW signals are not generated in real-time but rather computed in arbitrary waveform mode. Changes in the carrier settings are not considered until the instrument is triggered to accept and apply them.

The common application fields of the multi-carrier CW signals are the receiver tests with broadband test signals.

### 5.8.3 MCCW Settings

- ▶ To access the dialog box, select "Baseband > Multi-Carrier CW".

The "Multi-Carrier CW" dialog enables direct carrier configuration and access to the carrier table and the graphical representation of the configured carriers.



The remote commands required to define these settings are described in [Chapter 13.18.3.5, "SOURce:BB:MCCW Subsystem"](#), on page 909.

#### 5.8.3.1 General Carrier Settings

State.....	358
Set to Default.....	359
Number of Carriers.....	359
Carrier Spacing.....	359
Clock Frequency.....	359
Optimize Crest Factor Mode.....	360
Desired Crest Factor.....	360

#### State

Enables/disables the Multi-Carrier CW.

Switching on this option, turns off all the other digital standards and digital modulation modes in the corresponding signal path.

Because Multi-Carrier CW signals are computed in arbitrary waveform mode, changes to the settings of individual carriers are not adopted until the "Accept" function is triggered. This applies to the settings in the "Table Setup Assistant" section and the "Carrier Table" dialog.

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:STATe` on page 916

### Set to Default

Calls the default settings, see [Table 5-26](#).

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:PRESet` on page 915

### Number of Carriers

Sets the number of carriers composing the Multi-Carrier CW signal.

**Note:** Cross-reference between total bandwidth, carrier spacing, and number of carriers. The total bandwidth of the multi-carrier CW signal is calculated as follows:

Total Bandwidth = ("Number of Carriers" - 1) \* "Carrier Spacing"

The result must not exceed the system bandwidth of the instrument (see data sheet). If the total bandwidth is not respected when entering the number of carriers, the value selected as "Carrier Spacing" is reduced. Hence, the number of carriers entered defines the maximum carrier spacing.

By default the multi-carrier table already lists 64 carriers that are preset to the settings State = ON, Power = 0 dB, Phase = 0°.

When entering fewer carriers than the table contains, the approach is generally to delete the superfluous entries from the table, and when entering more carriers than the table contains the missing entries are added at the end of the table.

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:CARRier:COUNT` on page 916

### Carrier Spacing

Sets the spacing between carriers for the Multi-Carrier CW signal. The carriers are arranged symmetrically around the HF carrier.

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:CARRier:SPACing` on page 916

### Clock Frequency

Displays the clock rate at which the Multi-Carrier CW signal is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers and the selected carrier offset.

The value indicates the resolution during the marker generation.

Remote command:

[ :SOURce<hw> ] :BB:MCCW:CLOCK? on page 916

#### Optimize Crest Factor Mode

Selects the mode for automatically minimizing the crest factor. The carrier start phases are automatically configured according to the selected mode.

Methods of reducing the crest factor differ regarding both the optimization achievable and the time required for computation. For more information, refer to [Chapter 5.3.1.7, "Methods for Optimizing the Crest Factor"](#), on page 239.

- |                |  |
|----------------|--|
| "Off"          | There are no automatic settings for minimizing the crest factor. Use the "Phase" parameter to set the start phase.   |
| "Chirp"        | Rapid crest factor optimization regardless of the number of carriers. A minimal crest factor of < 3 dB is only obtained for multi-carrier signals in which all carriers are switched on and the power of the carriers is identical. In a configuration which differs from this, the achievable crest factor is worse.  |
| "Target Crest" | Optimization of the crest factor to a desired value for all carrier configurations. The optimization time depends on the number of carriers and the desired crest factor. Computation time increases only when the number of carriers exceeds 256 and the crest factor is below 4 dB. The desired value can be entered in "Desired Crest Factor".<br><br><b>Note:</b> Optimization can be canceled at any time, and the current value being displayed at that moment is then used. |

Remote command:

[ :SOURce<hw> ] :BB:MCCW:CFACTOR:MODE on page 917

#### Desired Crest Factor

For optimization "Target Crest", defines the desired crest factor.

Remote command:

[ :SOURce<hw> ] :BB:MCCW:CFACTOR on page 917

### 5.8.3.2 Carrier Table

The provided settings enable the configuration of selectable range of carriers.



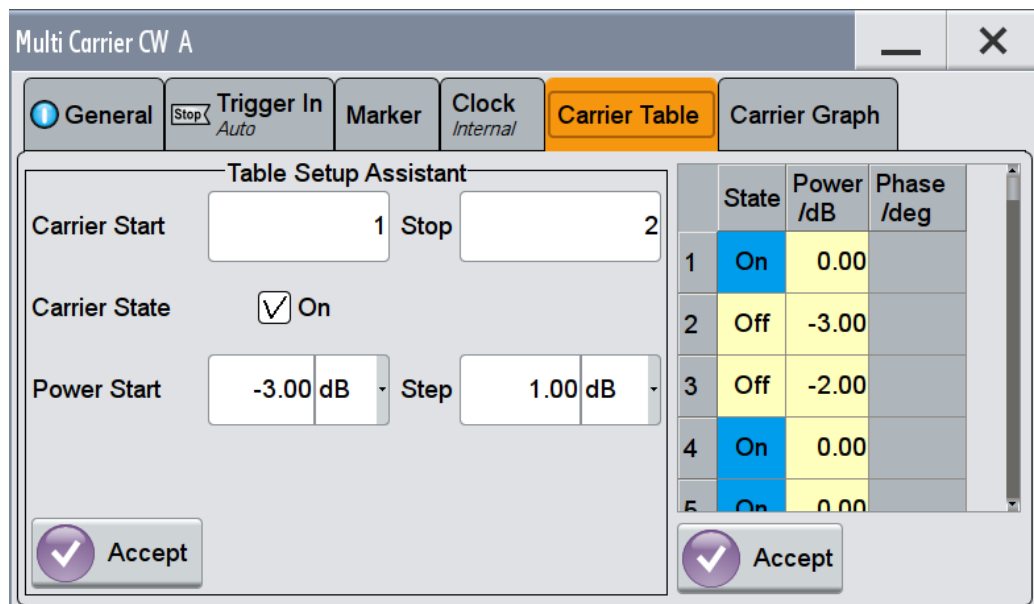


Table Setup Assistant..... 361

- L Carrier Start/Stop..... 361
- L Carrier State..... 361
- L Power Start..... 361
- L Power Step..... 362
- L Phase Start..... 362
- L Phase Step..... 362
- L Accept..... 362

Carrier Table..... 362

**Table Setup Assistant**

Enables joint configuration of selectable range of carriers.

**Carrier Start/Stop ← Table Setup Assistant**

Defines the start/stop index of the carrier range to which the following settings are intended to apply.

Remote command:

[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:START on page 921

[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:STOP on page 921

**Carrier State ← Table Setup Assistant**

Switches the carriers in the carrier range on/off.

Remote command:

[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:STATe on page 921

**Power Start ← Table Setup Assistant**

Sets the power of the starting carrier.

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:POWer [ :START ]` on page 920

#### **Power Step ← Table Setup Assistant**

Sets the width of the step with which the power is changed from carrier to carrier.

The individual power of each carrier ("Carrier Table > Carrier# >Power") is calculated as "Power Start" + n\*"Power Step".

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:POWer:STEP` on page 921

#### **Phase Start ← Table Setup Assistant**

Sets the phase of the starting carrier. This setting is only available for "Optimize Crest Factor Mode > Off".

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:PHASe [ :START ]` on page 920

#### **Phase Step ← Table Setup Assistant**

Sets the width of the step with which the phase is changed from carrier to carrier.

The individual phase of each carrier ("Carrier Table > Carrier# >Pahse") is calculated as "Phase Start" + n\*"Phase Step".

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:PHASe:STEP` on page 921

#### **Accept ← Table Setup Assistant**

Adopts the carrier range setting into the "Carrier Table".

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:EDIT:CARRier:EXECute` on page 922

#### **Carrier Table**

A table with settings for the configuration of the individual carriers.

The multi-carrier CW signal is only computed when the "Accept" function is triggered. Whenever the carrier table contains settings that have not yet been adopted with the "Accept" function, the background is yellow.

**Note:** The phase/deg settings are only valid if optimization of the crest factor is disabled ("Optimize Crest Factor > Off").

**Tip:** Use the [Carrier Graph](#) function to display the current carrier configuration.

"No."	This is the carrier index.
"State"	Switches a carrier on/off
"Power"	Sets the power of a carrier. If you use the <a href="#">Table Setup Assistant</a> settings to fill the individual carrier powers, the power of a carrier is calculated as "Power Start" + n*"Power Step".
"Phase"	Sets the starting phase of a carrier. If you use the <a href="#">Table Setup Assistant</a> settings to fill the individual carrier powers, the power of a carrier is calculated as "Phase Start" + n*"Phase Step".

"Accept" Transfers the settings in the carrier table into the instrument.

Remote command:

`[ :SOURce<hw> ] :BB:MCCW:CARRier:LIST:STATe` on page 918

`[ :SOURce<hw> ] :BB:MCCW:CARRier:STATe` on page 917

`[ :SOURce<hw> ] :BB:MCCW:CARRier:LIST:POWer` on page 920

`[ :SOURce<hw> ] :BB:MCCW:CARRier:POWer` on page 919

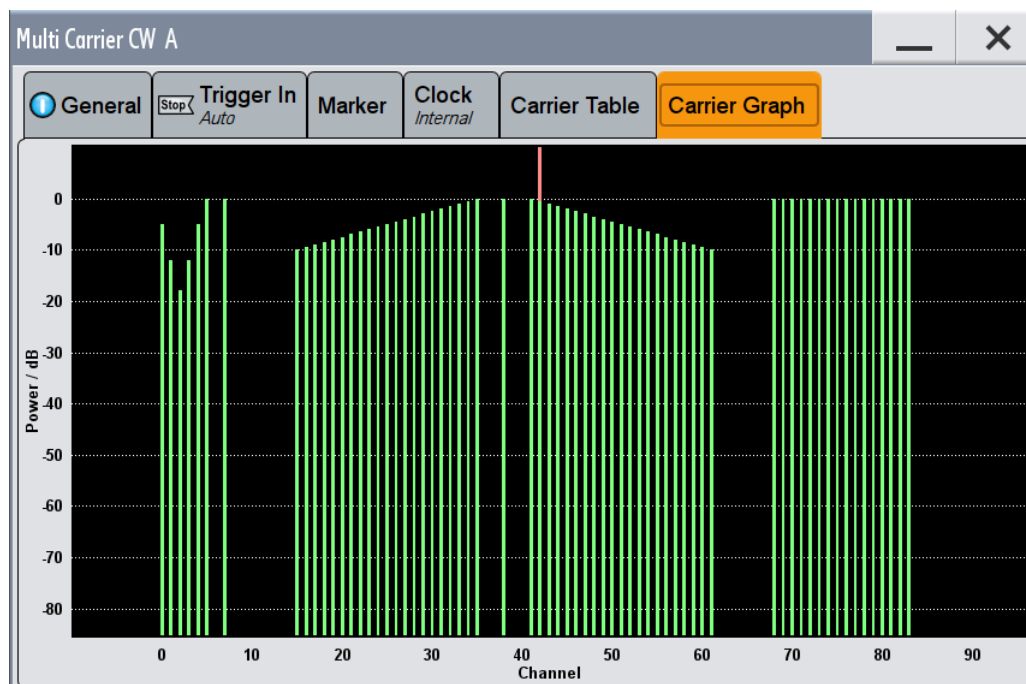
`[ :SOURce<hw> ] :BB:MCCW:CARRier:LIST:PHASe` on page 919

`[ :SOURce<hw> ] :BB:MCCW:CARRier:PHASe` on page 918

### 5.8.3.3 Carrier Graph

The "Carrier Graph" tab is a graphical representation of the current carrier configuration.

The carriers are on the X-axis and the colored bars represent those carriers which are in the On state. Power is on the Y-axis, and the height of the bars corresponds to the chosen power of each individual carrier.



### 5.8.3.4 Trigger, Marker and Clock Setting

These tabs provide standard settings.

For detailed description, see:

- [Chapter 5.3.2.1, "Trigger Settings"](#), on page 242
- [Chapter 5.3.2.2, "Marker Settings"](#), on page 247
- [Chapter 5.3.2.3, "Clock Settings"](#), on page 248
- [Chapter 5.3.2.4, "Local and Global Connector Settings"](#), on page 249

#### 5.8.4 How to Use the Multi-Carrier Continuous Wave Function

This section provides examples on how to use the multi-carrier continuous wave function in some general test cases.

##### To generate a test signal for testing the frequency response of a DUT

If the test case requires a signal for DUT testing, like Power Amplifier or Filter with a bandwidth of 80 MHz, proceed as follows:

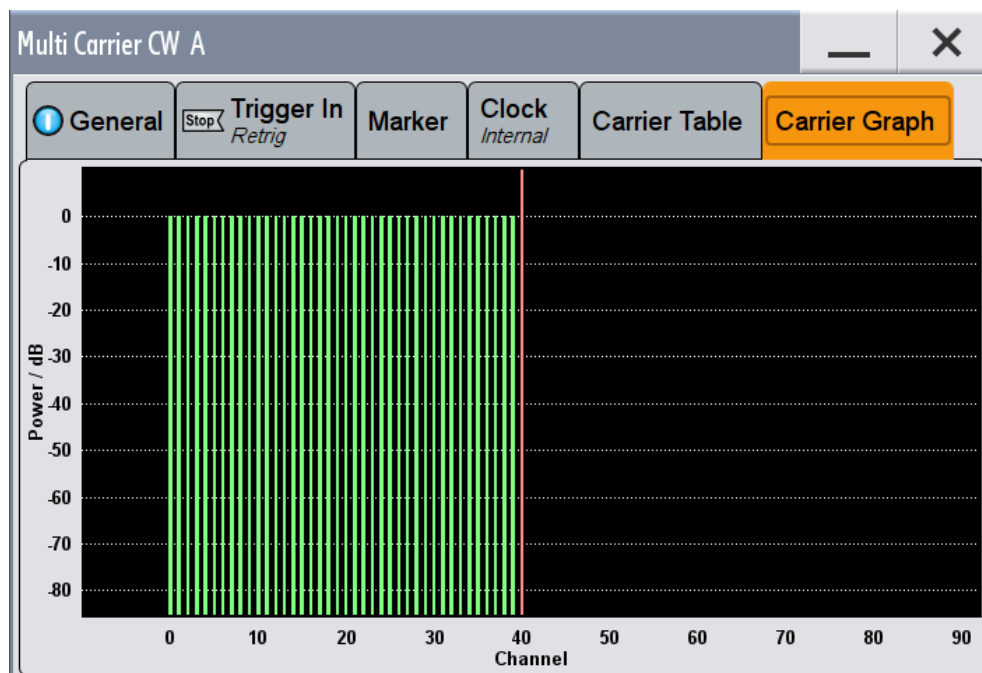
1. Connect the DUT to the output connectors of the instrument.
2. Connect a suitable measurement equipment, like signal analyzer to the DUT.
3. Select "Baseband > Multi-Carrier Continuous Wave" and enable "No. of Carriers = 81" and "Carrier Spacing = 1 MHz".
4. Adjust further settings, e.g. trigger setting, as required and enable signal generation with "Multi-Carrier Continuous Wave > State > ON".
5. Enable the signal output with "RF > ON".
6. On the connected signal analyzer, perform the required measurement tasks and measure the frequency response at the outputs of the DUT.

##### To generate a single sideband test signal for testing the image rejection

If a single sideband test signal for testing the image rejection capabilities of DUT is required, proceed as follows:

1. Connect the DUT to the output connectors of the instrument.
2. Connect a suitable measurement equipment, like signal analyzer to the DUT.
3. Select "Baseband > Multi-Carrier Continuous Wave" and enable "No. of Carriers = 81" and "Carrier Spacing = 1 MHz".
4. Select "Multi-Carrier Continuous Wave > Carrier Table" and select "Carrier Start = 40", "Carrier Stop = 80", "Carrier State = Off" and confirm with "Accept".

Open the "Multi-Carrier Continuous Wave > Carrier Graph" to visualize the configured single sideband signal.



5. Adjust further settings, e.g. trigger setting, as required and enable signal generation with "Multi-Carrier Continuous Wave > State > ON".
6. Enable the signal output with "RF > ON".
7. On the connected signal analyzer, perform the required measurement tasks and measure the frequency response at the outputs of the DUT.

### 5.8.5 References

**Table 5-26: MCCW default values**

Parameter	Value
State	Not affected by "Set to Default"
<b>Carrier Setup</b>	
Number of Carriers	64
Carrier Spacing	10 kHz
Optimize Crest Factor	Chirp
Desired Crest Factor	3 dB
<b>Trigger</b>	
Mode	Auto
Source	Internal
Ext. Delay	0
Ext. Inhibit	0

Parameter	Value
<b>Marker</b>	
Channel 1...4	Restart
<b>Clock</b>	
Source	Internal
<b>Multi Channel Setup</b>	
Start Carrier	0
Stop Carrier	0
State	ON
Power	0 dB
Power Step	0 dB
Initial Phase	0°
Phase Step	0°
<b>Channel Setup</b>	
State	ON
Phase	0°
Power	0 dB

## 5.9 Generating a Linear Slope Ramp Waveform

Generating a linear slope ramp waveform with the baseband generator is a function that requires the additional option Baseband Power Sweep (R&S SMW-K542). The main application field of these signals is amplifier tests, e.g. to determine the 1 dB compression point of an amplifier.

See user manual R&S®SMW-K542 Baseband Power Sweep.

## 5.10 Shifting and Boosting the Baseband Signal

The R&S SMW provides settings to frequency offset or power boost the baseband signals (internally generated and externally supplied) relative to the signals of the other baseband sources.

### 5.10.1 About the Baseband Offsets

The applied baseband frequency and phase offset and path gain affect the signal on the output of the corresponding block, "Baseband" or "BB Input". The shifting of the central frequency of the baseband signal is one of the tasks of the resampler.

#### 5.10.1.1 Impact of the Frequency Offset

For some applications, it is helpful to shift the baseband signal with a user defined baseband frequency offset to a different center frequency so that the signal characteristics are improved. The provided parameter frequency offset shifts the center frequency of the wanted baseband signal and provides a quick way to shift the used frequency band in the RF frequency domain without modifying the RF settings.

See [Chapter 5.10.3, "How to Improve Signal Characteristics by Shifting the Wanted Baseband Signal"](#), on page 371.

#### Limitations

The complex I/Q bandwidth of the shifted useful signal must not exceed the total available baseband bandwidth (see data sheet). The setting range of the frequency offset is then calculated as follows:

$$-(TotalBasebandBandwidth/2) + f_{use}/2 \leq f_{offset} \leq (TotalBasebandBandwidth/2) - f_{use}/2,$$

where

$f_{use}$  is the complex useful bandwidth of the I/Q signal before the offset

$f_{offset}$  is the frequency offset

The [Figure 5-23](#) illustrates the setting range of the frequency offset.

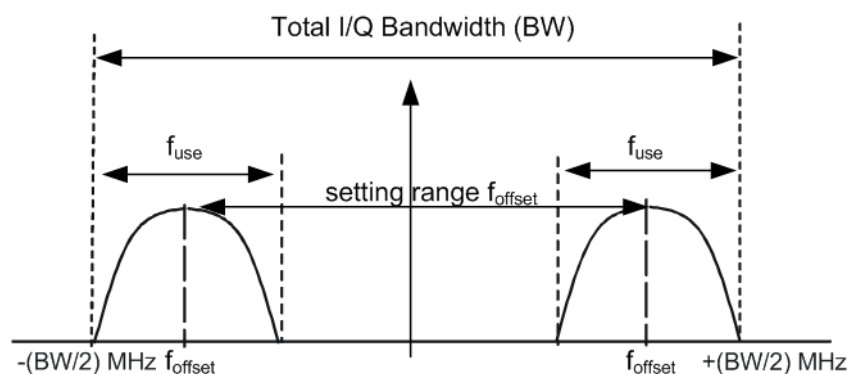


Figure 5-23: Setting range of frequency offset

**Example: Calculating the maximum frequency offset**

This example uses the following signal:

- "Standard = 3GPP FDD"
- "Chip Rate = 3.84 Mcps"
- "Filter Type = Root Cosine"
- "Roll Off Factor = 0.22"

The complex useful bandwidth of filtered signal is calculated as follows (see ["Impact of the Filter Parameters"](#) on page 238):

- $f_{use} = (1 + \text{"Roll Off Factor"}) * \text{"Symbol Rate"}$
- $f_{use} = (1 + 0.22) * 3.84 \text{ MHz} = 4.6848 \text{ MHz}$

For an instrument with a total available I/Q bandwidth of 160 MHz, the valid range of values for the frequency offset is then:

- $-160 \text{ MHz}/2 + 4.6848 \text{ MHz}/2 \leq f_{offset} \leq 160 \text{ MHz}/2 - 4.6848 \text{ MHz}/2$  or
- $-77.6576 \text{ MHz} \leq f_{offset} \leq 77.6576 \text{ MHz}$

**How to observe the effect?**

Use the built-in real-time graphical display ("System Configuration > Graphics > Power Spectrum") and observe the power spectrum of the signal with and without frequency offset:

- See [Chapter 3.3.6, "Verifying the Generated Signal with the Graphics Display"](#), on page 81
- See also ["To set and verify a baseband frequency offset"](#) on page 544.

**5.10.1.2 Impact of the Phase Offset**

The "Phase Offset" determines the phase offset between the different baseband signals. A phase offset rotates each point of an I/Q constellation diagram by the specified phase offset.

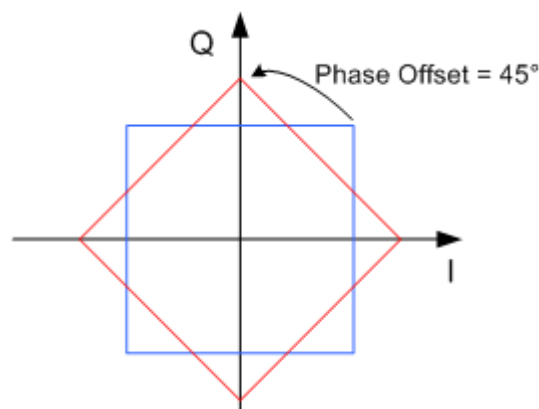


Figure 5-24: Effect of a Phase Offset of 45 degree angle on the I/Q constellation diagram



**How to observe the effect?**

Use the built-in real-time graphical display ("System Configuration > Graphics > Constellation") and observe that the points on the I/Q constellation diagram are turning counterclockwise, see [Chapter 9.1, "Displaying Baseband Signal Characteristics in Real-Time"](#), on page 526.

**5.10.1.3 Impact of the Gain**

The "Gain" of the different baseband sources determine the relative gain of the associated signals relative to each other.



In "System Configuration > Standard Mode", the baseband signal can be additionally faded and routed at the output of the fading simulator, in the way that the faded signals from the basebands are summed. The real gain of such signal is measured at the output of the "Fading" block and set with the fading parameter "Summation Ratio A/B" (see description "Fading Simulator", section "Summation Ratio A/B").

The relative gain set with the parameter "Gain" in the "Baseband" block is ignored.

The real gain in a signal path depends on the following parameters along with the defined baseband gain:

- Signal characteristics, in particular the crest factor
- Number of baseband sources
- Overall RF output level.

**How to observe the effect?**

To verify and visualize the cumulative baseband signal, use:

- the "System Configuration > Graphics > Power Spectrum" view, see ["To set and verify path gain and routing"](#) on page 546.  
See also [Chapter 3.3.6, "Verifying the Generated Signal with the Graphics Display"](#), on page 81.
- the "Setup > Baseband Powers Simulation" dialog, see [Chapter 9.2, "Querying Information on the Baseband Power Levels"](#), on page 553.

**5.10.2 Baseband Offsets Settings**

- ▶ To access this dialog box, select "Baseband > Baseband Offsets" or "BB Input > Baseband Offsets".

The "Baseband Offsets" dialog provides the settings necessary to add frequency and/or phase offset or a path gain to the baseband signals relative to each other.

Baseband Offsets			
	Frequency Offset /Hz	Phase Offset /°	Gain /dB
Baseband A	0.00	0.00	0.000
BB Input A	1 000 000.00		3.000
BB Input B	0.00		0.000
Baseband B	0.00	0.00	0.000

The block diagram shows an icon  $\Delta f$  on the corresponding signal path to indicate an applied frequency offset.

### Frequency Offset

Enters the frequency offset for the internal or external baseband signal and shifts the useful baseband signal in the center frequency.

See:

- [Chapter 5.10.1.1, "Impact of the Frequency Offset"](#), on page 367 for detailed information on the calculation of the frequency offset value range
- [Chapter 5.10.3, "How to Improve Signal Characteristics by Shifting the Wanted Baseband Signal"](#), on page 371

**Note:** A frequency offset cannot be applied to external or internal signals with sample rates of exactly 100 MHz. The digital signal is fed into the signal path directly and not routed to the resampler where the frequency offset is performed.

Remote command:

`[ :SOURce<hw> ] :BB:FOFFset` on page 812

`[ :SOURce<hw> ] :BBIN:FOFFset` on page 812

### Phase Offset

Enters the phase offset for the baseband signal of the selected baseband block compared to the other baseband signals (see [Chapter 5.10.1.2, "Impact of the Phase Offset"](#), on page 368).

The phase offset affects the signal on the "Baseband block" output.

Remote command:

`[ :SOURce<hw> ] :BB:POFFset` on page 813

### Gain

Enters the relative gain for the external or internal baseband signal compared with the signals of the other baseband sources. The gain affects the signal on the output of the "BB Input" block.

Refer to [Chapter 5.10.1.3, "Impact of the Gain"](#), on page 369 for detailed information.

Remote command:

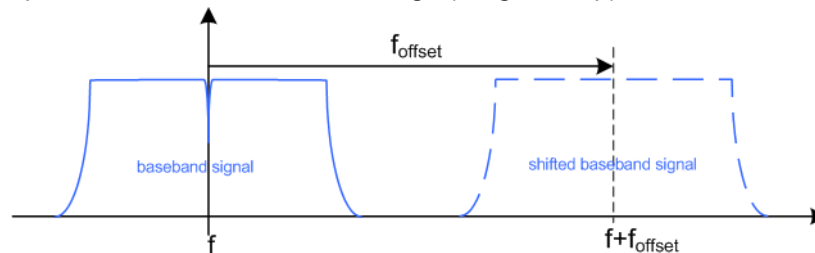
[ :SOURce<hw> ] :BB:PGAin on page 813

[ :SOURce<hw> ] :BBIN:PGAin on page 813

### 5.10.3 How to Improve Signal Characteristics by Shifting the Wanted Baseband Signal

Shifting of the generated baseband signal is useful in the following cases:

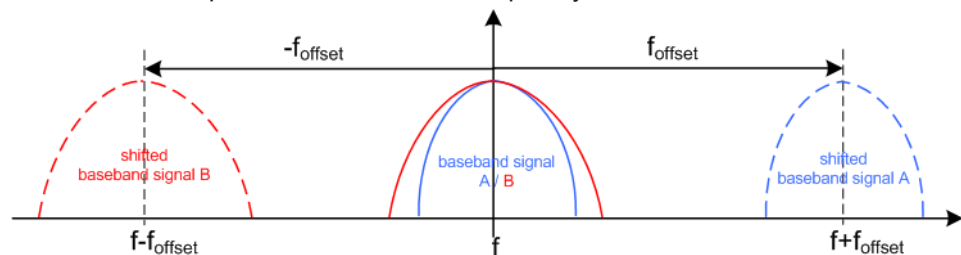
- You analyze the generated signal with a signal analyzer and the displayed signal spectrum indicates a carrier leakage (a signal drop) at the current RF frequency.



Shifting the baseband signal to a different center frequency can eliminate the carrier leakage problem.

Alternatively, apply an I and/or Q offset and vary the settings until the observed signal drop disappears, see ["To optimize the carrier leakage suppression"](#) on page 397.

- You generate a test signal as a sum of two basebands with overlapping spectra, for example two internal baseband signals (baseband A and baseband B), an internal and an externally supplied baseband signals, and you route the sum signal to the same RF output with the same RF frequency.



- Shifting one of the basebands allows you to analyze them both
- Shifting both baseband signals with the same frequency offset results in a signal with carrier frequency in the center of the RF bandwidth

In the following examples, we assume that:

- The R&S SMW generates a baseband signal
- A spectrum analyzer is connected to the R&S SMW, the analyzed is configured and measures the required signal characteristics.

#### To shift the generated baseband signal

- Select "Baseband > Baseband Offsets > Frequency Offset" and apply an offset to the generated baseband signal.

**To verify the characteristics of the generated signal and to observe the effect of applied frequency offset and gain**

- ▶ Use the built-in real-time graphical display.  
Refer to [Chapter 3.3.6, "Verifying the Generated Signal with the Graphics Display"](#), on page 81 for an example.

## 6 Simulating Fading, Adding Noise and Predistortions, and Impairing the Signal

The test case scenarios in accordance with the specifications often require a not "clean" signal but rather a signal that is impaired or interfered. To fulfill such requirements, the R&S SMW is equipped with a fading simulator and noise generator and provides the possibility to impair and predistort the digital I/Q signal.

This section describes the following functions:

- [Simulating Fading](#)..... 373
- [Adding Noise to the Signal](#).....373
- [Impairing the Signal](#)..... 390
- [Applying Digital Predistortion](#)..... 398

### 6.1 Simulating Fading

A wireless signal transmitted over the air is subject to noise interference and fading. Fading can impair the transmitted signal significantly and hence strongly influence the performance of a communication system. Fading can cause decreased signal-to-noise ratio or can introduce inter-symbol interference.

To simulate real-world conditions, the R&S SMW is equipped with an integrated real-time fading simulator. With the provided functions, you can simulate repeatable fading conditions for receiver tests.

For a description of the fading simulator, refer to the user manual "Fading Simulator".

### 6.2 Adding Noise to the Signal

This section introduces the concept of the AWGN generator (Additive White Gaussian Noise) and describes the settings for generation of noise, sine wave interferer, and adding noise to the generated signal.

#### 6.2.1 Required Options

The equipment layout for generating an AWGN signal includes:

- Option Baseband Generator (R&S SMW-B10) per signal path
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)
- Option Noise Generator (R&S SMW-K62) per signal path

## 6.2.2 About the AWGN Generator

Provided the required options are installed, the R&S SMW allows you to superimpose noise on the generated signal. The built-in internal noise generator generates an AWGN signal (Additive White Gaussian Noise) with selectable bandwidth and adds it to the digital baseband signal. The main characteristic of this kind of noise signal is the Gaussian distribution of the noise power density and uniform frequency distribution.

### Generation of the AWGN signal

The Gaussian noise is generated with a feedback shift register with subsequent probability transformation. The switching configuration is such that ideal statistical characteristics are achieved:

- I and Q paths are decorrelated from each other.
- Small probabilities are ensured via the crest factor of 15 dB
- The period of the noise signal depends on the selected system bandwidth. The relationship of period  $P$  to system bandwidth  $B_{\text{sys}}$  is approximated:  

$$P \approx (2^{800}-1) / B_{\text{sys}}$$
  - This results in periods between  $10^{225}$  years with minimum bandwidth and approximately 2 days with maximum bandwidth.
  - For comparison, this corresponds to a period of approximately one month for 3GPP FDD with a bandwidth of 3.84 Mcps, and a period of 427 days for GSM with 270.833 ksps.
- Scalable low-pass filters are used to produce a noise level with both a broad dynamic range and a broad bandwidth range (from 1 kHz to 60 MHz).

### AWGN modes

The AWGN generator generates signal in one of the following different modes:

- **"Additive Noise"**: the generated noise signal superimposes the interference-free useful signal
- **"Noise Only"**: a pure noise signal is generated and modulated to the carrier; the connection to the baseband is interrupted.

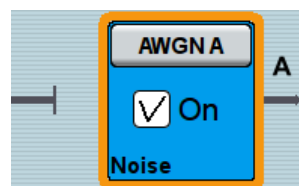


Figure 6-1: Representation of an "AWGN > Mode > Noise Only" in the block diagram

- **"CW Interferer mode"**: a sinusoidal signal with an adjustable frequency offset and carrier-to-interferer (C/I) power ratio is added to the baseband signal by a counter instead of a shift register.

### Signal and noise parameters

The [Figure 6-2](#) illustrates the relation between the signal and noise parameters.

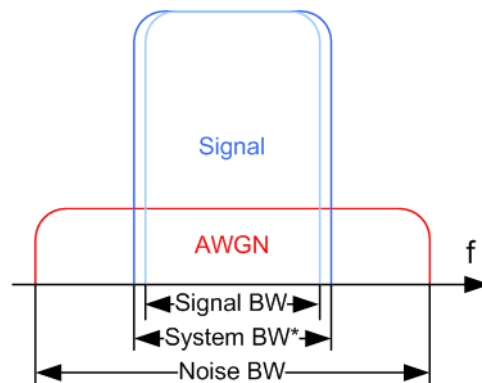


Figure 6-2: Graphical representation of the relation between system bandwidth and noise bandwidth (Minimum Noise/System BW = 2)

System BW\* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and is therefore a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but with the target signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*. This indication corresponds to the "Level" value in the "Status bar" (see Figure 6-3).

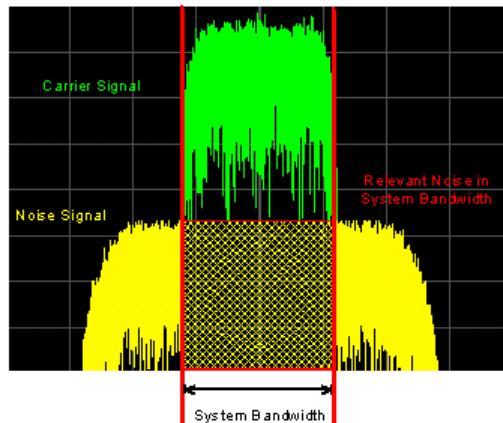
To ensure flat noise within the selected system bandwidth, the **noise bandwidth** has to be larger than the system bandwidth. The minimum noise bandwidth is sometimes part of the specifications and is calculated as follows:

$$\text{"Noise Bandwidth"} = \text{"System Bandwidth"} \times \text{"Minimum Noise/System Bandwidth Ratio"}$$

Logically, the calculated noise bandwidth may not exceed the total available bandwidth of the instrument, as specified in the data sheet.

By default, the **noise power** within the system bandwidth is not defined directly but calculated depending on the selected system bandwidth and the desired SNR. The noise power over the noise bandwidth is calculated respectively.

The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. This means that the total measurable noise power usually exceeds the displayed value "Noise Power".



For a correct measurement of the noise power within the system bandwidth, it is recommended that you perform channel power measurement with a signal analyzer.

In the "Additive Noise" mode, the output signal is the *signal with the noise distribution*. Hence, the power level at the RF output corresponds to the **carrier+noise power** (see [Figure 6-3](#)).

The noise power of digitally modulated signal is characterized by the parameter  $E_b/N_0$  indicating the ratio of bit energy to noise power density. The correlation to the SNR is as follows:

$C/N$  or  $S/N = (E_b/N_0) * (f_{bit}/B_{sys})$ , where  $B_{sys}$  is the system bandwidth and

the Bit Rate  $f_{bit} = \text{"Symbol Rate"} * \text{Modulation Value}$



#### Where the bit rate value is retrieved from?

The parameter "AWGN > Bit Rate" indicates the value used by the C/N or  $E_b/N_0$  calculation. The value is retrieved automatically depending on the configured baseband signal:

- For signals generated by the "Custom Dig Mod", the bit rate is determined by the selected standard (see parameter "Custom Dig Mod > General" > "[Symbol Rate](#)").
- For signals generated in accordance to a digital standard, the bit rate is often a stand-alone parameter. Some test cases however, for example the 3GPP Base Station Tests (TS 25.141), specify the E/N settings that apply to channel-coded data or block segments. Set the parameter "Bit Rate" to the required value, e.g. the bit rate before or after channel coding.

#### Understanding the displayed information

The following example explains the impact of the AWGN settings on the signal and noise parameters.

See [Figure 6-3](#) for an example of an AWGN generation with the following configuration:

- Default "System Configuration"



- "Mode = Standard"
- "Signal Routing = A -> A ,B ->B"
- "Baseband A"
  - "Custom Digital Modulation > Set acc. to standard > WCDMA-3GPP"
  - "State > On".
  - "Symbol Rate = 3.840 Msym/s"
- "AWGN A"
  - "General > Mode > Additive Noise"
  - "General > Min Noise/System Bandwidth Ratio = 3"
  - "General > State > On"
  - "Noise Power / Output Results > Show Results for Output > RF A"
  - "Noise Power / Output Results > Reference Mode > Carrier"
  - "Noise Power / Output Results > Carrier/Noise Ratio = 10 dB"
- "RF A > On"

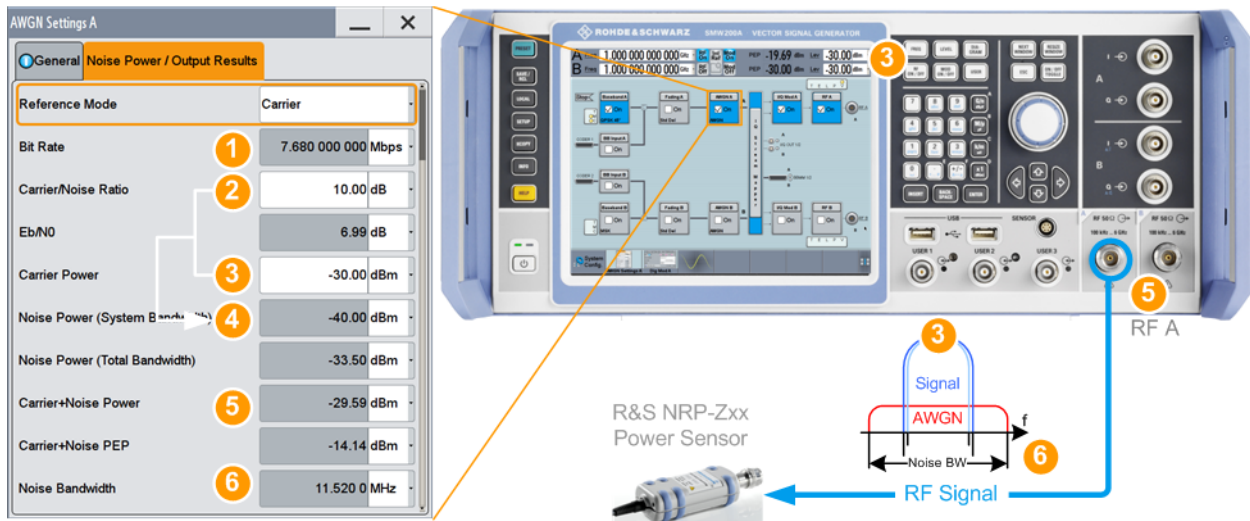


Figure 6-3: AWGN: Understanding the displayed information

- 1 = Bit Rate derived from the selected "Symbol Rate = 3.840 Msym/s"
- 2 = selected Carrier/Noise Ratio
- 3 = Carrier Power = Status bar > Level = 30 dBm
- 4 = Noise Power calculated from the "Carrier Power" and the "Carrier/Noise Ratio" = -30 dBm - 10 dB = -40 dBm; you would measure this value if you perform channel power measurement with a signal analyzer
- 5 = Carrier+Noise Power = power at the RF A output; i.e. the power a connected power meter would measure
- 6 = Noise Bandwidth = System Bandwidth\*Minimum Noise/System Bandwidth Ratio = 3.840 MHz\*3 = 11.520 MHz



Use the built-in graphical signal monitoring function of the instrument to display the signal characteristics in real-time, see "To observe the effect of enabled additive noise (AWGN)" on page 552.

### Joint configuration of all streams

In [Advanced mode](#), the instrument can generate the signal of one or more streams. In the AWGN, with the parameter [Coupled Mode](#) you define how this streams are configured; coupled, i.e. the same settings apply to all streams, or independently.

It is recommended that you configure the AWGN settings in the default coupled mode. When you disable the coupled mode, the instrument does not apply the current settings to all streams. The settings of the individual streams are in the state they were before the coupled mode was enabled.

If you prefer to configure the streams independently, consider the interdependencies listed in [Table 6-1](#):

**Table 6-1: State settings coupled and individual modes**

	AWGN > Coupled Mode > On	AWGN > Coupled Mode > Off
Effect of the parameters "AWGN > AWGN Settings > General > State" and "AWGN > State"	The states of all streams are coupled; the parameters "AWGN > AWGN Settings > General > State" and "AWGN > State" have the same effect.  Hence, enabling/disabling the AWGN block ("AWGN > On/Off") activates/deactivates all streams.	The parameter "AWGN > AWGN Settings > General > (Stream) State" enables/disables each stream individually.  The "AWGN > State > Off" deactivates all streams.  The "AWGN > State > On" activates all streams for that the "AWGN > AWGN Settings > (Stream) State > On"

### Application fields

Typically, the noise generator is required for the following tests:

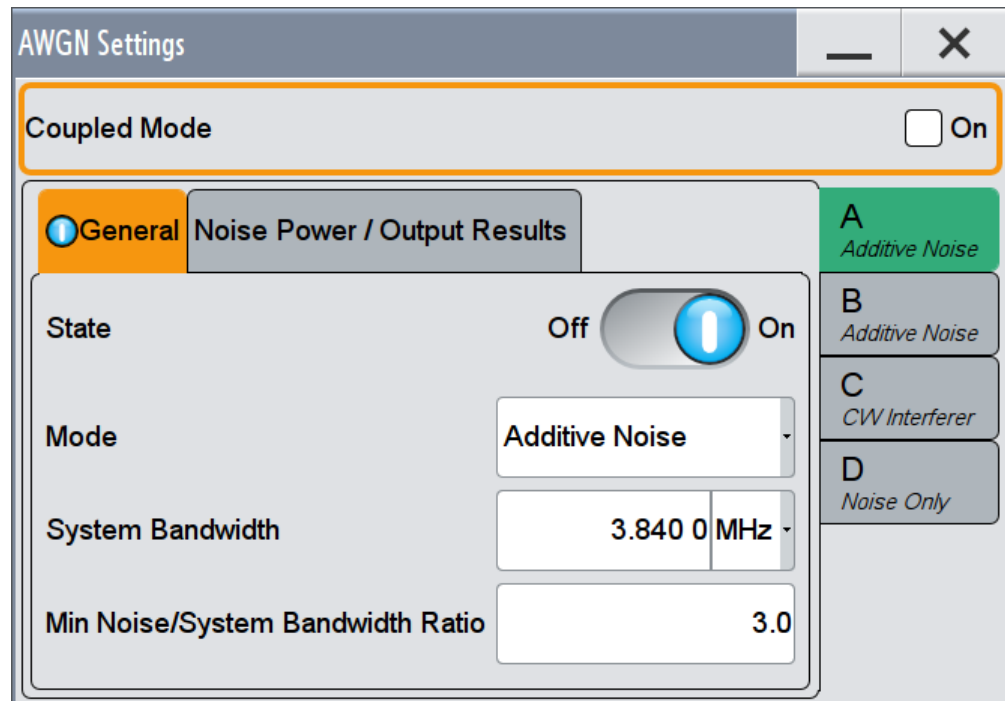
- In receiver sensibility tests with predefined SNR of the receiver, see ["To configure the AWGN for receiver sensibility tests with predefined SNR of the receiver"](#) on page 388
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

## 6.2.3 AWGN Settings

The "AWGN" block provides access to the settings for the AWGN generator.

### How to access and configure the "AWGN Settings"

1. To access the "AWGN Settings" dialog, select "Block Diagram > AWGN".



The dialog contains the settings for noise level configuration and CW interfering parameters.

If the instrument is configured to work in *Advanced mode* ("System Configuration > Fading/Baseband Configuration > Mode > Advanced") and *Coupled Mode* is disabled, the dialog consists of more than one side tabs, whereas the number of tabs corresponds to the number of selected *BB Signals (Tx Antennas)*. The tab name displays the baseband the settings are related to and the mode the noise is generated at.

- To activate the AWGN generator, select "Block Diagram > AWGN > On".

In *Advanced mode*, a dedicated LED indicates the state of each stream.

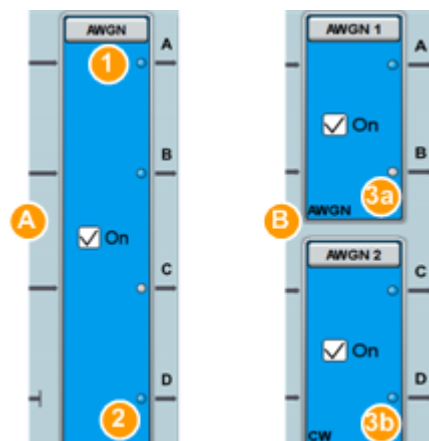


Figure 6-4: Representation of the AWGN blocks in "System Configuration > Advanced Mode"

- A = Example of an 1x4x4 configuration
- B = Example of a 2x2x2 configuration
- 1 = Dedicated LEDs indicate the state of each stream
- 2 = no AWGN mode indication in mixed AWGN streams configuration
- 3a, 3b = AWGN mode indication: AWGN indicates "AWGN Mode > Additive Noise/Noise Only", CW - "AWGN Mode > CW Interferer"

The remote commands required to define these settings are described in [Chapter 13.18.3.6, "SOURCE:AWGN Subsystem"](#), on page 929.

### 6.2.3.1 General Settings

State.....	380
Coupled Mode.....	380
Mode.....	380
System Bandwidth.....	381
Minimum Noise/System Bandwidth Ratio.....	381
Target CW Frequency Offset.....	381
Resulting CW Frequency Offset.....	381

#### State

Activates/deactivates the generation of an AWGN signal. The interferer (AWGN or CW interferer, depending on the selected mode) is generated after the generator is activated.

Remote command:

[ :SOURCE<hw> ] :AWGN:STATE on page 933

#### Coupled Mode

Couples the configuration of all streams.

**Note:** In the default state of the AWGN, this parameter is enabled. It is recommended that you configure the AWGN settings in coupled mode.

When you disable the coupled mode, the instrument does not apply the current settings to all streams. The settings of the individual streams are in the state they were before the coupled mode was enabled.

See also "[Joint configuration of all streams](#)" on page 378.

Remote command:

[ :SOURCE<hw> ] :AWGN:CMODE [ :STATE ] on page 932

#### Mode

Selects the mode for generating the interfering signal.

- |                  |   |
|------------------|---|
| "Additive Noise" | The AWGN noise signal with selectable system bandwidth is added to the baseband signal.   |
| "Noise Only"     | The pure AWGN noise signal with selectable system bandwidth is modulated to the carrier. The connection to the baseband is interrupted. |

"CW Interferer" A sine with a defined frequency offset is added to the baseband signal. The calculation of  $E_b/N_0$  ratio is omitted.

This mode is disabled in "System Configuration" with more than 4 input streams.

Remote command:

[ :SOURce<hw> ] :AWGN:MODE on page 933

### System Bandwidth

For "Additive Noise" and "Noise Only" modes, sets the RF bandwidth to which the set carrier/noise ratio relates.

Within this frequency range, the signal is superimposed with a noise signal which level corresponds exactly to the set C/N or S/N ratio.

For more information, refer to the description of [Figure 6-2](#).

Remote command:

[ :SOURce<hw> ] :AWGN:BWIDth on page 933

### Minimum Noise/System Bandwidth Ratio

For "Additive Noise" and "Noise Only" modes, sets the ratio of minimum noise bandwidth to system bandwidth, as required by some standards.

*Noise Bandwidth = System BW x Minimum Noise/System BW Ratio*

The parameter [Noise Bandwidth](#) displays the resulting noise bandwidth.

The calculation of level from the selected C/N or S/N ratio in relation to system bandwidth is not influenced.

Remote command:

[ :SOURce<hw> ] :AWGN:BWIDth:RATio on page 934

### Target CW Frequency Offset

In "CW Interferer" mode, sets the desired frequency of the sine wave.

Remote command:

[ :SOURce<hw> ] :AWGN:FREQuency:TARGet on page 937

### Resulting CW Frequency Offset

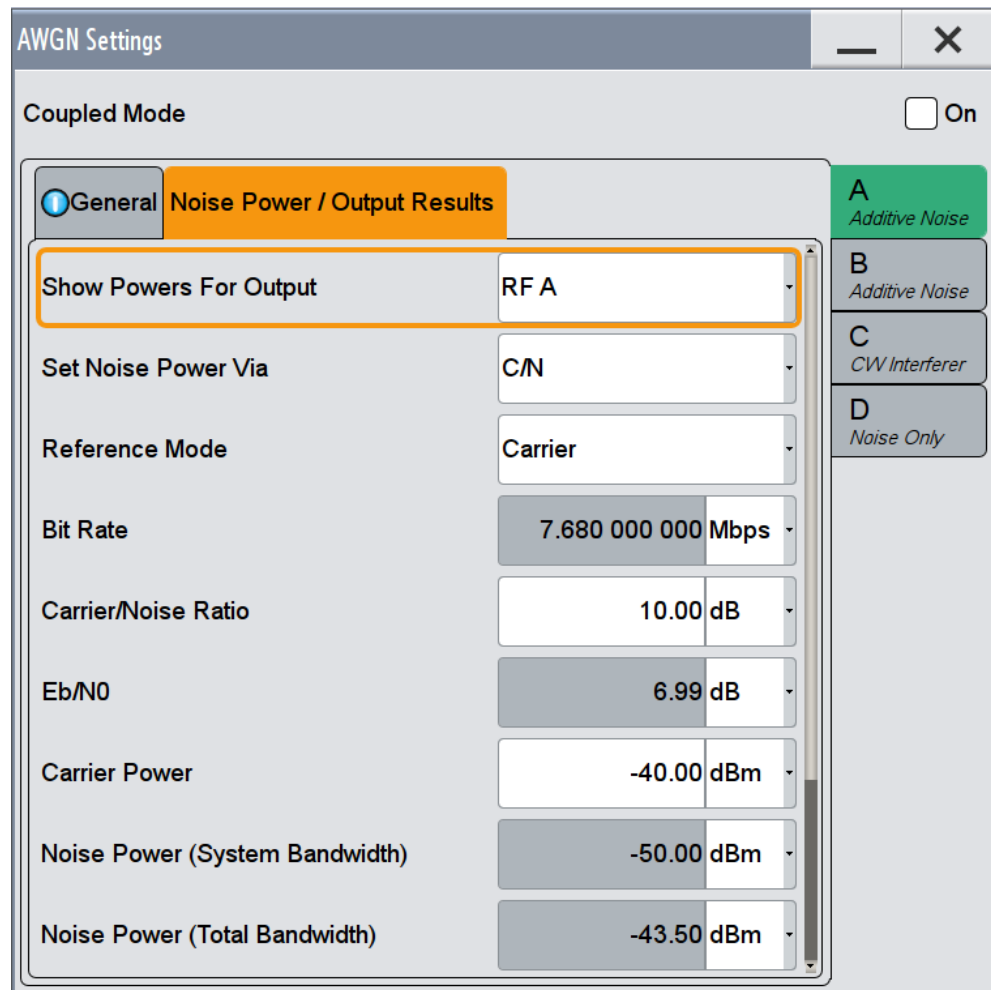
In "CW Interferer" mode, indicates the resulting frequency offset of the sine wave.

Remote command:

[ :SOURce<hw> ] :AWGN:FREQuency:RESult? on page 938

### 6.2.3.2 Noise Power/Output Results Settings

- ▶ To access these settings, select "AWGN > Noise Power/Output Results".



The available settings depend on the selected [Mode](#).

Show Powers for Output.....	383
Connected Instrument.....	383
Set Noise Power Via.....	383
Reference Mode.....	383
Bit Rate.....	384
Carrier/Noise Ratio, Signal/Noise Ratio.....	384
$E_b/N_0$ .....	384
Carrier Power, Signal Power.....	385
Noise Power (System Bandwidth), Interferer Power.....	385
Noise Power (Total Bandwidth).....	386

Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power .....	387
Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP .....	387
Noise Bandwidth.....	387

### Show Powers for Output

Sets the output to which the displayed settings are related to.

The available outputs depend on the current signal flow configuration, in particular on the current stream mapping (see [Chapter 4.4, "System Configuration Settings"](#), on page 131).

This setting also influences:

- The way the interfering parameters are displayed, e.g. if the SNR value is defined as C/N or as S/N.
- The value units:
  - The values related to the RF outputs are displayed in dBm
  - The values related to the baseband outputs - in dB

**Tip:** For better overview of the power values, use the build-in "Baseband Powers" function whenever you:

- Add baseband signals with different signal bandwidth
- add streams in the "Stream Mapper".

For description, see [Chapter 9.2, "Querying Information on the Baseband Power Levels"](#), on page 553.

Remote command:

[ :SOURce<hw> ] :AWGN:DISP:MODE on page 934

### Connected Instrument

Indicates the connected instrument.

### Set Noise Power Via

In "Additive Noise" mode, selects the way the noise power is determined.

The following correlation applies:

"C/N or S/N" =  $(E_b/N_0) * (f_{bit}/B_{sys})$ , where:

- "C/N or S/N" is the carrier/noise ratio
- " $E_b/N_0$ " is the ratio of bit energy to noise power density
- "Bit Rate"  $f_{bit}$  = "Symbol Rate" x Modulation Value
- $B_{sys}$  is the system bandwidth.

See also [Chapter 6.2.2, "About the AWGN Generator"](#), on page 374.

Remote command:

[ :SOURce<hw> ] :AWGN:POWer:MODE on page 934

### Reference Mode

Selects whether the carrier or the noise power is kept constant if the C/N or  $E_b/N_0$  ratio is changed.

In the common case, the instrument keeps the carrier power and adjusts the noise power accordingly. Some test cases however, for example the 3GPP Base Station Tests (TS 25.141), specify explicitly the noise power. These test cases require that the noise power is permanently set as a function of the base station power class, whereas the carrier power is variable.

Remote command:

[ :SOURce<hw> ] :AWGN:POWer:RMODe on page 935

### Bit Rate

In "Additive Noise" mode, indicates the bit rate used for converting C/N or S/N to  $E_b/N_0$ .

**Tip:** For digitally modulated signals, select the bit rate before or after channel coding, as required.

See also [Chapter 6.2.2, "About the AWGN Generator"](#), on page 374.

Remote command:

[ :SOURce<hw> ] :AWGN:BRATe on page 935

### Carrier/Noise Ratio, Signal/Noise Ratio

In "Additive Noise" and "CW Interferer" mode, sets the carrier/noise, signal/noise or signal/interferer ratio.

Whether a configuration of C/N or S/N is enabled, depend on the selected output [Show Powers for Output](#).

- In "Reference Mode > Carrier": sets the *power of the output signal*, i.e. the carrier + noise signal.  
It does not affect the power of the useful signal, i.e. the carrier power remains constant.
- In "Reference Mode > Noise", sets the *power of the useful signal*, i.e. the carrier power.  
The power of the output signal remains constant.
- The power of the noise signal is derived from the entered C/N or S/N value and displayed with the parameter "Noise Power" in the units of the useful signal.
- The power of the useful signal is displayed with the parameter "Carrier Power" and can also be changed there. This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also [Figure 6-3](#).

Remote command:

[ :SOURce<hw> ] :AWGN:CNRatio on page 935

### $E_b/N_0$

In "Additive Noise" mode, sets the ratio of bit energy to noise power density.

- In "Reference Mode > Carrier": sets the *noise power* and hence the power of the output signal, i.e. the carrier + noise signal.  
It does not affect the power of the useful signal, i.e. the carrier power is kept constant.
- In "Reference Mode > Noise": sets the *power of the useful signal*, i.e. the carrier power.  
The noise power is kept constant.



- The power of the noise signal is derived from the selected  $E_b/N_0$  and displayed with the parameter "Noise Power" in the units of the useful signal.
- The power of the useful signal is displayed with the parameter "Carrier Power". This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed as "Carrier + Noise Power".

See also [Figure 6-3](#).

Remote command:

[\[:SOURce<hw>\]:AWGN:ENRatio](#) on page 935

### Carrier Power, Signal Power

(Additive Noise and CW Interferer)

The name of this parameter depends on the selected output [Show Powers for Output](#).

- In "Reference Mode > Carrier": sets the carrier power. This indication corresponds to the "Level" value in the "Status bar".  
The power of the noise signal is derived from the selected C/N or S/N value and displayed with the parameter "Noise Power" in the units of the useful signal.
- In "Reference Mode > Noise", indicates the carrier power as derived from the entered C/N or S/N value. This indication corresponds to the "Level" value in the "Status bar".  
The noise power can be set with the parameter "Noise Power".

**Note:** The peak envelope power (PEP) displayed in the "Status bar" corresponds to the PEP value of the carrier. The parameter "Carrier+Noise (PEP)" indicates the PEP value of the overall signal.

See also [Figure 6-3](#).

Remote command:

[\[:SOURce<hw>\]:AWGN:POWer:CARRier](#) on page 936

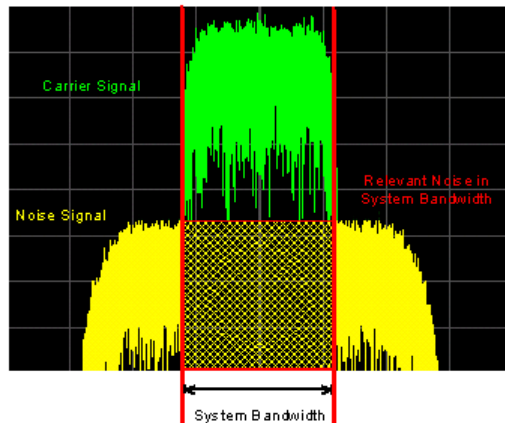
### Noise Power (System Bandwidth), Interferer Power

Displays the power of the noise signal in the system respectively the total bandwidth in "Noise Only" and "Additive Noise" mode.

- "Noise Only" mode  
Sets the power of the noise signal. This indication corresponds to the "Level" value in the "Status bar".
- "Additive Noise" mode
  - "Reference Mode > Noise"  
Sets the power of the noise signal. The power of the carrier is derived from the entered C/N or S/N or  $E_b/N_0$  value.
  - "Reference Mode > Carrier"  
Displays the power of the noise signal in the system bandwidth. The power of the noise signal is derived from the entered C/N or S/N or  $E_b/N_0$  value.  
The carrier power is selected with "Carrier Power"; respectively the signal power is displayed by "Signal Power".
- "CW Interferer" mode
  - "Reference Mode > Noise"  
Sets the power of the interfering signal. The power of the carrier is derived from the entered C/N or S/N value.
  - "Reference Mode > Carrier"

Displays the power of the interfering signal. The power of the interfering signal is derived from the entered C/N or S/N value. The carrier power is entered under "Carrier Power".

**Note:** The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. This means that the total measurable noise power usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.



See also [Figure 6-3](#).

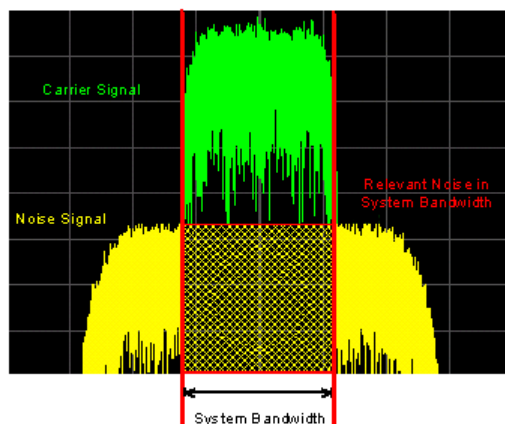
Remote command:

`[ :SOURce<hw> ] :AWGN:POWer:NOISe` on page 936

#### Noise Power (Total Bandwidth)

Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

**Note:** The noise signal is not generated arbitrarily for a particular bandwidth, but instead it is generated in steps. Noise therefore also occurs outside the set system bandwidth. This means that the total measurable noise power usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, we recommend that you measure the channel power with a signal analyzer.



See also [Figure 6-3](#).

Remote command:

[ :SOURce<hw> ] :AWGN:POWer:NOISe:TOTal? on page 936

#### **Carrier + Noise Power, Signal + Noise Power (System Bandwidth), Carrier + Interferer Power, Signal + Interferer Power**

In "Additive Noise" and "CW Interferer" mode, displays the overall power of the noise/interferer signal plus useful signal.

The output selected with the parameter [Show Powers for Output](#) determines:

- The name of this parameter
- The units the overall power is measured in, dBm or dB (full scale)

See also [Figure 6-3](#).

Remote command:

[ :SOURce<hw> ] :AWGN:POWer:SUM? on page 937

#### **Carrier + Noise PEP, Signal + Noise PEP (Total Bandwidth), Carrier + Interferer PEP, Signal + Interferer PEP**

In "Additive Noise" and "CW Interferer" mode, displays the peak envelope power (PEP) of the overall signal comprised of noise signal plus useful signal.

The output selected with the parameter [Show Powers for Output](#) determines:

- The name of this parameter
- The units the overall power is measured in, dBm or dB (full scale)

**Note:** The peak envelope power ("PEP") displayed in the "Status bar" corresponds to the PEP value of the carrier.

Remote command:

[ :SOURce<hw> ] :AWGN:POWer:SUM:PEP? on page 937

#### **Noise Bandwidth**

For "Additive Noise" and "Noise Only" modes and with activated AWGN generator, indicates the real noise bandwidth.

See also [Figure 6-2](#).

Remote command:

[ :SOURce<hw> ] :AWGN:BWIDth:NOISe? on page 934

## **6.2.4 How to Configure the Noise Generator for Receiver Tests**

This section shows you how to configure the noise generator for receiver tests, for example the tests specified in the 3GPP test specification TS 36.141, Chapter 7.

For the following example, we assume that the R&S SMW generates an uplink EUTRA/LTE signal with following characteristics:

- "EUTRA/LTE > Duplexing = FDD", "Link Direction = Uplink"
- "EUTRA/LTE > General Uplink Setting > Channel Bandwidth = 5 MHz" and "Occupied Bandwidth = 4.5 MHz"
- "EUTRA/LTE > Frame Configuration > UE1 > FRC > FRC State = On" and "FRC = TS 36.141: A2-3"
- "EUTRA/LTE > State = On"

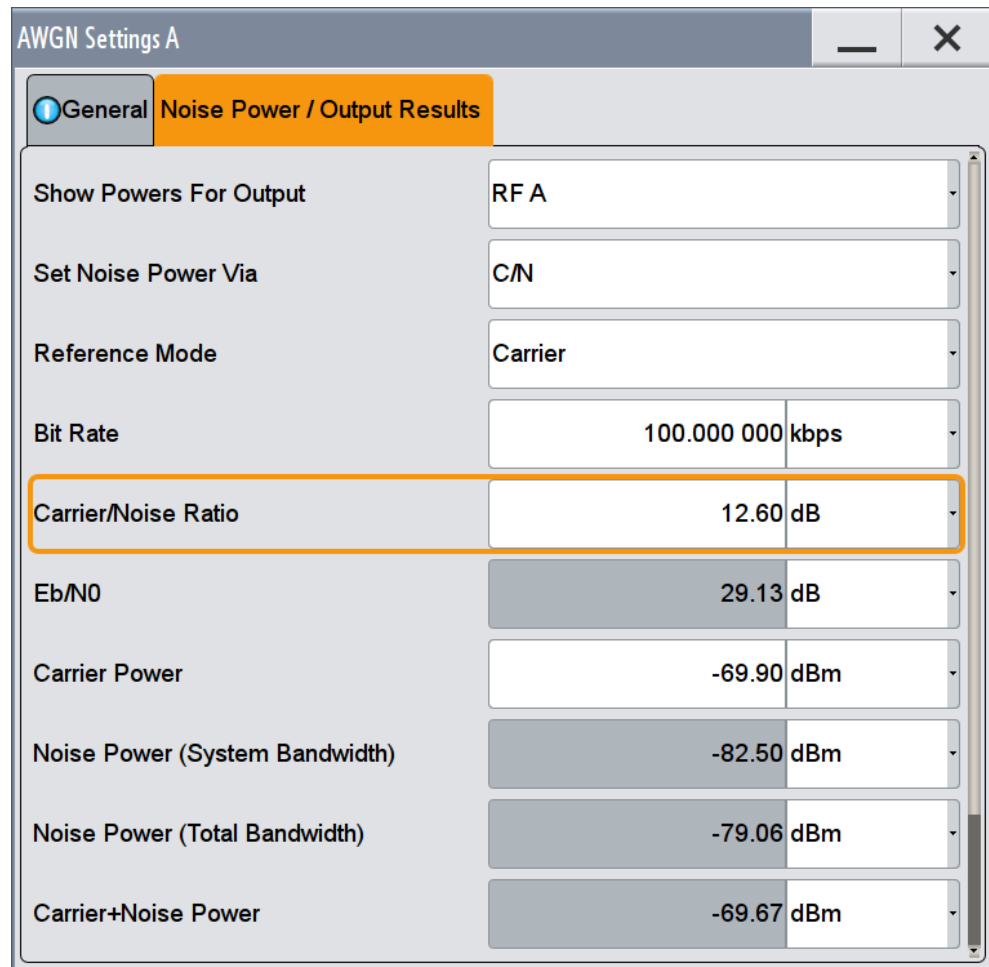
- "Status bar > Frequency = 1.95 GHz" and "Level = -69.9 dBm"
- "RF State > On"

**To configure the AWGN for receiver sensibility tests with predefined SNR of the receiver**

We assume that an AWGN interfering signal with the following characteristics is required:

The mean power of the interfering signal is -82.5 dBm/BW and C/N = 12.6 dB

1. Select "AWGN" and enable:
  - "Mode > Additive Noise"
  - "System Bandwidth = 4.5 MHz"  
The interfering signal mean power is defined as dBm/BW, where BW is the system bandwidth. The system bandwidth of the LTE signal is the occupied bandwidth.  
See also [Figure 6-2](#).
  - "Min Noise/System Bandwidth Ratio = 1.5"
2. Select "Noise Power/Output Results" and enable:
  - "Set Noise Power Via = C/N"
  - "Reference Mode = Carrier"
  - "Carrier/Noise Ratio = 12.6 dB"



The dialog confirms the required mean power of the interfering signal "Noise Power (System Bandwidth) = -82.5 dBm".

3. Select "AWGN > General > State > On".

#### To generate a CW interfering signal

For the following example, we assume that two interfering signals are required, a 5 MHz uplink LTE signal and a CW signal. The signals are transmitted at -52 dBm; the LTE signal at 1.96 GHz and the CW signal 10 MHz below it. Signals with equal (or similar) RF levels and at frequencies spaced within the max. RF bandwidth can be generated by the same path.

To configure the instrument:

1. Enable the required LTE signal:
  - a) Select "EUTRA/LTE > General Uplink Setting > Channel Bandwidth = 5 MHz" and "EUTRA/LTE > State = On"
  - b) Select "Status bar > Frequency = 1.96 GHz" and "Level = -52 dBm"
2. Enable the required interfering signal:
  - a) Select "AWGN > General > Mode > CW Interferer"

- b) Select "Target CW Frequency Offset = 10 MHz"
  - c) Select "Noise Power/Output Results > Reference Mode = Noise"
  - d) Select "Interferer Power = -52 dB"
  - e) Select "AWGN > General > State > On".
3. Select "RF > State > On"

## 6.3 Impairing the Signal

In the R&S SMW, *analog and digital linear impairments* such as I/Q imbalance and quadrature error can be added to the generated signal.

The instrument can also simulate the effect of non-linear memoryless effects like AM/AM and AM/PM conversion.

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

### 6.3.1 Required Options

The equipment layout for signal impairments includes:

- Option Baseband Generator (R&S SMW-B10) per signal path and Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)  
Sufficient for impairment of the digital I/Q and the analog signal

### 6.3.2 About the Linear I/Q Impairments

Signal impairments (**I/Q Impairments**) are well-defined arithmetic modifications of the data. Every data sample is modified in the same way.

Adding linear impairments to the data stream is provided for the following purpose:

- To simulate frequent sources of distortions in a real signal-processing chain as, it is required for tests with dirty transmitter conditions (receiver tests)
- To compensate the faults of the I/Q demodulator in the receiver

See [Chapter 6.3.4, "How to Optimize the Carrier Leakage and Sidebands Suppression"](#), on page 397.

The R&S SMW offers functions to impair the internally generated signal or the externally fed analog I/Q signal linearly:

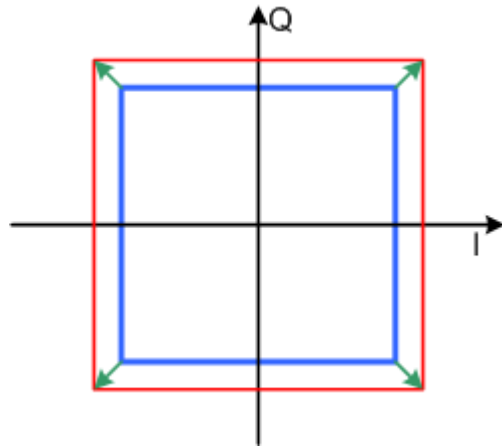
- Each generated I/Q stream can be impaired digitally
- Analog impairments can be added to the externally applied analog I/Q signal, before it is passed to in the I/Q modulator (see ["Defining the input signal of the I/Q modulator"](#) on page 399)

An external analog signal can thus be impaired twice, analog and digital. If both types of impairments are enabled, they superimpose each other in the signal.

Impairments caused by the I/Q modulator are automatically corrected by the [Adjust I/Q Modulator Current Frequency](#) function. See also "[Internal Adjustments](#)" on page 1077.

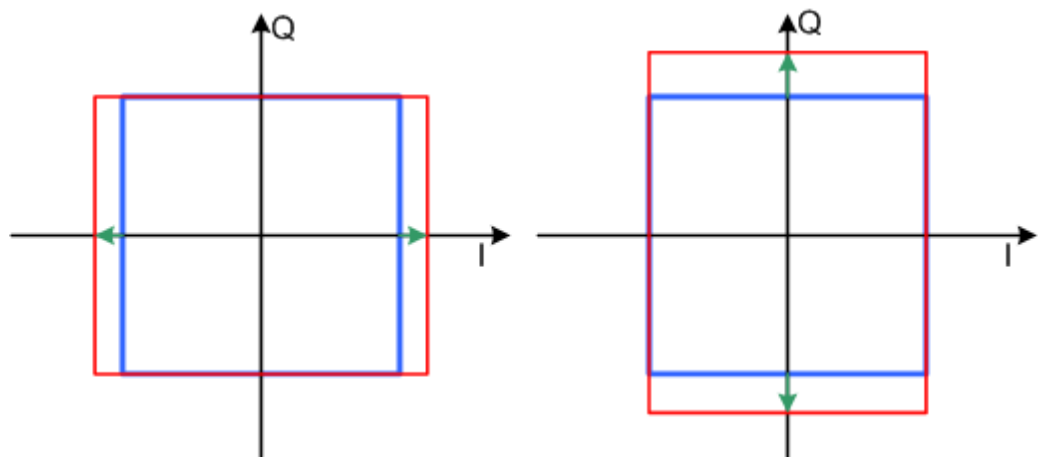
### 6.3.2.1 Gain and Gain Imbalance

An I/Q gain is a multiplication of all I/Q amplitudes by a common factor. The effect is equivalent to two identical I and Q gain factors. The effect of an increased gain factor in the I/Q constellation diagram is shown on [Figure 6-5](#).



*Figure 6-5: Effect of an increased amplitude in the I/Q constellation diagram*

An I gain multiplies the I amplitudes by a factor, leaving the Q amplitudes unchanged. A Q gain has the opposite effect. Different I and Q gain factors result in an I/Q imbalance, which is due to different gains of the amplifiers in the I and Q channels of the I/Q modulator. The effect of a positive and negative gain imbalance is shown on [Figure 6-6](#).



*Figure 6-6: Negative gain imbalance (left) and positive gain imbalance (right) in the I/Q constellation diagram*

### 6.3.2.2 I and Q Offset

An I offset adds a constant value to all I amplitudes, leaving the Q amplitudes unchanged. A Q offset has the opposite effect. A combination of I and Q values results in an I/Q offset, which is due to carrier feedthrough in the I/Q modulator. Possible reasons are interfering signals at the RF carrier frequency, e.g. an unsuppressed RF carrier subchannel. The effect of a positive I and Q offset in the I/Q constellation diagram is shown on [Figure 6-7](#).

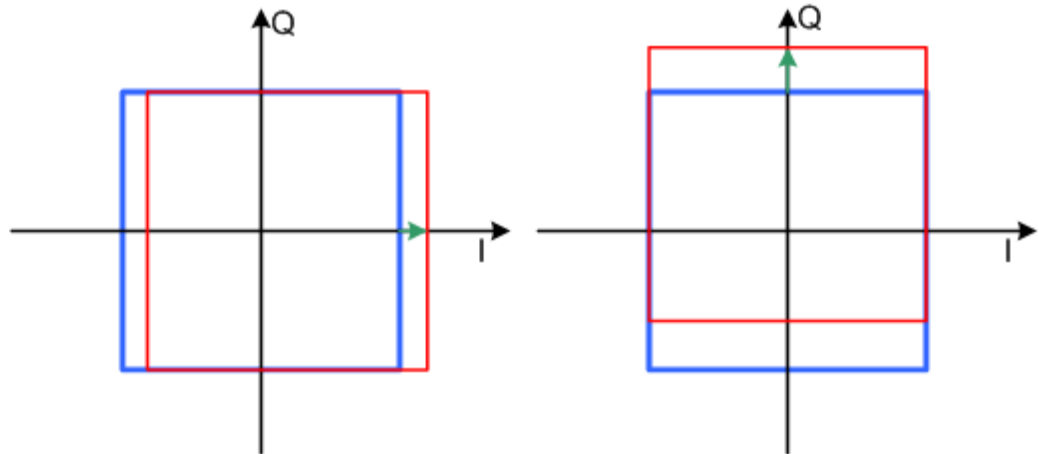


Figure 6-7: I offset (left) and Q offset (right) in the I/Q constellation diagram

### 6.3.2.3 Quadrature Offset

Changes the phase angle between the I and the Q vectors from the ideal 90 degrees, while the amplitudes are maintained. A positive quadrature offset results in a phase angle greater than 90 degrees. The effect of a positive quadrature offset in the I/Q constellation diagram is shown on [Figure 6-8](#).

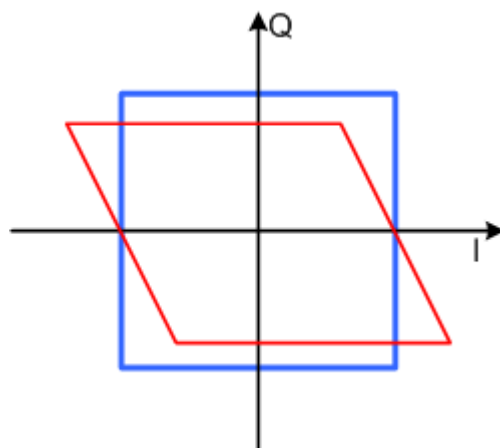


Figure 6-8: Positive quadrature offset in the I/Q constellation diagram

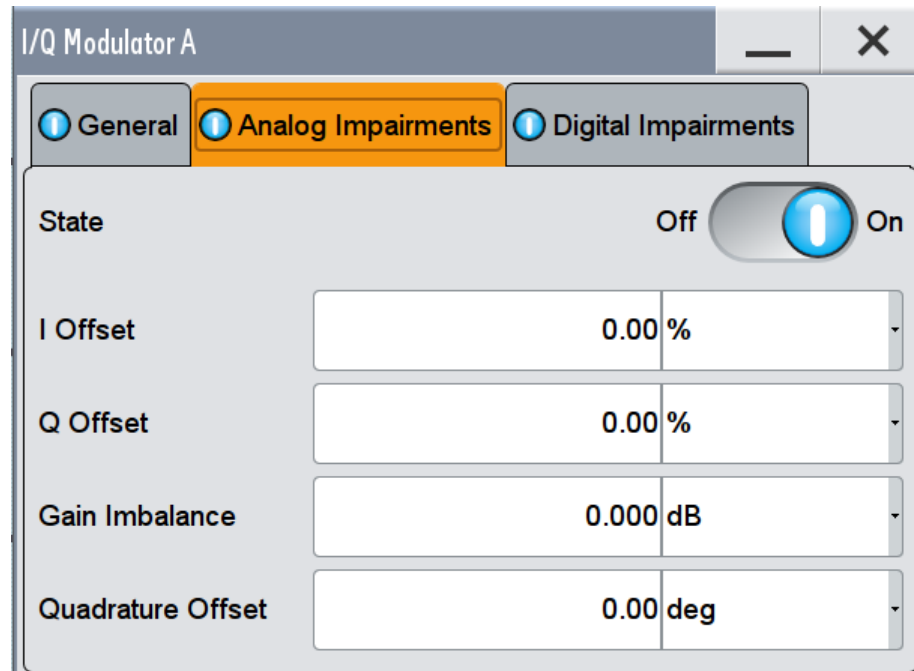


### 6.3.3 Analog and Digital Impairments Settings

You can add digital impairments to each internal generated I/Q stream and analog impairments to internal generated or external supplied analog I/Q signals

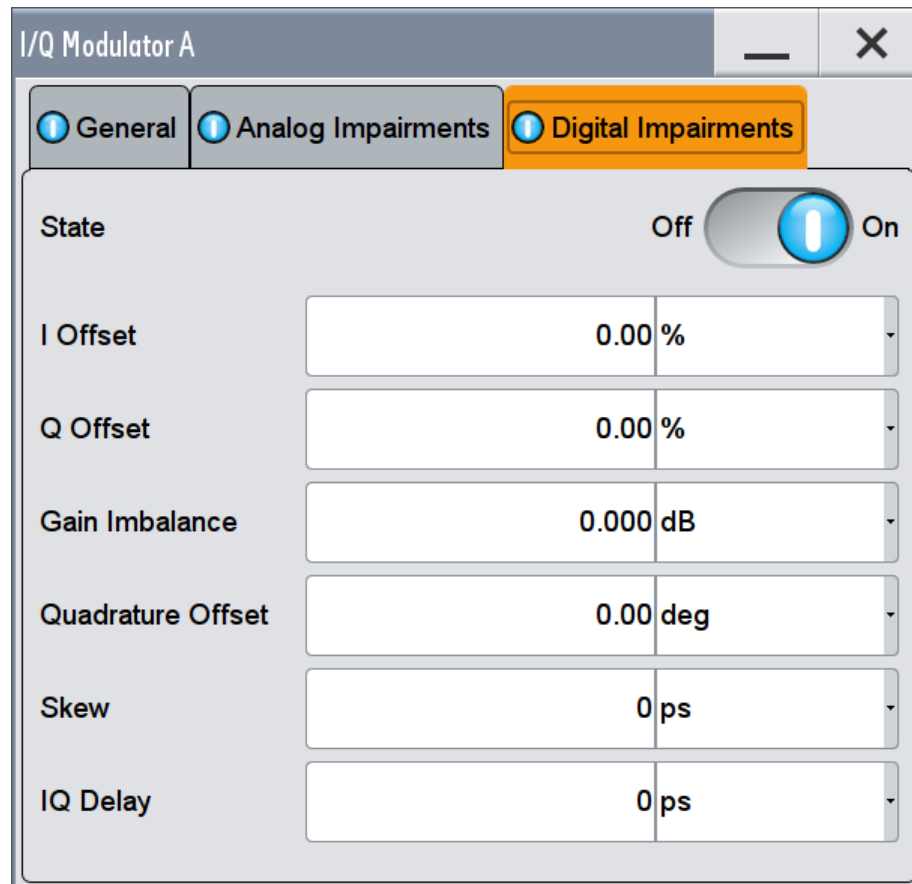
See also [Chapter 6.3.2, "About the Linear I/Q Impairments"](#), on page 390.

1. To access the dialog with settings for the **analog** I/Q signal, select "I/Q Mod > Analog Impairments".



The dialog covers the settings for I/Q impairment, like carrier leakage, imbalance and quadrature offset.

2. To access the dialog with settings for the corresponding **digital** I/Q impairments, select one of the following:
  - Select "I/Q Mod > Digital Impairments"
  - Select "I/Q Analog > Digital Impairments"
  - Select "I/Q Digital > Digital Impairments"



The dialog covers the settings for I/Q impairment, like carrier leakage, imbalance, offset and delay.

The parameters "Skew" and "IQ Delay" are enabled in the "I/Q Modulator or I/Q Analog > Digital Impairments" dialog.

If a R&S SGT is connected to one of the digital interfaces, digital impairments e.g. intended IQ delays are applied in the connected instrument (see [Figure 4-10](#)).

The remote commands required to define these settings are described in [Chapter 13.18.3.7, "SOURCE:BB:IMPAIRment Subsystem"](#), on page 938 and [Chapter 13.18.8, "SOURCE:IQ Subsystem"](#), on page 979.

The instrument can also simulate the effect of non-linear effects like AM/AM and AM/PM conversion.

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

<a href="#">State</a> .....	395
<a href="#">I/Q Offset</a> .....	395
<a href="#">Gain Imbalance</a> .....	395
<a href="#">Quadrature Offset</a> .....	396
<a href="#">Skew</a> .....	396
<a href="#">IQ Delay</a> .....	396

**State**

Activates the impairment of the I/Q signal.

If activated, the settings for I/Q offset, I/Q imbalance, and quadrature offset become effective.

Remote command:

For analog impairments: `[ :SOURce<hw> ] :IQ:IMPairment [ :STATe ]` on page 941

For digital impairments:

`[ :SOURce ] :BB:IMPairment:RF<ch>:STATe` on page 941

`[ :SOURce ] :BB:IMPairment:IQOutput<ch>:STATe` on page 941

`[ :SOURce ] :BB:IMPairment:FADer<ch>:STATe` on page 941

`[ :SOURce ] :BB:IMPairment:BBMM<ch>:STATe` on page 941

**I/Q Offset**

Sets a carrier offset (in percent) of the amplitudes (scaled to the peak envelope power (PEP)) for the I and/or Q signal component. An ideal I/Q modulator suppresses the carrier offset completely (offset = 0 percent).

For more information, see:

- [Chapter 6.3.2.2, "I and Q Offset"](#), on page 392
- ["To optimize the carrier leakage suppression"](#) on page 397

Remote command:

For analog impairments:

`[ :SOURce<hw> ] :IQ:IMPairment:LEAKage:I` on page 940

`[ :SOURce<hw> ] :IQ:IMPairment:LEAKage:Q` on page 940

For digital impairments:

`[ :SOURce ] :BB:IMPairment:BBMM<ch>:LEAKage:I` on page 940

`[ :SOURce ] :BB:IMPairment:BBMM<ch>:LEAKage:Q` on page 940

`[ :SOURce ] :BB:IMPairment:FADer<ch>:LEAKage:I` on page 940

`[ :SOURce ] :BB:IMPairment:FADer<ch>:LEAKage:Q` on page 940

`[ :SOURce ] :BB:IMPairment:IQOutput<ch>:LEAKage:I` on page 940

`[ :SOURce ] :BB:IMPairment:IQOutput<ch>:LEAKage:Q` on page 940

`[ :SOURce ] :BB:IMPairment:RF<ch>:LEAKage:I` on page 940

`[ :SOURce ] :BB:IMPairment:RF<ch>:LEAKage:Q` on page 940

**Gain Imbalance**

Sets the imbalance of the I and Q vector.

The entry is made in dB (default) or %, where 1 dB offset is roughly 12% according to the following:

$$\text{Imbalance [dB]} = 20 \log ( | \text{GainQ} | / | \text{GainI} | )$$

Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage. Negative values have the opposite effect.

For more information, see:

- [Chapter 6.3.2.1, "Gain and Gain Imbalance"](#), on page 391
- ["To optimize sideband suppression"](#) on page 397

Remote command:

For analog impairments: [:SOURce<hw>]:IQ:IMPairment:IQRatio[:MAGNitude] on page 939

For digital impairments:

[:SOURce]:BB:IMPairment:BBMM<ch>:IQRatio[:MAGNitude] on page 939

[:SOURce]:BB:IMPairment:FADer<ch>:IQRatio[:MAGNitude] on page 939

[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude] on page 939

[:SOURce]:BB:IMPairment:RF<ch>:IQRatio[:MAGNitude] on page 939

### Quadrature Offset

Sets the quadrature offset.

For more information, see:

- [Chapter 6.3.2.3, "Quadrature Offset"](#), on page 392
- ["To optimize sideband suppression"](#) on page 397

Remote command:

For analog impairments: [:SOURce<hw>]:IQ:IMPairment:QUADrature[:ANGLE] on page 940

For digital impairments:

[:SOURce]:BB:IMPairment:BBMM<ch>:QUADrature[:ANGLE] on page 940

[:SOURce]:BB:IMPairment:FADer<ch>:QUADrature[:ANGLE] on page 940

[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLE] on page 940

[:SOURce]:BB:IMPairment:RF<ch>:QUADrature[:ANGLE] on page 940

### Skew

In the "I/Q Modulator or I/Q Analog > Digital Impairments" dialog, sets a delay between the Q vector and the I vector of the corresponding stream.

If a R&S SGT is connected to one of the digital interfaces, digital impairments are applied in the connected instrument (see [Figure 4-10](#)).

Remote command:

[:SOURce]:BB:IMPairment:BBMM<ch>:SKEW on page 941

[:SOURce]:BB:IMPairment:FADer<ch>:SKEW on page 941

[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW on page 941

[:SOURce]:BB:IMPairment:RF<ch>:SKEW on page 941

### IQ Delay

In the "I/Q Modulator or I/Q Analog > Digital Impairments" dialog, sets the time delay of both I and Q vectors relative to the selected trigger and marker.

A positive value means that the I and Q vectors delay relative to the marker/trigger and the other way around.

If a R&S SGT is connected to one of the digital interfaces, digital impairments are applied in the connected instrument (see [Figure 4-10](#)).

Remote command:

[:SOURce]:BB:IMPairment:BBMM<ch>:DELay on page 939

[:SOURce]:BB:IMPairment:FADer<ch>:DELay on page 939

[\[:SOURCE\]:BB:IMPairment:IQOutput<ch>:DELay](#) on page 939

[\[:SOURCE\]:BB:IMPairment:RF<ch>:DELay](#) on page 939

### 6.3.4 How to Optimize the Carrier Leakage and Sidebands Suppression

Applying linear I/Q impairments helps to improve signal quality in the following cases:

- To suppress a carrier leakage at the current RF frequency
- To improve the attenuation of the unwanted sidebands

In the following examples, we assume that:

- The R&S SMW generates a baseband signal
- A spectrum analyzer is connected to the R&S SMW, the analyzed is configured, and measures the required signal characteristics.

#### To optimize sideband suppression

For a given baseband signal, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod > I/Q Digital Impairments".
2. Set the values of the parameters "Gain Imbalance" and "Quadrature Offset" to adjust the relative amplitude and phase relationship of the baseband signal.
3. Select "State > On".
4. On a connected signal analyzer, monitor the power spectrum.
5. Vary the values of the parameters "Gain Imbalance" and "Quadrature Offset" until the maximal sideband suppression is achieved.

#### To optimize the carrier leakage suppression

For a given baseband signal, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod > I/Q Digital Impairments".
2. Set the parameters "I Offset" and/or "Q Offset".
3. Select "State > On".
4. On a connected signal analyzer, monitor the power spectrum.
5. Vary the "I/Q Offset" until the maximal carrier leakage suppression is achieved.

Adjusting the I and Q offsets is one of the possible ways to control carrier leakage. See [Chapter 5.10.3, "How to Improve Signal Characteristics by Shifting the Wanted Baseband Signal"](#), on page 371 for other related settings.

## 6.4 Applying Digital Predistortion

Digital predistortion (DPD) is one of the methods, used to improve the efficiency of RF power amplifiers. In the R&S SMW, the generated digital signal can be deliberately AM/AM and AM/PM predistorted.

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

## 7 Applying I/Q Vector Modulation

The R&S SMW offers I/Q modulation with an external analog I/Q signals, external digital signals, and the internally generated digital signal.

For a description on the signal impairment functionality and settings for applying non-linear effects, see:

- [Chapter 6.3, "Impairing the Signal"](#), on page 390

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

### 7.1 Required Options

The equipment layout for I/Q modulation includes:

- One of the Frequency options RF path A (R&S SMW-B1xx)  
Sufficient for I/Q modulation with external analog signal
- Option Baseband Generator (R&S SMW-B10) per signal path and  
Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)  
Sufficient for I/Q modulation with internal and external digital signal
- Option Differential I/Q Inputs (R&S SMW-K739), for RF path A  
Required for I/Q modulation with external differential analog signal

### 7.2 About the I/Q Modulator

The R&S SMW offers I/Q modulation with the internally generated digital signal, the external digital signals (when separately processed), and an external analog I/Q signal. The maximum available RF bandwidth of externally applied wideband analog signal is higher than the bandwidths of the internal or external digital signal. For exact values, refer to the instrument specification (data sheet).

Analog I/Q input signals are directly applied to the analog I/Q modulation circuit, and are not routed through the baseband section of the R&S SMW.

#### Defining the input signal of the I/Q modulator

The [Table 7-1](#) gives an overview of the possible input signals and the connectors they are supplied at. Any of the specified input signals is processed by the I/Q modulator and output at the RF outputs. Which logical information, i.e. which **stream**, is output at which connector is defined by the "IQ Stream Mapper".

For additional information, refer to [Chapter 4.3, "Overview of the Input and Output Signals and Interfaces"](#), on page 127 and [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137.

Table 7-1: Physical input signals of the I/Q modulator

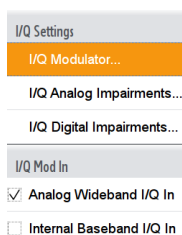
Input Signal	Connector	GUI Parameter
Internal digital baseband signal	-	"I/Q Mod > I/Q Mod In > Internal Baseband I/Q In" and "Baseband > On"
<ul style="list-style-type: none"> <li>External analog wideband</li> <li>External differential analog (in the first signal path)</li> </ul>	<ul style="list-style-type: none"> <li>I IN, Q IN</li> <li>I IN BAR, Q IN BAR</li> </ul>	<ul style="list-style-type: none"> <li>"I/Q Mod &gt; I/Q Mod In &gt; Analog Wideband I/Q In"</li> <li>"I/Q Mod &gt; I/Q Settings &gt; Source &gt; Differential Analog I/Q Input"</li> </ul>
External digital signal	DIG I/Q IN	"I/Q Mod > I/Q Mod In > Internal Baseband I/Q In" and "BB Input > On"



**Interdependencies**

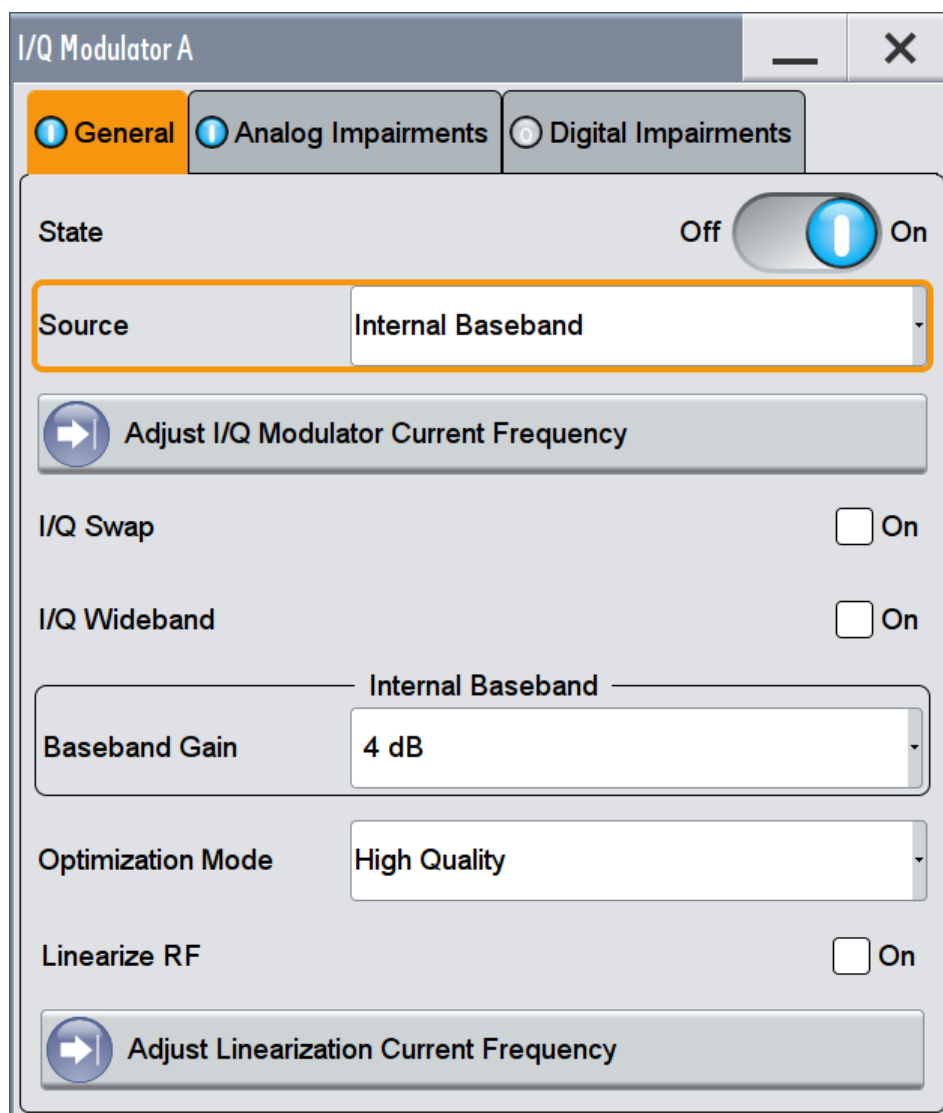
In the same signal path, an I/Q modulation with an **external analog** signal is not available simultaneously with AM, digital modulation, digital standards, fading, external digital baseband input signal, noise, arbitrary waveform generation, and multi-carrier CW.

### 7.3 I/Q Modulator Settings



1. To configure the input signal source of the I/Q modulator, select "I/Q Mod > I/Q Mod In" and enable an internal baseband or an analog wideband input signal.
2. To access the dialog box for configuring the I/Q modulator settings, select "I/Q Mod > I/Q Settings > I/Q Modulator".





- To define the external analog signal, select "Source > Differential Analog I/Q Input".

The dialog comprises the I/Q modulator settings, the optimized settings for wide-band modulation and settings for enabling the analog and/or digital impairments. The remote commands required to define these settings are described in [Chapter 13.18.8, "SOURCE:IQ Subsystem"](#), on page 979.

For a description on the signal impairment functionality and settings for applying non-linear effects, see:

- [Chapter 6.3, "Impairing the Signal"](#), on page 390

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.



System error correction of the I/Q modulator permits precise and repeatable measurements.

If a temperature fluctuation of several degrees occurs, trigger the correction routine using one of the following:

- Select "I/Q Mod > I/Q Modulator > Adjust I/Q Modulator Current Frequency" or
- Select "System Config > Setup > System > Internal Adjustment > Adjust I/Q Modulator Current Frequency".

See also "[Internal Adjustments](#)" on page 1077.

### Source

Selects the input signal for the I/Q modulator. Refer to [Table 7-1](#) for an overview of the possible input signals and the connectors they are supplied at.

"Internal Baseband"

Selects the internal baseband signal.

"Analog Wideband I/Q Input"

Selects an external analog signal.

See also "[To apply an external analog signal directly to the I/Q modulator](#)" on page 198.

"Differential Analog I/Q Input"

Enabled in instruments equipped with option Differential I/Q Inputs (R&S SMW-K739), for RF path A.

Selects an external differential analog signal.

If the instrument is equipped with one of the [High frequency options](#) and a "Freq > 19.5 GHz" is selected, the "Analog Wideband I/Q Input" is automatically selected.

Remote command:

`[ :SOURce<hw> ] :IQ:SOURce` on page 979

### State

Activates/deactivates I/Q modulation.

**Note:** Interdependency. With "Internal Baseband" signal, the I/Q modulator is always activated automatically when signal generation is activated ("Baseband > State > On"). I/Q modulation can, however, be deactivated later, e.g. if the relevant signal is the baseband signal and it is directly routed to the I/Q outputs.

Remote command:

`[ :SOURce<hw> ] :IQ:STATe` on page 979

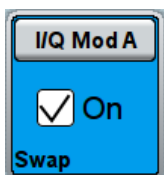
### Adjust I/Q Modulator Current Frequency

Starts the adjustment for the I/Q modulator for the currently set frequency and baseband gain. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

See also "[To trigger the internal correction routine of the I/Q modulator](#)" on page 406.

Remote command:

`:CALibration<hw>:IQModulator:LOCAl?` on page 737



### I/Q Swap

Selects normal or swapped I/Q control for the generated signal.

The IQ modulator defined in the IS2000 standard differs from the definition in this implementation. The definition on which the implementation is based is used by virtually all digital communication standards, except IS95 and IS2000.

In the final step, the filtered IQ signal is modulated to the desired RF in a different way in the IQ modulator:

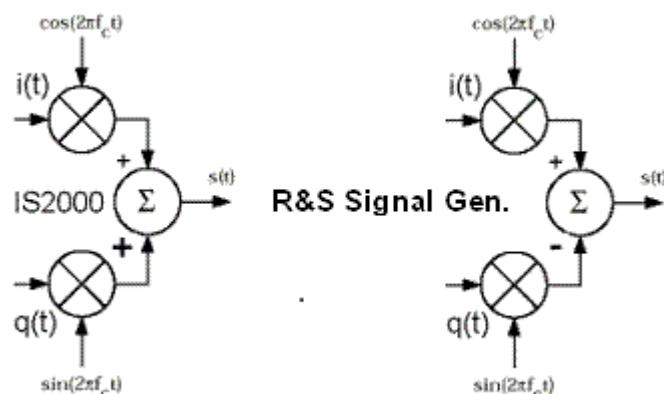


Figure 7-1: Definition of IQ modulator in IS2000 and the R&S SMW

IS2000 = the RF signal  $s(t)$  is derived from the baseband I/Q signal as  $s(t) = i(t)\cos(2\pi f_c t) + q(t)\sin(2\pi f_c t)$

R&S SMW = the RF signal  $s(t)$  is based on the definition  $s(t) = i(t)\cos(2\pi f_c t) - q(t)\sin(2\pi f_c t)$

See also:

- description "CDMA2000® incl. EV-DV Digital Standard for R&S SMW"
- description "1xEV-DO Rev. A, Rev. B Digital Standard for R&S SMW"

"Off" I/Q control is normal.

"On" The modulation sidebands are inverted by swapping the I and Q signals (the Q-part of the signal is inverted).  
The generated baseband signal is according to CDMA200 and 1xEV-DO standards.  
An I/Q modulator defined according to these standards can cope with the RF signal generated by the R&S SMW.

Remote command:

`[ :SOURce<hw> ] :IQ:SWAP [ :STATe ]` on page 981

### I/Q Wideband

Setting mode for wideband modulation signals (higher I/Q modulation bandwidth).

The modulation frequency response of the R&S SMW in the useful bandwidth is improved at the expense of poorer harmonic suppression. This is achieved by shifting the switching frequencies of the lowpass filters in the output section.

Remote command:

`[ :SOURce<hw> ] :IQ:WBStAt e` on page 981

### Crest Factor

Sets the crest factor of the *externally supplied analog signal*.

The crest factor gives the difference in level between the peak envelope power (PEP) and the average power value (RMS) in dB. The R&S SMW uses this value for the calculation of the RF output power. For more information, refer to [Chapter 4.10.2, "Important Signal Parameters and Interface's Characteristics"](#), on page 207

**Note:** To set the crest factor of an *externally supplied digital signal*, use the parameter "BB Input > Input Level > Crest Factor" (see "[Crest Factor](#)" on page 164).

See also "[To apply an external analog signal directly to the I/Q modulator](#)" on page 198.

Remote command:

[ :SOURce<hw> ] :IQ:CREStfactor on page 980

### (Baseband) Gain

Optimizes the modulation of the I/Q modulator for a subset of measurement requirement. Provided is a dynamic range of 16 dB divided into 2 dB steps. The optimization is a trade-off between signal distortion and signal-to-noise ratio (SNR).

In instruments equipped with one of the [High frequency options](#) and for "Freq > 19.5 GHz", this parameter is disabled.

See also [Chapter 7.4, "How to Adjust the I/Q Modulator to Optimize Performance"](#), on page 405.

"-4 dB/- 2 dB (Low Distortion)"

Activates -4 dB or -2 dB gain.

Baseband signal is internally attenuated to minimize signal distortions; the intermodulation characteristics of signal are optimized, the SNR however decreases.

"0 dB"

No changes on the baseband signal; optimization is not applied

"+2 dB/ +4 dB/ + 6dB (Low Noise)"

Activates a 2 dB, 4 dB or 6 dB gain

Baseband signal is internally boosted to maximize the SNR; signal noise is minimized, the signal distortions however increase.

These values are suitable for 3GPP signals with high adjacent channel power ratio (ACPR).

Remote command:

[ :SOURce<hw> ] :IQ:GAIN on page 980 (for analog I/Q signal)

[ :SOURce<hw> ] :BB:IQGain on page 980 (for digital I/Q signal)

### Optimization Mode

Selects the optimization mode.

"Fast"

Fast optimization by compensation for I/Q skew.

Use this mode in time sensitive environments.

"High Quality"

With "Source > Internal Baseband", enable an optimization by compensation for I/Q skew and frequency response correction. The setting times, however, increase.

Use this mode to generate a flat signal.

For information on the I/Q modulation performance, see the data sheet.

Remote command:

`[ :SOURce<hw> ] :BB:IMPairment:OPTimization:MODE` on page 941

### Linearize RF

In instruments equipped with option R&S SMW-K541, enables an automatic AM/AM predistortion of the non-linear RF chain.

During RF linearization, the "Digital Predistortions AM/AM and AM/PM" settings are disabled.

Remote command:

`[ :SOURce<hw> ] :IQ:DPD:LRF:STATe`

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

### Adjust Linearization Current Frequency

The correction data is calculated for the currently selected frequency.

During RF linearization, the "Digital Predistortions AM/AM and AM/PM" settings are disabled.

Remote command:

`[ :SOURce<hw> ] :IQ:DPD:LRF:ADJust`

See user manual R&S®SMW-K540, R&S®SMW-K541 Envelope Tracking and AM/AM, AM/PM Predistortion.

## 7.4 How to Adjust the I/Q Modulator to Optimize Performance

With its default settings, the I/Q Modulator provides vector modulated signal that is optimized for time sensitive measurements and lower noise.

Adjusting the settings helps to improve signal quality in the following cases:

- To optimize the intermodulation characteristics of the signal
- To optimize the signal-to-noise ratio (SNR) of the signal
- To improve the flatness of the RF signal

In the following examples, we assume that:

- The R&S SMW generates a baseband signal
- A spectrum analyzer is connected to the R&S SMW, the analyzed is configured, and measures the required signal characteristics.

### To improve signal flatness

For a given baseband signal and RF frequency, perform the following:

1. In the block diagram, select "I/Q Mod > I/Q Settings > I/Q Modulator".  
The I/Q modulator is enabled. Modulated is the internal baseband signal.
2. Select "Optimization Mode > High Quality"

3. On a connected signal analyzer, monitor the signal characteristics.

#### **To optimize the intermodulation characteristics of signal**

For a given baseband signal and RF frequency, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod > I/Q Settings > I/Q Modulator".  
The I/Q modulator is enabled. Modulated is the internal baseband signal.
2. If activated, disable the "I/Q Wideband > Off".
3. Select "Baseband Gain = - 2 dB".
4. On a connected signal analyzer, monitor the signal distortion characteristics.
5. Vary the value of the parameter "Baseband Gain" until the maximal suppression of the intermodulation products is achieved.

#### **To optimize the characteristics of signals with high adjacent channel power ratio (ACPR)**

For a given baseband signal (e.g. a 3GPP signal) and RF frequency, perform the following iterative steps:

1. In the block diagram, select "I/Q Mod > I/Q Settings > I/Q Modulator".  
The I/Q modulator is enabled. Modulated is the internal baseband signal.
2. Select "Baseband Gain = 6 dB".
3. On a connected signal analyzer, monitor the signal characteristics.
4. Vary the value of the parameter "Baseband Gain" until the maximal signal-to-noise ratio (SNR) is achieved.

#### **To trigger the internal correction routine of the I/Q modulator**

System error correction of the I/Q modulator permits precise and repeatable measurements.

If a temperature fluctuation of several degrees occurs, trigger the correction routine using one of the following:

1. Select "I/Q Mod > I/Q Modulator > Adjust I/Q Modulator Current Frequency"
2. Select "SETUP > System > Internal Adjustment > Adjust I/Q Modulator Current Frequency".  
See also "[Internal Adjustments](#)" on page 1077.

#### **To generate a wideband modulation signal**

1. In the block diagram, select "I/Q Mod > I/Q Settings > I/Q Modulator".  
The I/Q modulator is enabled. Modulated is the internal baseband signal.

2. Select "I/Q Wideband > On".

The R&S SMW shifts the switching frequencies of the lowpass filters in the output section and generates signal with higher I/Q modulation bandwidth.

The harmonic suppression, however, degrades.

## 8 Configuring the Signal in the RF Domain

The vector signal generator R&S SMW generates RF signals with outstanding spectral purity within the frequency range from 100 kHz up to 20 GHz and individually adjustable signal level over a wide range.

Versatile analog modulation types enable you to generate the RF signal according to your requirements, with definable characteristics. In addition to CW signals in real time, you can generate also RF signals from predefined lists, characterized by fast modifiability and precisely definable signal properties, as well as sweep signals that vary according to the frequency or amplitude curves.

The variably adjustable output level due to the built-in attenuator, allows you to vary the RF signal level over the full level range, see [Chapter 8.9.1, "Attenuator"](#), on page 499.

There are also various possibilities to improve signal performance to optimize the signal quality for the corresponding application, see [Chapter 8.9, "Advanced Configuration Tasks for Performance Improving"](#), on page 499. These include for example [Chapter 8.9.3, "User Correction"](#), on page 505 or [Chapter 8.9.2, "ALC - Automatic Level Control"](#), on page 501, which increase the accuracy and reliability of the generated RF signal.

In addition, The R&S SMW also supports R&S NRP-Zxx Power Sensors. Thus you can monitor the output level in the generator, see [Chapter 8.9.4.1, "NRP-Z Power Viewer"](#), on page 515, or you can determine the level correction values for user correction lists, see [Chapter 8.9.3, "User Correction"](#), on page 505.

### Signal Modes and Characteristics

The R&S SMW generates unmodulated, analog modulated or vector modulated RF signals. You can output the signal either in fixed mode, or as a signal having periodically varying frequencies or amplitudes.

**Signal modes** for RF signal generation:

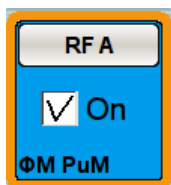
- **Unmodulated Signal**  
Generates an unmodulated continuous wave (CW) of constant frequency and amplitude. In [Configuring RF Frequency and Level](#) you can find all information regarding the signal frequency and level settings.  
See also [Chapter 3.3.1, "Generating an Unmodulated Carrier"](#), on page 65 for an example on how to configure a simple CW signal.
- **Analog modulated signal**  
Modulates the signal with an analog signal, as described in [Chapter 8.8, "Analog Modulations"](#), on page 471.  
The R&S SMW supports Amplitude, Phase, Frequency and Pulse Modulation. The instrument is able to generate the corresponding modulation signal internally, but you can also use an externally supplied signal.
- **Vector modulated signal**  
Generates an I/Q vector modulated signal, see [Chapter 7, "Applying I/Q Vector Modulation"](#), on page 399.



**RF signal output modes:**

- Fixed  
The RF signal as it is, that means modulated or unmodulated.
- Sweep  
An RF frequency or RF level sweep signal,  
Either continuously processed, step-by-step or individually, with various selectable trigger modes (external, internal or automatic). Note, that you cannot simultaneously run several sweeps.  
Find details of sweeps in [Chapter 8.7, "Varying the RF Signal in List or Sweep Mode"](#), on page 437.
- List Mode  
Generates the RF signal based on a list of predefined frequency / level values pairs and step widths.  
See [Chapter 8.7, "Varying the RF Signal in List or Sweep Mode"](#), on page 437 for detailed information.

## 8.1 How to Access the Functions in the RF Domain?



- ▶ To access the functions of the RF domain, select the config button in the corresponding "RF x" block and then the desired function in the RF menu list.

The RF block comprises all functions and settings concerning the RF signal. These include the RF frequency and level settings with all enhanced functions for improving the signal characteristics, the analog modulations, list and sweep mode settings as well as connector assignments and measurement functions of the RF signal.

The following overview provides information on where to find the descriptions of all functions accessed via the RF block menu in successive order.

**Table 8-1: RF Block Menu**

Menu item	Content	Described in ...
<b>RF Frequency</b>		
RF On	Activates RF signal output.	
Connectors	The instrument's customizable input and output interfaces: <ul style="list-style-type: none"> <li>• Global connectors</li> <li>• Local connectors</li> </ul>	<a href="#">Chapter 11.2, "Configuring the Local and Global Connectors"</a> , on page 612
Frequency / Phase	<ul style="list-style-type: none"> <li>• RF signal frequency and phase settings</li> <li>• The various possibilities for accessing the frequency settings</li> <li>• Impact of a downstream instrument to the frequency display</li> </ul>	<a href="#">Chapter 8.4, "Configuring RF Frequency and Level"</a> , on page 412

Menu item	Content	Described in ...
Ext. Ref. / LO Coupling	<ul style="list-style-type: none"> <li>• Internal reference frequency</li> <li>• Local oscillator (LO)</li> <li>• LO coupling</li> </ul>	Chapter 8.5, "Reference Oscillator", on page 422 and Chapter 8.6, "Local Oscillator Coupling", on page 428
<b>RF Level</b>		
Level	<ul style="list-style-type: none"> <li>• RF signal level settings</li> <li>• The various possibilities for setting the level</li> <li>• Impact of a downstream instrument to the level display</li> </ul>	Chapter 8.4, "Configuring RF Frequency and Level", on page 412
Attenuator	The electronic step attenuator settings.	Chapter 8.9.1, "Attenuator", on page 499
Power on / EMF	<ul style="list-style-type: none"> <li>• Determine the state of the RF signal output at power-on</li> <li>• Voltage level display in the status bar (no-load voltage)</li> </ul>	Chapter 8.9.5.1, "Power-On/EMF", on page 524
Automatic Level Control	The automatic adaptive control system to stabilize the RF output level.	Chapter 8.9.2, "ALC - Automatic Level Control", on page 501
User Correction	The level correction function for compensating external losses.	Chapter 8.9.3, "User Correction", on page 505
<b>RF Measurement</b>		Chapter 8.9.4, "Using Power Sensors", on page 514
NRP-Z Power Viewer	Function for monitoring and measuring the RF output power.	Chapter 8.9.4.1, "NRP-Z Power Viewer", on page 515
<b>Analog Modulation</b>	All settings for analog modulations, including the LF signal and some typical examples.	Chapter 8.8, "Analog Modulations", on page 471
Modulation Source	Signal sources for the LF signal: <ul style="list-style-type: none"> <li>• Internal signal generators</li> <li>• Externally applied LF signal</li> <li>• LF signal shapes</li> </ul>	Chapter 8.8.2, "Modulation Signals", on page 473 and Chapter 8.8.2.4, "Modulation Signal Waveforms", on page 478
Amplitude / Frequency / Phase Modulation	AM, FM and PhiM settings.	Chapter 8.8.3, "Modulation Settings", on page 480
LF Output	Configures the LF signal for output.	Chapter 8.8.3.3, "LF Signal Output Settings", on page 488
Pulse Modulation	Pulse modulation settings: <ul style="list-style-type: none"> <li>• General settings</li> <li>• Pulse generator settings</li> <li>• Graphical display of the pulse signal</li> </ul>	Chapter 8.8.3.5, "Pulse Modulation", on page 490
<b>Sweep / List</b>	Information on configuring an RF signal with varying frequencies or amplitudes, either in Sweep or List Mode.	Chapter 8.7, "Varying the RF Signal in List or Sweep Mode", on page 437

Menu item	Content	Described in ...
RF Frequency / RF Level Sweep / LF Frequency Sweep	Sweep mode settings.	<a href="#">Chapter 8.7.2, "Sweep Mode"</a> , on page 447
List Mode	List mode settings.	<a href="#">Chapter 8.7.3, "List Mode"</a> , on page 450

## 8.2 Required Options

The equipment layout for generating the RF signal includes:

- Option Frequency (R&S SMW-B1xx) for signal path A
- Option Frequency (R&S SMW-B2xx) for signal path B
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)
- **Note:** To perform, for example I/Q modulation and an analog frequency or phase modulation in one path simultaneously, option R&S SMW-B13T must be installed.

## 8.3 Activating RF Signal Output

Basically, the RF output signals are deactivated in both paths. The previous state is restored when the signals are reactivated.

If the settings for the RF output signal are made, you can turn on RF signal output via:

- the checkbox in the "RF Mod Block"
- the ON/OFF TOGGLE or the RF ON/OFF keys at the front panel
- the "RF Frequency > RF ON" entry in the "RFx" block menu  
To open the menu, select the configure button in the "RF x" block or the "RF connector" symbol of the corresponding block.

The current state of the RF output is indicated in the block diagram by means of the different block color and the status of the "On" checkbox.



To query the impedance of the RF outputs, use the command `:OUTPut<hw>:IMPedance?` on page 754

### RF On

Activates the RF output by changing the state of the "RF" functional block.

Remote command:

`:OUTPut<hw>[:STATe]` on page 753

`:OUTPut:ALL[:STATe]` on page 752

## 8.4 Configuring RF Frequency and Level

The simplest form of the RF signal is a continuous wave of constant frequency and amplitude, that is an unmodulated signal, which transmits the information without varying the carrier signal as with a modulation, for example. The RF signal is configured by its frequency and level.



### You have various possibilities to set the RF Frequency and Level ...

Since frequency and level are the core parameters of the RF signal, you have several options to adjust these parameters:

- |   |      |                  |     |        |         |         |     |        |     |     |        |     |
|---|------|------------------|-----|--------|---------|---------|-----|--------|-----|-----|--------|-----|
| A | Freq | 1.000 000 000 00 | GHz | RF On  | Ext Ref | Mod On  | PEP | 18.38  | mV  | Lev | -30.00 | dBm |
| B | Freq | 1.000 000 000 00 | GHz | RF Off | Ext Ref | Mod Off | PEP | -30.00 | dBm | Lev | -30.00 | dBm |

Select either the underlined label Freq or Lev, or the appropriate entry field in the status bar of the touchscreen and enter the target value directly via the on-screen keypad.

- Select the underlined label RF A in the block diagram opens the RF block menu, and you can access the frequency and level setting dialogs, and switch RF on or off.

- |      |       |
|------|-------|
| FREQ | LEVEL |
|------|-------|

Press the FREQ or the LEVEL key at the front panel and enter the value with the aid of the touchscreen, the keypad at the front panel, or use the rotary knob.

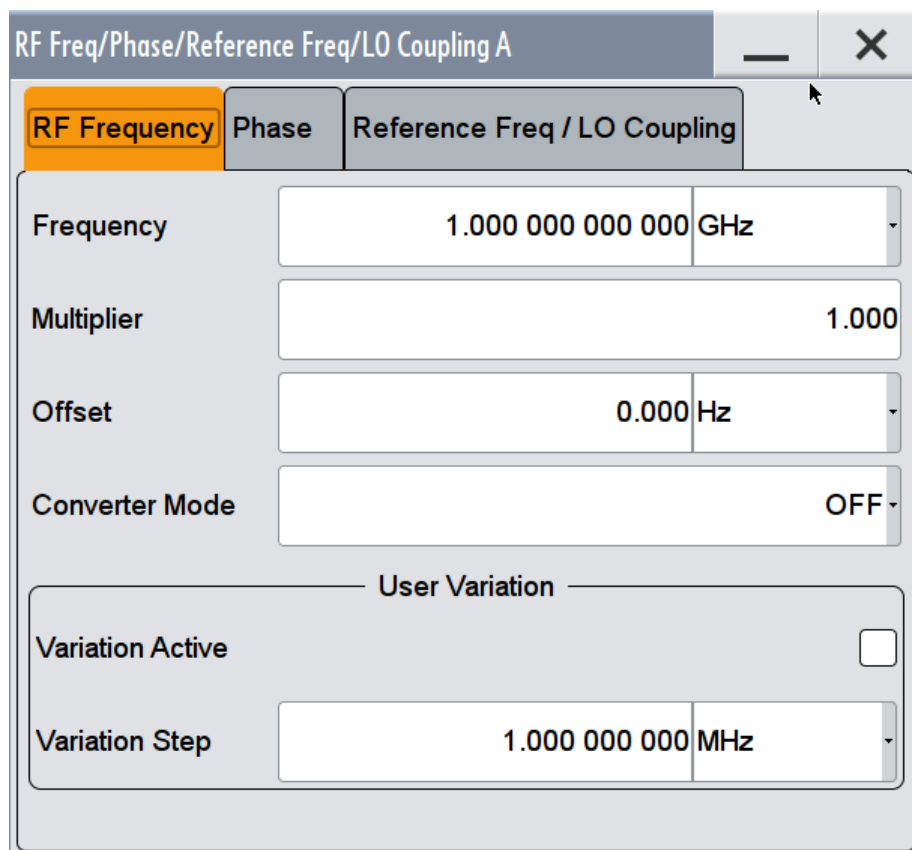
- Set the value in the associated settings dialog, see [Chapter 8.4.1, "RF Frequency Settings"](#), on page 412 and [RF Level Settings](#).

For a detailed description on entering data refer to [Chapter 3.5.4, "Entering Data"](#), on page 112.

To activate the RF signal output, see [Chapter 8.3, "Activating RF Signal Output"](#), on page 411.

### 8.4.1 RF Frequency Settings

- ▶ To access this dialog, select "RF" > "RF Frequency" > "Frequency".



In the "RF Frequency" tab of the combined "RF Frequency / Phase / Ext Ref..." dialog, you can configure the RF frequency and all the parameters that affect the frequency with the rotary knob, for example an offset or multiplication factor of a downstream instrument, as well as the step size for varying the frequency.

The remote commands required to define these settings are described in [Chapter 13.18.6, "SOURCE:FREQUENCY Subsystem"](#), on page 967.

**Frequency**

Sets the RF frequency.

This frequency is output at the RF connector. It does not consider a set offset or multiplication factor, see [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

**Note:** Status bar values blanked?

For security concerns or certain operating modes, the instrument blanks the frequency and level display in the status bar.



The display has been disabled for security reasons, see [Annotation Frequency](#) and [Annotation Amplitude](#).



The display is disabled when:

- list mode is running, see ["Interactions and characteristics"](#) on page 439
- digital only signals are generated, see User Manual "R&S SMW-K551 Generation of Digital "Slow IQ" Signals"

Remote command:

`[ :SOURce<hw> ] :FREQuency [ :CW | FIXed ]` on page 977

### Multiplier

Sets the multiplication factor for the RF frequency.

In the frequency field of the status bar, the instrument adjusts its frequency display according to the set multiplication factor. This frequency value shows the frequency at the output of the downstream multiplier. The entry does not change the frequency at the RF output of the R&S SMW, see also [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

Remote command:

`[ :SOURce<hw> ] :FREQuency:MUlTiplier` on page 973

### Offset

Sets the frequency offset.

This value represents the frequency shift of a downstream instrument, as for example a mixer, and is indicated in the status bar of the display. It does not change the frequency at the RF output, as shown in [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

Remote command:

`[ :SOURce<hw> ] :FREQuency:OFFSet` on page 974

### Converter Mode

Selects the mode for calculating the output frequency of a downstream converter.

#### Example: Functionality of the converter mode

As the R&S SMW is a 2 path signal generator, it optimally supports external frequency converters. For convenient operation, this functionality calculates the resulting system frequency.

The converter mixes an I/Q modulated RF signal of the first path with an unmodulated, multiplied signal generated in the second path of the R&S SMW.

To configure the converter frequency:

- Set the frequency of the modulation carrier and the multiplication factor in the first path.
- Select the mixing frequency in the second path.  
According to the selected converter mode, the R&S SMW shows the resulting frequency in the status bar.

The selectable modes show the formulas on that the calculation is based. Due to the interaction of the two paths, active converter modes are mutually exclusive. Depending on the band to be used, select the appropriate mode:

"OFF"                      No converter considered.

"Multiplier \* RFB + RFA" / "Multiplier \* RFA + RFB"

Uses the upper sideband.

"Multiplier \* RFB - RFA" / "Multiplier \* RFA - RFB"

Uses the lower sideband.

Remote command:

n.a.

#### **User Variation**

Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

#### **Variation Active ← User Variation**

Activates the set user-defined step width.

#### **Variation Step ← User Variation**

Sets the user-defined step width.

Remote command:

[ :SOURce<hw> ] :FREQuency:STEP:MODE on page 976

[ :SOURce<hw> ] :FREQuency:STEP [ :INCRement ] on page 976

[ :SOURce<hw> ] :POWer:STEP:MODE on page 1030

[ :SOURce<hw> ] :POWer:STEP [ :INCRement ] on page 1031

## **8.4.2 RF Level Settings**

- ▶ To access the settings dialog, select "RF > RF Level > Level".

RF Level / EMF / ALC / UCOR A

RF Level Attenuator Power-On/EMF ALC UCOR

Amplitude -30.00 dBm

Digital Attenuation 0.000 dB

Mode Normal

Setting Characteristics Auto

Level Range: -31.99 dBm ... -28.00 dBm

Readjust

Limit 30.00 dBm

Offset 0.00 dB

Variation Active

Variation Step 1.00 dB

In the "RF Level" tab of the combined "RF Level / EMF / ALC / UCOR" dialog, you can configure the offset free level, the level limit, and the step width for varying the level with the rotary knob.

The remote commands required to define these settings are described in [Chapter 13.18.15, "SOURCE:POWER Subsystem"](#), on page 1022.

#### Amplitude

Sets the level of the RF signal.

This value is supplied at the output connector.

**Note:** Status bar values blanked?



For security concerns or certain operating modes, the instrument blanks the frequency and level display in the status bar.



The display has been disabled for security reasons, see [Annotation Frequency](#) and [Annotation Amplitude](#).



The display is disabled when:

- list mode is running, see ["Interactions and characteristics"](#) on page 439
- digital only signals are generated, see User Manual "R&S SMW-K551 Generation of Digital "Slow IQ" Signals"

Remote command:

`[ :SOURce<hw> ] :POWER:POWER` on page 1029

**Note:** The SCPI command `[ :SOURce<hw> ] :POWER [ :LEVel ] [ :IMMediate ] [ :AMPLitude ]` sets the level of the "Level" display, that means the level containing offset, see [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

### Digital Attenuation

Attenuates or raises the level of the internal, digitally modulated I/Q baseband signals, and thus the level of the RF signal accordingly.

The function allows fast level changes of the internal I/Q signals. You can determine an attenuation value between -3 dB and +80 dB. The instrument calculates the digital attenuation to the  $Level_{PEP}$  and the  $Level_{rms}$  as follows:

$$Level_{PEP(RF\ output)} = Level_{PEP} - \text{Digital Attenuation}$$

$$Level_{rms(RF\ output)} = Level_{rms} - \text{Digital Attenuation}$$

The level range changes accordingly.

**Note:** The digital attenuation has no effect on the RF output level when you work in CW mode or with externally applied I/Q signals, i.e. with unmodulated signals. If the digital attenuation effects the RF level, the R&S SMW indicates the resulting level in the "Status bar". It is also denoted by an icon next to the level indicator (see ["Level Offset & Level EMF Offset & Level Ucor & Level Digital Attenuation"](#) on page 1146).

Since you can control the RF output level in various ways, the R&S SMW provides the appropriate information in the icons and the level value displayed. However, note the detailed information on the interaction of the level parameters, the displayed value, and the actual level at the RF output, described under [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

Remote command:

`[ :SOURce<hw> ] :POWER:ATTenuation:DIGital` on page 1026

### Mode

Allows you to optimize the RF output signal for applications, where improved harmonic distortion or improved wideband noise is required.

"Normal"                      Generates an RF output signal with high signal to noise ratio as well as low distortion, according to the data sheet.

"Low Noise" Optimizes the signal to noise ratio.

"Low Distortion"  
Reduces distortion (harmonics) of the RF signal to a minimum.

Remote command:

`[ :SOURce<hw> ] :POWer:LMODe` on page 1027

### Setting Characteristics

Selects additional quality characteristics to optimize the behavior of the RF signal level for the corresponding application.

"Auto" Sets the RF output level automatically according to the selected mode.  
In this mode, the instrument provides the highest dynamic range and fastest setting times, as specified in the data sheet.  
The RF signal is shortly blanked when the step attenuator is switching.

"Uninterrupted Level Settings"  
Suppresses blanking at frequency and level transitions.  
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

"Strictly Monotone"  
Executes signal level changes monotonically increasing or decreasing.  
The setting makes sure that increasing the level value exclusively results in an increased output level, and vice versa.  
All electronic switches, which might affect the monotonicity are fixed.  
The operation mode is useful for applications using level searching algorithms which rely on a strictly monotonous behavior.

"Constant VSWR"  
Suppresses output impedance variations at the RF output connector, due to changed level settings.

"Constant Phase"  
Suppresses phase discontinuities.  
This mode reduces the dynamic range of the instrument and the step attenuator is fixed (equates to "Strictly Monotone").

Remote command:

`[ :SOURce<hw> ] :POWer:LBEHaviour` on page 1027

### Level Range

Shows the interruption-free range of the level that you can use in the currently selected mode.

Remote command:

`:OUTPut<hw>:AFIXed:RANGe:LOWer?` on page 754

`:OUTPut<hw>:AFIXed:RANGe:UPPer?` on page 754

### Readjust

Recalculates and adjusts the internal switch positions of the RF chain according to the current level.

In the "Sample & Hold" and "Sample & On" modes, the function also triggers a new sample process. During the recalculation, the output level is blanked briefly.

Remote command:

`[ :SOURce<hw> ] :POWer:ALC:SONCe` on page 1025

### Limit

Sets an upper limit for the RF output power.

You can use it to protect your DUT from damage due to high input power. If you enter an RF level above this value, the instrument limits the output power to this specified value, and generates a warning message.

However, the level indication in the status bar is not affected.

**Note:** The value is not affected by an instrument preset (PRESET key), \*RST and the "Save/Recall" function. It is influenced only by the Factory Preset and the factory value is equal to maximum level. See also [Chapter 10.2, "Restoring the \(Default\) Instrument Configuration"](#), on page 574.

Remote command:

`[ :SOURce<hw> ] :POWer:LIMit [ :AMPLitude ]` on page 1027

### Offset

Sets a level offset.

This value represents the level shift of a downstream instrument, as for example an attenuator or an amplifier, and is indicated in the status bar of the display. It does not change the level at the RF output. See [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420 for information in detail.

Remote command:

`[ :SOURce<hw> ] :POWer [ :LEVel ] [ :IMMediate ] :OFFSet` on page 1032

### User Variation

Defines and activates a user-defined step width for varying the RF frequency or RF level with the rotary knob.

If disabled, the step width varies in steps of one unit at the cursor position.

### Variation Active ← User Variation

Activates the set user-defined step width.

### Variation Step ← User Variation

Sets the user-defined step width.

Remote command:

`[ :SOURce<hw> ] :FREQuency:STEP:MODE` on page 976

`[ :SOURce<hw> ] :FREQuency:STEP [ :INCRement ]` on page 976

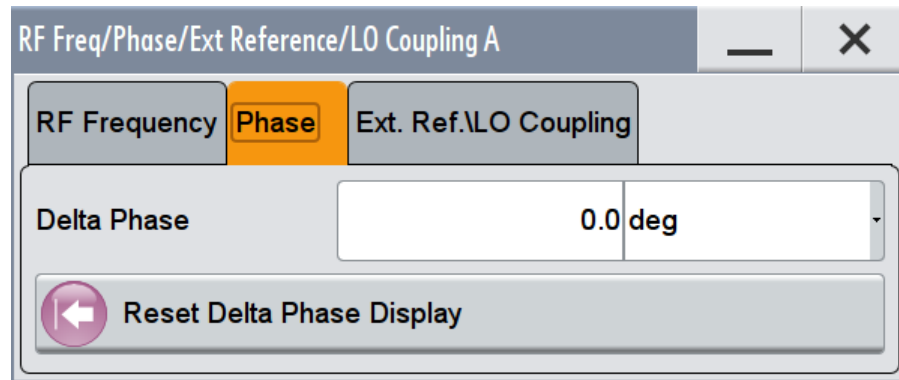
`[ :SOURce<hw> ] :POWer:STEP:MODE` on page 1030

`[ :SOURce<hw> ] :POWer:STEP [ :INCRement ]` on page 1031

## 8.4.3 RF Phase Settings

The phase in sinusoidal signals defines the initial angle at its origin.

- ▶ To set the phase for the RF signal, select "RF > RF Frequency > Phase".



In the "RF Phase" tab of the combined "RF Frequency / Phase / Ext. Ref..." dialog, you can determine the delta phase value, and reset the phase to this reference.

The remote commands required to define these settings are described in [Chapter 13.18.14, "SOURCE:PHASe Subsystem"](#), on page 1021.

#### Delta Phase

Sets the phase of the RF signal.

The current phase of the signal is used as the reference.

**Note:** To achieve a long-term stable phase-locked coupling, for example, to synchronize the output signal with the phase of a second signal generator, we recommend that you establish LO coupling, see [Chapter 8.6, "Local Oscillator Coupling"](#), on page 428.

Remote command:

[ :SOURCE<hw> ] : PHASe on page 1022

#### Reset Delta Phase Display

Adopts the set [Delta Phase](#) value as the current value, and resets delta phase to 0 degrees.

Remote command:

[ :SOURCE<hw> ] : PHASe:REFerence on page 1022

### 8.4.4 References

This section shows how the R&S SMW includes the factors of a downstream instrument to provide an optimal RF signal for the DUT.

#### 8.4.4.1 Displayed RF Frequency and Level Values with Downstream Instruments

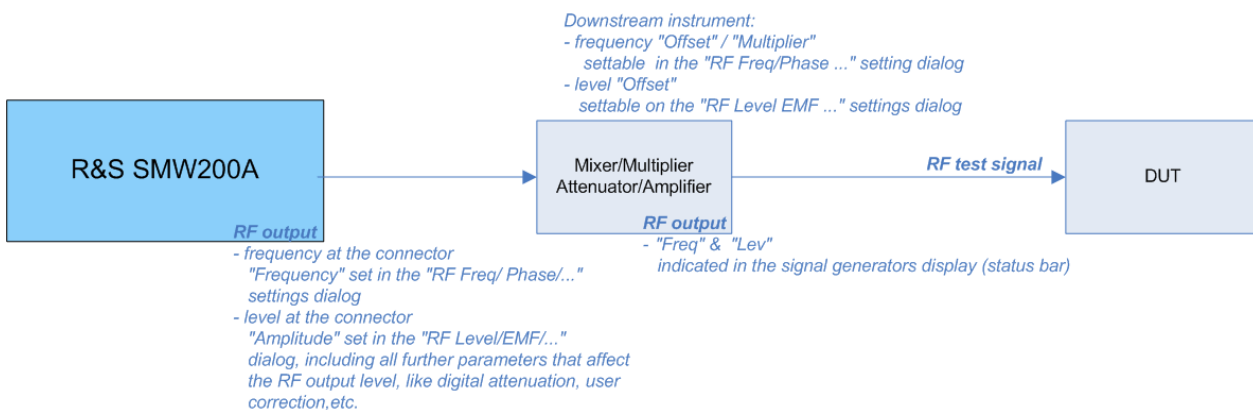
If you are working with a downstream instrument, like a mixer, a frequency multiplier, an amplifier or an attenuator, you can enter the parameter (offset, multiplier, amplitude) of the respective instrument in the frequency or level settings dialog of the R&S SMW.

The generator includes these parameters and displays the result in the "Freq" and "Lev" fields in the status bar, as if the downstream instrument and the generator were

one unit. Thus, the displayed value corresponds to the value at the RF output of the downstream instrument.

The R&S SMW generates the signal without the downstream parameters, but considers all additional features concerning the RF level, like digital attenuation, user correction, etc.

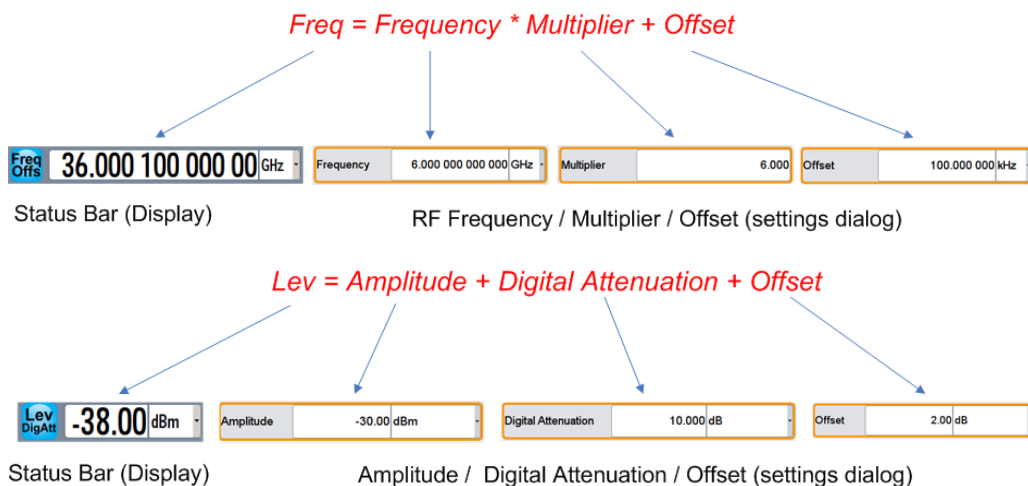
**RF Frequency and Level Display with a Downstream Instrument**



**Figure 8-1: RF frequency & level display vs. RF output frequency**

As shown in the figure, there are further parameters in addition to the frequency and amplitude, which affect the RF signal for the DUT, e.g. impacts of subsequent instruments. To include these impacts already in the configuration, you can set the associated parameters directly in the dialogs (see [RF Frequency Settings](#), or [RF Level Settings](#)).

In the "Freq" and "Lev" fields of the status bar, the R&S SMW shows the results of the following correlations:





As a special feature, the level displayed in the status bar includes "Amplitude", "Offset" and "Digital Attenuation". In contrast to level "Offset", the "Digital attenuation" directly affects the level value at the RF output. Offset represents a level value that impacts the RF signal outside the R&S SMW.

All additionally provided level affecting settings, e.g. user correction, are indicated by an icon in the status bar and directly affect the RF output level.

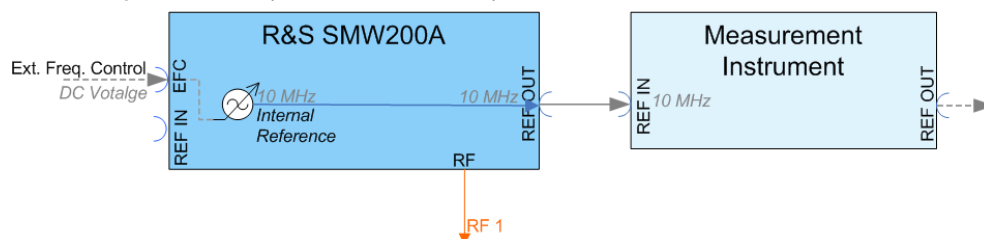
## 8.5 Reference Oscillator

The R&S SMW is equipped with an internal reference oscillator that generates a reference frequency of 10 MHz. It is used as internal reference source for the synthesizer and the local oscillator. Alternatively, you can apply an external reference signal even with a frequency different than 10 MHz.

Regardless of the used reference source (internal or external), the R&S SMW always provides the configured reference frequency at the output. You can use it, for example to synchronize several interconnected instruments.

The following examples briefly explain the possible test setups and the settings to be considered.

- Internal  $f_{\text{ref}} = 10 \text{ MHz}$  (10 MHz REF OUT)



**Figure 8-2: Synchronizing a subsequent instrument using the internal 10 MHz reference signal of the R&S SMW**

The internal reference oscillator supplies the reference frequency.

In addition, you can shift the frequency by an external tuning voltage within a certain range, **EFC** (External Frequency Control). This function is used, for example, in phase noise measurement systems.

The frequency shift resulting from a tuning voltage value depends on the technical equipment of the instrument. See the data sheet for the associated technical data like sensitivity, input voltage range and impedance. The maximum bandwidth for external tuning signal input is approximately 50 Hz.

**Note:** The bandwidth of an external PLL (Phase Locked Loop) used in a phase noise measurement system, must be less than the bandwidth of the external tuning signal input. If the measurement requires a higher bandwidth for the PLL, it is recommended that you use the external FM modulation (DC coupling) in low noise mode. The FM-DC mode yields a fixed tuning sensitivity that is independent of the RF output frequency and corresponds to the set FM deviation.

Settings:

- **Source:** "Internal"

- External  $f_{\text{ref}} = 10 \text{ MHz}$  (10 MHz REF OUT)  
If you have a clean external reference signal with 10 MHz frequency, you can directly pass it to the output. The signal quality remains the same.

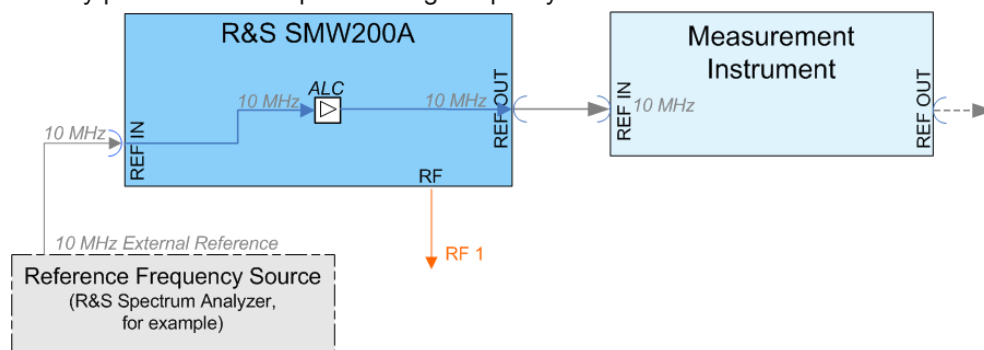


Figure 8-3: Synchronizing instruments with an externally applied 10 MHz reference signal

Settings:

- Source: "External"
- Variable Reference Frequency: "10 MHz"

Set the additionally provided parameters, as for example the synchronization bandwidth according to the requirements of the application.

- External  $f_{\text{ref}} = 1 \dots 100 \text{ MHz}$  (10 MHz REF OUT)  
(provided by instruments equipped with the latest SSYN assembly, part no. 1412.6667.02)  
If you have an external reference signal between 1 and 100 MHz, or the signal is interfered (noisy), you can route the internally referenced signal to the output. In this mode, the bandwidth is narrow (1 Hz).

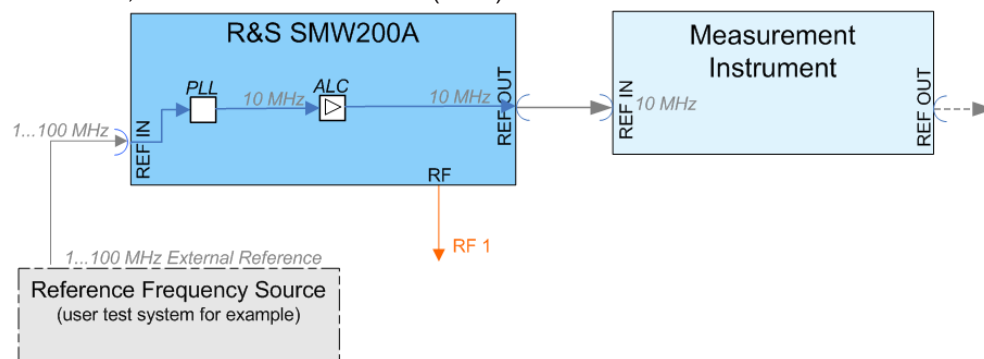
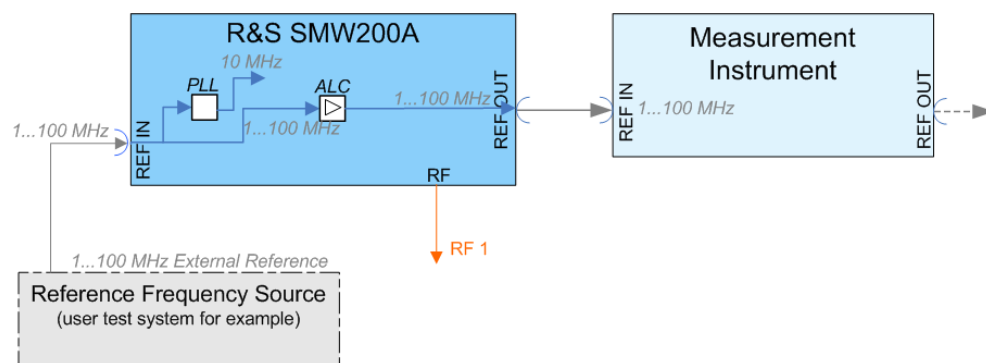


Figure 8-4: Synchronizing a subsequent instrument with 10 MHz, derived from an externally applied reference frequency between 1 and 100 MHz

Settings:

- Source: "External"
- Variable Reference Frequency: "Variable"
- Reference Frequency Output: "10 MHz Derived from Ref. Input"

- External  $f_{\text{ref}} = 1 \dots 100 \text{ MHz}$  (1..100 MHz REF OUT)  
(instruments equipped with the latest SSYN assembly, part no. 1412.6667.02)

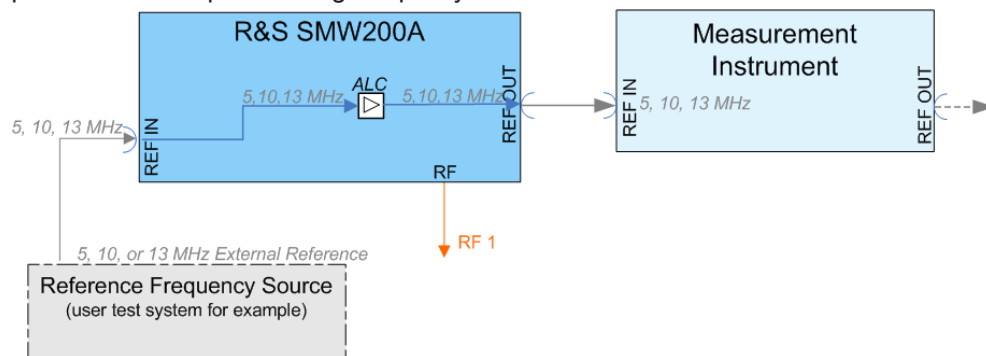


However, you can forward any external reference frequency between 1 and 100 MHz also directly to the output.

Settings:

- Source: "External"
- "Variable Reference Frequency" on page 427: "Variable"
- Reference Frequency Output: "Same As Reference Input"
- External  $f_{ref} = 5/10/13$  MHz (5/10/13 MHz REF OUT)  
(provided by instruments equipped with the previous SSYN assembly, part no. 1141.4220.02)

If you have an external reference signal with 5, 10 or 13 MHz, you can directly pass it to the output. The signal quality remains the same.



**Figure 8-5: Synchronizing a subsequent instrument an externally applied reference frequency of 5, 10, or 13 MHz**

Settings:

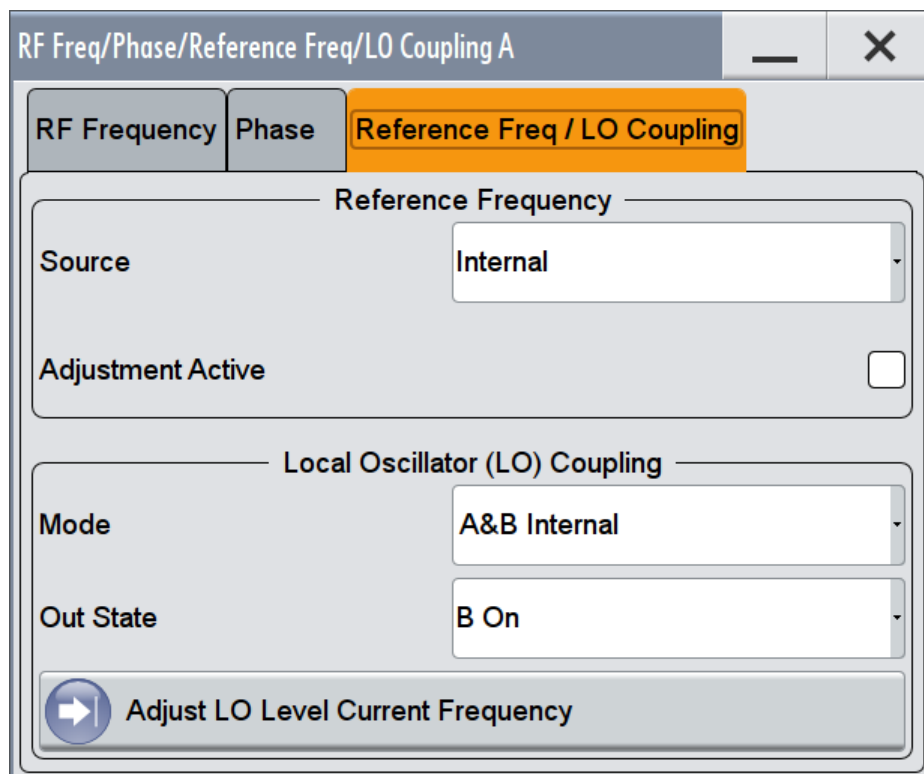
- Source: "External"
- Variable Reference Frequency: "5, 10 or 13 MHz"

The corresponding connectors (REF OUT, REF IN) are located at the rear panel, see [Chapter 3.2.2.1, "Connectors"](#), on page 60.



### 8.5.1 Reference Oscillator Settings

- ▶ To access the settings dialog for configuring the reference signal, select one of the following:
  - "RF > RF Frequency > Reference Freq / LO Coupling ..."
  - "System Config > Setup > Reference Freq / LO Coupling ..."



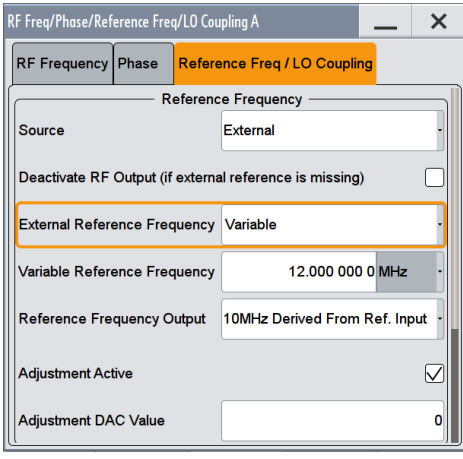
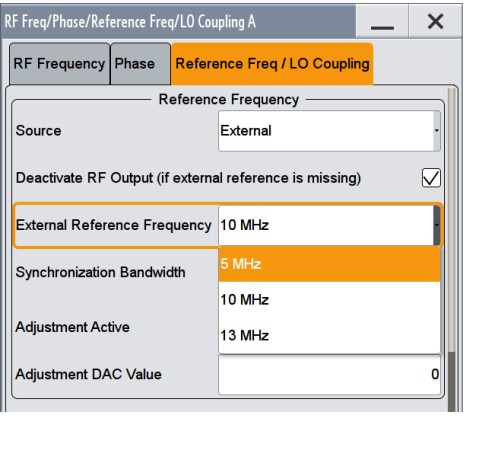
In the "Reference Freq/LO Coupling" tab, you can select the signal source of the reference frequency, enter and adjust the frequency of an external reference signal, and configure the [Local Oscillator Coupling](#).



Instruments equipped with the latest SSYN assembly (part no. 1412.6667.02) allow you to select either 10 MHz or a variable external reference frequency, whereas the instruments with the previous SSYN assembly (part no. 1141.4220.02) support only 5, 10 or 13 MHz, see [Table 8-2](#).

For an overview of the installed hardware options, see [Chapter 14.2.8.1, "Hardware Configuration Settings"](#), on page 1092

**Table 8-2: Reference frequency selection depending on the SSYN assembly version**

	
SSYN assembly (latest version, part no. 1412.6667.02)	SSYN assembly (predecessor, part no. 1141.4220.02)

The remote commands required to define the reference oscillator settings are described in [Chapter 13.18.16, "SOURce:ROSCillator Subsystem"](#), on page 1033.

### Source

Selects the reference frequency source.

- "Internal" Uses the internal 10 MHz reference signal, either with calibrated or a user-defined adjustment value.
- "External" Uses an external reference signal. The frequency of the external reference signal must be selected under [Variable Reference Frequency](#).

Remote command:

[\[:SOURce\]:ROSCillator:SOURce](#) on page 1035

### Deactivate RF Output (if external reference is missing)

Turns off the RF output when the external reference signal is selected, but no signal is supplied.

This function prevents that no improper RF signal due to the missing external reference signal is used for measurements. A message indicates that the RF output is deactivated.

Remote command:

[\[:SOURce\]:ROSCillator:EXTernal:RFOFF\[:STATe\]](#) on page 1034

### External Reference Frequency

Determines the frequency of the external reference signal.

The frequency values supported depend on the version of the installed SSYN assembly.

- "Variable" (applies to latest SSYN assembly 1412.6667.02)  
 Selects that the external reference signal has an arbitrary frequency, within the permissible range from 1 MHz to 100 MHz.  
 In this case, you can choose whether you want to use this signal as the reference signal for downstream instruments, or a signal with 10 MHz frequency derived from the reference input, see [Reference Frequency Output](#).
- "10 MHz" (applies to latest SSYN assembly 1412.6667.02)  
 Selects 10 MHz external reference frequency.
- "5, 10, 13 MHz" (applies to SSYN assembly 1141.4220.02 (predecessor))  
 Sets the frequency corresponding to the signal at the reference input.

Remote command:

`[ :SOURce ] :ROSCillator :EXTernal :FREQuency` on page 1033

#### Variable Reference Frequency

(applies to latest SSYN assembly 1412.6667.02)

Sets the variably settable external reference frequency.

Remote command:

`[ :SOURce ] :ROSCillator :EXTernal :FREQuency :VARiable` on page 1034

#### Reference Frequency Output

(applies to SSYN assembly 1412.6667.02)

Selects the signal that is to be output as frequency reference for downstream instruments.

"Same As Reference Input" Passes the assigned reference frequency to the output directly.

"10MHz Derived From Ref. Output" Derives a signal with 10 MHz frequency from the reference input and forwards this signal to the output.

Remote command:

`[ :SOURce ] :ROSCillator :OUTPut :FREQuency :MODE` on page 1035

#### Synchronization Bandwidth

Selects the synchronization bandwidth for an external reference signal with 5, 10 or 13 MHz.

- "Narrow" The synchronization bandwidth depends on the configuration of the instrument:
- Instruments equipped with option R&S SMW-B22  
 The synchronization bandwidth is a few Hz. The internal 10-MHz OCXO is synchronized to the external signal. This setting is recommended if the phase noise of the external signal is worse than the phase noise of the internal OCXO.
  - Instruments without option R&S SMW-B22  
 The synchronization bandwidth is approximately 20 Hz.

- "Wide" The synchronization bandwidth depends on the configuration of the instrument:
- Instruments without option R&S SMW-B22  
The synchronization bandwidth is approximately 750 Hz. This mode is the recommended standard mode.
  - Instruments equipped with the option R&S SMW-B22  
The synchronization bandwidth is approximately 100 Hz. This mode is recommended for precise reference sources of high spectral purity. The internal 10 MHz OCXO is bypassed and the external signal synchronizes a 100 MHz reference oscillator directly.

Remote command:

`[ :SOURce ] :ROSCillator :EXTernal :SBANdwidth` on page 1034

#### Adjustment Active

Selects the adjustment mode.

- "OFF" Uses the calibrated internal reference frequency.
- "ON" Allows you to apply a deviation to the internal reference frequency, according to your requirements. To enter the value, use [Adjustment DAC Value](#).

Remote command:

`[ :SOURce ] :ROSCillator [ :INTernal ] :ADJust [ :STATe ]` on page 1036

#### Adjustment DAC Value

Sets a user-defined adjustment value for the internal reference frequency. This value takes effect when it is activated with [Adjustment Active](#). "0" represents the calibrated state. The setting range depends on the reference oscillator type and its factory calibration value.

**Note:** A factory preset resets this setting to the calibration value of the instrument.

Remote command:

`[ :SOURce ] :ROSCillator [ :INTernal ] :ADJust :VALue` on page 1036

## 8.6 Local Oscillator Coupling

The "LO Coupling" function allows a distribution of the local oscillator signal in a way that multiple RF signals can be derived from the same LO signal. This is mandatory for minimizing the phase fluctuations between these RF signals.

The R&S SMW uses either the internal oscillator frequency for the LO signal, that is the output signal of the internal synthesizer, or an external frequency source. You can select the internal or external LO signal of path A, and optionally couple it with path B. Uncoupled, B uses its internal signal. When the LO signal is coupled, the R&S SMW indicates the connection line in the block diagram.

The internal LO signal is output at the LO OUT connector, and an external signal is fed in at the LO IN connector, see ["To find the physical Location of the LO IN/OUT connectors"](#) on page 433.



You can couple the LO signal as follows:

- **"A Internal & A -> B Coupled"**

The R&S SMW uses the internal oscillator signal of path A also in path B. The reference frequency settings in path B have no effect and are thus disabled for editing.

- **"A External & A -> B Coupled"**

The R&S SMW receives an external oscillator signal and uses this signal in both paths.

The reference frequency settings in both paths have no effect and are thus disabled for editing.

**Note:** As the instrument cannot verify the frequency of the oscillator signal that is fed in, it is essential that this signal has exactly the frequency shown in the settings dialog, see ["LO OUT Frequency"](#) on page 432.

Similarly, you can couple the signals of cascaded instruments as shown in ["To configure LO coupling with cascaded instruments to achieve phase coherence"](#) on page 434.

### Level adjustment

The level range of the LO input and LO output signal is 10 dBm  $\pm$ 3 dB, as specified in the data sheet of the R&S SMW.

The instrument uses the default settings to adjust its internal level, which is sufficiently accurate for most applications.

But consider that the oscillator signal level at LO IN should be stable, with minimized phase noise and interferences. The fed in signal is directly used in the instrument, and thus affects the instrument performance. It is recommended that you keep the (sub-)harmonics below -20 dBc, and the level stable within  $\pm$ 0.1 dB over time and temperature

However, if you need optimum performance, or if you have long interconnections between LO OUT and LO IN, it is recommended that you adjust the LO level at the current frequency. Using this function, the instrument readjusts the internal signal levels to optimum.

The adjustment may take a few milli seconds.



### Keep the order when performing LO Level adjustments for subsequent instruments

When you perform LO level adjustments in several interconnected signal generators, always start with the first R&S signal generator, and continue in the order of the following R&S signal generators. This sequence is necessary, because the second instrument adjusts its internal gain as long as the levels are accurate and then keeps this adjustment untouched. If you now would change the predecessor, the level of the second would change accordingly and its adjustment would no longer be correct.

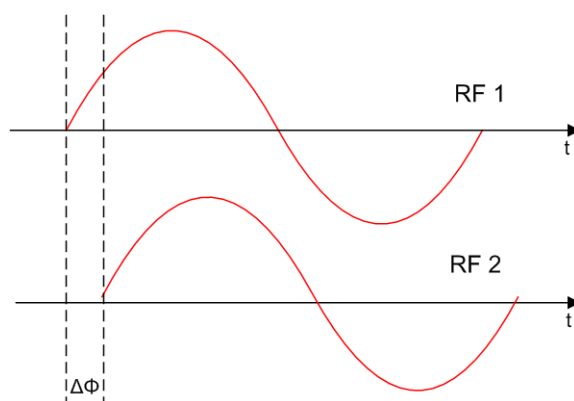
### 8.6.1 Required Options

The equipment layout for using the LO Coupling function is included in:

- Option Phase Coherence (R&S SMW-B90)

### 8.6.2 Phase Coherence

Phase coherence of RF signals designates a defined, constant delta phase between two or more RF carrier signals with the same frequency or a multiple of the frequency.



If two signal generators are coupled via their 10 MHz reference, they are generating the same frequency but only from the long term perspective. Having a closer look into the instantaneous differential phase (“delta phase”) of these two RF signals, this is instable due to:

- Phase noise of the two synthesizers
- “weak” coupling at 10 MHz and a long synthesis chain up to the RF domain
- Temperature differences which cause a change of the effective electrical length of some synthesizer components

Most critical for a stable delta phase is the thermal RF phase fluctuation between multiple RF synthesizers. These fluctuations can be minimized by using a common synthesizer, that means a common local oscillator (LO) signal for all RF carrier. Only if this LO signal (which is internally used for upconverting the baseband signal to the RF) is the same for all carriers, you can achieve a stable phase relationship between the RF signals.

### 8.6.3 LO Coupling Settings

- ▶ To access these settings, select "RF > Ext Ref / LO Coupling ...".

The "Local Oscillator (LO) Coupling" settings enable you to define the coupling of the local oscillator signal in the RF signal paths.

The related remote commands are described in [Chapter 13.18.6, "SOURCE:Frequency Subsystem"](#), on page 967.

### Mode

Selects the coupling mode of the LO signals in path A and B.

If you work with a one path instrument, the distinction between A & B as well as coupling are not relevant. You can select between "Internal" and "External".

See some of typical test setups in ["To configure LO coupling with cascaded instruments to achieve phase coherence"](#) on page 434.

**Note:** Working with an **external** oscillator signal disables all setting parameters of "RF Frequency / Phase / Ext. Reference" in the corresponding path.

"A&B Internal" Uses the internal local oscillator signal in each path.

"A External & B Internal"

Uses an external signal in path A, and the internal signal of path B.

"A Internal & A -> B Coupled"

Uses the internal oscillator signal of path A in both paths.

"A External & A -> B Coupled"

Uses an external signal in both paths.

"A Internal & B RF Off"

If the selected RF frequency exceeds the maximum frequency of path B (see the installed frequency options), this setting uses the internal local oscillator signal of path A. In addition, it enables you to route this LO signal to the LO output connector. Thus you can use it as LO input for a downstream instrument.

The RF OUT of path B is switched off in this case.

**"A External & B RF Off"**

If the selected RF frequency exceeds the maximum frequency of path B, this setting uses the LO IN signal for path A. You can route the signal to the LO output connector use it as LO input for a downstream instrument.

The RF output of path B is switched off in this case.

**"A RF Off & B External"**

If the selected RF frequency exceeds the maximum frequency of path A, this setting uses the LO IN signal for path B. You can route the signal to the LO output connector use it as LO input for a downstream instrument.

The RF output of path A is switched off in this case.

**"Internal"**

Uses the internal signal. This selection parameter applies to one path instruments.

**"External"**

Uses an externally supplied signal. This selection parameter applies to one path instruments.

Remote command:

[\[:SOURce<hw>\]:FREQuency:LOSCillator:MODE](#) on page 970

**Out State**

Activates/Deactivates the LO output.

**"B On / On"**

**Note:** Selection "B On" applies to two-path instruments, and "On" to one-path instruments, respectively.

The internal local oscillator signal is also available at the LO OUT connector (to couple two instruments).

**"Off"**

The LO OUT signal is switched off.

Remote command:

[\[:SOURce<hw>\]:FREQuency:LOSCillator:OUTPut:STATe](#) on page 971

**Mandatory LO IN Frequency**

Displays the frequency that must be applied as external LO frequency.

Remote command:

[\[:SOURce<hw>\]:FREQuency:LOSCillator:INPut:FREQuency?](#) on page 970

**LO OUT Frequency**

Displays the current LO frequency at the LO OUT connector.

Remote command:

[\[:SOURce<hw>\]:FREQuency:LOSCillator:OUTPut:FREQuency?](#) on page 971

**Adjust LO Level at Current Frequency**

Adjusts the level of the oscillator signal to optimum, when an external LO signal is applied, see [To adjust the LO level to current frequency](#).

The function is enabled when either an external "LO Coupling Mode" is selected, or the "Out State" is on ("B On" or "On" respectively).



**Note:** If your test setup consists of several cascaded Rohde & Schwarz signal generators, start the LO level adjustment always with the first instrument using an external oscillator signal, and continue in the order up to the last.

Remote command:

`:CALibration<hw>:LOSCillator:COUPling:LOCAl?` on page 737

#### 8.6.4 How to Adjust the LO Level, Find the Connectors and Configure Cascaded Instruments

This section describes how you can find out the location of the LO signal connectors, and tips on adjusting the LO signal level when using an external signal. You can also find instructions for configuring the LO signals of several disconnected signal generators.

##### To adjust the LO level to current frequency

If you are working with an external LO signal, it is recommended that the internal LO level is adjusted to the optimum value.

To adjust the internal signal level, proceed as follows:

1. In the "RF > Ext. Ref / LO Coupling" dialog, select one of the following:
  - "Mode > A External & B Internal"
  - "Mode > A External & A-> B Coupled"
  - "Mode > External" if you are working with a one path instrument
  - "Mode > A External & B RF Off"
  - "Mode > A RF OFF & B External"
2. Apply the oscillator signal, with a level of 10 dBm  $\pm$ 3 dB at the appropriate LO IN connector (see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618).
3. Check if the external oscillator signal has the required frequency, as shown in the dialog under "LO OUT Frequency".
4. Set "Output State > B On", or "On", respectively.
5. Execute "Adjust LO Level Current Frequency".

The R&S SMW automatically adjusts the internal LO signal level at the I/Q modulator and the LO OUT connector.

##### To find the physical Location of the LO IN/OUT connectors

The LO IN/OUT connectors are located on the rear panel. To find out the exact position, proceed as follows:

1. In the block diagram, select the [T/E/L/P/V status LEDs](#).
2. Select "RF Connectors > LO IN > Find".

The "Find Connectors > Rear" dialog indicates the position of the LO IN connector. See also [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

### To configure LO coupling with cascaded instruments to achieve phase coherence

The LO Coupling function can be used to generate beamforming signals.

The test setups in the following examples represent possible applications and provide information about the coupling modes set in the signal generators. For the configuration via remote control, refer to the programming examples in [Chapter 13.18.6, "SOURCE:FREQUENCY Subsystem"](#), on page 967.



#### Known Restrictions

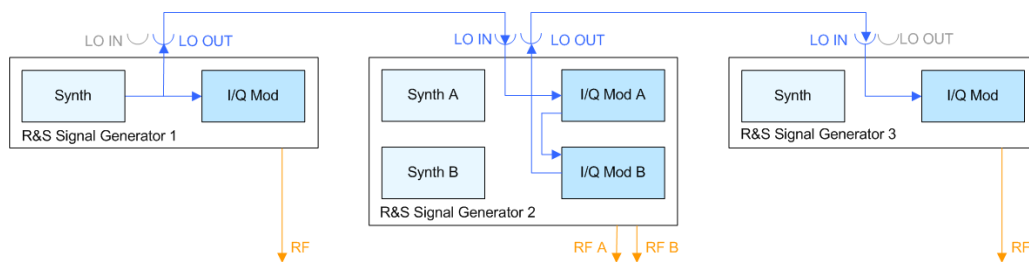
If you cascade instruments or channels at frequencies below 200 MHz, that is in coupled or external mode, make sure that:

- All channels are equipped equally regarding option R&S SMW-B22, that means each channel is equipped with or without the option.
- The connection between the REF OUT of the first instrument and REF IN of the subsequent instrument is established, see [Chapter 8.5, "Reference Oscillator"](#), on page 422.

Frequencies below 200 MHz are generated using downconversion. Therefore the coherence of the cascaded channels in this frequency range is not as good as at higher frequencies.

The first test setup example represents all variants of the coupling modes, and describes step-by-step how to configure each of the Rohde & Schwarz signal generators. The following examples show further conceivable test setups. To configure these test setups, proceed similarly as shown in the first example.

#### Example: Cascading three Rohde & Schwarz Signal Generators



**Figure 8-6: Set up of LO coupling with three R&S Signal Generators**

Generator 1 = "Internal"; "LO OUT > On"

Generator 2 = "A External & A->B Coupled"; "LO OUT > On"

Generator 3 = "External"; "LO OUT > Off"

R&S Signal Generator 1 uses its internal oscillator signal. R&S Signal Generator 2 receives the LO signal from the first instrument and assigns it to both paths. R&S Signal Generator 3 receives the LO signal from the second instrument. The frequency is assumed to be 5 GHz.

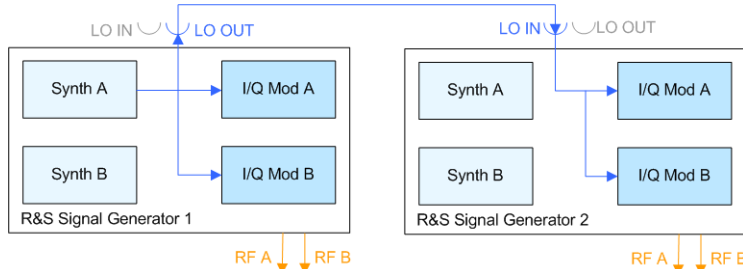
To configure the application, proceed as follows:

1. Connect the first signal generator LO OUT with "LO IN" of the second instrument, and similarly the "LO OUT" of the second signal generator with LO IN of the third.
2. Configure **Signal Generator 1**  
Select "Freq > 5 GHz".
  - a) Select "RF > Ext. Ref / LO Coupling > Mode > Internal".
  - b) Set "Out State > B On".
3. Configure **Signal Generator 2**
  - a) Set "Freq > 5 GHz".
  - b) Check if both paths are able to deal with the desired RF frequency.  
**Tip:** You can find out the maximum frequency with the remote control command `SOUR<ch>:FREQ? MAX.`
    - if both paths can handle the RF frequency, select "RF > Ext. Ref / LO Coupling > Mode > A External & A->B Coupled"
    - if path A is not sufficiently equipped, select "RF > Ext. Ref / LO Coupling > Mode > A RF Off & B External"
    - if path B is not able to handle the frequency, select "RF > Ext. Ref / LO Coupling > Mode > A External & B RF Off"
  - c) Set "Out State > On".
  - d) If the attenuation between the interconnection LO OUT and LO IN is more than 1 dB at the oscillator frequency, it is recommended that you execute "Adjust LO Level Current Frequency".  
**Note:** The adjustment procedure must be completed before you perform the adjustment on a subsequent instrument.  
The signal generator automatically adjusts the internal LO signal level at the I/Q modulator and LO OUT connector.
4. Configure **Signal Generator 3**
  - a) Set "Freq > 5 GHz".
  - b) Select "RF > Ext. Ref / LO Coupling > Mode > External".
  - c) Set "Out State > Off".
  - d) If the attenuation between the interconnection LO OUT and LO IN is greater than 1 dB at the oscillator frequency, it is recommended that you perform level adjustment:
    - Check if the "Adjust LO Level Current Frequency" procedure of the previous instrument is completed.
    - Execute "Adjust LO Level Current Frequency".
 The signal generator automatically adjusts the internal LO signal level at the I/Q modulator and LO OUT connector.

All instruments generate the RF signals in phase, as they use the same oscillator signal looped through all instruments.

**Example: Generating a beamformed signal with two R&S Signal Generators**

This example shows a test setup with two generators, each equipped with two paths, like for example the R&S SMW or the R&S SMU200A.



**Figure 8-7: Set up of LO coupling with two R&S Signal Generators**

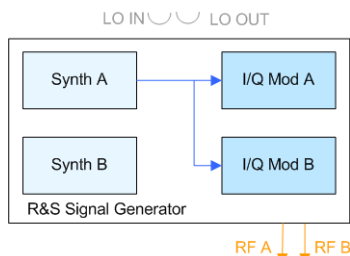
Generator 1 = "A Internal & A->B Coupled"; "LO OUT > On"  
 Generator 2 = "A External & A->B Coupled"; "LO OUT > Off"

The R&S Signal Generator 1 uses the internal oscillator signal of path A also in path B. The R&S Signal Generator 2 receives the LO signal from the first instrument and assigns it to both paths. The frequency is assumed to be 2 GHz.



Depending on the required RF frequency, your instrument may not be adequately equipped in one of the paths. If so, you can adjust the LO coupling mode accordingly to use the LO signal from the other path. Proceed as described under [Configure Signal Generator 2 in the example "Cascading three Rohde & Schwarz Signal Generators"](#).

**Example: Generating a beamformed signal with one R&S SMW**

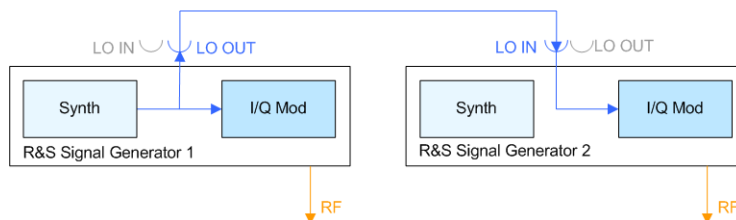


Generator = "A Internal & A->B Coupled"; "LO OUT > Off"

The R&S SMW uses its internal oscillator signal in both paths and outputs the signal at the LO OUT connector. The frequency is assumed to be 5 GHz.

### Example: Generating a beamformed signal with two one path R&S Signal Generators

This example shows a test setup with two generators, each equipped with one path.



Generator 1 = "Internal"; "LO OUT" > On

Generator 2 = "External"; "LO OUT" > Off

R&S Signal Generator 1 uses its internal oscillator signal. R&S Signal Generator 2 receives the LO signal from the first instrument. The frequency is assumed to be 2 GHz.

## 8.7 Varying the RF Signal in List or Sweep Mode

The operating modes "List" and "Sweep" allow you to generate an RF signal having periodically varying frequencies or amplitudes.

A signal generated with varying parameters scans a certain range of varying values of a parameter, with defined start and end points, and can be arbitrarily repeated.

The R&S SMW supports two basic methods:

- **Sweep Mode**

The instrument generates an RF signal which varies its frequency or level values cyclically between the start and end values. The values change according to a pre-defined waveform. Intermediate values are calculated internally by linear or logarithmic interpolation.

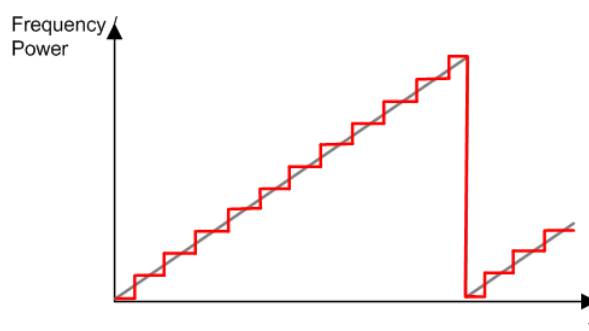
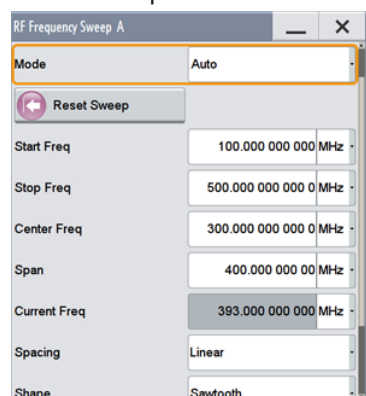


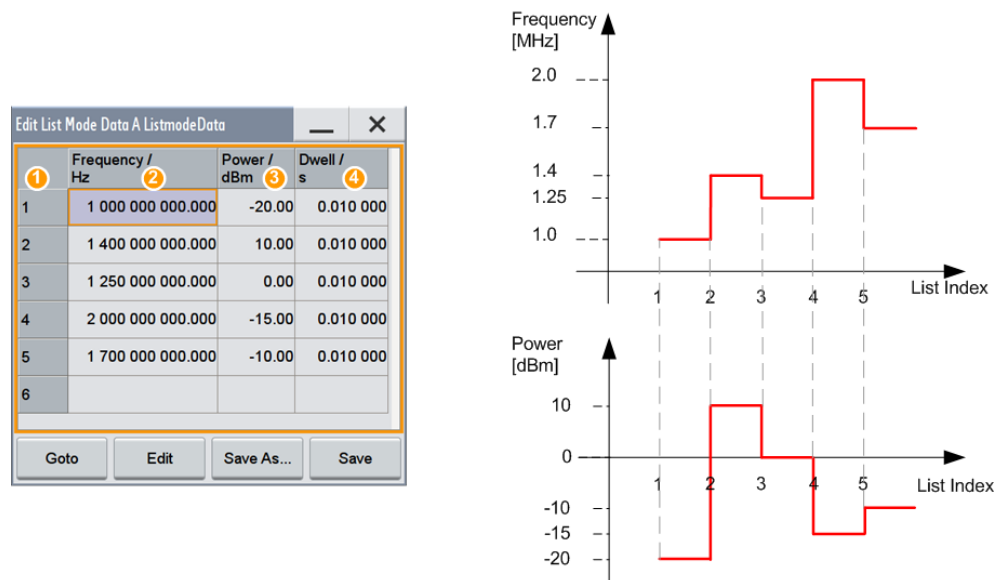
Figure 8-8: Schematic representation of a signal generated in sweep mode (RF Freq Sweep)

The main application field of the "Sweep" mode is to determine the frequency response or level-dependent behavior of the DUT.

- **List Mode**

The instrument generates the signal step-by-step, based on predetermined memorized frequency and amplitude value pairs with individual step sizes. While in sweep mode either the frequency or the level values change, you can vary both parameters simultaneously in list mode. In addition, you can use a global dwell time, which means that the time interval is constant for all steps of the list, or vary the dwell time for each value pair.

In this mode, the graph represents the frequency and power value pairs, as well as the dwell time of the corresponding index entry of the list mode table.



**Figure 8-9: Schematic representation of a signal generated in list mode, in this case with global dwell time**

- 1 = Index
- 2, 3 = Frequency / Power value pairs
- 4 = Dwell time for each Frequency / Power value pair

This mode is especially useful in high-speed measurements with fast changing frequency and level settings.



### Interactions and characteristics

- Activating the list mode automatically deactivates all RF and LF sweeps and vice versa.
- It is recommended that you switch off the display update for optimum sweep performance, especially with short dwell times, see [Chapter 11.1.4, "Display Update Settings"](#), on page 611.
- If you want to remain at a specific frequency or level value during a sweep, enter the value in the status bar. The sweep stops immediately.
- In list processing mode, the frequency and level display in the status bar is disabled.
- In contrast to sweep processing, you can create a list with freely selectable frequency and amplitude value pairs in list mode. This means that the values do not need to have ascending or descending order, they can vary arbitrarily. Moreover, you can set a global dwell time which uses a constant time interval for all list steps, or vary the dwell time for each value pair individually.
- The sweep modes only work with a *global* dwell time, that means the time intervals are constant during signal generation.

## 8.7.1 Signal Generating and Triggering in the Sweep and List Modes

In both operating modes "List" and "Sweep", triggering and generation of the signal is performed according to the same principle. The instrument generates the signal either continuously, that means triggered automatically or in individual steps, which are controlled manually with an internal or external trigger signal.

To feed an external trigger signal, there are the connectors INST TRIG A/B at the back of the instrument, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

The following graphs give an overview on the signal generation in the sweep and list modes and the appropriate triggering. In the graphs you see the signal state after activating the mode, as well as the generation of the signal when a trigger event occurs. The relevant parameters and settings are briefly explained to each mode.

Each "Sweep" and "List" mode dialogs additionally provide a "Reset" button that sets the signal to the start value, or the beginning of the list, respectively. Depending on the trigger mode selected, the signal generation proceeds accordingly.



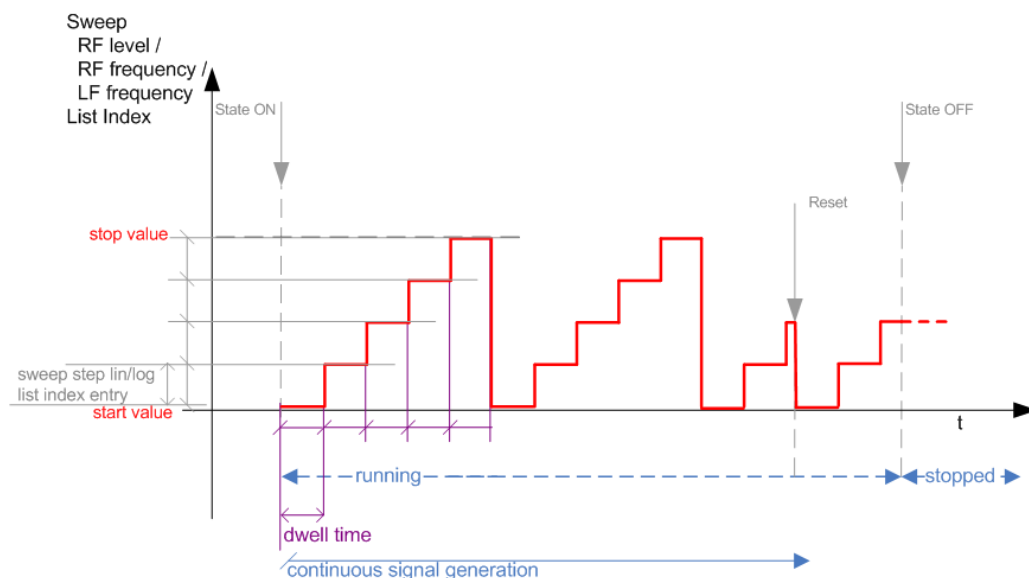
The naming of the selection parameters in manual control (GUI) sometimes deviates from the naming in the remote-control commands. In addition, the value names of the selection parameters used in the signal generator partly differ from the SCPI syntax. The instrument accepts all value names.

Hence, the correlation between the manual control and the corresponding remote control commands, including the SCPI conform syntax are explained for each mode (see the cross-reference tables).

See also the following programming examples on the sweep and list modes in remote control:

- [Example "Setup an RF frequency or power sweep"](#) on page 1037
- [Example "Setup an LF sweep"](#) on page 990
- [Example "Create an RF list and activate the list mode"](#) on page 1004

### AUTO mode (Sweep/List)



**Figure 8-10: AUTO mode (Sweep/List)**

- The instrument generates the signal continuously.
- Trigger mode "Auto" is prerequisite. It causes the continuous generation of the sweep signal.
- Starts signal generation immediately with state "On".
- Switches automatically to the next sweep step when the **Dwell time** has elapsed.
- Stops signal generation with state "Off".



Table 8-3: Cross-reference between manual and remote control in AUTO mode (Sweep/List)

Manual control mode: "Auto"	Remote commands R&S proprietary and [SCPI conform] value name
RF Frequency Sweep	:TRIGger<hw>:FSweep:SOURce AUTO [IMMediate] :SOURce<hw>:SWEep:FREQuency:MODE AUTO
RF Level Sweep	:TRIGger<hw>:PSweep:SOURce AUTO [IMMediate] :SOURce<hw>:SWEep:POWer:MODE AUTO
LF Frequency Sweep	:TRIGger<hw>:LFFSweep:SOURce AUTO [IMMediate] :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO
List	:SOURce<hw>:LIST:MODE AUTO :SOURce<hw>:LIST:TRIGger:SOURce AUTO

Single / Extern Single mode (Sweep/List)

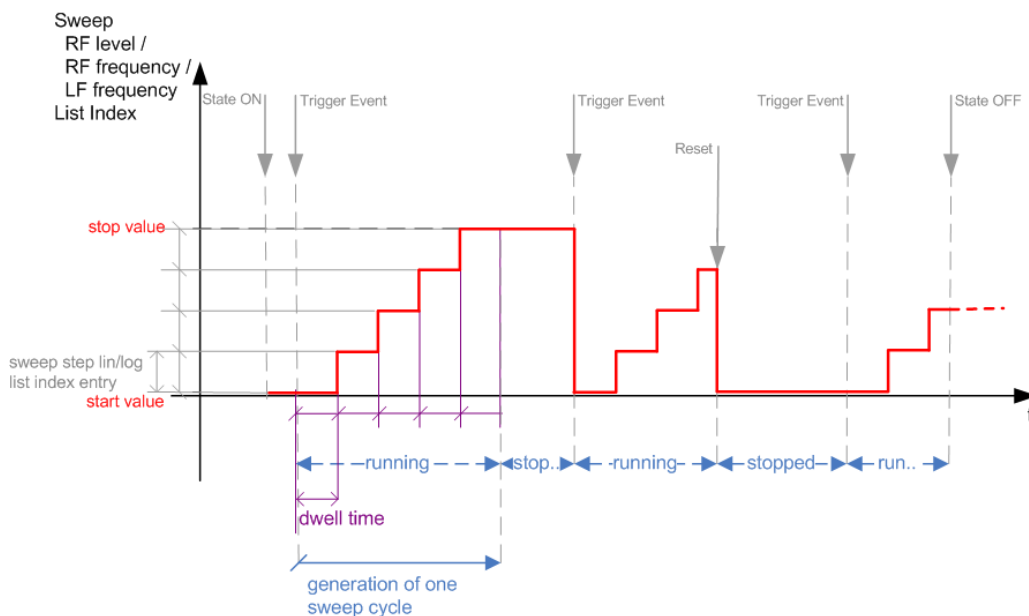


Figure 8-11: Single / Extern Single mode (Sweep / List)



In single mode, you can additionally specify, that the signal returns to the start value as soon as a sweep cycle has been completed. See "The Retrace Function" on page 446 for details.

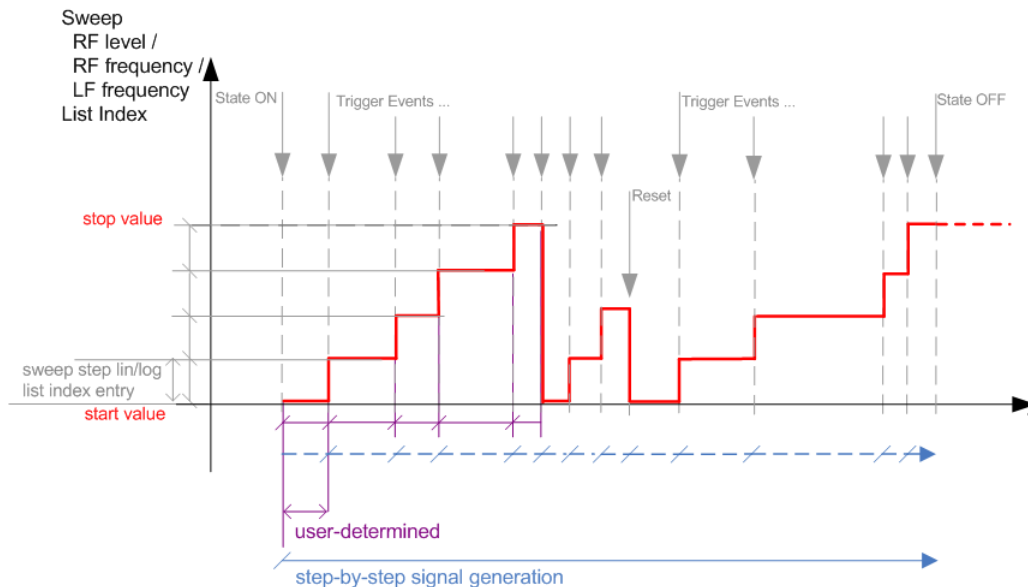
- The instrument generates a single sweep cycle.
- Trigger mode "Manual". A trigger event initiates one sweep from the start value to the end value.
- State "On" sets the signal to the start value. That is either the sweep start frequency, the sweep start power or the frequency-power value pair of the selected index in the list.
- Starts signal generation with a trigger event.

- Switches automatically to the next step when the **Dwell time** has elapsed.
- Stops signal generation at the set end value and waits for the subsequent trigger event.
- Trigger sources:
  - The "Execute Single" button in the corresponding sweep and list settings dialog.
  - The corresponding remote control command.
  - An externally applied trigger signal, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.
- State "Off" stops the signal generation in sweep or list mode.

**Table 8-4: Cross-reference between manual and remote control in Single / Extern Single modes (Sweep/List)**

Manual control mode: "Single / Extern Single"	Remote commands R&S proprietary and [SCPI conform] value name
RF Frequency Sweep	:TRIGger<hw>:FSweep:SOURce SINGLE [BUS] "Single" or :TRIGger<hw>:FSweep:SOURce EXTernal [EXTernal] "Extern Single" :SOURce<hw>:SWEep:FREQuency:MODE AUTO
RF Level Sweep	:TRIGger<hw>:PSweep:SOURce SINGLE [BUS] for "Single" or :TRIGger<hw>:PSweep:SOURce EXTernal [EXTernal] for "Extern Single" :SOURce<hw>:SWEep:POWer:MODE AUTO
LF Frequency Sweep	:TRIGger<hw>:LFFSweep:SOURce SINGLE [BUS] "Single" or :TRIGger<hw>:LFFSweep:SOURce EXTernal [EXTernal] "Extern Single" :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO
List	:SOURce<hw>:LIST:TRIGger:SOURce SINGLE "Single" or :SOURce<hw>:LIST:TRIGger:SOURce EXTernal "Extern Single" :SOURce<hw>:LIST:MODE AUTO

**Step / Extern Step mode (Sweep/List)**



**Figure 8-12: Step / Extern Step mode (Sweep / List)**

- The instrument generates the signal step-by-step.
- Starts signal generation with state = "On".
- Switches to the next step with a manual action.  
If the end value is reached, signal generation starts again from the beginning.
- Stops signal generation with state = "Off".
- Trigger sources:
  - The ROTARY KNOB at the front panel.
  - The ARROW keys at the front panel.
  - The corresponding remote control commands.
  - An externally applied trigger signal, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

**Table 8-5: Cross-reference between manual and remote control in Step / Extern Step modes (Sweep/ List)**

Manual control mode: "Step / Extern Step"	Remote commands R&S proprietary and [SCPI conform] value name
RF Frequency Sweep	:TRIGger<hw>:FSweep:SOURce SINGLE [BUS] "Step" or :TRIGger<hw>:FSweep:SOURce EXTernal [EXTernal] for "Extern Step" :SOURce<hw>:SWEep:FREquency:MODE STEP
RF Level Sweep	:TRIGger<hw>:PSWep:SOURce SINGLE [BUS] "Step" or :TRIGger<hw>:PSWep:SOURce EXTernal [EXTenal] "Extern Step" :SOURce<hw>:SWEep:POWer:MODE STEP

Manual control mode: "Step / Extern Step"	Remote commands R&S proprietary and [SCPI conform] value name
LF Frequency Sweep	:TRIGger<hw>:LFFSweep:SOURce SINGle [BUS] "Step" or :TRIGger<hw>:LFFSweep:SOURce EXTeRnal [EXTeRnal] "Extern Step" :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE STEP
List	:SOURce<hw>:LIST:TRIGger:SOURce SINGle "Step" or :SOURce<hw>:LIST:TRIGger:SOURce EXTeRnal "Extern Step" :SOURce<hw>:LIST:MODE STEP

To step through the sweep frequencies/levels, activate the [Current Freq / Current Level](#) field and use the UP / DOWN navigation keys or the ROTARY KNOB.

To step through the sweep frequencies in remote control mode, use the commands [ :SOURce<hw> ] :FREQuency:MANual, or [ :SOURce<hw> ] :POWER:MANual with the UP or DOWN parameter.



Steps that would exceed the sweep range are ignored.

### Extern Start / Stop mode (Sweep)

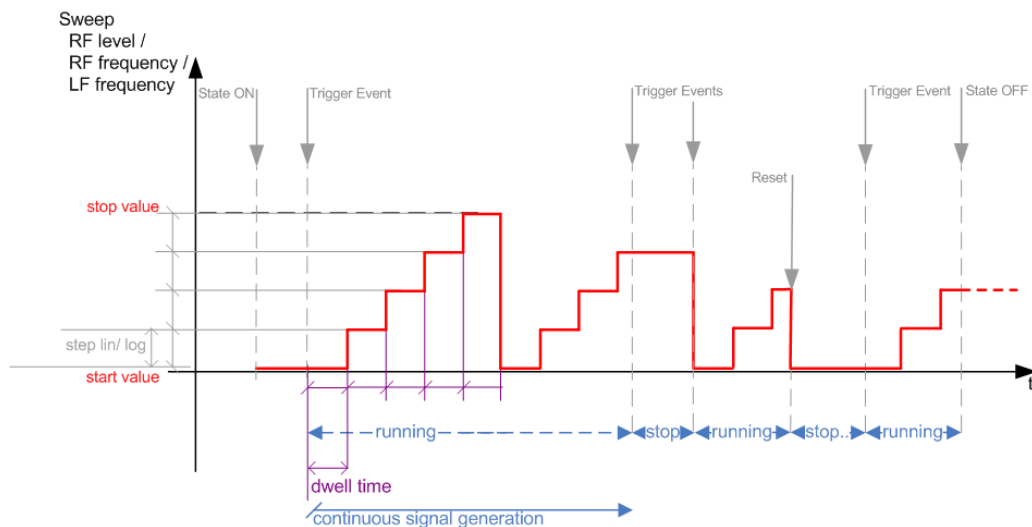


Figure 8-13: Extern Start / Stop mode (Sweep)

- The instrument generates the signal continuously.
- Trigger mode "Auto" and sweep signal state "On" are prerequisite.
- State "On" sets the signal to the start value. That is either the sweep start frequency, the sweep start power or the frequency-power value pair of the selected index in the list.
- Starts signal generation with a trigger event.
- Switches automatically to the next sweep step when the [Dwell time](#) has elapsed.

If the end value is reached, signal generation continues with the next sweep cycle.

- Stops signal generation with the next external trigger event.
- Starts the signal generation again with the next trigger event, beginning at the start value.
- State "Off" stops the signal generation in sweep or list mode.
- Trigger source:
  - An externally applied trigger signal, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

Table 8-6: Cross-reference between manual and remote control in Step / Extern Step modes (Sweep)

Manual control mode: "Extern Start / Stop"	Remote commands R&S proprietary and [SCPI conform] value name
RF Frequency Sweep	:TRIGger<hw>:FSweep:SOURce EAUTO [-] :SOURce<hw>:SWEep:FREQuency:MODE AUTO
RF Level Sweep	:TRIGger<hw>:PSweep:SOURce EAUTO [-] :SOURce<hw>:SWEep:POWer:MODE AUTO
LF Frequency Sweep	:TRIGger<hw>:LFFSweep:SOURce EAUTO [-] :SOURce<hw>:LFOutput<ch>:SWEep:FREQuency:MODE AUTO

Manual mode (Sweep/List)



The **manual** mode only applies to remote control. It is not visible in the graphical user interface of the instrument, but is described here for completeness.

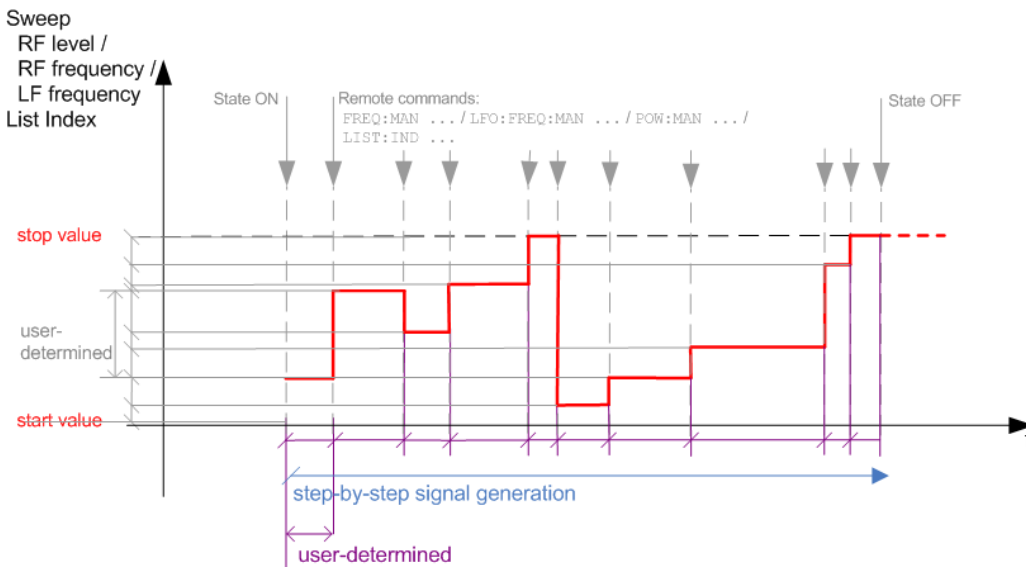


Figure 8-14: Manual mode in remote control (Sweep / List)

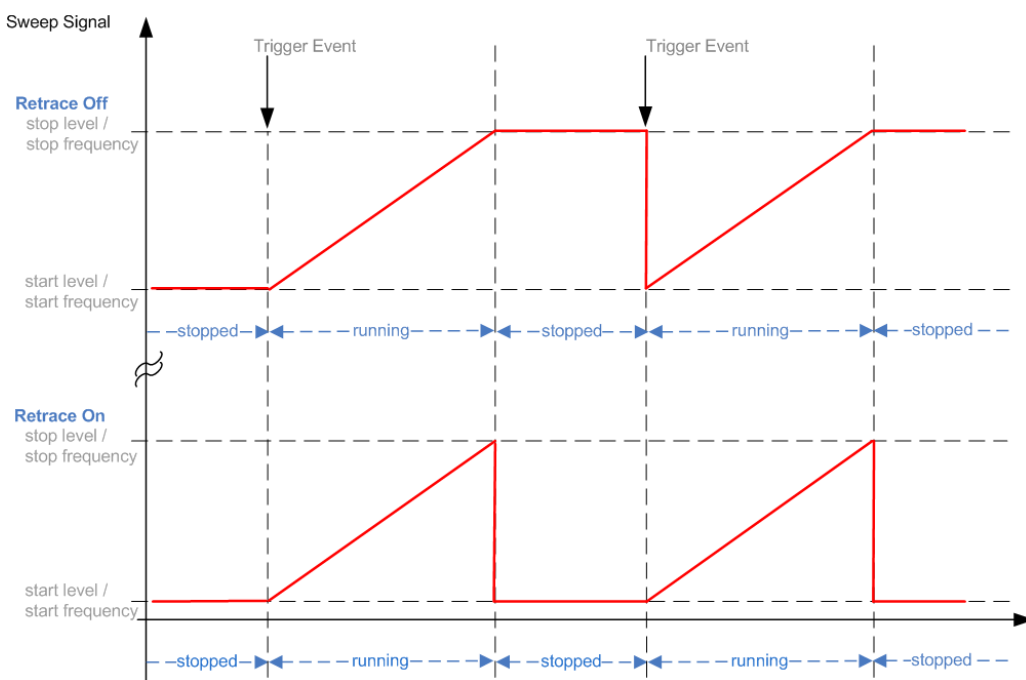
- The instrument generates the signal in steps.
- Starts signal generation with state = "On".

- Switches to the next step with a user defined setting via remote control. You can arbitrarily select a value within the range of the start and stop values by setting the frequency, power or index using the corresponding remote control command. There is no ascending or descending order.
- Stops signal generation with state = "Off".

**Table 8-7: Cross-reference between manual and remote control in Step / Extern Step modes (Sweep/ List)**

Remote control mode:	Remote commands
<b>Manual</b>	<b>R&amp;S proprietary and [SCPI conform] value name</b>
RF Frequency Sweep	:SOURce<hw>:FREQUency:MANUal <Manual>
RF Level Sweep	:SOURce<hw>:POWer:MANUal <Manual>
LF Frequency Sweep	:SOURce<hw>:LFOUtpuT:FREQUency:MANUal <Manual>
List	:SOURce<hw>:LIST:INDex <Index>

**The Retrace Function**



Retrace is a function especially designed for "Single" sweep modes, when the sweep signal follows a sawtooth shape. Working in this mode, the instrument performs a single sweep cycle when a trigger event occurs. The signal generation stops at the set end point (stop frequency or stop level), and waits for the next trigger event.

In this state, the upper value of the signal remains at the output until the next cycle starts. In particular if you generate a level sweep signal, the high amplitude of the signal is output for a certain time. To protect the DUT from overload, the retrace function immediately resets the signal value to the start value at the end of a sweep cycle. It shifts down the power, or frequency value during the waiting period.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single", see ["Shape"](#) on page 458 and ["Mode"](#) on page 456.

## 8.7.2 Sweep Mode

In sweep mode, the signal generator scans the sweep range gradually from one point to another, with a defined step width, following a triangle or sawtooth shape, see [Chapter 8.7.2.2, "Sweep Signal Shapes"](#), on page 449.

This mode also enables you to change direction, that means, it is possible to step backwards.

### Configuration and Operation of Sweep Mode Signals

- The R&S SMW generates a sweep signal by varying either the *RF frequency*, the *LF frequency* or the *RF level*.
- With various sweep modes provided, you can perform either a complete sweep cycle once, repeat the cycle continuously or step through it gradually.
- The parameters configuring the sweep signal are defined directly in the instrument, see [Chapter 8.7.5, "Sweep Mode Settings"](#), on page 454.
- The instrument generates the sweep signal according to the settings of the associated sweep.
- The "Reset Sweep" button sets the sweep to the start value.



### Impact of Changing the Sweep Mode During Performance

If you change the sweep mode during the execution, the signal generator stops the sweep and starts with the next trigger event at the initial value.

#### 8.7.2.1 Correlating Parameters in Sweep Mode

A sweep signal is a periodic signal that changes its frequency / level from a starting value to an ending value in a defined time.

In the R&S SMW, you have some possibilities, to configure a sweep signal, for example, you can determine the sweep range by means of the start and end values, or, alternatively, on the basis of the start value and span. In any case, related parameters are adjusted accordingly.

The formulas below show how the sweep parameters correlate and the corresponding calculation basis, by means of the frequency and offset settings. Apart from "Center Frequency", "Span" and "Step\_lin", the values apply accordingly to the level settings.

**Table 8-8: Variables that are used in the following formulas:**

Variable	Description
Sweep range	Defined frequency or level value range
$f_{\text{CENTer}}$	Defined center frequency

Variable	Description
$f_{SPAN}$	Defined extend of the sweep range
$f_{OFFSet}$	Frequency offset
$f_{START}$	Start frequency of the sweep range
$f_{STOP}$	End frequency of the sweep range
$f_1$	Current sweep frequency
$f_2$	Next, subsequent sweep frequency
step_lin	Step width in linear scaling
step_log	Step width in logarithmic scaling
POINTS	Number of steps within the sweep range

### Sweep Range

The sweep range is defined by a start and an end value. How the remaining parameters correlate is shown below.

#### Offset=0

$$\text{Sweep Range} = f_{START} \dots f_{STOP}$$

$$f_{CENTer} = (f_{START} + f_{STOP}) / 2$$

With:

$$f_{START} = f_{CENTer} - (f_{SPAN} / 2)$$

$$f_{STOP} = f_{CENTer} + (f_{SPAN} / 2)$$

$$\text{Sweep Range} = f_{CENTer} - (f_{SPAN} / 2) \dots f_{CENTer} + (f_{SPAN} / 2),$$

Consequently, the span is:

$$f_{SPAN} = (f_{STOP} - f_{START})$$

#### Offset≠0

A defined offset also affects the sweep range, and consequently the center frequency. Therefore, the set frequencies are only absolute values, if the Offset = 0. Offset ≠ 0 shifts the frequencies according to the offset value:

$$\text{Sweep Range} = f_{START} + f_{OFFSet} \dots f_{STOP} + f_{OFFSet}$$

$$f_{CENTer} = f_{CENTer} + f_{OFFSet}, \text{ and}$$

$$f_{SPAN} = f_{SPAN} + f_{OFFSet}$$

Consequently, the entire value range of the instrument is:

$$RF_{min} + f_{OFFSet} \dots RF_{max} + f_{OFFSet}$$





It is possible to set  $f_{\text{START}} > f_{\text{STOP}}$  as well as  $f_{\text{START}} < f_{\text{STOP}}$ , so that even a negative value is permitted for the "Span".

If you change the start and/or stop frequency, the span and center frequency change accordingly, and vice versa.

### Sweep Steps

The following is how the sweep steps are calculated depending on the defined spacing mode. The formulas are shown by means of a frequency sweep, but apply accordingly to the level settings.

Basically, the step width is added to the current value, to get the subsequent sweep step.

With **linear** scaling, the next frequency is calculated according to:

$$f_2 = f_1 + \text{step\_lin}$$

In the **logarithmic** scaling, the step width is determined in %, as a constant fraction of the current frequency.

Successive frequencies are calculated as follows:

- $f_{\text{START}} < f_{\text{STOP}}$   
 $f_2 = f_1 * (1 + \text{step\_log} / 100)$   
 If  $f_2$  exceeds  $f_{\text{STOP}}$ :  $f_2$  is set to  $f_{\text{STOP}}$
- $f_{\text{START}} > f_{\text{STOP}}$   
 $f_2 = f_1 / (1 + \text{step\_log} / 100)$   
 If  $f_2$  falls below  $f_{\text{STOP}}$ , it is set to  $f_{\text{STOP}}$

When the shape "Triangle" is set, the frequency values on the slope from  $f_{\text{STOP}}$  to  $f_{\text{START}}$  are the same as on the slope from  $f_{\text{START}}$  to  $f_{\text{STOP}}$ .

Additionally, if you specify the number of steps within the sweep range, the step width is adjusted according to the following correlation:

- For **linear** sweeps and  $f_{\text{START}} < f_{\text{STOP}}$   
 $\text{POINTS}_{\text{frequency}} = ((f_{\text{START}} - f_{\text{STOP}}) / \text{step\_lin}) + 1 = (f_{\text{SPAN}} / \text{step\_lin}) + 1$
- For **logarithmic** sweeps and  $f_{\text{START}} < f_{\text{STOP}}$   
 $\text{POINTS}_{\text{frequency}} = ((\log f_{\text{STOP}} - \log f_{\text{START}}) / \log \text{step\_log}) + 1$

If  $\text{step\_log}$  changes, the value of POINTs is adjusted. The  $f_{\text{START}}$  and  $f_{\text{STOP}}$  values are retained.

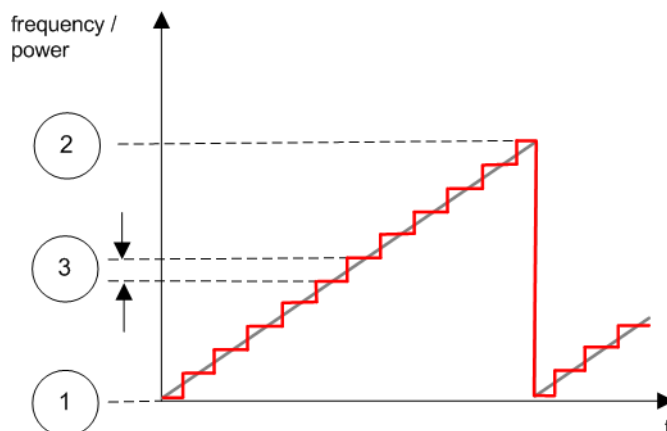
#### 8.7.2.2 Sweep Signal Shapes

To generate a sweep signal, the variable parameter changes by a predefined waveform.

For this purpose, the R&S SMW supports the following waveforms:

- Sawtooth

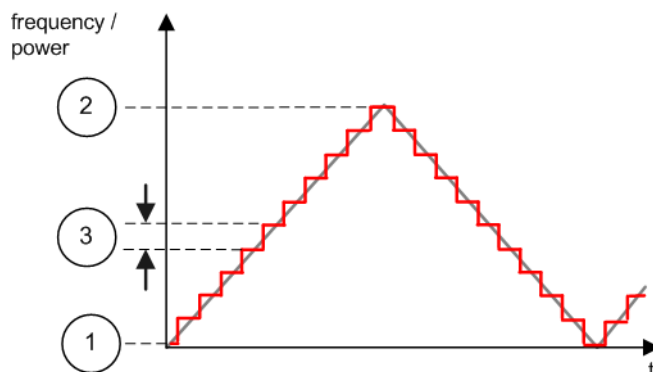
The sweep sequence resembles a sawtooth. One sweep runs from start to stop frequency, or level value respectively. Each subsequent sweep starts again at the start value.



**Figure 8-15: Sweep Signal Sawtooth Shape**

1 = Start value  
2 = Stop value  
3 = Step width

- **Triangle**  
The sweep sequence resembles a triangle. One sweep runs from start to stop value frequency and back. Each subsequent sweep starts at the start value.



**Figure 8-16: Sweep Signal Triangle Shape**

1 = Start value  
2 = Stop value  
3 = Step width

The used sweep parameter (RF frequency or RF level or LF Frequency) varies the values according to the selected shape.

### 8.7.3 List Mode

The list mode is used to generate the RF signal on the basis of a set of predefined frequency and amplitude value pairs, with individual step times. You can define the values arbitrarily, in any order and varying step sizes, within the entire configurable value range of the instrument.

### Configuration and Operation of List Mode Signals

The parameters configuring the RF signal are defined in a list (table) and stored in a file.

- Creating a list

To create a list, you can use the internal "List Editor" or create it externally and import it.

- The internal editor contains a table with columns for the frequency and level values, as well as the dwell time you can set for each value pair individually. You can fill the table manually or automatically, see [Chapter 8.7.7, "List Editor"](#), on page 464.

Each list is stored in a file with selectable filename and the predefined file extension \*.lsw. To load a previously stored file, use the file manager [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590.

- If you create a list externally, you can use any program, preferably a spreadsheet software that supports \*.txt (ASCII) or \*.csv file format. The "Import" function converts the file to the list format and loads it into the instrument. Vice versa, you can also "Export" the list data into an ASCII file.

- Dwell Time Mode

As a special feature, you can choose whether you want to use different dwell times or a fixed value for all steps in the list mode:

- the "Global" mode processes the list using a fixed time interval.
- the "From List" mode uses the values from the data table.

**Note:**

When you select the "Global" dwell time, note that you still need to enter the dwell time values in the data list, see [Edit List Mode Data](#). The reason is that the instrument stores only completed rows and ignores incomplete entries. In addition, the data list must be filled completely, in case you want to change the dwell time mode to "From List".

- Run Mode

For signal generation you have two run modes:

- "Learned (Frozen RF Settings)"

The instrument reads the values, calculates the corresponding hardware settings and stores the learned data in the temporary memory, before signal generation start. The RF hardware settings include for example modulation states and settings.

See also [Learn List Mode Data - List processing mode](#).

After learning, the R&S SMW generates the signal immediately using the stored data.

**Note:** The R&S SMW generates the signal from the stored data reflecting the state of the instrument at the time of recording. Modifications of settings during list processing are ignored. If you turn off the instrument, the list file remains stored on the hard disk, but not the learned data in the temporary memory.

- "Live"

The instrument generates the signal straightway after reading the values and adjusting the hardware settings, if required. It does not use the temporary memory.

See "[Live](#)" - List processing mode.

### 8.7.4 Significant Parameters and Functions

This section provides some basic parameters, settings and functions that affect the operating modes CW, list and sweep, that means at all frequency and level transitions of the RF signal.

#### Dwell time

Dwell time is the length of time that elapses from the beginning until the end of a step. It applies to "Auto", "Single" and "Extern Single" modes, that are triggered either continuously or manually.

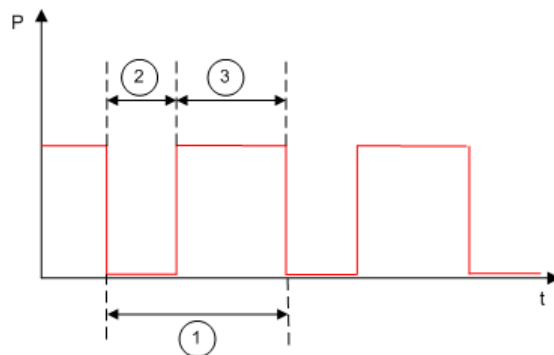


Figure 8-17: Dwell Time <-> Settling Time

1 = Dwell Time (set by the user)

2 = Settling Time

3 = Dwell Time (effective)

The set dwell time defines the duration of a list or sweep step. However, the time the instrument requires for the signal to settle reduces the effective dwell time.

$$t_{\text{dwell(effective)}} = t_{\text{dwell}} - t_{\text{settling}}$$

In "Single" mode, the time between two entries determines the duration of a step, and accordingly, the time between two trigger events in "Extern Step" mode. In these operating modes, the dwell time does not affect signal generation.

#### Hardware adjustments

The first time a list (new or modified) is processed, the instrument automatically calculates the necessary hardware settings. It can be performed during list processing, but may delay the first cycle, especially with very short dwell times.

With long dwell times, you can perform this calculation while the list is being processed; the entered dwell times are observed. With very short dwell times, calculation of the hardware settings increases the dwell time for the initial processing cycle; the entered value is only observed from the second processing cycle onwards. In this case

a message indicates that there is a deviation between the current and set dwell times. After the first cycle, you do not need to perform additional calculations. The current dwell times will definitely no longer deviate from the set dwell times.

### Blanking

The instrument is equipped with a *blanking* circuit, which temporarily switches off the RF signal whenever the frequency changes, until the signal has settled to a stable state.

If you disable this function, the signal will not be switched off during transition, but a temporary loss of power still occurs while the instrument adjusts the hardware. The power level immediately increases and may exceed the set level value before the hardware controls take effect. However, the time until the signal is stable and automatically level controlled is shorter than that of the blanking interval.

This setting applies to all operating modes with frequency transitions.

### Learn List Mode Data - List processing mode

Before signal generation starts, the function "Learn List Mode Data" reads the values of the data list in sequence and determines the corresponding hardware settings for each value pair. Along with the current RF state and the modulation settings, the function stores the data in the list.

Once the entire table is processed, the R&S SMW starts signal generation by replaying the stored values from the list. Thus, it achieves very fast switching of the RF signal with high accuracy.

This mode provides optimized switching times, and is particularly useful if dwell times of less than 2 ms are required.

However, keep in mind that the instrument ignores all modifications during list processing with learned data, including temperature drifts.



### When to perform "Learn List Mode Data" ?

The instrument performs the learning process if ...

- RF state is on (prerequisite)
- you deliberately activate this function, provided a list is loaded and RF is on.
- you switch list mode on in "Learned" run mode and no data is available in the memory
- you change the list data file

When to deliberately perform list mode learning?

- It is mandatory to activate list mode learning if ...
  - you change any value in the list.
  - any hardware settings change.  
Especially if you have fluctuating environmental conditions, the hardware settings need to be adjusted.
- It is recommended that you always learn the list before activating the list mode, even if the list has been learnt previously.

### "Live" - List processing mode

The R&S SMW generates the signal directly from the value pairs in the data base, and adjusts the hardware settings accordingly. The current instrument state and thus any change during the signal generation directly affects the RF signal.

You can conveniently modify parameters like modulation settings during run-time. Learning list mode data is not required, even more, you can conveniently change parameters during run-time. Impacts like temperature drift are also considered immediately.

This mode is optimized for maximum signal quality, and is useful if dwell times higher than 2 ms are sufficient.

## 8.7.5 Sweep Mode Settings



Since all sweep modes use the similar parameters to be configured, the description comprises the settings of the three dialogs, "RF Freq Sweep", "RF Level Sweep" and "LF Freq Sweep". If parameters relate to only particular modes, they are pointed out.

The corresponding remote-control commands are always listed in the same order as mentioned above, also recognizable by the syntax.

- ▶ To access a sweep dialog, select "RF > Sweep/List > RF Frequency Sweep or ...RF Level Sweep or ...LF Frequency Sweep".

<p>Sweep / List</p> <p><b>RF Frequency Sweep...</b></p> <p>RF Level Sweep...</p>	<p>Sweep / List</p> <p>RF Frequency Sweep...</p> <p><b>RF Level Sweep...</b></p>	<p>Sweep / List</p> <p>RF Frequency Sweep...</p> <p>RF Level Sweep...</p> <p><b>LF Frequency Sweep...</b></p>
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Table 8-9: R&S SMW Sweep Mode Dialogs

RF Frequency Sweep	RF Level Sweep	LF Frequency Sweep

In these dialogs you can configure the corresponding sweep signal.

The remote commands required to define these settings are described in [Chapter 13.18.6, "SOURCE:FREQUENCY Subsystem"](#), on page 967 and [Chapter 13.18.17, "SOURCE:SWEep Subsystem"](#), on page 1036 and [Chapter 13.18.10, "SOURCE:LFOutput Subsystem"](#), on page 990.

**State - RF Frequency Sweep**

Activates RF frequency sweep signal generation.

Remote command:

[ :SOURCE<hw> ] :FREQUENCY:MODE on page 972

**State - RF Level Sweep**

Activates RF level sweep signal generation.

Remote command:

[ :SOURce<hw> ] :POWer:MODE on page 1029

### State - LF Frequency Sweep ← State - RF Level Sweep

Activates the generation of an LF frequency sweep signal in the "LF Frequency" dialog.

In the "Sources" tab of the analog modulations, the instrument shows the current state of the LF frequency sweep.

Remote command:

[ :SOURce<hw> ] :LFOutput:FREQuency:MODE on page 994

### Mode

Selects the sweep mode.

For detailed information on the sweep modes and the triggering, see [Chapter 8.7.1, "Signal Generating and Triggering in the Sweep and List Modes"](#), on page 439.

- "Auto" Generates a continuously repeating sweep signal directly after activating the sweep mode.  
The sweep steps are performed automatically, controlled by the dwell time. See ["AUTO mode \(Sweep/List\)"](#) on page 440
- "Single / Extern Single" Generates a single sweep cycle after a trigger event.  
The sweep steps within the cycle are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event. See ["Single / Extern Single mode \(Sweep/List\)"](#) on page 441.
- "Step / Extern Step" Generates the sweep signal step-by-step, manually triggered.  
See ["Step / Extern Step mode \(Sweep/List\)"](#) on page 443
- "Extern Start/Stop" Generates a continuously repeating sweep signal that is started, stopped, and restarted by subsequent external trigger events.  
The sweep steps are performed automatically, controlled by the dwell time.  
See ["Extern Start / Stop mode \(Sweep\)"](#) on page 444

Remote command:

[ :SOURce<hw> ] :SWEep [ :FREQuency ] :MODE on page 1042

[ :SOURce<hw> ] :SWEep:POWer:MODE on page 1039

[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :MODE on page 1001

:TRIGger<hw> [ :SWEep ] :SOURce on page 1072

:TRIGger<hw>:FSWeep:SOURce on page 1072

:TRIGger<hw>:PSWeep:SOURce on page 1072

:TRIGger<hw>:LFFSweep:SOURce on page 1072

### Execute Single Sweep

Starts a sweep manually.

This trigger button is displayed in "Single" mode.



Remote command:

[ :SOURce<hw> ] :SWEep [ :FREQuency ] :EXECute on page 1042  
 [ :SOURce<hw> ] :SWEep:POWer:EXECute on page 1039  
 [ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :EXECute on page 1000  
 :TRIGGer<hw> [ :SWEep ] [ :IMMediate ] on page 1073  
 :TRIGGer<hw>:FSWEEP [ :IMMediate ] on page 1073  
 :TRIGGer<hw>:PSWEEP [ :IMMediate ] on page 1073  
 :TRIGGer<hw>:LFFSWEEP:IMMediate on page 1073

### Reset Sweep

Resets a sweep.

With the next trigger event, the sweep starts at the initial value.

Remote command:

[ :SOURce<hw> ] :SWEep:RESet [ :ALL ] on page 1045

### Start Freq / Stop Freq

Defines the frequency sweep range by setting the start and end values.

See [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

Remote command:

[ :SOURce<hw> ] :FREQuency:START on page 975  
 [ :SOURce<hw> ] :FREQuency:STOP on page 975  
 [ :SOURce<hw> ] :LFOutput:FREQuency:START on page 994  
 [ :SOURce<hw> ] :LFOutput:FREQuency:STOP on page 994

### Start Level / Stop Level

Defines the level sweep range by setting the start and end values.

See [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

Remote command:

[ :SOURce<hw> ] :POWer:START on page 1030  
 [ :SOURce<hw> ] :POWer:STOP on page 1031

### Center Freq

Applies to "RF Frequency Sweep" mode.

Defines the RF center frequency. See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

Remote command:

[ :SOURce<hw> ] :FREQuency:CENTer on page 969

### Span

Applies to "RF Frequency Sweep" mode.

Defines the extent of the frequency sweep range. See [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447 for correlations of the parameters.

Remote command:

`[ :SOURce<hw> ] :FREQuency:SPAN` on page 974

### Current Freq

Applies to "RF and LF Frequency Sweep" modes.

Displays the current frequency.

In "Step" mode (**Mode**), the parameter is editable and you can enter the next frequency step.

Remote command:

`[ :SOURce<hw> ] :FREQuency:MANual` on page 972

`[ :SOURce<hw> ] :LFOutput:FREQuency:MANual` on page 993

### Current Level

Applies to "RF Level Sweep" mode.

Displays the current level value.

In "Step" mode (**Mode**), the parameter is editable and you can enter the next level step.

Remote command:

`[ :SOURce<hw> ] :POWer:MANual` on page 1028

### Spacing

Applies to "RF and LF Frequency Sweep" modes.

Selects the mode for the calculation of the frequency intervals, with which the current frequency at each step is increased or decreased. To enter the spacing use [Step Lin/Log](#).

"Linear" Takes the frequency value entered as absolute value in Hz.

"Logarithmic" Takes the value entered as a logarithmic value, i.e. as a constant fraction of the current frequency in %.

Remote command:

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :SPACing` on page 1044

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :SPACing` on page 1003

### Shape

Selects the waveform shape of the sweep signal. You can select between "Sawtooth" or "Triangle", see also [Chapter 8.7.2.2, "Sweep Signal Shapes"](#), on page 449.

"Sawtooth" The sweep runs from start to stop frequency. The subsequent sweep starts at the start value, i.e. the shape of the sweep sequence resembles a sawtooth.

"Triangle" The sweep runs from start to stop value and back, i.e. the shape of the sweep resembles a triangle. Each subsequent sweep starts at the start frequency.

Remote command:

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :SHAPE` on page 1044

`[ :SOURce<hw> ] :SWEep:POWer:SHAPE` on page 1041

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :SHAPE` on page 1002

**Retrace**

Activates that the signal changes to the start value while it is waiting for the next trigger event.

You can enable this function, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

Remote command:

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :RETRace` on page 1043

`[ :SOURce<hw> ] :SWEep:POWer:RETRace` on page 1040

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :RETRace` on page 1002

**Step Lin/Log**

Applies to "RF and LF Frequency Sweep" modes.

Sets the step width for the individual frequency sweep steps. The value is added at each sweep step to the current frequency.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

Depending on the [Spacing](#) mode, you have set, you can enter either an absolute or logarithmic step width.

"Step Lin"            The step width is a constant value in Hz.

"Step Log"            The step width is determined logarithmically in %, i.e. as a constant fraction of the current frequency.

Remote command:

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :STEP [ :LINear ]` on page 1045

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :STEP:LOGarithmic` on page 1045

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :STEP [ :LINear ]` on page 1003

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :STEP:LOGarithmic`

on page 1003

**Step**

Applies to "RF Level Sweep" mode.

Sets the step width for the level sweep steps.

The step width is specified logarithmically in dB, i.e. as constant fraction of the current level.

Remote command:

`[ :SOURce<hw> ] :SWEep:POWer:STEP [ :LOGarithmic ]` on page 1041

**Dwell Time**

Defines the duration of the individual sweep steps.

Refer also to ["Dwell time"](#) on page 452 for explanation in detail.

Remote command:

`[ :SOURce<hw> ] :SWEep [ :FREQuency ] :DWELl` on page 1042

`[ :SOURce<hw> ] :SWEep:POWer:DWELl` on page 1039

`[ :SOURce<hw> ] :LFOutput:SWEep [ :FREQuency ] :DWELl` on page 1000

**Instrument Trigger Slope**

Selects the polarity of the active slope of an applied instrument trigger.

Remote command:

[ :SOURce<hw> ] : INPut : TRIGger : SLOPe on page 979

## 8.7.6 List Mode Settings

The "List Mode" dialog contains all the functions and settings for creating and handling lists with RF frequency/level pairs for generating the RF signal based on these values.

### How to access the "List Mode" settings

- ▶ To access the "List Mode" dialog, select "Block Diagram > RF > Sweep / List > List mode".

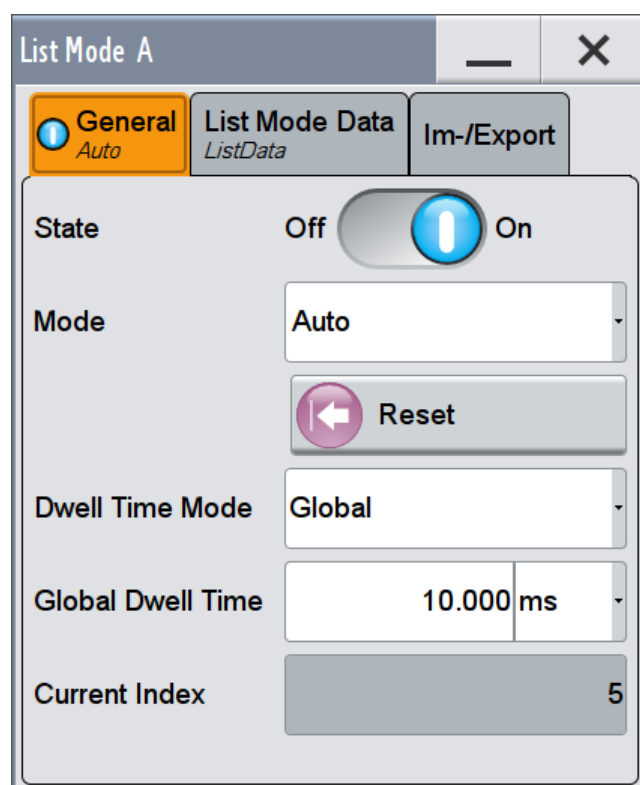


Figure 8-18: List Mode

The dialog contains parameters for configuring the list mode processing, entering list mode data as well as transferring data files from or to the instrument.

The remote commands required to define these settings are described in [Chapter 13.18.11, "SOURce:LIST Subsystem"](#), on page 1004.

### 8.7.6.1 General Settings

In the "General" tab, you can configure the trigger and dwell time modes for list processing and activate signal generation.

**State**

Activates the list mode and processes the currently selected list.

Remote command:

[ :SOURce<hw> ] :FREQuency:MODE on page 972

**Mode**

Selects the mode for list processing.

For detailed information on the signal generation and the triggering, see [Chapter 8.7.1, "Signal Generating and Triggering in the Sweep and List Modes"](#), on page 439.

"Auto" Generates the signal by processing the frequency/level value pairs of the list from the beginning to the end.  
The list steps are performed automatically, controlled by the dwell time. See ["AUTO mode \(Sweep/List\)"](#) on page 440. If you switch from any mode to "Auto", signal generation always starts at the top of the list.

"Single / Extern Single"

Generates the signal by processing the frequency/level value pairs of the list once from the beginning to the end after a trigger event.

The list steps are performed automatically, controlled by the dwell time. If one cycle is completed, the instrument waits for the next trigger event. See ["Single / Extern Single mode \(Sweep/List\)"](#) on page 441.

"Step / Extern Step"

Generates the signal by processing the frequency/level value pairs of the list step-by-step, manually triggered.

See ["Step / Extern Step mode \(Sweep/List\)"](#) on page 443.

Remote command:

[ :SOURce<hw> ] :LIST:TRIGger:SOURce on page 1013

[ :SOURce<hw> ] :LIST:MODE on page 1011

**Execute Single**

Manually starts list processing in "Single" mode.

Remote command:

[ :SOURce<hw> ] :LIST:TRIGger:EXECute on page 1013

**Reset**

Resets the list to the starting point.

Remote command:

[ :SOURce<hw> ] :LIST:RESet on page 1015

**Dwell Time Mode**

Selects either variable dwell times or a fixed dwell time to perform signal generation in list mode.

"Global" Uses the same dwell time for all lists steps, set with [Global Dwell Time](#).

"From List" Uses the dwell times from the list.  
You can define the dwell time for each frequency/level value pair individually, see [Chapter 8.7.7, "List Editor"](#), on page 464.

Remote command:

`[ :SOURce<hw> ] :LIST:DWELL:MODE` on page 1008

#### Global Dwell Time

Sets the dwell time for "Dwell Time Mode > Global", see [Dwell Time Mode](#).

Refer also to ["Dwell time"](#) on page 452 for some background information.

Remote command:

`[ :SOURce<hw> ] :LIST:DWELL` on page 1008

#### Current Index

Sets the list index for list processing in "Step" mode. In the other modes, the index indicates the current step.

Remote command:

`[ :SOURce<hw> ] :LIST:INDEX` on page 1010

#### Instrument Trigger Slope

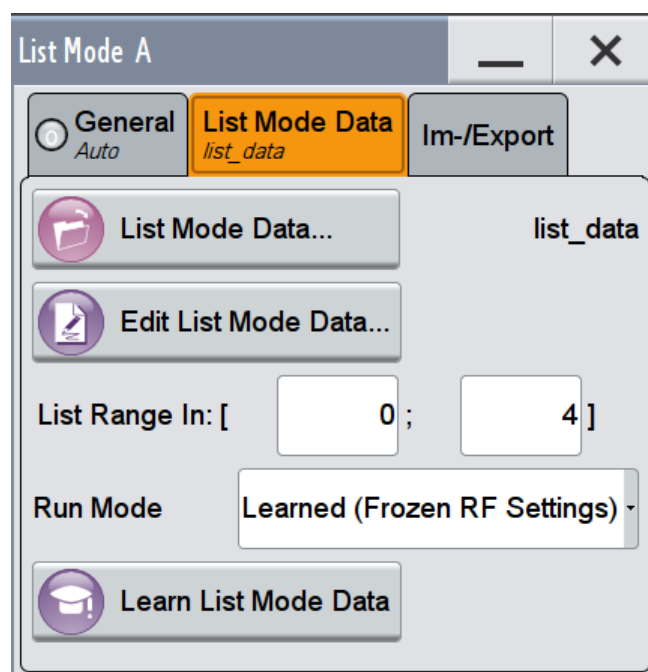
Selects the polarity of the active slope of an applied instrument trigger.

Remote command:

`[ :SOURce<hw> ] :INPut:TRIGger:SLOPe` on page 979

### 8.7.6.2 List Mode Data Settings

- ▶ To access this dialog, select "RF > Sweep / List > List Mode > List Mode Data".



This dialog contains the parameters required for creating and editing lists, activating the learning function and selecting the list processing mode.

#### List Mode Data...

Provides access to the "Select List" dialog for selecting, creating and editing a list file. The currently loaded file is indicated next to the button.

You can either create a data list with the internal editor, or externally, see also "[Configuration and Operation of List Mode Signals](#)" on page 451

Remote command:

[ :SOURce<hw> ] :LIST:CATalog? on page 1014

[ :SOURce<hw> ] :LIST:SElect on page 1015

[ :SOURce<hw> ] :LIST:DElete on page 1014

[ :SOURce<hw> ] :LIST:DElete:ALL on page 1014

#### Edit List Mode Data

Opens the editor to insert and save data lists with RF frequency, power and dwell time value pairs, see [Chapter 8.7.7, "List Editor"](#), on page 464.

This button is also located in the standard file select dialog, accessed via [List Mode Data...](#)

#### List Range In

Defines an index range in the current list by setting the start and stop index. Only the values in the selected index range are processed in list mode, all other list entries are ignored.

Remote command:

[ :SOURce<hw> ] :LIST:INDEX:START on page 1010

[ :SOURce<hw> ] :LIST:INDEX:STOP on page 1010

#### Run Mode

Selects whether the instrument generates the signal by processing the list directly, or by learning and replaying the data.

"Learned (Frozen RF Settings)"

Generates the signal with the previously learned and stored data from the temporary memory.

Find more to this operating mode under "[Learn List Mode Data - List processing mode](#)" on page 453.

"Live"

Generates the signal directly from the database.

The instrument reads the pairs of values from the list, calculates the hardware settings and generates the signal immediately.

Find more to this operating mode under "["Live" - List processing mode](#)" on page 454.

Remote command:

[ :SOURce<hw> ] :LIST:RMODe on page 1012

#### Learn List Mode Data...

Reads the settings from the list data table and calculates the associated hardware settings. The learned data is stored in the temporary memory.

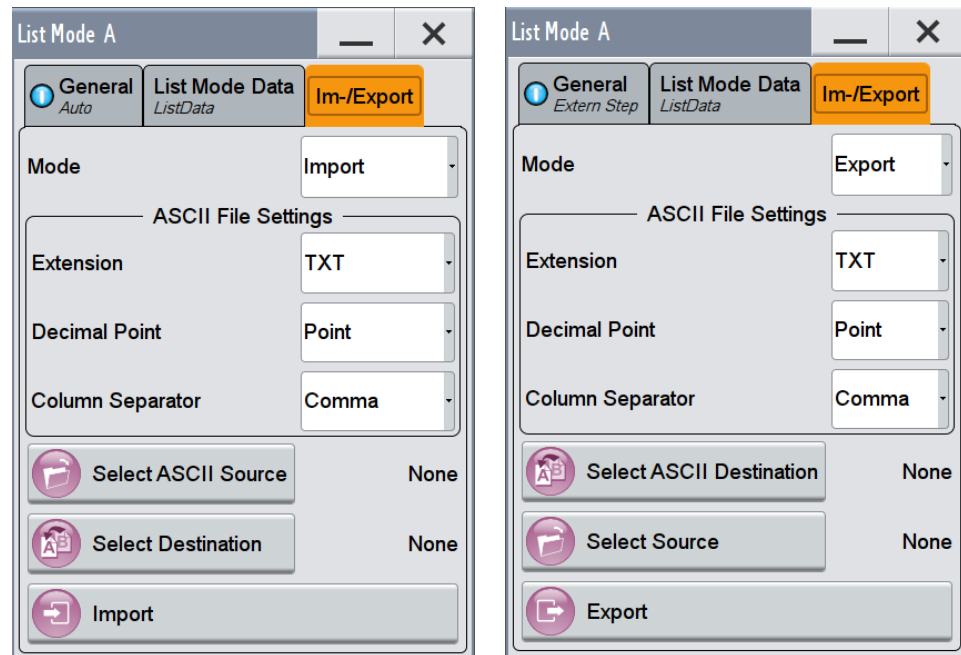
Refer also to [When to perform "Learn List Mode Data" ?](#).

Remote command:

[ :SOURce<hw> ] :LIST:LEARn on page 1011

### 8.7.6.3 Import/Export

- ▶ To access this dialog, select "RF > Sweep / List > List Mode > Im-/Export".



The "Im-/Export" dialog provides the parameters for importing or exporting list mode data files in standard ASCII \*.txt (ASCII) or \*.csv file format.



Since you need to determine the same parameters for all standard ASCII file formats, the settings of these dialogs are similar to the settings of user correction, for example.

Therefore, [Chapter 8.7.8, "Import/Export List Files"](#), on page 467 describes the settings in general.

### 8.7.7 List Editor

The R&S SMW "User Correction" and "List Mode" dialogs provide a list editor for defining the frequency/level value pairs.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview, shown by the example of the "List Data Editor". If a function relates to a particular dialog, it is explicitly stated.



To access the "List Mode Data" or "User Correction Data" editor, select one of the following:

1. "RF > Sweep / List > List Mode > Edit List Mode Data"
2. "RF > RF Level > User Correction > Edit User Cor. Data"

	Frequency / Hz	Power / dBm	Dwell / s
1	6 000 000 000.000	-20.00	0.001 000
2	5 400 000 000.000	10.00	0.000 500
3	5 250 000 000.000	0.00	0.000 750
4	4 000 000 000.000	-15.00	0.002 000
5	4 700 000 000.000	-10.00	0.000 700
6			

	Frequency / Hz	Power / dB
1	1 000 000 000.00	24.78
2	1 500 000 000.00	36.99
3	2 000 000 000.00	31.82
4		

The dialogs contain a table for entering the RF frequency and power-value pairs, and the associated navigation functions. The "Edit List Mode Data" dialog also provides a column for entering variable dwell times.



A data table requires that you complete a line. Rows with missing values are ignored and not stored. Values of incomplete rows get lost.

In this regard, note the following for **List Mode**, when using the global dwell time:

- The instrument uses the value set with [Global Dwell Time](#) for all list steps.
- However, to store the data list, you must fill the "Dwell Time" column according to the number of frequency and power value pairs, although the values are not used for generating the signal.

**Tip:** Use the [Fill Data Table Automatically](#) function to fill the dwell time column.

### Edit List Mode Data

Provides the parameter value pairs.

For details on editing and storing list files, see [Data handling keys](#). For handling and possibilities to fill the data table see "[Fill Data Table Automatically](#)" on page 466.

"Frequency /Hz"

Sets the frequency values.

"Power /dBm"

Sets the level values.

"Dwell /s"

In list mode, sets the dwell time values.

Remote command:

[\[:SOURCE<hw>\]:LIST:FREQuency](#) on page 1009

[\[:SOURCE<hw>\]:LIST:POWer](#) on page 1011

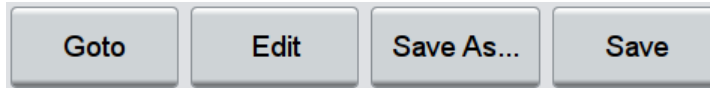
[ :SOURce<hw> ] :LIST:DWELL:LIST on page 1009

[ :SOURce<hw> ] :CORRection:CSET:DATA:FREQuency on page 960

[ :SOURce<hw> ] :CORRection:CSET:DATA:POWer on page 960

### Data handling keys

Contain basic editing functions.



The following description assumes that the various functions are largely known and self-explanatory. Therefore, just a brief overview of the available options is given.

**Note:** Save a list only after filling both columns (frequency and level), otherwise the entries are lost.

#### **Goto** ← Data handling keys

Selects a row for editing.

#### **Edit** ← Data handling keys

Enables you to insert, or delete a row or ranges within a list, and provides access to a dialog for automatic filling.

#### **Fill with Sensor** ← Data handling keys

Opens a dialog to configure the settings for automatic filling of user correction data with an R&S NRP-Zxx power sensor, see [Chapter 8.9.3.4, "Fill with Sensor"](#), on page 511. This key is visible only in UCOR mode.

#### **Save As... / Save** ← Data handling keys

Stores the list in a file. To save a copy, or a new file, use the "Save as" command to assign a file name.

#### **Fill Data Table Automatically**

Describes all parameters for filling a table automatically with user-defined values.

Figure 8-19: Fill table dialog

Since the settings are interdependent, the affected parameters change accordingly if you set a value.

To fill the table, press the "Fill" button.

**Note:** Save a list only after filling all columns and rows, otherwise the entries are lost.

"From / Range"

Defines the start line and number of the row to be filled.

"Select Column to Fill"

Selects the respective value, including the unit.

"Start / End Value"

Provides the default values corresponding to the selected column.

"Increment"

Determines the step size.

### 8.7.8 Import/Export List Files

- To access this dialog section, select "Import / Export >>>" in the corresponding dialog.

<p><b>Mode</b> Import</p> <p><b>ASCII File Settings</b></p> <p>Extension TXT</p> <p>Decimal Point Point</p> <p>Column Separator Comma</p> <p>Select ASCII Source None</p> <p>Select Destination None</p> <p>Import</p>	<p><b>Import / Export UCOR Files</b></p> <p>Mode Import</p> <p><b>ASCII File Settings</b></p> <p>Extension TXT</p> <p>Decimal Point Point</p> <p>Column Separator Comma</p> <p>Select ASCII Source None</p> <p>Select Destination None</p> <p>Import</p>
<i>Import / Export List Mode Data</i>	<i>Import / Export UCOR Data</i>

The "Import / Export" section contains all functions and settings to import externally created list data, or to export it accordingly. You can process and store a list in the formats \*.txt (ASCII), or \*.csv (plain text with identical sequence of fields). The table separators and the decimal floating point numbers are customizable.

### Mode

Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:

[\[:SOURCE<hw>\]:LIST:DEXChange:MODE](#) on page 1018

[\[:SOURCE<hw>\]:CORrection:DEXChange:MODE](#) on page 966

### ASCII File Settings

Defines the format and the separators of the associated data file.

"Extension" Selects \*.csv or \*.txt format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator" Sets the separator between the columns in an ASCII table. You can use a "Tab", "Semicolon", "Comma" or "Space" to separate the values in your table.

Remote command:

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:EXTension](#) on page 1016

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:SEParator:DECimal](#) on page 1017

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:SEParator:COLumn](#) on page 1017

[\[:SOURCE<hw>\]:CORrection:DEXChange:AFIle:EXTension](#) on page 965

`[ :SOURce<hw> ] :CORRection:DEXChange:AFILe:SEParator:DECimal`  
on page 966

`[ :SOURce<hw> ] :CORRection:DEXChange:AFILe:SEParator:COLumn`  
on page 966

#### Select ASCII Source / Destination

Opens a file manager dialog to select directory and path for import (source) or export (destination) of the ASCII file.

Remote command:

`[ :SOURce<hw> ] :LIST:DEXChange:AFILe:CATalog?` on page 1016

`[ :SOURce<hw> ] :LIST:DEXChange:AFILe:SElect` on page 1017

`[ :SOURce<hw> ] :CORRection:DEXChange:AFILe:CATalog?` on page 965

`[ :SOURce<hw> ] :CORRection:DEXChange:AFILe:SElect` on page 965

#### Select Source / Destination

Opens a file manager dialog to select directory and path for import (source) or export (destination) of the data list.

Remote command:

`[ :SOURce<hw> ] :LIST:DEXChange:SElect` on page 1018

`[ :SOURce<hw> ] :CORRection:DEXChange:SElect` on page 967

#### Import / Export

Imports or exports the selected data list file, according to the set mode.

Remote command:

`[ :SOURce<hw> ] :LIST:DEXChange:EXECute` on page 1016

`[ :SOURce<hw> ] :CORRection:DEXChange:EXECute` on page 966

## 8.7.9 How to Generate a Signal in List or Sweep Mode

This section shows you how to configure a varying RF output signal for both, the list and sweep modes.

#### Example: RF Frequency Sweep

We assume that the R&S SMW generates an RF frequency sweep signal with the following characteristics:

- RF Signal in path A: 6 GHz frequency, -25 dBm level
- Sweep range from 200 MHz to 600 MHz
- Dwell time 10.0 ms
- RF frequency sweep mode: Single
- Signal Shape: Sawtooth
- Linear spacing

#### To configure the frequency sweep signal

1. In the status bar, enter "A > Freq > 6 GHz" and "Lev > -25 dBm".

2. Select "RF A > Sweep / List > RF Frequency Sweep"
3. Set "Start Freq > 200 MHz" and "Stop Freq > 600 MHz".  
(Alternatively you can set "Center Freq > 400 MHz" and "Span > 400 MHz".)
4. Select "Spacing > Linear".
5. Set the step width "Step Lin > 10 MHz" and "Dwell Time > 10.0 ms".
6. Select "Mode > Single".
7. Trigger the sweep "Single".
8. Select "State > On".

#### **Example: Fast Changing Frequency and Level Settings in List Mode**

The following example shows you how to generate an amplitude modulated RF signal based on list mode data:

We assume that the R&S SMW generates an amplitude modulated RF signal based on list mode data with the following characteristics:

- RF frequency / level & dwell time pairs:  
2 GHz / 0 dBm / 2 ms,  
1 GHz / -5 dBm / 1 ms,  
2.5 GHz / -10 dBm / 0.5 ms,  
4 GHz / -15 dBm / 1 ms
- List mode: Auto
- Amplitude modulated
- Run Mode: Learned (Frozen RF Settings)

#### **To perform the main steps in correct order**

Since any change of the hardware settings or list entries can affect the RF signal characteristics directly, we recommend that you basically proceed according to the following steps:

1. First, configure the modulation settings, activate the RF Signal, and make sure that the hardware settings have settled.
2. Create a data list.
3. Configure the list processing mode.
4. Execute "Learn List Mode Data" if required.
5. Activate list mode.

#### **To configure amplitude modulation and switch RF on**

1. Press PRESET to start from an initial state.
2. In the block diagram, select "RF A > Modulations > Amplitude Modulation > On".
3. Select "RF A > On" to activate RF signal generation.

**To create list mode data**

1. Select "RF A > Sweep / List > List Mode".
2. In the "List Mode Data" tab, select "List Mode Data > New".
3. Enter the file name `ListMode_Test` for the data list and confirm with "Ok".  
The instrument creates a file and stores it in the `/var/user/` directory.
4. Select "Edit List Mode Data".
5. Enter the first value pairs "Frequency > 2", "Power > 0" and "Dwell > 2".
6. Repeat the last step (5) and enter the remaining value pairs, that means the frequencies, power and dwell time values as specified above.
7. Select "Save" and close the dialog.

**To configure the list processing mode, learn list mode data and start signal generation**

1. In the "General" tab, select "List Mode > Auto".
2. Select "Dwell Time Mode > From List".
3. Select "List Mode Data > Learn List Mode Data".
4. Switch state to "On".
5. Select "Run Mode > Learned (Frozen RF Settings)".
6. Select "General > State > On".

The instrument continuously generates an amplitude-modulated RF signal whose frequency and level values change according to the associated dwell times, corresponding to the list entries.

During list processing, the generator displays no frequency and level values in the status bar, but you can check the following parameters.

- In the list mode dialog, the current index indicates the steps of the signal generation.
- In remote control mode, you can query ...
  - The current state with `LIST:RUNN?`
  - Current parameters with the commands `FREQ?`, `POW?` and `DWEL?`.

## 8.8 Analog Modulations

Analog modulation is a method used to transmit information of an LF (Low Frequency) signal in accordance with a second signal, typically one of a higher frequency. This is done by varying one or more properties of a high frequency waveform, called the modulation or carrier signal, with the modulating signal that contains the information to be transmitted.

The three key parameters of the modulation signal are the:

- Amplitude
- Phase
- Frequency

These parameters are modified in accordance with the low frequency signal to obtain the modulated RF signal.

The R&S SMW provides all the various types of modulation, such as AM (Amplitude Modulation), FM (Frequency Modulation),  $\Phi$ M (Phase Modulation (PhiM)), and also PULM (Pulse Modulation). The instrument generates the LF modulation signal as sine, triangle, trapezoidal or square (pulse) waveform, that can be output for use in a downstream instrument, if required. You can also create various interference signals such as white noise with selectable bandwidth and level distribution.

Furthermore, a monitor function allows you to synchronize the LF output signal with the amplitude, frequency or phase modulation signal.

The instrument provides the following internal **modulation signal sources**:

- An LF generator
- A multifunction generator and a noise generator
- A high performance pulse generator

The R&S SMW generates both the carrier (LF) and RF frequencies, provides sine or square waves, waveforms with rising and falling edges (triangle, sawtooth and trapezoid), and various noise signals, such as a white noise with selectable bandwidth and level distribution.

To configure and perform a modulation, you need to select the LF modulation signal source, configure the LF signal, and determine the settings of the modulation.

See the following sections for detailed information:

- [Modulation Signals](#) describes the characteristics of the available modulation signal sources, and provides access to the [RF Connectors Settings](#).
- [Modulation Signal Waveforms](#) shows the waveform shapes and their respective parameters graphically.
- [Modulation Settings](#) contains the settings for the AM, FM, PhiM and Pulse modulation.
- [LF Signal Output Settings](#) enables you to select the signal for output, and to specify the amplitude and an offset.





### Interactions and characteristics

- Some modulations and operating modes exclude each other, that means they cannot be performed simultaneously. See [Chapter 8.8.6.1, "Simultaneous Operation of Several Modulations"](#), on page 498 for an overview in detail.
- The settings of the modulation signal affect all analog modulations that use an internal modulation source.
- In sweep mode, LF frequency sweep is possible.
- You can feed an external LF signal in each of the two paths.
- An activated analog modulation automatically turns off:
  - I/Q modulation,
  - Arbitrary waveform generation,
  - Digital modulation and
  - Digital standards.

## 8.8.1 Required Options

The equipment layout for generating the analog modulation signals includes per signal path

- Option Frequency (R&S SMW-B10x)
- Option FM/PhiM Modulator (R&S SMW-B20) , or
- option FM/PhiM Modulator and Low Phase Noise (R&S SMW-B22)
- Option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/-B13T)  
**Note:** To perform for example I/Q modulation and an analog frequency or phase modulation in one path simultaneously, option R&S SMW-B13T must be installed.
- Option Pulse Modulator (R&S SMW-K22)
- Option High Performance Pulse Generator (R&S SMW-K23)  
comprises "Single" and "Double" pulse generation
- Option Multi-Function Generator (R&S SMW-K24)  
**Note:** The options of the pulse modulator and generators have floating licenses, that means you can use a license in one of the paths. To use an option in both paths simultaneously, two licenses must be purchased.

## 8.8.2 Modulation Signals

The signal sources for the modulation signal are two internal generators, LF and Noise, and a pulse generator, but you can also use an externally supplied signal, see [External Signal Sources](#).

You can perform the AM, FM and PhiM with the signal of any of the provided sources. Even more, you can merge two modulation signals, for example, to generate a two-tone signal. Similarly, you can forward the used modulation signal to the output.

### 8.8.2.1 Internal Signal Sources

Fully equipped, the R&S SMW provides the following internal modulation sources:

- **LF Generator**  
Supplies sinusoidal and square waves in the frequency range 0.1 Hz ... 1 MHz and selectable shapes.  
To obtain a triangle, trapezoid or square wave, a pulse signal, the R&S SMW converts the sinusoidal signal internally to the respective shape.
- **Multifunction generator**  
A further LF generator for use as a second modulation source. It features an extended frequency range of 0.1 Hz ... 10 MHz and selectable signal shapes. Alternatively, you can use it to generate a noise modulation signal.
- **Noise generator**  
Supplies white noise with selectable bandwidth and level distribution.
- **High performance pulse generator**  
Allows you to generate either single or double pulse signals.

### 8.8.2.2 External Signal Sources

For the input of an external amplitude, frequency or phase modulation signal, you can assign the signal at the EXT1 and EXT2 connectors located at the rear panel of the instrument, see "EXT 1, 2" on page 63.

External pulse modulation signals are fed via the global connectors, assigned in the "Global Connector Settings" dialog, see [Chapter 11.2.4, "Global Connectors Settings"](#), on page 619.



The external modulation signal at the input must have a voltage of  $U_S = 1\text{ V}$  ( $U_{\text{EFF}} = 0.707\text{ V}$ , in case of sine signals) to achieve the displayed modulation depth and range. The input voltage should not exceed 1.1 V, otherwise modulation distortions might occur. With external pulse modulation, the switching point is max. 2.4 V and the voltage at the input should not exceed 5 V. The maximum modulation frequency is 10 MHz for frequency and phase modulation.

---

### 8.8.2.3 Assigning the LF Signal to the Output

The R&S SMW can also act as the source for modulations in downstream equipment. The instrument is equipped with two connectors located at the rear panel, see "LF OUT 1/2" on page 63. Regardless of the used signal source, which can be the internally generated or an externally fed LF modulation signal, you can optionally select the signal for output.



Note that the output of the internal LF signal and the analog I/Q signal use the same physical connectors (LF OUT 1/2 and I/Q OUT 1/2), that means these signals cannot be output simultaneously. If both, the I/Q and the LF signal output are switched on, the I/Q signal is suppressed and the instrument provides the LF signal.

---

You can freely assign the LF signals from both paths (A or B) to the outputs. To perform the assignment, use the "LF Output" tab. It is available both in the "Modulation" dialog of path A and path B, but the functionality applies to both paths the same way. Therefore, the instrument adjusts your settings always in parallel. The "Overview" tab shows the current configuration graphically, and allows you to modify the assignments there directly. The assignment of the shown LF output is of course in both paths the same.

Since there are two LF output connectors, but the R&S SMW can process multiple LF signals simultaneously, there are some configurations that exclude each other.

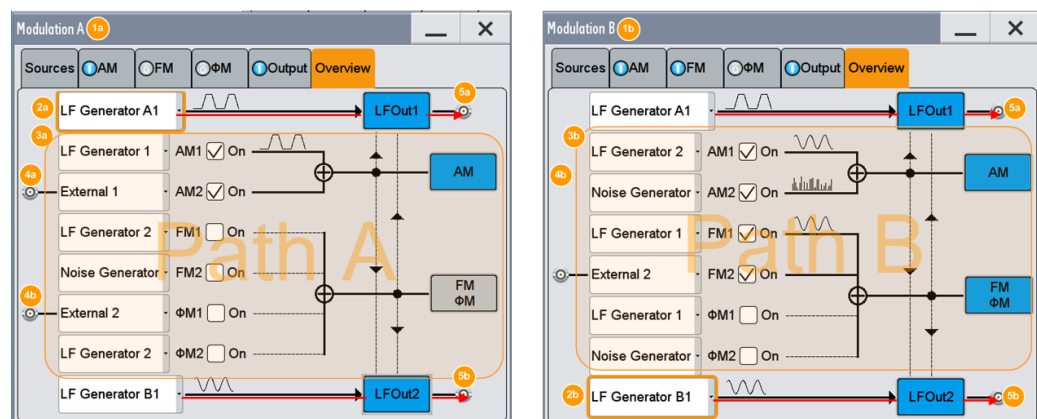
See the following examples to the overview tab, the versatile options for configuring the modulation signals and the graphical representation of the signal flow.

**Example: Introduction to the Overview tab**

This example briefly explains the view and the elements of the "Overview" tab of the two paths (A and B). The tab shows the two common LF output signal connectors, which are the same in both paths, and the specific modulation settings of the respective path. Active signals are indicated by thick lines, the inactive signals are illustrated by dotted lines.

The following modulations are configured:

- Path A (first image)  
Amplitude modulation that is performed with an internally generated trapezoid wave signal and a superposed external signal.
- Path B (second image)  
Amplitude modulation, performed with the sine signal of the LF Generator 2 and a superposed noise signal.  
Simultaneously, the instrument performs frequency modulation with an LF signal that is composed of a sine wave (LF Generator 1, path B) and an external signal.
- LF OUT 1 / LF OUT 2 (the same in both images)  
The LF signal of the LF Generator 1 in path A is assigned to the output LF OUT 1, and the signal of LF generator 2 in path B is assigned to LF OUT 2 (see the red lines).



**Figure 8-20: Example: Elements in the analog modulations "Overview" tab**

- 1a, 1b = Modulation dialogs of path A, and path B  
 2a, 2b = assigned modulation signals to the LF outputs 1 and 2  
 3a, 3b = modulation signal sources used in path A, and path B  
 4a, 4b = external input connectors 1 and 2  
 5a, 5b = LF output connectors 1 and 2

This tab reflects the signal sources of the analog modulations AM, FM and  $\phi$ M as in the corresponding settings dialogs. Therefore, you can also select the signal source as well as turn a modulation on or off in this tab. Corresponding to the activated modulation, the used signal sources are displayed. Furthermore, the overview also shows the signals that are routed to one of the LF output connectors.

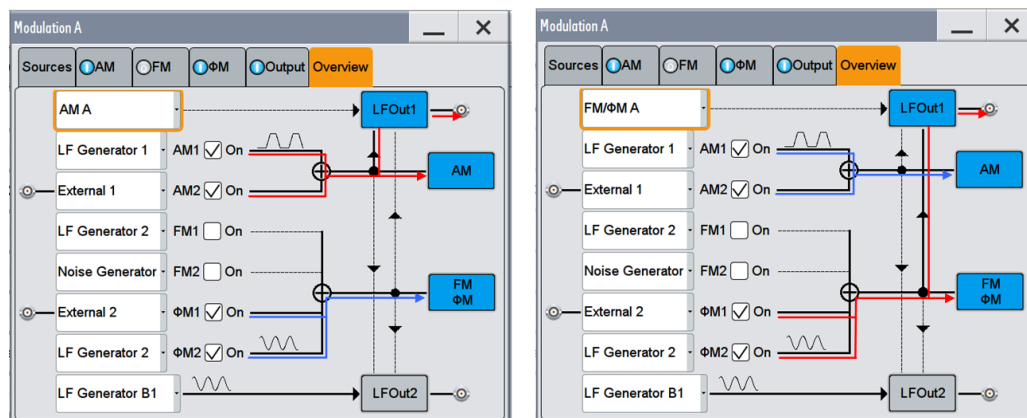
In addition to the basic overview, you see in these pictures, that the signal of the first LF generator is routed to the first output (LF OUT 1), and the signal of the second generator to LF OUT 2. This assignment is not mandatory. It has been chosen randomly and can be changed arbitrarily.

**Example: Assigning a composite modulation signal to the LF output**

This example shows two different configurations for analog modulations in path A.

The following modulations are configured:

- Analog modulation (first image)  
Amplitude modulation performed with an internally generated trapezoid wave signal and a superposed external signal. This composite LF signal is assigned to the output LF OUT1 (see the red lines in the first image).  
Simultaneously, the instrument performs phase modulation with an LF signal that is composed of an external signal and a sine wave, provided by the "LF Generator 2". This signal is used for the modulation and does not affect the LF output (blue lines).
- Path B  
Phase modulation performed with two internally generated trapezoid wave signals that are combined and routed to the output LF OUT1 (red lines in the second image).



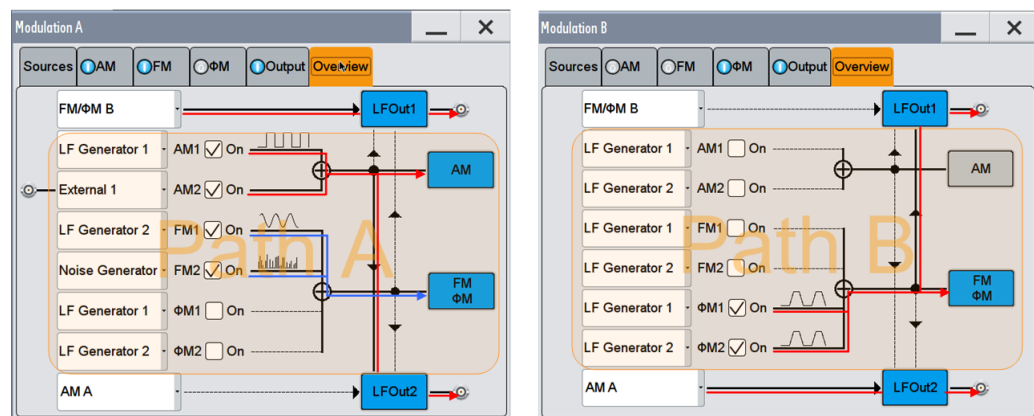
In the first image, both signals selected for the amplitude modulation in path A are combined. The instrument performs the amplitude modulation with this signal and also provides it at the LF output.

The second image shows the similar configuration set up for the phase modulation.

### Example: Assigning two independent composite modulation signals to the LF outputs

This example shows the following configuration:

- Path A  
Amplitude modulation performed with an internally generated square wave signal and a superposed external signal. This composite LF signal is also assigned to the output LF OUT2 (see the red lines in the first image). Simultaneously, the instrument performs frequency modulation with an LF signal that is composed of the internally generated sine wave, superposed with noise. This signal is used for the modulation and does not affect the LF output (blue lines).
- Path B  
Phase modulation performed with two internally generated trapezoid wave signals that are combined and routed to the output LF OUT1 (red lines in the second image).



The two images illustrate how the same configuration is displayed in the "Overview" tabs of the two paths.

In the tab of path A (see the first image), you can see the settings of the modulations in path A. The signal coming from B is only displayed. Vice versa, the tab in the path B (second image) shows the configuration of the modulations of this path, but also the signal coming from A.

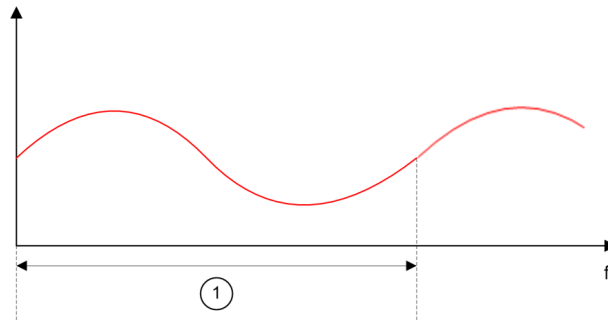
#### 8.8.2.4 Modulation Signal Waveforms

The following graphs show the modulation signal waveforms of the R&S SMW.

#### LF Generator

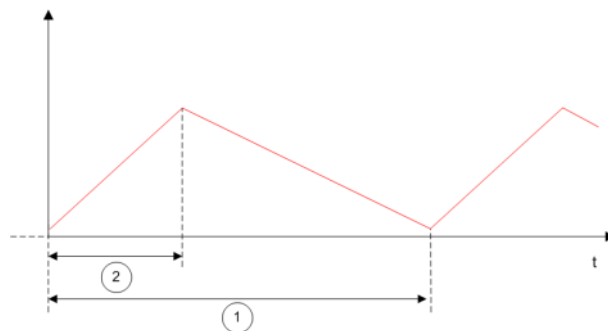
The LF and multifunction generators support the following signal shapes:

Sine



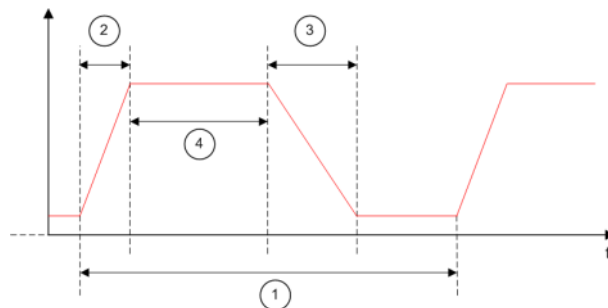
1 = Period

Triangle



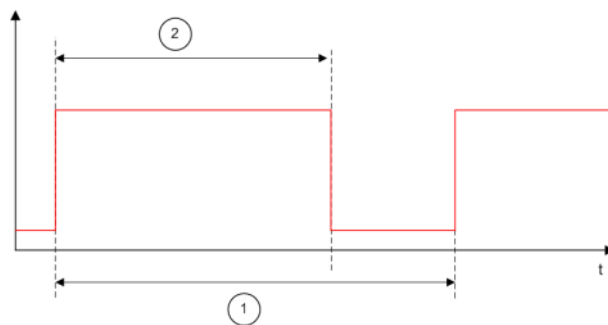
1 = Triangle Period 2 = Triangle Rise

Trapezoid



1 = Trapezoid Period 2 = Trapezoid Rise  
3 = Trapezoid Fall 4 = Trapezoid High

Pulse (Square)



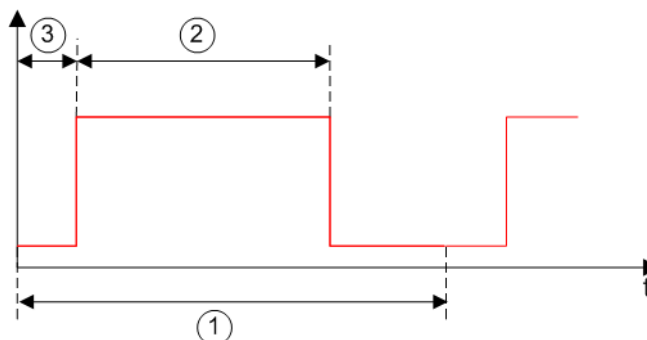
1 = Pulse Period 2 = Pulse Width

To configure the associated parameters of a signal shape, see [LF Generator](#).

### Pulse Generator

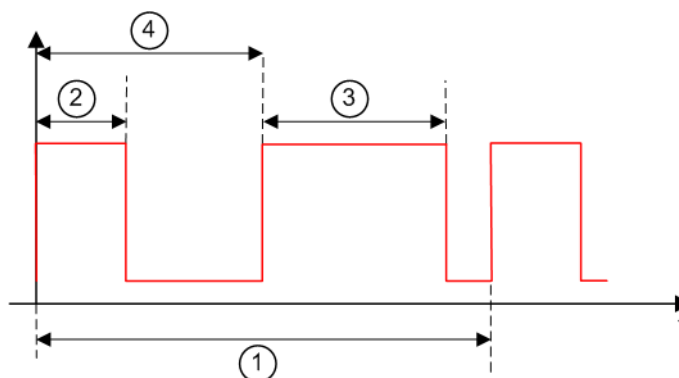
The high performance pulse generator enables you to generate single or double pulse signals.

#### Single



1 = Pulse Period 2 = Pulse Width 3 = Pulse Delay

#### Double



1 = Pulse Period 2 = Pulse Width  
3 = Double Pulse Width 4 = Double Pulse Delay

To configure the associated parameters of the pulse generator, see [LF Generator](#).

### 8.8.3 Modulation Settings

- To access the analog modulation settings dialogs, select "RF > Analog Modulation".

The "Modulation" dialog contains all functions and settings to configure the analog modulations, the LF signal sources for performing a modulation, and the LF signal output. The settings are arranged in several tabs according to their topics.

The remote commands required to define these settings are described in [Chapter 13.18.2.1, "SOURCE:AM Subsystem"](#), on page 796, [Chapter 13.18.2.2, "SOURCE:FM Subsystem"](#), on page 799, [Chapter 13.18.2.3, "SOURCE:PM Subsystem"](#), on page 803, [Chapter 13.18.2.4, "SOURCE:PULM Subsystem"](#), on page 806 and [Chapter 13.18.10, "SOURCE:LFOOutput Subsystem"](#), on page 990.



### 8.8.3.1 AM, FM and PhiM Modulation Sources

- ▶ To access this dialog, select "RF > Analog Modulation > Modulation Source...".

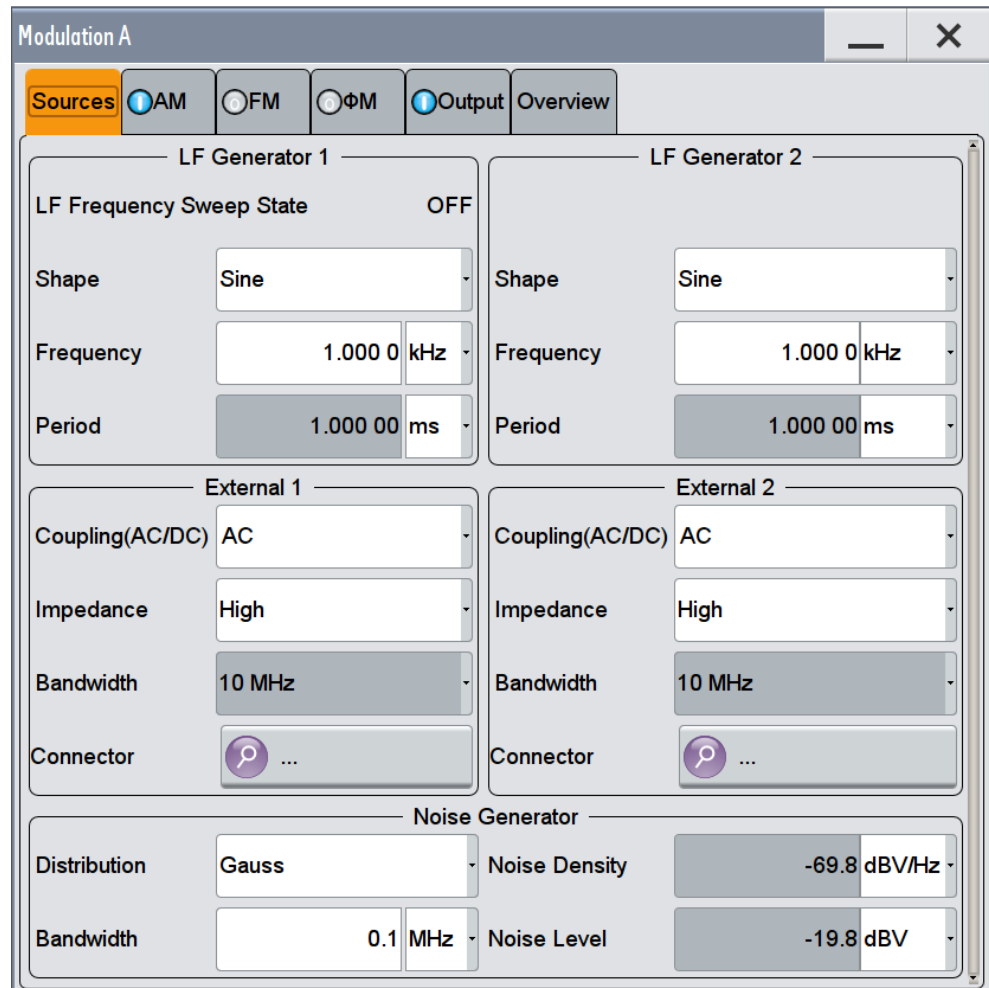


Figure 8-21: Analog Modulation > Sources

In the "Sources" tab, you can configure an LF modulation signal for performing analog modulations. It includes the setting parameters of the internal LF- and multi-function generators, the noise generator, and an external signal source.

To select an external signal, you can directly access the settings of the [Connectors](#) dialog.

The remote commands required to define these settings are described in [Chapter 13.18.10, "SOURCE:LFOutput Subsystem"](#), on page 990.

#### LF Generator

The "LF Generator" settings section contains all parameters required to configure the signal of the internal LF Generator.

**State - LF Frequency Sweep ← LF Generator**

Activates the generation of an LF frequency sweep signal in the "LF Frequency" dialog. In the "Sources" tab of the analog modulations, the instrument shows the current state of the LF frequency sweep.

Remote command:

```
[ :SOURce<hw> ] :LFOutput:FREQuency:MODE on page 994
```

**Shape ← LF Generator**

Selects the waveform shape ("Sine", "Pulse", "Triangle" or "Trapezoid") of the LF signal.

The "Triangle" and "Trapezoid" waveforms are available if the instrument is equipped with the multifunction generator, see [Required Options](#).

Remote command:

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE on page 997
```

**Frequency ← LF Generator**

Sets the frequency of the LF generator for sine signals, selected with [Shape](#).

Remote command:

```
[ :SOURce<hw> ] :LFOutput<ch>:FREQuency on page 993
```

**Period (Sine, Pulse, Triangle, Trapezoid) ← LF Generator**

Sets the repetition rate of the generated LF signal for triangle, trapezoid or pulse shapes, see [Shape](#).

For sine signals, the frequency determines the duration of a sine wave, indicated by the instrument.

Remote command:

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE:TRAPeze:PERiod on page 998
```

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE:TRIangle:PERiod on page 999
```

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE:PULSe:PERiod on page 997
```

**Pulse Width ← LF Generator**

Sets the pulse duration of the generated pulse signal.

Remote command:

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE:PULSe:WIDTh on page 998
```

**Pulse Duty Cycle ← LF Generator**

Sets the ratio between the pulse duration and the pulse period in percent.

Remote command:

```
[ :SOURce<hw> ] :LFOutput<ch>:SHAPE:PULSe:DCYCLe on page 997
```

**Triangle Rise ← LF Generator**

Sets the time required for the triangle signal to change from low level to high level, see also [Modulation Signal Waveforms](#).

Remote command:

`[ :SOURce<hw> ] :LFOutput<ch> :SHAPE:TRIangle:RISE` on page 999

#### Trapezoid Rise / Fall ← LF Generator

Sets the time required for the trapezoid signal to change from low level to high level, and vice versa, see [Modulation Signal Waveforms](#).

Remote command:

`[ :SOURce<hw> ] :LFOutput<ch> :SHAPE:TRAPeze:RISE` on page 999

`[ :SOURce<hw> ] :LFOutput<ch> :SHAPE:TRAPeze:FALL` on page 998

#### Trapezoid High ← LF Generator

Sets the duration the trapezoid signal is at high level.

Remote command:

`[ :SOURce<hw> ] :LFOutput<ch> :SHAPE:TRAPeze:HIGH` on page 998

#### External

The "External" settings section contains all parameters required to configure the signal of an externally supplied LF signal.

#### Coupling (AC/DC) ← External

Selects the coupling mode (AC or DC) for the external signal.

**Note:** You can set the coupling of the external modulation signal for AM, FM and  $\Phi$ M separately.

Remote command:

`[ :SOURce<hw> ] :INPut:MODext:COUPling<ch>` on page 978

#### Impedance ← External

Sets the impedance for the externally supplied LF signal.

Remote command:

`[ :SOURce<hw> ] :INPut:MODext:IMPedance<ch>` on page 978

#### Bandwidth ← External

Displays the bandwidth of the external LF signal.

Remote command:

`[ :SOURce ] :LFOutput<ch> :BANDwidth?` on page 992



#### Find ← External

Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see ["Connector status indication"](#) on page 614).

#### Noise Generator

The "Noise Generator" settings contain all parameters to configure the signal of the internal noise generator.

**Distribution ← Noise Generator**

Selects the distribution of the noise power density.

"Gaussian" Generates the noise power according to a Gaussian distribution.

"Equal" Generates an even distributed noise.

Remote command:

[\[:SOURce<hw>\]:NOISe:DISTRibution](#) on page 1019

**Bandwidth ← Noise Generator**

Selects the noise bandwidth.

You can set the bandwidth between 10 kHz and 10 MHz, according to the frequency with varying step sizes:

- 100 kHz steps (100 kHz ... 1 MHz)
- 1 MHz steps (1 MHz ... 5 MHz)
- 5 MHz steps (5 MHz ... 10 MHz)

The noise signal is generated within the set frequency bandwidth. The noise level in the frequency band is defined by Noise Level (System Bandwidth).

Remote command:

[\[:SOURce<hw>\]:NOISe:BANDwidth|BWIDth](#) on page 1018

[\[:SOURce<hw>\]:NOISe:BWIDth:STATe](#) on page 1019

**Noise Density ← Noise Generator**

Indicates the level of the noise signal for a bandwidth of 1 Hz (relative).

Remote command:

[\[:SOURce<hw>\]:NOISe:LEVel<ch>:RELative?](#) on page 1019

**Noise Level ← Noise Generator**

Indicates the level of the noise signal per Hz within the total bandwidth (absolute).

Remote command:

[\[:SOURce<hw>\]:NOISe:LEVel<ch>\[:ABSolute\]?](#) on page 1020

**8.8.3.2 AM, FM and PhiM Modulation Settings**

The "AM", "FM" and "ΦM" tabs contain the parameters for the respective modulation types.



Since you need to determine an LF signal source for all modulations, "Source" and "State" are described in general. These parameters apply to the modulation modes AM, FM and ΦM. The following description explains the specific settings for the appropriate modulation modes.

- ▶ To access the corresponding dialog, select "RF" and the associated menu entry: "Amplitude Modulation", "Frequency Modulation" or "Phase Modulation".

**State**

Activates a modulation.

**Note:** Some analog modulations cannot be run simultaneously with e.g. ARB, I/Q modulation or digital modulation, as well as with the digital standards. See [Chapter 8.8.6.1, "Simultaneous Operation of Several Modulations"](#), on page 498 for an overview.

Remote command:

[ :SOURce<hw> ] :AM<ch> :STATe on page 798

[ :SOURce<hw> ] :FM<ch> :STATe on page 802

[ :SOURce<hw> ] :PM<ch> :STATe on page 805

### Source

Selects the LF signal source.

You can vary the signal sources for each of the modulations.

"LF Generator1/2"

Selects one of internally generated LF signals.

"External 1/2" Selects an externally supplied LF signal

"Noise Generator"

Selects the internally generated noise signal.

Remote command:

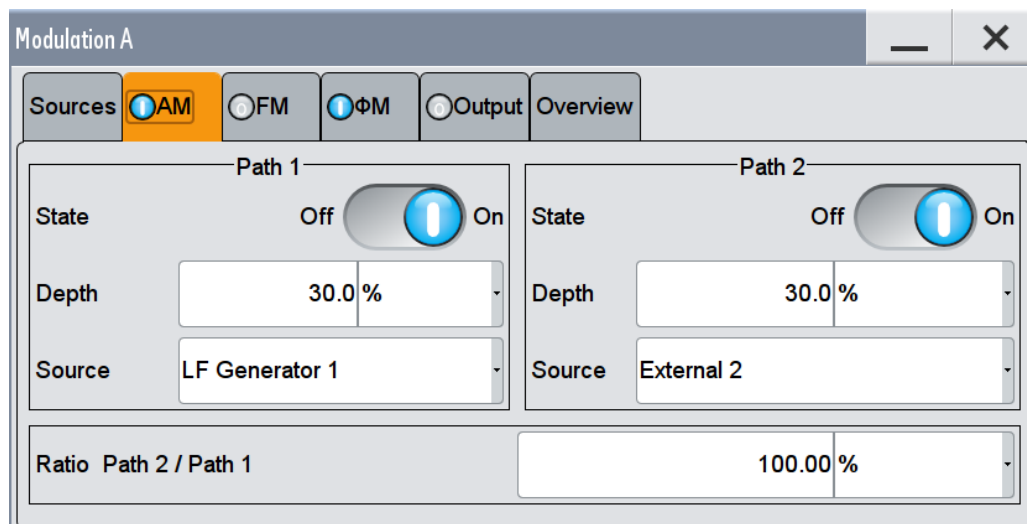
[ :SOURce<hw> ] :AM<ch> :SOURce on page 798

[ :SOURce<hw> ] :FM<ch> :SOURce on page 802

[ :SOURce<hw> ] :PM<ch> :SOURce on page 805

### AM

Provides the settings for amplitude modulation.



### AM Depth ← AM

Determines the depth of the modulation signal in percent.

The depth is limited by the maximum peak envelope power (PEP).

Remote command:

`[ :SOURce<hw> ] :AM<ch> [ :DEPTh ]` on page 799

#### Ratio Path2/Path1 ← AM

Sets the deviation ratio (path2 to path1) in per cent.

Remote command:

`[ :SOURce<hw> ] :AM:RATio` on page 797

#### FM

Provides the settings for the frequency modulation.

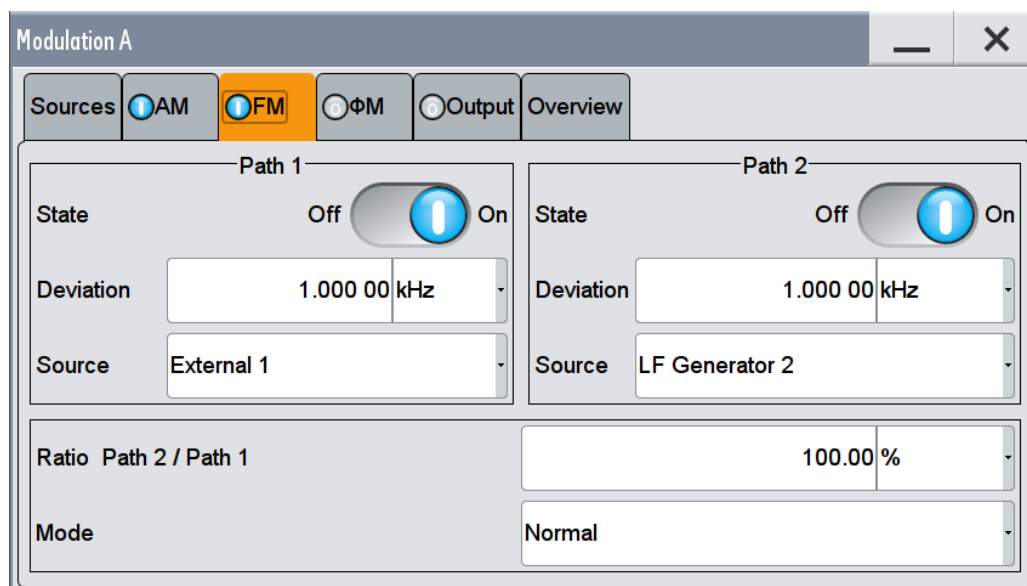


Figure 8-22: Analog Modulation > FM

#### Deviation ← FM

Sets the frequency modulation deviation in Hz.

The maximal deviation depends on the RF frequency and the selected modulation mode (see data sheet).

Remote command:

`[ :SOURce<hw> ] :FM<ch> [ :DEVIation ]` on page 800

#### Ratio Path2/Path1 ← FM

Sets the deviation ratio (path2 to path1) in per cent.

For example, if you set 10 kHz deviation in path1, and the ratio to 50%, the deviation in path 2 is automatically determined with 5 kHz.

Remote command:

`[ :SOURce<hw> ] :FM:RATio` on page 801

#### Mode ← FM

Selects the mode of the frequency modulation.

- "Normal" The maximum range for modulation bandwidth is available. However, phase noise is increased for low frequencies. The range for FM deviation is limited.
- "Low Noise" Phase modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced (see data sheet).

Remote command:

[ :SOURce<hw> ] :FM:MODE on page 801

### PhiM

Provides the settings for phase modulation ("ΦM").

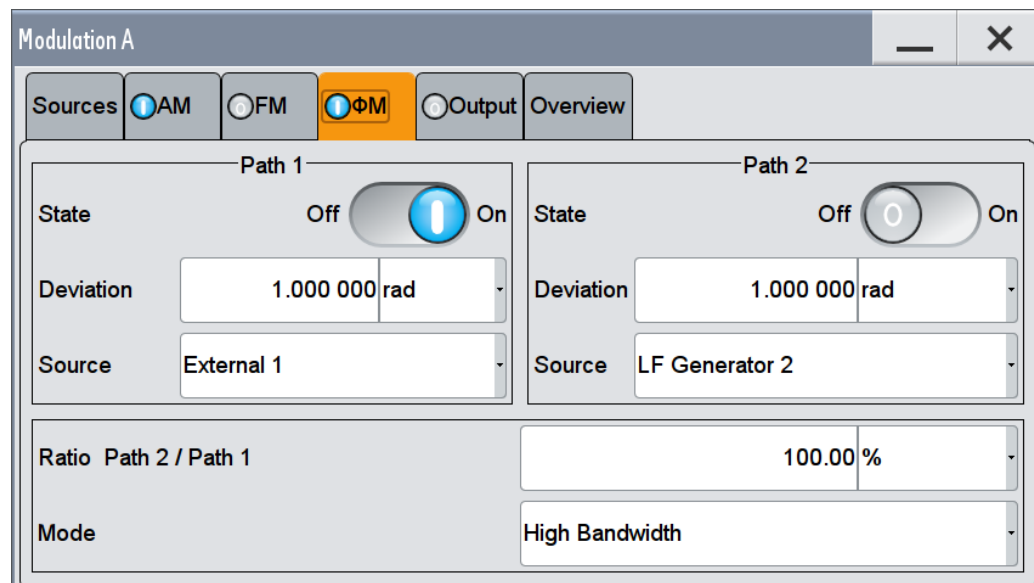


Figure 8-23: Analog Modulation > ΦM

### Deviation ← PhiM

Sets the phase modulation deviation in RAD or degree.

The maximal deviation depends on the RF frequency and the selected modulation mode (see data sheet). It may be that you set a deviation that is too high for the particular frequency, or that you vary the frequency within a range that deviation is not possible. In both cases, the instrument sets the maximal possible deviation, and displays a warning message.

Remote command:

[ :SOURce ] :PM<ch> [ :DEVIation ] on page 806

### Ratio Path2/Path1 ← PhiM

Sets the deviation ratio (path2 to path1) in per cent.

For example, if you set 10 rad deviation in path1, and the ratio to 50%, the deviation in path 2 is automatically determined with 5 rad.

Remote command:

[ :SOURce<hw> ] :PM:RATio on page 804

### Mode ← PhiM

Selects the mode of the phase modulation.

"High Bandwidth" The maximum range for modulation bandwidth and  $\Phi$ M deviation is available. However, phase noise increases at low frequencies, and the range of  $\Phi$ M deviation is limited. It is recommended that you process high frequencies in this mode.

"High Deviation" The maximum range for  $\Phi$ M deviation is available. Phase noise is improved for low frequencies compared to the default mode. The range for modulation frequency is limited (see data sheet). This mode is recommended for low modulation frequencies and/or high  $\Phi$ M deviation.

"Low Noise" Frequency modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced (see data sheet).

Remote command:

[ :SOURce<hw> ] :PM:MODE on page 804

### 8.8.3.3 LF Signal Output Settings

► To access this dialog, select "RF > LF Output".

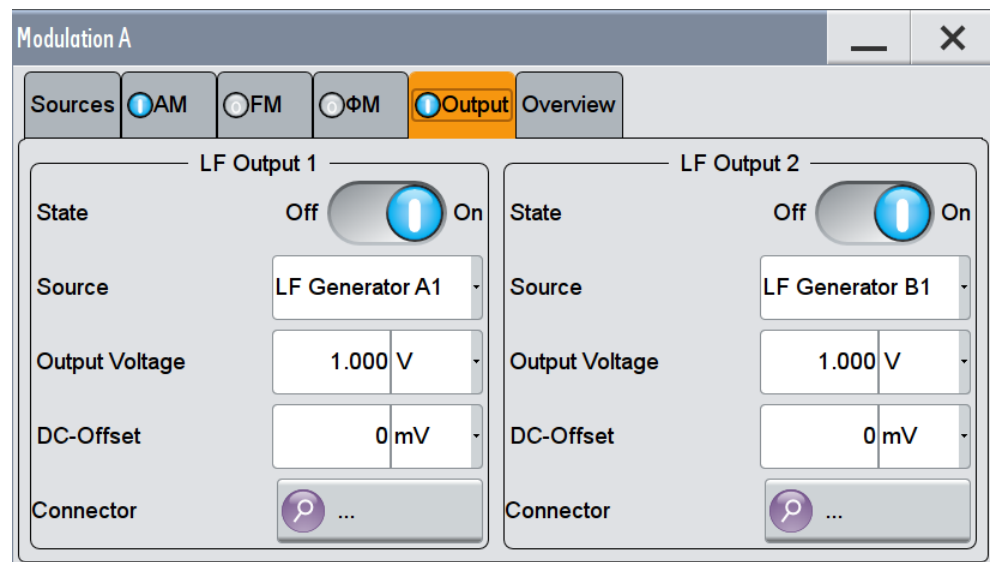


Figure 8-24: Analog Modulation - LF output

In the "Output" tab, you can configure the signal at the LF output, for example monitor a modulated signal, determine the output voltage or add a DC offset.



**State**

Activates the output of the LF signal.

Remote command:

[\[:SOURce\]:LFOutput<ch>\[:STATe\]](#) on page 996

**Source**

Determines the LF signal to be synchronized of the corresponding path.

"LF Generator A1/2, B1/2"

Selects one of internally generated LF signals.

"AM A/B"

Selects the AM signal.

"FM/ΦM A/B"

Selects the signal also used by the frequency or phase modulations.

"Noise Generator A/B"

Selects the internally generated noise signal.

"External 1/2"

Selects an externally supplied LF signal

Remote command:

[\[:SOURce\]:LFOutput<ch>:SOURce](#) on page 995

**Output Voltage**

Sets the voltage (peak) of the LF output.

Remote command:

[\[:SOURce\]:LFOutput<ch>:VOLTage](#) on page 996

**DC-Offset**

Adds a DC offset to the LF output signal.

Remote command:

[\[:SOURce\]:LFOutput<ch>:OFFSet](#) on page 995

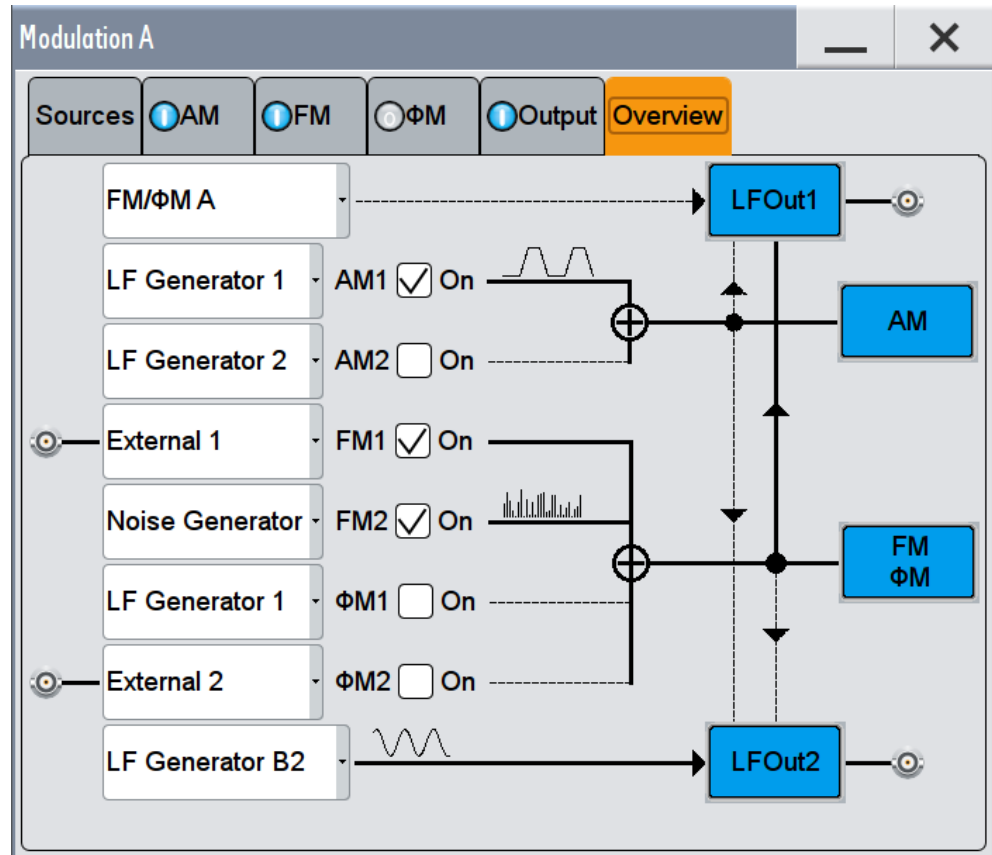
**Find**

Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see "[Connector status indication](#)" on page 614).

### 8.8.3.4 Overview

- ▶ To access this dialog, select "RF > Modulations > Overview".

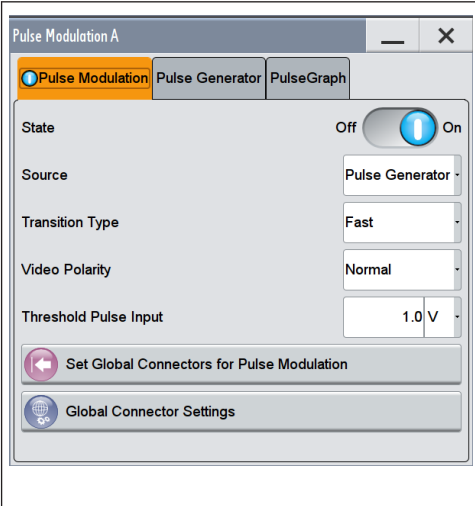
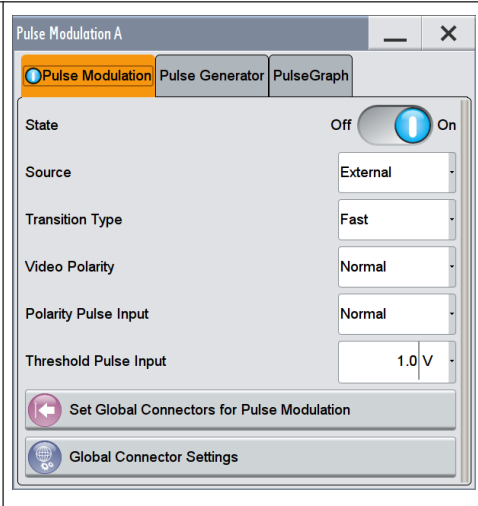


The "Overview" tab shows the active modulations and the LF signal sources used by each. In addition, you can modify the settings or activate the analog modulations here. See [Chapter 8.8.2.3, "Assigning the LF Signal to the Output"](#), on page 474 for a detailed explanation of this tab. For all further settings relating to an analog modulation, see [Chapter 8.8.3, "Modulation Settings"](#), on page 480.

### 8.8.3.5 Pulse Modulation

- ▶ To access this dialog, select "RF > Analog Modulation > Pulse Modulation".

Table 8-10: Pulse Modulation

	
"Signal Source > Pulse Generator " (internal)	"Signal Source > Pulse Generator " External

The "Pulse Modulation" dialog contains all parameters required to configure pulse modulation and pulse signal generation. It also displays the pulse signal graphically.

In the "Pulse Modulation" tab, you can configure the parameters of the modulation signal, such as trigger mode or transition characteristics, depending on the selected signal source. For the assignment of an externally applied signal, you can directly access the settings, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.

### State

Activates pulse modulation.

Remote command:

`[ :SOURce<hw> ] :PULM:STATe` on page 810

### Source

Selects between the internal "Pulse Generator", or an "External" pulse signal for the modulation. To configure the internal signal see [Pulse Generator](#).

"Pulse Generator"

Selects the internal generator.

"External"

Enables an externally supplied signal, see also [Chapter 8.8.2.2, "External Signal Sources"](#), on page 474.

Remote command:

`[ :SOURce<hw> ] :PULM:SOURce` on page 807

### Transition Type

Selects between "Fast" or "Smoothed" slew rate (slope).

"Fast"

Enables fast transitions with shortest rise and fall times.

"Smoothed"

Flattens the slew rate, resulting in longer rise / fall times. Use this mode if you are working with devices that are sensitive to steep slopes.

Remote command:

[ :SOURce<hw> ] :PULM:TTYPe on page 811

#### Video Polarity

Sets the polarity of the internally generated pulse video (modulating) signal, related to the RF (modulated) signal.

This signal synchronizes the pulse generator signal and the RF signal.

"Normal"            The video signal level follows the RF signal, that means it is high and low simultaneously with the RF signal.

"Inverse"           Inverts the polarity between the video and the RF signal, that means it is high, when RF is low, and vice versa.

Remote command:

[ :SOURce<hw> ] :PULM:OUTPut:VIDeo:POLarity on page 809

#### Polarity Pulse Input

Sets the polarity of the active slope of a pulse input signal, that is the external pulse modulation signal.

Remote command:

[ :SOURce<hw> ] :PULM:POLarity on page 810

#### Threshold Pulse Input

Sets the high/low threshold in volts for the pulse input, e.g. for the external pulse modulation signal.

Remote command:

[ :SOURce ] :INPut:USER:PULM:LEVel on page 794

#### Impedance Pulse Input

Selects the input impedance for an external pulse modulation signal.

Remote command:

[ :SOURce<hw> ] :PULM:IMPedance on page 808

#### Set Global Connector for Pulse Modulation

Routes the pulse input signal by default to the global user connector USER 4 ("Pulse In A/B"), and correspondingly the pulse output signal to USER 5 ("Pulse Out A/B").

See also [Table 11-1](#) in [Chapter 11.2.1.1, "Global Connectors"](#), on page 612.

### 8.8.3.6 Pulse Generator

- ▶ To access this dialog, select "RF > Analog Modulation > Pulse Generator".

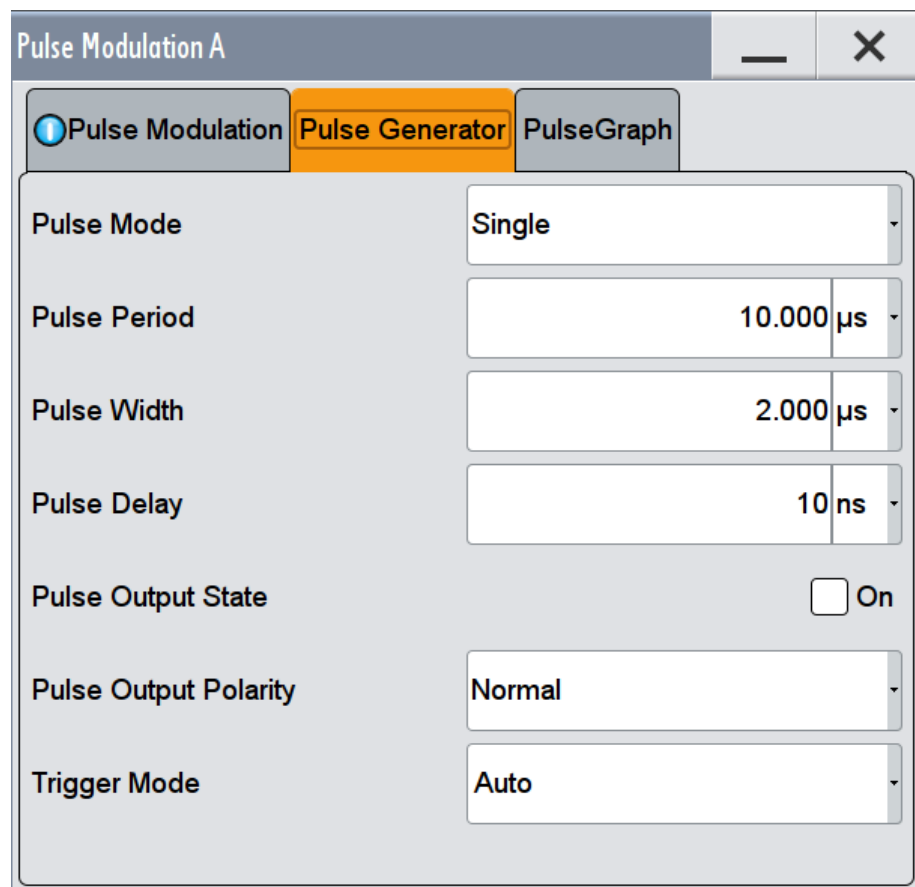


Figure 8-25: Pulse Generator

The "Pulse Generator" tab contains the settings for creating the pulse modulation signal internally.

#### Pulse Mode

Sets the operating mode of the pulse generator. Depending on the selection, the instrument displays the associated parameters.

"Single" Generates a single pulse in one pulse period.

"Double" Generates two pulses in one pulse period.

Remote command:

[\[:SOURce<hw>\]:PULM:MODE](#) on page 809

#### Pulse Period

Sets the repetition rate of the generated pulse signal.

Remote command:

[\[:SOURce<hw>\]:PULM:PERiod](#) on page 809

#### Pulse Width

Sets the pulse duration of the generated pulse signal.

**Note:** The pulse width must be at least 20 ns less than the set pulse period.

Remote command:

`[ :SOURce<hw> ] :PULM:WIDTh` on page 811

#### Double Pulse Width

Sets the width of the second pulse.

Remote command:

`[ :SOURce<hw> ] :PULM:DOUBle:WIDTh` on page 808

#### Pulse Delay

Sets the pulse delay. The pulse delay determines the time that elapses after a trigger event before pulse modulation starts. The pulse delay is not effective for double pulse generation.

Remote command:

`[ :SOURce<hw> ] :PULM:DELay` on page 808

#### Double Pulse Delay

Sets the delay from the start of the first pulse to the start of the second pulse.

Remote command:

`[ :SOURce<hw> ] :PULM:DOUBle:DELay` on page 808

#### Pulse Output State

Activates the output of the pulse modulation signal.

Remote command:

`[ :SOURce<hw> ] :PGENerator:OUTPut [ :STATe ]` on page 1021

#### Output Polarity

Sets the polarity of the pulse output signal.

Remote command:

`[ :SOURce<hw> ] :PGENerator:OUTPut:POLarity` on page 1020

#### Trigger Mode

Selects between continuous triggering or triggering initiated by a trigger event from an external signal.

"Auto" generates the modulation signal continuously.

"Ext Triggered" generates the signal each time an external trigger event occurs.

"Ext Single" generates the signal triggered by an external trigger event.

"Ext Gated" generates the signal triggered by an external gate signal.

Remote command:

`[ :SOURce<hw> ] :PULM:TRIGger:MODE` on page 810

### 8.8.3.7 Pulse Graph

The pulse graph is the graphical representation of the current pulse signal.

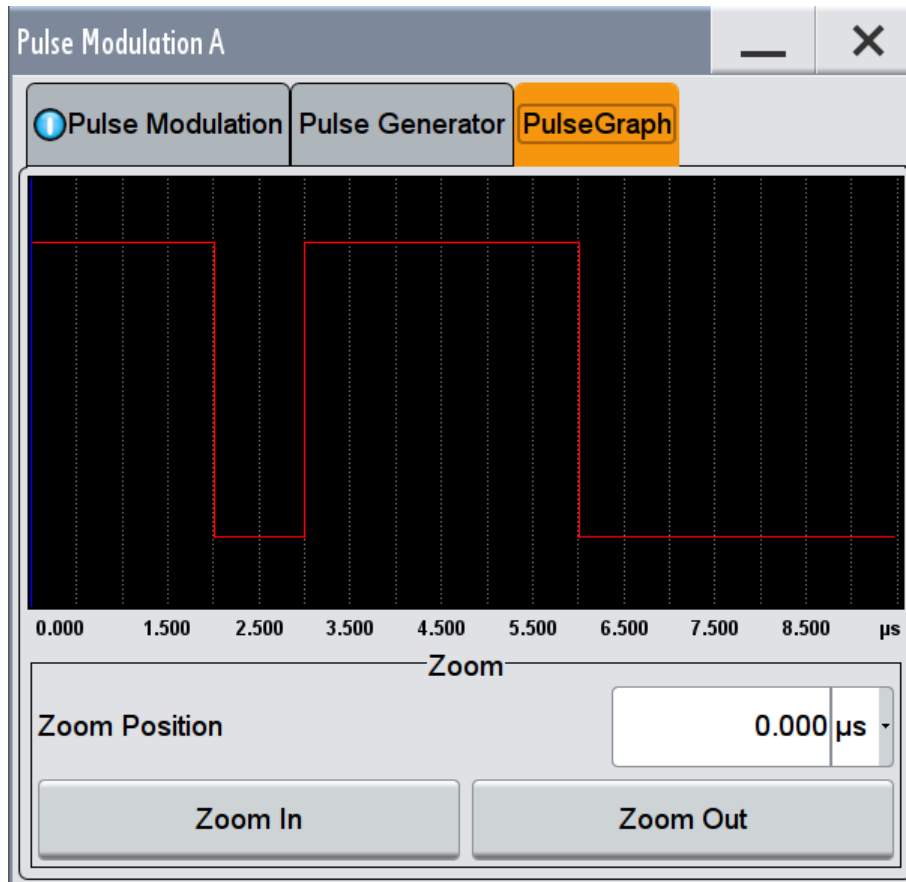


Figure 8-26: Pulse Graph

The height of the bars corresponds to the selected amplitude of the pulse signal.

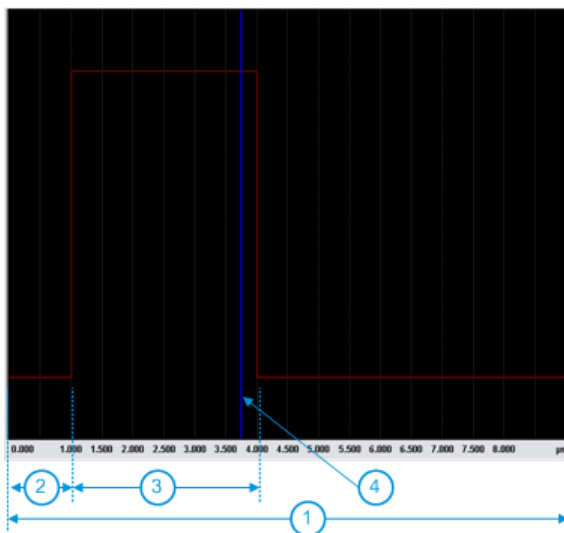
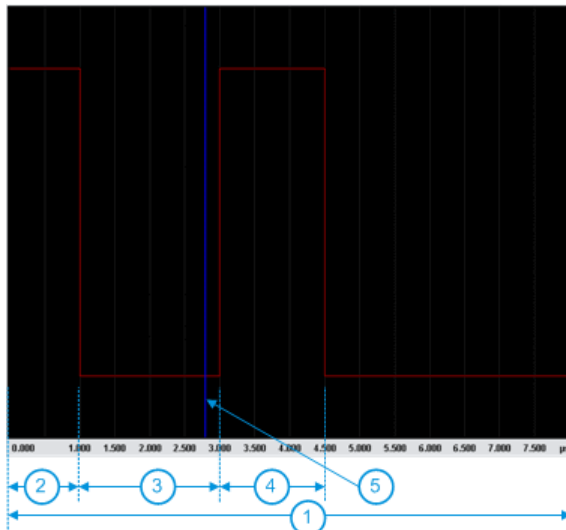


Figure 8-27: Pulse Graph - single pulse

- 1 = Pulse Period
- 2 = Pulse Delay
- 3 = Pulse Width
- 4 = Pulse Zoom Position



**Figure 8-28: Pulse Graph - double pulse**

- 1 = Pulse Period
- 2 = Pulse Width
- 3 = Double Pulse Delay
- 4 = Double Pulse Width
- 5 = Pulse Zoom Position

### 8.8.4 How to Generate an Amplitude Modulated Signal

Using the internal LF generator, let us generate an amplitude modulated signal with the following characteristics:

- RF signal in path A: 2 GHz frequency, -25 dBm level
- LF generator as modulation source, 20 kHz frequency, sine shape
- Continuously triggered
- 60% AM depth

The example shows how to perform the settings right on the screen, such as the frequency or level. Alternatively, you can also enter the values in the corresponding dialogs.

► Now perform the following steps:

Start from an initial state, and set and frequency and level of the RF signal.

1. Press PRESET to start from a defined state.  
The function presets the signal generator.
2. Select "Frequency" of path A in the status bar and enter *2.0 GHz*.



3. Similarly select "Level" and enter *-20 dBm*.

Set the modulation signal:

1. Start in the "RF A" block and select "Analog Modulation > Modulation Source".  
The "Sources" tab in the combined modulation dialog opens.
2. Select "Shape > Sine".
3. Set "Frequency" to *20 kHz*.  
The signal "Period" is calculated automatically and indicates: *"50.00 µs"*.
4. Select "Trigger Mode > Auto".

Configure the amplitude modulation settings:

1. Switch to the "AM" tab.
  2. Set "Depth" to *30%*
  3. Select "Source > LF Generator1"  
The amplitude modulated RF signal is configured.
- ▶ Activate "State" to enable signal output.

### 8.8.5 How to Generate a Pulse Modulated Signal

Using the internal pulse generator we generate a pulse modulated signal with the following settings:

- RF signal in path A: *4 GHz* frequency, *-20 dBm* level
  - Pulse generator as modulation source
  - Double pulse mode
  - Pulse period *10 µs*
  - Pulse width *2.0 µs*
  - Double pulse width *1.2 µs*
  - Double pulse delay *4.5 µs*
  - Continuously triggered
- ▶ Perform the following steps:

Start from an initial state, and set the frequency and level of the RF signal:

1. Press PRESET to start from a defined state.  
The function presets the signal generator.
2. In the status bar, select "Frequency" and enter *4.0 GHz*.
3. Select "Level" and enter *-25 dBm*.

Configure the pulse modulation settings:

1. Start in the "RF A" block and select "Analog Modulation > Pulse Modulation".  
The "Pulse Modulation " dialog opens.
2. Set "Trigger Mode > Auto".

Configure the pulse generator settings, and check it in the graphical representation:

1. Switch to the "Pulse Generator" tab.
2. Select "Pulse Mode > Double".
3. Set "Pulse Period" to  $10.0 \mu\text{s}$ .
4. Set "Pulse Width" to  $2.0 \mu\text{s}$ .
5. Set "Double Pulse Width" to  $1.2 \mu\text{s}$ .
6. Set "Double Pulse Delay" to  $4.5 \mu\text{s}$ .

The pulse modulated RF signal is configured.

1. Switch to the "Pulse Modulation" tab.
2. Activate "State" to enable signal output.
3. Switch to the "Pulse Graph" tab to look at the graph of the configured double pulse signal.

## 8.8.6 References

### 8.8.6.1 Simultaneous Operation of Several Modulations

The table shows the modulations and operating modes that can be activated simultaneously (+) or which deactivate each other (-).



To perform for example I/Q modulation and an analog frequency or phase modulation in one path simultaneously, option R&S SMW-B13T must be installed.

	AM	FM	$\Phi$ M	Pulse	I/Q	DM	ARB
Amplitude modulation (AM)	/	+	+	+	-	-	-
Frequency modulation (FM)	+	/	-	+	+	+	+
Phase modulation ( $\Phi$ M)	+	-	/	+	+	+	+
Pulse modulation	+	+	+	/	+	+	+
Vector modulation (I/Q)	-	+	+	+	/	-	-

	AM	FM	$\Phi$ M	Pulse	I/Q	DM	ARB
Digital modulation (DM)	-	+	+	+	-	/	-
ARB	-	+	+	+	-	-	/

## 8.9 Advanced Configuration Tasks for Performance Improving

### 8.9.1 Attenuator

The R&S SMW is equipped with an electronic step attenuator unit that supports RF interruption-free level setting.

#### 8.9.1.1 About

The attenuator is an electronic component which enables you to vary the amplitude of the RF signal. Basically, it is characterized by low VSWR up to 6 GHz over the full level range.

According to the requirements of your application, you can e.g. compensate the loss of a cable connection by a higher output power, or, vice versa, set a low output power, to test the behavior of a DUT under low signal to noise conditions.

Apart from the standard operation mode (Auto), in which the generator adjusts the attenuation of the RF output signal automatically, you can also set a fix attenuation value, to obtain uninterrupted level settings, i.e. a constant VSWR (Voltage Standing Wave Ratio).

If you turn the signal off and on again, you can maintain the constant VSWR by setting the parameter "RF Off Mode > Unchanged".

If highest level accuracy is required, enter the target level value in "Fixed" mode, and activate ALC (Automatic Level Control), see [Chapter 8.9.2, "ALC - Automatic Level Control"](#), on page 501). In this operating mode, the generator adjusts the output level whenever the frequency or level setting changes.

For noise sensitive applications, the parameter "RF Off > Full Attenuation" sets maximum attenuation and thus suppresses noise when you turn off the RF signal.



#### Interactions and characteristics

Note that the spectral purity of the RF output signal decreases with high attenuation. Fixed mode is effective when automatic level control is activated ("ALC State = On"), see [State](#).

### Reverse Power Protection

The R&S SMW is equipped against overloading by an external signal applied to the RF output.

The reverse power protection is tripped when the power of the external signal becomes too high. A relay opens and interrupts the internal connection to the RF output. This condition is indicated in the display header by the "OVERLOAD" status message.

### Overload

If an "Overload" status message is indicated in the display header, reset the overload protection by pressing the RF ON/OFF key.

The RF input is activated when the overload protection is reset.

Remote command:

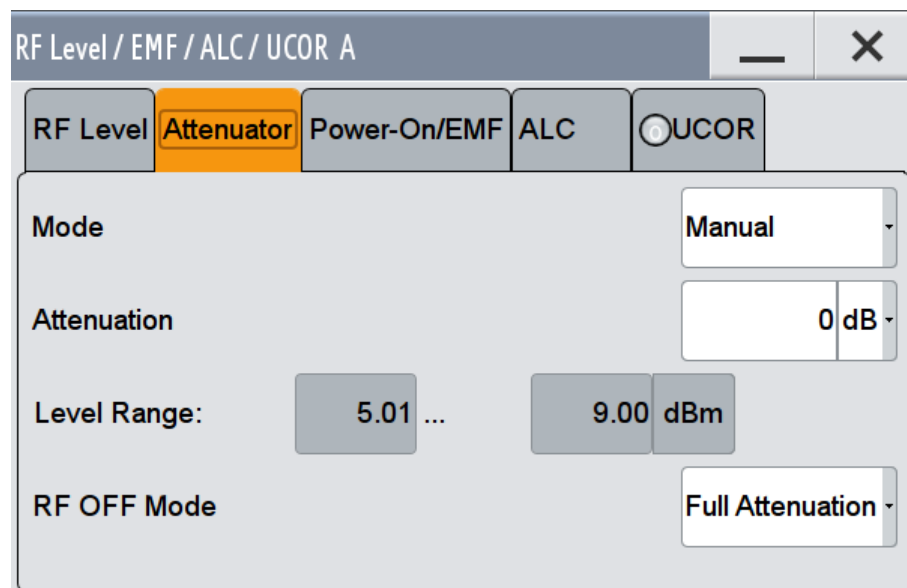
:OUTPut<hw>:PROTection:TRIPped? on page 755

:OUTPut<hw>:PROTection:CLEar on page 755

:OUTPut<hw>:PROTection:STAtE on page 755

#### 8.9.1.2 Attenuator Settings

- To access the settings dialog, select "RF > RF Level > Attenuator".



In the "Attenuator" tab of the combined "RF Level / EMF / ALC ..." dialog, you can select the operating mode of the electronic attenuator, the instrument is equipped with.

The remote commands required to define these settings are described in [Chapter 13.15, "OUTPut Subsystem"](#), on page 752, and [Chapter 13.18.15, "SOURce:POWer Subsystem"](#), on page 1022.

**Mode**

Determines the operating mode of the attenuator at the RF output.

- "Auto" Adjusts the level settings within the full variation range automatically.
- "Fixed" Fixes the attenuator, relays and amplifier stages at the current position.  
This mode provides signal output without level interruption. The resulting variation range is calculated and indicated. This mode is coupled with ALC, and therefore only effective when ALC is enabled.
- "Manual" Allows you to set the attenuation, see [Attenuation](#).  
The user-specified nominal attenuation is useful for instruments equipped with a mechanical step attenuator.  
Similar to "Fixed" mode, relays and amplifier stages keep the specified value, providing interruption-free signal output level.

Remote command:

`:OUTPut<hw>:AMODE` on page 753

**Attenuation**

Sets the nominal attenuation of the RF signal in "Manual" mode, see [Mode](#).

Remote command:

`[ :SOURce ] :POWer:ATTenuation` on page 1025

**Level Range**

Shows the interruption-free range of the level that you can use in the currently selected mode.

Remote command:

`:OUTPut<hw>:AFIXed:RANGe:LOWer?` on page 754

`:OUTPut<hw>:AFIXed:RANGe:UPPer?` on page 754

**RF OFF Mode**

Determines the state of the attenuator, when the RF signal is switched off.

- "Unchanged" Freezes the setting of the attenuator.  
This setting is recommended if a constant VSWR (**V**oltage **S**tanding **W**ave **R**atio) is required.
- "Full Attenuation"  
Switches to the maximum attenuation.  
This setting is recommended for applications that require a high level of noise suppression.

Remote command:

`[ :SOURce<hw> ] :POWer:ATTenuation:RFOff:MODE` on page 1026

**8.9.2 ALC - Automatic Level Control**

The R&S SMW is equipped with an automatic level control unit to obtain best RF level accuracy.

**Automatic Level Control (ALC)** is an adaptive control system to stabilize the RF output level. It continuously monitors the current level and adjusts it to keep a steady state over temperature and time.



ALC is active in almost all applications by default. However, the **Pulse Modulation** mode excludes ALC, as the control loop would detect incorrect values and result in level deviations.

Also note that ALC may detect incorrect values in **multi-transmitter** test setups. If multiple generators are coupled, reverse power may affect the ALC readings. Based on incorrect values, ALC would have an impact on the signal to intermodulation ratio.

### ALC States and their Effects

The following description basically explains the ALC states and their principle of operation:

- **AUTO**  
Adjusts the output level to the operating conditions automatically. ALC is active in almost all operating modes.
- **On**  
Activates the internal level control permanently, regardless of the operating conditions. This setting provides the highest level accuracy.  
If you also set "Attenuator Mode > Fixed", the instrument recalibrates every level and frequency setting, resulting in high-level accuracy.
- **Off (Sample & Hold)**  
Deactivates ALC, but still allows you to maintain a constant output level. The R&S SMW switches briefly in the CW mode and enables ALC to adjust the level to the set target value. The instrument freezes this setting, turns off ALC again, and switches back to the operating mode.
- **"Sample & On"**  
Initially the level control circuit uses a sample process to settle to the current level. When settled, it continues level control with highest level accuracy.
- **"Off (Table)"**  
Deactivates internal level control. The instrument recalibrates every level and frequency setting using the attenuation values from the internal (ALC) table. Level attenuation between two table values is done with linear interpolation. This mode enables you to perform a strictly monotone, but not quite as precise level adjustment.  
This mode achieves fastest setting times, since the output signal is not interrupted by the measurement, and also not disturbed.
- **"Table & On"**  
Starts with the associated value of the internal level table and then activates the automatic level control. This mode achieves maximum level accuracy and fast setting times. It is recommended if in CW mode the signal/intermodulation ratio is to be improved for multi-transmitter measurements.

The R&S SMW displays the level control setting as a status message in the info line.

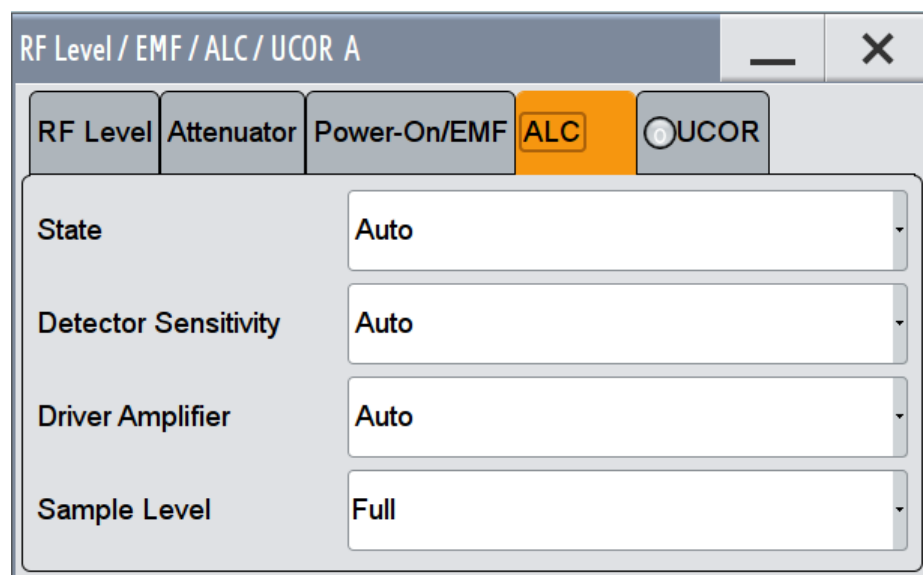
### 8.9.2.1 Required Options

The equipment layout for automatic level control includes per signal path

- Option Frequency (R&S SMW-B10x)

### 8.9.2.2 ALC Settings

- ▶ To access the settings dialog, select "RF > RF Level > Automatic Level Control".



In the "ALC" tab of the combined "RF Level / EMF / ALC ..." dialog, you can configure the settings for the automatic level control of the RF signal to achieve optimal accuracy.

The remote commands required to define these settings are described in [Chapter 13.18.15, "SOURCE:POWER Subsystem"](#), on page 1022.

#### State

Selects the internal level control mode.

Find further details about the individual settings in ["ALC States and their Effects"](#) on page 502. It covers an overview of the functionality and indicates what is to be considered.

"Auto" Selects the most appropriate ALC mode automatically.

"On" Activates ALC permanently.

"Off (Sample & Hold)"

Deactivates the ALC, but allows you to recalibrate the level at each frequency and level change. The value remains up to the next change.

"Sample & On" Starts the internal level control with the first change.

- "Off (Table)" Controls the level using the attenuation values of the internal ALC table.
- "Table & On" Starts with the attenuation setting from the table and continues with automatic level control.

Remote command:

`[ :SOURce<hw> ] :POWer:ALC [ :STATe ]` on page 1025

### Detector Sensitivity

Determines the path of the internal level detector.

The level detector of the ALC has three paths distinguished by their sensitivity.

- "Auto" Selects the detector sensitivity automatically, according to the given level.  
This mode is the recommended operation mode.
- "Low" Selects the detector path with low sensitivity.  
This setting is intended for signals with high internal electronic levels.
- "Med" Selects the path with medium sensitivity.  
This setting corresponds to normal mode. It is intended for signals with medium internal electronic levels.
- "High" Selects the detector path with high sensitivity, intended for signals with low internal electronic levels.
- "Fix" Fixes the last set sensitivity setting.

Remote command:

`[ :SOURce<hw> ] :POWer:ALC:DSEnSitivity` on page 1023

### Driver Amplifier

Selects the switching state of the driver amplifier, that means the switchable amplifier or attenuator at the output.

- "Auto" Switches the attenuator automatically.
- "On""Off" The driver amplifier is switched on, or off respectively.
- "On (maximum Gain)" The driver amplifier is switched on.  
The R&S SMW supplies the maximum level at the output within the frequency range 6 GHz to 10 GHz.  
"Note:" In this mode, the harmonics increase.
- "Fix" Fixes the last setting.  
The [Readjust](#) button switches the driver amplifier state first on automatic, calculates all level settings and then resets to fix.

Remote command:

`[ :SOURce<hw> ] :POWer:ALC:DAMPlifier` on page 1023

### Sample Level

Determines the level at the output of the instrument during the sample process.

- "Full" Provides the currently set level.
- "Attenuated" Attenuates the signal for about 40 dB to protect external devices like the DUT from damage due to high input power.



"Minimum" Attenuates the signal level with the maximum value.

Remote command:

[ :SOURce<hw> ] :POWer:ALC:SLEVel on page 1024

### 8.9.3 User Correction

The R&S SMW supports a correction function to compensate external losses, as for example caused by the RF cable, to achieve a precise target input level at the DUT.

#### 8.9.3.1 About

This section provides background information on the impact of the described settings.

**User correction** is a method that determines the external level loss over a frequency range in advance.

The difference between the generator output level and the level at the DUT determines the correction value at the respective frequency. Alternatively, the attenuation characteristics over a certain frequency range of e.g. an RF cable are also specified in the association data sheet.

During **signal generation**, the generator adds the correction value internally and thus increases the output level by exactly the amount of the loss between its output and the DUT. With frequencies which are not contained in the list, the level correction is determined by interpolation of the closest correction values.

**User correction values** are stored in a data list. To create a list, you can use the internal "List Editor", see [Chapter 8.7.7, "List Editor"](#), on page 464, or create it externally and import it.

The **internal editor** provides a table with columns for frequency and power values which you can fill manually or automatically.

To **automatically fill** the table, you can use:

- The **Fill** function, which linearly interpolates the values for each column, based on the value range and step size. For handling and possibilities to fill the data table, see ["Fill Data Table Automatically"](#) on page 466
- The **Fill with Sensor** function, that acquires the real frequency response characteristics of the used component by means of an R&S NRP power sensor, see [Chapter 8.9.3.4, "Fill with Sensor"](#), on page 511.  
The sensor measures the power values for the given frequency, and returns the value to the signal generator. The difference to the target value is automatically filled in the correction value table.

**Note:**

It is important that you measure the level directly at the input of the DUT. The correction values can be acquired any time irrespective of the modulation settings of the generator.



### Advanced features when working with R&S NRP power sensors

With the features and internal correction functions of an R&S NRP power sensor, you can additionally increase the accuracy and optimize the RF level.

These are e.g.:

- **S-Parameter** to consider the impact of any two-port – e. g. an adapter – between the signal generator and the sensor input.

For more information, refer to the operating manual of the R&S Power Sensor.

If you create a list **externally**, you can use any program, preferably a spreadsheet software that supports \*.txt (ASCII) or \*.csv file format. The "Import" function converts the file to the list format and loads it into the instrument. Vice versa, you can also "Export" the user correction data into an ASCII file, see [Chapter 10.7, "Loading, Importing and Exporting Lists"](#), on page 590. To load a previously stored file, use the file manager

Each data list is stored in a file with selectable filename and the predefined file extension \*.ucor, see also [Chapter B.3, "Extensions for User Files"](#), on page 1142. For general file handling, see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590.



### Interactions and characteristics

If activated, **User Correction** is effective in all operating modes.

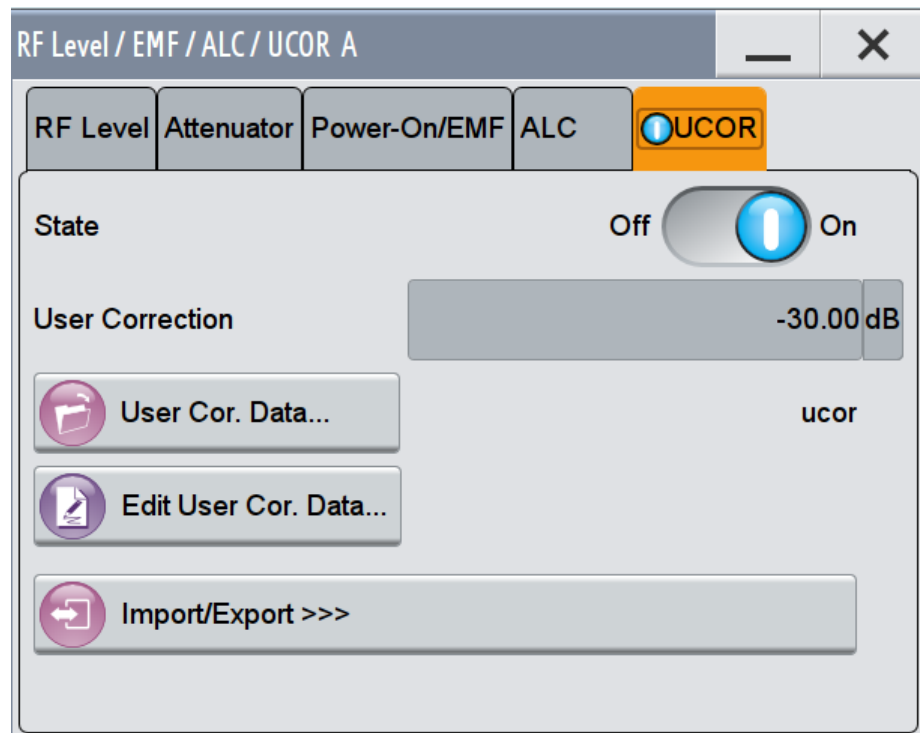
The R&S SMW displays "UCOR" as a status information next to the "Level" value in the status bar.

Note that the RF output level is the sum of both values:

"Level" + "UCOR" = Output level

#### 8.9.3.2 User Correction Settings

- ▶ To access the user correction settings dialog, select "RF A > RF Level > User Correction".



The "UCOR" tab of the combined "RF Level / EMF / ALC ..." dialog contains all settings for creating and handling data lists with user defined level correction values.

The remote commands required to define these settings are described in [Chapter 13.18.5, "SOURCE:CORREction Subsystem"](#), on page 956.

#### State

Activates user correction.

The R&S SMW displays a "UCOR" status message in the frequency and level display.

Remote command:

`[ :SOURCE<hw> ] :CORREction [ :STATe ]` on page 962

#### User Correction

Indicates the current value for level correction.

Remote command:

`[ :SOURCE<hw> ] :CORREction:VALue?` on page 961

#### User Cor. Data...

Opens a file dialog for loading or creating a user correction list file, and provides access to the file manager, see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590. You can see the currently loaded file next to the button.

You can either generate a data list internally in the data editor or externally.

- To select an existing list, select "Select List > navigate to the list file \*.uco > Select"
- Use the general editor function to create internally new data lists or to edit an existing one.

- Use the standard file manager function to load external data lists to the instrument.

Remote command:

[ :SOURce ] :CORRection:CSET:CATalog? on page 962

[ :SOURce<hw> ] :CORRection:CSET [ :SElect ] on page 961

[ :SOURce ] :CORRection:CSET:DElete on page 962

### Edit User Cor. Data...

Opens an editor to insert and save data lists with RF frequency and power value pairs.

See also:

- [Chapter 8.7.7, "List Editor"](#), on page 464
- ["Fill Data Table Automatically"](#) on page 466

You can also acquire the correction values with R&S NRP-Zxx power sensors, see [Chapter 8.9.3.4, "Fill with Sensor"](#), on page 511.

### Import / Export

Expands the section in the dialog to transfer list mode data files, see [Chapter 8.7.8, "Import/Export List Files"](#), on page 467.

### 8.9.3.3 List Editor

The R&S SMW "User Correction" and "List Mode" dialogs provide a list editor for defining the frequency/level value pairs.

Since the table and navigation functions can be assumed to be known, the following description contains a brief overview, shown by the example of the "List Data Editor". If a function relates to a particular dialog, it is explicitly stated.

To access the "List Mode Data" or "User Correction Data" editor, select one of the following:

1. "RF > Sweep / List > List Mode > Edit List Mode Data"
2. "RF > RF Level > User Correction > Edit User Cor. Data"

	Frequency / Hz	Power / dBm	Dwell / s
1	6 000 000 000.000	-20.00	0.001 000
2	5 400 000 000.000	10.00	0.000 500
3	5 250 000 000.000	0.00	0.000 750
4	4 000 000 000.000	-15.00	0.002 000
5	4 700 000 000.000	-10.00	0.000 700
6			

	Frequency / Hz	Power / dB
1	1 000 000 000.00	24.78
2	1 500 000 000.00	36.99
3	2 000 000 000.00	31.82
4		

List Mode Data Editor

User Correction Data Editor

The dialogs contain a table for entering the RF frequency and power-value pairs, and the associated navigation functions. The "Edit List Mode Data" dialog also provides a column for entering variable dwell times.



A data table requires that you complete a line. Rows with missing values are ignored and not stored. Values of incomplete rows get lost.

In this regard, note the following for **List Mode**, when using the global dwell time:

- The instrument uses the value set with [Global Dwell Time](#) for all list steps.
- However, to store the data list, you must fill the "Dwell Time" column according to the number of frequency and power value pairs, although the values are not used for generating the signal.

**Tip:** Use the [Fill Data Table Automatically](#) function to fill the dwell time column.

### Edit List Mode Data

Provides the parameter value pairs.

For details on editing and storing list files, see [Data handling keys](#). For handling and possibilities to fill the data table see "[Fill Data Table Automatically](#)" on page 466.

"Frequency /Hz"

Sets the frequency values.

"Power /dBm"

Sets the level values.

"Dwell /s"

In list mode, sets the dwell time values.

Remote command:

[\[:SOURce<hw>\]:LIST:FREQuency](#) on page 1009

[\[:SOURce<hw>\]:LIST:POWer](#) on page 1011

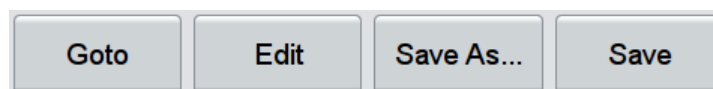
[\[:SOURce<hw>\]:LIST:DWELL:LIST](#) on page 1009

[\[:SOURce<hw>\]:CORRection:CSET:DATA:FREQuency](#) on page 960

[\[:SOURce<hw>\]:CORRection:CSET:DATA:POWer](#) on page 960

### Data handling keys

Contain basic editing functions.



The following description assumes that the various functions are largely known and self-explanatory. Therefore, just a brief overview of the available options is given.

**Note:** Save a list only after filling both columns (frequency and level), otherwise the entries are lost.

#### **Goto** ← Data handling keys

Selects a row for editing.

#### **Edit** ← Data handling keys

Enables you to insert, or delete a row or ranges within a list, and provides access to a dialog for automatic filling.

**Fill with Sensor ← Data handling keys**

Opens a dialog to configure the settings for automatic filling of user correction data with an R&S NRP-Zxx power sensor, see [Chapter 8.9.3.4, "Fill with Sensor"](#), on page 511. This key is visible only in UCOR mode.

**Save As... / Save ← Data handling keys**

Stores the list in a file. To save a copy, or a new file, use the "Save as" command to assign a file name.

**Fill Data Table Automatically**

Describes all parameters for filling a table automatically with user-defined values.

*Figure 8-29: Fill table dialog*

Since the settings are interdependent, the affected parameters change accordingly if you set a value.

To fill the table, press the "Fill" button.

**Note:** Save a list only after filling all columns and rows, otherwise the entries are lost.

"From / Range"

Defines the start line and number of the row to be filled.

"Select Column to Fill"

Selects the respective value, including the unit.

"Start / End Value"

Provides the default values corresponding to the selected column.

"Increment"

Determines the step size.

### 8.9.3.4 Fill with Sensor

- ▶ To access this dialog, select "Fill With Sensor" in the corresponding dialog.

Fill User Correction Data With Sensor

Sensor: 1 - NRP-Z51 SN 101426

List To Fill: /var/user/ucor

Include Zeroing:  On

Execute

Used SMW Settings For Measurement

RF Source: A

Modulation: Off (CW)

Amplitude: -20.00 dBm

Use SParameter: Off

Attenuator Mode Path 1: Auto

Fixed Range (PEP) In: 4.25 ... 9.46 dBm

Figure 8-30: Fill data with sensor dialog

This dialog describes all parameters for filling a table automatically with sensor readings.



Since the settings are interdependent, the affected parameters change accordingly if you set a value.

To fill the table, press the "Execute" button.

To select the sensor and determine its parameters, refer to [Chapter 8.9.4.1, "NRP-Z Power Viewer"](#), on page 515.

**Fill User Correction Data with Sensor**

- "Sensor"  
Displays connected sensors for selection.
- "List To Fill"  
Indicates the used list.
- "Include Zeroing"  
Performs a zeroing procedure before acquiring the user correction data to improve precision. Since during zeroing no signal may be applied to the sensor, RF is temporarily switched off at the generator.  
When unchecked, the zeroing procedure is skipped. However, the RF signal level might be blanked shortly. This setting is recommended if blanking of RF is undesirable or the absence of power at the sensor can not be guaranteed.
- "Execute"

The "Execute" button is only enabled if a sensor is detected and the user correction list contains at least one frequency value.

Remote command:

`[ :SOURce<hw> ] :CORRection:ZERoing:STATe` on page 962

`[ :SOURce<hw> ] :CORRection:CSET:DATA [ :SENSor<ch> ] [ :POWer ] :SONCe`  
on page 961

**Used SMW Settings For Measurement**

Displays the settings relevant for the measurement.

- |                             |   |
|-----------------------------|---|
| "RF Source"                 | Shows the path for which the correction menu settings are made. |
| "Modulation"                | Indicates the modulation state                                  |
| "Amplitude"                 | Shows the currently set level.                                  |
| "Use SPa-<br>ra-<br>meter"  | Indicates whether SParameter correction is used.                |
| "Attenuator<br>Mode Path 1" | Displays the selected mode of the attenuator.                   |
| "Level range"               | Shows the level range.  |

Remote command:

n.a.

**8.9.3.5 Import/Export List Files**

- ▶ To access this dialog section, select "Import / Export >>>" in the corresponding dialog.



<p><b>Mode</b> Import</p> <p><b>ASCII File Settings</b></p> <p><b>Extension</b> TXT</p> <p><b>Decimal Point</b> Point</p> <p><b>Column Separator</b> Comma</p> <p>Select ASCII Source None</p> <p>Select Destination None</p> <p>Import</p>	<p><b>Import / Export UCOR Files</b></p> <p><b>Mode</b> Import</p> <p><b>ASCII File Settings</b></p> <p><b>Extension</b> TXT</p> <p><b>Decimal Point</b> Point</p> <p><b>Column Separator</b> Comma</p> <p>Select ASCII Source None</p> <p>Select Destination None</p> <p>Import</p>
<i>Import / Export List Mode Data</i>	<i>Import / Export UCOR Data</i>

The "Import / Export" section contains all functions and settings to import externally created list data, or to export it accordingly. You can process and store a list in the formats \*.txt (ASCII), or \*.csv (plain text with identical sequence of fields). The table separators and the decimal floating point numbers are customizable.

### Mode

Selects import or export of a data list file. The provided parameters vary according to the selected mode.

Remote command:

[\[:SOURCE<hw>\]:LIST:DEXChange:MODE](#) on page 1018

[\[:SOURCE<hw>\]:CORrection:DEXChange:MODE](#) on page 966

### ASCII File Settings

Defines the format and the separators of the associated data file.

"Extension" Selects \*.csv or \*.txt format.

"Decimal Point" Sets "Point" (dot) or "Comma" as the decimal separator used in the ASCII data with floating-point numerals.

"Column Separator" Sets the separator between the columns in an ASCII table. You can use a "Tab", "Semicolon", "Comma" or "Space" to separate the values in your table.

Remote command:

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:EXTension](#) on page 1016

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:SEParator:DECimal](#) on page 1017

[\[:SOURCE<hw>\]:LIST:DEXChange:AFIle:SEParator:COLumn](#) on page 1017

[\[:SOURCE<hw>\]:CORrection:DEXChange:AFIle:EXTension](#) on page 965

[\[:SOURce<hw>\]:CORRection:DEXChange:AFILe:SEParator:DECimal](#)  
on page 966

[\[:SOURce<hw>\]:CORRection:DEXChange:AFILe:SEParator:COLumn](#)  
on page 966

#### Select ASCII Source / Destination

Opens a file manager dialog to select directory and path for import (source) or export (destination) of the ASCII file.

Remote command:

[\[:SOURce<hw>\]:LIST:DEXChange:AFILe:CATalog?](#) on page 1016

[\[:SOURce<hw>\]:LIST:DEXChange:AFILe:SElect](#) on page 1017

[\[:SOURce<hw>\]:CORRection:DEXChange:AFILe:CATalog?](#) on page 965

[\[:SOURce<hw>\]:CORRection:DEXChange:AFILe:SElect](#) on page 965

#### Select Source / Destination

Opens a file manager dialog to select directory and path for import (source) or export (destination) of the data list.

Remote command:

[\[:SOURce<hw>\]:LIST:DEXChange:SElect](#) on page 1018

[\[:SOURce<hw>\]:CORRection:DEXChange:SElect](#) on page 967

#### Import / Export

Imports or exports the selected data list file, according to the set mode.

Remote command:

[\[:SOURce<hw>\]:LIST:DEXChange:EXECute](#) on page 1016

[\[:SOURce<hw>\]:CORRection:DEXChange:EXECute](#) on page 966

## 8.9.4 Using Power Sensors

The R&S SMW works with R&S Power Sensors and thus supports various applications tasks for improving the RF signal level. For example, you can determine attenuation characteristics of downstream equipment or cables, and then compensate the losses, either with internal control functions or with an external control circuit, which compensates in real time.

Sensors of the R&S NRP-Z series are highly accurate standalone measuring instruments, suitable for a wide range of applications. They communicate directly with the signal generator, calculate the average or peak power internally, include S-parameter correction and return the results to the generator.

The R&S SMW works with any sensor of the R&S NRP-Zx series, that is connected via USB interface. Up to four sensors can be operated at a time.

You can perform the following functions when working with power sensors:

- [Chapter 8.9.4.1, "NRP-Z Power Viewer"](#), on page 515  
A function for measuring or monitoring either the RF output power, or a freely selectable signal source.
- [Chapter 8.9.4.2, "NRP-Z Info Update"](#), on page 522

Provides direct access to update the sensor firmware.



It is recommended that you regularly check the current state of the firmware when using an R&S NRP-Z power sensor and, where appropriate, perform an update.

#### 8.9.4.1 NRP-Z Power Viewer

The R&S SMW features the power viewer function for measuring or monitoring either the RF output power, or a freely selectable signal source with R&S NRP-Z power sensors.

The instrument is able to perform up to 4 power measurements simultaneously. You can either directly connect a power sensor at the provided SENSOR connector, or via USB, using a suitable adapter cable (R&S NRP-Z3 or R&S NRP-Z4).

For assignment of the external signals and the provided connectors, see [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618.



#### Using the R&S NRP-Z5 Sensor Hub

The R&S NRP-Z5 USB Sensor Hub (high-speed USB 2.0) can host up to 4 R&S NRP-Z sensors and provides simultaneous internal and external triggering of all connected sensors.

You can directly connect the R&S NRP-Z Sensors to the standard NRP sensor connectors of the hub. The hub is connected to the R&S instrument either with the R&S NRP-Z2 extension cable, or via USB with the adapter cable R&S NRP-Z4.

When you connect your power sensor via the R&S NRP-Z5 USB sensor hub, each channel of the hub is firmly assigned to the associated sensor channel in the generator.

See also the R&S website <http://www.rohde-schwarz.com> in section "Power Meters & Voltmeters > R&S NRP-Z Sensors" for information on the sensor hub and the available accessories.

The R&S SMW automatically detects a connected R&S NRP-Z power sensor and indicates it in the "NRP-Z Power Viewer" dialog. A sensor connected at the SENSOR socket is always assigned as "Sensor 1". If no sensor is connected to this socket, channel 1 remains not assigned. Sensors 2...4 are assigned to the sensors at the USB connectors, according to their sequence of connection, see [NRP-Z Power Viewer Settings](#). In addition, you find specific information on the connected sensor under [Chapter 8.9.4.2, "NRP-Z Info Update"](#), on page 522.

A sensor measures the average signal power of the selected source continuously. The signal generator shows the result in the [NRP-Z Power Viewer Settings](#) dialog, but you can also permanently display the readings in the task bar (display).

For detailed information on the scope of your R&S NRP-Z power sensor refer to its manual.

## Zeroing

Activates the auto zero function.

Zeroing calibrates the external power sensor by adjusting its reading at zero signal power. For this purpose, the RF power source must be switched off or disconnected from the sensor (see tips below). R&S power sensors automatically detect the presence of any significant input power. This aborts zeroing and generates an error message. Zeroing can take a few seconds, depending on the sensor model; refer to the documentation of your external power sensor for more information.

### Tips for zeroing

Zeroing should be performed:

- During warm-up after switching on or connecting the instrument
- After a substantial change of the ambient temperature
- After fastening the power sensor module to an RF connector at high temperature
- After several hours of operation
- When very low-power signals are to be measured, e.g. less than 10 dB above the lower measurement limit.
- Switch off the RF power source for zeroing; do not disconnect it from the power sensor. In this way you will maintain the thermal equilibrium, and zeroing will also compensate for the noise superimposed on the measured signal (e.g. from a broadband amplifier).

## Filter

The power viewer function includes an averaging filter used to reduce fluctuations of the measurement result to the desired extent. Such fluctuations can be caused by inherent noise of the measuring instrument, modulation of the measurement signal or influences from the superposition of adjacent carriers. A more stable display must be maintained with longer measurements. The measurement result is obtained by a two-step averaging process.

The relative noise content is defined as the magnitude in dB of the level variation caused by the inherent noise of the sensor (two standard deviations).

Since the filter length is the multiplier for the time window, it directly influences the measurement time.



*Longer measurements* do not mean that it takes longer to display a new result, but rather that it takes longer for the result to settle when the power changes.

Measurements are continuously repeated in a predefined time window. The measurement result is obtained by averaging the measured values for the last  $2N$  time windows. The number  $N$  is the filter length, the factor of 2 arises because the output signals from the microwave detector to suppress low-frequency noise are chopped at the same rate as the time windows, which means that an independent measured value can only be obtained from two consecutive values.

The filter length can be selected automatically or it can be manually set to a fixed value. As a prerequisite, always check if the auto mode is giving satisfactory results because you always have to adjust an optimal, manual filter-length setting if the power is not constant.



- The "Auto Once" button can be used to search for the optimum filter length for the current measurement conditions. The found filter length is indicated in the field to the right.
- Selection "Fixed Noise" is offered for reaching defined measurement accuracy.
- The time window varies depending on the used sensor. For most sensors, it is fixed to 20 ms. For the R&S NRP-Z81 sensor, it is 10  $\mu$ s. Therefore, the user filter length for the R&S NRP-Z81 has to be about 1000 times larger than the filter length for other sensors to achieve the same filtering result.



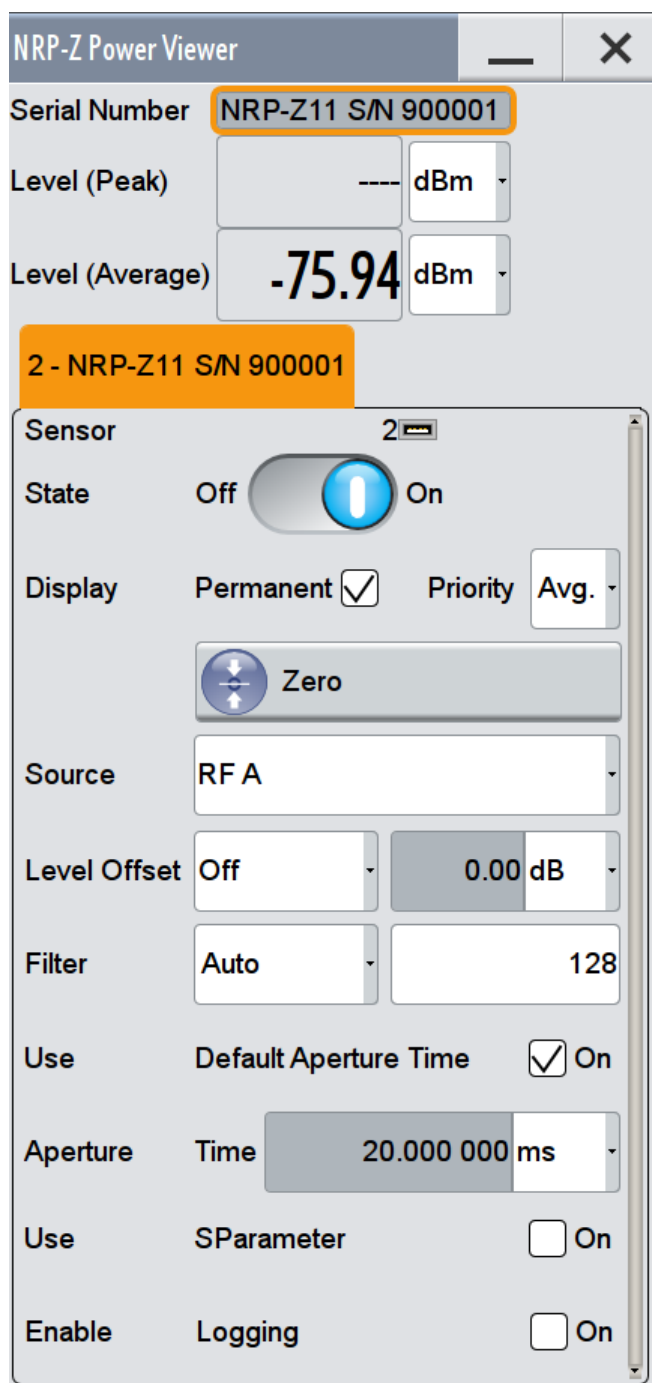
Further functions of the R&S SMW related to R&S NRP-Z power sensors are:

- Acquisition of level correction data, see [Chapter 8.9.3, "User Correction"](#), on page 505.
- The software version of the connected power sensor can be retrieved with the remote control command `:SENSe<ch>[:POWER]:TYPE?` on page 764. Use the [Chapter 8.9.4.2, "NRP-Z Info Update"](#), on page 522 dialog to update the sensor software.

---

### NRP-Z Power Viewer Settings

- ▶ To access this dialog, select "RF > RF Measurement > NRP-Z Power Viewer".



The dialog contains all parameters for configuring the sensor settings, like average or peak display, reference source, filter and level offset. It automatically displays a separate tab per detected sensor, see [NRP-Z Power Viewer Settings](#).

The remote commands required to define these settings are described in [Chapter 13.16, "SENSe, READ and INITiate Subsystems"](#), on page 755, including the triggering of the measurement and the retrieval of measurement results.



The local state is set with the `INIT` command. Switching off the local state enhances the measurement performance. In remote control, the sensor parameters are set with the `SENSe` commands. To trigger the remote measurement, use the `READ` query which also provides the measurement results. The state is not influenced by these commands, measurements results can be retrieved in local state on or off.

### Serial Number

Indicates the type and the serial number of a connected R&S NRP-Z power sensor. The values listed below belong to the respective sensor.

Remote command:

`:SENSe<ch>[:POWer]:TYPE?` on page 764

`:SENSe<ch>[:POWer]:SNUMber?` on page 763

### Level (Peak) / Level (Average)

Indicates the measured level value, either peak or average, depending on the setting of [Priority](#). Additionally, you can select the unit for the results display: Watt, dBm or dBµV.

**Note:** Peak level measurement provides that the power sensor supports this feature.

Remote command:

`:READ<ch>[:POWer]?` on page 757

`:SENSe<ch>:UNIT[:POWer]` on page 757

### Sensor

Indicates the socket, the sensor is connected to.

### State

Activates level measurement.

Remote command:

`:INITiate<ch>[:POWer]:CONTinuous` on page 756

To query the availability of a sensor at a given connector, use the command :

`SENSe<ch>[:POWer]:STATus[:DEVIce]?` on page 763.

### Display

Sets the display mode for power readings.

#### Permanent ← Display

Activates the permanent indication of the power measurement result in the task bar of the display. The instrument shows the type of sensor, the corresponding connector, the measurement source and - if set - the offset.

You can activate the permanent display for several sensors.

Remote command:

`:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe` on page 759

#### Priority ← Display

Sets the display of results on mean or peak.

Remote command:

`:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority` on page 758

### Zero

Activates the auto zero function. For details, see ["Zeroing"](#) on page 516

Remote command:

`:SENSe<ch>[:POWer]:ZERO` on page 764

### Source

Selects the source for measurement, either an RF path of the instrument, or a freely selected signal.

- "RF" Assigns one of the RF signals (path A or B) of the R&S SMW. The sensor measures the power of the RF signal at the set frequency, considers the appropriate correction factor, and uses the level setting of the instrument as reference level. Changes in frequency are automatically routed to the sensor. You can also allocate two sensors in one path, e.g. for measuring the power before and after the DUT.
- "User" Selects any freely selectable signal source, e.g. for measurement of amplifier gain with 2 sensors. If selected, the instrument also displays a field for entering the frequency, see [Frequency](#).

Remote command:

`:SENSe<ch>[:POWer]:SOURce` on page 763

### Frequency

Defines the frequency value for a "User" RF signal.

Remote command:

`:SENSe<ch>[:POWer]:FREQuency` on page 762

### Level Offset

Activates and defines a level offset which is added to the measured value. This allows e.g. an attenuator in the signal path to be considered. The offset is always entered in dB, irrespective of the selected unit for result display.

Remote command:

`:SENSe<ch>[:POWer]:OFFSet` on page 762  
`:SENSe<ch>[:POWer]:OFFSet:STATe` on page 762

### Filter

Selects the filter length used for measurement. The filter length is the multiplier for the measurement time and thus directly influences it. See also ["Filter"](#) on page 516 for additional information.

- "Auto" The filter length is automatically selected and adjusted to the currently measured value. With high signals the filter length and therefore the measurement time can be short. With low signal levels the filter length and therefore the measurement time is increased to reduce noise. The used filter length is indicated in the field to the right, see [Filter Length](#).



- "User" The filter length is set manually.  
The filter length is entered in the entry window to the right, see [Filter Length](#). As the filter length works as a multiplier for the time window, this results in a constant measurement time. Values 1 and 2<sup>n</sup> are settable.
- "Fixed Noise" The averaging factor is selected so that the sensor's intrinsic noise (2 standard deviations) does not exceed the specified noise content.  
The desired noise content is entered in the entry field to the right, see [Noise Content](#).  
To avoid long settling times when the power is low, the averaging factor can be limited with the "Timeout" parameter.

Remote command:

`:SENSe<ch>[:POWer]:FILTer:TYPE` on page 761

### Filter Length

Indicates the used filter length for filter type "Auto" or "User", see [Filter](#).

Remote command:

`:SENSe<ch>[:POWer]:FILTer:LENGTh:AUTO?` on page 759

`:SENSe<ch>[:POWer]:FILTer:LENGTh[:USER]` on page 759

### Auto Once

Searches for the optimum filter length for the current measurement conditions and indicates the value in the [Filter](#) field above.

Remote command:

`:SENSe<ch>[:POWer]:FILTer:SONCe` on page 761

### Noise Content

Sets the noise content for filter type "Fixed Noise", see [Filter](#).

Remote command:

`:SENSe<ch>[:POWer]:FILTer:NSRatio` on page 760

### Timeout

Sets a time limit for the averaging process for filter type "Fixed Noise", see [Filter](#).

Remote command:

`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIME` on page 760

### Use Default Aperture Time

Enables you to specify a user-defined aperture time for the respective sensor.

The sensor default setting is sufficient. If however, the readings vary, it is recommended that you adjust the aperture time exactly to one modulation period, in order to obtain stable readings. To specify the aperture time, see [Aperture Time](#).

Remote command:

`:SENSe<ch>[:POWer]:APERTure:DEFAult:STATe` on page 758

### Aperture Time

Defines the acquisition time for the respective sensor, provided the entry field is enabled, see [Use Default Aperture Time](#).

For example, you can adjust the aperture time exactly to one signal period, in order to obtain a sufficient low average value.

Remote command:

`:SENSe<ch>[:POWer]:APERture:TIME` on page 758

#### Use SParameter - Power Sensors

Activates the use of the S-Parameter correction data of the connected power sensor. For sensors with attenuator this checkbox is automatically checked.

Refer to the manual of the connected R&S NRP-Zxx power sensor for a description of how to use the SParameter table.

Remote command:

`:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe` on page 758

#### Enable Logging

Activates recording of R&S NRP-Z power sensor readings.

If enabled, every value measured by a connected power sensor and indicated in the user interface, is written to a log file. Per measurement the function logs the measured value (2 readings when you work with peak sensors), the sensor type, and the measurement time (time stamp).

The function automatically creates the file name `SensLog<n>.txt` and stores the file in `*txt` format under `/var/user/temp/SensorLogging` on the hard disk. You can enable logging for each connected sensor separately. If enabled, one file per sensor is written.

**Note:** This specific function is intended for measurements with long time intervals, or if there is a risk that the connection to the sensor can be interrupted and you need the data for reconstruction.

The simplified recording function continuously writes the values in the file of the corresponding sensor number, like `Sens1Log.txt`. When you start a new measurement, the existing data is not overwritten, but added to the file.

If you use this function, it is recommended that you regularly remove the files from the hard disk, since they require storage capacity.

Remote command:

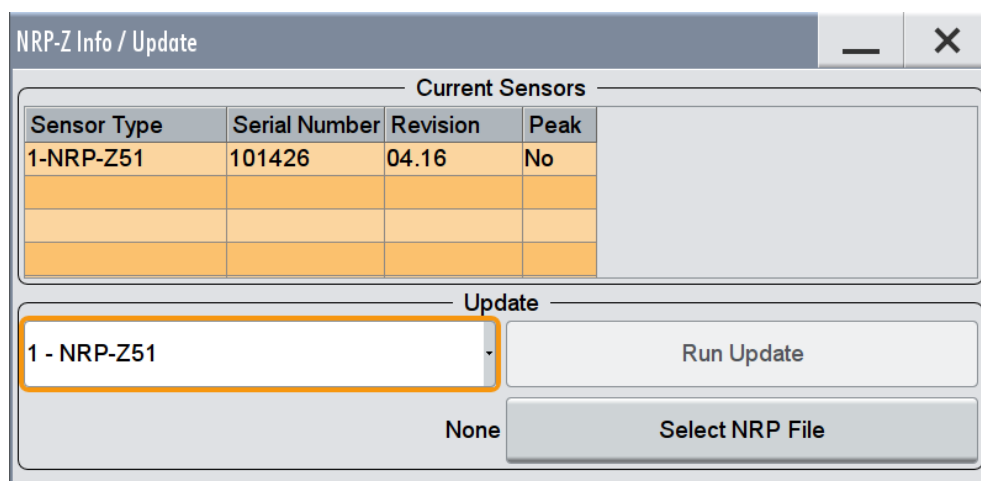
`:SENSe<ch>[:POWer]:LOGGing:STATe` on page 762

#### 8.9.4.2 NRP-Z Info Update

The "NRP-Z Info/Update..." dialog covers information on connected power sensors, like serial number, revision state and features of the particular sensor. You can directly update the sensor firmware.

##### NRP-Z Info Update Settings

- ▶ To access this dialog, select "System Config > Setup > Instrument Assembly > NRP-Z Info Update".



The "NRP-Z Info / Update" dialog indicates the connected R&S NRP-Z Power Sensors with specific information and contains the functions to update the firmware of a connected sensor.

The remote commands required to configure the display and keyboard are described in [Chapter 13.16, "SENSe, READ and INITiate Subsystems"](#), on page 755.

### Current Sensors

Shows the sensors that are connected to the generator with information on serial number, the revision state, and some characteristic features.

Remote command:

`:SENSe<ch>[:POWER]:TYPE?` on page 764

`:SENSe<ch>[:POWER]:SVERsion?` on page 764

`:SENSe<ch>[:POWER]:SNUMber?` on page 763

### Update

Provides all functions needed to run the sensor update.

**Note:** Before you start the update, you must download the required update file in advance. See [How To Update the Sensor Firmware](#) for information on how to proceed.

- Selection field  
Selects the sensor to be updated.
- "Select NRP File"  
Provides access to the file system to select the update file. The selected file is indicated to the left of the button.
- "Run Update"  
Starts the update.

**Note:** If the update is interrupted, for example by accidental removal of the sensor during the process, the button "Rescue" appears. Thus, you can restart the update as described in [How To Restart an Interrupted Update](#).

### How To Update the Sensor Firmware

To update the sensor firmware, proceed as follows:

1. Open the R&S website <http://www.rohde-schwarz.com> in section "Power Meters & Voltmeters > R&S NRP-Z Sensors".
2. Select the respective sensor, e.g. R&S NRP-Z81.
3. Select "Downloads > Firmware" and the offered firmware suitable for your sensor.
4. Save the firmware in the /var/user/temp/ directory.
5. Connect the sensor to the R&S SMW and select "System Config > Setup > Instrument Assembly > NRP-Z Info Update" to open the dialog.
6. Select the sensor in the left sensor selection field.
7. Select the update file with "Select NRP File" and activate "Run Update".

The update starts and a bar indicates the progress.

### How To Restart an Interrupted Update

If an update has been interrupted, for example by accidental removal of the sensor during the process, you can rescue the procedure.



It is prerequisite that no other sensor is connected to the instrument.

---

To restart an interrupted update of the sensor firmware:

1. Make sure that no further sensor is connected to the instrument.
2. Do not reconnect the sensor but keep it ready to be connected.
3. Select "Rescue" in the "NRP-Z Info / Update" dialog.
4. Activate "Run Update".
5. Confirm the query in message box.
6. Connect sensor within 4 seconds

The update starts and a bar indicates the progress.

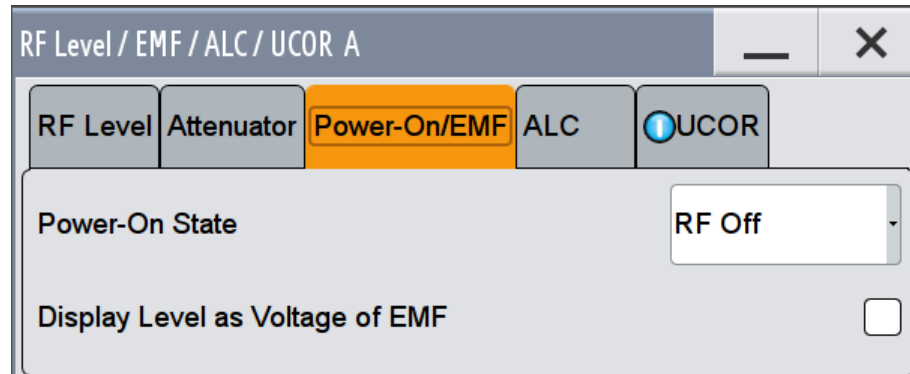
## 8.9.5 Additional Functions on the Level

### 8.9.5.1 Power-On/EMF

As additional functions for the level settings, you can determine the state of the RF signal, and the level display in the status bar when you turn on the R&S SMW.

## Power-On/EMF Settings

- ▶ To access the settings tab, select "RF A > RF Level > Power-On / EMF".



The "Power-On/EMF" tab in the combined "RF Level / EMF / ALC ..." dialog contains all settings for configuring the power-on behavior and the level display.

### Power-On State

Determines the RF signal output state when the instrument is switched on.

You can disable the RF output signal in general, or start it in the same state as it had been when it was switched off.

Remote command:

`:OUTPut<hw>[:STATe]:PON` on page 753

### Display Level as Voltage of EMF

Activates display of the signal level as voltage of the EMF (no-load voltage).

If disabled, the level is displayed as a voltage over a 50 Ohm load.

**Note:** This setting is not affected by an instrument preset (PRESET key), \*RST) or the "Save/Recall" function. Only the [Chapter 10.2.1, "Preset, Set To Default and Factory Preset Settings"](#), on page 576 resets the setting.

Remote command:

`[:SOURce<hw>]:POWER:EMF:STATe` on page 1026

## 9 Monitoring Signal Characteristics

The R&S SMW is a highly configurable signal generator with versatile routing possibilities and level settings distributed over several dialogs. To optimize the signal generation process and to help monitoring the variation of the signal parameters through the instrument, the R&S SMW is equipped with a real time graphical signal display and a power level surveillance function.

This section explains the provided functions for monitoring of the signal characteristics in real time. Here you can find out how to visualize the generated signal with measurement diagrams and how to enable measurements on the baseband power levels.

### 9.1 Displaying Baseband Signal Characteristics in Real-Time

In test setups, you usually use signal and spectrum analyzers or an oscilloscope to display and analyze the characteristics of the generated signal. In the R&S SMW, you can also use the built-in graphical signal display function and visualize a subset of signal characteristics.

#### 9.1.1 About the Graphical Signal Display

To ease the setting and routing of baseband signals, R&S SMW is able to capture these signals and display them graphically in different ways: as I/Q, vector, eye or constellation diagram, as power spectrum or as statistical evaluations.

In the digital domain, the measurements are based on recorded I/Q samples. The sources of these samples are selectable points (acquisition points) in the signal flow. You can configure and display the signal characteristics simultaneously in up to diagrams.

##### 9.1.1.1 Available Diagrams

This section focuses on graphical signal displays, their content and application. See [Table 9-1](#) for an overview of the signal characteristics you can monitor.

**Table 9-1: Graphics modes overview**

Graphics modes	Domain	Measurement is known from this instrument
<a href="#">I/Q Diagram</a>	Time	Oscilloscope (standard mode)
<a href="#">Vector Diagram</a>	Time	Oscilloscope (XY mode)
<a href="#">Constellation Diagram</a>	Time	Oscilloscope (XY mode)
<a href="#">Eye Diagram</a>	Time	Oscilloscope (triggered to symbol clock and showing repetitive traces)

Graphics modes	Domain	Measurement is known from this instrument
<a href="#">CCDF Display</a>	Statistical representation of peaks	Peak Power Analyzer
<a href="#">Power Spectrum</a>	Frequency	Spectrum Analyzer

### I/Q Diagram

The I/Q diagram displays the in-phase component ( $i[t]$ ) and quadrature component ( $q[t]$ ) of the I/Q signal over time.

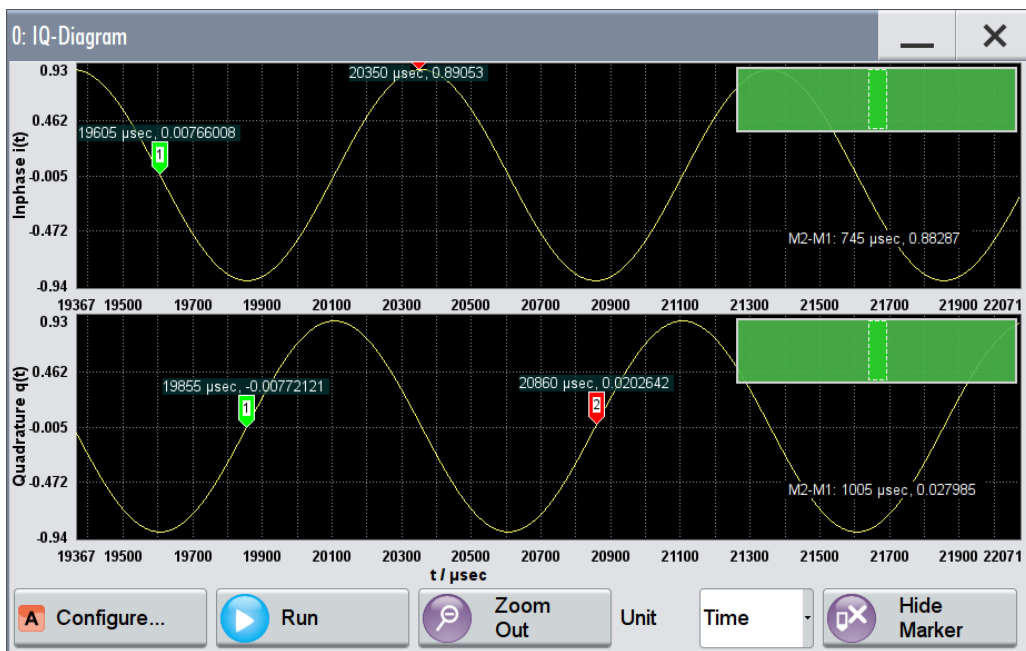


Figure 9-1: I/Q diagram with markers

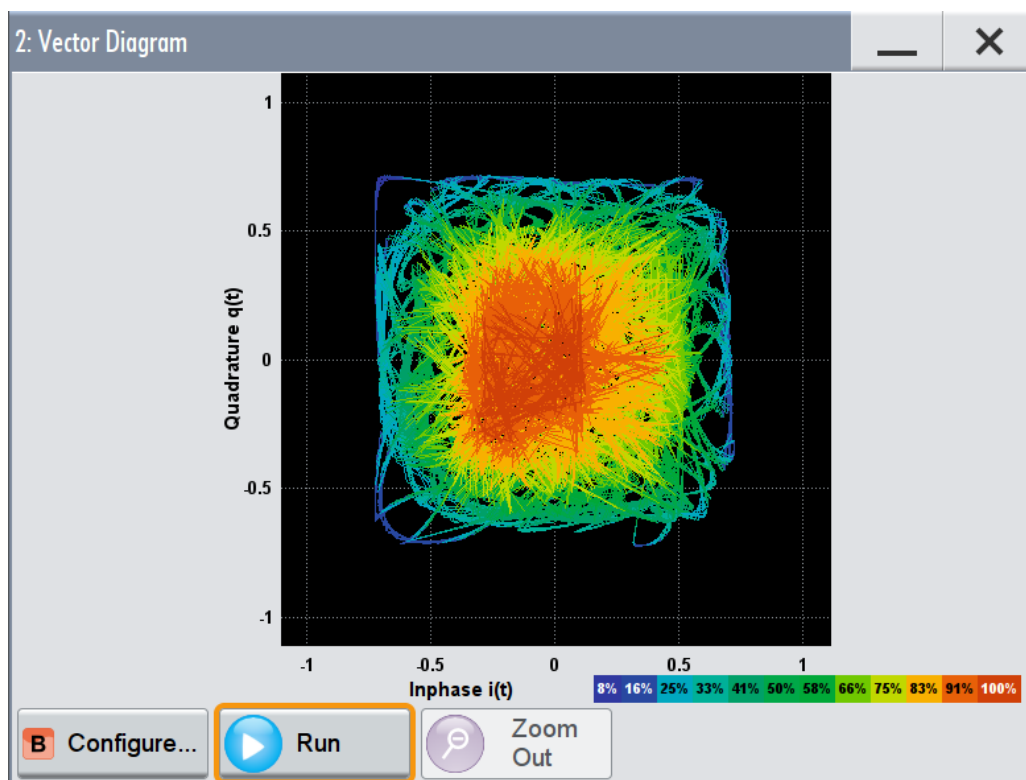
= window with two separate coordinate systems with identical X and Y axes  
 X-axis = time represented as number of symbols, chips, or samples depending on the signal  
 Y-axes = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

**Application:** To analyze impairments, fading, added noise and added signals (e.g. from external baseband input or from second path) in the time domain. This mode shows the signal like an oscilloscope.

**Signal acquisition points:** See [Table 9-2](#).

### Vector Diagram

The vector diagram displays the Q component over the I component. All points in the complex domain are connected by lines.



**Figure 9-2: Vector diagram (64 QAM)**

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

**Application:** To analyze the transition between the various states of modulation mapping, especially with linear modulations like MSK, QPSK or QAM. This mode shows the signal like an oscilloscope (X/Y-mode).

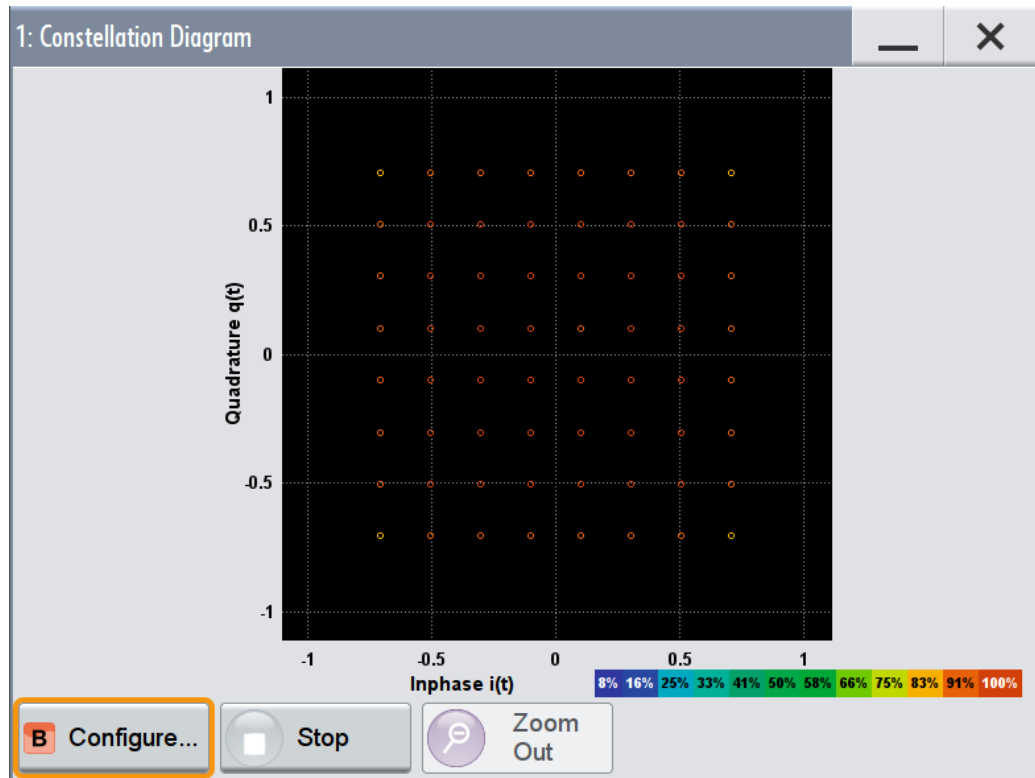
**Signal acquisition points:** See [Table 9-2](#).

### Constellation Diagram

Constellation diagrams display the modulation symbols as discrete points in the I/Q plane. Unlike the vector diagram, the constellation diagram displays only one sample per symbol. This sample represents the symbol.

Constellation diagrams are helpful when generating signals using the "Custom Digital Modulation" settings. Compare the displayed constellation diagram with the diagram displayed in the "Custom Digital Modulation > Modulation" dialog.





**Figure 9-3: Constellation diagram (64 QAM)**

X-axis, Y-axis = amplitudes of the signal components, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

**Application:** To classify modulation.

**Signal acquisition points:** See [Table 9-2](#).

### Eye Diagram

The eye diagram displays synchronized and superimposed sections of either the in-phase or the quadrature components of the signal.

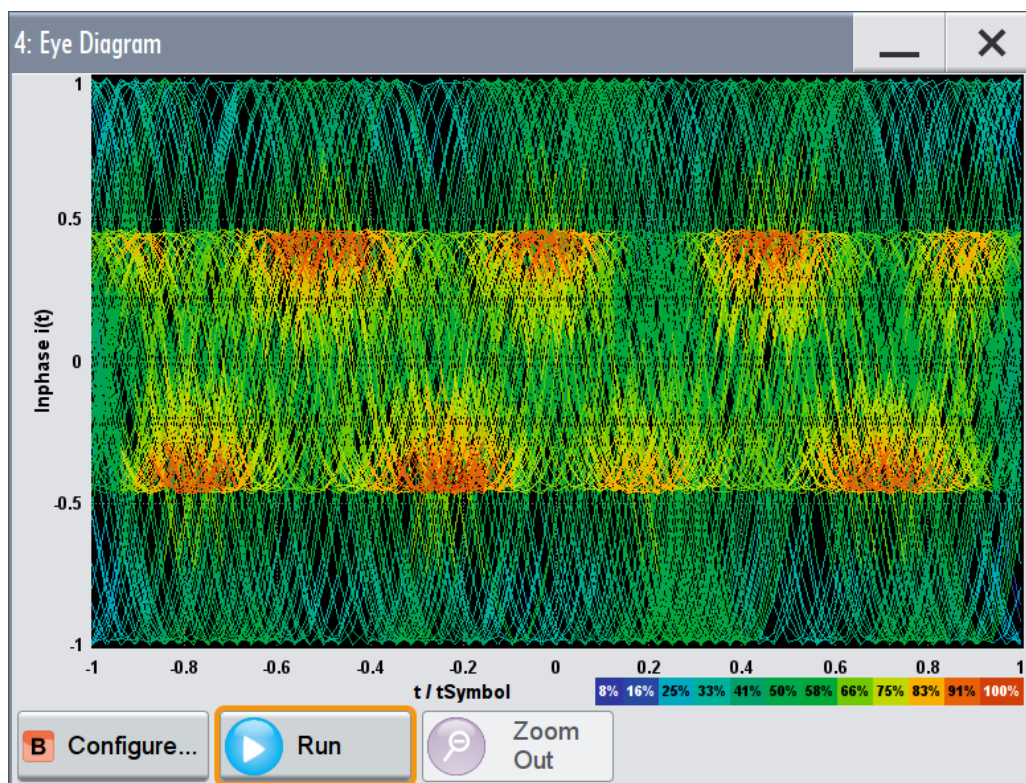


Figure 9-4: Eye diagram with partially closed eye (2FSK)

X-axis = time in the range of  $\pm 1$  symbol

Y-axis = amplitude, scaled to the peak envelope power; where minimum scaled amplitude = -1, maximum scaled amplitude = +1

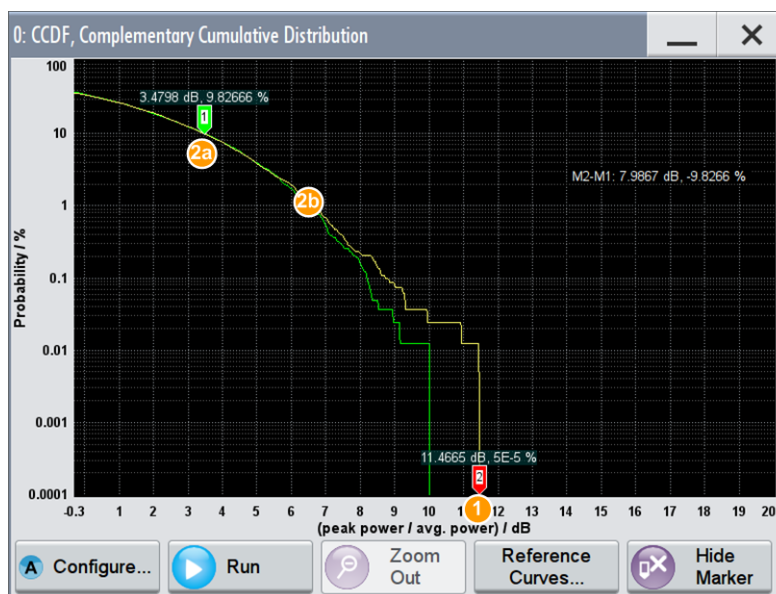
The display width is normalized for 2 symbols, with the one-symbol "eye opening" in the center of the display and 1/2-symbols to the left and right of the center eye for capturing time transitions. Several hundreds curve segments are superimposed. The beginning of the recording is synchronous to the symbol and chip clock pulse.

**Application:** To analyze amplitude and time distortion elements (e.g. jitter) at high-speed digital data systems. A high quality, unimpaired signal should show a clearly open eye (horizontally and vertically).

**Signal acquisition points:** See [Table 9-2](#).

### CCDF Display

The Complementary Cumulative Distribution Function (CCDF) displays the probability with which the output signal exceeds the average power.



**Figure 9-5: CCDF diagram of a 5MHz LTE Signal with enabled reference curve (green) (Level -30 dBm, PEP -18.43 dBm)**

- X-axis = level over the average signal power, where the average power (RMS) corresponds to the origin
- Y-axis = probability of exceeding the average power, that is the percentage of time the signal spends at or above the power level specified by the X-axis
- 1 (Marker 2) = the point where the trace crosses the x-axis; indicates the highest peak that is found in the sample block = 11.47 dB higher than average.
- 2a (Marker 1) = interpolation: 10% of the samples exceed 3.5 dB above average
- 2b = interpolation: 1% of the samples exceed 6.5 dB above average

The CCDF diagram on [Figure 9-5](#) is calculated over 8 ksample and corresponds to a signal with the following characteristics:

- "Baseband > LTE" and "Test Model > E\_TM 1.1 5 MHz"
  - "Status bar > Level = - 30 dBm" and "Status bar > PEP = - 18.43 dBm"
- A level of -30 dBm and a PEP of -19.4 dBm result in a peak to average ratio of 11.57 dB.
- The PEP value does not indicate how often the peak level is reached. The CCDF shows the probability for reaching a dedicated instantaneous power.

**Signal acquisition points:** See [Table 9-2](#).

### Power Spectrum

The power spectrum displays the signal spectrum which is calculated from the I/Q signal with Fast Fourier Transformation (FFT). The power density over frequency is displayed.

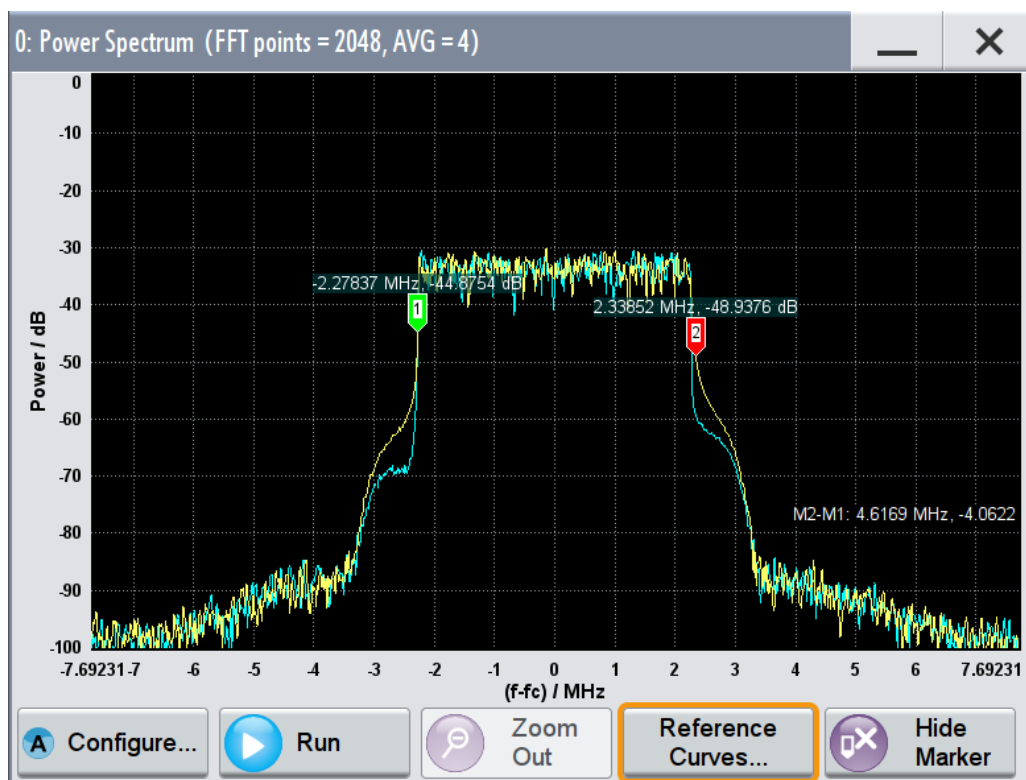


Figure 9-6: Power spectrum diagram of a 5 MHz LTE signal with enabled reference curve (blue)

"FFT points" = indicates the number of I/Q value pairs that are used for calculating a (part-)FFT  
 "AVG" = indicates the number of subspectra used for averaging  
 X-axis = frequency plotted symmetrically (- Sampling Rate/2 to +Sampling Rate/2)  
 Y-axis = power density

Signal acquisition points: see Table 9-2.

### 9.1.1.2 Signal Acquisition Points

Signal characteristics can be displayed using different methods and different acquisition points, also at the same time.

The following signal acquisition points are available:

- Baseband signals
- Input streams of the "IQ Stream Mapper"
- Analog outputs (RF A/B, I/Q OUT 1/2)
- Digital output streams of the "IQ Stream Mapper" (DIG I/Q OUT)

The Figure 9-7 shows an example for locations of signal acquisition points.

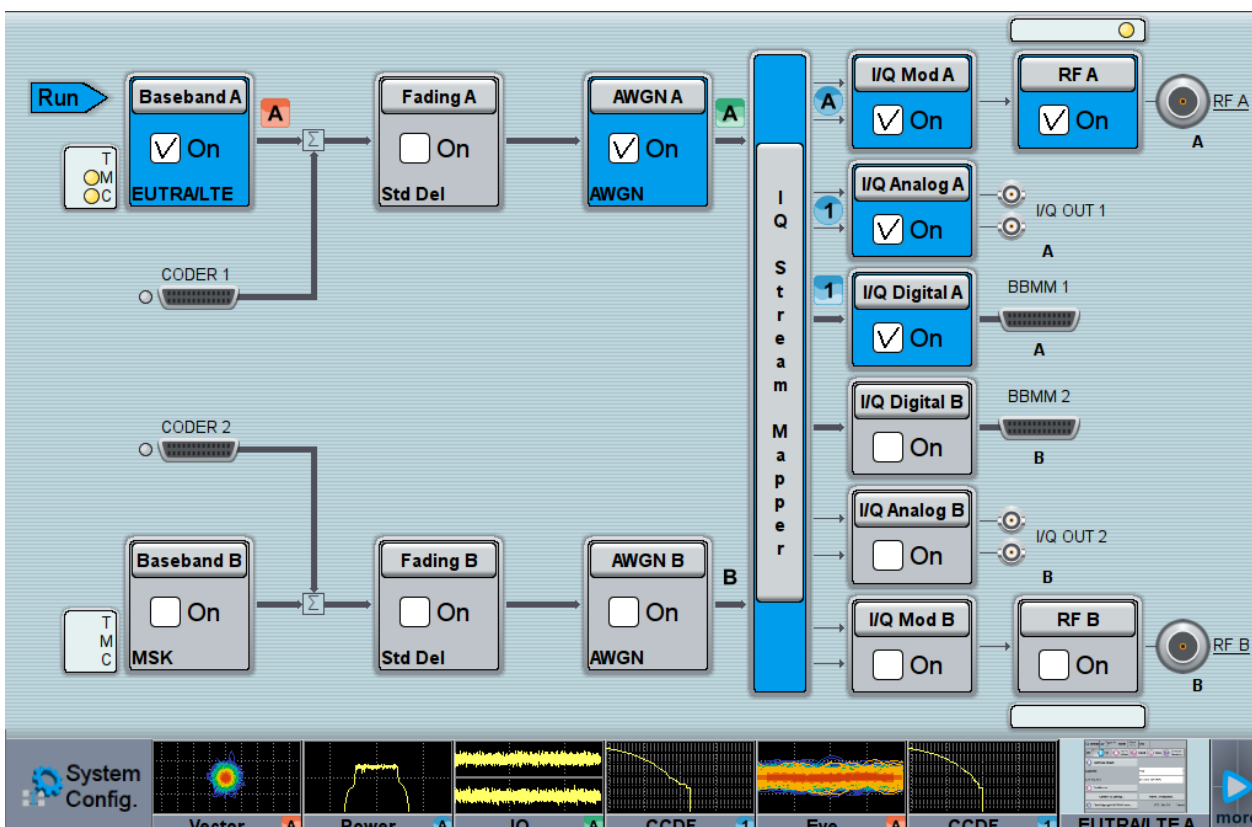


Figure 9-7: Block diagram with graphical signal display and signal acquisition points

The available signal acquisition points depend on the selected configuration (signal routing), see Chapter 4, "Signal Routing and System Configuration", on page 120.

The Table 9-2 shows which signal acquisition point is suitable for which kind of graphical signal display.

Table 9-2: Signal acquisition points for the different graphical signal displays

Graphics modes	Signal acquisition points
I/Q diagram, vector diagram, CCDF diagram, power spectrum diagram	All
Constellation diagram, eye diagram	Baseband signals

### 9.1.1.3 Display Functions

The graphical display provides general display functions known from other measurement instruments and offers zoom and markers.

#### Zooming

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

Zooming is merely a visual tool, it does not change the number of samples used for the calculation. You can increase the number of samples before zooming.

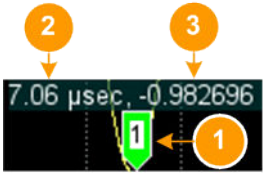

See also ["To zoom into a diagram"](#) on page 549.

### Using markers

Markers are tools for numerical readout of measured data in diagrams. They help you analyze the displayed signal characteristics by determining particular values in the diagram.

In most diagrams, you can use markers, for example to measure the frequency distance of two peaks or to measure the power decrease of an oscillator at a given frequency offset, dBc value (markers in the diagram are not related to the markers in the digital standards).

In the graphical display, the markers and their values (for example time or frequency) are displayed as usual.

Single marker indication	Delta marker indication
 <ul style="list-style-type: none"> <li>• 1 = marker number</li> <li>• 2 = marker position on the x-axis in the current units</li> <li>• 3 = marker value on the y-axis</li> </ul>	 <ul style="list-style-type: none"> <li>• 1 = delta marker</li> <li>• 2, 3 = result of the marker function, i.e. the delta values in the current units</li> </ul>

See also ["To enable markers to readout exact measured data"](#) on page 550.

### Persistence and color maps

In addition to the standard representation, the vector, the constellation, and the power spectrum diagrams use a color map.

The color encodes the relative amplitude (in percent) of the probability distribution of the data points in the diagram. Data points in an area with high probability are marked in red, data points in an area with low probability in blue. Thus, on the displayed power spectrum diagram, for example, you can observe not only the "level versus frequency" trace but also a third dimension, the probability of the power level.

### Reference trace

Reference traces help you analyze a displayed characteristic, as do the markers. Reference traces are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper power limits which are allowed from a device under test (DUT).

The R&S SMW supports up to five reference traces. You can load reference traces and activate them simultaneously.

## 9.1.2 Graphical Signal Display Settings

This section focuses on the functions of the enlarged graphical signal displays.

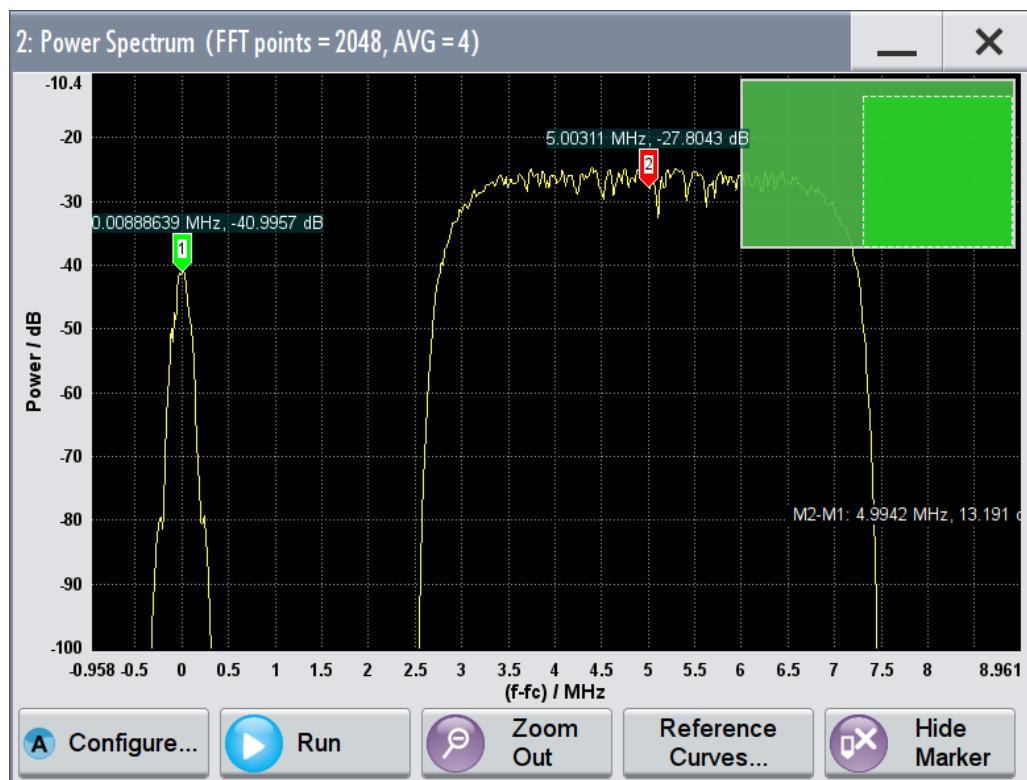


Figure 9-8: Graphical signal display of a power spectrum, zoomed in with markers

### Configure

Opens the "Graphics Configuration" dialog, see [Chapter 9.1.3, "Graphics Configuration Settings"](#), on page 536.

**Note:** This function is available for enlarged graphical signal displays and in the context menus of the thumbnails.

### Stop / Run

Stops the processing of the displayed signal and freezes it.

"Run" continues a stopped displayed signal.

### Zoom out

Resets a previous zoom, see also ["To zoom into a diagram"](#) on page 549.

### Display Units

Changes the units of the X-axis. The available values depend on the generated signal.

### Show / Hide marker

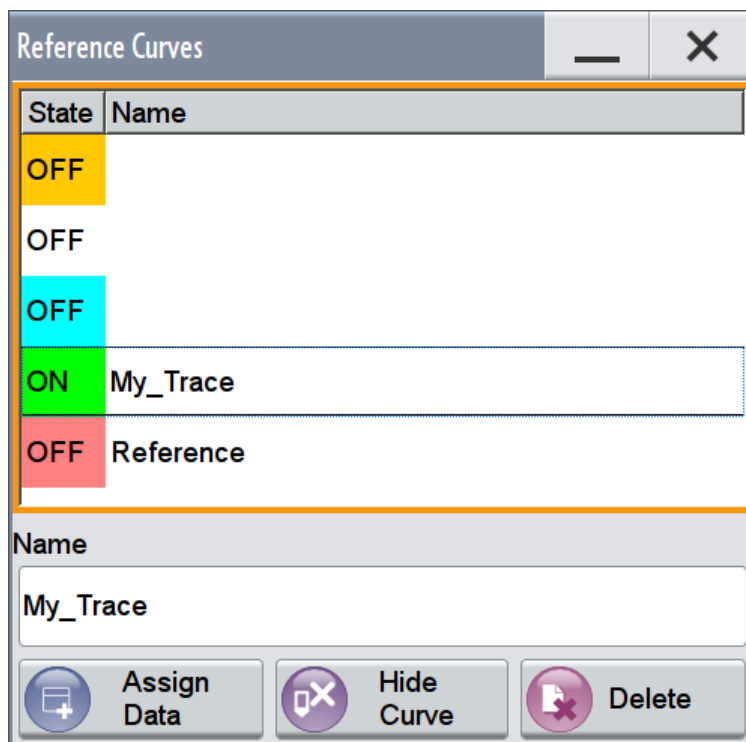
Sets two markers to the displayed signal or hides them.

See also:

- ["Using markers"](#) on page 534
- ["To enable markers to readout exact measured data"](#) on page 550

### Reference Curve

Enable the indication of up to five configurable reference curves (traces).



See ["Reference trace"](#) on page 534.

"Ref Curves Table"

Lists the configured reference curves and their current state.  
To change a curve, select it.

"Name" Enters the name of a new reference curve

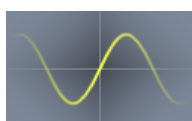
"Assign Data" Accesses the standard "File Select" function to load a file describing a reference curve

"Show Curve" Toggles the show/hide state of the selected curve

"Delete" Removes the curve

### 9.1.3 Graphics Configuration Settings

This section focuses on the graphics configuration dialog, which determines the number and kind of the graphical signal displays.



1. To access this dialog, select "Taskbar > System Config > Graphics" or use the wave icon.

The "Graphics Configuration" dialog opens.



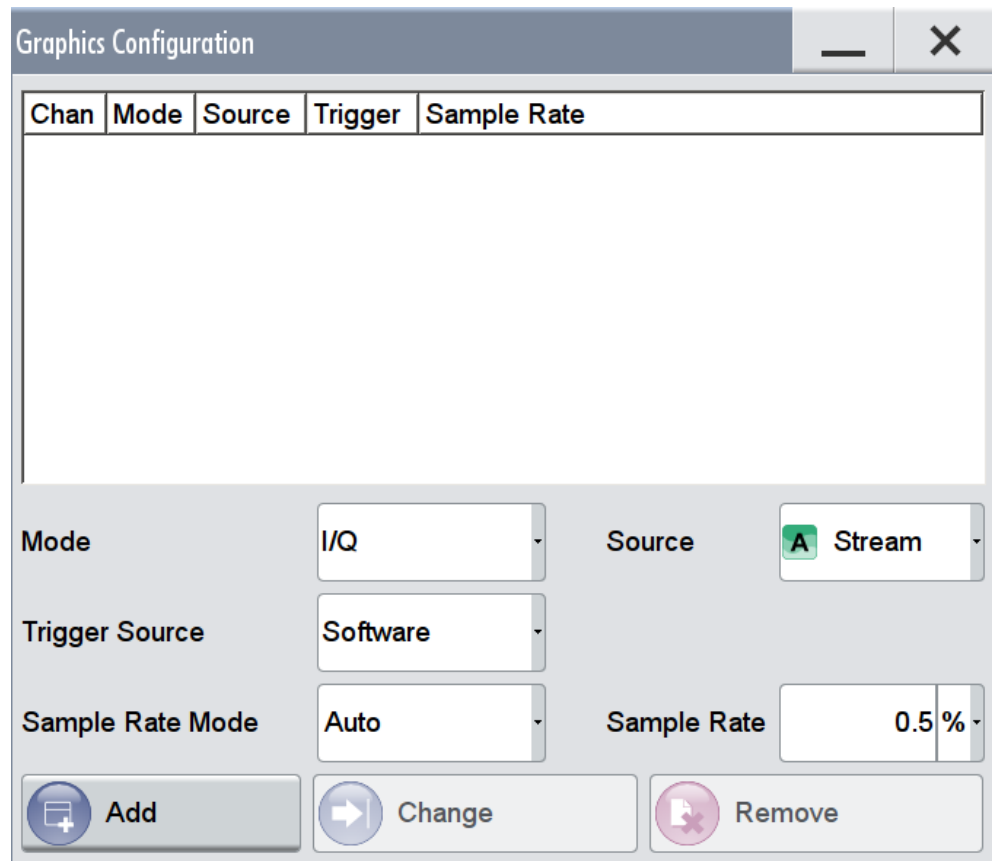


Figure 9-9: Graphics configuration dialog

2. To determine the kind of signal display, use the parameter "Mode".
3. To select suitable signal acquisition points, use the parameter "Source".
4. To enable the graphical signal display, select "Add".

A thumbnail of the graphical signal display is shown in the taskbar.

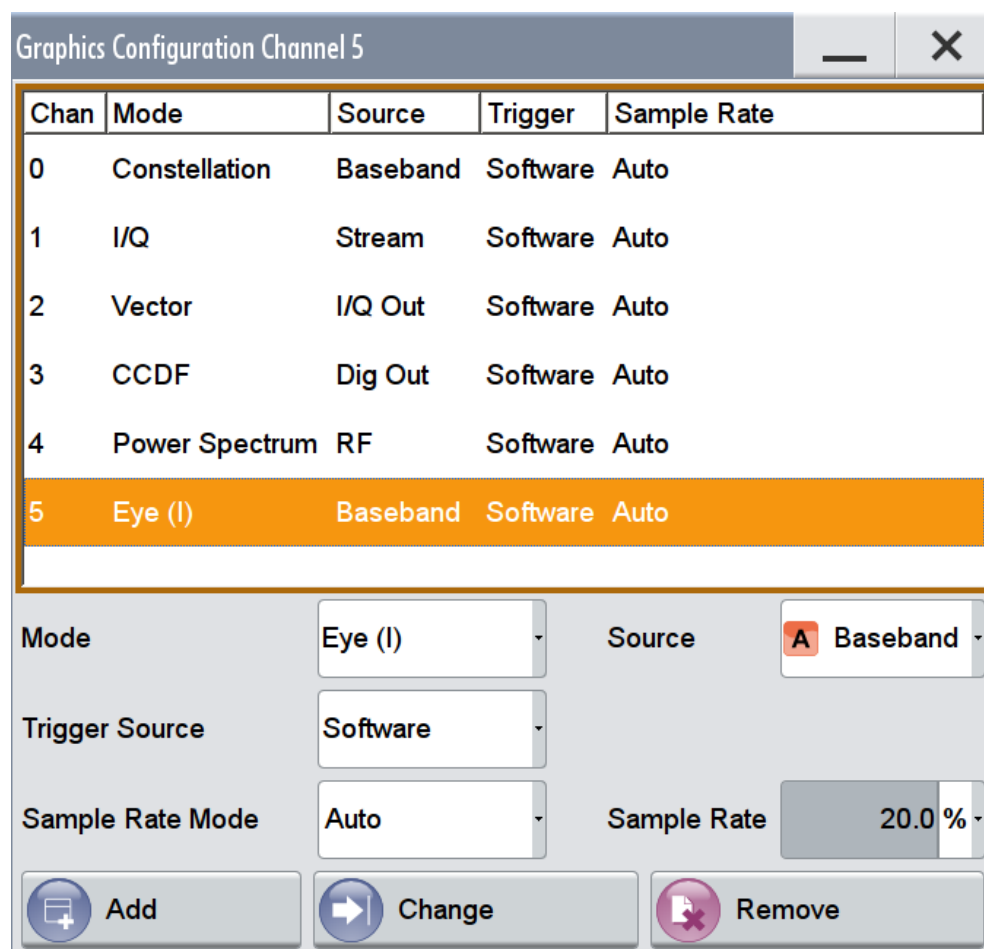


Figure 9-10: Graphics configuration dialog with active graphical signal displays

- To enlarge the thumbnail select it.

### Graphical Diagrams Table

The active graphical signal displays are listed in the table at the top of the dialog.

#### Mode

Determines the graphics mode, see [Chapter 9.1, "Displaying Baseband Signal Characteristics in Real-Time"](#), on page 526.

Remote command:

`[ :SOURce<hw> ] :BB:GRAPhics:MODE` on page 942

#### Source

Defines the signal acquisition point, see [Chapter 9.1.1.2, "Signal Acquisition Points"](#), on page 532.

External digital baseband signals fed via the FADER 1/2 connectors cannot be monitored.

Remote command:

`[ :SOURce ] :BB:GRAPhics:SOURce` on page 943

### Trigger Source

Defines the trigger for signal recording.

- |            |  |
|------------|--|
| "Software" | Recording of signals starts automatically in predefined intervals. This asynchronous method is suitable if a representative display of the complete signal is required.  |
| "Marker 1" | The starting point for recording of signals is determined by the marker 1 setting of the activated digital standard ("Trigger/Marker" dialog). This synchronous method is suitable if specific signal segments are to be shown in greater detail. With periodic signals, a static image is obtained by selecting a period length of marker 1 that is equal to the signal period.<br>The displayed signal segment can be shifted by entering a marker delay in the "Trigger/Marker" dialog of the activated digital standard. |

Remote command:

`[ :SOURce<hw> ] :BB:GRAPhics:TRIGger:SOURce` on page 944

### Sample Rate Mode

Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a display covering the entire signal bandwidth. The higher the resolution, the shorter the length of the displayed signal segment.

- |                  |  |
|------------------|--|
| "Auto"           | The resolution is set to an optimum value in terms of signal and display type.           |
| "Full Bandwidth" | The resolution is set so that the display covers the entire signal bandwidth.            |
| "User"           | Activates the "Sample Rate" input field, where the user can manually set the resolution. |

Remote command:

`[ :SOURce<hw> ] :BB:GRAPhics:SRATe:MODE` on page 942

### Sample Rate

With "Auto" and "Full Bandwidth":

Displays the percentage of the entire signal bandwidth which is used for the graphical signal display.

With "User":

Input for the percentage of signal bandwidth which is used for the graphical signal display.

Remote command:

`[ :SOURce<hw> ] :BB:GRAPhics:SRATe:USER` on page 942

### Add

Adds a graphical signal display (as set in the "Graphics Configuration" dialog) to the taskbar/graphical diagrams table.

Remote command:

[ :SOURce ] :BB:GRAPhics:ADD on page 943

### Change

Enables the current settings for the selected graphical signal display.

### Remove

Removes the selected graphical signal display from the taskbar/graphical diagrams table.

Remote command:

[ :SOURce ] :BB:GRAPhics:CLOSe on page 943.

Note, that this command closes all graphical signal displays.

## 9.1.4 How to Verify the Generated Signal with the Graphics Display

This section shows you how to use the different graphic modes to visualize the signal characteristics of the generated signal and to observe the effect of standard settings, like applied filter, an enabled fading or AWGN. The examples use a simple custom digital modulated signal.

### To generate a simple WCDMA-3GPP (QPSK 45° Offset) signal

- Use the custom digital modulation and enable a predefined WCDMA-3GPP signal. For more information, see [Chapter 3.3.2, "Generating a Digitally Modulated Signal"](#), on page 67.

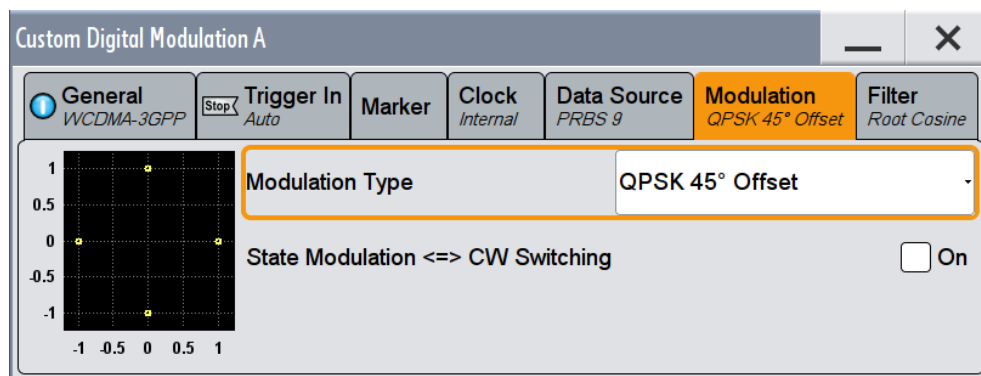
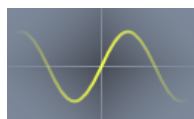


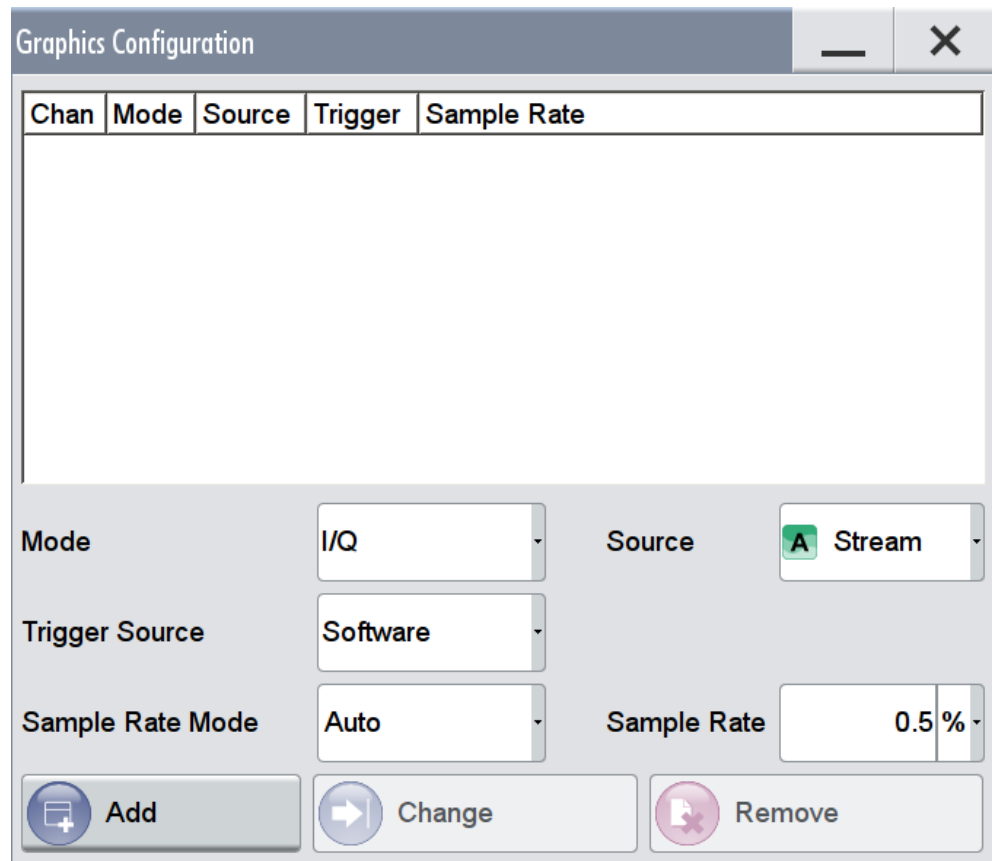
Figure 9-11: Used modulation type

### Configure the graphical signal display

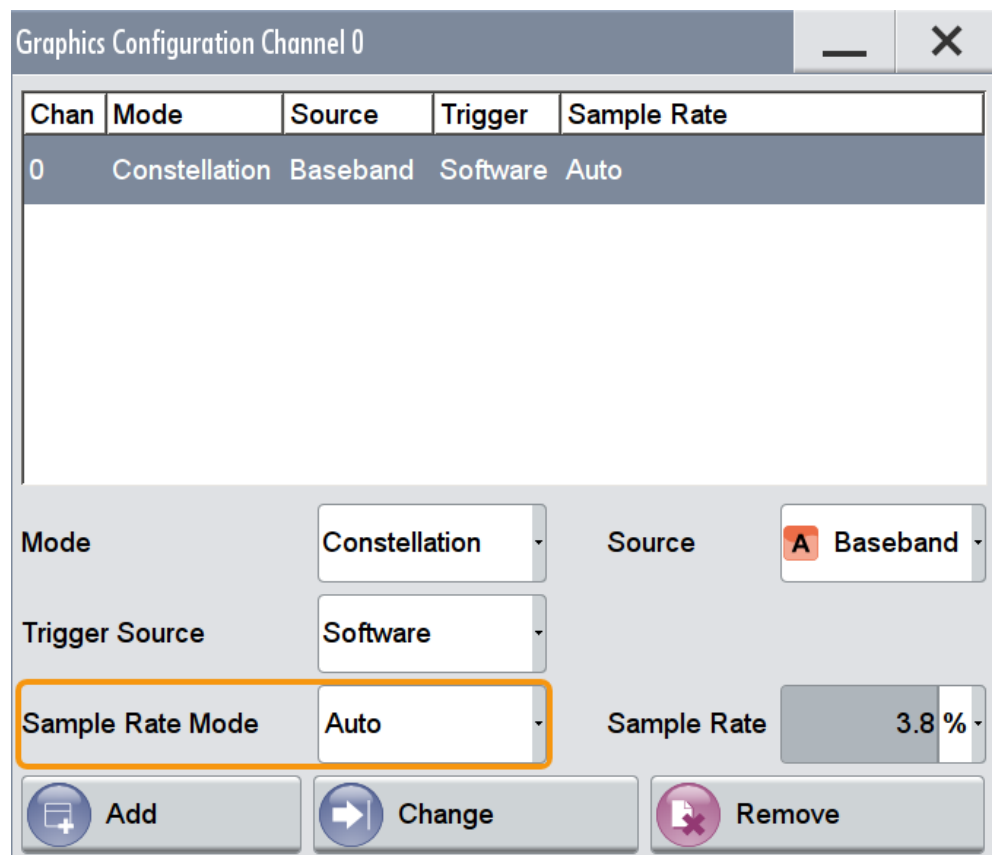
1. Select the wave icon:



The "Graphics Configuration" dialog opens.



2. Select "Mode > Constellation".
3. Select "Source > Baseband A".
4. To view the signal, select "Add".



A new thumbnail (minimized view) indicating the constellation diagram appears in the "Taskbar".

5. To enlarge the constellation diagram, select it.

The displayed constellation diagram confirms the used modulation type, see [Figure 9-11](#).

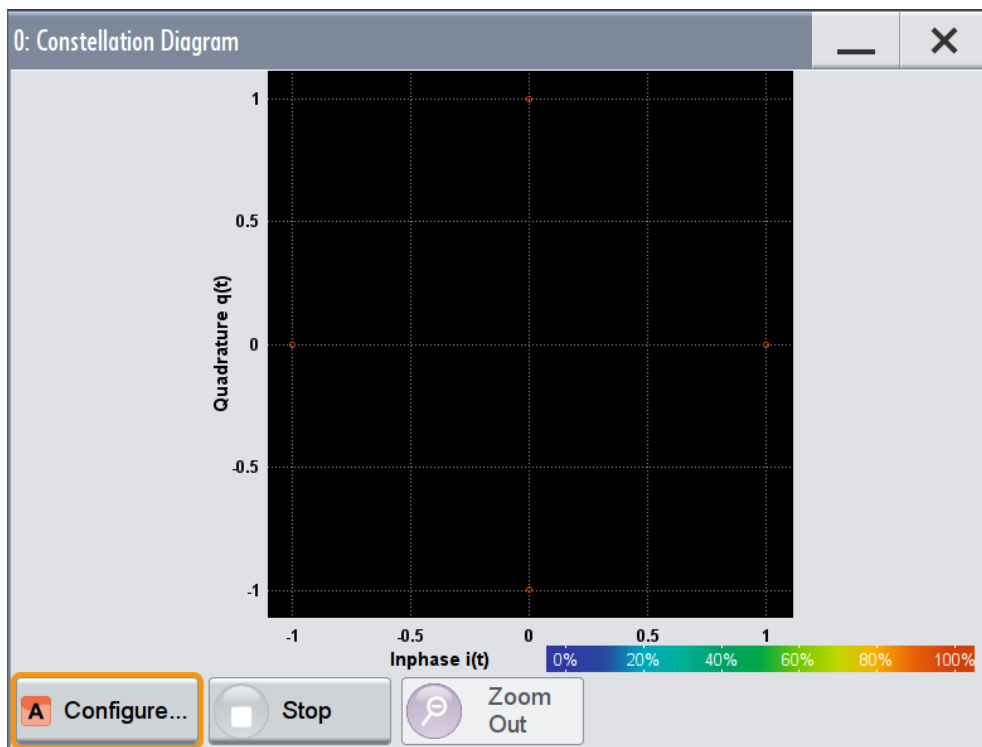
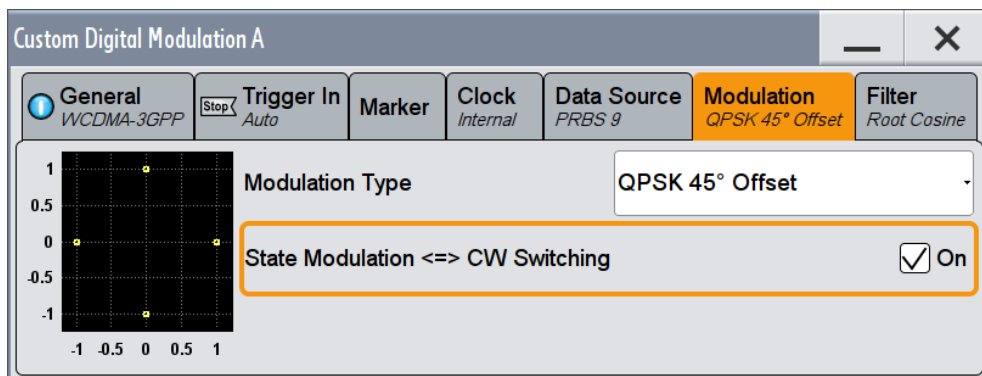


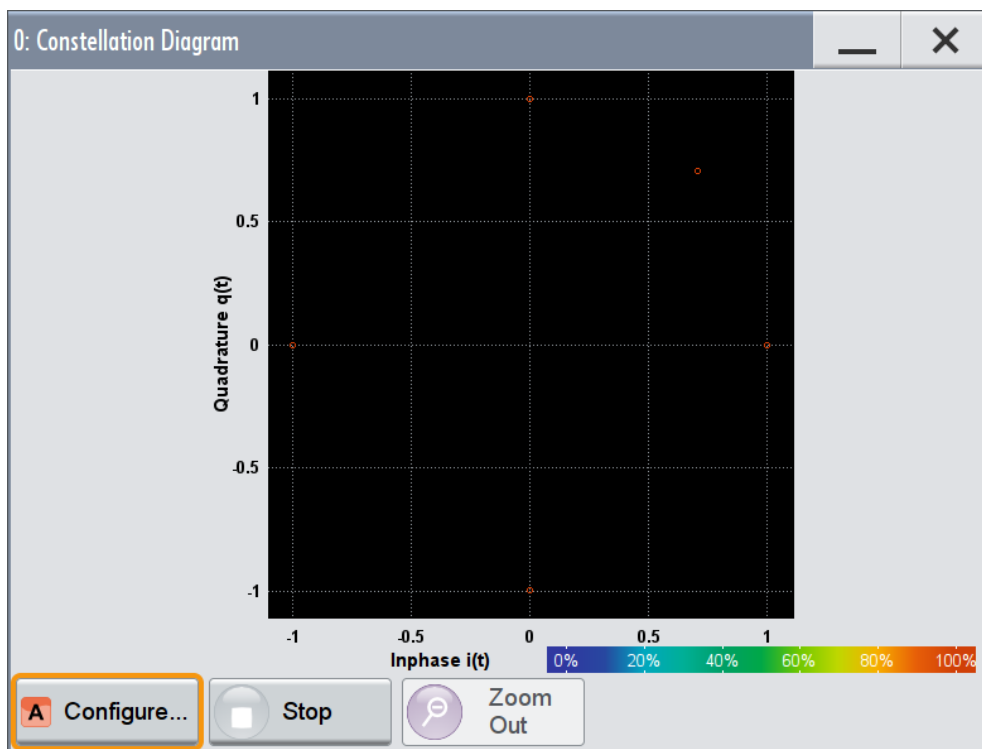
Figure 9-12: Constellation diagram of a WCDMA-3GPP (QPSK 45° Offset) signal

**To observe the effect of an enabled "State Modulation <-> CW Switching"**

1. In the "Custom Digital Modulation > Modulation" dialog, set "State Modulation <-> CW Switching > On".



2. Compare the displayed constellation diagram.



**To set and verify a baseband frequency offset**

1. Select "Baseband A > Baseband Offsets" and enable a "Baseband A > Frequency Offset = 1 Hz"

	Frequency Offset /Hz	Phase Offset /°	Gain /dB
Baseband A	1.00	0.00	0.000
BB Input A	0.00		0.000
BB Input B	0.00		0.000
Baseband B	0.00	0.00	0.000

2. In the "Constellation Diagram", select "Configure".  
The "Graphics Configuration" dialog opens.
3. Add a vector diagram with signal acquisition point "Stream A" and enlarge it.  
The vector diagram rotates with 1 Hz.



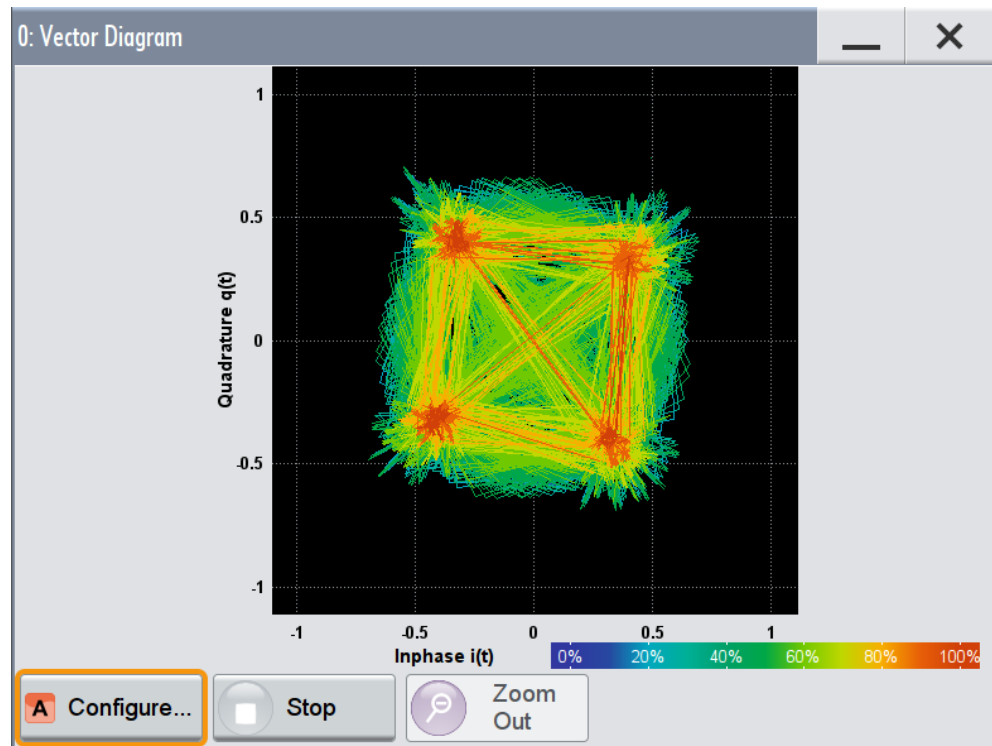
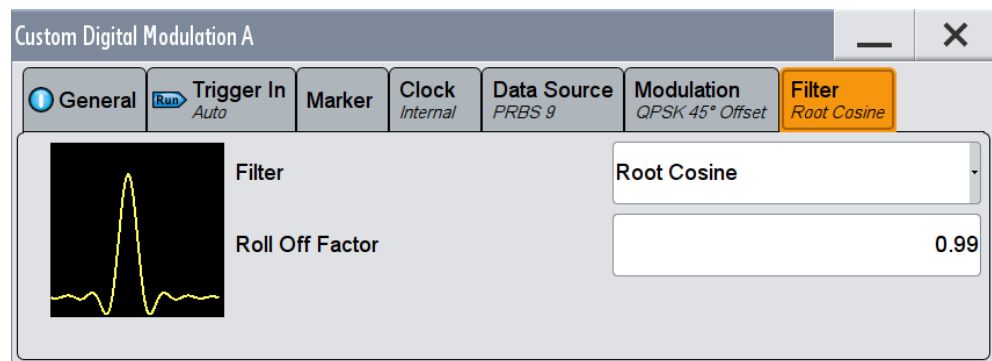


Figure 9-13: Rotating vector diagram

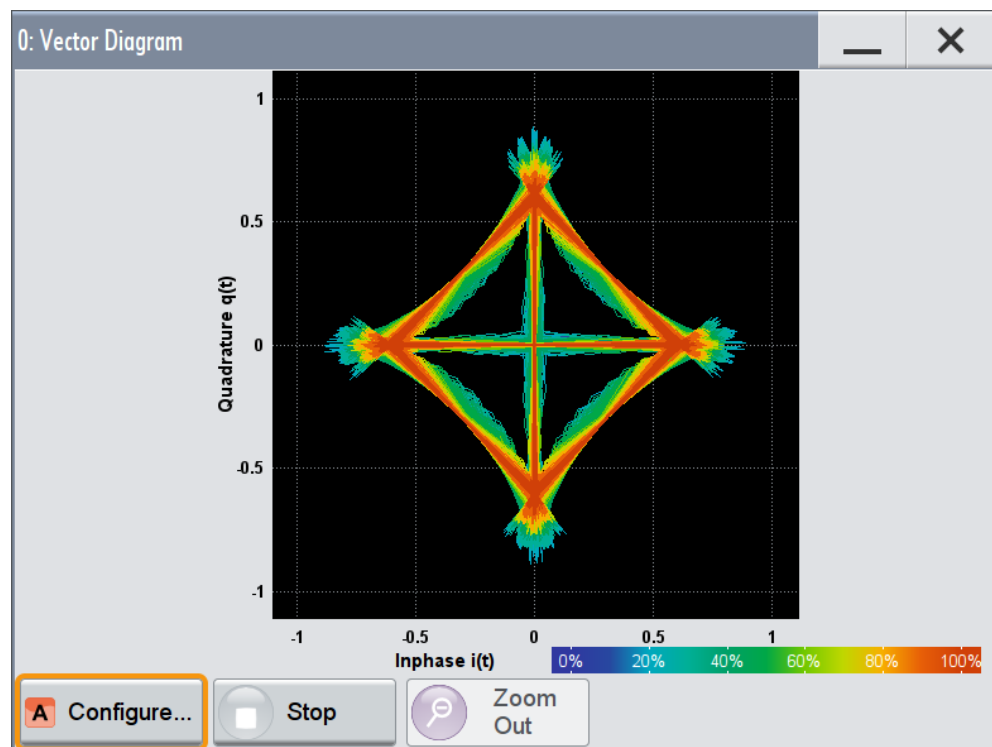
4. Reset the baseband frequency offset to 0 Hz.

**To visualize the effect of the filter parameters on the generated signal**

1. Select "Baseband A > Custom Digital Mod... > Filter > Roll Off Factor = 0.99"



The vector diagram does not change, i.e. the "Roll Off Factor" has no effect on it.



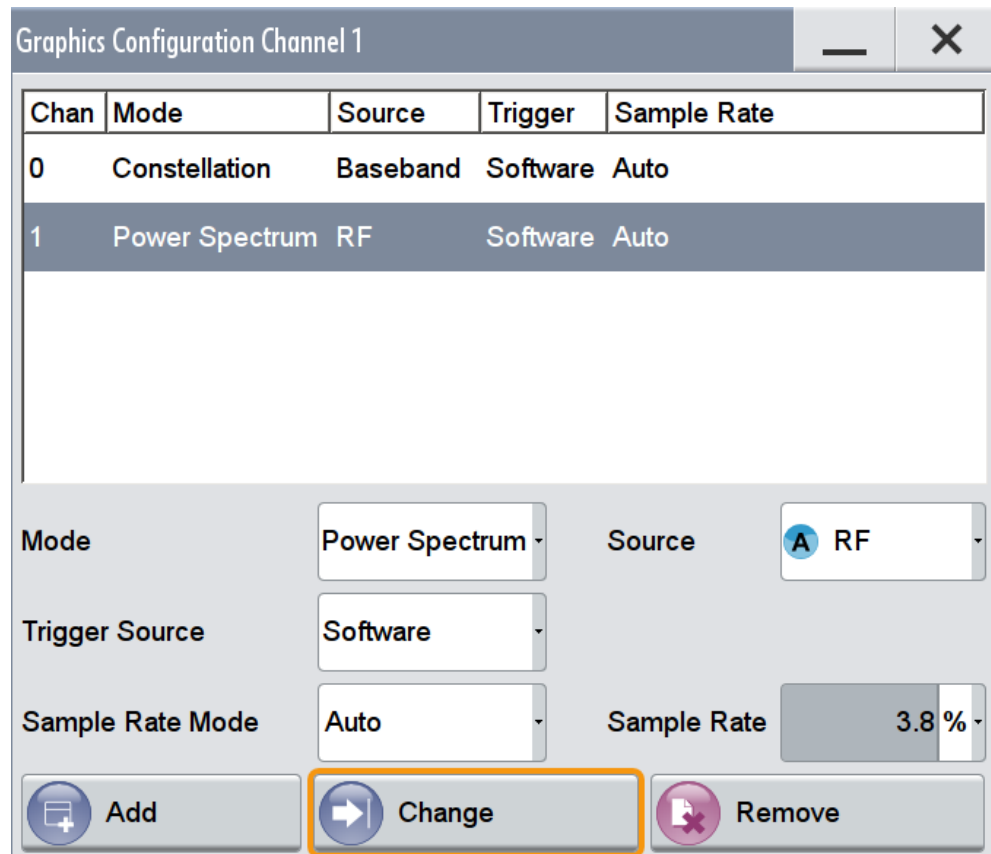
2. Select "Roll Off Factor", open the context menu, and select "Preset this parameter".

#### To set and verify path gain and routing

The power spectrum diagram is a suitable representation of the effect of these settings.

1. In the vector diagram, select "Graphics... > Mode > Power Spectrum", "Source > RF A" and "Change".

Displaying Baseband Signal Characteristics in Real-Time



2. Select "Baseband A > Baseband Offsets > Baseband A > Frequency Offset = 5 MHz".

The power spectrum confirms the shifted WCDMA-3GPP signal.

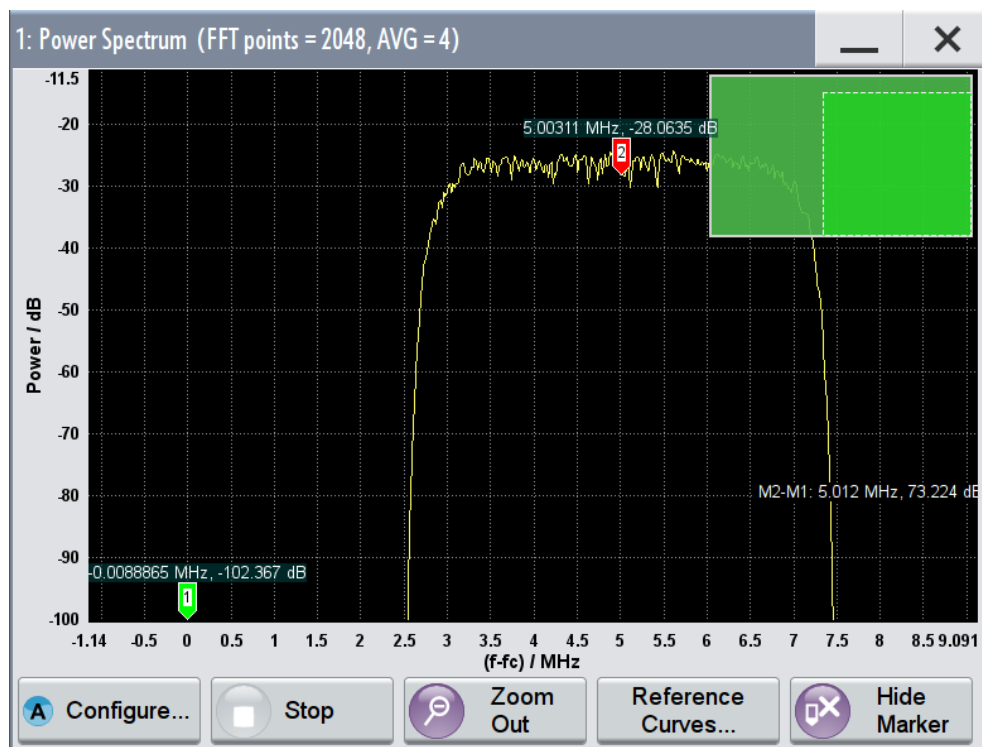


Figure 9-14: Power spectrum with shifted WCDMA-3GPP signal and marker for measuring the offset

3. Select "Baseband B > Custom Digital Modulation > State On " to enable a custom digital modulation with the default GSM signal.
4. Select "Baseband B > route to path A and B" to route both signals to the first path
5. Select "Baseband B > Baseband Offsets > Baseband B > Path Gain = -30" to attenuate the signal.

	Frequency Offset /Hz	Phase Offset /°	Gain /dB
Baseband A	5 000 000.00	0.00	0.000
BB Input A	0.00		0.000
BB Input B	0.00		0.000
Baseband B	0.00	0.00	-30.000

The power spectrum diagram displays two signals, an attenuated GSM signal and the shifted WCDMA signal.



Figure 9-15: Power spectrum with attenuated GSM signal and shifted WCDMA signal

At the RF output, the GSM signal appears attenuated with 15 dB only because the power level is measured with large bandwidth. For details also see [Chapter 9.2, "Querying Information on the Baseband Power Levels"](#), on page 553.

6. Select the area in the diagram to be enlarged and zoom it, see ["To zoom into a diagram"](#) on page 549.
7. Enable markers to readout the measured data, for example the frequency offset or the power level of the signals, see ["To enable markers to readout exact measured data"](#) on page 550.
8. Select "Baseband A > Baseband Offsets > Baseband A = 0" to disable the frequency offset.
9. Select "Baseband B > State > Off" to disable the GSM signal

#### To zoom into a diagram

In an enlarged diagram:

1. Use the one-finger zoom to zoom with a fixed zoom factor.
2. Use the two-finger zoom to do a multiple zoom.  
This works like the two-finger pinching for magnifying images on your cell phone.  
If the diagram is zoomed, an overview window appears.
3. Move the visible area in the graphics or in the overview window.

- For the reverse operation, select "Zoom out".

#### To enable markers to readout exact measured data

In an enlarged diagram:

- Select "Show Marker".

Two markers appear, one over the other.

- To position the markers, select and shift them.

"M2-M1" indicates the distance of marker 1 and marker 2 on the x-axis (left value) and on the y-axis (right value).

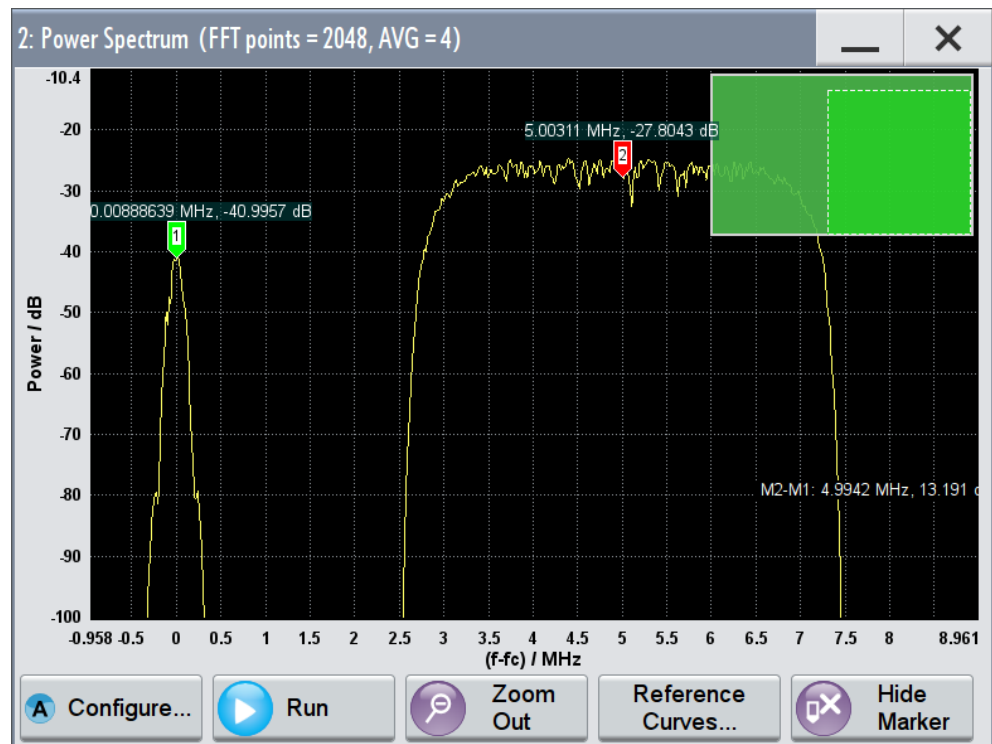
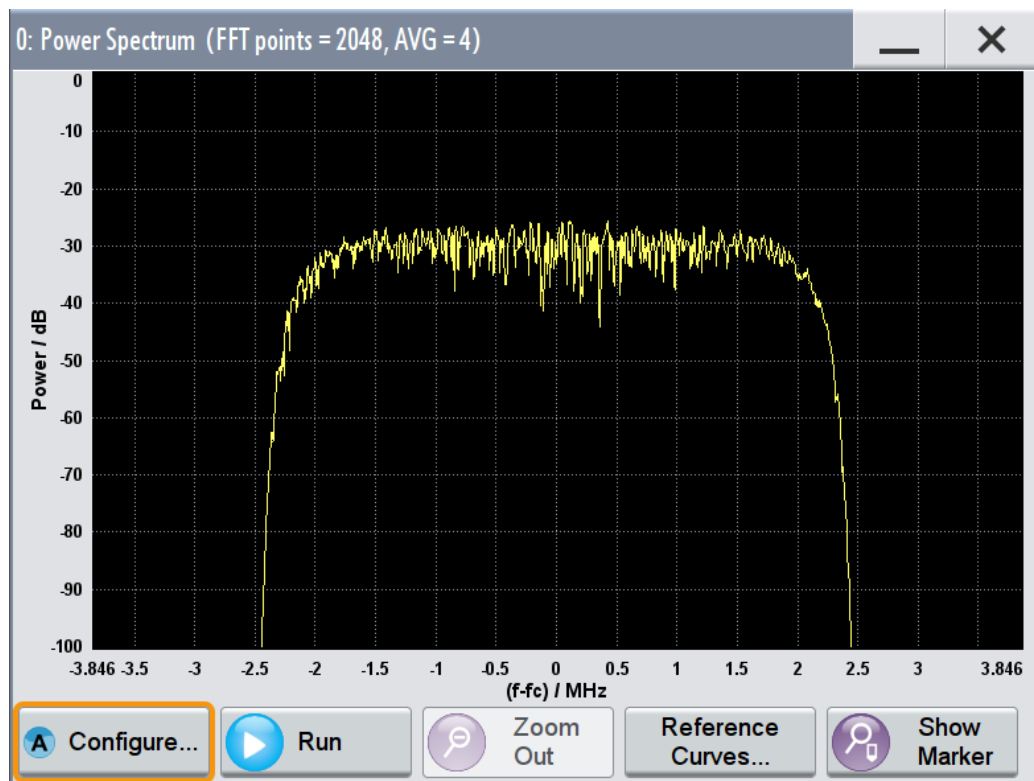


Figure 9-16: Power spectrum with GSM and WCDMA signal and markers

- To hide the markers, select "Hide Marker".

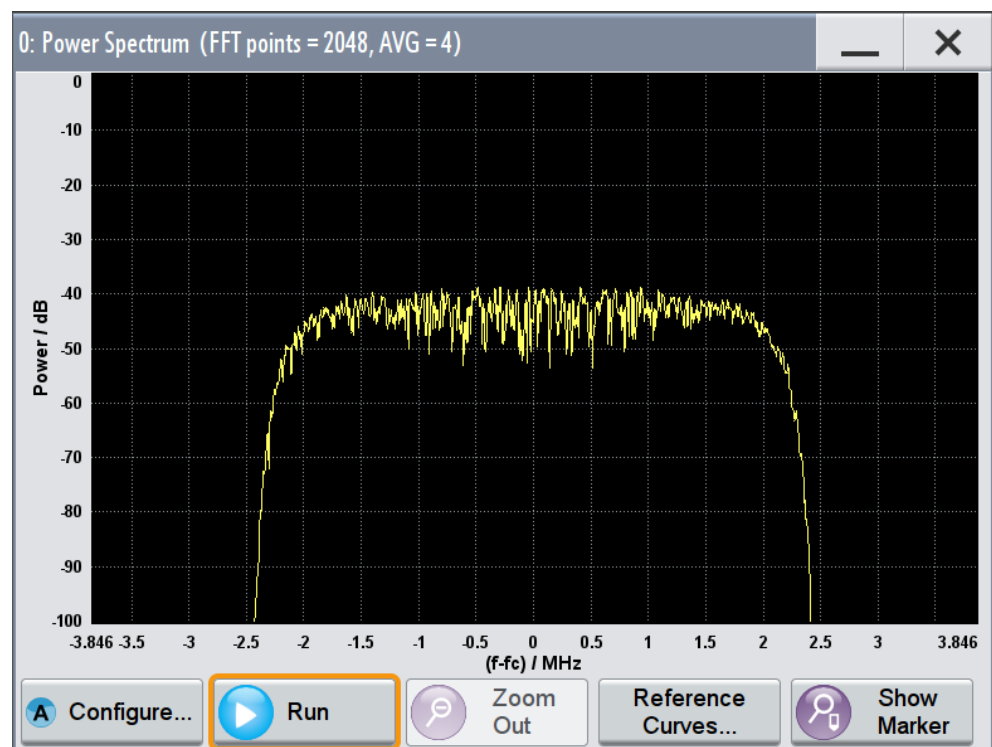
#### To observe the effect of fading

We assume that a WCDMA-3GPP signal is generated and you observe the power spectrum diagram. The display confirms the WCDMA-3GPP spectrum with a maximum level at around -30 dBm.



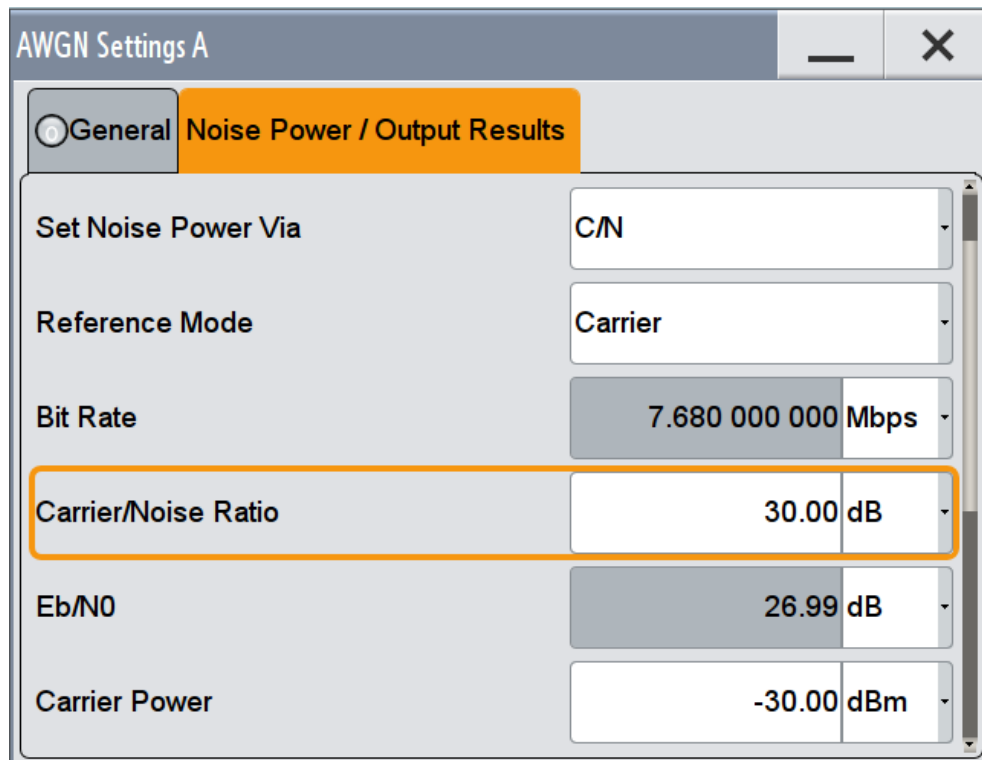
- ▶ Select "Fading A > On" to enable the fading simulator.

The power spectrum diagram shows the same shape, but the level changes dynamically.

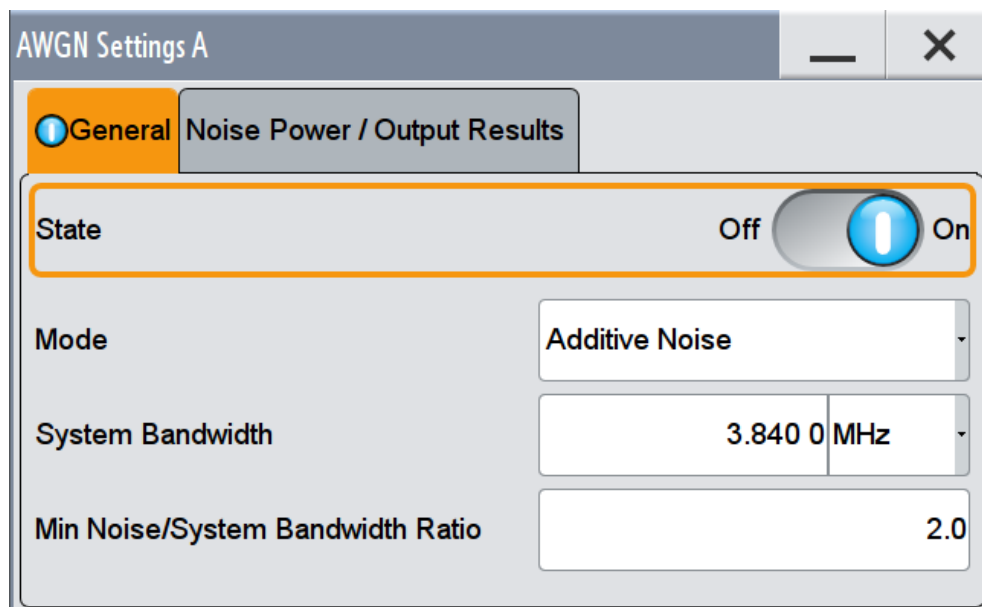


**To observe the effect of enabled additive noise (AWGN)**

1. Select "AWGN A > AWGN > Mode > Additive Noise"
2. Select "Noise Power / Output Results > Carrier/Noise Ratio = 30 dB"



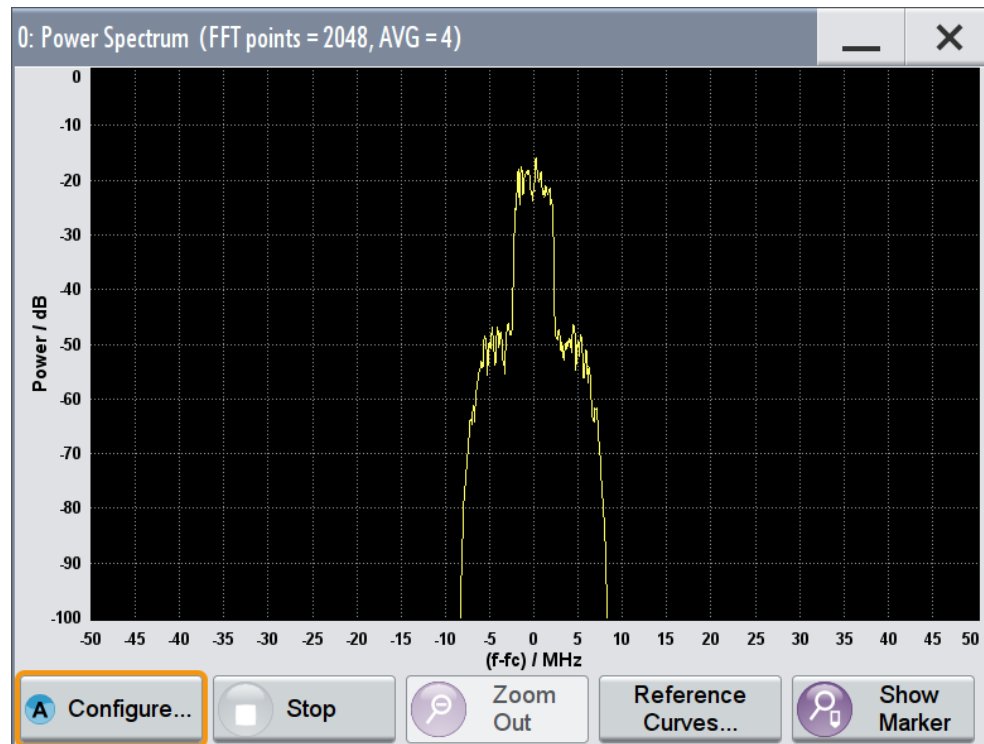
3. Select "AWGN > State > On"





4. Observe the power spectrum display.

In addition to the changing level from fading the power spectrum shows a noise floor with constant level.



#### To print current power spectrum

1. Press H COPY.
2. Use the default settings and select "Save".  
The instrument creates a screenshot of the current screen and stores it in a file with a predefined file name in the default user directory /var/usb/.  
See [Chapter 10.10, "Creating Screenshots of Current Settings"](#), on page 602.
3. Use one of the standard file transfer methods to access the user directory of the instrument and transfer the file to a PC.  
See [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595.
4. Print the file content.

## 9.2 Querying Information on the Baseband Power Levels

The R&S SMW fulfills the requirements for a flexible configuration of signal power at different processing points of the signal flow. This great flexibility, however, leads to a variety of interdependent parameters grouped in different dialog boxes. This section focuses on the "Baseband Powers" measurement functionality provided for retrieving the power and peak power of the digital baseband signal at configurable acquisition

points, like at the input or the output of the fading block, the I/Q output connectors, etc. The provided measurement results are based on signal measurement with different acquisition methods.

The [Chapter 9.2.1, "About Leveling"](#), on page 554 provides general information on leveling as well as a background information on the leveling principle used in the instrument. Understanding of this principle a prerequisite for the correct interpretation of the displayed measurement results.

Refer to [Chapter 9.2.3, "How to Query Information on the Baseband Power Levels"](#), on page 562 for examples on using the baseband power measurements.

## 9.2.1 About Leveling

The instrument provides different signal routing possibilities, involving also signal summing and enabling of power offsets.

This section does not focus on all possible alternatives but rather on the principle of signal leveling. For detailed description refer to:

- [Chapter 4.2, "Possible Ways to Configure the Signal Flow"](#), on page 124
- [Chapter 4.5, "Signal Routing Settings"](#), on page 155
- [Chapter 4.2.2, "Using the System Configuration Capabilities"](#), on page 125
- [Chapter 4.4.2, "I/Q Stream Mapper Settings"](#), on page 137
- [Chapter 5.10, "Shifting and Boosting the Baseband Signal"](#), on page 366
- [Chapter 6.2, "Adding Noise to the Signal"](#), on page 373

### Baseband Leveling Principle

In the R&S SMW, signal routing is performed in the digital domain, i.e. before the I/Q modulation and the RF up-conversion. This implementation ensures a lossless signal addition with high precision. In the digital domain however, real RF levels do not exist. To let you define baseband signals with different average levels, the R&S SMW introduces the concept of baseband leveling. This principle bases on a *relative leveling of the baseband signals in the digital domain*.

By default, when two identical baseband signals are added, they are output at the RF output with the equal average levels. To set a relative level between the baseband signals, use one of the possible alternatives, e.g:

- Enable "Baseband > Baseband Offsets > Gain".
- In MIMO configurations, select "Fading > Fading Settings" and adjust the MIMO correlation matrix.
- In non-MIMO configurations, enable "Fading > Summation Ratio A/B".

### 9.2.1.1 Why is a Power Level Surveillance Important

When routing the signal to the I/Q output connectors of the instrument, adding signals from several baseband sources and/or applying baseband power offsets or fading the signal, the signal power is an important parameter.

For example, when measuring the power after fading the peak and RMS power values can fluctuate significant due to the varying channel state information (CSI) of the fading process. The retrieving of correct measurement results for the faded signal requires not only a suitable acquisition point but also a sufficient (long enough) measurement time to allow the power results to converge reliable values for the long channel state information. Similar situation and requirements apply when measuring the carrier power and the carrier+noise power before and after an AWGN block.

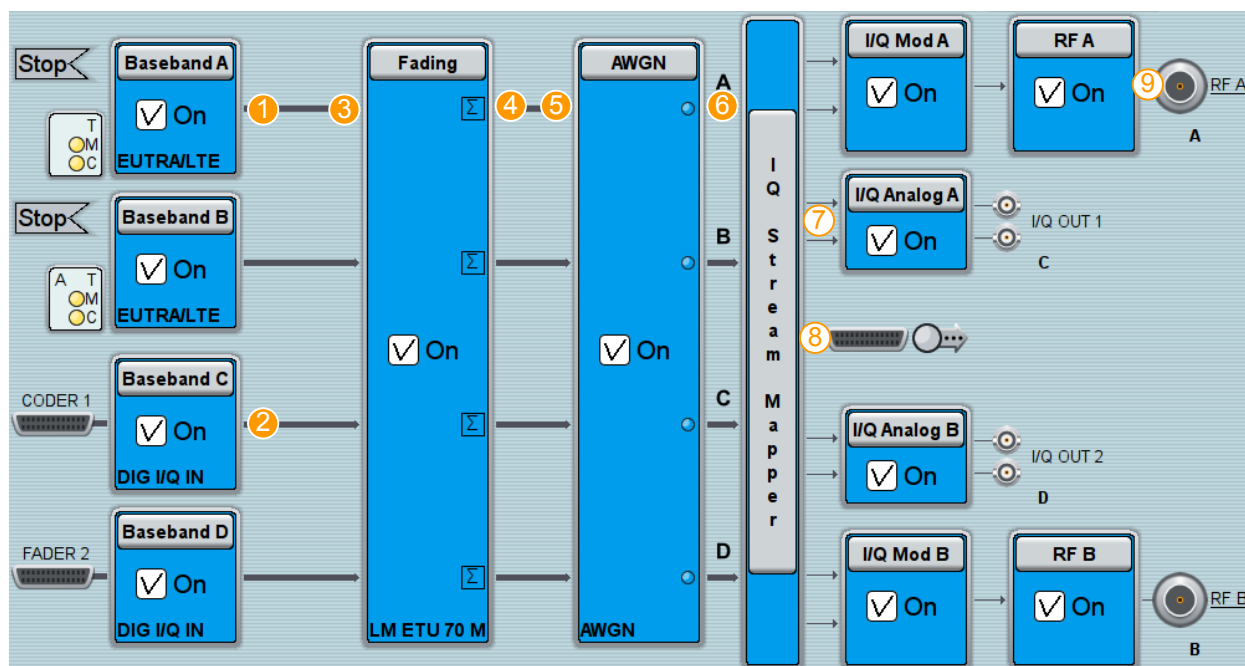
Use the observed information for an evaluation and verification of the correct signal processing throughout the instrument and for a correct adjustment of the power settings at the connected device.



The power values observed in the "Baseband Power Simulation" dialog are suitable as control mechanism. The values cannot be modified to influence the power and level control in the instrument.

### 9.2.1.2 Defining Suitable Acquisition Points

The [Figure 9-17](#) shows an overview of the possible signal acquisition points.



**Figure 9-17: Overview of the acquisition points (source) and output points**

- 1 = Baseband A/B/C/D/E/F/G/H
- 2 = BB Input A/B
- 3 = Fading Input A/B/C/D
- 4 = Fading Output A/B/C/D
- 5 = AWGN Input A/B/C/D
- 6 = Stream A/B/C/D/E/F/G/H
- 7 = output: I/Q Out 1/2
- 8 = output: Dig Out 1/2
- 9 = output: RF A/B

- Depending on the current routing, the signal at the input of the fading blocks (3) can be:
  - One of the basebands
  - The sum product of the corresponding internal baseband and externally applied digital baseband signal (BB input).
 Enabled power offsets are considered.
- The signal at the fading output (4) is the faded signal if fading is enabled or the sum product of the input signals if summation after the fading is performed. Enabled power offset is considered.
- The signal measured at the acquisition points "Stream A/B/C/D" (6) is the signal after the AWGN block. Depending on the AWGN settings, performed are measurement on interference-free digital I/Q baseband signal or the signal superimposed by the noise generator AWGN.
- The points 7, 8 and 9 represent the possible outputs for the corresponding analog, digital or RF output. The measured values are displayed in the current units of the corresponding output. Enabled power offsets are considered (see also [Chapter 9.2.1.4, "Understanding the Displayed Measurement Results"](#), on page 557).

### 9.2.1.3 Selecting a Suitable Acquisition Method

The provided measurement results are based on signal measurement with different acquisition methods. Select the acquisition method most fitting to your current task.

Depending on whether the displayed power values are pre-calculated or measured, there are two acquisition approaches:

- Static results
 

In "Nominal" acquisition mode, the displayed power and peak values are statistical *theoretical* values as calculated by the instrument.
- Measured results
  - "Continuous"
 

The displayed power values are determined upon analysis of the complete signal. The sweep time of the performed measurement is selectable, see ["Sweep Time/Duration"](#) on page 560.

This acquisition method is suitable for measurements of continuous signals, the sum product of correlated signals, and time varying signals
  - "Gated"
 

The displayed single RMS and peak values are determined upon evaluation of a specific signal segment; the values are the result of one measurement of signal segments at which a selected marker signal is high. Any of the "Marker 1/2/3" can be used, where the marker signals always relate to the current baseband signal source.
  - "Multi Gated"
 

In this acquisition mode, the instrument initiates a set of submeasurements and displays the measurement results separately on different lines.

The measurement function uses the two used-defined marker signals, the "Marker 2/3", as they are enabled for the current baseband signal source. The

signal "Marker 2" serves as an "init. marker signal" signal that determines the repetition window; the signal "Marker 3" is a user defined marker signal and defines different gates in this repetition window. The term gate describes the time from a rising edge to a subsequent falling edge of the marker signal. For example, the "Marker 3" signal illustrated on [Figure 9-18](#) defines three gates.



**Figure 9-18: Marker signals used in multi-gated acquisition measurement**

Marker 2 = init. marker signal

Marker 3 = user-defined marker signal

In multi-gated acquisition mode, the measured values of different gates are displayed as separate submeasurements, i.e. not combined in one result as in the gated mode. However, the submeasurement results for the same gate index performed in consecutive repetition windows are combined to smoothen RMS and peak power depending on measurement duration / sweep time.

**Note:** It is recommended that you configure up to 32 submeasurements per measurement, i.e. 32 gates in a repetition window. The repetition window is defined by Marker 2 and has to be longer than 100 ms.

This acquisition method is suitable for power measurements on bursted signals or pulse signals with different duty cycles. Like for example measurement on a periodic signal composed of a preamble, sounding channel and data, where each of these three fields is transmitted with different power.



The displayed power values are suitable as control mechanism. The values cannot be modified to influence the power and level control in the instrument.

A combination of different measurements acquisition methods can be enabled at each acquisition point. The measurement results are displayed simultaneously in a list.

Refer to [Chapter 9.2.3, "How to Query Information on the Baseband Power Levels"](#), on page 562 for examples on using the provided acquisition methods and their application fields.

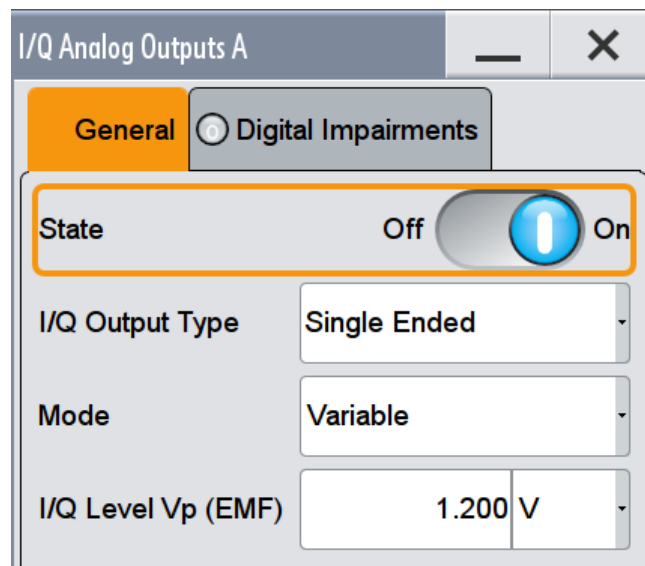
#### 9.2.1.4 Understanding the Displayed Measurement Results

The following rules apply by the calculation and display of the measurement results:

- The displayed power values refer to the selected [Output](#)
- As a reference value serves the 0dBfs level.
- The results are displayed in the current units of the corresponding [Output](#)  
For example, if an R&S SGT is connected to one of the DIG IQ OUT interfaces, the results are displayed in dBm; the instrument name is also indicated.

**Example: Results calculation and interpretation at the analog I/Q OUT**

Enable the following settings in the "I/Q Analog > Analog I/Q Output Settings" dialog:



In the "Setup > General > Baseband Powers Simulation" dialog, enable a power measurement with the following properties:

- "Source > Baseband A"
- "Output > I/Q Out 1"
- "Acquisition > Nominal"
- "I/Q level Vp (EMF) = 1.2 V"

A full scale value before the IQ modulation corresponds to 1.2 V. A -6 dBFS value for RMS or peak would then correspond to 0.6 V.

**Example: Results calculation at the RF output**

The reference value for the power calculation at the RF outputs is the "Level" value, as displayed in the status bar. A configured power offsets, for example "RF > RF Level > Offset" are considered.

Set the "RF Level = 5 dBm"

In the "Setup > Baseband Powers Simulation" dialog, enable a power measurement with the following properties:

- "Source > Baseband A"
- "Output > RF A"
- "Acquisition > Nominal"

The display shows "PEP = 15 dBm", "Level = 5 dBm"

## 9.2.2 Baseband Powers Settings

- ▶ To access the dialog box, select "SETUP > General > Baseband Powers".

Source	Output	Acquisition	Gate Source	Sweep Time / s	Progress / %	PEP	Level
Baseband A	RF A	Nominal	None	0	100	-24.36 dBm	-33.01 dBm
Fading Input A	RF A	Nominal	None	0	100	-24.36 dBm	-33.01 dBm
Fading Output A	RF A	Nominal	None	0	100	-8.34 dBm	-30.00 dBm
AWGN Input A	RF A	Nominal	None	0	100	-8.34 dBm	-30.00 dBm
Stream A	RF A	Nominal	None	0	100	-8.34 dBm	-30.00 dBm
Baseband A	I/Q Out 1	Continuous	None	10	100	500.0 mV	158.1 mV

Source: Baseband A, Output: RF A, Acquisition: Nominal, Gate Source: None, Sweep Time: 0.000 s

Buttons: Add, Change, Remove, Run Mode (Auto, Abort, Running)

The dialog provides a summarized information on the important baseband level parameters, like power level and peak power (PEP) of selectable acquisition points.

The remote commands required to define these settings are described in [Chapter 13.18.3.9, "SOURCE:BB:MEASUREMENT Subsystem"](#), on page 944.

### BB Powers Summary List

Displays the measurement results of all currently enabled measurements.

You can configure and enable up to 8 measurements simultaneously. To enable a new measurement or to change the settings of an existing one, use the [Add](#), [Change](#), [Remove](#), [Start](#), [Abort](#) functions.

"Progress %" Indicates the status of an initiated measurement.

Remote command:

`[ :SOURCE ] :BB:MEASUREMENT:POWER:PROGRESS?` on page 948

### Source/Output

Determines the start and end point for the power measurement, i.e. determines the influence of which source signal is measured at which output point. Available are measurements at all input and output interfaces of each block belonging to the baseband domain.

The available acquisition points depend on the current "System Configuration > Fading/Baseband Configuration".

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :SOURce` on page 945

`[ :SOURce ] :BB:MEASurement :POWer :OUTPut` on page 946

### Acquisition

Determines the used acquisition method, see [Chapter 9.2.1.3, "Selecting a Suitable Acquisition Method"](#), on page 556.

Refer to [Chapter 9.2.3, "How to Query Information on the Baseband Power Levels"](#), on page 562 for examples on using the provided acquisition methods and their application fields.

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :ACQuisition` on page 946

### Gate Source

In gated and multi-gated measurements, sets/displays the signal used to determine the signal part to be measured.

With "Acquisition > Gated", the starting point of the signal measurement is determined by one of the marker signals "Marker 1/2/3", as enabled for the current baseband signal source.

With "Acquisition > Multi Gated", the instruments uses the "Marker 2" and "Marker 3" signals, see [Figure 9-18](#).

See also [Chapter 9.2.3, "How to Query Information on the Baseband Power Levels"](#), on page 562.

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :GSOURCE` on page 946

### Sweep Time/Duration

Depending on the selected [Run Mode](#), determines the measurement duration/sweep time of the performed measurement.

#### Note:

Especially if a fading is enabled, it is important to trigger the measurement with an appropriate duration. To ensure correct obtained average values:

- Enable a "Run Mode > Single"
- Select a measurement period that is long enough to average the fading signal and the channel state information.

In "Acquisition > Gated", the value of the parameter "Sweep Time/Duration" relates to the effective time during that the signal is measured; the duration is determined by the corresponding marker(s) signal (high values) and not to as an absolute duration/sweep time.

#### Example:

A measurement with the following settings:

- "Acquisition > Gated"
- Duty cycle of the marker signal used as gate source = 1%
- "Duration/Sweep Time = 1 s"

This measurement lasts effectively 100 s.



Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :DURation` on page 948

### Level/PEP

Indicates the measured power level and peak power (PEP) retrieved according to the selected acquisition method and at the selected acquisition point.

The power units depend on the selected output measurement point:

- Measurements at the digital output interfaces, e.g. BBMM 1 OUT are represented in dBFs, as relative to full scale of 0.5 V
- Measurements at the analog I/Q OUT in mV respectively
- All other measurement results are represented in dBm.

Possible internal gains and attenuations are compensated.

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :PEAK?` on page 947

`[ :SOURce ] :BB:MEASurement :POWer :RMS?` on page 947

### Run Mode

Determines whether the measurements are performed continuously with the selected "Sweep Time" ("Auto") or are executed once ("Single").

"Auto" This mode is suitable for measurements with short "Sweep Time" and if several measurements are running simultaneously.

The measurement results are retrieved and updated contentiously.

"Single" This mode is suitable for measurements with longer measurement time ("Duration").

See also [Chapter 9.2.3, "How to Query Information on the Baseband Power Levels"](#), on page 562.

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :RMODE` on page 946

### Add, Change, Remove, Start, Abort

Standard function for measurements handling, like enabling a new measurement, changing an existing one or starting/stopping current measurement. You can configure and enable up to 8 measurements simultaneously, each with up to 32 submeasurements.

To retrieve information on the status of an initiated measurement, observe the "Progress" indication in the [BB Powers Summary List](#) and the [Running/Stopped](#) indication.

Remote command:

`[ :SOURce ] :BB:MEASurement :POWer :ADD` on page 947

`[ :SOURce ] :BB:MEASurement :POWer :INDEX` on page 949

`[ :SOURce ] :BB:MEASurement :POWer :CHANge` on page 949

`[ :SOURce ] :BB:MEASurement :POWer :DELeTe` on page 949

`[ :SOURce ] :BB:MEASurement :POWer :EXECute` on page 949

`[ :SOURce ] :BB:MEASurement :POWer :ABORT` on page 949

### Running/Stopped

Displays the status (running/stopped) of the current measurement.

Remote command:

[ :SOURce ] :BB:MEASurement :POWer:RState? on page 948

### 9.2.3 How to Query Information on the Baseband Power Levels

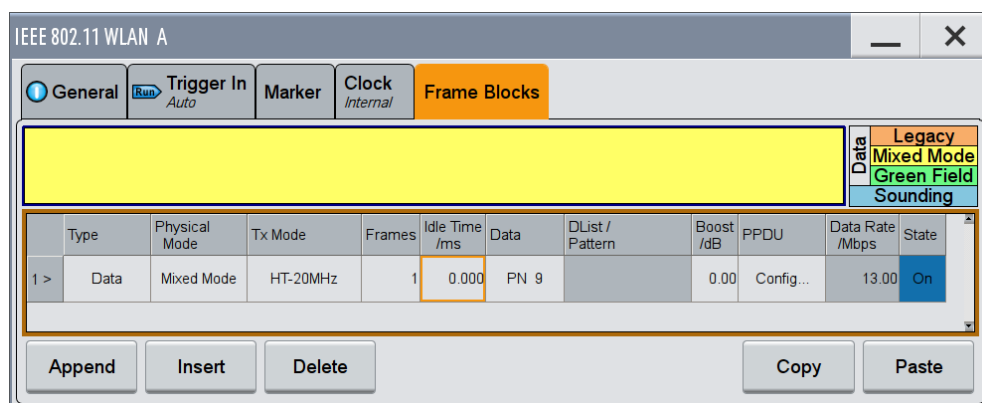
The examples in this section explain how to enable the baseband power measurements with different acquisition methods to measure different kind of signals. The measurements require a baseband signal. In these examples, we use a base unit equipped with the firmware option R&S SMW-K54 IEEE 802.11a/b/g/n and generate a WLAN signal with suitable frame and marker configuration.

The following tasks do not require special knowledge on the WLAN IEEE 802.11 standard; a basic understanding on working with the option is however a prerequisite.

#### To perform baseband power measurements using the continuous acquisition

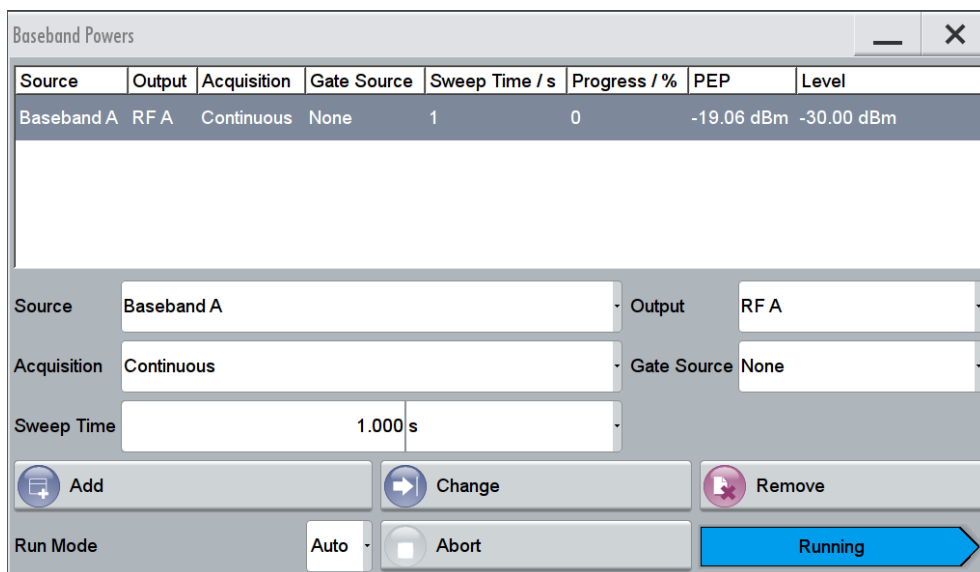
The baseband power measurements using continuous acquisition analyze the complete signal. Perform the following settings to generate a non-bursted WLAN 802.11n signal in Baseband A, Baseband B, route, and sum both signals and measure the influence of the baseband signals on the generated signal in all these cases.

1. Press the PRESET key.
2. In the block diagram, select "Baseband A > IEEE 802.11" and perform the following:
  - a) Select "IEEE 802.11 WLAN > Frame Blocks > Idle Time = 0"
  - b) Select "IEEE 802.11 WLAN > General > State > On"



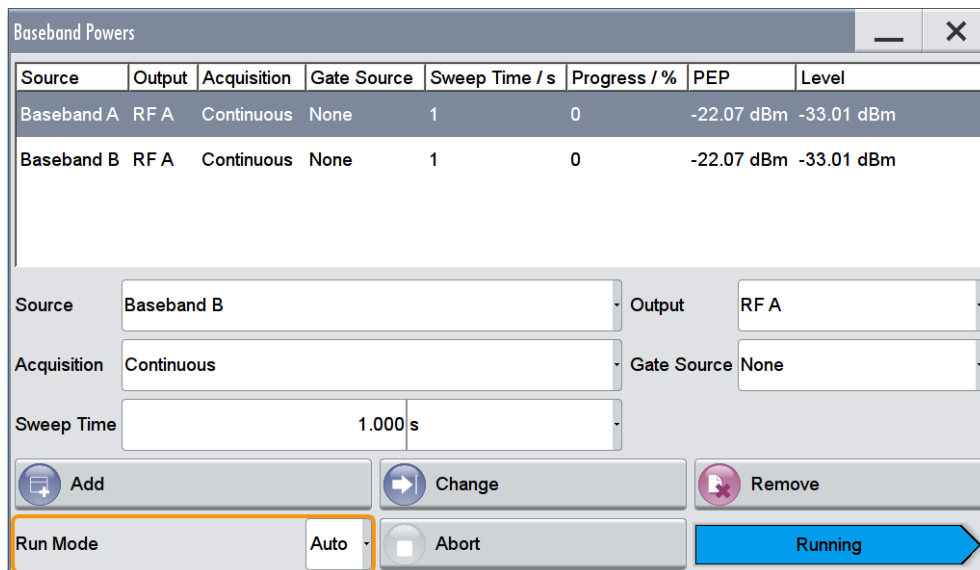
3. In the task bar, select "System Config > Setup > Baseband Powers" and perform the following:
  - a) "Source > Baseband A"
  - b) "Output > RF A"
  - c) "Acquisition > Continuous"
  - d) "Sweep Time = 1 s"
  - e) "Run Mode > Auto"
  - f) Select "Add"
  - g) Select "Start" to trigger the measurement.

Querying Information on the Baseband Power Levels



The measurement is running automatically with sweep time of 1 s. The dialog displays the measured values in the units of the RF output signal: "Level = -30 dBm" and "PEP = -19.06 dBm". These values are identical to the "Level" and "PEP" values displayed in the status bar.

- In the block diagram, select "Baseband B > IEEE 802.11" and enable the same settings as in the first baseband.
- Select "Baseband B > Signal Routing > Route to Path A and Path B".  
The signals of "Baseband A" and "Baseband B" are summed and routed to the RF A output.
- In the task bar, select "System Config > Setup > Baseband Powers", enable a second analogical measurement with "Source > Baseband B" and select "Start".



Two simultaneous measurements are running.

The dialog displays identical measured values "Level = -33.01 dBm" and "PEP = -22.07 dBm" for both measurements.

In the R&S SMW, when two identical baseband signals are added, they are output at the RF output with equal average levels. The parameter "Status bar > Level = -30 dBm" determines the level of the sum signal at the RF output; logically, the measured level values for each of the baseband signals are 3.01 dB lower than this sum level.

- In the block diagram, select "Baseband B > Baseband Offsets" and enable "Baseband B > Gain > -3 dB".

	Frequency Offset /Hz	Phase Offset /°	Gain /dB
Baseband A	0.00	0.00	0.000
BB Input A	0.00		0.000
BB Input B	0.00		0.000
Baseband B	0.00	0.00	-3.000

Both baseband signals are summed but the signal of "Baseband A" is 3 dB higher than the one of the second path.

- Open the "Baseband Powers" dialog, select "Start", and compare the measurement results.

Source	Output	Acquisition	Gate Source	Sweep Time / s	Progress / %	PEP	Level
Baseband A	RF A	Continuous	None	1	0	-20.82 dBm	-31.76 dBm
Baseband B	RF A	Continuous	None	1	0	-23.82 dBm	-34.76 dBm

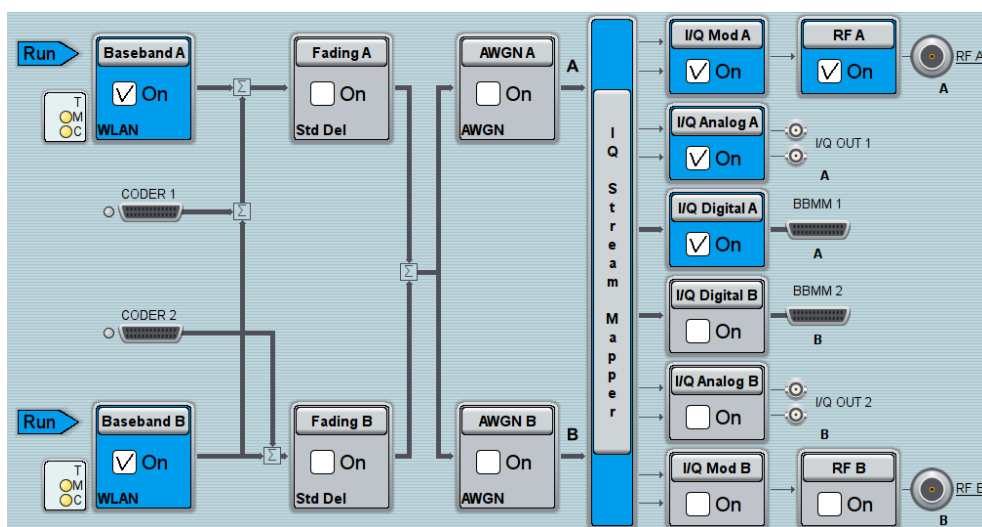
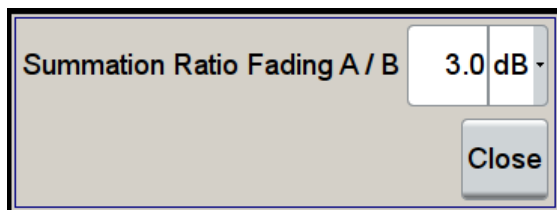
  

Source	Baseband B	Output	RF A
Acquisition	Continuous	Gate Source	None
Sweep Time	1.000 s		
Add		Change	
Remove		Remove	
Run Mode	Auto	Abort	Running

The influence of both signals on the output RF signal is different; the measured values confirm that the signal of "Baseband B" is 3 dB lower than the signal of the

"Baseband A". The level of the sum signal is still  $-31.76 \text{ dBm} + -34.76 \text{ dBm} = -30 \text{ dBm}$ .

9. Select "Fading A > Signal Routing (non-MIMO) > A to A&B, B to A&B" and select "Fading A > Summation Ratio A/B = 3 dB" to boost the baseband A with 3 dB more.



10. In the "Baseband Powers" dialog, configure three more measurements shown in the following figure.

Source	Output	Acquisition	Gate Source	Duration / s	Progress / %	PEP	Level
Baseband A	RF A	Continuous	None	1	100	-24.77 dBm	-34.77 dBm 1a
Baseband B	RF A	Continuous	None	1	100	-18.75 dBm	-28.75 dBm 1b
Fading Output A	RF A	Continuous	None	1	100	-18.75 dBm	-31.76 dBm 4a
Fading Output B	RF A	Continuous	None	1	100	-24.77 dBm	-34.77 dBm 4b
AWGN Input A	RF A	Continuous	None	1	100	-15.23 dBm	-30.00 dBm 5

Source	AWGN Input A	Output	RF A
Acquisition	Continuous	Gate Source	None
Duration	1.000 s		

Run Mode:

Querying Information on the Baseband Power Levels

- 1a, = Baseband A is 6 dB higher than baseband B (in the current routing, both signals are summed
- 1b ("Baseband B > Gain = -3 dB") and the baseband B is added to this sum product ("Fading A > Signal Routing (non-MIMO) > A to A&B, B to A&B")
- 4a, = The signal at the output of the "Fading A" is 3 dB higher than the one at the output of the "Fading B" ("Summation Ratio A/B = 3 dB")
- 4b
- 5 = The signal at the input of the "AWGN A" is the sum product of the two output signals after the fading blocks; the level at that point corresponds to the output level because the "AWGN A > State > Off"

The measurements are performed once ("Run Mode > Single"); the measurement time is determined by the selected "Duration".

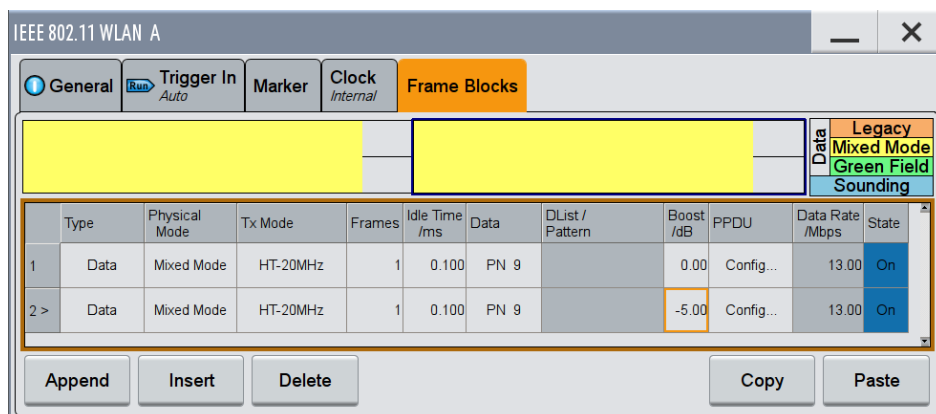
The displayed measured values are accurate and differ from the theoretical nominal values.

The baseband power measurements consider enabled power offsets and signal routing. With suitable acquisition points and method, you can measure the influence of an enabled fading simulator or detect the configured signal-to-noise value in the AWGN generator.

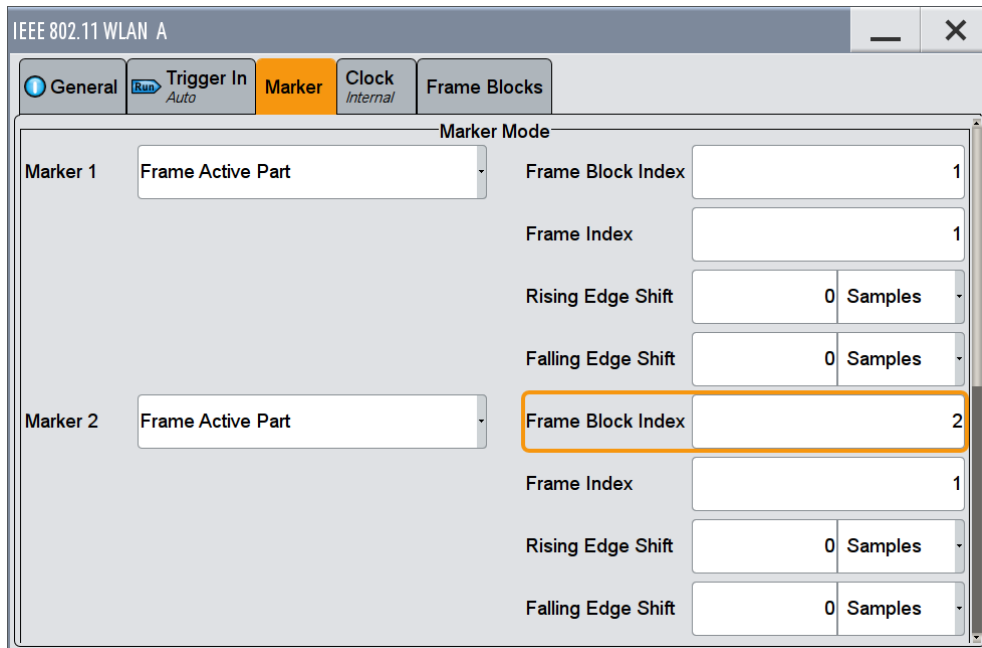
**To perform baseband power measurements on bursted signals using the gated acquisition**

The baseband power measurements using gated acquisition use marker signals to determine the particular part of the signal to be analyzed. Perform the following settings to generate a bursted WLAN 802.11n signal consisting of two frame blocks with idle periods between them.

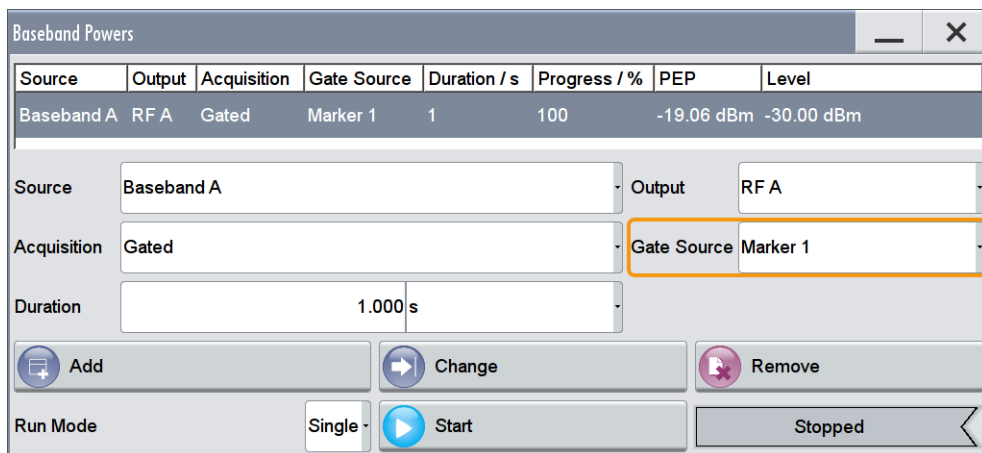
1. Press the PRESET key.
2. In the block diagram, select "Baseband A > IEEE 802.11" and perform the following:
  - a) Select "IEEE 802.11 WLAN > Frame Blocks > Append", configure "Frame Block#2 > Boost = -5 dB" and "Frame Block#2 > State = On"
  - b) Select "IEEE 802.11 WLAN > General > State > On".



- c) Select "IEEE 802.11 WLAN > Marker" and enable two marker signals, each one indicating of the PPDU part of the frame block:
  - "Marker Mode > Marker 1 > Frame Active Part", "Frame Block Index = 1", "Frame Index = 1"
  - "Marker Mode > Marker 2 > Frame Active Part", "Frame Block Index = 2", "Frame Index = 1"

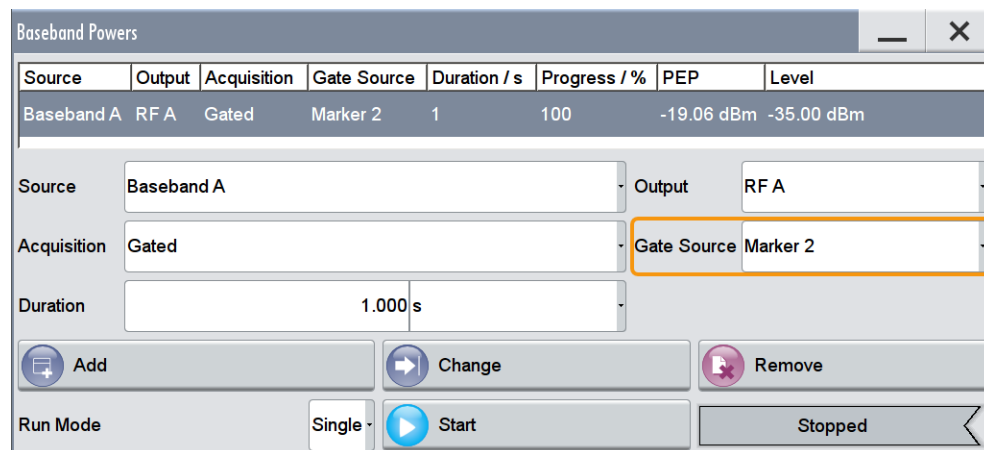


3. In the task bar, select "System Config > Setup > Baseband Powers" and perform the following:
  - a) "Source > Baseband A" and "Output > RF A"
  - b) "Acquisition > Gated" and "Gate Source > Marker 1"
  - c) "Duration = 1 s" and "Run Mode > Single"
  - d) Select "Add" and "Start" to trigger the measurement.



Performed is one single measurement. The signal "Marker 1" indicates the active part of the first frame block. The measured result confirms the expected level of -30 dBm ("Frame Block#1 > Boost = 0 dB").

4. Select "Gate Source > Marker 2", select "Change", and trigger the measurement with "Start".



Performed is one single measurement. The signal "Marker 2" indicates the active part of the second frame block. The measured result confirms the expected level of -35 dBm ("Frame Block#2 > Boost = -5 dB").

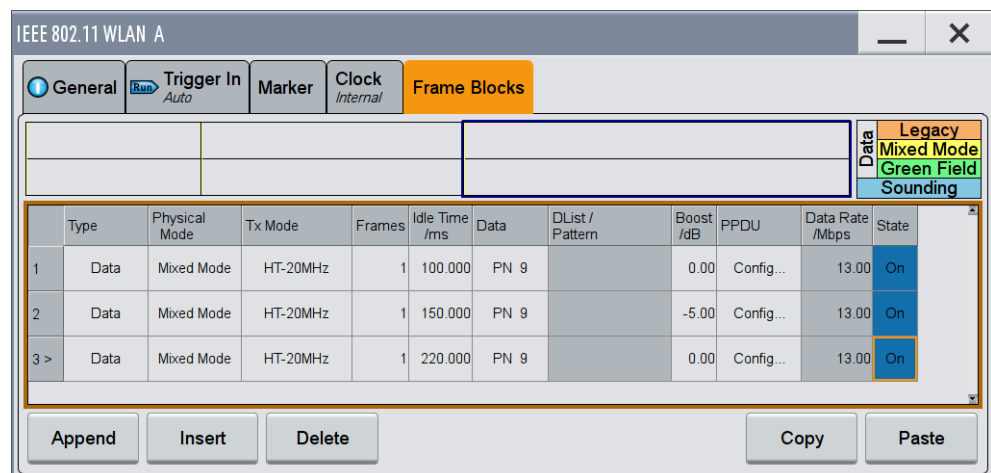
### To perform baseband power measurements on bursted signals using the multi-gated acquisition

The baseband power measurements using multi-gated acquisition use marker signals, "Marker 2" and "Marker 3", to determine the measurement period and the particular part of the signal to be analyzed. Perform the following settings to generate a bursted WLAN 802.11n signal consisting of three frame blocks with short active part and different long idle periods between them.

This example is based on the predefined marker signals. The goal is to capture and measure the short active frame parts to explain the measurement in principle. In your particular case, you would rather measure some exact signal parts or even frame parts and you may have to define one or more customized marker signals.

1. Press the PRESET key.
2. In the block diagram, select "Baseband A > IEEE 802.11" and perform the settings shown on the following figure:





The baseband signal is a bursted signal with different and short duty cycles of around 1%.

3. Select "IEEE 802.11 WLAN > Marker" and enable the two required marker signals. The Figure 9-19 shows an example of a possible marker configuration for measuring the baseband power of the second frame block.

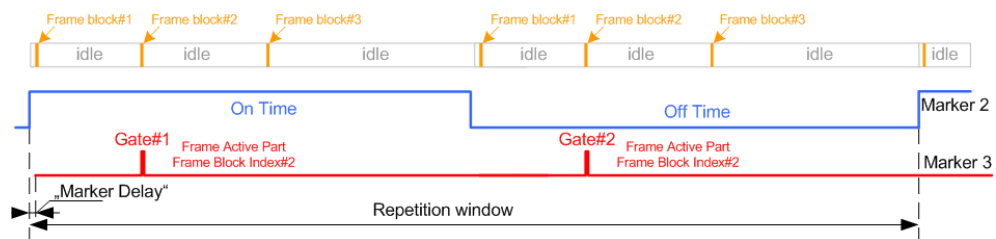
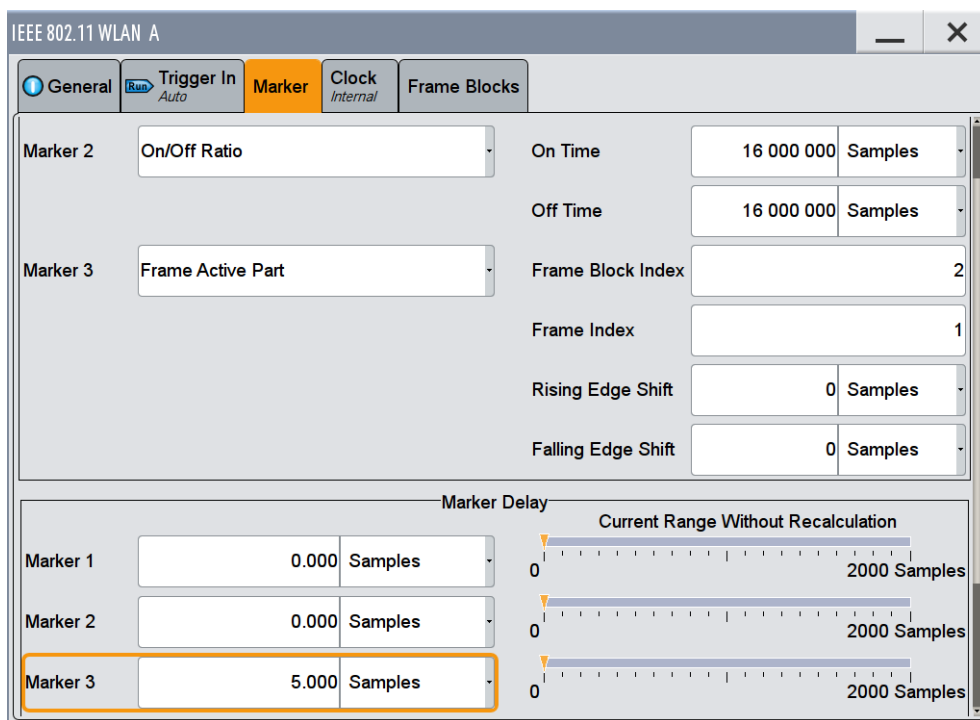


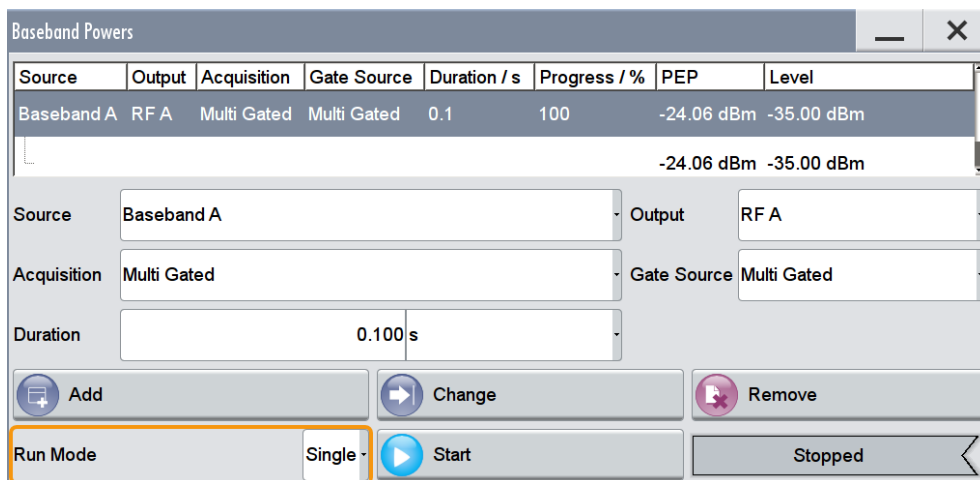
Figure 9-19: Example: Marker configuration for multi-gated baseband power measurements.

Perform for example the following:

- a) Select "Marker Mode > Marker 2 > On/Off Ratio", "On Time = 16 MSamples", "Off Time = 16 MSamples".  
The signal "Marker 2" determines the repetition window; the selected "On Time" is long enough so that the measurement captures several gates defined by the "Marker 3" signal.
- b) Select "Marker Mode > Marker 3 > Frame Active Part" and "Frame Block Index = 2".
- c) Select "Marker Delay > Marker 3 > 5 Samples" to make sure that this marker signal is within the measurement period.



4. Select "IEEE 802.11 WLAN > General > State > On".
5. In the task bar, select "System Config > Setup > Baseband Powers", enable the settings shown on the following figure, and select "Start" to trigger the measurement.



The single measurement is started and lasts a given measurement time. Observe the progress indication for information on the current progress status. The delivered measurement results of the submeasurements confirm the expected level value of -35 dBm for the second frame block. All submeasurements retrieve equal values because the selected repetition window is large and the measurement captures two gates (two frame active parts of the frame block 2).

## 10 File and Data Management

The R&S SMW uses files to save all instrument data. The instrument allows you to store and to load instrument settings, as well as to import and to export user data for processing in another instrument or at a later time. Finally, you can create a file with the current settings displayed on the screen.

The main save and recall function for managing of the instrument settings is available via the SAVE/RCL key. Dedicated save/recall functions are available in the settings dialogs of the digital standards or accessible whenever user files are used.

This section focuses on the functions provided for managing of user data files and covers the topics listed below.

For information on the related remote control commands, refer to [Chapter 13.7, "Memory Subsystem"](#), on page 723.

For information on how to store the displayed setting in a file, refer to [Chapter 10.10, "Creating Screenshots of Current Settings"](#), on page 602.

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• <a href="#">Creating Screenshots of Current Settings</a> .....	602

### 10.1 About the File System

Depending on the contained information, two file groups can be distinguished: system and user files.



Due to security reasons, system files and the system directory are protected and therefore not accessible.

The scope of this section is only the files with user data.

This section is an overview of the R&S SMW file system and covers the following topics:

- ["Types of User Data"](#) on page 572
- ["File Storage Location"](#) on page 572
- ["File Handling"](#) on page 573
- ["File Naming Conventions"](#) on page 573
- ["File Extensions"](#) on page 573

- ["File Contents"](#) on page 574

### Types of User Data

The **user data** includes saved instrument settings, data for the different digital standards, lists for the list mode and the user correction, and the waveforms for the arbitrary waveform generator.

You can also save the settings in the form of command sequences, e.g. in SCPI or other languages.

Depending on the **content**, the user data can be roughly divided into the following data types:

- *Settings*, e.g. the frame setting of the GSM/EDGE standard or the current instrument settings, can be stored and loaded later or in the other instrument path. See [Chapter 10.4, "Storing and Recalling Instrument Settings"](#), on page 580
- *SCPI Scripts*, a series of commands that can be run to perform a task. See [Chapter 10.6, "Exporting Remote Command Lists"](#), on page 589
- Externally or internally generated *lists*, e.g. user correction lists, or data lists can be loaded in the instrument. See [Chapter 10.7, "Loading, Importing and Exporting Lists"](#), on page 590 and [Chapter 10.5, "Accessing Files with User Data"](#), on page 586
- Externally or internally generated *complex modulation and control data* can be loaded in the instrument. See [Chapter 10.5, "Accessing Files with User Data"](#), on page 586
- Externally generated *waveforms* can be loaded in the "Arbitrary Waveform Generation" dialog. See [Chapter 5.5, "Using the Arbitrary Waveform Generator \(ARB\)"](#), on page 287

Depending on the **data storage method**, user data can be:

- *Persistent*, i.e. user files that are recorded on the data storage. Data is preserved when instrument is powered off and can be accessed and modified subsequently.
- *Temporary*, i.e. volatile data that the instrument retains while it is powered on. Volatile data is immediately lost when the R&S SMW is switched off.

### File Storage Location

The R&S SMW stores user files on the internal hard disk, or if selected, on a memory stick.

Both, the user directory `/var/user` on the hard disk or the `/var/usb` directory, can be used to **preserve** user-defined data. Any directory structure can be created.

The `/var/volatile` directory serves as a RAM drive and can be used to protect sensitive information. The data is available **temporary**.

### Default Storage Location

The R&S SMW stores user data in the user directory.

In manual control, you access this directory via the "File Manager", see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590. In remote control, you can query it with the command `:SYSTEM:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command `:MMEMory:CDIRectory`.

### File Handling

To access files and the file system of the instrument or to use the general file management functions such as copying and moving data, use the standard "File Manager" dialog (see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590).

To transfer files from and to the instruments or to exchange files, use one of the following alternatives:

- Connect a memory stick to one of the USB interfaces.  
The instrument recognizes automatically a connected memory stick and assigns the `/var/usb/` drive to it.

- Connect the instrument to a LAN.

An instrument connected to a LAN supports two standard file transfer methods from a remote client:

- FTP (file transfer protocol)
- File sharing according to the SAMBA/SMB (server message block) protocol.

Both file transfer methods access the folder `/var/user/share`.

For step-by-step description, refer to [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595.

- Map a network folder or a computer to an instrument connected to a LAN.  
A mapped network folder is indicated as `/shares/<"Local Folder">`.  
For step-by-step description, refer to [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594.

### File Naming Conventions

To enable files to be used in different file systems, the following file naming conventions should be observed.

The *file name* can be of any length and *is case-sensitive*, i.e. it is distinguished between uppercase and lowercase letters. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). Where possible, special characters should not be used. Use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved by the operating system, e.g. CLOCK\$, CON, AUX, COM1 . . . COM4, LPT1 . . . LPT3, NUL and PRN.

### File Extensions

The R&S SMW distinguishes the files according to their extensions; each type of file is assigned a specific file content and hence a specific file extension. The extension is usually of no consequence to the user since access to the files occurs in the individual

dialogs where only the relevant type of file is available. For example, files with frame settings can only be saved and loaded in the "GSM/EDGE" dialog.

See [Chapter B.3, "Extensions for User Files"](#), on page 1142 for an overview of the supported file extensions.

### File Contents

To maintain the file size and to accelerate the loading and processing times, not all instrument settings but rather the settings in state different than the preset one are stored. Considered is also configuration data for the operating elements and lists with user data, e.g. dialog positions and a list of user correction data. However, if a list data is part of the instrument settings, a reference to this list is stored, not the list itself.

This approach ensures that the created files contain only relevant information and allows you to transfer instrument settings even between different equipped signal generators. During the recall process, the instrument interprets only the relevant settings; all non-referenced parameters are set to the associated preset values. Error messages indicate the settings which cannot be implemented, like referencing non-existing lists or the attempt to activate settings which are not supported by the instrument.



Network settings and remote settings cannot be saved and restored.

---

## 10.2 Restoring the (Default) Instrument Configuration

The R&S SMW has various options to set default settings, see [Figure 10-1](#). You can preset the R&S SMW to an initial state at any time as a known starting point for configurations. This is often recommendable as a first step in troubleshooting when unusual results arise.

The graph on [Figure 10-1](#) shows the impact of the particular reset functions.

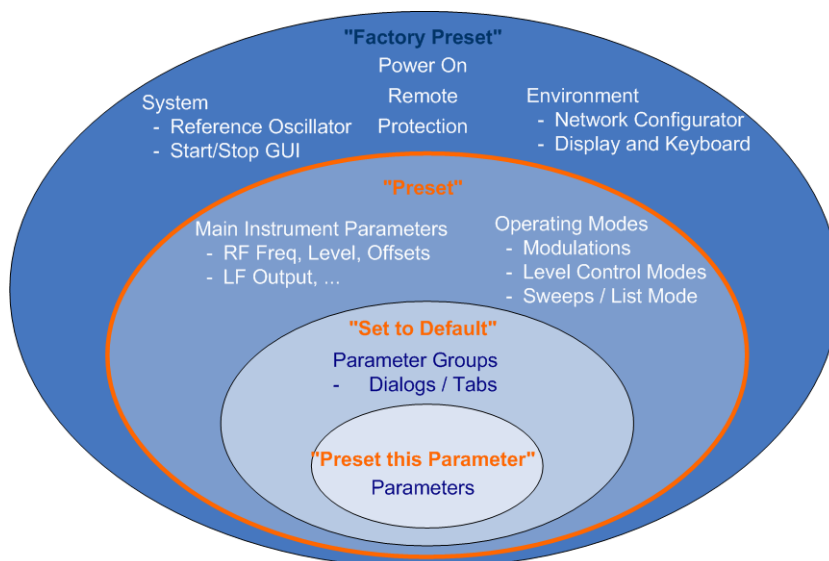


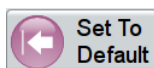
Figure 10-1: Parameter and operating modes, reset by the respective preset functions

### Overview of the characteristics of the preset functions

Select the preset option that most fits to your particular application:



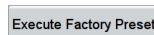
- **PRESET**  
This is the most frequently used function.  
A **Preset** executes a defined instrument setup to provide an initial instrument state as a basis for a new configuration. It resets all parameters and switching states, including also those of inactive operating modes.  
Network, remote access or system settings are retained.
- ▶ To execute a preset, press the PRESET key at the front panel.



- **"Set to Default"**  
**Set To Default** relates to individual dialogs or tabs and resets the associated settings of the corresponding dialog.  
For example, you can use it to reset all digital modulation settings in the "Custom Digital Mod" dialog. All other settings are retained.
- ▶ To reset the grouped settings, click "Set To Default".



- **"Preset this parameter"**  
Sets a single parameter to its default value.
- ▶ To reset an individual parameter, open its context-sensitive menu and select "Preset this parameter...".



- **"Factory Preset"**  
This is the most profound preset function that resets almost all instrument settings, including reference oscillator, network and remote access settings.

Retained are the following settings:

- Security, password, and settings protected by these passwords
- User-defined data, like setups, data lists, waveforms
- Settings that relate to an integration of the instrument in a measurement setup.

- ▶ To restore the factory defaults, select [System Config > Setup > Settings > Factory Preset](#).

**Note:** Perform a "Factory Preset" only if it is necessary. After a "Factory Preset", the network connection to the instrument no longer exists.

### Presetting the instrument to a user-defined instrument state

The Reset functions set the parameters and operating modes to default values predefined by the factory. Alternatively to these default settings, you can:

- Define user-specific recall settings to be restored after a preset (see [Chapter 10.2.3, "How To Recall User Settings Automatically after Preset"](#), on page 578)
- Store and reload user-defined instrument states (see [Chapter 10.4.2, "How to Save and Recall Instrument Settings"](#), on page 584)

### Mark / Don't Mark Parameters Changed from Preset

To survey the current state of the settings concerning default values, the R&S SMW offers a feature that visually identifies deviations from the default values, see [Chapter 10.2.2, "How to Identify all Parameters which are not in a Preset State"](#), on page 577.

## 10.2.1 Preset, Set To Default and Factory Preset Settings

### Preset

Resets all parameters and switching states, and closes all opened dialogs.

**Note:** External instruments connected to the R&S SMW are also preset. See [Chapter 4.4.3, "External RF and I/Q Settings"](#), on page 139.

Consider also the following possibilities:

- You can define the settings that are restored when you preset the instrument (see [Chapter 10.2.3, "How To Recall User Settings Automatically after Preset"](#), on page 578)
- In remote control, you can preset the settings of the two instrument paths separately (see [Chapter 13.6, "Preset Commands"](#), on page 722)
- You can reset the instrument to the factory state (see ["Execute Factory Preset"](#) on page 577)

See also [Table 10-1](#) that contains the key parameters that are reset by the corresponding preset functions.



Remote command:

\*RST on page 720

#### Set To Default

Resets the associated settings of the corresponding dialog or tab.

Remote command:

For example [:SOURce<hw>]:BB:<Digital Standard>:PRESet

#### Preset this Parameter

Restores the default value of a single parameter.

#### Execute Factory Preset

Resets the instrument to its factory settings.

**Note:** "Factory Preset" retains all security settings and does not delete any user files like setups, data lists or waveforms.

See also [Table 10-1](#) that contains the key parameters that are reset by the corresponding preset functions.

Remote command:

:SYSTem:FPReset on page 723

## 10.2.2 How to Identify all Parameters which are not in a Preset State

To recognize the current state of the settings related to their default values at the first glance, you can enable a function that visually identifies parameters in states different than preset.

- ▶ To activate this display press and hold the screen anywhere in the GUI of the R&S SMW and select "Mark all parameters changed from preset".



Mark all parameters changed from preset



Don't mark parameters changed from preset

If enabled, the corresponding settings appear colored, as shown in the example.

**Example:**

The screenshot shows a dialog box titled "RF Freq/Phase/Ext Ref/LO Coupling A". It has three tabs: "RF Frequency" (selected), "Phase", and "Ext. Ref./LO Coupling". Under "RF Frequency", there are three input fields: "Frequency" (2.000 000 000 00 GHz), "Offset" (2.000 00 kHz), and "Multiplier" (1.000). Below these is a "User Variation" section with a "Variation Active" checkbox (checked) and a "Variation Step" field (1.000 000 00 MHz).

*Figure 10-2: Labeled parameters show that the value deviates from its default*

Frequency	= changed (default = 1 GHz)
Offset	= changed (default = 0 kHz)
Multiplier	= unchanged
Variation Active	= changed (default = enabled)
Variation Step	= unchanged

### 10.2.3 How To Recall User Settings Automatically after Preset

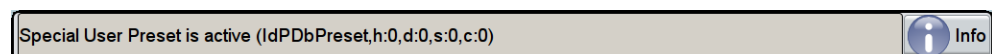
You can define the settings that are restored when you preset the instrument.

1. Configure the settings as required and store them as described in [Chapter 10.4.2, "How to Save and Recall Instrument Settings"](#), on page 584.
2. Save the settings as a file with the predefined file name `UserPreset.savrc1.txt` and store this file in the directory `/var/user/`.

The file name `UserPreset.savrc1.txt` and the directory `/var/user/` are mandatory.

Now when you press the PRESET key or send the `*RST` command to the instrument, the defined settings are restored.

An "Info" message confirms, that a file with user-defined preset setting is loaded.



## 10.2.4 Reference

See [Table 10-1](#) for an overview of the main generator settings that are affected by the corresponding preset functions. While the regular PRESET key primarily resets the signal relevant parameters of the instrument, the "Factory Preset" affects almost all instrument settings.

For information on the default values of further parameters refer to the description of the associated remote commands.

**Table 10-1: Key parameters affected by Preset and Factory Preset**

Parameter	Preset value	Preset	Factory Preset
RF frequency	1 GHz	x	x
RF level (RF output)	off	x	x
Offsets	0	x	x
Modulation state	off	x	x
Uninterrupted level settings	off	x	x
Level attenuator mode	auto	x	x
Level ALC (internal level control)	auto	x	x
Level UCOR (user correction)	off	x	x
LF output state	off	x	x
Sweep state	off	x	x
List mode state	off	x	x
Reference frequency settings (reference oscillator)	-	-	x
Power on settings (Level/EMF)	-	-	x
Network settings	-	-	x
Hostname <sup>1)</sup>	-	-	x
GPIB address	-	-	x
Start/Stop Display Update	-	-	x
Display and keyboard settings	-	-	x
Password and settings protected by passwords (e.g. disabled LAN or USB)	-	-	-
Security settings	-	-	-
User files (setups <sup>2)</sup> , data lists, waveforms)	-	-	-

- <sup>1)</sup> Hostname syntax `rs<inst><serial no>` has changed to `<INST>-<serial no>` (FW 3.20.200.xx and later), see [Chapter 3.1.4.2, "Using Computer Names \(Hostnames\)"](#), on page 46

2) `UserPreset.savrc1txt` is renamed as `UserPresetInactive.savrc1txt`; an existing file with the same name is overwritten.



If the default values in the "Remote Access" dialog had been changed, a Factory Preset via remote control (`:SYSTem:FPReset`) terminates the connection to the instrument!

Security settings are never reset.

Resets all parameters and switching states, and closes all opened dialogs.



A PRESET resets also external instruments connected to the R&S SMW. See [Chapter 4.4.3, "External RF and I/Q Settings"](#), on page 139.

## 10.3 Protecting Data

During operation, the R&S SMW stores user data permanently, see ["File Storage Location"](#) on page 572.

To protect any classified data and to avoid storing any sensitive data on the R&S SMW permanently, you can:

- Store user files temporary in the `/var/volatile` directory, which remains available only until the instrument is switched off.  
You can access data stored in volatile memory just as data stored permanently in the `/var/user/`.  
See also [Chapter 10.8.3, "How to Display All Stored Files"](#), on page 593.
- Activate write protection on the nonvolatile memory, so that no information can be written to memory permanently.  
Instead, you can only store data temporary in the volatile memory or on a connected external storage device, such as a memory stick.  
See also:
  - ["Write Nonvolatile Memory"](#) on page 637
  - [Chapter 10.9.4, "How to Use a USB Storage Device for File Transfer"](#), on page 600

## 10.4 Storing and Recalling Instrument Settings

Possibly you would like to restore or repeat a signal generation you performed under specific conditions on the instrument. Or, in a test setup with more than one signal generators, you want to transfer the used settings to another R&S SMW. Some test setups may also require similar settings in all instrument paths. In these cases, you can store and recall instrument and user settings, and possibly other related data.

In each of these cases, you can create a file with the complete instrument settings or you can choose to store only the settings belonging to a particular digital standard. The instrument uses a similar save/recall principle; both ways are scope of this section.

### Save/Recall the complete instrument settings

Two different methods are available for managing *complete instrument settings*:

- Immediate (quick) Save/Recall  
A defined set of instrument settings are stored or recalled quickly in just one step, without defining a file name or storage location. This function enables a fast switching between different instrument settings.
- Save/Recall in files with user-defined names  
The defined set of instrument settings are stored to a definable storage location. The file extension is \*.savrc1txt.  
Settings files created in this way are visible in the file system and accessible with the supported methods for file handling.

In the general case, a recall process replaces the instruments settings with the saved values. An exception is the frequency and level settings. During recall of the instrument settings, it is possible to retain the current settings or to overwrite them with the stored values.

### Save/Recall the settings belonging to a firmware option

Each of the firmware option provides a special "Save/Recall" function to manage directly the settings associated to the corresponding digital standard, e.g. all settings in the "3GPP FDD" dialog.

The "Save/Recall" function creates files with user-defined names, predefined file extension and on a definable storage location. The files are accessible with the supported methods for file handling.



#### Accessing and recalling instrument setups

For quick access to a stored instrument setup file, assign the appropriate action to the USER key.

See [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627.

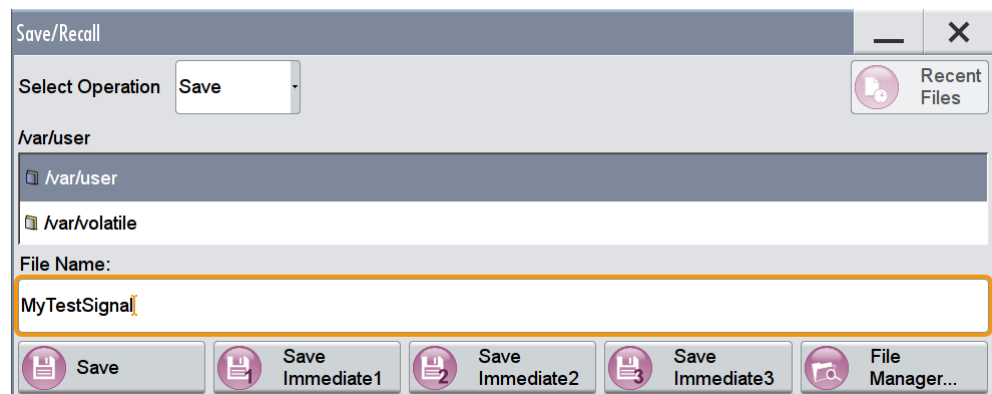
---

## 10.4.1 Save/Recall Settings

### To access the dialog for storing and loading the complete instrument settings

1. Select "SETUP > Settings > Save/Recall" or press the SAVE/RCL key.
2. Choose "Select Operation > Save or Recall" to access the corresponding settings.

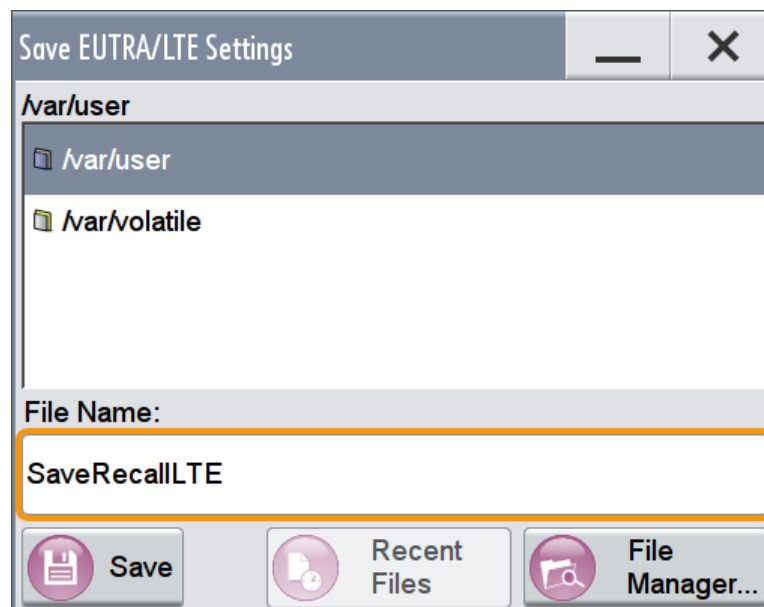
The provided settings for both operations are similar and closely related.



### To access the dialog for storing and loading the settings of a firmware option

- ▶ In the general dialog of the corresponding digital standard, select the "Save" or "Recall" operation, e.g. select "Block Diagram > Baseband > EUTRA/LTE > General > Save".

The name of the dialog is context-sensitive and differs depending on the particular digital standard. The provided functions are similar.



### Select Operation

Accesses the settings for storing ("Save") and loading ("Recall") of the instrument settings, or for exporting created SCPI files ("SCPI-Export").

See [Chapter 10.6, "Exporting Remote Command Lists"](#), on page 589.

### Directory, File List and File Name

#### Note:

You access this generic standard function each time you perform one of the following:

- Store or load (settings) files
- Define a folder in that these files are stored

- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

With the provided settings, you can perform the following:

- To navigate through the file system, use the directory tree.
- To create a file, load and store files, use the dedicated functions "New", "Select", Save, and Recent files.
- To access the general data list editor, use the "Edit" button (see also Chapter 8.7.7, "List Editor", on page 464).
- to perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Chapter 10.8, "Performing General File Management Functions with the File Manager", on page 590).

Remote command:

To list all files in a directory:

`:MMEMory:CDIRectory` on page 730

`:MMEMory:CATalog?` on page 729

Refer to the description of firmware options for the syntax of the corresponding SCPI command:

`[ :SOURce<hw> ] :BB :<Digital Standard> :SETTing :CATalog`

`[ :SOURce ] :CORRection :CSET :CATalog?` on page 962

To list files with user data:

`[ :SOURce<hw> ] :BB :DM :DLISt :CATalog?` on page 838

`[ :SOURce<hw> ] :BB :DM :CLISt :CATalog?` on page 838

### Recent files

Displays the files last used.

### Save

Saves the current instrument settings or the settings belonging to a digital standard under the defined file name.

Remote command:

`:MMEMory:STORe:STATe` on page 734

Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI commands:

`[ :SOURce<hw> ] :BB :<Digital Standard> :SETTing :STORe`

`[ :SOURce<hw> ] :BB :<Digital Standard> :SETTing :DELete`

### Save Immediate x

Stores the current instrument setting in one of the three intermediate memories.

These instrument settings are retained until a different instrument setting is stored in the intermediate memory. When the instrument is switched off, the contents of the intermediate memories are retained.

Remote command:

\*`SAV` on page 720

### Exclude Frequency

The current frequency is retained when a stored instrument setting is loaded.

Remote command:

`[ :SOURce<hw> ] :FREQuency [ :CW | FIXed ] :RCL` on page 977

### Exclude Level

The current level is retained when a stored instrument setting is loaded.

Remote command:

`[ :SOURce<hw> ] :POWer [ :LEVel ] [ :IMMediate ] :RCL` on page 1032

### Recall

Restores the selected configuration.

During recall, the instrument considers all related settings, for example sweeps in active state or lists. An error message indicates the settings which cannot be implemented.

Remote command:

`:MMEMory:LOAD:STATe` on page 732

Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:

`[ :SOURce<hw> ] :BB:<Digital Standard>:SETTing:LOAD`

### Recall Immediate x

Loads the selected configuration from one of the three intermediate memories. A message appears if no instrument configuration is stored in this memory.

Remote command:

`*RCL` on page 720

### File Manager

Accesses the "File Manager" dialog, see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590.

## 10.4.2 How to Save and Recall Instrument Settings

Instrument settings can be saved to a file and loaded again later, so that you can repeat the tests with the same settings.



### Accessing and recalling instrument setups

For quick access to a stored instrument setup, assign the appropriate action to the USER key, see [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627.

### To save and recall instrument settings quickly

1. Select "SAVE/RCL > Save/Recall" and select "Select Operation > Save".

2. Select "Save Immediate 1".

The instrument saves its settings in the intermediate memory 1. The file name and the storage location cannot be changed.

3. Adapt the instrument settings as required and select "Save Immediate 2"



4. To restore the settings, select the "Select Operation > Recall"
5. Select "Recall Immediate 1"  
The instrument is restored to the previous state.
6. Select "Recall Immediate 2" to switch to the settings stored in the second file.

#### To save complete instrument settings

1. Select "SAVE/RCL > Save/Recall" and select "Select Operation > Save".
2. Navigate in the file selection dialog and select a file name and storage location for the settings file.
3. Select "Save".  
A file with the defined name and path and the extension `*.savrc1.txt` is created.

#### To restore instrument's configuration

Store the configuration as described in ["To save complete instrument settings"](#) on page 585.

1. To restore settings, select "SAVE/RCL > Save/Recall > Select Operation > Recall".
2. To retain the current frequency and level settings, enable "Save/Recall > Exclude Frequency/Level"
3. Navigate in the file selection dialog and select the file name and storage location of the settings file.

The settings are restored, but the frequency and level settings are retained; you can repeat the signal generation with the same settings.

See also [Chapter 10.2.3, "How To Recall User Settings Automatically after Preset"](#), on page 578.

### 10.4.3 How to Save and Recall the Settings of a Firmware Option

Some test setups, e.g. for MIMO tests, require that two or more instruments generate baseband signal with similar settings. One easy way to speed up the configuration is to use the dedicated save/recall function to transfer the configuration data from one instrument to the other.

#### To use the "Save/Recall" function to transfer settings related to a digital standard to another instrument

1. In the first instrument, select "Baseband > Digital Standard, e.g. 3GPP FDD" and adjust the settings as required.
2. In the "3GPP FDD > General" tab, select "Save", navigate in the file selection dialog, and select a file name and storage location for the settings file.

A file with the defined name and path and a predefined extension (`*.3g`) is created.

3. Connect both instrument to a LAN or use a USB stick to transfer the created \*.3g file to the second instrument.
4. In the second instrument, select "Baseband > 3GPP FDD > General > Recall" to load the stored file.
5. Navigate in the file selection dialog and select the file name and storage location of the settings file.

The settings are loaded in the second instrument. If the corresponding settings are left unchanged, the second instrument generates a signal with identical baseband settings.

## 10.5 Accessing Files with User Data

By the calculation of signals according to the different digital standards or by the generation of custom digitally modulated signals, the R&S SMW uses the data from different data sources (see also [Chapter 5.3.1.1, "Data, Clock and Control Signals and Sources in the Baseband"](#), on page 216). To simulate the signal of one UE for instance, the instrument modulates and codes the provided data for each channel and further process the signal as described in the corresponding standard.

Whenever a data list file is enabled as a data source, the instrument provides direct access to the standard "File Select" function. This enables you to select, create and edit the data list files.

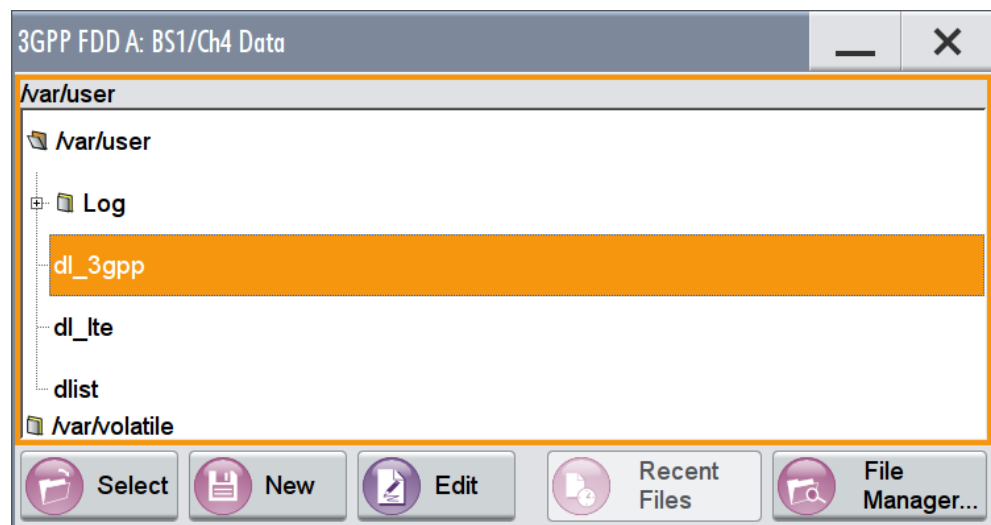
### 10.5.1 File Select Settings

The "File Select" dialog opens automatically each time you select a data list file as data source or you select a control list.

#### To access a loadable data list file

1. Select the "Data List Name" in the individual dialog, e.g. for "Baseband > 3GPP FDD > Basestations > BS1 > Channel Table > P-CCPCH > Data = Data List" select "DList = None".

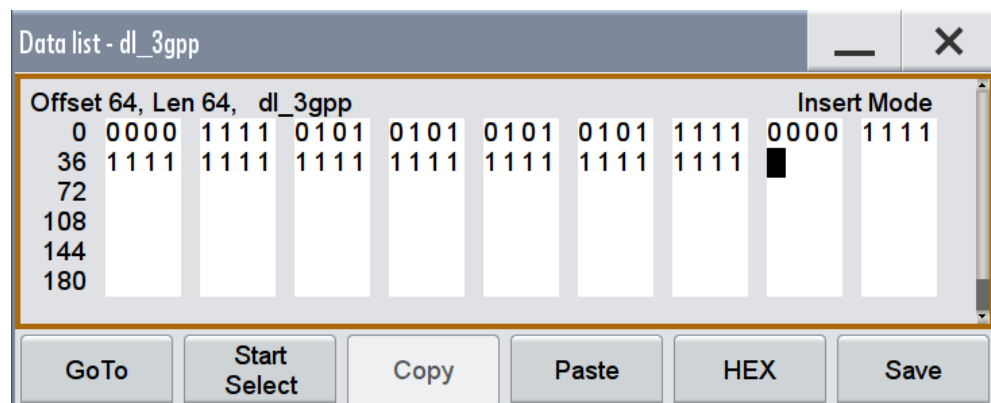
A "File Select" dialog for loading, creating and modifying a file is displayed.



**Tip:** The name of the dialog is context-sensitive and differs depending on the particular function this dialog is from. However, the provided functions are similar.

2. To load an existing file, navigate through the file system, select the file, and confirm with "Select".
3. To create a file, for example if there is no data list file specified, navigate through the file system to the desired folder, select "New", and specify the file name.  
A new empty file is created and stored in the selected folder.
4. To edit an existing or newly created file, navigate through the file system, select the file, and select "Edit".

The standard "Data List Editor" dialog opens, see [Chapter 5.4.3.7, "Data List Editor"](#), on page 267.



5. Edit the file content and confirm with "Save".

### Directory, File List and File Name

#### Note:

You access this generic standard function each time you perform one of the following:

- Store or load (settings) files
- Define a folder in that these files are stored

- Navigate through the file system.

The dialog name changes depending on the context. The provided functions are self-explanatory and similar.

With the provided settings, you can perform the following:

- To navigate through the file system, use the directory tree.
- To create a file, load and store files, use the dedicated functions "New", "Select", Save, and Recent files.
- To access the general data list editor, use the "Edit" button (see also Chapter 8.7.7, "List Editor", on page 464).
- to perform standard file management functions, like create directories, move, copy, delete files and/or directories, use the standard "File Manager" function (see Chapter 10.8, "Performing General File Management Functions with the File Manager", on page 590).

Remote command:

To list all files in a directory:

`:MMEMory:CDIRectory` on page 730

`:MMEMory:CATalog?` on page 729

Refer to the description of firmware options for the syntax of the corresponding SCPI command:

`[ :SOURce<hw> ] :BB:<Digital Standard> :SETTing:CATalog`

`[ :SOURce ] :CORRection:CSET:CATalog?` on page 962

To list files with user data:

`[ :SOURce<hw> ] :BB:DM:DLISt:CATalog?` on page 838

`[ :SOURce<hw> ] :BB:DM:CLISt:CATalog?` on page 838

### Functions for handling of data lists

Provided are the following standard functions for file handling:

"Select"            Select and load the file.

Remote command:

`[ :SOURce<hw> ] :BB:DM:DLISt:SElect` on page 839

Refer to the descriptions of the firmware options for the correct syntax of the corresponding SCPI command:

`[ :SOURce<hw> ] :BB:<Digital Standard> :...:DATA DLISt`

`[ :SOURce<hw> ] :BB:<Digital Standard> :...:DSElect`

"New"                Creates file with the specified "File Name".  
To confirm, select "OK"; use "Cancel" to undo the operation.  
To edit the file content, select "File Select > Edit".

"Edit"                Accesses the "Data List Editor" and loads the selected file for editing, see Chapter 5.4.3.7, "Data List Editor", on page 267.

### Functions for handling of control lists

Provided are the following standard functions for file handling:

"Select"            Select and load the file.

Remote command:

[ :SOURce<hw> ] :BB:DM:CLISt:SElect on page 839

"New"              Creates file with the specified name. To edit the file content, select "File Select > Edit".

"Edit"              Access the "Control List Editor" and loads the selected file for editing, see [Control and Marker Lists Editor](#).

#### Recent files

Displays the files last used.

#### File Manager

Accesses the "File Manager" dialog, see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590.

## 10.5.2 How to Create and Access Data and Control Lists

The general principle for accessing files with user data is described in ["To access a loadable data list file"](#) on page 586. Detailed and further information on how to create and access files with user data like data lists and control lists is provided in the following sections:

- [Chapter 5.4.4.2, "How to Create and Assign a Data List"](#), on page 275  
Overview of the possible ways and detailed description on how to create data lists
- [Chapter 5.4.4.1, "How to Create and Assign a Control List"](#), on page 273  
Overview of the possible ways and detailed description on how to create control lists
- [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724  
Information on accessing files in a remote environment

## 10.6 Exporting Remote Command Lists

To set specific instrument settings or perform a task automatically, you can create scripts that contain the appropriate settings in the form of remote control command sequences.

You can either record or manually create SCPI lists, or generate a list of the current instrument state in one step, see [Chapter 12.15, "How to Record / Create SCPI Lists"](#), on page 699.

Completed scripts are stored in files, converted to different formats, depending on the used language of the source code.

The R&S SMW supports the most commonly used languages by default, as there are:

- Plain SCPI: \* .txt
- MATLAB: \* .m

- NICVI: \*.c

It is also possible, to convert the SCPI command list to a user-specific language, see [Chapter 12.16, "How to Convert and Store SCPI Lists"](#), on page 703.

## 10.7 Loading, Importing and Exporting Lists

Although the R&S SMW provides built-in editors for creating of data and control list, as well as list for the list mode or lists with user correction data, you may want to create or evaluate them with an external application. The instrument provides interfaces with the following functionality:

- Import and export list files in a standard ASCII format file
- Load files with modulation and control information
- Load of internally or externally generated waveform file

Lists are stored and loaded in the appropriate dialogs. For example, the user correction data list is created and stored in the "User Correction" dialog; waveform files are created with the signal generation software R&S WinIQSIM2 or in the dialogs of some of the digital standards.

For more information, refer to:

- [Chapter 10.5.2, "How to Create and Access Data and Control Lists"](#), on page 589
- [Chapter 8.7.8, "Import/Export List Files"](#), on page 467

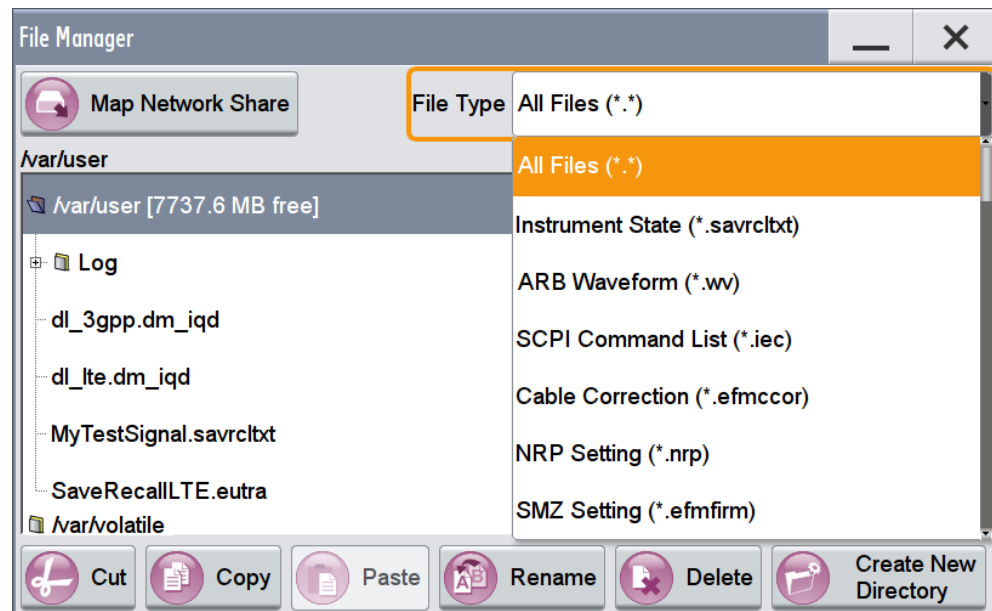
## 10.8 Performing General File Management Functions with the File Manager

The "File Manager" is a tool similar to a standard Windows Explorer and helps you manage mass storage media and files stored on the R&S SMW.

You can perform the following tasks:

- Copying multiple files from disk to other media  
See [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595
  - Copying files into another directory  
See [Cut, Copy&Paste and Delete](#)
  - Renaming and deleting files
  - Creating directories  
See [Create New Directory](#)
  - Mapping shared network folders  
See [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594
  - Displaying stored files  
See [Chapter 10.8.3, "How to Display All Stored Files"](#), on page 593
- To access this dialog, select "SAVE/RCL > File Manager".

**Tip:** Each "Save/Recall" dialog and each "File Select" dialog provides a quick access to the "File Manager", i.e. whenever you select data lists or files with user data.



The "File Manager" dialog provides all standard functions required for file management. It displays the contents of the selected folder on the R&S SMW and provides functions to rename, delete, copy, or move individual files.

### 10.8.1 File Manager Settings

#### Map Network Share

Accesses the [Map Network Share Settings](#) dialog where you can map one or more network folders.

See also [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594.

#### File Type

Selects the file type to be listed. If a file type with a specific file extension is selected only files with this extension are listed.

See [Chapter B.3, "Extensions for User Files"](#), on page 1142 for an overview of the supported file extensions.

#### Directory and File Name

Selects the directory in which the file to be deleted or copied is located. The dialog lists all files in this directory. Selected files are highlighted. The path is indicated above the directory tree.

Unlike the "Save/Recall" and "File Select" dialogs, the "File Manager" displays the full file names including extensions.

Remote command:

:MMEMemory:CDIRectory on page 730

### Cut, Copy&Paste and Delete

Standard file management functions.

Before a file is deleted, a message appears prompting the user to confirm deletion of the file.

Remote command:

:MMEMemory:DELeTe on page 732

:MMEMemory:COpy on page 730

### Rename

Renames the selected file or directory.

Remote command:

:MMEMemory:MOve on page 733

### Create New Directory

Creates a folder and opens an edit dialog box to enter name and path (absolute or relative to the current directory) of the new folder.

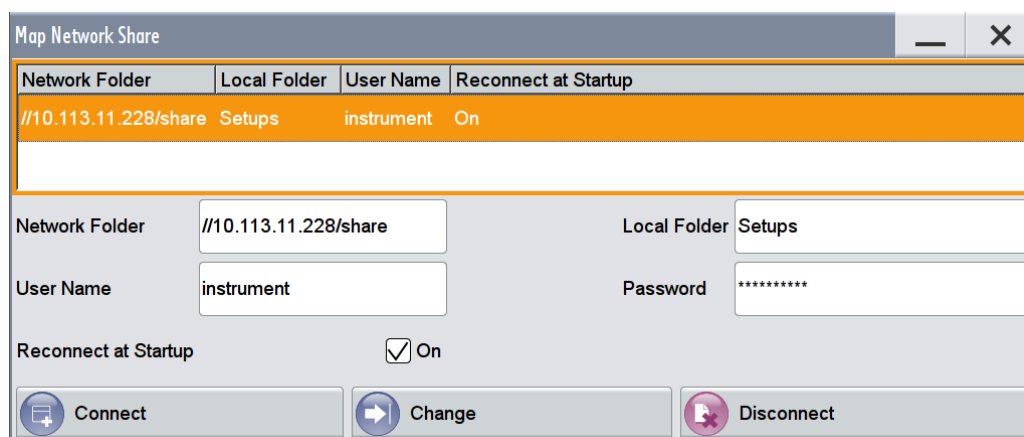
Remote command:

:MMEMemory:MDIRectory on page 733

## 10.8.2 Map Network Share Settings

The "Map Network Share" dialog provides settings that are similar to the standard Windows Explorer function "Map network drive". These settings help you to create up to 10 "shortcuts" to shared folders or computers in the network.

The dialog displays a list of current mapped network folders. The directory tree of the "File Manager", "Save/Recall", and "File Select" dialogs indicates a mapped network folder as /shares/<"Local Folder">.



See also [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594.



**Network Folder**

Enter the path of the folder or computer, e.g. `//<IP Address>/share`  
or `//<server name>/share`.

**Local Folder**

Enter a letter or an alias name to describe the folder.

In the directory tree, a mapped network folder is indicated as `/shares/`  
`<"Local Folder">`.

**User Name**

Enter a user name of a user that has the permission to access the selected network folder.

**Password**

Enter the password of the selected user.

**Reconnect at Startup**

Enables reconnecting every time you start up the instrument.

**Connect**

Triggers the instrument to prove the credential and to map (i.e. connect) the selected network folder or computer to the instrument.

You can map up to 10 network folders.

**Change**

Applies the changes.

**Disconnect**

Disconnects the network drive.

### 10.8.3 How to Display All Stored Files

**To display all stored files on the internal hard disk**

1. Press SAVE/RCL.
2. Select "File Manager" and navigate to `/var/user/`.

**To display all stored files on a connected USB stick**

1. Press SAVE/RCL.
2. Select "File Manager" and navigate to `/var/usb/`.

**To display all files in the volatile memory**

1. Press SAVE/RCL.

2. Select "File Manager" and navigate to `/var/volatile/`.

### 10.8.4 How to Map a Network Folder

Possibly you would like to transfer instrument or user settings to another R&S SMW, distribute waveform files to several instruments or you have to access frequently the same network drive. In these cases, on a R&S SMW connected to a LAN you can create a shortcut to this network folder or this computer.

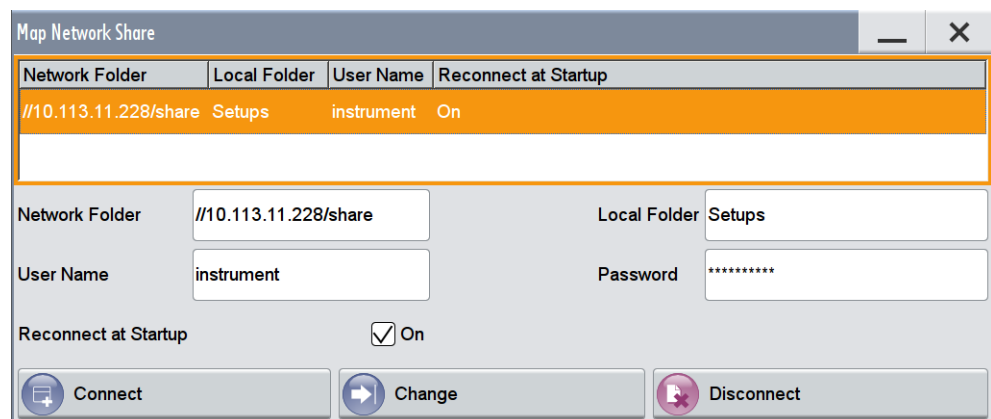
For information on how to set up a LAN connection, refer to:

- [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45
- [Chapter 12, "Network and Remote Control Operation"](#), on page 649

To map a network folder proceed as follows:

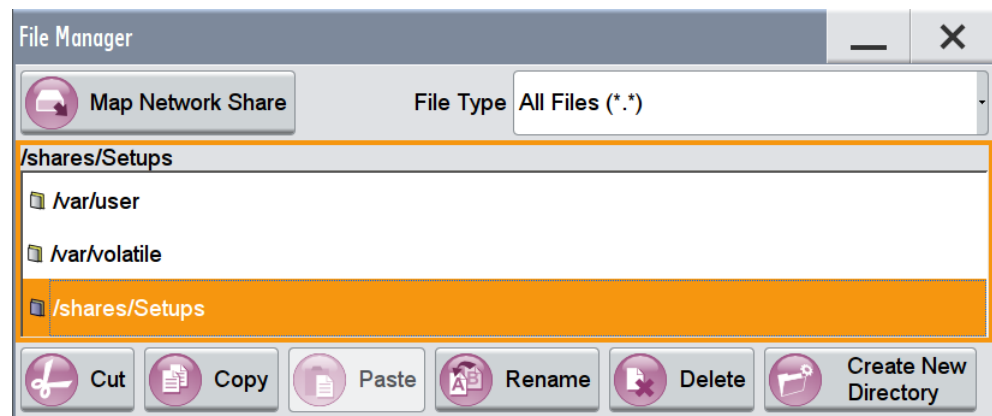
1. On the computer or the network folder you want to map, enable remote access. You can specify a list of users allowed for remote access. The remote access settings depend on the operating system the remote computer is using. For step-by-step instructions, refer to the documentation of the particular operating system.
2. On the R&S SMW, [enable file transfer via SMB \(samba\)](#).
3. Select "System Config > Setup > Remote Access > Network" and select:
  - a) "Address Mode > Auto (DHCP)"
  - b) Check that the "DNS Suffix" and "DNS Server" are correct.
4. Press the SAVE/RCL key.
5. In the "Save/Recall" dialog, select "File Manager > Map Network Share".
6. In the "Map Network Share" dialog, select:
  - a) In the "Network Folder" field, enter `//<IP Address>/share` or `//<Server Name>/share`, e.g. `//10.113.10.228/share`.
  - b) In the "Local Folder" field, enter an alias name, e.g. *Setups*.
  - c) Enter the "User Name" and "Password" of a user for that the remote access to the selected network folder is allowed.
  - d) If required, enable "Reconnect at Startup".
  - e) Select "Connect".

The selected network folder is mapped to your instrument. The list of mapped network folders is updated.



7. Close the "Map Network Share" dialog.

The navigation tree in the "File Manager" dialog displays the mapped network folder as `shares/Setups`.



If the connection does not succeed, consider to check the following:

- Is the network folder or computer you try to map turned on?
- Is the network folder or computer enabled for remote access?
- Does the selected user have the necessary permissions?

See also [Chapter 10.9.5, "How to Access a File Server and Use the Same Test Files on Several Instruments"](#), on page 601.

## 10.9 Transferring Files from and to the Instrument

As explained in "File Handling" on page 573, you access the file system of the R&S SMW via one of the following ways:

- Via the built-in "File Manager"  
See [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590.

- On an instrument connected to a LAN,
  - Via one of the standard functions ftp or SMB (samba);  
See [Chapter 10.9.2, "How to Access the File System of the R&S SMW via ftp"](#), on page 597 and  
[Chapter 10.9.3, "How to Access the File System of the R&S SMW via SMB \(Samba\)"](#), on page 599
  - Via mapped network drives  
See [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594.
- Via a connected USB storage device  
See [Chapter 10.9.4, "How to Use a USB Storage Device for File Transfer"](#), on page 600

Mainly because of security reasons, the access to the file system of your R&S SMW may be denied, because one or all these access methods are deliberately disabled. Access to the file system via LAN and/or USB requires that the corresponding service is enabled and a write access to the file system is enabled. Refer to [Chapter 10.9.1, "How to Enable an Access to the File System of the R&S SMW"](#), on page 596 for description of the required steps.

This section provides an introduction to the topic. For comprehensive information, refer to the Application Note [1GP72 "Connectivity of Rohde&Schwarz Signal Generators"](#).

- [How to Enable an Access to the File System of the R&S SMW](#)..... 596
- [How to Access the File System of the R&S SMW via ftp](#).....597
- [How to Access the File System of the R&S SMW via SMB \(Samba\)](#)..... 599
- [How to Use a USB Storage Device for File Transfer](#)..... 600
- [How to Access a File Server and Use the Same Test Files on Several Instruments](#)..... 601

## 10.9.1 How to Enable an Access to the File System of the R&S SMW

The following prerequisites have to be fulfilled, if you try to access the file system via ftp, SMB (samba) or USB:

- The write protection on the file system has to be disabled
- The corresponding service/interface has to be enabled.

### To enable write permission on the file system

1. Select "System Config > Setup > Security > Security > General"
2. Enable "Write Nonvolatile Memory"
3. Enter the "Security Password".  
The default password is *123456*. For more information, refer to [Chapter 11.5, "Managing the Security Settings"](#), on page 634.
4. Select "System Config > Setup > Maintenance > Shut Down"
5. Select "Reboot".

The system reboots. The enabled settings are active.

**To enable file transfer via ftp**

1. Select "System Config > Setup > Security > Security > LAN Services".
2. Enable "LAN Interface"
3. Enable "FTP"
4. Enter the "Security Password".  
The default password is 123456. For more information, refer to [Chapter 11.5, "Managing the Security Settings"](#), on page 634.
5. Select "Accept".

**To enable file transfer via SMB (samba)**

1. Select "System Config > Setup > Security > Security > LAN Services"
2. Enable "LAN Interface"
3. Enable "SMB (Samba)"
4. Enter the "Security Password".  
The default password is 123456. For more information, refer to [Chapter 11.5, "Managing the Security Settings"](#), on page 634.
5. Select "Accept".

**To enable file transfer via USB**

1. Select "System Config > Setup > Security > Security > General"
2. Enable "USB Storage"
3. Enter the "Security Password".  
The default password is 123456. For more information, refer to [Chapter 11.5, "Managing the Security Settings"](#), on page 634.
4. Select "Accept".

## 10.9.2 How to Access the File System of the R&S SMW via ftp

If the R&S SMW is connected to a LAN and the required configurations are completed, you can use File Transfer Protocol (ftp) to access the file system and to transfer files from and to the instrument.

For information on how to set up a LAN connection, refer to:

- [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45
- [Chapter 12, "Network and Remote Control Operation"](#), on page 649

**To access the file system via ftp**

We assume that the instrument and the remote PC are connected to a LAN.

1. [Enable file transfer via ftp](#)

2. [Enable write permission on the file system](#)
3. Select "System Config > Setup > Remote Access > Network".
4. Write down the "IP Address" or the "Hostname" of the instrument, e.g. 10.113.10.91
5. On the remote PC, start the Windows Explorer.
6. In the address field, enter `ftp://<"IP Address" of the Instrument>`, e.g. `ftp://10.113.10.91`

A log-on dialog opens and requests a password.

The default user name and password is *instrument*.

**Tip:**

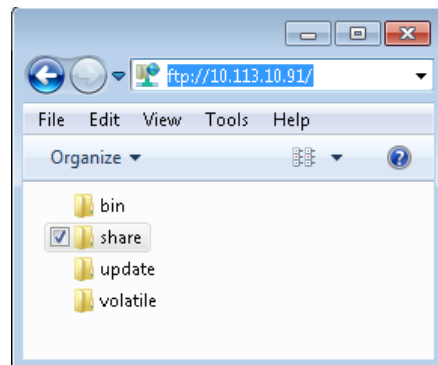
**Default password**

The FTP and SAMBA file access use the user "instrument" with default password "instrument".

It is highly recommended that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network!

See [Chapter 11.5.4, "Password Management"](#), on page 641.

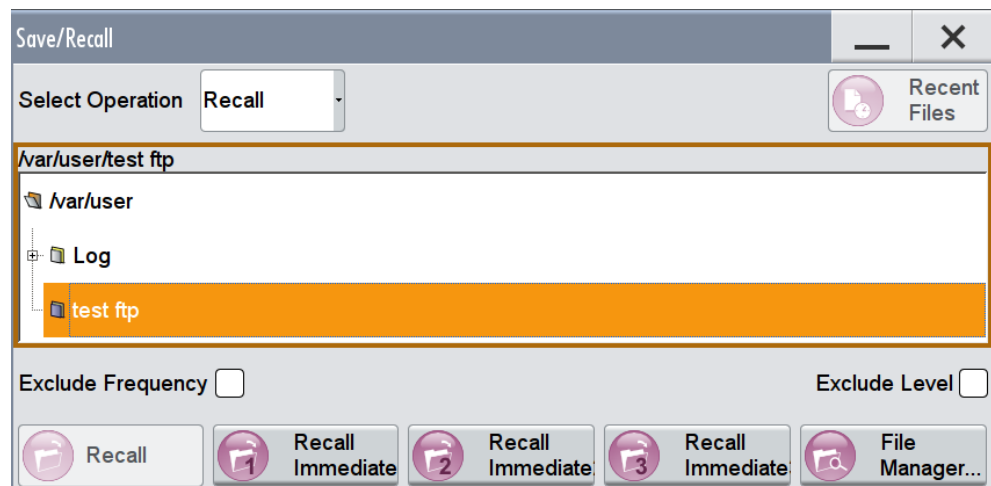
7. Enter the password to access the `/var/user/share` directory.



You can access the files in the `/var/user` directory, perform standard function like creating directory, storing files, etc.

8. Open the `/var/user/share` directory and create a directory, e.g. `test ftp`.
9. On the instruments front panel, press the SAVE/RCL key and open the `/var/user` directory.

The dialog displays the `/var/user/test ftp` directory.



### 10.9.3 How to Access the File System of the R&S SMW via SMB (Samba)

The SMB (Samba) protocol is an alternative way to access the file system of the instrument from a remote PC, if both the instrument and the PC are connected to a LAN.

For information on how to set up a LAN connection, refer to:

- [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45
- [Chapter 12, "Network and Remote Control Operation"](#), on page 649

#### To map the R&S SMW as a network drive to the remote PC

We assume that the instrument and the remote PC are connected to a LAN.

1. [Enable file transfer via SMB \(Samba\)](#)
2. [Enable write permission on the file system](#)
3. Select "System Config > Setup > Remote Access > Network".
4. Write down the "IP Address" or the "Hostname" of the instrument, e.g. `10.113.10.91`.

**Note:** FW version 3.20.200.xxx and later provides modified syntax of the computer name (hostname). The computer name in parentheses shows the previous syntax. See also [Chapter 3.1.4.2, "Using Computer Names \(Hostnames\)"](#), on page 46.

#### Example notation

"SMW200A-102030" ("rssmw200a102030")

5. On the remote PC, start the Windows Explorer and open the "Map Network Drive" dialog.
  - a) Select a valid "Drive", e.g. *W*.
  - b) In the "Folder" field, enter `//<"IP Address" of the Instrument>/share` or `//<"Hostname" of the Instrument>/share`, e.g. `10.113.10.91/share`, or `//SMW200A-102030/share` (previous syntax: `//rssmw200a102030/share`).

c) Select "Finish".

A log-on dialog opens and requests a user name and a password.

The default user name and password is *instrument*.

**Tip:**

**Default password**

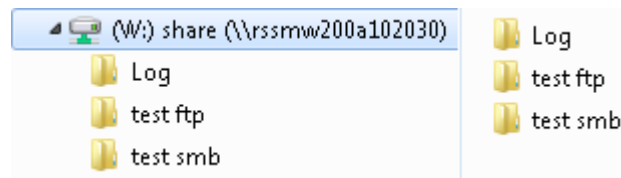
The FTP and SAMBA file access use the user "instrument" with default password "instrument".

It is highly recommended that you change this password in the "Setup > Security > Password Management > Change User Password" dialog before connecting the instrument to the network!

See [Chapter 11.5.4, "Password Management"](#), on page 641.

6. Enter the user name and the password of your instrument.

The `/var/user/share` directory of the instrument is mapped to and displayed as a network drive of the remote PC.



You can access the files in the `/var/user` directory, perform standard function like creating directory, storing files, etc.

## 10.9.4 How to Use a USB Storage Device for File Transfer

Alternatively to the file transfer possibility via LAN, you can use a USB storage device for direct file transfer from and to the instrument.

We recommend that you transfer files with user data, like for example waveform files, data lists, instrument setup files, to the instrument, rather than load and/or play them from a connected USB storage device.

### To transfer a file with user data to the instrument

1. Connect a USB storage device, for example a USB memory stick to one of the USB interfaces of the instrument, see ["Connecting a USB storage device"](#) on page 44.

The R&S SMW recognizes the connected USB storage device automatically.

2. [Enable file transfer via USB](#)

3. [Enable write permission on the file system](#)

4. On the instruments front panel, press the SAVE/RCL key.

The dialog displays the `/var/user` directory and the `/usb` drive.

5. In the "Save/Recall" dialog, select "File Manager".

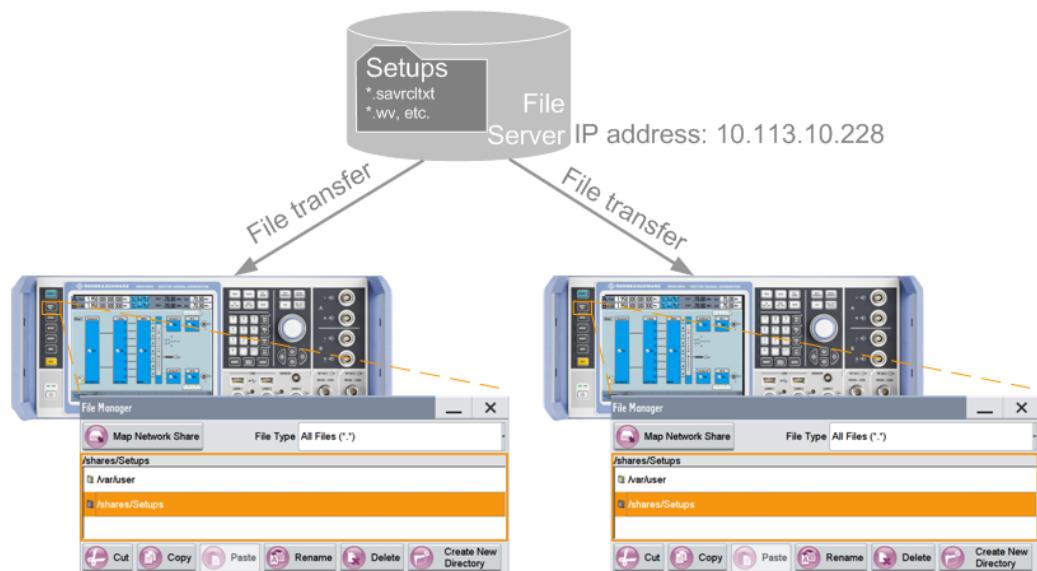


6. In the directory tree, navigate to the `/usb` drive and select the required file with user data.
7. Select "Copy".
8. In the directory tree, navigate to the `/var/user` directory and select "Paste".

The file with user data is transferred to the instrument.

### 10.9.5 How to Access a File Server and Use the Same Test Files on Several Instruments

If you use a central file storage location like a file server in your company network, you would possibly like to store setup files, SCPI scripts, application programs, or waveform files on this file server and distribute the files to several instruments. If the R&S SMWs are connected to a LAN, you can create a shortcut on the instruments to the file server.



#### To access the file server

1. On each R&S SMW, map the required directory of the file server to the instrument. Perform the steps described in [Chapter 10.8.4, "How to Map a Network Folder"](#), on page 594.
2. On each R&S SMW, use the same alias name for the directory of the file server, i.e. enter the same "Local Folder" (in this example `Setups`).

On any of the R&S SMW, you access the file server directly from the "File Manager" and under the same name, e.g. `/shares/Setups`.

An extra advantage in remote control is that the same application program would control the instruments.

For example, use the remote control command `MMEMoRY:CDIRectory "/shares/Setups"` to set the default directory for mass storage.

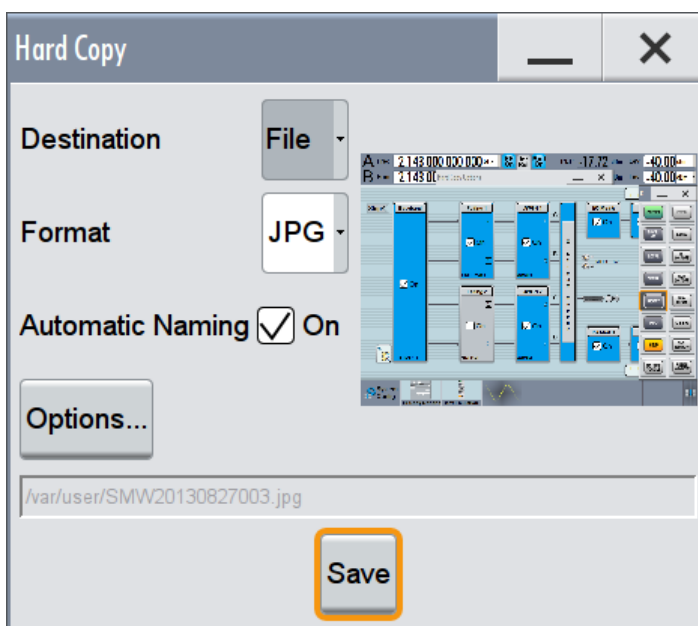
## 10.10 Creating Screenshots of Current Settings

The save/recall function enables you to store current settings in a file. To document the most important settings for a performed signal generation, you can also store a hard-copy of the current display.

- [Hard Copy Settings](#)..... 602
- [Hard Copy Options](#)..... 603
- [How to Store a Hardcopy of the Display](#)..... 606

### 10.10.1 Hard Copy Settings

- ▶ To access the dialog, press the HCOPI key.



The remote commands required to define these settings are described in [Chapter 13.13, "HCOPY Subsystem"](#), on page 746 .

#### Destination

Indicates that the hardcopy is stored in a file.

Remote command:

`:HCOPI:DEVIce` on page 748

#### Format

Selects the output file format, for example `*.bmp`, `*.jpg*`, `*.xpm*`, `*.png`.

Remote command:

[:HCOPY:IMAGe:FORMat](#) on page 748

### Automatic Naming

If enabled, creates the output filenames automatically according to the rules set with the [Automatic Naming Settings](#).

Remote command:

[:HCOPY:FILE\[:NAME\]:AUTO:STATe](#) on page 750

### Options...

Accesses the [Hard Copy Options](#) dialog.

### File...

In "Automatic Naming > Off" mode, accesses the standard file select dialog and enables you to select the path and the file name the hardcopy is stored in.

Remote command:

[:HCOPY:FILE\[:NAME\]](#) on page 748

### Save

Store a hardcopy of the current display as a file.

Remote command:

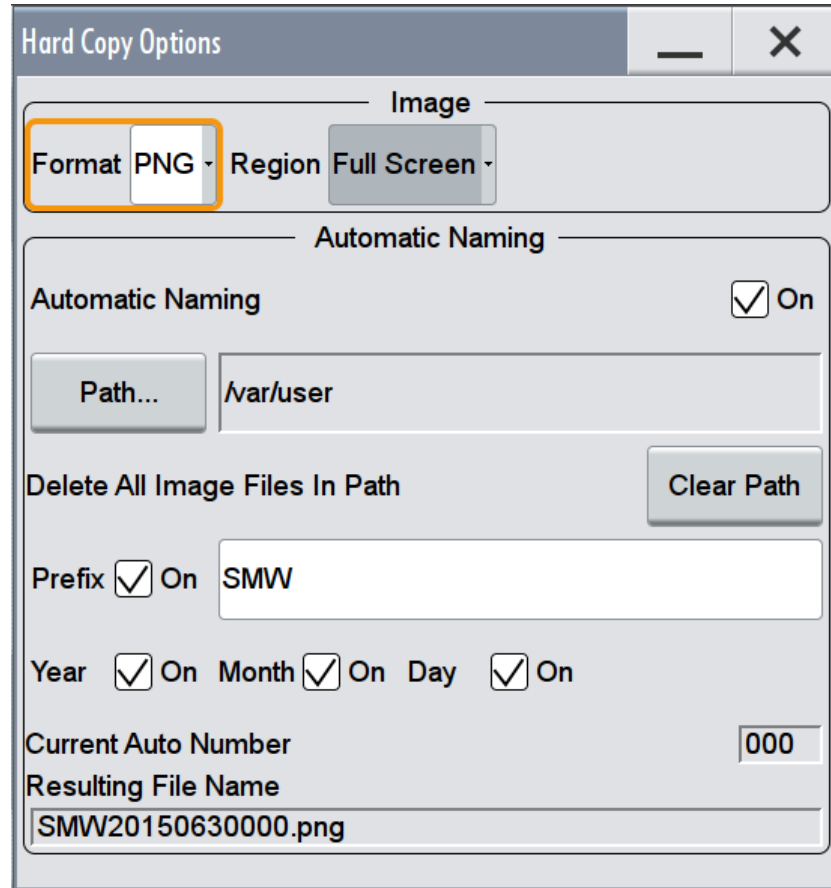
[:HCOPY\[:EXECute\]](#) on page 749

## 10.10.2 Hard Copy Options

To access this dialog:

1. Press the HCOPI key.

2. Select "Hard Copy > Options...".



With the provided settings, you can customize the file format and the syntax of the automatically assigned file name.

### Image Settings

Provided are the following settings:

#### Format ← Image Settings

Selects the output file format, for example \*.bmp, \*.jpg\*.xpm\*.png.

Remote command:

[:HCOPY:IMAGE:FORMAT](#) on page 748

#### Region

Selects the snapshot area, either the entire screen or the currently active dialog.

Remote command:

[:HCOPY:REGION](#) on page 748

#### Automatic Naming Settings

Provided are the following settings:

**Automatic Naming ← Automatic Naming Settings**

If enabled, creates the output filenames automatically according to the rules set with the [Automatic Naming Settings](#).

Remote command:

`:HCOPY:FILE[:NAME]:AUTO:STATE` on page 750

**Path... ← Automatic Naming Settings**

Selects the directory.

**Note:** To select the destination path, specify also a file name. Otherwise an error message is displayed and selection is canceled.

Remote command:

`:HCOPY:FILE[:NAME]:AUTO:DIRectory` on page 749

**Clear Path ← Automatic Naming Settings**

Deletes all image files with extensions \*.bmp, \*.img, \*.png, \*.xpm and \*.csv in the directory set for automatic naming.

Before deleting the files, a warning message is displayed requiring confirmation.

Remote command:

`:HCOPY:FILE[:NAME]:AUTO:DIRectory:CLEar` on page 750

**Prefix, Year, Month, Day ← Automatic Naming Settings**

Determines the rules for "Automatic Naming".

Per default, the automatically generated file name is composed of:

`<Path>/<Prefix><YYYY><MM><DD><Number>.<Format>`, where Y, M and D mean Year, Month, Day; Number is the [Current Auto Number](#).

You can deactivate/activate each component separately.

The "Resulting File Name" indicates the current file name syntax.

Remote command:

`:HCOPY:FILE[:NAME]:AUTO[:FILE]:PREFIX:STATE` on page 751

`:HCOPY:FILE[:NAME]:AUTO[:FILE]:YEAR:STATE` on page 751

`:HCOPY:FILE[:NAME]:AUTO[:FILE]:MONTH:STATE` on page 751

`:HCOPY:FILE[:NAME]:AUTO[:FILE]:DAY:STATE` on page 751

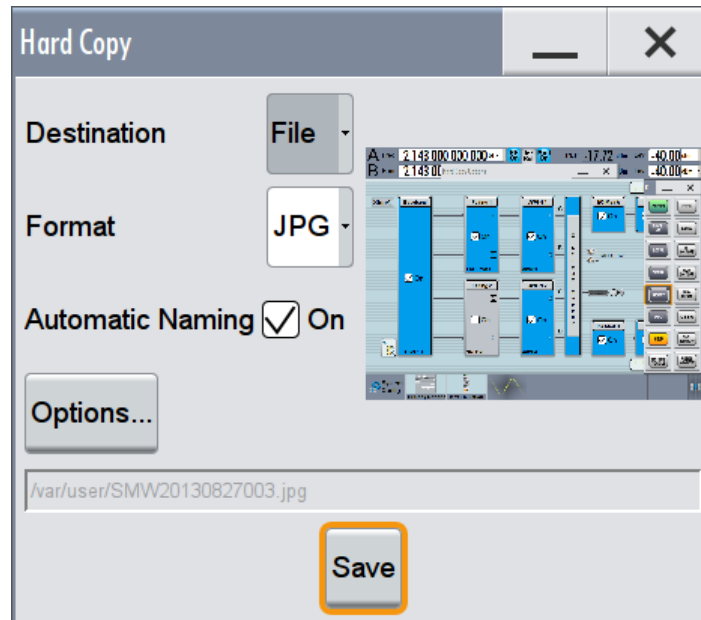
**Current Auto Number ← Automatic Naming Settings**

Indicates the number which is used in the automatically generated file name.

**Note:** When initially switching on the instrument, the number is reset to the lowest possible value. Starting with number 0 the output directory is scanned for existing files. As long as files with the same name are existing, the number is increased by 1. The number is automatically set so that the resulting file name is unique within the selected path. The current number is not in the save/recall file but is temporarily stored within the database. At following save operation, the number is increased.

### 10.10.3 How to Store a Hardcopy of the Display

1. To access the "Hard Copy" dialog, press the HCOPY key.



The parameter "Destination > File" indicates that the hardcopy is stored in a file.

2. To define the output format, select "Format > JPG"
3. To enable the instrument to create output file names, select "Automatic Naming > On".
4. Select "Options...".
5. In the "Hard Copy Options" dialog:
  - a) Select "Image > Size" and define the image size in pixels.
  - b) To change the default directory the file is stored in, select "Automatic Naming Settings > Path" and define a path and a file name. For example select the default directory `/var/user`.
  - c) If required, disable or change some of the parameters in the "Automatic Naming Settings".
  - d) Close the "Hard Copy Options" dialog.
6. In the "Hard Copy" dialog, select "Save".

The instrument stores a hardcopy of the current instrument display as a `*.jpg` file. The file name (`SMW20130827003.jpg`) is automatically created.

7. To print the hardcopy, connect the instrument to a LAN and perform the following:
  - a) Transfer the hardcopy file to a remote computer, see [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595.

- b) On the remote computer, navigate through the file system, select, and open the file `SMW20130827003.jpg` and print it.  
For more information, refer to the online help of the operating system.

# 11 General Instrument Functions

The general instrument functions include basic instrument settings, regardless of the selected operating mode and measurement. Some of these settings like screen display and peripherals are initially configured at the setup of the instrument, according to personal preferences and requirements. However, you can individually adjust the settings at any time, for example, if required for specific applications.

The following special functions help you in service and basic system configuration:

- [Chapter 11.1, "Customizing the User Interface"](#), on page 608  
Allows you to adjust the display and keyboard language settings.  
See [Chapter 3.1.5, "Configuring the Initial Instrument Settings"](#), on page 48 for information on how to perform the settings in detail.
- [Chapter 11.2, "Configuring the Local and Global Connectors"](#), on page 612  
Allows you to map internal or external signals to the multi-purpose connectors.
- [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627  
Allows you to assign user defined actions to the user key.
- [Chapter 11.4, "Managing Licenses and License Keys"](#), on page 630  
If you have purchased an additional option for the R&S SMW, you can enable it using a license key.
- [Chapter 10.2, "Restoring the \(Default\) Instrument Configuration"](#), on page 574  
At any time, you can restore a default configuration to start a measurement at a defined instrument state, or set the instrument to factory preset.
- [Chapter 14.2, "Performing Maintenance Tasks"](#), on page 1077  
Special functions like calibration routines and selftests put your instrument to an initial state.
- [Chapter 11.5, "Managing the Security Settings"](#), on page 634  
Special security and protection functions protect your instrument from unauthorized use or activate specific test routines.

## 11.1 Customizing the User Interface

The R&S SMW provides basic alignments of instrument settings regarding the user interface, that means the touch panel (screen), the appearance of the displayed dialogs and graphics, and an external keyboard.

In detail described in the following paragraphs, you can:

- Set display and keyboard language, see [Chapter 11.1.2, "Display and Keyboard Settings"](#), on page 609
- Customize the GUI appearance, see [Transparency Adjustment](#) and [Chapter 11.1.3, "GUI Appearance Settings"](#), on page 610
- Set date and time for the system clock, see [Chapter 14.2.1, "Date and Time Settings"](#), on page 1078
- Configure and activate a [Screen Saver](#)



- Deactivate display update to improve performance, see [Chapter 11.1.4, "Display Update Settings"](#), on page 611



The instructions in [Chapter 3.1.5, "Configuring the Initial Instrument Settings"](#), on page 48 show you how to perform the settings in detail.

---

### 11.1.1 About

#### Transparency Adjustment

The R&S SMW enables you to activate an opacity factor for less relevant elements, so that the background remains visible. When activated, inactive dialogs, i.e. dialogs or windows during moving with the finger and progress bars appear transparent. For information on how to activate the transparency, see [Chapter 11.1.3, "GUI Appearance Settings"](#), on page 610

#### Start / Stop Display Update

The operating system of the R&S SMW refreshes the displayed settings by default in almost real time, to keep the display updated with the internally used values. However, you can turn off this function to reduce settling times when the instrument is remote controlled.



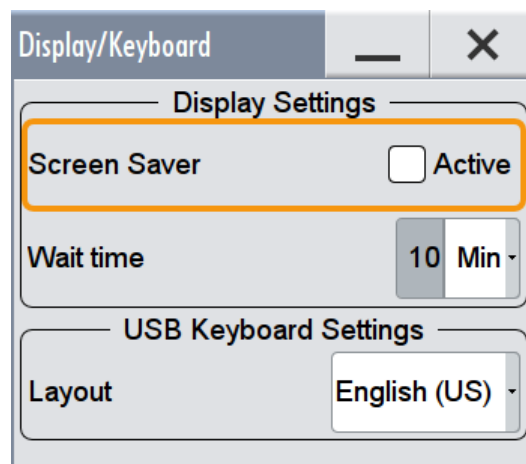
We recommend that you switch off the display update for optimum sweep performance with short dwell times and for fast settling times.

Consider that in this case the displayed values can differ from the operated values.

---

### 11.1.2 Display and Keyboard Settings

- ▶ To access this dialog, select "System Config > Setup > User Interface > Display or Keyboard".



In the "Display Settings / Keyboard Settings" dialog, you can change regional and language options for the GUI and an external keyboard, and define the screen saver settings.

The remote commands required to configure the display and keyboard are described in [Chapter 13.11, "DISPlay Subsystem"](#), on page 741 and [Chapter 13.14, "KBOard Subsystem"](#), on page 752.

#### Screen Saver

Activates the screensaver.

If activated, the display including backlight is switched off after the selected [Wait Time](#) elapses and if no entries via touch panel, front panel, external mouse, or external keyboard are made

Remote command:

[:DISPlay:PSAVe\[:STATe\]](#) on page 742

#### Wait Time

Enters the idle time that must elapse before the display lamp is shut off when no entries are made.

Remote command:

[:DISPlay:PSAVe:HOLDoff](#) on page 742

#### Layout

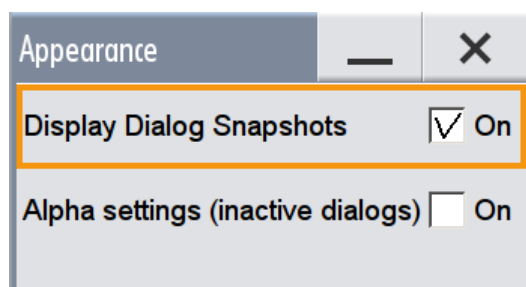
Selects the language of an externally connected keyboard via USB. The function assigns the corresponding keys automatically.

Remote command:

[:KBOard:LAYout](#) on page 752

### 11.1.3 GUI Appearance Settings

- ▶ To access this dialog, select "System Config > Setup > User Interface > Appearance".



In this dialog, you can set inactive dialog opaque and enable the display of dialog snapshots.

#### Display Dialog Snapshots

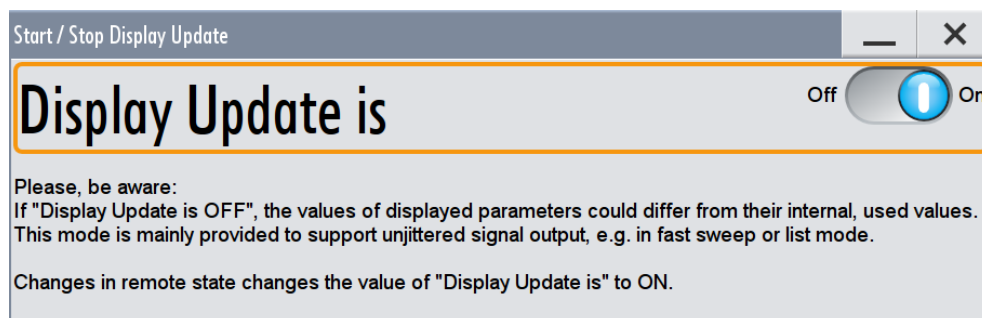
Displays thumbnails of open dialogs in the task bar.

#### Alpha Settings (inactive dialogs)

Activates the transparency of inactive dialogs.

### 11.1.4 Display Update Settings

- To access this dialog, select "System Config" > "Setup" > "User Interface" > "Start/ Stop Display Update".



This dialog enables you, to deactivate updating the display.

The remote command to switch off the display update is described in [Chapter 13.11, "DISPlay Subsystem"](#), on page 741.

#### Display Update is

Disables the automatic refreshing of the displayed values.

Remote command:

[:DISPlay:UPDate](#) on page 742

## 11.2 Configuring the Local and Global Connectors

The R&S SMW is equipped with multi-purpose bi-directional connectors.

Grouped according to their impact, the R&S SMW provides the following connector types:

- [Chapter 11.2.1.1, "Global Connectors"](#), on page 612
- [Chapter 11.2.1.2, "Baseband Local Connectors"](#), on page 613

Grouped according to their impact on the baseband or on the RF signal, the same connectors are divided into:

- [Chapter 11.2.2, "Trigger Marker Clock Settings"](#), on page 616
- [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618

### 11.2.1 About the Local and Global Connectors

#### Signal to Connector Mapping

As described in [Chapter 5.3.1, "Basics on Signals, Modulation Types and Filters Used the Baseband Domain"](#), on page 216, the R&S SMW uses several internally generated and externally supplied signals. To handle these signals and the more than two baseband signals, the R&S SMW introduces the concept of signal to connector mapping. The available signals are not dedicated to a particular connector but can be mapped to one or more globally shared USER or local T/M/(C) connectors.

The signal mapping and the polarity, the trigger threshold, and the input impedance of the input connectors are configurable parameters. The connectors settings are grouped in the [Global Connectors Settings](#) and [Local Connectors Settings](#) dialogs.



For an overview of the required configuration steps, refer to ["General Workflow"](#) on page 626.

#### 11.2.1.1 Global Connectors

The R&S SMW is equipped with six USER interfaces which can be freely assigned a selection of signals and which can be configured as both inputs and outputs.

A common threshold and input impedance is effective for all trigger and clock signal inputs provided at the global USER connectors. The settings influence the custom digital modulations, the generation of waveforms or multi carrier signals, and all digital standards.

Additionally, the R&S SMW is equipped with two INST TRIG A/B connectors. The instrument trigger setting influences all sweeps and is effective in the List mode (see also [Chapter 8.7, "Varying the RF Signal in List or Sweep Mode"](#), on page 437).

The [Table 11-1](#) gives an overview of the signals that can be applied to and output at the USER connector.

**Table 11-1: Mapping control signals to global user connectors**

Connector	Direction	Assigned Signal	Remark
USER 1,2,3	Input	"Global Trigger 1/2" "Global Clock 1/2" "Global Next Segment 1/2"	-
	Output	"Baseband <BB> Marker 1/2/3" <sup>1</sup>	<sup>1</sup> ) where: <ul style="list-style-type: none"> <li>• &lt;BB&gt; = A/B/C/D in "System Configuration &gt; Baseband Source &gt; Separate"</li> <li>• &lt;BB&gt; is omitted in "System Configuration &gt; Baseband Source &gt; Coupled"</li> <li>• &lt;BB&gt; = 1/2/3/4 in "System Configuration &gt; Baseband Source &gt; Coupled per Entity"</li> </ul>
USER 4,5,6	Input	"Global Trigger 1/2" "Global Clock 1/2" "Global Next Segment 1/2" "Pulse In A/B" <sup>2</sup>	<sup>2</sup> ) In an instrument equipped with 1 RF path, the name of the signal is "Pulse In"
	Output	"Baseband <BB> Marker 1/2/3" "Signal Valid A/B" <sup>3</sup> "Pulse Out A/B" <sup>3</sup> "Sync A/B" <sup>3</sup>	<sup>3</sup> ) In an instrument equipped with 1 RF path, the names of the signals are "Signal Valid", "Pulse Gen" and "Sync"
USER 6	Input	"Feedback"	

### 11.2.1.2 Baseband Local Connectors

Apart from the multipurpose global USER connectors, each baseband coder board is equipped with one local T/M/C and two T/M connectors.

The [Table 11-2](#) gives an overview of the signals that can be applied and output at the T/M/(C) connectors.

**Table 11-2: Mapping control signals to the local T/M/(C) connectors**

Connector shared between "Baseband A/C"	Connector shared between "Baseband B/D"	Direction	Assigned Signal
T/M/C 1	T/M/C 4	Input	"Trigger" "Clock"
T/M 2	T/M 5	Input	"Data"

Connector shared between "Baseband A/C"	Connector shared between "Baseband B/D"	Direction	Assigned Signal
T/M 2,3	T/M 5,6	Input	"Trigger"
T/M 3	T/M 6	Input	"Feedback"
T/M/(C) 1,2,3	T/M/(C) 4,5,6	Output	"Baseband <BB> Marker 1/2/3" <sup>1)</sup> "Symbol Clock <BB>" <sup>1)</sup> "Lev Att <BB>" <sup>1)</sup> "Burst Gate <BB>" <sup>1)</sup> "Hop <BB>" <sup>1)</sup> "CW/Mod <BB>" <sup>1)</sup> "Triggered <BB>" <sup>1)</sup> <sup>1)</sup> where: <ul style="list-style-type: none"> <li>• &lt;BB&gt; = A/C or B/D in "System Configuration &gt; Baseband Source &gt; Separate"</li> <li>• &lt;BB&gt; is omitted in "System Configuration &gt; Baseband Source &gt; Coupled"</li> <li>• &lt;BB&gt; = 1/3 or 2/4 in "System Configuration &gt; Baseband Source &gt; Coupled per Entity"</li> </ul>

### 11.2.1.3 Trigger Marker Clock and RF Connectors

The [Trigger Marker Clock Settings](#) and [RF Connectors Settings](#) dialogs provide an overview of the current mapping of the logical signals to the corresponding connectors. The dialogs are summary representation of related settings, as configured with the [Global Connectors Settings](#) and [Local Connectors Settings](#) settings.

### 11.2.1.4 Status Indicators

#### Connector status indication

A dedicated LED indicates the connector status:

- Green: an input connector
- Yellow: an output connector
- No light: the connector is not active


#### T/M/C status LEDs



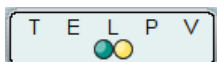
For quick overview of the source (internal/external) of the used trigger, marker and clock signals, the block diagram displays *T/M/C status LEDs* on the left side of each "Baseband" block.

If the corresponding baseband generator is active, the displayed information is color coded, where:

- A green LED indicates that an external signal is used
- A yellow LED confirms that the signal is available at the output connector

The display of the letter "A" or "B" indicates that the internal signal of other baseband source is used. The icon  indicates that common trigger settings are applied.

**T/E/L/P/V status LEDs**



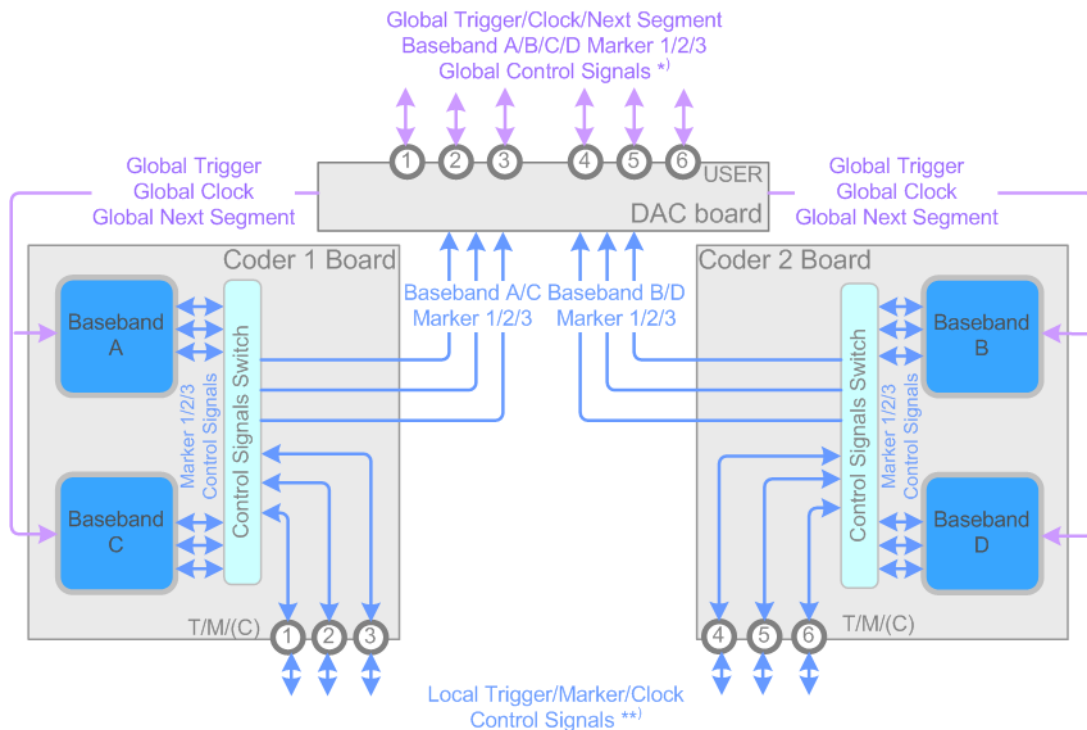
For quick overview of the source (internal/external) of the control signals, the block diagram displays *T/E/L/P/V status LEDs* on the top/bottom of the "RF" blocks.

If the corresponding RF block is active, the displayed information is color coded, where:

- A green LED indicates that an external signal is used
- A yellow LED confirms that the signal is available at the output connector

**11.2.1.5 Internal Resources for the Trigger, Marker, Clock and Control Signals**

Apparently, not all trigger, marker, clock and control signals can be output or input at the same time. The [Figure 11-1](#) is a graphical representation of the available internal resources concerning the trigger, marker, clock and control signals. The diagram focuses on the internal signals routing rather than showing the exact input and output signals.



**Figure 11-1: Internal resources for the marker and trigger signals**

- \* = Pulse In/Out A/B, Sync A/B, Signal Valid A/B  
 \*\* = Lev Att, Burst Gate, CW/Mod, Hop, Triggered

The baseband couples A/C are implemented on the same hardware, CODER 1 board, and hence share the T/M/(C) 1/2/3 connectors. The baseband B/D couple share the T/M/(C) 4/5/6 connectors.

## 11.2.2 Trigger Marker Clock Settings

- To access this dialog, perform one of the following:
  - In the "Block Diagram", select the [T/M/C status LEDs](#) on the left side of the "Baseband" blocks.
  - Select "Baseband > Trigger Marker Clock".

The "Trigger Marker Clock" gives an overview of the current mapping of the logical signals to the connectors, as configured in the [Global Connectors](#) and [Local Connectors](#) dialogs. A click on the connector name accesses directly the related connector settings.

The dialog consists of several tabs, each tab corresponds to one of the available basebands.

	Logical Signal	Connector	Find
Trigger Source	Internal		
Clock Source	Internal		
Clock Output		T/M/C 1	...
Marker 1	On/Off Ratio	User 1, T/M 2	...
Marker 2	On/Off Ratio	User 2, T/M 3	...
Marker 3	On/Off Ratio		

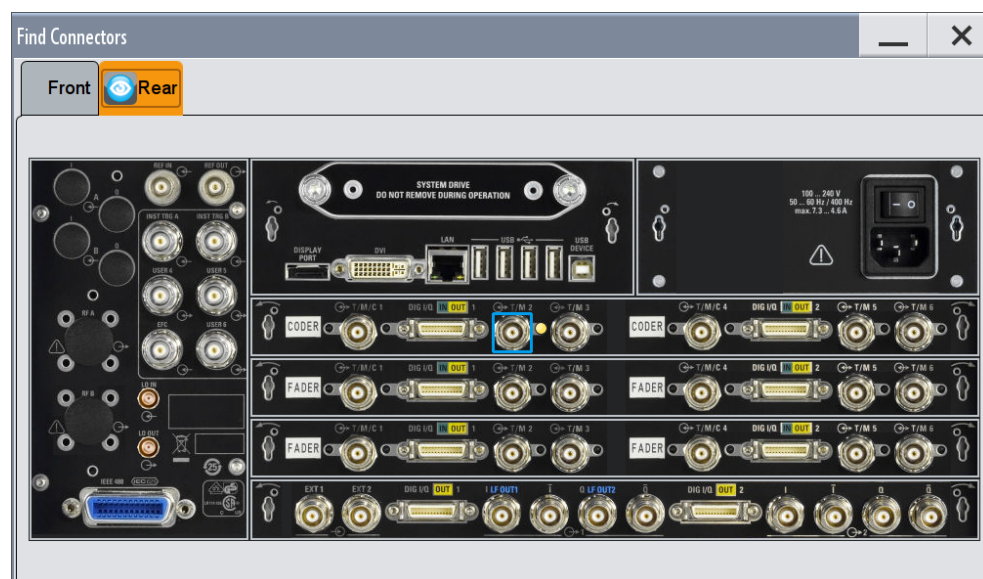
**Diagram Legend**  
 T=Trigger =Common to all Basebands  
 M=Marker  
 C=Clock  
=Signal is available at Output Connector  
=Signal Source is external


Local Connector Settings...  
 Global Connector Settings...

- Use the built-in [Find](#) function to display the physical location of the selected connector.

A blinking LED on the front/rear panel indicates the selected connector, too.






The eye icon  in the tab header indicates the panel (front, rear or both) the selected connector is located at.

### 11.2.2.1 Overview Table

#### Common to All Basebands

To enable simultaneous signal generation in all basebands, the R&S SMW couples the trigger settings in the available basebands in any instrument's configuration involving signal routing with signal addition (e.g. MIMO configuration, routing and summing of basebands and/or streams).

The icon  indicates that common trigger settings are applied.

You can access and configure the common trigger source and trigger mode settings in any of the basebands. An arm or a restart trigger event applies to all basebands, too. You can still apply different delay to each of the triggers individually.

#### Logical Signal

Displays the logical signal, as configured in the "Trigger In", "Marker" or "Clock" tab of the corresponding digital standard, see for example [Chapter 5.3.2.1, "Trigger Settings"](#), on page 242.

#### Connector

Displays the connector(s), as configured in the [Global Connectors](#) and [Local Connectors](#) dialogs.



#### Find

Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see ["Connector status indication"](#) on page 614).

### 11.2.2.2 Local and Global Connector Settings

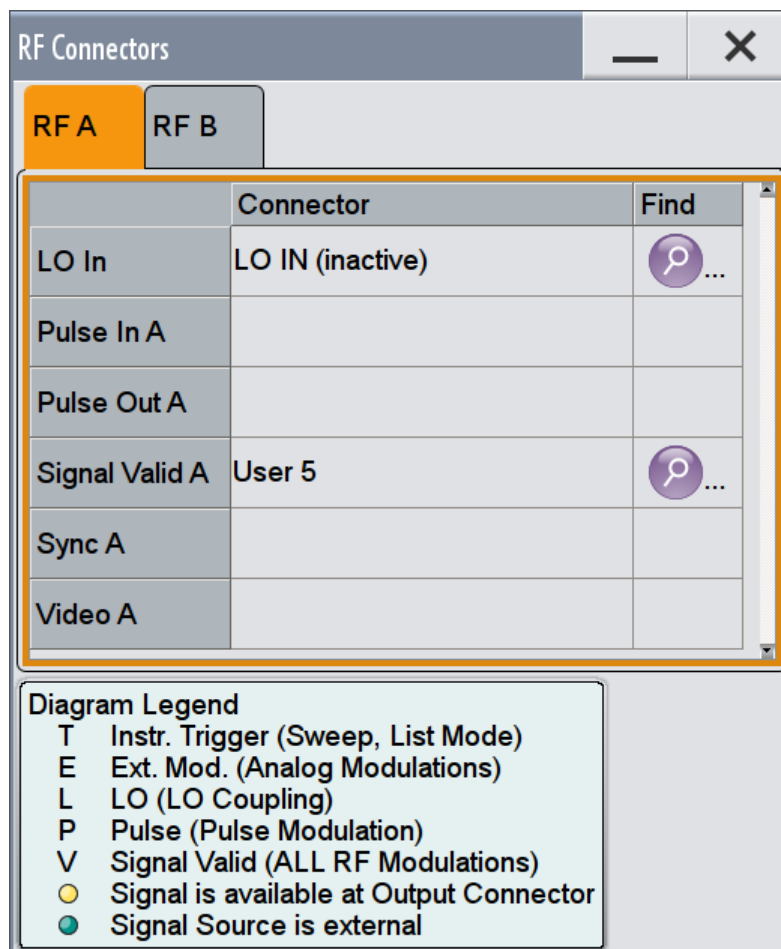
Each of the "Trigger In", "Marker" and "Clock" dialogs as well as the "Trigger Marker Clock" dialog provides a quick access to the related local and global connector settings.

For more information, refer to the description R&S SMW User Manual, section "Local and Global Connectors".

### 11.2.3 RF Connectors Settings

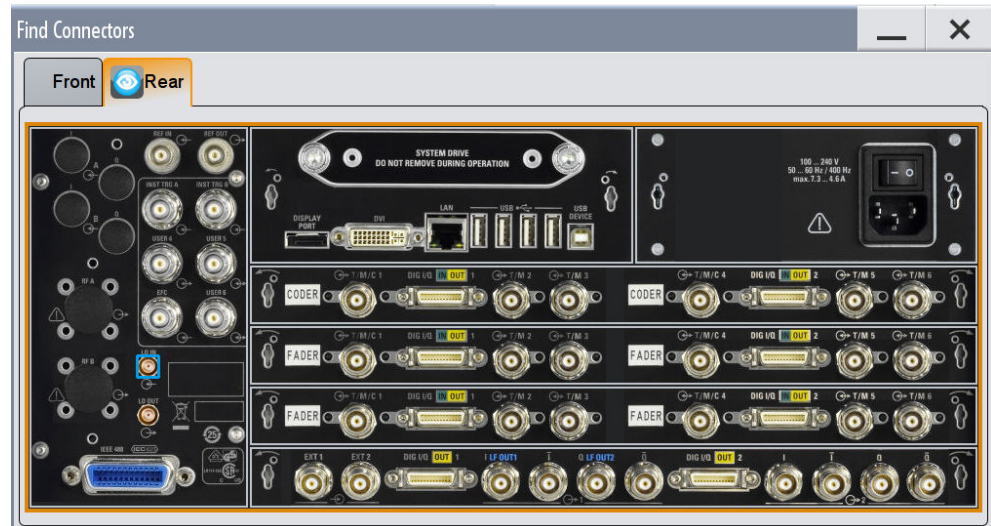
- To access this dialog, perform one of the following:
  - in the "RF block", select "RF > RF Frequency > Connectors".
  - in the "control signal block" next to the RF block, select [T/E/L/P/V status LEDs](#).


The "RF Connectors" dialog gives an overview of the current mapping of the logical signals to the connectors, as configured in the [Global Connectors Settings](#) dialog. Selecting a connector name accesses directly the related connector settings. The dialog has a separate tab for each of the RF blocks.



- Use the built-in **Find** function to display the physical location of the selected connector.

A blinking LED on the front/rear panel indicates the selected connector, too.



The eye icon  in the tab header indicates the panel (front, rear or both) the selected connector is located at.

### Connector

Displays the connector(s), as configured in the [Global Connectors](#) and [Local Connectors](#) dialogs.



### Find

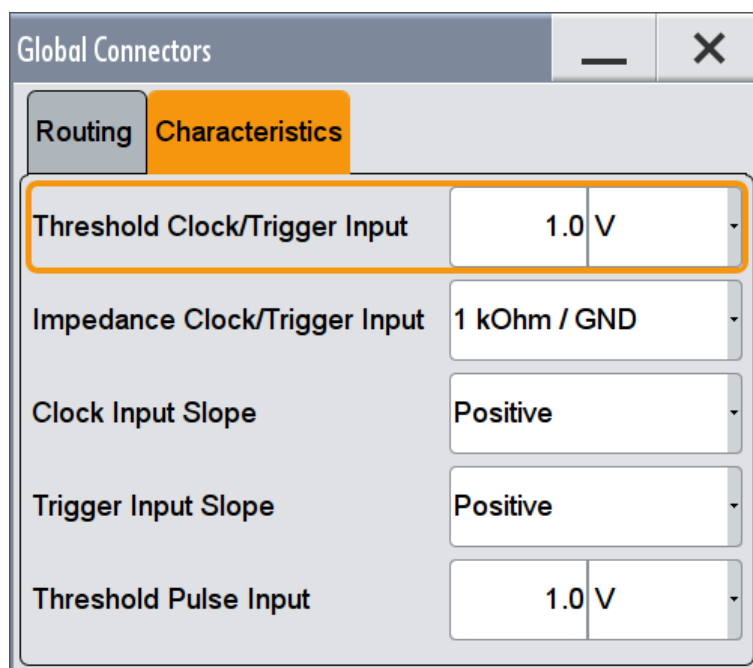
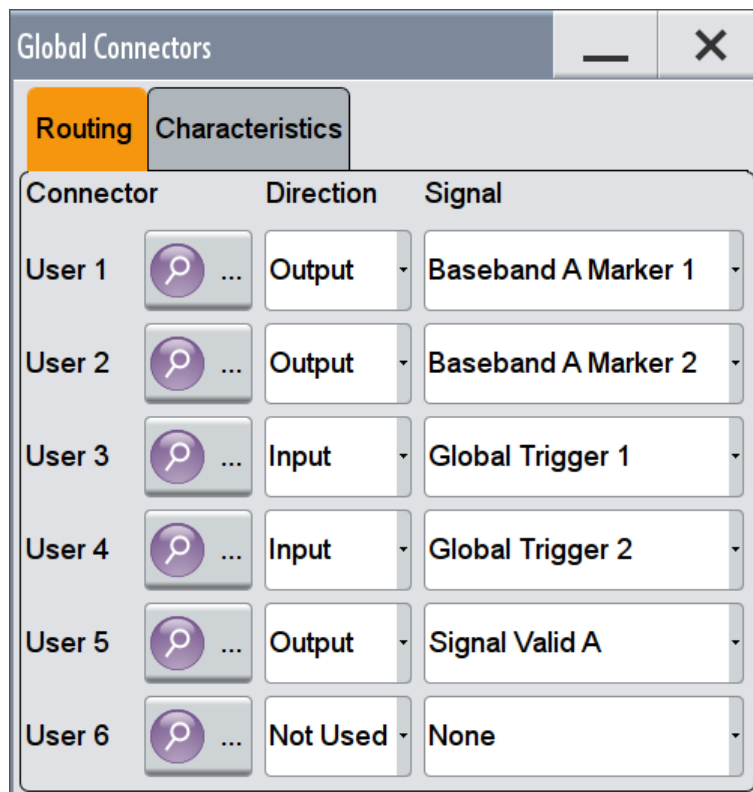
Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see ["Connector status indication"](#) on page 614).

## 11.2.4 Global Connectors Settings

- To access this dialog, perform one of the following:
  - In the "Block Diagram", select the [T/M/C status LEDs](#) to access the "Trigger Marker Clock" dialog and:
    - Select a global User connector or
    - Select "Global Connector Settings"
  - Select "Baseband > Custom Digital Modulation > Trigger In > Global Connector Settings" or respectively the "Trigger In", "Marker" or "Clock" tab of the corresponding digital standard.
  - In the "Block Diagram", select the T/E/P/V status LEDs to access the "RF Connectors" dialog and select a global User connector.

The "Global Connectors" dialog comprises the settings necessary to configure the signal to connector routing and the physical characteristics of the input connectors for trigger, clock and control signals.



- Use the built-in [Find](#) function to display the physical location of the selected connector.

A blinking LED on the rear panel indicates the selected connector, too.



### Find

Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see "[Connector status indication](#)" on page 614).

### User 1 .. 6 Connector Direction

Determines whether the connector is used as an input or an output.

A connector with not specified direction is in a "Not Used" state.

Remote command:

`[ :SOURce ] : INPut : USER <ch> : DIRection` on page 790

`: OUTPut : USER <ch> : DIRection` on page 790

### Signal

Determines the control signal that is input or output at the selected connector. Whether the connector is used as an input or an output is selected by the parameter [Direction](#)

The [Table 11-1](#) lists the available control signals.

"Global Trigger 1/2"

Input for triggering custom digital modulations, digital standards and ARB. A trigger event affects the signal generation in all basebands for which the "Global Trigger" signal is enabled.

"Global Clock 1/2"

Input for external clock signal for synchronizing the internal clocks in all basebands to an externally applied clock signal. The active edge can be configured.

"Global Next Segment 1/2"

Input next segment for triggering of multi-segment waveform files (see [Chapter 5.6, "Generating Multi-Segment Waveform Files"](#), on page 310).

"Baseband <BB> Marker 1/2/3"

Marker signal output for triggering and control of external devices with user-definable marker signals.

Where <BB> (A/B/C/D or 1/2/3/4) indicates the baseband the signal is related to.

"Feedback"

Input for global feedback signal, required for 3GPP HSUPA HARQ Feedback, 3GPP Dynamic Power Control or EUTRA/LTE Closed Loop BS tests.

"Pulse In A/B"

Input of external pulse signal or input of external trigger/gate signal for internal pulse generator (see [Chapter 8.8.3.6, "Pulse Generator"](#), on page 492).

"Pulse Out A/B"

Output of the internal pulse signal generated by the internal pulse generator (see [Chapter 8.8.3.6, "Pulse Generator"](#), on page 492).

"Signal Valid A/B"	Automatically generated output signal for indication of the valid signal times (valid level and frequency indication) for all analog modulations (see also <a href="#">Chapter 8.8.3, "Modulation Settings"</a> , on page 480). The signal is indicated by the T/E/P/V status LEDs near to the corresponding "RF" block.
"Sync A/B"	Output for internal Sync signals for pulse modulation. Sync signals are generated at the beginning of a list or a sweep and used for synchronization to other instruments (see also <a href="#">Chapter 8.7, "Varying the RF Signal in List or Sweep Mode"</a> , on page 437).
"Video A/B"	Output of the external or internal pulse modulation signal (video signal). See also <a href="#">Chapter 8.8.3.5, "Pulse Modulation"</a> , on page 490
"None"	No signal is assigned to the connector.

Remote command:

[\[:SOURce\]:INPut:USER<ch>:SIGNal](#) on page 790

[:OUTPut:USER<ch>:SIGNal](#) on page 791

#### Threshold Clock/Trigger Input

Sets the high/low threshold in volts for the global trigger and clock signals.

Remote command:

[\[:SOURce\]:INPut:USER:TRIGger:LEVel](#) on page 793

[\[:SOURce\]:INPut:USER:CLOCK:LEVel](#) on page 793

#### Impedance Clock/Trigger Input

Selects the input impedance for the external trigger/clock inputs.

Set the value to 1 k $\Omega$ /GND for high clock rates.

Remote command:

[\[:SOURce\]:INPut:USER:TRIGger:IMPedance](#) on page 793

[\[:SOURce\]:INPut:USER:CLOCK:IMPedance](#) on page 793

#### Clock Input Slope

Sets the polarity of the active slope of an externally applied clock signal.

Remote command:

[\[:SOURce\]:INPut:USER:CLOCK:SLOPe](#) on page 793

#### Trigger Input Slope

Sets the polarity of the active slope of an applied instrument trigger.

Remote command:

[\[:SOURce\]:INPut:USER:TRIGger:SLOPe](#) on page 793

#### Threshold Pulse Input

Sets the high/low threshold in volts for the pulse input, e.g. for the external pulse modulation signal.

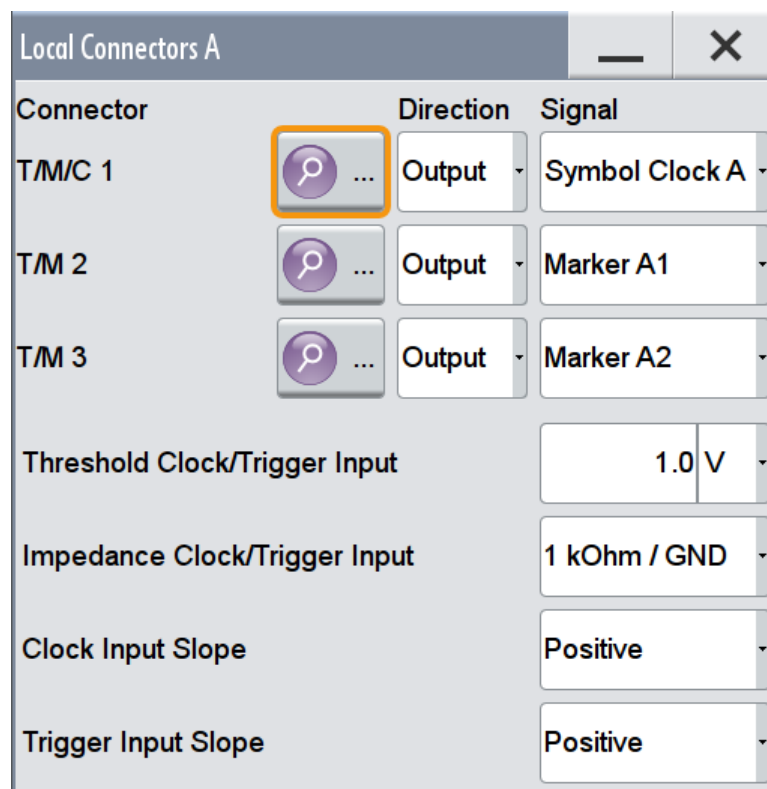
Remote command:

[ :SOURce ] : INPut : USER : PULM : LEVel on page 794

## 11.2.5 Local Connectors Settings

- To access this dialog, perform one of the following:
  - In the "Block Diagram", select the [T/M/C status LEDs](#) to access the "Trigger Marker Clock" dialog and:
    - Select a local T/M/C connector or
    - Select "Local Connector Settings"
  - Select "Baseband > Custom Digital Modulation > Trigger In > Local Connector Settings" or respectively the "Trigger In", "Marker" or "Clock" tab of the corresponding digital standard.

The "Local Connectors" dialog comprises the settings necessary to route the signals to the local connectors and to determine the physical characteristics of the input connectors for trigger, clock and marker signals.



- Use the built-in [Find](#) function to display the physical location of the selected connector.

A blinking LED on the rear panel indicates the selected connector, too.



### Find

Accesses the "Find Connector" dialog that displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too (see "[Connector status indication](#)" on page 614).

### T/M/(C) Connector Direction

Determines whether the connector is used as an input or an output.

Remote command:

[\[:SOURce<hw>\]:INPut:TM<ch>:DIRection](#) on page 790

[:OUTPut<hw>:TM<ch>:DIRection](#) on page 790

### Signal

Determines the control signal that is input or output at the selected connector. Whether the connector is used as an input or an output is selected by the parameter [Direction](#).

Refer to [Table 11-2](#) for an overview of the available control signals.

The indication <BB> (A/C or B/D; 1/3 or 2/4) in each signal name indicates the baseband the signal is related to.

**Note:** The T/M/(C) 1/2/3 connectors are shared between the baseband A and C; the T/M/(C) 4/5/6 connectors, between basebands B and D.

"Trigger"	Marks the trigger event caused by the selected trigger signal (internally or externally). To define the trigger, use the respective "Trigger In" tab of the corresponding digital standard.
"Clock"	Input for external clock signal
"Data"	Input for external serial data signal
"Baseband <BB> Marker 1/2/3"	A broad selection of suitable marker signals is offered in the "Marker" tab of the corresponding digital standard.
"Symbol Clock <BB>"	Output of the internal clock signal used for digital modulations. The signal is generated automatically when the standard is switched on.
"Lev Att <BB>"	Output signal that determines whether the signal level is attenuated, if envelope curve control is active. The internal "Lev Att <BB>" control signal is defined in a control list and activated in the "Baseband > Custom Digital Modulation > Power Ramp Control" dialog. See also <a href="#">Chapter 5.4.3.8, "Control and Marker Lists Editor"</a> , on page 269.
"Burst Gate <BB>"	Output for control signal for envelope curve control. This control signal is defined in a control list and activated in the "Baseband > Custom Digital Modulation > Power Ramp Control" dialog. See also <a href="#">Chapter 5.4.3.8, "Control and Marker Lists Editor"</a> , on page 269.



**"HOP <BB>"**

Marks the hop trigger for frequency hopping in the List mode for "Custom Digital Modulation". The hop signal is defined in a control list and activated by loading the control list, see [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269.

**"CW/Mod <BB>"**

Output signal to indicate the output of RF signal in unmodulated form (digital modulation is deactivated).

This control signal is defined in a control list, see [Chapter 5.4.3.8, "Control and Marker Lists Editor"](#), on page 269.

**"Triggered <BB>"**

A pulse like marker signal, generated on received internal or external trigger signal in the corresponding Baseband.

**"Feedback"**

Input for local feedback signal, required for 3GPP HSUPA HARQ Feedback, 3GPP Dynamic Power Control or EUTRA/LTE Closed Loop BS tests.

**Remote command:**

[\[:SOURce<hw>\]:INPut:TM<ch>:SIGNa1](#) on page 791

[\[:OUTPut<hw>:TM<ch>:SIGNa1](#) on page 792

**Threshold Clock/Trigger Input**

Sets the high/low threshold in volts for the trigger and clock signal inputs of the baseband section.

**Remote command:**

[\[:SOURce<hw>\]:INPut:TM:CLOCK:LEVel](#) on page 794

[\[:SOURce<hw>\]:INPut:TM:TRIGger:LEVel](#) on page 794

**Impedance Clock/Trigger Input**

Selects the input impedance for the external trigger/clock inputs.

**Remote command:**

[\[:SOURce<hw>\]:INPut:TM:CLOCK:IMPedance](#) on page 794

[\[:SOURce<hw>\]:INPut:TM:TRIGger:IMPedance](#) on page 794

**Clock Input Slope**

Sets the polarity of the active slope of an externally applied clock signal.

**Remote command:**

[\[:SOURce<hw>\]:INPut:TM:CLOCK:SLOPe](#) on page 795

**Trigger Input Slope**

Sets the polarity of the active slope of an externally applied trigger signal.

Remote command:

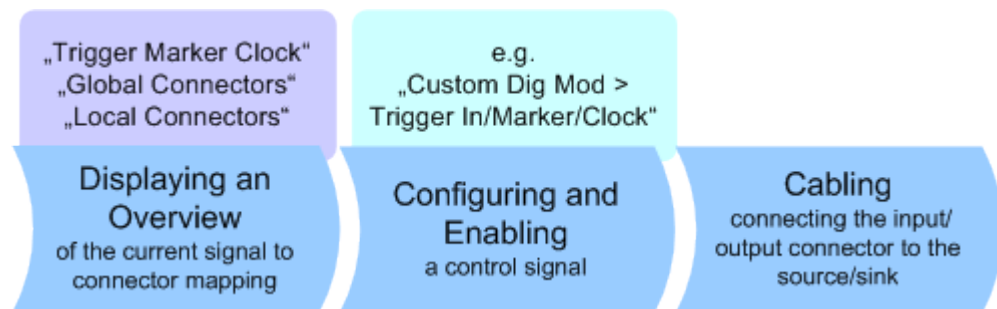
[ :SOURce<hw> ] :INPut:TM:TRIGger:SLOPe on page 795

## 11.2.6 How to Enable Signals and Perform Signal to Connector Mapping

This section introduces the general principle of connector configuration.

### General Workflow

The [Figure 11-2](#) shows the main configuration stages, together with the corresponding user interface dialogs.



**Figure 11-2:** The principle of the signal to connector mapping

To perform the signal to connector mapping, perform the following:

1. Verify the current connector configuration and mapping and if required (re)define it.
2. Configure and enable the required signal, e.g. trigger, marker, clock signal.
3. Connect the configured connector, e.g. to the external instrument or device.

For a step-by-step description, see [Chapter 3.3.3, "Triggering the Instrument with an External Signal"](#), on page 69.

### To find out the physical location of the connector on the front/rear panel of the instrument

Proceed as follows:

1. Select [T/M/C status LEDs](#) or [T/E/L/P/V status LEDs](#) to open the "Trigger Marker Clock" and the "RF Connectors" dialog.
2. For the corresponding connector, select the "Find" icon.

The "Find Connector" dialog opens and displays the physical location of the selected connector on the front/rear panel of the instrument.

A blinking LED on the front/rear panel indicates the selected connector, too. See also ["Connector status indication"](#) on page 614.

## 11.3 Assigning Action to the User Key

The USER key is a key with customizable function, i.e. there is no predefined function assigned to it. You can define the action to be executed or the function to be accessed upon selecting this key.

### Possible applications

The USER key is useful in the following situations:

- There are functions or tasks you have to perform more frequently than other but they are not accessible via a front panel key.
- The required functions are grouped in a dialog that is not directly accessible from a functional block on the block diagram.
- Your task involves the frequently loading and executing of certain SCPI scripts. Refer to [Chapter 12.15, "How to Record / Create SCPI Lists"](#), on page 699 for information on how to create an SCPI script.
- A quick access to stored setups is required.

### Dialog Identification

To identify each dialog, the instrument uses a dedicated dialog ID. The dialog ID contains the dialog position on the display and the current active tab. The action that triggers the instrument to open a dialog uses this identification.

### Save/Recall vs. Recall Setup

Sometimes, you would like to restore a signal generation you performed under specific conditions on the instrument and perform further configuration based on this particular instrument state. The R&S SMW provides two ways to achieve this, by the "Save/Recall" function and by the "Recall Setup" function.

- "Save/Recall"  
For a detailed description of the "Save/Recall" function, refer to [Chapter 10.4, "Storing and Recalling Instrument Settings"](#), on page 580.
- "Recall Setup"  
If the "Recall Setup" is the only one user action assigned to the USER key, pressing this key triggers the R&S SMW to load *immediately* the user defined preset file.

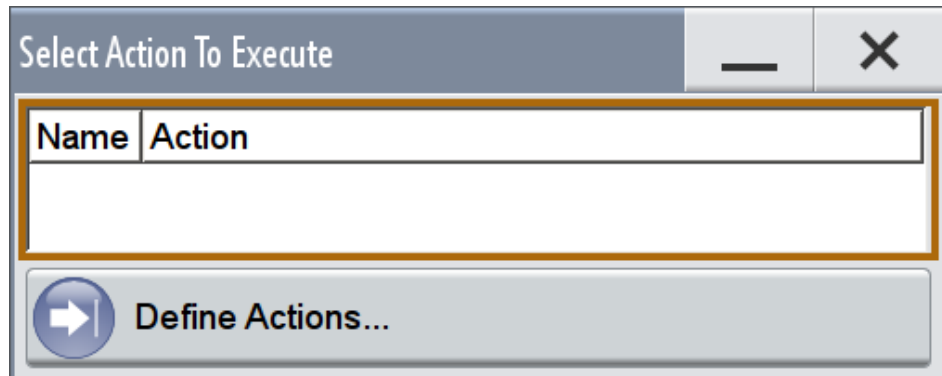


Recalling a user defined preset file using the USER key is even faster than immediate recall function provided by the SAVE/RCL key.

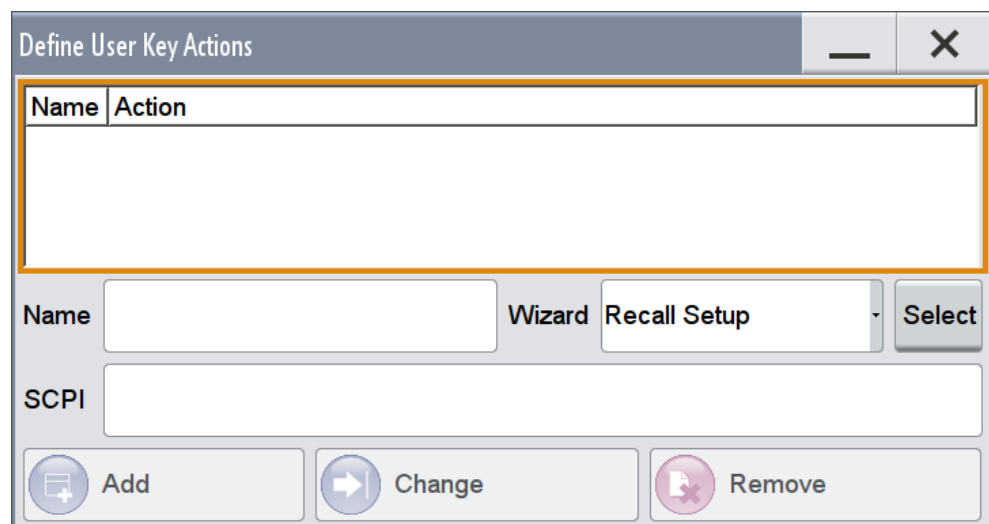
### 11.3.1 Define User Key Actions Settings

- ▶ To access this dialog, perform one of the following:

- a) Press USER and select "Select Action to Execute > Define Action".



- b) Select "System Configuration > Setup > User Interface > Define User Key".



The dialog displays a list of the currently enabled actions and provides functions to define new, edit or remove existing actions. If no actions have been defined, the list is empty.

For an example on how to use the provided settings, refer to:

- [Chapter 11.3.2, "How to Customize the User Key to Access a Frequently Used Dialog"](#), on page 629
- The application sheet "RS\_SMW\_FastDataAlignment\_AppSheet", available for download from the R&S SMW [product page](#).

The remote commands required to define these settings are described in [Chapter 13.11, "DISPlay Subsystem"](#), on page 741.

#### **Name**

Enters a user defined name for the action.

#### **Wizard**

Defines the action to be executed.

"Load SCPI Script"	Upon the triggering of the action, the selected SCPI script is loaded and executed.
"Recall Setup"	Load a setup for quick access to the user defined settings
"Open Dialog/Open Dialog (Append)"	Quick access to the selected dialog. Use the "Open Dialog (Append)" function to define a sequence of several dialogs to be opened simultaneously/subsequently

**Select**

Depending on the selected "Wizard", provides access to:

- The standard "File Select" function for loading of an SCPI script or setup file
- A list of the Dialog IDs of all currently opened dialogs. The dialog ID is used for dialog identification in the remote control (see "SCPI" on page 629).

**SCPI**

For the currently selected action, displays the corresponding SCPI command with the associated parameter for dialog identification (Dialog ID). The automatically displayed SCPIs are enabled for subsequent modification.

Remote command:

[:DISPlay:DIALog:OPEN](#) on page 744

See also [:DISPlay:DIALog:ID?](#) on page 743

**Add, Change, Delete**

Standard functions for managing of the actions.

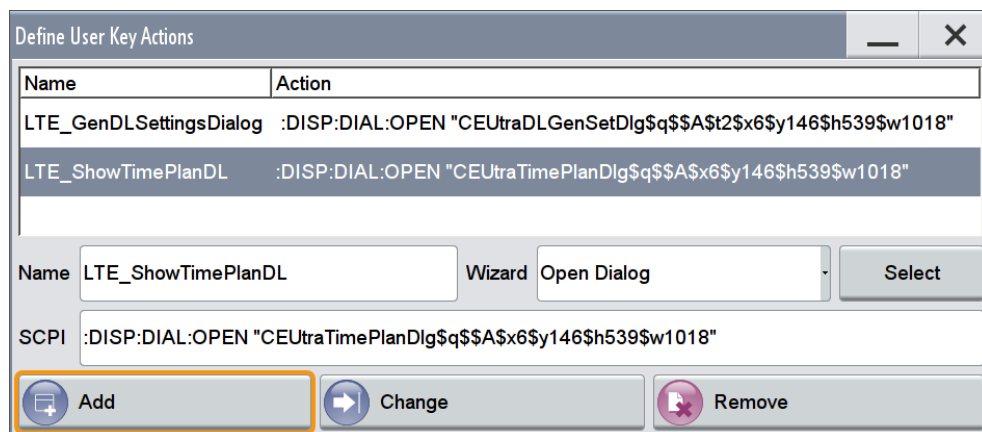
**Select Action to Execute > Define Action**

Accesses the [Define User Key Actions](#) dialog.

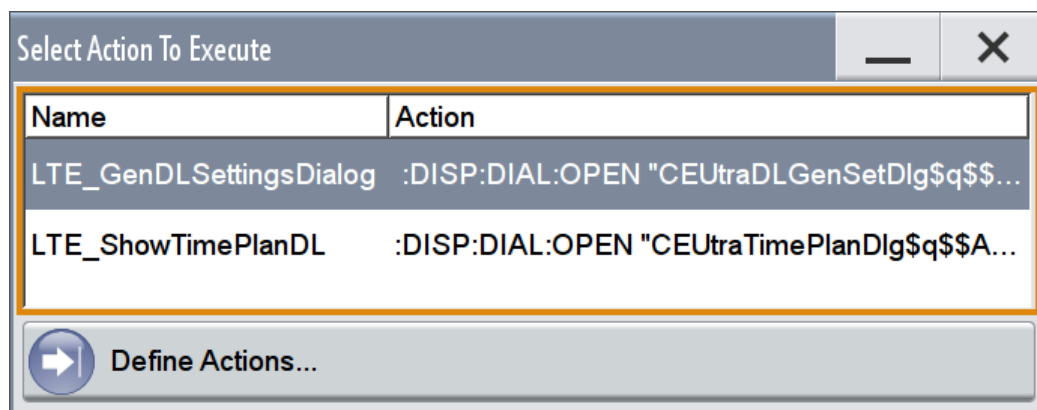
### 11.3.2 How to Customize the User Key to Access a Frequently Used Dialog

1. Open the dialog for that you are creating a quick access, e.g. select "Baseband > EUTRA/LTE > DL Frame Configuration > Time Plan > Show Time Plan in Dialog".
2. Select "System Configuration > Setup > User Interface > Define User Key".
3. To create an action:
  - a) specify the "Name", e.g. *LTE\_ShowTimePlanDL*
  - b) select "Wizard > Open Dialog"
  - c) Select "Select" and select the corresponding dialog ID from the list

The corresponding SCPI command is automatically displayed and can be later modified.
4. Select "Add" to store the new action in the list of user key actions.



5. To execute the created action, press USER and in the list of actions ("Select Action to Execute" dialog) navigate to the required action, i.e. "LTE\_ShowTimePlanDL".



The action is executed. In this example, the "EUTRA/LTE: Time Plan" dialog opens in a new dialog.

## 11.4 Managing Licenses and License Keys

An option is ready to operate after it is enabled with a license key code supplied with the option. The license key is delivered as a file or on paper. Unregistered licenses must be registered for a particular instrument before the corresponding option can be enabled for operation.



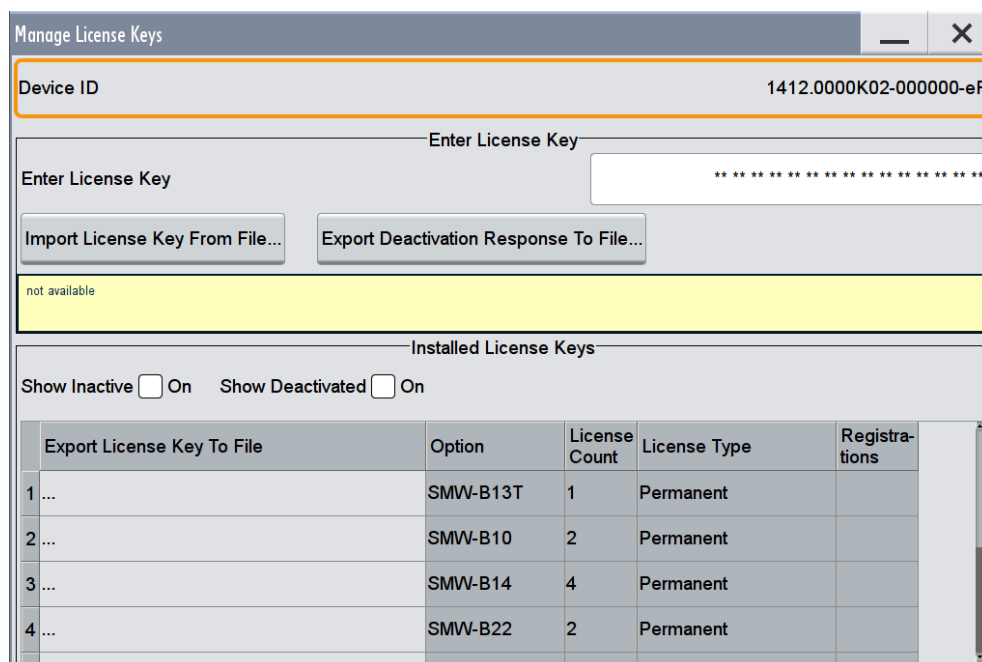
For reliable operation, a software option usually requires the latest firmware version. The required version is specified in the delivery. If your instrument works with a former firmware version, update the firmware before enabling the software option.

The firmware update is described in the R&S SMW service manual.

### 11.4.1 Manage License Keys Settings

This dialog is the central dialog for licenses registration and performing the required instrument-related steps during the process of unregistration.

- ▶ To access this dialog, select "System Config > Setup > Instrument Assembly > Manage License Keys".



In this dialog, you can manage licenses for newly purchased and/or newly registered options, perform the necessary steps to cancel a registration and/or to move licenses.

#### Device ID

Displays the instrument-specific identification number. The device ID is a unique string with the following structure:

<stock number>-<serial number>-<checksum>

#### Enter License Key

Type here the license key provided with the option.

For license keys delivered as a file, use [Import License Key from File...](#)

#### Import License Key from File...

Opens a dialog for selecting the file with the license key.

Use this function also to import the deactivation key file generated by the R&S License Manager online tool (see [How To Move a Portable License](#)).

#### Export Deactivation Response to File...

Exports the generated deactivation response key to a file and opens a file management dialog to save the file. This key is required during the unregistration process.

If you have a portable unregistered option, you can register it later on another instrument (see [How To Move a Portable License](#)).

#### Info Line

Indicates status information on the performed actions.

#### Show Inactive Licenses

Enables/disables the display of the inactive (expire) licenses in the [Installed License Keys Table](#).

#### Show Deactivated Licenses

Enables/disables the display of the deactivated licenses in the [Installed License Keys Table](#).

See [How To Move a Portable License](#) for information on how to activate deactivated licenses.

#### Installed License Keys Table

Shows information on the currently installed options.

##### "Export License Key to File"

Opens a dialog to save the generated license key file. This file is required during the unregistration process. If you have a portable unregistered option, you can register it later on another instrument (see [How To Move a Portable License](#)).

##### "Option"

Displays the option short designation.

**Tip:** Open the dialog to retrieve more information about the installed options.

##### "License Count"

Displays the number of the licenses for the selected option key.

##### "License Type"

Displays the type of license.

A license type is a joint qualification applicability duration and the portability of a license. The following license types are provided: evaluation, permanent, portable, quantified, timed with duration of 1, 3, 6 or 12 months. A license can also be in the states deactivated and expired.

For time limited licenses, the left time of applicability is displayed too.

## 11.4.2 How To Move a Portable License

This example is intended to explain how to perform the required steps at the instrument.

Use a USB stick to transfer the license key files between the instruments and the browser.





We assume knowledge about the handling of the R&S License Manager online tool and the description of the whole process.

1. Open your browser and go to <https://extranet.rohde-schwarz.com/service>. Select "Manage Licenses > Move Portable License".  
The first step requires the Device IDs of the source and target instruments.
2. To find out the Device IDs, proceed as follows:
  - a) On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Device ID".



- b) On the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Device ID".
  - c) In the browser, select "Manage Licenses > Move Portable License > Select Devices" and enter the Device IDs.
3. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Installed License Keys table", navigate to the portable license you want to move, and select the "Export License to File" column, e.g. R&S SMW-K40.  
A standard file manager dialog opens. Enter a user-specific file name and save the exported license key, e.g. `k40_portable_key_to_move.xml`.
4. In the browser, select "Manage Licenses > Move Portable License > Select License (from file)" and select the exported license key.  
Check the selection, create the deactivation key, and save it to file.
5. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Import License Keys from File" and select the transferred deactivation key.
6. On the source instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Export Deactivation Response to File".
7. In the browser, go to "Manage Licenses > Move Portable License > Install Deactivation Key (from file)" and enter the deactivation response of the instrument.  
The license is deactivated for the source instrument.
8. In the "Manage Licenses > Move Portable License", go to step "Create License" to generate a license key for this portable option and the selected target instrument.  
Download the license key as a file and transfer it to the target instrument.

- In the target instrument, select "System Config > Setup > Instrument Assembly > Manage License Keys > Import License Keys from File" and select the created license key file.

The portable option is installed on the target instrument.

## 11.5 Managing the Security Settings

The protection function of the R&S SMW offers several levels to activate particular functions like selftest or tests for service purposes specifically.

### Protection

The five protection levels are automatically active on startup, the protection levels, that means all protected functions are locked.

- ▶ To unlock a protection level, enter the correct password.
- ▶ To lock a protection level, clear the corresponding check box.

The following functions are protected in the respective levels:

- Protection Level 1  
Protects against accidental changes of certain settings, such as clock and date, network settings or instrument names. You can access this level with the password 123456.
- Protection Level 2  
Unlocks protected service functions. It is accessible to authorized personnel of Rohde & Schwarz Service Departments only.
- Protection Level 3–5  
Are reserved for factory internal use.

To access the protection level dialog, see [Chapter 11.5.1, "Protection Level Settings"](#), on page 635.

### Security

The security concept of the R&S SMW helps you to protect your instrument against uncontrolled access and changes. All provided security services require that you enter the security password.

Provided security services are:

- **General** security parameters as:
  - **USB Storage** secures controlled access to the mass memory of the instrument
  - **Write nonvolatile memory** protects against modification or deletion of data in the file system.
  - **Annotation** frequency and amplitude prevent reading the display.  
To access the settings of these topics, see [Chapter 11.5.2, "Setting Security Parameters"](#), on page 636.

- Password** management secures controlled user access to the instrument  
 With the two-step password concept, you can assign a user-defined password for the operating system, as well as a security password for accessing the mass storage of the instrument. See also [Chapter 11.5.2, "Setting Security Parameters"](#), on page 636.  
 For more information concerning the user and security passwords, see the description *Resolving Security Issues when Working with an R&S SMW*. You can find this document on the R&S website of the instrument, under "Download > Security".
- LAN Services** secures controlled network access  
 You can individually lock and unlock the supported LAN interface services, see [Chapter 11.5.3, "Configuring LAN Services"](#), on page 639.  
 Remote control via LAN interface requires that the interface is activated, but you can enable the required services specifically.
- User Interface** prevents front panel operation and/or reading the display.

### 11.5.1 Protection Level Settings

- To access this dialog, select "System Config > Setup > Security > Protection".

Protection Level	Checked	Status	Password
Protection Level 1	<input checked="" type="checkbox"/>	On	*****
Protection Level 2	<input checked="" type="checkbox"/>	On	*****
Protection Level 3	<input checked="" type="checkbox"/>	On	*****
Protection Level 4	<input checked="" type="checkbox"/>	On	*****
Protection Level 5	<input checked="" type="checkbox"/>	On	*****

The "Protection" dialog provides access to the unlocking of different protection levels.

The remote commands required to unlock a protected stage are described in [Chapter 13.19, "SYSTEM Subsystem"](#), on page 1045.

#### Protection Level/Password

Unlocks the appropriate level of protection, provided the correct password is entered. If you clear the check box, the lock is enabled again.

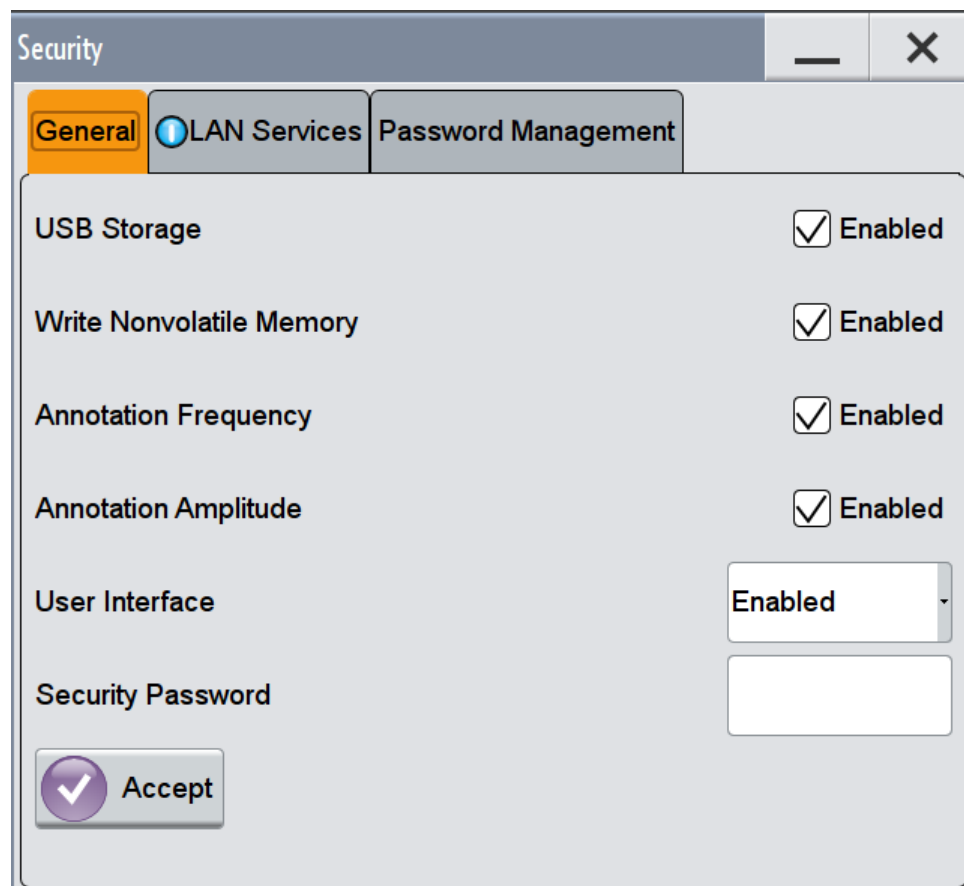
**Tip:** To expand the functionality of the internal adjustment and access the self tests, unlock protection level 1. The password is 123456.

Remote command:

:SYSTEM:PROTECT<ch> [:STATE] on page 1057

## 11.5.2 Setting Security Parameters

- ▶ To access this dialog, select "System Config > Setup > Security > General".



In the "Security" dialog, you can configure the mass storage security settings.



The settings in this dialog are not assigned until you enter the [Security Password](#) and confirm with the [Accept](#) button.

The remote commands available to control security settings are described in [Chapter 13.11, "DISPlay Subsystem"](#), on page 741.

### USB Storage

Activates the access to external USB storage media.

This setting has no effect on a mouse or a keyboard, connected via USB.

The setting requires the entry of the security password and is only accepted after the "Accept" button is selected.

See also [Chapter 10.9.4, "How to Use a USB Storage Device for File Transfer"](#), on page 600.

### Write Nonvolatile Memory

Activates write protection on the file system to prevent modification or erasure of valuable data.

The setting takes effect, when you enter the security password, confirm with "Accept", and reboot the instrument.

Remote command:  
n.a.

### Annotation Frequency

Enables the display of the currently used frequency in the header of the instrument.

The setting requires the entry of the security password and is not assigned until you select the "Accept" button.

Remote command:  
[:DISPlay:ANNotation:FREQuency](#) on page 743

### Annotation Amplitude

Enables the display of the currently selected level in the header of the instrument.

**Note:** The setting requires the entry of the security password and is not assigned until you confirm with the "Accept" button.

Remote command:  
[:DISPlay:ANNotation:AMPLitude](#) on page 743

### User Interface

Allows you to lock the controls for manual operation and the display individually.

The setting requires the entry of the security password *123456* and is only accepted after the "Accept" button is pressed. See also [Chapter 11.5, "Managing the Security Settings"](#), on page 634 for more information on the security concept.

"Enabled" Enables the display and all controls for the manual operation of the instrument.


"Touchscreen Off"

Locks the touch sensitivity of the screen.




This security feature protects the instrument against unintentional change of settings by accidentally touching of the screen.

Still available controls for manual operation are:

- The keys at the front panel, including the rotary knob
- The external mouse and keyboard
- Remote operation over VNC

The instrument indicates the locked touchscreen by an icon  in the upper left corner of the block diagram.

Unlocking is possible via VNC, external controls or remote control.

"VNC Only"	<p>Locks the keys at the front panel, the touchscreen and externally connected keyboard and mouse.</p> <p>The display on the screen remains and shows the current settings and changes.</p> <p>The instrument indicates the activated "VNC only" feature by the icon  in the upper left corner of the block diagram.</p> <p>Unlocking is possible via VNC or turning off and on again.</p>
"Display Only"	<p>Locks the manual operation of the instrument. The display on the screen remains and shows the current settings and changes.</p> <p>This security feature protects the instrument against unauthorized access, but still shows the current settings and processes, for example when you operate the instrument via remote control.</p> <p>The function disables:</p> <ul style="list-style-type: none"> <li>• The touchscreen functionality of the display</li> <li>• The keys at the front panel of the instrument</li> <li>• The external mouse and keyboard</li> </ul> <p>The instrument indicates the locked controls by a padlock  softkey in the taskbar.</p> <p>Unlocking is possible by entering the security password, see <a href="#">Enabling a locked user interface for manual operation</a>.</p>
"Disabled"	<p>Locks the display and all controls for the manual operation of the instrument.</p> <p>This security feature protects the instrument against unauthorized reading and access, for example when you operate the instrument via remote control.</p> <p>The function disables:</p> <ul style="list-style-type: none"> <li>• The display</li> <li>• The touchscreen</li> <li>• The keys at the front panel of the instrument</li> <li>• The external mouse and keyboard</li> </ul> <p>The screen shuts off and displays a padlock symbol  instead.</p> <p>Unlocking is possible by entering the security password, see also <a href="#">Enabling a locked user interface for manual operation</a>.</p>

Remote command:

[:SYSTem:ULOCK](#) on page 1049

[:SYSTem:DLOCK](#) on page 1050

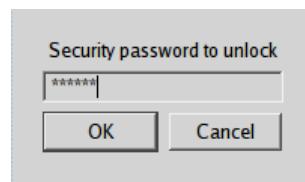
[:SYSTem:KLOCK](#) on page 1050

#### Enabling a locked user interface for manual operation

To unlock the user interface for manual operation, you have the following options:

- On the instrument's keypad or external keyboard, enter the security password 123456.

Even if you press any key, the instrument prompts you to enter the security password for unlocking.



**Note:** The character of the first key you pressed is immediately added in the input field. Delete the entry before inserting the password.

- In remote control mode, send the command `SYST:ULOC ENABled` to release all locks at once.  
Alternatively, you can use the command `SYST:KLOC OFF` to unlock the keyboard and touchscreen, or `SYST:DLOC OFF` to release all locks.  
Via remote control, there is no password required.

Remote command:

- `:SYSTem:ULOCK` on page 1049
- `:SYSTem:DLOCK` on page 1050
- `:SYSTem:KLOCK` on page 1050

### Security Password

Enters the password that is required to enable or to disable the settings protected by a security password. Default is `123456`.

**Note:**

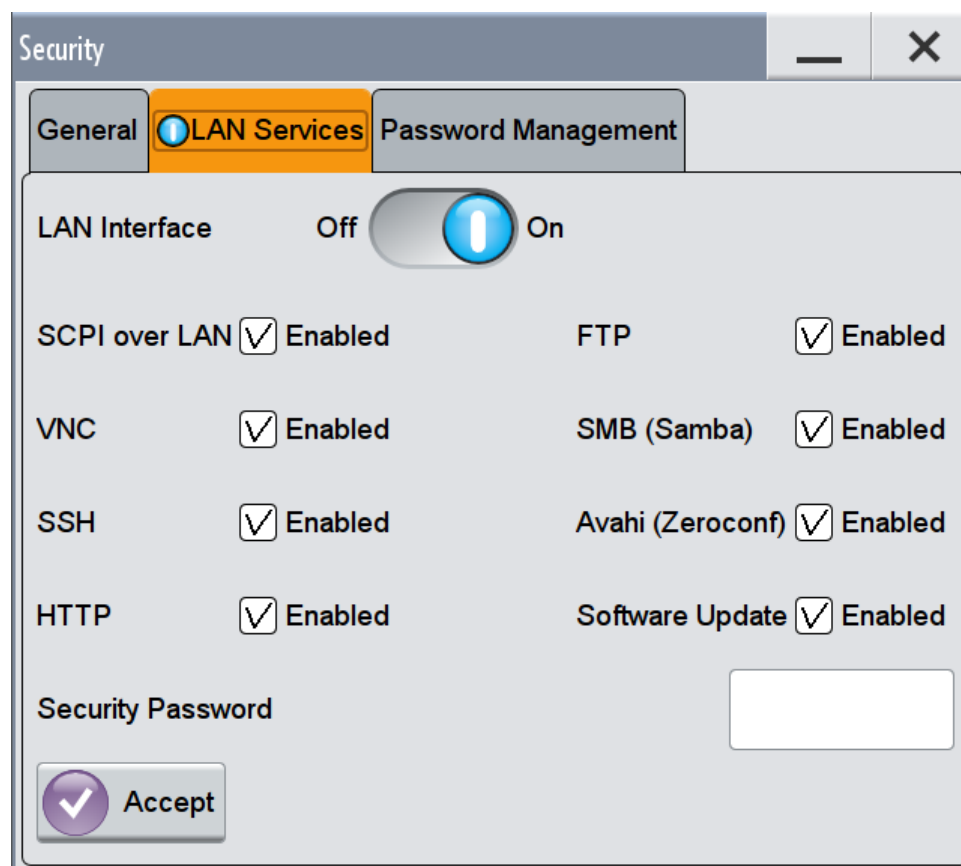
- We recommend that you change the default security password before connecting the instrument to the network.
- The security settings are not assigned until you select the "Accept" button.

### Accept

Applies the modified settings, provided the security password is entered and correct.

## 11.5.3 Configuring LAN Services

- ▶ To access this dialog, select "System Config > Setup > Security > Security > LAN Services".



In the "LAN Services" dialog, you can individually enable or disable the supported LAN interface services.



The activated LAN services are not activated until you enter the "Security Password" on page 639 and confirm with [Accept](#).

### LAN Interface

Enables the LAN interface in general, and thus provides remote access via all unlocked services.

### Enable LAN Services individually

Enables or disables the following interface services individually.

#### "SCPI over LAN"

Activates access over LAN to control the instrument remotely, by using SCPI (Standard Commands for Programmable Instruments) commands.

See also "[Starting a remote control session over LAN with R&S VISA](#)" on page 684.



"VNC"	Activates access via VNC (Virtual Network Computing) interface, a graphical desktop sharing system that uses RFB protocol to control the instrument remotely. See also <a href="#">Chapter 12.17, "How to Set Up Remote Operation via VNC"</a> , on page 704.
"SSH"	Activates access via SSH (Secure Shell), a network protocol for secure data communication.
"HTTP"	Activates access via HTTP (Hyper Text Transfer Protocol), the application protocol for hypermedia information systems.
"FTP"	Activates access via FTP (File Transfer Protocol), used to transfer files from a host to the instrument and vice versa. See also <a href="#">Chapter 10.9.2, "How to Access the File System of the R&amp;S SMW via ftp"</a> , on page 597.
"SMB (Samba)"	Activates access to SMB (Server Message Block), used for providing shared access to files, printers and serial ports of a network. See also <a href="#">Chapter 10.9.3, "How to Access the File System of the R&amp;S SMW via SMB (Samba)"</a> , on page 599.
"Avahi (Zeroconf)"	Activates Avahi, a service for automatic configuration of the instrument in a network environment.
"Software Update"	Allows updating the software.

**Security Password**

Enters the password that is required to enable or to disable the settings protected by a security password. Default is 123456.

**Note:**

- We recommend that you change the default security password before connecting the instrument to the network.
- The security settings are not assigned until you select the "Accept" button.

**Accept**

Applies the modified settings, provided the security password is entered and correct.

**11.5.4 Password Management**

- ▶ To access this dialog, select "System Config > Setup > Security > Security > Password Management".

The screenshot shows a window titled "Security" with three tabs: "General", "LAN Services", and "Password Management". The "Password Management" tab is selected and highlighted in orange. It contains two sections:

- Change User Password**: Valid for VNC, FTP and SMB (Samba) access. It includes a "User Name" field with the value "instrument", and three password input fields labeled "Old Password", "New Password", and "Confirm Password". A "Change Password" button with a wrench icon is at the bottom.
- Change Security Password**: It includes three password input fields labeled "Old Password", "New Password", and "Confirm Password". A "Change Password" button with a wrench icon is at the bottom.

In this tab, you can assign the security and a user defined password, as well as the bluetooth pin.



A new password does not take effect until you confirm it with the corresponding "Change Password" button.

To confirm the new password, always press [Change Password](#) in the section of the user password, and [Change Password](#) for the security password, respectively.

#### **User Name**

Indicates the user name used for access to the Linux operating system and valid for VNC, FTP and SMB (Samba) access.

#### **User Password**

Allows you to change and confirm the user password.

**Old Password ← User Password**

Enters the current user password. The default password is "instrument".

**Note:** It is highly recommended that you change the default user password before connecting the instrument to a network.

**New Password ← User Password**

Enters the new user password.

The security password may contain decimal characters only.

**Confirm Password ← User Password**

Confirms the new user password by repeating.

**Note:** The new password is not assigned until you select the [Change Password](#) button.

**Change Password ← User Password**

Changes the user password accordingly.

**Security Password**

Enables you to change and confirm the security password.

**Old Password ← Security Password**

Enters the currently used security password. The default password is '123456'.

**Note:** It is highly recommended that you change the default security password before connecting the instrument to the network.

The security password is required when changing the status of the USB and LAN interface.

**New Password ← Security Password**

Enters the new security password.

The security password may contain decimal characters only.

**Confirm Password ← Security Password**

Confirms the new security password by repeating.

**Note:** The new password is not assigned until you select the [Change Password](#) button.

**Change Password ← Security Password**

Changes the password accordingly.

**Bluetooth Pin**

Defines the pin of an external bluetooth device. This pin is required to enable remote control via bluetooth.

## 11.6 Undoing or restoring actions

"Undo" is a function that removes the effect of the last action on the instrument and reverts it to an older state. Conversely, "Redo" restores a previously undone action.

You can "Undo/Redo" actions according to two criteria:

- Step by step  
Gradually undo/redo the actions in reverse order as previously performed. Depending on the available memory the "Undo/Redo" steps may restore all actions.
- Multiple steps at once  
Select any specific action in the history list to "Undo/Redo" multiple actions in a single step.  
**Note:** This mode requires a system restoration file on the instrument.

### 11.6.1 Undo/Redo Settings

- ▶ To access this dialog select "Setup > Settings > Undo/Redo".

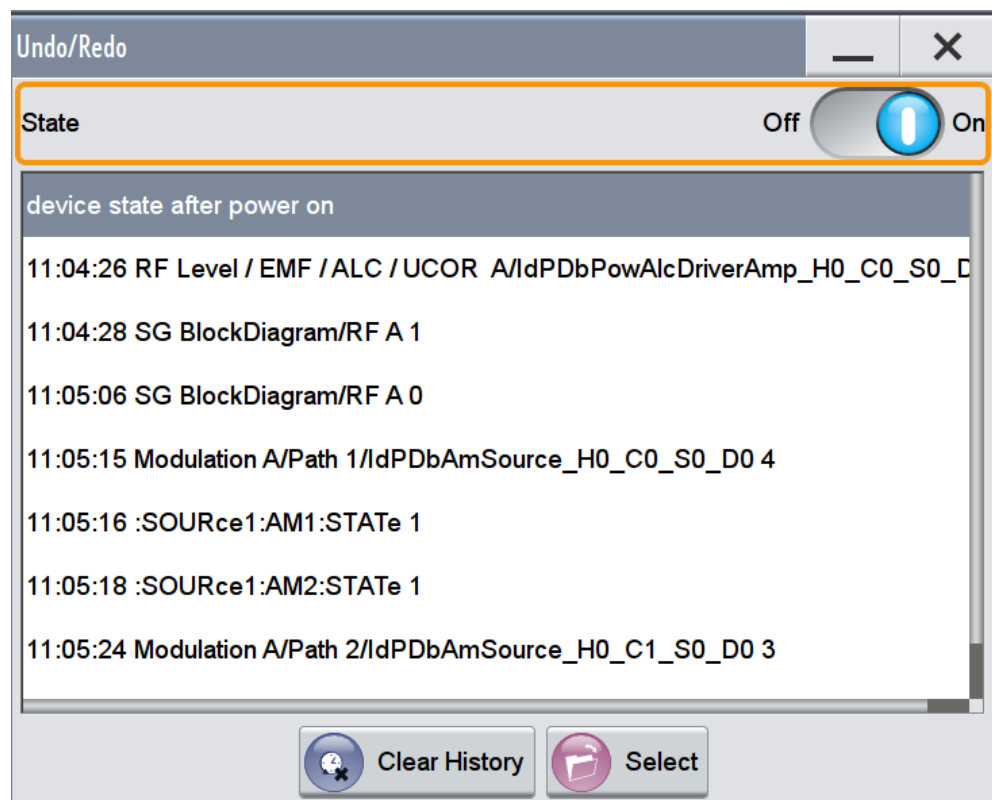


Figure 11-3: Undo/Redo History

The dialog contains all functions for enabling the "Undo/Redo" functionality.

#### State

Enables the recording of the performed actions.

#### History List

Lists the performed actions, provided "Undo/Redo" state is "On".

**Clear History**

Deletes the recorded list of the performed steps.

**Apply**

Performs the "Undo/Redo".

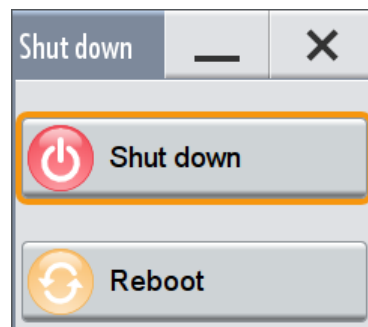
If you select a previously performed action of the list, all subsequent actions are undone. The list entries remain.

If you select a subsequently executed action, you can restore all the actions undone up to this state.

## 11.7 Shutting Down and Rebooting the Instrument

The POWER ON/STANDBY front panel key switches the instrument from the standby to the ready state or vice versa. In remote operation from a remote computer or in manual control, there is another possibility to shut down the instrument or to reboot the system.

- ▶ To access the required settings, select "System Config > Setup > Maintenance > Shut Down".



Remote control commands:

- `:SYSTem:REBoot` on page 1063
- `:SYSTem:SHUTdown` on page 1063

## 11.8 Reference

This section provides reference information on where to find the descriptions of all functions accessed via the SETUP key. This reference information is provided in successive order, i.e sorted in the order the corresponding function appears in the "Setup" dialog.

This cross-reference information is useful, if you are familiar with the documentation of other R&S signal generators, like the R&S SMU.

Table 11-3: Setup Menu

Menu item	Content	Described in ...
<b>General</b>		
System Configuration	Introduces you to the various configuration options.	<a href="#">Chapter 4, "Signal Routing and System Configuration"</a> , on page 120
Global Connectors	Explains the possible, assignable global connector interfaces.	<a href="#">Chapter 11.2, "Configuring the Local and Global Connectors"</a> , on page 612
Reference Freq / LO Coupling	Describes the parameters for setting the internal reference frequency.	<a href="#">Chapter 8.5, "Reference Oscillator"</a> , on page 422
Internal Adjustments	Describes how you can calibrate your unit or individual components.	<a href="#">Chapter 14.2.3, "Internal Adjustment Settings"</a> , on page 1084
Baseband Powers	Explains how you can retrieve the power and peak power of the generated signal at configurable acquisition points.	<a href="#">Chapter 9.2, "Querying Information on the Baseband Power Levels"</a> , on page 553
<b>Remote Access</b>		
Network	Contains all relevant information for the remote control of the R&S SMW.	<a href="#">Chapter 12.4.1, "Network Settings"</a> , on page 661
Visa Resource Strings	Shows the VISA resource strings provided for remote control via the various interfaces.	<a href="#">Chapter 12.4, "Remote Access Settings"</a> , on page 660
Instrument Emulations	Enables you to emulate a remote control command set of another Rohde & Schwarz signal generator.	<a href="#">Chapter 12.4.5, "Instrument Emulations Settings"</a> , on page 667
LXI Status	Indicates the LAN - LXI connection parameters.	<a href="#">Chapter 12.5, "LXI Settings"</a> , on page 670
<b>Instrument Assembly</b>		
Hardware Config	Provides an overview of all installed hardware assemblies.	<a href="#">Chapter 14.2.8, "Requesting Instrument Configuration and Specifications"</a> , on page 1091
Software / Options	Contains a list of all installed software assemblies.	<a href="#">Chapter 14.2.8, "Requesting Instrument Configuration and Specifications"</a> , on page 1091
Manage License Keys	Explains how to enable an option for the R&S SMW.	<a href="#">Chapter 11.4, "Managing Licenses and License Keys"</a> , on page 630
NRP-Z Info Update	Provides information and firmware update of a connected R&S NRP-Zxx Power Sensor.	<a href="#">Chapter 8.9.4.2, "NRP-Z Info Update"</a> , on page 522
<b>User Interface</b>		

Menu item	Content	Described in ...
Graphics	Describes the different ways of graphical signal display, the content, and the application of the various graphs and the available signal sources.	<a href="#">Chapter 9.1, "Displaying Base-band Signal Characteristics in Real-Time"</a> , on page 526
Display	Sets the GUI language.	<a href="#">Chapter 11.1.2, "Display and Keyboard Settings"</a> , on page 609
Start/Stop Display Update	Enables you to deactivate the update function of the GUI.	<a href="#">Chapter 11.1.4, "Display Update Settings"</a> , on page 611
Appearance	Contains parameters for configuring the transparency and instantaneous display of dialogs.	<a href="#">Chapter 11.1.3, "GUI Appearance Settings"</a> , on page 610
Keyboard	Sets the keyboard layout.	"Layout" on page 610
Define User Key	Describes how to assign a function to the user key.	<a href="#">Chapter 11.3, "Assigning Action to the User Key"</a> , on page 627
<b>Security</b>		
Security	Contains security functions to protect the instrument against uncontrolled access.	<a href="#">Chapter 11.5.2, "Setting Security Parameters"</a> , on page 636
Protection	Provides different levels of protection for certain features specifically unlock.  Provides incremental protection levels to unlock test functions, for example for service purposes.	<a href="#">Chapter 11.5.1, "Protection Level Settings"</a> , on page 635
<b>Maintenance</b>		
Shut Down	Enables you to shut down or reboot the instrument without using the POWER ON/STANDBY front panel key.	<a href="#">Chapter 11.7, "Shutting Down and Rebooting the Instrument"</a> , on page 645
Date / Time	Contains the date and time settings of the operating system.	<a href="#">Chapter 14.2.1, "Date and Time Settings"</a> , on page 1078
Check Front Panel	Enables you to test the function of the front panel keys.	<a href="#">Chapter 14.2.2, "Check Front Panel"</a> , on page 1079
PCI-FPGA Update	Provides updating the PCI-FPGA.	<a href="#">Chapter 14.2.7, "PCI-FPGA Update Settings"</a> , on page 1091
Create R&S Support Information	Creates a support file with service-related information.	<a href="#">Chapter 15.6, "Obtaining Technical Support"</a> , on page 1100
<b>Settings</b>		
Save/Recall	Contains the main save and recall function for managing of the instrument settings.	<a href="#">Chapter 10.4, "Storing and Recalling Instrument Settings"</a> , on page 580
Factory Preset	Resets the instrument to its factory settings.	<a href="#">Chapter 10.2, "Restoring the (Default) Instrument Configuration"</a> , on page 574

Menu item	Content	Described in ...
Undo/Redo	Restores previously performed actions, or restores an undone action.	<a href="#">Chapter 11.6, "Undoing or restoring actions"</a> , on page 643
<b>Help</b>		
Contents Index	Accesses the embedded help system.	<a href="#">Chapter 3.5.5, "Getting Information and Help"</a> , on page 114
Tutorials	Accesses the embedded tutorials.	<a href="#">Chapter 3.5.5.1, "Using the Tutorials"</a> , on page 116



## 12 Network and Remote Control Operation

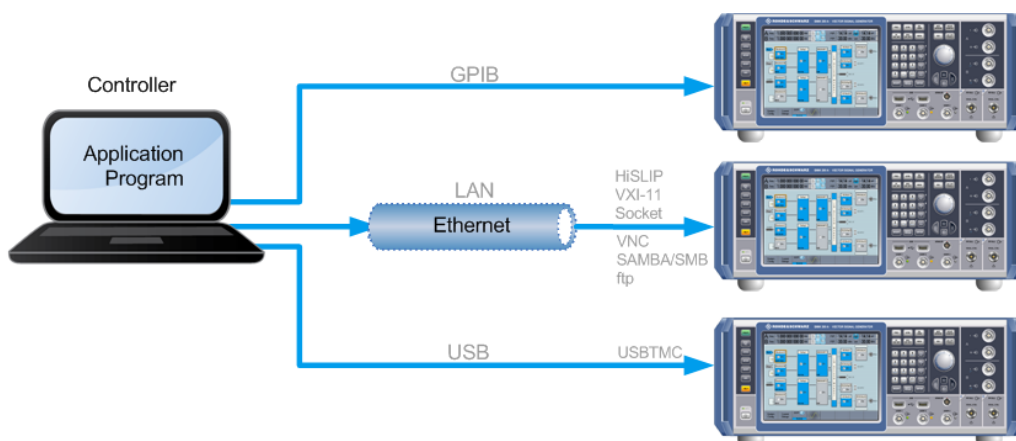


The description in this section requires basic knowledge of the remote control operation. Definitions specified in the SCPI standard are not provided.

Nevertheless, you find some basic information to the SCPI syntax, command lists, and general programming recommendations in [Chapter B.1, "Additional Basics on Remote Control"](#), on page 1114. In addition, this section provides information on the status reporting system of the instrument:

As an alternative to the interactive operation directly at the instrument, you can operate the R&S SMW also from a remote location.

The [Figure 12-1](#) shows the possibilities of the physical connection (interfaces) for the remote access.



**Figure 12-1: Supported remote connections**



For information on how to configure a network, see the [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45.

The various interfaces provide flexible access to the instrument, such as *remote control*, *remote operation* or *remote file access*. These remote access modes are fundamentally different, although they are often considered interchangeable. Therefore, the distinguishing characteristics are briefly explained in [Overview of Remote Access Modes](#).

For comprehensive information on these topics, refer to the Application Note 1GP72 "Connectivity of Rohde&Schwarz Signal Generators".

## 12.1 Overview of Remote Access Modes

This section explains the possible access modes and their distinguishing characteristics in brief.

### Remote Control (SCPI)

- A remote PC controls the instrument, usually via VISA (Virtual Instrument Software Architecture) interfaces.
- Remote control blocks the manual operation of the instrument; you can set different lock states.
- The GUI is not visible.
- Remote control commands (SCPI) perform the settings, either individually or in sequences (SCPI programs).
- Using SCPI programs is faster than the manual operation, since they automate repeating applications.

### Remote Operation (VNC)

#### NOTICE

#### Risk of Unauthorized Access

If the VNC service is enabled on the instrument, any user in the network who knows the computer name and password can access it.

Disable the VNC service on the instrument to prevent unauthorized access.

See "[Enable LAN Services individually](#)" on page 640.

- A remote device accesses the instrument via the common platform technology VNC (Virtual Network Computing).
- The protocol allows simultaneous operation from several remote devices and the instrument nevertheless remains locally operable.
- The GUI is visible.
- To perform the settings, you can operate the instrument as with the manual control.
- Clients supporting remote operation depend on the used remote device, see [Table 12-1](#).

**Table 12-1: Supported VNC operation modes**

Remote device	VNC Client	Requirements	Characteristics
Desktop (Windows, Linux, Mac™OS)	<ul style="list-style-type: none"> <li>• Ultr@VNC</li> <li>• Other dedicated client software</li> </ul>	<i>Ultr@VNC or Client Software</i> must be installed.	Fast, supports several options like full screen mode or auto-login.
	<ul style="list-style-type: none"> <li>• Any web browser</li> </ul>	<i>Java Runtime</i> must be installed and activated in the browser settings.	Fast and convenient - only the instrument address required. Java runtime is sometimes considered as security concern.

Remote device	VNC Client	Requirements	Characteristics
	<ul style="list-style-type: none"> <li>Web browser with HTML5</li> </ul>	<i>Web sockets</i> must be supported.	Slower than the other modes. No additional installation or activation required. No security concern.
Smart device (Tablet / Smart Phone)	<ul style="list-style-type: none"> <li>Dedicated client App</li> </ul>	<i>App</i> must be installed.	Fast, supports several options like full screen mode or auto-login.
	<ul style="list-style-type: none"> <li>Web browser with HTML5</li> </ul>	<i>Web sockets</i> must be supported.	Support of QR code scanning Slower than a dedicated App.

### Remote file access (FTP, SAMBA/SMB)

- A remote client accesses the instrument's file system, using the protocols FTP (file transfer protocol) and SAMBA/SMB (server message block).
- The protocols enable you to transfer files from or to the signal generator, and to get direct access to the instrument's file sharing directory `/var/user/share`.

For more information, refer to [Chapter 10.9, "Transferring Files from and to the Instrument"](#), on page 595.

## 12.2 Remote Control Interfaces and Protocols

The instrument supports various interfaces for remote control. The table gives an overview on the connectivity:

**Table 12-2: Remote control interfaces and protocols**

Interface	Protocols, VISA <sup>1)</sup> address string and Library	Remarks
Local Area Network (LAN)	<ul style="list-style-type: none"> <li><b>HiSLIP</b> High-Speed LAN Instrument Protocol (IVI-6.1) TCP/IP::host address::hislip0[::INSTR] VISA</li> <li><b>VXI-11</b> TCP/IP::host address[::LAN device name][::INSTR] VISA</li> <li><b>Socket communication</b> (Raw Ethernet, simple Telnet) TCP/IP::host address[::LAN device name]::&lt;port&gt;::SOCKET VISA or socket controller</li> </ul>	<p>A LAN connector is located on the front or rear panel of the instrument, or both.</p> <p>The interface is based on TCP/IP and supports various protocols.</p> <p>For a description of the protocols, refer to:</p> <ul style="list-style-type: none"> <li><a href="#">Chapter 12.2.1.2, "HiSLIP Protocol"</a>, on page 654</li> <li><a href="#">Chapter 12.2.1.3, "VXI-11 Protocol"</a>, on page 654</li> <li><a href="#">Chapter 12.2.1.4, "Socket Communication"</a>, on page 654</li> </ul>
USB	<ul style="list-style-type: none"> <li><b>USBTMC</b> USB::&lt;vendor ID&gt;::&lt;product ID&gt;::&lt;serial number&gt;[::INSTR] VISA</li> </ul>	<p>USB connectors are located on the front or the rear panel of the instrument, or both.</p> <p>For a description of the interface, refer to <a href="#">Chapter 12.2.2, "USB Interface"</a>, on page 655</p>

Interface	Protocols, VISA <sup>*)</sup> address string and Library	Remarks
GPIB (IEC/IEEE Bus Interface)	<ul style="list-style-type: none"> <li>– GPIB::<code>primary address</code>[:<code>INSTR</code>] (no secondary address) VISA</li> </ul>	<p>Optional GPIB bus interfaces according to standard IEC 625.1/IEEE 488.1 are located on the rear panel of the instrument.</p> <p>For a description of the interface, refer to <a href="#">Chapter 12.2.3, "GPIB Interface (IEC/IEEE Bus Interface)"</a>, on page 656.</p>
<p><sup>*)</sup> VISA (Virtual Instrument Software Architecture) is a standardized software interface library providing input and output functions to communicate with instruments. A VISA installation on the controller is a prerequisite for remote control over LAN (when using VXI-11 or HiSLIP protocol), USB and serial interface. For remote control via socket communication VISA installation is optional. For more information, see <a href="#">Chapter 12.3.1, "VISA Library"</a>, on page 657.</p>		



Rohde & Schwarz provides the standardized I/O software library R&S VISA for communication with the instruments via TCP/IP (LAN: HiSlip, VXI-11 and raw socket), USB (USBTMC) or serial interfaces.

R&S VISA is available for download at the Rohde & Schwarz website <http://www.rohde-schwarz.com/rsvisa>.

How to configure the remote control interfaces is described in [Chapter 12.8, "How to Set Up a Remote Control Connection"](#), on page 679.

### SCPI (Standard Commands for Programmable Instruments)

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. The instrument supports the SCPI version 1999. 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. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

For more information, see also [Chapter B.1, "Additional Basics on Remote Control"](#), on page 1114.

## 12.2.1 LAN Interface

To be integrated in a LAN, the instrument is equipped with a LAN interface, consisting of a connector, a network interface card and protocols.

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol. The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and (for specified protocols only) the VISA program library must be installed on the controller.



### Identifying instruments in a network

If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by the resource string.

#### 12.2.1.1 VISA Resource Strings

The VISA resource string is required to establish a communication session between the controller and the instrument in a LAN. The resource string is a unique identifier, composed of the specific IP address of the instrument and some network and VISA-specific keywords.

**TCPIP::host address[:LAN device name][:INSTR]**

TCPIP = designates the network protocol  
 host address = designates the IP address or hostname of the instrument  
 [:LAN device name] = defines the protocol and the instance number of a subinstrument  
 [:INSTR] = indicates the instrument resource class (optional)

The **IP address** (host address/computer name) is used by the programs to identify and control the instrument. It is automatically assigned by the DHCP server the first time the device is registered on the network. Alternatively, you can also assign its **LAN device name**.

You can find the IP address in the "Remote Access > Network" dialog, and also adjust it manually, if required (see "IP Address" on page 663).

See below the characteristics of the VISA resource strings for the corresponding interface protocols. The highlighted characters are crucial.

#### HiSLIP

**TCPIP::host address::hislip0[:INSTR]**

hislip0 = HiSLIP device name, designates that the interface protocol HiSLIP is used (mandatory)

**hislip0** is composed of [:HiSLIP device name[,HiSLIP port]] and must be assigned.

For details of the HiSLIP protocol, refer to [Chapter 12.2.1.2, "HiSLIP Protocol"](#), on page 654.

#### VXI-11

**TCPIP::host address[:inst0][:INSTR]**

[:inst0] = LAN device name, indicates that the VXI-11 protocol is used (optional)

**inst0** currently selects the VXI-11 protocol by default and can be omitted.

For details of the VXI-11 protocol, refer to [Chapter 12.2.1.2, "HiSLIP Protocol"](#), on page 654.

#### Socket Communication

**TCPIP::host address::port::SOCKET**

port = determines the used port number  
 SOCKET = indicates the raw network socket resource class

Socket communication requires the specification of the port (commonly referred to as port number) and of "SOCKET" to complete the VISA resource string with the associated protocol used.

The registered port for socket communication is port 5025.

See also [Chapter 12.2.1.4, "Socket Communication"](#), on page 654.

### 12.2.1.2 HiSLIP Protocol

The HiSLIP (**H**igh **S**peed **L**AN **I**nstrument **P**rotocol) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - one for fast data transfer, the other for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks



Note that HiSLIP data is sent to the device using the "fire and forget" method with immediate return, as opposed to VXI-11, where each operation is blocked until a VXI-11 device handshake returns. Thus, a successful return of a VISA operation such as `viWrite()` does not guarantee that the instrument has finished or started the requested command, but is delivered to the TCP/IP buffers.

---

For more information see also the application note: [1MA208: Fast Remote Instrument Control with HiSLIP](#).

### 12.2.1.3 VXI-11 Protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol which in turn relies on TCP/IP as the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

### 12.2.1.4 Socket Communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred to as "Raw

Ethernet communication", does not necessarily require a VISA installation on the remote controller side. It is available by default on all operating systems.

The simplest way to establish socket communication is to use the built-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For more convenience and to enable automation by means of programs, user-defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. All R&S SMW use port number 5025 for this purpose. The port is configured for communication on a command-to-command basis and for remote control from a program.

## 12.2.2 USB Interface

For remote control via the USB connection, the PC and the instrument must be connected via the USB type B interface. A USB connection requires the VISA library to be installed. VISA detects and configures the R&S instrument automatically when the USB connection is established. You do not have to install a separate driver.

USBTMC (**USB Test & Measurement Class Specification**) is a protocol that is built on top of USB for communication with USB devices, like GPIB. It defines class code information of the instrument, that identifies its functionality to load the respective device driver. Using VISA library, it supports service request, triggers, and other specific operations, similar to GPIB.

### 12.2.2.1 USB Resource String

The resource string represents an addressing scheme that is used to establish a communication session with the instrument. It is based on the instrument address and some instrument- and vendor-specific information.

The syntax of the used USB resource string is:

```
USB::<vendor ID>::<product ID>::<serial number>[::INSTR]
```

USB = denotes the used interface  
 <vendor ID> = is the manufacturer ID for Rohde&Schwarz  
 <product ID> = is the product identification of the R&S instrument  
 <serial number> = is the individual serial number on the rear of the instrument  
 [::**INSTR**] = indicates the instrument resource class (optional)

To set the USB resource string, see [Remote Access Settings](#).

#### Example:

```
USB::0x0AAD::0x0092::100001
```

0x0AAD is the vendor ID for Rohde&Schwarz

0x0092 is the product ID for the R&S SMW

100001 is the serial number of the particular instrument

### 12.2.3 GPIB Interface (IEC/IEEE Bus Interface)

To be able to control the instrument via the GPIB bus, the instrument and the controller must be linked by a GPIB bus cable. A GPIB bus card, the card drivers and the program libraries for the programming language used must be provided in the controller.

#### GPIB address

The controller must address the instrument with the GPIB bus channel (see [Chapter 12.4.3, "GPIB Address Settings"](#), on page 666). GPIB provides channel addresses from 0 to 30.

Finally, the GPIB resource string is composed of:

`GPIB::<address>[:INSTR]`

GPIB = denotes the used interface

<channel address> = the used channel

[:INSTR] = indicates the instrument resource class (optional)

**Note:** If the VISA implementation supports the GPIB interface, you can optionally define the VISA Instrument Control Resource (INSTR). It is used to define the basic operations and attributes for a device, such as reading, writing, or triggering.

#### Notes and Characteristics

In connection with the GPIB interface, note the following:

- Up to 15 instruments can be connected.
- The total cable length is restricted to a maximum of 15 m, or 2 m times the number of devices, whichever is less; the cable length between two instruments should not exceed 2 m.
- A wired "OR"-connection is used if several instruments are connected in parallel, since the slowest instrument determines the speed.



Any connected IEC bus cable must be terminated by an instrument or controller.

---

### 12.2.4 LXI Browser Interface

LAN extension for instrumentation (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology, see also [Chapter 12.18.1, "LXI - Classes and LXI Functionality"](#), on page 710.

The LXI browser interface allows easy configuration of the LAN and remote control of the R&S SMW without additional installation requirements. The instrument's LXI browser interface works correctly with all W3C compliant browsers.

The LAN settings are configured using the instrument's LXI Browser Interface described in [Chapter 12.5.2.1, "LAN Configuration"](#), on page 673. The LXI status settings in the R&S SMW are described in [Chapter 12.5.1, "LXI Status Settings"](#), on page 670.



## 12.3 Remote Control Programs and Libraries

This section shows how the remote-control programs access the instrument, and the libraries they require for the appropriate interface protocols.

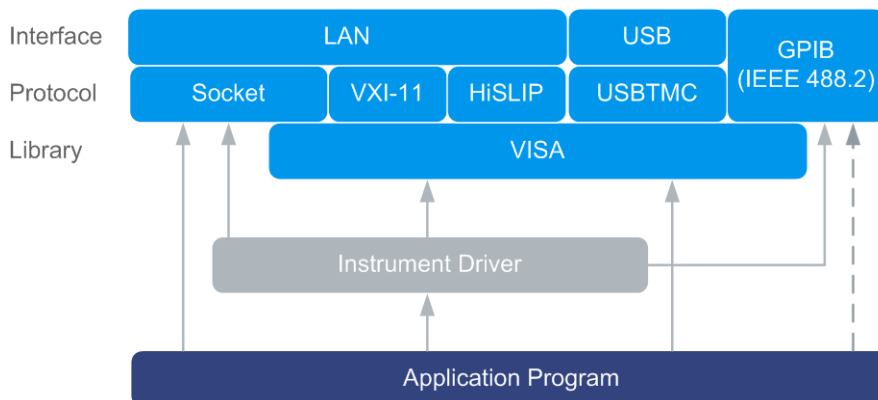


Figure 12-2: Overview of remote control interfaces, protocols and libraries

### 12.3.1 VISA Library

VISA is a standardized software interface library providing input and output functions to communicate with instruments. Thus, you can configure the interface without having to adjust the application program to the used interface. The I/O channel (LAN or TCP/IP, USB, GPIB,...) is selected at initialization time with the channel-specific address string ("VISA resource string"), or by an appropriately defined VISA alias (short name). See also [Table 12-2](#) for an overview.

Instrument access via VXI-11 or HiSLIP protocols is achieved from high level programming platforms using VISA as an intermediate abstraction layer. VISA encapsulates the low-level VXI or GPIB function calls and thus makes the transport interface transparent for the user.

A VISA installation is a prerequisite for remote control using the following interfaces:

- LAN Interface using [HiSLIP Protocol](#)
- LAN interface using [VXI-11 Protocol](#)
- [USB Interface](#)

Instrument access via the LAN socket protocol or GPIB connections can be operated both, with or without the VISA library. See also [Chapter 12.2.1.4, "Socket Communication"](#), on page 654 and [Chapter 12.2.3, "GPIB Interface \(IEC/IEEE Bus Interface\)"](#), on page 656.

For more information about VISA Library, refer to the user documentation.

### 12.3.2 Possible Setups and Access Functions

The following examples give an overview of dependencies between the available libraries, the possible interfaces and protocols, and whether an instrument driver is provided. The involved parts are **highlighted**. For more information, see the Application Note [1GP72](#), "Connectivity of Rohde & Schwarz Signal Generators".



#### Hostname syntax changed

The remote control program examples in this section address an instrument via its hostname. It affects all commands using `..., "TCPIP:<hostname>::...", ...`. From FW version 3.20.200.xx, the syntax of the hostname was modified. Hostname follows the syntax `SMW200A-<serial number>`, whereas the former syntax was `rssmw200a<serial number>`.

- Remote control (application) program using VISA

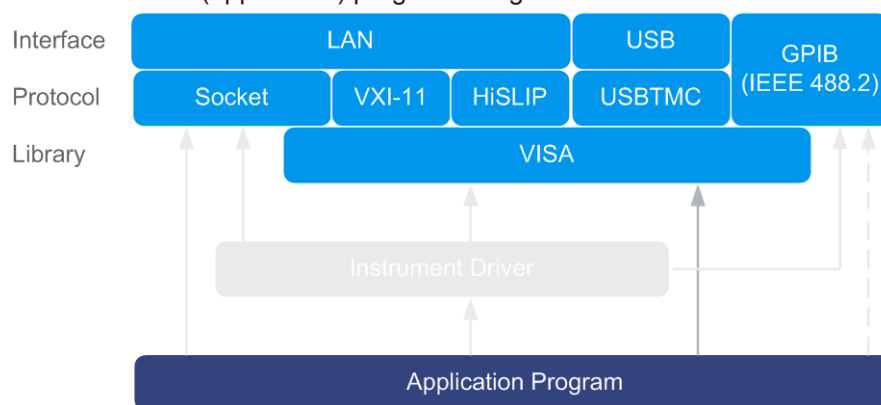


Figure 12-3: Application program using VISA

Protocol	Remote Control Program
Socket	<code>viOpen (... , "TCPIP:SMW200A-100010::5025::SOCKET", ...)</code> <code>viPrintf (... , "SOUR:FREQ 2GHz\n")</code>
VXI-11	<code>viOpen (... , "TCPIP:SMW200A-100010::inst0::INSTR", ...)</code> <code>viPrintf (... , "SOUR:FREQ 2GHz\n")</code>
HiSLIP	<code>viOpen (... , "TCPIP:SMW200A-100010::hislip0::INSTR", ...)</code> <code>viPrintf (... , "SOUR:FREQ 2GHz\n")</code>
USBTMC	<code>viOpen (... , "USB::0x0092::0x0088::1000010::INSTR", ...)</code> <code>viPrintf (... , "SOUR:FREQ 2GHz\n")</code>
GPIB	<code>viOpen (... , "GPIB::28::INSTR", ...)</code> <code>viPrintf (... , "SOUR:FREQ 2GHz\n")</code>

- Remote control program using instrument driver (VISA available)

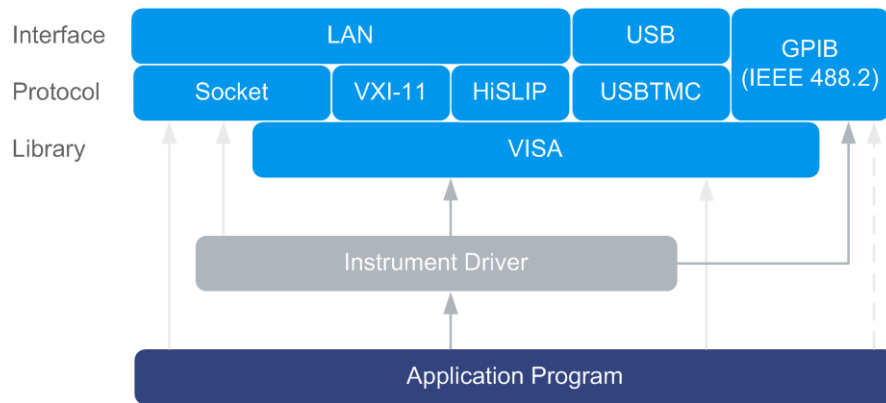


Figure 12-4: Application using instrument driver (VISA available)

Protocol	Remote Control Program
Socket	<code>rssmw_init ("TCPIP:SMW200A-100010::5025::SOCKET", ...)</code> <code>rssmw_SetFrequency (... , 2e9)</code>
VXI-11	<code>rssmw_init ("TCPIP:SMW200A-100010::inst0::INSTR", ...)</code> <code>rssmw_SetFrequency (... , 2e9)</code>
HiSLIP	<code>rssmw_init ("TCPIP:SMW200A-100010::hislip0::INSTR", ...)</code> <code>rssmw_SetFrequency (... , 2e9)</code>
USBTMC	<code>rssmw_init ("USB::0x0092::0x0088::1000010::INSTR", ...)</code> <code>rssmw_SetFrequency (... , 2e9)</code>
GPIB	<code>rssmw_init ("GPIB::28::INSTR", ...)</code> <code>rssmw_SetFrequency (... , 2e9)</code>

- Remote control program using instrument driver (VISA not available)

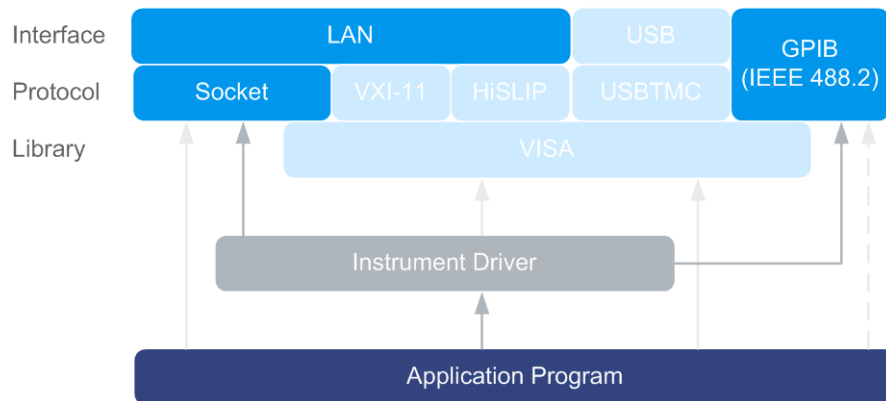


Figure 12-5: Remote control program using instrument driver (VISA not available)

Protocol	Remote Control Program
Socket	<pre>rssmw_init ("TCP/IP:SMW200A-100010::5025::SOCKET", ...) rssmw_SetFrequency (... , 2e9)</pre>
GPIB	<pre>rssmw_init ("GPIB::28::INSTR", ...) rssmw_SetFrequency (... , 2e9)</pre>

## 12.4 Remote Access Settings

### Network

#### **NOTICE**

##### **Risk of network errors!**

Connection errors can affect the entire network.

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the instrument to the LAN.

Contact your network administrator to obtain a valid IP address.

##### **Default Gateway**

This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

##### **Instrument Emulations**

The R&S SMW can also be remotely controlled via the command set of several other generators, for example of an HP generator. You find the available command sets for the generator in the selection list. This feature allows to replace a generator by an R&S SMW in existing test setups. Refer to the corresponding Application Note at the download area of the product site on the Internet.

The selected instrument also defines the identification string that is retrieved with query `*IDN?`. If required, use the parameter "Mode" on page 668 and "IDN String" on page 668 to change this string.

As any other parameter, the remote control command set can also be changed remotely by means of the SCPI command `SYST:LANG`. However, this remote control command is enabled only in the instrument's specific SCPI command set, i.e. it is possible to change the command set remotely from the original one (`SYST:LANG SCPI`) to the command set to be emulated but not vice versa.



While working in an emulation mode, the R&S SMW specific command set is disabled, i.e. the SCPI command `SYST:LANG` will be discarded.

To return to the SCPI command set of the R&S SMW, use the appropriate command of the selected command set. If for example a HP generator is emulated, the HP command `EX` returns to the instrument-specific GPIB command set.

### 12.4.1 Network Settings

#### **NOTICE**

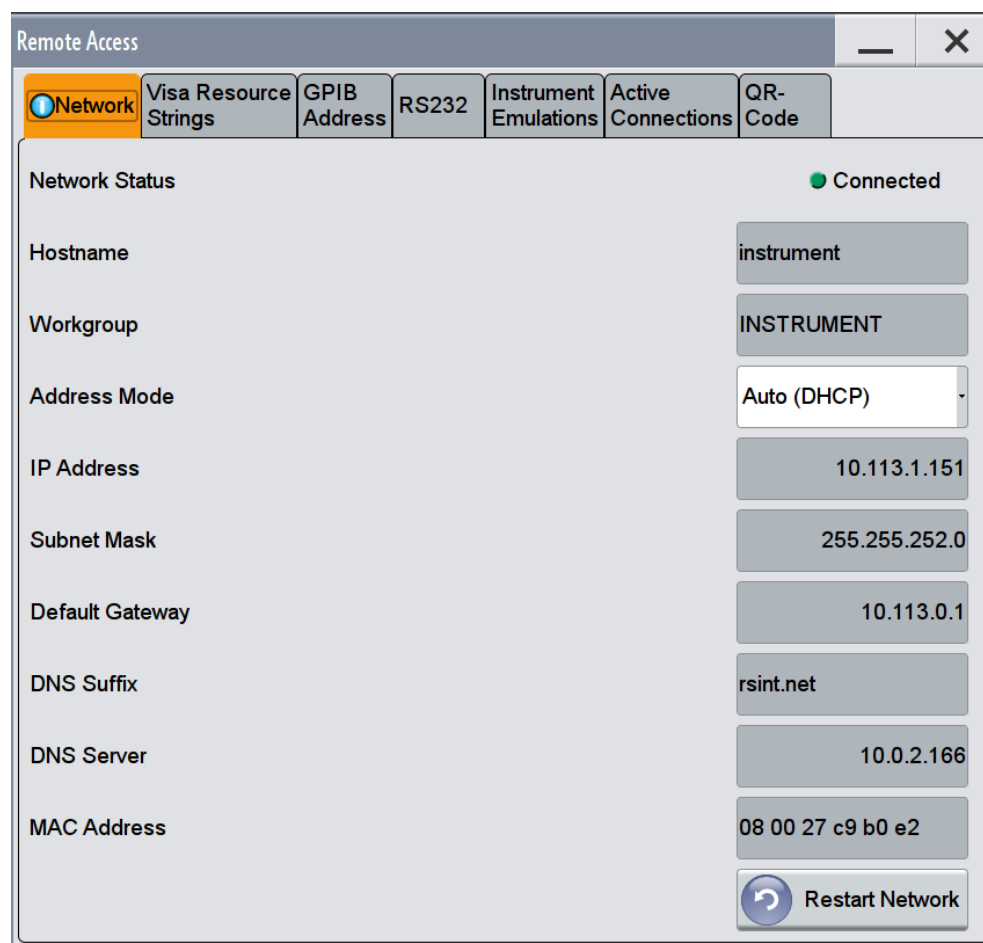
##### **Risk of network errors!**

Connection errors can affect the entire network.

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the instrument to the LAN.

Contact your network administrator to obtain a valid IP address.

- ▶ To access this dialog, select "System Config > Remote Access > Network".



In the "Network" tab of the "Remote Access" dialog, you can configure the settings of the general network environment and specific identification parameters of the instrument in the network.

The remote commands required to remotely configure the network are described in [Chapter 13.19, "SYSTEM Subsystem"](#), on page 1045.

How to connect the signal generator to the network is described in the [Chapter 3.1.4, "Setting Up a Network \(LAN\) Connection"](#), on page 45.

### Network Status

Indicates that the instrument is connected to the network.

Remote command:

`:SYSTEM:COMMunicate:NETWork:STATus?` on page 1053

### Hostname

Displays the hostname.

Each instrument is delivered with an assigned hostname, a logical name which can be used instead of the IP address. With the default network settings, the IP address is allocated by the DHCP server. This address may change each time the instrument is reconnected. Unlike the IP address, the hostname name does not change.

**Note:**

- Since the hostname of the instrument is a protected parameter, you must first unlock protection level 1 to enable the entry (see [Chapter 11.5.1, "Protection Level Settings"](#), on page 635).

It is recommended that you neither change the default network settings nor the hostname in order to avoid problems with the network connection.

However, if you change the hostname be sure to use an unique name.

- Note also, that from **FW version 3.20.200.xxx and later** the syntax of the host-name (computer name) has changed, according to recent conventions of Rohde & Schwarz.

The modification affects:

- instruments supplied with this FW
- performed factory preset on an instrument with updated FW

Remote command:

`:SYSTEM:COMMunicate:NETWork[:COMMON]:HOSTname` on page 1053

**Workgroup**

Sets the individual windows workgroup name of the R&S SMW. This parameter is required in case the instrument is integrated in a windows network.

**Note:** Since the workgroup name of the instrument is a protected parameter, you must first unlock protection level 1 to enable the entry (see [Chapter 11.5.1, "Protection Level Settings"](#), on page 635).

Remote command:

`:SYSTEM:COMMunicate:NETWork[:COMMON]:WORKgroup` on page 1054

**MAC Address**

Indicates the MAC (Media Access Control) address, a unique identifier of the network adapter in the R&S SMW.

Remote command:

`:SYSTEM:COMMunicate:NETWork:MACaddress?` on page 1052

**Address Mode**

Selects the mode for assigning the IP address.

**NOTICE!** Risk of network errors!. Connection errors can affect the entire network.

If your network does not support DHCP, or if you choose to disable dynamic TCP/IP configuration, you must assign valid address information before connecting the instrument to the LAN.

Contact your network administrator to obtain a valid IP address.

"Auto (DCHP)"

Assigns the IP address automatically, provided the network supports DHCP (Dynamic Host Configuration Protocol)

"Static"

Enables you to assign the IP address manually.

Remote command:

`:SYSTEM:COMMunicate:NETWork:IPAddress:MODE` on page 1052

**IP Address**

Displays the IP address of the instrument in the network.

By default, the R&S SMW is configured to use dynamic TCP/IP configuration and to obtain the whole address information automatically.

If the network does not support DHCP or the attempt does not succeed, the instrument tries to obtain the IP address via Zeroconf (APIPA) protocol. IP addresses assigned via Zeroconf start with the number blocks 169.254.\*.\*.

**Note:** An IP address that is assigned via the Zeroconf protocol although the network requires an IP address assigned via the DHCP server may cause network connection failures.

See [Chapter 15.5, "Resolving Network Connection Failures"](#), on page 1100.

To assign the IP address manually, select [Address Mode](#) > "Static".

Remote command:

`:SYSTem:COMMunicate:NETWork:IPADdress` on page 1052

### Subnet Mask

Displays the bit group of the subnet in the host identifier.

To assign the subnet mask manually, select [Address Mode](#) > "Static".

Remote command:

`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 1054

### Default Gateway

Displays the gateway address.

To assign the gateway address manually, select [Address Mode](#) > "Static".

This address identifies the router on the same network as the instrument that is used to forward traffic to destinations beyond the local network.

Remote command:

`:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway` on page 1054

### DNS Suffix

Displays the primary DNS (Domain Name System) suffix, that means the DNS name without the hostname part.

The DNS system uses the suffix for registration and name resolution to uniquely identify the instrument in the entire network.

To assign the DNS suffix manually, select [Address Mode](#) > "Static".

Remote command:

`:SYSTem:COMMunicate:NETWork[:COMMON]:DOMain` on page 1053

### DNS Server

Determines the preferred server for name resolution. The DNS server contains the underlying numerical values that are required for name resolution of the hostname as part of the IP address.

To select the DNS server manually, select [Address Mode](#) > "Static".



Remote command:

`:SYSTem:COMMunicate:NETWork[:IPAddress]:DNS` on page 1054

### Restart Network

Terminates the network connection of the instrument and subsequently sets it up again. You can use this function to fix network problems.

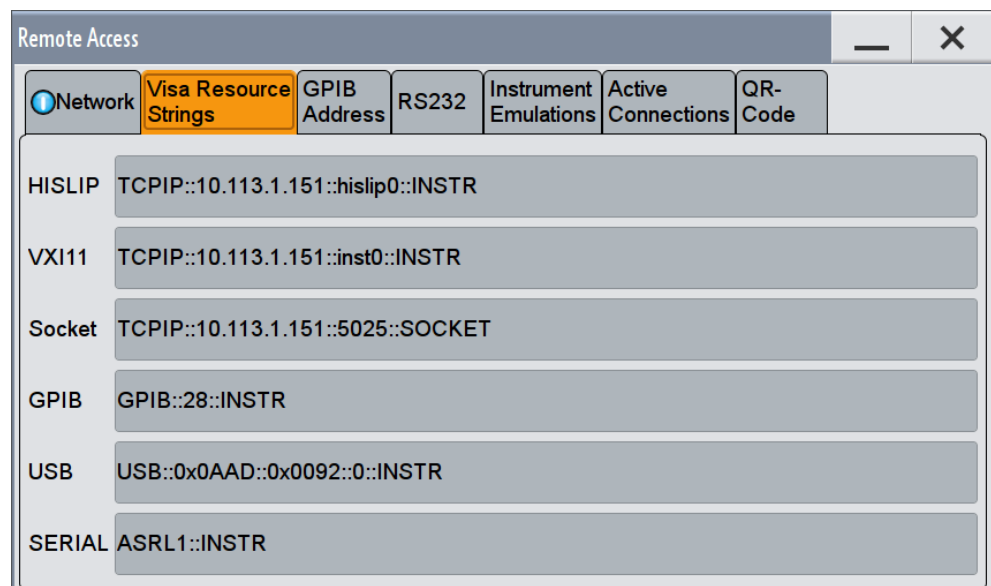
**Note:** This function restarts only the connection of the instrument to the network. It does not impact the network itself.

Remote command:

`:SYSTem:COMMunicate:NETWork:REStart` on page 1053

## 12.4.2 VISA Resource Strings

- To access this dialog, select "System Config > Remote Access > VISA Resource Strings".



The "VISA Resource String" tab of the "Remote Access" dialog displays the VISA resource strings provided for remote control via the various interfaces.

SCPI commands:

`:SYSTem:COMMunicate:HISLip:RESource?` on page 1051

`:SYSTem:COMMunicate:NETWork:RESource?` on page 1052

`:SYSTem:COMMunicate:SOCKet:RESource?` on page 1056

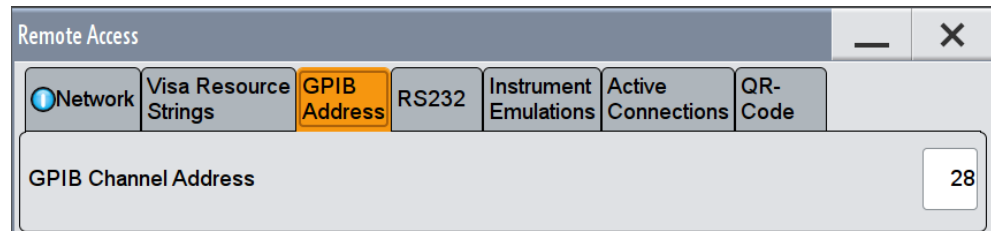
`:SYSTem:COMMunicate:GPIB:RESource?` on page 1051

`:SYSTem:COMMunicate:USB:RESource?` on page 1056

`:SYSTem:COMMunicate:SERial:RESource?` on page 1055

### 12.4.3 GPIB Address Settings

1. To access this dialog, select "System Config > Remote Access > GPIB Address".



2. Set the address of the GPIB channel the instrument is connected to.

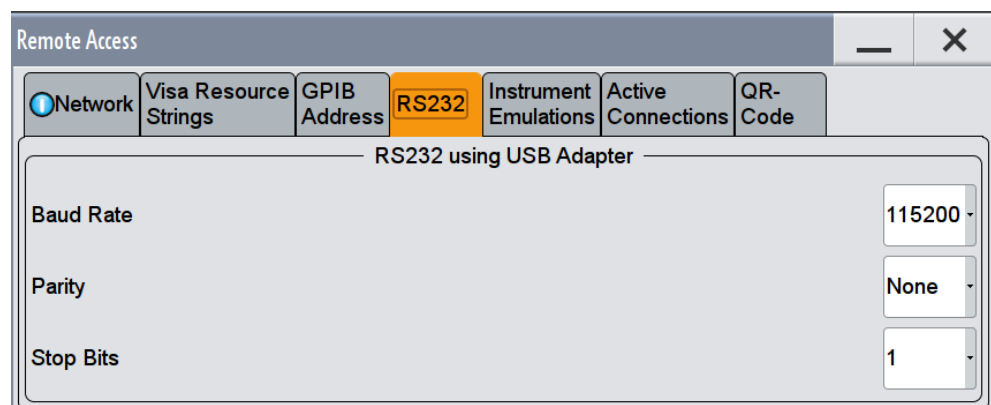
SCPI command:

`:SYSTEM:COMMunicate:GPIB[:SELF]:ADDRESS` on page 1051

### 12.4.4 RS232 Settings

Remote control via a serial interface is possible via a USB. The controller and the instrument must be connected with the external USB/serial-adapter R&S TS1-USB (see recommended extras in the data sheet) and a serial crossover (null modem) cable. A USB connection requires the VISA library to be installed on the controller. VISA will detect and configure the R&S SMW automatically when the USB connection is established.

- To access this dialog, select "System Config > Remote Access > RS232".



In the "RS232" tab of the "Remote Access" dialog, you can configure the settings of the serial interface.

The remote commands required to remotely configure the emulation settings are described in [Chapter 13.19, "SYSTEM Subsystem"](#), on page 1045.

#### Baud Rate

Sets the baudrate for the serial remote control interface.

Remote command:

:[SYSTem:COMMunicate:SERial:BAUD](#) on page 1055

### Parity

Sets the parity for the serial remote control interface.

Remote command:

:[SYSTem:COMMunicate:SERial:PARity](#) on page 1055

### Stop Bits

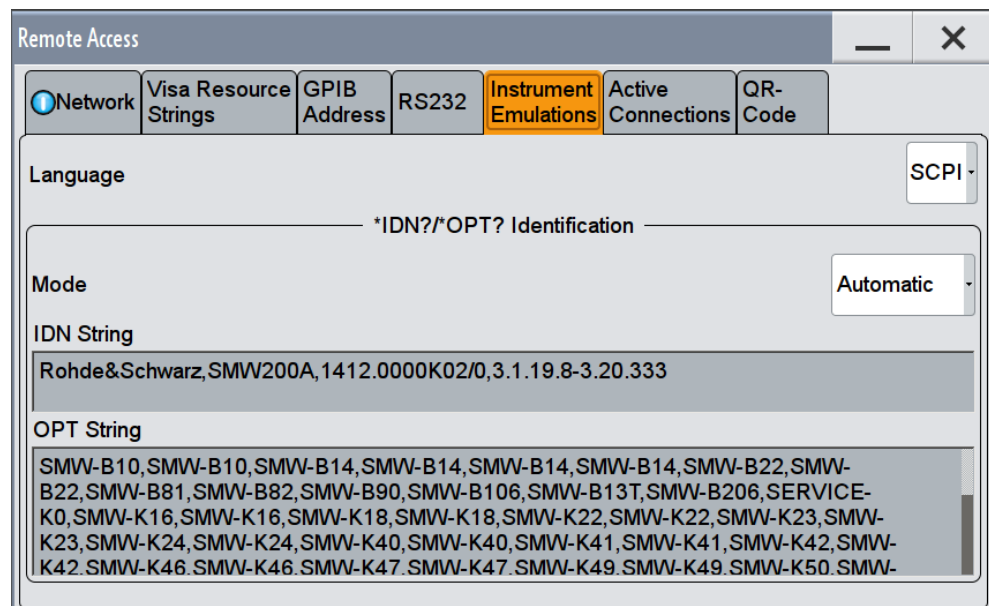
Sets the number of stop bits for the serial remote control interface.

Remote command:

:[SYSTem:COMMunicate:SERial:SBITs](#) on page 1055

## 12.4.5 Instrument Emulations Settings

- To access this dialog, select "System Config > Remote Access > Instrument Emulations".



The "Instrument Emulations" tab of the "Remote Access" dialog enables you to emulate a remote control command set of another Rohde & Schwarz signal generator.

The remote commands required to remotely configure the emulation settings are described in [Chapter 13.19, "SYSTem Subsystem"](#), on page 1045.

### Language

Selects the instrument whose remote command set is emulated by the R&S SMW.

Remote command:

:[SYSTem:LANGuage](#) on page 1057

### Mode

Selects the way the instrument identification is performed.

"Automatic" Sets the "IDN String" and the "OPT String" automatically for the instrument selected with the parameter "Language".

"User defined" Enables you to define the "IDN String" and the "OPT String".

Remote command:

:[SYSTem:IDENTification](#) on page 1056

### Set to Default

Enables you to reset the \*IDN and \*OPT strings in user defined mode, see [Mode](#).

### IDN String

Indicates the identification string of the instrument when queried with the common command \*IDN?.

In addition to the preset values, a user defined identification string can be entered, e.g. to provide individual identification for each generator, like 'MY\_R&S SMW' for instance.

Remote command:

[\\*IDN?](#) on page 718

### OPT String

Indicates the option string of the instrument as queried with common command \*OPT?.

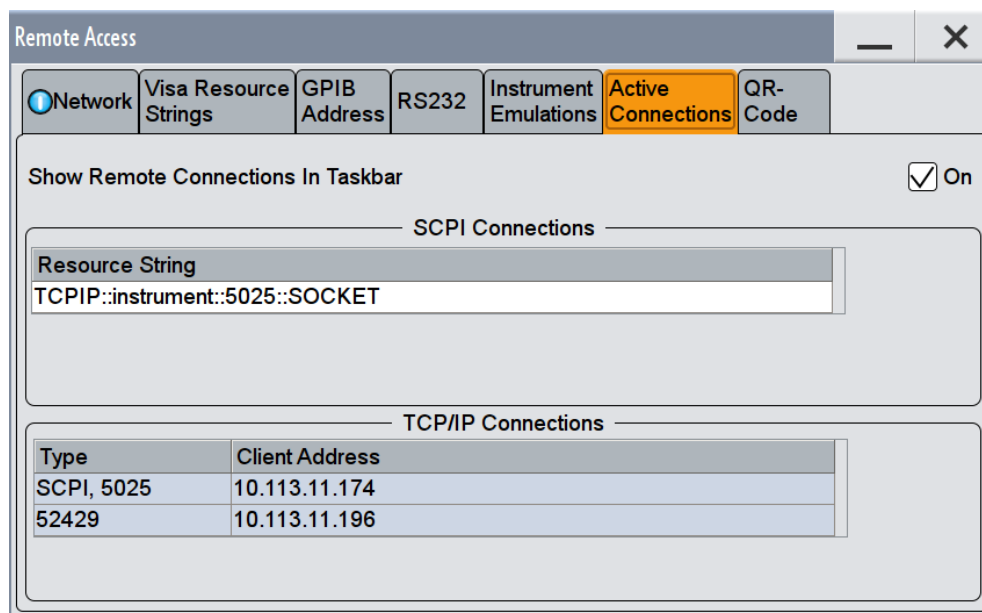
If a "User Defined" [Mode](#) is selected, a user defined option string can be created, additionally to the automatically created one.

Remote command:

[\\*OPT?](#) on page 719

## 12.4.6 Active Connections Settings

- ▶ To access this dialog, select "System Config > Remote Access > Active Connections".



The "Active Connections" tab of the "Remote Access" dialog shows all active SCPI and TCP/IP connections.

#### Show Remote Connections in Taskbar

Displays the currently active connections in the taskbar.

#### SCPI Connections

Shows the active VISA resource string of the interface via which the instrument is remotely controlled.

Remote command:  
n.a.

#### TCP/IP Connections

Shows the type and client address of the LAN interface connection.

Remote command:  
n.a.

### 12.4.7 QR Code

- ▶ To access this dialog, select "System Config > Remote Access > QR Code".



The "QR Code" tab of the "Remote Access" dialog shows the current instrument address (IP address) in quick response (QR) format.

This functionality provides fast access to the instrument via VNC with for example a smart phone or a tablet.

## 12.5 LXI Settings

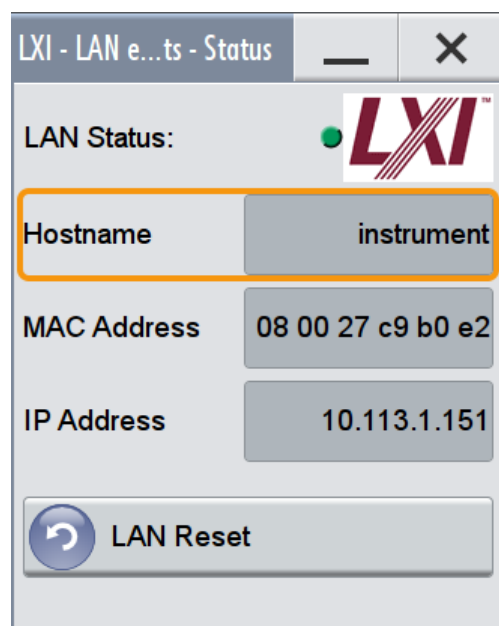
On the R&S SMW the LXI Class C functionality is already installed and enabled, see [LXI Status Settings](#). Thus, the instrument can be accessed via any web browser (like the Microsoft Internet Explorer) to perform the following tasks:

- Modifying network configurations
- Remote control the instrument
- Performing SCPI remote diagnostics

The LAN settings are configured using the instrument's LXI Browser Interface described in [Chapter 12.5.2.1, "LAN Configuration"](#), on page 673.

### 12.5.1 LXI Status Settings

- ▶ To access this dialog, select "System Config > Setup > Remote Access > LXI Status...".



The "LXI - LAN eXtensions for Instruments" dialog shows the parameters of the LAN connection.

Alternatively, you can change the LAN settings using the LXI web browser interface, see [Chapter 12.5.2.1, "LAN Configuration"](#), on page 673.

### LAN Status

The LED indicates the LXI status.

The LAN Status is also indicated with the LED "LAN Status" on the front panel of the instrument.

"green"	Normal operation
"green (flashing)"	Device identification
"red"	LAN fault

### Hostname / MAC Address / IP Address

See ["Hostname"](#) on page 662

### LAN Reset

Initiates the network configuration reset mechanism for the instrument and resets the hostname, MAC address, and IP address.

According to the LXI standard, a LAN reset must place the following network settings to a default state:

Parameter	Value
TCP/IP Mode	DHCP + Auto IP Address
Dynamic DNS	Enabled

Parameter	Value
ICMP Ping	Enabled
Password for LAN configuration	LxiWeblfc

The LAN reset also resets the following parameters for the R&S SMW:

Parameter	
Hostname	Instrument-specific hostname
Description	Vector Signal Generator
Negotiation	Auto Detect
VXI-11 Discovery	Enabled

## 12.5.2 LXI Browser Settings

To access the instrument via the web browser:

- Type in the instrument's host name or IP address in the address field of the browser on your PC, for example "http://10.113.1.151".

**Note:** Do not add the missing zeros in the IP address, while opening the instrument home page.

The instrument home page (welcome page) opens.

The screenshot shows the LXI browser interface for an R&S SMW instrument. The main content area displays the following information:

Instrument Model	R&S SMW
Manufacturer	Rohde & Schwarz GmbH & Co. KG
Description	Rohde & Schwarz Vector Signal Generator SMW200A 0
LXI Version	1.4 LXI Core 2011
LXI Extended Features	
DNS Host Name(s)	instrument
MAC Address	08:00:27:c9:b0:e2
IP Address	10.113.1.151
Firmware Revision	3.20.261.18
Current Time	Wednesday, 2015/06/10, 09:20:12
Current Time source	Operating System
VISA resource string	TCPIP::10.113.1.151::inst0::INSTR TCPIP::10.113.1.151::hislip0::INSTR
Device Indicator	<input type="button" value="INACTIVE (press to toggle)"/>

The navigation pane on the left includes the following elements:

- LXI
  - Home
  - Lan Configuration
  - Status
  - Utilities
- Instrument Control
  - Web Control
- Diagnostics
  - SCPI Remote Trace
- Help
  - Glossary
  - www.rohde-schwarz.com

The status bar at the bottom indicates "No error" and includes the copyright notice: © 2015 ROHDE&SCHWARZ. All rights reserved.

The navigation pane of the browser interface contains the following elements:

- "LXI"
  - "Home" opens the instrument home page.



The home page displays the device information required by the LXI standard, including the VISA resource string in read-only format.

- "Device Indicator" activates or deactivates the LXI status indication. When activated, the LXI LEDs flash, both in the browser dialog and in the LXI dialog of the connected instrument, see "[LAN Status](#)" on page 671. A green LXI status symbol indicates that a LAN connection has been established; a red symbol indicates that no LAN cable is connected.
- "Lan Configuration" allows you to configure LAN parameters and to initiate a ping, see "[Ping Client](#)" on page 675.
- "Status" displays information about the LXI status of the instrument.
- "Utilities" provides access to the LXI event log functionality required by the LXI standard.
- "Instrument Control"
  - "Web Control" provides remote access to the instrument, see "[Starting a Remote Control via the LXI web browser](#)" on page 680.
- "Diagnostics"
  - "SCPI Remote Trace" records messages exchanged via the remote control interface, see "[SCPI Remote Trace](#)" on page 676.
- "Help"
  - "Glossary" explains terms related to the LXI standard.
  - [www.rohde-schwarz.com](http://www.rohde-schwarz.com) opens the Rohde & Schwarz home page.

### 12.5.2.1 LAN Configuration

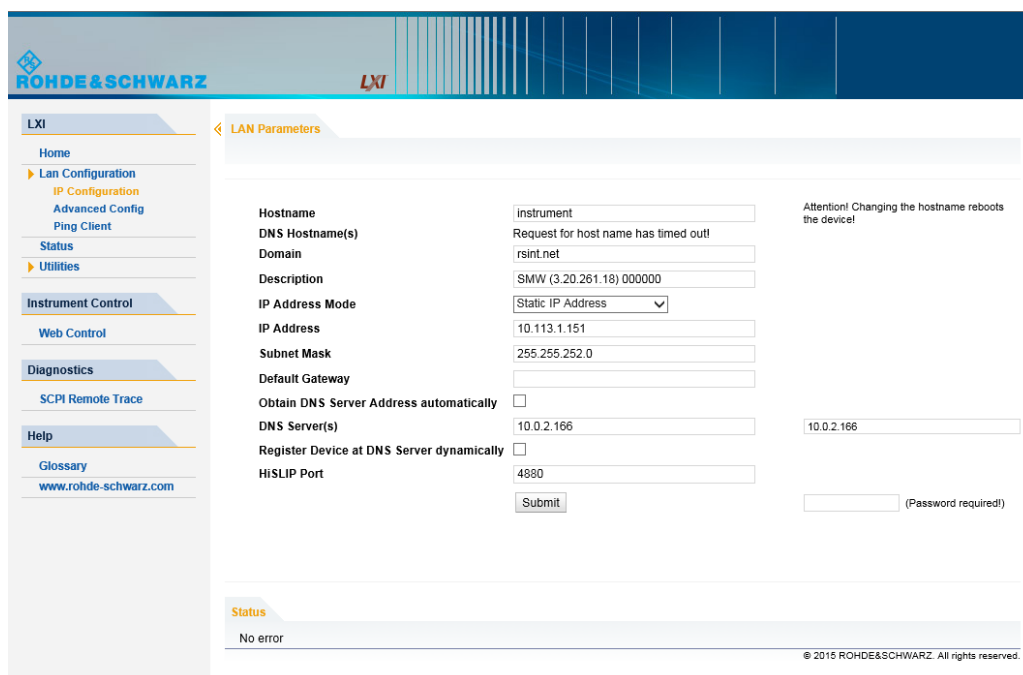
The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

- [IP Configuration](#)..... 673
- [Advanced Config](#).....674
- [Ping Client](#).....675
- [SCPI Remote Trace](#).....676

#### IP Configuration

The "IP configuration" web page displays all mandatory LAN parameters and allows their modification.



The "IP Address Mode" selects a configuration mode for the IP address of the instrument. With static configuration, the entered IP address, subnet mask, and default gateway are used. With dynamic configuration, DHCP or dynamic link local addressing (automatic IP) are used to obtain the instrument IP address.



**Password protection**

Changing the LAN configuration is password-protected and requires the security password. The default password is "instrument".

**Note:** It is highly recommended that you change the default security password, see [Chapter 11.5.4, "Password Management"](#), on page 641.

**Advanced Config**

The "Advanced Config" web page provides LAN settings that are not declared mandatory by the LXI standard.

The following advanced parameters are available:

- "mDNS and DNS-SD": The additional protocols "multicast DNS" and "DNS service discovery" are used for device communication in zero configuration networks, working without DNS and DHCP.
- "ICMP Ping": Must be enabled to use the ping utility.  
If you disable this setting, the instrument does not answer ping requests. The setting does not affect the LXI ping client. You can ping other hosts from the instrument, even if the setting is disabled.
- "VXI-11 Discovery": Must be enabled to detect the instrument in the LAN.  
If you disable this setting, the instrument cannot be detected by the VXI-11 discovery protocol mechanism. The setting does not affect other detection mechanisms. Setting up a VXI-11 connection via the IP address or the host name is independent of this setting.



### Password protection

Changing the LAN configuration is password-protected and requires the security password. The default password is "instrument".

**Note:** It is highly recommended that you change the default security password, see [Chapter 11.5.4, "Password Management"](#), on page 641.

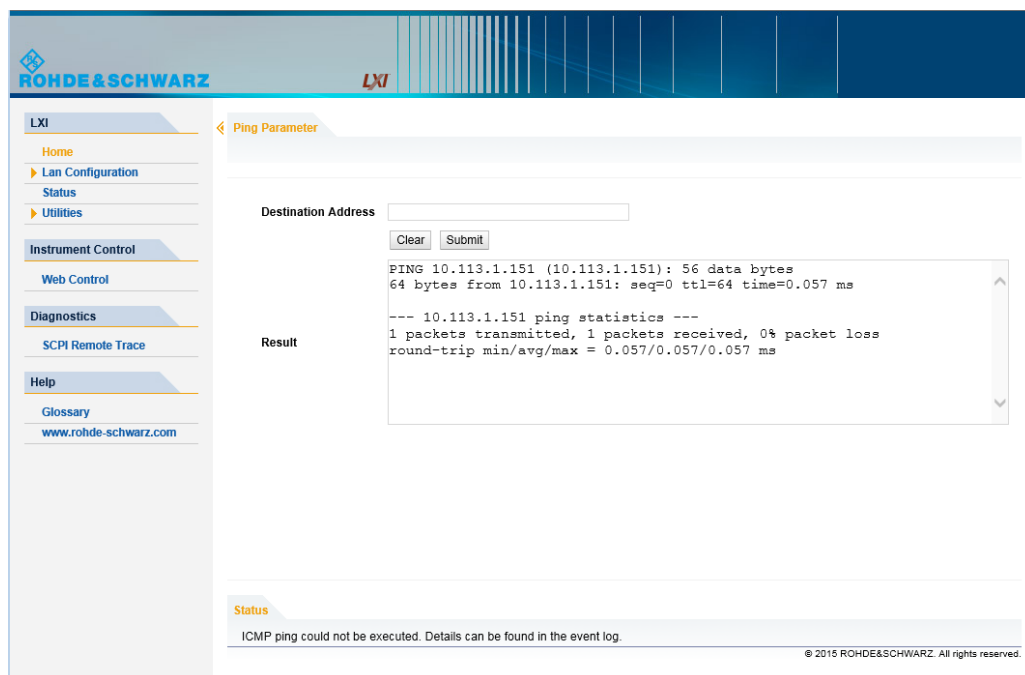
### Ping Client

The "Ping Client" page provides the ping utility to verify the connection between the LXI-compliant instrument and another device.

The ping is initiated from the instrument. Using the `ICMP` echo request and echo reply packets, the function checks whether the communication with a device via LAN is working. Ping is useful for the diagnosis of IP network or router failures.

To initiate a ping at the instrument:

1. On the "Ping Client" page, enter the IP address of the host to be pinged into the "Destination Address" field (for example 10.113.1.151).
2. Select "Submit".



### SCPI Remote Trace

The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SMW, see [Chapter 12.9, "How to Trace SCPI Commands and Messages exchanged via the LXI Web Browser Interface"](#), on page 689.

A recorded trace (message log) can be evaluated directly in the dialog. Use the highlighting and navigation functions provided by the lower toolbar to locate error messages and messages containing arbitrary search strings. You can also export the message log to a \*.csv file and evaluate the file using a suitable program.

To trace and display messages, switch on "logging" and "live mode" in the toolbar.

The screenshot shows the LXI Settings interface with the SCPI Remote Trace dialog open. The toolbar at the top of the dialog includes controls for 'live mode' (set to 'on'), 'logging' (set to 'on'), a 'filter' dropdown menu, and buttons for 'log file', 'refresh', 'download', 'clear', and 'details'. The main area displays a table of message logs with the following data:

rec	MT	I	message
0	>	1	*idn?
0	<	1	Rohde&Schwarz, SMW200A, 1412.0000K02/0, 3.1.19.8-3.20.261.18
0	>	1	*opt?
0	<	1	SMW-B10, SMW-B10, SMW-B14, SMW-B14, SMW-B14, SMW-B14, SMW-B22, SMW-B22, SMW-B81, SMW-B82, SMW-B90, SMW-...
0	>	1	Freq?
0	<	1	1000000000
0	>	1	LEV-25

Below the table, the 'Status' section shows '9 live records received'. The footer of the interface contains the copyright notice: © 2015 ROHDE&SCHWARZ. All rights reserved.

## Toolbars

The toolbar at the top of the dialog provides basic settings and functions.

- "Live mode" / "logging": If logging is switched on, messages are traced. They are stored in an internal database and can be displayed upon request, using the refresh button (live mode off) or they can be displayed automatically (live mode on).
- "Filter": applies a filter to columns and/or rows when working (live mode off)
- "Refresh": reads the message log from the internal database and displays it
- "Download": stores the SCPI trace log to a \* .CSV file
- "Clear": deletes all message log entries in the database and at the screen
- "Details": displays details of the selected message, for example an SCPI command in hex format (also possible by double-clicking a message)

## Columns

The following columns are available if no column filter is applied:

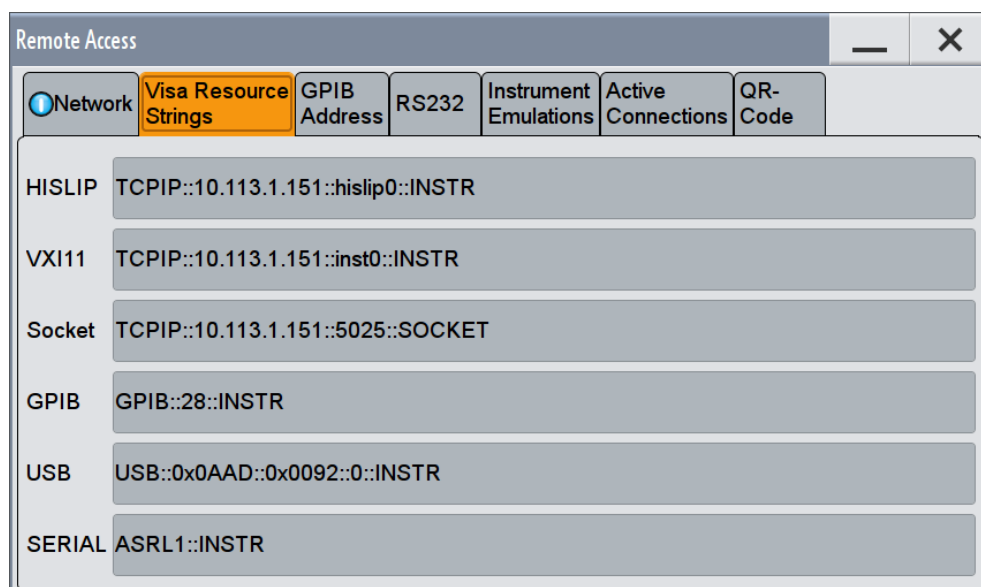
- "Rec": record number of the message within the message log
- I: number of the subinstrument
- "MT": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, highlighted by red color
  - T = execution time, i.e. time required by the instrument to process the command internally

- "message": indicates the type of the message. Possible values and related message contents are:
  - > = incoming command
  - < = outgoing response to a query
  - E = error message, denoted in red
  - T = execution time, i.e. time required by the instrument to process the command internally

## 12.6 How to find the VISA Resource String

This section shows how you can check the instrument's address for the corresponding remote control connections.

- ▶ To find the VISA resource strings of your instrument, select "System Config > Remote Access > VISA Resource Strings".



The dialog shows all specified resource strings of the supported remote control interfaces.



- Information on how to assign the IP address manually, see [Chapter 3.1.4.3, "Assigning the IP Address"](#), on page 47.
- Also note that using the RS232 serial interface via USB requires the USB serial adapter R&S TS-USB1.

## 12.7 How to Change the GPIB Instrument Address

To control the instrument remotely via the GPIB bus, it must be addressed using the GPIB address. The remote control address is factory-set to 28, but it can be changed if it does not fit in the network environment. For remote control, addresses 0 through 30 are allowed. The GPIB address is maintained after a reset of the instrument settings.

To set the GPIB address:

1. Select "System Config > Remote Access > GPIB Address".
2. In the "Remote Access" dialog, select GPIB tab.
3. Enter a value between 0 and 30.

**SCPI command:**

```
SYST:COMM:GPIB:ADDR 18
```



**Risk of losing remote connection**

Since a Factory Preset resets the remote access and network settings to the default values, executing factory preset via remote control terminates the connection to the instrument, if these settings had been configured to values different to the default ones!

## 12.8 How to Set Up a Remote Control Connection

This section guides you through the steps required to set up remote control connections of the available interfaces.

- [Chapter 12.8.1, "Setting up a Remote Control Connection over the LXI Browser Interface", on page 680](#)
- [Setting Up a Remote Control Connection over LAN using VXI-11 Protocol](#)
- [Setting Up a Remote Control Connection over LAN Using Socket Communication](#)
- [Setting Up a Remote Control Connection over GPIB](#)
- [Setting Up a Remote Control Connection over USB](#)

The instrument and the controller have to be connected with the suitable cable and switched on.

A remote control program must open a connection to the instrument, before it can send commands to and receive device responses from the instrument.



### Instrument Address

To operate the instrument via remote control, it must be addressed using the defined interface address. See [Chapter 12.2.1, "LAN Interface"](#), on page 652, [Chapter 12.2.2, "USB Interface"](#), on page 655 or [Chapter 12.2.3, "GPIB Interface \(IEC/IEEE Bus Interface\)"](#), on page 656 for details.

The VISA resource strings are indicated in the "System Config > Remote Access > VISA Resource Strings" dialog.



### Securing the display

To prevent unauthorized personnel from reading the display, you can disable the frequency and level display explicitly. This is useful when you remotely control the instrument from a different location.

For information on how to disable the frequency and level display, refer to ["Annotation Frequency"](#) on page 637 and ["Annotation Amplitude"](#) on page 637.

## 12.8.1 Setting up a Remote Control Connection over the LXI Browser Interface

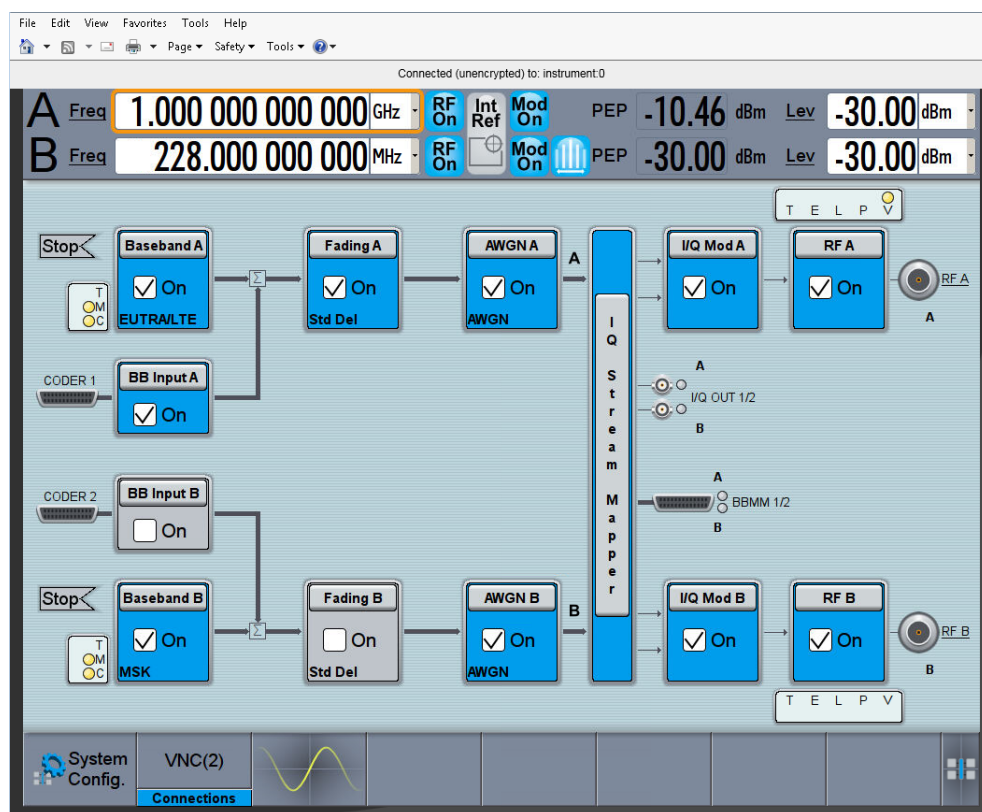
Via the LXI browser interface to the R&S SMW one or more users can control the instrument remotely from another PC without additional installation. Most instrument controls are available via the front panel simulation. File upload and download between the instrument and the remote PC is also available.

### Starting a Remote Control via the LXI web browser

This section assumes that the instrument and the controller PC are connected in the LAN.

1. Start a web browser that supports html5 (W3C compliant).
2. Enter the IP address of the R&S SMW in the browser's address bar.  
The R&S SMW's welcome page is displayed.
3. In the navigation pane, select "Instrument Control" > "Web Control".  
Remote access to the instrument requires the password. The default password is *instrument*.
4. Enter the password and confirm with the ENTER key.  
After the connection is established, the current screen of the R&S SMW is displayed in the browser window.





5. Use the mouse cursor and keyboard to access the functionality of the instrument as you would directly perform on the instruments touch screen and front panel.

### 12.8.2 Setting Up a Remote Control Connection over LAN using VXI-11 Protocol

In this example, the I/O software library R&S VISA from Rohde & Schwarz is used to set up a LAN remote control link and remotely control the R&S SMW. R&S VISA is running on a controller PC with Windows operating system. When the connection is set up you can send commands to the instrument, and receive the responses.

The remote control connection requires a VISA installation but no additional hardware on the controller PC. The LAN I/O channel is selected at initialization time using the VISA resource string (also referred to as "address string"). A VISA alias (short name) is used to replace the complete resource string. The host address is either the R&S SMW's hostname or IP address. See also [Chapter 12.2.1, "LAN Interface"](#), on page 652.



In this example, it is assumed that:

- A LAN remote control link between the controller and the R&S SMW is set up.
- The R&S VISA program is installed on the remote PC, see "<http://www.rohde-schwarz.com/rsvisa> > RS VISA Release Notes".

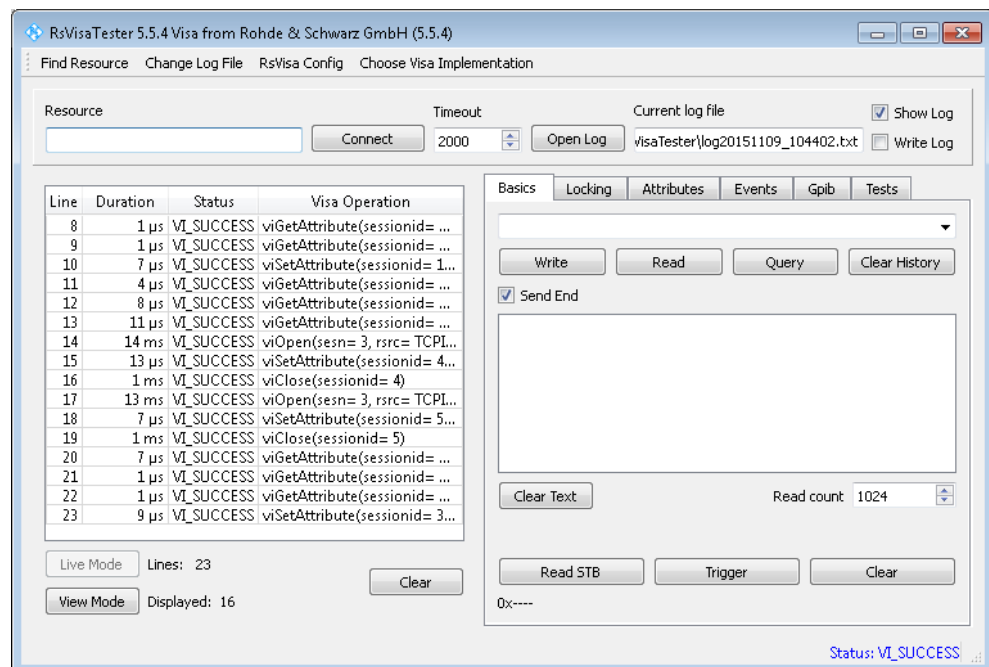
### Setting up the controller with R&S VISA

To remote control the R&S SMW, we use the R&S VISA Tester application. The application communicates via TCP/IP protocol.



The instrument is preconfigured for networks using DHCP (dynamic host configuration protocol). If this configuration is used, enter the computer name in the position of the IP address.

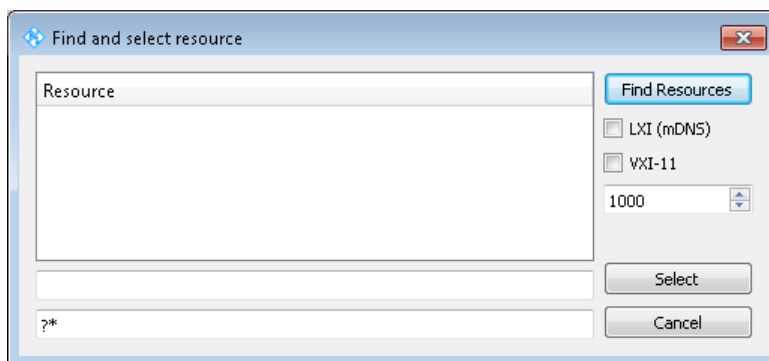
1. Make sure that the controller and the instrument are connected in the network (network cable) and switched on.
2. On the controller, start "R&S VISA > Tester 32bit" or "R&S VISA > Tester 64bit", respectively.



3. In the menu bar, select "Choose VISA Implementation > Rohde & Schwarz Visa".



4. Select "Rohde & Schwarz Visa" and confirm with "OK".
5. In the menu bar, select "Find Resource" to search for the instrument in the LAN.

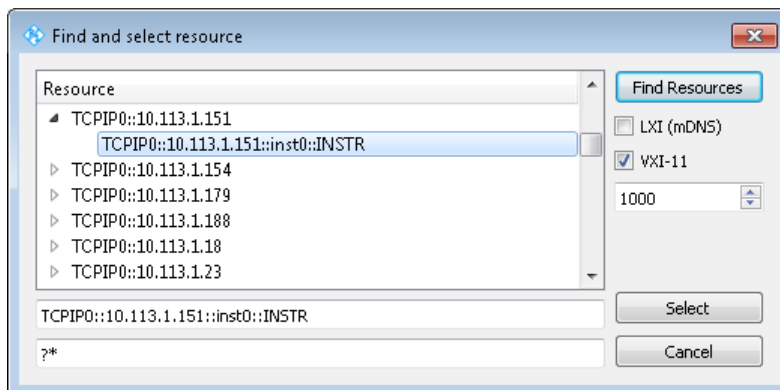


6. Select "VXI-11" and "Find Resources".

R&S VISA scans the network for connected instruments and lists all detected instruments in the "Resource" list.

**Note:** The search may take some time, particularly in large networks.

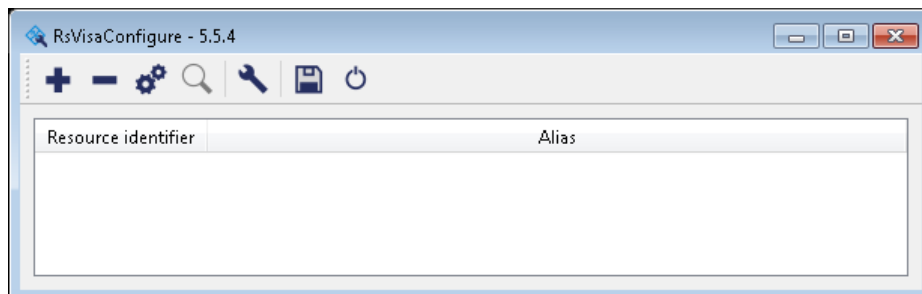
7. Select the required instrument and confirm with "Select".



The "Find and select resource" dialog closes and R&S VISA indicates the IP address in the "Resource" field of the main application window.

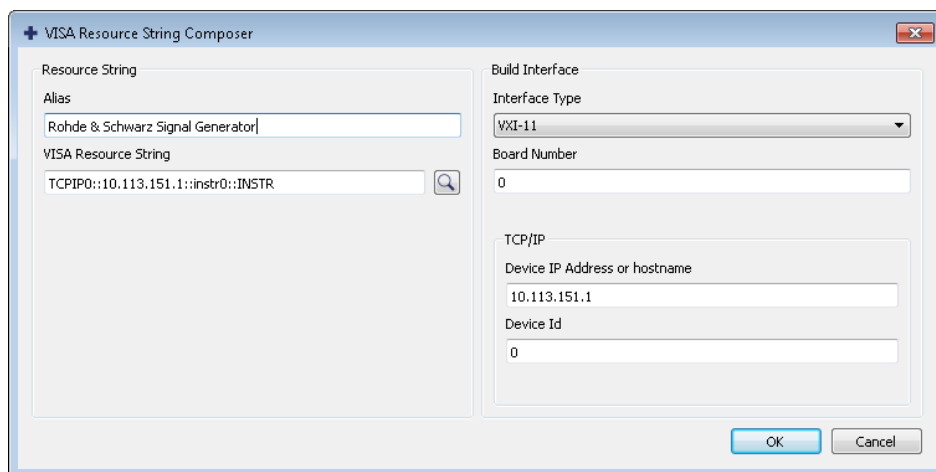
8. As an alternative to the IP address, you can assign an alias name to the R&S SMW:

- a) In the menu bar, select "RsVisaConfig".

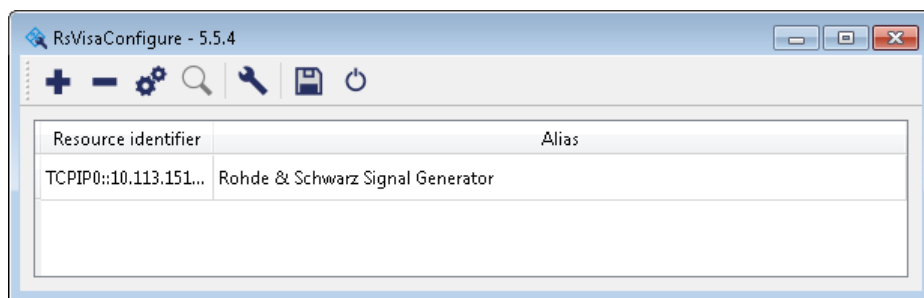


- b) In the toolbar, select "+" to access the "VISA Resource String Composer".

- c) Fill in the "Alias" name, the "VISA Resource String" and the "Device IP Address or host name" as shown in the figure, and confirm with "OK".



The "Alias" name is assigned.



- d) Close the dialog.  
The R&S SMW is now registered in the program and can be addressed via the resource string or alias name.

9. In the main window, select "Connect".

R&S VISA establishes the connection to the R&S SMW.

Now you can send settings to configure the instrument and receive its responses.

**Note:** If the connection cannot be set up, R&S VISA displays an error in the log view. For information on how to proceed when network failures occur, see [Chapter 15.5, "Resolving Network Connection Failures"](#), on page 1100.

For further information on the functions to read and write to an open session, as well as the utility applications the software provides, see the R&S VISA User Manual.

### Starting a remote control session over LAN with R&S VISA

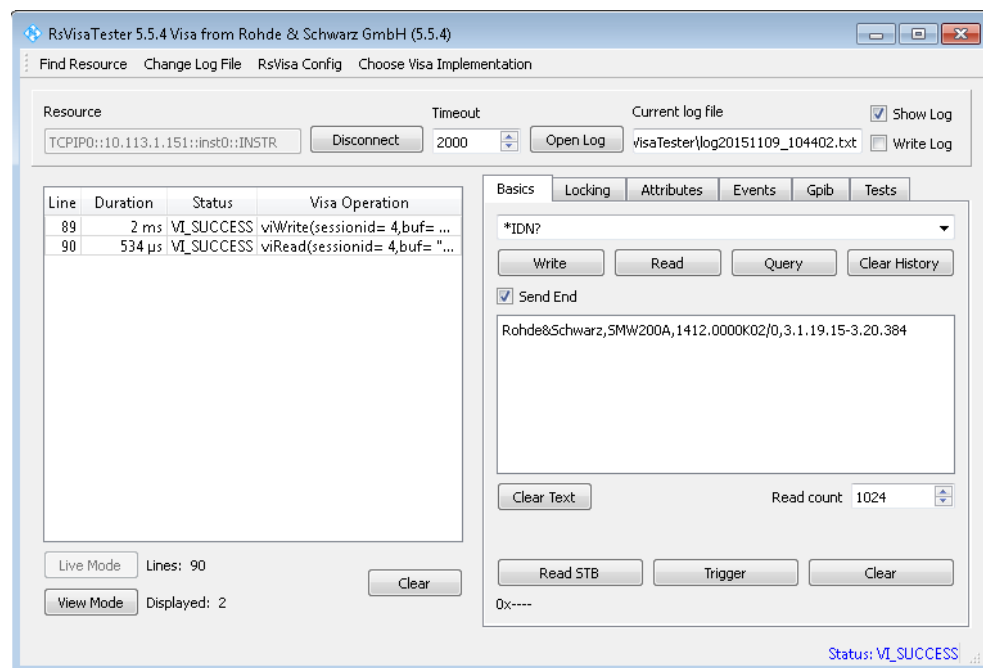
To set the instrument to remote control, you can use the addressed command `&GTR`, or send any command from the controller.

1. Start the R&S VISA Tester and establish the connection to the R&S SMW, see ["Setting up the controller with R&S VISA"](#) on page 682.

- In the R&S VISA "Basics" tab, enter a SCPI command, e.g. "\*IDN?" and confirm with "Query".

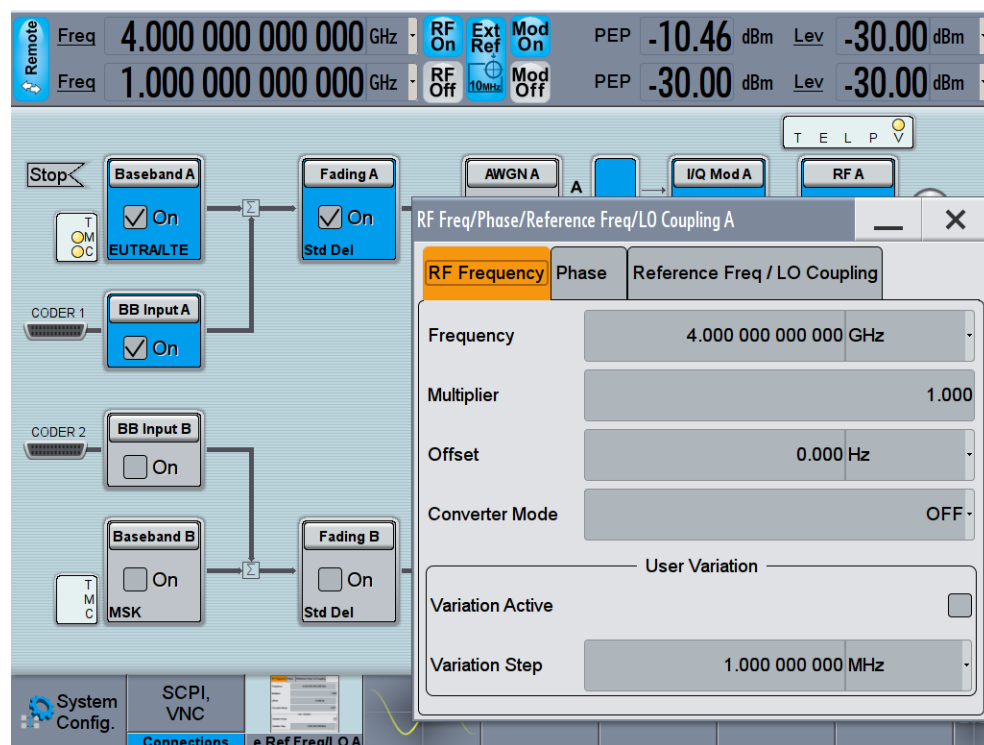
The instrument is switched to remote control when it receives a command from the controller.

- Select "Read" to obtain the instrument response.



**Tip:** If the "Show Log" checkbox is checked R&S VISA displays each VISA function call in the log-view on the left. If you check the "Write Log" checkbox the log-view entry is written to the log file as well. You can operate the log-view in two modes: the "Live Mode" shows only the most recent messages whereas the "View Mode" allows you to scroll the history.

- To set, e.g. the frequency, enter `SOUR1:FREQ 4 GHz` and select "Write". To check the performed setting, `SOUR1:FREQ?` and select "Read". The instrument response is `4000000000`, i.e. the frequency is returned in Hz.



While remote control is active, the "Remote" icon in the status bar indicates that the instrument is in remote control mode. Currently ongoing communication (data transfer) is indicated by green colored arrows in the icon.

Additionally, the "Connections" softkey in the taskbar shows the currently established remote connections. The operation via the front and touch panel or via mouse and keyboard are locked, allowing a remote control program to be performed without interruption.

On the display, keys and entry fields are grayed out and cannot be activated or modified, but you can still open dialogs, for example to verify settings.

5. To disable the access to the dialogs, use the command `SYST:KLOC ON`.
6. To prevent unintentional return to manual operation, use the command `&LLO`. See also [Chapter B.1.2, "LAN Interface Messages"](#), on page 1115. The instrument switches to "Remote LLO" state. The LOCAL key is disabled.
7. To enable the LOCAL key, use the command `&GTR`.
8. To return to manual operation, see [Chapter 12.10, "How to Return to Manual Operation"](#), on page 690.

**Tip:** Switching from manual operation to remote control and vice versa does not affect the other instrument settings.

### 12.8.3 Setting Up a Remote Control Connection over LAN Using Socket Communication

This section provides an example on how to establish a remote control connection over Telnet client and a simple sockets-based program example that can be further developed (see also [Chapter B.2, "Telnet program examples"](#), on page 1137).



Note that the telnet client transmits information unencrypted. Therefore, for sensitive information we recommend that you use a client which supports secure protocols, as e.g. SSH.

In the following example, we assume basic knowledge of programming and operation of the controller. You can find information on the interface commands in the corresponding manuals.

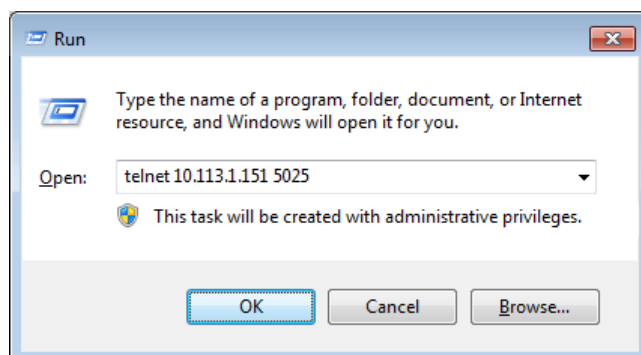
#### Setting up a Telnet Connection

To control the software, only a Telnet program is required. The Telnet program is part of every operating system.

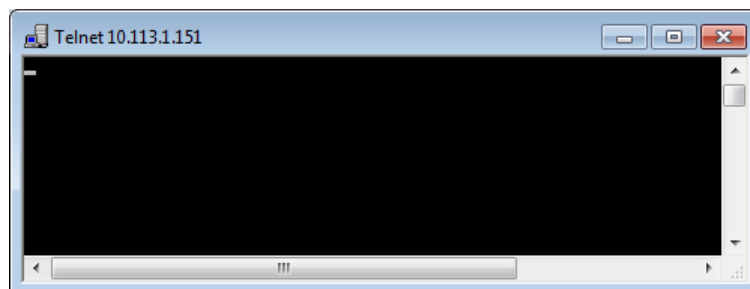
1. To establish a Telnet connection with the R&S SMW, start the Telnet program and enter the socket address.

The socket address is a combination of the IP address or the hostname of the R&S SMW and the number of the port configured for remote-control via Telnet.

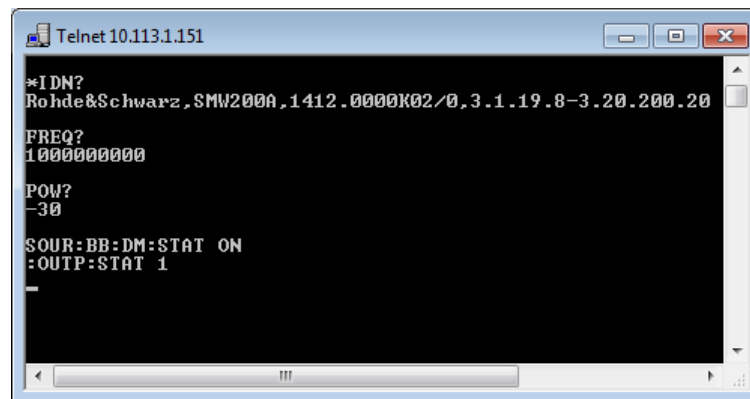
**Tip:** The R&S SMW uses the port number 5025 for remote connection via Telnet.



The connection to the instrument is set up and you can send remote-control commands.



2. Note that Telnet does not reflect your first entry. Insert a command, e.g. \*IDN and confirm with "Enter".
3. Observe the screen.  
A response on the query confirms that the connection is working. The client displays all subsequent inputs and responses.
4. Even if the cursor is not visible on the screen, enter blind a remote-control command and confirm with Enter.



#### 12.8.4 Setting Up a Remote Control Connection over GPIB

The program example in this section is written in VISUAL BASIC. A condition for programming in VISUAL BASIC is that the modules NIGLOBAL (Niglobal.bas) and VBIB32 (Vbib\_32.bas) are added to the projects.



Drivers for instrument, for example IVI-COM and LabVIEW drivers, are available in the download area of the product website ([http://www2.rohde-schwarz.com/en/products/test\\_and\\_measurement/product\\_categories/signal\\_generation/](http://www2.rohde-schwarz.com/en/products/test_and_measurement/product_categories/signal_generation/)).

##### Starting a remote control session over GPIB

As a prerequisite, the GPIB address of the instrument, which is factory-set to 28, must not have been changed.

1. Connect instrument and controller using GPIB cable and switch them on.
2. Execute the following commands on the controller:
  - a) Open the port to the instrument.  
`CALL IBFIND("DEV1", generator%)`
  - b) Inform the controller about instrument address.  
`CALL IBPAD(generator%, 28)`
  - c) Reset the instrument.  
`CALL IBWRT(generator%, "*RST;*CLS")`
  - d) Set the instrument to new address.  
`CALL IBWRT(generator%, "SYST:COMM:GPIB:ADDR 18")`



- e) Inform the controller about new address.

```
CALL IBPAD(generator%, 18)
```

The GPIB address of the instrument is changed.

3. To return to manual operation, press the LOCAL key at the front panel.



#### Risk of losing network connection

Since a factory preset resets the remote access and network settings to the default values, executing factory preset via remote control terminates the connection to the instrument, if these settings had been configured to values different to the default ones!

## 12.8.5 Setting Up a Remote Control Connection over USB

For remote control via the USB connection, the PC and the instrument must be connected via the USB type B interface. A USB connection requires the VISA library to be installed. VISA detects and configures the R&S instrument automatically when the USB connection is established. You do not have to enter an address string or install a separate driver.

### Starting a remote control session over USB

1. Connect instrument and controller using USB cable and switch them on.

2. Execute the following commands on the controller:

- a) Open the port to the instrument

```
viOpen (... , "USB::0x0092::0x0088::1000010::INSTR", ...)
```

- b) Reset the instrument

```
viRST (generator%, "*RST;*CLS")
```

- c) Set 2 GHz frequency

```
viPrintf (... , "SOUR:FREQ 2GHz\n")
```

- d) Set 20 dBm output level

```
viPrintf (... , "SOUR:POW -20dBm\n")
```

The RF frequency and signal level of the instrument are changed.

3. To return to manual operation, press the LOCAL key at the front panel.

## 12.9 How to Trace SCPI Commands and Messages exchanged via the LXI Web Browser Interface

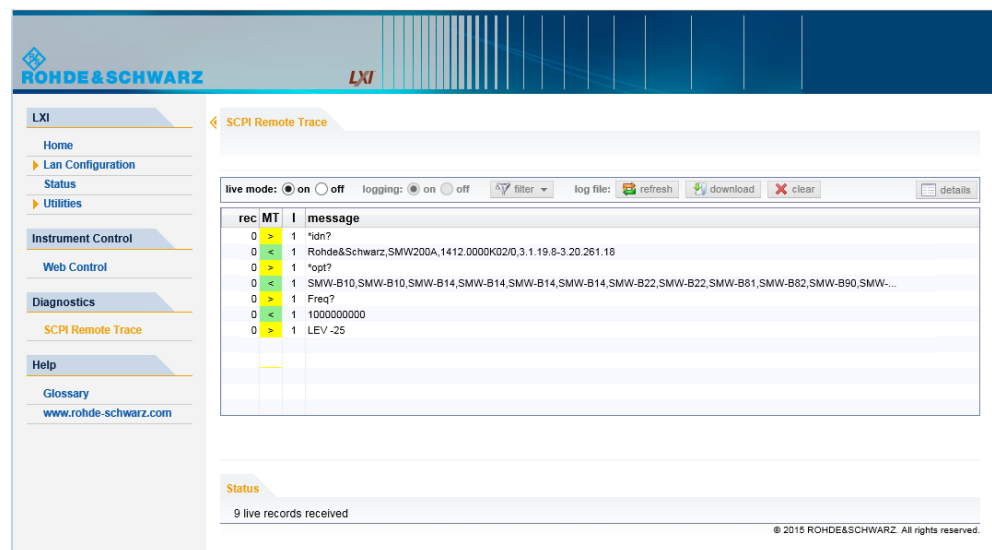
The remote trace functionality allows you to trace commands and messages exchanged via a remote control interface of the R&S SMW.

To activate the SCPI remote trace:

1. Start a web browser that supports html5 (W3C compliant).

2. Enter the IP address of the R&S SMW in the browser's address bar.  
The R&S SMW's welcome page is displayed.
3. In the navigation pane, select "Diagnostics > SCPI Remote Trace".
4. In the toolbar bar of the "SCPI Remote Trace" page, select "live mode > on" and "logging > on".  
"live mode > on" displays all commands and responses, and "logging > on" also traces messages.

If you now control the R&S SMW with SCPI commands, using an appropriate tool, the LXI function records the information sent and received.



The screenshot shows the LXI SCPI Remote Trace interface. The left sidebar contains navigation options: LXI, Home, Lan Configuration, Status, Utilities, Instrument Control, Web Control, Diagnostics (with SCPI Remote Trace selected), and Help. The main area displays the SCPI Remote Trace page with controls for live mode (on/off), logging (on/off), a filter, and log file actions (refresh, download, clear, details). A table shows recorded messages:

rec	MT	I	message
0	>	1	*Idn?
0	<	1	Rohde&Schwarz,SMW200A,1412.0000K02/0.3.1.19.8-3.20.261.18
0	>	1	*opt?
0	<	1	SMW-B10,SMW-B10,SMW-B14,SMW-B14,SMW-B14,SMW-B14,SMW-B22,SMW-B22,SMW-B81,SMW-B82,SMW-B90,SMW-...
0	>	1	Freq?
0	<	1	1000000000
0	>	1	LEV-25

Below the table, the status bar indicates "9 live records received". The footer contains the copyright notice: "© 2015 ROHDE&SCHWARZ. All rights reserved."

The function records all sent commands, received responses and messages, and stores them in an internal database. If "live mode" is disabled, you can display the recent traces upon request, using the "refresh" button. You can also store the log in a file.

**Note:** The diagnostics functionality will be extended in later releases, e.g. to download or upload SCPI command files from / to the instrument.

## 12.10 How to Return to Manual Operation



Before returning to manual control, command processing must be completed. Otherwise, the instrument switches back to remote control immediately.

1. To return from "Remote" state to manual state, perform one of the following:
  - On the controller, use the command `&GTL`  
**Note:** If `&NREN` has been set before `&GTL` is locked. Use `&GTR` instead.
  - In the status bar, select the "Remote" icon.

- On the front panel, press the LOCAL key.
  - In the block diagram, select "Context sensitive menu > Key Emulation > Local"
2. To return from "Remote LLO" state to manual or to "Remote" state, perform one of the following:

**Note:** In the local lockout state, the command `&GTL` and the LOCAL key are locked. You can unlock this state only via remote control.

- On the controller, use the command `&LOCS`.  
This command switches directly to manual operation.
- Send the command `&REMS`.  
This command changes the remote control state from "Remote LLO" to "Remote".
- Use the Visual Basic command `CALL IBLOC (generator%)`.  
The command switches directly to manual operation.
- VISA function `viGpibControlREN()`  
This function switches directly to manual operation.

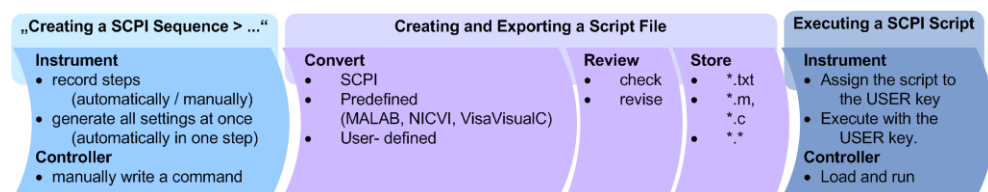
## 12.11 Automating Tasks via Remote Command Scripts

To achieve fast configuration, perform complex test setups or repeating measurements reproducible, you can automate the required settings with scripts. A script contains a series of SCPI commands corresponding to the settings. When completed, it is converted to an executable format, stored in a file and can be run whenever needed.



If you frequently need to load and run a script, assign the script to the "User Key", and you can quickly and easily perform the task, see [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627.

**Note:** In contrast to "Recall Setup" via the USER key, an assigned script execution does not close active dialogs and windows. On the contrary, even active window control (open / close) is possible.



**Figure 12-6: Steps for performing SCPI Scripts**

In the graph, you can see the main steps required to work with a SCPI script.

### Creating a SCPI list

With the SCPI record functions, you can create a SCPI command list directly in the instrument and then export the list to the controller. If you want to edit or write a script manually, use a suitable editor on the controller. Even for manually creating, the instru-

ment supports you by showing the corresponding command syntax and the current settings value.

Directly in the instrument, you can create a SCPI list at any time of operation, in the following ways:

- Recording steps

Both, automatic or manual SCPI recording is possible, i.e. you can record all the settings that you perform between a start and an end point, or select deliberately the commands you want to record.

  - Automatically record all performed steps

The instrument records the appropriate SCPI command and settings value of each step you perform, as if you run a series of commands, and then writes the commands to the file system, see [How to record SCPI lists automatically](#).
  - Manually record the steps selectively

In manual recording mode, you can deliberately record a SCPI command with the "Add to Script" function, see [How to record SCPI lists manually](#).
- Generating all settings at once

Generates the SCPI commands of the current instrument settings in one step, and writes the command list in a temporary list, see [How to create a SCPI list with the current instrument settings in one step](#).

**Note:** This function lists all commands in alphabetical order, in contrast to the recording or manual creation, which consider the order the settings are configured. This can slow down the run time or cause errors during execution. Therefore, always check a script and possibly revise, see "[How to check a SCPI list](#)" on page 702.



Some parameters cannot be set by a SCPI command.

If so, "no SCPI command found" is entered instead of a command when you record or generate all settings at once.

---



### The difference between "Show SCPI Command" and the provided cross-reference

If you want to enter your settings in a script, or use a remote control program, you must know the associated SCPI command and the exact syntax.

If you need to look up the SCPI command, the instrument offers two ways to figure it out quickly.

- "Show SCPI command" (context-sensitive menu)  
Is dynamic information on the correct syntax of the SCPI command corresponding to the currently selected instrument function, including the relevant setting, see [Chapter 12.12, "How to Find Out the SCPI Command Corresponding to the Manual Operation via "Show SCPI Command"">Chapter 12.12, "How to Find Out the SCPI Command Corresponding to the Manual Operation via "Show SCPI Command"](#), on page 696.
- Online Help  
Describes each manual instrument function, and includes also a cross-reference to the associated SCPI command. The referenced section is a complete description of the SCPI command and comprises, besides the command syntax, all available parameters, value ranges, example, etc., see [Chapter 12.13, "How to Find Out the SCPI Command Corresponding to the Manual Operation Using the Online Help"](#), on page 696.

### Creating and Exporting a Script File

When the script list is completed a code generator translates the SCPI commands to the source code of a proprietary programming language, using a code template. Therefore, each language requires an appropriate code template. When converted, the script is stored in a file with an extension corresponding to the programming language.

The R&S SMW provides the following predefined code templates by default:

- Plain SCPI  
Represents SCPI base format, that is ASCII format, stored as text file (\*.txt).
- MATLAB  
A programming environment, frequently used in signal processing and test and measurement applications (\*.m).  
You can directly use this format with MATLAB(c) Toolkit. For comprehensive information on this topic, refer to the Application Note 1GP60 "MATLAB Toolkit for R&S Signal Generators".
- NICVI  
An ANSI C programming environment designed for measurements and tests (\*.c).  
You can directly use this format with National Instruments LabWindows CVI.

You can also convert a script to a user-specific format. In this case, you need an appropriate code template, which must have the extension \*.expcodetmpl.

For information on how to select the code template and store the script in a file, see [Chapter 12.11.2, "SCPI Recording Export Settings"](#), on page 695.

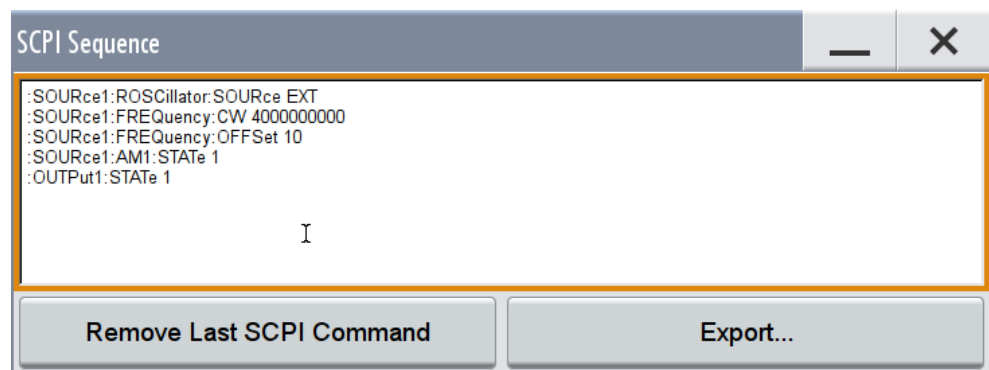
### Executing a SCPI Script

A SCPI script primarily runs on the controller PC. In addition, you can execute a script directly on the instrument, by assigning the appropriate script to the USER key. See also [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627.

#### 12.11.1 Displaying a SCPI List

The instrument displays a recorded SCPI list and thus provides viewing the recorded results before exporting.

- ▶ Depending on the starting point, you can access the "SCPI Sequence" dialog as follows:
  - During recording  
Select "Show current SCPI Sequence" in the context sensitive menu.
  - At any time outside recording  
Select "Show last SCPI Sequence" in the context sensitive menu.  
This implies that at least one recording has been executed after power-on.
  - At the end of the recording  
The dialog automatically opens. That is, when you have selected "Stop automatic SCPI recording" or "Stop manual SCPI recording".
  - After you have exported the script to a file, select "Show file content" in the "SCPI Recording Export" dialog, see [Chapter 12.11.2, "SCPI Recording Export Settings"](#), on page 695.



The "SCPI Sequence" shows the last recorded and exported commands.

#### Export

Opens the [SCPI Recording Export Settings](#) dialog for configuring the file parameters for export.

#### Remove last SCPI Command

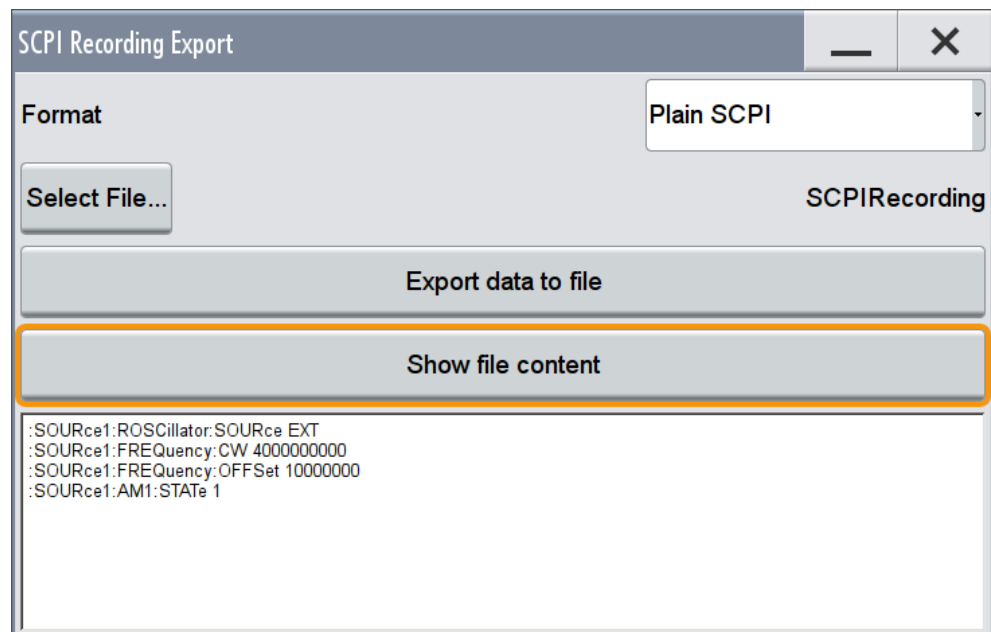
Deletes the last recorded command.

## 12.11.2 SCPI Recording Export Settings

Scripts are configured and stored in the "SCPI Recording Export" dialog.

This dialog opens automatically, when you stop recording.

1. To access this dialog, select "Show Last SCPI sequence" in the context sensitive menu.  
The "SCPI Sequence" dialog opens.
2. Select "Export".



The "SCPI Recording Export" dialog contains all functions required for export of command lists to a file. It enables you to select the source code format, assign an individual file name and display the file content.

### Format

Selects the source code format for the command list.

"Plain SCPI" Uses SCPI syntax.

"Predefined Code Generator"

Accesses the predefined templates for common source code generators that convert the recorded settings in the programming languages MATLAB or NICVI.

"User Code Generator"

Provides the ability to convert a script by a user-specific code generator.

### Select Code Template

Opens the standard "File Select" dialog and lists the predefined or user-defined code templates.

See [Chapter 10.5.1, "File Select Settings"](#), on page 586.

**Select File**

Opens a standard file select dialog "Select Output File", see [Chapter 10.5.1, "File Select Settings"](#), on page 586.

**Export data to file**

Executes data export.

**Show file content**

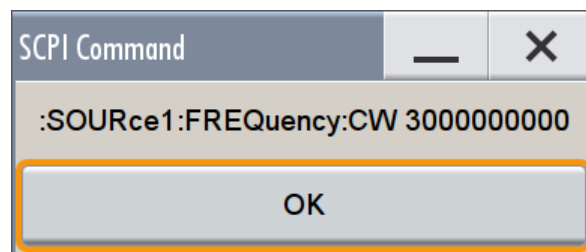
Displays the content of the script in the appropriate source code.

## 12.12 How to Find Out the SCPI Command Corresponding to the Manual Operation via "Show SCPI Command"

1. To find out the SCPI command of a parameter in manual operation, select the respective parameter.
2. Open the context-sensitive menu and select "Show SCPI command"



You get the detailed command syntax, including the currently set value.



## 12.13 How to Find Out the SCPI Command Corresponding to the Manual Operation Using the Online Help

If you are looking for the remote command to a function in manual operation, you find it in the description of the online help.

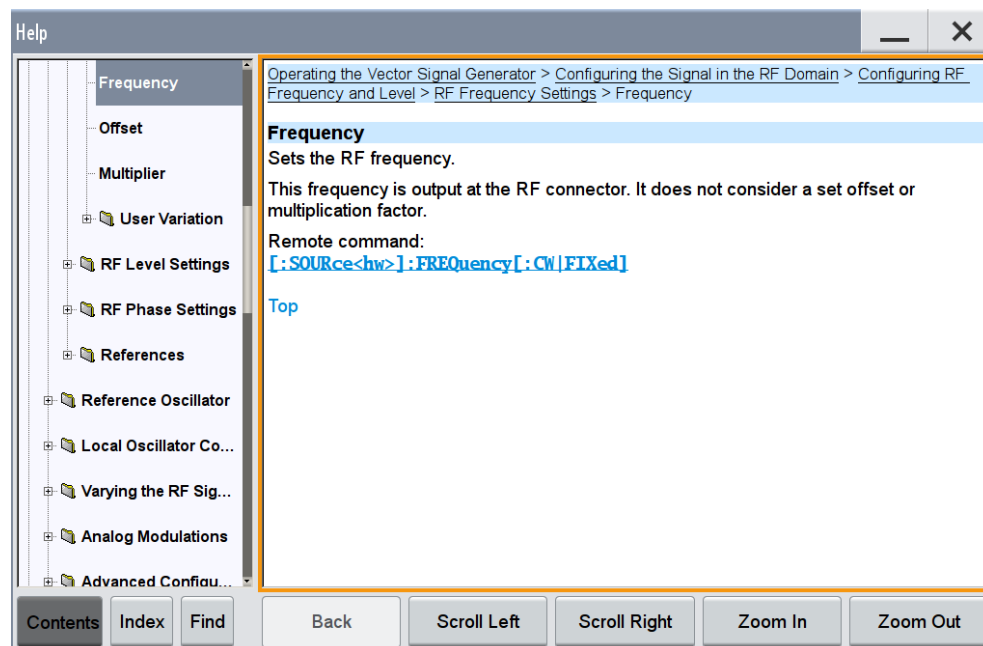
1. To find out the SCPI command of a parameter in manual operation, select the respective parameter.
2. To open the corresponding help topic, select one of the following:
  - In the display, select "context-sensitive menu > Help".





- On the front panel, press the HELP key.

The help topic opens. Apart from the function description, it contains the SCPI command in detailed syntax.



#### How to find the corresponding GUI function to a command

Conversely, if you are looking for a function in the GUI, which belongs to a SCPI, you find it via a cross-reference in the online help and in the user manual.

See [How to Find Out a Function in Manual Operation Corresponding to a SCPI Command](#).

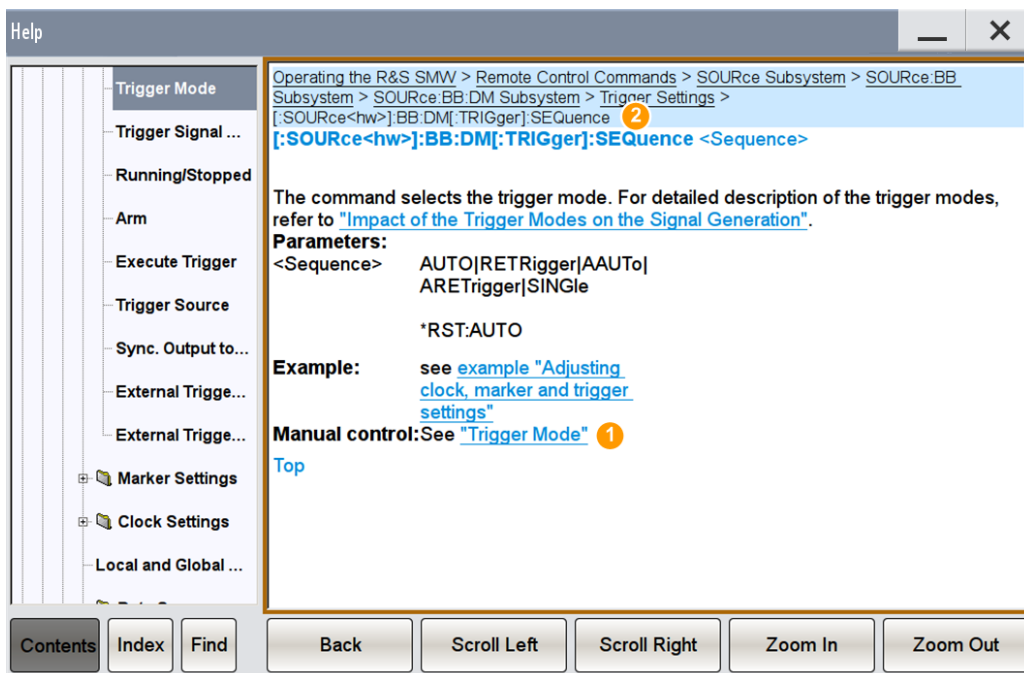
## 12.14 How to Find Out a Function in Manual Operation Corresponding to a SCPI Command

If you are searching for the associated function to a remote command in the manual operation (GUI), you can proceed as shown in the following example:

### Example

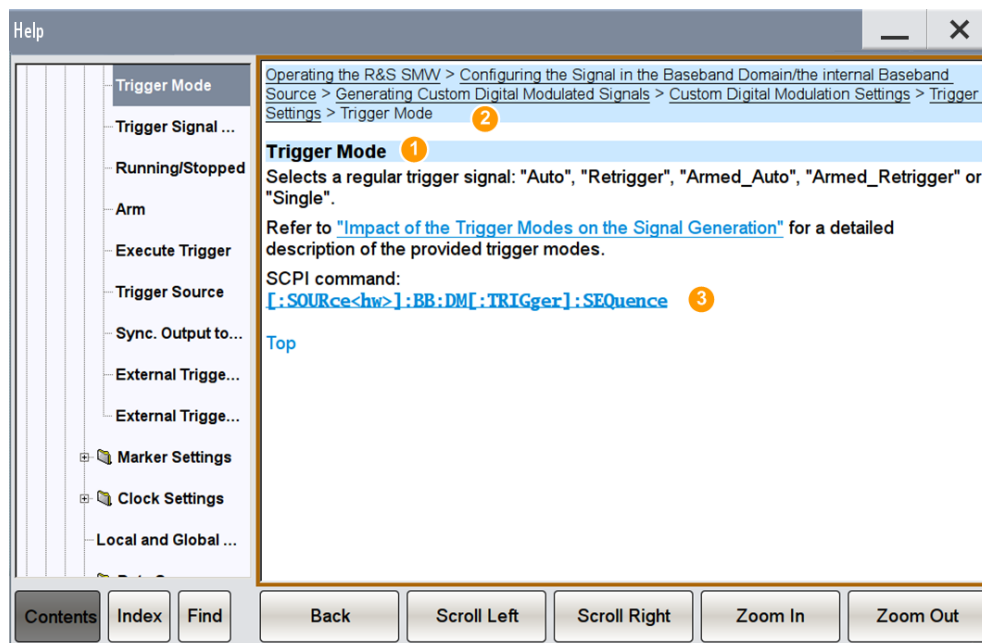
Point of origin is the description of a remote control command in the user manual, in the following example the "Trigger Mode" of the digital modulation dialog:

How to Find Out a Function in Manual Operation Corresponding to a SCPI Command



1 = cross-reference to corresponding topic in manual control  
 2 = path for tracing with location of the current topic (breadcrumbs navigation)

- To find the corresponding function in manual control, select the cross-reference. In the description of the manual control, you find additional information on the parameter. You can follow the link in the breadcrumbs navigation area (2) and find out to which dialog and functional block the parameter belongs.



- 1 = description of the function in manual control
- 2 = path for tracing (breadcrumbs navigation)
- 3 = cross-reference to return back to the SCPI command

## 12.15 How to Record / Create SCPI Lists

### How to record SCPI lists automatically

The following example briefly explains how to proceed when you want to record SCPI lists.

For comprehensive information on this topic, refer to the Application Note 1GP98 "SCPI Recorder Test Automation on a Fingertip".

1. On the screen, open the context-sensitive menu (touch and hold, or right mouse click) and select "Start automatic SCPI recording".



Starting from now, all steps you perform are recorded.

2. To stop SCPI recording, select "context-sensitive menu > Stop automatic SCPI recording".



The "SCPI Recording Export" dialog opens automatically.

3. Proceed with [How to check a SCPI list](#).

### How to record SCPI lists manually



It is recommended that you activate the "Mark all parameters changed from preset". This function facilitates to track the changes.

1. To retrace your settings, open the context-sensitive menu and select "Mark all parameters changed from preset".



This function identifies all settings you have changed, both in the block diagram, and in the dialogs. They appear orange.

RF Freq/Phase/Ext Ref/LO Coupling A

RF Frequency Phase Ext. Ref.\LO Coupling

Frequency 2.000 000 000 00 GHz

Offset 2.000 00 kHz

Multiplier 1.000

User Variation

Variation Active

Variation Step 1.000 000 00 MHz

- Open the context-sensitive menu and select "Start manual SCPI recording".



Now you can selectively record your steps:

- Set the parameter.
- Open the context-sensitive menu.
- Select "Add SCPI command to sequence"



**Tip:** You cannot see "Add SCPI ..." in the menu?

This may happen if you open it outside of a dialog or input field, for example in block diagram. Open the context-sensitive menu within the corresponding dialog or input field, and the feature is available.

- Continue with the next setting, and repeat steps *a to b* whenever needed.

Each time you select "Add SCPI ...", the SCPI command is appended to a temporary list.

- To check the progress of the recording, select "Context-Sensitive > Show current SCPI sequence".



The "SCPI Sequence" dialog opens, displaying all recorded settings so far.

- To stop SCPI recording, open the context-sensitive menu again and select "Stop manual SCPI recording".



The "SCPI Recording Export" dialog automatically opens.

- Proceed with [How to check a SCPI list](#).

### How to create a SCPI list with the current instrument settings in one step

You can also generate the appropriate SCPI list to a manually created instrument state at any time, in only one step.

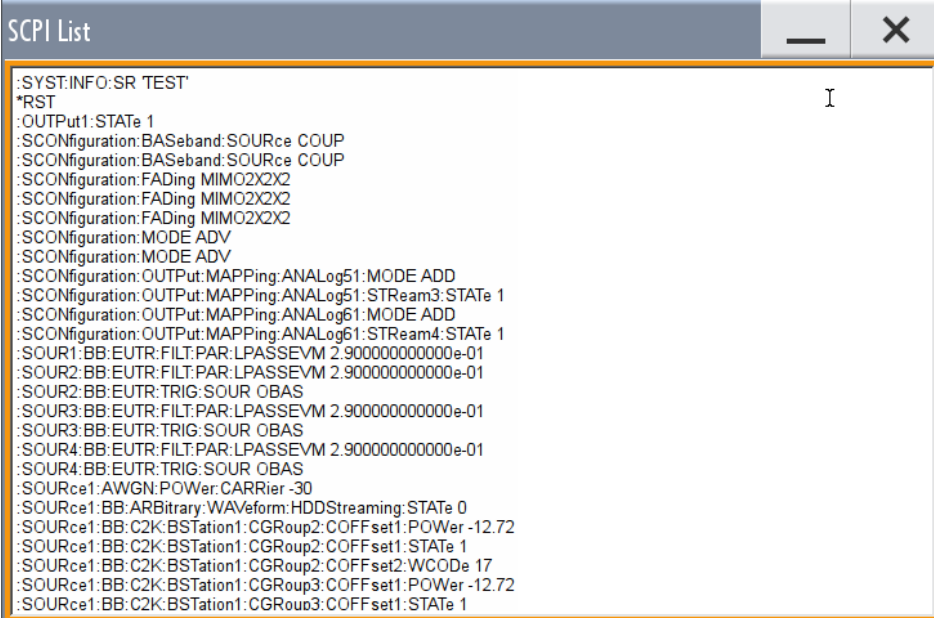
- To generate a SCPI list with commands for all settings performed, select "Save/Recall > SCPI Export".



The instrument opens a standard file select dialog, see [Chapter 10.4.1, "Save/Recall Settings"](#), on page 581. The "Format" entry field appears for selecting the source code format.

- In the "Format" entry field, select the source code.
- Depending on the selected format, convert the script as described in [Chapter 12.16, "How to Convert and Store SCPI Lists"](#), on page 703
- Enter a filename.
- Select "Export".  
The instrument writes all SCPI commands of the key parameters and the modified settings in the file. The file extension is automatically assigned according to the source code format

6. To preview the content of the SCPI list, open the file select dialog again with SAVE/RCL:
  - a) "Select Operation > SCPI-Export"
  - b) In the /var/user/temp/ directory, select a previously stored file.
  - c) On the right, select "Show SCPI List".



```

SCPI List
:SYST:INFO:SR TEST
*RST
:OUTPut1:STATe 1
:SCONfiguration:BASEband:SOURce COUP
:SCONfiguration:BASEband:SOURce COUP
:SCONfiguration:FADing MIMO2X2X2
:SCONfiguration:FADing MIMO2X2X2
:SCONfiguration:FADing MIMO2X2X2
:SCONfiguration:MODE ADV
:SCONfiguration:MODE ADV
:SCONfiguration:OUTPut:MAPPing:ANALog51:MODE ADD
:SCONfiguration:OUTPut:MAPPing:ANALog51:STReam3:STATe 1
:SCONfiguration:OUTPut:MAPPing:ANALog61:MODE ADD
:SCONfiguration:OUTPut:MAPPing:ANALog61:STReam4:STATe 1
:SOUR1:BB:EUTR:FILT:PAR:LPASSEVM 2.900000000000e-01
:SOUR2:BB:EUTR:FILT:PAR:LPASSEVM 2.900000000000e-01
:SOUR2:BB:EUTR:TRIG:SOUR OBAS
:SOUR3:BB:EUTR:FILT:PAR:LPASSEVM 2.900000000000e-01
:SOUR3:BB:EUTR:TRIG:SOUR OBAS
:SOUR4:BB:EUTR:FILT:PAR:LPASSEVM 2.900000000000e-01
:SOUR4:BB:EUTR:TRIG:SOUR OBAS
:SOURce1:AWGN:POWer:CARRier -30
:SOURce1:BB:ARbitrary:WAVeform:HDDStreaming:STATe 0
:SOURce1:BB:C2K:BSTation1:CGRoup2:COFFset1:POWer -12.72
:SOURce1:BB:C2K:BSTation1:CGRoup2:COFFset1:STATe 1
:SOURce1:BB:C2K:BSTation1:CGRoup2:COFFset2:WCODe 17
:SOURce1:BB:C2K:BSTation1:CGRoup3:COFFset1:POWer -12.72
:SOURce1:BB:C2K:BSTation1:CGRoup3:COFFset1:STATe 1

```

The list of all SCPI commands is displayed for example for a final check.



To export the SCPI list of the instrument state in one step, is a fast and convenient method. Nevertheless, it usually requires postprocessing, which is currently only possible on a PC.

### How to check a SCPI list

The easiest way to check a list is executing it. The generator returns a warning if a setting could not be performed.

However, it is recommended that you check the list and possibly rework. It can be that ...

- A parameter has not assigned a SCPI command or an element of the user interface has not an assigned parameter. In these cases, `:SYST:INF:SCPI 'SCPI command not available'` is entered in the list instead. Such entries are also detected during execution. The instrument recognizes these incomplete commands and displays an error message.
- a preset has been executed, but several standards subsequently perform some internal settings that are also assigned to the list with "SCPI Export".
- after a preset still some settings are defined, which are then written to the list generated with "SCPI Export."

Some suggestions on how you can check and revise a list:

1. Search and remove missing command entries.
2. Remove unnecessary content that has been written after a preset.
3. Rearrange the commands to a reasonable order. If you for example set a `STATe` command to the last position of a list, you can avoid intermediate calculations of the signal.
4. Preview the list for completeness by comparing it with the modified settings in the manual mode.
  - a) To retrace your settings in manual operation, open the context-sensitive menu and select "Mark all parameters changed from preset".  
The function identifies all settings you have changed, both in the block diagram, and in the dialogs. They appear orange.
  - b) Check whether there is a command in the list for all modified settings.
5. To perform modifications, export the list to a PC, using for example a USB stick.

## 12.16 How to Convert and Store SCPI Lists

After completing the recording (automatic or manual), the "SCPI Recording Export" dialog automatically opens.

1. Select the "Format" for the command syntax in which you want to save the list.
2. "Select Code Template"  
Depending on the selected format, proceed accordingly:  
**Note:** The code template must be selected before exporting.
  - a) Plain SCPI  
Continue with the next step.
  - b) Predefined Code Generator  
The "SCPI Recording Export - Select Predefined Code Template" dialog opens.  
Select one of the predefined code templates.
  - c) User Code Generator  
A file system ("SCPI Recording Export - Select User Code Template") dialog opens.  
Select your user-defined code template. The code template must have file extension `*.expcodetmpl`.
3. "Select File..."  
The "SCPI Recording Export - Select Output File" dialog opens.  
Select the directory and assign a file name for storing the recorded list.
4. "Export data to file"

Stores the recorded data either in ASCII format (plain SCPI), or in the corresponding format of the used code template, and activates the "Show File Content" button.

5. "Show file content"  
Displays the source code in the corresponding syntax.

## 12.17 How to Set Up Remote Operation via VNC

This section shows you some examples of the various possibilities to set up remote operation.

- Using a desktop system
  - [Chapter 12.17.1.1, "Using a Web Browser"](#), on page 704
  - [Chapter 12.17.1.2, "Using a VNC Client Software"](#), on page 705
- Using a smart device
  - [Chapter 12.17.2.1, "Using a VNC App"](#), on page 708
  - [Chapter 12.17.2.2, "Using a Web Browser with HTML5"](#), on page 708
  - [Chapter 12.17.2.3, "Special Mode QR Code "](#), on page 709



### Enabled Direct Control

The direct control of the instrument is not disabled and the instrument can be controlled from the front panel and via the remote computer alternately.

---

## 12.17.1 Setting Up a Remote Operation from a Desktop System

### 12.17.1.1 Using a Web Browser

The R&S SMW supports remote operation via VNC with any web browser, like Windows Internet Explorer or Mozilla Firefox for instance, or alternatively, an HTML5 web browser.

To operate the instrument via a web browser remotely:

1. Install the *JRE (Java Runtime Environment)* on the remote computer.  
**Note:** Skip this step if you are working with an HTML5 web browser.
2. Type the instruments' IP address in the address field of the web browser on your PC, e.g. `http://10.113.1.151`  
The VNC authentication screen appears.
3. Enter the password and confirm with "OK".



The default password is *Instrument*.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

### 12.17.1.2 Using a VNC Client Software

A VNC client software is an application which can be used to access and control the instrument from a remote computer through a LAN connection.

The VNC client software for setting up the connection is included in the operating system Linux/Unix per default. For Windows operating systems, a VNC client software must be installed manually. Therefore, various free-of-charge programs are available such as Ultr@VNC. See [Setting Up the VNC Connection on a Windows Desktop Client](#) for information on how to proceed. Similar VNC client programs are available as free-of-charge downloads on the internet.

#### Setting Up the VNC Connection on a Linux/Unix Desktop Client

The VNC program is available per default for Linux/Unix operating systems.

1. Start a web browser on the remote computer and enter the IP address of the instrument.
2. Enter the following address:  
`vnc://<IP-address of the instrument>`, for example `vnc://10.113.1.151`.

A dialog opens requesting the password for the remote VNC connection.

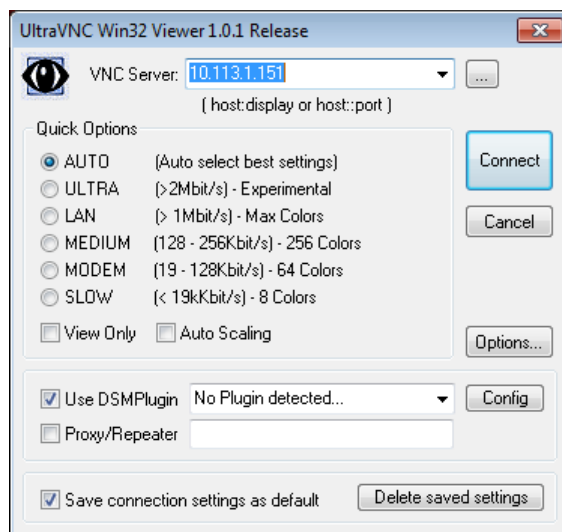
3. Enter the password and confirm with "OK".  
The default password is *Instrument*.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

#### Setting Up the VNC Connection on a Windows Desktop Client

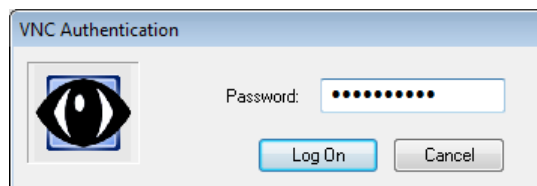
To perform remote operation from a windows desktop client, a VNC viewer must be installed on the computer.

1. Install the VNC viewer program component on the remote computer.
  - a) On the Internet, select a VNC client program and download it onto your PC.  
For example the free of charge software Ultr@VNC (`vncviewer.exe` is available, see <http://www.uvnc.com/download/index.html>).
  - b) Execute the VNC client installation.
  - c) Select the VNC viewer program component and follow the installation instructions.
2. Start VNC viewer program component on the PC.



3. Select "VNC Server" and enter the IP address of the instrument.
4. To initialize the connection, select "Connect".

A dialog opens requesting the password.



5. Enter the password and confirm with "OK".  
The default password is *Instrument*.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated from the remote computer.

### Terminating VNC Connection

You can terminate the remote operation via VNC connection on the remote client device.

Terminating the connection does not disable it. It can be established again any time. But consider the note concerning unauthorized access due to VNC connection ("[Risk of Unauthorized Access](#)" on page 650).

- ▶ To terminate the connection on the external controller PC, perform one of the following:
  - a) On an external Unix/Linux PC, close the internet browser or close the signal generator window.
  - b) On an external Windows PC, close the VNC viewer program.

The connection is terminated. In the "Active Connections" tab, the displayed TCP/IP connection disappears.

## 12.17.2 Setting Up a Remote Operation from a Smart Device

The R&S SMW supports remote operation via VNC from a smart device (remote client), like a tablet (tablet computer) or a smart phone. The smart device accesses the instrument via WLAN, either by a suitable App, or an HTML5 web browser, that means with embedded *Javascript*.

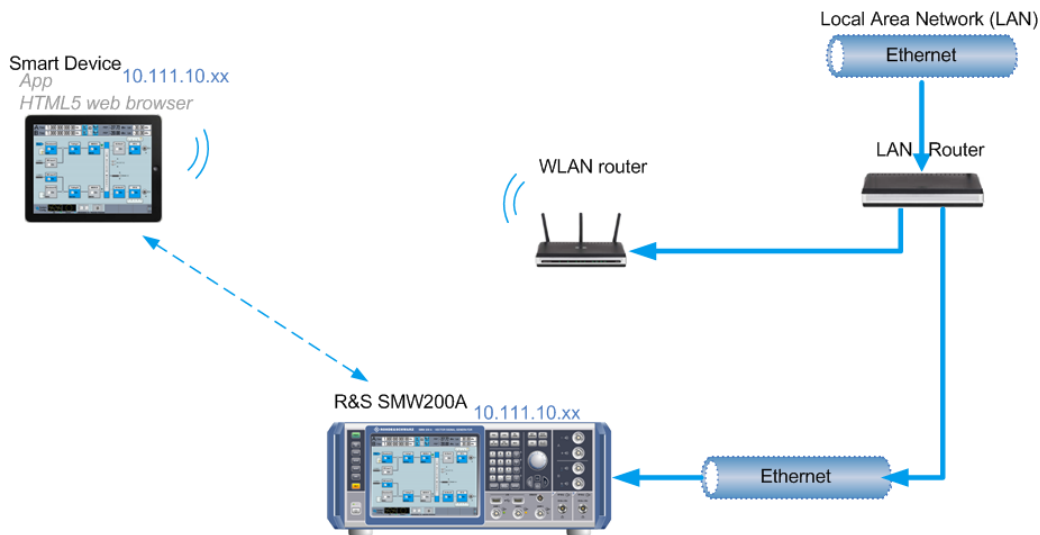


There are several possibilities to establish a WLAN connection between the smart device and the R&S SMW, which are, however, not all described in this manual. This section gives an example of how a network environment can be built up, and some essential configuration steps.

For comprehensive information on this topic refer to the R&S Application Notes:

- 1MA216 "Remote Operation of Windows Based Instruments with Apple iPad"
- 7BM82 "Apple iPad Remote Control of Broadcasting T&M Instruments"

### Example:



**Figure 12-7: Example of a network configuration for remote operation with a smart device**

As shown in the figure, the R&S SMW and the WLAN router are connected to the LAN router. The smart device accesses the R&S instrument via the WLAN router.

For this network configuration, the following prerequisites must be met:

- The required equipment is:
  - A LAN router
  - A WLAN router (hot spot)  
Required for accessing the R&S SMW
- The smart device must be known and accepted in the network of the R&S SMW.
- The App or web browser implements the VNC functionality on the smart device for remote operation.

Generally it is recommended that all components in the network use DHCP, which automatically assigns the relevant address information.



With the configuration in the example, you can reach the instrument from a great distance, since the WLAN router acts as an additional access point.

### 12.17.2.1 Using a VNC App

Using a *VNC App* enables the smart device to access the R&S SMW via WLAN.



The VNC Apps are available from various manufacturers of the smart devices. The list of supported devices is different according to the smart device. Refer to the manufacturer's website to find out whether a VNC App is available for your device, and how it is installed.

To set up the remote operation perform the following:

1. In the network, establish the connection of the WLAN router to the LAN router. It is assumed, that the LAN router and the R&S SMW are connected and configured in the LAN.
2. Configure the WLAN router according to the manufacturer's instructions.
3. Install the required *VNC App* on your smart device.
4. On the R&S SMW, select "System Config > Remote Access > Network".
5. Write down the "IP Address" of the instrument, for example 10.111.10.125
6. On the smart device, start the *VNC App*.
7. In the address field, enter the IP address of the instrument.

A log-on dialog opens and requests the password for the VNC connection.

The default user name and password is *instrument*.

**Tip:** Default password. Remote access via VNC uses the user name "instrument" with default user password "instrument".

We recommend that you change this password in the "Setup > Security > Password Management" dialog before connecting to the network.

8. Enter the password to establish the remote access.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

### 12.17.2.2 Using a Web Browser with HTML5

The R&S SMW supports remote operation from a smart device via VNC with any HTML5 compliant web browser, like Internet Explorer, Firefox, Chrome, or Safari for instance.

To operate the instrument remotely via a web browser, proceed as follows:

1. In the web browser enter the IP address of the instrument, e.g. *http://10.113.1.151*.
2. Type the instrument IP address in the address field of the web browser on your PC, e.g. *http://10.113.1.151*

**Tip:** You can find the IP address in the "Network" tab of the "Remote Access" dialog. On the instrument, select "System Config > Remote Access".

The VNC authentication screen appears.

3. Enter the password and confirm with "OK".  
The default password is *instrument*.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

### 12.17.2.3 Special Mode QR Code

If your smart device is equipped with a camera and a QR code reader, you can easily read out the instruments IP address for connection, and for instance, access the instrument with the safari web browser.



QR code readers are available from various manufacturers of the smart devices. The list of supported devices is different according to the smart device. Refer to the manufacturer's website to find out whether a reader is available for your device, and how it is installed.

---

To set up the remote operation, perform the following:

1. Install the required QR code reader software on your device.
2. Start the reader.
3. On the R&S SMW, select "System Config > Remote Access".
4. In the "Remote Access" dialog, select the "QR-Code" tab.
5. Scan the QR code of the instrument with your smart device.
6. On the device, decode the scanned QR code and pass it to the web browser.  
A dialog opens requesting the password for the VNC connection.
7. Enter the password and confirm with "OK".  
The default password is *instrument*.

After the connection is established, the current screen of the signal generator is displayed and the instrument can be remotely operated.

## 12.18 References

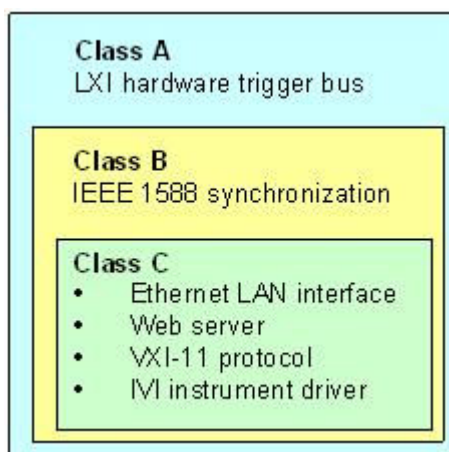
### 12.18.1 LXI - Classes and LXI Functionality

LAN Extensions for Instrumentation (LXI) is an instrumentation platform for measuring instruments and test systems that is based on standard Ethernet technology. LXI is intended to be the LAN-based successor to GPIB, combining the advantages of Ethernet with the simplicity and familiarity of GPIB.

Like GPIB, LXI determines and standardizes the way the instrument behaves in a LAN. The LXI implementation in the R&S SMW allows you to change certain LAN settings, to reset the LAN connection, and to identify the instrument.

#### LXI classes and LXI functionality

LXI-compliant instruments are divided into three classes, A, B and C, with the functionality of the classes hierarchically based one upon the other:



- **Class C** instruments are characterized by a common LAN implementation, including an ICMP ping responder for diagnostics. The instruments can be configured via a web browser; a LAN Configuration Initialize (LCI) mechanism resets the LAN configuration. The LXI class C instruments shall also support automatic detection in a LAN via the VXI-11 discovery protocol and programming by means of IVI drivers.
- **Class B** adds IEEE 1588 Precision Time Protocol (PTP) and peer-to-peer communication to the base class. IEEE 1588 allows all instruments on the same network to automatically synchronize to the most accurate clock available and then provide time stamps or time-based synchronization signals to all instruments with exceptional accuracy.
- **Class A** instruments are additionally equipped with the eight-channel hardware trigger bus (LVDS interface) defined in the LXI standard.



For information about the LXI standard refer to the LXI website at <http://www.lxistandard.org>. See also "News from Rohde & Schwarz, article 2006/II - 190".

Instruments of classes A and B can generate and receive software triggers via LAN messages and communicate with each other without involving the controller.

The R&S SMW supports some LXI class C features, but it is not LXI class C compliant. In addition to the general class C features described above, it provides the following LXI-related functionality:

- Integrated "LXI Status" dialog for LXI status indication and reset of the LAN configuration (LAN Configuration Initialize, LCI), see [Chapter 12.5.1, "LXI Status Settings"](#), on page 670.
- "LXI Browser Interface", as described in [Chapter 12.5.2.1, "LAN Configuration"](#), on page 673.
- "SCPI Remote Trace" utility, a feature beyond the scope of LXI class C, see ["SCPI Remote Trace"](#) on page 676.



#### Firmware update

To enable the full LXI functionality after a firmware update, shut down and restart the instrument.

## 12.18.2 Code Generator Templates

This section describes the main structure of the code generator templates, and shows the method by means of the NICVI template.

The code generation is controlled by templates with the following blocks:

Command	Function
#EXTENSION_START #EXTENSION_END	Defines the output file extension.
#INIT_CODE_START #INIT_CODE_END	Contains initial entries, such as included files and libraries, buffer size, commands for synchronization, or creating a VISA session. All entries between start and end are written once at the beginning of the output file.
#COMMAND_CODE_START #COMMAND_CODE_END	Frame for a SCPI command. A command is accessed with %COMMAND.
#NO_COMMAND_CODE_START #NO_COMMAND_CODE_END	Frame for a parameter with no SCPI command available. A parameter is accessed with %PARAMETER.
#EXIT_CODE_START #EXIT_CODE_END	Closes the visa session. All entries between start and end are written once at the end of the output file.

Templates are created in ASCII format with file extension \*.expcodetempl.

**Example:**

Example to the code generator template NICVI.expcodetempl:

```
#EXTENSION_START
.c
#EXTENSION_END

#INIT_CODE_START
#include <ansi_c.h>
#include <visa.h>
#include <cvirte.h>

#define MAX_BUFFER_SIZE 200
static ViStatus status;
static ViSession defaultRM, handle;

static void write_command(char *command)
{
    char writeBuffer[MAX_BUFFER_SIZE];
    char readBuffer[MAX_BUFFER_SIZE];
    int length;
    int readCount;

    strcpy(writeBuffer, command);
    //append "*OPC?" to sync
    strcat(writeBuffer, "*OPC?");
    length = strlen (writeBuffer);
    writeBuffer[length]='\n';
    length = length+1;
    viWrite (handle, writeBuffer, length, VI_NULL);
    //read result
    viRead(handle, readBuffer, 100, &readCount);
}

int main (int argc, char *argv[])
{
    if (InitCVIRTE (0, argv, 0) == 0)
        return -1;    /* out of memory */
        //create a VISA session and return a handle to it
    viOpenDefaultRM (&defaultRM);
        //create a VISA session to the serial port and return a handle to it
    viOpen (defaultRM, (ViRsrc)"TCPIP::localhost::INSTR", VI_NULL, VI_NULL,
&handle);
#INIT_CODE_END

#COMMAND_CODE_START
    write_command("%COMMAND");
#COMMAND_CODE_END
```



```

#NO_COMMAND_CODE_START
  //no SCPI command available for parameter %PARAMETER !
#NO_COMMAND_CODE_END




#EXIT_CODE_START
  viClose (handle);
      viClose (defaultRM);
      return 0;
}
#EXIT_CODE_END

```

### 12.18.3 Remote Control States

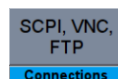
The following table shows the different remote control states and the associated commands or actions to return to manual control.

**Table 12-3: Remote control status icons**

GUI symbol	Transition to remote control state...	Transition to manual operation...(local state)
	&GTR (controller) Remote control, but usable front panel keys. The parameters are in read-only mode.	<ul style="list-style-type: none"> <li>• &amp;GTL (controller)</li> <li>• Tap the "Remote" icon (display)</li> <li>• LOCAL (front panel or key emulation)</li> </ul>
		A currently performed setting is indicated by the green arrows.  The setting must be completed (white arrows), otherwise the instrument remains in remote state.
	&LLO (controller) Remote control with locked front panel keys to prevent user interaction.  The parameters are in read-only mode.  You can unlock LLO, and thus return to manual operation only via remote control.	<ul style="list-style-type: none"> <li>• &amp;LOCS (controller)</li> <li>• CALL IBLOC (generator%) (controller)</li> </ul> <b>Note:</b> The command &REMS returns to "Remote" state.



A softkey in the task bar shows the currently established remote control connections, see [Chapter 12.4.6, "Active Connections Settings"](#), on page 668.



## 13 Remote Control Commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

For an introduction to remote control and the status registers, refer to:

- [Chapter 12, "Network and Remote Control Operation"](#), on page 649
- [Chapter B.1, "Additional Basics on Remote Control"](#), on page 1114

### 13.1 Conventions used in SCPI Command Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**  
If not specified otherwise, commands can be used both for setting and for querying parameters.  
If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**  
If not specified otherwise, a parameter can be used to set a value and it is the result of a query.  
Parameters required only for setting are indicated as **Setting parameters**.  
Parameters required only to refine a query are indicated as **Query parameters**.  
Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**  
Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S SMW follow the SCPI syntax rules.
- **Asynchronous commands**  
A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (\*RST)**  
Default parameter values that are used directly after resetting the instrument (\*RST command) are indicated as **\*RST values**, if available.
- **Default unit**  
This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**  
If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

## 13.2 Backward Compatibility with other Rohde & Schwarz Signal Generators

To allow you to use your existing scripts, the R&S SMW accepts also a defined subset of SCPI parameter values of other Rohde & Schwarz signal generators, like the R&S SMU. The R&S SMW accepts these values and maps them automatically to the corresponding newly introduced parameters.



### Handling of parameters provided for backward compatibility with other Rohde & Schwarz signal generators

The parameter values provided for backwards compatibility are "setting only" values; the query commands return the corresponding new value.

#### Example:

```
SOURce1:BB:ARbitrary:TRIGger:SOURce EXTernal
```

The backwards compatibility parameter value `EXTernal` is accepted

```
SOURce1:BB:ARbitrary:TRIGger:SOURce?
```

```
Response: EGT1
```

The query returns the correct new value

## 13.3 SCPI Command Aliases for Advanced Mode with Multiple Entities

When working in [Advanced mode](#), the R&S SMW can generate the signal of several entities. An entity is a *self-contained independent system*, consisting of a baseband source, a fading simulator, a noise generator (AWGN), and an RF part.

Additional *baseband, fading, and AWGN* SCPI commands are provided to allow consistent addressing of the entities in remote control. All these commands start with the mnemonic (keyword) **ENTity**.

The additional SCPI commands are not listed in this description because their syntax is straightforward: the mnemonic **ENTity** is prepended to the existing SCPI header.

#### Suffixes in the keywords **ENTity<ch>** and **SOURce<hw>**

You can address the same configuration with multiple entities in one of the following ways:

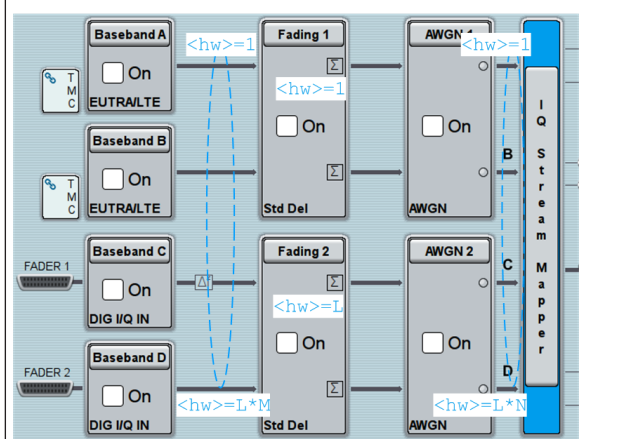
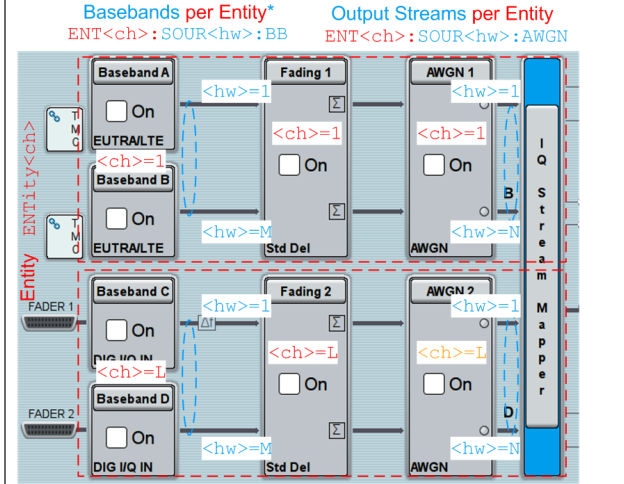
- By using the SCPI commands starting with the keyword `SOURce`
- By using the alias commands that start with the keyword `ENTity`.

You can use these ways alternatively or complementary.

Consider the interdependency in the suffix ranges. Note also that the meaning of the keyword `SOURce<hw>` changes.

The figures in Table 13-1 highlight the differences. The figures illustrate the same LxMxN configuration but address the entities in different way.

Table 13-1: Addressing entities in remote control

SOURCE<hw> only	ENTITY<ch>:SOURCE<hw> combination
<p>Basebands SOUR&lt;hw&gt;:BB    Fading Simulators SOUR&lt;hw&gt;:FSIM    Output Streams SOUR&lt;hw&gt;:AWGN</p>  <p>LxMxN is the short form of the used system configuration, where:</p> <ul style="list-style-type: none"> <li>• L represents the Entity</li> <li>• M the Baseband</li> <li>• N the Stream</li> </ul>	<p>Fading Simulators ENT&lt;ch&gt;:SOUR1:FSIM</p> <p>Basebands per Entity* ENT&lt;ch&gt;:SOUR&lt;hw&gt;:BB    Output Streams per Entity ENT&lt;ch&gt;:SOUR&lt;hw&gt;:AWGN</p>  <p>* ) applies for:</p> <ul style="list-style-type: none"> <li>• SOUR:BB:FOFF   POFF   PGA</li> <li>• SOUR:BBIN:...</li> <li>• SOUR:BB:..., if separate baseband sources are used</li> </ul>

**Example:**

- "System Configuration > Mode > Advanced"
- "Entities = 2", "Basebands = 2", "Streams = 2"
- "BB Source Config > Separate Source"

The command ENTity2:SOURce1:BB:EUTRa:STATE 1 enables the generation of an EUTRA/LTE signal in the second baseband within the second entity.

It is equivalent to SOURce3:BB:EUTRa:STATE 1.

Logically, also the following command pairs are equivalent to each other:

- ENTity2:SOURce1:FSIMulator:STATE and SOURce2:FSIMulator:STATE
- ENTity2:SOURce1:AWGN:STATE and SOURce3:AWGN:STATE
- ENTity2:SOURce1:BB:FOFF and SOURce3:BB:FOFF
- ENTity2:SOURce1:BBIN:DIG:SOUR and SOURce3:BBIN:DIG:SOUR



You can find the corresponding commands also with the "Show SCPI command" functions in the context menu of parameters.

See Chapter 12.12, "How to Find Out the SCPI Command Corresponding to the Manual Operation via "Show SCPI Command"", on page 696.

## 13.4 Programming Examples

The corresponding sections of the same title provide simple programming examples for the R&S SMW. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (for example comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p)reset is recommended to set the R&S SMW to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

In all the examples we assume that:

- A remote PC is connected to the instrument
- The remote PC and the instrument are switched on
- A connection between them is established
- The security setting "System Config > Setup > Security > SCPI over LAN" is enabled.

## 13.5 Common Commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "\*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

<code>*CLS</code> .....	718
<code>*ESE</code> .....	718
<code>*ESR?</code> .....	718
<code>*IDN?</code> .....	718
<code>*IST?</code> .....	719
<code>*OPC</code> .....	719
<code>*OPT?</code> .....	719
<code>*PRE</code> .....	719
<code>*PSC</code> .....	719
<code>*RCL</code> .....	720
<code>*RST</code> .....	720
<code>*SAV</code> .....	720
<code>*SRE</code> .....	721
<code>*STB?</code> .....	721

*TRG.....	721
*TST?.....	721
*WAI.....	721

---

### \*CLS

Clear status

Sets the status byte (STB), the standard event register (ESR) and the `EVENT` part of the `QUESTIONABLE` and the `OPERATION` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

**Usage:**                    Setting only

---

### \*ESE <Value>

Event status enable

Sets the event status enable register to the specified value. The query returns the contents of the event status enable register in decimal form.

**Parameters:**

<Value>                    Range:     0 to 255

---

### \*ESR?

Event status read

Returns the contents of the event status register in decimal form and subsequently sets the register to zero.

**Return values:**

<Contents>                Range:     0 to 255

**Usage:**                    Query only

---

### \*IDN?

Identification

Returns the instrument identification.

**Return values:**

<ID>                        "Rohde&Schwarz,<device type>,<serial number>,<firmware version>"

**Example:**

Rohde&Schwarz, SMW,  
1407.6004k02/000000, 3.1.17.1-03.01.158

**Usage:**                    Query only

**Manual operation:**    See "[IDN String](#)" on page 668

---

**\*IST?**

Individual status query

Returns the contents of the IST flag in decimal form. The IST flag is the status bit which is sent during a parallel poll.

**Return values:**

<ISTflag>            0 | 1

**Usage:**                Query only

---

**\*OPC**

Operation complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query form writes a "1" into the output buffer as soon as all preceding commands have been executed. This is used for command synchronization.

---

**\*OPT?**

Option identification query

Queries the options included in the instrument. For a list of all available options and their description refer to the data sheet.

**Return values:**

<Options>            The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

**Usage:**                Query only

**Manual operation:**   See "[OPT String](#)" on page 668

---

**\*PRE <Value>**

Parallel poll register enable

Sets parallel poll enable register to the indicated value. The query returns the contents of the parallel poll enable register in decimal form.

**Parameters:**

<Value>                Range:     0 to 255

---

**\*PSC <Action>**

Power on status clear

Determines whether the contents of the `ENABLE` registers are preserved or reset when the instrument is switched on. Thus a service request can be triggered when the instrument is switched on, if the status registers ESE and SRE are suitably configured. The query reads out the contents of the "power-on-status-clear" flag.

**Parameters:**

<Action> 0 | 1

**0**

The contents of the status registers are preserved.

**1**

Resets the status registers.

**\*RCL** <Number>

Recall

Loads the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command `*SAV` with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>, <file_name.extension>` command.

**Manual operation:** See "[Recall Immediate x](#)" on page 584

**\*RST**

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

**Usage:** Setting only

**Manual operation:** See "[Preset](#)" on page 576

**\*SAV** <Number>

Save

Stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command `*RCL` with the associated number.

To transfer the stored instrument settings in a file, use the command `:MMEMory:STORe:STATe`.

**Manual operation:** See "[Save Immediate x](#)" on page 583



---

**\*SRE** <Contents>

Service request enable

Sets the service request enable register to the indicated value. This command determines under which conditions a service request is triggered.

**Parameters:**

<Contents>                      Contents of the service request enable register in decimal form.  
Bit 6 (MSS mask bit) is always 0.  
Range:                      0 to 255

---

**\*STB?**

Status byte query

Reads the contents of the status byte in decimal form.

**Usage:**                      Query only

---

**\*TRG**

Trigger

Triggers all actions waiting for a trigger event. In particular, \*TRG generates a manual trigger signal. This common command complements the commands of the TRIGger subsystem.

**Usage:**                      Event

---

**\*TST?**

Self-test query

Initiates self-tests of the instrument and returns an error code

**Return values:**

<ErrorCode>                      **integer > 0 (in decimal format)**  
An error occurred.  
(For details see the Service Manual supplied with the instrument).  
**0**  
No errors occurred.

**Usage:**                      Query only

---

**\*WAI**

Wait to continue

Prevents servicing of the subsequent commands until all preceding commands have been executed and all signals have settled (see also command synchronization and \*OPC).

**Usage:** Event

## 13.6 Preset Commands

The preset commands are not bundled in one subsystem. Therefore, they are listed separately in this section. In addition, a specific preset command is provided for each digital standard and for the fader. These specific commands are described in the associated subsystems.

Four presetting actions are available:

- Activating the default state of all internal instrument functions (\*RST on page 720). Functions that concern the integration of the instrument into a measurement setup are not changed, e.g. GPIB address or reference oscillator source settings.
- Activating the preset state of the parameters related to the selected signal path (:SOURCE<hw>:PRESet on page 722)
- Activating the preset state of all parameters that are not related to the signal path (:DEVICE:PRESet on page 722)
- Activating the original state of delivery (factory reset, :SYSTEM:FPreSet on page 723). Only functions that are protected by a password remain unchanged as well as the passwords themselves.

:DEVICE:PRESet.....	722
:SOURCE<hw>:PRESet.....	722
:SYSTEM:PRESet.....	723
:SYSTEM:FPreSet.....	723

---

### :DEVICE:PRESet

Presets all parameters which are not related to the signal path, including the LF generator.

**Example:** DEV:PRESet  
presets all instruments settings that are not related to the signal path

**Usage:** Event

**Manual operation:** See "Connect/Disconnect All Remote" on page 141

---

### :SOURCE<hw>:PRESet

Presets all parameters which are related to the selected signal path.

Fading (if available) and transient recorder are only preset by command \*RST.

**Example:**            `SOUR:PRES`  
presets all settings that are related to signal path

**Usage:**            Event

#### **:SYSTem:PRESet**

Triggers an instrument reset. It has the same effect as:

- the `*RST` command

**Example:**            `SYST:PRES`  
All instrument settings (also those that are not currently active) are reset to their default values.

**Usage:**            Setting only

#### **:SYSTem:FPReset**

Triggers an instrument reset to the original state of delivery.

**Example:**            `SYST:FPR`  
all instrument settings (also those that are not currently active) are reset to the factory values.

**Usage:**            Event

**Manual operation:** See "[Execute Factory Preset](#)" on page 577

## 13.7 MMEMory Subsystem

The `MMEMory` subsystem (Mass MEMory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

### Mass Storage Location

The R&S SMW stores user files on the internal hard disk, or if selected, on a memory stick.

Both, the user directory `/var/user` on the hard disk or the `/var/usb` directory, can be used to **preserve** user-defined data. Any directory structure can be created.

The `/var/volatile` directory serves as a RAM drive and can be used to protect sensitive information. The data is available **temporary**.

### Default Storage Location

The R&S SMW stores user data in the user directory.

In manual control, you access this directory via the "File Manager", see [Chapter 10.8, "Performing General File Management Functions with the File Manager"](#), on page 590. In remote control, you can query it with the command `:SYSTem:MMEMory:PATH:USER?`.

To query and change the default directory used for mass storage, use the command : [MMEMory:CDIRectory](#).

### 13.7.1 File Naming Conventions

To enable files to be used in different file systems, the following file naming conventions should be observed.

The *file name* can be of any length and *is case-sensitive*, i.e it is distinguished between uppercase and lowercase letters. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). Where possible, special characters should not be used. Use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved by the operating system, e.g. CLOCK\$, CON, AUX, COM1 . . . COM4, LPT1 . . . LPT3, NUL and PRN.

#### File extension

The file and the optional file *extension* are separated by a dot. The R&S SMW distinguishes the files according to their extensions; each type of file is assigned a specific file content and hence a specific file extension. Refer to [Chapter B.3, "Extensions for User Files"](#), on page 1142 for an overview of the supported file extensions.

#### Wildcards

The two characters "\*" and "?" function as "wildcards", i.e. they are used for selecting several files. The "?" character represents exactly one character, while the "\*" character represents all characters up to the end of the file name. "\*.\*" therefore stands for all the files in a directory.

#### File name and file path

When used in remote control commands, the parameter `<file_name>` is specified as a string parameter with quotation marks. It can contain either the complete path including the root user directory `/var/user` and file name, or only the file name. The file name must include the file extension. The same applies for the directory `/var/volatile` and for the parameters `<directory_name>` and `<path>`.

Depending on how much information is provided, either the values specified in the parameter or the values specified with the command `MMEM:CDIR` (default directory) are used for the path and drive setting in the commands.

### 13.7.2 Accessing Files in the Default or in a Specified Directory

For better overview and easy file handling, you may not store all user files in the user directory `/var/user` but rather organize them into subdirectories.

The command syntax defines two general ways to access files with user data in a *specific* directory:

- **Change the current default directory** for mass memory storage and then directly access the files in this default directory, like stored list files, files with user data or save/recall files.  
(See [Example "Store the user settings in a file in a specific directory"](#) on page 725).  
The subsequent commands for file handling (select, delete, read out files in the directory, etc.) require only specification of the file name. File extension may be omitted; after syntax evaluation of the used command, the R&S SMW provides access only to the relevant files.
- Define the **absolute file path**, including the user directory `/var/user`, created subdirectories and file name (see [Example "Load a data list file from a specific directory"](#) on page 726).  
As a rule, whenever an absolute file path is determined, it overwrites a previously specified default directory.

The following example explains this rule as a principle. Exceptions of this general rule are stated in the description of the corresponding command. The [Chapter 13.7.3, "Programming Examples"](#), on page 726 explains the general working principle with the commands for mass memory storage.

The same rule applies to the `/var/volatile` directory, see [Example "Working with Files in the Volatile Memory"](#) on page 728.

#### Example: Store the user settings in a file in a specific directory

This example uses the commands for storing and loading files with Custom Digital Modulation settings. Working with the files of other subsystems or files containing the settings of a particular digital standard (e.g. `SOURCE:BB:EUTRa:SETTING:...`), is analogical.

We assume that the directory `/var/user/DigMod` is existing and contains the files `SaveRecallTest.dm` and `dmSavRcl.dm`.

```
// *****
// Set the default directory first
// *****
MMEMory:CDIRectory "/var/user/DigMod"
SOURCEl:BB:DM:SETTING:CATalog?
// "SaveRecallTest","dmSavRcl"

// *****
// Specify only the file name; the extension *.dm is assigned automatically
// *****
SOURCEl:BB:DM:SETTING:STORe "dmSettings"
SOURCEl:BB:DM:SETTING:DELeTe "dmSavRcl"
SOURCEl:BB:DM:SETTING:LOAD "SaveRecallTest"
SOURCEl:BB:DM:SETTING:CATalog?
// "SaveRecallTest","dmSettings"
```

**Example: Load a data list file from a specific directory**

This example shows how to use the Custom Digital Modulation commands to set the data source and select a data list. Working with other list files, like control lists (`..:CLISt:..`) or lists with modulation data (`...:MLISt:...` ), and the handling of data list files of other subsystems or of a particular digital standard (like `SOURce:BB:EUTRa:...:DSElect`), is analogical.

We assume that the directory `/var/user/lists` is existing and contains the files `dlist1.dm_iqd` and `myDList.dm_iqd`.

```
// *****
// Select a data list file as data source
// *****
SOURce1:BB:DM:SOURce DLISt

// *****
// Query the data list files (*.dm_iqd) in the default directory
// *****
MMEMory:CDIRectory "/var/user/lists"
SOURce1:BB:DM:DLISt:CATalog?
// "dlist1","myDList"

// *****
// Specify the complete path to select a data list file (*.dm_iqd)
// in the specific directory
// *****
MMEMory:CDIRectory
SOURce1:BB:DM:DLISt:SElect "/var/user/lists/myDList"
SOURce1:BB:DM:DLISt:DElete "/var/user/lists/dlist1"
```

### 13.7.3 Programming Examples

**Example: Storing and Loading Current Settings**

This example shows two ways of how to store the current instrument setting in the file `settings.savrcl.txt` in the directory `/var/user/savrcl`.



Before the instrument settings can be stored in a file, they have to be stored in an intermediate memory using common command `*SAV <number>`. The specified number is then used in the `:MMEMory:STORe:STATe` command.

Also, after loading a file with instrument settings with command `:MMEMory:LOAD:STATe`, these settings have to be activated with the common command `*RCL <number>`.

```
// *****
// Store the current settings in an intermediate memory with number 4
// *****
```

```

*SAV 4
// *****
// store the settings in a file in a specific directory;
// the complete path has to be specified
// *****
MMEMory:StORe:StATe 4,"/var/user/savrcl/settings.savrcltxt"

// *****
// store the settings in a file in the default directory;
// set the default directory; specify only the file name
// *****
MMEMory:CDIRectory  "/var/user/savrcl"
*SAV 4
MMEMory:StORe:StATe 4,"settings.savrcltxt"

// *****
// Load the stored settings in the intermediate memory 4 and activate them
// *****
MMEMory:LOAD:StATe 4,"/var/user/settings.savrcltxt"
*RCL 4

```

### Example: Working with Files and Directories

This example shows how to list files in a directory, list the subdirectories, query the number of files in a directory, create directory, rename and delete files.

```

// *****
// Query the current default directory for mass storage,
// change the directory to the default user directory "/var/user"
// and read out the files in it
// *****
MMEMory:CDIRectory?
// "/var/user/temp"
MMEMory:CDIRectory
MMEMory:CDIRectory?
// "/var/user/"
MMEMory:CATalog?
// 1282630,8102817792,".,DIR,4096","..,DIR,4096","Log,DIR,4096",
// "settings.savrcltxt,BIN,16949","temp,DIR,4096","test,DIR,4096",
// "waveform.wv,BIN,1245201"
// the directory "/var/user" contains the predefined directory "Log",
// the subdirectories "test" and "temp"
// as well as the files "settings.savrcltxt" and "waveform.wv"

// *****
// query only the subdirectories of the current or specified directory
// *****
MMEMory:DCATalog? "/var/user"
// ".,",".","Log","temp","test"

// *****

```

```

// query only number of subdirectories in the current or specified directory
// *****
MMEemory:DCATalog:LENGth? "/var/user"
// 5

// *****
// query number of files in the current or specified directory
// *****
MMEemory:CATalog:LENGth? "/var/user"
// 7

// *****
// Create a new directory for mass memory storage in the specified directory
// *****
MMEemory:MDIRectory "/var/user/new"

// *****
// Copy the file "settings.savrc1txt" into the new directory
// *****
MMEemory:COpy "/var/user/settings.savrc1txt","/var/user/new/settings.savrc1txt"

// *****
// Rename the file "settings.savrc1txt" into the new directory
// and read out the files in this specific directory
// *****
MMEemory:CDIRectory "/var/user/new"
MMEemory:MOve "settings.savrc1txt","settings_new.savrc1txt"
MMEemory:CATalog? "/var/user/new"
// 25141,8102789120,".",DIR,4096","..,DIR,4096","settings_new.savrc1txt,BIN,16949"

// *****
// Remove the "test" directory
// *****
MMEemory:RDIRectory "/var/user/test"

```

### Example: Working with Files in the Volatile Memory

This example shows how to work with files in the `/var/volatile` directory.

```

// *****
// Change the default directory for mass storage,
// read out the files, load and play a file with the ARB
// *****
MMEemory:CDIRectory "/var/volatile"
MMEemory:CDIRectory?
// "/var/volatile"
MMEemory:CATalog?
//13928,525352960,".",DIR,60","..,DIR,4096","Tests_Waveform.wv,BIN,9772"

:SOURce1:BB:ARbitrary:WAVEform:SElect "/var/volatile/Tests_Waveform"

```



```
:SOURce1:BB:ARbitrary:STATe 1
:OUTPut1:STATe 1
```

### 13.7.4 Remote Control Commands

:MMEMory:CATalog?	729
:MMEMory:CATalog:LENGth?	730
:MMEMory:CDIRectory	730
:MMEMory:COpy	730
:MMEMory:DATA	731
:MMEMory:DCATalog?	731
:MMEMory:DCATalog:LENGth?	732
:MMEMory:DELeTe	732
:MMEMory:LOAD:STATe	732
:MMEMory:MDIRectory	733
:MMEMory:MOVE	733
:MMEMory:MSIS	733
:MMEMory:RDIRectory	734
:MMEMory:STORe:STATe	734

---

#### :MMEMory:CATalog? <path>

Returns the content of a particular directory.

##### Query parameters:

<path>	string
--------	--------

String parameter to specify the directory.  
If you leave out the path, the command returns the contents of the directory selected with [:MMEMory:CDIRectory](#).  
The path may be relative or absolute.

##### Return values:

<UsedDiskSpace>	Byte size of all files in the directory.
<FreeDiskSpace>	Remaining disk space in bytes.
<FileInfo>	<NameFileN>,<SuffixFileN>,<SizeFileN>

List of files, separated by commas

**<NameFileN>**  
Name of the file.

**<SuffixFileN>**  
Type of the file. Possible suffixes are: ASCii, BINary, DIRectory

**<SizeFileN>**  
Size of the file in bytes.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Query only

**Manual operation:** See ["Directory, File List and File Name"](#) on page 582

---

**:MMEMory:CATalog:LENGth?** <Path>

Returns the number of files in the current or in the specified directory.

**Query parameters:**

<Path>	string
--------	--------

String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with `:MMEMory:CDIRectory` command.

**Return values:**

<FileCount>	integer
-------------	---------

Number of files.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Query only

---

**:MMEMory:CDIRectory** <Directory>

Changes the default directory for mass memory storage. The directory is used for all subsequent `MMEM` commands if no path is specified with them.

**Parameters:**

<Directory>	<directory_name>
-------------	------------------

String containing the path to another directory. The path can be relative or absolute.  
To change to a higher directory, use two dots '..'.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** SCPI confirmed

**Manual operation:** See ["Directory, File List and File Name"](#) on page 582

---

**:MMEMory:COPY** <SourceFile>[,<DestinationFile>]

Copies an existing file to a new file. Instead of just a file, this command can also be used to copy a complete directory together with all its files.

**Setting parameters:**

<SourceFile>	string
--------------	--------

String containing the path and file name of the source file

<DestinationFile>	string
-------------------	--------

String containing the path and name of the target file. The path can be relative or absolute.  
If <DestinationFile> is not specified, the <SourceFile> is copied to the current directory, queried with the `:MMEMory:CDIRectory` command.

**Note:** Existing files with the same name in the destination directory are overwritten without an error message.

- Example:** See [Example "Working with Files and Directories"](#) on page 727.
- Usage:** Setting only  
SCPI confirmed
- Manual operation:** See ["Cut, Copy&Paste and Delete"](#) on page 592

**:MMEMory:DATA** <Filename>, <BinaryBlock>

**:MMEMory:DATA?** <Filename>

The setting command writes the block data <BinaryBlock> to the file identified by <Filename>. Set the GPIB-bus terminator to `EOI` to ensure correct data transfer.

The query command transfers the specified file from the instrument to the GPIB-bus and then on to the controller. It is important to ensure that the intermediate memory on the controller is large enough to take the file. The setting for the GPIB-bus terminator is irrelevant.

**Tip:** Use this command to read/transfer stored instrument settings or waveforms directly from/to the instrument.

**Parameters:**

<BinaryBlock>      #<number><length\_entry><data>  
 #: Hash sign; always comes first in the binary block  
 <number>: the first digit indicates how many digits the subsequent length entry has  
 <length\_entry>: indicates the number of subsequent bytes  
 <data>: binary block data for the specified length.  
 For files with a size with more than 9 digits (Gigabytes) the instrument allows the syntax # (<Length>), where <Length> is the file size in decimal format.

**Parameters for setting and query:**

<Filename>      string  
 String parameter to specify the name of the file.

**Example:** `MMEMory:DATA '/var/user/test.txt',#15hallo`  
 Writes the block data to the file `test.txt`.  
 The digit 1 indicates a length entry of 1 digit; the digit 5 indicate a length of the binary data (`hallo`) in bytes.  
`MMEMory:DATA? '/var/user/test.txt'`  
 sends the data of the file `test.txt` from the instrument to the controller in the form of a binary block.  
 Response: `#15hallo`

**Usage:** SCPI confirmed

**:MMEMory:DCATalog?** <path>

Returns the subdirectories of a particular directory.

**Query parameters:**

<path> String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with `:MMEMory:CDIRectory` command.

**Return values:**

<Catalog> <file\_entry>  
Names of the subdirectories separated by colons. The first two strings are related to the parent directory.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Query only

**:MMEMory:DCATalog:LENGth? [<Path>]**

Returns the number of subdirectories in the current or specified directory.

**Query parameters:**

<Path> String parameter to specify the directory. If the directory is omitted, the command queries the contents of the current directory, to be queried with `:MMEMory:CDIRectory` command.

**Return values:**

<DirectoryCount> integer  
Number of parent and subdirectories.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Query only

**:MMEMory:DELeTe <Filename>**

Removes a file from the specified directory.

**Setting parameters:**

<Filename> string  
String parameter to specify the name and directory of the file to be removed.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Event  
SCPI confirmed

**Manual operation:** See ["Cut, Copy&Paste and Delete"](#) on page 592

**:MMEMory:LOAD:STATe <SavRclStateNumb>, <file\_name>**

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

**Setting parameters:**

<SavRclStateNumb> Determines to the specific <number> to be used with the \*RCL command, e.g. \*RCL 4.

<file\_name> String parameter to specify the file name with extension \*.savrc1txt.

**Example:** See [Example "Storing and Loading Current Settings"](#) on page 726.

**Usage:** Setting only

**Manual operation:** See ["Recall"](#) on page 584

**:MMEMory:MDIRectory <Directory>**

Creates a subdirectory for mass memory storage in the specified directory. If no directory is specified, a subdirectory is created in the default directory. This command can also be used to create a directory tree.

**Setting parameters:**

<Directory> string  
String parameter to specify the new directory.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Event

**Manual operation:** See ["Create New Directory"](#) on page 592

**:MMEMory:MOVE <SourceFile>, <DestinationFile>**

Moves an existing file to a new location or, if no path is specified, renames an existing file.

**Setting parameters:**

<SourceFile> string  
String parameter to specify the name of the file to be moved.

<DestinationFile> string  
String parameters to specify the name of the new file.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Event  
SCPI confirmed

**Manual operation:** See ["Rename "](#) on page 592

**:MMEMory:MSIS <Msis>**

Defines the drive or network resource (in the case of networks) for instruments with windows operating system, using `msis` (MSIS = Mass Storage Identification String).

**Note:** Instruments with Linux operating system ignore this command, since Linux does not use drive letter assignment.

**Usage:** SCPI confirmed

#### **:MMEMory:RDIRectory** <Directory>

Removes an existing directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

#### **Setting parameters:**

<Directory> string  
String parameter to specify the directory to be deleted.

**Example:** See [Example "Working with Files and Directories"](#) on page 727.

**Usage:** Event

#### **:MMEMory:STORE:STATE** <savrcl\_state\_nr>, <file\_name>

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an internal memory with the same number using the common command \*SAV.

#### **Setting parameters:**

<savrcl\_state\_nr> Corresponds to the specific <number> defined with the \*SAV command, e.g. \*SAV 4.

<file\_name> String parameter to specify the file name with extension \*.savrcltxt.

**Example:** See [Example "Storing and Loading Current Settings"](#) on page 726.

**Usage:** Event

**Manual operation:** See ["Save"](#) on page 583

## 13.8 CALibration Subsystem

The CALibration subsystem contains the commands needed for performing internal adjustments. This procedure is triggered by the query commands.

Response of 0 means error-free execution of the adjustments, while 1 indicates that an error occurred and the process has been cancelled.

<a href="#">:CALibration&lt;hw&gt;:ALL:DATE?</a> .....	735
<a href="#">:CALibration&lt;hw&gt;:ALL:TEMP?</a> .....	735
<a href="#">:CALibration&lt;hw&gt;:ALL:WARN</a> .....	735
<a href="#">:CALibration&lt;hw&gt;:ALL[:MEASure]?</a> .....	735
<a href="#">:CALibration&lt;hw&gt;:CONTInueonerror</a> .....	736

:CALibration<hw>:DEBug.....	736
:CALibration<hw>:FREQuency[:MEASure]?	736
:CALibration<hw>:IQModulator:LOCal?	737
:CALibration<hw>:LEVel[:MEASure]?	737
:CALibration<hw>:LOSCillator:COUPling:LOCAl?	737

---

#### :CALibration<hw>:ALL:DATE?

Queries the date of the most recently executed full adjustment.

##### Return values:

<Date> string

##### Example:

CAL:ALL:DATE?

returns the date of the last full adjustment.

##### Usage:

Query only

**Manual operation:** See "[Last Full Adjustment](#)" on page 1085

---

#### :CALibration<hw>:ALL:TEMP?

Queries the temperature deviation compared to the calibration temperature.

##### Return values:

<Temperature> string

##### Example:

CAL:ALL:TEMP?

Response: "+39.00 K"

##### Usage:

Query only

**Manual operation:** See "[Temperature Offset To Last Full Adjustment](#)" on page 1085

---

#### :CALibration<hw>:ALL:WARN <UncalWarning>

Generates a warning message, if the instrument is in uncalibrated state.

##### Parameters:

<UncalWarning> 0 | 1 | OFF | ON

\*RST: 0

##### Example:

CALib:ALL:WARN ON

activates the display of a warning message.

---

#### :CALibration<hw>:ALL[:MEASure]? [<Force>]

Starts all internal adjustments that do not need external measuring equipment.

##### Query parameters:

<Force> string

**Return values:**

<Measure>           select

**Example:**

CAL:ALL:MEAS?

executes the adjustments of all instrument functions.

Response 0 after completion indicates that the adjustment has been performed successfully.

**Usage:**

Query only

**Manual operation:** See "[Adjust All](#)" on page 1085

**:CALibration<hw>:CONTinueonerror <State>**

Continues the calibration even though an error was detected. By default adjustments are aborted on error.

**Parameters:**

<State>           0 | 1 | OFF | ON

\*RST:            0

**Example:**

CAL:CONT ON

continues calibraion after an error.

**Manual operation:** See "[Continue Adjustment on Error](#)" on page 1086

**:CALibration<hw>:DEBug <State>**

Activates logging of the internal adjustments.

**Setting parameters:**

<State>           0 | 1 | OFF | ON

\*RST:            0

**Example:**

CAL:DEB 1

activates debugging.

**Usage:**

Setting only

**Manual operation:** See "[Log Debug Info](#)" on page 1086

**:CALibration<hw>:FREQuency[:MEASure]?**

Performs all adjustments which affect the frequency in the selected path.

**Return values:**

<Measure>           0 | 1 | OFF | ON

**Example:**

CAL:FREQ:MEAS?

starts the adjustments for maximum frequency accuracy.

Response: 0

the adjustments have been performed successfully.

**Usage:**

Query only



**:CALibration<hw>:IQModulator:LOCAl?**

Starts adjustment of the I/Q modulator for the currently set frequency and baseband gain. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

**Return values:**

<Local> 0 | 1 | OFF | ON  
\*RST: 0

**Example:**

CAL:IQM:LOC?  
starts adjustment for the I/Q modulator for the currently set frequency.  
Response: 0  
adjustment has been performed successfully

**Usage:** Query only

**Manual operation:** See "[Adjust I/Q Modulator Current Frequency](#)" on page 402

**:CALibration<hw>:LEVel[:MEASure]? [<Force>]**

Performs all level adjustments in the selected path.

**Query parameters:**

<Force> "force"  
\*RST: force

**Return values:**

<Measure> 0 | 1

**Example:**

CAL:LEV:MEAS? "force"  
starts adjustments for maximum level accuracy.  
Response: 0  
adjustment has been performed successfully.

**Usage:** Query only

**:CALibration<hw>:LOSCillator:COUPling:LOCAl?**

Adjusts the internal LO level at the I/Q modulator automatically, when an external LO signal is fed.

**Return values:**

<CouplingLevel> 0 | 1 | OFF | ON  
\*RST: 1

**Example:**

CAL:LOSC:COUP:LOC ON  
performs internal adjustment of the LO signal level.

**Usage:** Query only

**Manual operation:** See "[Adjust LO Level at Current Frequency](#)" on page 432

## 13.9 CLOcK Subsystem

The CLOcK subsystem contains the commands for configuration of the signals at the clock input and output connectors.

---

### :CLOCK:INPut:FREQUency?

Returns the measured frequency of the external clock signal.

#### Return values:

<Frequency>	float
	Range: 0 to max
	Increment: 0.001
	*RST: 0

**Example:** CLOC:INP:FREQ?  
returns the measured frequency of the external clock reference.

**Usage:** Query only

**Manual operation:** See "[Measured External Clock](#)" on page 249

## 13.10 DIAGnostic Subsystem

The DIAGnostic subsystem contains the commands used for instrument diagnosis and servicing. SCPI does not define any DIAGnostic commands; the commands listed here are all device-specific. All DIAGnostic commands are query commands which are not influenced by \*RST.



The test functions are intended for services purposes, and thus protected functions. They can be accessed if the corresponding protection level is unlocked. More information is available in the Service Manual of the R&S SMW.

---

The numeric suffix <hw> determines the path.

**Example: Programming Example**

The example lists the commands required to query assemblies and test points for diagnosis purposes.

```
// *****
// Query the modules available in the instrument
// and variant and revision state of a certain assembly, e.g. SSYN.
// *****
DIAGnostic1:BGInfo? "SSYN"
// Response: "SSYN 1412.6667.02 05.02 100000"
DIAGnostic1:BGInfo:CATalog?
// Response: "IEC_BOARD,BNC_BOARD,BBMB,FPNL,SSYN,SYNEX,RFMB,..."

// *****
// Query the test points available in the instrument
// and trigger the measurement in a selected test point.
// *****
DIAGnostic1:POINt:CATalog?
// Response: "ASATT6HP_M5V7,ASATT6HP_OFFSET,..."
DIAGnostic1:MEASure:POINt? "BBB_CODER_BBB_US"
// Response: "-1.000000V/°C"
```

:DIAGnostic<hw>:BGInfo:CATalog?..... 739  
 :DIAGnostic<hw>:BGInfo?..... 739  
 :DIAGnostic<hw>:POINt:CATalog?..... 740  
 :DIAGnostic<hw>[:MEASure]:POINt?..... 740

---

**:DIAGnostic<hw>:BGInfo:CATalog?**

Queries the names of the assemblies available in the instrument.

**Return values:**

<Catalog> string  
 List of all assemblies; the values are separated by commas  
 The length of the list is variable and depends on the instrument equipment configuration.

**Example:** see :DIAGnostic<hw>:BGInfo? on page 739

**Usage:** Query only

---

**:DIAGnostic<hw>:BGInfo? [<Board>]**

Queries information on the modules available in the instrument, using the variant and revision state.

**Query parameters:**

<Board> string  
 Module name, as queried with the command :  
[DIAGnostic<hw>:BGInfo:CATalog?](#)  
 If this parameter is omitted, a complete list of all modules is returned.  
 The length of the list is variable and depends on the instrument equipment configuration.

**Return values:**

<BgInfo> <Module name> <Module stock number incl. variant> <Module revision> <Module serial number>  
 List of comma separated entries, one entry per module.  
 Each entry for one module consists of four parts that are separated by space characters.

**Example:** See [Example "Programming Example"](#) on page 739.

**Usage:** Query only

**Manual operation:** See ["Assembly"](#) on page 1092

**:DIAGnostic<hw>:POINT:CATalog?**

Queries the test points available in the instrument. A detailed description of the test points can be found in chapter 3, section "Troubleshooting" of the Service Manual.

**Return values:**

<Catalog> string

**Example:** See [Example "Programming Example"](#) on page 739.

**Usage:** Query only

**:DIAGnostic<hw>[:MEASure]:POINT? <Name>**

Triggers the voltage measurement at the specified test point and returns the measured voltage. A detailed description of the test points can be found in section "Troubleshooting" of the Service Manual.

A list of the available test points for the respective path can be queried using the command [:DIAGnostic<hw>:POINT:CATalog?](#) on page 740.

**Query parameters:**

<Name> <test point identifier>

**Return values:**

<Value> <value><unit>

**Example:** See [Example "Programming Example"](#) on page 739.

**Usage:** Query only

## 13.11 DISPlay Subsystem

The DISPlay system contains the commands to set the power-save mode of the instrument.

### Programming Examples

#### Example: Activating screen saver mode and display update

Use the following commands to switch on the screen saver of your instrument or to automatic display. These settings are particularly useful when you control the instrument remotely.

```
// *****
// Set the wait time interval and activate the screen saver
// *****
:DISPlay:PSAVe:HOLDoff 10
:DISPlay:PSAVe:STATe ON

// *****
// Disable the display of the current frequency and level values in remote control
// *****
:DISPlay:ANNotation:ALL ON
// :DISPlay:ANNotation:FREQuency ON
// :DISPlay:ANNotation:AMPLitude ON

// *****
// Enable automatic update of the display at defined time intervals
// *****
:DISPlay:UPDate ON
```

#### Example: Querying the dialog IDs, opening and closing dialogs

Use the following commands to query the dialog IDs of all currently open dialogs. The dialog ID is a prerequisite for opening and closing dialogs via the remote control.



The dialog ID is also required to define user key actions, see [Chapter 11.3, "Assigning Action to the User Key"](#), on page 627.

```
// *****
// Query the dialog IDs of all open dialogs
// *****
:DISPlay:DIALog:ID?
// CEUltraDLGenSetDlg,_, $A DlgKeyRf_Rosc

// *****
// Open and close dialogs via remote control
// *****
:DISPlay:DIALog:OPEN "CEUltraDLGenSetDlg,_, $A"
:DISPlay:DIALog:OPEN "DlgKeyRf_Rosc"
```

:DISPlay:DIALog:CLoSe "DlgKeyRf_Rosc"	
:DISPlay:DIALog:CLoSe:ALL	
:DISPlay:PSAVe:HOLDoff.....	742
:DISPlay:PSAVe[:STATe].....	742
:DISPlay:UPDate.....	742
:DISPlay:ANNotation:AMPLitude.....	743
:DISPlay:ANNotation:FREQuency.....	743
:DISPlay:ANNotation[:ALL].....	743
:DISPlay:DIALog:ID?.....	743
:DISPlay:DIALog:OPEN.....	744
:DISPlay:DIALog:CLoSe.....	744
:DISPlay:DIALog:CLoSe:ALL.....	744

---

### :DISPlay:PSAVe:HOLDoff <HoldoffTimeMin>

Sets the wait time for the screen saver mode of the display.

#### Parameters:

<HoldoffTimeMin> integer  
 Range: 1 to 60  
 \*RST: 10  
 Default unit: minute

**Example:** see [Example "Activating screen saver mode and display update"](#) on page 741

**Manual operation:** See ["Wait Time"](#) on page 610

---

### :DISPlay:PSAVe[:STATe] <State>

Activates the screen saver mode of the display.

To define the wait time, use the command `:DISPlay:PSAVe:HOLDoff`.

#### Parameters:

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Activating screen saver mode and display update"](#) on page 741

**Manual operation:** See ["Screen Saver"](#) on page 610

---

### :DISPlay:UPDate <Update>

Activates the refresh mode of the display.

#### Parameters:

<Update> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** See [Example "Activating screen saver mode and display update"](#) on page 741

**Manual operation:** See ["Display Update is"](#) on page 611

**:DISPlay:ANNOtation:AMPLitude** <State>

Indicates asterisks instead of the level values in the status bar.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 1

**Example:** See [Example "Activating screen saver mode and display update"](#) on page 741

**Manual operation:** See ["Annotation Amplitude"](#) on page 637

**:DISPlay:ANNOtation:FREQuency** <State>

Indicates asterisks instead of the frequency values in the status bar.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 1

**Example:** see [Example "Activating screen saver mode and display update"](#) on page 741

**Manual operation:** See ["Annotation Frequency"](#) on page 637

**:DISPlay:ANNOtation[:ALL]** <State>

Displays asterisks instead of the level and frequency values in the status bar of the instrument. This setting is particularly useful when you remotely control the instrument.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 1

**Example:** see [Example "Activating screen saver mode and display update"](#) on page 741

**:DISPlay:DIALog:ID?**

Returns the dialog identifiers of the open dialogs in a string separated by blanks.

**Return values:**

<DialogIdList> <dialog ID(1)>< ><dialog ID(2)>< > ... < ><dialog ID(n)>

**Example:** see [Example "Querying the dialog IDs, opening and closing dialogs"](#) on page 741

**Usage:** Query only  
**Manual operation:** See "SCPI" on page 629

#### **:DISPlay:DIALog:OPEN** <DialogId>

Opens the specified dialog. To determine the dialog identifier, use command :  
[DISPlay:DIALog:ID?](#).

#### **Setting parameters:**

<DialogId> string

**Example:** see [Example "Querying the dialog IDs, opening and closing dia-logs"](#) on page 741

**Usage:** Setting only

**Manual operation:** See "SCPI" on page 629

#### **:DISPlay:DIALog:CLOSe** <DialogId>

Closes the specified dialog. To determine the dialog identifier, use the command :  
[DISPlay:DIALog:ID?](#).

#### **Setting parameters:**

<DialogId> string

**Example:** see [Example "Querying the dialog IDs, opening and closing dia-logs"](#) on page 741

**Usage:** Setting only

#### **:DISPlay:DIALog:CLOSe:ALL**

Closes all open dialogs.

**Example:** see [Example "Querying the dialog IDs, opening and closing dia-logs"](#) on page 741

**Usage:** Event

## 13.12 FORMat Subsystem

The commands in the FORMat subsystem determine the format of data returned by the R&S SMW to the controller. This affects all query commands that return a list of numerical data or block data, noted in the descriptions of the commands. The set data format applies to both paths.

<a href="#">:FORMat:BORDER</a> .....	745
<a href="#">:FORMat:SREGister</a> .....	745
<a href="#">:FORMat[:DATA]</a> .....	745



---

**:FORMat:BORDER** <Border>

Determines the sequence of bytes within a binary block. This only affects blocks which use the IEEE754 format internally.

**Parameters:**

<Border>                    NORMal | SWAPped

**NORMal**

Expects/sends the *least* significant byte of each IEEE754 floating-point number first and the *most* significant byte last.

**SWAPped**

Expects/sends the *most* significant byte of each IEEE754 floating-point number first and the *least* significant byte last.

\*RST:                    NORMal

**Example:**

FORM:BORD SWAP

transfers the data with the most significant bit first.

---

**:FORMat:SREGister** <Format>

Determines the numeric format for responses of the status register.

**Parameters:**

<Format>                    ASCii | BINary | HEXadecimal | OCTal

**ASCii**

Returns the register content as a decimal number.

**BINary|HEXadecimal|OCTal**

Returns the register content either as a binary, hexadecimal or octal number. According to the selected format, the number starts with #B (binary), #H (hexadecimal) or #O (octal).

\*RST:                    ASCii

**Example:**

FORM:SREG HEX

returns the register content as a hexadecimal number.

---

**:FORMat[:DATA]** <Data>

Determines the data format the instrument uses to return data via the IEC/IEEE bus.

The instrument automatically detects the data format used by the controller, and assigns it accordingly. Data format determined by this SCPI command is in this case irrelevant.

**Parameters:**

&lt;Data&gt;

ASCIi | PACKed

**ASCIi**

Transfers numerical data as plain text separated by commas.

**PACKed**

Transfers numerical data as binary block data.

The format within the binary data depends on the command.

The various binary data formats are explained in the description of the parameter types.

\*RST: ASCIi

**Example:**

FORM ASC

transfers the data as ASCII data.

## 13.13 HCOPY Subsystem

The `HCOPY` subsystem contains the commands to generate and save a hard copy of the display.



To access a stored hard copy file, use the commands of the `MEMM` subsystem.

### 13.13.1 Programming Examples

**Example: Store a hardcopy of the display**

The following example lists commands to configure and execute a hardcopy to an automatic named file.

```
// *****
// Hardcopy settings
// *****
:HCOPY:DEVIce FILE
:HCOPY:FILE:NAME:AUTO:STATe 1
// sets hardcopy destination to file
// sets the instrument to automatically create output file names

// *****
// Configure hardcopy options, set automatic naming rules
// *****
:HCOPY:DEVIce:LANGUage BMP
// defines output format *.bmp
:HCOPY:REGion DIALog
// selects the region to be copied
```

```

:HCOPY:FILE:AUTO:DIR "/usb/HCopy"
// sets destination directory of automatic named file to "/usb/HCopy"
:HCOPY:FILE:NAME:AUTO:FILE:PREFIX:STATE 1
:HCOPY:FILE:NAME:AUTO:FILE:PREFIX:"hardcopy"
:HCOPY:FILE:NAME:AUTO:FILE:YEAR:STATE 1
:HCOPY:FILE:NAME:AUTO:FILE:MONTH:STATE 1
// uses automatic naming prefix
// sets automatic naming prefix to "hardcopy"
// uses automatic naming date parameters year and month

// *****
// Execute and transfer hardcopy
// *****
:HCOPY:EXECute
:HCOPY:DATA
// executes hardcopy
// transfers the hard copy to the remote client
:HCOPY:FILE:AUTO:FILE?
// queries the automatic file name
// response: "hardcopy1807001.bmp"
:HCOPY:FILE:AUTO:NUMBER?
// queries the number in the automatic file name
// response: "001"

```

### 13.13.2 Hardcopy Settings

With the following commands, you can configure the settings of a hard copy.

:HCOPY:DATA?	747
:HCOPY:DEvice	748
:HCOPY:IMAGe:FORMat	748
:HCOPY:DEvice:LANGuage	748
:HCOPY:REGion	748
:HCOPY:FILE[:NAME]	748
:HCOPY[:EXECute]	749

---

#### :HCOPY:DATA?

Transfers the hard copy data directly as a NByte stream to the remote client.

#### Return values:

<Data>                    block data

**Example:**                See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:**                    Query only

---

**:HCOPY:DEVIce** <Device>

Defines the output device. The hardcopy can be output in a file. Use the `HCOPY:FILE:...` commands for configuration.

**Parameters:**

<Device> FILE  
\*RST: FILE

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Destination"](#) on page 602

---

**:HCOPY:IMAGe:FORMat** <Format>**:HCOPY:DEVIce:LANGUage** <Language>

Selects the graphic format for the hard copy. You can use both commands alternatively.

**Parameters:**

<Language> BMP | JPG | XPM | PNG  
\*RST: BMP

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

---

**:HCOPY:REGIon** <Region>

Selects the area to be copied.

You can create a snapshot of the screen or an active dialog.

**Parameters:**

<Region> ALL | DIALog  
\*RST: ALL

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Region"](#) on page 604

---

**:HCOPY:FILE[:NAME]** <Name>

Determines the file name and path to save the hard copy, provided automatic naming is disabled.

**Note:** If you have enabled automatic naming, the instrument automatically generates the file name and directory, see [Chapter 13.13.3, "Automatic Naming"](#), on page 749.

**Parameters:**

<Name> string

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["File..."](#) on page 603

---

**:HCOPY[:EXECute]**

Generates a hard copy of the current display. Output destination is a file.

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Event

**Manual operation:** See ["Save"](#) on page 603

**13.13.3 Automatic Naming**

Use the following commands to automatically assign a file name.

<a href="#">:HCOPY:FILE[:NAME]:AUTO?</a> .....	749
<a href="#">:HCOPY:FILE[:NAME]:AUTO:DIRectory</a> .....	749
<a href="#">:HCOPY:FILE[:NAME]:AUTO:DIRectory:CLEar</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO:FILE?</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO:STATe</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:DAY?</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:MONTH?</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:YEAR?</a> .....	750
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:DAY:STATe</a> .....	751
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:MONTH:STATe</a> .....	751
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe</a> .....	751
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:NUMBer?</a> .....	751
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:PREFix</a> .....	751
<a href="#">:HCOPY:FILE[:NAME]:AUTO[:FILE]:PREFix:STATe</a> .....	751

**:HCOPY:FILE[:NAME]:AUTO?**

Queries the destination path and file name, if you have enabled *Automatic Naming*.

**Return values:**

<Auto> string

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Query only

**:HCOPY:FILE[:NAME]:AUTO:DIRectory <Directory>**

Determines the path to save the hard copy, if you have enabled *Automatic Naming*.

If the directory does not yet exist, the instrument automatically creates a new directory, using the instrument name and *HCOPY* by default.

**Parameters:**

<Directory> string  
\*RST: .\HCOPY

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Path..."](#) on page 605

**:HCOPY:FILE[:NAME]:AUTO:DIRectory:CLEar**

Deletes all files with extensions \*.bmp, \*.img, \*.png and \*.bmp in the directory set for automatic naming.

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Event

**Manual operation:** See ["Clear Path"](#) on page 605

**:HCOPY:FILE[:NAME]:AUTO:FILE?**

Queries the name of the automatically named hardcopy file.

By default, an automatically generated file name consists of:

<Prefix><YYYY><MM><DD><Number>.<Format>.

You can activate each component separately, to individually design the file name.

**Return values:**

<File> string

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Query only

**:HCOPY:FILE[:NAME]:AUTO:STATe <State>**

Activates automatic naming of the hard copy files.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: ON

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Automatic Naming"](#) on page 603

**:HCOPY:FILE[:NAME]:AUTO[:FILE]:DAY?****:HCOPY:FILE[:NAME]:AUTO[:FILE]:MONTH?****:HCOPY:FILE[:NAME]:AUTO[:FILE]:YEAR?**

Queries the date (day, month or year) in the date part of the automatic file name.

**Return values:**

<Day> integer  
Range: 1 to 31  
\*RST: 1

<Month> integer  
Range: 1 to 12  
\*RST: 1

<Year> integer  
 Range: 1784 to 8000  
 \*RST: 0

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Query only

**:HCOPY:FILE[:NAME]:AUTO[:FILE]:DAY:STATe** <State>  
**:HCOPY:FILE[:NAME]:AUTO[:FILE]:MONTH:STATe** <State>  
**:HCOPY:FILE[:NAME]:AUTO[:FILE]:YEAR:STATe** <State>

Uses the date parameters (year, month or day) for automatic naming. With the associated `STATe` commands you can activate each of the date components separately.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Prefix, Year, Month, Day"](#) on page 605

**:HCOPY:FILE[:NAME]:AUTO[:FILE]:NUMBer?**

Adds one to the number in the automatically generated file name.

The instrument starts with file number 0 at first switch on. Then it searches for the highest number in stored files. It increases this number by one to achieve an unique file name within the selected path.

**Return values:**

<Number> integer  
 Range: 0 to 999999  
 \*RST: 0

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Usage:** Query only

**:HCOPY:FILE[:NAME]:AUTO[:FILE]:PREFIX** <Prefix>  
**:HCOPY:FILE[:NAME]:AUTO[:FILE]:PREFIX:STATe** <State>

Uses the prefix for the automatic generation of the file name, provided `PREF:STAT` is activated.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** See [Example "Store a hardcopy of the display"](#) on page 746

**Manual operation:** See ["Prefix, Year, Month, Day"](#) on page 605

## 13.14 KBOard Subsystem

The `KBOard` subsystem contains the commands to set a connected keyboard.

`:KBOard:LAYout`..... 752

---

**:KBOard:LAYout** <Layout>

Selects the language for an external keyboard and assigns the keys accordingly.

**Parameters:**

<Layout> CHINese | DANish | DUTCh | DUTBe | ENGLish | ENGUK |  
FINNish | FRENch | FREBe | FRECa | GERMan | ITALian |  
JAPANese | KORean | NORWegian | PORTuguese | RUSSian |  
SPANish | SWEDish | ENGUS  
\*RST: ENGLish

**Example:**

`KBO:LAY US`  
activates American keyboard layout.

**Manual operation:** See "[Layout](#)" on page 610

## 13.15 OUTPut Subsystem

In the `OUTPut` subsystem, you can configure the output signals.

The LF output signal is defined with the commands of the [Chapter 13.18.10, "SOURce:LFOutput Subsystem"](#), on page 990 system.

The numeric suffix <hw> determines the path.

`:OUTPut:ALL[:STATe]`..... 752  
`:OUTPut<hw>[:STATe]`..... 753  
`:OUTPut<hw>[:STATe]:PON`..... 753  
`:OUTPut<hw>:AMODe`..... 753  
`:OUTPut<hw>:BLANK:LIST:STATe`..... 754  
`:OUTPut<hw>:IMPedance?`..... 754  
`:OUTPut<hw>:AFIXed:RANGe:LOWer?`..... 754  
`:OUTPut<hw>:AFIXed:RANGe:UPPer?`..... 754  
`:OUTPut<hw>:PROTection:CLEar`..... 755  
`:OUTPut<hw>:PROTection:STATe`..... 755  
`:OUTPut<hw>:PROTection:TRIPped?`..... 755

---

**:OUTPut:ALL[:STATe]** <State>

Activates all RF output signals of the instrument.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0



**Example:**            `OUTP:ALL OFF`  
switches off all RF output signals.

**Manual operation:** See "RF On" on page 411

**:OUTPut<hw>[:STATe] <State>**

Activates the RF output.

**Parameters:**

<State>            0 | 1 | OFF | ON  
\*RST:            0

**Example:**            `OUTP ON`  
turns on the RF output.

**Manual operation:** See "RF On" on page 411

**:OUTPut<hw>[:STATe]:PON <Pon>**

Defines the status of the RF output signal when the instrument is switched on.

**Parameters:**

<Pon>            OFF | UNCHanged  
\*RST:            UNCHanged

**Example:**            `OUTP:PON OFF`  
deactivates the RF output when the instrument is switched on.

**Manual operation:** See "Power-On State" on page 525

**:OUTPut<hw>:AMODe <AMode>**

Sets the attenuator mode at the RF output.

**Parameters:**

<AMode>            AUTO | FIXed | MANual

**AUTO**

The attenuator automatically adjusts the level settings, within the full variation range.

**FIXed**

The attenuator, relays and amplifier stages are fixed at the current position, providing level settings without interruption. The resulting variation range is calculated according to the position. This function is only effective when automatic level control is activated (see [ :SOURce<hw> ] :POWer:ALC [ :STATe ] on page 1025).

**MANual**

You can set the level manually, in 10 dB steps.

\*RST:            AUTO

**Example:**            POW:ALC ON  
                           activates automatic level control at the RF output.  
                           OUTP:AMOD FIX  
                           sets the fixed mode with uninterrupted level for RF output.

**Manual operation:** See "Mode" on page 501

**:OUTPut<hw>:BLANk:LIST:STATe <State>**

Activates RF output blanking.

**Parameters:**

<State>                0 | 1 | OFF | ON  
                           \*RST:                1

**Example:**            OUTP:BLAN:LIST:STAT ON  
                           activates the RF output blanking.

**:OUTPut<hw>:IMPedance?**

Queries the impedance of the RF outputs.

**Return values:**

<Impedance>         G1K | G50 | G10K  
                           \*RST:                G50

**Example:**            OUTP:IMP?  
                           queries the impedance of RF output.  
                           Response: 50  
                           the impedance is 50 ohms

**Usage:**                Query only

**:OUTPut<hw>:AFIXed:RANGe:LOWer?**

**:OUTPut<hw>:AFIXed:RANGe:UPPer?**

Queries the settable minimum/maximum value in mode :OUTPut<hw>:AMODe FIXed, i.e. when the attenuator is not being adjusted.

**Return values:**

<Upper>                float  
                           Increment: 0.01  
                           Default unit: dBm

**Example:**            OUTP:AFIX:RANG:LOW?  
                           Response: -50  
                           OUTP:AFIX:RANG:UPP?  
                           Response: -27

**Usage:**                Query only

**Manual operation:** See "Level Range" on page 418

---

**:OUTPut<hw>:PROTection:CLEAr**

Resets the protective circuit after it has been tripped. The state of the output is again determined by `:OUTPut<hw>[:STATe]`.

**Example:** `OUTP:PROT:CLE`  
resets the protective circuit of the RF output.

**Usage:** Event

**Manual operation:** See "Overload" on page 500

---

**:OUTPut<hw>:PROTection:STATe <State>**

Attenuates the RF output signal for about 40 dB to protect external devices against internal signals.

**Parameters:**  
<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** `OUTP:PROT:STAT ON`  
attenuates the RF Output signal for about 40 dB.

**Manual operation:** See "Overload" on page 500

---

**:OUTPut<hw>:PROTection:TRIPped?**

Queries the state of the protective circuit.

**Return values:**  
<Tripped> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** `OUTP:PROT:TRIP`  
queries the state of the protective circuit of the RF output.  
Response: 0  
the protective circuit has not tripped.

**Usage:** Query only

**Manual operation:** See "Overload" on page 500

---

## 13.16 SENSE, READ and INITiate Subsystems

The `SENSe` subsystem contains the commands for configuring the power measurements with R&S NRP-Zxx power sensor(s) connected to the generator. To start the measurement and retrieve the result, use the `:READ<ch>[:POWer]?` command.

You can connect up to four sensors to the signal generator. They are distinguished by means of the suffix <ch> under SENSe:

- power sensor connected to the SENSOR port = SENSe [ 1 ]
- power sensor connected first to one of the USB interfaces = SENSe 2
- further power sensors connected second and third via USB = SENSe 3 and SENSe 4

:INITiate<ch>[:POWer]:CONTinuous.....	756
:READ<ch>[:POWer]?.....	757
:SENSe<ch>:UNIT[:POWer].....	757
:SENSe<ch>[:POWer]:APERture:DEFault:STATe.....	758
:SENSe<ch>[:POWer]:APERture:TIME.....	758
:SENSe<ch>[:POWer]:CORRection:SPDeVice:STATe.....	758
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRiority.....	758
:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe.....	759
:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?.....	759
:SENSe<ch>[:POWer]:FILTer:LENGth[:USER].....	759
:SENSe<ch>[:POWer]:FILTer:NSRatio.....	760
:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIME.....	760
:SENSe<ch>[:POWer]:FILTer:SONCe.....	761
:SENSe<ch>[:POWer]:FILTer:TYPE.....	761
:SENSe<ch>[:POWer]:FREQuency.....	762
:SENSe<ch>[:POWer]:LOGGing:STATe.....	762
:SENSe<ch>[:POWer]:OFFSet.....	762
:SENSe<ch>[:POWer]:OFFSet:STATe.....	762
:SENSe<ch>[:POWer]:SNUMber?.....	763
:SENSe<ch>[:POWer]:SOURce.....	763
:SENSe<ch>[:POWer]:STATus[:DEVice]?.....	763
:SENSe<ch>[:POWer]:SVERsion?.....	764
:SENSe<ch>[:POWer]:TYPE?.....	764
:SENSe<ch>[:POWer]:ZERO.....	764

---

#### :INITiate<ch>[:POWer]:CONTinuous <Continuous>

Switches the local state of the continuous power measurement by R&S NRP-Z power sensors on and off. Switching off local state enhances the measurement performance during remote control.

The remote measurement is triggered with :READ<ch>[:POWer]?). This command also returns the measurement results. The local state is not affected, measurement results can be retrieved with local state on or off.

#### Parameters:

<Continuous>            0 | 1 | OFF | ON  
                               \*RST:        OFF

#### Example:

INIT1:CONT ON  
 switches local state of continuous power measurement on.

**Manual operation:** See "State" on page 519

**:READ<ch>[:POWer]?**

Triggers power measurement and displays the results. The sensor returns the result in the unit set with command `:SENSe<ch>:UNIT[:POWer]`

Certain power sensors, such as the R&S NRP-Z81, return two values, first the value of the average level and - separated by a comma - the peak value.

**Note:** This command does not affect the local state, i.e. you can get results with local state on or off. For long measurement times it is recommended that you use an SRQ for command synchronization (MAV bit).

**Suffix:**

<ch> 1..4

**Return values:**

<Power> string

**Example:**

```
SENS1:UNIT DBM
selects unit dBm for presentation of measurement result.
READ1?
queries the measurement result of the sensor.
Response: -45.6246576745440230
-45.6 dBm were measured at the given frequency.
```

**Example:**

```
R&S NRP-Z81
READ1?
Response:
-55.62403263352178, -22.419472478812476
-55,6 dbm is the measured average level, -22. 4 dBm is the
measured peak level at the given frequency.
```

**Usage:** Query only

**Manual operation:** See "[Level \(Peak\) / Level \(Average\)](#)" on page 519

**:SENSe<ch>:UNIT[:POWer] <Power>**

Selects the unit (Watt, dBm or dBµV) of measurement result display, queried with `:READ<ch>[:POWer]?`.

**Parameters:**

<Power> DBM | DBUV | WATT  
\*RST: DBM

**Example:**

```
SENS2:UNIT DBM
selects unit dBm for the measured value returned by command
READ.
READ2?
Response: 7.34
7.34 dBm are measured by sensor 2.
```

**Manual operation:** See "[Level \(Peak\) / Level \(Average\)](#)" on page 519

---

**:SENSe<ch>[:POWer]:APERture:DEFault:STATe <UseDefAp>**

Deactivates the default aperture time of the respective sensor.

To specify a user-defined value, use the command `:SENSe<ch>[:POWer]:APERture:TIME` on page 758.

**Parameters:**

<UseDefAp> 0 | 1 | OFF | ON  
\*RST: 1

**Example:**

`SENS:POW:APER:DEF:STAT 0`  
deactivates the default aperture time of the sensor.

**Manual operation:** See ["Use Default Aperture Time"](#) on page 521

---

**:SENSe<ch>[:POWer]:APERture:TIME <ApTime>**

Defines the aperture time (size of the acquisition interval) for the corresponding sensor.

**Parameters:**

<ApTime> float  
Range: depends on connected power sensor to depends on connected power sensor  
Increment: 1E-9  
\*RST: depends on connected power sensor

**Example:**

`SENS:POW:APER:TIM 23ms`  
sets 23 ms aperture time.

**Manual operation:** See ["Aperture Time"](#) on page 521

---

**:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe <State>**

Activates the use of the S-parameter correction data.

**Note:** If you use power sensors with attenuator, the instrument automatically activates the use of S-parameter data.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:**

`SENS1:POW:CORR:SPD:STAT ON`  
activates the use of the S-parameters correction data of power sensor 1.

**Manual operation:** See ["Use SParameter - Power Sensors"](#) on page 522

---

**:SENSe<ch>[:POWer]:DISPlay:PERManent:PRiority <Priority>**

Selects average or peak power for permanent display.

**Parameters:**

<Priority> AVERage | PEAK  
 \*RST: AVERage

**Example:**

SENS1:DISP:PERM:STAT ON  
 the permanent viewer is switched on.  
 SENS1:DISP:PERM:PRI AVER  
 the measured average power is indicated.

**Manual operation:** See "[Priority](#)" on page 519

**:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe <State>**

Activates the permanent display of the measured power level results in the winbar. The instrument additionally indicates the sensor type, the connection, the measurement source and the offset if set.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: ON

**Example:**

SENS1:POW:DISP:PERM:STAT ON  
 the permanent viewer is switched on.

**Manual operation:** See "[Permanent](#)" on page 519

**:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?**

Queries the current filter length in filter mode AUTO (:SENSe<ch>[:POWer]:FILTer:TYPE)

**Return values:**

<Auto> float  
 Range: 1 to 65536

**Example:**

SENS1:FILT:TYPE AUTO  
 selects auto filter.  
 SENS1:FILT:LENG:AUTO?  
 queries the automatically set filter length.  
 Response: 1024

**Usage:** Query only

**Manual operation:** See "[Filter Length](#)" on page 521

**:SENSe<ch>[:POWer]:FILTer:LENGth[:USER] <User>**

Selects the filter length for [SENS:POW:FILT:TYPE USER](#). As the filter length works as a multiplier for the time window, a constant filter length results in a constant measurement time. You can set values 1 and 2<sup>n</sup>.

The time window is fixed to 20 ms.

**Parameters:**

<User> float  
 Range: 1 to 65536  
 \*RST: 1

**Example:**

SENS1:FILT:TYPE USER  
 selects user filter mode.  
 SENS1:FILT:LENG 16  
 sets a filter length of 16. The resulting measurement time is 640 ms (2x16x20 ms).

**Manual operation:** See "[Filter Length](#)" on page 521

**:SENSe<ch>[:POWer]:FILTer:NSRatio <NSRatio>**

Sets an upper limit for the relative noise content in fixed noise filter mode (:SENSe<ch>[:POWer]:FILTer:TYPE). This value determines the proportion of intrinsic noise in the measurement results.

**Parameters:**

<NSRatio> float  
 Range: 0.001 to 1  
 Increment: 0.001  
 \*RST: 0.01

**Example:**

SENS1:FILT:TYPE NSR  
 selects fixed noise filter mode.  
 SENS1:FILT:NSR 0.2  
 sets a noise content of 0.2.

**Manual operation:** See "[Noise Content](#)" on page 521

**:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIME <MTime>**

Sets an upper limit for the settling time of the auto-averaging filter in the NSRatio mode and thus limits the length of the filter. The filter type is set with command :SENSe<ch>[:POWer]:FILTer:TYPE.

**Parameters:**

<MTime> float  
 Range: 1 to 999.99  
 Increment: 0.01  
 \*RST: 4  
 Default unit: s

**Example:**

SENS1:FILT:TYPE NSR  
 selects fixed noise filter mode.  
 SENS1:FILT:NSR .2  
 sets a noise content of 0.2.  
 SENS1:FILT:NSR:MTIM 5  
 limits the settling time to 5 seconds.



**Manual operation:** See "Timeout" on page 521

---

### :SENSe<ch>[:POWer]:FILTer:SONCe

Starts searching the optimum filter length for the current measurement conditions. You can check the result with command :SENS1:POW:FILT:LENG:USER? in filter mode USER (:SENSe<ch>[:POWer]:FILTer:TYPE).

**Example:**

```
SENS1:FILT:TYPE USER
selects user filter mode.
SENS1:FILT:SONC
activates the search for the optimum filter length.
SENS1:FILT:LENG?
returns the found optimum filter length.
Response: 128
```

**Usage:** Event

**Manual operation:** See "Auto Once" on page 521

---

### :SENSe<ch>[:POWer]:FILTer:TYPE <Type>

Selects the filter mode. The filter length is the multiplier for the time window and thus directly affects the measurement time.

**Parameters:**

<Type>

AUTO | USER | NSRatio

**AUTO**

Automatically selects the filter length, depending on the measured value. The higher the power, the shorter the filter length, and vice versa.

**USER**

Allows you to manually set the filter length. As the filter-length takes effect as a multiplier of the measurement time, you can achieve constant measurement times.

**NSRatio**

Selects the filter length (averaging factor) according to the criterion that the intrinsic noise of the sensor (2 standard deviations) does not exceed the specified noise content. You can define the noise content with command :SENSe<ch>[:POWer]:FILTer:NSRatio.

**Note:** To avoid very long settling times when the power is low, you can limit the averaging factor limited with the "timeout" parameter (:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIME).

\*RST: AUTO

**Example:**

```
SENS1:FILT:TYPE AUTO
selects automatic filter selection.
```

**Manual operation:** See "Filter" on page 520

---

**:SENSe<ch>[:POWer]:FREQuency <Frequency>**

Sets the RF frequency of the signal, if signal source "USER" is selected (:SENSe<ch>[:POWer]:SOURce).

**Parameters:**

<Frequency> float  
\*RST: 1 GHz

**Example:**

SENS1:SOUR USER  
selects user-defined source.  
SENS1:FREQ 2.44GHz  
enters the RF frequency of the source which is 2.44 GHz.

**Manual operation:** See "Frequency" on page 520

---

**:SENSe<ch>[:POWer]:LOGGing:STATe <State>**

Activates the recording of the power values, measured by a connected R&S NRP-Z power sensor.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:**

SENS:LOGG:STAT ON  
activates recording of the power measurement of the first sensor.

**Manual operation:** See "Enable Logging" on page 522

---

**:SENSe<ch>[:POWer]:OFFSet <Offset>**

Enters a level offset which is added to the measured level value after activation with command :SENSe<ch>[:POWer]:OFFSet:STATe. This allows e.g. an attenuator in the signal path to be taken into account.

**Parameters:**

<Offset> float  
Range: -100.0 to 100.0  
\*RST: 0  
Default unit: dB

**Example:**

SENS1:POW:OFFS 10.0  
sets a level offset of 10 dB

**Manual operation:** See "Level Offset" on page 520

---

**:SENSe<ch>[:POWer]:OFFSet:STATe <State>**

Activates the addition of the level offset to the measured value. The level offset value is set with command :SENSe<ch>[:POWer]:OFFSet.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: OFF

**Example:**

SENS1:POW:OFFS 0.4dB  
 sets a level offset of 0.4 dB  
 SENS1:POW:OFFS:STAT ON  
 a level offset of 0.4 dB is added to the measured value.

**Manual operation:** See "[Level Offset](#)" on page 520

**:SENSe<ch>[:POWer]:SNUMber?**

Queries the serial number of the sensor.

**Return values:**

<SNumber> string

**Example:**

SENS1:SNUM?  
 queries the serial number.

**Usage:**

Query only

**Manual operation:** See "[Serial Number](#)" on page 519

**:SENSe<ch>[:POWer]:SOURce <Source>**

Determines the signal to be measured. You can select the RF signal of path A, path B or a user defined source.

**Note:** When measuring the RF signal, the sensor considers the corresponding correction factor at that frequency, and uses the level setting of the instrument as reference level.

**Parameters:**

<Source> A | B | USER | RF  
 \*RST: A

**Example:**

SENS1:SOUR A  
 the sensor measures the power of the RF signal in path A.

**Manual operation:** See "[Source](#)" on page 520

**:SENSe<ch>[:POWer]:STATus[:DEVice]?**

Checks whether a sensor is connected.

**Return values:**

<Status> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**                `SENS1:STAT?`  
 queries if a sensor is connected to the instrument.  
**Response:** 1  
 a sensor is connected at the circled SENSOR socket.

**Usage:**                Query only

**Manual operation:** See "[State](#)" on page 519

---

#### **:SENSe<ch>[:POWer]:SVERsion?**

Queries the software version of the connected R&S NRP-Z power sensor.

**Return values:**

<SVersion>                string

**Example:**                `SENS1:POW:SVER?`  
 queries the software version of the power sensor.

**Usage:**                Query only

**Manual operation:** See "[Current Sensors](#)" on page 523

---

#### **:SENSe<ch>[:POWer]:TYPE?**

Queries the sensor type. The type is automatically detected.

**Return values:**

<Type>                    string

**Example:**                `SENS1:TYPE?`  
 queries the type of sensor.  
**Response:** NRP-Z21  
 the R&S NRP-Z21 sensor is used.

**Usage:**                Query only

**Manual operation:** See "[Serial Number](#)" on page 519

---

#### **:SENSe<ch>[:POWer]:ZERO**

Performs zeroing of the sensor.

Zeroing is required after warm-up, i.e. after connecting the sensor. Additionally, it is recommended that you zero in regular intervals (at least once a day), if the temperature has varied more than about 5 °C, if the sensor has been replaced, or if very low-power are to be measured.

**Note:** The RF power source must be switched off or disconnected from the sensor before zeroing.

**Example:**                `SENS1:ZERO`  
 performs zeroing.

**Usage:**                Event

**Manual operation:** See "Zero" on page 520

## 13.17 SCONfiguration Subsystem

The SCONfiguration subsystem contains the commands for defining the system configuration setting, like stream mapping and used fading configuration.

### Suffixes

The following suffixes are used:

Suffix	Value range	Description
STReam<st>	1 .. 8	Available IQ streams
CODer<ch>, BBMM<ch>, IQOutput<ch>	1 .. 2	DIG IQ connector
FADer<ch>	1 .. 4	DIG IQ connector

### Example: Distributing the I/Q streams to the output connectors

The following example lists the commands necessary to fulfill this task.

```
// *****
// Reset the system configuration and enable a 1x4x4 MIMO fading config
// *****
:SCONfiguration:PRESet
:SCONfiguration:MODE ADVanced
:SCONfiguration:FADing MIMO4X4
:SCONfiguration:BASEband:SOURce COUPled
:SCONfiguration:APPLY

// *****
// Map the I/Q streams to the output connectors
// *****
:SCONfiguration:OUTPut:MAPPING:STReam1:FOFFset 20E6
:SCONfiguration:OUTPut:MAPPING:STReam1:POFFset 0
:SCONfiguration:OUTPut:MAPPING:RF1:STReam1:STATe ON
:SCONfiguration:OUTPut:MAPPING:RF2:STReam2:STATe ON
:SCONfiguration:OUTPut:MAPPING:IQOutput1:STReam3:STATe ON
:SCONfiguration:OUTPut:MAPPING:IQOutput2:STReam4:STATe ON
// The digital I/Q outputs are not used
:SCONfiguration:OUTPut:MAPPING:BBMM1:STReam1:STATe OFF
:SCONfiguration:OUTPut:MAPPING:BBMM2:STReam2:STATe OFF

// Alternatively:
// stream A&C and B&D are added and output at BBMM 1 and BBMM 2 outputs
// :SCONfiguration:OUTPut:MAPPING:BBMM1:MODE ADD
```

```
// :SCONfiguration:OUTPut:MAPPING:BBMM2:MODE ADD
// :SCONfiguration:OUTPut:MAPPING:BBMM1:STReam1:STATe ON
// :SCONfiguration:OUTPut:MAPPING:BBMM2:STReam2:STATe ON
// :SCONfiguration:OUTPut:MAPPING:BBMM1:STReam3:STATe ON
// :SCONfiguration:OUTPut:MAPPING:BBMM2:STReam4:STATe ON
```

### Example: Connecting and configuring external instrument

The following example lists the commands necessary to fulfill this task.

```
:SCONfiguration:EXTernal:DISPlay ALL
:SCONfiguration:EXTernal:REMOte:CLEan
:SCONfiguration:EXTernal:REMOte:SCAN
:SCONfiguration:EXTernal:REMOte:SCAN:STATe?
// 0

:SCONfiguration:EXTernal:CODer1:DIRection?
// Response: IN
:SCONfiguration:EXTernal:BBMM1:DIRection?
// Response: OUT
:SCONfiguration:EXTernal:IQOutput1:DIRection?

:SCONfiguration:EXTernal:CODer1:IQConnection:STATe?
// Response: 1
:SCONfiguration:EXTernal:BBMM1:IQConnection:STATe?
// Response: 1

:SCONfiguration:EXTernal:REMOte:LIST?
// Response: SMBV100A,SGS_2,SGT100A,SMBV_1,SMBV_2,SMU200A (100010)
:SCONfiguration:EXTernal:REMOte:ADD "SGS_1","USB","100007"
:SCONfiguration:EXTernal:REMOte:ADD "SMU200A (100001)","LAN","10.112.11.125","2"
:SCONfiguration:EXTernal:REMOte:LIST?
// Response: SMBV100A,SGS_2,SGT100A,SMBV_1,SMBV_2,SMU200A (100010),SGS_1,SMU200A (100001)
:SCONfiguration:EXTernal:REMOte:REName "SGS_2","SGS (102030)"
:SCONfiguration:EXTernal:REMOte:LIST?
// Response:
// SMBV100A,SGS (102030),SGT100A,SMBV_1,SMBV_2,SMU200A (100010),SGS_1,SMU200A (100001)

// Detecting a connected external instrument and connecting it
:SCONfiguration:EXTernal:BBMM1:REMOte:DETECT?
// Response: "SGT100A"
:SCONfiguration:EXTernal:BBMM1:REMOte:ISElect?
// Response: "SGT100A","A"
:SCONfiguration:EXTernal:BBMM1:REMOte:CONNEct

// Manually defining the external instrument
:SCONfiguration:EXTernal:IQOutput1:REMOte:ISElect "SGS_1","A"
:SCONfiguration:EXTernal:IQOutput1:REMOte:CONNEct

:SCONfiguration:EXTernal:IQOutput1:RCONNECTION:STATe?
// Response: 1
```

```

:SCONfiguration:EXtErnal:BBMM1:RCONnection:STATe?
// Response: 1

:SCONfiguration:EXtErnal:CODer1:INAMe?
:SCONfiguration:EXtErnal:BBMM1:INAMe?
// Response: "SGT100A [A]"
:SCONfiguration:EXtErnal:IQOutput1:INAMe?
// Response: "SGS_1 [A]"

:SCONfiguration:EXtErnal:BBMM1:RF:COUPling ON
:SCONfiguration:EXtErnal:BBMM1:RF:FREQuency:OFFSet 0
:SCONfiguration:EXtErnal:BBMM1:RF:POWer:OFFSet -10
:OUTput1:STATe ON
:SCONfiguration:EXtErnal:BBMM1:RF:STATe?
// Response: 1

:SCONfiguration:EXtErnal:IQOutput1:RF:COUPling OFF
:SCONfiguration:EXtErnal:IQOutput1:RF:FREQuency 2143000000
:SCONfiguration:EXtErnal:IQOutput1:RF:POWer -20
:SCONfiguration:EXtErnal:IQOutput1:RF:STATe ON

:SCONfiguration:EXtErnal:REMOte:INITialization:PREDeFined:CATalog?
// Response: "external_reference_10MHz.iec"
:SCONfiguration:EXtErnal:IQOutput1:REMOte:INITialization:PREDeFined:FILE
"external_reference_10MHz"
:SCONfiguration:EXtErnal:IQOutput1:REMOte:INITialization:FILE?
// Response: "external_reference_10MHz"

// Alternatively use an user defined initialization file
// MMEMory:CDIRectory "/var/user/RcExtInstr"
// :SCONfiguration:EXtErnal:REMOte:INITialization:USER:CATalog?
// Response: init_seq_sgs
// :SCONfiguration:EXtErnal:IQOutput1:REMOte:INITialization:USER:FILE "init_seq_sgs.iec"

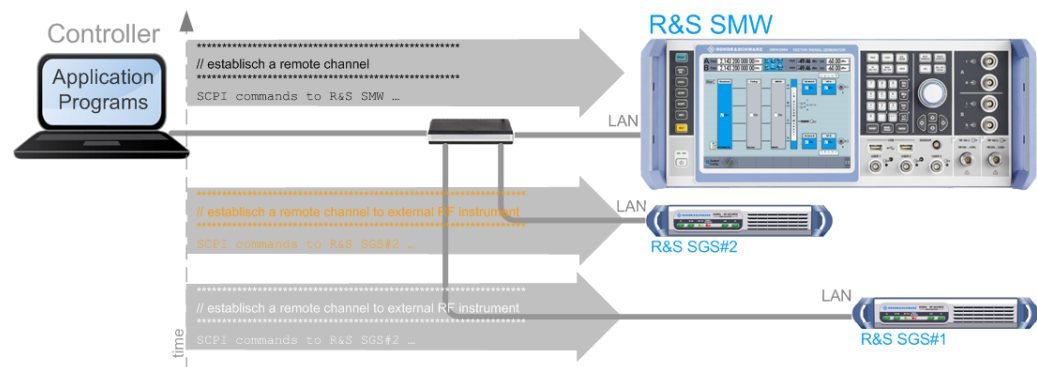
:SCONfiguration:EXtErnal:ACONnect 1
*RST
:SCONfiguration:EXtErnal:BBMM1:INAMe?

:SCONfiguration:EXtErnal:REMOte:PURGe
// Disabling remote control of the external instruments
:SCONfiguration:EXtErnal:REMOte:DISConnect[:ALL]

```

### Example: Controlling the R&S SMW and external RF instruments with the same application program

If you have to remote control a test setup with R&S SMW and other instruments from a remote computer (external controller), you have to synchronize remote commands (SCPI commands) you send to the different instruments (see [Example "Controlling the R&S SMW and external RF instruments with the same application program"](#) on page 768).



**Figure 13-1: Conventional way to remote control the R&S SMW and external RF instruments**

This example shows you how to use the same application program to control the external RF instruments via the R&S SMW, without opening remote sessions to these instruments.

### Overview of the possible solutions

If the required remote control connections (LAN or USB) to the external instruments are established additionally to the I/Q connections, you can control these external devices from the R&S SMW in one of the following ways:

- In manual operation:
  - Use the "System Configuration > External RF and I/Q" settings and the "External Instruments > Config ...> External Instrument Configuration" settings. You can for example set the frequency and level of the connected instruments, as well as activate or deactivate their RF outputs. See [Chapter 4.9.6, "How to Connect and Configure External RF and I/Q Instruments"](#), on page 185
  - Use the "External Instrument Configuration > Remote Control" settings to send individual SCPI commands or a sequence of SCPI commands to the connected external instruments.
- In remote operation:
  - Use the `SCONfiguration:...` remote control commands that correspond to settings in manual operation. See [Example "Connecting and configuring external instrument"](#) on page 766
  - Use the `:SCONfiguration:EXTernal:<Connector>:REMOte:SEND` commands to control the connected RF instruments. See ["Your R&S SMW as a controller of external instruments"](#) on page 769.

The [Figure 13-2](#) shows the extent of the particular solution.



„System Config > External RF and I/Q > External Instruments Configuration > Remote Control“  
 :SCONfiguration:EXTernal:<Connector>:REMOte:SEND „remote control commands“  
 e.g:  
 ...  
 SCONfiguration:EXTernal:IQOUT1:REMOte:SEND „SOURCE:IQ:IMPairment:LEAKage:I -1“  
 SCONfiguration:EXTernal:IQOUT1:REMOte:SEND „SOURCE:IQ:IMPairment:IQRatio:MAGNitude?“  
 ...

„System Config > External RF and I/Q > External Instruments Configuration > Initialization Sequence“

Subset of setting stored as an initialization file (\*.iec)

„System Config > External RF and I/Q“

Major instrument setting:  
 RF Frequency,  
 RF Level,  
 RF State

Instrument Name	RF Coupl	RF Frequency Hz	RF Level dBm	RF State
SGS [A]	<input type="checkbox"/>	12 750 000 000.0	-15.00	On
SGS_2 [A]	<input type="checkbox"/>	12 750 000 000.0	-15.00	On

Any setting of the connected external instrument

Figure 13-2: Extent and impact of the provided solutions

Your R&S SMW as a controller of external instruments

The Figure 13-3 shows a simplified version of the test setup on Figure 4-17. The figure shows a configuration example of two R&S SGS, directly controlled by an R&S SMW. The figure illustrates the principle and does not show all connections.

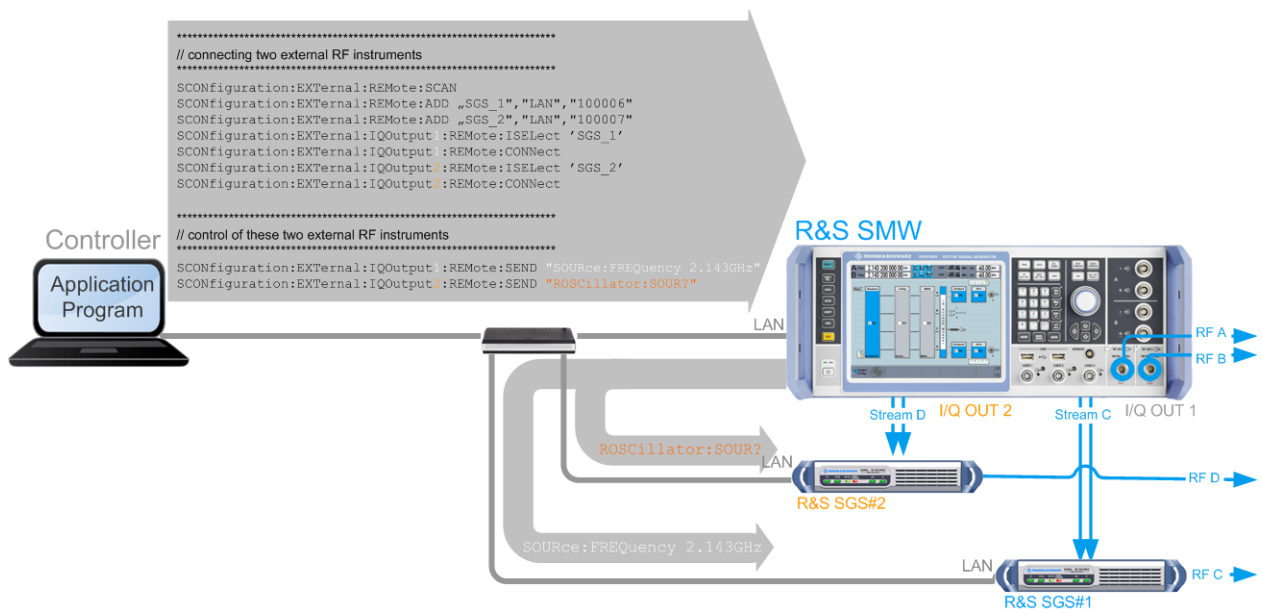


Figure 13-3: Remote control of external RF instruments via the R&S SMW

In this setup, a controller does not need to access the external instruments directly. Instead, the R&S SMW acts as a controller to these instruments.

We assume that:

- You control the R&S SMW from a remote controller

- The instruments are connected to a LAN and there is no active remote channel from the controller to the external instruments
- External RF instruments are connected to the R&S SMW, for example two R&S SGS.

### To control an external instrument from the R&S SMW remotely

Perform the following general steps:

1. Connect the external RF instruments to the R&S SMW.

See:

- [Chapter 4.9.5, "How to Cable the Instruments in MIMO Test Setups"](#), on page 184
- ["To connect and configure RF instruments to the I/Q analog interface"](#) on page 186

2. Connect a controller and establish a remote control connection to the R&S SMW, see [Chapter 12.8, "How to Set Up a Remote Control Connection"](#), on page 679.

3. Write an application program and use

the `:SCONfiguration:EXTernal:<Connector>:REMOte:SEND` commands to control the connected RF instruments.

See also [Example "Connecting an external instrument and sending SCPI commands to it"](#) on page 771.

**Example: Connecting an external instrument and sending SCPI commands to it**

The following example lists the commands necessary to fulfill this task. This example uses the configuration made in [Example "Connecting and configuring external instrument"](#) on page 766.

We assume that an external instrument (R&S SGT) is connected to the BBMM1 connector.

```
:SCONfiguration:EXternal:DISPlay ALL
:SCONfiguration:EXternal:REMOte:CLEan
:SCONfiguration:EXternal:REMOte:SCAN

:SCONfiguration:EXternal:BBMM1:IQConnection:STATe?
// Response: 1

:SCONfiguration:EXternal:REMOte:LIST?
// Response: SMBV100A,SGS_2,SGT100A,SMBV_1,SMBV_2,SMU200A (100010),SGS_1,SMU200A (100001)

// Detecting a connected external instrument and connecting it
:SCONfiguration:EXternal:BBMM1:REMOte:DETECT?
// Response: "SGT100A"
:SCONfiguration:EXternal:BBMM1:REMOte:ISElect?
// Response: "SGT100A","A"
:SCONfiguration:EXternal:BBMM1:REMOte:CONNect

:SCONfiguration:EXternal:BBMM1:RCONnection:STATe?
// Response: 1

:SCONfiguration:EXternal:BBMM1:INAME?
// Response: "SGT100A [A]"

// Sending SCPI commands directly to the connected external instrument
:SCONfiguration:EXternal:BBMM1:REMOte:SEND ":SOURce1:FREQuency 2.1GHz"
:SCONfiguration:EXternal:BBMM1:REMOte:SEND ":SOURce1:FREQuency?"
```

**Example: Generating digital multiplexed signals**

The following is a general example. Not all required settings are considered.

```
// *****
// Reset the system configuration and enable a 1x2x8 MIMO fading config
SCONfiguration:PRESet
SCONfiguration:MODE ADVanced
SCONfiguration:FADing MIMO2X8

// Enable the generation of digital multiplexed signals
SCONfiguration:OUTPut:MODE DIGM
SCONfiguration:APPLY

// *****
// Verify the I/Q stream mapping
SCONfiguration:OUTPut:MAPPING:BBMM1:MODE?
```

```
// Response:  MULT
SCONfiguration:OUTPut:MAPPING:BBMM2:MODE?
// Response:  MULT
SCONfiguration:OUTPut:MAPPING:BBMM1:STReam1:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM1:STReam3:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM1:STReam5:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM1:STReam7:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM2:STReam2:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM2:STReam4:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM2:STReam6:STATE?
// Response:  1
SCONfiguration:OUTPut:MAPPING:BBMM2:STReam8:STATE?
// Response:  1
```

### 13.17.1 Baseband and Fading Configuration

:SCONfiguration:PRESet.....	772
:SCONfiguration:MODE.....	772
:SCONfiguration:OUTPut:MODE.....	773
:SCONfiguration:FADing.....	773
:SCONfiguration:BASeband:SOURce.....	774
:SCONfiguration:APPLy.....	774

---

#### :SCONfiguration:PRESet

Presets the signal routing in the baseband section and the fading configuration to the default state.

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Usage:** Event

**Manual operation:** See ["Set to Default"](#) on page 133

---

#### :SCONfiguration:MODE <Mode>

Switches between the operating modes.

**Parameters:**

<Mode> ADVanced | STANdard

**ADVanced|STANdard**

Switches between the [Standard mode](#) and [Advanced mode](#).

\*RST: STANdard

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:** See ["Mode"](#) on page 133

---

### **:SCONfiguration:OUTPut:MODE <Mode>**

Defines whether an analog and digital or digital only/digital multiplexed signal is generated.

**Parameters:**

<Mode> DIGMux | DIGital | ALL

**ALL**

The generated signal is output at the analog and the digital interfaces

**DIGital | DIGMux**

The generated signal is output as single stream or multiplexed digital signal at the digital interfaces

\*RST: ALL

**Example:** SCONfiguration:OUTPut:MODE DIGMux

**Options:** DIGMux|DIGital require option R&S SMW-K551

**Manual operation:** See ["Signal Outputs"](#) on page 134

---

### **:SCONfiguration:FADing <FadConfig>**

Defines the signal routing.

<b>:SCONfiguration:MODE</b>	<FadConfig>
STANdard	FAAFBNone   FANFBB   FAAFBB   FAAFBA   FABFBB   FAABFBN   FANFBAB   FAABFBAB
ADVanced	MIMO1X2   MIMO2X2   MIMO2X3   MIMO2X4   MIMO3X2   MIMO3X3   MIMO3X4   MIMO4X2   MIMO4X3   MIMO4X4   MIMO1X8   MIMO8X1   MIMO2X8   MIMO8X2   MIMO2X1   MIMO2X1X2   MIMO2X2X1   MIMO2X1X3   MIMO2X1X4   MIMO2X2X2   MIMO1X3   MIMO3X1   MIMO1X4   MIMO4X1   MIMO3X1X2   MIMO3X2X1   MIMO4X1X2   MIMO3X2X2   MIMO4X2X2   MIMO4X2X1   SISO2X1X1   SISO3X1X1   SISO4X1X1   SISO5X1X1   SISO6X1X1   SISO7X1X1   SISO8X1X1   MIMO2X2X4   MIMO2X4X2   MIMO2X2X3   MIMO2X3X1   MIMO2X3X2   MIMO2X4X1  MIMO4X8   MIMO8X4   MIMO2X4X4   MIMO2X3X3   MIMO2X3X4   MIMO2X4X3

**Parameters:**

<FadConfig>      FAAFBNone | FANFBB | FAAFBB | SISO2X1X1 | FAAFBA | FABFBB | FAABFBN | FANFBAB | FAABFBAB | MIMO1X2 | MIMO2X2 | MIMO2X3 | MIMO2X4 | MIMO3X2 | MIMO3X3 | MIMO3X4 | MIMO4X2 | MIMO4X3 | MIMO4X4 | MIMO1X8 | MIMO8X1 | MIMO2X8 | MIMO8X2 | MIMO2X1 | MIMO2X1X2 | MIMO2X2X1 | MIMO2X2X2 | MIMO1X3 | MIMO3X1 | MIMO1X4 | MIMO4X1 | MIMO3X1X2 | MIMO3X2X1 | MIMO4X1X2 | MIMO3X2X2 | MIMO4X2X2 | MIMO4X2X1 | SISO3X1X1 | SISO4X1X1 | SISO5X1X1 | SISO6X1X1 | SISO7X1X1 | SISO8X1X1 | MIMO2X2X4 | MIMO2X4X2 | MIMO4X8 | MIMO8X4 | MIMO2X1X3 | MIMO2X1X4 | MIMO2X2X3 | MIMO2X3X1 | MIMO2X3X2 | MIMO2X4X1 | MIMO2X4X4 | MIMO2X3X3 | MIMO2X3X4 | MIMO2X4X3

\*RST:      FAAFBB

**Example:**      see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Options:**      LxMxN configurations with  $L > 2$  require option R&S SMW-K76  
Higher order MIMO configurations require option R&S SMW-K75

**Manual operation:**    See ["Signal Routing"](#) on page 134

**:SCONfiguration:BASEband:SOURce <SourConfig>**

Determines whether coupled or separated baseband sources are used.

**Parameters:**

<SourConfig>      SEParate | COUPled | CPENtity

**SEParate**  
Enabled in LxMxN configurations with  $L \leq 2$  and  $M < 4$

**COUPled|CPENtity**  
Enabled in LxMxN configurations with  $L > 2$   
CPENtity enabled in LxMxN configurations with  $L > 1$  and  $M > 1$ .

\*RST:      SEParate

**Example:**      See [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:**    See ["Baseband Source Configuration"](#) on page 136

**:SCONfiguration:APPLY**

Assigns and confirms the settings.

**Example:**      see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Usage:**      Event

**Manual operation:** See ["Apply"](#) on page 136

### 13.17.2 I/Q Stream Mapping

:SCONfiguration:OUTPut:MAPPing:FADer<ch>:STReam<st>:STATe?	775
:SCONfiguration:OUTPut:MAPPing:RF<ch>:STReam<st>:STATe	775
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:STReam<st>:STATe	775
:SCONfiguration:OUTPut:MAPPing:BBMM<ch>:STReam<st>:STATe	775
:SCONfiguration:OUTPut:MAPPing:FADer<ch>:MODE?	775
:SCONfiguration:OUTPut:MAPPing:RF<ch>:MODE	775
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:MODE	775
:SCONfiguration:OUTPut:MAPPing:BBMM<ch>:MODE	775
:SCONfiguration:OUTPut:MAPPing:STReam<st>:FOFFset	776
:SCONfiguration:OUTPut:MAPPing:STReam<st>:POFFset	776

---

```

:SCONfiguration:OUTPut:MAPPing:FADer<ch>:STReam<st>:STATe?
:SCONfiguration:OUTPut:MAPPing:RF<ch>:STReam<st>:STATe <State>
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:STReam<st>:STATe <State>
:SCONfiguration:OUTPut:MAPPing:BBMM<ch>:STReam<st>:STATe <State>

```

Maps the I/Q output streams to the output connectors.

The stream mapping to the FADER connectors is fixed.

**Parameters:**

```

<State>          0 | 1 | OFF | ON
                  *RST:      0

```

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:** See ["Map Stream X to Connector"](#) on page 138

---

```

:SCONfiguration:OUTPut:MAPPing:FADer<ch>:MODE?
:SCONfiguration:OUTPut:MAPPing:RF<ch>:MODE <Mode>
:SCONfiguration:OUTPut:MAPPing:IQOutput<ch>:MODE <Mode>
:SCONfiguration:OUTPut:MAPPing:BBMM<ch>:MODE <Mode>

```

Enables routing of multiple streams to the same output physical connector and defines the way the streams are internally processed.

**Parameters:**

```

<Mode>          SINGle | ADD | MULTiplex
                  ADD enabled for the RF, I/Q OUT and BBMM outputs
                  MULTiplex enabled for the BBMM outputs and
                  :SCONfiguration:OUTPut:MODE DIGMux
                  *RST:      SINGle

```

- Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765  
see [Example "Generating digital multiplexed signals"](#) on page 771
- Options:** MULTiplex requires option R&S SMW-K551
- Manual operation:** See ["Combination Mode"](#) on page 139

**:SCONfiguration:OUTPut:MAPPING:STReam<st>:FOFFset <SmFreqOffset>**

Sets an absolute frequency offset and shifts streams routed to the RF, I/Q OUT and BBMM connectors in the frequency domain.

**Parameters:**

<SmFreqOffset> float  
Range: -40E6 to 40E6  
Increment: 0.01  
\*RST: 0

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:** See ["f<sub>offset</sub>, MHz"](#) on page 138

**:SCONfiguration:OUTPut:MAPPING:STReam<st>:POFFset <SmPhasOffset>**

Sets the phase offset of the corresponding stream.

**Parameters:**

<SmPhasOffset> float  
Range: -999.99 to 999.99  
Increment: 0.01  
\*RST: 0

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:** See ["Phase, deg"](#) on page 138

### 13.17.3 External RF and I/Q Instruments

:SCONfiguration:EXTErnal:DISPlay.....	778
:SCONfiguration:EXTErnal:ACONnect.....	778
:SCONfiguration:EXTErnal:REMOte:CONNEct[:ALL].....	778
:SCONfiguration:EXTErnal:REMOte:DISCONNEct[:ALL].....	778
:SCONfiguration:EXTErnal:CODer<ch>:DIRectioN?.....	779
:SCONfiguration:EXTErnal:FADer<ch>:DIRectioN?.....	779
:SCONfiguration:EXTErnal:BBMM<ch>:DIRectioN?.....	779
:SCONfiguration:EXTErnal:IQOUTput<ch>:DIRectioN?.....	779
:SCONfiguration:EXTErnal:CODer<ch>:IQCONNEctioN:STATe?.....	779



:SCONfiguration:EXTernal:FADer<ch>:IQConnection:STATe?	779
:SCONfiguration:EXTernal:BBMM<ch>:IQConnection:STATe?	779
:SCONfiguration:EXTernal:FADer<ch>:RCONnection:STATe?	779
:SCONfiguration:EXTernal:BBMM<ch>:RCONnection:STATe?	779
:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?	779
:SCONfiguration:EXTernal:CODer<ch>:INAMe?	779
:SCONfiguration:EXTernal:FADer<ch>:INAMe?	779
:SCONfiguration:EXTernal:BBMM<ch>:INAMe?	780
:SCONfiguration:EXTernal:IQOutput<ch>:INAMe?	780
:SCONfiguration:EXTernal:FADer<ch>:RF:COUPLing	780
:SCONfiguration:EXTernal:BBMM<ch>:RF:COUPLing	780
:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPLing	780
:SCONfiguration:EXTernal:FADer<ch>:RF:FREQUency	780
:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQUency	780
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQUency	780
:SCONfiguration:EXTernal:FADer<ch>:RF:FREQUency:OFFSet	781
:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQUency:OFFSet	781
:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQUency:OFFSet	781
:SCONfiguration:EXTernal:FADer<ch>:RF:POWer	781
:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer	781
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer	781
:SCONfiguration:EXTernal:FADer<ch>:RF:POWer:OFFSet	781
:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer:OFFSet	781
:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet	781
:SCONfiguration:EXTernal:FADer<ch>:RF:STATe	782
:SCONfiguration:EXTernal:BBMM<ch>:RF:STATe	782
:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe	782
:SCONfiguration:EXTernal:REMote:SCAN	782
:SCONfiguration:EXTernal:REMote:SCAN:STATe?	782
:SCONfiguration:EXTernal:REMote:LIST?	783
:SCONfiguration:EXTernal:REMote:ADD	783
:SCONfiguration:EXTernal:REMote:REName	784
:SCONfiguration:EXTernal:FADer<ch>:REMote:DETEct?	784
:SCONfiguration:EXTernal:BBMM<ch>:REMote:DETEct?	784
:SCONfiguration:EXTernal:FADer<ch>:REMote:ISElect	784
:SCONfiguration:EXTernal:BBMM<ch>:REMote:ISElect	784
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:ISElect	784
:SCONfiguration:EXTernal:FADer<ch>:REMote:CONNEct	785
:SCONfiguration:EXTernal:BBMM<ch>:REMote:CONNEct	785
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNEct	785
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?	785
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO?	785
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?	785
:SCONfiguration:EXTernal:FADer<ch>:REMote:DISConnect	785
:SCONfiguration:EXTernal:BBMM<ch>:REMote:DISConnect	785
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect	785
:SCONfiguration:EXTernal:REMote:INITialization:PREDEfined:CATalog?	786
:SCONfiguration:EXTernal:REMote:INITialization:USER:CATalog?	786
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:USER:FILE	786
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:USER:FILE	786

:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:USER:FILE.....	786
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:PREDefined:FILE.....	787
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:PREDefined:FILE.....	787
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:PREDefined:FILE.....	787
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:FILE?.....	787
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:FILE?.....	787
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE?.....	787
:SCONfiguration:EXTernal:REMote:PURGe.....	787
:SCONfiguration:EXTernal:REMote:CLEan.....	787
:SCONfiguration:EXTernal:FADer<ch>:REMote:SEND.....	788
:SCONfiguration:EXTernal:BBMM<ch>:REMote:SEND.....	788
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:SEND.....	788

---

### **:SCONfiguration:EXTernal:DISPlay** <DisplayMode>

Filters the displayed connectors upon the selected criteria.

#### **Parameters:**

<DisplayMode> ALL | MAPPed | INPut | OUTPut  
 \*RST: MAPPed

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Manual operation:** See ["Display"](#) on page 141

---

### **:SCONfiguration:EXTernal:ACONnect** <State>

Enables automatic detection and connection setup of connected external instruments.

#### **Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Distributing the I/Q streams to the output connectors"](#) on page 765

**Manual operation:** See ["Auto Connect"](#) on page 141

---

### **:SCONfiguration:EXTernal:REMote:CONNect[:ALL]**

### **:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]**

Triggers the instrument to establish the connections to all configured external RF and I/Q instruments or to disconnect all existing connections.

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Event

**Manual operation:** See ["Connect/Disconnect All Remote"](#) on page 141

---

```

:SCONfiguration:EXTernal:CODer<ch>:DIRection?
:SCONfiguration:EXTernal:FADer<ch>:DIRection?
:SCONfiguration:EXTernal:BBMM<ch>:DIRection?
:SCONfiguration:EXTernal:IQOutput<ch>:DIRection?

```

Queries the connector direction.

**Return values:**

```

<Direction>      NONE | IN | OUT
                  *RST:    IN

```

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See "[Direction](#)" on page 142

---

```

:SCONfiguration:EXTernal:CODer<ch>:IQConnection:STATe?
:SCONfiguration:EXTernal:FADer<ch>:IQConnection:STATe?
:SCONfiguration:EXTernal:BBMM<ch>:IQConnection:STATe?

```

Queries the status of the I/Q connection of the digital interfaces.

**Return values:**

```

<IQConnState>   0 | 1 | OFF | ON

```

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See "[I/Q Connection](#)" on page 143

---

```

:SCONfiguration:EXTernal:FADer<ch>:RCONnection:STATe?
:SCONfiguration:EXTernal:BBMM<ch>:RCONnection:STATe?
:SCONfiguration:EXTernal:IQOutput<ch>:RCONnection:STATe?

```

Queries the status of the remote connection.

**Return values:**

```

<State>          0 | 1 | OFF | ON

```

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See "[Remote Connection Status](#)" on page 144

---

```

:SCONfiguration:EXTernal:CODer<ch>:INAMe?
:SCONfiguration:EXTernal:FADer<ch>:INAMe?

```

**:SCONfiguration:EXTernal:BBMM<ch>:INAMe?**  
**:SCONfiguration:EXTernal:IQOutput<ch>:INAMe?**

Queries the name of the connected external instrument.

**Return values:**

<InstrName> string  
 Returns the name of the connected external instrument in one of the following formats:  
**<InstrumentName> (SerialNumber) <Path>**  
 the instrument name, as retrieved via the DIG I/Q interface  
**<InstrumentName>[, <RfPath>] or <InstrumentName> (Serial-Number)**  
 the instrument name, as defined in with the "Remote Config" settings or as defined by the command `:SCONfiguration:EXTernal:REMOte:ADD`

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See ["Instrument Name"](#) on page 144

**:SCONfiguration:EXTernal:FADer<ch>:RF:COUPling <RfCouplingState>**  
**:SCONfiguration:EXTernal:BBMM<ch>:RF:COUPling <RfCouplingState>**  
**:SCONfiguration:EXTernal:IQOutput<ch>:RF:COUPling <RfCouplingState>**

Enables/disables coupling all major RF setting (like the frequency, level and RF state) of the external instrument to the R&S SMW.

**Parameters:**

<RfCouplingState> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Manual operation:** See ["RF Couple"](#) on page 145

**:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency <Frequency>**  
**:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQuency <Frequency>**  
**:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency <Frequency>**

In uncoupled mode, sets the RF frequency of the external instrument.

**Parameters:**

<Frequency> float  
 Range: 100E3 to 3E9  
 Increment: 0.01  
 \*RST: 1E9

**Example:**                   :SCONfiguration:EXTernal:IQOutput1:RF:COUPling  
OFF  
:SCONfiguration:EXTernal:IQOutput1:RF:FREQuency  
2143E6

**Manual operation:** See "(Delta) RF Frequency/ RF Level" on page 145

**:SCONfiguration:EXTernal:FADer<ch>:RF:FREQuency:OFFSet <FreqOffset>**  
**:SCONfiguration:EXTernal:BBMM<ch>:RF:FREQuency:OFFSet <FreqOffset>**  
**:SCONfiguration:EXTernal:IQOutput<ch>:RF:FREQuency:OFFSet <FreqOffset>**

In coupled mode, sets a delta frequency value.

**Parameters:**

<FreqOffset>               float  
 Range:           -3E9 to 3E9  
 Increment:      0.01  
 \*RST:           0

**Example:**                   :SCONfiguration:EXTernal:IQOutput1:RF:COUPling  
ON  
:SCONfiguration:EXTernal:IQOutput1:RF:  
FREQuency:OFFSet 2143E6

**Manual operation:** See "(Delta) RF Frequency/ RF Level" on page 145

**:SCONfiguration:EXTernal:FADer<ch>:RF:POWer <Power>**  
**:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer <Power>**  
**:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer <Power>**

In uncoupled mode, sets the RF level of the external instrument.

**Parameters:**

<Power>                   float  
 Range:           -130 to 20  
 Increment:      0.01  
 \*RST:           -30

**Example:**                   :SCONfiguration:EXTernal:IQOutput1:RF:COUPling  
OFF  
:SCONfiguration:EXTernal:IQOutput1:RF:POWer -20

**Manual operation:** See "(Delta) RF Frequency/ RF Level" on page 145

**:SCONfiguration:EXTernal:FADer<ch>:RF:POWer:OFFSet <PowerOffset>**  
**:SCONfiguration:EXTernal:BBMM<ch>:RF:POWer:OFFSet <PowerOffset>**  
**:SCONfiguration:EXTernal:IQOutput<ch>:RF:POWer:OFFSet <PowerOffset>**

In coupled mode, sets a delta level value.

**Parameters:**

<PowerOffset> float  
 Range: -100 to 100  
 Increment: 0.01  
 \*RST: 0

**Example:**

```
:SCONfiguration:EXTernal:IQOutput1:RF:COUPling
ON
:SCONfiguration:EXTernal:IQOutput1:RF:POWer:
OFFSet -20
```

**Manual operation:** See "[\(Delta\) RF Frequency/ RF Level](#)" on page 145

```
:SCONfiguration:EXTernal:FADer<ch>:RF:STATe <RemConnState>
:SCONfiguration:EXTernal:BBMM<ch>:RF:STATe <RemConnState>
:SCONfiguration:EXTernal:IQOutput<ch>:RF:STATe <RemConnState>
```

Queries/sets the RF output state of the connected external instrument.

**Parameters:**

<RemConnState> 0 | 1 | OFF | ON

**Example:**

```
:SCONfiguration:EXTernal:IQOutput1:RF:COUPling
ON
:OUTput1:STATe ON
:SCONfiguration:EXTernal:IQOutput1:RF:STATe?
Response: ON
```

**Example:**

```
:SCONfiguration:EXTernal:BBMM1:RF:COUPling OFF
:SCONfiguration:EXTernal:BBMM1:RF:STATe ON
```

**Manual operation:** See "[RF State](#)" on page 145

**:SCONfiguration:EXTernal:REMOte:SCAN**

Scans the network for connected instruments, like R&S SMW, R&S SGS, R&S SMBV, R&S SMU, R&S SMATE and R&S SMJ.

**Example:**

see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:**

Event

**Manual operation:** See "[Detect/Scan](#)" on page 147

**:SCONfiguration:EXTernal:REMOte:SCAN:STATe?**

Queries if scanning is performed or not.

To start the scanning process, use the command `:SCONfiguration:EXTernal:REMOte:SCAN` on page 782.

**Return values:**

<ScanState> 0 | 1 | OFF | ON  
**1**  
 Scanning process running  
**0**  
 Not scanning

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See ["Detect/Scan"](#) on page 147

**:SCONfiguration:EXTernal:REMOte:LIST?**

Lists all available instruments, found by the `:SCONfiguration:EXTernal:REMOte:SCAN` command.

**Return values:**

<InstrNames> String  
 String with symbolic names and/or alias names

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See ["Select Instrument"](#) on page 147

**:SCONfiguration:EXTernal:REMOte:ADD** <InstrName>, <HwChan>, <TcplporUsbAddr>[, <RfPathNumber>]

Adds manually an external instrument to the list of available instruments.

**Parameters:**

<HwChan> String  
 Hardware channel (USB or LAN) used by the remote channel to the external instrument  
 Range: "LAN" to "USB"  
 \*RST: "LAN"

<TcplporUsbAddr> String  
 IP address or hostname of the connected external instrument

<RfPathNumber> String  
 Determines the number of RF paths the external instrument is equipped with  
 Range: "1" to "2"  
 \*RST: "1"

**Setting parameters:**

<InstrName> String  
Alias name of the instrument

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Setting only

**Manual operation:** See ["Select Instrument"](#) on page 147

**:SCONfiguration:EXTernal:REMOte:REName** <Rename>

Changes the symbolic name of the instrument.

**Parameters:**

<Rename> "current name","new name"

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Setting only

**:SCONfiguration:EXTernal:FADer<ch>:REMOte:DETECT?**

**:SCONfiguration:EXTernal:BBMM<ch>:REMOte:DETECT?**

Searches for external instruments connected to the particular digital interfaces.

**Return values:**

<DetectedInstr> string  
If the detection fails, the query returns "None".

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See ["Detect/Scan"](#) on page 147

**:SCONfiguration:EXTernal:FADer<ch>:REMOte:ISElect** <InstrName>[, <RfPath>]

**:SCONfiguration:EXTernal:BBMM<ch>:REMOte:ISElect** <InstrName>[, <RfPath>]

**:SCONfiguration:EXTernal:IQOutput<ch>:REMOte:ISElect** <InstrName>[, <RfPath>]

Select an external instrument for the selected connector.

**Parameters:**

<InstrName> String  
Instrument alias name, as retrieved with the command `:SCONfiguration:EXTernal:REMOte:LIST?` or defined with the command `:SCONfiguration:EXTernal:REMOte:ADD`.

<RfPath> String  
Determines the used RF output of the external instrument.



**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Manual operation:** See ["Select Instrument"](#) on page 147

```
:SCONfiguration:EXTernal:FADer<ch>:REMote:CONNect
:SCONfiguration:EXTernal:BBMM<ch>:REMote:CONNect
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:CONNect
```

Triggers the connection establishment.

**Example:** see [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Event

**Manual operation:** See ["Apply and Connect"](#) on page 149

```
:SCONfiguration:EXTernal:FADer<ch>:REMote:INFO?
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INFO?
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INFO?
```

Queries information on the external instrument.

**Return values:**

<Info> string  
Returns information in one of the following formats:

**"None"**  
An external instrument is not assigned

**<SymbolicName>,<RemoteChannel>,<RemoteAddress>,<RF Path>**  
An external instrument is assigned, but not connected

**<SymbolicName>,<RemoteChannel>,<RemoteAddress>,<RF Path>[,<\*IDN? String>]**  
An external instrument is assigned and connected

**Example:** `:SCONfiguration:EXTernal:BBMM1:REMote:INFO?`  
`"SGT (101676)", "LAN", "rssgt100a101676", "A",`  
`"Rohde&Schwarz,SGT100A,1419.4501k02/101676,3.1.19.4-3.18.251.99"`

**Usage:** Query only

**Manual operation:** See ["Remote Connection Status"](#) on page 144

```
:SCONfiguration:EXTernal:FADer<ch>:REMote:DISConnect
:SCONfiguration:EXTernal:BBMM<ch>:REMote:DISConnect
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:DISConnect
```

Disconnects the selected remote connection. To disconnect all remote connections at once, use the command `:SCONfiguration:EXTernal:REMote:DISConnect[:ALL]`.

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Event

**Manual operation:** See ["Remote Connection Status"](#) on page 144

**:SCONfiguration:EXTernal:REMote:INITialization:PREDeFined:CATalog?  
:SCONfiguration:EXTernal:REMote:INITialization:USER:CATalog?**

Queries the names of the existing user defined/predefined initialization files.

Per default, the instrument stores user-defined files in the `/var/user/` directory. Use the command `MMEM:CDIRectory` to change the default directory to the currently used one.

Only files with extension `*.iec` are listed.

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Query only

**Manual operation:** See ["Initialization Sequence"](#) on page 150

**:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:USER:FILE  
<Filename>**

**:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:USER:FILE  
<Filename>**

**:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:USER:FILE  
<Filename>**

Loads the selected user-defined initialization file (extension `*.iec`).

Per default, the instrument stores user-defined files in the `/var/user/` directory. Use the command `MMEM:CDIRectory` to change the default directory to the currently used one.

**Setting parameters:**

<Filename> string

For files stored in the default directory, only the file name is required.

**Example:** See [Example "Connecting and configuring external instrument"](#) on page 766

**Usage:** Setting only

**Manual operation:** See ["Initialization Sequence"](#) on page 150

---

```
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:PREDefined:FILE  
    <Filename>
```

```
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:PREDefined:FILE  
    <Filename>
```

```
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:PREDefined:  
FILE <Filename>
```

Loads the selected predefined initialization file (extension \* .iec).

**Setting parameters:**

<Filename>                    string  
                                 Only the file name is required

**Example:**                    See [Example "Connecting and configuring external instrument"](#)  
                                 on page 766

**Usage:**                        Setting only

**Manual operation:**    See ["Initialization Sequence"](#) on page 150

---

```
:SCONfiguration:EXTernal:FADer<ch>:REMote:INITialization:FILE?  
:SCONfiguration:EXTernal:BBMM<ch>:REMote:INITialization:FILE?  
:SCONfiguration:EXTernal:IQOutput<ch>:REMote:INITialization:FILE?
```

Queries the currently selected initialization file.

**Return values:**

<Filename>                    string  
                                 filename with file extension (\* .iec)

**Example:**                    see [Example "Connecting and configuring external instrument"](#)  
                                 on page 766

**Usage:**                        Query only

**Manual operation:**    See ["Initialization Sequence"](#) on page 150

---

```
:SCONfiguration:EXTernal:REMote:PURGe
```

Removes unused instruments from the pool of external instruments.

**Example:**                    see [Example "Connecting and configuring external instrument"](#)  
                                 on page 766

**Usage:**                        Event

**Manual operation:**    See ["Purge/Clean"](#) on page 147

---

```
:SCONfiguration:EXTernal:REMote:CLEan
```

Removes all instruments from the pool of external instruments.

**Example:**                    see [Example "Connecting and configuring external instrument"](#)  
                                 on page 766

**Usage:** Event

**Manual operation:** See "Purge/Clean" on page 147

---

```
:SCONfiguration:EXtErnal:FADer<ch>:REMote:SEND <SendScpiCommand>
:SCONfiguration:EXtErnal:BBMM<ch>:REMote:SEND <SendScpiCommand>
:SCONfiguration:EXtErnal:IQOutput<ch>:REMote:SEND <SendScpiCommand>
```

Allows you to send SCPI commands to the RF instruments connected to the R&S SMW.

**Setting parameters:**

<SendScpiCommand>"<SCPI syntax>"

String containing an SCPI command (query or setting)

**Example:** See [Chapter 13.17, "SCONfiguration Subsystem"](#), on page 765

**Usage:** Setting only

**Manual operation:** See "[Command, Send Command](#)" on page 152

## 13.18 SOURce Subsystem

The SOURce subsystem contains the commands for configuring the digital and analog signals.

### Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
ENTity<ch>	1 .. 4	Entity in a multiple entity configuration
SOURce<hw>	[1] to 8	Baseband signals/paths <ul style="list-style-type: none"> <li>• SOURce[1] = Path A/Baseband A (optional keyword)</li> <li>• SOURce2 = Path B/Baseband B (mandatory keyword)</li> <li>• LF output = SOURce:LFOutput (SOURce is optional keyword)</li> </ul>
OUTPut<ch>	[1] to 3	Available markers

You can address multiple entities configurations by using the SCPI commands starting with the keyword SOURce or the alias commands starting with the keyword ENTity.

See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

- [Connector Settings](#).....789
- [Analog Modulation Subsystems](#).....795
- [SOURce:BB Subsystem](#).....811
- [SOURce:BBIN Subsystem](#).....951

• SOURce:CORRection Subsystem.....	956
• SOURce:FREQUency Subsystem.....	967
• SOURce:INPut Subsystem.....	978
• SOURce:IQ Subsystem.....	979
• SOURce:IQ:OUTPut Subsystem.....	981
• SOURce:LFOutput Subsystem.....	990
• SOURce:LIST Subsystem.....	1004
• SOURce:NOISe Subsystem.....	1018
• SOURce:PGEN Subsystem.....	1020
• SOURce:PHASe Subsystem.....	1021
• SOURce:POWer Subsystem.....	1022
• SOURce:ROSCillator Subsystem.....	1033
• SOURce:SWEep Subsystem.....	1036

### 13.18.1 Connector Settings

This section summarizes the commands of the `OUTPut` and `INPut` subsystems, necessary to configure the local and global connectors settings. Listed are the commands for configuring the output signals and the inputs for trigger, data, and control signals.

The `...:USER<ch>:...`  commands determine the global trigger threshold and input impedance values, that affect all trigger and control signal inputs. The global connector settings concern to all sweeps, digital modulations, the generation of waveforms or multi carrier signals, and all digital standards, in both paths.

Refer to [Chapter 13.18.7, "SOURce:INPut Subsystem"](#), on page 978 for description of the commands for configuring the inputs for external modulation signals.

<code>[:SOURce&lt;hw&gt;]:INPut:TM&lt;ch&gt;:DIRection.....</code>	790
<code>:OUTPut&lt;hw&gt;:TM&lt;ch&gt;:DIRection.....</code>	790
<code>[:SOURce]:INPut:USER&lt;ch&gt;:DIRection.....</code>	790
<code>:OUTPut:USER&lt;ch&gt;:DIRection.....</code>	790
<code>[:SOURce]:INPut:USER&lt;ch&gt;:SIGNal.....</code>	790
<code>:OUTPut:USER&lt;ch&gt;:SIGNal.....</code>	791
<code>[:SOURce&lt;hw&gt;]:INPut:TM&lt;ch&gt;:SIGNal.....</code>	791
<code>:OUTPut&lt;hw&gt;:TM&lt;ch&gt;:SIGNal.....</code>	792
<code>[:SOURce]:INPut:USER:CLOCK:LEVel.....</code>	793
<code>[:SOURce]:INPut:USER:TRIGger:LEVel.....</code>	793
<code>[:SOURce]:INPut:USER:CLOCK:IMPedance.....</code>	793
<code>[:SOURce]:INPut:USER:TRIGger:IMPedance.....</code>	793
<code>[:SOURce]:INPut:USER:CLOCK:SLOPe.....</code>	793
<code>[:SOURce]:INPut:USER:TRIGger:SLOPe.....</code>	793
<code>[:SOURce]:INPut:USER:PULM:LEVel.....</code>	794
<code>[:SOURce&lt;hw&gt;]:INPut:TM:CLOCK:LEVel.....</code>	794
<code>[:SOURce&lt;hw&gt;]:INPut:TM:TRIGger:LEVel.....</code>	794
<code>[:SOURce&lt;hw&gt;]:INPut:TM:CLOCK:IMPedance.....</code>	794
<code>[:SOURce&lt;hw&gt;]:INPut:TM:TRIGger:IMPedance.....</code>	794
<code>[:SOURce&lt;hw&gt;]:INPut:TM:CLOCK:SLOPe.....</code>	795
<code>[:SOURce&lt;hw&gt;]:INPut:TM:TRIGger:SLOPe.....</code>	795

---

**[ :SOURce<hw> ] :INPut:TM<ch>:DIRection <Direction>**  
**:OUTPut<hw>:TM<ch>:DIRection <Direction>**

Determines whether the connector is used as an input or an output.

**Suffix:**

OUTPut<hw> | 1 | 2

SOURce<hw> Determines the baseband the connectors belong to, where:  
 OUTPut1 | SOURce1 = Baseband A/C and  
 OUTPut2 | SOURce2 = Baseband B/D

TM<ch> 1|2|3

Determines the local connector, where:

OUTPut1 : TM1 | 2 | 3 = SOURce1 : INPut : TM1 | 2 | 3 = TMC1/2/3  
 of Baseband A/C and

OUTPut2 : TM1 | 2 | 3 = SOURce2 : INPut : TM1 | 2 | 3 = TMC4/5/6  
 of Baseband B/D

**Parameters:**

<Direction> INPut | OUTPut

\*RST: OUTPut

**Manual operation:** See "[T/M/\(C\) Connector Direction](#)" on page 624

---

**[ :SOURce ] :INPut:USER<ch>:DIRection <Direction>**  
**:OUTPut:USER<ch>:DIRection <Direction>**

Determines whether the connector is used as an input or an output.

**Suffix:**

USER<ch> 1 to 6

**Parameters:**

<Direction> INPut | OUTPut | UNUSed

UNUSed = the connector is not defined

**Manual operation:** See "[User 1 .. 6 Connector Direction](#)" on page 621

---

**[ :SOURce ] :INPut:USER<ch>:SIGNal <Signal>**

Determines the control signal that is input at the selected connector.

To define the connector direction, use the command `[ :SOURce ] :INPut:USER<ch>:DIRection`.

**Suffix:**

USER<ch> 1 to 6

**Parameters:**

<Signal> TRIG1 | TRIG2 | CLOCK1 | CLOCK2 | NSEGM1 | NSEGM2 |  
 IPULSA | IPULSB | NONE | FEEDback  
 TRIG1 | TRIG2 = Global Trigger 1/2  
 CLOCK1 | CLOCK2 = Global Clock 1/2  
 NSEGM1 | NSEGM2 = Global Next Segment 1/2  
 IPULSA | IPULSB = Pulse In A/B, available for USER4 | 5 | 6  
 FEEDback = Baseband Feedback, available for USER6

**Manual operation:** See "Signal" on page 621

**:OUTPut:USER<ch>:SIGNal** <Signal>

Determines the control signal that is output at the selected connector.

To define the connector direction, use the command **:OUTPut:USER<ch>:DIRection**.

**Suffix:**

USER<ch> 1 to 6

**Parameters:**

<Signal> MARKA1 | MARKA2 | MARKA3 | MARKB1 | MARKB2 |  
 MARKB3 | MARKC1 | MARKC2 | MARKC3 | MARKD1 |  
 MARKD2 | MARKD3 | SVALA | SVALB | OPULSA | OPULSB |  
 SYNCA | VIDEOA | VIDEOB | SYNCA | NONE  
 MARK<A | B | C | D><1 | 2 | 3> = Baseband <BB> Marker 1/2/3  
 SVALA | SVALB = Signal Valid A/B, available for USER4 | 5 | 6  
 OPULSA | OPULSB = Pulse Out A/B, available for USER4 | 5 | 6  
 SYNCA | SYNCA = Sync A/B, available for USER4 | 5 | 6  
 VIDEOA | VIDEOB = Video A/B, available for USER4 | 5 | 6  
 \*RST: MARKA1

**Example:**

```
:OUTPut:USER4:DIRection OUTPut
:OUTPut:USER4:SIGNal OPULSB
```

**Manual operation:** See "Signal" on page 621

**[:SOURce<hw>]:INPut:TM<ch>:SIGNal** <Signal>

Determines the control signal that is input at the selected connector.

To define the connector direction, use the command **[ :SOURce<hw> ] :INPut:TM<ch>:DIRection**.

**Suffix:**

SOURce<hw> 1 | 2

Determines the baseband the connectors belong to, where:  
 SOURce1 = Baseband A/C and  
 SOURce2 = Baseband B/D

TM<ch> 1|2|3  
 Determines the local connector, where:  
 SOURce1:INPut:TM1|2|3 = TMC1/2/3 of Baseband A/C and  
 SOURce2:INPut:TM1|2|3 = TMC4/5/6 of Baseband B/D

**Parameters:**

<Signal> TRIGger | CLOCk | FEEDback | DATA  
 CLOCk is available only for TM1  
 DATA is available only for TM2  
 FEEDback is available only for TM3

**Manual operation:** See "Signal" on page 624

**:OUTPut<hw>:TM<ch>:SIGNal <Signal>**

Determines the control signal that is output at the selected connector.

To define the connector direction, use the command **:OUTPut<hw>:TM<ch>:DIRection**.

**Suffix:**

OUTPut<hw> 1 | 2  
 Determines the baseband the connectors belong to, where:  
 OUTPut1 = Baseband A/C or Baseband 1/3  
 OUTPut2 = Baseband B/D or Baseband 2/4

TM<ch> 1|2|3  
 Determines the local connector, where:  
 OUTPut1:TM1|2|3 = TMC1/2/3 of Baseband A/C or 1/3 and  
 OUTPut2:TM1|2|3 = TMC4/5/6 of Baseband B/D or 2/4

**Parameters:**

<Signal> MARKA1 | MARKA2 | MARKA3 | SCLA | LATTA | BGATA |  
 HOPA | CWMODA | TRIGA | MARKB1 | MARKB2 | MARKB3 |  
 SCLB | LATTB | BGATB | HOPB | CWMODB | TRIGB |  
 MARKC1 | MARKC2 | MARKC3 | SCLC | LATTC | BGATC |  
 HOPC | CWMODC | TRIGC | MARKD1 | MARKD2 | MARKD3 |  
 SCLD | LATTD | BGATD | HOPD | CWMODD | TRIGD  
 MARKA1 | MARKC1 | MARKA2 | MARKC2 | MARKA3 | MARKC3 = Base-  
 band A/C Marker 1/2/3  
 SCLA | SCLB | SCLC | SCLD = Symbol Clock A/B/C/D  
 LATTA | LATTB | LATTC | LATTD = Lev Att A/B/C/D  
 BGATA | BGATB | BGATC | BGATD = Burst Gate A/B/C/D  
 HOPA | HOPB | HOPC | HOPD = HOP A/B/C/D  
 CWMODA | CWMODB | CWMODC | CWMODD = CW/Mod A/B/C/D  
 TRIGA | TRIGB | TRIGC | TRIGD = Triggered A  
 The character A/B/C/D in the parameter value indicates the  
 baseband the signal is related to.  
 \*RST: depends on TM suffix



**Example:**               :SOURCE2:INPut:TM2:DIRection OUTPut  
                           :OUTPut2:TM2:DIRection?  
**Response:** OUTPut  
                           :OUTPut2:TM2:SIGNal MARKA2

**Manual operation:** See ["Signal"](#) on page 624

**[ :SOURCE ]:INPut:USER:CLOCK:LEVel <Level>**  
**[ :SOURCE ]:INPut:USER:TRIGger:LEVel <Level>**

Sets the threshold for the global trigger and clock signals.

**Parameters:**

<Level>               float  
                           Range:        0.1 to 2  
                           Increment: 0.1  
                           \*RST:        1

**Manual operation:** See ["Threshold Clock/Trigger Input"](#) on page 622

**[ :SOURCE ]:INPut:USER:CLOCK:IMPedance <Impedance>**  
**[ :SOURCE ]:INPut:USER:TRIGger:IMPedance <Impedance>**

Selects the input impedance for the external trigger/clock inputs.

**Parameters:**

<Impedance>        G1K | G50  
                           \*RST:        G1K

**Manual operation:** See ["Impedance Clock/Trigger Input"](#) on page 622

**[ :SOURCE ]:INPut:USER:CLOCK:SLOPe <Slope>**

Sets the polarity of the active slope of an externally applied clock signal.

**Parameters:**

<Slope>             NEGative | POSitive  
                           \*RST:        POSitive

**Manual operation:** See ["Symbol Clock Slope/Clock Slope"](#) on page 258

**[ :SOURCE ]:INPut:USER:TRIGger:SLOPe <Slope>**

Sets the polarity of the active slope of an applied instrument trigger.

**Parameters:**

<Slope>             NEGative | POSitive  
                           \*RST:        POSitive

**Manual operation:** See ["Trigger Input Slope"](#) on page 622

---

**[[:SOURce]:INPut:USER:PULM:LEVel <Level>**

Sets the global connector threshold of the external pulse modulation signal.

**Parameters:**

<Level> float  
 Range: 0.1 to 2  
 Increment: 0.1  
 \*RST: 1

**Example:** INP:USER:PULS:LEV 2.0  
 sets 2 V threshold.

**Manual operation:** See "[Threshold Pulse Input](#)" on page 492

---

**[[:SOURce<hw>]:INPut:TM:CLOCK:LEVel <Level>**

**[[:SOURce<hw>]:INPut:TM:TRIGger:LEVel <Level>**

Sets the high/low threshold in volts for the trigger and clock signal inputs of the baseband section.

**Suffix:**

SOURce<hw> 1 | 2  
 Determines the baseband the connectors belong to, where:  
 SOURce1 = Baseband A/C and  
 SOURce2 = Baseband B/D

**Parameters:**

<Level> float  
 Range: 0.3 to 2  
 Increment: 0.1  
 \*RST: 1

**Manual operation:** See "[Threshold Clock/Trigger Input](#)" on page 625

---

**[[:SOURce<hw>]:INPut:TM:CLOCK:IMPedance <Impedance>**

**[[:SOURce<hw>]:INPut:TM:TRIGger:IMPedance <Impedance>**

Selects the input impedance for the external trigger/clock inputs.

**Suffix:**

SOURce<hw> 1 | 2  
 Determines the baseband the connectors belong to, where:  
 SOURce1 = Baseband A/C and  
 SOURce2 = Baseband B/D

**Parameters:**

&lt;Impedance&gt; G1K | G50 | G10K

**G10K**

Provided only for backward compatibility with other R&S signal generators.

The R&S SMW accepts this value and maps it automatically to G1K.

\*RST: G1K

**Manual operation:** See "[Impedance Clock/Trigger Input](#)" on page 625

[:SOURce&lt;hw&gt;]:INPut:TM:CLOCK:SLOPe &lt;Slope&gt;

Sets the polarity of the active slope of an externally applied clock signal.

**Suffix:**

SOURce&lt;hw&gt; 1 | 2

Determines the baseband the connectors belong to, where:

SOURce1 = Baseband A/C and

SOURce2 = Baseband B/D

**Parameters:**

&lt;Slope&gt; NEGative | POSitive

\*RST: POSitive

**Manual operation:** See "[Clock Input Slope](#)" on page 625

[:SOURce&lt;hw&gt;]:INPut:TM:TRIGger:SLOPe &lt;Slope&gt;

Sets the polarity of the active slope of an externally applied trigger signal.

**Suffix:**

SOURce&lt;hw&gt; 1 | 2

Determines the baseband the connectors belong to, where:

SOURce1 = Baseband A/C and

SOURce2 = Baseband B/D

**Parameters:**

&lt;Slope&gt; NEGative | POSitive

\*RST: POSitive

**Manual operation:** See "[Trigger Input Slope](#)" on page 625

## 13.18.2 Analog Modulation Subsystems

The subsystems in this section describe all commands for analog modulation of the RF signal. Divided in separate sections, you can configure amplitude modulation (AM), frequency modulation (FM), phase modulation (PhiM) and pulse modulation (PULM).

You can perform each of the modulations either with an internally generated modulation signal, or with an externally applied signal. To configure the internal signal, use the

commands of the [SOURce:LFOutput Subsystem](#). Moreover, the instrument provides the signal of the LF generator at the output. For information on the signal output, and on the input of an external modulation signal.

See [Chapter 8.8.2.3, "Assigning the LF Signal to the Output"](#), on page 474, "LF OUT 1/2" on page 63, and "EXT 1, 2" on page 63.

### 13.18.2.1 SOURce:AM Subsystem

The AM subsystem contains the commands for setting the amplitude modulation and also the broadband amplitude modulation.



Activation of amplitude modulation deactivates ARB, I/Q modulation, digital modulation and all digital standards.

The following examples show some variants for generating AM signals.

#### Example: Creating an amplitude modulated RF signal

Using the internal LF generator, the following command sequence configures an amplitude modulated signal.

```
// *****
// Reset the instrument to start from a defined state
*RST

// Set RF frequency and amplitude
SOURce1:FREQuency:CW 6000000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the modulation signal
SOURce1:LFOutput1:SHAPE SINE
SOURce1:LFOutput1:FREQuency 20000

// Configure the amplitude modulation settings and switch AM on
SOURce1:AM1:SOURce LF1
SOURce1:AM1:DEPTh 30
SOURce1:AM:RATio 40
SOURce1:AM1:STATe 1

// Switch on LF and RF signal output
SOURce1:LFOutput1:STATe 1
OUTPut1:STATe 1
// *****
```

#### Example: Using an external signal source

Using an external signal source, you can additionally determine whether you want to use only the AC component of the external modulation signal.

```
// *****
// Reset the instrument to start from a defined state
*RST

// Set frequency and amplitude
SOURcel:FREQuency:CW 6000000000
SOURcel:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the amplitude modulation settings and switch AM on
SOURcel:AM1:SOURce EXT1
SOURcel:AM1:DEPTh 40

// Query the input sensitivity at the external modulation input
SOURcel:AM1:SENSitivity?
// Response: 40
// Since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 50%/V.
// This value is assigned to the voltage value for full
// modulation of the input.

// select the coupling mode AC for external amplitude modulation
SOURcel:INPut:MODext:COUPling1 AC

// Switch on AM and RF signal output
SOURcel:AM1:STATE 1
OUTPut1:STATE 1
// *****
```

The following commands are available:

<a href="#">[:SOURce&lt;hw&gt;]:AM:RATio.....</a>	797
<a href="#">[:SOURce&lt;hw&gt;]:AM:SENSitivity?.....</a>	798
<a href="#">[:SOURce&lt;hw&gt;]:AM&lt;ch&gt;:SOURce.....</a>	798
<a href="#">[:SOURce&lt;hw&gt;]:AM&lt;ch&gt;:STATE.....</a>	798
<a href="#">[:SOURce&lt;hw&gt;]:AM&lt;ch&gt;[:DEPTh].....</a>	799

---

**[:SOURce<hw>]:AM:RATio <Ratio>**

Sets the deviation ratio (path#2 to path#1) in percent.

**Parameters:**

<Ratio> float  
 Range: 0 to 100  
 Increment: 0.01  
 \*RST: 100

**Example:** See [Example "Creating an amplitude modulated RF signal"](#) on page 796.

**Manual operation:** See ["Ratio Path2/Path1"](#) on page 486

**[[:SOURce<hw>]:AM:SENSitivity?**

Queries the sensitivity of the externally applied signal for amplitude modulation. The sensitivity depends on the set modulation depth.

The returned value reports the sensitivity in %/V. It is assigned to the voltage value for full modulation of the input.

**Return values:**

<Sensitivity> float  
Range: 0 to 100

**Example:** See [Example "Using an external signal source"](#) on page 796.

**Usage:** Query only

**[[:SOURce<hw>]:AM<ch>:SOURce <Source>**

Selects the modulation source for amplitude modulation.

**Suffix:**

AM<ch> 1..2  
determines the modulation signal channel.

**Parameters:**

<Source> LF1 | LF2 | NOISe | EXT1 | EXT2 | EXTeRnal | INTeRnal

**LF1|LF2**

uses an internally generated LF signal.

**EXT1|EXT1**

uses an externally supplied LF signal.

**NOISe**

uses the internally generated noise signal.

**INTeRnal**

uses the internally generated signal of LF1.

**EXTeRnal**

uses an external LF signal (EXT1).

\*RST: LF1 <AM1>; LF2 <AM2>

**Example:** See [Example "Creating an amplitude modulated RF signal"](#) on page 796.

**Manual operation:** See ["Source"](#) on page 485

**[[:SOURce<hw>]:AM<ch>:STATe <State>**

Activates amplitude modulation.

**Suffix:**

AM<ch> 1..2  
determines the modulation signal channel.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** See [Example "Creating an amplitude modulated RF signal"](#) on page 796.

**Manual operation:** See ["State"](#) on page 484

**[[:SOURce<hw>]:AM<ch>[:DEPTH] <Depth>**

Sets the depth of the amplitude modulation in percent.

**Suffix:**

<ch> 1..2  
 determines the modulation signal channel.

**Parameters:**

<Depth> float  
 Range: 0 to 100  
 Increment: 0.1

**Example:** See [Example "Creating an amplitude modulated RF signal"](#) on page 796.

**Manual operation:** See ["AM Depth"](#) on page 485

### 13.18.2.2 SOURce:FM Subsystem

The FM subsystem contains the commands for setting the frequency modulation.

The following examples show some variants for generating AM signals.

**Example: Creating a frequency modulated RF signal**

Using the internal LF generator, the following command sequence configures a frequency modulated signal.

```
// *****
// Reset the instrument to start from a defined state
*RST

// Set RF frequency and amplitude
SOURce1:FREQuency:CW 6000000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the modulation signal
SOURce1:LFOutput1:SHAPE SINE
SOURce1:LFOutput1:FREQuency 20000

// Configure the frequency modulation settings and switch FM on
SOURce1:FM1:SOURce LF1
SOURce1:FM1:DEVIation 1000
```

```

SOURce1:FM:RATio 40
SOURce1:FM1:MODE NORM
SOURce1:FM1:STATe 1

// Switch on LF and RF signal output
SOURce1:LFOutput1:STATe 1
OUTPut1:STATe 1
// *****

```

### Example: Using an external signal source

Alternatively configure the frequency modulation settings with an external modulation signal.

```

// *****
// Reset the instrument to start from a defined state
*RST

// Set RF frequency and amplitude
SOURce1:FREQuency:CW 6000000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the frequency modulation settings and switch FM on
SOURce1:FM1:SOURce EXT1
SOURce1:FM1:DEVIation 5000

// Query the input sensitivity at the external modulation input
:SOURce1:FM1:SENSitivity?
// Response: 1000
// since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 5000 Hz/V.

// Switch on FM and RF signal output
SOURce1:FM1:STATe 1
OUTPut1:STATe 1
// *****

```

The following commands are available:

<a href="#">[:SOURce&lt;hw&gt;]:FM&lt;ch&gt;[:DEVIation]</a> .....	800
<a href="#">[:SOURce&lt;hw&gt;]:FM:MODE</a> .....	801
<a href="#">[:SOURce&lt;hw&gt;]:FM:RATio</a> .....	801
<a href="#">[:SOURce&lt;hw&gt;]:FM:SENSitivity?</a> .....	802
<a href="#">[:SOURce&lt;hw&gt;]:FM&lt;ch&gt;:SOURce</a> .....	802
<a href="#">[:SOURce&lt;hw&gt;]:FM&lt;ch&gt;:STATe</a> .....	802

---

#### **[\[:SOURce<hw>\]:FM<ch>\[:DEVIation\] <Deviation>](#)**

Sets the modulation deviation of the frequency modulation in Hz. The maximum deviation depends on the RF frequency and the selected modulation mode (see data sheet).



**Suffix:**

FM<ch> 1..2  
determines the modulation signal channel.

**Parameters:**

<Deviation> float  
Range: 0 Hz to See data sheet  
Increment: 0.01  
\*RST: 1E3

**Example:** See [Example "Creating a frequency modulated RF signal"](#) on page 799.

**Manual operation:** See ["Deviation"](#) on page 486

**[[:SOURce<hw>]:FM:MODE <Mode>**

Selects the mode for the frequency modulation.

**Parameters:**

<Mode> NORMal | LNOise  
**NORMal**  
The maximum range for modulation bandwidth and FM deviation is available.  
**LNOise**  
Frequency modulation with phase noise and spurious characteristics close to CW mode. The range for modulation bandwidth and FM deviation is reduced (see data sheet).  
\*RST: NORMal

**Example:** See [Example "Creating a frequency modulated RF signal"](#) on page 799.

**Manual operation:** See ["Mode"](#) on page 486

**[[:SOURce<hw>]:FM:RATio <Ratio>**

Sets the deviation ratio (path2 to path1) in percent.

**Parameters:**

<Ratio> float  
Range: 0 to 100  
Increment: 0.01  
\*RST: 100

**Example:** See [Example "Creating a frequency modulated RF signal"](#) on page 799.

**Manual operation:** See ["Ratio Path2/Path1"](#) on page 486

**[:SOURce<hw>]:FM:SENSitivity?**

Queries the sensitivity of the externally supplied signal for frequency modulation. The sensitivity depends on the set modulation deviation.

The returned value reports the sensitivity in Hz/V. It is assigned to the voltage value for full modulation of the input.

See [Chapter 11.2.3, "RF Connectors Settings"](#), on page 618 for the supply of the external signal.

**Return values:**

<Sensitivity> float  
 Range: 0 to max  
 Increment: 0.01

**Example:** See [Example "Using an external signal source"](#) on page 800.

**Usage:** Query only

**[:SOURce<hw>]:FM<ch>:SOURce <Source>**

Selects the modulation source for frequency modulation.

**Suffix:**

FM<ch> 1..2  
 determines the modulation signal channel.

**Parameters:**

<Source> LF1 | LF2 | NOISe | EXT1 | EXT2 | INTernal | EXTernal

**LF1|LF2**

uses an internally generated LF signal.

**EXT1|EXT1**

uses an externally supplied LF signal.

**NOISe**

uses the internally generated noise signal.

**INTernal**

uses the internally generated signal of LF1.

**EXTernal**

uses an external LF signal (EXT1).

\*RST: LF1 <FM1>; LF2 <FM2>

**Example:** See [Example "Creating a frequency modulated RF signal"](#) on page 799.

**Manual operation:** See ["Source"](#) on page 485

**[:SOURce<hw>]:FM<ch>:STATe <State>**

Activates frequency modulation.

<b>Suffix:</b>	
FM<ch>	1..2 determines the modulation signal channel.
<b>Parameters:</b>	
<State>	0   1   OFF   ON
	*RST: 0
<b>Example:</b>	See <a href="#">Example "Creating a frequency modulated RF signal"</a> on page 799.
<b>Manual operation:</b>	See <a href="#">"State"</a> on page 484

### 13.18.2.3 SOURce:PM Subsystem

The PM subsystem contains the commands for setting the phase modulation. The settings for the internal modulation source (LF generator) are made in the [SOURce:LFOutput](#) subsystem.

For information about the required options, see [Chapter 8.8.1, "Required Options"](#), on page 473.

#### Example: Performing phase modulation

The following example shows a command sequence to perform phase modulation.

```
// *****
// Reset the instrument to start from an initial state
*RST; *CLS

// Set the RF signal frequency and level
SOURce:FREQuency:CW 4000000000
SOURce:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the phase modulation settings
SOURce1:LFOutput1:SHAPE SINE
SOURce1:LFOutput1:FREQuency 1000

// Select the LF signal generated by the internal modulation generator
// or the internally generated noise signal
SOURce1:PM1:DEVIation 1
SOURce1:PM1:SOURce LF1
// SOURce1:PM1:SOURce INTernal
// SOURce1:PM1:SOURce NOISe
SOURce1:PM1:RATio 40
SOURce1:PM1:MODE HBAN

// Alternatively configure the phase modulation settings for an
// external modulation source and query the input sensitivity.
SOURce1:PM1:SOURce EXT1
// SOURce1:PM1:SOURce EXTernal
SOURce1:PM1:DEVIation 1
```

```

SOURce1:PM1:SENSitivity?
// Response: 1
// since the voltage value for full modulation is 1V,
// the resulting sensitivity is precisely 1RAD/V.

// Activate the signal output
SOURce1:PM1:STATe 1
OUTPut1:STATe 1
// *****

```

The following commands are available:

<a href="#">[:SOURce&lt;hw&gt;]:PM:MODE</a> .....	804
<a href="#">[:SOURce&lt;hw&gt;]:PM:RATio</a> .....	804
<a href="#">[:SOURce&lt;hw&gt;]:PM:SENSitivity?</a> .....	805
<a href="#">[:SOURce&lt;hw&gt;]:PM&lt;ch&gt;:SOURce</a> .....	805
<a href="#">[:SOURce&lt;hw&gt;]:PM&lt;ch&gt;:STATe</a> .....	805
<a href="#">[:SOURce]:PM&lt;ch&gt;[:DEVIation]</a> .....	806

---

#### **[\[:SOURce<hw>\]:PM:MODE <Mode>](#)**

Selects the mode for the phase modulation.

##### **Parameters:**

<Mode> HBANdwidth | HDEVIation | LNOise

##### **HBANdwidth**

Sets the maximum available bandwidth.

##### **HDEVIation**

Sets the maximum range for  $\Phi$ M deviation.

##### **LNOise**

Selects a phase modulation mode with phase noise and spurious characteristics close to CW mode.

\*RST: HBANdwidth

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Manual operation:** See ["Mode"](#) on page 488

---

#### **[\[:SOURce<hw>\]:PM:RATio <Ratio>](#)**

Sets the deviation ratio (path2 to path1) in percent.

##### **Parameters:**

<Ratio> float  
 Range: 0 to 100  
 Increment: 0.01  
 \*RST: 100

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Manual operation:** See ["Ratio Path2/Path1"](#) on page 487

**[[:SOURce<hw>]:PM:SENSitivity?**

Queries the sensitivity of the externally applied signal for phase modulation.

The returned value reports the sensitivity in RAD/V. It is assigned to the voltage value for full modulation of the input.

**Return values:**

<Sensitivity> float

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Usage:** Query only

**[[:SOURce<hw>]:PM<ch>:SOURce <Source>**

Selects the modulation source for phase modulation signal.

**Suffix:**

PM<ch> 1..2  
determines the modulation signal channel.

**Parameters:**

<Source> LF1 | LF2 | NOISe | EXT1 | EXT2 | INTernal | EXTernal

**LF1|LF2**

uses an internally generated LF signal.

**EXT1|EXT1**

uses an externally supplied LF signal.

**NOISe**

uses the internally generated noise signal.

**INTernal**

uses the internally generated signal of LF1.

**EXTernal**

uses an external LF signal (EXT1).

\*RST: LF1 <PM1>; LF2 <PM2>

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Manual operation:** See ["Source"](#) on page 485

**[[:SOURce<hw>]:PM<ch>:STATe <State>**

Activates phase modulation.

Activation of phase modulation deactivates frequency modulation.

**Suffix:**

PM<ch> 1..2  
determines the modulation signal channel.

**Parameters:**

<State> 0 | 1 | OFF | ON

\*RST: 0

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Manual operation:** See ["State"](#) on page 484

**[:SOURce]:PM<ch>[:DEVIation] <Deviation>**

Sets the modulation deviation of the phase modulation in RAD.

The maximal deviation depends on the RF frequency and the selected modulation mode (see data sheet).

**Parameters:**

<Deviation>	float
Range:	0 to See data sheet
Increment:	1
*RST:	1

**Example:** See [Example "Performing phase modulation"](#) on page 803.

**Manual operation:** See ["Deviation"](#) on page 487

#### 13.18.2.4 SOURce:PULM Subsystem

The PULM subsystem contains the commands for setting the pulse modulation.

- [Pulse Modulation Settings](#).....806

##### Pulse Modulation Settings

With the commands described in this section, you can configure the settings for pulse modulation, select the trigger mode and determine delay times for the pulse modulation signal.

##### Example: Perform pulse modulation

The example shows a command sequence to perform pulse modulation.

```
// *****
// Reset the instrument to start from an initial state
*RST; *CLS

// Set the RF signal frequency and level
SOURce:FREQuency:CW 4000000000
SOURce:POWer:LEVel:IMMediate:AMPLitude -25

// Configure the pulse modulation settings
// Select the internal modulation generator,
// set trigger mode, select pulse mode, transition type
// and select the polarity of the internally generated pulse video output
SOURce:PULM:SOURce INT
SOURce:PULM:TRIGger:MODE AUTO
SOURce:PULM:MODE DOUB
SOURce:PULM:TTYPe SMO
```

```

SOURce:PULM:OUTPut:VIDeo:POLarity INVerted

// Alternatively configure the pulse modulation settings for
// external modulation source
// Select the source, set the polarity of the external signal,
// select the impedance for the external pulse modulation input,
// and for the external pulse modulation trigger input
SOURce:PULM:SOURce EXT
SOURce:PULM:POLarity NORMal
SOURce:PULM:IMPedance G1K
SOURce:PULM:TRIGger:EXTernal:IMPedance G10K

// Configure the pulse generator settings
// Set pulse period, width, and delay
SOURce:PULM:PERiod 10 us
SOURce:PULM:WIDth 8 us
SOURce:PULM:DOUBle:WIDTh 0.0000012
SOURce:PULM:DOUBle:DELay 0.0000045

// Activate the signal output
SOURce:PGENERator:OUTPut:STATe 1
SOURce:PULM:STATe 1
OUTPut1:STATe 1
// *****
    
```

The following commands are available:

<a href="#">[:SOURce&lt;hw&gt;]:PULM:SOURce</a> .....	807
<a href="#">[:SOURce&lt;hw&gt;]:PULM:DELay</a> .....	808
<a href="#">[:SOURce&lt;hw&gt;]:PULM:DOUBle:DELay</a> .....	808
<a href="#">[:SOURce&lt;hw&gt;]:PULM:DOUBle:WIDTh</a> .....	808
<a href="#">[:SOURce&lt;hw&gt;]:PULM:IMPedance</a> .....	808
<a href="#">[:SOURce&lt;hw&gt;]:PULM:MODE</a> .....	809
<a href="#">[:SOURce&lt;hw&gt;]:PULM:OUTPut:VIDeo:POLarity</a> .....	809
<a href="#">[:SOURce&lt;hw&gt;]:PULM:PERiod</a> .....	809
<a href="#">[:SOURce&lt;hw&gt;]:PULM:POLarity</a> .....	810
<a href="#">[:SOURce&lt;hw&gt;]:PULM:STATe</a> .....	810
<a href="#">[:SOURce&lt;hw&gt;]:PULM:TRIGger:EXTernal:IMPedance</a> .....	810
<a href="#">[:SOURce&lt;hw&gt;]:PULM:TRIGger:MODE</a> .....	810
<a href="#">[:SOURce&lt;hw&gt;]:PULM:TTYPe</a> .....	811
<a href="#">[:SOURce&lt;hw&gt;]:PULM:WIDTh</a> .....	811

---

**[:SOURce<hw>]:PULM:SOURce <Source>**

Selects between the internal (Pulse Generator), or an external pulse signal for the modulation.

**Parameters:**

<Source>                    INTernal | EXTernal  
 \*RST:                    INTernal

**Example:**                See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Source"](#) on page 491

**[[:SOURce<hw>]:PULM:DELay <Delay>**

Sets the pulse delay.

The pulse delay determines the time that elapses after a trigger event before pulse modulation starts. The pulse delay is not effective when you perform double pulse generation.

**Parameters:**

<Delay> float  
\*RST: 1ms

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Pulse Delay"](#) on page 494

**[[:SOURce<hw>]:PULM:DOUBLE:DELay <Delay>**

Sets the delay from the start of the first pulse to the start of the second pulse.

**Parameters:**

<Delay> float  
\*RST: 1E-6

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Double Pulse Delay"](#) on page 494

**[[:SOURce<hw>]:PULM:DOUBLE:WIDTh <Width>**

Sets the width of the second pulse.

**Parameters:**

<Width> float  
Increment: 5E-9

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Double Pulse Width"](#) on page 494

**[[:SOURce<hw>]:PULM:IMPedance <Impedance>**

Sets the impedance for the external pulse modulation input.

**Parameters:**

<Impedance> G50 | G1K  
\*RST: G1K

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Impedance Pulse Input"](#) on page 492



---

**[[:SOURce<hw>]:PULM:MODE <Mode>**

Selects the mode for the pulse modulation.

**Parameters:**

<Mode> SINGle | DOUBle

**SINGle**

Generates a single pulse.

**DOUBle**

Generates two pulses within one pulse period.

\*RST: SINGle

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Pulse Mode"](#) on page 493

---

**[[:SOURce<hw>]:PULM:OUTPut:VIDeo:POLarity <Polarity>**

Sets the polarity of the pulse video (modulating) signal, related to the RF (modulated) signal.

**Parameters:**

<Polarity> NORMal | INVerted

**NORMal**

the video signal follows the RF signal, that means it is high when RF signal is high and vice versa.

**INVerted**

the video signal follows in inverted mode.

\*RST: NORMal

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Video Polarity"](#) on page 492

---

**[[:SOURce<hw>]:PULM:PERiod <Period>**

Sets the period of the generated pulse, that means the repetition frequency of the internally generated modulation signal.

**Parameters:**

<Period> float

The minimum value depends on the installed options R&S R&S SMW-K22 or R&S SMW-K23

Range: 100E-9 to 100

Increment: 10E-9

\*RST: 10E-6

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Pulse Period"](#) on page 493

---

---

**[:SOURce<hw>]:PULM:POLarity <Polarity>**

Sets the polarity of the externally applied modulation signal.

**Parameters:**

<Polarity>            NORMal | INVerted

**NORMal**

Suppresses the RF signal during the pulse pause.

**INVerted**

Suppresses the RF signal during the pulse.

\*RST:            NORMal

**Example:**            See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Polarity Pulse Input"](#) on page 492

---

**[:SOURce<hw>]:PULM:STATe <State>**

Activates pulse modulation.

**Parameters:**

<State>            0 | 1 | OFF | ON

\*RST:            0

**Example:**            See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["State"](#) on page 491

---

**[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance <Impedance>**

Sets the impedance for the external pulse trigger.

**Parameters:**

<Impedance>        G50 | G10K

\*RST:            G50

**Example:**            See [Example "Perform pulse modulation"](#) on page 806.

---

**[:SOURce<hw>]:PULM:TRIGger:MODE <Mode>**

Selects a trigger mode - auto, external, external single or external gated - for generating the modulation signal.

**Parameters:**

<Mode>            AUTO | EXTernal | EGATe | ESINGle

\*RST:            AUTO

**Example:**            See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Trigger Mode"](#) on page 494

---

**[:SOURce<hw>]:PULM:TTYPe <Source>**

Sets the transition mode for the pulse signal.

**Parameters:**

<Source> SMOothed | FAST

**SMOothed**  
flattens the slew rate, resulting in longer rise/fall times.

**FAST**  
enables fast transitions with shortest rise and fall times.

\*RST: FAST

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Transition Type"](#) on page 491

**[:SOURce<hw>]:PULM:WIDTh <Width>**

Sets the width of the generated pulse, that means the pulse length. It must be at least 20ns less than the set pulse period.

**Parameters:**

<Width> float

Range: 20E-9 to 100

Increment: 10E-9

\*RST: 2E-6

**Example:** See [Example "Perform pulse modulation"](#) on page 806.

**Manual operation:** See ["Pulse Width"](#) on page 493

### 13.18.3 SOURce:BB Subsystem

This subsystem contains all commands for digital signal generation. It is divided into several subsystems which are described separately.

- [SOURce:BB Subsystem General Commands](#)..... 812
- [SOURce:BB:DM Subsystem](#)..... 815
- [SOURce:BB:ARBitrary Subsystem](#)..... 844
- [Waveform, Data and List Format](#)..... 888
- [SOURce:BB:MCCW Subsystem](#)..... 909
- [SOURce:AWGN Subsystem](#)..... 929
- [SOURce:BB:IMPairment Subsystem](#)..... 938
- [SOURce:BB:GRAPhics Subsystem](#)..... 942
- [SOURce:BB:MEASurement Subsystem](#)..... 944
- [SOURce:BB:PROGress Subsystem General Commands](#)..... 950

### 13.18.3.1 SOURce:BB Subsystem General Commands

The following section describes the commands for setting the frequency shift and the phase offset for the signal at the output of the "Baseband" and "BB Input" blocks.

#### Suffixes in the keywords ENTity<ch> and SOURce<hw>

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

*Table 13-2: Value ranges of the suffixes ENTity<ch> and SOURce<hw> in advanced configuration with multiple entities*

SCPI Syntax	ENTity<ch>	SOURce<hw>
<code>SOURce&lt;hw&gt;:BB:...</code>	-	1 .. 8
<code>ENTity&lt;ch&gt;:SOURce&lt;hw&gt;:BB:...</code>	1 .. 8	1 .. 4



See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

The following commands are available:

<code>[:SOURce&lt;hw&gt;]:BB:FOFFset</code> .....	812
<code>[:SOURce&lt;hw&gt;]:BBIN:FOFFset</code> .....	812
<code>[:SOURce&lt;hw&gt;]:BB:POFFset</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BB:PGAin</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BBIN:PGAin</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BB:ROUte</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BBIN:ROUte</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BB:CODer:MODE</code> .....	813
<code>[:SOURce&lt;hw&gt;]:BB:POWer:PEAK?</code> .....	814
<code>[:SOURce&lt;hw&gt;]:BB:CFACTOR?</code> .....	814
<code>[:SOURce&lt;hw&gt;]:BB:POWer:RMS?</code> .....	814

**`[:SOURce<hw>]:BB:FOFFset <FOffset>`**

**`[:SOURce<hw>]:BBIN:FOFFset <FOffset>`**

Sets a frequency offset for the internal/external baseband signal. The offset affects the generated baseband signal.

#### Parameters:

<FOffset>                      float  
                                     Range:     -40E6 to 40E6  
                                     Increment: 0.01  
                                     \*RST:     0  
                                     Default unit: Hz

**Example:**                      `BBIN:FOFF 2 MHz`  
                                     sets a frequency offset of 2 MHz.

**Manual operation:**        See "[Frequency Offset](#)" on page 370

---

**[[:SOURce<hw>]:BB:POFFset <POffset>**

Sets the relative phase offset for the selected baseband signal compared to the baseband signals of the other baseband sources (second path or external baseband).

**Parameters:**

<POffset>                      float  
    Range:        0 to 359.9  
    Increment: 0.01  
    \*RST:        0  
    Default unit: DEG

**Example:**                      BB:POFF 0.5DEG  
    sets a relative phase offset of 0.5 DEG for the baseband signal

**Manual operation:**    See "[Phase Offset](#)" on page 370

---

**[[:SOURce<hw>]:BB:PGAin <PGain>**

**[[:SOURce<hw>]:BBIN:PGAin <PGain>**

Sets the relative gain for the internal or external baseband signal compared with the signals of the other baseband sources.

**Parameters:**

<PGain>                              float  
    Range:        -50 to 50  
    Increment: 1E-3  
    \*RST:        0  
    Default unit: dB

**Example:**                      BBIN:PGA 3dB  
    sets the relative gain of 3 dB for the external baseband signal.

**Manual operation:**    See "[Gain](#)" on page 370

---

**[[:SOURce<hw>]:BB:ROUTE <Route>**

**[[:SOURce<hw>]:BBIN:ROUTE <Route>**

Selects the signal route for the external baseband signal. The internal and external signals are summed if necessary.

**Parameters:**

<Route>                              A | B | AB

**Example:**                      BBIN:ROUT A  
    The external baseband signal is introduced into path A.

**Manual operation:**    See "[Signal Routing](#)" on page 159

---

**[[:SOURce<hw>]:BB:CODer:MODE <Mode>**

Defines the source of the baseband generator.

**Parameters:**

<Mode>                    CODer | BBIN

**CODer**  
Internal baseband generator

**BBIN**  
An external digital baseband signal provided at the digital interface

\*RST:                    CODer

**Example:**                    SOURce1:BB:CODer:MODE BBIN

**[:SOURce<hw>]:BB:POWER:PEAK?**

Queries the peak level of the baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

**Return values:**

<Peak>                    float

Range:                    -145 to 30

Increment:                0.01

\*RST:                    0

Default unit: dBfs

**Example:**                    BB:POW:PEAK  
Queries the peak level of the baseband signal.

**Usage:**                    Query only

**[:SOURce<hw>]:BB:CFACTOR?**

Queries the crest factor of the baseband signal.

**Return values:**

<CFactor>                float

Range:                    0 to 100

Increment:                0.01

\*RST:                    0

Default unit: dB

**Example:**                    SOURce1:BB:CFACTOR?  
queries the crest factor of the baseband signal.

**Usage:**                    Query only

**[:SOURce<hw>]:BB:POWER:RMS?**

Queries the RMS level of the baseband signal relative to full scale of 0.5V (in terms of dB full scale).

**Return values:**

<Rms> float  
 Range: -145 to 30  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dBfs

**Example:**

BB:POW:RMS  
 queries the rms level of the baseband signal.

**Usage:**

Query only

**13.18.3.2 SOURce:BB:DM Subsystem**

This section lists the commands of the `SOURce:BB:DM` subsystem. The commands are divided into sections, where the last one describes how to use lists for digital modulation in remote control, and all other sections describe the configuration of the digital modulation.

**Suffixes in the keywords ENTity<ch> and SOURce<hw>**

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

*Table 13-3: Value ranges of the suffixes ENTity<ch> and SOURce<hw> in advanced configuration with multiple entities*

SCPI Syntax	ENTity<ch>	SOURce<hw>
<code>SOURce&lt;hw&gt;:BB:...</code>	-	1 to 4
<code>ENTity&lt;ch&gt;:SOURce&lt;hw&gt;:BB:...</code>	1 to 4	1 to 4



See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

The commands are grouped in the following sections:

- [Programming Examples](#).....816
- [General Commands](#).....818
- [Save/Recall Settings](#).....822
- [Filter Settings](#).....823
- [Modulation and Coding Settings](#).....825
- [Power Ramping](#).....827
- [Trigger Settings](#).....829
- [Marker Settings](#).....834
- [Clock Settings](#).....837
- [Handling List Files](#).....838

## Programming Examples

### Example: Performing general tasks

This example shows how to enable Custom Digital Modulation with predefined settings as basis for further customization (e.g. adjusting the data source); intermediate results and configuration are stored with the save/recall function.

```
// *****
// Reset instrument first
// *****
*RST; *CLS

SOURce:BB:DM:PRESet
SOURce:BB:DM:STANdard W3GPP
SOURce:BB:DM:SRATe?
// 3840000
SOURce:BB:DM:CODing?
// WCDMA
SOURce:BB:DM:FORMat?
// QPSK45
SOURce:BB:DM:STATe ON
SOURce:BB:DM:SETTing:STORe "/var/user/digMod/CustDM3GPP"

// *****
// Recall settings
// *****
MME:CDIR "/var/user/digMod"
SOURce:BB:DM:SETTing:CATalog?
// CusDigMod, cdm3gpp, CustDM3GPP
SOURce:BB:DM:SETTing:DELeTe "cdm3gpp"
SOURce:BB:DM:SETTing:LOAD "CusDigMod"

// *****
// Change the data source
// *****
SOURce:BB:DM:SOURce?
// PRBS
SOURce:BB:DM:PRBS:LENGth?
// 9
SOURce:BB:DM:SOURce DLIST
// Set the default directory and query the existing data lists
MME:CDIR "/var/user/DLists"
SOURce:BB:DM:DLISt:CATalog?
// "DList1","DList2"
// delete a list and create a new data list
SOURce:BB:DM:DLISt:DELeTe "DList1"
SOURce:BB:DM:DLISt:SELeCt "DList2"
// copy the content of an existing data list to the new data list
SOURce:BB:DM:DLISt:COpy "DList3"
```



```
// query the content of the new data list and modify it (append data to it)
FORM ASCII
SOURCE:BB:DM:DLIST:DATA? 2048,1024
// 1,1,0,0,0, ...
SOURCE:BB:DM:DLIST:DATA:APPend 1,1,1,0,0,0,1,1,0,1...
SOURCE:BB:DM:DLIST:SElect "DList3"
// query the free memory and nuber of bit to be utilized
SOURCE:BB:DM:DLIST:FREE?
SOURCE:BB:DM:DLIST:POINTs?
```

### Example: Adjusting clock, marker and trigger settings

The following example lists the provided commands

```
// *****
// Clock settings
// *****
SOURCE:BB:DM:CLOCK:SOURce INTernal

// *****
// Configure and enable standard marker signals
// *****
SOURCE:BB:DM:TRIGger:OUTPut2:MODE PULSe
SOURCE:BB:DM:TRIGger:OUTPut2:PULSe:DIVider 5
SOURCE:BB:DM:TRIGger:OUTPut2:PULSe:FREQuency?
SOURCE:BB:DM:TRIGger:OUTPut3:MODE PATtern
SOURCE:BB:DM:TRIGger:OUTPut3:PATtern #HE0F52,20
SOURCE:BB:DM:TRIGger:OUTPut1:MODE RATio
SOURCE:BB:DM:TRIGger:OUTPut1:ONTime 40
SOURCE:BB:DM:TRIGger:OUTPut1:OFFTime 20

SOURCE:BB:DM:TRIGger:OUTPut2:DELay 16
SOURCE:BB:DM:TRIGger:OUTPut:DELay:FIXed ON
SOURCE:BB:DM:TRIGger:OUTPut1:DELay:MINimum?
// 0
SOURCE:BB:DM:TRIGger:OUTPut1:DELay:MAXimum?
// 2000

// *****
// Configure and enable signal generation
// *****
SOURCE:BB:DM:TRIGger:SEQuence SINGLE
SOURCE:BB:DM:TRIGger:SEnGth 200
// the first 200 samples will be output after the next trigger event
// SOURCE:BB:DM:TRIGger:SEQuence ARETrigger
// SOURCE:BB:DM:TRIGger:SOURce EGT1
// external trigger signal must be provided at the connector
// configured for the External Global Trigger 1 signal
// SOURCE:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut ON
// SOURCE:BB:DM:TRIGger:EXTernal:DELay 200
// SOURCE:BB:DM:TRIGger:EXTernal:INHibit 100
```

```
// SOURce:BB:DM:TRIGger:SOURce INTB
// the internal trigger signal from the other path must be used
// SOURce:BB:DM:TRIGger:OBASeband:DELay 25
// SOURce:BB:DM:TRIGger:OBASeband:INHibit 10

SOURce:BB:DM:TRIGger:SEQuence AAUTO
SOURce:BB:DM:TRIGger:SOURce INTernal
SOURce:BB:DM:STAT ON
SOURce:BB:DM:TRIGger:EXEC
```

### Example: Enable power ramping

The following example lists the provided commands

```
SOURce:BB:DM:PRAMP:SOURce INTernal
SOURce:BB:DM:PRAMP:SHAP COS
SOURce:BB:DM:PRAMP:TIME 5
SOURce:BB:DM:PRAMP:RDELay 0
SOURce:BB:DM:PRAMP:FDELay -1
SOURce:BB:DM:PRAMP:ATTenuation 10
SOURce:BB:DM:PRAMP:BBONLY:STATE ON
SOURce:BB:DM:PRAMP:STATE ON
```

### General Commands

---

#### [SOURce<hw>]:BB:DM:STATE <State>

Enables/disables digital modulation. Switching on digital modulation turns off all the other digital standards in the same signal path.

#### Parameters:

<State>            0 | 1 | OFF | ON  
 \*RST:            0

**Example:**            see [Example "Performing general tasks"](#) on page 816

**Manual operation:**    See ["State"](#) on page 254

---

#### [SOURce<hw>]:BB:DM:PRESet

Sets the default settings for digital modulation (\*RST values specified for the commands).

Not affected is the state set with the command SOURce<hw>:BB:DM:STATE

**Example:**            see [Example "Performing general tasks"](#) on page 816

**Usage:**            Event

**Manual operation:**    See ["Set To Default"](#) on page 254

---

**[[:SOURce<hw>]:BB:DM:SRATe <SRate>**

Sets the symbol rate in Hz/kHz/MHz or Symb/s / kSymb/s and MSymb/s.

**Parameters:**

<SRate> float  
Range: 50 to 100E6  
Increment: 1E-3  
\*RST: 270833.333

**Example:** see [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Symbol Rate"](#) on page 255

---

**[[:SOURce<hw>]:BB:DM:STANdard <Standard>**

Selects predefined set of settings according to the selected standard.

**Parameters:**

<Standard> USER | BLUetooth | DECT | ETC | GSM | GSMEdge | NADC |  
PDC | PHS | TETRa | W3GPp | TDSCdma | CFORward |  
CREVerse | WORLdspace | TFTS | APCOPH1C4fm |  
APCOPH1CQpsk | APCOPH2HCpm | APCOPH2HDQpsk |  
APCOPH2HD8PSKW | APCOPH2HD8PSKN | APCOPH1Lsm |  
APCOPH1Wcqpsk  
A query returns the value USER if a user-defined Custom Dig  
Mod setting was loaded or if one of the associated settings was  
changed subsequent to the selection of a standard.  
\*RST: GSM

**Example:** see [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Set according to Standard"](#) on page 255

---

**[[:SOURce<hw>]:BB:DM:SOURce <Source>**

Selects the data source, e.g. a sequence of 0 or 1, a pseudo-random sequence with different length, a pattern, a data list (DLISt), or external serial data (SERial).

**Parameters:**

<Source> ZERO | ONE | PRBS | PATTErn | DLISt | SERial  
\*RST: PRBS

**Example:** See [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Data Source"](#) on page 257

---

**[[:SOURce<hw>]:BB:DM:PATTern <Pattern>**

Selects the data pattern for the internal data when PATTErn is selected as the data source. The maximum length is 64 bits.

**Parameters:**

<Pattern> string  
 Range: #B0,1 to #B111...1,64  
 \*RST: #B0,1

**Example:**

```
SOURce:BB:DM:SOURce PATT
SOURce:BB:DM:PATtern #B01110111010101010,17
generates the user-defined sequence of 0/1 data.
```

**[:SOURce<hw>]:BB:DM:PRBS[:LENGth] <Length>**

Defines the length of the pseudo-random sequence in accordance with the following equation:

$$\text{Length} = (2^{\text{Length}}) - 1$$

**Parameters:**

<Length> 9 | 11 | 15 | 16 | 20 | 21 | 23 | PN9 | PN11 | PN15 | PN16 |  
 PN20 | PN21 | PN23  
 \*RST: 9

**Example:** see [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Data Source"](#) on page 257

**[:SOURce<hw>]:BB:DM:SMODulation:BORDER <BitOrder>**

Sets the bit order for processing extern serial data.

**Parameters:**

<BitOrder> LSBit | MSBit  
 \*RST: LSBit

**Example:**

```
SOURce1:INPut:TM1:DIRectioN INP
SOURce1:INPut:TM1:SIGNal CLOCK
SOURce1:INPut:TM2:DIRectioN INP
SOURce1:INPut:TM2:SIGNal DATA

SOURce1:BB:DM:SOURce SERIAL
SOURce1:BB:DM:SMODulation:BORDER LSBit
SOURce1:BB:DM:SMODulation:CDTDeviation?
SOURce1:BB:DM:SMODulation:CLOCK:SLOPe:BIT POSitive
SOURce1:BB:DM:SMODulation:THROUGHput:DELay?
SOURce1:BB:DM:SMODulation:RCVState?
// Response: OPERational
```

**Manual operation:** See ["Bit Order"](#) on page 259

**[:SOURce<hw>]:BB:DM:SMODulation:CDTDeviation <Deviation>**

Queries the timing deviations (time offset) between the clock and the data signals.

**Parameters:**

<Deviation> float  
 Range: -5E-3 to 5E-3  
 Increment: 1E-12  
 \*RST: 0

**Example:** see [:SOURce<hw>]:BB:DM:SMODulation:BORDER  
 on page 820

**Manual operation:** See "Clock to Data Time Deviation" on page 260

**[:SOURce<hw>]:BB:DM:SMODulation:CLOCK:SLOPe:BIT <Slope>**

Sets the active edge of the bit clock.

**Parameters:**

<Slope> NEGative | POSitive  
 \*RST: POSitive

**Example:** see [:SOURce<hw>]:BB:DM:SMODulation:BORDER  
 on page 820

**Manual operation:** See "Bit Clock Slope" on page 258

**[:SOURce<hw>]:BB:DM:SMODulation:THRoughput:DElay?**

Queries the throughput delay from the data input to the RF output in the case of external modulation.

**Return values:**

<Delay> integer  
 Range: -100 to 100  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [:SOURce<hw>]:BB:DM:SMODulation:BORDER  
 on page 820

**Usage:** Query only

**Manual operation:** See "Throughput Delay" on page 260

**[:SOURce<hw>]:BB:DM:SMODulation:RCVState? <RcvState>**

Queries the current state of the receiver of the external data.

**Parameters:**

<RcvState> OFF | OPERational | UFLow | OFLow  
 \*RST: OFF

**Example:** see [:SOURce<hw>]:BB:DM:SMODulation:BORDER  
 on page 820

**Usage:** Query only  
**Manual operation:** See ["Receiver State"](#) on page 259

### Save/Recall Settings

---

**[:SOURce<hw>]:BB:DM:STANdard:ULISt:CATalog?**  
**[:SOURce<hw>]:BB:DM:SETTing:CATalog?**

Queries the files with digital modulation respectively user standard settings in the default directory. Listed are files with the file extension \*.dm and \*.dm\_stu.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

**Return values:**  
 <Catalog> "<filename1>,<filename2>,..."  
 Returns a string of file names separated by commas.

**Example:** See [Example "Performing general tasks"](#) on page 816

**Usage:** Query only  
**Manual operation:** See ["Save/Recall"](#) on page 254

---

**[:SOURce<hw>]:BB:DM:STANdard:ULISt:STORe <Filename>**  
**[:SOURce<hw>]:BB:DM:SETTing:STORe <Filename>**

Stores the current settings into the selected file; the file extension (\*.dm respectively \*.dm\_stu) is assigned automatically.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

**Setting parameters:**  
 <Filename> string  
**Example:** See [Example "Performing general tasks"](#) on page 816  
**Usage:** Setting only  
**Manual operation:** See ["Save/Recall"](#) on page 254

---

**[:SOURce<hw>]:BB:DM:STANdard:ULISt:LOAD <Filename>**  
**[:SOURce<hw>]:BB:DM:SETTing:LOAD <Filename>**

Loads the selected file from the default or the specified directory. Loaded are files with extension \*.dm respectively \*.dm\_stu.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

**Setting parameters:**

<Filename> string

**Example:** See [Example "Performing general tasks"](#) on page 816

**Usage:** Setting only

**Manual operation:** See ["Save/Recall"](#) on page 254

**[ :SOURce<hw>]:BB:DM:STANdard:ULISt:DELeTe <Filename>**

**[ :SOURce<hw>]:BB:DM:SETTing:DELeTe <Filename>**

Deletes the selected file from the default or specified directory. Deleted are files with the file extension \*.dm respectively \*.dm\_stu.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

**Setting parameters:**

<Filename> string

**Example:** See [Example "Performing general tasks"](#) on page 816

**Usage:** Setting only

**Manual operation:** See ["Save/Recall"](#) on page 254

**Filter Settings**

**[ :SOURce<hw>]:BB:DM:FILTer:TYPE <Type>**

The command selects the filter type.

When a standard is selected (:BB:DM:STAN), the filter type and filter parameter are set to the default value.

**Parameters:**

<Type> RCOSine | COSine | GAUSs | LGAuss | CONE | COF705 |  
COEQualizer | COFequalizer | C2K3x | APCO25 | SPHase |  
RECTangle | USER | PGAuss | LPASs | DIRac | ENPShape |  
EWPSshape | LTEFilter | LPASSEVM | APCO25Hcpm |  
APCO25Lsm  
\*RST: GAUSs

**Example:** see [\[ :SOURce<hw>\]:BB:DM:FILTer:PARAmeter:SPHase](#) on page 824

**Manual operation:** See ["Filter"](#) on page 264

**[ :SOURce<hw>]:BB:DM:FILTer:PARAmeter:APCO25 <ApcO25>**

**[ :SOURce<hw>]:BB:DM:FILTer:PARAmeter:APCO25Lsm:GAUSs <FiltParm>**

**[ :SOURce<hw>]:BB:DM:FILTer:PARAmeter:APCO25Lsm:LOWPass <FiltParm>**

**[ :SOURce<hw>]:BB:DM:FILTer:PARAmeter:COSine:BANdwidth <FiltParm>**

`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:COsine[:ROLLoff] <Cosine>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:GAUSs <Gauss>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:LPASs <LPass>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:LPASSEVM <LPassEvm>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:PGAuss <PGauss>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:RCOSine <RCosine>`  
`[ :SOURce<hw>]:BB:DM:FILTER:PARAMeter:SPHase <SPHase>`

The command sets corresponding filter parameter.

Filter Type	Parameter	Parameter Name	Min	Max	Increment	Default
APCO25	Roll-off factor	<Apco25>	0.05	0.99	0.01	0.2
APCO25Lsm	Cut off frequency for the lowpass/gauss filter ( :LOWPass/ :GAUSs)	<FiltParm>	400	25E6	1E-3	270833.333
COSinebandwidth	Bandwidth	<FiltParm>	400	25E6	1E-3	270833.333
COSinebandwidth	Roll-off factor	<Cosine>	0.05	1	0.01	0.35
GAUSs	Roll-off factor	<Gauss>	0.15	100000	0.01	0.3
LPASs	Cut-off frequency	<LPass>	0.05	2	0.01	0.5
LPASSEVM	Cut-off frequency	<LPassEvm>	0.05	2	0.01	0.5
PGAuss	Roll-off factor	<PGauss>	0.15	2.5	0.01	0.3
RCOSine	Roll-off factor	<RCosine>	0.05	1	0.01	0.35
SPHase	B x T	<SPHase>	0.15	2.5	0.01	2

**Parameters:**

`<SPHase>` float  
 Range: 0.15 to 2.5  
 Increment: 0.01  
 \*RST: 2

**Example:**

`SOURce:BB:DM:FILTER:TYPE SPHase`  
`SOURce:BB:DM:FILTER:PARAMeter:SPHase 0.5`

**Manual operation:** See "Filter Parameter" on page 264

---

`[ :SOURce<hw>]:DM:FILTER:PARAMeter <Parameter>`

Sets the filter parameter of the currently selected filter type.

To set the filter type, use command `[ :SOURce<hw>]:BB:DM:FILTER:TYPE` on page 823.

**Parameters:**

`<Parameter>` float  
 Range: 0.05 to 2.5  
 Increment: 0.01  
 \*RST: 0.35



**Example:** see `[ :SOURce<hw> ] :BB:DM:FILTER:PARAMeter:SPHase`  
on page 824

### Modulation and Coding Settings

---

**[ :SOURce<hw> ] :BB:DM:CODing <Coding>**

Selects the modulation coding.

**Parameters:**

<Coding> OFF | DIFF | DPHS | DGRay | GRAY | GSM | NADC | PDC |  
PHS | TETRa | APCO25 | PWT | TFTS | INMarsat | VDL |  
EDGE | APCO25FSK | ICO | CDMA2000 | WCDMA |  
APCO258PSK

**OFF**

The coding is automatically disabled if the selected modulation type is not possible with the coding that has been set

**DPHS**

Phase Difference

**DGRay**

Difference + Gray

\*RST: GSM

**Example:** See [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Coding"](#) on page 255

---

**[ :SOURce<hw> ] :BB:DM:FORMat <Format>**

Sets the modulation type.

When a standard is selected (`[ :SOURce<hw> ] :BB:DM:STANdard`), the modulation type is set to the default value.

**Parameters:**

<Format> ASK | BPSK | P2DBpsk | QPSK | QPSK45 | OQPSk | P4QPsk |  
P4DQpsk | PSK8 | P8D8psk | P8EDge | QAM16 | QAM32 |  
QAM64 | QAM256 | QAM1024 | MSK | FSK2 | FSK4 | USER |  
FSKVar | QAM128 | QEDGe | QAM16EDge | QAM32EDge |  
AQPSk | QAM4096

\*RST: MSK

**Example:** see [Example "Performing general tasks"](#) on page 816

**Manual operation:** See ["Modulation Type"](#) on page 261

---

**[ :SOURce<hw> ] :BB:DM:AQPSk:ANGLE <Angle>**

For AQPSK modulation, sets the angle alpha between the point (0,0) and the I axis.

**Parameters:**

<Angle> float  
 Range: 0 to 180  
 Increment: 0.01  
 \*RST: 0  
 Default unit: Deg

**Example:**

BB:DM:FORM AQPS  
 BB:DM:AQPS:ANGL 45

**Manual operation:** See ["Angle Alpha"](#) on page 262

**[:SOURce<hw>]:BB:DM:ASK:DEPTH <Depth>**

Sets the ASK modulation depth for modulation type ASK.

**Parameters:**

<Depth> float  
 Range: 0 to 100  
 Increment: 0.1  
 \*RST: 100  
 Default unit: PCT

**Example:**

BB:DM:FORM ASK  
 BB:DM:ASK:DEPT 50 PCT

**Manual operation:** See ["ASK Depth"](#) on page 262

**[:SOURce<hw>]:BB:DM:FSK:DEVIation <Deviation>**

Sets the frequency deviation when FSK modulation is selected.

The range of values depends on the symbol rate.

**Parameters:**

<Deviation> float  
 Range: 1 to 40E6  
 Increment: 0.5  
 \*RST: 135416.5

**Example:**

SOURce:BB:DM:FORMat  
 FSK4 SOURce:BB:DM:FSK:DEVIation 1MHZ

**Manual operation:** See ["FSK Deviation"](#) on page 262

**[:SOURce<hw>]:BB:DM:FSK:VARiable:SYMBol<ch0>:DEVIation <Deviation>**

Sets the deviation of the selected symbol for variable FSK modulation mode.

**Parameters:**

&lt;Deviation&gt; float

The range of values depends on the symbol rate that is set (see data sheet) and the maximum deviation is 10 MHz.

Range: -40E6 to 40E6

Increment: 0.5

Default unit: Hz

**Example:**

SOURce:BB:DM:FORMat FSKVar

SOURce:BB:DM:FSK:VARiable:TYPE FSK4

SOURce:BB:DM:FSK:VARiable:SYMBOL:DEVIation  
135000**Manual operation:** See "[Deviation xxxx](#)" on page 263**[:SOURce<hw>]:BB:DM:FSK:VARiable:TYPE <Type>**

The command selects the modulation type for Variable FSK.

**Parameters:**

&lt;Type&gt; FSK4 | FSK8 | FSK16

\*RST: FSK4

**Example:**see [\[:SOURce<hw>\]:BB:DM:FSK:VARiable:SYMBOL<ch0>:DEVIation](#) on page 826**Manual operation:** See "[FSK Type](#)" on page 263**[:SOURce<hw>]:BB:DM:SWITching:STATe <State>**

Enables switching between a modulated and an unmodulated signal.

**Parameters:**

&lt;State&gt; 0 | 1 | OFF | ON

\*RST: 0

**Example:**

SOURce1:BB:DM:SWITching:STATe ON

**Manual operation:** See "[State Modulation <=> CW Switching](#)" on page 263**Power Ramping****[:SOURce<hw>]:BB:DM:PRAMP:SOURce <Source>**

Sets the source for the power ramp control signals.

**Parameters:**

&lt;Source&gt; INTernal

\*RST: INTernal

**Example:**see [Example "Enable power ramping"](#) on page 818**Manual operation:** See "[Source](#)" on page 266

---

**[[:SOURce<hw>]:BB:DM:PRAMP:SHAPE <Shape>**

Sets the edge shape of the ramp envelope.

**Parameters:**

<Shape>               LINear | COSine  
 \*RST:                COSine

**Example:**            see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["Ramp Function"](#) on page 266

---

**[[:SOURce<hw>]:BB:DM:PRAMP:TIME <Time>**

Sets the power ramping rise time and fall time for a burst.

**Parameters:**

<Time>                float  
                           Range:     0.25 to 16  
                           Increment: 0.01  
                           \*RST:     1  
                           Default unit: symbol

**Example:**            see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["Ramp Time"](#) on page 266

---

**[[:SOURce<hw>]:BB:DM:PRAMP:FDELAY <FDelay>**

**[[:SOURce<hw>]:BB:DM:PRAMP:RDELAY <RDelay>**

Sets the delay in the rising edge.

**Parameters:**

<RDelay>             float  
                           Range:     0 to 4  
                           Increment: 0.01  
                           \*RST:     0  
                           Default unit: symbol

**Example:**            see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["Rise Delay"](#) on page 266

---

**[[:SOURce<hw>]:BB:DM:PRAMP:ATTENUATION <Attenuation>**

Sets the level attenuation for signal ranges that are flagged with level attribute *attenuated* by the control signal.

**Parameters:**

<Attenuation> float  
 Range: 0 to 50  
 Increment: 0.1  
 \*RST: 15  
 Default unit: dB

**Example:** see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["Attenuation"](#) on page 266

**[ :SOURce<hw>]:BB:DM:PRAMP:BBONLY[:STATe] <State>**

Enables power ramping in the baseband only or mixed power ramping in the baseband and the RF section.

The ON setting is mandatory if, with power ramping active, only the baseband signal is output (I/Q outputs)

In case of two-path instruments, the ON setting is also mandatory if a baseband signal is applied to two RF paths (RF A and RF B).

Only then can a signal with a defined, predictable level be output.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["In Baseband Only"](#) on page 267

**[ :SOURce<hw>]:BB:DM:PRAMP[:STATe] <State>**

Enables or disables power ramping.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Enable power ramping"](#) on page 818

**Manual operation:** See ["State"](#) on page 266

**Trigger Settings**

**[ :SOURce<hw>]:BB:DM[:TRIGger]:SEQUence <Sequence>**

Selects the trigger mode. For detailed description of the trigger modes, refer to ["Impact of the Trigger Modes on the Signal Generation"](#) on page 227.

**Parameters:**

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGLE  
 \*RST: AUTO

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Trigger Mode"](#) on page 243

**[[:SOURce<hw>]:BB:DM:TRIGger:SOURce <Source>**

Selects the trigger signal source and determines the way the triggering is executed. Provided are internal triggering by a command, external trigger signal via one of the provided local or global connectors and triggering by a signal from the other paths.

**Parameters:**

<Source> INTB | INTernal | OBASeband | EGT1 | EGT2 | EGC1 | EGC2 | ELTRigger | INTA | ELCLock | BEXternal | EXternal

**INTernal**

Internal

**INTA | INTB**

Internal trigger from the other baseband

**EGT1 | EGT2**

External global trigger

**EGC1 | EGC2**

External global clock

**ELTRigger**

External local trigger

**ELCLock**

External local clock

**OBASeband|BEXternal|EXternal**

Provided only for backward compatibility with other R&S signal generators.

The R&S SMW accepts these values and maps them automatically as follows:

EXternal = EGT1, BEXternal = EGT2, OBASeband = INTA or INTB (depending on the current baseband)

\*RST: INTernal

**Example:** See [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Trigger Source"](#) on page 244

**[[:SOURce<hw>]:BB:DM:TRIGger:SLENgth <SLength>**

Defines the length of the signal sequence to be output in the SINGLe trigger mode.

**Parameters:**

<SLength> integer  
 Range: 1 to 4294967295  
 \*RST: 1000  
 Default unit: symbol

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Trigger Signal Duration"](#) on page 244

#### **[:SOURce<hw>]:BB:DM:TRIGger:RMODE?**

Queries the status of signal generation.

**Return values:**

<RMode> STOP | RUN

**Example:** SOURce1:BB:DM:TRIGger:SOURce ELTRigger  
 SOURce1:BB:DM:TRIGger:SEQuence ARETrigger  
 SOURce1:BB:DM:TRIGger:RMODE?  
 Response: RUN

**Usage:** Query only

**Manual operation:** See ["Running/Stopped"](#) on page 244

#### **[:SOURce<hw>]:BB:DM:TRIGger:EXTernal:SYNChronize:OUTPut <Output>**

Enables/disables output of the signal synchronous to the external trigger event. For more information, refer to ["Impact of the Additional Trigger Settings"](#) on page 230.

**Parameters:**

<Output> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Sync. Output to External Trigger"](#) on page 245

#### **[:SOURce<hw>]:BB:DM:TRIGger:ARM:EXECute**

Stops signal generation; a subsequent internal or external trigger event restart signal generation.

**Example:** see also [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Usage:** Event

**Manual operation:** See ["Arm"](#) on page 244

#### **[:SOURce<hw>]:BB:DM:TRIGger:EXECute**

Executes a trigger.

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Usage:** Event

**Manual operation:** See ["Execute Trigger"](#) on page 244

**[:SOURce<hw>]:BB:DM:TRIGger:OBASeband:DELay <Delay>**

Specifies the trigger delay (expressed as a number of symbols) for triggering by the trigger signal from the other path.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:DM:TRIGger:OBASeband:RDELay?**

Queries the time a trigger event from the other path is delayed.

**Return values:**

<ObResTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Actual Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:DM:TRIGger:OBASeband:TDELay <ObasTimeDelay>**

Specifies the trigger delay for triggering by the signal from the other path.

**Parameters:**

<ObasTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246



---

**[[:SOURce<hw>]:BB:DM:TRIGger:OBASeband:INHibit <Inhibit>**

Specifies the number of symbols by which a restart is inhibited. This command applies only for triggering by the second path.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 67108863  
 \*RST: 0  
 Default unit: symbol

**Example:** See [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["External Trigger Inhibit"](#) on page 245

---

**[[:SOURce<hw>]:BB:DM:TRIGger:DELay:UNIT <TrigDelUnit>**

Determines the units the trigger delay is expressed in.

**Parameters:**

<TrigDelUnit> SAMPLE | TIME  
 \*RST: SAMPLE

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See ["External Delay Unit"](#) on page 246

---

**[[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:DELay <Delay>**

Specifies the trigger delay.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215  
 Increment: 0.01  
 \*RST: 0  
 Default unit: symbol

**Example:** See [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

---

**[[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>**

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

**Parameters:**

<ExtTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:RDElay?**

Queries the time (in seconds) an external trigger event is delayed for.

**Return values:**

<ResTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Actual Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:DM:TRIGger[:EXTernal]:INHibit <Inhibit>**

Specifies the number of symbols by which a restart is inhibited.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 21.47\*symbRate  
 \*RST: 0  
 Default unit: symbol

**Example:** See [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["External Trigger Inhibit"](#) on page 245

**Marker Settings****[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:MODE <Mode>**

Defines the signal for the selected marker output.

For detailed description of the regular marker modes, refer to ["Marker Modes"](#) on page 224.

**Parameters:**

<Mode> CLISt | PULSe | PATTeRn | RATIo

**CLISt**

A marker signal that is defined in the selected control list is generated.

\*RST: RATIo

**Example:**

see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See "[Marker Mode](#)" on page 247

**[[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay <Delay>**

Defines the delay between the signal on the marker outputs and the start of the signal, expressed in terms of symbols.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215  
 Increment: 0.001  
 \*RST: 0

**Example:**

see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See "[Marker x Delay](#)" on page 248

**[[:SOURce<hw>]:BB:DM:TRIGger:OUTPut:DELay:FIXed <Fixed>**

Restricts the marker delay setting range to the dynamic range.

**Parameters:**

<Fixed> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See "[Marker x Delay](#)" on page 248

**[[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay:MINimum?  
 [[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:DELay:MAXimum?**

Queries the minimum/maximum marker delay for fixed marker delay setting.

**Return values:**

<Maximum> float  
 Range: 0 to 16777215  
 Increment: 1E-3  
 \*RST: 2000

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Usage:** Query only

**Manual operation:** See ["Marker x Delay"](#) on page 248

**[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:ONTime <OnTime>**  
**[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:OFFTime <OffTime>**

Sets the number of symbols in a period (ON time + OFF time) for marker `RATio`

**Parameters:**

<OffTime> integer  
 Range: 1 to 16777215  
 \*RST: 1  
 Default unit: symbol

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Marker Mode"](#) on page 247

**[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PATTern <Pattern>**

Defines the bit pattern used to generate the marker signal `PATTern`.

**Parameters:**

<Pattern> integer  
 Range: #B0,1 to #B111...1,32  
 \*RST: #B,1

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Marker Mode"](#) on page 247

**[:SOURce<hw>]:BB:DM:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>**

Sets the divider for Pulse marker mode (`PULSe`).

**Parameters:**

<Divider> integer  
 Range: 2 to 1024  
 \*RST: 2

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Marker Mode"](#) on page 247

---

**[ :SOURce<hw> ]:BB:DM:TRIGger:OUTPut<ch>:PULSe:FREQuency?**

Queries the pulse frequency of the pulsed marker signal PULSe.

**Return values:**

<Frequency> float

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Usage:** Query only

**Manual operation:** See ["Marker Mode"](#) on page 247

---

**Clock Settings**

---

**[ :SOURce<hw> ]:BB:DM:CLOCK:MODE <Mode>**

Sets the type of externally supplied clock.

**Parameters:**

<Mode> SYMBol | MSYMBol  
\*RST: SYMBol

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Clock Mode"](#) on page 249

---

**[ :SOURce<hw> ]:BB:DM:CLOCK:MULTIplier <Multiplier>**

Specifies the multiplier for clock type MSYMBol in the case of an external clock source.

**Parameters:**

<Multiplier> integer  
Range: 1 to 64  
\*RST: 4

**Example:** see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Clock Multiplier"](#) on page 249

---

**[ :SOURce<hw> ]:BB:DM:CLOCK:SOURce <Source>**

Selects the clock source.

**Parameters:**

<Source>           INTernal | EGC1 | EGC2 | ELClock | EXTernal

**INTernal**  
The instrument uses its internal clock reference

**EGC1|EGC2**  
External global clock

**ELCLock**  
External local clock

**EXTernal**  
EXTernal = EGC1  
Setting only; provided for backward compatibility with other R&S signal generators.

\*RST:           INTernal

**Example:**           see [Example "Adjusting clock, marker and trigger settings"](#) on page 817

**Manual operation:** See ["Clock Source"](#) on page 249

**Handling List Files**

[ :SOURce<hw> ]:BB:DM:CLIST:CATalog?  
[ :SOURce<hw> ]:BB:DM:FLIST:CATalog?  
[ :SOURce<hw> ]:BB:DM:MLIST:CATalog?  
[ :SOURce<hw> ]:BB:DM:DLIST:CATalog?

Reads out the list files present in the default directory (see [:MMEMory:CDIRectory](#)).

List type	Command	File extension
Data list	...:DLIST...	*.dm_iqd
Control list	...:CLIST...	*.dm_iqc
User filter files	...:FLIST...	*.vaf
User mapping lists	...:MLIST...	*.vam

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

The numeric suffix on SOURce<[1] | 2> is ignored.

**Return values:**

<Catalog>           "<filename1>,<filename2>,..."  
Returns a string of file names separated by commas

**Example:**           See [Example "Performing general tasks"](#) on page 816

**Usage:**           Query only

**Manual operation:** See ["Data Source"](#) on page 257

```
[:SOURce<hw>]:BB:DM:CLIST:SElect <Filename>
[:SOURce<hw>]:BB:DM:FLIST:SElect <Filename>
[:SOURce<hw>]:BB:DM:MLIST:SElect <Filename>
[:SOURce<hw>]:BB:DM:DLIST:SElect <Select>
```

Selects the specified list file from the default directory (see [:MMEMory:CDIRectory](#)) or in the directory specified with the absolute file path.

If a list with the specified name does not yet exist, it is created. The file extension can be omitted.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

List type	Command	File extension
Data list	...:DLIST...	*.dm_iqd
Control list	...:CLIST...	*.dm_iqc
User standard	...:ULIST...	*.dm_stu
User filter files	...:FLIST...	*.vaf
User mapping lists	...:MLIST...	*.vam

**Parameters:**

<Select>                    <list name>

**Example:**                See [Example "Performing general tasks"](#) on page 816

**Manual operation:**    See ["Data Source"](#) on page 257

```
[:SOURce<hw>]:BB:DM:CLIST:DElete <Filename>
[:SOURce<hw>]:BB:DM:FLIST:DElete <Filename>
[:SOURce<hw>]:BB:DM:MLIST:DElete <Filename>
[:SOURce<hw>]:BB:DM:DLIST:DElete <Filename>
```

Deletes the specified list from the default directory (see [:MMEMory:CDIRectory](#)) or from the directory specified with the absolute file path.

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

List type	Command	File extension
Data list	...:DLIST...	*.dm_iqd
Control list	...:CLIST...	*.dm_iqc
User standard	...:ULIST...	*.dm_stu
User filter files	...:FLIST...	*.vaf
User mapping lists	...:MLIST...	*.vam

**Setting parameters:**

&lt;Filename&gt; string

**Example:** See [Example "Performing general tasks"](#) on page 816**Usage:** Setting only**Manual operation:** See ["Select Data List"](#) on page 257**[:SOURce<hw>]:BB:DM:CLIST:FREE?****[:SOURce<hw>]:BB:DM:FLIST:FREE?****[:SOURce<hw>]:BB:DM:MLIST:FREE?****[:SOURce<hw>]:BB:DM:DLIST:FREE?**

Queries the list free memory.

List type	Command	File extension
Data list	...:DLIST...	*.dm_iqd
Control list	...:CLIST...	*.dm_iqc
User filter files	...:FLIST...	*.vaf
User mapping lists	...:MLIST...	*.vam

**Return values:**

&lt;Free&gt; integer

Range: 0 to INT\_MAX

\*RST: 0

**Example:** See [Example "Performing general tasks"](#) on page 816**Usage:** Query only**[:SOURce<hw>]:BB:DM:CLIST:POINTs?**

Queries the number of lines (2 bytes) in the currently selected list.

**Return values:**

&lt;Points&gt; integer

Range: 0 to INT\_MAX

\*RST: 0

**Example:** SOURce:BB:DM:CLIST:SElect "c\_list"

SOURce:BB:DM:CLIST:POINTs?

Response: 20

(the control list consists of 20 lines)

**Usage:** Query only



**[ :SOURce<hw>]:BB:DM:DLIST:POINTs <Points>**

Defines the number of bits in the selected data list to be utilized. When a list is being filled with block data, this data is only ever sent in multiples of 8 bits. However the exact number of bits to be exploited can be set to a different figure. The superfluous bits in the list are then ignored.

**Parameters:**

<Points> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0

**Example:**

SOURce:BB:DM:DLIST:POINTs 234

Defines the number of bits in the data list to be utilized as 234 bits. If the list was filled with block data, at least the last 6 bits are ignored.

**[ :SOURce<hw>]:BB:DM:FLIST:POINTs?****[ :SOURce<hw>]:BB:DM:MLIST:POINTs?**

Queries the user modulation mapping/user filter list length.

**Return values:**

<Points> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0

**Example:**

BB:DM:FORM USER  
 BB:DM:MLIS:POIN?

**Usage:**

Query only

**[ :SOURce<hw>]:BB:DM:CLIST:COPY <Filename>****[ :SOURce<hw>]:BB:DM:DLIST:COPY <Filename>**

Copies the selected data list (\*.dm\_iqd)/ control list (\*.dm\_iqc) as a new list with name specified by <Filename>. If a list with the specified name exists, it is overwritten. If it does not yet exist, it is created.

The source file has to be available in the default directory (see [:MMEMory:CDIRectory](#)).

Refer to [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724 for general information on file handling in the default and a specific directory.

**Setting parameters:**

<Filename> string

**Example:**

See [Example "Performing general tasks"](#) on page 816

**Usage:**

Setting only

**Manual operation:**

See ["Select Data List"](#) on page 257

**[ :SOURce<hw>]:BB:DM:CLIST:DATA <Data>**

Sends the data to the currently selected control list. If the list already contains data, it is *overwritten*. This command only writes data into the data section of the file.

The values for the control signals are sent, arranged in an 8-bit value as defined in [Table 13-4](#).

**Table 13-4: Contents of a control lists**

Signal	Order	Decimal value of bits
Marker 1	LSB	1
Marker 2		2
Marker 3		4
Marker 4		8
Burst	LSB	16
LevAtt1	LSB	32
CWMod	LSB	64
Hop	MSB	128

The data can also be sent as a binary block, each binary block being a 2-byte value in which the 16 bits represent the binary values (16-bit unsigned integer, 2 bytes, LSB first).

When binary data transmission is in use, use the command `:SYSTem:COMMunicate:GPIB:LTERminator EOI` to set the termination character mode to 'EOI control data message only' so that a random LF in the data sequence is not interpreted as `End`, thereby prematurely terminating the data transmission. The command `...LTER STAN` resets the mode.

According to the specifications, the byte sequence is defined as 'most significant byte first'.

**Tip:** Control lists are created in binary format. You may however need the control list in an ASCII format, e.g for creating a waveform file with R&S WinIQSIM2. Refer to the example in ["How to Create a Control List Using Tag File Format"](#) on page 906 for description on how to create a control list file in ASCII format manually.

\*RST has no effect on data lists.

**Setting parameters:**

<Data> string

**Example:**

```
MMEMoRY:CDIRECTory "/var/user/clists"
SOURce1:BB:DM:CLIST:SElect "clist_marker4"
SOURce1:BB:DM:CLIST:DATA
0,0,0,0,8,8,8,0,0,0,0...
```

Enters the control values in list `clist_marker4`. In the example, only ramps for Marker 4 are set.

**Usage:** Setting only

**Manual operation:** See ["Select Ramp to Edit"](#) on page 270

---

```
[ :SOURce<hw>]:BB:DM:DLIST:DATA <Data>
[ :SOURce<hw>]:BB:DM:DLIST:DATA? [<Start>[, <Count>]]
```

The **Setting** command sends the bit data to the selected data list. Any existing content in the list is *overwritten*. This command only writes data into the data section of the file.

Data can be sent as block data in binary or packet format (:FORMat ASCii | PACKed), each byte being interpreted as 8 data bits.

When binary data transmission is in use, use the command :SYSTem:COMMunicate:GPIB:LTERminator EOI to set the termination character mode to 'EOI control data message only' so that a random LF in the data sequence is not interpreted as End, thereby prematurely terminating the data transmission. The command . . .LTER STAN resets the mode.

According to the specifications, the byte sequence is defined as 'most significant byte first'.

The **query** reads out the data part of the list file. If the query is expanded by using the two parameters <Start> and <Count>, the list is read out in smaller sections. Without the parameters the total length is always read out starting from address 1.

\*RST has no effect on data lists.

**Parameters:**

<Data>                    integer  
                             bit data

**Query parameters:**

<Start>                    integer  
                             Range:        1 to 2147483647

<Count>                    integer  
                             Range:        1 to 2147483647

**Example:**                see [Example "Performing general tasks"](#) on page 816

---

```
[ :SOURce<hw>]:BB:DM:DLIST:DATA:APPend <Bits>
```

Appends the bit data onto the end of the existing data in the selected data list. Existing content in the data list is not overwritten. Hence, you can create long data lists piece-meal.

The command cannot be used with an empty data list, like for example data lists that has just been created. Use the command [ :SOURce<hw>]:BB:DM:DLIST:DATA first and enter modulation data in the list.

\*RST has no effect on data lists.

**Setting parameters:**

<Bits>                    0 | 1 {,0 | 1 } | block data

**Example:**                See [Example "Performing general tasks"](#) on page 816

**Usage:**                    Setting only

**[:SOURce<hw>]:BB:DM:CLIST:TAG?**

**[:SOURce<hw>]:BB:DM:DLIST:TAG?**

Queries the content of the specified tag in the selected file.

**Return values:**

<Tag>                                    <control list>,<tag name>

Refer to "[Tag Description](#)" on page 889 for description of the available tag formats.

**Example:**

SOURce1:BB:DM:DLIST:TAG? "D\_list","date"  
queries the Date tag in list D\_list.

**Usage:**

Query only

### 13.18.3.3 SOURce:BB:ARbitrary Subsystem

This section list the commands of the SOURce:BB:ARbitrary subsystem.

#### Suffixes in the keywords ENTity<ch> and SOURce<hw>

You can address multiple entities configurations by using the SCPI commands starting with the keyword SOURce or the alias commands starting with the keyword ENTity.

*Table 13-5: Value ranges of the suffixes ENTity<ch> and SOURce<hw> in advanced configuration with multiple entities*

SCPI Syntax	ENTity<ch>	SOURce<hw>
SOURce<hw>:BB:...	-	1 .. 8
ENTity<ch>:SOURce<hw>:BB:...	1	1 .. 8
	2 .. 4	1 .. 4



See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

The commands are grouped in the following sections:

- [Programming Examples](#)..... 845
- [General Commands](#)..... 853
- [Test Signal Commands](#)..... 853
- [Waveform Commands](#)..... 856
- [Multi-Segment Commands](#)..... 862
- [Multi-Segment Sequencing Commands](#)..... 866
- [Multi-Carrier Commands](#)..... 869
- [Trigger Commands](#)..... 879
- [Marker Commands](#)..... 884
- [Clock Commands](#)..... 887

## Programming Examples

### Example: Creating test signals

The following example lists commands necessary to configure the different test signals.

```
// *****
// Reset instrument first
// *****
*RST; *CLS
SOURce:BB:ARbitrary:PRESet

// *****
// Create test signals
// *****
SOURce:BB:ARbitrary:TSIGnal:CIQ:I -0.5
SOURce:BB:ARbitrary:TSIGnal:CIQ:Q -0.33
SOURce:BB:ARbitrary:TSIGnal:CIQ:CREate

SOURce:BB:ARbitrary:TSIGnal:SINE:FREQuency 1MHz
SOURce:BB:ARbitrary:TSIGnal:SINE:SAMPles 100
SOURce:BB:ARbitrary:TSIGnal:SINE:PHASe -90
SOURce:BB:ARbitrary:TSIGnal:SINE:CREate:NAMed "/var/user/ARBtestSignals/sineTest"

SOURce:BB:ARbitrary:TSIGnal:RECTangle:FREQuency 100KHz
SOURce:BB:ARbitrary:TSIGnal:RECTangle:SAMPles 1000
SOURce:BB:ARbitrary:TSIGnal:RECTangle:AMPLitude 0.5
SOURce:BB:ARbitrary:TSIGnal:RECTangle:OFFSet -0.3
SOURce:BB:ARbitrary:TSIGnal:RECTangle:CREate:NAMed "/var/user/ARBtestSignals/rectTest"

SOURce:ARbitrary:STATe ON
```

### Example: Managing waveform files

The following example lists the commands provided for handling of waveform files.

```
// *****
// Reset instrument first
// *****
*RST; *CLS
SOURce:BB:ARbitrary:PRESet

// *****
// Set the default directory and list the available waveform files
// *****
MMEM:CDIR "/var/user/ARBtestSigs"
SOURce:BB:ARbitrary:WAVEform:CATalog?
// sineTest,rectTest,ciqTestSignal,waveformTest,test2
SOURce:BB:ARbitrary:WAVEform:CATalog:LENGth?
// 5
```

```

// SOURce:BB:ARBitrary:WAVeform:FREE?

// *****
// Select a waveform and query information
// *****
// SOURce:BB:ARBitrary:WAVeform:DELeTe "/var/user/ARBtestSigs/test2"
SOURce:BB:ARBitrary:WAVeform:SELeCt "/var/user/ARBtestSigs/wvTest"
SOURce:BB:ARBitrary:WAVeform:POINts?
// 100
SOURce:BB:ARBitrary:WAVeform:TAG? "TYPE"
// "SMU-WV"
SOURce:BB:ARBitrary:WAVeform:TAG? "COMMENT"
// "Waveform for test purposes"
// alternatively: query the comment tag of the current waveform file
// SOURce:BB:ARBitrary:WAVeform:DATA? "comment"
// "Waveform for test purposes"

// to query the date tag of a specific waveform file
// SOURce:BB:ARBitrary:WAVeform:DATA? "/var/user/ARBtestSigs/waveformTest","date"
// #2192014-04-15;16:19:30

// *****
// Clock settings
// *****
SOURce:BB:ARBitrary:CLOCK:SOURce INTernal
SOURce:BB:ARBitrary:CLOCK?
// 10000000
// or alternatively use SOURce:BB:ARBitrary:WAVeform:TAG? "CLOCK"

// *****
// Configure and enable standard marker signals
// *****
SOURce:BB:ARBitrary:TRIGger:OUTPut1:MODE REStArt
SOURce:BB:ARBitrary:TRIGger:OUTPut2:MODE PULSe
SOURce:BB:ARBitrary:TRIGger:OUTPut2:PULSe:DIVider 5
SOURce:BB:ARBitrary:TRIGger:OUTPut2:PULSe:FREQuency?
// 20000000
SOURce:BB:ARBitrary:TRIGger:OUTPut3:MODE PATtern
SOURce:BB:ARBitrary:TRIGger:OUTPut3:PATtern #HE0F52,20
SOURce:BB:ARBitrary:TRIGger:OUTPut1:MODE RATio
SOURce:BB:ARBitrary:TRIGger:OUTPut1:ONTime 40
SOURce:BB:ARBitrary:TRIGger:OUTPut1:OFFTime 20

SOURce:BB:ARBitrary:TRIGger:OUTPut2:DELay 16
SOURce:BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed ON
SOURce:BB:ARBitrary:TRIGger:OUTPut1:DELay:MINimum?
// 0
SOURce:BB:ARBitrary:TRIGger:OUTPut1:DELay:MAXimum?
// 2000

```

```

// *****
// Configure and enable signal triggering; start ARB generator
// *****
SOURce:BB:ARbitrary:TRIGger:SEQuence SINGLE
SOURce:BB:ARbitrary:TRIGger:SLENgth 200
// the first 200 samples of the current waveform will be output after
// the next trigger event
// SOURce:BB:ARbitrary:TRIGger:SEQuence ARETrigger
// SOURce:BB:ARbitrary:TRIGger:SOURce EGT1
// external trigger signal must be provided at the USER connector
// SOURce:BB:ARbitrary:TRIGger:EXTErnal:SYNChronize:OUTPut ON
// SOURce:BB:ARbitrary:TRIGger:EXTErnal:DELay 200
// SOURce:BB:ARbitrary:TRIGger:EXTErnal:INHibit 100

// SOURce:BB:ARbitrary:TRIGger:SOURce INTB
// the internal trigger signal from the other path must be used
// SOURce:BB:ARbitrary:TRIGger:OBASeband:DELay 25
// SOURce:BB:ARbitrary:TRIGger:OBASeband:INHibit 10

SOURce:BB:ARbitrary:TRIGger:SEQuence AAUTO
SOURce:BB:ARbitrary:TRIGger:SOURce INTernal
SOURce:BB:ARbitrary:STAT ON
SOURce:BB:ARbitrary:TRIGger:EXEC

```

#### Example: Specifying delay and inhibit values in time units

The following example lists the commands necessary to configure the instrument as described in ["Specifying delay and inhibit values in time units"](#) on page 232.

```

SOURcel:BB:ARbitrary:CLOCK 1000000
SOURcel:BB:ARbitrary:TRIGger:SEQuence AAUT
SOURcel:BB:ARbitrary:TRIGger:SOURce EGT1
SOURcel:BB:ARbitrary:TRIGger:DELay:UNIT SAMP
SOURcel:BB:ARbitrary:TRIGger:EXTErnal1:DELay 100
SOURcel:BB:ARbitrary:TRIGger:EXTErnal1:RDELay?
// Response: 100

SOURcel:BB:ARbitrary:TRIGger:DELay:UNIT TIME
SOURcel:BB:ARbitrary:TRIGger:EXTErnal1:TDELay 0.00001
SOURcel:BB:ARbitrary:TRIGger:EXTErnal1:RDELay?
// Response: 0.00001

SOURcel:BB:ARbitrary:TRIGger:DELay:UNIT SAMP
SOURcel:BB:ARbitrary:TRIGger:EXTErnal1:DELay 10

```

#### Example: Creating a multi-segment waveform

The following example lists the commands necessary to create a multi-segment waveform.

```

// *****
// Reset instrument first
// *****
*RST; *CLS
// SOURce:BB:ARbitrary:PRESet

// *****
// Set the default directory and list the available waveform files
// *****
MMEM:CDIR "/var/user/ARB/multi_segment"
SOURce:BB:ARbitrary:WAVEform:CATALog:LENGth?
// 4
SOURce:BB:ARbitrary:WAVEform:CATALog?
// Seg_0, Seg_1, Seg_2, Seg_3
// *****
// List the available configuration files and select/create file
// *****
SOURce:BB:ARbitrary:WSEGment:CONFIgure:CATALog?
// multi_segment,ms_waveform
// the directory contains the configuration files multi_segment.inf_mswv
// and ms_waveform.inf_mswv
SOURce:BB:ARbitrary:WSEGment:CONFIgure:DELeTe "ms_waveform.inf_mswv"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SELeCt
"/var/user/ARB/multi_segment/config.inf_mswv"
// creates new empty configuration file config.inf_mswv

// *****
// Append waveforms to the multi segment sequence
// *****
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SEGment:APPend "Seg_0"
// Waveform Seg_0.wv will be the first segment of a
// multi segment waveform created with configuration file config.inf_mswv
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SEGment:APPend "Seg_1"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SEGment:APPend "Seg_2"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SEGment:APPend "Seg_3"

SOURce:BB:ARbitrary:WSEGment:CONFIgure:BLAnk:APPend 1000,100000000
// adds a blank segment with 1000 samples and 100 MHz clock rate

SOURce:BB:ARbitrary:WSEGment:CONFIgure:LEVel:MODE ERMS
SOURce:BB:ARbitrary:WSEGment:CONFIgure:CLOCk:MODE HIGHest
// SOURce:BB:ARbitrary:WSEGment:CONFIgure:CLOCk:MODE USER
// SOURce:BB:ARbitrary:WSEGment:CONFIgure:CLOCk 30000000
SOURce:BB:ARbitrary:WSEGment:CONFIgure:MARKer:MODE TAKE

SOURce:BB:ARbitrary:WSEGment:CONFIgure:SELeCt
"/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:COMMeNt "Multi Segment File"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:OFILe "ms_0to3"
SOURce:BB:ARbitrary:WSEGment:CONFIgure:SEGment:CATALog?

```



```
// /var/user/ARB/multi_segment/Seg_0.wv,/var/user/ARB/multi_segment/Seg_1.wv,
// /var/user/ARB/multi_segment/Seg_2.wv,/var/user/ARB/multi_segment/Seg_3.wv

// *****
// Create and load the waveforms into the ARB generator; the ARB is activated
// the first segment is output depending on the trigger settings
// *****
// SOURce:BB:ARBitrary:WSEGment:CREate "/var/user/ARB/multi_segment/config.inf_mswv"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTO
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STAT ON
SOURce:BB:ARBitrary:TRIGger:EXEC
```

### Example: Configuring the output order of the segments

The following example lists the commands necessary to trigger the output of the segments in desired playback order. The example lists only the relevant commands.

We assume, that the multi-segment sequence `ms_0to3` composed of four segments, `Seg_0`, `Seg_1`, `Seg_2` and `Seg_3` is created and loaded in the ARB (see [Example "Creating a multi-segment waveform"](#) on page 847). The required output order of the segments is `Seg_0`, `Seg_3 [2]`, `Seg_2`.

```
// *****
// Select a multi segment waveform
// *****
MMEM:CDIR "/var/user/ARB/multi_segment"
SOURce:BB:ARBitrary:WSEGment:CONFigure:CATalog?
// config
SOURce:BB:ARBitrary:WSEGment:CONFigure:SElect "config"
SOURce:BB:ARBitrary:WSEGment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3"
SOURce:BB:ARBitrary:WSEGment:CLOad "/var/user/ARB/multi_segment/config.inf_mswv"

// *****
// Adjust trigger settings and enable the ARB
// *****
SOURce:BB:ARBitrary:TRIGger:SEQuence AAUTO
SOURce:BB:ARBitrary:TRIGger:SOURce INTernal
SOURce:BB:ARBitrary:STATe ON

// *****
// Select the next segment trigger mode and source
// *****
SOURce:BB:ARBitrary:TRIGger:SMODE NEXT
// SOURce:BB:ARBitrary:TRIGger:SMODE NSEam
SOURce:BB:ARBitrary:WSEGment:NEXT:SOURce INTernal

SOURce:BB:ARBitrary:WSEGment?
```

```

// 0
SOURCE:BB:ARbitrary:WSEgment:NAME?
// "/var/user/ARB/multi_segment/Seg_0.wv"
// Seg_0 is output continuously

// *****
// Trigger a switch over to the next segment
// *****
SOURCE:BB:ARbitrary:WSEgment:NEXT 3
// stops Seg_0 and starts immediatly Seg_3; Seg_3 is output continuously
SOURCE:BB:ARbitrary:TRIGger:EXECute
//restarts Seg_3
SOURCE:BB:ARbitrary:WSEgment:NEXT 2
SOURCE:BB:ARbitrary:WSEgment:NEXT 0

// *****
// Scrolling trough the segments, i.e. shwitch over in incremental order
// *****
SOURCE:BB:ARbitrary:WSEgment:NEXT:EXECute
SOURCE:BB:ARbitrary:WSEgment?
// 1
SOURCE:BB:ARbitrary:WSEgment:NEXT:EXECute
SOURCE:BB:ARbitrary:WSEgment?
// 2

```



Refer to ["To apply a manual segment switch to the output segments in the required order"](#) on page 332 for description of the steps necessary to achieve a similar task via manual operation of the instrument.

### Example: Using the ARB sequencer

The following example lists the commands necessary to configure a play list. The example lists only the relevant commands.

We assume, that the multi-segment sequence `ms_0to3` composed of four segments, `Seg_0`, `Seg_1`, `Seg_2` and `Seg_3` is created and loaded in the ARB (see [Example "Creating a multi-segment waveform"](#) on page 847). The required output order of the segments is `Seg_0`, `Seg_3 [2]`, `Seg_2`.



The ARB Sequencer mode requires waveform files with equal clock rate!

```

// *****
// Select a multi segment waveform composed from waveforms with equal clock rates
// *****
MMEM:CDIR "/var/user/ARB/multi_segment"
SOURCE:BB:ARbitrary:WSEgment:CONFigure:CATalog?
// config
SOURCE:BB:ARbitrary:WSEgment:CONFigure:SElect "config"

```

```

SOURce:BB:ARbitrary:WSEgment:CLoad "/var/user/ARB/multi_segment/config.inf_msvv"
SOURce:BB:ARbitrary:WSEgment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// *****
// Select a sequencing list (*.wvs)
// *****
SOURce:BB:ARbitrary:WSEgment:SEquence:SElect "play_list"
SOURce:BB:ARbitrary:WSEgment:SEquence:APPend ON,0,1,NEXT
// adds the segment number 0 as a new (first) segment in the sequencing list
// this segment is activ and will be repeated once followed by the next segment
SOURce:BB:ARbitrary:WSEgment:SEquence:APPend ON,3,2,NEXT
SOURce:BB:ARbitrary:WSEgment:SEquence:APPend ON,2,1,SEGO

SOURce:BB:ARbitrary:TRIGger:SMODE SEQuencer
SOURce:BB:ARbitrary:TRIGger:SEquence AAUTO
SOURce:BB:ARbitrary:TRIGger:SOURce INTERNAL
SOURce:BB:ARbitrary:STAT ON
SOURce:BB:ARbitrary:TRIGger:EXEC

```



Refer to ["To apply a manual segment switch to the output segments in the required order"](#) on page 332 for description of the steps necessary to achieve a similar task via manual operation of the instrument.

### Example: Adding extra marker signals

The following example lists the commands necessary to add two marker signals, a sequence restart marker and a segment restart marker, to the multi-segment sequence. The example lists only the relevant commands.

```

// *****
// Select the multi segment file and the corresponding configuration list
// *****
MME:CDIR "/var/lists/ARB/multi_segment"
SOURce:BB:ARbitrary:WSEgment:CONFigure:CATalog?
// config
SOURce:BB:ARbitrary:WSEgment:CONFigure:SElect "config"
SOURce:BB:ARbitrary:WSEgment:CLoad "/var/user/ARB/multi_segment/config.inf_msvv"
SOURce:BB:ARbitrary:WSEgment:CONFigure:OFILe?
// "/var/user/ARB/multi_segment/ms_0to3.wv"

// *****
// Enable restart markers on marker trace 1 and 2
// *****
SOURce:BB:ARbitrary:WSEgment:CONFigure:MARKer:MODE IGNore
SOURce:BB:ARbitrary:WSEgment:CONFigure:MARKer:FSEgment MRK1
SOURce:BB:ARbitrary:WSEgment:CONFigure:MARKer:ESEgment MRK2

SOURce:BB:ARbitrary:TRIGger:OUTPut1:MODE UNCHanged
SOURce:BB:ARbitrary:TRIGger:OUTPut2:MODE UNCHanged

```

**Example: Generating a multi carrier signal**

The following example lists the commands necessary to generate a multi carrier signal.

```
// *****
// Generating a multi carrier signal
// *****
// Load a standardized 3GPP downlink test model, e.g. "Test Model 1 16 Channels"
SOURcel:BB:W3Gpp:SETTing:TMODeL:BSTation "Test_Model_1_16channels"
// Confirm that the standardized 3GPP downlink test model is currently selected
SOURcel:BB:W3Gpp:SETTing:TMODeL:BSTation?
// "Test_Model_1_16channels"
// Enable the generation of 3GPP FDD signal
SOURcel:BB:W3Gpp:STATe ON
// Generate a 3GPP FDD ARB waveform file with name "3gpp_arb"
// store the waveform in the default directory ("/var/user")
SOURcel:BB:W3Gpp:WAVEform:CREate "3gpp_arb"

// *****
// Configure a multi carrier scenario with 4 carriers
// and carrier spacing of 5 MHz
// Activate the carriers
// *****
SOURcel:BB:ARBitrary:MCARrier:CARRier:COUNT 4
SOURcel:BB:ARBitrary:MCARrier:CARRier:SPACing 5 MHz
SOURcel:BB:ARBitrary:MCARrier:CARRier1:STATe ON
SOURcel:BB:ARBitrary:MCARrier:CARRier2:STATe ON
SOURcel:BB:ARBitrary:MCARrier:CARRier3:STATe ON
SOURcel:BB:ARBitrary:MCARrier:CARRier4:STATe ON

// *****
// Select and load the waveform file "3gpp_arb" to all 4 carriers
// (the file "3gpp_arb" is in default directory)
// *****
SOURcel:BB:ARBitrary:MCARrier:CARRier1:FILE "3gpp_arb"
SOURcel:BB:ARBitrary:MCARrier:CARRier2:FILE "3gpp_arb"
SOURcel:BB:ARBitrary:MCARrier:CARRier3:FILE "3gpp_arb"
SOURcel:BB:ARBitrary:MCARrier:CARRier4:FILE "3gpp_arb"

// *****
// Trigger the signal caulation and load the waveform in the ARB generator
// *****
// Define the file name of the multi carrier output file, e.g. "3gpp_mc"
SOURcel:BB:ARBitrary:MCARrier:OFIle "3gpp_mc"
// Create and load the multi carrier waveform file in the ARB generator
SOURcel:BB:ARBitrary:MCARrier:CLoad
// Alternatively: create the multi carrier waveform and
// load it subsequently in the ARB generator
// SOURcel:BB:ARBitrary:MCARrier:CREate
// SOURcel:BB:ARBitrary:WAVEform:SELEct"3gpp_mc"
```

```
// Activate the ARB generator
SOURcel:BB:ARbitrary:STATe ON

// *****
// Use the save/recall function to store the settings
// *****
// Query available settings files in a specified directory
MMEM:CDIR "/var/user/waveform"
SOURcel:BB:ARbitrary:MCARrier:SETTing:CATalog?
// mcar1, mcar2
// the directory contains the settings files mcar1.arb_multcarr and mcar2.arb_multcarr
SOURcel:BB:ARbitrary:MCARrier:SETTing:STORe "3gpp_mc"
```

### General Commands

---

#### [[:SOURce<hw>]:BB:ARbitrary:PRESet

Sets all ARB generator parameters to their default values.

**Example:** see ["Programming Examples"](#) on page 845

**Usage:** Event

**Manual operation:** See ["Set To Default"](#) on page 294

---

#### [[:SOURce<hw>]:BB:ARbitrary:STATe <State>

Enables the ARB generator.

A waveform must be selected before the ARB generator is activated.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** See ["Programming Examples"](#) on page 845

**Manual operation:** See ["State"](#) on page 293

---

### Test Signal Commands

---

[[:SOURce<hw>]:BB:ARbitrary:TSIGnal:CIQ:I <I>  
 [[:SOURce<hw>]:BB:ARbitrary:TSIGnal:CIQ:Q <TSig>

Sets the value for the I and Q component of the test signal

**Parameters:**

<TSig> float  
 Range: -1 to 1  
 Increment: 0.001  
 \*RST: 0  
 Default unit: FS

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See "[I Value, Q Value](#)" on page 301

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:RECTangle:AMPLitude <Amplitude>**

Sets the digital amplitude of the rectangular wave.

**Parameters:**

<Amplitude> float  
 Range: 0 to 1  
 Increment: 0.001  
 \*RST: 0.800  
 Default unit: FS

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See "[Amplitude](#)" on page 300

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:RECTangle:FREQuency <Frequency>**

Sets the frequency of the test signal.

**Parameters:**

<Frequency> float  
 Range: 100 to depends on hardware  
 Increment: 0.01  
 \*RST: 1000

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See "[Frequency](#)" on page 299

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:RECTangle:OFFSet <Offset>**

Sets the DC component.

**Parameters:**

<Offset> float  
 Range: -1 to 1  
 Increment: 0.001  
 \*RST: 0  
 Default unit: FS

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See "[Offset DC](#)" on page 300

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:RECTangle:SAMPles <Samples>**

Sets the number of sample values required for the rectangular signal per period.

**Parameters:**

<Samples> integer  
 Range: 4 to 1000  
 \*RST: 100

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See ["Samples per Period"](#) on page 299

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:SINE:FREQuency <Frequency>**

Sets the frequency of the simple sinusoidal test signal.

**Parameters:**

<Frequency> float  
 Range: 100 to depends on hardware  
 Increment: 0.01  
 \*RST: 1000  
 Default unit: Hz

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See ["Frequency"](#) on page 297

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:SINE:PHASe <Phase>**

Sets the phase offset of the sine wave on the Q channel relative to the sine wave on the I channel.

**Parameters:**

<Phase> float  
 Range: -180 to 180  
 Increment: 0.01  
 \*RST: 90  
 Default unit: DEG

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See ["Phase Offset Q"](#) on page 298

**[:SOURce<hw>]:BB:ARbitrary:TSIGnal:SINE:SAMPles <Samples>**

Sets the sample rate for the sine signal in samples per period.

The resulting clock rate must not exceed the maximum ARB clock rate (see data sheet).

The maximum value is automatically restricted by reference to the set frequency and has to fulfill the rule  $Frequency * Samples \leq ARB \text{ clock rate}$ .

**Parameters:**

<Samples> integer  
 Range: 4 to 1000  
 \*RST: 100

**Example:** see [Example "Creating test signals"](#) on page 845

**Manual operation:** See ["Samples per Period"](#) on page 298

```
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed <Filename>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed <Filename>
```

Generates a signal and saves it to a waveform file.

**Setting parameters:**

<Filename> string

**Example:** see [Example "Creating test signals"](#) on page 845

**Usage:** Setting only

**Manual operation:** See ["Generate Signal HD"](#) on page 298

```
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate
```

Generates a signal and uses it as output straight away.

**Example:** see [Example "Creating test signals"](#) on page 845

**Usage:** Event

**Manual operation:** See ["Generate Signal RAM"](#) on page 298

**Waveform Commands**

The following rule applies for all commands described in this section.

By default, the waveform files are saved in the default directory of the instrument, that is the `/var/user/` directory or the directory specified with the command `:MMEMory:CDIRectory`. To access the waveform files in this default directory, only the file name is required, without the path and the file extension (`*.wv`).

However, to access waveform files located in a directory different to the default one, the complete file path and file name are required.

```
[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?
```

Reads out the files extension `*.wv` in the default directory.



**Return values:**

<Catalog> string  
Returns a list of the file names separated by commas

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**[:SOURce<hw>]:BB:ARbitrary:WAVEform:CATalog:LENGth?**

Reads out the files with extension \* .wv in the default directory and returns the number of waveform files in this directory. The default directory is set using command `MMEM:CDIRectory`.

**Return values:**

<Length> integer  
Number of waveform files in default directory  
Range: 0 to INT\_MAX  
\*RST: 0

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**[:SOURce<hw>]:BB:ARbitrary:WAVEform:SELEct <Filename>**

Selects an existing waveform file, i.e. file with extension \* .wv.

**Parameters:**

<Filename> string

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Load Waveform/File"](#) on page 294

**[:SOURce<hw>]:BB:ARbitrary:WAVEform:DELEte <Filename>**

Deletes the specified waveform file. If the file is not on the default path, the path must be specified at the same time. The file extension may be omitted. Only files with the file extension \* .wv are deleted.

**Setting parameters:**

<Filename> string

**Example:** See [Example "Managing waveform files"](#) on page 845

**Usage:** Setting only

**[:SOURce<hw>]:BB:ARbitrary:WAVEform:FREE?**

Queries the free disk space on the default path of the instrument's hard disk.

**Return values:**

<Free> integer  
 Range: 0 to INT\_MAX  
 \*RST: 1

**Example:** See [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**[ :SOURce<hw> ]:BB:ARbitrary:WAVEform:POINTS?**

Queries the number of samples (the number of I/Q values pairs) in the selected waveform file.

**Return values:**

<Points> <waveform filename>  
 Range: 0 to 1000  
 \*RST: 1

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**[ :SOURce<hw> ]:BB:ARbitrary:WAVEform:DATA <Filename>, <Data>**  
**[ :SOURce<hw> ]:BB:ARbitrary:WAVEform:DATA? [<Filename>, ]<Tag>**

The **setting** command writes the binary block data <data> to the file identified by <filename>. The *complete content* of the waveform file (i.e. including all tags) must be specified; the complete content is transmitted as binary data block.

I/Q data and the marker data can also be written to a file with the command : [MMEMoRY:DATA:UNPRotected](#).

**Tip:** To ensure trouble-free data transmission, set the GPIB delimiter to EOI.

The **query** command retrieves the content of the specified tag of the currently selected waveform file or the waveform file specified with the <filename>.

See also ["Tag Description"](#) on page 889.

**Setting parameters:**

<Data> block data

**Query parameters:**

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' |  
 'poweroffset'

**Parameters for setting and query:**

<Filename> string  
 Specifies the name of the waveform file in that the binary data is copied

**Example:** **Query**  
 See [Example "Managing waveform files"](#) on page 845

**Example:**                   **Setting**  
 SOURce:BB:ARB:WAVEform:DATA  
 "/var/user/test1.wv",#3767<binary data>  
 Writes the binary block data <binary data> to file  
 test1.wv'.

#### **[:SOURce<hw>]:BB:ARbitrary:WAVEform:TAG?**

Queries the content of the specified tag of the selected waveform file (see also [Chapter 13.18.3.4, "Waveform, Data and List Format"](#), on page 888).

**Return values:**

<Tag>                    'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' |  
 'poweroffset' | 'samples'

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Usage:**                    Query only

#### **[:SOURce<hw>]:BB:ARbitrary:CLOCK <Clock>**

Sets the clock rate in samples.

If you load a waveform, the clock rate is determined as defined with the waveform tag {**CLOCK: frequency**}. This command subsequently changes the clock rate; see data sheet for value range.

In the case of an external clock source, the clock of the external source must be entered with this command.

**Parameters:**

<Clock>                    float  
                               Range:     400 to 200.0E6  
                               Increment: 0.001

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Manual operation:**    See ["Clock Frequency"](#) on page 295

#### **[:SOURce<hw>]:BB:ARbitrary:COUPled:STATe <State>**

In an instrument configuration with [Coupled sources](#), selects that all basebands use the same waveform.

**Parameters:**

<State>                    0 | 1 | OFF | ON  
                               \*RST:     0

**Example:**

```

SCONfiguration:PRESet
SCONfiguration:MODE ADV
SCONfiguration:FADing SISO4X1X1
SCONfiguration:BASEband:SOURce COUP
SCONfiguration:APPLY

ENTity1:SOURce1:BB:ARbitrary:COUPled:STATe 0
ENTity1:SOURce1:BB:ARbitrary:WAVEform:SElect "/var/user/lte"
ENTity1:SOURce2:BB:ARbitrary:WAVEform:SElect "/var/user/lte"
ENTity1:SOURce3:BB:ARbitrary:WAVEform:SElect "/var/user/3gpp"
ENTity1:SOURce4:BB:ARbitrary:WAVEform:SElect "/var/user/gsm"
ENTity1:SOURce4:BB:ARbitrary:COUPled:TRIGger:DElay:OFFSet 100
SOURce1:BB:ARbitrary:STATe 1

```

**Manual operation:** See ["Use one Waveform for all basebands"](#) on page 294

**[:SOURce<hw>]:BB:ARbitrary:COUPled:TRIGger:DElay:OFFSet <Offset>**

Sets a time delay to delay the waveform processing of a particular baseband.

**Parameters:**

<Offset>	float
Range:	0 to 688
Increment:	250E-12
*RST:	0

**Example:** see `[ :SOURce<hw> ] :BB:ARbitrary:COUPled:STATe` on page 859

**Manual operation:** See ["Delay"](#) on page 295

**:MMEMory:DATA:UNPRotected <Msus>, <Data>**

The **setting** command sends the I/Q data and the marker data to the file defined with the <Msus> parameter. The required tags are created automatically so that the file content follows the waveform file format.

The **query** reads out the I/Q data part or the marker information of the specified file.

Waveform files can also be created with the command `[ :SOURce<hw> ] :BB:ARbitrary:WAVEform:DATA`. In this case, the *complete content* of the waveform file must be specified, i.e. not only the I/Q or marker data but all required tags.

(see [Chapter 13.18.3.4, "Waveform, Data and List Format"](#), on page 888).

**Parameters:**

<Msus> <Identifier>:<file name>  
 Mass Storage Unit Specifier  
 A string that specifies whether I/Q data (NVWFM) or marker data (NVMKR) is transferred and the file name the data is stored in. If the file with the specified name does not exist, a file is created. Any existing content in the file is *overwritten*. Complete file path and file extension can also be specified. If omitted, files are stored in the default directory and the extension \*.wv is assigned to the file name.

**Setting parameters:**

<Data> block data  
 I/Q data or marker binary data, where the number of marker elements should be equal to the number of I/Q samples

**I0Q0..IxQx...IN-1QN-1**  
 IxQx... represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each component consists of 2 bytes in MSB format (most significant byte first). The values of the 2 bytes in an I component and a Q component are in the range: -32768 to +32767.

**M0M1...Mx...MN-1**  
 Mx represents one marker byte, where only the last 4 bits are used. These 4 bits are assigned to the 4 possible markers of the instrument, 1 bit per marker: Bit<sub>0</sub> = Marker 1, ... Bit<sub>3</sub> = Marker 4. One 4-bit marker element is required for every I/Q sample.

**Example:**

```
:MMEM:DATA:UNPR "NVWFM:/var/user/wave.wv",#232123456789009876543218978
// the specified I/Q data is added to a file named wave.wv
// in the specified directory
:MMEMory:DATA:UNPRotected? "NVWFM:/var/user/wave.wv"
:MMEMory:DATA:UNPRotected "NVMKR:/var/user/wave.wv",#185*7uuf5*
// the specified marker data is added to a file named wave.wv
// in the specified directory
// used are printable values;
// used are only the last 4 bits of a byte
:MMEMory:DATA:UNPRotected? "NVMKR:/var/user/wave.wv"
// note that, the query returns binary values
SOURcel:BB:ARbitrary:WAVeform:CLOCK "/var/user/wave.wv",1.1E6
SOURcel:BB:ARbitrary:WAVeform:CLOCK? "/var/user/wave.wv"
```

---

**[:SOURce<hw>]:BB:ARbitrary:WAVeform:CLOCK <Filename>, <Clock>**

Appends information on the ARB clock rate to specified waveform file. The file must contain I/Q and/or marker data and have been created with the command `:MMEMory:DATA:UNPRotected` on page 860.

**Parameters:**

<Filename> string  
 Complete file path and file name with file extension (\* .wv).  
 If the file is in the default directory, the file path can be omitted.

**Setting parameters:**

<Clock> float  
 Range: 400 to 100E6  
 Increment: 1E-3  
 \*RST: 1E6

**Example:** see [:MMEMory:DATA:UNPRotected](#) on page 860

**Multi-Segment Commands****[ :SOURce<hw> ]:BB:ARBitrary:WSEgment?**

Queries the index of the currently processed segment.

**Return values:**

<WSegment> integer  
 Range: 0 to 1023  
 \*RST: 0

**Example:** see [Example "Configuring the output order of the segments"](#) on page 849

**Usage:** Query only

**Manual operation:** See ["Current Segment/Current Segment Index"](#) on page 328

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:NAME?**

Queries the name of the waveform of the currently output segment of the multi-segment waveform.

**Return values:**

<Name> string

**Example:** See [Example "Configuring the output order of the segments"](#) on page 849

**Usage:** Query only

**Manual operation:** See ["Current Segment/Current Segment Index"](#) on page 328

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:NEXT <Next>**

Selects the segment to be output.

**Parameters:**

<Next> integer  
 Range: 0 to 1023  
 \*RST: 0

**Example:** see [Example "Configuring the output order of the segments"](#) on page 849

**Manual operation:** See ["Segment"](#) on page 329

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:NEXT:EXECute**

Triggers manually switchover to the subsequent segment in the multi-segment file. This command is disabled, if a sequencing play list is enabled.

**Example:** See [Example "Configuring the output order of the segments"](#) on page 849

**Usage:** Event

**Manual operation:** See ["Execute Next Segment"](#) on page 330

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:NEXT:SOURce <Source>**

Selects the next segment source, i.e. determines whether the next segment is switched upon receiving of an external trigger signal or upon executing of software trigger [\[:SOURce<hw>\]:BB:ARbitrary:WSEgment:NEXT:EXECute](#).

**Parameters:**

<Source> INTernal | NSEGM1 | NSEGM2  
 \*RST: INTernal

**Example:** see [Example "Configuring the output order of the segments"](#) on page 849

**Manual operation:** See ["Next Segment Source"](#) on page 330

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:LMODe <LevelMode>**

Sets how the segments are leveled.

**Parameters:**

<LevelMode> HIGHest | UNCHanged  
 \*RST: HIGHest

**Example:** `:SOURce1:BB:ARbitrary:WSEgment:LMODe HIGHest`

**Manual operation:** See ["Level Mode"](#) on page 330

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:SEquence:SElect <Filename>**

Selects the sequencing list (files with extension `*.wvs`)

**Parameters:**

<Filename> string

**Example:** see [Example "Using the ARB sequencer"](#) on page 850

**Manual operation:** See ["New/Load Sequencing List"](#) on page 325

**[:SOURce<hw>]:BB:ARBitrary:WSEgment:SEquence:APPend <State>, <Segment>, <Count>, <Next>**

Appends a new segment to the selected sequencing play list.

**Setting parameters:**

<State> ON | OFF

Activates/deactivates the appended segment

\*RST: ON

<Segment> integer

Indicates the number of the segment as in the multi-segment waveform file

Range: 0 to SegmentCount - 1

<Count> integer

Defines how many times this segment is repeated

Range: 1 to 1048575

<Next> NEXT | BLANK | ENDLess | SEG0 | SEG1 | ... | SEG31 | 0...maxSegment

Determines the action after completing the current segment, like for instance which segment is processed after the processing of the current one is finished.

**Example:** See [Example "Using the ARB sequencer"](#) on page 850

**Usage:** Setting only

**Manual operation:** See ["Append"](#) on page 327

**[:SOURce<hw>]:BB:ARBitrary:WSEgment:CREate <FilenameInput>**

Creates a multi-segment waveform (\*.wv) using the current settings of the specified *configuration file* (\*.inf\_mswv).

**Setting parameters:**

<FilenameInput> Absolute file path, file name of the configuration file and file extension (\*.inf\_mswv)

**Example:** See [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Setting only

**Manual operation:** See ["Save List/Save List As..."](#) on page 318



---

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:CLOad <FilenameInput>**

Creates a multi-segment waveform using the current entries of the specified *configuration file* (\*.inf\_mswv).

The ARB generator is activated, the new multi-segment waveform (\*.wv) is loaded and the first segment is output in accordance to the trigger settings.

**Setting parameters:**

<FilenameInput>      string  
                                  Absolute file path, file name of the configuration file and file extension (\*.inf\_mswv)

**Example:**                See [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:**                    Setting only

**Manual operation:**    See ["Save List/Save List As..."](#) on page 318

---

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:CONFigure:MARKer:MODE <Mode>**

Defines the way the marker information within the separate segments is processed.

**Parameters:**

<Mode>                    IGNore | TAKE  
                                  \*RST:        TAKE

**Example:**                see [Example "Adding extra marker signals"](#) on page 851

**Manual operation:**    See ["Segment Marker"](#) on page 322

---

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:CONFigure:MARKer:ESEgment <Mode>**

**[ :SOURce<hw> ]:BB:ARBitrary:WSEgment:CONFigure:MARKer:FSEgment <Mode>**

Enables/disables the generation of an additional marker restart signal at the beginning of the first segment (FSEgment) or at the beginning of each segment (ESEgment).

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

**Parameters:**

<Mode>                    OFF | MRK1 | MRK2 | MRK3 | MRK4  
                                  \*RST:        OFF

**Example:**                see [Example "Adding extra marker signals"](#) on page 851

**Manual operation:**    See ["Sequence Restart"](#) on page 323

---

**[ :SOURce<hw> ]:BB:ARBitrary:TRIGger:SMODE <SMODE>**

Selects the extended trigger mode for multi segment waveforms.

**Parameters:**

<SMode> SAME | NEXT | SEQuencer | NSEam  
 NSEam = Next Segment Seamless  
 \*RST: NEXT

**Example:** see [Example "Configuring the output order of the segments"](#) on page 849

**Manual operation:** See ["Next Segment Mode"](#) on page 329

**Multi-Segment Sequencing Commands**


---

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:BLANK:APPend**  
 <SampCount>, <Frequency>

Adds a blank segment to the multi-segment file.

**Setting parameters:**

<SampCount> float  
 Specifies the number of samples.  
 Range: 512 to 1E7  
 Increment: 1  
 \*RST: 1000

<Frequency> float  
 Determines the clock rate.  
 Range: 400 Hz to Max (depends on instrument type)  
 Increment: 0.001  
 \*RST: 1E8

**Example:** See [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Setting only

**Manual operation:** See ["Blank Segment"](#) on page 320

---

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:CATalog?**

Queries the available configuration files in the default directory. See also [Chapter 5.6.2.3, "File Concept"](#), on page 312.

**Return values:**

<Catalog> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Load List"](#) on page 318

---

**[ :SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:CLOCK <Clock>**

Defines the clock rate used for multi-segment waveform output if the clock mode is USER.

**Parameters:**

<Clock> float  
Increment: 1E-3  
\*RST: max SampleRate

**Example:** See [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["User Clock Rate"](#) on page 322

---

**[ :SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:CLOCK:MODE <Mode>**

Selects the clock rate mode for the multi segment waveform. Use the command [ :SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:CLOCK to define the clock in clock mode user.

**Parameters:**

<Mode> UNCHanged | HIGHest | USER  
\*RST: UNCHanged

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["Clock"](#) on page 322

---

**[ :SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:COMMENT <Comment>**

Enters a comment for the selected configuration file.

**Parameters:**

<Comment> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["Comment"](#) on page 318

---

**[ :SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:DELeTe <Filename>**

Deletes the selected configuration file.

**Setting parameters:**

<Filename> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Setting only

**Manual operation:** See ["Multi Segment Table, Append/Delete/Shift Seg."](#) on page 320

---

**[[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:LEVel[:MODE] <Mode>**

Selects the level mode, unchanged or equal RMS, for the multi-segment waveform.

**Parameters:**

<Mode> UNCHanged | ERMS  
 \*RST: UNCHanged

**Example:** See [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["Level"](#) on page 322

---

**[[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:OFILe <OFile>**

Defines the file name of the output multi-segment waveform.

**Parameters:**

<OFile> string

**Example:** See [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["Save List/Save List As..."](#) on page 318

---

**[[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:SEGMENT:APPend  
 <Waveform>**

Appends the specified waveform to the configuration file.

**Setting parameters:**

<Waveform> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Setting only

**Manual operation:** See ["Multi Segment Table, Append/Delete/Shift Seg."](#)  
 on page 320

---

**[[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:SEGMENT:CATalog?**

Queries the segments of the currently selected configuration file.

**Return values:**

<Catalog> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Multi Segment Table, Append/Delete/Shift Seg."](#)  
 on page 320

---

**[:SOURce<hw>]:BB:ARbitrary:WSEgment:CONFigure:SElect <Filename>**

Selects a configuration file from the default directory. If a configuration file with the specified name does not yet exist, it is created. The file extension `*.inf_mswv` may be omitted.

**Parameters:**

<Filename> string

**Example:** see [Example "Creating a multi-segment waveform"](#) on page 847

**Manual operation:** See ["New List"](#) on page 317

---

**Multi-Carrier Commands**

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:PRESet**

Sets all the multi-carrier parameters to their default values.

**Example:** `SOURce1:BB:ARbitrary:MCARrier:PRESet`

**Usage:** Event

**Manual operation:** See ["Set to Default"](#) on page 343

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:SETTING:CATalog?**

Queries the available settings files in the specified default directory. Only files with the file extension `*.arb_multcarr` are listed.

**Return values:**

<Catalog> string

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Usage:** Query only

**Manual operation:** See ["Save/Recall Frame"](#) on page 344

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:SETTING:LOAD <Filename>**

Loads the settings file.

The file extension may be omitted. Only files with the file extension `*.arb_multcarr` are loaded or .

**Setting parameters:**

<Filename> string

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Usage:** Setting only

**Manual operation:** See ["Save/Recall Frame"](#) on page 344

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:SETTING:STORE <Filename>**

Stores the current multi-carrier settings in a file in the specified directory.

The file extension may be omitted, the files are stored with the file extension \*.arb\_multcarr.

**Setting parameters:**

<Filename> string

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Usage:** Setting only

**Manual operation:** See ["Save/Recall Frame"](#) on page 344

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier:COUNT <Count>**

Sets the number of carriers in the ARB multi-carrier waveform.

**Parameters:**

<Count> integer  
 Range: 1 to 512  
 \*RST: 1

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Manual operation:** See ["Number of Carriers"](#) on page 344

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier:MODE <Mode>**

The command sets the carrier frequency mode.

**Parameters:**

<Mode> EQUidistant | ARbitrary  
 \*RST: EQUidistant

**Example:** BB:ARB:MCAR:CARR:MODE EQU  
 Sets an equidistant carrier spacing. The carrier frequency cannot be set.

**Manual operation:** See ["Mode"](#) on page 344

---

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier:SPACing <Spacing>**

Sets the frequency spacing between adjacent carriers of the multi-carrier waveform (see [Chapter 5.7.2.1, "Defining the Carrier Frequency"](#), on page 341).

**Parameters:**

<Spacing> float  
 Range: 0.0 to 160E6  
 Increment: 0.01  
 \*RST: 0  
 Default unit: Hz

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Manual operation:** See ["Carrier Spacing"](#) on page 344

#### **[[:SOURce<hw>]:BB:ARbitrary:MCARrier:SAMPles?**

Queries the resulting file size.

**Return values:**

<Samples> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0  
 Default unit: samples

**Example:** SOURce1:BB:ARbitrary:MCARrier:SAMPles?  
 Queries the file size of the currently calculated multi-carrier waveform.

**Usage:** Query only

**Manual operation:** See ["File Size"](#) on page 349

#### **[[:SOURce<hw>]:BB:ARbitrary:MCARrier:TIME <Time>**

Sets the user-defined signal period.

**Parameters:**

<Time> float  
 Range: 0 to 1E9  
 Increment: 1E-9  
 \*RST: 0  
 Default unit: s

**Example:** SOURce1:BB:ARbitrary:MCARrier:MODE USER  
 Selects signal period mode user.  
 SOURce1:BB:ARbitrary:MCARrier:TIME 10  
 Sets a signal period of 10 seconds

**Manual operation:** See ["Signal Period"](#) on page 346

#### **[[:SOURce<hw>]:BB:ARbitrary:MCARrier:CFACTOR:MODE <Mode>**

Sets the mode for optimizing the crest factor by calculating the carrier phases.

**Parameters:**

<Mode> OFF | MIN | MAX  
 \*RST: OFF

**Example:** SOURce1:BB:ARbitrary:MCARrier:CFACTOR:MODE OFF  
 Switches off automatic crest factor optimization.

**Manual operation:** See ["Crest Factor Mode"](#) on page 345

---

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLIPping:CFACTOR <CFactor>**

Sets the value of the desired crest factor, if baseband clipping is enabled.

A target crest factor above the crest factor of the unclipped multicarrier signal has no effect.

**Parameters:**

<CFactor> float  
Range: -50 to 50  
Increment: 0.01  
\*RST: 50  
Default unit: dB

**Example:** see [ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLIPping[:STATE] on page 872

**Manual operation:** See "Target Crest Factor" on page 345

---

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLIPping:CUTOFF <Cutoff>**

Sets the cutoff frequency of the final low pass filter, if baseband clipping is enabled.

**Parameters:**

<Cutoff> float  
Range: 0 to 50E6  
Increment: 0.01  
\*RST: 50E6  
Default unit: MHz

**Example:** [ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLIPping[:STATE] on page 872

**Manual operation:** See "Filter Cut Off Frequency" on page 345

---

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLIPping[:STATE] <State>**

Switches baseband clipping on and off.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** SOURce1:BB:ARbitrary:MCARrier:CLIPping:STATE ON  
SOURce1:BB:ARbitrary:MCARrier:CLIPping:CFACTOR 37  
SOURce1:BB:ARbitrary:MCARrier:CLIPping:CUTOFF 50

**Manual operation:** See "Clipping" on page 345



**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:TIME:MODE <Mode>**

Selects the mode for calculating the resulting signal period of the multi-carrier waveform. The resulting period is always calculated for all carriers in the carrier table irrespective of their state (ON/OFF).

**Parameters:**

<Mode> USER | LONG | SHORT | LCM  
\*RST: LONG

**Example:**

BB:ARB:MCAR:TIME:MODE LONG

The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

**Manual operation:** See ["Signal Period Mode"](#) on page 346

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:POWer:REFeRence <Reference>**

Defines the way the individual carriers in a composed multi carrier signal are leveled.

**Parameters:**

<Reference> RMS | PEAK  
\*RST: RMS

**Manual operation:** See ["Power Reference"](#) on page 346

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:OFILe <OFile>**

Defines the output file name for the multi-carrier waveform (file extension \* .wv).

This file name is required to calculate the waveform with the commands [ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLoad or [ :SOURce<hw>]:BB:ARbitrary:MCARrier:CREate.

**Parameters:**

<OFile> string

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Manual operation:** See ["File"](#) on page 349

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLoad**

Creates a multi-carrier waveform using the current entries of the carrier table and activates the ARB generator.

Use the command [ :SOURce<hw>]:BB:ARbitrary:MCARrier:OFILe to define the multi-carrier waveform file name. The file extension is \* .wv.

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Usage:** Event

**Manual operation:** See ["Create/Create and Load"](#) on page 349

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CLOCK?**

Queries the resulting sample rate at which the multi-carrier waveform is output by the arbitrary waveform generator. The output clock rate depends on the number of carriers, carrier spacing, and input sample rate of the leftmost or rightmost carriers.

**Return values:**

<Clock> float  
 Range: 400 to Max  
 Increment: 1E-3

**Example:** BB:ARB:MCAR:CLOC?  
 Queries the ARB multi-carrier output clock rate.

**Usage:** Query only

**Manual operation:** See ["Clock Rate"](#) on page 349

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CREate**

Creates a multi-carrier waveform using the current settings of the carrier table.

Use the command `[ :SOURce<hw>]:BB:ARbitrary:MCARrier:OFILe` to define the multi-carrier waveform file name. The file extension is \*.wv.

**Example:** See [Example "Generating a multi carrier signal"](#) on page 852

**Usage:** Event

**Manual operation:** See ["Create/Create and Load"](#) on page 349

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:STATe <State>**

Enables/diasbled the selected carrier.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Generating a multi carrier signal"](#) on page 852

**Manual operation:** See ["State"](#) on page 351

**[ :SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:FREQUency <Frequency>**

Sets or indicates the carrier frequency, depending on the selected carrier frequency mode.

**Parameters:**

<Frequency> integer  
 Range: -80E6 to 80E6  
 \*RST: 0

**Example:**           SOURce1:BB:ARbitrary:MCARrier:CARRier:MODE ARB  
 SOURce1:BB:ARbitrary:MCARrier:CARRier1:  
 FREQuency 5.0  
 Sets 5.0 MHz carrier frequency.

**Manual operation:** See "[Carrier Freq \[MHz\]](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:PHASe <Phase>**

Sets the start phase of the selected carrier.

**Parameters:**

<Phase>           float  
 Range:           0 to 359.99  
 Increment:       0.01  
 \*RST:            0  
 Default unit: DEG

**Example:**           SOURce1:BB:ARbitrary:MCARrier:CARRier19:PHASe  
 90  
 Sets a start phase of 90° for carrier 15.

**Manual operation:** See "[Phase](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:POWER <Power>**

Sets the gain of the selected carrier.

**Parameters:**

<Power>           float  
 Range:           -80 to 0  
 Increment:       0.01  
 \*RST:            0  
 Default unit: dB

**Example:**           SOURce1:BB:ARbitrary:MCARrier:CARRier15:POWER  
 -50  
 sets the power of carrier 15 to -50 dB.

**Manual operation:** See "[Gain](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:DELay <Delay>**

Sets the start delay of the selected carrier.

**Parameters:**

<Delay>           float  
 Range:           0 to 1  
 Increment:       1E-9  
 \*RST:            0  
 Default unit: s

**Example:** BB:ARB:MCAR:CARR15:DEL 5us  
sets a start delay of 50 us for carrier 15.

**Manual operation:** See "[Delay](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:FILE <File>**

Selects the file with I/Q data to be modulated onto the selected carrier.

**Parameters:**

<File> <file name>

**Example:** see [Example "Generating a multi carrier signal"](#) on page 852

**Manual operation:** See "[File](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:CARRier<ch>:CONFLICT?**

Queries carrier conflicts. A conflict arises when the carriers overlap.

**Return values:**

<Conflict> 0 | 1 | OFF | ON

0

No conflict

\*RST: 0

**Example:** BB:ARB:MCAR:CARR:CONF?

**Usage:** Query only

**Manual operation:** See "[!!!!](#)" on page 351

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:STATe <State>**

Switches all the carriers in the selected carrier range on or off.

**Parameters:**

<State> 0 | 1 | OFF | ON

\*RST: 1

**Example:** BB:ARB:MCAR:EDIT:CARR:STAT ON  
sets all the carriers in the carrier range to ON.

**Manual operation:** See "[Carrier State](#)" on page 352

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:START <Start>**

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:STOP <Stop>**

Selects the last carrier in the carrier range to which the settings shall apply.

**Parameters:**

<Stop> integer  
 Range: 0 to 511  
 \*RST: 0

**Example:** BB:ARB:MCAR:EDIT:CARR:STOP 4  
 the carrier range stops at carrier 4.

**Manual operation:** See "[Carrier Start/Start](#)" on page 353

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>**

Sets the step width by which the starting power of the carriers in the defined carrier range is incremented.

**Parameters:**

<Step> float  
 Range: -80 to 80  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:** BB:ARB:MCAR:EDIT:CARR:POW -80dB  
 Sets a power of -80 dB for the carriers in the carrier range.  
 BB:ARB:MCAR:EDIT:CARR:POW:STEP 1 dB  
 The power is incremented by 1dB for each carrier.  
 That is, the first carrier has -80 dB, the second -79 dB, and so on.

**Manual operation:** See "[Gain Step](#)" on page 353

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:POWer[:START] <Start>**

Sets the power for the individual carriers in the defined carrier range.

**Parameters:**

<Start> float  
 Range: -80 to 0  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:** BB:ARB:MCAR:EDIT:CARR:POW -50 dB  
 sets the power of the carriers in the carrier range to -50 dB.

**Manual operation:** See "[Gain Start](#)" on page 353

**[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>**

Sets the step width by which the start phases of the carriers in the defined carrier range is incremented.

**Parameters:**

<Step> float  
 Range: -359.99 to 359.99  
 Increment: 0.01  
 \*RST: 0  
 Default unit: DEG

**Example:**

```
BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG
```

Sets a start phase of 90° for the carriers in the carrier range.

```
BB:ARB:MCAR:EDIT:CARR:PHAS:STEP 1 DEG
```

The start phase is incremented by 1° for each carrier. That is, the first carrier has a start phase of 90°, the second a start phase of 91°, and so on.

```
[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:PHASe[:START] <Start>
```

Sets the start phase for the individual carriers in the defined carrier range.

**Parameters:**

<Start> float  
 Range: 0 to 359.99  
 Increment: 0.01  
 \*RST: 0  
 Default unit: DEG

**Example:**

```
BB:ARB:MCAR:EDIT:CARR:PHAS 90 DEG
```

sets a start phase of 90° for the carriers in the carrier range.

**Manual operation:** See "[Phase Start](#)" on page 353

```
[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>
```

Sets the step width by which the start delays of the carriers in the defined carrier range is incremented.

**Parameters:**

<Step> float  
 Range: -1 to 1  
 Increment: 1E-9  
 \*RST: 0  
 Default unit: s

**Example:**

```
BB:ARB:MCAR:EDIT:CARR:DEL 5 us
```

Sets a start delay of 5 us for the carriers in the carrier range.

```
BB:ARB:MCAR:EDIT:CARR:DEL:STEP 1 us
```

The start delay is incremented by 1us for each carrier. That is, the first carrier has a start delay of 5 us, the second a start delay of 6 us, and so on.

**Manual operation:** See "[Delay Step](#)" on page 354

---

**[[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>**

Sets the start delay for the individual carriers in the defined carrier range.

**Parameters:**

<Start> float  
 Range: 0 to 1  
 Increment: 1E-9  
 \*RST: 0  
 Default unit: s

**Example:** BB:ARB:MCAR:EDIT:CARR:DEL 5us  
 sets a start delay of 5 us for the carriers in the carrier range.

**Manual operation:** See ["Delay Start"](#) on page 353

---

**[[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:FILE <File>**

Selects the input file. The data of the file are modulated onto the carriers in the defined carrier range.

**Parameters:**

<File> string

**Example:** BB:ARB:MCAR:EDIT:CARR:FILE  
 "/var/user/temp/IQ\_wcdma"  
 selects input file IQ\_wcdma.

**Manual operation:** See ["Input Waveform File"](#) on page 354

---

**[[:SOURce<hw>]:BB:ARbitrary:MCARrier:EDIT:CARRier:EXECute**

Adopts the settings for the selected carrier range.

**Example:** BB:ARB:MCAR:EDIT:CARR:STAR 4  
 BB:ARB:MCAR:EDIT:CARR:STOP 20  
 BB:ARB:MCAR:EDIT:CARR:STAT ON  
 BB:ARB:MCAR:EDIT:CARR:EXEC

**Usage:** Event

**Manual operation:** See ["Apply Assistant Settings"](#) on page 354

### Trigger Commands

---

**[[:SOURce<hw>]:BB:ARbitrary[:TRIGger]:SEQUence <Sequence>**

The command selects the trigger mode.

**Parameters:**

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGLE  
 \*RST: AUTO

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Trigger Mode"](#) on page 243

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:SOURce <Source>**

Selects the trigger signal source and determines the way the triggering is executed. Provided are internal triggering by a command, external trigger signal via one of the provided local or global connectors and triggering by a signal from the other paths.

**Parameters:**

<Source> INTB | INTernal | OBASeband | EGT1 | EGT2 | EGC1 | EGC2 | ELTRigger | INTA | ELCLock | BEXTernal | EXTernal

**INTernal**

Internal

**INTA | INTB**

Internal trigger from the other baseband

**EGT1 | EGT2**

External global trigger

**EGC1 | EGC2**

External global clock

**ELTRigger**

External local trigger

**ELCLock**

External local clock

**OBASeband|BEXTernal|EXTernal**

Provided only for backward compatibility with other R&S signal generators.

The R&S SMW accepts these values and maps them automatically as follows:

EXTernal = EGT1, BEXTernal = EGT2, OBASeband = INTA or INTB (depending on the current baseband)

\*RST: INTernal

**Example:** See [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Trigger Source"](#) on page 244

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:RMODE?**

Queries the status of waveform output.

**Return values:**

<RMode> STOP | RUN

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**Manual operation:** See ["Running/Stopped"](#) on page 244



**[ :SOURce<hw>]:BB:ARbitrary:TRIGger:SEnGth <SLength>**

Defines the length of the signal sequence to be output in the Single trigger mode.

**Parameters:**

<SLength> integer  
 Maximun value dependents on the selected units [ :SOURce<hw>]:BB:ARbitrary:TRIGger:SLUNit as follows:  
 SAMPlE: Max =  $2^{32}-1$   
 SEQuence: Max = 1000  
 Range: 1 to dynamic  
 \*RST: 1

**Example:** See [Example "Managing waveform files"](#) on page 845

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger:SLUNit <SLUnit>**

Defines the unit for the entry of the length of the signal sequence to be output in the Single trigger mode.

**Parameters:**

<SLUnit> SEQuence | SAMPlE  
 \*RST: SEQuence

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Trigger Signal Duration"](#) on page 244

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger:ARM:EXECute**

Stops (arms) waveform output.

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Event

**Manual operation:** See ["Arm"](#) on page 244

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger:EXECute**

Executes an internal trigger event.

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Event

**Manual operation:** See ["Execute Trigger"](#) on page 244

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut <Output>**

Enables/disables output of the signal synchronous to the external trigger event.

**Parameters:**

<Output> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Sync. Output to External Trigger"](#) on page 245

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OBASeband:DELay <Delay>**

Specifies the trigger delay for triggering by the signal from the second path.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215 samples  
 Increment: 0.01  
 \*RST: 0

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OBASeband:RDELay?**

Queries the time a trigger event from the other path is delayed.

**Return values:**

<ObResTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0  
 Default unit: s

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Actual Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OBASeband:TDELay <ObasTimeDelay>**

Specifies the trigger delay for triggering by the signal from the other path.

**Parameters:**

<ObasTimeDelay> float  
 Range: 0 to depends on other values  
 Increment: 250E-12  
 \*RST: 0  
 Default unit: s

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See "[\(External\) Trigger Delay/Specified Trigger Delay](#)" on page 246

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OBASeband:INHibit <Inhibit>**

For triggering via the other path, specifies the number of samples by which a restart is inhibited.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 67108863  
 \*RST: 0  
 Default unit: sample

**Example:** See [Example "Managing waveform files"](#) on page 845

**Manual operation:** See "[External Trigger Inhibit](#)" on page 245

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:DELay:UNIT <TrigDelUnit>**

Determines the units the trigger delay is expressed in.

**Parameters:**

<TrigDelUnit> SAMPLE | TIME  
 \*RST: SAMPLE

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See "[External Delay Unit](#)" on page 246

**[:SOURce<hw>]:BB:ARbitrary:TRIGger[:EXTernal]:DELay <Delay>**

Specifies the trigger delay.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215 samples  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See "[\(External\) Trigger Delay/Specified Trigger Delay](#)" on page 246

**[:SOURce<hw>]:BB:ARbitrary:TRIGger[:EXTernal]:TDELay <ExtTimeDelay>**

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

**Parameters:**

<ExtTimeDelay> float  
 Range: 0 to depends on other values  
 Increment: 1E-9  
 \*RST: 0  
 Default unit: s

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger[:EXTernal]:RDELay?**

Queries the time (in seconds) an external trigger event is delayed for.

**Return values:**

<ResTimeDelay> float  
 Range: 0 to 688  
 Increment: 250E-12  
 \*RST: 0

**Example:** see [Example "Specifying delay and inhibit values in time units"](#) on page 847

**Usage:** Query only

**Manual operation:** See ["Actual Trigger Delay"](#) on page 246

**[ :SOURce<hw>]:BB:ARbitrary:TRIGger[:EXTernal]:INHibit <Inhibit>**

Specifies the number of samples by which a restart is to be inhibited following an external trigger event.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 21.47\*clockRate  
 \*RST: 0

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["External Trigger Inhibit"](#) on page 245

**Marker Commands****[ :SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:MODE <Mode>**

Defines the signal for the selected marker output.

For detailed description of the regular marker modes, refer to ["Marker Modes"](#) on page 224.

**Parameters:**

<Mode> UNCHanged | RESTart | PULSe | PATtern | RATio  
**UNCHanged**  
 A marker signal as defined in the waveform file (tag 'marker mode x') is generated.  
 \*RST: UNCHanged

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Marker Mode"](#) on page 301

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>**

Sets the number of samples in the ON and OFF periods.

**Parameters:**

<OffTime> integer  
 Range: 1 to 14913079  
 \*RST: 1

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Marker Mode"](#) on page 301

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>**

Sets the number of samples in the ON or OFF period.

**Parameters:**

<OnTime> integer  
 Range: 1 to 14913079  
 \*RST: 1

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Marker Mode"](#) on page 301

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:PATtern <Pattern>**

Defines the bit pattern used to generate the marker signal

**Parameters:**

<Pattern> <64 bits pattern>  
 0 is marker off, 1 is marker on  
 \*RST: #H2,2

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Marker Mode"](#) on page 301

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>**

Sets the divider for the pulsed marker signal.

**Parameters:**

<Divider>                    integer  
                                  Range:     2 to 1024  
                                  \*RST:     2

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Manual operation:**    See ["Marker Mode"](#) on page 301

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:PULSe:FREQUency?**

Queries the pulse frequency of the pulsed marker signal. The pulse frequency is derived by dividing the symbol rate by the divider.

**Return values:**

<Frequency>                float  
                                  Increment: 0.001

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Usage:**                        Query only

**Manual operation:**    See ["Marker Mode"](#) on page 301

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:DELay <Delay>**

Defines the delay between the signal on the marker outputs and the start of the signals.

**Parameters:**

<Delay>                        float  
                                  Range:     0 to depends on other values  
                                  Increment: 0.001  
                                  \*RST:     0  
                                  Default unit: Symbol

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Manual operation:**    See ["Marker x Delay"](#) on page 248

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut:DELay:FIXed <Fixed>**

Restricts the marker delay setting range to the dynamic range. The setting always affects every marker.

**Parameters:**

<Fixed>                        0 | 1 | OFF | ON  
                                  \*RST:     0

**Example:**                    see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Marker x Delay"](#) on page 248

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?**

Queries the maximum marker delay.

**Return values:**

<Maximum> float  
Range: 0 to 16777215  
Increment: 1E-3  
\*RST: 2000

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**Manual operation:** See ["Marker x Delay"](#) on page 248

---

**[:SOURce<hw>]:BB:ARbitrary:TRIGger:OUTPut<ch>:DELay:MINimum?**

Queries the minimum marker delay.

**Return values:**

<Minimum> float  
Range: 0 to 16777215  
Increment: 1E-3  
\*RST: 0

**Example:** see [Example "Managing waveform files"](#) on page 845

**Usage:** Query only

**Manual operation:** See ["Marker x Delay"](#) on page 248

### Clock Commands

---

**[:SOURce<hw>]:BB:ARbitrary:CLOCK:SOURce <Source>**

Selects the clock source.

**Parameters:**

<Source> INTernal | EGC1 | EGC2 | ELClock | EXTernal

**INTernal**

The instrument uses its internal clock reference

**EGC1|EGC2**

External global clock

**ELCLock**

External local clock

**EXTernal**

EXTernal = EGC1

Setting only; provided for backward compatibility with other R&S signal generators.

\*RST: INTernal

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Clock Source"](#) on page 249

**[ :SOURce<hw> ] :BB:ARBItrary:CLOCK:MODE <Mode>**

Enters the type of externally supplied clock.

**Parameters:**

<Mode> SAMPlE | MSAMPlE

\*RST: SAMPlE

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Clock Mode"](#) on page 249

**[ :SOURce<hw> ] :BB:ARBItrary:CLOCK:MULTIplier <Multiplier>**

Specifies the multiplier.

**Parameters:**

<Multiplier> integer

Range: 1 to 64

\*RST: 4

**Example:** see [Example "Managing waveform files"](#) on page 845

**Manual operation:** See ["Clock Multiplier"](#) on page 249

#### 13.18.3.4 Waveform, Data and List Format

The R&S SMW uses a simple tag-oriented format for externally or internally generated waveforms, data and control lists. Files with this format can be transmitted via the GPIB interface from an external computer to the instrument and vice versa. These files are transmitted as a binary data block, using SCPI command `[ :SOURce<hw> ] :BB:`



ARbitrary:WAVEform:DATA, [:SOURce<hw>]:BB:DM:DLIST:DATA, and [:SOURce<hw>]:BB:DM:CLIST:DATA.

### Tag general format

Tags are self-contained information units, enclosed in braces { }. Their general format is {Name: Data} or {Name-Length: Data}. The colon separates the name part and the data part. The colon can be followed by a space for the sake of legibility.

- The **Name** identifies the tag. It is always expressed in capital letters.
- The **Data** is tag-specific, and usually it is in ASCII plain text.
- The **Length** specifies the number of bytes in a WAVEFORM tag, DATA LIST tag, or EMPTYTAG  
Length is an ASCII integer value, defining the number of bytes from the colon : to the end brace }

### Rules

Each waveform file must begin with the TYPE tag. The sequence of the remaining tags is arbitrary. For each tag, an indication shows whether it must be included in the file concerned (mandatory) or may be included (optional).

Unknown tags are not analyzed by the R&S SMW; they are left unchanged and saved without an error message for a possible further read back.

R&S SMU waveforms can also be loaded on the instrument, where they are converted internally into an R&S SMW waveform.



In all examples of file contents listed in this section, the tags have been separated by line breaks for better reading.

### Tag Description

This section describes the mandatory TYPE tag followed by description of all other tags in an alphabetical order. Most tags are valid for all three file types. If a tag is valid only for a single file type, e.g. only for a waveform, this fact is indicated in the description.

{TYPE: magic, xxxxxxxx}.....	890
{CLOCK: frequency}.....	891
{COMMENT: string} .....	891
{COPYRIGHT: string}.....	891
{DATA BITLENGTH: BitLength}.....	892
{DATA LIST-Length: #d0d1...dx...dN-1...}.....	892
{DATE: yyyy-mm-dd;hh:mm:ss}.....	892
{EMPTYTAG-Length: #EmptySequence}.....	893
{CONTROL LENGTH: ControlLength}.....	894
{LEVEL OFFS: RMSOffset_dB,PeakOffset_dB}.....	894
{SAMPLES: Samples}.....	895
{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}.....	896
{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1...}.....	896
{MWV_SEGMENT_COUNT: NumOfSeg}.....	897

{MWV_SEGMENT_LENGTH: SamplesSeg0, SamplesSeg1, ..., SamplesSegN-1}.....	898
{MWV_SEGMENT_START: SampleStartOffsetSeg0, SampleStartOffsetSeg1, ..., SampleStartOffsetSegN-1}.....	898
{MWV_SEGMENT_CLOCK_MODE: Mode}.....	898
{MWV_SEGMENT_CLOCK: ClockSeg0, ClockSeg1, ..., ClockSegN-1}.....	899
{MWV_SEGMENT_LEVEL_OFFS: RMSOffs_dBSg0, PeakOffs_dBSg0, ..., RMSOffs_dBSgN-1, PeakOffs_dBSgN-1}.....	899
{MWV_SEGMENT_FILES: "FileNameSeg0.wv", "FileNameSeg1.wv", ..., "FileNameSegN-1.wv"}.....	900
{MWV_SEGMENTx_COMMENT: text}.....	900
{CONTROL LIST WIDTH4–Length: #m0m1...mx...mM-1}.....	900

---

**{TYPE: magic, xxxxxxxx}**

**(mandatory, must be the first tag in the file)**

Identifies the file as a valid R&S SMW file. It must be present and must be the first in the waveform. If a file of the same name exists on the target medium, it is overwritten.

**Setting parameters:**

magic	Designates the file type and has the following values: <b>SMU-WV</b> A valid R&S SMW waveform. <b>SMU-MWV</b> A valid R&S SMW multi-segment waveform. <b>SMU-DL</b> A valid R&S SMW data list. <b>SMU-CL</b> A valid R&S SMW control list.
xxxxxxx	Is an ASCII-coded checksum of the data part of the <code>WAVEFORM</code> tag in the file. This value is always 0 for data lists and control lists. The checksum for waveforms is used for detecting transmission errors. If the <code>TYPE</code> tag contains 0 or a non-numeric value for the checksum, it is ignored. It is calculated in accordance with the algorithm given bellow, where 'start' is a pointer to the first byte after the '#' character in the <code>WAVEFORM</code> tag and 'length' is the number of bytes between 'start' and the closing curly bracket (excluding the latter; 'length' must be divisible by 4 without a remainder): <pre> UINT32 checksum(void *start, UINT32 length) {     UINT32 i, result = 0xA50F74FF;     for(i=0; i &lt; length/4; i++)         result = result ^ ((UINT32 *)start)[i];     return(result); } </pre>

**Example:**            {TYPE: SMU-WV,106656}  
                  BB:ARB:WAV:TAG? 'TYPE'  
                  Queries the content of the TYPE tag.  
                  Response: 'SMU-WV,106656'  
                  This is a valid waveform.

---

### **{CLOCK: frequency}**

#### **(mandatory for waveforms)**

The tag specifies the clock frequency at which the waveform has to be output, in Hz (on multi-segment waveforms this tag contains the maximal clock of all segments).

A query of `ARB:CLOCK?` after loading the waveform returns the value set using the `CLOCK` tag. This value can later be altered with the command `ARB:CLOCK?`.

**Example:**            {CLOCK: 54000000}  
                  BB:ARB:WAV:TAG? 'CLOCK'  
                  Queries the content of the CLOCK tag.  
                  Response: 54000000  
                  The clock frequency is set to 54 MHz.

**Usage:**             Setting only

---

### **{COMMENT: string}**

The tag contains a plain text ASCII string of arbitrary length. The string is not analyzed in the R&S SMW. It is used to describe the file. The string is allowed to contain all printable ASCII characters except the closing curly bracket.

**Example:**            {COMMENT: File with data for 3GPP enhanced  
                          channels}  
                  BB:ARB:WAV:TAG? 'COMMENT'  
                  Queries the content of the COMMENT tag of the selected wave-  
                  form file.  
                  Response: 'File with data for 3GPP enhanced  
                          channels'  
                  The comment on the waveform reads "File with data for 3GPP  
                  enhanced channels".

**Usage:**             Setting only

---

### **{COPYRIGHT: string}**

The tag contains an ASCII string of arbitrary length. The string is not analyzed in the R&S SMW. It is used to store copyright information about the file content.

**Example:**            {COPYRIGHT: Rohde&Schwarz}  
 BB:ARB:WAV:TAG? 'COPYRIGHT'  
 Queries the content of the COPYRIGHT tag of the selected waveform file.  
 Response: 'Rohde&Schwarz'  
 Copyright resides with Rohde & Schwarz.

**Usage:**            Setting only

**{DATA BITLENGTH: BitLength}****(mandatory for data lists)**

The tag contains the length of the data held in the DATA LIST tag in bits in ASCII format.

**Example:**            {DATA BITLENGTH: 444}  
 BB:DM:DLIS:SEL "/var/user/dl"  
 BB:DM:DLIS:TAG? "dl", "DATA BITLENGTH"  
 Queries the content of the DATA BITLENGTH tag of the selected data list file.  
 Response: '444'  
 The data list is 444 bits long.

**Usage:**            Setting only**{DATA LIST-Length: #d0d1...dx...dN-1...}****(mandatory for data lists)**

The tag contains the actual bit sequence of the data list in binary format.

**Setting parameters:**

**Length**            Defines the number of bytes in the DATA LIST tag in ASCII Format (see {WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1...} for details).

**dx**                Data bits in binary format (8-bit unsigned characters, MSB first).

**Example:**            {DATA LIST-17: #d0d1...dx...d127}  
 16 bytes containing 128 data bits, first bit is the MS bit of the first byte.

**Usage:**            Setting only**{DATE: yyyy-mm-dd;hh:mm:ss}****(optional)**

The tag contains the date and time at which the file was created. The year must be expressed as four digits. The instrument does not analyze this tag.

**Example:**            {DATE: 2009-04-02;14:32:12}  
                           BB:ARB:WAV:TAG? 'DATE'  
 Queries the content of the DATE tag of the selected waveform file.  
 Response: '2009-04-02;14:32:12'  
 The waveform was created on April 2, 2009 at 14 hrs 32 min

**Usage:**             Setting only

### {EMPTYTAG-Length: #EmptySequence}

(mandatory in automatically generated one and multi-segment waveforms)

This tag is empty, i.e. contains no data, and is used as placeholder.

#### Setting parameters:

**Length**             An ASCII integer value that specifies the number of bytes in the EMPTYTAG, i.e. defines the number of bytes from the colon : to the end brace }

**Note:** If you change the content of a waveform file, change also the {EMPTYTAG-Length} value. For example, if you add a tag or add bytes to a tag, reduce the length by the number of newly introduced bytes.

**EmptySequence**    An empty sequence containing blanks only. The number of used blanks is calculated as the difference between the hex addresses of the {WAVEFORM} tag and the hash sign # in the {EMPTYTAG}.

The {WAVEFORM} tag always starts at hex address #4000.

#### Example:

```
{TYPE:SMU-WV, 837236424}
{COPYRIGHT:2003 Rohde&Schwarz SMU}
{DATE:2012-07-11;14:38:01}
{SAMPLES:80000}
{CLOCK:86666666.666666666}
{VECTOR MAX:1.000000038569158}
{LEVEL OFFS:3.333553817875577e-07,0}
{MARKER LIST 1:0:1;1:0;1249:0}
{MARKER LIST 2:0:1;1:0;1249:0}
{MARKER LIST 3:0:1;1:0;1249:0}
{MARKER LIST 4:0:1;1:0;1249:0}
{EMPTYTAG-15947:# ...}
{WAVEFORM-320017:#IQIQIQ...}
```

The example waveform file contains 436 (0x1b4) bytes before the # sign in the EMPTYTAG; the hex address of the # sign is 0x1b5. The {WAVEFORM} starts at 0x4000. The EMPTYTAG contains 15946 blanks and has a length of (15946+1) bytes.

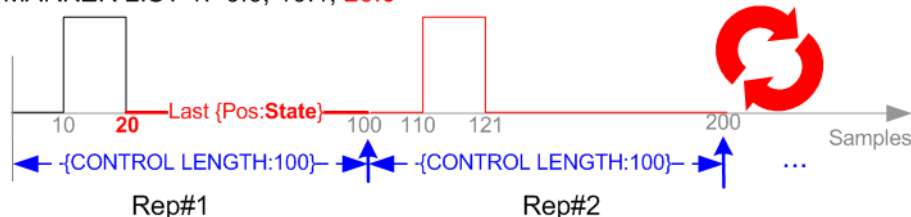
**Usage:**             Setting only

**{CONTROL LENGTH: ControlLength}****(optional / recommended for marker and control lists)**

The tag specifies the length of *all* control or marker list in ASCII format.

The control length influences the way the marker and control lists are processed, in particular the way traces are repeated; see [Figure 13-4](#).

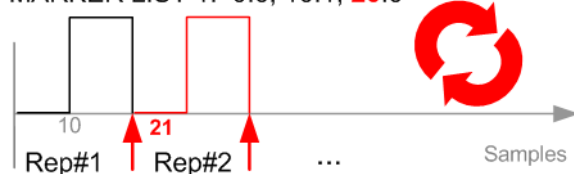
MARKER LIST 1: 0:0; 10:1; 20:0



*Figure 13-4: Example: Processing of MARKER TRACE if CONTROL LENGTH is specified*

If the `CONTROL LENGTH` tag is not used, the marker and control list length are determined by the last position, that is the last `{Pos:State}` couple, defined in the particular `[TRACE] LIST` tag; see [Figure 13-5](#).

MARKER LIST 1: 0:0; 10:1; 20:0



*Figure 13-5: Example: Processing of MARKER TRACE if CONTROL LENGTH is not used*

To maintain marker signals and waveform data synchronized, set the `CONTROL LENGTH` to be equal to the number of samples specified with the tag `SAMPLES`.

See also "[How to Define Periodically Repeating Traces](#)" on page 901.

**Example:**

```
{CONTROL LENGTH: 500}
SOURCE:BB:ARBitary:CLIST:TAG? 'CONTROL LENGTH'
Queries the length of the control list.
Response: 500
```

**Manual operation:** See "[Total List Length](#)" on page 271

**{LEVEL OFFS: RMSOffset\_dB,PeakOffset\_dB}****(recommended for waveforms)**

The tag determines the level of the ARB signal in the waveform file. The offset levels define the offset of RMS and peak value relative to the 16-bit full scale modulation (-32767 to + 32767) = 0 dB.

**Setting parameters:**

**RMSOffset\_dB** Defines the RMS level offset of the signal relative to full scale ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format. The value is always positive.  
A 3 dB value indicates that the RMS level of the signal is 3 dBs below the full scale.  
full scale = max. amplitude of vector of I/Q samples =  $|S_{IQ}|_{\max} = \sqrt{I^2+Q^2}_{\max} = 0$  dB

**PeakOffset\_dB** Defines the peak level offset of the signal relative to full scale for the ARB signal in the `WAVEFORM` tag. The offset is defined in ASCII float format.  
The value usually equals 0 dB as usually the I/Q samples (signed 16-bit integer values) are modulated to full scale: Full scale = 0 dB = max. amplitude of vector of I/Q samples =  $|S_{IQ}|_{\max} = \sqrt{I^2+Q^2}_{\max} = (2^{15})-1 = 32767$ .  
A positive `PeakOffset_dB` value indicates that a headroom to full scale is provided when generating the waveform. A negative `PeakOffset_dB` value indicates that overrange is likely for some samples, i.e. clipping might occur.  
The crest factor can be calculated from the two values as follows:  
Crest Factor =  $|PeakOffset\_dB - RMSOffset\_dB|$

**Example:**

```
{LEVEL OFFS: 3.45,2}
BB:ARB:WAV:TAG? 'LEVEL OFFS'
```

Queries the content of the `LEVEL OFFS` tag of the selected waveform file.

```
Response: 3.45,2
```

The level of the waveform is below full scale, clipping does not occur.

**Usage:**

Setting only

**{SAMPLES: Samples}****(recommended for waveforms)**

The tag contains the number of I/Q samples in the waveform in ASCII format.

On multi-segment waveforms, this tag contains the total I/Q samples of all segments.

**Example:**

```
{SAMPLES: 1000}
BB:ARB:WAV:TAG? 'SAMPLES'
```

Queries the content of the `SAMPLES` tag of the selected waveform file.

```
Response: 1000
```

The waveform contains 1000 I/Q samples.

**Usage:**

Setting only

See also "[How to Define Periodically Repeating Traces](#)" on page 901.

---

**{[TRACE] LIST [#]: Pos0:State0; Pos1:State1; ...PosN-1:StateN-1}**

**(mandatory for control lists / optional for waveforms)**

The tag contains the data for the marker and control signals in the control list or the marker signals of ARB waveforms.

Traces are processed different, depending on the selected [CONTROL LENGTH](#).

See also "[How to Define Periodically Repeating Traces](#)" on page 901.

**Setting parameters:**

[TRACE]	MARKER   BURST   LEVATT   CW MODE   HOP   MAP
	Name of the marker or control signal. For ARB waveforms, it is only meaningful to define marker signals; in the ARB multi-segment waveforms these tags are ignored!
[#]	1 .. 3
	Sets the marker or control trace number; supported is only LEVATT LIST 1.
Pos	Specifies in ASCII format the position (i.e. sample number or data value), with effect from which the binary <i>State</i> of the marker or of the control signal changes.
State	0   1
	Specifies the binary state of the marker or of the control signal from $Pos_x$ to $Pos_{x+1}$ exclusive in ASCII format.

**Example:**

```
{MARKER LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'MARKER LIST 1'
```

Queries the content of the `MARKER LIST 1` tag of the selected control list file.

Response: '0:0;10:1;20:0;30:1'

The marker setting for samples 0 to 9 = 0 (low), for 10 to 19 = 1 (high) and for 20 to 29 = 0. From sample 30 onward the marker setting = 1.

**Example:**

```
{LEVATT LIST 1: 0:0;10:1;20:0;30:1}
BB:DM:CLIS:TAG? 'LEVATT LIST 1'
```

Queries the content of the `LEVATT LIST 1` tag of the selected control list file.

Response: '0:0;10:1;20:0;30:1'

Level attenuation applies to data values 10 to 19 (high) and from data value 30 onward.

**Usage:** Setting only

**Manual operation:** See "[Select Ramp to Edit](#)" on page 270

---

**{WAVEFORM-Length: #I0Q0I1Q1...IxQx...IN-1QN-1...}**

**(mandatory for waveforms)**



The tag contains the actual waveform data or multi-segment waveform data (I/Q stream). Refer to [Chapter 5.6, "Generating Multi-Segment Waveform Files"](#), on page 310 for background information description of the multi-segment waveform function.

**Setting parameters:**

Length	Specifies the number of bytes in a <code>WAVEFORM</code> tag and is calculated as follows: Length = Number of I/Q pairs * 4 (2 bytes per I and 2 bytes per Q value) + 1 byte (the length of the #)
IxQx	<code>IxQx...</code> represents binary data (16-bit signed integer in 2's complement notation) containing the I and Q component alternately and starting with the I component. Each component consists of 2 bytes in Little endian format representation, i.e. least significant byte (LSB) first. The values of the 2 bytes in an I component and a Q component are in the range 0x0 to 0xFFFF (-32767 to +32767). This value is transferred to the D/A converter. This tag is also used to store multi-segment waveforms. The I/Q streams of the individual waveforms are directly concatenated to one collectively waveform I/Q stream. The number of segments and the start offset and length of the individual segments inside the total waveform I/Q stream is determined by the additional tags <code>MWV_SEGMENT_COUNT</code> , <code>MWV_SEGMENT_START</code> , and <code>MWV_SEGMENT_LENGTH</code> . Further <code>MWV_SEGMENT_...</code> tags are also available, for example for level and clock information.

**Example:** **One segment waveform**  
{WAVEFORM-401:#I<sub>0</sub>,Q<sub>0</sub>,I<sub>1</sub>,Q<sub>1</sub>,I<sub>2</sub>,Q<sub>2</sub>,...I<sub>99</sub>,Q<sub>99</sub>}  
100 I/Q pairs with 4 bytes each are transmitted - none multi-segment

**Example:** **Multi-segment waveform**  
{WAVEFORM-1201:  
#I<sub>0,Seg0</sub>,Q<sub>0,Seg0</sub>,I<sub>1,Seg0</sub>,Q<sub>1,Seg0</sub>,...I<sub>99,Seg0</sub>,Q<sub>99,Seg0</sub>,I<sub>0,Seg1</sub>,Q<sub>0,Seg1</sub>,I<sub>1,Seg1</sub>,Q<sub>1,Seg1</sub>,...I<sub>199,Seg1</sub>,Q<sub>199,Seg1</sub>}  
2 segments: segment 0 with 100 I/Q pairs; segment 1 with 200 I/Q pairs. Each I/Q pair consists of 2\*16 bit = 4 bytes  
The data is transmitted using SCPI command [ :  
`SOURce<hw>]:BB:ARbitrary:WAVEform:DATA.`

**Usage:** Setting only

---

**{MWV\_SEGMENT\_COUNT: NumOfSeg}**

**(mandatory for multi-segment waveforms)**

The tag contains the number of segments in the multi-segment waveform in ASCII integer format.

**Example:** {MWV\_SEGMENT\_COUNT: 2}  
Multi-segment waveform with 2 segments

**Usage:** Setting only

**{MWV\_SEGMENT\_LENGTH: SamplesSeg0, SamplesSeg1, ..., SamplesSegN-1}**

**(mandatory for multi-segment waveforms)**

The tag contains a list of I/Q sample lengths for every segment in the multi-segment waveform in ASCII integer format.

**Example:** {MWV\_SEGMENT\_LENGTH: 100,200}  
2 segments: 100 samples in segment 0 and 200 samples in segment 1.

**Usage:** Setting only

**{MWV\_SEGMENT\_START:**

**SampleStartOffsetSeg0, SampleStartOffsetSeg1, ..., SampleStartOffsetSegN-1}**

**(mandatory for multi-segment waveforms)**

The tag contains a list of I/Q sample start offsets for every segment in the multi-segment waveform in ASCII integer format.

**Example:** {MWV\_SEGMENT\_START: 0,100}  
2 segments with 100 samples in segment 0 and 200 samples in segment 1.  
The start offset of first segment is 0 samples, start offset of next segment 1 is the sample length of segment 0 = 100 samples.

**Usage:** Setting only

**{MWV\_SEGMENT\_CLOCK\_MODE: Mode}**

**(mandatory for multi-segment waveforms)**

The tag contains a string in ASCII format which supplies the clock rate mode, that was used for calculation of the multi-segment output waveform (see also "[Clock](#)" on page 322).

The tag `CLOCK` contains always the highest clock rate of all segments. The tag `MWV_SEGMENT_CLOCK` contains the clock rates of the individual segments.

**Setting parameters:**

**Mode** **UNCHANGED**  
The segments may have different clock rates; each segment is output with the clock rate defined in its waveform file.

**HIGHEST**

All segments are output at the highest available clock rate.

**USER**

All segments are output at the clock rate defined by the user.

**Note:** Only upsampling is allowed, no downsampling!

**Example:** {MWV\_SEGMENT\_CLOCK\_MODE: UNCHANGED}

**Usage:** Setting only

**{MWV\_SEGMENT\_CLOCK: ClockSeg0, ClockSeg1, ..., ClockSegN-1}****(mandatory for multi-segment waveforms)**

The tag contains a list of clock frequencies for every segment in the multi-segment waveform in ASCII floating point format.

**Example:** {MWV\_SEGMENT\_CLOCK: 100e6,80e6}  
2 segments: clock of segment 0 is 100 MHz, clock of segment 1 is 80 MHz.

**Note:** If the segments have different clock frequencies, there are some restrictions on signal output, i.e. seamless switching between segments is only possible, if all segments have the same clock frequency. Software resampling (upsampling) can be used to bring all segments to the same clock.

**Usage:** Setting only

**{MWV\_SEGMENT\_LEVEL\_OFFS:**

**RMSOffs\_dBSg0,PeakOffs\_dBSg0, ..., RMSOffs\_dBSgN-1, PeakOffs\_dBSgN-1}**

**(mandatory for multi-segment waveforms)**

The tag contains a list of level pairs in ASCII floating point format, one pair for every segment in the multi-segment waveform. The first value of a level pair defines the rms offset and the second value the peak offset relative to the 16-bit full scale modulation (-32767; + 32767) = 0 dB. The meaning of one level value pair is the same as in the [LEVEL OFFS](#) tag for normal waveforms.

**Example:** {MWV\_SEGMENT\_LEVEL\_OFFS: 3.0,0.0,6.0,0.0}  
2 segments: RMS level of segment 0 is 3 dB below full scale;  
RMS level of segment 1 is 6dB below full scale.  
Peak level of both segments is 0 dB full scale.

**Usage:** Setting only

---

**{MWV\_SEGMENT\_FILES:**  
 "FileNameSeg0.wv", "FileNameSeg1.wv", ..., "FileNameSegN-1.wv"}  
 (optional for multi-segment waveforms)

The tag contains a list of file names for every segment in the multi-segment waveform in ASCII format.

**Example:** {MWV\_SEGMENT\_FILES: "d:\waveforms\sine.wv", "d:\waveforms\rect.wv"}

**Usage:** Setting only

---

**{MWV\_SEGMENTx\_COMMENT: text}**

(optional for multi-segment waveforms)

The tag contains a user comment for a specific segment  $x = [0 \dots \text{NumOfSeg}-1]$  in the multi-segment waveform in ASCII format.

**Example:** {MWV\_SEGMENT1\_FILES: segment 1 contains a QPSK signal.}

**Usage:** Setting only

---

**{CONTROL\_LIST\_WIDTH4–Length: #m0m1...mx...mM-1}**

(optional for waveforms and multi-segment waveforms)

The tag contains a binary marker element stream, which is output synchronously to the I/Q sample sequence. One marker element  $m_x$  consists of 4 bit, which are assigned to the 4 possible marker lines of the instrument (1 bit per marker line). One 4-bit marker element is required for every I/Q sample in the WAVEFORM tag. Hence, the number of marker elements  $m$  should be equal to the number of I/Q samples. The CONTROL LENGTH tag has to contain the number of all marker elements  $m$ .

MSB 7	Byte						LSB 1
Marker element $m_x$ (synchronous to I/Q Sample $x$ )				Marker element $m_{x+1}$ (synchronous to I/Q Sample $x+1$ )			
Marker 4	Marker 3	Marker 2	Marker 1	Marker 4	Marker 3	Marker 2	Marker 1

*Figure 13-6: Marker element in 4-bit binary format bit order*

For standard waveforms, the MARKER LIST  $x$  tags are a more compact way to define markers, but in principle this CONTROL LIST WIDTH4 format can also be used instead of the MARKER LIST  $x$  tags.

For multi-segment waveforms, this CONTROL LIST WIDTH4 format is required for marker definition. The binary marker streams of the individual segments are directly concatenated (without any gap) to one collectively marker stream.

**Setting parameters:**

Length	Defines the number of bytes in the <code>CONTROL LIST WIDTH4</code> tag in ASCII Format and is calculated as follows: $Length = Size\ of\ "\#\ " (1\ byte) + Number\ of\ marker\ elements\ m_x * (4\ bit) / (8\ bits/byte)$ The value is rounded up for byte alignment.
mx	Marker element in 4-bit binary format.
<b>Example:</b>	{CONTROL LIST WIDTH4-51: #m <sub>0</sub> m <sub>1</sub> ...m <sub>x</sub> ...m <sub>99</sub> } 100 marker elements, each marker element with 4 bits
<b>Usage:</b>	Setting only

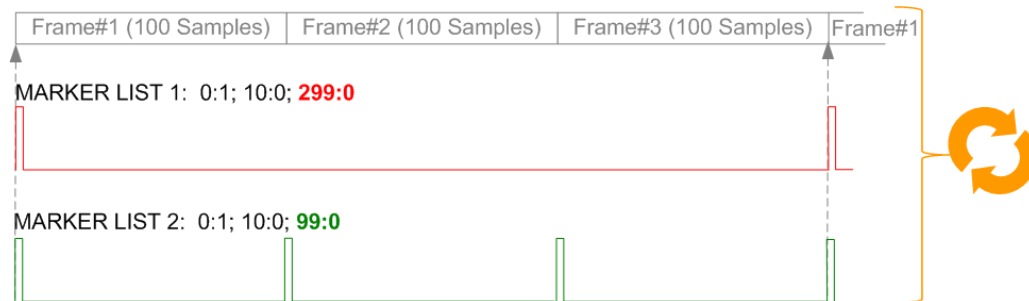
**How to Define Periodically Repeating Traces**

If a marker trace is required that marks for example each frame start, it is sufficient to define the trace ones and repeat it over the length of a waveform. This is useful if you describe a long waveform and a periodical marker is required.

The following examples use marker traces; control lists are processed in the same way.

**To define periodical marker trace**

The waveform in the example on [Figure 13-7](#) consists of 3 frames, each frame is 100-samples long. The waveform is processed continuously ("Trigger Mode > Auto").



**Figure 13-7: Example: Defining marker traces (CONTROL LENGTH tag is not used)**

To define a restart marker and a frame start marker, use the following tags:

1. The waveform is 300 samples long, i.e. set `{SAMPLES: 300}`.
2. Set two `[TRACE] LIST` tags:
  - For Marker 1 that acts as a restart marker:  
`{MARKER LIST 1: 0:1; 10:0; 299:0}`
  - For Marker 2 that marks each frame start:  
`{MARKER LIST 2: 0:1; 10:0; 99:0}`
3. Do not use the `CONTROL LENGTH` tag.

The length of the repeated patterns is determined by the last sample number in the `[TRACE] LIST`, that is the last `{Pos:State}`.

### Example: How the CONTROL LENGTH tag influences the processing of the traces

For the example on [Figure 13-7](#), use the same marker traces and set the CONTROL LENGTH tag, e.g. {CONTROL LENGTH: 150}.

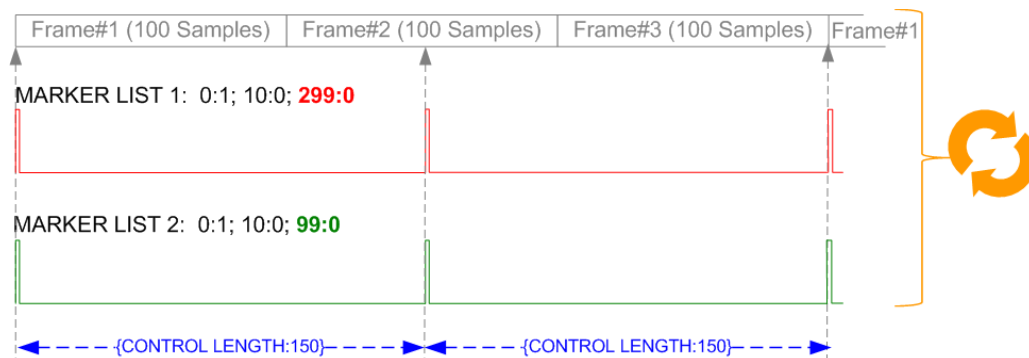


Figure 13-8: Example: Processing of control signals if the CONTROL LENGTH tag is used

The length of **all** control signals is determined by the CONTROL LENGTH. Observe how the marker traces are processed. In this example, both marker traces are repeated each 150 samples.

### How to Manually Create a Waveform Using Tag File Format

As described in [Chapter 5.5.2.1, "Waveform Files Sources"](#), on page 288, you can generate waveform files internally, with the built-in function, and externally. For description on how to generate waveform files internally, see [Chapter 5.5.4.2, "How to Create Waveform Files with the Built-In "Generate Waveform File" Function"](#), on page 303. This section provides an example on how to create a waveform externally. The waveform file is created manually; the tag-oriented file format is used.

The provided example uses a sine function in the I channel and a cosine function in the Q channel, each with 20 points. The example uses a short program written in the programming language C to calculate the sine and cosine values (see [Example "C-program for creating a waveform file"](#) on page 905). They are stored in the file `SICO.txt`. The decimal values in `SICO.txt` are normalized such that they are between  $-1.0$  and  $+1.0$ . The data is converted into binary format. The appropriate mandatory tags are added and the data is packed into the WAVEFORM tag. As result, the waveform file `SICO.wv` is generated.

This example follows the general principle of creating of a waveform manually, using the tag file format. The [Figure 13-9](#) illustrates this general workflow.

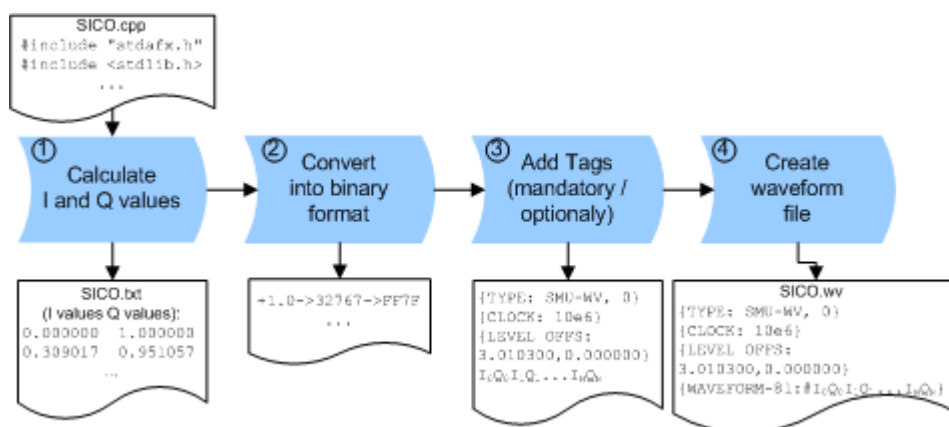


Figure 13-9: Principle of creating a waveform manually

The following steps outline how to create the waveform file `SICO.wv`:

1. Calculate the sine and cosine values, e.g. use the `SICO.cpp` program.

The result is stored in the file `SICO.txt`.

```

0.000000 1.000000
0.309017 0.951057
0.587785 0.809017
0.809017 0.587785
0.951057 0.309017
1.000000 -0.000000
0.951057 -0.309017
0.809017 -0.587785
0.587785 -0.809017
0.309017 -0.951057
-0.000000 -1.000000
-0.309017 -0.951056
-0.587785 -0.809017
-0.809017 -0.587785
-0.951056 -0.309017
-1.000000 0.000000
-0.951056 0.309017
-0.809017 0.587785
-0.587785 0.809017
-0.309017 0.951057
  
```

Figure 13-10: Contents of `SICO.txt`: first column Sine (I), second column Cosine (Q)

2. Convert the values from the file `SICO.txt` into binary format consisting of 16-bit signed integer numbers. The numeric range between  $-1.0$  and  $+1.0$  corresponds to the modulation range of the waveform 16-bit D/A converter of  $-32767$  to  $+32767$ .

```

+1.0 -> 32767 -> = 0x7FFF
0.0 -> 0 -> = 0x0000
-1.0 -> -32767 -> = 0x8001
  
```

The [Figure 13-11](#) shows the calculation and conversion steps. The highlighted columns contain the resulting I and Q values represented in Little endian format.

Sample n	deg = 360°/20 * n	I = sin(deg)	I <sub>quant,dec</sub> = I * FS = I * (2 <sup>15</sup> -1)	I <sub>quant,hex</sub>	I <sub>quant,hex</sub> (Little endian waveform file representation)	Q = cos(deg)	Q <sub>quant,dec</sub> = I * FS = I * (2 <sup>15</sup> -1)	Q <sub>quant,hex</sub>	Q <sub>quant,hex</sub> (Little endian waveform file representation)
0	0	0.000000	0	0000	0000 I <sub>0</sub>	1.000000	32767	7FFF	FF7F Q <sub>0</sub>
1	18	0.309017	10126	278E	8E27	0.951057	31163	79BB	BB79
2	36	0.587785	19260	4B3C	3C4B	0.809017	26509	678D	8D67
3	54	0.809017	26509	678D	8D67	0.587785	19260	4B3C	3C4B
4	72	0.951057	31163	79BB	BB79	0.309017	10126	278E	8E27
5	90	1.000000	32767	7FFF	FF7F	0.000000	0	0000	0000
6	108	0.951057	31163	79BB	BB79	-0.309017	-10126	D872	72D8
7	126	0.809017	26509	678D	8D67	-0.587785	-19260	B4C4	C4B4
8	144	0.587785	19260	4B3C	3C4B	-0.809017	-26509	9873	7398
9	162	0.309017	10126	278E	8E27	-0.951057	-31163	8645	4586
10	180	0.000000	0	0000	0000	-1.000000	-32767	8001	0180
11	198	-0.309017	-10126	D872	72D8	-0.951057	-31163	8645	4586
12	216	-0.587785	-19260	B4C4	C4B4	-0.809017	-26509	9873	7398
13	234	-0.809017	-26509	9873	7398	-0.587785	-19260	B4C4	C4B4
14	252	-0.951057	-31163	8645	4586	-0.309017	-10126	D872	72D8
15	270	-1.000000	-32767	8001	0180	0.000000	0	0000	0000
16	288	-0.951057	-31163	8645	4586	0.309017	10126	278E	8E27
17	306	-0.809017	-26509	9873	7398	0.587785	19260	4B3C	3C4B
18	324	-0.587785	-19260	B4C4	C4B4	0.809017	26509	678D	8D67
19	342	-0.309017	-10126	D872	72D8	0.951057	31163	79BB	BB79

Figure 13-11: I and Q values calculation and conversion

- Use an ASCII editor which is able to handle binary data. Create and add the following mandatory tags before this binary data set can be further processed:

- TYPE
- CLOCK
- LEVEL OFFS

An example of the `SICO.wv` file contents could be:

```
{TYPE: SMU-WV, 0}{CLOCK: 10e6}{LEVEL OFFS: 3.010300,0.000000}
0000FF7F8E27BB79 ... 72D8BB79
```

To simplify the example, the checksum is set to 0, i.e. the instrument does not evaluate a checksum.

**Tip:** The tags `TYPE`, `CLOCK`, `LEVEL OFFS` and `WAVEFORM` are mandatory for each waveform. All other tags are optional and can be inserted after the `TYPE` tag in arbitrary order.

- Pack the binary data into a `WAVEFORM` tag with the described structure.

```
{WAVEFORM-Length: #I0Q0I1Q1I2Q2 ... InQn}
```

- Calculate the Length  
Length = Number of I/Q pairs \* 4 + 1 = 20\*4 + 1 = 81 bytes
- Place the string `{WAVEFORM-81: #` at the beginning of the data set
- Place the symbol `}` at the end of the data set

The contents of the waveform file `SICO.wv` for 20 I/Q pairs is now ready for operation and reads:

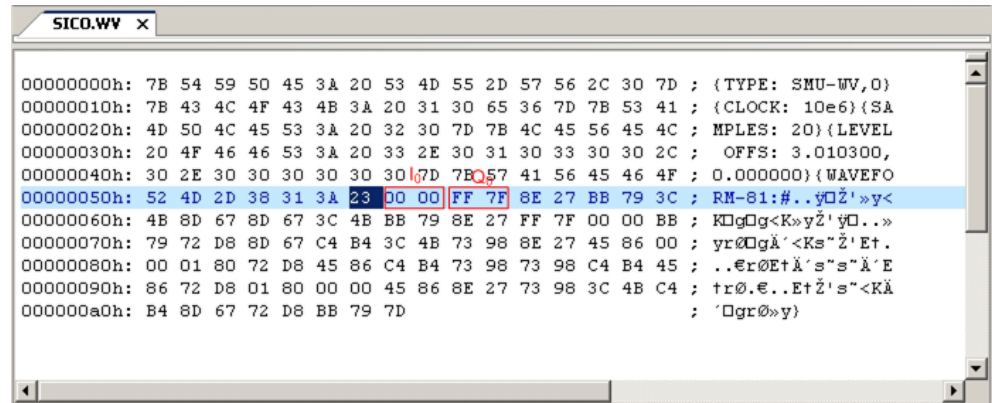
```
{TYPE: SMU-WV, 0}
{CLOCK: 10e6}
{LEVEL OFFS: 3.010300,0.000000}
```



```
{WAVEFORM-81:#I0Q0I1Q1...InQn}
```

**Note:** There is no readable representation for binary values in this document. This is why we use the sequence I0Q0I1Q1...InQn to characterize the binary code in the present example.

The following figure shows this waveform in a data editor.



### Example: C-program for creating a waveform file

C-program SICO.cpp for creating the file SICO.txt containing 20 sine and cosine pairs, converting them into binary data and creating the waveform file SICO.wv.

```
// SICO.cpp
// Defines the entry point for the console application

#include "stdafx.h"
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int _tmain(int argc, _TCHAR* argv[])
{
    const unsigned int samples = 20;
    const float pi = 3.141592654f;
    int i;

    // SICO.txt
    // Creating the file SICO.txt containing 20 sine and cosine pairs
    float grad, rad;
    FILE *fp;
    fp = fopen("SICO.txt", "w");
    if (fp == 0)
        return;
    for (i=0; i<samples; i++)
    {
        grad = (360.0f / (float)samples) * (float)i;
        rad = grad * (pi / 180.0f);
        fprintf(fp, "%f %f\n", sin(rad), cos(rad));
    }
}
```

```

fclose(fp);

// SICO.wv
// Generating a binary data set from the I/Q pairs in the file SICO.txt
// and storing the result to file SICO.wv
FILE *fp_sour, *fp_dest;
float i_float, q_float;
unsigned short i_usint, q_usint;
fp_sour = fopen("SICO.TXT", "rt");
if (fp_sour == 0)
    return -1;
fp_dest = fopen("SICO.WV", "wb");
if (fp_dest == 0)
{
    fclose(fp_sour);
    return -1;
}
// Write required tags to waveform file
fprintf(fp_dest, "{TYPE: SMU-WV,0}");
fprintf(fp_dest, "{CLOCK: 10e6}");
fprintf(fp_dest, "{SAMPLES: %d}", samples);
// RMS, Peak
fprintf(fp_dest, "{LEVEL OFFS: %f,%f}", -1.0f * 20.0f * log10(1.0f/sqrt(2.0f)), 0.0f);
fprintf(fp_dest, "{WAVEFORM-%d:#", (samples * 4) + 1);
for (i=0; i<samples; i++)
{
    // Read I/Q pair from ASCII file
    if (fscanf(fp_sour, "%f %f", &i_float, &q_float) == EOF)
        break;
    // Convert I/Q pair to unsigned short
    i_usint = (unsigned short)floor((i_float * 32767.0) + 0.5);
    q_usint = (unsigned short)floor((q_float * 32767.0) + 0.5);
    // Write converted I/Q pair to waveform file
    fwrite(&i_usint, 2, 1, fp_dest);
    fwrite(&q_usint, 2, 1, fp_dest);
}
fprintf(fp_dest, "}");
fclose(fp_dest);
fclose(fp_sour);
return 0;
}

```

### How to Create a Control List Using Tag File Format

The R&S SMW provides the following ways to create a file containing control signals:

- to use the dedicated "Control Data Editor" and create a file in ASCII format and with extension \*.dm\_iqc, see ["To create a control list in ASCII format manually"](#) on page 274
- To use the tag-oriented format and create a control list file, see ["To create a control list using tag file format"](#) on page 907

- To use SCPI commands and create a file in binary format, see ["To create a control list in binary format"](#) on page 907

### To create a control list using tag file format

To create an ASCII control list file directly, use the provided tag commands.

1. Use a hex data editor and create the **mandatory** tags:
  - `TYPE`
  - `[TRACE] LIST`

The `[TRACE] LIST` tag defines the individual markers or control traces in a combined `{Pos:State}` way within the control list period (`CONTROL LENGTH`).

2. Use a hex data editor and create the **recommended** tag `CONTROL LENGTH`.

This tag defines the *periodicity* of the total control list

3. Add the required optional tags.  
They can be inserted after the `TYPE` tag in arbitrary order.

An example of the control list file contents could be:

```
{TYPE:SMU-CL}{COPYRIGHT:Rohde&Schwarz}
{DATE:2012-06-11;15:00:09}{HOP LIST:0:0;498:1;506:0}
{CW MODE LIST:0:0;380:1}{LEVATT LIST 3:0:0;464:1}
{BURST LIST:0:0;122:1;270:0;582:1;924:0}
{MARKER LIST 4:0:0;706:1;764:0}
{MARKER LIST 3:0:0;530:1;633:0}
{MARKER LIST 2:0:0;350:1;457:0}
{MARKER LIST 1:0:0;108:1;160:0}
{CONTROL LENGTH:1000}
```

The [Figure 5-14](#) shows the representation of the created control list in the "Control Data Editor".

Compare the displayed ramp values of "Marker 1" and the "Total List Length" with the values in the corresponding tags.

**Note:** In the provided example, the tags have been separated by line breaks for better reading.

See also [Example "How to assign and activate control signals from a control list"](#) on page 908.

### To create a control list in binary format

Generation of a control list in binary format is not necessary but possible.

- ▶ Use the commands `BB:DM:CLIST:...` to generate a control list in binary format (see ["Handling List Files"](#) on page 838 and the example in `[ :SOURCE<hw> ] :BB:DM:CLIST:DATA` on page 842).

See also [Example "How to assign and activate control signals from a control list"](#) on page 908.

**Example: How to assign and activate control signals from a control list**

**Note:** Irrespectively on the way they are created, generated control lists are not automatically used.

We assume, that a control list `clist.dm_iqc` containing information on marker 2, burst gate and level attenuation control signals is created and stored in the directory `/var/user/temp/`.

The following example shows how to enable the R&S SMW to:

- Use the control list for a particular marker output, e.g. the "Custom Digital Modulation > Marker 2".
- Use the Burst Gate and Level Attenuation control signals as defined in a control list.

```
MMEM:CDIRectory "/var/user/temp"
SOURce1:BB:DM:CLISt:CATalog?
// Response: clist
SOURce1:BB:DM:CLISt:SElect "clist"
SOURce1:BB:DM:TRIGger:OUTPut2:MODE CLISt

SOURce1:BB:DM:PRAMp:SOURce INTernal
```

**How to Create a Data List Using Tag File Format**

The R&S SMW provides the following ways to create a data list file:

- To use the dedicated "Data List Editor" and create a file with extension `*.dm_iqd`, see ["To create a data list manually"](#) on page 275.
- To use the tag-oriented format and create a data list file, see ["To create a data list using tag file format"](#) on page 908.
- To use SCPI commands and create a file in binary format, see ["To create a data list in binary format"](#) on page 909.

**To create a data list using tag file format**

To create a data list file directly, use the provided tag commands.

- Use a hex data editor and create the mandatory tags, the `TYPE`, the `{DATA BITLENGTH}`, and `{DATA LIST-Length}`.

Consider the rules of the required tags.

An example of the data list file contents could be:

```
{TYPE:SMU-DL}{COPYRIGHT:Rohde&Schwarz}
{DATE:201-06-11;15:00:09}
{DATA BITLENGTH: 8}
{DATA LIST-2: #01110101}
```

**Note:** In the provided example, the tags have been separated by line breaks for better reading.

See [Figure 5-15](#) for representation of the created data list in the "Data List Editor". See also [Example "How to assign and activate a data list"](#) on page 909.

### To create a data list in binary format

- Use the commands `BB:DM:DLIST:...`, see ["Handling List Files"](#) on page 838.

```
MMEM:CDIRectory "/var/user"
// create a new data list file
SOURCE1:BB:DM:DLIST:SElect "dl_new"
// append data to the data list and query the content
:FORMat ASCii
SOURCE1:BB:DM:DLIST:DATA:APPend 0,1,1,1,0,1,0,1
SOURCE1:BB:DM:DLIST:DATA?
// Response: 0,1,1,1,0,1,0,1
```

See also [Example "How to assign and activate a data list"](#) on page 909.

#### Example: How to assign and activate a data list

**Note:** Irrespectively on the way they are created, generated data lists are not automatically used.

We assume, that a data list `dl.dm_iqd` is created and stored in the directory `/var/user/`.

The following example shows how to enable the R&S SMW to use this data list as data source for the custom digital modulation.

```
MMEM:CDIRectory "/var/user"
SOURCE1:BB:DM:DLIST:CATalog?
// Response: dl
SOURCE1:BB:DM:DLIST:SElect "dl"
```

### Editing Waveform Files, Data and Control Lists

You can edit the internally and externally crated waveform files, data and control lists. The waveform, data and control lists files contain binary and ASCII data.

Consider the following rules while editing files with binary data.

#### Rules for editing binary data (waveforms, data and control lists)

- **Use hex data editor**  
Always use a hex data editor to edit files containing binary data. Editing of binary data file with a text editor, even if you only change the ASCII part of the file, corrupts the file.
- **Adapt the length information in the {EMPTYTAG}**  
If you change the content of a waveform file, change also the {EMPTYTAG-Length} value.  
For example, if you add a tag or add bytes to an existing tag, reduce the length information by the number of newly introduced bytes.

#### 13.18.3.5 SOURCE:BB:MCCW Subsystem

This subsystem contains the commands for setting the Multi-Carrier CW signals.



The generation of multi-carrier CW signals requires an instrument equipped with the software options R&S SMW-K61.

### Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
ENTity<ch>	1 to 4	Entity in a multiple entity configuration
SOURce<ch>	[1] to 4	Available baseband signals
OUTPut<ch>	1 to 3	Available markers

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

### Programming Examples

#### Generating a multi-carrier signal to test the frequency response of a DUT

```
// *****
// Generating a multi-carrier signal to test the frequency response of a DUT
// *****

// *****
// Reset the instrument first
// *****
*RST; *CLS

// *****
// Configuring and enabling the multi-carrier signal
// *****
SOURce:BB:MCCW:CARRier:COUNT 81
SOURce:BB:MCCW:CARRier:SPACing 1E6
// Set the number of carriers and their distance
// Further settings stay in default state (for example trigger settings)

SOURce:BB:MCCW:STATe ON
// Enable signal generation

OUTPut ON
// Enable the signal output

// *****
// Storing the current settings
```

```
// *****
:MMEMory:MDIR '/var/user/savrcl'
// Create a new directory "savrcl"
*SAV 4
:MMEMory:STORe:STATe 4,"/var/user/savrcl/mccw_SSB.savrcltxt"
// Store the current settings in an intermediate memory with number 4
// Store the settings file in the specified directory; the complete path
// and filename has to be specified
```



To visualize the configured signal, switch to local mode with the command `&NREN` and open the "Multi-carrier Continuous Wave > Carrier Graph".

### Generating a multi-carrier signal to test the image rejection of an SSB filter

This example generates a multi-carrier single sideband signal as shown in [Figure 13-12](#).

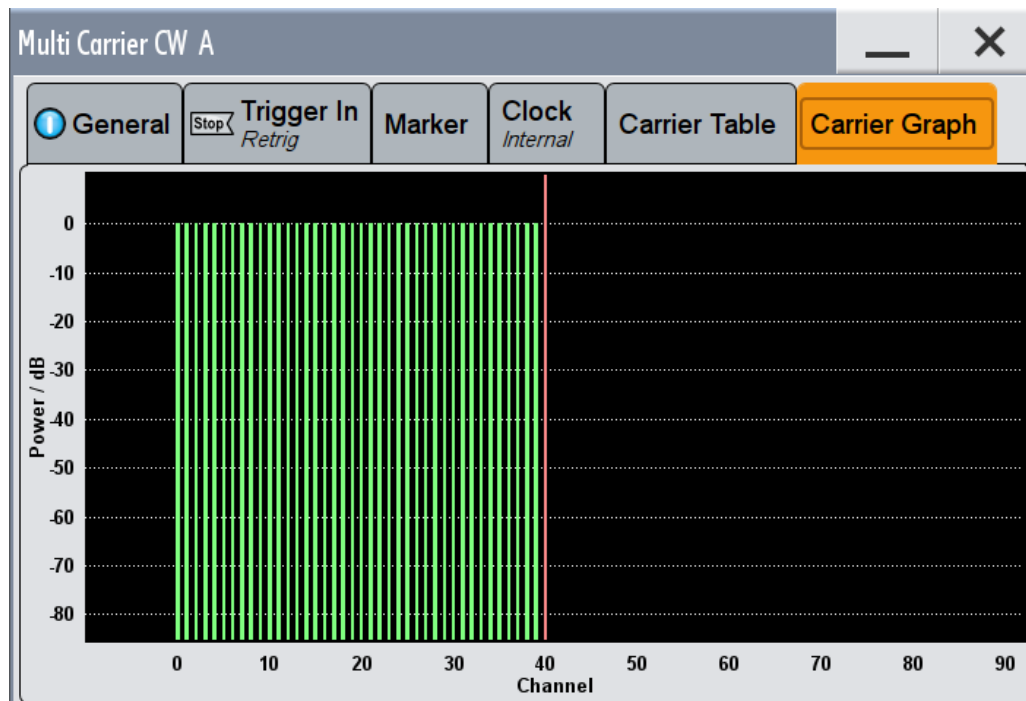


Figure 13-12: Multi-carrier signal to test the image rejection of an SSB filter

```
// *****
// Generating a multi-carrier signal to test the image rejection of an SSB filter
// *****

// *****
// Reset the instrument first
// *****
```

```

*RST; *CLS

// *****
// Configuring and enabling the multi-carrier signal
// *****
SOURce:BB:MCCW:CARRier:COUNT 81
SOURce:BB:MCCW:CARRier:SPACing 1E6
// Set the number of carriers and their distance
// Further settings stay in default state (for example trigger settings)

SOURce:BB:MCCW:EDIT:CARRier:START 40
SOURce:BB:MCCW:EDIT:CARRier:STOP 80
SOURce:BB:MCCW:EDIT:CARRier:STATE OFF
SOURce:BB:MCCW:EDIT:CARRier:EXECute
// Configure the carrier table for the single sideband signal:
// Set the carriers no. 40 to 80 to "OFF"

SOURce:BB:MCCW:STATE ON
// Enable signal generation

OUTPut ON
// Enable signal output

```

### Generating a composed multi-carrier signal

This example generates a multi-carrier signal as shown in [Figure 13-13](#).

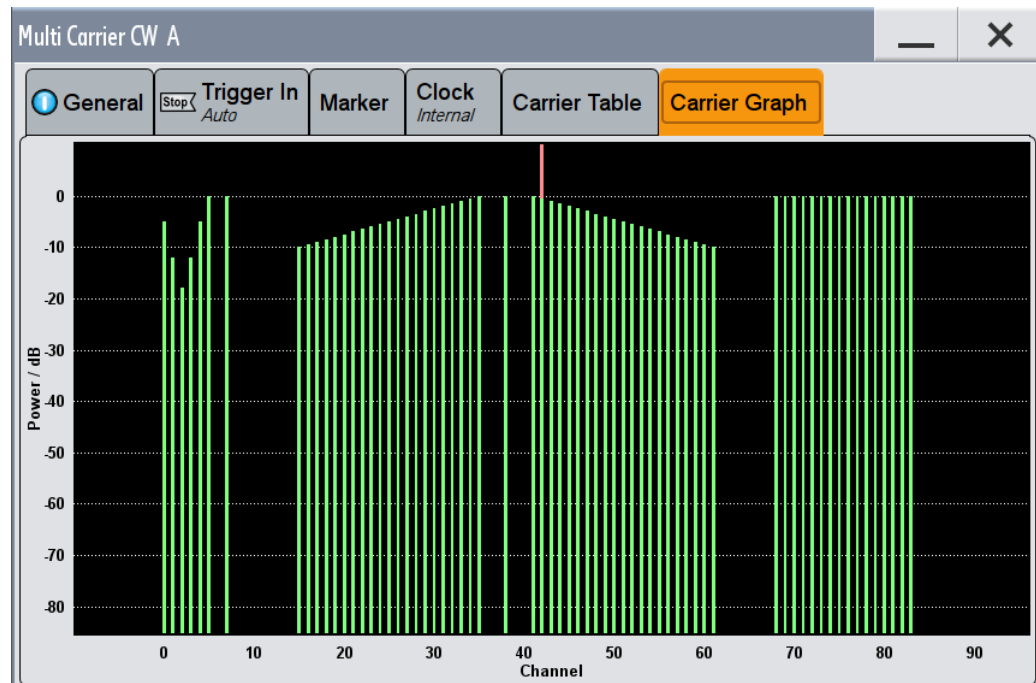


Figure 13-13: Composed multi-carrier signal



```

// *****
// Generating a composed multi-carrier signal
// *****
// *****
// Reset the instrument first
// *****
*RST; *CLS

// *****
// Configuring the multi-carrier signal
// *****
SOURCE:BB:MCCW:CARRIER:COUNT 100
SOURCE:BB:MCCW:CARRIER:SPACING 500000
// Setup 100 carriers with a spacing of 500kHz

SOURCE:BB:MCCW:CLOCK?
// Return value 1000000
SOURCE:BB:MCCW:CFACTOR:MODE SLOW
SOURCE:BB:MCCW:CFACTOR 3
SOURCE:BB:MCCW:CFACTOR:ACTUAL?
// Return value 3

// *****
// Adjust the settings of a group of carriers
// *****
SOURCE:BB:MCCW:CARRIER:LIST:POWER -6,-12,-18,-12,-6,0
// Set the power levels for carriers no. 1 to 6 to -10dB,-15dB,-20dB,-15dB,-10dB,0dB
SOURCE:BB:MCCW:CARRIER:LIST:STATE ON,ON,ON,ON,ON,ON,OFF,ON
// Set the state of the carriers no. 1 to 8
SOURCE:BB:MCCW:EDIT:CARRIER:START 15
SOURCE:BB:MCCW:EDIT:CARRIER:STOP 35
SOURCE:BB:MCCW:EDIT:CARRIER:STATE ON
SOURCE:BB:MCCW:EDIT:CARRIER:POWER:STAR -10
SOURCE:BB:MCCW:EDIT:CARRIER:POWER:STEP 0.5
SOURCE:BB:MCCW:EDIT:CARRIER:EXECUTE
// Set the carriers no. 15 to 35 to "ON"
// Increase the power in 0.5dB steps starting with a power level of -10dB
// Apply the settings

SOURCE:BB:MCCW:EDIT:CARRIER:POWER 38,0
SOURCE:BB:MCCW:EDIT:CARRIER:STATE 38,ON
// Set a power level of 0dB for carrier no. 38 and set it to "ON"

SOURCE:BB:MCCW:EDIT:CARRIER:START 41
SOURCE:BB:MCCW:EDIT:CARRIER:STOP 61
SOURCE:BB:MCCW:EDIT:CARRIER:STATE ON
SOURCE:BB:MCCW:EDIT:CARRIER:POWER:START 0
SOURCE:BB:MCCW:EDIT:CARRIER:POWER:STEP -0.5
SOURCE:BB:MCCW:EDIT:CARRIER:EXECUTE

```

```

// Set the carriers no. 41 to 61 to "ON"
// Decrease the power in 0.5dB steps starting with a power level of 0dB
// Apply the settings

SOURCE:BB:MCCW:EDIT:CARRIER:START 70
SOURCE:BB:MCCW:EDIT:CARRIER:STOP 85
SOURCE:BB:MCCW:EDIT:CARRIER:STATE ON
SOURCE:BB:MCCW:EDIT:CARRIER:EXECUTE
// Set the carriers no. 70 to 85 to "ON"
// Apply the settings

// *****
// Configuring the clock settings
// *****
SOURCE:BB:MCCW:CLOCK:SOURCE INTERNAL

// *****
// Configuring and enabling marker signals
// *****
SOURCE:BB:MCCW:TRIGGER:OUTPUT1:MODE RESTART
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:MODE PULSE
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:PULSE:DIVIDER 5
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:PULSE:FREQUENCY?
SOURCE:BB:MCCW:TRIGGER:OUTPUT3:MODE PATTERN
SOURCE:BB:MCCW:TRIGGER:OUTPUT3:PATTERN #HE0F52,20
// SOURCE:BB:MCCW:TRIGGER:OUTPUT1:MODE RATIO
// SOURCE:BB:MCCW:TRIGGER:OUTPUT1:ONTIME 40
// SOURCE:BB:MCCW:TRIGGER:OUTPUT1:OFFTIME 20
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:DELAY 16
SOURCE:BB:MCCW:TRIGGER:OUTPUT:DELAY:FIXED ON
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:DELAY:MINIMUM?
// Return value 0
SOURCE:BB:MCCW:TRIGGER:OUTPUT2:DELAY:MAXIMUM?
// Return value 2000

// *****
// Configuring and enabling signal triggering
// *****
SOURCE:BB:MCCW:TRIGGER:SEQUENCE SINGLE
SOURCE:BB:MCCW:TRIGGER:SLLENGTH 200
// The first 200 samples of the current waveform will be output after
// the next trigger event
SOURCE:BB:MCCW:TRIGGER:SEQUENCE ARETRIGGER
SOURCE:BB:MCCW:TRIGGER:SOURCE INTERNAL
// SOURCE:BB:MCCW:TRIGGER:SOURCE EGT1
// An external global trigger signal must be provided at the connector
// configured for the External Global Trigger 1 signal
// SOURCE:BB:MCCW:TRIGGER:EXTERNAL:SYNCHRONIZE:OUTPUT ON
// SOURCE:BB:MCCW:TRIGGER:EXTERNAL:DELAY 200
// SOURCE:BB:MCCW:TRIGGER:EXTERNAL:INHIBIT 100

```

```
// SOURce:BB:MCCW:TRIGger:SOURce OBASEband
// The internal trigger signal from the other path must be used
// SOURce:BB:MCCW:TRIGger:OBASEband:DELay 25
// SOURce:BB:MCCW:TRIGger:OBASEband:INHibit 10

// *****
// Applying the settings and enabling signal generation
// *****

*TRG
SOURce:BB:MCCW:STATe ON
// Stop the internal trigger manually
SOURce:BB:MCCW:TRIGger:ARM:EXECute
// Execute manual internal trigger, i.e. restarting signal generation
SOURce:BB:MCCW:TRIGger:EXECute
SOURce:BB:MCCW:TRIGger:RMODE?
// RUN
```

**General Settings and Carrier Setup Settings**

[SOURce<hw>]:BB:MCCW:PRESet.....	915
[SOURce<hw>]:BB:MCCW:STATe.....	916
[SOURce<hw>]:BB:MCCW:CARRier:COUNT.....	916
[SOURce<hw>]:BB:MCCW:CARRier:SPACing.....	916
[SOURce<hw>]:BB:MCCW:CLOCK?.....	916
[SOURce<hw>]:BB:MCCW:CFACTOR:MODE.....	917
[SOURce<hw>]:BB:MCCW:CFACTOR.....	917
[SOURce<hw>]:BB:MCCW:CFACTOR:ACTual?.....	917
[SOURce<hw>]:BB:MCCW:CARRier:STATe.....	917
[SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe.....	918
[SOURce<hw>]:BB:MCCW:CARRier:PHASe.....	918
[SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe.....	919
[SOURce<hw>]:BB:MCCW:CARRier:POWer.....	919
[SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer.....	920
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:STARt].....	920
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:STARt].....	920
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe:STEP.....	921
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP.....	921
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:STARt.....	921
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:STOP.....	921
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:STATe.....	921
[SOURce<hw>]:BB:MCCW:EDIT:CARRier:EXECute.....	922

---

**[SOURce<hw>]:BB:MCCW:PRESet**

Sets all multi carrier signal parameters to their default values.

**Example:** see "Programming Examples" on page 910

**Usage:** Event

**Manual operation:** See ["Set to Default"](#) on page 359

**[[:SOURce<hw>]:BB:MCCW:STATe <State>**

Enables/disables the multi carrier CW signal.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** see ["Programming Examples"](#) on page 910

**Manual operation:** See ["State"](#) on page 358

**[[:SOURce<hw>]:BB:MCCW:CARRier:COUNT <Count>**

Sets the number of carriers in the multi carrier CW signal.

**Parameters:**

<Count> integer  
Range: 1 to 8192  
\*RST: 64

**Example:** see ["Programming Examples"](#) on page 910

**Manual operation:** See ["Number of Carriers"](#) on page 359

**[[:SOURce<hw>]:BB:MCCW:CARRier:SPACing <Spacing>**

Sets the carrier spacing.

**Parameters:**

<Spacing> float  
Range: 0 to 120E6  
Increment: 0.01  
\*RST: 10E3

**Example:** see ["Programming Examples"](#) on page 910

**Manual operation:** See ["Carrier Spacing"](#) on page 359

**[[:SOURce<hw>]:BB:MCCW:CLOCK?**

Queries the output clock rate. The output clock rate depends on the number of carriers and on the selected carrier spacing.

**Return values:**

<Clock> float  
Range: 0 to Max  
Increment: 1E-3  
\*RST: 0

- Example:** See ["Programming Examples"](#) on page 910
- Usage:** Query only
- Manual operation:** See ["Clock Frequency"](#) on page 359

**[:SOURce<hw>]:BB:MCCW:CFACTOR:MODE <Mode>**

Sets the mode by which automatic settings minimize the crest factor or hold it at a chosen value.

**Parameters:**

<Mode> OFF | CHIRp | SLOW

**SLOW**  
corresponds to the manual control "Target Crest"

\*RST: CHIRp

- Example:** See ["Programming Examples"](#) on page 910
- Manual operation:** See ["Optimize Crest Factor Mode"](#) on page 360

**[:SOURce<hw>]:BB:MCCW:CFACTOR <CFactor>**

Sets the desired crest factor, if the optimization mode target crest factor is used.

**Parameters:**

<CFactor> float

Range: 0 to 30

Increment: 0.01

\*RST: 3

- Example:** See ["Programming Examples"](#) on page 910
- Manual operation:** See ["Desired Crest Factor"](#) on page 360

**[:SOURce<hw>]:BB:MCCW:CFACTOR:ACTUAL?**

Queries the actual Crest Factor for optimization mode target crest.

**Return values:**

<Actual> float

Range: 0 to 100

Increment: 0.01

\*RST: 3

- Example:** see ["Programming Examples"](#) on page 910
- Usage:** Query only

**[:SOURce<hw>]:BB:MCCW:CARRIER:STATE <CarrierIndex>, <State>**

Switches the selected carrier on or off.

The counting in remote control differs from the numbers in the carrier table. Index 0 corresponds to number 1 (first line) in the table. Therefore, switching the state of the channel via remote control always switches the state of `<CarrierIndex> + 1` in the table.

**Parameters:**

`<CarrierIndex>` integer  
 Range: 0 to lastCarrier

`<State>` select  
 \*RST: 0

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe <Stat0[,Stat1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:STATe? <Start>, <Count>
```

Switches the carrier on or off with the aid of a value list.

The first value in the list is assigned to the carrier with index 0, the second value to the carrier with index 1, etc. The maximum length corresponds to the maximum number of multi carriers. There is no need to enter all the values every time. Values not set by the value list are set with the default values provided they have already been explicitly set by a previous command. If this is the case, the values continue to apply until overwritten.

**Setting parameters:**

`<Stat0[,Stat1..]>` ON | OFF

**Query parameters:**

`<Start>` integer  
 start carrier index  
 Range: 0 to lastCarrier

`<Count>` integer  
 number of carriers in the carrier range, starting from the  
`<Start>` carrier  
 Range: 1 to lastCarrier

**Return values:**

`<State[,State..]>` select

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[:SOURce<hw>]:BB:MCCW:CARRier:PHASe <CarrierIndex>, <Phase>
```

For disabled optimization of the crest factor, sets the start phase of the selected carrier.

**Parameters:**

<CarrierIndex> integer  
 Range: 0 to lastCarrier

<Phase> float  
 Range: 0 to 359.99  
 Increment: 0.01  
 \*RST: 0  
 Default unit: DEG

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[ :SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe <Phas0[,Phas1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:PHASe? [<Start>[, <Count>]]
```

Sets the start phase of the carrier with the aid of a value list.

**Setting parameters:**

<Phas0[,Phas1..]> float  
 Range: 0 to 360  
 Increment: 0.01  
 \*RST: 0  
 Default unit: DEG

**Query parameters:**

<Start> integer  
 start carrier index  
 Range: 0 to lastCarrier

<Count> integer  
 number of carriers in the carrier range, starting from the  
 <Start> carrier  
 Range: 1 to max

**Return values:**

<Phas[,Phas..]> float

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[ :SOURce<hw>]:BB:MCCW:CARRier:POWer <CarrierIndex>, <Power>
```

Sets the power of the selected carrier.

**Parameters:**

<CarrierIndex> integer  
 Range: 0 to lastCarrier

<Power> float  
 Range: -80 to 0  
 Increment: 0.01  
 \*RST: 0

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[ :SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer <Pow0[,Pow1..]>
[:SOURce<hw>]:BB:MCCW:CARRier:LIST:POWer? <Start>, <Count>
```

Sets the power of the carrier with the aid of a value list.

**Setting parameters:**

<Pow0[,Pow1..]> float  
 Increment: 0.01  
 \*RST: 0 dB

**Query parameters:**

<Start> integer  
 start carrier index  
 Range: 0 to lastCarrier

<Count> integer  
 number of carriers in the carrier range, starting from the  
 <Start> carrier  
 Range: 1 to lastCarrier

**Return values:**

<Pow[,Pow..]> float

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Carrier Table" on page 362

```
[ :SOURce<hw>]:BB:MCCW:EDIT:CARRier:PHASe[:START] <Start>
[:SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer[:START] <Start>
```

Sets the power/pahse for the starting carrier. The power of the remaining carriers is stepped up or down by the power specified with the `[ :SOURce<hw>]:BB:MCCW:EDIT:CARRier:POWer:STEP` command.

**Parameters:**

<Start> float  
 Range: -80 to 0  
 Increment: 0.01  
 \*RST: 0

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Power Start" on page 361



---

**[[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:PHASe:STEP <Step>**

For disabled optimization of the crest factor, sets the step width by which the start phase of the carriers in the defined carrier range is incremented.

**Parameters:**

<Step> float  
 Range: -359.99 to 359.99  
 Increment: 0.01  
 \*RST: 0

**Example:** See "Programming Examples" on page 910

**Manual operation:** See "Phase Step" on page 362

---

**[[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:POWER:STEP <Step>**

Sets the step width by which the starting power of the carriers in the defined carrier range is incremented.

**Parameters:**

<Step> float  
 Range: -80 to 80  
 Increment: 0.01  
 \*RST: 0

**Example:** See "Programming Examples" on page 910

**Manual operation:** See "Power Step" on page 362

---

**[[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:START <Start>****[[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:STOP <Stop>**

Defines the first/last carrier in the carrier range to which joint configuration applies.

**Parameters:**

<Stop> integer  
 Range: 0 to 8191  
 \*RST: 0

**Example:** See "Programming Examples" on page 910

**Manual operation:** See "Carrier Start/Stop" on page 361

---

**[[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:STATe <State>**

Switches all the carriers in the selected carrier range on or off.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** see "Programming Examples" on page 910

**Manual operation:** See ["Carrier State"](#) on page 361

---

**[:SOURce<hw>]:BB:MCCW:EDIT:CARRIER:EXECute**

Adopts the settings for the carrier range.

**Example:** see ["Programming Examples"](#) on page 910

**Usage:** Event

**Manual operation:** See ["Accept"](#) on page 362

**Trigger Settings**

<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:ARM:EXECute</a> .....	922
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:EXECute</a> .....	922
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut</a> .....	922
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OBASeband:DELay</a> .....	923
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OBASeband:INHibit</a> .....	923
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:RMODE?</a> .....	923
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:SLENgth</a> .....	924
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:SOURce</a> .....	924
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger[:EXTernal]:DELay</a> .....	925
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger[:EXTernal]:INHibit</a> .....	925
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW[:TRIGger]:SEQUence</a> .....	925

---

**[:SOURce<hw>]:BB:MCCW:TRIGger:ARM:EXECute**

Stops signal generation.

**Example:** see ["Programming Examples"](#) on page 910

**Usage:** Event

**Manual operation:** See ["Arm"](#) on page 244

---

**[:SOURce<hw>]:BB:MCCW:TRIGger:EXECute**

Executes a trigger.

**Example:** see ["Programming Examples"](#) on page 910

**Usage:** Event

**Manual operation:** See ["Execute Trigger"](#) on page 244

---

**[:SOURce<hw>]:BB:MCCW:TRIGger:EXTernal:SYNChronize:OUTPut <Output>**

Enables/disables output of the signal synchronous to the external trigger event. For more information, refer to ["Impact of the Additional Trigger Settings"](#) on page 230.

**Parameters:**

<Output> 0 | 1 | OFF | ON  
 \*RST: 1

**Example:** see ["Programming Examples"](#) on page 910

**Manual operation:** See ["Sync. Output to External Trigger"](#) on page 245

**[:SOURce<hw>]:BB:MCCW:TRIGger:OBASeband:DELay <Delay>**

Specifies the trigger delay for external triggering.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215  
 Increment: 0.01  
 \*RST: 0  
 Default unit: samples

**Example:** see ["Programming Examples"](#) on page 910

**Manual operation:** See ["\(External\) Trigger Delay/Specified Trigger Delay"](#) on page 246

**[:SOURce<hw>]:BB:MCCW:TRIGger:OBASeband:INHibit <Inhibit>**

Specifies the number of samples by which a restart is inhibited following a trigger event from the other path.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 67108863  
 \*RST: 0

**Example:** See ["Programming Examples"](#) on page 910

**Manual operation:** See ["External Trigger Inhibit"](#) on page 245

**[:SOURce<hw>]:BB:MCCW:TRIGger:RMODE?**

Queries the status of signal generation for all trigger mode, if multi-carrier CW generation is on.

**Return values:**

<RMode> STOP | RUN

**Example:** See ["Programming Examples"](#) on page 910

**Usage:** Query only

**Manual operation:** See ["Running/Stopped"](#) on page 244

**[:SOURce<hw>]:BB:MCCW:TRIGger:SLENgth <SLength>**

Defines the length of the signal sequence to be output in the "Single" trigger mode.

**Parameters:**

<SLength>                    integer  
                                  Range:        1 to 1000  
                                  \*RST:        1  
                                  Default unit: samples

**Example:**                    see "[Programming Examples](#)" on page 910

**Manual operation:**    See "[Trigger Signal Duration](#)" on page 244

**[:SOURce<hw>]:BB:MCCW:TRIGger:SOURce <Source>**

Selects the trigger signal source and determines the way the triggering is executed. Provided are internal triggering by a command, external trigger signal via one of the provided local or global connectors and triggering by a signal from the other paths.

**Parameters:**

<Source>                    INTB | INTernal | OBASeband | EGT1 | EGT2 | EGC1 | EGC2 |  
                                  ELTRigger | INTA | ELClock | BEXTernal | EXTernal

**INTernal**

Internal

**INTA | INTB**

Internal trigger from the other baseband

**EGT1 | EGT2**

External global trigger

**EGC1 | EGC2**

External global clock

**ELTRigger**

External local trigger

**ELClock**

External local clock

**OBASeband|BEXTernal|EXTernal**

Provided only for backward compatibility with other R&S signal generators.

The R&S SMW accepts these values and maps them automatically as follows:

EXTernal = EGT1, BEXTernal = EGT2, OBASeband = INTA or INTB (depending on the current baseband)

\*RST:                    INTernal

**Example:**                    See "[Programming Examples](#)" on page 910

**Manual operation:**    See "[Trigger Source](#)" on page 244

**[[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:DELay <Delay>**

Specifies the trigger delay.

**Parameters:**

<Delay> float  
 Range: 0 to 16777215  
 Increment: 0.01  
 \*RST: 0  
 Default unit: samples

**Example:** See "[Programming Examples](#)" on page 910

**Manual operation:** See "[\(External\) Trigger Delay/Specified Trigger Delay](#)" on page 246

**[[:SOURce<hw>]:BB:MCCW:TRIGger[:EXTernal]:INHibit <Inhibit>**

Specifies the number of samples by which a restart is inhibited following an external trigger event.

**Parameters:**

<Inhibit> integer  
 Range: 0 to 21.47\*clockRate  
 \*RST: 0

**Example:** See "[Programming Examples](#)" on page 910

**Manual operation:** See "[External Trigger Inhibit](#)" on page 245

**[[:SOURce<hw>]:BB:MCCW[:TRIGger]:SEQuence <Sequence>**

Selects the trigger mode. For detailed description of the trigger modes, refer to "[Impact of the Trigger Modes on the Signal Generation](#)" on page 227.

**Parameters:**

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGLE  
 \*RST: AUTO

**Example:** see "[Programming Examples](#)" on page 910

**Manual operation:** See "[Trigger Mode](#)" on page 243

**Marker Settings**

This section lists the remote control commands, necessary to configure the markers.

<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut:DELay:FIXed</a> .....	926
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:DELay</a> .....	926
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:DELay:MAXimum?</a> .....	926
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:DELay:MINimum?</a> .....	926
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:MODE</a> .....	927
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:OFFTime</a> .....	927

<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:ONTime.....</a>	927
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:PATTern.....</a>	927
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:PULSe:DIVider.....</a>	928
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:TRIGger:OUTPut&lt;ch&gt;:PULSe:FREQUency?.....</a>	928

---

### **[\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut:DELay:FIXed <Fixed>](#)**

Restricts the marker delay setting range to the dynamic range.

#### **Parameters:**

<Fixed>                    0 | 1 | OFF | ON  
                               \*RST:            0

**Example:**                see ["Programming Examples"](#) on page 910

**Manual operation:**    See ["Marker x Delay"](#) on page 248

---

### **[\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut<ch>:DELay <Delay>](#)**

Defines the delay between the signal on the marker outputs and the start of the signals, expressed in terms of samples.

#### **Parameters:**

<Delay>                    float  
                               Range:            0 to 16777215  
                               Increment:      0.001  
                               \*RST:            0

**Example:**                see ["Programming Examples"](#) on page 910

**Manual operation:**    See ["Marker x Delay"](#) on page 248

---

### **[\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut<ch>:DELay:MAXimum?](#)**

Queries the maximum marker delay for enabled [\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut<ch>:DELay](#) on page 926.

#### **Return values:**

<Maximum>                float  
                               Range:            0 to 16777215  
                               Increment:      1E-3

**Example:**                see ["Programming Examples"](#) on page 910

**Usage:**                    Query only

**Manual operation:**    See ["Marker x Delay"](#) on page 248

---

### **[\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut<ch>:DELay:MINimum?](#)**

Queries the minimum marker delay for enabled [\[:SOURce<hw>\]:BB:MCCW:TRIGger:OUTPut<ch>:DELay](#) on page 926.

**Return values:**

<Minimum> float  
 Range: 0 to 16777215  
 Increment: 1E-3  
 \*RST: 0

**Example:** see "Programming Examples" on page 910

**Usage:** Query only

**Manual operation:** See "Marker x Delay" on page 248

**[[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:MODE <Mode>**

Defines the signal for the selected marker output. For detailed description of the regular marker modes, refer to "Marker Modes" on page 224.

**Parameters:**

<Mode> REStart | PULSe | PATTern | RATio  
 \*RST: REStart

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Marker Mode" on page 247

**[[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:OFFTime <OffTime>**

**[[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:ONTime <OnTime>**

Sets the number of samples in the on and off periods of the marker signal.

**Parameters:**

<OnTime> integer  
 Range: 1 to 16777215  
 \*RST: 1

**Example:** See "Programming Examples" on page 910

**Manual operation:** See "Marker Mode" on page 247

**[[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PATTern <Pattern>**

Defines the bit pattern used to generate the marker signal; 0 is marker off, 1 is on.

**Parameters:**

<Pattern> <32 bit pattern>  
 \*RST: 0

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Marker Mode" on page 247

---

**[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:DIVIder <Divider>**

Sets the divider for pulse marker mode.

**Parameters:**

<Divider>                    integer  
                                   Range:     2 to 1024  
                                   \*RST:     2

**Example:**                    see "Programming Examples" on page 910

**Manual operation:**    See "Marker Mode" on page 247

---

**[:SOURce<hw>]:BB:MCCW:TRIGger:OUTPut<ch>:PULSe:FREQuency?**

Queries the pulse frequency of the pulsed marker signal.

**Return values:**

<Frequency>                float  
                                   Increment: 1E-3

**Example:**                    see "Programming Examples" on page 910

**Usage:**                      Query only

**Manual operation:**    See "Marker Mode" on page 247

---

**Clock Settings**

This section lists the remote control commands, necessary to configure the clock.

<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:CLOCK:SOURce.....</a>	928
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:CLOCK:MODE.....</a>	929
<a href="#">[:SOURce&lt;hw&gt;]:BB:MCCW:CLOCK:MULTIplier.....</a>	929

---

**[:SOURce<hw>]:BB:MCCW:CLOCK:SOURce <Source>**

Selects the clock source.

**Parameters:**

<Source>                    INTernal | EGC1 | EGC2 | ELCLock | EXTernal

**INTernal**

The instrument uses its internal clock reference

**EGC1|EGC2**

External global clock

**ELCLock**

External local clock

**EXTernal**

EXTernal = EGC1

Setting only; provided for backward compatibility with other R&S signal generators.

\*RST:                    INTernal



**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Clock Source" on page 249

**[ :SOURce<hw> ] :BB:MCCW:CLOCK:MODE <Mode>**

Sets the type of externally supplied clock.

**Parameters:**

<Mode>                   SAMPLE | MSAMple  
\*RST:                   SAMPlE

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Clock Mode" on page 249

**[ :SOURce<hw> ] :BB:MCCW:CLOCK:MULTIPLIER <Multiplier>**

Specifies the multiplier for clock type multiple.

**Parameters:**

<Multiplier>           integer  
Range:                 1 to 64  
\*RST:                 4

**Example:** see "Programming Examples" on page 910

**Manual operation:** See "Clock Multiplier" on page 249

### 13.18.3.6 SOURce:AWGN Subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

#### Suffixes in the keywords ENTity<ch> and SOURce<hw>

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

*Table 13-6: Value ranges of the suffixes ENTity<ch> and SOURce<hw> in advanced configuration with multiple entities*

SCPI Syntax	ENTity<ch>	SOURce<hw>
<code>SOURce&lt;hw&gt;:AWGN:...</code>	-	1 .. 8
<code>ENTity&lt;ch&gt;:SOURce&lt;hw&gt;:AWGN:...</code>	1 .. 8	1 .. 4

The meaning of the numeric suffix to `SOURce` depends on:

- The presence of the keyword `ENTity`
- The selected `:SCONfiguration:MODE`
- The enabled MIMO configuration (`:SCONfiguration:FADing`)
- The state of the `[ :SOURce<hw> ] :AWGN:CMODE [ :STATe ]`



See the example in [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

## Programming Examples

### Example: Enabling/disabling the AWGN generator and the streams

The following example shows the difference between working with coupled and uncoupled streams.

```

SCONfiguration:MODE ADVanced
SCONfiguration:FADing MIMO4X4

// coupled mode; the AWGN generator and all four streams are enabled
SOURCE1:AWGN:CMODE:STATE ON
SOURCE1:AWGN:STATE ON

// uncoupled mode; the streams are configured individually
SOURCE1:AWGN:CMODE:STATE OFF
SOURCE1:AWGN:STATE?
// Response: 1
SOURCE2:AWGN:STATE?
// Response: 0
SOURCE3:AWGN:STATE?
// Response: 0
SOURCE4:AWGN:STATE?
// Response: 0
// stream B, C and D are disabled
SOURCE4:AWGN:STATE ON

```

### Example: Generating a pure noise signal

The following example generates a pure noise signal with specified bandwidth and noise level.

```

SCONfiguration:MODE STANdard
SOURCE1:AWGN:MODE ONLY
SOURCE1:AWGN:BWIDth 3840000
SOURCE1:AWGN:BWIDth:RATio 2
SOURCE1:AWGN:STATE ON
SOURCE1:AWGN:BWIDth:NOISE?
// Response: 7680000
SOURCE1:AWGN:DISP:MODE RFA
SOURCE1:AWGN:POWER:NOISE -80
// SOURCE1:POWER:LEVel:IMMediate:AMPLitude?
// Response: -80
SOURCE1:AWGN:POWER:NOISE:TOTal?

```

**Example: Generating a CW interferer signal**

The following example generates a CW interferer signal in stream B with specified target frequency and level.

```

SCONfiguration:MODE ADVanced
SCONfiguration:FADing MIMO2X2
SOURCE:AWGN:CMODE:STATE OFF

SOURCE2:AWGN:MODE CW
SOURCE2:AWGN:FREQUENCY:TARGET 20000000
SOURCE2:AWGN:STATE ON
SOURCE2:AWGN:FREQUENCY:RESULT?

SOURCE2:AWGN:POWER:RMODE CARRIER
SOURCE2:AWGN:CNRRatio 10
SOURCE2:AWGN:POWER:CARRIER -80
// the Level display indicates the PEP of the carrier
// SOURCE2:POWER:LEVEL:IMMEDIATE:AMPLITUDE?
// Response: -80
// Query the power of the interfering signal
SOURCE2:AWGN:POWER:NOISE?
// Response: -90
SOURCE2:AWGN:POWER:SUM?
// Response: -79.5860731484178
SOURCE2:AWGN:POWER:SUM:PEP?
// Response: -80

```

**Example: Generating an additive noise signal**

The following example shows how to adjust the AWGN settings to generate a signal with the following characteristics:

- The carrier signal is an uplink EUTRA/LTE signal with:
  - "Channel Bandwidth = 1.4 GHz", i.e. "Occupied Bandwidth = 1.080 MHz"
  - "RF Frequency = 1.950 GHz"
  - "RF Level = -76 dBm"
- Required is an SNR of 12.7 dB

```

SCONfiguration:MODE STANdard
SOURCE1:FREQUENCY:CW 1950000000
SOURCE1:POWER:LEVEL:IMMEDIATE:AMPLITUDE -76

SOURCE1:AWGN:MODE ADD
// set the system bandwidth to the occupied bandwidth
SOURCE1:AWGN:BWIDTh 1080000
SOURCE1:AWGN:BWIDTh:RATIo 1.5
SOURCE1:AWGN:STATE ON
SOURCE1:AWGN:BWIDTh:NOISE?
// Response: 1620000

```

```

SOURcel:AWGN:DISP:MODE RFA
SOURcel:AWGN:POWer:MODE CN
SOURcel:AWGN:POWer:RMODe CARRier
SOURcel:AWGN:BRATe?
// Response: 100000
SOURcel:AWGN:CNRatio 12.7
SOURcel:AWGN:ENRatio?
// Response: 23.0342375548695
SOURcel:AWGN:POWer:CARRier?
// Response: -76
// the Level display indicates the PEP of the carrier

// Query the resulting noise power, in the system and total bandwidth
SOURcel:AWGN:POWer:NOISe?
// Response: -88.7
SOURcel:AWGN:POWer:NOISe:TOTal?
// Response: -88.7
// Query the carrier+noise power and PEP
SOURcel:AWGN:POWer:SUM?
// Response: -75.7728170942726
SOURcel:AWGN:POWer:SUM:PEP?
// Response: -76

```

<a href="#">[:SOURce&lt;hw&gt;]:AWGN:CMODE[:STATE]</a> .....	932
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:STATE</a> .....	933
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:MODE</a> .....	933
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:BWIDth</a> .....	933
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:BWIDth:RATio</a> .....	934
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:BWIDth:NOISe?</a> .....	934
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:DISP:MODE</a> .....	934
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:MODE</a> .....	934
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:RMODe</a> .....	935
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:BRATe</a> .....	935
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:CNRatio</a> .....	935
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:ENRatio</a> .....	935
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:CARRier</a> .....	936
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:NOISe</a> .....	936
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:NOISe:TOTal?</a> .....	936
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:SUM?</a> .....	937
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:POWer:SUM:PEP?</a> .....	937
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:FREQuency:TARGet</a> .....	937
<a href="#">[:SOURce&lt;hw&gt;]:AWGN:FREQuency:RESult?</a> .....	938

---

### **[\[:SOURce<hw>\]:AWGN:CMODE\[:STATE\]](#) <State>**

Couples the configuration of all streams. This is the recommended state.

#### **Parameters:**

<State>                    0 | 1 | OFF | ON  
 \*RST:                    1

**Example:** See [Example "Enabling/disabling the AWGN generator and the streams"](#) on page 930

**Manual operation:** See ["Coupled Mode"](#) on page 380

**[:SOURce<hw>]:AWGN:STATE <State>**

Activates or deactivates the AWGN generator or the corresponding stream.

See also ["Suffixes in the keywords ENTity<ch> and SOURce<hw>"](#) on page 929.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** see [Example "Enabling/disabling the AWGN generator and the streams"](#) on page 930

**Manual operation:** See ["State"](#) on page 380

**[:SOURce<hw>]:AWGN:MODE <Mode>**

Determines how the interfering signal is generated.

**Parameters:**

<Mode> ONLY | ADD | CW

**ADD**

The AWGN noise signal is added to the baseband signal.

**ONLY**

The pure AWGN noise signal is modulated to the carrier. The connection to the baseband is interrupted

**CW**

The sine interfering signal is added to the baseband signal.

\*RST: ADD

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["Mode"](#) on page 380

**[:SOURce<hw>]:AWGN:BWIDth <BWidth>**

Sets the system bandwidth.

**Parameters:**

<BWidth> float  
Range: 1000 to 80E6  
Increment: 100  
\*RST: 3.84E6

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["System Bandwidth"](#) on page 381

---

**[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>**

Sets the ratio of minimum real noise bandwidth to system bandwidth, see also "[Signal and noise parameters](#)" on page 374.

**Parameters:**

<Ratio> float  
 Range: 1 to Max  
 Increment: 0.1  
 \*RST: 1

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See "[Minimum Noise/System Bandwidth Ratio](#)" on page 381

---

**[:SOURce<hw>]:AWGN:BWIDth:NOISe?**

Queries the real noise bandwidth.

**Return values:**

<Noise> float  
 Range: 0 to 200E6  
 Increment: 100  
 \*RST: 0

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Usage:** Query only

**Manual operation:** See "[Noise Bandwidth](#)" on page 387

---

**[:SOURce<hw>]:AWGN:DISP:MODE <Mode>**

Sets the output to that the AWGN settings are related.

**Parameters:**

<Mode> RFA | RFB | IQOUT1 | IQOUT2 | BBMM1 | BBMM2 | FADER1 |  
 FADER2 | FADER3 | FADER4  
 \*RST: RF

**Example:** See [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See "[Show Powers for Output](#)" on page 383

---

**[:SOURce<hw>]:AWGN:POWer:MODE <Mode>**

Selects the mode for setting the noise level.

**Parameters:**

<Mode> CN | SN | EN  
 \*RST: SN

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["Set Noise Power Via"](#) on page 383

---

**[[:SOURce<hw>]:AWGN:POWer:RMODe <RMode>**

Determines whether the carrier or the noise level is kept constant when the C/N value or Eb/N0 value is changed.

**Parameters:**

<RMode> CARRier | NOISe  
 \*RST: CARRier

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["Reference Mode"](#) on page 383

---

**[[:SOURce<hw>]:AWGN:BRATe <BRate>**

Sets the bit rate used for calculation of bit energy to noise power ratio.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

**Parameters:**

<BRate> float  
 Range: 400 to depends on hardware  
 Increment: 0.001  
 \*RST: 100000

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["Bit Rate"](#) on page 384

---

**[[:SOURce<hw>]:AWGN:CNRatio <CnRatio>**

Sets the carrier/interferer ratio.

**Parameters:**

<CnRatio> float  
 Range: -50 to 45  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See ["Carrier/Noise Ratio, Signal/Noise Ratio"](#) on page 384

---

**[[:SOURce<hw>]:AWGN:ENRatio <EnRatio>**

Sets the ratio of bit energy to noise power density.

**Parameters:**

<EnRatio> float  
 Range: -50 to depends on hardware  
 Increment: 0.01  
 \*RST: 15.84  
 Default unit: dB

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See "[E<sub>b</sub>/N<sub>0</sub>](#)" on page 384

**[SOURce<hw>]:AWGN:POWer:CARRier <Carrier>**

Sets the carrier power.

**Parameters:**

<Carrier> float  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See "[Carrier Power, Signal Power](#)" on page 385

**[SOURce<hw>]:AWGN:POWer:NOISe <Noise>**

Sets the power of the noise signal in the system respectively total bandwidth.

**Parameters:**

<Noise> float  
 Increment: 0.01

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Manual operation:** See "[Noise Power \(System Bandwidth\), Interferer Power](#)" on page 385

**[SOURce<hw>]:AWGN:POWer:NOISe:TOTal?**

Queries the noise level in the total bandwidth.

**Return values:**

<Total> float  
 Range: -145 to 20  
 Increment: 0.01  
 \*RST: -30

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Usage:** Query only

**Manual operation:** See "[Noise Power \(Total Bandwidth\)](#)" on page 386



---

**[:SOURce<hw>]:AWGN:POWer:SUM?**

Queries the overall power of the noise/interferer signal plus useful signal

**Return values:**

<Sum>	float
	Range: -145 to 20
	Increment: 0.01
	*RST: 0

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Usage:** Query only

**Manual operation:** See ["Carrier + Noise Power, Signal + Noise Power \(System Bandwidth\), Carrier + Interferer Power, Signal + Interferer Power"](#) on page 387

---

**[:SOURce<hw>]:AWGN:POWer:SUM:PEP?**

Queries the peak envelope power of the overall signal comprised of noise signal plus useful signal.

**Return values:**

<Pep>	float
	Range: -145 to 20
	Increment: 0.01
	*RST: 0

**Example:** see [Example "Generating an additive noise signal"](#) on page 931

**Usage:** Query only

**Manual operation:** See ["Carrier + Noise PEP, Signal + Noise PEP \(Total Bandwidth\), Carrier + Interferer PEP, Signal + Interferer PEP"](#) on page 387

---

**[:SOURce<hw>]:AWGN:FREQuency:TARGet <Target>**

Sets the desired frequency of the sine wave.

**Parameters:**

<Target>	float
	Range: -40E6 to 40E6
	Increment: 0.01
	*RST: 0

**Example:** see [Example "Generating a CW interferer signal"](#) on page 931

**Manual operation:** See ["Target CW Frequency Offset"](#) on page 381

**[:SOURce<hw>]:AWGN:FREQuency:RESult?**

Queries the actual frequency of the sine wave.

**Return values:**

<Result> float  
 Range: -40E6 to 40E6  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Generating a CW interferer signal"](#) on page 931

**Usage:** Query only

**Manual operation:** See ["Resulting CW Frequency Offset"](#) on page 381

**13.18.3.7 SOURce:BB:IMPairment Subsystem**

This subsystem contains the commands for the analog and digital I/Q impairments.

**Suffixes**

The following suffixes are used:

Suffix	Value range	Description
RF<ch>, BBMM<ch>, IQOutput<ch>	1 to 2	DIG IQ connector
FADer<ch>	1 to 4	DIG IQ connector

<a href="#">[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:DELay</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:DELay</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:DELay</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:DELay</a> .....	939
<a href="#">[:SOURce&lt;hw&gt;]:IQ:IMPairment:IQRatio[:MAGNitude]</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:IQRatio[:MAGNitude]</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:IQRatio[:MAGNitude]</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:IQRatio[:MAGNitude]</a> .....	939
<a href="#">[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:IQRatio[:MAGNitude]</a> .....	939
<a href="#">[:SOURce&lt;hw&gt;]:IQ:IMPairment:LEAKage:I</a> .....	940
<a href="#">[:SOURce&lt;hw&gt;]:IQ:IMPairment:LEAKage:Q</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:LEAKage:I</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:LEAKage:Q</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:LEAKage:I</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:LEAKage:Q</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:LEAKage:I</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:LEAKage:Q</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:LEAKage:I</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:LEAKage:Q</a> .....	940
<a href="#">[:SOURce&lt;hw&gt;]:IQ:IMPairment:QUADrature[:ANGLE]</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:QUADrature[:ANGLE]</a> .....	940
<a href="#">[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:QUADrature[:ANGLE]</a> .....	940

<code>[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:QUADrature[:ANGLE]</code> .....	940
<code>[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:QUADrature[:ANGLE]</code> .....	940
<code>[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:SKEW</code> .....	941
<code>[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:SKEW</code> .....	941
<code>[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:SKEW</code> .....	941
<code>[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:SKEW</code> .....	941
<code>[:SOURce&lt;hw&gt;]:IQ:IMPairment[:STATE]</code> .....	941
<code>[:SOURce]:BB:IMPairment:BBMM&lt;ch&gt;:STATE</code> .....	941
<code>[:SOURce]:BB:IMPairment:FADer&lt;ch&gt;:STATE</code> .....	941
<code>[:SOURce]:BB:IMPairment:IQOutput&lt;ch&gt;:STATE</code> .....	941
<code>[:SOURce]:BB:IMPairment:RF&lt;ch&gt;:STATE</code> .....	941
<code>[:SOURce&lt;hw&gt;]:BB:IMPairment:OPTimization:MODE</code> .....	941

---

```

[:SOURce]:BB:IMPairment:BBMM<ch>:DELay <Delay>
[:SOURce]:BB:IMPairment:FADer<ch>:DELay <Delay>
[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay <Delay>
[:SOURce]:BB:IMPairment:RF<ch>:DELay <Delay>

```

Defines the time delay of both I and Q vectors between the marker signal at the marker outputs relative to the signal generation start.

A positive value means that the I and Q vectors delay relative to the marker/trigger or to the other instrument and vice versa.

**Parameters:**

```

<Delay>          float
                  Range:    0 to 10E-6
                  Increment: 1E-12
                  *RST:     0

```

**Example:** `BB:IMP:RF:DEL 32.0E-9`  
sets the I/Q delay

**Manual operation:** See "[IQ Delay](#)" on page 396

---

```

[:SOURce<hw>]:IQ:IMPairment:IQRatio[:MAGNitude] <Magnitude>
[:SOURce]:BB:IMPairment:BBMM<ch>:IQRatio[:MAGNitude] <IqRatio>
[:SOURce]:BB:IMPairment:FADer<ch>:IQRatio[:MAGNitude] <IqRatio>
[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude] <IqRatio>
[:SOURce]:BB:IMPairment:RF<ch>:IQRatio[:MAGNitude] <IqRatio>

```

Sets the ratio of I modulation to Q modulation (amplification imbalance) of the corresponding digital channel. The input may be either in dB or %. The resolution is 0.001 dB, an input in percent is rounded to the closest valid value in dB. A query returns the value in dB.

**Parameters:**

```

<IqRatio>        float
                  Range:    -1 to 1
                  Increment: 1E-4
                  *RST:     0

```

**Example:** `BB:IMP:RF:IQR 3 PCT`  
sets the imbalance to 3 percent.  
`BB:IMP:RF:IQR?`  
queries the imbalance.  
Response: 0.259000  
the value is returned in dB.

**Manual operation:** See "[Gain Imbalance](#)" on page 395

```
[:SOURce<hw>]:IQ:IMPairment:LEAKage:I <I>
[:SOURce<hw>]:IQ:IMPairment:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:BBMM<ch>:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:FADer<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:FADer<ch>:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q <Q>
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:RF<ch>:LEAKage:Q <Q>
```

Determines the leakage amplitude of the I or Q signal component of the corresponding stream

**Parameters:**

<Q> float  
Range: -10 to 10  
Increment: 0.01  
\*RST: 0

**Example:** `BB:IMP:RF:LEAK:Q 4 PCT`  
sets the leakage for the Q-component to 4 percent.

**Manual operation:** See "[I/Q Offset](#)" on page 395

```
[:SOURce<hw>]:IQ:IMPairment:QUADrature[:ANGLE] <Angle>
[:SOURce]:BB:IMPairment:BBMM<ch>:QUADrature[:ANGLE] <Angle>
[:SOURce]:BB:IMPairment:FADer<ch>:QUADrature[:ANGLE] <Angle>
[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLE] <Angle>
[:SOURce]:BB:IMPairment:RF<ch>:QUADrature[:ANGLE] <Angle>
```

Sets a quadrature offset (phase angle) between the I and Q vectors deviating from the ideal 90 degrees. A positive quadrature offset results in a phase angle greater than 90 degrees.

**Parameters:**

<Angle> float  
Range: -10 to 10  
Increment: 0.01  
\*RST: 0

**Example:** `BB:IMP:RF:QUAD -5DEG`  
sets the quadrature offset to -5 degrees.

**Manual operation:** See "Quadrature Offset" on page 396

---

```
[:SOURce]:BB:IMPairment:BBMM<ch>:SKEW <Skew>
[:SOURce]:BB:IMPairment:FADer<ch>:SKEW <Skew>
[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW <Skew>
[:SOURce]:BB:IMPairment:RF<ch>:SKEW <Skew>
```

Sets a delay between the Q vector and the I vector of the corresponding stream.

**Parameters:**

```
<Skew>          float
                  Range:    -500E-9 to 500E-9
                  Increment: 1E-12
                  *RST:     0
```

**Manual operation:** See "Skew" on page 396

---

```
[:SOURce<hw>]:IQ:IMPairment[:STATe] <State>
[:SOURce]:BB:IMPairment:BBMM<ch>:STATe <State>
[:SOURce]:BB:IMPairment:FADer<ch>:STATe <State>
[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe <State>
[:SOURce]:BB:IMPairment:RF<ch>:STATe <State>
```

Activates the impairment or correction values LEAKage, QUADrature and IQRatio for the corresponding stream.

**Parameters:**

```
<State>          0 | 1 | OFF | ON
                  *RST:     0
```

**Example:** SOURce1:BB:IMPairment:RF1:STATe ON  
Activates digital impairment.

**Manual operation:** See "State" on page 395

---

```
[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>
```

Sets the optimization mode.

**Parameters:**

```
<Mode>          FAST | QHIGH
                  FAST
                  Optimization by compensation for I/Q skew.
                  QHIGH
                  Optimization by compensation for I/Q skew and frequency
                  response correction.
                  *RST:     FAST
```

**Example:** SOURce1:IQ:SOURce BASEband  
SOURce1:BB:IMPairment:OPTimization:MODE FAST  
sets the optimization mode Fast.

**Manual operation:** See "Optimization Mode" on page 404

### 13.18.3.8 SOURce:BB:GRAPhics Subsystem

This subsystem contains the commands used to setup the graphical display.

<code>[:SOURce&lt;hw&gt;]:BB:GRAPhics:MODE</code> .....	942
<code>[:SOURce&lt;hw&gt;]:BB:GRAPhics:SRATe:MODE</code> .....	942
<code>[:SOURce&lt;hw&gt;]:BB:GRAPhics:SRATe:USER</code> .....	942
<code>[:SOURce]:BB:GRAPhics:CLoSe</code> .....	943
<code>[:SOURce]:BB:GRAPhics:ADD</code> .....	943
<code>[:SOURce]:BB:GRAPhics:SOURce</code> .....	943
<code>[:SOURce&lt;hw&gt;]:BB:GRAPhics:TRIGger:SOURce</code> .....	944

---

#### `[:SOURce<hw>]:BB:GRAPhics:MODE <Mode>`

Selects the graphics mode of the graphical signal display.

**Parameters:**

<Mode> IQ | VECTor | CCDF | PSPectrum | CONSTellation | EYEI | EYEQ  
 \*RST: IQ

**Example:**

`BB:GRAP:MODE VECT`  
 selects the vector diagram graphics mode.

**Manual operation:** See "Mode" on page 538

---

#### `[:SOURce<hw>]:BB:GRAPhics:SRATe:MODE <Mode>`

Sets how the time resolution of the signal is determined. Maximum resolution corresponds to a diagram covering the entire signal bandwidth. The higher the resolution is, the shorter the length of the displayed signal segment will be for the specified recording depth.

**Parameters:**

<Mode> AUTO | FULL | USER  
 \*RST: AUTO

**Example:**

`BB:GRAP:SRAT:MODE FULL`  
 sets the sample rate mode.

**Manual operation:** See "Sample Rate Mode" on page 539

---

#### `[:SOURce<hw>]:BB:GRAPhics:SRATe:USER <User>`

(Enabled for `BB:GRAP:SRAT:MODE USER`)

Selects the signal bandwidth for the diagram. The setting range moves between the minimum and maximum bandwidth which is possible for the selected graphical signal display. The selection is made graphically by moving the pointer.

**Parameters:**

<User> float  
 Range: 0.01 to 100  
 Increment: 0.01  
 \*RST: 10  
 Default unit: PCT

**Example:** BB:GRAP:SRAT:USER 20  
 sets the sample rate factor.

**Example:** BB:GRAP:SRAT:MODE USER  
 sets the sample rate mode.

**Manual operation:** See ["Sample Rate"](#) on page 539

**[[:SOURce]:BB:GRAPhics:CLOSe**

Closes all graphical signal displays.

**Usage:** Event

**Manual operation:** See ["Remove"](#) on page 540

**[[:SOURce]:BB:GRAPhics:ADD <Size>**

Adds a graphical signal display (according to the current MODE, SOURce, SRATe:\* and TRIGger:\* settings).

**Setting parameters:**

<Size> MAXimized | MINimized

**Usage:** Setting only

**Manual operation:** See ["Add"](#) on page 539

**[[:SOURce]:BB:GRAPhics:SOURce <Source>**

Defines the signal acquisition point, that is the location in the signal flow where the displayed signal is tapped from.

The available acquisition points depend on the selected system configuration.

**Parameters:**

<Source> STRA | STRB | STRC | STRD | STRE | STRF | STRG | STRH |  
 BBA | BBB | BBC | BBD | BBE | BBF | BBG | BBH | RFA | RFB |  
 RFC | RFD | IQO1 | IQO2 | DO1 | DO2 | BBIA | BBIB  
**STRA|STRB|STRC|STRD|STRE|STRF|STRG|STRH**  
 Streams (A ... H); input stream of the "IQ Stream Mapper"  
**BBA|BBB|BBC|BBD|BBE|BBF|BBG|BBH**  
 Baseband signals (A ... H)  
**BBIA|BBIB**  
 Digital baseband input signals  
**RFA|RFB|RFC|RFD**  
 RF signals (A ... D)  
**IQO1|IQO2**  
 Analog I/Q output signals  
**DO1|DO2**  
 Digital I/Q output signals; outputs of the "IQ Stream Mapper"  
 \*RST: STRA

**Manual operation:** See "Source" on page 538

Location and use of the source types is shown in [Chapter 9.1.1.2, "Signal Acquisition Points"](#), on page 532.

**[:SOURce<hw>]:BB:GRAPhics:TRIGger:SOURce <Source>**

Defines the trigger for the starting time of the graphic recording.

**Parameters:**

<Source> SOFTware | MARKer  
 \*RST: SOFTware

**Example:**

BB:GRAP:TRIG:SOUR MARK  
 sets the trigger source.

**Manual operation:** See "Trigger Source" on page 539

### 13.18.3.9 SOURce:BB:MEASurement Subsystem

This subsystem contains the commands for measuring the power values of the digital baseband signal.

#### **Example: Querying information on burst baseband signals using the multi-gated acquisition**

The following example lists the commands necessary to start baseband power measurements and retrieve measurements results. We assume, that the instrument is configured as described in ["To perform baseband power measurements on bursted signals using the multi-gated acquisition"](#) on page 568.



```

// configure and enable baseband power measurements
:SOURce:BB:MEASurement:POWer:SOURce BBA
:SOURce:BB:MEASurement:POWer:OUTPut RFA
:SOURce:BB:MEASurement:POWer:ACQuisition MGATed
:SOURce:BB:MEASurement:POWer:GSource MGATed
:SOURce:BB:MEASurement:POWer:DURation 0.1
:SOURce:BB:MEASurement:POWer:RMODe SINGLE
:SOURce:BB:MEASurement:POWer:ADD
:SOURce:BB:MEASurement:POWer:EXECute

// query status information on the initiated measurement
:SOURce:BB:MEASurement:POWer:PROGress?
// Response: 23
// the initiated measurement is in progress
:SOURce:BB:MEASurement:POWer:RSTate?
// Response: 1
:SOURce:BB:MEASurement:POWer:PROGress?
// Response: 100
:SOURce:BB:MEASurement:POWer:RSTate?
// Response: 0
// performed is one single measurment

// query baseband power values
:SOURce:BB:MEASurement:POWer:PEAK?
// Response: -24.0601192007,-24.0601192007,-24.0601192007,-24.0601192007
:SOURce:BB:MEASurement:POWer:RMS?
// Response: -35.0006514336062,-35.0006514336062,-35.0006514336062,-35.0006514336062
// performed are four sub-measurements

// stop and remove the measurement
:SOURce:BB:MEASurement:POWer:INDex 1
:SOURce:BB:MEASurement:POWer:ABORt
:SOURce:BB:MEASurement:POWer:DELeTe

```

---

**[ :SOURce ]:BB:MEASurement:POWer:SOURce <Source>**

Defines the measurement signal source.

**Parameters:**

<Source>            BBA | BBB | BBC | BBD | BBINA | BBINB | FADINPA |  
                       FADINPB | FADINPC | FADINPD | FADOUTA | FADOUTB |  
                       FADOUTC | FADOUTD | AWGNA | AWGNB | AWGNC |  
                       AWGND | STREAMA | STREAMB | STREAMC | STREAMD  
 \*RST:            BBA

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:**    See ["Source/Output"](#) on page 559

---

**[[:SOURce]:BB:MEASurement:POWer:OUTPut <Output>**

Defines the output point the measurement are performed at.

**Parameters:**

<Output> RFA | RFB | IQOUT1 | IQOUT2 | BBMM1 | BBMM2  
\*RST: RFA

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:** See ["Source/Output"](#) on page 559

---

**[[:SOURce]:BB:MEASurement:POWer:ACQuisition <Acquisition>**

Sets the acquisition method.

**Parameters:**

<Acquisition> NOMinal | CONTInuous | GATed | MGATed  
\*RST: CONTInuous

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:** See ["Acquisition"](#) on page 560

---

**[[:SOURce]:BB:MEASurement:POWer:GSource <GateSource>**

Determines the marker signal defining the signal part to be evaluated. The available values depend on the selected acquisition ([\[:SOURce\]:BB:MEASurement:POWer:ACQuisition](#)).

**Parameters:**

<GateSource> NONE | MARK1 | MARK2 | MARK3 | MGATed  
**NONE**  
Default value for nominal and continuous acquisition.  
**MARK1|MARK2|MARK3**  
Marker signal as defined in the baseband  
**MGATed**  
Reserved for multi gated acquisition  
\*RST: NONE

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:** See ["Gate Source"](#) on page 560

---

**[[:SOURce]:BB:MEASurement:POWer:RMODe <RunMode>**

Determines whether a single or a continuous measurement is executed.

**Parameters:**

<RunMode> SINGLE | AUTO  
 \*RST: AUTO

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:** See ["Run Mode"](#) on page 561

**[ :SOURce]:BB:MEASurement:POWER:ADD**

Adds a measurement.

**Example:** See [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Event

**Manual operation:** See ["Add, Change, Remove, Start, Abort"](#) on page 561

**[ :SOURce]:BB:MEASurement:POWER:PEAK?**

Queries the peak power of the baseband signal at the measurement point determined with the command `[ :SOURce]:BB:MEASurement:POWER:OUTPut`.

**Return values:**

<PeakPower> <Peak\_SubMes#1>,<Peak\_SubMes#2>,...  
 Returns the peak power of the measured signal or if a multi-gated acquisition is used, a string of measured values with one value per performed submeasurement  
 Range: -145 to 30

**Example:** See [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Query only

**Manual operation:** See ["Level/PEP"](#) on page 561

**[ :SOURce]:BB:MEASurement:POWER:RMS?**

Queries the RMS power of the baseband signal at the measurement point determined with the command `[ :SOURce]:BB:MEASurement:POWER:OUTPut`.

**Return values:**

<RmsPower> <Power\_SubMes#1>,<Level\_SubMes#2>,...  
 Returns the power of the measured signal or if a multi-gated acquisition is used, a string of measured values with one value per performed submeasurement  
 Range: -145 to 30

**Example:** See [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Query only  
**Manual operation:** See "[Level/PEP](#)" on page 561

#### **[[:SOURce]:BB:MEASurement:POWER:RState?**

Queries the state (running/stopped) of the current measurement.

**Return values:**  
 <RunState> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Query only  
**Manual operation:** See "[Running/Stopped](#)" on page 561

#### **[[:SOURce]:BB:MEASurement:POWER:PROGress?**

Queries the status of the initiated measurement. The query returns a value that indicates the task progress in percent.

**Return values:**  
 <Progress> float  
 Range: 0 to 100  
 \*RST: 0

**Example:** See [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Query only  
**Manual operation:** See "[BB Powers Summary List](#)" on page 559

#### **[[:SOURce]:BB:MEASurement:POWER:DURation <Duration>**

Sets the measurement's time of a single measurement.

**Parameters:**  
 <Duration> float  
 Range: 1E-3 to 5400  
 Increment: 1E-3  
 \*RST: 1

**Example:** see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:** See "[Sweep Time/Duration](#)" on page 560

---

**[[:SOURce]:BB:MEASurement:POWER:INDEX <MeasIndex>**

Selects the measurement index the subsequent settings apply to, for example changing, starting or removing from the list of measurements.

**Parameters:**

<MeasIndex>            integer  
Range:            1 to dynamic  
\*RST:            1

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Manual operation:**    See ["Add, Change, Remove, Start, Abort"](#) on page 561

---

**[[:SOURce]:BB:MEASurement:POWER:CHANGE**

Triggers the instrument to adopt the changed measurement configuration.

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:**                Event

**Manual operation:**    See ["Add, Change, Remove, Start, Abort"](#) on page 561

---

**[[:SOURce]:BB:MEASurement:POWER:EXECute**

**Example:**            Triggers the instrument to perform the configured measurement.

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:**                Event

**Manual operation:**    See ["Add, Change, Remove, Start, Abort"](#) on page 561

---

**[[:SOURce]:BB:MEASurement:POWER:ABORT**

Stops the current measurement.

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:**                Event

**Manual operation:**    See ["Add, Change, Remove, Start, Abort"](#) on page 561

---

**[[:SOURce]:BB:MEASurement:POWER:DELeTe**

Removes the selected measurement from the list.

**Example:**            see [Example "Querying information on burst baseband signals using the multi-gated acquisition"](#) on page 944

**Usage:** Event

**Manual operation:** See "Add, Change, Remove, Start, Abort" on page 561

### 13.18.3.10 SOURce:BB:PROGress Subsystem General Commands

In the R&S SMW, some calculation processes take longer time. While operating the instrument manually, you can observe the status of an initiated process by the busy indicator. The following commands fulfill the same task in the remote control operation.

#### Example: Querying the status of the Create Waveform file process

The following is an example on how to use these commands to retrieve information about how many percent of the initiated process are completed.

```
:SCONfiguration:MODE ADVanced
:SCONfiguration:FADing MIMO4x4
:SCONfiguration:BASEband:SOURce COUPled
:SCONfiguration:APPLY
:SOURcel:BB:EUTRa:SETTing:TMOD:DL "E-TM1_1__15MHz"
:SOURcel:BB:EUTRa:SLENgth 100
:SOURcel:BB:PROGress:MCODer?
// 100 (task compleated)
:SOURcel:BB:EUTRa:STATe ON
:BB:PROGress:MCODer?
// 67 (task in progress)
:SOURcel:BB:EUTRa:WAVEform:CREate
:SOURcel:BB:PROGress:MCODer?
// 25 (task in progress)
// :SOURcel:BB:PROGress:MCODer:DM:FILTer?
// 100
```

```
[:SOURce<hw>]:BB:PROGress:MCODer?.....950
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?.....950
[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?.....950
[:SOURce<hw>]:BB:PROGress:MCODer:DM:FILTer?.....951
```

---

**[:SOURce<hw>]:BB:PROGress:MCODer?**

**[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:MCARrier?**

**[:SOURce<hw>]:BB:PROGress:MCODer:ARBitrary:WSEGment?**

Queries the status of an initiated process, like for example the calculation of a signal in accordance to a digital standard, or the calculation of a multi-carrier or multi-segment waveform file.

**Return values:**

<WSegment> integer  
Indicates the task progress in percent  
Range: 0 to 100  
\*RST: 100

**Example:** See [Example "Querying the status of the Create Waveform file process"](#) on page 950

**Usage:** Query only

#### **[:SOURce<hw>]:BB:PROGress:MCODer:DM:FILTer?**

Queries the status of an applied offline filtering, like for example during the calculation of a waveform and a multi carrier waveform file.

**Return values:**

<Filter> integer  
Indicates the task progress in percent  
Range: 0 to 100  
\*RST: 100

**Example:** see [Example "Querying the status of the Create Waveform file process"](#) on page 950

**Usage:** Query only

### 13.18.4 SOURce:BBIN Subsystem

The SOURce:BBIN subsystem contains the commands for setting the external digital baseband signal.

In [Standard mode](#), the external baseband signal A can be routed to path A, path B, or both paths. The external baseband signal B can be routed to path B only.

#### **Suffixes in the keywords ENTity<ch> and SOURce<hw>**

You can address multiple entities configurations by using the SCPI commands starting with the keyword SOURce or the alias commands starting with the keyword ENTity.

*Table 13-7: Value ranges of the suffixes ENTity<ch> and SOURce<hw> in advanced configuration with multiple entities*

SCPI Syntax	ENTity<ch>	SOURce<hw>
SOURce<hw>:BBIN:...	-	1 to 4
ENTity<ch>:SOURce<hw>:BBIN:...	1 to 4	1 to 4



See also [Chapter 13.3, "SCPI Command Aliases for Advanced Mode with Multiple Entities"](#), on page 715.

#### **Example: Programming Example**

The following example lists the commands necessary to apply an external digital baseband signal, to enable automatic level settings, and to monitor the signal.

An external digital signal must be applied at the corresponding connectors of the instrument.

```

// uses the external signal supplied at the CODER 1 interface
SOURce1:BBIN:DIGital:SOURce CODER1
// SOURce1:BBIN:DIGital:IQSWap:STATe 1
// set the sample rate source and query the value
SOURce1:BBIN:SRATe:SOURce DIN
SOURce1:BBIN:SRATe[:ACTual]?
SOURce1:BBIN:STATe ON
// enable automatic adjustment of the baseband input signal
SOURce1:BBIN:DIGital:ASETting:STATe ON
SOURce1:BBIN:MPERiod 10s
SOURce1:BBIN:ALEVel:EXECute
SOURce1:BBIN:CFACTOR?
SOURce1:BBIN:POWer:PEAK?
SOURce1:BBIN:POWer:RMS?
// monitor the signal
SOURce1:BBIN:OLOad:STATe?
// 0, i.e. no overflow detected
SOURce1:BBIN:OLOad:HOLD:RESet
SOURce1:BBIN:OLOad:HOLD:STATe?

```

The following commands are available:

<a href="#">[:SOURce&lt;hw&gt;]:BBIN:STATe</a> .....	952
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:DIGital:SOURce</a> .....	953
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:IQSWap[:STATe]</a> .....	953
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:MODE</a> .....	953
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:SRATe:SOURce</a> .....	953
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:SRATe[:ACTual]</a> .....	954
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:DIGital:ASETting:STATe</a> .....	954
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:MPERiod</a> .....	954
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:ALEVel:EXECute</a> .....	954
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:CFACTOR</a> .....	955
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:POWer:PEAK</a> .....	955
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:POWer:RMS?</a> .....	955
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:OLOad:STATe?</a> .....	955
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:OLOad:HOLD:STATe?</a> .....	956
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:OLOad:HOLD:RESet</a> .....	956
<a href="#">[:SOURce&lt;hw&gt;]:BBIN:CDEVice?</a> .....	956

---

#### **[\[:SOURce<hw>\]:BBIN:STATe <State>](#)**

Switches the feeding of an external analog signal into the signal path on/off.

#### **Parameters:**

<State>            0 | 1 | OFF | ON  
 \*RST:            0

**Example:**            see [Example "Programming Example"](#) on page 951

**Manual operation:**    See ["State"](#) on page 161



---

**[ :SOURce<hw>]:BBIN:DIGital:SOURce <DigInpSource>**

Defines the connector used as an external signal source.

**Parameters:**

<DigInpSource>      CODER1 | FADER1 | FADER2 | CODER2  
\*RST:                CODER1

**Example:**            see [Example "Programming Example"](#) on page 951.

**Manual operation:** See ["Source"](#) on page 161

---

**[ :SOURce<hw>]:BBIN:IQSWap[:STATe] <State>**

If activated, swaps the I and Q channel.

**Parameters:**

<State>                0 | 1 | OFF | ON  
\*RST:                0

**Example:**            see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["I/Q Swap"](#) on page 161

---

**[ :SOURce<hw>]:BBIN:MODE <Mode>**

Defines that a digital external signal is applied.

**Parameters:**

<Mode>                DIGital  
\*RST:                DIGital

**Example:**            see [Example "Programming Example"](#) on page 951

---

**[ :SOURce<hw>]:BBIN:SRATe:SOURce <Source>**

Selects whether the sample rate is estimated based on the digital input signal or is a user-defined value.

**Parameters:**

<Source>                USER | DIN  
**DIN**  
Enabled for [ :SOURce<hw>]:BBIN:DIGital:SOURce  
CODER1 | CODER2  
\*RST:                USER

**Example:**            See [Example "Programming Example"](#) on page 951

**Manual operation:** See ["Sample Rate Source"](#) on page 162

---

---

**[ :SOURce<hw>]:BBIN:SRATe[:ACTual] <Actual>**

Sets the sample rate of the external digital baseband signal.

**Parameters:**

<Actual> float  
 Range for [ :SOURce<hw>]:BBIN:DIGital:SOURce  
 FADER1 | FADER2: 100E6 | 200E6  
 Range: 400 to 200E6  
 Increment: 0.001  
 \*RST: 100E6

**Example:** see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["Sample Rate Value"](#) on page 163

---

**[ :SOURce<hw>]:BBIN:DIGital:ASETting:STATe <State>**

Activates automatic adjustment of the baseband input signal.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["DIG IQ Auto Setting"](#) on page 164

---

**[ :SOURce<hw>]:BBIN:MPERiod <MPeriod>**

For [ :SOURce<hw>]:BBIN:DIGital:SOURceCODER1 | CODER2, sets the recording duration for measuring the baseband input signal by executed [ :SOURce<hw>]:BBIN:ALEVel:EXECute.

**Parameters:**

<MPeriod> integer  
 Range: 1 to 32  
 \*RST: 2  
 Default unit: s

**Example:** see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["Measurement Period"](#) on page 164

---

**[ :SOURce<hw>]:BBIN:ALEVel:EXECute**

For [ :SOURce<hw>]:BBIN:DIGital:SOURceCODER1 | CODER2, starts measuring the input signal. The measurement estimates the crest factor, peak and RMS level.

**Example:** see [Example "Programming Example"](#) on page 951

**Usage:** Event

**Manual operation:** See ["Auto Level Set"](#) on page 164

**[:SOURce<hw>]:BBIN:CFACTOR <CFactor>**

Enters the crest factor of the external baseband signal.

**Parameters:**

<CFactor> float  
 Range: 0 to 30  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:** see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["Crest Factor"](#) on page 164

**[:SOURce<hw>]:BBIN:POWER:PEAK <Peak>**

Peak level of the external baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

**Parameters:**

<Peak> float  
 Range: -60 to 3.02  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dBfs

**Example:** see [Example "Programming Example"](#) on page 951

**Manual operation:** See ["Peak Level"](#) on page 164

**[:SOURce<hw>]:BBIN:POWER:RMS?**

Queries the RMS level of the external digital baseband signal.

**Return values:**

<Rms> float  
 Range: -100 to 10  
 Increment: 0.01  
 \*RST: 0

**Example:** see [Example "Programming Example"](#) on page 951

**Usage:** Query only

**Manual operation:** See ["Level"](#) on page 164

**[:SOURce<hw>]:BBIN:OLOad:STATE?**

Queries the current overflow state.

**Return values:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [Example "Programming Example"](#) on page 951

**Usage:** Query only

**Manual operation:** See ["Signal Monitoring"](#) on page 165

**[ :SOURce<hw>]:BBIN:OLOad:HOLD:STATe?**

Queries an overload since the last reset for evaluating the measurement.

**Return values:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** see [\[:SOURce<hw>\]:BBIN:OLOad:STATe?](#) on page 955

**Usage:** Query only

**Manual operation:** See ["Signal Monitoring"](#) on page 165

**[ :SOURce<hw>]:BBIN:OLOad:HOLD:RESet**

Reset of the Overload Hold indication.

**Example:** see [\[:SOURce<hw>\]:BBIN:OLOad:STATe?](#) on page 955

**Usage:** Event

**[ :SOURce<hw>]:BBIN:CDEvice?**

Indicates the ID of an externally connected R&S Instrument or R&S Device.

**Return values:**

<CDevice> string

**Example:** `SOURce:BBIN:CDEvice?`  
 queries the connected device ID.

**Usage:** Query only

**Manual operation:** See ["Connected Device"](#) on page 161

### 13.18.5 SOURce:CORRection Subsystem

The `SOURce:CORRection` subsystem contains the commands for adjusting the output level, required, to define correction values for external test assemblies. E.g., you can compensate the frequency response of a cable or a connector.

To determine the correction values, you can measure the RF output level at several frequency points, and enter the value pairs manually in a table. Or, e.g. as a conven-

ient alternative, you can connect an R&S Power Sensor to the generator output signal. With the aid of the command `[ :SOURce<hw> ] :CORRection:CSET:DATA [ :SENSor<ch> ] [ :POWer ] :SONCe`, the sensor determines the values and fills a table automatically.

You can acquire the correction values any time, regardless of the modulation settings of the generator.

The correction is performed by adding the correction values to the output level of the respective RF frequency.

With the commands of this subsystem, you can create, select, transfer and activate user correction tables. Further more, you can store each table in a user correction file, whereby the file extension `*.uco` is firmly assigned, but you can freely select the file name and the target directory.

To determine a default directory, use the command `:MMEMory:CDIRectory` on page 730. For the use of files, stored in this default directory, just specify the file name in a command. To use files in other directories, you must specify the complete absolute path in every command.



- The following command examples assume that the files are stored in the default directory.
- Note also, that the same tables are accessed for both paths. File operations such as creating, deleting and querying files are therefore path-independent. In this case, the suffix under `SOURce` **must** be omitted. An error message is displayed if the suffix is specified.
- `*RST` does not affect data lists.

#### Example: Create a table with user defined correction values for the RF level

The following example shows a command sequence to create and activate a list for assigning level correction values to arbitrary RF frequencies. Further hardware settings are not considered.

```
// *****
// Reset the instrument to start from an initial state
// Query the available user correction list files in the default
// directory /var/user
// Select a file or create a new one
// *****
*RST; *CLS
SOURce1:CORRection:CSET:CATalog?
// Response: shows the name of available user correction files (if applicable)
// Select a file
SOURce1:CORRection:CSET:SElect "/var/user/ucor1.uco"
// Create a new file (if not existing)
SOURce1:CORRection:CSET:SElect "ucor2.uco"

// *****
```

```

// Enter the frequency/level value pairs in the table;
// existing data is overwritten
// Query the number of frequency/power entries in the selected list
// *****
SOURcel:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
SOURcel:CORRection:CSET:DATA:POWer -10dB,-7.5dB,-5.0dB,-2.5dB,0dB,2.5dB
SOURcel:CORRection:CSET:DATA:FREQuency:POINts?
// Response: "6"
SOURcel:CORRection:CSET:DATA:POWer:POINts?
// Response: "6"

// *****
// Enable user correction mode
// Enable RF output
// *****
SOURcel:CORRection:STATe 1
OUTPut1:STATe ON

// *****
// Query the currently used correction value
// *****
SOURcel:CORRection:VALue?
// Response: "-2.5"

// *****
// Delete a user correction file
// *****
SOURcel:CORRection:CSET:DELEte "/var/user/ucor1.uco"

```

### Example: Fill user correction data with sensor

The following example shows a command sequence to fill a user correction list automatically supported by a connected R&S power sensor.

```

// *****
// Fill a user correction list with the level values
// measured by an R&S Power Sensor,
// store the data in a file and enable multi level user correction.
// *****

*RST; *CLS

SOURcel:CORRection:CSET:SElect "var/user/Ucor1_AutoFill.uco"
SOURcel:CORRection:CSET:DATA:FREQuency 100MHz,110MHz,120MHz,130MHz,140MHz,150MHz
SOURcel:CORRection:ZERoing:STATe 1
SOURcel:CORRection:CSET:DATA:SENSor1:POWer:SONce

// *****
// Query the number of automatically filled correction level values
// *****

```

```

SOURcel:CORRection:CSET:DATA:POWer:POINTs?
// Response: "6"

// *****
// Activate user correction
// *****
SOURcel:CORRection:STATe 1

// *****
// Query the correction value at a certain frequency
// *****
FREQ 12000000
SOURcel:CORRection:VALue?
// Response: "-52.13"

```

### Example: User correction data exchange

The following example shows a command sequence to export a user correction list (here the list created with the example before) into an ASCII file. Further hardware settings are not considered.

```

// *****
// Reset the instrument to start from an initial state
// Select a user correction file for exporting to file in ASCII format
// *****
*RST; *CLS

// *****
// Set ASCII data parameters
// *****
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
SOURcel:CORRection:DEXChange:AFILe:EXTension CSV
SOURcel:CORRection:DEXChange:AFILe:SEParator:DECimal DOT
SOURcel:CORRection:DEXChange:AFILe:SEParator:COLumn COMMa

// *****
// Select source and destination path/directory
// *****
SOURcel:CORRection:DEXChange:AFILe:SElect "/var/user/ucor2ASCII"

// Export the user correction data into the ASCII file
SOURcel:CORRection:DEXChange:MODE EXPort
SOURcel:CORRection:DEXChange:EXECute

// Query the available ASCII files with extension .csv
SOURcel:CORRection:DEXChange:AFILe:CATalog?
// Response: "ucor21ASCII"

```

```
// Import a user correction ASCII file
SOURce1:CORRection:DEXChange:MODE IMPort
SOURce1:CORRection:DEXChange:AFIle:CATalog?
// Response: "ucor1,ucor21ASCII"
SOURce1:CORRection:DEXChange:AFIle:SElect "/var/user/ucor1"
SOURce1:CORRection:DEXChange:EXECute
```

- [Correction Settings](#).....960
- [SGamma Correction Data](#).....963
- [Correction Data Exchange](#).....965

### 13.18.5.1 Correction Settings

---

**[ :SOURce<hw>]:CORRection:CSET:DATA:FREQuency <Frequency>**

Enters the frequency value in the table selected with `[ :SOURce<hw>]:CORRection:CSET [ :SElect ]`.

**Parameters:**

<Frequency>            Frequency#1[, Frequency#2, ...]

**Example:**            See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Manual operation:**   See ["Edit List Mode Data"](#) on page 465

---

**[ :SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts?**

Queries the number of frequency values in the selected table.

**Return values:**

<Points>                integer  
                           Range:        0 to 10000  
                           \*RST:        0

**Example:**            See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Usage:**                Query only

---

**[ :SOURce<hw>]:CORRection:CSET:DATA:POWer <Power>**

Enters the level values to the table selected with `[ :SOURce<hw>]:CORRection:CSET [ :SElect ]`.

**Parameters:**

<Power>                 Power#1[, Power#2, ...]

**Example:**            See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Manual operation:**   See ["Edit List Mode Data"](#) on page 465



---

**[[:SOURce<hw>]:CORRection:CSET:DATA:POWER:POINTs?**

Queries the number of level values in the selected table.

**Return values:**

<Points>	integer
Range:	0 to 10000
*RST:	0

**Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Usage:** Query only

---

**[[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWER]:SONCe**

Fills the selected user correction table with the level values measured by the power sensor for the given frequencies.

To select the used power sensor set the suffix in key word `SENSe`.

**Example:** See [Example "Fill user correction data with sensor"](#) on page 958.

**Usage:** Event

**Manual operation:** See ["Fill User Correction Data with Sensor"](#) on page 512

---

**[[:SOURce<hw>]:CORRection:CSET[:SElect] <Filename>**

Selects or creates a file for the user correction data.

If the file does not exist, the instrument automatically creates a new file with the name you assigned. Note the predefined file extensions under [Chapter B.3, "Extensions for User Files"](#), on page 1142.

**Parameters:**

<Filename>	<table name>
------------	--------------

**Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Manual operation:** See ["User Cor. Data..."](#) on page 507

---

**[[:SOURce<hw>]:CORRection:VALue?**

Queries the current value for user correction.

**Return values:**

<Value>	float
Range:	-100 to 100
Increment:	0.01
*RST:	0

**Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Usage:** Query only

**Manual operation:** See ["User Correction"](#) on page 507

**[:SOURce<hw>]:CORRection:ZERoing:STATe <State>**

Activates the zeroing procedure before filling the user correction data acquired by a sensor.

**Parameters:**

<State> 0 | 1 | OFF | ON

**Example:** See [Example "Fill user correction data with sensor"](#) on page 958.

**Manual operation:** See ["Fill User Correction Data with Sensor"](#) on page 512

**[:SOURce<hw>]:CORRection[:STATe] <State>**

Activates user correction with the currently selected table.

**Parameters:**

<State> 0 | 1 | OFF | ON

\*RST: 0

**Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Manual operation:** See ["State"](#) on page 507

**[:SOURce]:CORRection:CSET:CATalog?**

Queries a list of available user correction tables. The individual lists are separated by commas.

**Return values:**

<Catalog> string

**Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Usage:** Query only

**Manual operation:** See ["User Cor. Data..."](#) on page 507

**[:SOURce]:CORRection:CSET:DELeTe <Filename>**

Deletes the specified user correction list file.

**Setting parameters:**

<Filename> <table name>

- Example:** See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .
- Usage:** Setting only
- Manual operation:** See ["User Cor. Data..."](#) on page 507

### 13.18.5.2 SGamma Correction Data

The signal generator can perform a measured-value correction taking the complex reflection coefficient (source gamma) of the signal source into account. The state must be activated.

---

**[:SOURce<hw>]:CORRection:CSET:DATA:POWer:SGAMma:STATe <State>**

Activates the auto fill process to create a list with SGamma correction data.

SGamma correction is possible when the table is filled with multi level user correction data.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

- Example:** CORR:CSET:DATA:POW:SGAM:STAT ON  
 activates the acquisition of multi level gamma correction data with a connected power sensor.

---

**[:SOURce<hw>]:CORRection:CSET:DATA:SGAMma:DELeTe**

Deletes SGamma correction values in the selected table.

- Example:** CORR:CSET:DATA:SGAM:DEL  
 "/var/user/temp/lists/ucor/multilevelucor1"  
 deletes the SGamma correction values.

**Usage:** Event

---

**[:SOURce<hw>]:CORRection:CSET:DATA:SGAMma:MAGNitude <Magnitude1>[, <MagnitudeN>]**

Sets the magnitude of the reflection coefficient of the DUT for SGamma correction (multi level user correction data).

**Parameters:**

<Magnitude1> float  
 Range: 0.0 to 1.0  
 Increment: 0.01

<MagnitudeN> float  
 Range: 0.0 to 1.0  
 Increment: 0.01

**Example:** `CORR:CSET:DATA:POW:SGAM:MAG 0.1,0.2,0.3,0.4`  
sets the magnitude values.

---

**[:SOURce<hw>]:CORRection:CSET:DATA:SGAMma:MAGNitude:POINts?**

Queries the number of magnitude entries in the selected multi level user correction table.

**Return values:**

<Points> integer

**Example:**

`CORR:CSET`  
`"/var/user/temp/lists/ucor/multilevelucor1"`  
selects the data table `multilevelucor1`.  
`CORR:CSET:DATA:SGAM:MAGN:POIN?`  
queries the number of magnitude entries.  
Response: 40  
the table contains 40 magnitude values.

**Usage:** Query only

---

**[:SOURce<hw>]:CORRection:CSET:DATA:SGAMma:PHASe <Phase1>[, <PhaseN>]**

Sets the phase angle of the reflection coefficient of the DUT for SGamma correction (multi level user correction data).

**Parameters:**

<Phase1> float  
Range: -360 to 360  
Increment: 0.1

<PhaseN> float  
Range: -360 to 360  
Increment: 0.1

**Example:** `CORR:CSET:DATA:POW:SGAM:PHAS`  
`-360.0,-180.0,180.0,360.0`  
sets the phase values.

---

**[:SOURce<hw>]:CORRection:CSET:DATA:SGAMma:PHASe:POINts?**

Queries the number of phase entries in the selected multi level user correction table.

**Return values:**

<Points> integer

**Example:**           CORR:CSET "/var/user/temp/multilevelucor"  
 selects the data table multilevelucor.  
 CORR:CSET:DATA:SGAM:PHAS:POIN?  
 queries the number of phase entries.  
 Response: 40  
 the table contains 40 phase values.

**Usage:**            Query only

### 13.18.5.3 Correction Data Exchange

With the following commands, you can configure user correction lists and export or import them accordingly.

---

#### **[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?**

Queries the available ASCII files for export or import of user correction data in the current or specified directory.

As response, you get a string containing the existing ASCII files \*.txt or \*.csv, separated by commas.

**Return values:**

<Catalog>           string

**Example:**           See [Example "Create a table with user defined correction values for the RF level"](#) on page 957 .

**Usage:**            Query only

**Manual operation:** See ["Select ASCII Source / Destination"](#) on page 469

---

#### **[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension <Extension>**

Determines the extension of the ASCII files for file import or export, or to query existing files.

**Parameters:**

<Extension>           TXT | CSV  
 \*RST:                TXT

**Example:**           See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:** See ["ASCII File Settings"](#) on page 468

---

#### **[:SOURce<hw>]:CORRection:DEXChange:AFILe:SElect <Filename>**

Selects the ASCII file to be imported or exported.

**Parameters:**

<Filename>           string  
 ASCII file name

**Example:**           See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:** See ["Select ASCII Source / Destination"](#) on page 469

---

**[ :SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn <Column>**

Selects the separator between the frequency and level column of the ASCII table.

**Parameters:**

<Column> TABulator | SEMicolon | COMMa | SPACe  
 \*RST: COMMa

**Example:** See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:** See ["ASCII File Settings"](#) on page 468

---

**[ :SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal <Decimal>**

Sets the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

**Parameters:**

<Decimal> DOT | COMMa  
 \*RST: DOT

**Example:** See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:** See ["ASCII File Settings"](#) on page 468

---

**[ :SOURce<hw>]:CORRection:DEXChange:EXECute**

Executes the import or export of the selected correction list, according to the previously set transfer direction with command [\[ :SOURce<hw>\]:CORRection:DEXChange:MODE](#).

**Example:** See [Example "User correction data exchange"](#) on page 959 .

**Usage:** Event

**Manual operation:** See ["Import / Export"](#) on page 469

---

**[ :SOURce<hw>]:CORRection:DEXChange:MODE <Mode>**

Determines import or export of a user correction list. With the command [\[ :SOURce<hw>\]:CORRection:DEXChange:SELeCt](#), you can specify the source or destination file.

**Parameters:**

<Mode> IMPort | EXPort  
 \*RST: IMPort

**Example:** See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:** See ["Mode "](#) on page 468

---

**[:SOURce<hw>]:CORRection:DEXChange:SELEct <Filename>**

Selects the ASCII file for import or export, containing a user correction list.

**Parameters:**

<Filename>                    string  
                                  ASCII file name

**Example:**                    See [Example "User correction data exchange"](#) on page 959 .

**Manual operation:**    See ["Select Source / Destination"](#) on page 469

### 13.18.6 SOURce:FREQuency Subsystem

The SOURce:FREQuency subsystem contains the commands used to define the frequency settings for the RF sources and sweeps.

#### Examples to LO Coupling

The following example shows how to set up LO coupling via remote control.

The example is based on a test setup of three R&S signal generators using a coupled oscillator signal. The first and the third generators in the chain are one-path instruments, and the second instrument is equipped with two paths, like for example the R&S SMW.

The required interconnections:

- ▶ Connect the LO OUT output of the first generator with LO IN of the second, and LO OUT of the second generator with LO IN of the third.

R&S Signal Generator 1 uses its internal oscillator signal. R&S Signal Generator 2 receives the LO signal from the first instrument and assigns it to both paths. R&S Signal Generator 3 receives the LO signal from the second instrument. The frequency is assumed to be 5 GHz.

To optimize performance, the adjustment of the internal LO level at the current frequency is considered, see ["Level adjustment"](#) on page 429.

Refer to ["To configure LO coupling with cascaded instruments to achieve phase coherence"](#) on page 434 to find the test setup shown graphically, as wells the configuration via manual control.

### Example: Set up of LO Coupling and LO Level adjustment with three R&S Signal Generators

The following example shows the command sequences for coupling the oscillator signal of three connected R&S signal generators, as shown in the figure:

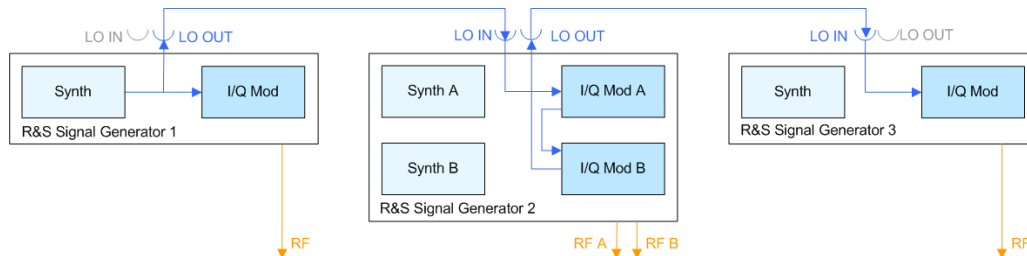


Figure 13-14: Set up of LO coupling with three R&S Signal Generators

See also [Example "Cascading three Rohde & Schwarz Signal Generators"](#) on page 434.

The frequency is assumed to be 5 GHz.

```
// *****
// Address and reset the first instrument
// *****
*RST; *CLS

// *****
// Configure the oscillator signal of the first instrument
// *****
[SOURce:]FREQuency 5 GHz
[SOURce:]FREQuency:LOSCillator:MODE INTernal
[SOURce:]FREQuency:LOSCillator:OUTPut:STATe ON
[SOURce:]FREQuency:LOSCillator:OUTPut:FREQuency?
// Response: 1000000000

// *****
// Address and reset the second instrument
// *****
*RST; *CLS

// *****
// Configure the oscillator signal of the second instrument
// *****
SOURce1:FREQuency 5 GHz
SOURce1:FREQuency:LOSCillator:MODE ECOupled
SOURce1:FREQuency:LOSCillator:OUTPut:STATe ON

// *****
// If the attenuation between the interconnection LO OUT and LO IN is
// greater than 1 dB at the oscillator frequency, it is recommended
// that you perform the LO level adjustment
```



```
// *****
:CALibration:LOSCillator:COupling:LOCAL?

// *****
// Address and reset the third instrument
// *****
*RST; *CLS

// *****
// Configure the oscillator signal of the third instrument
// *****
[SOURce:]FREQuency 5 GHz
[SOURce:]FREQuency:LOSCillator:MODE EXTernal
[SOURce:]FREQuency:LOSCillator:OUTPut:STATe OFF

// *****
// If the attenuation between the interconnection LO OUT and LO IN is
// greater than 1 dB at the oscillator frequency, it is recommended
// that you perform the LO level adjustment
// *****
:CALibration:LOSCillator:COupling:LOCAL?

// *****
```

[SOURce<hw>]:FREQuency:CENTer.....	969
[SOURce<hw>]:FREQuency:LOSCillator:INPut:FREQuency?.....	970
[SOURce<hw>]:FREQuency:LOSCillator:MODE.....	970
[SOURce<hw>]:FREQuency:LOSCillator:OUTPut:FREQuency?.....	971
[SOURce<hw>]:FREQuency:LOSCillator:OUTPut:STATe.....	971
[SOURce<hw>]:FREQuency:MANual.....	972
[SOURce<hw>]:FREQuency:MODE.....	972
[SOURce<hw>]:FREQuency:MUlTiplier.....	973
[SOURce<hw>]:FREQuency:OFFSet.....	974
[SOURce<hw>]:FREQuency:PLL:MODE.....	974
[SOURce<hw>]:FREQuency:SPAN.....	974
[SOURce<hw>]:FREQuency:STARt.....	975
[SOURce<hw>]:FREQuency:STOP.....	975
[SOURce<hw>]:FREQuency:STEP:MODE.....	976
[SOURce<hw>]:FREQuency:STEP[:INCRement].....	976
[SOURce<hw>]:FREQuency[:CW FIXed].....	977
[SOURce<hw>]:FREQuency[:CW FIXed]:RCL.....	977

---

**[SOURce<hw>]:FREQuency:CENTer <Center>**

Sets the center frequency of the sweep.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447 for correlations of the parameters.

**Parameters:**

<Center> float  
 Range: 300 kHz to RFmax  
 Increment: 0.01 Hz  
 \*RST: 300E6  
 Default unit: Hz

**Example:**

FREQ:CENT 400MHz  
 sets the center frequency for the frequency sweep to 400 MHz.  
 FREQ:SPAN 200MHz  
 sets a span of 200 MHz. This sets the sweep range to 300 MHz to 500 MHz.

**Manual operation:** See "[Center Freq](#)" on page 457

**[[:SOURce<hw>]:FREQUENCY:LOSCillator:INPut:FREQUENCY?**

Queries the required external reference frequency.

**Return values:**

<Frequency> float  
 Range: 100E3 to 20E9  
 Increment: 0.01  
 \*RST: 0

**Usage:** Query only

**Manual operation:** See "[Mandatory LO IN Frequency](#)" on page 432

**[[:SOURce<hw>]:FREQUENCY:LOSCillator:MODE <Mode>**

Selects the mode of the local oscillator coupling.

*Table 13-8: Parameter values corresponding to selection in manual operation*

Parameter value	Parameter in manual operation
INTernal	A&B Internal / Internal (one path instrument)
EXTernal	A External & B Internal (one path instrument)
COUPled	A Internal & A->B Coupled
ECOupled	A External & A->B Coupled
BOFF	A Internal & B RF Off
EBOFf	A External & B RF Off
AOFF	A RF Off & B External

**Parameters:**

<Mode> INTERNAL | EXTERNAL | COUPLED | ECOUPLED | BOFF | AOFF | EBOFF

**INTERNAL**

Uses the internal oscillator signal in both paths.

**EXTERNAL**

Uses an external signal in path A. B uses its internal signal.

**COUPLED**

Assigns the internal oscillator signal of path A also to path B.

**ECOUPLED**

Assigns an externally supplied signal to both paths.

**BOFF**

Uses the internal local oscillator signal of path A, if the selected frequency exceeds the maximum frequency of path B.

**EBOFF**

Uses the LO IN signal for path A, if the selected RF frequency exceeds the maximum frequency of path B.

**AOFF**

Uses the LO IN signal for path B, if the selected RF frequency exceeds the maximum frequency of path A.

\*RST: INT

**Example:** See ["Examples to LO Coupling"](#) on page 967.

**Manual operation:** See ["Mode"](#) on page 431

**[[:SOURce<hw>]:FREQUENCY:LOSCillator:OUTPut:FREQUENCY?**

Queries the current frequency of the local oscillator at the LO OUT connector.

**Return values:**

<Frequency> float  
 Range: 100E3 to 20E9  
 Increment: 0.01  
 \*RST: 0

**Example:** See ["Examples to LO Coupling"](#) on page 967.

**Usage:** Query only

**Manual operation:** See ["LO OUT Frequency"](#) on page 432

**[[:SOURce<hw>]:FREQUENCY:LOSCillator:OUTPut:STATE <State>**

Activates the LO output in path B.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** See "Examples to LO Coupling" on page 967.

**Manual operation:** See "Out State " on page 432

**[ :SOURce<hw>]:FREQUENCY:MANual <Manual>**

Determines the frequency and triggers a sweep step manually in [SWE:MODE MAN](#).

**Note:** You can select any frequency within the setting range. The range is defined with the commands [\[ :SOURce<hw> \] :FREQUENCY:START](#) on page 975 and [\[ :SOURce<hw> \] :FREQUENCY:STOP](#) on page 975. A frequency offset, set with command [\[ :SOURce<hw> \] :FREQUENCY:OFFSet](#), also affects the frequency range as follows:

(START frequency + OFFSet) to (STOP frequency + OFFSet)

**Parameters:**

<Manual> float  
 Range: START to STOP  
 Increment: 0.01Hz  
 \*RST: 100 MHz  
 Default unit: Hz

**Example:**

SWE:MODE MAN  
 sets the Step sweep mode.  
 FREQ:MAN 500MHz  
 sets an RF frequency of 500 MHz for the next step in the sweep step mode.  
 FREQ:MODE SWE  
 sets the frequency sweep mode. An RF frequency of 500 MHz is output.  
 FREQ:MAN 550MHz  
 triggers the next sweep step with an RF frequency of 550 MHz.

**Manual operation:** See "Current Freq" on page 458

**[ :SOURce<hw>]:FREQUENCY:MODE <Mode>**

Sets the frequency mode for generating the RF output signal in the selected path. The selected mode determines the parameters to be used for further frequency settings.

**Parameters:**

&lt;Mode&gt;

CW | FIXed | SWEep | LIST

**CW|FIXed**

Sets the fixed frequency mode. CW and FIXed are synonyms.

The instrument operates at a defined frequency, set with command `[ :SOURce<hw> ] :FREQuency [ :CW | FIXed ]`.**SWEep**

Sets sweep mode.

The instrument processes frequency and level settings in defined sweep steps.

To determine the corresponding frequencies, use the commands

`[ :SOURce<hw> ] :FREQuency:STARt` on page 975 and `[ :``SOURce<hw> ] :FREQuency:STOP` on page 975, `[ :``SOURce<hw> ] :FREQuency:CENTer` on page 969, `[ :``SOURce<hw> ] :FREQuency:SPAN` on page 974 or `[ :``SOURce<hw> ] :FREQuency:MANual` on page 972**LIST**

Sets list mode.

The instrument processes frequency and level settings by means of values loaded from a list.

To configure list mode settings, use the commands of the [Chapter 13.18.11, "SOURce:LIST Subsystem"](#), on page 1004.`*RST: CW`**Example:**`FREQ:MODE SWE`

sets the sweep mode

**Manual operation:** See "[State - RF Frequency Sweep](#)" on page 455**[ :SOURce<hw> ] :FREQuency:MULTiplier <Multiplier>**Sets the multiplication factor  $N_{\text{FREQ:MULT}}$  of a subsequent downstream instrument, e.g. a frequency multiplier.**Note:** The parameters offset and multiplier affect the frequency set with the command `[ :SOUR ] :FREQ`. Therefore, the query `[ :SOUR ] :FREQ?` returns the value corresponding to the formula:

$$f_{[:\text{SOUR}]:\text{FREQ}} = f_{\text{RFout}} * N_{\text{FREQ:MULT}} + f_{\text{FREQ:OFFSer}}$$

However, a specified multiplication factor does not change the frequency at the RF output  $f_{\text{RFout}}$ .Find additional information on the displayed and actual RF output frequency in [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

**Parameters:**

<Multiplier> float  
 Range: 1 to dynamic  
 Increment: 0.001  
 \*RST: 1

**Example:**

FREQ:MULT 2  
 sets the multiplication factor to 2.

**Manual operation:** See "[Multiplier](#)" on page 414

**[[:SOURce<hw>]:FREQUENCY:OFFSet <Offset>**

Sets the frequency offset  $f_{\text{FREQ:OFFSet}}$  of a downstream instrument, for example a mixer.

**Note:** The parameters offset and multiplier affect the frequency set with the command [\[:SOUR\]:FREQ](#). Therefore, the query [\[:SOUR\]:FREQ?](#) returns the value corresponding to the formula:

$$f_{[:SOUR]:FREQ} = f_{\text{RFout}} * N_{\text{FREQ:MULT}} + f_{\text{FREQ:OFFSet}}$$

Find additional information on the displayed and actual RF output frequency in [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

**Note:**

The offset also affects RF frequency sweep.

**Parameters:**

<Offset> float  
 Increment: 0.01  
 \*RST: 0

**Example:**

FREQ:OFFS 500kHz  
 sets the frequency offset to 500 kHz.

**Manual operation:** See "[Offset](#)" on page 414

**[[:SOURce<hw>]:FREQUENCY:PLL:MODE <Mode>**

Sets the bandwidth of the main PLL (Phase Locked Loop).

**Parameters:**

<Mode> NORMal | NARRow | WIDE  
 \*RST: NORMal

**Options:**

R&S SMW-B22

**[[:SOURce<hw>]:FREQUENCY:SPAN <Span>**

Determines the extent of the frequency sweep range.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447 for correlations of the parameters.

**Parameters:**

<Span> float  
 Full frequency range  
 Increment: 0.01  
 \*RST: 400E6

**Example:**

FREQ:CENT 400 MHz  
 sets the center frequency to 400 MHz.  
 FREQ:SPAN 200 MHz  
 sets a span of 200 MHz, resulting in a sweep range from 300 MHz to 500 MHz.

**Manual operation:** See ["Span"](#) on page 457

**[:SOURce<hw>]:FREQUENCY:START <Start>**

Sets the start frequency for the RF sweep.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447 for details to the correlation of the parameters.

**Parameters:**

<Start> float  
 Range: 300kHz to RFmax  
 Increment: 0.01Hz  
 \*RST: 100 MHz

**Example:**

FREQ:START 1 MHz  
 sets the start frequency for the frequency sweep to 1 MHz.  
 FREQ:STOP 2 GHz  
 sets the stop frequency for the frequency sweep to 2 GHz.

**Manual operation:** See ["Start Freq / Stop Freq"](#) on page 457

**[:SOURce<hw>]:FREQUENCY:STOP <Stop>**

Sets the stop frequency range for the RF sweep.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447 for details to the correlation of the parameters.

**Parameters:**

<Stop> float  
 Range: 300kHz to RFmax  
 Increment: 0.01Hz  
 \*RST: 500 MHz  
 Default unit: Hz

**Example:**            `FREQ:START 1 MHz`  
                          sets the start frequency to 1 MHz.  
                          `FREQ:STOP 2 GHz`  
                          sets the stop frequency to 2 GHz.

**Manual operation:** See "[Start Freq / Stop Freq](#)" on page 457

#### `[:SOURce<hw>]:FREQuency:STEP:MODE <Mode>`

Defines the type of step size to vary the RF frequency step-by-step with the commands [FREQ UP](#), or [FREQ DOWN](#). You can define the step mode for each path separately.

**Parameters:**

<Mode>                    DECimal | USER

**DECimal**

Increases or decreases the level in steps of ten.

**USER**

Increases or decreases the level in increments, determined with the command [FREQ:STEP\[:INCR\]](#).

\*RST:            DECimal

**Example:**            `FREQ:STEP 50 kHz`  
                          sets the step width for the frequency setting to 50 kHz.  
                          `FREQ:STEP:MODE USER`  
                          activates user-defined step width.  
                          `FREQ UP`  
                          increases the RF frequency by the specified step width.

**Manual operation:** See "[Variation Step](#)" on page 415

#### `[:SOURce<hw>]:FREQuency:STEP[:INCRement] <Increment>`

Sets the step width for the selected path. You can use this value to vary the RF frequency with command [FREQ UP](#), or [FREQ DOWN](#), provided , you have activated [FREQ:STEP:MODE USER](#).

**Note:** This value also applies to the step width of the rotary knob on the instrument and increases or decreases the frequency accordingly, when you work in user-defined step mode.

**Parameters:**

<Increment>            float  
                          Range:        0 Hz to RFmax - 100 kHz  
                          Increment: 0.01 Hz  
                          \*RST:        1E6



**Example:**

```
FREQ:STEP 50 kHz
sets the step width for the frequency setting to 50 kHz.
FREQ:STEP:MODE USER
activates user-defined step width.
FREQ UP
increases the RF frequency by the specified step width.
```

**Manual operation:** See "[Variation Step](#)" on page 415

**[ :SOURce<hw>]:FREQuency[:CW|FIXed] <Fixed>**

Sets the frequency of the RF output signal in the selected path.

In CW mode, see [FREQ:MODE CW | FIXed](#), the instrument operates at a fixed frequency.

In sweep mode [FREQ:MODE SWE](#), the value applies to the sweep frequency, and the instrument processes the frequency settings in defined sweep steps.

You can enter either a numerical frequency value, or decrease or increase the current frequency step by step, with [FREQ UP](#) and [FREQ DOWN](#). The frequency is then increased or decreased by the value set with [\[ :SOURce<hw> \] :FREQuency:STEP \[ :INCRement \]](#) in [FREQ:STEP:MODE USER](#).

**Note:**

A defined offset affects the value range. Therefore, the set frequency is only an absolute value, if the Offset = 0. Offset ≠ 0 shifts the frequency range to the offset value:

$$RF_{\min} + f_{\text{Offset}} \dots RF_{\max} + f_{\text{Offset}}$$

Find additional information on the displayed and actual RF output frequency in [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

**Parameters:**

<Fixed> float  
\*RST: 100 MHz

**Example:**

```
FREQ 3GHZ
sets 3 GHz RF output frequency.
```

**Manual operation:** See "[Frequency](#)" on page 413

**[ :SOURce<hw>]:FREQuency[:CW|FIXed]:RCL <Rcl>**

Determines whether the RF frequency value is retained or taken from a loaded instrument configuration, when you recall instrument settings with command [\\*RCL](#).

The selected mode applies to both RF paths, i.e. a specified suffix is ignored.

**Parameters:****<Rcl>** INCLude | EXCLude**INCLude**

Takes the frequency value of the loaded settings.

**EXCLude**

Retains the current frequency when an instrument configuration is loaded.

**\*RST:** INCLude**Example:**

FREQ:RCL INCL

**Manual operation:** See "Exclude Frequency" on page 583

takes the frequency from the loaded instrument configuration.

### 13.18.7 SOURce:INPut Subsystem

The `SOURce:INPut` subsystem contains the commands for configuring the inputs for external modulation signals. The instrument trigger setting influences all sweeps and is effective in the List mode (Instrument Trigger).

<code>[:SOURce&lt;hw&gt;]:INPut:MODext:COUPling&lt;ch&gt;</code> .....	978
<code>[:SOURce&lt;hw&gt;]:INPut:MODext:IMPedance&lt;ch&gt;</code> .....	978
<code>[:SOURce&lt;hw&gt;]:INPut:TRIGger:SLOPe</code> .....	979

---

**`[:SOURce<hw>]:INPut:MODext:COUPling<ch>` <Coupling>**

Selects the coupling mode for an externally applied modulation signal.

**Parameters:****<Coupling>** AC | DC**AC**

Passes the AC signal component of the modulation signal.

**DC**

Passes the modulation signal with both components, AC and DC.

**\*RST:** AC**Example:**

INP:MOD:COUP AC

selects the coupling mode AC for an externally applied modulation signal.

**Manual operation:** See "Coupling (AC/DC)" on page 483

---

**`[:SOURce<hw>]:INPut:MODext:IMPedance<ch>` <Impedance>**

Sets the impedance (50 kOhm or High = 100 kOhm to ground) for the externally supplied modulation signal.

**Parameters:**

<Impedance> G50 | HIGH  
 \*RST: HIGH

**Example:**

INP:MOD:IMP 50  
 sets 50 kOhm to ground.

**Manual operation:** See "[Impedance](#)" on page 483

**[[:SOURce<hw>]:INPut:TRIGger:SLOPe <Slope>**

Sets the polarity of the active slope of an applied instrument trigger.

**Parameters:**

<Slope> NEGative | POSitive  
 \*RST: POSitive

**Manual operation:** See "[Instrument Trigger Slope](#)" on page 459

### 13.18.8 SOURce:IQ Subsystem

The SOURce:IQ subsystem contains the commands for configuring the I/Q modulation.

**[[:SOURce<hw>]:IQ:SOURce <Source>**

Selects the input signal source for the I/Q modulator.

**Parameters:**

<Source> BASEband | ANALog | DIFFerential  
 DIFFerential requires option R&S SMW-K739  
 You can feed BASEband as well as ANALog into both paths, while DIFFerential is provided in path A only.  
 Both, the external analog and external differential signals, disable the amplitude modulation, an enabled custom digital modulation, any configured digital standard or an applied digital baseband input signal.  
 \*RST: BASEband

**Example:**

SOURce1:IQ:SOURce ANALog  
 selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

**Manual operation:** See "[Source](#)" on page 402

**[[:SOURce<hw>]:IQ:STATe <State>**

Enables/disables the I/Q modulation.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

`IQ:STAT ON`  
 activates I/Q modulation.

**Manual operation:** See "[State](#)" on page 402

**[[:SOURce<hw>]:IQ:GAIN <Gain>**

**[[:SOURce<hw>]:BB:IQGain <lqGain>**

Optimizes the modulation of the I/Q modulator for a subset of measurement requirement. Provided is a dynamic range of 16 dB divided into 2 dB steps.

**Parameters:**

<lqGain> DB0 | DB6 | DBM4 | DBM2 | DB2 | DB4 | DB8

**DB0|DB2|DB4|DB6|DB8**

Activates the specified gain of 0 dB, +2 dB, +4 dB, +6 dB, +8 dB

**DBM2|DBM4**

Activates the specified gain of -2 dB, -4 dB

**DBM3|DB3|AUTO**

Provided only for backward compatibility with other R&S signal generators.

The R&S SMW accepts these values and maps them automatically as follows:

DBM3 = DBM2, DB3 = DB2, AUTO = DB2

\*RST: DB4

**Example:**

`:SOURce1:BB:IQGain DB2`  
`:SOURce1:IQGain DB2`

**Manual operation:** See "[\(Baseband\) Gain](#)" on page 404

**[[:SOURce<hw>]:IQ:CREStfactor <CrestFactor>**

Specifies the crest factor for the external analog signal.

**Parameters:**

<CrestFactor> float  
 Range: 0 to 35  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:**

`IQ:CRES 10`  
 specifies 10 dB crest factor for the external analog signal.

**Manual operation:** See "[Crest Factor](#)" on page 403

---

**[ :SOURce<hw>]:IQ:SWAP[:STATe] <State>**

Swaps the I and Q channel.

**Parameters:**

<State>                    0 | 1 | OFF | ON  
 \*RST:                    0

**Example:**                    IQ:SWAP ON  
 swaps the I and Q channel.

**Manual operation:**    See "[I/Q Swap](#)" on page 402

---

**[ :SOURce<hw>]:IQ:WBSTate <WbState>**

Activates wideband mode.

This setting automatically optimizes the settings for wideband modulation signals (>5 MHz, State ON).

**Parameters:**

<WbState>                    0 | 1 | OFF | ON  
 \*RST:                    0

**Example:**                    IQ:WBST ON  
 switches to wideband mode.

**Manual operation:**    See "[I/Q Wideband](#)" on page 403

---

## 13.18.9 SOURce:IQ:OUTPut Subsystem

The SOURce:IQ:OUTPut subsystem contains the commands for configuring the analog and digital I/Q output signals.

For information about the required options, see:

- [Chapter 4.7, "I/Q Digital Output Settings"](#), on page 166
- [Chapter 4.8, "I/Q Analog Output Settings"](#), on page 173

Refer to [Table 4-4](#) for information on the connector and interfaces the analog and digital I/Q signals are output at.

### 13.18.9.1 SOURce:IQ:OUTPut:ANALog Commands

This section describes the commands of the output of an analog I/Q signal.

[ :SOURce<hw>]:IQ:OUTPut:ANALog:STATe.....	982
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet.....	982
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?.....	982
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe.....	983
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD.....	983
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELeTe.....	983
[ :SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE.....	983

<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe]</code> .....	983
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:BIAS:I</code> .....	984
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:BIAS:Q</code> .....	984
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut:LEVel</code> .....	984
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:MODE</code> .....	984
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:OFFSet:I</code> .....	985
<code>[:SOURce&lt;hw&gt;]:IQ:OUTPut[:ANALog]:OFFSet:Q</code> .....	985

---

### `[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe <State>`

Activates the specified analog I/Q output.

**Note:** By default, the output connectors I/Q OUT 1/2 are deactivated.

**Suffix:**

`:SOURce<hw>` 1|2  
Determines the connectors, I/Q OUT 1 or I/Q OUT 2

**Parameters:**

`<State>` 0 | 1 | OFF | ON  
\*RST: 0

**Example:**

`SOURce:IQ:OUTPut:ANALog:STATe ON`  
activates the output of the analog I/Q signal on the I/Q OUT 1 connectors.

**Manual operation:** See "State" on page 175

---

### `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet`

Sets the default settings (\*RST values specified for the commands).

Not affected is the state set with the command `[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe`.

**Usage:** Event

**Manual operation:** See "Set to Default" on page 175

---

### `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?`

Queries the files with I/Q output settings in the default directory. Listed are files with the file extension \*.iqout.

**Return values:**

`<Catalog>` "<filename1>,<filename2>,..."  
Returns a string of file names separated by commas.

**Usage:** Query only

**Manual operation:** See "Save/Recall" on page 175

---

**[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTING:STORe <Filename>**

Stores the current settings into the selected file; the file extension (\*.iqout) is assigned automatically.

**Setting parameters:**

<Filename>            string

**Usage:**                Setting only

**Manual operation:**   See "Save/Recall" on page 175

---

**[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTING:LOAD <Filename>**

Loads the selected file from the default or the specified directory. Loaded are files with extension \*.iqout.

**Setting parameters:**

<Filename>            string

**Usage:**                Setting only

**Manual operation:**   See "Save/Recall" on page 175

---

**[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTING:DELeTe <Filename>**

Deletes the selected file from the default or specified directory. Deleted are files with the file extension \*.iqout.

**Setting parameters:**

<Filename>            string

**Usage:**                Setting only

**Manual operation:**   See "Save/Recall" on page 175

---

**[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE <Type>**

Determines the type of the analog signal.

**Parameters:**

<Type>                SINGle | DIFFerential  
\*RST:                SINGle

**Example:**             SOURce1:IQ:OUTPup:ANALog:TYPE DIFFerential

**Manual operation:**   See "I/Q Output Type" on page 176

---

**[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe] <State>**

Couples the bias setting of the I and Q signal components.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

`IQ:OUTP:BIAS:COUP ON`  
 activates I/Q bias coupling.

**Manual operation:** See "[Couple I/Q Bias](#)" on page 177

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I <I>`  
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q <Q>`

Specifies the amplifier bias of the respective I- or Q- component.

The maximum overall voltage depends on the I/Q output type.

See [Table 4-9](#).

**Parameters:**

<Q> float  
 Range: -3.6 to 3.6  
 Increment: 0.002  
 \*RST: 0

**Example:**

`IQ:OUTP:BIAS:Q 0.1 V`

**Manual operation:** See "[Bias \(EMF\)](#)" on page 177

`[:SOURce<hw>]:IQ:OUTPut:LEVel <Level>`

Sets the off-load voltage of the analog I/Q signal output.

The value range and maximum overall voltage vary, depending on the I/Q output type.

See [Table 4-9](#).

**Parameters:**

<Level> float  
 Range: 0.02 to 4  
 Increment: 0.001  
 \*RST: 1

**Example:**

`:IQ:OUTP:TYPE DIFF`  
`:IQ:OUTP:LEV 1.5 V`  
 outputs the differential I/Q signal with 1.5 V power.

**Manual operation:** See "[I/Q Level Vp EMF](#)" on page 176

`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE <Mode>`

Determines the mode for setting the output parameters.



**Parameters:**

<Mode>                   FIXed | VARiable

**FIXed**  
locks the I/Q output settings

**VARiable**  
unlocks the settings

\*RST:           FIXed

**Example:**

```
SOUR:IQ:OUTP:MODE VAR
SOUR:IQ:OUTP:ANAL:POW:LEV 2V
```

**Manual operation:** See "Mode" on page 176

```
[[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I <I>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q <Q>
```

Sets an offset between the inverting and non-inverting input of the differential analog I/Q output signal.

**Parameters:**

<Q>                   float

Range:           -0.3 to 0.3

Increment:      1E-4

\*RST:           0

**Example:**

```
:SOURce1:IQ:OUTPut:ANALog:TYPE DIFF
:SOURce1:IQ:OUTPut:ANALog:OFFSet:I 0.05 V
:SOURce1:IQ:OUTPut:ANALog:OFFSet:Q 0.05 V
```

**Manual operation:** See "Offset (EMF)" on page 177

### 13.18.9.2 SOURce:IQ:OUTPut:DIGital Commands

This section describes the commands of the output of a digital I/Q signal.

**Suffixes**

The following suffixes are used:

Suffix	Value range	Description
BBMM<ch>	1 to 2	DIG IQ connector
FADer<ch>	1 to 4 <sup>*)</sup>	DIG IQ connector

<sup>\*)</sup> The number of the available DIG I/Q connectors on the FADER boards depends on the selected configuration (see also :SCONfiguration:FADing).

```
[[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:STATe..... 986
[:SOURce]:IQ:OUTPut:DIGital:FADer<ch>:STATe.....986
[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:PON..... 986
[:SOURce]:IQ:OUTPut:DIGital:FADer<ch>:PON.....986
```

<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:SRATe:SOURce</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:SRATe:SOURce</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:SRATe</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:SRATe</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:CDEVice?</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:CDEVice?</code> .....	987
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:POWer:VIA</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:POWer:VIA</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:POWer:PEP</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:POWer:PEP</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:POWer:LEVel</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:POWer:LEVel</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:POWer:STEP:MODE</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:POWer:STEP:MODE</code> .....	988
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:POWer:STEP[:INCRement]</code> .....	989
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:POWer:STEP[:INCRement]</code> .....	989
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:GDELay:CState</code> .....	989
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:OFLow:STATe?</code> .....	989
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:OFLow:STATe?</code> .....	989
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:OFLow:HOLD:RESet</code> .....	990
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:OFLow:HOLD:RESet</code> .....	990
<code>[:SOURce]:IQ:OUTPut:DiGital:BBMM&lt;ch&gt;:OFLow:HOLD:STATe?</code> .....	990
<code>[:SOURce]:IQ:OUTPut:DiGital:FADer&lt;ch&gt;:OFLow:HOLD:STATe?</code> .....	990

---

**`[:SOURce]:IQ:OUTPut:DiGital:BBMM<ch>:STATe <State>`**

**`[:SOURce]:IQ:OUTPut:DiGital:FADer<ch>:STATe <State>`**

Activates the digital I/Q signal output.

**Parameters:**

<State>                    0 | 1 | OFF | ON  
 \*RST:                    0

**Example:**

`SOURce:IQ:OUTPut:DiGital:BBMM2:STATe ON`  
 activates the BBMM 2 OUT connector.

**Manual operation:** See "[State](#)" on page 169

---

**`[:SOURce]:IQ:OUTPut:DiGital:BBMM<ch>:PON <Pon>`**

**`[:SOURce]:IQ:OUTPut:DiGital:FADer<ch>:PON <Pon>`**

Sets the power-on state of the selected digital I/Q output.

**Parameters:**

<Pon>                    OFF | UNCHanged  
 \*RST:                    OFF

**Example:**

`:SOURce:IQ:OUTPut:DiGital:BBMM2:PON OFF`  
 deactivates the BBMM 2 OUT connector when the instrument is switched on.

**Manual operation:** See "[Power-On State](#)" on page 172

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:SRATe:SOURce <Source>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:SRATe:SOURce <Source>
```

Selects whether the sample rate is estimated based on the digital signal or is a user-defined value.

**Parameters:**

<Source> USER | DOUT

**DOUT**

Enabled for BBMM1|BBMM2 connectors

\*RST: USER

**Example:**

```
:SOURce:IQ:OUTPut:DIGital:BBMM2:SRATe:SOURce
DOUT
```

Sample rate estimation based on the applied I/Q data clock

```
:SOURce:IQ:OUTPut:DIGital:BBMM2:SRATe?
```

**Manual operation:** See "[Sample Rate Source](#)" on page 169

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:SRATe <SRate>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:SRATe <SRate>
```

Sets/queries the sample rate of the digital I/Q output signal.

**Parameters:**

<SRate> float

Range for FADER connectors: 100E6 | 200E6

Range: 400 to depends on connected receiving device

\*RST: 1E8

**Example:**

```
see [:SOURce]:IQ:OUTPut:DIGital:FADer<ch>:SRATe:
SOURce on page 987
```

**Manual operation:** See "[Sample Rate Value](#)" on page 169

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:CDEvice?
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:CDEvice?
```

Queries information on the connected device.

**Return values:**

<CDevice> string

**Example:**

```
:SOURce:IQ:OUTPut:DIGital:BBMM2:CDEvice?
```

**Usage:**

Query only

**Manual operation:** See "[Connected Device](#)" on page 169

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:POWer:VIA <Via>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:POWer:VIA <Via>
```

**Parameters:**

```
<Via>                PEP | LEVel
                    *RST:    PEP
```

**Manual operation:** See ["Signal Output"](#) on page 170

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:POWer:PEP <Pep>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:POWer:PEP <Pep>
```

Enters the peak level of the output signal relative to full scale of 0.5 V (in terms of dB full scale).

**Parameters:**

```
<Pep>                float
                    Range:    -90 to 0
                    Increment: 0.01
                    *RST:    0
```

**Example:** `:SOURce:IQ:OUTPut:DIGital:BBMM2:POWer:PEP -10`

**Manual operation:** See ["Signal Output"](#) on page 170

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:POWer:LEVel <Level>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:POWer:LEVel <Level>
```

Enters the RMS level of the output signal.

**Parameters:**

```
<Level>              float
                    Range:    -90 to 0
                    Increment: 0.01
                    *RST:    0
```

**Example:** `:SOURce:IQ:OUTPut:DIGital:BBMM2:POWer:LEVel -10`

**Manual operation:** See ["Signal Output"](#) on page 170

---

```
[ :SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:POWer:STEP:MODE <Mode>
```

```
[ :SOURce]:IQ:OUTPut:DIGital:FADer<ch>:POWer:STEP:MODE <Mode>
```

Defines the type of step size to vary the digital output power step-by-step.

**Parameters:**

&lt;Mode&gt; DECimal | USER

**DECimal**

increases or decreases the level in steps of ten.

**USER**increases or decreases the level in increments, determined with the command `[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:POWer:STEP[:INCRement]`.

\*RST: DECimal

**Example:**`:SOURce:IQ:OUTPut:DIGital:BBMM2:POWer:STEP:MODE  
USER``:SOURce:IQ:OUTPut:DIGital:BBMM2:POWer:STEP 5 dB`  
activates the step width for level variation in 5 dB steps**Manual operation:** See ["User Variation"](#) on page 171`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:POWer:STEP[:INCRement]  
<Increment>``[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:POWer:STEP[:INCRement]  
<Increment>`

Sets the step width. Use this value to vary the digital I/Q output level step-by-step.

**Parameters:**

&lt;Increment&gt; float

Range: 0 to 100

Increment: 0.01

\*RST: 1

**Example:**see `[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:POWer:  
STEP:MODE` on page 988**Manual operation:** See ["User Variation"](#) on page 171`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:GDElay:CState <CompState>`

Enables/disables group delay compensation.

**Parameters:**

&lt;CompState&gt; 0 | 1 | OFF | ON

\*RST: 0

**Example:**`SOURce:IQ:OUTPut:DIGital:BBMM1:GDElay:CState`**Manual operation:** See ["Group Delay Compensation"](#) on page 172`[ :SOURce ] :IQ:OUTPut:DIGital:BBMM<ch>:OFLOW:STATE?``[ :SOURce ] :IQ:OUTPut:DIGital:FADer<ch>:OFLOW:STATE?`

Queries whether the I/Q output signal is clipped or not.

**Return values:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

:SOURce:IQ:OUTPut:DIGital:BBMM2:OFLow:STATe?  
 Response: "0" (no overflow).

**Usage:**

Query only

**Manual operation:** See "[Signal Monitoring](#)" on page 171

**[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:OFLow:HOLD:RESet**  
**[:SOURce]:IQ:OUTPut:DIGital:FADer<ch>:OFLow:HOLD:RESet**

Resets the overflow hold state and LED.

**Example:**

:SOURce:IQ:OUTPut:DIGital:BBMM2:OFLow:HOLD:  
 RESet

**Usage:**

Event

**Manual operation:** See "[Signal Monitoring](#)" on page 171

**[:SOURce]:IQ:OUTPut:DIGital:BBMM<ch>:OFLow:HOLD:STATe?**  
**[:SOURce]:IQ:OUTPut:DIGital:FADer<ch>:OFLow:HOLD:STATe?**

Queries an overload since last reset for evaluating the measurement.

**Return values:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

:SOURce:IQ:OUTPut:DIGital:BBMM2:OFLow:HOLD:  
 STATe?

**Usage:**

Query only

**Manual operation:** See "[Signal Monitoring](#)" on page 171

### 13.18.10 SOURce:LFOutput Subsystem

The `SOURce:LFOutput` subsystem contains the commands for setting the LF signal source in CW and Sweep mode as well as for analog modulation.

**Example: Setup an LF sweep**

The following example shows a command sequence to setup an LF sweep.

```
// *****
// Reset the instrument to start from an initial state
// *****
*RST; *CLS
```

```

// *****
// Set the trigger mode, the sweep mode and the sweep range
// *****
TRIGger1:LFFSweep:SOURce SINGLE
SOURcel:LFOOutput1:SWEep:FREQuency:MODE AUTO
SOURcel:LFOOutput1:FREQuency:STARt 1 kHz
SOURcel:LFOOutput1:FREQuency:STOP 7 kHz

// *****
// Select linear spacing
// Select the waveform shape for the frequency sweep cycle
// Set the step width and the dwell time.
// *****
SOURcel:LFOOutput1:SWEep:FREQuency:SPACing LINear
SOURcel:LFOOutput1:SWEep:FREQuency:SHAPE SAWtooth
SOURcel:LFOOutput1:SWEep:FREQuency:STEP:LINear 100 Hz
SOURcel:LFOOutput1:SWEep:FREQuency:DWELl 150 ms
// Alternatively to the step width set the number of steps.
SOURcel:LFOOutput1:SWEep:FREQuency:POINts 61

// *****
// Activate change to startfrequency while waiting for next trigger
// *****
// Prerequisites: sweep mode single and sweep waveform sawtooth.
SOURcel:LFOOutput:SWEep:FREQuency:RETRace 1

// *****
// Activate the LF frequency sweep.
// *****
SOURcel:LFOOutput:FREQuency:MODE SWE

// *****
// Trigger the sweep(depending on the set mode) and query the status.
// *****
// Perform a one-off LF sweep
SOURcel:LFOOutput1:SWEep:FREQuency:EXECute
SOURcel:LFOOutput1:SWEep:FREQuency:RUNNing?
// Response "1": the frequency sweep is running.

// *****
// For manual step LF sweep use the following commands
// *****
*RST; *CLS
SOURcel:LFOOutput:SWEep:FREQuency:MODE MANual
// Activate the LF frequency sweep.
SOURcel:LFOOutput:FREQuency:MODE SWEep
// Activate LF Output1.
SOURcel:LFOOutput1:STATe 1
// Input the frequency manually for each step

```

```

SOURce1:LFOutput1:FREQuency:MANual 2 kHz
SOURce1:LFOutput1:FREQuency:MANual 2.1 kHz
// Alternatively use UP or DOWN parameter with set step width.
SOURce1:LFOutput1:SWEep:FREQuency:STEP:LINear 500 Hz
SOURce1:LFOutput1:FREQuency:MANual UP

```

- [LF Generator Settings](#).....992
- [LF Sweep Settings](#)..... 1000

### 13.18.10.1 LF Generator Settings

With the commands described in this section, you can configure the LF signal source.

<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:BANDwidth?</a> .....	992
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:FREQuency</a> .....	993
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:PERiod?</a> .....	993
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput:FREQuency:MANual</a> .....	993
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput:FREQuency:MODE</a> .....	994
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput:FREQuency:START</a> .....	994
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput:FREQuency:STOP</a> .....	994
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:OFFSet</a> .....	995
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:SOURce</a> .....	995
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:SOURce:PATH</a> .....	996
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;[:STATe]</a> .....	996
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:VOLTage</a> .....	996
<a href="#">[:SOURce]:LFOutput&lt;ch&gt;:INTernal:VOLTage</a> .....	996
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE</a> .....	997
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:PULSe:DCYCLE</a> .....	997
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:PULSe:PERiod</a> .....	997
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:PULSe:WIDTh</a> .....	998
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRAPeZe:FALL</a> .....	998
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRAPeZe:HIGH</a> .....	998
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRAPeZe:PERiod</a> .....	998
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRAPeZe:RISE</a> .....	999
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRlangle:PERiod</a> .....	999
<a href="#">[:SOURce&lt;hw&gt;]:LFOutput&lt;ch&gt;:SHAPE:TRlangle:RISE</a> .....	999

---

#### **[:SOURce]:LFOutput<ch>:BANDwidth?**

Queries the bandwidth of the external LF signal.

##### **Return values:**

```

<Bandwidth>      BW0M2 | BW10m
                  *RST:      BW10m

```

##### **Example:**

```

LFO:BAND?
Response: "BW10m"
the bandwidth of the externally supplied LF signal is 10 MHz.

```

**Usage:** Query only

**Manual operation:** See "[Bandwidth](#)" on page 483



**[ :SOURce<hw>]:LFOOutput<ch>:FREQuency <Frequency>**

Sets the frequency of the LF signal in [ :SOURce<hw>]:LFOOutput:FREQuency:MODE CW|FIXed mode.

**Note**

- If signal source "Internal" is set, the instrument performs the analog modulations (AM/FM/ΦM/PM) with this frequency.
- In sweep mode ([ :SOURce<hw>]:LFOOutput:FREQuency:MODE SWE), the frequency is coupled with the sweep frequency.

**Parameters:**

<Frequency> float  
 Range: 0.1 to depends on option K24  
 Increment: 0.1  
 \*RST: 1000  
 Default unit: Hz

**Example:** LFO:FREQ 5kHz  
 sets 5 kHz LF signal frequency.

**Manual operation:** See "Frequency" on page 482

**[ :SOURce<hw>]:LFOOutput<ch>:PERiod?**

Queries the repetition frequency of the sine signal.

**Return values:**

<LfSinePeriod> float  
 Range: 1E-6 to 100  
 Increment: 10E-9  
 \*RST: 0.001  
 Default unit: s

**Example:** LFOOut:PER?  
 Response: 0.0000001  
 The period is 0.1 μs corresponding to 10 MHz frequency.

**Usage:** Query only

**[ :SOURce<hw>]:LFOOutput:FREQuency:MANual <Manual>**

Determines the frequency and triggers each sweep step manually in sweep-step mode LFO:SWE:MODE MAN.

**Note:**

You can select any frequency within the setting range. The range is defined with the commands [ :SOURce<hw>]:LFOOutput:FREQuency:START and [ :SOURce<hw>]:LFOOutput:FREQuency:STOP.

**Parameters:**

<Manual> float  
 Range: START to STOP  
 Increment: 0.1  
 \*RST: 1000

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Current Freq"](#) on page 458

**[ :SOURce<hw>]:LFOutput:FREQUENCY:MODE <Mode>**

Sets the mode for the output of the LF generator frequency, and determines the commands to be used for frequency settings.

**Parameters:**

<Mode> CW | FIXed | SWEep

**CW|FIXed**

Sets the fixed-frequency mode. CW and FIXed are synonyms.

To set the output frequency, use command [ :SOURce<hw> ] : LFOutput<ch> : FREQUENCY

**SWEep**

Sets sweep mode.

To set the frequency, use either the commands [ :SOURce<hw> ] : LFOutput : FREQUENCY : START and [ :SOURce<hw> ] : LFOutput : FREQUENCY : STOP, or [ :SOURce<hw> ] : LFOutput : FREQUENCY : MANUal.

\*RST: CW

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["State - LF Frequency Sweep"](#) on page 456

**[ :SOURce<hw>]:LFOutput:FREQUENCY:START <Start>**

Sets the start frequency for [ :SOURce<hw> ] : LFOutput : FREQUENCY : MODE [ :SOURce<hw> ] : LFOutput : FREQUENCY : MODE SWEep.

**Parameters:**

<Start> float  
 Range: 0.1 Hz to 1 MHz  
 Increment: 0.1  
 \*RST: 1 KHz

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Start Freq / Stop Freq"](#) on page 457

**[ :SOURce<hw>]:LFOutput:FREQUENCY:STOP <Stop>**

Sets the frequency range for the LF sweep.

**Parameters:**

<Stop> float  
 Range: 0.1 Hz to 1 MHz  
 Increment: 0.1 Hz  
 \*RST: 100 KHz

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Start Freq / Stop Freq"](#) on page 457

**[:SOURce]:LFOutput<ch>:OFFSet <Offset>**

Sets a DC offset at the selected LF Output.

**Parameters:**

<Offset> float  
 Range: -3.6 to 3.6  
 Increment: 0.001  
 \*RST: 0  
 Default unit: V

**Example:** LFO:OFFS 2 V  
 sets a DC OFFSet of 2 V

**Manual operation:** See ["DC-Offset"](#) on page 489

**[:SOURce]:LFOutput<ch>:SOURce <Source>**

Determines the LF signal to be synchronized, when monitoring is enabled.

**Parameters:**

<Source> LF1 | LF2 | NOISe | EXT1 | EXT2 | AM | FMPM | LF1B | LF2B |  
 AMB | NOISB | FMPMB | LF1A | LF2A | NOISA | FMPMA | AMA  
**LF1|LF2|LF1A|LF2A|LF1B|LF2B**  
 selects an internally generated LF signal.  
**NOISe|NOISA|NOISB**  
 selects an internally generated noise signal.  
**EXT1|EXT2**  
 selects an externally supplied LF signal  
**AM|AMA|AMB**  
 selects the AM signal.  
**FMPM|FMPMA|FMPMB**  
 selects the signal also used by the frequency or phase modulations.  
 \*RST: LF1

**Example:** LFO:SOUR NOIS  
 outputs signal generated by the noise generator.

**Manual operation:** See ["Source"](#) on page 489

---

**[[:SOURce]:LFOutput<ch>:SOURce:PATH <SourPath>**

Determines the path of the LF output source.

**Parameters:**

<SourPath>           A | B  
\*RST:                A

**Example:**

LFO:SOUR:PATH?  
queries the currently set path for the LF output signal source.

---

**[[:SOURce]:LFOutput<ch>[:STATe] <State>**

Activates LF signal output

**Parameters:**

<State>               0 | 1 | OFF | ON  
\*RST:                0

**Example:**

LFO:STAT ON  
activates signal output of the LF generator 1.

**Manual operation:** See "[State](#)" on page 489

---

**[[:SOURce]:LFOutput<ch>:VOLTage <Voltage>**

Sets the output voltage of the selected LF output.

**Parameters:**

<Voltage>             float  
Range:                0 to dynamic  
Increment:           0.001  
\*RST:                1  
Default unit: V

**Example:**

LFO:VOLT 3 V  
sets the voltage of the LF output to 3 V.

**Manual operation:** See "[Output Voltage](#)" on page 489

---

**[[:SOURce]:LFOutput<ch>:INTernal:VOLTage <Voltage>**

Sets the output voltage for the two LF generators. The sum of both values must not exceed the overall output voltage, set with command [\[:SOURce\]:LFOutput<ch>:VOLTage](#).

**Parameters:**

<Voltage>             float  
Range:                0V to 4V  
\*RST:                0.5V

**Example:** `LFO:INT:VOLT 0.5V`  
sets the output voltage of the first LF generator to 0.5 volts

---

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE <Shape>**

Selects the waveform shape of the LF signal.

**Parameters:**

<Shape> SINE | SQUare | TRIangle | TRAPeze  
\*RST: SINE

**Example:** `LFO:SHAP SQU`  
selects a rectangular (pulse) shape for the signal of the LF generator.

**Manual operation:** See "[Shape](#)" on page 482

---

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE:PULSE:DCYCLE <DCycle>**

Sets the duty cycle for the shape pulse.

**Parameters:**

<DCycle> float  
Range: 1E-6 to 100  
Increment: 0.001 PCT  
\*RST: 50 PCT

**Example:** `SOUR:LFO2:SHAP:PULS:DCYC 50`  
sets a duty cycle of 50% for the pulse shape of the signal of LF generator 1.

**Manual operation:** See "[Pulse Duty Cycle](#)" on page 482

---

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE:PULSE:PERiod <Period>**

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

**Parameters:**

<Period> float  
Range: 1E-6 to 100  
Increment: 1E-8  
\*RST: 1E-3

**Example:** `SOUR:LFO2:SHAP:PULS:PER 2ms`  
sets a pulse period of 2ms for the pulse shape of the signal of LF generator 2.

**Manual operation:** See "[Period \(Sine, Pulse, Triangle, Trapezoid\)](#)" on page 482

---

**[[:SOURce<hw>]:LFOOutput<ch>:SHAPE:PULSE:WIDTH <Width>**

Sets the pulse length of the generated pulse.

**Parameters:**

<Width>	float
Range:	1E-6 to 100
Increment:	1E-8
*RST:	5E-4

**Example:**

```
SOUR:LFO2:SHAP:PULS:WIDT 0.2ms
```

sets a pulse width of 0.2 ms for the pulse shape of the signal of LF generator 2.

**Manual operation:** See ["Pulse Width"](#) on page 482

---

**[[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRAPEZE:FALL <Fall>**

Selects the fall time for the trapezoid shape of the LF generator.

**Parameters:**

<Fall>	float
Range:	1E-6 to 100
Increment:	10E-9
*RST:	250E-6

**Example:**

```
SOUR:LFO2:SHAP:TRAP:FALL 0.1ms
```

selects a fall time of 0.1 ms for trapezoid shape of the signal of LF generator 2.

**Manual operation:** See ["Trapezoid Rise / Fall"](#) on page 483

---

**[[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRAPEZE:HIGH <High>**

Sets the high time for the trapezoid signal of the LF generator.

**Parameters:**

<High>	float
Range:	1E-6 to 100
Increment:	10E-9
*RST:	250E-6

**Example:**

```
SOUR:LFO2:SHAP:TRAP:HIGH 5ms
```

selects a high time of 5 ms for trapeze shape of the signal of LF generator 2.

**Manual operation:** See ["Trapezoid High"](#) on page 483

---

**[[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRAPEZE:PERIOD <Period>**

Sets the period of the generated trapezoid shape. The period determines the repetition frequency of the internal signal.

**Parameters:**

<Period> float  
 Range: 1E-6 to 100  
 Increment: 1E-8  
 \*RST: 1E-3

**Example:**

SOUR:LFO2:SHAP:TRAP:PER 1ms  
 sets a pulse period of 1 ms for the trapezoid shape of the signal of LF generator 2.

**Manual operation:** See "[Period \(Sine, Pulse, Triangle, Trapezoid\)](#)" on page 482

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRAPeZe:RISE <Rise>**

Selects the rise time for the trapezoid shape of the LF generator.

**Parameters:**

<Rise> float  
 Range: 1E-6 to 100  
 Increment: 10E-9  
 \*RST: 250E-6

**Example:**

SOUR:LFO2:SHAP:TRAP:RISE 0.2ms  
 selects a rise time of 0.2 ms for trapeze shape of the signal of LF generator 2.

**Manual operation:** See "[Trapezoid Rise / Fall](#)" on page 483

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRIangle:PERiod <Period>**

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

**Parameters:**

<Period> float  
 Range: 1E-6 to 100  
 Increment: 10E-9  
 \*RST: 0.001

**Example:**

SOUR:LFO2:SHAP:TRIA:PER 1ms  
 sets a pulse period of 1 ms for the pulse shape of the signal of LF generator 2.

**Manual operation:** See "[Period \(Sine, Pulse, Triangle, Trapezoid\)](#)" on page 482

**[:SOURce<hw>]:LFOOutput<ch>:SHAPE:TRIangle:RISE <Rise>**

Selects the rise time for the triangle single of the LF generator.

**Parameters:**

<Rise> float  
 Range: 1E-6 to 100  
 Increment: 10E-9  
 \*RST: 0.5E-3

**Example:**

SOUR:LFO1:SHAP:TRI:RISE 13s  
 selects a rise time of 13 s for triangle shape of the signal of LF generator 1.

**Manual operation:** See "Triangle Rise" on page 482

**13.18.10.2 LF Sweep Settings**

With the commands described in this section, you can configure the sweep of the LF signal.

[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:DWELI.....	1000
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:EXECute.....	1000
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:MODE.....	1001
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:POINts.....	1001
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:RETRace.....	1002
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:RUNNING?.....	1002
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:SHAPE.....	1002
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:SPACing.....	1003
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:STEP:LOGarithmic.....	1003
[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:STEP:LINear.....	1003

**[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:DWELI <Dwell>**

Sets the dwell time for each frequency step of the sweep.

**Parameters:**

<Dwell> float  
 Range: 1E-3 to 100  
 Increment: 100E-6  
 \*RST: 15E-3  
 Default unit: s

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See "Dwell Time" on page 459

**[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:EXECute**

Immediately starts an LF sweep.

[ :SOURce<hw> ]:LFOOutput:SWEep[:FREQUENCY]:MODE determines which sweep is executed, e.g. SOURce:LFOOutput:SWEep:FREQUENCY:MODE STEP.

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Usage:** Event



**Manual operation:** See "Execute Single Sweep" on page 456

---

**[ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:MODE <Mode>**

Sets the cycle mode of the LF sweep.

**Parameters:**

<Mode>

AUTO | MANual | STEP

**AUTO**

Performs a complete sweep cycle from the start to the end value when a trigger event occurs.

The dwell time determines the time period until the signal switches to the next step.

**MANual**

Performs a single sweep step when a manual trigger event occurs.

The trigger system is not active. You can trigger each frequency step of the sweep individually with the command [ :SOURce<hw>]:LFOutput:FREQuency:MANual on page 993.

With each step, the frequency increases by the value specified with [ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear], or [ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic, respectively. A frequency value, entered with the [ :SOURce<hw>]:LFOutput:FREQuency:MANual is not taken into consideration.

**STEP**

Each trigger command triggers one sweep step only. The frequency increases by the value entered under [ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP[:LINear], or [ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:STEP:LOGarithmic.

\*RST: AUTO

**Example:** See Example "Setup an LF sweep" on page 990.

**Manual operation:** See "Mode" on page 456

---

**[ :SOURce<hw>]:LFOutput:SWEep[:FREQuency]:POINTs <Points>**

Sets the number of steps in an LF sweep.

Depending on linear or logarithmic spacing, the *Points* are determined as follows:

- for linear sweeps and START < STOP  
 $POINTs = ((STOP - START) / STEP:LIN) + 1$
- for logarithmic sweeps and START < STOP  
 $POINTs = ((\log STOP - \log START) / \log STEP:LOG) + 1$

If POINTs changes, the corresponding STEP value changes accordingly. START and STOP remain unchanged.

Each sweep spacing mode has assigned the `POINTS` value separately. Thus, the command refers always to the particular set mode.

**Parameters:**

<Points> integer  
 Range: 2 to POINTs  
 Increment: 1  
 \*RST: 100

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**[[:SOURce<hw>]:LFOutput:SWEep[:FREQUENCY]:RETRace <State>**

Activates that the signal changes to the start frequency value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Manual operation:** See ["Retrace"](#) on page 459

**[[:SOURce<hw>]:LFOutput:SWEep[:FREQUENCY]:RUNNING?**

Queries the current status of the LF frequency sweep mode.

**Return values:**

<State> 0 | 1 | OFF | ON

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Usage:** Query only

**[[:SOURce<hw>]:LFOutput:SWEep[:FREQUENCY]:SHAPE <Shape>**

Sets the cycle mode for a sweep sequence (shape).

**Parameters:**

<Shape> SAWTooth | TRIangle

**SAWTooth**

One sweep runs from start to stop frequency. Each subsequent sweep starts at the start frequency, i.e. the shape of the sweep sequence resembles a sawtooth.

**TRIangle**

One sweep runs from start to stop frequency and back, i.e. the shape of the sweep resembles a triangle. Each subsequent sweep starts at the start frequency.

\*RST: SAWTooth

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Shape"](#) on page 458

**[ :SOURce<hw> ]:LFOutput:SWEep[:FREQUency]:SPACing <Spacing>**

Selects linear or logarithmic sweep spacing.

**Parameters:**

<Spacing> LINear | LOGarithmic | RAMP  
\*RST: LINear

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Spacing"](#) on page 458

**[ :SOURce<hw> ]:LFOutput:SWEep[:FREQUency]:STEP:LOGarithmic  
<Logarithmic>**

Sets the step width factor for logarithmic sweeps to calculate the frequencies of the steps.

The next sweep frequency value is calculated using the following formula ( $f_{\text{START}} < f_{\text{STOP}}$ ):

$$f_{\text{step}+1} = f_{\text{step}} + \text{STEP:LOG} \times f_{\text{step}}$$

STEP:LOG therefore is the fraction of the previous frequency in per cent.

In the next step, the frequency increases according to the again calculated factor.

**Note:** STEP:LOG is given in percent and you must enter the suffix PCT.

In addition, the number of steps (:LFOutput:SWEep[:FREQUency]:POINTs) is calculated by means of the STEP:LOG factor ( $f_{\text{START}} < f_{\text{STOP}}$ ):

$$\text{POINTs} = ((\log \text{STOP} - \log \text{START}) / \log \text{STEP:LOG}) + 1$$

If STEP:LOG changes, the corresponding POINTs value changes accordingly. START and STOP remain unchanged.

**Parameters:**

<Logarithmic> float  
Range: 0.01 to 100  
Increment: 0.01  
\*RST: 1

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Step Lin/Log"](#) on page 459

**[ :SOURce<hw> ]:LFOutput:SWEep[:FREQUency]:STEP[:LINear] <Linear>**

Sets the step width for the linear sweep.

The number of steps (:LFOutput:SWEp[:FREQUENCY]:POINTs) is calculated by means of the STEP value ( $f_{\text{START}} < f_{\text{STOP}}$ ):

$$\text{POINTs} = ((\text{STOP}-\text{START}) / \text{STEP:LIN}) + 1$$

If STEP[:LINear] changes, the corresponding POINTs value changes accordingly. START and STOP remain unchanged.

**Parameters:**

<Linear> float  
 Range: 0 to STOP-START  
 Increment: 0.1  
 \*RST: 1000

**Example:** See [Example "Setup an LF sweep"](#) on page 990.

**Manual operation:** See ["Step Lin/Log"](#) on page 459

### 13.18.11 SOURce:LIST Subsystem

The SOURce:LIST subsystem contains all commands for defining lists, and the handling of list files.

List files have the predefined file extension \*.lsw. For loading and saving files, you can specify the drive and directory in advance with the commands MMEM:CDIR (default drive) and MMEM:CDIR (default directory), see [Chapter 10, "File and Data Management"](#), on page 571 for more details.

To access the files in this directory, you can only enter the file name, without path and file extension. Alternatively, you can specify a path also within the command :SOUR:LIST:CAT?.



You can use the same lists for both paths. File operations such as creating, deleting and querying lists are therefore path-independent. In this case, the suffix <HW> under SOURce **must** be omitted. An error message is displayed if the suffix is specified.

---

\*RST does not affect data lists.

---



SCPI refers to the individual lists as segments.

---

**Example: Create an RF list and activate the list mode**

The following example shows a command sequence to create an RF list and to activate the list mode. Further hardware settings are not considered.

```
// *****
// Reset the instrument to start from an initial state
// Query the available list files in the default
```

```

// directory /var/user
// Select the list file or create it (if not existing)
// *****
*RST; *CLS
SOURcel:LIST:CATalog?
// Response:- shows the name of available list files (if applicable)
SOURcel:LIST:SElect "/var/user/list1.lsw"

// *****
// Write the frequency/level/dwell time value pairs in the selected list file
// existing data is overwritten
// Query the number of frequency/power/dwell time entries in the selected list
// Query the amount of free memory (in bytes) for list mode lists
// *****
SOURcel:LIST:FREQuency 58 MHz, 61 MHz, 73 MHz, 86 MHz, 91 MHz, 92 MHz, 98 MHz
SOURcel:LIST:POWer 13 dBm, 12 dBm, 5 dBm, 3 dBm, 0 dBm, 4 dBm, 6 dBm
SOURcel:LIST:DWELL 10000, 100000, 200000, 19000, 10000, 150000, 220000
SOURcel:LIST:FREQuency:POINts?
// Response: "7"
SOURcel:LIST:POWer:POINts?
// Response: "7"
SOURcel:LIST:DWELL:POINts?
// Response: "7"
SOURcel:LIST:FREE?
// Response: 2147483647 (bytes of free memory)

// *****
// Use dwell times from list
// Configure the list mode parameters
// Learn list mode data
// Enable RF output
// *****
SOURcel:LIST:MODE AUTO
SOURcel:LIST:TRIGger:SOURce AUTO
SOURcel:LIST:DWELL:MODE "LIST"
SOURcel:LIST:LEARN
OUTPut1:STATe ON

// *****
// Use global dwell time
// Set only a part of the list (value pairs 3..5) to be processed
// Configure the list mode parameters using global dwell time
// Learn list mode data
// Enable RF output
// *****
SOURcel:LIST:INDEx:START 2
SOURcel:LIST:INDEx:STOP 4
SOURcel:LIST:MODE AUTO
SOURcel:LIST:TRIGger:SOURce AUTO
SOURcel:LIST:DWELL 500 ms

```

```

SOURce1:LIST:LEARN
OUTPut1:STATE ON
SOURce1:LIST:RMODE LEARNed

// *****
// Enable the list mode
// Trigger the list (depending on the mode, not needed with trigger
// mode AUTO); query the current index
// Reset the list to the starting point
// *****
SOURce1:FREQuency:MODE LIST
SOURce1:LIST:TRIGger:EXECute
SOURce1:LIST:INDEX?
// Response: "3" (changes when the value is queried again)
SOURce1:LIST:RESet

// *****
// For list mode STEP use the following commands
*RST; *CLS
// Change list mode to STEP
SOURce1:LIST:MODE STEP
// Activate RF Output1
Output1:STATE 1
// Activate the list mode
SOURce1:FREQuency:MODE LIST
// For each step: select frequency/powerlevel pair as index from the list
SOURce1:LIST:INDEX 2
SOURce1:LIST:INDEX 3
SOURce1:LIST:INDEX 4

// *****
// Use the selected list for path B (with List Mode B default settings)
SOURce2:LIST:SElect "/var/user/list1.lsw"
OUTPut2:STATE ON
SOURce2:FREQuency:MODE LIST
SOURce2:LIST:INDEX?
// Response: "2" (changes when the value is queried again)

// *****
// Deactivate the list mode
SOURce1:FREQuency:MODE CW
// *****

```

### Example: List Mode Data Exchange

The following example shows a command sequence to export a list (here the RF list created with the example before) into an ASCII file. Further hardware settings are not considered.

```

// *****

```

```

// Reset the instrument to start from an initial state
// Select that a list is exported into an ASCII file
// *****
*RST; *CLS
LIST:DEXChange:MODE EXPort

// *****
// Set ASCII data parameters
// *****
// Set the ASCII file extension, the decimal separator
// and the column separator for the ASCII data
SOURcel:LIST:DEXChange:AFILe:EXTension CSV
SOURcel:LIST:DEXChange:AFILe:SEParator:DECimal DOT
SOURcel:LIST:DEXChange:AFILe:SEParator:COLumn COMMa

// *****
// Select source and destination path/directory
// *****
// Query available listfiles in default directory "/var/user"
SOURcel:LIST:CATalog?
// Response: "list1"
SOURcel:LIST:DEXChange:AFILe:SElect "/var/user/list1ASCII"
SOURcel:LIST:DEXChange:SElect "/var/user/list1"

// Export the list file data into the ASCII file
SOURcel:LIST:DEXChange:EXECute

// Query the available ASCII files with extension .csv
SOURcel:LIST:DEXChange:AFILe:CATalog?
// Response: "list1ASCII"

// *****
// Deactivate the list mode
SOURcel:FREQuency:MODE CW
// *****

```

- [List Mode Settings](#).....1007
- [List Mode File Operation](#)..... 1013
- [List Mode Data Exchange](#)..... 1015

### 13.18.11.1 List Mode Settings

With the following commands, you can create list mode data, select the trigger mode and determine the dwell time.

```

[:SOURce<hw>]:LIST:DWELI..... 1008
[:SOURce<hw>]:LIST:DWELI:MODE.....1008
[:SOURce<hw>]:LIST:DWELI:LIST..... 1009
[:SOURce<hw>]:LIST:DWELI:LIST:POINTs?... 1009
[:SOURce<hw>]:LIST:FREQuency.....1009

```

<code>[SOURce&lt;hw&gt;]:LIST:FREQuency:POINts?</code>	1010
<code>[SOURce&lt;hw&gt;]:LIST:INDex</code>	1010
<code>[SOURce&lt;hw&gt;]:LIST:INDex:START</code>	1010
<code>[SOURce&lt;hw&gt;]:LIST:INDex:STOP</code>	1010
<code>[SOURce&lt;hw&gt;]:LIST:LEARn</code>	1011
<code>[SOURce&lt;hw&gt;]:LIST:MODE</code>	1011
<code>[SOURce&lt;hw&gt;]:LIST:POWer</code>	1011
<code>[SOURce&lt;hw&gt;]:LIST:POWer:POINts?</code>	1012
<code>[SOURce&lt;hw&gt;]:LIST:RMODE</code>	1012
<code>[SOURce&lt;hw&gt;]:LIST:TRIGger:EXECute</code>	1013
<code>[SOURce&lt;hw&gt;]:LIST:TRIGger:SOURce</code>	1013

---

### `[SOURce<hw>]:LIST:DWELI <Dwell>`

Sets the global dwell time. The instrument generates the signal with the frequency / power value pairs of each list entry for that particular period.

See also [Significant Parameters and Functions](#).

#### Parameters:

<code>&lt;Dwell&gt;</code>	float
	Range: 7E-4 to 100
	Increment: 1E-4
	*RST: 15E-3
	Default unit: s

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Global Dwell Time"](#) on page 462

---

### `[SOURce<hw>]:LIST:DWELI:MODE <DwellMode>`

Selects the dwell time mode.

#### Parameters:

<code>&lt;DwellMode&gt;</code>	LIST   GLOBal
	<b>LIST</b>
	uses the dwell time, specified in the data table for each value pair individually.
	<b>GLOBal</b>
	uses a constant dwell time, set with command <code>[ : SOURce&lt;hw&gt; ] : LIST : DWELI</code> .
	*RST: GLOBal

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Dwell Time Mode"](#) on page 461



---

**[[:SOURce<hw>]:LIST:DWELI:LIST <Dwell>**

Enters the dwell time values in the selected list in  $\mu$ s.

**Parameters:**

<Dwell> <Dwell#1>{, <Dwell#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data. The list of numbers can be of any length, with the list entries separated by commas.

In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy. See also :

[FORMat \[ : DATA \]](#) on page 745 for more details.

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Edit List Mode Data"](#) on page 465

---

**[[:SOURce<hw>]:LIST:DWELI:LIST:POINTS?**

Queries the number (points) of dwell time entries in the selected list.

**Return values:**

<Points> integer

Range: 0 to INT\_MAX

\*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Query only

---

**[[:SOURce<hw>]:LIST:FREQUency <Frequency>**

Enters the frequency values in the selected list.

**Parameters:**

<Frequency> <Frequency#1>{, <Frequency#2>, ...} | block data

You can either enter the data as a list of numbers, or as binary block data.

The list of numbers can be of any length, with the list entries separated by commas.

In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy. See also :

[FORMat \[ : DATA \]](#) on page 745 for more details.

Range: 300 kHz to RFmax (RFmax depending on model)

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Edit List Mode Data"](#) on page 465

---

**[[:SOURce<hw>]:LIST:FREQUency:POINTs?**

Queries the number (points) of frequency entries in the selected list.

**Return values:**

<Points> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Query only

**[[:SOURce<hw>]:LIST:INDEX <Index>**

Sets the list index in [LIST:MODE STEP](#).

After the trigger signal, the instrument processes the frequency and level settings of the selected index.

**Parameters:**

<Index> integer  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Current Index"](#) on page 462

**[[:SOURce<hw>]:LIST:INDEX:START <Start>**

Sets the start index of the index range which defines a subgroup of frequency/level value pairs in the current list. Only the values in the set index range (`LIST:INDEX:START ... LIST:INDEX:STOP`) are processed in List mode.

**Parameters:**

<Start> integer  
 Range: 0 to list length  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["List Range In"](#) on page 463

**[[:SOURce<hw>]:LIST:INDEX:STOP <Stop>**

Sets the stop index of the index range which defines a subgroup of frequency/level value pairs in the current list. Only the values in the set index range (`LIST:INDEX:START ... LIST:INDEX:STOP`) are processed in List mode.

**Parameters:**

<Stop> integer  
 Range: 0 to list length  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["List Range In"](#) on page 463

**[:SOURce<hw>]:LIST:LEARn**

Learns the selected list to determine the hardware setting for all list entries. The results are saved with the list.

See also ["Learn List Mode Data - List processing mode"](#) on page 453.

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Event

**Manual operation:** See ["Learn List Mode Data..."](#) on page 463

**[:SOURce<hw>]:LIST:MODE <Mode>**

Sets the list mode, similar to `[ :SOURce<hw> ] :SWEp [ :FREQuency ] :MODE`. The instrument processes the list according to the selected mode and trigger source, see [LIST:TRIG:SOUR AUTO, SING or EXT](#).

**Parameters:**

<Mode> AUTO | STEP

**AUTO**

Each trigger event triggers a complete list cycle.

**STEP**

Each trigger event triggers only one step in the list processing cycle. The list is processed in ascending order. In this mode, you can select between [LIST:TRIG:SOUR SING](#) or [EXT](#).

\*RST: AUTO

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Mode"](#) on page 461

**[:SOURce<hw>]:LIST:POWer <Power>**

Enters the level values in the selected list. The number of level values must correspond to the number of frequency values. Existing data is overwritten.

**Parameters:**

<Power> <Power#1>{, <Power#2>, ...} | block data  
 You can either enter the data as a list of numbers, or as binary block data.  
 The list of numbers can be of any length, with the list entries separated by commas.  
 In binary block format, 8 (4) bytes are always interpreted as a floating-point number with double accuracy. See [:FORMat \[ :DATA\]](#) on page 745 for more details.  
 Range: Minimum level to Maximum level  
 Default unit: dBm

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Edit List Mode Data"](#) on page 465

**[ :SOURce<hw> ] :LIST:POWer:POINts?**

Queries the number (points) of level entries in the selected list.

**Return values:**

<Points> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Query only

**[ :SOURce<hw> ] :LIST:RMODe <RMode>**

Selects the run mode for processing the list.

**Parameters:**

<RMode> LEARned | LIVE  
**LEARned**  
 generates the signal by replaying the previously learned and stored data from the temporary memory.  
**LIVE**  
 generates the signal by processing the list directly.  
 \*RST: LEARned

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Run Mode"](#) on page 463

**[ :SOURce<hw> ] :LIST:TRIGger:EXECute**

Starts the processing of a list in list mode.

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Event

**Manual operation:** See ["Execute Single"](#) on page 461

**[ :SOURce<hw> ] :LIST:TRIGger:SOURce <Source>**

Selects the trigger source for processing lists.

The names of the parameters correspond to those in sweep mode. SCPI uses other names for the parameters; these names are also accepted by the instrument. The SCPI names should be used if compatibility is an important consideration. An overview of the various names is given in the following table:

R&S name	SCPI name	Command under manual control
AUTO	IMMediate	MODE AUTO
SINGle	BUS	MODE SINGLE or STEP
EXTernal	EXTernal	MODE EXT TRIG SINGLE or EXT TRIG STEP

**Parameters:**

<Source>

AUTO | IMMediate | SINGle | BUS | EXTernal

**AUTO|IMMediate**

The trigger is free-running, i.e. the trigger condition is fulfilled continuously. The selected list is restarted as soon as it is finished.

**SINGle|BUS**

The list is triggered by the GPIB command `[ :SOURce<hw> ] :LIST:TRIGger:EXECute`. The list is executed once.

**EXTernal**

The list is triggered externally and executed once.

\*RST: AUTO

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["Mode"](#) on page 461

**13.18.11.2 List Mode File Operation**

The following section covers basic commands to file handling in list mode.

<code>[:SOURce&lt;hw&gt;]:LIST:CATalog?</code> .....	1014
<code>[:SOURce&lt;hw&gt;]:LIST:DELeTe</code> .....	1014
<code>[:SOURce&lt;hw&gt;]:LIST:DELeTe:ALL</code> .....	1014
<code>[:SOURce&lt;hw&gt;]:LIST:FREE?</code> .....	1015
<code>[:SOURce&lt;hw&gt;]:LIST:RESet</code> .....	1015
<code>[:SOURce&lt;hw&gt;]:LIST:SElect</code> .....	1015

---

### `[:SOURce<hw>]:LIST:CATalog?`

Queries the available list files in the specified directory.

#### Return values:

<Catalog>                      string  
                                     List of list files \*.lsw, separated by commas

**Example:**                      See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:**                         Query only

**Manual operation:**        See ["List Mode Data..."](#) on page 463

---

### `[:SOURce<hw>]:LIST:DELeTe <Filename>`

Deletes the specified list.

#### Setting parameters:

<Filename>                      string

**Example:**                      `M MEM:CDIR "/var/user/temp/listmode"`  
                                     selects the directory for the list mode files.  
                                     `LIST:DEL "my_list"`  
                                     deletes the list my\_list, provided the directory and path are determined in advance.

**Usage:**                         Setting only

**Manual operation:**        See ["List Mode Data..."](#) on page 463

---

### `[:SOURce<hw>]:LIST:DELeTe:ALL`

Deletes all lists in the set directory.

**Note:** This command can only be executed, if no list file is selected. The list mode must be disabled (command `SOUR:FREQ:MODE CW` or `SWE`).

**Example:**                      `M MEM:CDIR "/var/user/temp/listmode"`  
                                     `FREQ:MODE SWE`  
                                     selects the directory for the list mode files.  
                                     `SOUR2:FREQ:MODE SWE`  
                                     deactivate the list mode for RF output in both paths and activate the sweep mode.  
                                     `LIST:DEL:ALL`  
                                     deletes all list mode files in the set directory.

**Usage:** Event

**Manual operation:** See ["List Mode Data..."](#) on page 463

#### **[[:SOURce<hw>]:LIST:FREE?**

Queries the amount of free memory (in bytes) for list mode lists.

**Return values:**

<Free> integer  
 Range: 0 to INT\_MAX  
 \*RST: 0

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Query only

#### **[[:SOURce<hw>]:LIST:RESet**

Skips to the beginning of the list.

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Usage:** Event

**Manual operation:** See ["Reset"](#) on page 461

#### **[[:SOURce<hw>]:LIST:SElect <Filename>**

Selects or creates a data list in list mode.

If the list with the selected name does not exist, a new list is created.

**Parameters:**

<Filename> string

**Example:** See [Example "Create an RF list and activate the list mode"](#) on page 1004.

**Manual operation:** See ["List Mode Data..."](#) on page 463

### 13.18.11.3 List Mode Data Exchange

With the following commands, you can configure lists in ASCII format and export or import them accordingly.

<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:AFILe:CATalog?</a> .....	1016
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:EXECute</a> .....	1016
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:AFILe:EXTension</a> .....	1016
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:AFILe:SElect</a> .....	1017
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:AFILe:SEParator:COLumn</a> .....	1017

<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:AFILe:SEParator:DECimal.....</a>	1017
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:MODE.....</a>	1018
<a href="#">[:SOURce&lt;hw&gt;]:LIST:DEXChange:SElect.....</a>	1018

---

### **[:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?**

Queries the available ASCII files for export or import of list mode data in the current or specified directory.

#### **Return values:**

<Catalog> string  
List of ASCII files \*.txt or \*.csv, separated by commas.

#### **Example:**

```
LIST:DEXC:MODE IMP
determines that ASCII files with frequency and level value pairs
are imported into list mode lists.
MMEM:CDIR "/var/user/temp/"
selects the directory for the ASCII files with frequency and level
value pairs.
LIST:DEXC:AFIL:EXT TXT
determines the extension *.txt for the query.
LIST:DEXC:AFIL:CAT?
queries the available files with extension *.txt.
Response: 'my_list,list'
the ASCII files my_list.txt and list.txt exist.
LIST:DEXC:AFIL:SEL "/var/user/temp/list.csv"
selects list.csv for import.
LIST:DEXC:SEL "/var/user/temp/list_imp"
determines the destination file list_imp.
LIST:DEXC:EXEC
imports the ASCII file data into the list file.
```

**Usage:** Query only

**Manual operation:** See ["Select ASCII Source / Destination"](#) on page 469

---

### **[:SOURce<hw>]:LIST:DEXChange:EXECute**

Executes the import or export of the selected list file, according to the previously set transfer direction with command [\[:SOURce<hw>\]:LIST:DEXChange:MODE](#)

**Example:** see [\[:SOURce<hw>\]:LIST:DEXChange:AFILe:CATalog?](#) on page 1016

**Usage:** Event

**Manual operation:** See ["Import / Export"](#) on page 469

---

### **[:SOURce<hw>]:LIST:DEXChange:AFILe:EXTension <Extension>**

Determines the extension of the ASCII file for import or export, or to query existing files.



**Parameters:**

<Extension>           TXT | CSV  
 \*RST:            TXT

**Example:**            see [:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?  
 on page 1016

**Manual operation:** See "ASCII File Settings" on page 468

**[:SOURce<hw>]:LIST:DEXChange:AFILe:SElect <Filename>**

Selects the ASCII file to be imported or exported.

**Parameters:**

<Filename>            string

**Example:**            see [:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?  
 on page 1016

**Manual operation:** See "Select ASCII Source / Destination" on page 469

**[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:COLumn <Column>**

Selects the separator between the frequency and level column of the ASCII table.

**Parameters:**

<Column>            TABulator | SEMicolon | COMMa | SPACe  
 \*RST:            COMMa

**Example:**

```
LIST:DEXC:MODE EXP
selects that the list is exported into an ASCII file.
LIST:DEXC:AFIL:SEL "/var/user/temp/list.csv"
determines ASCII file list.csv as destination for the list mode
list data.
LIST:DEXC:AFIL:SEP:COL TAB
defines a tabulator to separate the frequency and level values
pairs.
LIST:DEXC:AFIL:SEP:DEC DOT
selects the decimal separator dot.
LIST:DEXC:SEL "/var/user/temp/list_imp"
determines the source file list_imp for export into the ASCII
file list.csv.
LIST:DEXC:EXEC
exports the list file data into the ASCII file.
```

**Manual operation:** See "ASCII File Settings" on page 468

**[:SOURce<hw>]:LIST:DEXChange:AFILe:SEParator:DECimal <Decimal>**

Sets "." (decimal point) or "," (comma) as the decimal separator used in the ASCII data with floating-point numerals.

**Parameters:**

<Decimal>            DOT | COMMa  
 \*RST:            DOT

**Example:**

see [:SOURce<hw>]:LIST:DEXChange:AFILe:  
 SEParator:COLumn on page 1017

**Manual operation:** See "ASCII File Settings" on page 468

**[:SOURce<hw>]:LIST:DEXChange:MODE <Mode>**

Determines the import or export of a list. With the command [:SOURce<hw>]:LIST:DEXChange:SElect, you can specify the source or destination file.

**Parameters:**

<Mode>            IMPort | EXPort  
 \*RST:            IMPort

**Example:**

see [:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?  
 on page 1016

**Manual operation:** See "Mode " on page 468

**[:SOURce<hw>]:LIST:DEXChange:SElect <Filename>**

Selects the ASCII file for import or export, containing a list.

**Parameters:**

<Filename>            string

**Example:**

see [:SOURce<hw>]:LIST:DEXChange:AFILe:CATalog?  
 on page 1016

**Manual operation:** See "Select Source / Destination" on page 469

### 13.18.12 SOURce:NOISe Subsystem

The SOURce:NOISe subsystem contains the commands for setting the noise modulation signal. The noise generator is optional.

[:SOURce<hw>]:NOISe:BANDwidth BWIDth.....	1018
[:SOURce<hw>]:NOISe:BWIDth:STATe.....	1019
[:SOURce<hw>]:NOISe:DISTRibution.....	1019
[:SOURce<hw>]:NOISe:LEVel<ch>:RELative?.....	1019
[:SOURce<hw>]:NOISe:LEVel<ch>[:ABSolute]?.....	1020

**[:SOURce<hw>]:NOISe:BANDwidth|BWIDth <BWidth>**

Sets the noise level in the system bandwidth when bandwidth limitation is enabled.

You can set distinct bandwidths between 10 kHz and 10 MHz:

- 100 kHz steps (range 100 .. 1 MHz)

- 1 MHz (range 1 MHz .. 5 MHz)
- 5 MHz (5 MHz ... 10 MHz)

**Parameters:**

<BWidth> float  
 Range: 100E3 to 10E6  
 Increment: 100E3  
 \*RST: 100E3

**Example:**

NOIS:BWID:STAT ON  
 enables bandwidth limitation.  
 NOIS:BWID 1 MHz  
 sets the system bandwidth to 1 MHz.

**Manual operation:** See "[Bandwidth](#)" on page 484

**[:SOURce<hw>]:NOISe:BWIDth:STATe <State>**

Activates noise bandwidth limitation.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

NOIS:BWID:STAT ON  
 activates bandwidth limitation.

**Manual operation:** See "[Bandwidth](#)" on page 484

**[:SOURce<hw>]:NOISe:DISTRibution <Distribution>**

Sets the distribution of the noise power density.

**Parameters:**

<Distribution> GAUSs | EQUal  
 \*RST: GAUSs

**Example:**

NOIS:DIST GAUS  
 selects Gaussian distribution.

**Manual operation:** See "[Distribution](#)" on page 484

**[:SOURce<hw>]:NOISe:LEVel<ch>:RELative?**

Queries the level of the noise signal per Hz in the total bandwidth.

**Return values:**

<Relative> float  
 Range: -149.18 to -52.67  
 Increment: 0.1  
 \*RST: -69.84

- Example:** `NOIS:LEV:REL?`  
returns the noise level within the system bandwidth.
- Usage:** Query only
- Manual operation:** See "Noise Density" on page 484

#### `[SOURce<hw>]:NOISe:LEVel<ch>[:ABSolute]?`

Queries the level of the noise signal in the system bandwidth within the enabled bandwidth limitation.

**Return values:**

<Absolute> float  
\*RST: 3.84 MHz

- Example:** `NOIS:BWID:STAT ON`  
enables bandwidth limitation.  
`NOIS:BWID 10 MHz`  
sets a system bandwidth of 1 MHz.  
`NOIS:LEV:ABS?`  
returns the noise level within the bandwidth limitation.

- Usage:** Query only
- Manual operation:** See "Noise Level" on page 484

### 13.18.13 SOURce:PGEN Subsystem

The PGEN subsystem contains the commands for setting output of the pulse modulation signal.

<code>[SOURce&lt;hw&gt;]:PGENerator:OUTPut:POLarity</code> .....	1020
<code>[SOURce&lt;hw&gt;]:PGENerator:OUTPut[:STATe]</code> .....	1021
<code>[SOURce&lt;hw&gt;]:PGENerator:STATe</code> .....	1021

#### `[SOURce<hw>]:PGENerator:OUTPut:POLarity <Polarity>`

Sets the polarity of the pulse output signal.

**Parameters:**

<Polarity> NORMal | INVerted

**NORMal**  
Outputs the pulse signal during the pulse width, that means during the high state.

**INVerted**  
Inverts the pulse output signal polarity. The pulse output signal is suppressed during the pulse width, but provided during the low state.

\*RST: NORMal

**Example:** PGEN:OUTP:POL INV  
inverts the polarity.

**Manual operation:** See "Output Polarity" on page 494

**[[:SOURce<hw>]:PGENERator:OUTPUT[:STATe] <State>**

Activates the output of the pulse modulation signal.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** PGEN:OUTP ON  
activates pulse generator output.

**Manual operation:** See "Pulse Output State" on page 494

**[[:SOURce<hw>]:PGENERator:STATe <State>**

Enables the output of the video/sync signal..

The signal output and the pulse generator are automatically switched on with activation of pulse modulation, provided the pulse generator is used as modulation source. The signal output can be switched off subsequently.

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** PULM:SOUR INT  
selects the internal pulse generator as source for pulse modulation.  
PULM:STAT ON  
activates pulse modulation. The pulse generator and the output of the signals are automatically activated in addition.  
PGEN:STAT OFF  
deactivates the output of the pulse signal by the pulse generator. The pulse modulation of the RF carrier must be activated with command SOURce:PULM:STATe.

### 13.18.14 SOURce:PHASe Subsystem

This subsystem contains the commands for adjusting the phase of the RF output signal relative to a reference signal of the same frequency.

**Example: Programming Example**

```
// *****
// Reset the instrument to start from an initial state
*RST; *CLS

// change the phase relative to the current phase
SOURce1:PHASe 2 DEG
// adopt the setting as the current phase
SOURce1:PHASe:REFerence
// *****
```

The following commands are available:

```
[ :SOURce<hw>]:PHASe..... 1022
[ :SOURce<hw>]:PHASe:REFerence..... 1022
```

**[ :SOURce<hw>]:PHASe <Phase>**

Specifies the phase variation relative to the current phase. The variation is specified in DEGRees.

**Parameters:**

<Phase>	float
	Range: -720 to 720
	Increment: 0.1
	*RST: 0

**Example:** See [Example "Programming Example"](#) on page 1022.

**Manual operation:** See ["Delta Phase"](#) on page 420

**[ :SOURce<hw>]:PHASe:REFerence**

Assigns the value that is specified with command [ :SOURce<hw>]:PHASe as the reference phase.

**Example:** See [Example "Programming Example"](#) on page 1022.

**Usage:** Event

**Manual operation:** See ["Reset Delta Phase Display"](#) on page 420

**13.18.15 SOURce:POWer Subsystem**

The SOURce:POWer subsystem contains the commands for setting the output level, level control and level correction of the RF signal.

Other units can also be used instead of dBm:

- by entering the unit directly after the numerical value (example :POW 0.5V)
- by changing the DEFault unit in the UNIT system (see the command :UNIT:POWer).

<code>[:SOURce&lt;hw&gt;]:POWer:ALC:DAMPlifier</code> .....	1023
<code>[:SOURce&lt;hw&gt;]:POWer:ALC:DSEnsitivity</code> .....	1023
<code>[:SOURce&lt;hw&gt;]:POWer:ALC:OMODE</code> .....	1024
<code>[:SOURce&lt;hw&gt;]:POWer:ALC:SEARCh</code> .....	1024
<code>[:SOURce&lt;hw&gt;]:POWer:ALC:SLEVel</code> .....	1024
<code>[:SOURce&lt;hw&gt;]:POWer:ALC:SONCe</code> .....	1025
<code>[:SOURce&lt;hw&gt;]:POWer:ALC[:STATe]</code> .....	1025
<code>[:SOURce]:POWer:ATTenuation</code> .....	1025
<code>[:SOURce&lt;hw&gt;]:POWer:ATTenuation:DIgital</code> .....	1026
<code>[:SOURce&lt;hw&gt;]:POWer:ATTenuation:RFOff:MODE</code> .....	1026
<code>[:SOURce&lt;hw&gt;]:POWer:EMF:STATe</code> .....	1026
<code>[:SOURce&lt;hw&gt;]:POWer:LBEHaviour</code> .....	1027
<code>[:SOURce&lt;hw&gt;]:POWer:LIMit[:AMPLitude]</code> .....	1027
<code>[:SOURce&lt;hw&gt;]:POWer:LMODe</code> .....	1027
<code>[:SOURce&lt;hw&gt;]:POWer:MANual</code> .....	1028
<code>[:SOURce&lt;hw&gt;]:POWer:MODE</code> .....	1029
<code>[:SOURce&lt;hw&gt;]:POWer:PEP?</code> .....	1029
<code>[:SOURce&lt;hw&gt;]:POWer:POWer</code> .....	1029
<code>[:SOURce&lt;hw&gt;]:POWer:STARt</code> .....	1030
<code>[:SOURce&lt;hw&gt;]:POWer:STEP:MODE</code> .....	1030
<code>[:SOURce&lt;hw&gt;]:POWer:STEP[:INCRement]</code> .....	1031
<code>[:SOURce&lt;hw&gt;]:POWer:STOP</code> .....	1031
<code>[:SOURce&lt;hw&gt;]:POWer[:LEVel][:IMMediate]:OFFSet</code> .....	1032
<code>[:SOURce&lt;hw&gt;]:POWer[:LEVel][:IMMediate]:RCL</code> .....	1032
<code>[:SOURce&lt;hw&gt;]:POWer[:LEVel][:IMMediate][:AMPLitude]</code> .....	1033

---

#### `[:SOURce<hw>]:POWer:ALC:DAMPlifier <Amplifier>`

Selects the driver amplifier switching state.

#### Parameters:

<code>&lt;Amplifier&gt;</code>	OFF   ON   AUTO   FIX   ONMG
	<b>AUTO</b> automatically switches the attenuator.
	<b>ON OFF</b> switches on or off the driver amplifier.
	<b>FIXed</b> fixes the last setting.
	<b>ONMG</b> supplies maximum level at the output.
	*RST:        AUTO

**Example:**            `POW:ALC:DAMP AUTO`  
provides automatic switching of the attenuator.

**Manual operation:** See "[Driver Amplifier](#)" on page 504

---

#### `[:SOURce<hw>]:POWer:ALC:DSEnsitivity <Sensitivity>`

Sets the sensitivity of the ALC detector.

**Parameters:**

<Sensitivity> AUTO | LOW | MEDium | HIGH | FIXed

**AUTO**

automatically selects the optimum sensitivity.

**LOW|MEDium|HIGH**

sets either low, medium or high sensitivity.

**FIXed**

fixes the internal level detector.

\*RST: AUTO

**Example:**

POW:ALC:DSEN HIGH

sets the maximum sensitivity of the power detector.

**Manual operation:** See "[Detector Sensitivity](#)" on page 504

**[:SOURce<hw>]:POWER:ALC:OMODE <OffMode>**

Sets the level control mode. It is activated when automatic level control is switched off (ALC Off).

**Parameters:**

<OffMode> SHOLd

Temporarily activates level control when the level or frequency changes ("ALC Off Sample & Hold").

\*RST: SHOLd

**Example:**

POW:ALC OFF

deactivates automatic level control at the RF output.

POW:ALC:OMOD SHOL

briefly activates level control when changing frequency or level.

**[:SOURce<hw>]:POWER:ALC:SEARch <Search>**

Recalculates the instrument internal settings optimized for the current level. Not required for automatic modes.

**Parameters:**

<Search> ON

\*RST: ON

**Example:**

POW:ALC:SEAR ON

executes redadjustment.

**[:SOURce<hw>]:POWER:ALC:SLEVel <SampLevel>**

Sets the sample level of automatic level control (ALC).

**Parameters:**

<SampLevel> FULL | MINimum | ATTenuated

\*RST: FULL



**Example:** `POW:ALC:SLEV MIN`  
sets the automatic level control to minimum value.

**Manual operation:** See "[Sample Level](#)" on page 504

#### **[:SOURce<hw>]:POWer:ALC:SONCe**

Temporarily activates level control for correction purposes.

**Example:** `POW:ALC OFF`  
deactivates automatic level control at the RF output.  
`POW:ALC:SONC`  
executes level control (once).

**Usage:** Event

**Manual operation:** See "[Readjust](#)" on page 418

#### **[:SOURce<hw>]:POWer:ALC[:STATe] <State>**

Activates automatic level control selectable in the appropriate mode.

**Parameters:**

<State>                    `AUTO | OFFTable | ON | 1 | OFF | 0 | ONSample | ONTable`

**AUTO**  
automatically adjusts the output level to the operating conditions.

**ON**  
Activates internal level control permanently.

**OFF**  
Deactivates internal level control, **Sample & Hold** mode is active.

**OFFTable**  
controls the level by means of attenuation values of the internal ALC table.

**ONTable**  
starts with the attenuation setting from the table and continues with automatic level control.

**ONSample**  
starts the internal level control with the first change.

\*RST:                    `AUTO`

**Example:** `POW:ALC ON`  
activates internal level control.

**Manual operation:** See "[State](#)" on page 503

#### **[:SOURce]:POWer:ATTenuation <Attenuation>**

Sets the attenuation value of the RF signal in manual mode, set with command :  
`OUTPut<hw>:AMODe` on page 753.

**Parameters:**

<Attenuation> integer  
 Range: depends on options  
 Increment: 4|5|6  
 \*RST: 0

**Example:**

SOUR:POW:ATT 20dB  
 sets the power attenuation to 20 dB.

**Manual operation:** See "[Attenuation](#)" on page 501

**[:SOURce<hw>]:POWER:ATTenuation:DIGital <AttDigital>**

Sets a relative attenuation value for the baseband signal.

**Parameters:**

<AttDigital> float  
 Range: -3.522 to 80  
 Increment: 1E-3  
 \*RST: 0

**Manual operation:** See "[Digital Attenuation](#)" on page 417

**[:SOURce<hw>]:POWER:ATTenuation:RFOF:MODE <Mode>**

Selects the state the attenuator is to assume if the RF signal is switched off.

In default setting *MAXim*, the electronic step attenuator switches to maximum possible attenuation when RF is off. *FIXed* freezes the current setting to keep the output impedance constant during RF off.

**Parameters:**

<Mode> UNCHanged | FATTenuation  
 \*RST: FATTenuation

**Example:**

SOUR:POW:ATT:RFOF:MODE MAX  
 sets the attenuation to maximum when RF is switched off.

**Manual operation:** See "[RF OFF Mode](#)" on page 501

**[:SOURce<hw>]:POWER:EMF:STATe <State>**

Displays the signal level as voltage of the EMF. The displayed value represents the voltage over a 50 Ohm load.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

POW:EMF:STAT 1  
 activates voltage level display.

**Manual operation:** See "[Display Level as Voltage of EMF](#)" on page 525

---

**[:SOURce<hw>]:POWER:LBEHaviour <Behaviour>**

Selects the level behavior at the RF output over time.

**Parameters:**

<Behaviour> AUTO | UNINterrupted | MONotone | CVSWr | CPHase | USER

**CWSWr**

Constant VSWR

**CPHase**

Constant Phase

\*RST: AUTO

**Example:**

POW:LBEH AUTO

automatically sets the output level.

**Manual operation:** See "[Setting Characteristics](#)" on page 418

---

**[:SOURce<hw>]:POWER:LIMit[:AMPLitude] <Amplitude>**

Limits the maximum RF output level in CW and sweep mode. It does not influence the "Level" display or the response to the `[ :SOURce<hw> ] :POWER [ :LEVel ] [ :IMMediate ] [ :AMPLitude ]` query command.

This parameter is not affected by an instrument preset (PRESET key), \*RST or the "Save/Recall" function. However, factory preset resets this parameter to the upper limit.

**Parameters:**

<Amplitude> float

The value range is given in the data sheet.

Increment: 0.01

\*RST: 30

Default unit: dBm

**Example:**

POW:LIM 10

limits the RF level to maximum +10 dBm.

**Manual operation:** See "[Limit](#)" on page 419

---

**[:SOURce<hw>]:POWER:LMODe <LevMode>**

Sets the RF level mode.

**Parameters:**

<LevMode>                    NORMal | LOWNoise | LOWDistortion

**NORMal**

Supplies the RF signal with the standard power level of the instrument.

**LOWNoise**

Supplies a very low noise sinewave signal.

**LOWDistortion**

Supplies a very pure sinewave signal.

\*RST:            NORMal

**Example:**

POW:LMODE LOWD

sets the LOWDistortion mode. The instrument reduces distortions of the RF signal to a minimum.

**Manual operation:** See "[Mode](#)" on page 417

**[ :SOURce<hw>]:POWer:MANual <Manual>**

Sets the level for the next sweep step in manual sweep step mode (see [SWE:POW:MODE MAN](#)).

Each sweep step is triggered by a separate POW:MAN command.

**Note:**

You can select any level value between minimum and maximum. This range is defined with the commands [ :SOURce<hw>]:POWer:START and [ :SOURce<hw>]:POWer:STOP. It is affected by a level offset [ :SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet according to the formula:

Minimum level + OFFSet ... Maximum level + OFFSet

**Parameters:**

<Manual>                    float

Determines the level for the next power sweep step.

Range:            Minimum level to Maximum level

Increment:    0.01

Default unit: dBm

**Example:**

SWE:POW:MODE MAN

sets manual sweep mode for RF output.

POW:MAN -5 dBm

sets -5 dBm RF level for the next step.

POW:MODE SWE

sets the sweep mode for RF output.

POW:MAN -5.5 dBm

triggers the next sweep step with a level of -5.5 dBm.

**Manual operation:** See "[Current Level](#)" on page 458

**[ :SOURce<hw>]:POWer:MODE <Mode>**

Selects the operating mode of the instrument to set the output level.

**Parameters:**

<Mode>

CW | FIXed | SWEep

**CW|FIXed**

Operates at a constant level.

CW and FIXed are synonyms. To set the output level value, use the command [ :SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude].

**SWEep**

Operates in power sweep mode.

Set the range and current level with the commands [ :SOURce<hw>]:POWer:START, [ :SOURce<hw>]:POWer:STOP and [ :SOURce<hw>]:POWer:MANual.

\*RST: CW

**Example:**

POW:MODE SWE

sets the sweep mode. The commands SOURce:POW:START; STOP; MANual are effective.

**Manual operation:** See "State - RF Level Sweep " on page 455

**[ :SOURce<hw>]:POWer:PEP?**

Queries the PEP (Peak Envelope Power) of digital modulation or digital standards at the RF output. This value corresponds to the level specification, displayed in the status bar (header).

**Return values:**

<Pep>

float

**Example:**

POW:PEP?

Response: "4"

the PEP value of digital modulation is 4 dBm at the RF output.

**Usage:**

Query only

**[ :SOURce<hw>]:POWer:POWer <Power>**

Sets the level at the RF output connector.

This value does not consider a specified offset. The command [ :SOURce<hw>]:POWer[:LEVel][:IMMediate][:AMPLitude] sets the level of the "Level" display, that means the level containing offset. See also [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420 for information in detail.

**Parameters:**

<Power> float  
 Determines the level at the RF output.  
 Range: Minimum level to Maximum level  
 Increment: 0.01  
 Default unit: dBm

**Example:**

POW:POW 15  
 sets the RF level at output to 15 dBm.

**Manual operation:** See "[Amplitude](#)" on page 416

**[ :SOURce<hw>]:POWer:STARt <Start>**

Sets the RF start level in sweep mode.

**Note:** You can select any level within the setting range. This range is defined using the commands `[ :SOURce<hw>]:POWer:STARt` and `[ :SOURce<hw>]:POWer:STOP`. It is affected by a level offset `[ :SOURce<hw>]:POWer[:LEVel][:IMMediate]:OFFSet` according to the formula:

Minimum level + OFFSet ... Maximum level + OFFSet

**Parameters:**

<Start> float  
 Sets the start level value of the setting range.  
 Range: Minimum level to Maximum level  
 \*RST: -30  
 Default unit: dBm

**Example:**

POW:STAR -20 dBm

**Manual operation:** See "[Start Level / Stop Level](#)" on page 457

**[ :SOURce<hw>]:POWer:STEP:MODE <Mode>**

Defines the type of step width to vary the RF output power step-by-step with the commands [POW UP](#), or [POW DOWN](#). You can define the step mode for each path separately.

**Parameters:**

<Mode> DECimal | USER  
**DECimal**  
 increases or decreases the level in steps of ten.  
**USER**  
 increases or decreases the level in increments, determined with the command `[ :SOURce<hw>]:POWer:STEP[:INCRement]`.  
 \*RST: DECimal

**Example:** `POW:STEP:MODE USER`  
`POW:STEP 2`  
 activates the step width for level variation in 2 dB steps.

**Manual operation:** See "[Variation Step](#)" on page 415

#### **[ :SOURce<hw>]:POWER:STEP[:INCRement] <Increment>**

Specifies the step width in the appropriate path for [POW:STEP:MODE USER](#).

To adjust the level step-by-step with this increment value, use the command [POW UP](#), or [POW DOWN](#).

**Note:** The command also sets "Variation Step" in the manual control, that means the user-defined step width for setting the level with the rotary knob or the UP/DOWN arrow keys.

#### **Parameters:**

<Increment> float  
 Range: 0 to 100  
 Increment: 0.01  
 \*RST: 1  
 Default unit: dB

**Example:** `POW:STEP 2`  
 sets the step width for entering the RF level to 2 dB.

**Manual operation:** See "[Variation Step](#)" on page 415

#### **[ :SOURce<hw>]:POWER:STOP <Stop>**

Sets the RF stop level in sweep mode.

#### **Note:**

You can select any level within the setting range. This range is defined using the commands [\[:SOURce<hw>\]:POWER:START](#) and [\[:SOURce<hw>\]:POWER:STOP](#). It is affected by a level offset [\[:SOURce<hw>\]:POWER\[:LEVel\]\[:IMMEDIATE\]:OFFSet](#) is included according to the formula:

Minimum level + OFFSet ... Maximum level + OFFSet

#### **Parameters:**

<Stop> float  
 Determines the stop level of the setting range.  
 Range: Minimum level to Maximum level  
 \*RST: -10  
 Default unit: dBm

**Example:** `POW:STOP 3`  
 sets the level sweep stop level to 3 dBm for RF output.

**Manual operation:** See "[Start Level / Stop Level](#)" on page 457

**[ :SOURce<hw>]:POWER[:LEVel][:IMMediate]:OFFSet <Offset>**

Sets the level offset (constant value) of a downstream attenuator/amplifier. If specified, the actual RF output power does not change, but rather the value given with [ :SOURce<hw>]:POWER[:LEVel] [:IMMediate] [:AMPLitude], according to the following formula:

$$\text{POWER} = \text{RF output level} + \text{Power offset}$$

Find additional information on the displayed and actual RF output level in [Chapter 8.4.4.1, "Displayed RF Frequency and Level Values with Downstream Instruments"](#), on page 420.

**Note:**

The level offset also affects the RF level sweep.

The unit of the level offset is always given in dB, linear units (V, W, etc.) are not configurable.

**Parameters:**

<Offset> float  
 Range: -100 to 100  
 Increment: 0.01  
 \*RST: 0

**Example:**

POW:OFFS 10  
 sets the RF level offset to 10 dB

**Manual operation:** See ["Offset"](#) on page 419

**[ :SOURce<hw>]:POWER[:LEVel][:IMMediate]:RCL <Rcl>**

Determines whether the current level is retained or whether the stored level setting is adopted when an instrument configuration is loaded.

\*RST does not affect this setting.

The setting is valid for both paths. If a suffix is specified, it is ignored.

**Parameters:**

<Rcl> INCLude | EXCLude  
**INCLude**  
 Takes the current level when an instrument configuration is loaded.  
**EXCLude**  
 Retains the current level when an instrument configuration is loaded.  
 \*RST: INCLude

**Example:**

POW:RCL INCL  
 takes the level value from an instrument configuration loaded with command \*RCL.

**Manual operation:** See ["Exclude Level"](#) on page 584



---

**[[:SOURce<hw>]:POWER[:LEVel][:IMMediate]][:AMPLitude] <Amplitude>**

Sets the RF level applied to the DUT.

**Notes:**

If specified, a level offset `[[:SOURce<hw>]:POWER[:LEVel][:IMMediate]:OFFSet]` is included according to the formula:

Minimum level + OFFSet ... Maximum level + OFFSet

In addition to numerical values, you can increase or decrease the values step by step with the commands `UP` and `DOWN`, with the step width defined with `[[:SOURce<hw>]:POWER:STEP[:INCRement]]`.

**Parameters:**

<Amplitude> float  
 Determines the RF output level.  
 Range: Minimum level to Maximum level  
 \*RST: -30  
 Default unit: dBm

**Example:** `POW 15`  
 sets the RF level to 15 dBm.

**Manual operation:** See "Amplitude" on page 416

### 13.18.16 SOURce:ROSCillator Subsystem

The `SOURce:ROSCillator` subsystem contains the commands for setting the external and internal reference frequency.



The commands of this subsystem are not affected by an instrument reset (\*RST on page 720).

---

<code>[[:SOURce]:ROSCillator:EXTernal:FREQUency</code> .....	1033
<code>[[:SOURce]:ROSCillator:EXTernal:FREQUency:VARiable</code> .....	1034
<code>[[:SOURce]:ROSCillator:EXTernal:RFOF[:STATe]</code> .....	1034
<code>[[:SOURce]:ROSCillator:EXTernal:SBANDwidth</code> .....	1034
<code>[[:SOURce]:ROSCillator:OUTPut:FREQUency:MODE</code> .....	1035
<code>[[:SOURce]:ROSCillator:OUTPut:FREQUency:MODE</code> .....	1035
<code>[[:SOURce]:ROSCillator:SOURce</code> .....	1035
<code>[[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue</code> .....	1036
<code>[[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]</code> .....	1036

---

**[[:SOURce]:ROSCillator:EXTernal:FREQUency <Frequency>**

Sets the frequency of the external reference.

**Parameters:**

<Frequency> 10MHZ | 5MHZ | 13MHZ  
 \*RST: 10MHZ

**Example:**

ROSC:EXT:FREQ 10MHZ

**Manual operation:** See ["External Reference Frequency"](#) on page 426

**[:SOURce]:ROSCillator:EXTernal:FREQuency:VARiable** <Frequency>

Specifies the user-defined external reference frequency.

**Parameters:**

<Frequency> float  
 Range: 1E6 to 100E6  
 Increment: 0.1  
 \*RST: 1E7

**Example:**

ROSC:EXT:FREQ VAR  
 ROSC:EXT:FREQ:VAR 20MHZ  
 sets the user-defined external reference frequency to 20 MHz.

**Manual operation:** See ["Variable Reference Frequency"](#) on page 427

**[:SOURce]:ROSCillator:EXTernal:RFOF[:STATe]** <State>

Determines that the RF output is turned off when the external reference signal is selected, but missing.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

ROSC:SOUR EXT  
 ROSC:EXT:RFOF ON  
 selects the external source and enables that the RF output turns off automatically when the external reference signal is missing.

**Manual operation:** See ["Deactivate RF Output \(if external reference is missing\)"](#) on page 426

**[:SOURce]:ROSCillator:EXTernal:SBANDwidth** <SBandwidth>

Selects the synchronization bandwidth for the external reference signal.

**Parameters:**

&lt;SBandwidth&gt; WIDE | NARRow

**NARRow**

The synchronization bandwidth is a few Hz (with option SMW-B22) and approximately 20 Hz (without option SMW-B22).

**WIDE**

The synchronization bandwidth is a 100 (with option SMW-B22) and approximately 750 Hz (without option SMW-B22).

**Example:**

ROSC:SOUR EXT

ROSC:EXT:FREQ 5 MHz

selects the external source and informs the instrument that the external reference has a frequency of 5 MHz.

ROSC:EXT:SBAN WID

selects wideband setting for synchronization bandwidth.

**Manual operation:** See "[Synchronization Bandwidth](#)" on page 427

[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE &lt;OutpFreqMode&gt;

Selects the mode for the determination and output of the reference frequency.

**Parameters:**

&lt;OutpFreqMode&gt; DER10M | SAME

\*RST: DER10M

**Example:**

ROSC:OUTP:FREQ:MODE DER10M

derives 10 MHz from the external input reference frequency for output.

**Manual operation:** See "[Reference Frequency Output](#)" on page 427

[:SOURce]:ROSCillator:OUTPut:FREQuency:MODE &lt;OutpFreqMode&gt;

Selects the mode for the determination and output of the reference frequency.

**Parameters:**

&lt;OutpFreqMode&gt; DER10M | SAME

\*RST: DER10M

**Example:**

ROSC:OUTP:FREQ:MODE DER10M

derives 10 MHz from the external input reference frequency for output.

**Manual operation:** See "[Reference Frequency Output](#)" on page 427

[:SOURce]:ROSCillator:SOURce &lt;Source&gt;

Selects between internal or external reference frequency.

**Parameters:**

<Source>           INTernal | EXTernal  
 \*RST:            INTernal

**Example:**

```
ROSC:SOUR EXT
ROSC:EXT:FREQ 5 MHz
```

selects the external source with 5 MHz frequency.

**Manual operation:** See "[Source](#)" on page 426

**[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue** <Value>

Specifies the frequency correction value (adjustment value).

**Parameters:**

<Value>           integer  
 \*RST:            0

**Example:**

```
ROSC:ADJ:VAL 1400
```

sets the adjustment value to 1400.

**Manual operation:** See "[Adjustment DAC Value](#)" on page 428

**[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]** <State>

Determines whether the calibrated (OFF) or a user-defined (ON) adjustment value is used for fine adjustment of the frequency. If turned on, the instrument is no longer in the calibrated state. However, the calibration value is not changed and the instrument resumes the calibrated state after switching the Adjustment State to Off.

**Parameters:**

<State>           0 | 1 | OFF | ON  
 \*RST:            0

**Example:**

```
ROSC:SOUR INT
ROSC:ADJ ON
ROSC:ADJ:VAL 1400
```

selects the internal source and activates the use of a user-defined adjustment value of 1400.

**Manual operation:** See "[Adjustment Active](#)" on page 428

### 13.18.17 SOURce:SWEEp Subsystem

The `SOURce:SWEEp` subsystem contains the commands for configuring RF sweep signals.



- The keyword [:FREQUENCY] can be omitted, then the commands are SCPI-compliant.
- To activate a RF sweep mode, use the following commands:
  - RF frequency sweep: SOURce:FREQUency:MODE SWEEp (SOURce:FREQUency:MODE CW (off))
  - RF level sweep: SOURce:POWer:MODE SWEEp (SOURce:POWer:MODE CW (off))
- All sweeps, including the LF sweep, can be set independently of each other.
- For detailed information on the sweep modes and the triggering, see [Chapter 8.7.1, "Signal Generating and Triggering in the Sweep and List Modes"](#), on page 439

#### Example: Setup an RF frequency or power sweep

The following example shows a command sequence to setup an RF frequency sweep, triggered by the execute command. For an RF power sweep replace FREQUENCY in the SWEEp commands with POWer. Exceptions are the power spacing (defined with LINear only) and the power step width (defined with LOGarithmic only).



It is recommended that you switch off the "Display Update" for optimum sweep performance especially with short dwell times.

```
// *****
// Reset the instrument to start from an initial state
// Switch off display update to improve performance
// Set the sweep mode (first two commands) and the sweep range
// Select linear spacing
// Select the waveform shape for the frequency sweep
// *****
*RST; *CLS
SYSTem:DISPlay:UPDate OFF
TRIGger1:FSWep:SOURce SINGLE
SOURce1:SWEEp:FREQUency:MODE AUTO
SOURce1:FREQUency:SPAN 300 MHz
SOURce1:FREQUency:CENTer 200 MHz
// Alternatively use
// SOURce1:FREQUency:START 50 MHz
// SOURce1:FREQUency:STOP 350 MHz
SOURce1:SWEEp:FREQUency:SPACing LINear
SOURce1:SWEEp:FREQUency:SHAPE SAWTooth

// *****
// Activate change to start frequency while waiting for next trigger
// *****
// Prerequisites: sweep mode single and sweep waveform sawtooth.
SOURce1:SWEEp:FREQUency:RETRace 1
```

```

// Alternatively reset all sweeps to their initial value
SOURcel:SWEep:RESet:ALL

// *****
// Set the step width and dwell time.
// *****
SOURcel:SWEep:FREQuency:STEP:LINear 1 MHz
// Alternatively set the number of steps, then the sweep step width is
// set automatically
SOURcel:SWEep:FREQuency:POINTs 301
SOURcel:SWEep:FREQuency:DWELl 500 ms
// With logarithmic spacing select the step width as follows
// (steps of 10 percent of the previous frequency in each instance)
SOURcel:SWEep:FREQuency:SPACing LOG
SOURcel:SWEep:FREQuency:STEP:LOGarithmic 10PCT

// *****
// Activate the sweep.
// Trigger the sweep (depending on the set mode) and query the status.
// *****
SOURcel:FREQuency:MODE SWEep
// Perform a one-off RF frequency sweep
SOURcel:SWEep:FREQuency:EXECute
SOURcel:SWEep:FREQuency:RUNning?
// Response "1": the frequency sweep is running.

// *****
// For manual step RF sweep use the following commands
// *****
*RST; *CLS
// Activate manual step RF sweep
SOURcel:SWEep:FREQuency:MODE MANual
// Activate the RF frequency sweep.
SOURcel:FREQuency:MODE SWEep
// Activate RF Output1.
Output1:STATe 1
// Input the frequency manually for each step
SOURcel:FREQuency:MANual 200 MHz
SOURcel:FREQuency:MANual 201 MHz
// Alternatively use the UP or DOWN commands with the set step width.
SOURcel:SWEep:FREQuency:STEP:LINear 1 MHz
SOURcel:FREQuency:MANual UP

```

<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:DWELl.....</a>	1039
<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:EXECute.....</a>	1039
<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:MODE.....</a>	1039
<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:POINTs.....</a>	1040
<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:RETRace.....</a>	1040
<a href="#">[:SOURce&lt;hw&gt;]:SWEep:POWER:RUNning?.....</a>	1041

<code>[:SOURce&lt;hw&gt;]:SWEep:POWer:SHApe</code> .....	1041
<code>[:SOURce&lt;hw&gt;]:SWEep:POWer:SPACing:MODE?</code> .....	1041
<code>[:SOURce&lt;hw&gt;]:SWEep:POWer:STEP[:LOGarithmic]</code> .....	1041
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:DWELI</code> .....	1042
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:EXECute</code> .....	1042
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:MODE</code> .....	1042
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:POINTS</code> .....	1043
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:RETRace</code> .....	1043
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:RUNNing?</code> .....	1044
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:SHApe</code> .....	1044
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:SPACing</code> .....	1044
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:STEP:LOGarithmic</code> .....	1045
<code>[:SOURce&lt;hw&gt;]:SWEep[:FREQUency]:STEP[:LINear]</code> .....	1045
<code>[:SOURce&lt;hw&gt;]:SWEep:RESet[:ALL]</code> .....	1045

---

### `[:SOURce<hw>]:SWEep:POWer:DWELI <Dwell>`

Sets the dwell time for a level sweep step.

#### Parameters:

`<Dwell>` float  
 Range: 1E-3 to 100  
 Increment: 100E-6  
 \*RST: 15E-3  
 Default unit: s

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Dwell Time"](#) on page 459

---

### `[:SOURce<hw>]:SWEep:POWer:EXECute`

Executes a level sweep at the RF output.

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Usage:** Event

**Manual operation:** See ["Execute Single Sweep"](#) on page 456

---

### `[:SOURce<hw>]:SWEep:POWer:MODE <Mode>`

Sets the cycle mode for the level sweep.

**Parameters:**

&lt;Mode&gt; AUTO | MANual | STEP

**AUTO**

Each trigger triggers exactly one complete sweep.

**MANual**The trigger system is not active. You can trigger every step individually with the command `[ :SOURce<hw> ] :POWER:MANual`.The level value increases at each step by the value that you define with `[ :SOURce<hw> ] :POWER:STEP [ :INCRement ]`.Values directly entered with the command `[ :SOURce<hw> ] :POWER:MANual` are not taken into account.**STEP**Each trigger triggers one sweep step only. The level increases by the value entered with `[ :SOURce<hw> ] :POWER:STEP [ :INCRement ]`.

\*RST: AUTO

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.**Manual operation:** See ["Mode"](#) on page 456**[ :SOURce<hw> ] :SWEep:POWER:POINTS <Points>**

Sets the number of steps within the RF level sweep range.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.**Parameters:**

&lt;Points&gt; integer

Range: 2 to Max

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.**[ :SOURce<hw> ] :SWEep:POWER:RETRace <State>**

Activates that the signal changes to the start level value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

**Parameters:**

&lt;State&gt; 0 | 1 | OFF | ON

\*RST: 0

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.**Manual operation:** See ["Retrace"](#) on page 459



---

**[[:SOURce<hw>]:SWEep:POWer:RUNNING?**

Queries the current state of the RF level sweep mode.

**Return values:**

<State> 0 | 1 | OFF | ON

**Usage:** Query only

See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

---

**[[:SOURce<hw>]:SWEep:POWer:SHAPE <Shape>**

Determines the waveform shape for a level sweep sequence.

See also [Chapter 8.7.2.2, "Sweep Signal Shapes"](#), on page 449.

**Parameters:**

<Shape> SAWTooth | TRIangle  
\*RST: SAWTooth

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Shape"](#) on page 458

---

**[[:SOURce<hw>]:SWEep:POWer:SPACing:MODE?**

Queries the level sweep spacing. The sweep spacing for level sweeps is always linear.

**Return values:**

<Mode> LINear  
\*RST: LINear

**Example:** SWE:POW:SPAC:MODE?  
queries the sweep spacing for a level sweep at RF output.  
Result: "LIN"  
linear spacing

**Usage:** Query only

---

**[[:SOURce<hw>]:SWEep:POWer:STEP[:LOGarithmic] <Logarithmic>**

Sets a logarithmically determined step width for the RF level sweep.

The level is increased by a logarithmically calculated fraction of the current level. The level step width is measured in decibels, that means you must enter the unit dB with the command.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

**Parameters:**

<Logarithmic> float  
 Range: 0.01 to 139 dB  
 Increment: 0.01  
 \*RST: 1

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Step"](#) on page 459

**[ :SOURce<hw>]:SWEep[:FREQUENCY]:DWEll <Dwell>**

Sets the dwell time for a frequency sweep step.

**Parameters:**

<Dwell> float  
 Range: 2E-3 to 100  
 Increment: 100E-6  
 \*RST: 15E-3  
 Default unit: s

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Dwell Time"](#) on page 459

**[ :SOURce<hw>]:SWEep[:FREQUENCY]:EXECute**

Executes an RF frequency sweep.

The command performs a single sweep and is therefore only effective in manual sweep mode.

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Usage:** Event

**Manual operation:** See ["Execute Single Sweep"](#) on page 456

**[ :SOURce<hw>]:SWEep[:FREQUENCY]:MODE <Mode>**

Sets the cycle mode for the frequency sweep.

**Parameters:**

<Mode> AUTO | MANual | STEP

**AUTO**

Each trigger event triggers exactly one complete sweep.

**MANual**

The trigger system is not active. You can trigger every step individually by input of the frequencies with the command [ : SOURce<hw> ] : FREQuency : MANual.

**STEP**

Each trigger event triggers one sweep step. The frequency increases by the value entered with [ : SOURce<hw> ] : SWEep [ : FREQuency ] : STEP [ : LINear ] (linear spacing) or [ : SOURce<hw> ] : SWEep [ : FREQuency ] : STEP : LOGarithmic (logarithmic spacing).

\*RST: AUTO

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Mode"](#) on page 456

**[ : SOURce<hw> ] : SWEep [ : FREQuency ] : POINts <Points>**

Sets the number of steps within the RF frequency sweep range.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

Two separate POINts values are used for linear or logarithmic sweep spacing (LIN | LOG [ : SOURce<hw> ] : SWEep [ : FREQuency ] : SPACing). The command always affects the currently set sweep spacing.

**Parameters:**

<Points> integer  
Range: 2 to Max

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**[ : SOURce<hw> ] : SWEep [ : FREQuency ] : RETRace <State>**

Activates that the signal changes to the start frequency value while it is waiting for the next trigger event.

You can enable this feature, when you are working with sawtooth shapes in sweep mode "Single" or "External Single".

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Retrace"](#) on page 459

---

### **[ :SOURce<hw>]:SWEep[:FREQuency]:RUNNING?**

Queries the current state of the RF frequency sweep mode.

**Return values:**

<State> 0 | 1 | OFF | ON

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Usage:** Query only

---

### **[ :SOURce<hw>]:SWEep[:FREQuency]:SHAPE <Shape>**

Determines the waveform shape for a frequency sweep sequence.

See also [Chapter 8.7.2.2, "Sweep Signal Shapes"](#), on page 449.

**Parameters:**

<Shape> SAWTooth | TRIangle  
\*RST: SAWTooth

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Shape"](#) on page 458

---

### **[ :SOURce<hw>]:SWEep[:FREQuency]:SPACing <Spacing>**

Selects the mode for the calculation of the frequency intervals, with which the current frequency at each step is increased or decreased.

The keyword [ :FREQuency ] can be omitted; then the command is SCPI-compliant.

**Parameters:**

<Spacing> LINear | LOGarithmic

**LINear**

Sets a fixed frequency value as step width and adds it to the current frequency. The linear step width is entered in Hz, see [ :SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear].

**LOGarithmic**

Sets a constant fraction of the current frequency as step width and adds it to the current frequency. The logarithmic step width is entered in %, see [ :SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic.

\*RST: LINear

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Spacing"](#) on page 458

---

**[ :SOURce<hw>]:SWEep[:FREQuency]:STEP:LOGarithmic <Logarithmic>**

Sets a logarithmically determined step width for the RF frequency sweep. The value is added at each sweep step to the current frequency. The logarithmic frequency step width is given in percent, that means you must enter the unit `PCT` with the command.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

**Parameters:**

<Logarithmic> float  
 Range: 0.01 to 100  
 Increment: 1E-3  
 \*RST: 1

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Step Lin/Log"](#) on page 459

---

**[ :SOURce<hw>]:SWEep[:FREQuency]:STEP[:LINear] <Linear>**

Sets the step width for linear sweeps.

See also [Chapter 8.7.2.1, "Correlating Parameters in Sweep Mode"](#), on page 447.

The keywords `[:FREQuency]` and `[:LINear]` can be omitted. The command is then SCPI-compliant.

**Parameters:**

<Linear> float  
 Range: 0.001 Hz to (STOP - START)  
 Increment: 0.01

**Example:** See [Example "Setup an RF frequency or power sweep"](#) on page 1037.

**Manual operation:** See ["Step Lin/Log"](#) on page 459

---

**[ :SOURce<hw>]:SWEep:RESet[:ALL]**

Resets all active sweeps to the starting point.

**Usage:** Event

**Manual operation:** See ["Reset Sweep"](#) on page 457

---

## 13.19 SYSTem Subsystem

The `SYSTem` subsystem contains a series of commands for general functions which do not directly affect signal generation.

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---

### :SYSTem:ERRor:ALL?

Queries the error/event queue for all unread items and removes them from the queue. The response is a comma separated list of error number and a short description of the error in FIFO order.

Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

#### Return values:

<All> string  
 List of: Error/event\_number,"Error/event\_description>[:Device-dependent info]"  
 If the queue is empty, the response is 0, "No error"

#### Example:

SYST:ERR:ALL?  
 queries all entries in the error queue.  
 Response: 0, 'no error'  
 No errors have occurred since the error queue was last read out.

**Usage:** Query only

**Manual operation:** See "[Clear History](#)" on page 1099

---

### :SYSTem:ERRor:CODE:ALL?

Queries all entries in the error queue and then deletes them. Only the error numbers are returned and not the entire error text.

#### Return values:

<All> string  
**0**  
 "No error", i.e. the error queue is empty  
**positive value**  
 Positive error numbers denote device-specific errors  
**negative value**  
 Negative error numbers denote error messages defined by SCPI.

#### Example:

SYST:ERR:CODE:ALL  
 queries all entries in the error queue.  
 Response: 0  
 no errors have occurred since the error queue was last read out.

**Usage:** Query only

---

**:SYSTem:ERRor:CODE[:NEXT]?**

Queries the oldest entry in the error queue and then deletes it. Only the error number is returned and not the entire error text.

**Return values:**

<Next> string  
**0**  
 "No error", i.e. the error queue is empty  
**positive value**  
 Positive error numbers denote device-specific errors  
**negative value**  
 Negative error numbers denote error messages defined by SCPI.

**Example:**

SYST:ERR:CODE  
 queries the oldest entry in the error queue.  
 Response: 0  
 No errors have occurred since the error queue was last read out.

**Usage:** Query only

---

**:SYSTem:ERRor:COUNT?**

Queries the number of entries in the error queue. If the error queue is empty, '0' is returned.

**Return values:**

<Count> string

**Example:**

SYST:ERR:COUN  
 queries the number of entries in the error queue.  
 Response: 1  
 One error has occurred since the error queue was last read out.

**Usage:** Query only

---

**:SYSTem:ERRor[:NEXT]?**

Queries the error/event queue for the oldest item and removes it from the queue. The response consists of an error number and a short description of the error.

Positive error numbers are instrument-dependent. Negative error numbers are reserved by the SCPI standard.

**Return values:**

<Next> string  
 Error/event\_number,"Error/event\_description>[:Device-dependent info]"  
 If the queue is empty, the response is 0, "No error"



- Example:**           SYST:ERR?  
queries the oldest entry in the error queue.  
Response: 0, 'no error'  
No errors have occurred since the error queue was last read out.
- Usage:**             Query only
- Manual operation:** See "[Show History / Show Static](#)" on page 1099
- 

**:SYSTem:SERRor?**

Returns a list of all errors existing at the time when the query is started. This list corresponds to the display on the info page under manual control.

**Return values:**

<StaticErrors>       string

**Example:**

SYST:SErr?  
queries all errors existing in the error queue.  
Response: -221, "Settings conflict", 153, "Input voltage out of range"  
the two returned errors have occurred since the error queue was last queried.

**Usage:**             Query only

---

**:SYSTem:ULOCK <Mode>**

Locks or unlocks the user interface of the instrument.

**Parameters:**

<Mode>                ENABLEd | DONLy | DISabled | TOFF | VNConly

**ENABLEd**

Unlocks the display, the touchscreen and all controls for the manual operation.

**DONLy**

Locks the touchscreen and controls for the manual operation of the instrument. The display shows the current settings.

**VNConly**

Locks the touchscreen and controls for the manual operation, and enables remote operation over VNC. The display shows the current settings.

**TOFF**

Locks the touchscreen for the manual operation of the instrument. The display shows the current settings.

**DISabled**

Locks the display, the touchscreen and all controls for the manual operation.

\*RST:                ENABLEd

**Example:** `SYST:ULOC ON`  
activates the user interface lock.

**Manual operation:** See "[User Interface](#)" on page 637

---

**:SYSTem:DLOCK <DispLockStat>**

Display **LOCK** disables the manual operation via the display, or enables it again (OFF).  
The command disables also the front panel keyboard of the instrument including the LOCAL key.

**Parameters:**

<DispLockStat> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** `SYST:DLOC ON`  
activates the display lock. The instrument cannot be operated via the display until it has been enabled with `SYST:DLOC OFF`.

**Manual operation:** See "[User Interface](#)" on page 637

---

**:SYSTem:KLOCK <State>**

Keyboard **LOCK** disables the front panel keyboard of the instrument including the LOCAL key, or enables it again (OFF).

**Parameters:**

<State> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** `SYST:KLOC ON`  
locks the front panel and external controls. To enable the controls, set `SYST:KLOC OFF`.

**Manual operation:** See "[User Interface](#)" on page 637

---

**:SYSTem:COMMunicate:GPIB:LTERminator <LTerminator>**

Sets the terminator recognition for remote control via GPIB interface.

**Parameters:**

<LTerminator> STANdard | EOI

**EOI**

Recognizes an LF (Line Feed) as the terminator only when it is sent with the line message EOI (End of Line). This setting is recommended particularly for binary block transmissions, as binary blocks may coincidentally contain a character with value LF (Line Feed), although it is not determined as a terminator.

**STANdard**

Recognizes an LF (Line Feed) as the terminator regardless of whether it is sent with or without EOI.

\*RST: STANdard

**Example:**

SYST:COMM:GPIB:LTER EOI

only a character which is sent simultaneously with the line message EOI is accepted as the terminator.

**:SYSTem:COMMunicate:GPIB:RESource?**

Queries the visa resource string for remote control via the GPIB interface.

To change the GPIB address, use the command `:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess`.

**Return values:**

<Resource> string

**Example:**

SYST:COMM:GPIB:RES?

queries the VISA resource string.

Response: "GPIB::28::INSTR"

**Usage:**

Query only

**:SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <Address>**

Sets the GPIB address.

**Parameters:**

<Address> integer

Range: 0 to 30

\*RST: 28

**Example:**

SYST:COMM:GPIB:ADDR 28

sets GPIB address.

**:SYSTem:COMMunicate:HISLip:RESource?**

Queries the VISA resource string . This string is used for remote control of the instrument with HiSLIP protocol.

**Return values:**

<Resource> string

**Example:**

SYST:COMM:HISL:NETW:RES?

Response: "TCPIP::10.0.2.15::hislip0::INSTR"

**Usage:**

Query only

**:SYSTEM:COMMunicate:NETWork:IPADdress <IpAddress>**

Sets the IP address.

**Parameters:**

<IpAddress> string

Range: 0.0.0.0. to ff.ff.ff.ff

**Example:**

SYST:COMM:NETW:IPAD 10.0.2.15

sets an IP address for the instrument.

**Manual operation:** See "[IP Address](#)" on page 663

**:SYSTEM:COMMunicate:NETWork:IPADdress:MODE <Mode>**

Selects manual or automatic setting of the IP address.

**Parameters:**

<Mode> AUTO | STATic

\*RST: AUTO

**Example:**

SYST:COMM:NETW:IPAD:MODE AUTO

the IP address is assigned automatically (DHCP).

**Manual operation:** See "[Address Mode](#)" on page 663

**:SYSTEM:COMMunicate:NETWork:MACaddress? <MacAddress>**

Queries the MAC address of the network adapter.

**Return values:**

<MacAddress> string

**Example:**

SYST:COMM:NETW:MAC?

queries the MAC address.

**Usage:**

Query only

**Manual operation:** See "[MAC Address](#)" on page 663

**:SYSTEM:COMMunicate:NETWork:RESource?**

Queries the visa resource string for Ethernet instruments.

**Return values:**

<Resource> string

**Example:**            `SYST:COMM:NETW:RES?`  
 queries the VISA resource string.  
 Response: "TCPIP::10.0.2.15::inst0::INSTR"

**Usage:**            Query only

#### **:SYSTEM:COMMunicate:NETWork:REStart**

Restarts the network.

**Example:**            `SYST:COMM:NETW:REST`  
 terminates the network connection and sets it up again.

**Usage:**            Event

**Manual operation:** See "[Restart Network](#)" on page 665

#### **:SYSTEM:COMMunicate:NETWork:STATus?**

Queries the network configuration state.

**Return values:**  
 <State>            0 | 1 | OFF | ON

**Example:**            `SYST:COMM:NETW:STAT?`  
 Response: "1"  
 the network is active.

**Usage:**            Query only

**Manual operation:** See "[Network Status](#)" on page 662

#### **:SYSTEM:COMMunicate:NETWork[:COMMON]:DOMain <Domain>**

Determines the primary suffix of the network domain.

**Parameters:**  
 <Domain>            string

**Example:**            `SYST:COMM:NETW:COMM:DOM 'ABC.DE'`  
 enters the domain of the network.

**Manual operation:** See "[DNS Suffix](#)" on page 664

#### **:SYSTEM:COMMunicate:NETWork[:COMMON]:HOSTname <Hostname>**

Sets an individual hostname for the R&S SMW.

**Note:** It is recommended that you do not change the hostname in order to avoid problems with the network connection. However, if you change the hostname be sure to use an unique name.

The hostname is a protected parameter. To change it, first disable protection level 1 with command `:SYSTEM:PROTECT<ch>[:STATE]`.

**Parameters:**

<Hostname> string

**Example:**

SYST:PROT1 OFF, 123456  
deactivates protection level 1.  
SYST:COMM:NETW:HOST 'SIGGEN'  
assigns an individual computer name to the instrument.

**Manual operation:** See "[Hostname](#)" on page 662

**:SYSTem:COMMunicate:NETWork[:COMMON]:WORKgroup <Workgroup>**

Sets an individual workgroup name for the instrument.

**Parameters:**

<Workgroup> string

**Example:**

SYST:COMM:NETW:COMM:WORK 'TEST\_09'  
enters the workgroup name TEST\_09.

**Manual operation:** See "[Workgroup](#)" on page 663

**:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS <DNS>**

Determines the net DNS server to resolve the name.

**Parameters:**

<DNS> string

**Example:**

SYST:COMM:NETW:IPAD:DNS 123.456.0.1

**Manual operation:** See "[DNS Server](#)" on page 664

**:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway <Gateway>**

Sets the IP address of the default gateway.

**Parameters:**

<Gateway> string

Range: 0.0.0.0 to ff.ff.ff.ff

**Example:**

SYST:COMM:NETW:GAT 1.2.3.4  
enters the IP address of the default gateway.

**Manual operation:** See "[Default Gateway](#)" on page 664

**:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>**

Sets the subnet mask.

**Parameters:**

<Mask> string

**Example:** `SYST:COMM:NETW:SUBN:MASK 255.255.255.0`  
enters the subnet mask.

**Manual operation:** See ["Subnet Mask"](#) on page 664

**:SYSTem:COMMunicate:SERial:BAUD <Baud>**

Defines the baudrate for the serial remote control interface.

**Parameters:**

<Baud> 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200  
\*RST: 115200

**Example:** `SYST:COMM:SER:BAUD 115200`  
enters the baudrate 115200.

**Manual operation:** See ["Baud Rate"](#) on page 666

**:SYSTem:COMMunicate:SERial:PARity <Parity>**

Enters the parity for the serial remote control interface.

**Parameters:**

<Parity> NONE | ODD | EVEN  
\*RST: NONE

**Example:** `SYST:COMM:SER:PAR NONE`  
selects parity NONE.

**Manual operation:** See ["Parity"](#) on page 667

**:SYSTem:COMMunicate:SERial:RESource?**

Queries the visa resource string for the serial remote control interface. This string is used for remote control of the instrument.

**Return values:**

<Resource> string

**Example:** `SYST:COMM:SER:RES`  
queries the VISA resource string.  
Response: "ASRL1::INSTR"

**Usage:** Query only

**:SYSTem:COMMunicate:SERial:SBITs <SBits>**

Defines the number of stop bits for the serial remote control interface.

**Parameters:**

<SBits> 1 | 2  
\*RST: 1

**Example:**                `SYST:COMM:SER:SBIT 2`  
selects 2 stop bits.

**Manual operation:** See "[Stop Bits](#)" on page 667

#### **:SYSTEM:COMMunicate:SOCKet:RESource?**

Queries the visa resource string for remote control via LAN interface, using TCP/IP socket protocol.

**Return values:**  
<Resource>                string

**Example:**                `SYST:COMM:SOCK:RES?`  
queries the VISA resource string for remote control with TCP/IP socket protocol.  
Response: "`TCPIP::10.10.02.15::5025::SOCKET`"

**Usage:**                    Query only

#### **:SYSTEM:COMMunicate:USB:RESource?**

Queries the visa resource string for remote control via the USB interface.

**Return values:**  
<Resource>                string

**Example:**                `SYST:COMM:USB:RES?`  
queries the VISA resource string for remote control via the USB interface.  
Response: "`USB::0x0AAD::0x0092::0::INSTR`"

**Usage:**                    Query only

#### **:SYSTEM:HCLear**

Clears the history.

**Example:**                `SYST:HCL`  
Deletes the history entries.

**Usage:**                    Event

**Manual operation:** See "[Clear History](#)" on page 1099

#### **:SYSTEM:IDENtification <Identification>**

Selects the mode to determine the "IDN String" and the "OPT String" for the instrument, selected with command `:SYSTEM:LANGuage`.

**Note:** While working in a emulation mode, the R&S SMW specific command set is disabled, that is, the SCPI command `SYST:IDEN` will be discarded.



**Parameters:**

<Identification> AUTO | USER

**AUTO**

automatically determines the "IDN String" and the "OPT String".

**USER**

Enables the selection of user definable "IDN String" and "OPT String".

\*RST: AUTO

**Example:**

SYST:IDEN AUTO

automatically assigns the OPT and IDN strings according to the selected instrument language.

**Manual operation:** See "Mode" on page 668

**:SYSTem:LANGUage** <Language>

Sets the remote control command set.

**Parameters:**

<Language> string

**Example:**

SYSTem:LANGUage "SCPI"

selects SCPI command set.

**Manual operation:** See "Language" on page 667

**:SYSTem:INFormation:SCPI** <InfoString>

Inserts system information in recorded SCPI command lists, for example information on a missing command.

**Parameters:**

<InfoString> string

**Example:**

SYST:INF:SCPI "missing command"

enters the information into a recorded SCPI command list.

**:SYSTem:PROTect<ch>[:STATe]** <State>[, <Key>]

Activates and deactivates the specified protection level.

**Suffix:**

<ch>

Indicates the protection level.

There are several protection levels which disable specific service functions (authorized personnel of R&S Service Departments only).

**Parameters:**

<State> select

\*RST: 1

**Setting parameters:****<Key>** integer

The respective functions are disabled when the protection level is activated. No password is required for activation of a level. A password must be entered to deactivate the protection level. The password for the first level is 123456. This protection level can be used to unlock internal adjustments.

**Example:**

SYST:PROT1 ON

activates protection level 1. Internal adjustments are only possible after deactivating the lock-out.

SYST:PROT1 OFF,123456

deactivates protection level 1. Internal adjustments are enabled again.

**Manual operation:** See "[Protection Level/Password](#)" on page 635**:SYSTem:SPECification? <Id>**

Retrieves data sheet information.

**Setting parameters:****<Id>** string

The query is performed with the "Id" string, that identifies the name of the entry in the data sheet.

**Return values:****<ValList>** float

The query returns the specified and, optional, the typical value of the parameter, separated by a comma.

**Example:**

SYST:SPEC? "ID\_RF\_LEVEL\_MAX\_GENERAL\_DBM"

**Usage:**

Query only

**:SYSTem:SPECification:IDENTification:CATalog?**

Queries the parameter IDs available in the data sheet.

**Return values:****<IdList>** string

The query returns a list of parameter IdDs in a comma-separated string.

**Example:**

SYST:SPEC:IDEN:CAT?

Response:

"ID\_RF\_FREQ\_SETTING\_TIME\_MS,

ID\_RF\_FREQ\_SETTING\_TIME\_LISTMODE\_MS,..."

returns all parameter IDs.

**Usage:**

Query only

---

**:SYSTem:SPECification:PARAmeter? <Id>, <Parameter>**

Retrieves data sheet information to a specific parameter.

**Setting parameters:**

<Id>	string	The query is performed with the "Id" string, that identifies the name of the entry in the data sheet.
<Parameter>	float	Returns an additional value the result (ValList) depends on.

**Return values:**

<ValList>	float	The query returns the specified value and, optional, the typical value of the parameter, separated by a comma.
-----------	-------	--

**Example:**           SYST:SPEC:PAR? "ID\_RF\_FREQ\_SETTING\_TIME\_MS",0.1  
 SYST:SPEC:PAR? "ID\_RF\_LEVEL\_MAX\_GENERAL\_DBM",  
 0.1

**Usage:**           Query only

---

**:SYSTem:SPECification:VERSion <Version>**

Queries the data sheet version stored in the instrument.

**Parameters:**

<Version>           string

**Example:**           SYST:SPEC:VERS?  
 Response: "01.00"  
 edition V01.00 of the data sheet is stored in the instrument.

---

**:SYSTem:SPECification:VERSion:CATalog?**

Queries all data sheet versions stored in the instrument.

**Return values:**

<VersCatalog>      string

**Example:**           SYST:SPEC:VERS:CAT?  
 Response: "01.90,01.02,01.01,01.00"  
 three versions of the data sheet are stored in the instrument.

**Usage:**           Query only

---

**:SYSTem:SPECification:VERSion:FACTory?**

Queries the data sheet version of the factory setting.

**Return values:**

<Version>           string

**Example:**            `SYST:SPEC:VERS>FACT?`  
                           Response: "00.53"  
                           the data sheet version from the factory is V00.53.

**Usage:**             Query only

#### **:SYSTEM:STARtup:COMPLete?**

Queries if the startup of the instrument is completed.

**Return values:**

<Complete>            0 | 1 | OFF | ON  
 \*RST:                 0

**Example:**            `SYST:STAR:COMP?`  
                           Response: 1  
                           the startup of the instrument is completed.

**Usage:**             Query only

#### **:SYSTEM:DATE <Year>, <Month>, <Day>**

Queries or sets the date for the instrument-internal calendar.

This parameter is protected, in order to prevent accidental changes.

It can be accessed with protection level 1, see [:SYSTEM:PROTECT<ch>\[:STATE\]](#) on page 1057.

**Parameters:**

<Year>                 <year>,<month>,<day>  
 <Month>               integer  
                           Range:        1 to 12  
 <Day>                 integer  
                           Range:        1 to 31

**Example:**            `SYST:DATE?`  
                           Response: "2011,05,01"  
                           it is the 1st of May, 2011.

**Manual operation:** See ["Date"](#) on page 1078

#### **:SYSTEM:TIME <Hour>, <Minute>, <Second>**

Queries or sets the time for the instrument-internal clock.

The parameter is protected, in order to prevent accidental changes.

It can be accessed with protection level 1, see [:SYSTEM:PROTECT<ch>\[:STATE\]](#) on page 1057.

**Parameters:**

<Hour>	0...23,0...59,0...59
	Range: 0 to 23
<Minute>	integer
	Range: 0 to 59
<Second>	integer
	Range: 0 to 59

**Example:**

SYSTem:TIME?  
Response: "12, 0, 0" it is precisely 12 pm.

**Manual operation:** See "Time" on page 1078

**:SYSTem:TIME:ZONE <TimeZone>**

Sets the timezone. You can query the list of the available timezones with :SYSTem:TIME:ZONE:CATalog?.

**Parameters:**

<TimeZone> string

**Manual operation:** See "Timezone" on page 1079

**:SYSTem:TIME:ZONE:CATalog?**

Queries the list of available timezones.

**Return values:**

<Catalog>

**Usage:** Query only

**Manual operation:** See "Timezone" on page 1079

**:SYSTem:UPTime?**

Queries the up time of the operating system.

**Return values:**

<UpTime> <ddd.hh:mm:ss>

**Example:**

SYSTem:UPTime?  
Response: "0.08:11:00"

**Usage:** Query only

**:SYSTem:BIOS:VERSion?**

Queries the BIOS version of the instrument.

**Return values:**

<Version> string

**Example:**           SYST:BIOS:VERS?  
                  queries the BIOS version.  
                  Response: 123456

**Usage:**            Query only

---

#### **:SYSTem:VERSion?**

Queries the SCPI version the instrument's command set complies with.

**Return values:**

<Version>           string

**Example:**           SYST:VERS  
                  queries the SCPI version.  
                  Response: "1996"  
                  The instrument complies with the SCPI version from 1996.

**Usage:**            Query only

---

#### **:SYSTem:OSYStem?**

Queries the operating system of the instrument.

**Return values:**

<OperSystem>       string

**Example:**           SYSTem:OSYStem?  
                  Response: "Linux"

**Usage:**            Query only

---

#### **:SYSTem:MMEMory:PATH:USER?**

Queries the user directory, that means the directory the R&S SMW stores user files on.

**Return values:**

<PathUser>           string

**Example:**           SYSTem:MMEMory:PATH:USER?  
                  Response: "/var/user/"

**Usage:**            Query only

---

#### **:SYSTem:DFPR?**

Queries the device footprint of the instrument. The retrieved information is in machine-readable form suitable for automatic further processing.

If you are obtaining technical support as described in [Chapter 15.6, "Obtaining Technical Support"](#), on page 1100, this information is automatically retrieved and is part of the created \*.tar.gz support file.

**Return values:**

<DeviceFootprint> string  
Information on the instrument type and details on the installed FW version, hardware and software options.

**Example:** :SYSTem:DFPR?

**Usage:** Query only

**:SYSTem:REBoot**

Reboots the instrument including the operating system.

**Usage:** Event

**:SYSTem:REStArt**

Restarts the instrument without restarting the operating system.

**Usage:** Event

**:SYSTem:SHUTdown**

Shuts down the instrument.

**Usage:** Event

## 13.20 STATus Subsystem

This system contains the commands for the status reporting system. See also [Chapter B.1.5, "Status Reporting System"](#), on page 1128 for detailed information.

\*RST on page 720 has no effect on the status registers.

**Value ranges**

- Queries return the current value of the respective register, which permits a check of the device status.  
Return values: A decimal value in the range 0 to 32767 ( $=2^{15}-1$ )
- The configuration commands set the respective register thus determining which status changes of the R&S SMW cause the status registers to be changed.  
Setting values: A decimal value in the range 0 to 32767 ( $=2^{15}-1$ )

:STATus:OPERation:CONDition.....	1064
:STATus:OPERation:ENABle.....	1064
:STATus:OPERation[:EVENT].	1064
:STATus:OPERation:NTRansition.....	1064
:STATus:OPERation:PTRansition.....	1065
:STATus:PRESet.....	1065
:STATus:QUEStionable:CONDition.....	1065

:STATus:QUEStionable:ENABle.....	1065
:STATus:QUEStionable[:EVENT].	1066
:STATus:QUEStionable:NTRansition.....	1066
:STATus:QUEStionable:PTRansition.....	1066
:STATus:QUEue[:NEXT]?	1067

---

#### **:STATus:OPERation:CONDition <Condition>**

Sets the content of the CONDition part of the STATus:OPERation register. This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out because it indicates the current hardware status.

##### **Parameters:**

<Condition>                    string

##### **Example:**

```
:STATus:OPERation:CONDition?
queries the Status:Operation:Condition register.
```

---

#### **:STATus:OPERation:ENABle <Enable>**

Sets the bits of the ENABle part of the STATus:OPERation register. This setting determines which events of the Status-Event part are forwarded to the sum bit in the status byte. These events can be used for a service request.

##### **Parameters:**

<Enable>                        string

##### **Example:**

```
:STAT:OPER:ENAB 32767
all events are forwarded to the sum bit of the status byte.
```

---

#### **:STATus:OPERation[:EVENT] <Event>**

Queries the content of the EVENT part of the STATus:OPERation register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENT part is deleted after being read out.

##### **Parameters:**

<Event>                         string

##### **Example:**

```
:STAT:OPER:EVENT?
queries the STATus:OPERation:EVENT register.
```

---

#### **:STATus:OPERation:NTRansition <Ntransition>**

Sets the bits of the NTRansition part of the STATus:OPERation register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENT part of the register. The disappearance of an event in the hardware is thus registered, for example the end of an adjustment.

##### **Parameters:**

<Ntransition>                   string



**Example:** `:STAT:OPER:NTR 0`  
 a transition from 1 to 0 in the condition part of the Status:Operation register does not cause an entry to be made in the EVENT part.

#### **:STATus:OPERation:PTRansition <Ptransition>**

Sets the bits of the PTRansition part of the STATus:OPERation register. If a bit is set, a transition from 0 to 1 in the condition part causes an entry to be made in the EVENT part of the register. A new event in the hardware is thus registered, for example the start of an adjustment.

**Parameters:**

<Ptransition> string

**Example:** `:STAT:OPER:PTR 32767`  
 all transitions from 0 to 1 in the condition part of the Status:Operation register cause an entry to be made in the EVENT part.

#### **:STATus:PRESet <Preset>**

Resets the status registers. All PTRansition parts are set to FFFFh (32767), i.e. all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, i.e. 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, i.e. all events in these registers are not passed on.

**Parameters:**

<Preset> string

**Example:** `STAT:PRES`  
 resets the status registers.

#### **:STATus:QUEStionable:CONDition <Condition>**

Queries the content of the CONDition part of the STATus:QUEStionable register. This part contains information on the action currently being performed in the instrument. The content is not deleted after being read out since it indicates the current hardware status.

**Parameters:**

<Condition> string

**Example:** `:STATus:QUEStionable:CONDition?`  
 queries the Status:Questionable:Condition register.

#### **:STATus:QUEStionable:ENABLE <Enable>**

Sets the bits of the ENABLE part of the STATus:QUEStionable register. This setting determines which events of the Status-Event part are enabled for the sum bit in the status byte. These events can be used for a service request.

**Parameters:**

<Enable> string

**Example:**

STAT:OPER:ENAB 1

problems when performing an adjustment cause an entry to be made in the sum bit.

**:STATus:QUEStionable[:EVENT] <Event>**

Queries the content of the EVENT part of the STATus:QUEStionable register. This part contains information on the actions performed in the instrument since the last readout. The content of the EVENT part is deleted after being read out.

**Parameters:**

<Event> string

**Example:**

STAT:QUES:EVEN?

queries the Status:Questionable:Event register.

**:STATus:QUEStionable:NTRansition <Ntransition>**

Sets the bits of the NTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENT part of the register.

**Parameters:**

<Ntransition> string

**Example:**

STAT:OPER:NTR 0

a transition from 1 to 0 in the condition part of the Status:Questionable register does not cause an entry to be made in the EVENT part

**:STATus:QUEStionable:PTRansition <PTransition>**

Sets the bits of the PTRansition part of the STATus:QUEStionable register. If a bit is set, a transition from 1 to 0 in the condition part causes an entry to be made in the EVENT part of the register.

**Parameters:**

<PTransition> string

**Example:**

:STAT:OPER:PTR 32767

all transitions from 0 to 1 in the condition part of the Status:Questionable register cause an entry to be made in the EVENT part

**:STATus:QUEue[:NEXT]?**

Queries the oldest entry in the error queue and then deletes it. Positive error numbers denote device-specific errors, and negative error numbers denote error messages defined by SCPI. If the error queue is empty, 0 ("No error") is returned.

The command is identical to `:SYSTem:ERRor[:NEXT]?` on page 1048.

**Return values:**

<Next>                    string

**Example:**

`:STATus:QUEue?`

queries the oldest entry in the error queue.

Response: 0, 'no error'

no errors have occurred since the error queue was last read out

**Usage:**

Query only

## 13.21 TEST Subsystem

The `TEST` subsystem contains the commands for performing test routines directly at the hardware assemblies.

The selftest responses with a 0 if the test is performed successfully, otherwise a value other than 0 is returned. None of the commands of this system has a `*RST` value.

### NOTICE

#### Improper use may destroy the assembly!

The respective hardware assembly responds directly to the `:TEST:DIRect` command; any safety mechanisms are bypassed. The command is used for servicing purposes and should not be applied by the user.

<code>:TEST:BASEband?</code> .....	1067
<code>:TEST:BB:BNC:CONNection?</code> .....	1068
<code>:TEST:BB:BNC:DESTination</code> .....	1068
<code>:TEST:BB:BNC:LOG?</code> .....	1068
<code>:TEST:BB:BNC:SOURce</code> .....	1069
<code>:TEST:BB:GENerator:ARBITrary</code> .....	1069
<code>:TEST:BB:GENerator:FREQuency</code> .....	1069
<code>:TEST:BB:GENerator:GAIN</code> .....	1069
<code>:TEST:BB:GENerator:SOURce</code> .....	1070
<code>:TEST:BB:GENerator:STATe</code> .....	1070
<code>:TEST&lt;hw&gt;:DIRect:BLOCK:READ?</code> .....	1070
<code>:TEST&lt;hw&gt;:DIRect:BLOCK:WRITe</code> .....	1071

**:TEST:BASEband?**

Queries the result of the baseband selftest.

**Return values:**

<TestBbError> 0 | 1 | RUNning | STOPped

**Example:**

TEST:BBAS?  
queries the baseband test result.  
Response: 0 The test succeeded.

**Usage:**

Query only

**Manual operation:** See "[Execute Baseband Selftest](#)" on page 1091

**:TEST:BB:BNC:CONNECTION?**

Queries the BNC connection test result.

**Return values:**

<TestStatus> 0 | 1 | RUNning | STOPped

**Example:**

TEST:BB:BNC:CONN?  
queries the connection test result.  
Response: RUN The test is still running.

**Usage:**

Query only

**Manual operation:** See "[Execute BNC Connection Test](#)" on page 1088

**:TEST:BB:BNC:DESTINATION <BncDestination>**

Selects the BNC connection test destination.

**Parameters:**

<BncDestination> AUTO | USER1 | USER2 | USER3 | USER4 | USER5 | USER6 |  
TRGA | TRGB | C1TMC1 | C1TM2 | C1TM3 | C2TMC4 |  
C2TM5 | C2TM6 | F1TMC1 | F1TM2 | F1TM3 | F2TMC4 |  
F2TM5 | F2TM6 | F3TMC1 | F3TM2 | F3TM3 | F4TMC4 |  
F4TM5 | F4TM6  
\*RST: USER2

**Example:**

TEST:BB:BNC:SOUR TRGA  
tests the instrument trigger connector of path A. The connector  
is located on the rear of the instrument.

**Manual operation:** See "[Destination](#)" on page 1088

**:TEST:BB:BNC:LOG?**

Queries the log message reported during the BNC connector test.

**Return values:**

<Log> string

**Example:**

TEST:BB:BNC:LOG?  
queries the reported message.

**Usage:**

Query only

**Manual operation:** See ["Log Message"](#) on page 1088

---

**:TEST:BB:BNC:SOURce** <BncSource>

Selects the BNC connection test source.

**Parameters:**

<BncSource> AUTO | USER1 | USER2 | USER3 | USER4 | USER5 | USER6 |  
 TRGA | TRGB | C1TMC1 | C1TM2 | C1TM3 | C2TMC4 |  
 C2TM5 | C2TM6 | F1TMC1 | F1TM2 | F1TM3 | F2TMC4 |  
 F2TM5 | F2TM6 | F3TMC1 | F3TM2 | F3TM3 | F4TMC4 |  
 F4TM5 | F4TM6  
 \*RST: USER1

**Example:**

TEST:BB:BNC:SOUR AUTO  
 automatically detects the connectors that have assigned a signal  
 and performs the connector test.

**Manual operation:** See ["Source"](#) on page 1088

---

**:TEST:BB:GENerator:ARBItary** <Filename>

Selects the ARB waveform to be tested.

**Parameters:**

<Filename> string

**Example:**

TEST:BB:GEN:ARB "3gpp.wv"  
 tests the loaded waveform, generating a 3GPP signal.

**Manual operation:** See ["Select ARB File"](#) on page 1090

---

**:TEST:BB:GENerator:FREQuency** <Frequency>

Sets the frequency of the test sine or constant I/Q test signal.

**Parameters:**

<Frequency> float  
 Range: -80E6 to 80E6  
 Increment: 1E-3  
 \*RST: 1E6

**Example:**

TEST:BB:GEN:FREQ 50 MHz  
 sets the test signal test frequency to 50 MHz.

**Manual operation:** See ["Frequency"](#) on page 1090

---

**:TEST:BB:GENerator:GAIN** <Gain>

Sets the gain for a sine or constant I/Q test signal.

**Parameters:**

<Gain> float  
 Range: -1 to 1  
 Increment: 1E-6  
 \*RST: 1

**Example:** TEST:BB:GEN:GAIN 0.5  
 amplifies the test signal by a factor of 0.5.

**Manual operation:** See "Gain" on page 1090

**:TEST:BB:GENerator:SOURce <IqSource>**

Selects the test signal source.

**Parameters:**

<IqSource> SINE | CONStant | ARB  
**SINE**  
 Generates a sine waveform. To determine the frequency, use command :TEST:BB:GENerator:FREQuency on page 1069.  
**CONStant**  
 Uses a constant I/Q test signal.  
**ARB**  
 Selects a signal generated generated by the ARB.  
 \*RST: SINE

**Example:** TEST:BB:GEN:SOUR SINE  
 uses the sine signal or testing.

**Manual operation:** See "IQ Source" on page 1089

**:TEST:BB:GENerator:STATe <State>**

Starts the test generator.

**Parameters:**

<State> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:** TEST:BB:GEN:STAT ON  
 activates the test generator.

**Manual operation:** See "State" on page 1089

**:TEST<hw>:DIRect:BLOCK:READ? <Board>, <SubAddr>, <Addr>[, <Len>]**

Direct mode for querying the blocks of the hardware assemblies directly.

The respective hardware assembly responds directly to the command; any safety mechanisms are bypassed. This function is only available via remote control.

**Query parameters:**

<Board>	string
<SubAddr>	integer
<Addr>	integer
<Len>	integer

**Return values:**

<DataBlock>	string
-------------	--------

**Example:** TEST:DIR:BLOC:READ? 'TEST\_SCPI',0,0,8

**Usage:** Query only

**:TEST<hw>:DIRect:BLOCK:WRITe** <BoardName>, <SubAddress>, <StartAddress>, <DataBlock>

Direct mode for programming the blocks of the hardware assemblies directly.

The respective hardware assembly responds directly to the command; any safety mechanisms are bypassed. This function is only available via remote control.

**Setting parameters:**

<BoardName>	string
	<Board>, <SubAddr>, <Addr>, <Data>
<SubAddress>	integer
<StartAddress>	integer
<DataBlock>	string

**Example:** TEST:DIR:BLOC:WRIT 'TEST\_SCPI',0,0,#1812345678

**Usage:** Setting only

## 13.22 TRIGger Subsystem

The TRIGger system contains the commands for selecting the trigger source for the RF and LF sweep.

You can work with an internal or with an externally applied trigger signal. In this case, use the commands in the SOURce:INPut subsystem to configure the signal.

The trigger system of the R&S SMW is a simplified implementation of the SCPI trigger system. The TRIGger system differs from the SCPI system as follows:

- No INITiate command; the instrument behaves as if INITiate:CONTinuous ON were set.
- Under TRIGger several sweep subsystems exist.
- The trigger source names correspond directly to the various settings of manual control. SCPI uses different names which are also accepted by the instrument. The SCPI names should be used if compatibility is an important consideration.

In addition to these commands, see more trigger-related commands in the modulation and RF signal subsystems.

**Table 13-9: Cross-reference between the manual and remote control**

R&S proprietary value name	SCPI conform value name	Parameter in manual control
AUTO	IMMEDIATE	"Auto" mode
SINGLE	BUS	"Single" mode.
EXTERNAL	EXTERNAL	"Ext Single" and "Ext Step" mode. Use command <code>LFO:SWEep:MODE</code> to select between the two sweep modes.
EAUTO	-	"Ext Start/Stop" mode.

<code>:TRIGger&lt;hw&gt;:FSweep:SOURce</code> .....	1072
<code>:TRIGger&lt;hw&gt;:LFFSweep:SOURce</code> .....	1072
<code>:TRIGger&lt;hw&gt;:PSweep:SOURce</code> .....	1072
<code>:TRIGger&lt;hw&gt;[:SWEep]:SOURce</code> .....	1072
<code>:TRIGger&lt;hw&gt;:FSweep[:IMMEDIATE]</code> .....	1073
<code>:TRIGger&lt;hw&gt;:PSweep[:IMMEDIATE]</code> .....	1073
<code>:TRIGger&lt;hw&gt;:LFFSweep:IMMEDIATE</code> .....	1073
<code>:TRIGger&lt;hw&gt;[:SWEep][:IMMEDIATE]</code> .....	1073
<code>:TRIGger&lt;hw&gt;:LFFSweep</code> .....	1074

---

```

:TRIGger<hw>:FSweep:SOURce <Source>
:TRIGger<hw>:LFFSweep:SOURce <Source>
:TRIGger<hw>:PSweep:SOURce <Source>
:TRIGger<hw>[:SWEep]:SOURce <Source>

```

Selects the trigger source for the corresponding sweeps:

- `FSweep` - RF frequency
- `LFFSweep` - LF frequency
- `PSweep` - RF level
- `SWEep` - all sweeps

The source names of the parameters correspond directly to the values provided in manual control of the instrument. They differ lightly from the SCPI compliant names, but the instrument accepts both variants. Use the SCPI name, if compatibility is an important criterion. Find the corresponding SCPI compliant commands in [Cross-reference between the manual and remote control](#).



**Setting parameters:**

<Source> AUTO | IMMEDIATE | SINGLE | BUS | EXTERNAL | EAUTO

**AUTO [IMMEDIATE]**

Executes a sweep automatically.

In this free-running mode, the trigger condition is met continuously. I.e. as soon as a sweep is completed, the next one starts immediately.

**SINGLE [BUS]**

Executes one complete sweep cycle.

You can initiate the trigger event with the associated commands

SOUR:SWE:POW|FREQ:EXECUTE,

TRIG:SWE|PSW|FSW:IMMEDIATE or \*TRG.

This setting requires that you set the corresponding trigger mode to AUTO, i.e. SOUR:SWE:FREQ|POW:MODE, or

SOUR:LFO:SWE:FREQ:MODE respectively.

In sweep step mode (SOUR:SWE:POW|FREQ:STEP or SOUR:LFO:SWE:STEP), the instrument executes only one step.

**EXTERNAL**

An external signal triggers the sweep.

**EAUTO**

An external signal triggers the sweep. As soon as one sweep is finished, the next sweep starts. A second trigger event stops the sweep at the current frequency, a third trigger event starts the trigger at the start frequency, and so on.

\*RST: AUTO

**Example:**

TRIG:SOUR EXT

selects triggering with an external trigger.

**Usage:**

Setting only

**Manual operation:** See "Mode" on page 456

---

**:TRIGger<hw>:FSweep[:IMMEDIATE]**

**:TRIGger<hw>:PSweep[:IMMEDIATE]**

**:TRIGger<hw>:LFFSweep:IMMEDIATE**

**:TRIGger<hw>[:SWEep][:IMMEDIATE]**

Immediately starts the activated, corresponding sweep:

- FSweep - RF frequency
- PSweep - RF level
- LFFSweep - LF frequency
- SWEep - all sweeps

The command performs a single sweep and is therefore only effective in sweep mode AUTO with sweep source SING. Use the commands

TRIG:FSW|LFFS|PSW[:SWE]:SOUR SING, and SOUR:SWE:FREQ|POW:MODE, or SOUR:LFO:SWE:[FREQ:]MODE to set the respective single sweep.

You can alternatively use an `IMMediate` command instead of the respective `SWEep`:  
`[FREQ:] | POW:EXECute` command.

**Example:**                `TRIG`  
                              starts all active sweeps.

**Usage:**                 `Event`

**Manual operation:**   See "[Execute Single Sweep](#)" on page 456

### **:TRIGger<hw>:LFFSweep**

Executes an LF frequency sweep in single trigger mode.

To execute the sweep, preset `LFO:SWE:MODE AUTO`, and `TRIG:LFFS:SOUR SING`.

**Usage:**                 `Event`

## 13.23 UNIT Subsystem

The `UNIT` subsystem is used to set default units for parameters if no unit is indicated in a command. These settings are valid for the entire instrument.

The following example shows the settable default units.

### **Example: Setting default units for remote control**

```
UNIT:POW V
UNIT:ANGL DEG
UNIT:VEL KMH
```

Sets V (volts) as unit of all power parameters, DEG (degrees) for the phase modulation angle and KMH for the speed.

<a href="#">:UNIT:ANGLE</a> .....	1074
<a href="#">:UNIT:POWer</a> .....	1074
<a href="#">:UNIT:VELocity</a> .....	1075

### **:UNIT:ANGLE <Angle>**

Sets the default unit for phase modulation angle. The command affects no other parameters, such as RF phase, or the manual control or display.

#### **Parameters:**

<Angle>                 `DEGree | DEGRee | RADian`  
                              \*RST:                 `RADian`

### **:UNIT:POWer <Power>**

Sets the default unit for all power parameters. This setting affects the GUI, as well as all remote control commands that determine power values.

**Parameters:**

<Power> V | DBUV | DBM  
\*RST: DBM

---

**:UNIT:VELOCITY** <Velocity>

Sets the default unit for the velocity of the wave.

**Parameters:**

<Velocity> MPS | KMH | MPH | NMPH  
\*RST: MPS

## 14 Maintenance

The instrument does not need periodic maintenance. Only the cleaning of the instrument is essential. The outside of the instrument is suitably cleaned using a soft, line-free dust cloth. Make sure that the air vents are not obstructed.

---

### **WARNING**

#### **Shock hazard**

Before cleaning the instrument, make sure that the instrument is switched off and disconnected from all power supplies.

---

### **NOTICE**

#### **Instrument damage caused by cleaning agents**

Cleaning agents contain substances that may damage the instrument. For example, cleaning agents that contain a solvent may damage the front panel labeling, plastic parts, or the display.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

---

Follow the instructions in the service manual and the safety instructions when exchanging modules or ordering spares. The order no. for spare parts is included in the service manual. The service manual includes further information particularly on troubleshooting, repair, exchange of modules and alignment.

The address of our support center and a list of all Rohde & Schwarz service centers can be found at the beginning of this manual.

### 14.1 Storing and Packing

The storage temperature range of the instrument is given in the data sheet. If the instrument is to be stored for a longer period of time, it must be protected against dust.

Repack the instrument as it was originally packed when transporting or shipping. The two protective foam plastic parts prevent the control elements and connectors from being damaged. The antistatic packing foil avoids any undesired electrostatic charging to occur.

If you do not use the original packaging, use a sturdy cardboard box of suitable size and provide for sufficient padding to prevent the instrument from slipping inside the package. Wrap antistatic packing foil around the instrument to protect it from electrostatic charging.

## 14.2 Performing Maintenance Tasks

The R&S SMW is accurate due to integrated adjustment procedures, which you can execute directly on the instrument.

### Internal Adjustments

#### **NOTICE**

##### **Risk of invalid adjustment**

In order to achieve correct adjustment of the instrument, make sure that the instrument is warm before performing adjustments. The warm-up time is 30 minutes.



Self-calibration routines that do not require additional (external) equipment are carried out by an R&S service center.

### **When to perform adjustments?**

We recommend that you perform internal adjustments in the following cases:

- Before starting any application, that requires a maximum of level and frequency accuracy
- When a long period of time has passed since the last adjustments
- If the ambient temperature of the instrument significantly differs from the one of the last adjustments.

### **Additional Information to the Adjustments**

You can perform internal adjustments in each path separately, see [Chapter 14.2.3, "Internal Adjustment Settings"](#), on page 1084.

During adjustments, a progress indicator shows the status of the process. If any error occurs, the process aborts and an error message appears in the info line.

The extent of the adjustments depends on the installed options.

### **Performing Selftests**

The available selftests check internally various functions of the instrument. We recommend that you perform a selftest, if the instrument does not respond as expected.

The accessible selftests are divided in:

- Testing baseband and BNC connections, see [Chapter 14.2.4, "Selftest Connections Settings"](#), on page 1087
- Test generator, see [Chapter 14.2.5, "Selftest Test Generator Settings"](#), on page 1089
- Testing the baseband domain, see [Chapter 14.2.6, "Selftest Baseband Settings"](#), on page 1090

### 14.2.1 Date and Time Settings

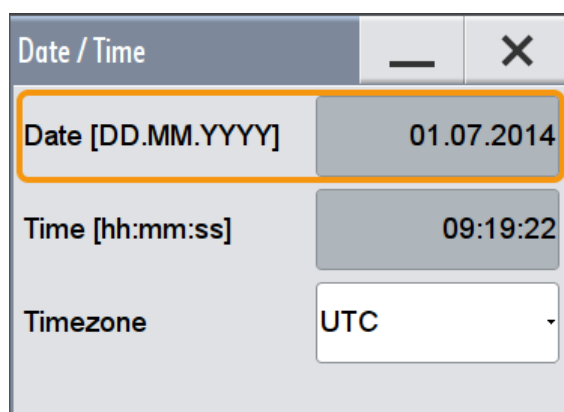
The R&S SMW uses an internal real time clock to determine the date and time. It adjusts the time and date to the timezone of your location automatically, by providing a selection list of continents and cities.

The instrument records the time whenever you create or modify files on your instrument or you use timed licenses.

You can see the current date and time as follows:

#### To access the required settings

- ▶ Select "System Config > Setup > Maintenance > Date / Time".



The "Date / Time" dialog contains the time and data settings of the operating system.

**Note:** The parameters "Date" and "Time" are protected to prevent accidental changes.

To enable editing, unlock protection level 1, see "[Protection Level/Password](#)" on page 635.

To set the date and time, proceed as described in "[To change the date and time](#)" on page 49.

The required remote commands are described in [Chapter 13.19, "SYSTEM Subsystem"](#), on page 1045.

#### Date

Displays the date set in the operating system in the format [dd.mm.yyyy].

Remote command:

:[SYSTem:DATE](#) on page 1060

#### Time

Displays the time set in the operating system in the format [hh.mm.ss].

The time setting corresponds to the selected [Timezone](#).

Remote command:

:SYSTem:TIME on page 1060

### Timezone

Selects the timezone.

You can select the timezone according to the major cities on the respective continents.

**Note:** By typing the first letter, you can quickly navigate through the lists to find the desired destination.

Remote command:

:SYSTem:TIME:ZONE on page 1061

:SYSTem:TIME:ZONE:CATalog? on page 1061

## 14.2.2 Check Front Panel

With the functions provided in this dialog, you can verify the functionality of the control keys and the touchscreen.

See [Chapter 14.2.2.2, "How to Perform the Front Panel Tests"](#), on page 1080 for instructions on how to perform the tests and the expected results.

In case of malfunctions, contact your Rohde & Schwarz Customer Support Center.



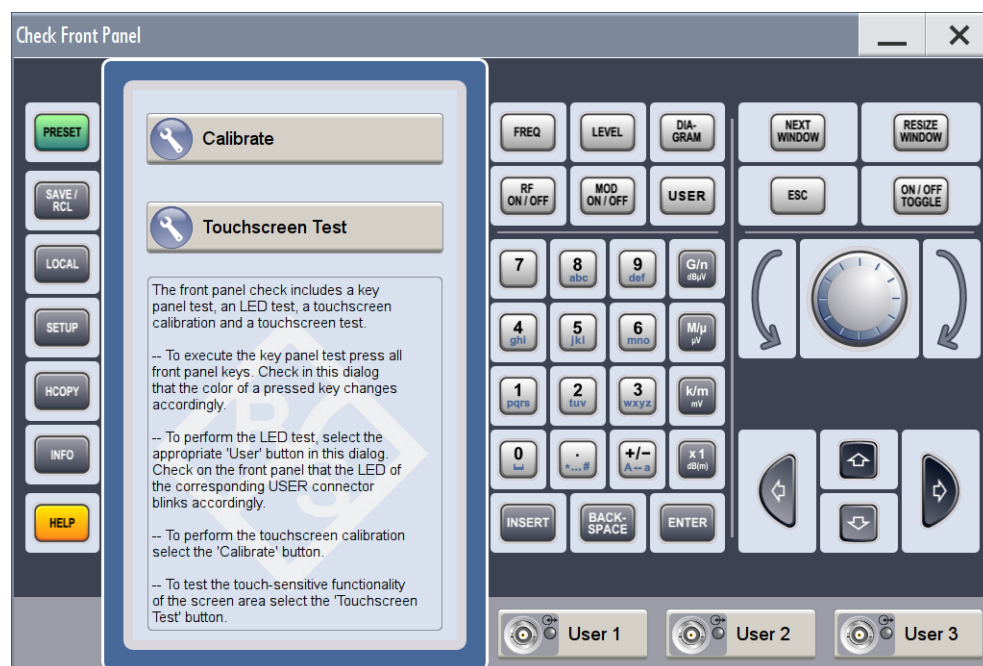
### Accessing the online help in the check front panel dialog or exiting via ESC

During the test, the actual functions of all keys are disabled, including the HELP and the ESC keys.

---

#### 14.2.2.1 Check Front Panel Settings

- ▶ To access this dialog, select "System Config > Setup > Maintenance > Check Front Panel".



Reflecting the front panel, the "Check Front Panel" dialog contains all functions to test the operating elements of the instrument. These are the key panel test, an LED test, and the touchscreen calibration. In addition, you can check the touch-sensitive functionality by dragging one or more lines across the screen with your finger.

### Calibrate

Executes the touchscreen calibration.

See [Chapter 3.1.5.5, "Calibrating the Touchscreen"](#), on page 51 for executing the test.

### Touchscreen Test

Enables you to perform a touchscreen test. This test checks whether the touchscreen area has gaps in the response. See ["How to perform the touchscreen test"](#) on page 1083

## 14.2.2.2 How to Perform the Front Panel Tests

### How to perform the touchscreen calibration

The screen responds to the touch of your finger, that means you can select or activate an item by tapping it. Due to the design of the touchscreen, the capture area is firmly set to a certain size and you do not need to define a range. But if the instrument does not respond correctly to the touch, it is recommended that you calibrate the touchscreen. See [Chapter 3.1.5.5, "Calibrating the Touchscreen"](#), on page 51 for information on how to proceed.



### How to perform the key panel test

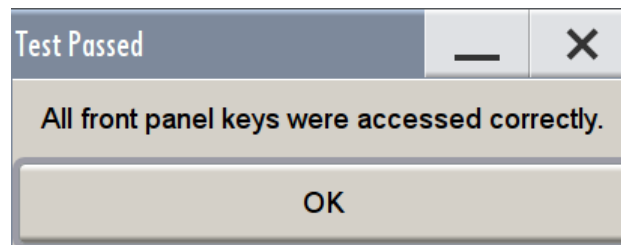
To perform the key panel test, you operate the keys at the front panel, and check the response of the instrument in the "Check Front Panel" dialog. To perform this test properly, check each key of the front panel. The test is only completed, when you have verified all keys.

During the test, the actual functions of the keys are disabled.

Proceed as follows:

1. Press the SETUP key.
2. Select "Maintenance > Check Front Panel"  
The "Check Front Panel" dialog opens.
3. Press a key on the front panel.  
Check if the corresponding key in the "Check Front Panel" dialog turns green.
4. Press the same key a second time.  
Check that the key in the dialog turns red.  
**Note:** Pressing the same key again has no further effect, except for the ESC key, see [Press the ESC key a third time](#).
5. Continue with the next key on the front panel and repeat [step 3](#) to [step 5](#) until all keys are tested.

The test is completed, when each key is verified successfully, confirmed by a "Test passed" message.



- ▶ Press the ESC key a third time.  
Exits the "Check Front Panel" dialog.

Expected responses:

- Pressing a key once (green), pressing twice (red)
- Pressing the ESC key a third time exits the dialog.

If you detect a malfunction, for example, you press the front panel key the first time, and the color of the button in the dialog turns red (instead of green), the front panel key may be stuck. In this case, contact the Rohde & Schwarz Service Department for support (<http://services.rohde-schwarz.com>).

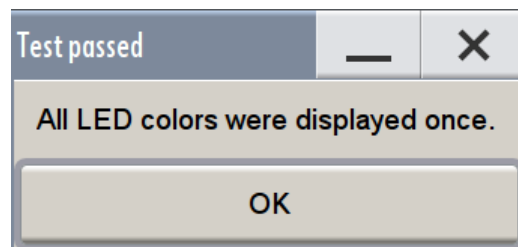
### How to perform the LED test

To perform the LED test, you operate the corresponding USER buttons in the "Check Front Panel" dialog, and check the response of the connector LEDs on the front panel. To perform this test properly, check each USER connector. The test is only completed, when you have verified the functionality of all connector LEDs.

Proceed as follows:

1. Press the SETUP key.
2. Select "Maintenance > Check Front Panel"  
The "Check Front Panel" dialog opens.
3. Select a USER button in the dialog.  
The associated LED in the dialog changes its color.  
Check that the LED of the corresponding USER connector on the front blinks in the same color.
4. Repeat [step 3](#) until all possible colors were displayed once. With the last step, the associated LED in the dialog changes to gray and the USER button turns green.  
Check that the LED of the corresponding USER connector on the front panel stops blinking.  
**Note:** Selecting the same user connector again has no further effect.
5. Repeat [step 3](#) and [step 4](#) for the remaining USER buttons, until all connector LEDs are tested.

The test is completed, when each LED functionality is verified successfully.



When you have completed the test and close the dialog, the LEDs switch back to the state they had before the test, according to the current settings of the USER connector.

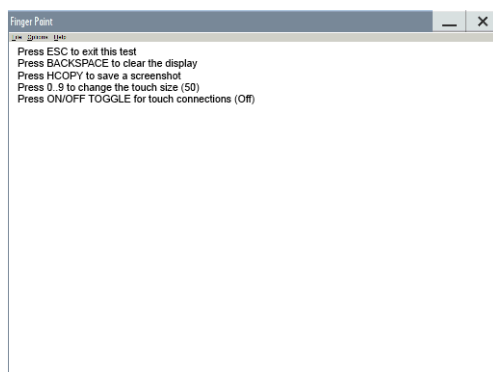
Expected responses:

- Selecting the USER button three times (the LED at the front panel is blinking green, yellow, red)
- Selecting the USER key once more, the LED turns off.
- After testing all LEDs, a "Test passed" message confirms the success.

If you detect a malfunction, for example an LED is not lit, or it no longer changes color, it is defective. In this case, contact the Rohde & Schwarz Customer Support Center for technical support (<http://www.customersupport@rohde-schwarz.com>).

### How to perform the touchscreen test

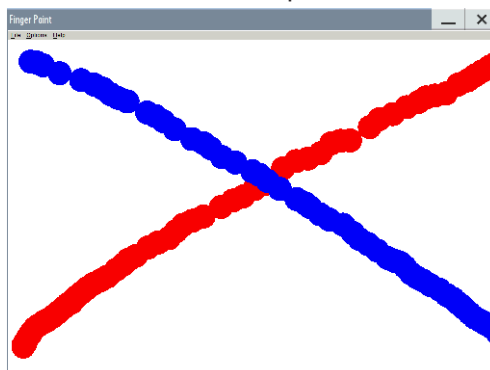
1. Press the SETUP key.
2. Select "Maintenance > Check Front Panel"  
The "Check Front Panel" dialog opens.
3. Select "Touchscreen Test" to access the "Finger Paint" test window.



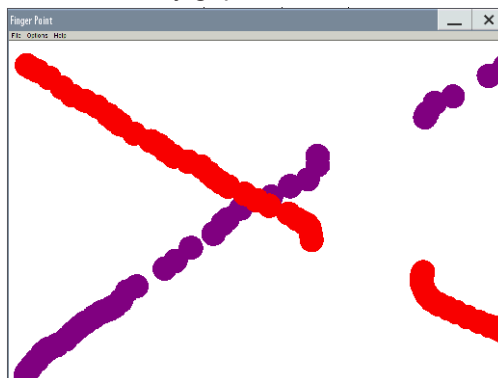
4. Drag with your finger one or more lines, for example diagonally across the screen.  
The test traces the movements of your finger on the screen.

The following results are expected:

- If the lines are uninterrupted, the touchscreen works properly.



- If there are any gaps, the touch-sensitive functionality is damaged.

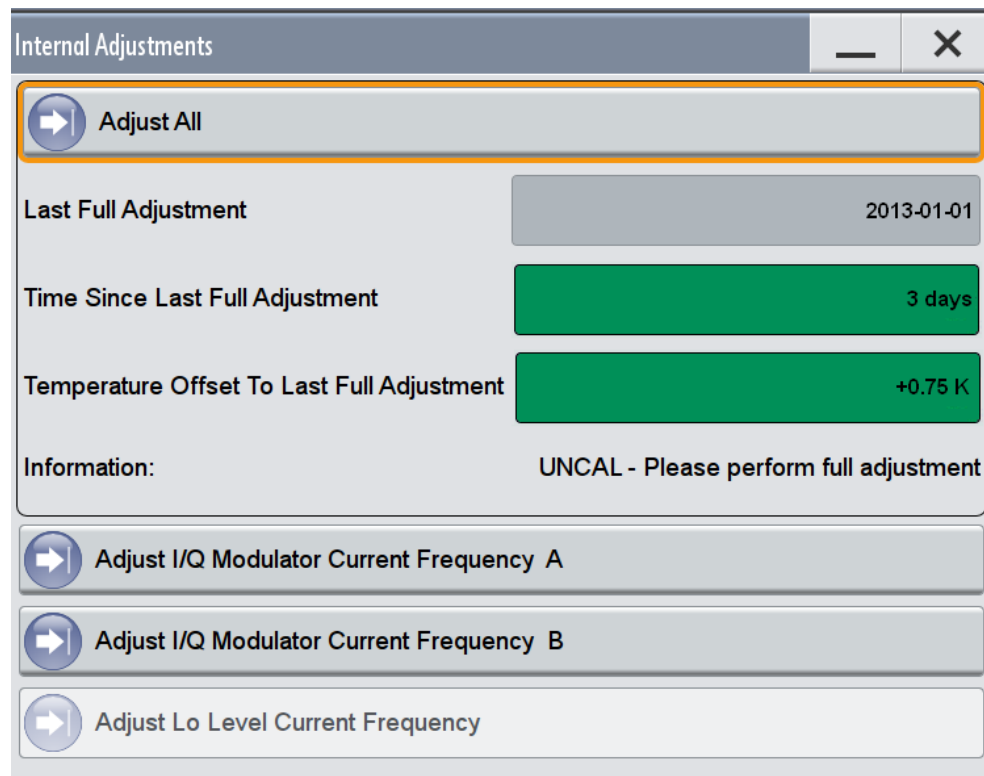


- To return to the "Check Front Panel" dialog, press ESC.

In this case, contact the Rohde & Schwarz Customer Support Center for support (<http://www.customersupport@rohde-schwarz.com>).

### 14.2.3 Internal Adjustment Settings

- ▶ To access this dialog, select "System Config > Setup > System > Internal Adjustments".



In this dialog, you can perform internal calibration routines, and get information on the last performed calibration.

The remote commands required to define these settings are described in [Chapter 13.8, "CALibration Subsystem"](#), on page 734.



In case an error occurs during the internal adjustments, you can continue the process with these functions, record the results in a log file, and send this report to the R&S Service department for an initial check.

The information fields show by their background color whether the calibration state of the instrument is still sufficient. We recommend that you perform internal adjustments when either the temperature offset or the time since the last full adjustment exceeds the specified criteria, see [Time Since Last Full Adjustment](#) and [Temperature Offset To Last Full Adjustment](#).

If you unlock protection level 1, you access further functions like "Continue Adjustment On Error", "Log Debug Info", and "Save Cal Data to File", see [Chapter 11.5.1, "Protection Level Settings"](#), on page 635.

Also note that individually targeted calibration routines can be performed. These routines are blocked by higher protection levels and thus can only be executed by Rohde & Schwarz authorized service personnel.

For further information, see also the R&S SMW Service Manual.

### **Adjust All**

Performs all available internal calibration routines of the instrument, considering all installed paths.

Remote command:

`:CALibration<hw>:ALL[:MEASure]?` on page 735

### **Last Full Adjustment**

Displays the date and time of the last fully performed adjustments.

Remote command:

`:CALibration<hw>:ALL:DATE?` on page 735

### **Time Since Last Full Adjustment**

Displays the elapsed days since the last full adjustment.

If the last adjustment has been performed more than 100 days ago, the background color of the parameter turns red.

### **Temperature Offset To Last Full Adjustment**

Displays the temperature difference compared to the calibration temperature.

If the temperature deviates more than  $\pm 5$  K, the background of the parameter turns red.

Remote command:

`:CALibration<hw>:ALL:TEMP?` on page 735

### **Information**

Displays information to the current adjustment state.

### **Adjust I/Q Modulator Current Frequency**

Starts the adjustment for the I/Q modulator for the currently set frequency and base-band gain. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

See also ["To trigger the internal correction routine of the I/Q modulator "](#) on page 406.

Remote command:

[:CALibration<hw>:IQModulator:LOCal?](#) on page 737

#### **Adjust LO Level at Current Frequency**

Adjusts the level of the oscillator signal to optimum, when an external LO signal is applied, see [To adjust the LO level to current frequency](#).

The function is enabled when either an external "LO Coupling Mode" is selected, or the "Out State" is on ("B On" or "On" respectively).

**Note:** If your test setup consists of several cascaded Rohde & Schwarz signal generators, start the LO level adjustment always with the first instrument using an external oscillator signal, and continue in the order up to the last.

Remote command:

[:CALibration<hw>:LOSCillator:COUpling:LOCal?](#) on page 737

#### **Continue Adjustment on Error**

Continues the calibration even though an error was detected. By default adjustments are aborted on error.

The function is accessible if protection level 1 is unlocked.

Remote command:

[:CALibration<hw>:CONTInueonerror](#) on page 736

#### **Log Debug Info**

Activates logging of the internal adjustments. To save the log file with the calibration report use the [Save Cal Data to File...](#) button.

The function is accessible if protection level 1 is unlocked.

Remote command:

[:CALibration<hw>:DEBug](#) on page 736

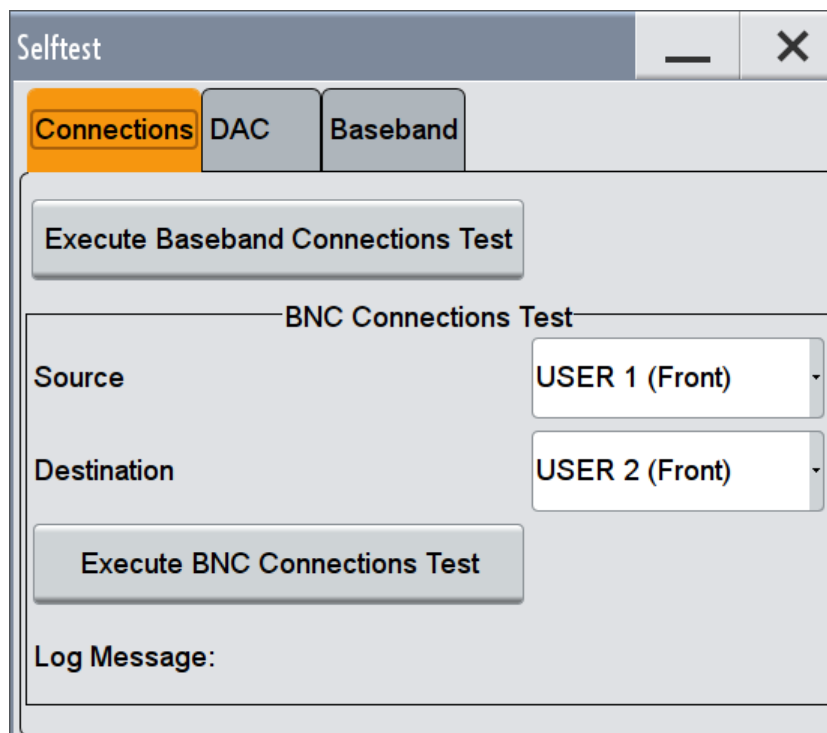
#### **Save Cal Data to File...**

Opens the standard file select dialog to store the calibration data in a file.

The function is accessible if protection level 1 is unlocked.

## 14.2.4 Selftest Connections Settings

- ▶ To access this dialog, select "System Config > Setup > Maintenance > Selftest > Connections".



The "Connections" tab of the "Selftest" dialog contains the parameters for testing the signal flow at the connectors.

The remote commands required to define these settings are described in [Chapter 13.21, "TEST Subsystem"](#), on page 1067.

### How to set up the instrument for testing the BNC connections

To execute the BNC connection test, proceed as follows:

1. In the settings dialog, select the BNC Source (signal output), see [Source](#) .
2. Select the BNC Destination (signal input) [Destination](#)
3. On the instrument, connect the assigned "Source" connector with the associated "Destination" connector.  
The selection list in the dialog shows you where to find the associated connector on the instrument.
4. Execute BNC connection test.

**Execute Baseband Connection Test**

Performs a connection test on each of the internal digital baseband links. This implies to all installed options as baseband inputs, motherboard, universal coding generators, fading simulators, and baseband outputs. The result (succeeded or failed) is displayed in the status field next to the "Execute Baseband Connection Selftest" button.

Remote command:

n.a.

**Source**

Selects the BNC connector source to be tested.

Remote command:

[:TEST:BB:BNC:SOURce](#) on page 1069

**Destination**

Selects the BNC connector destination to be tested.

Remote command:

[:TEST:BB:BNC:DESTination](#) on page 1068

**Execute BNC Connection Test**

Performs the BNC connection test at the selected connectors.

Remote command:

[:TEST:BB:BNC:CONNECTION?](#) on page 1068

**Log Message**

Displays the log message reported during the BNC connector test.

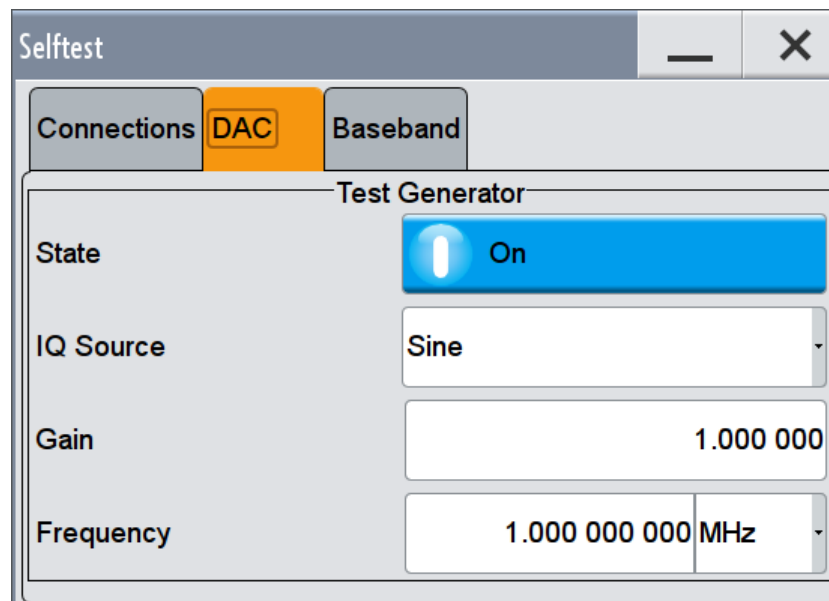


Remote command:

:TEST:BB:BNC:LOG? on page 1068

## 14.2.5 Selftest Test Generator Settings

- To access this dialog, select "System Config > Setup > Maintenance > Selftest > Test Generator".



The "Test Generator" tab of the "Selftest" dialog contains the parameters for testing the IQ signal source.

The remote commands required to define these settings are described in [Chapter 13.21, "TEST Subsystem"](#), on page 1067.

### State

Starts the test generator.

Remote command:

:TEST:BB:GENerator:STATe on page 1070

### IQ Source

Selects the test signal source.

- "Sine" Generates a sine waveform with frequency as set with the parameter [Frequency](#).
- "Constant I/Q" Uses a constant I/Q test signal. For more details, see [Chapter 5.5.3.4, "Constant IQ Test Signal"](#), on page 300.
- "ARB" Selects a signal generated by the ARB. You can select the waveform file for use with [Select ARB File](#).

Remote command:

[:TEST:BB:GENerator:SOURce](#) on page 1070

### Gain

Determines the gain for a sine or a constant I/Q test signal.

Remote command:

[:TEST:BB:GENerator:GAIN](#) on page 1069

### Frequency

Defines the frequency of the test signal.

Remote command:

[:TEST:BB:GENerator:FREQuency](#) on page 1069

### Select ARB File

Provides access to the standard "File Select" function of the instrument. The provided navigation possibilities in the dialog are self-explanatory.

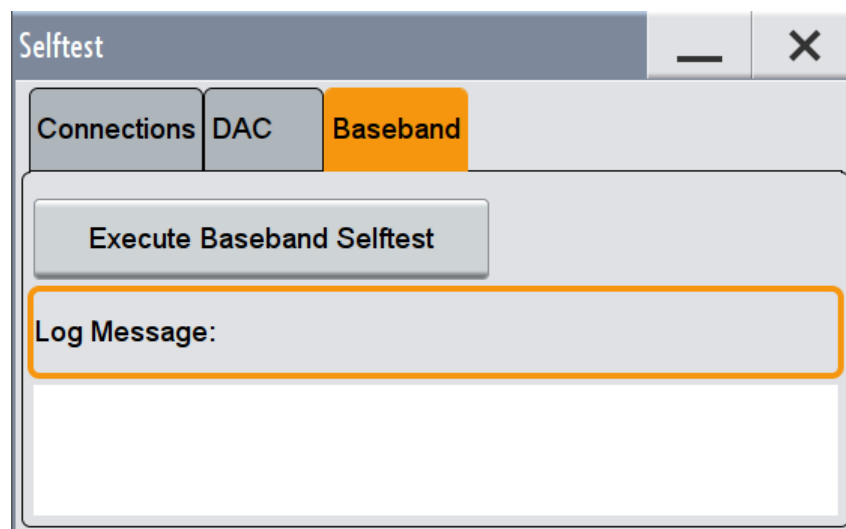
See also, chapter "File and Data Management" in the R&S SMW User Manual.

Remote command:

[:TEST:BB:GENerator:ARBitrary](#) on page 1069

## 14.2.6 Selftest Baseband Settings

- ▶ To access this dialog, select "System Config > Setup > Maintenance > Selftest > Baseband".



In the "Baseband" tab of the "Selftest" dialog you can execute the baseband selftest.

The remote command required to start the test is described in [Chapter 13.21, "TEST Subsystem"](#), on page 1067.

**Execute Baseband Selftest**

Performs a baseband selftest. The result (succeeded or failed) is displayed in the status field on the right.

Remote command:

:TEST:BASEband? on page 1067

**Log Message**

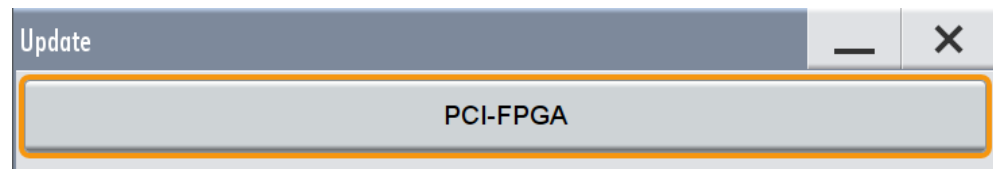
Displays the log message reported during the baseband test.

Remote command:

n.a.

**14.2.7 PCI-FPGA Update Settings**

- ▶ To access this dialog, select "System Config > Setup > Maintenance > PCI-FPGA Update".



This dialog enables you to update the PCI-FPGA.

**PCI-FPGA**

Performs an update of the PCI-FPGA.

Remote command:

n.a.

**14.2.8 Requesting Instrument Configuration and Specifications**

The R&S SMW is equipped with various hardware and software components. To get an overview of what your instrument is equipped with, you can request the assemblies, hardware and software options, and the firmware version. The components are structured according to the hardware configuration, software options, including the license management, and externally used Rohde & Schwarz equipment, like R&S NRP-Zxx Power Sensors.

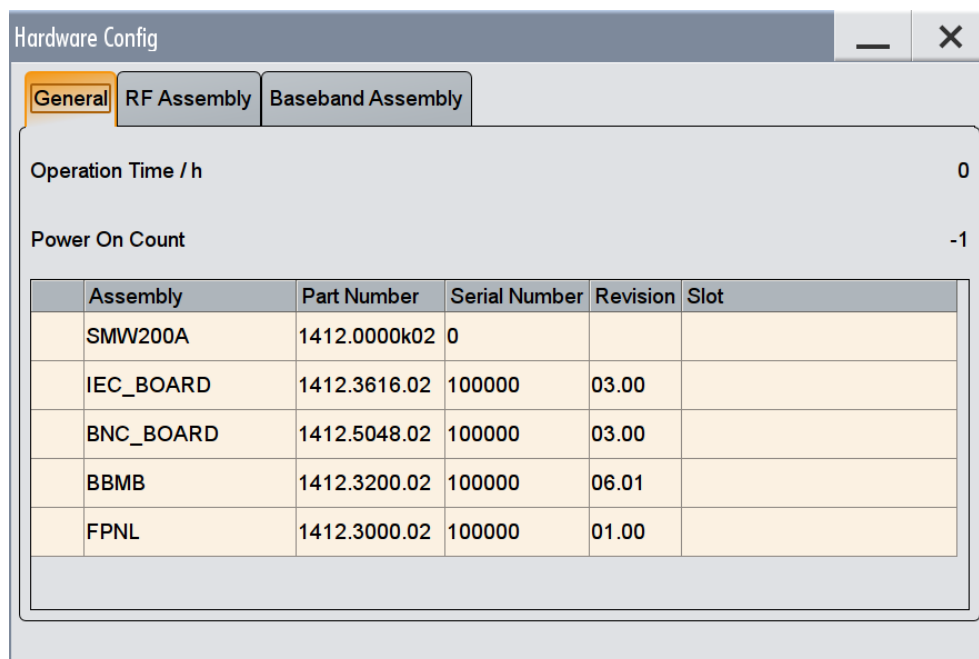


Software options purchased at a later stage can be activated with a keycode. The activation code is supplied with the software option. How to install options is described in chapter 4 of the R&S SMW Service Manual.

The installation of hardware options purchased at a later stage is also described in chapter 4 of the Service Manual. Most of the hardware options have to be installed at an authorized Rohde & Schwarz service center.

### 14.2.8.1 Hardware Configuration Settings

- ▶ To access this dialog, select "System Config > Setup > Instrument Assembly > Hardware Config".



The "Hardware Config" dialog lists all installed assemblies with information on their part and serial numbers and revision states. The dialog is divided in tabs, according to the hardware components of the signal domains.

The remote commands required to query the hardware configuration are described in [Chapter 13.10, "DIAGnostic Subsystem"](#), on page 738.

#### Operation Time / h

Displays the operation time in hours.

Remote command:

n.a.

#### Power On Count

Displays the number of power-on.

Remote command:

n.a.

#### Assembly

The tables in the tabs show characteristics of the installed general, baseband and RF assemblies.

"Path" Shows the path to that the assembly belongs.

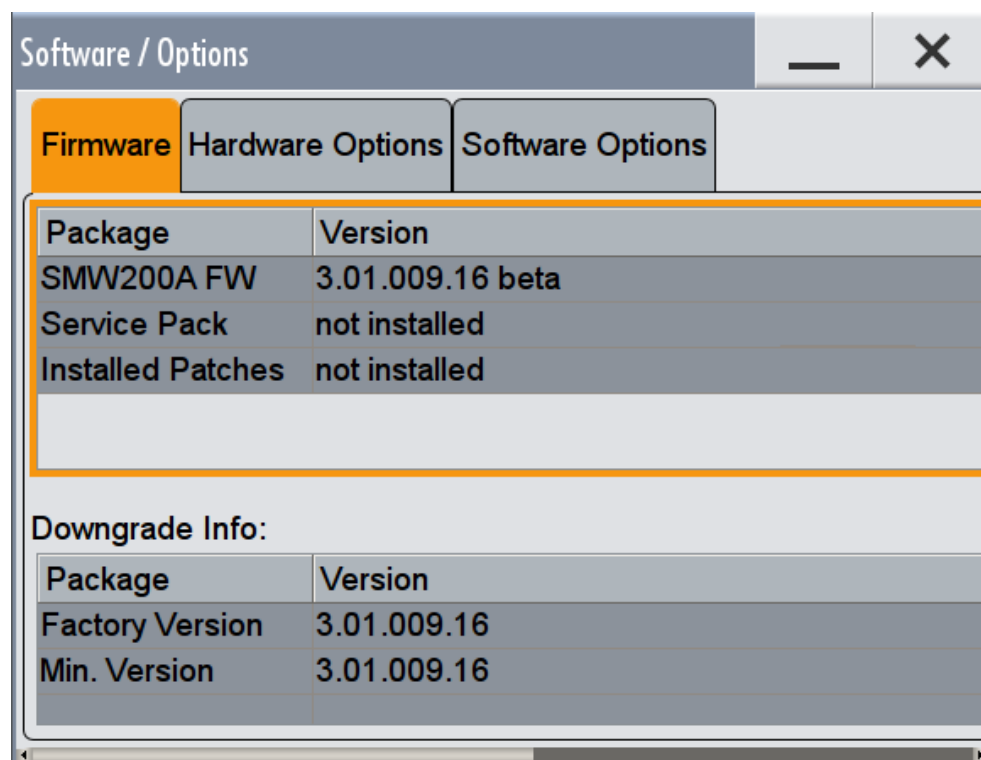
"Assembly" Assembly designation.

"Part Number" Part number of the assembly.

- "Serial Number"      Serial Number of the assembly.
- "Revision"            Revision state of the assembly.
- "Slot"                  Indicates whether the assembly is connected to the serial bus or PCI bus.
- Remote command:  
:DIAGnostic<hw>:BGInfo? on page 739

#### 14.2.8.2 Software / Options Settings

- ▶ To access this dialog, select "System Config > Setup > Instrument Assembly > Software / Options".



The "Software / Options" dialog shows the version of the installed instrument firmware and the hardware and software options.

The remote commands required to query the hardware configuration are described in [Chapter 13.10, "DIAGnostic Subsystem"](#), on page 738.

#### Firmware

Shows the firmware version and the version of the software platform.

**Note:** Your instrument is delivered with the latest firmware version available. You can download firmware updates and the Release Notes that describe the modifications and the firmware update procedure from the R&S SMW [product page](#) > "Downloads > Firmware".

Remote command:  
n.a.

### Downgrade Info

Shows downgrade information, like factory version and minimum required firmware version.

Remote command:  
n.a.

### Hardware Options / Software Options

The tables in the sections "Hardware" and "Software" list the installed hardware and software options.

"Option"            Short name of option

"Designation"    Name of Option

"Licenses"        (optional)  
Number of licenses.

The licenses for the software options are "floating licenses". This means that in the case of two-path instruments just one license is required to use the option for either of the two paths. However, two licenses must be purchased to use an option on both paths simultaneously.

"Expiration Date"

For regular options, "Permanent" is indicated in this column. Some options are available as trial versions. This column shows their expiration date. After this date, the option is no longer available on the instrument.

Remote command:  
[\\*OPT?](#) on page 719  
[\\*IDN?](#) on page 718

# 15 Troubleshooting and Error Messages

The R&S SMW distinguishes between various different messages such as status messages, error messages, warnings, or information that are displayed in the "Info" line on the screen, and also entered in the error/event queue of the status reporting system.

This section describes the types of error messages and warnings. The information and status messages concerning the operating status of the instrument, see [Chapter C.4, "Status Information Displayed in the Info Line"](#), on page 1151. The status reporting system is described in detail in [Chapter B.1.5, "Status Reporting System"](#), on page 1128.

You can also access an Info window with detailed information about all messages in a history list. For details, see [Chapter 15.4, "Querying Error Messages & Info Key"](#), on page 1098

## 15.1 Error Messages

Error messages indicate errors in the instrument. They are displayed in different colors depending on their importance and display duration. Errors (e.g. no calibration data) are displayed in red, information (e.g. file not found) and warnings in black. Warnings indicate less significant errors (e.g. the instrument operates outside specified data).

Some error messages require that the error must be eliminated before correct instrument operation can be ensured. To access the "Info" dialog with a list of current messages and a detailed description of each message, select the INFO key.

In the remote control mode, error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. If the error queue is empty, 0 ("No error") is returned.

### 15.1.1 Volatile Messages

Volatile messages report automatic settings in the instrument (e.g. switching off of incompatible types of modulation) or on illegal entries that are not accepted by the instrument (e.g. range violations). They are displayed in the info line on a yellow background. They are displayed on top of status information or permanent messages.

Volatile messages do not normally demand user actions and disappear automatically after a brief period of time. They are stored in the history, however.

SCPI command: `:SYSTem:ERRor:ALL?` or `:SYSTem:ERRor:CODE[:NEXT]?`

### 15.1.2 Permanent Messages

Permanent messages are displayed if an error occurs that impairs further instrument operation, e.g. a hardware fault. The error signaled by a permanent message must be eliminated before correct instrument operation can be continued.

The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

SCPI command: `:SYSTem:SERRor?`

## 15.2 SCPI-Error Messages

The SCPI error messages are the same in all SCPI instruments. Detailed information and an overview of all error messages as defined in SCPI standard can be found in the corresponding documentation.

The errors are assigned negative numbers. The error text being entered into the error/event queue or being displayed is printed in bold face on the left together with the error code. Below the error text, there is an explanation as to the respective error.

## 15.3 Device-Specific Error Messages

The following table contains all error messages specific for the instrument in alphabetical order, as well as an explanation of the error situation. The positive error codes mark the errors specific to the instrument.

The device-specific error messages set bit 3 in the ESR register.



The index provides a list of the error messages sorted according to their error codes.

Error Code	Error	Description	Remedy
50	Extern reference out of range or disconnected	External reference is selected but no external signal is applied or the signal is out of range.	<ul style="list-style-type: none"> <li>Check the selected reference signal source (internal or external) in the "Setup &gt; Reference Oscillator" dialog.</li> <li>Change setting to 'internal' if no appropriate external source is available.</li> </ul>
140	This modulation forces other modulations off	<p>A modulation has been switched on which cannot be used at the same time as an already active modulation. The previous modulation has been switched off.</p> <p>Example: Enabling modulation GSM/EDGE switches any active digital modulation off.</p>	



Error Code	Error	Description	Remedy
180	Adjustment failed	Adjustment could not be executed	The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the device (see " <a href="#">Internal Adjustments</a> " on page 1077).
182	Adjustment data missing	Adjustment data is missing.	The adjustment data has to be generated first by an internal or external adjustment or to be loaded into the instrument.
183	Adjustment data invalid	Adjustment data is invalid and must be restored.	The adjustment data has to be generated again by an internal or external adjustment or to be loaded into the instrument.
200	Cannot access hardware	The data transmission to a module was unsuccessful.	The module is not installed, not properly installed or missing.
201	Hardware revision out of date	A later version of certain parts of the instrument is necessary to execute the function selected.	The driver does not support the installed version of a module.
202	Cannot access the EEPROM	An error occurs when writing or reading a EEPROM.	The EEPROM might be defect and has to be replaced.
203	Invalid EEPROM data	Reading a EEPROM is possible, however the data are inconsistent.	
204	Driver initialization failed	Initialization of a driver fails when booting the instrument firmware.	The driver is not compatible with the hardware or software configuration of the instrument.
241	No current list	There is no list selected. To execute the required operation, a list has to be selected in the related menu. If no list is available, a new list must be created.	
242	Unknown list type specified	The list type selected is not valid for the required operation. For instance, the file extension for waveform list files is *.wv. It is not possible to enter another file extension when selecting a list.	Check the selected list type.
261	Waveform Protected	The selected waveform file cannot be transferred to a controller. The waveform is produced with simulation software R&S WinIQSIM2 and is protected.	
460	Cannot open file	The selected file cannot be opened.	Check the path and file name.
461	Cannot write file	The file cannot be written.	Check if the file is read-only.
462	Cannot read file	The file cannot be read.	Check if the file contents are compatible with the file type.

Error Code	Error	Description	Remedy
463	Filename missing	The required operation cannot be executed because the file name is not specified.	Enter file name when creating list.
464	Invalid filename extension	The file extension is not valid for the required operation.	Check the file extension. For instance, the file extension for waveform list files is *.wv. It is not possible to enter another file extension when storing a list.
465	File contains invalid data	The selected file contains data that is not valid for the file type.  The file extension determines the data that is valid for this file type. If the file extension is changed, the lists are no longer recognized and the data is therefore invalid.  Example: the extension of a waveform file (= *.wv) was changed to *.txt	Check the file extension.

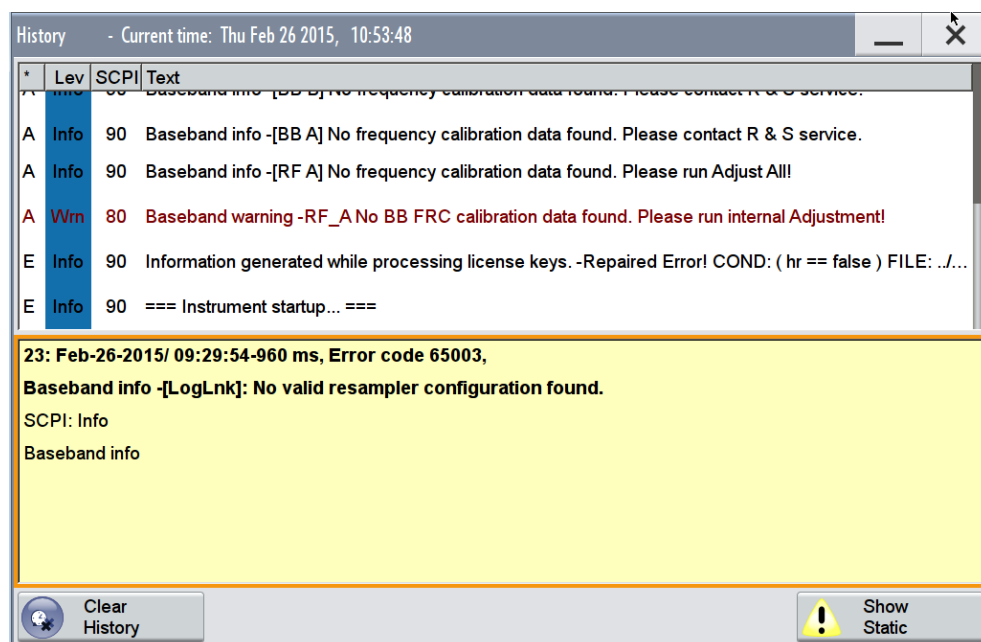
## 15.4 Querying Error Messages & Info Key

The R&S SMW monitors the functions performed and automatically detects errors and irregularities. The instrument displays the messages in the info-line and records them in the background with a detailed description.

Find details to the system messages also in [Chapter C.4, "Status Information Displayed in the Info Line"](#), on page 1151 and [Chapter 15, "Troubleshooting and Error Messages"](#), on page 1095.

- ▶ To access the "Info" line, perform one of the following:
  - On the front panel, press the INFO key.
  - In the taskbar, select the "System Config > Info".

**Tip:** For some messages, the information line appears briefly in the block diagram, and provides the option to open the info dialog using the "Info" button.



The "Static" info dialog contains the last monitored message in the upper section. The lower section displays additional information on the highlighted message. In "History" view, the section lists all accumulated messages with a short description.



If any critical error occurs, the R&S SMW automatically shows the icon in the task-bar. Select the icon to obtain information on the error and the number of occurrences. The icon is assigned to permanent messages, i.e. the message and icon are displayed until the error is eliminated.

### Clear History

Clears all messages in the "History" view.

Remote command:

`:SYSTem:ERRor:ALL?` on page 1047

Each time a `SYST:ERR:ALL?` query is sent, the error queue is returned and at the same time cleared.

`:SYSTem:HCLear` on page 1056

Clears the messages in the "History" view.

### Show History / Show Static

Toggles between "History" and "Static" view of the info dialog.

Remote command:

`:SYSTem:ERRor[:NEXT]?` on page 1048

Each time a `SYST:ERR?` or `STAT:QUE?` query is sent, the oldest entry in the error queue is returned and at the same time cleared in the list.

## 15.5 Resolving Network Connection Failures

Several issues may cause failures in the network connection to the instrument. This section lists the most likely reasons and the recommended solutions.

### Common reasons for network connection failures

- Network connecting cables and cable connectors of poor quality
- Incompatibility between the network interface of the R&S SMW and certain switches or routers available on the market
- An invalid IP address assigned to the instrument

### Possible solutions

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#### **NOTICE**

#### **Risk of connection errors**

Before configuring the network, changing IP addresses or exchanging hardware, consult your network administrator.

Connection errors can affect the entire network.

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- Check the network infrastructure. Exchange connecting cables if obvious damage is visible.
- Observe the link status LED on the R&S SMW or the connected network device. The link status LED is located next to the LAN connector. If a link failure is detected, connect the instrument to a different device port or to a different network device.
- Check whether the LAN interface and the required LAN services are enabled. See [Chapter 11.5.3, "Configuring LAN Services"](#), on page 639.
- Check whether the IP address of the instrument is within the network's address range. (See ["IP Address"](#) on page 663). Check whether IP addresses that were set manually or obtained via the Zeroconf (APIPA) protocol are valid.

## 15.6 Obtaining Technical Support

If problems occur, the instrument generates error messages which usually are sufficient for you to detect the cause of an error and find a remedy. Error message types are described in [Chapter 15, "Troubleshooting and Error Messages"](#), on page 1095.

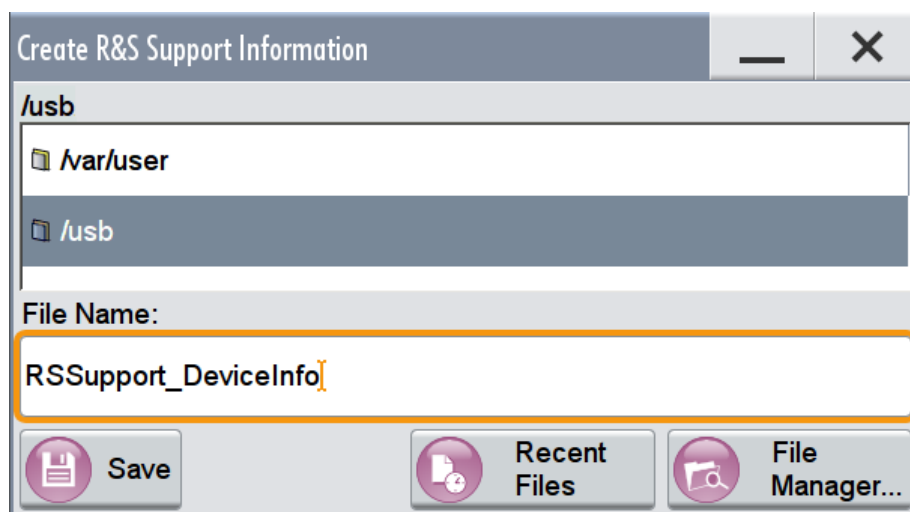
In addition, our customer support centers are there to assist you in solving any problems that you may encounter with your R&S SMW. We will find solutions more quickly and efficiently if you provide us with the following information.

- The following dialog boxes in the "Setup > Instrument Assembly" menu provide useful information:
  - **Hardware Configuration:** hardware assemblies
  - **Software and Options:** the status of all software and hardware options installed on your instrument
- **System Messages:** displayed in the "Info" line and provide information on any errors that may have occurred
- **Support file:** a special file (\*.tar.gz file) with important support information that can be created automatically.  
The support \*.tar.gz file has a user definable name and contains the following information:
  - **Error Log**  
The SgErrors.txt file contains a chronological record of errors.
  - **Save/Recall file**  
The SystemRestorationSMW.savrc1.txt file contains the instrument settings at the last correct shutdown of the instrument.
  - **Device footprint**  
The DeviceFootprint\_<SerialNumber>\_<Date>\_<Time>.xml file contains service-related information on the instrument's configuration.
  - **Adjustment files**  
Several files with information on the last performed adjustment

Collect the error information and send an e-mail in which you describe the problem to the customer support address for your region as listed at the beginning of the R&S SMW Getting Started manual.

#### To collect error information in a support file

1. Connect a USB device to the R&S SMW.
2. On the front panel, press the SETUP key and select "Maintenance > Create R&S Support Information".
3. In the "Create R&S Support Information" dialog, navigate to the /usb directory and enter the support file name, for example RSSupport\_DeviceInfo.



The error information and further required data is collected automatically.  
The support file `RSSupport_DeviceInfo.tar.gz` is created and stored in the `/usb` directory.

#### To remove sensitive data

- ▶ For information on how to handle or remove the sensitive data from your instrument, refer to the description "Resolving Security Issues when working with R&S SMW".



#### Packing and transporting the instrument

If the instrument has to be transported or shipped, for example due to damage during delivery, observe the notes described in [Chapter 3.1.1.2, "Unpacking and Checking the Instrument"](#), on page 37.

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## Annex

# A Summary: New Features for R&S SMU200A Users

The R&S SMW introduces new features in the R&S Signal Generators family. If you have used an R&S SMU or other R&S Vector Signal Generator before, you may find the summary information in the following sections and the comparison to the R&S SMU useful.



To gain a better overview of the new functionality, refer to the configuration examples in [Chapter 3.3, "Trying Out the Instrument"](#), on page 64. The following sections are a short summary for experienced R&S SMU users.

During this section, we use the R&S SMU as an example instrument that represents the vector signal generators family.

## A.1 Improvements in the Manual Operation

- The R&S SMW is equipped with a modern touchscreen. You can operate the instrument completely from the touchscreen. This makes interaction with the user interface easy and fast.
- The touchscreen provides *an alternative way* to control blocks and dialog boxes, and to change instrument settings. Tap a function field like "RF Freq" or "Level" and enter the value in the input field that appears.
- If you however prefer to use the front panel keys and/or the Rotary knob, you can use one of the following modes:
  - exclusive operation from the touchscreen
  - exclusive operation by front panel keys and/or the Rotary knob, as you perform this in a signal generator like R&S SMU.
  - mixed operation by combining both operation possibilities, possibly also in combination with a connected mouse.
- To access important functions or dialogs directly by one tap, use also the provided hot spots. There are several of them on the block diagram, like:
  - Icons
  - Connectors
  - Underlined text labels

**Example: Configuring a RF offset of 10 MHz**

Compare the steps necessary to fulfill the same task in R&S SMU and R&S SMW.

Required steps in R&S SMU	Required steps in R&S SMW
Press the DIAGRAM key Turn the rotary knob and select "RF A" block Push the rotary knob to open the context menu Turn the rotary knob to navigate and select "Frequency" Push the rotary knob to open the dialog Turn the rotary knob and select "Offset" Use the front panel keypad and enter 10 MHz Press ESC to close the dialog	In the block diagram, tap the "RF A" button In the context menu, tap the "Frequency" In the "Frequency" dialog, tap the parameter "Offset" In the on-screen keypad, tap on "10"MHz" Close the dialog

## A.2 Revised Front Panel Keys

The R&S SMW introduced redesigned front panel keys. There are new or changed functions assigned to the front panel keys; keys are removed and new keys are introduced.

Consider the following comparison between the R&S SMW and the R&S SMU front panel keys.

Front panel keys in R&S SMU	Front panel keys in R&S SMW	Comment	Assigned Function
-	USER	New	Key with a customizable function. You can define the action to be executed.
FILE	SAVE/RCL	Renamed	Saves and loads instrument setting Accesses the file manager
CLOSE HIDE WINBAR	-	Removed The touchscreen functions take over the window/dialog management	-
-	NEXT WINDOW	New	Toggles between the active dialogs
MENU	-	Removed Access to the main and setup menus is provided via the block diagram and the softkeys on the taskbar	-



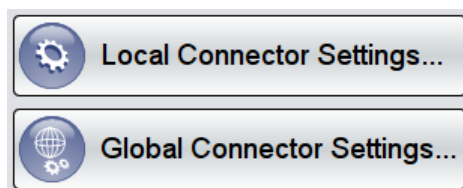
## A.3 New Connectors' Concept

The R&S SMW introduced new connectors' concept.

- The R&S SMU uses a static routing of the control signals and dedicated connectors. For example, the "Marker 1" signal of "Baseband A" is output at the MARKER 1 connector.  
In R&S SMW, however, the signal to connector mapping is not dedicated. You define the connector at which the "Marker 1" signal of "Baseband A" is output.
- The R&S SMW distinguishes between shared and local connectors:
  - the globally shared connectors (USER 1 .. 6)
  - the local connectors of the modulation coders (T/M/(C) 1/2/3 and T/M/(C) 4/5/6)
- The signal to connector mapping requires two major steps:
  - defining the signal
  - defining the connector

For example, in the dialog of a digital standard, select the "Marker" tab and define the marker pattern.

In the "Marker" tab, select the "Local/Global Connector Setting" and define the connector.



For details, see the configuration examples in [Chapter 3.3, "Trying Out the Instrument"](#), on page 64.

In the default state, the signal to connector mapping in R&S SMW repeats the one you are familiar with. Consider the following comparison between the R&S SMW and the R&S SMU connectors.

**Table A-1: Default signal to connector mapping in the R&S SMW**

Connector on R&S SMU	Connector on R&S SMW	Physical location on the R&S SMW	Default assigned signal
MARKER1 (Path A)	USER 1	Front panel	output Baseband A Marker 1
MARKER2 (Path A)	USER 2	Front panel	output Baseband A Marker 2
TRIGGER1	USER 3	Front panel	input Global Trigger 1
TRIGGER2	USER 4	Rear panel	input Global Trigger 2

Connector on R&S SMU	Connector on R&S SMW	Physical location on the R&S SMW	Default assigned signal
USER with default signal "No Signal (Blank)", path A	USER 5	Rear panel	output Signal Valid A
CLOCK	T/M/C 1 T/M/C 4	Rear panel (CODER 1 board, topmost left) (CODER 2 board, topmost right)	output Symbol Clock A/C Symbol Clock B/D
BBIN A	DIG I/Q IN/OUT 1	Rear panel (CODER 1 board, topmost left)	input BB Input A
BBIN B	DIG I/Q IN/OUT 2	Rear panel (CODER 2 board, topmost right)	input BB Input B
BBOUT A	DIG I/Q OUT 1	Rear panel (BBMM board, left side)	output Stream A
BBOUT B	DIG I/Q OUT 2	Rear panel (BBMM board, right side)	output Stream B
EXT MOD	EXT1 and EXT2	Rear panel (BBMM board)	dedicated inputs External analog modula- tion signals
I/Q (analog outputs)	I/Q OUT 1/2	Rear panel (BBMM board)	output Stream A/B <b>Note:</b> By default, the out- put connectors are deacti- vated

## A.4 Revised Options Concept

The R&S SMW uses revised options concept.

- The input of digital baseband signals Baseband Inputs is included in the R&S SMW-B10, i.e. no additional option like R&S SMU-B17 is required. The R&S SMW does not support input of analog signals in the baseband generator. Analog I/Q signals are input directly to the I/Q Modulator.
- The features of the 3GPP FDD digital standard are split into two main options, the R&S SMW-K42 (as in R&S SMU) and one enhanced option, R&S SMW-K83.
- The features of the IEEE 802.11 a/b/g digital standard are included in the R&S SMW-K54 WLAN a/b/g/n, i.e. no additional option like R&S SMU-K48 is required. The features of the IEEE 802.11 ac digital standard, however, require the additional option R&S SMW-K86.

## A.5 Redesigned Dialog Concept Based on a New Tab Structure

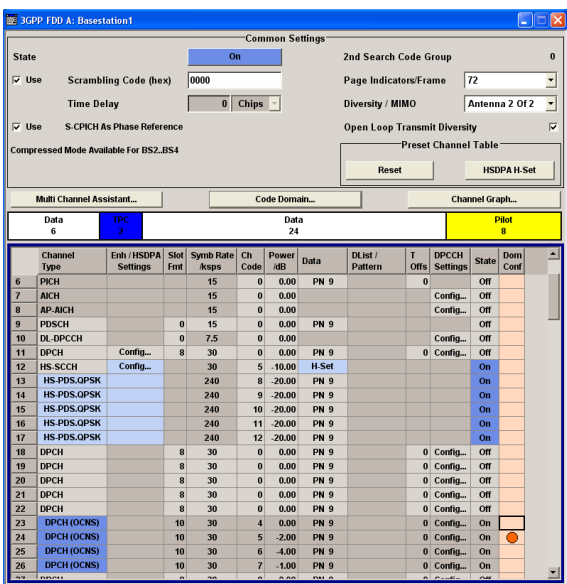
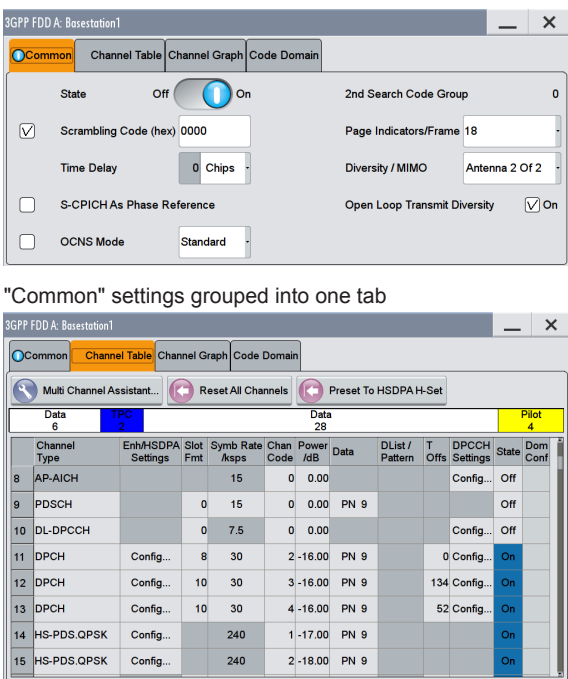
The R&S SMW introduces more user friendly representation in the user interface by:

- Settings split into tabs rather than arranging them vertically in very long dialogs
- Dialog structure based on a repeating tab concept
- Integrated (sub)dialogs as additional tabs in the main dialog
- Redesigned user interface for faster information acquisition
  - display of summary information with icons, state indicators, dialog and tab headers
  - improved blocks/dialog/tab naming conventions

### Example:

Consider the following comparison between the R&S SMW and the R&S SMU dialog concept.

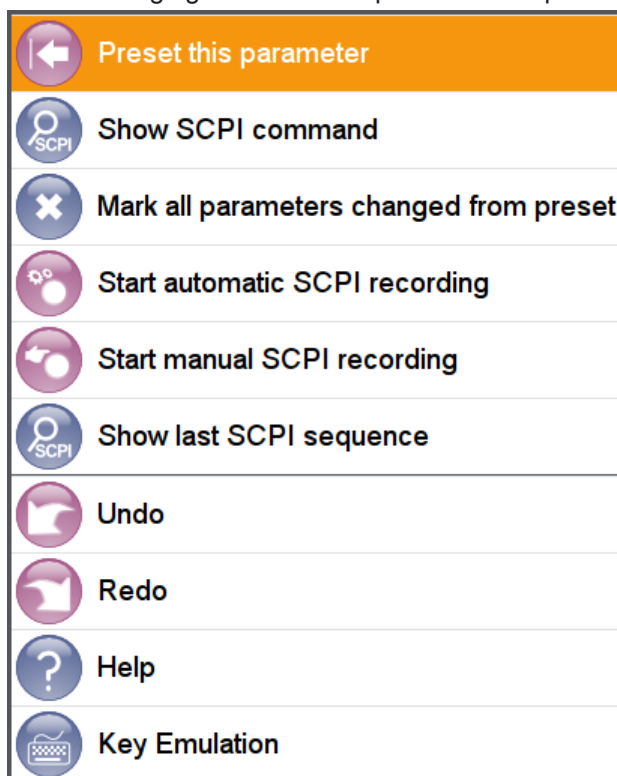
Table A-2: Comparison of the settings representation ("3GPP FDD > Basestations > BS1" settings)

Dialog in the R&S SMU	Dialog in the R&S SMW
 <p>"Common Settings" and channel table listed in one dialog</p>	 <p>"Common" settings grouped into one tab</p> <p>"Channel Table" builds another separate tab</p> <p>The two separate windows "Code Domain" and "Channel Graph" implemented as tabs</p>

## A.6 Quick Access to Important Information and Actions via Context-Sensitive Menu

The R&S SMW offers a context-sensitive menu to all parameters or interactive elements on the user interface

- To access this menu, touch an element and hold
- The context-sensitive menus provide extended and new functionality
- The context-sensitive menus are tailored to the particular parameter.  
The following figure is an example of the one provided for a numeric value.



Refer to [Chapter 3.5.3, "Accessing the Functionality"](#), on page 111 for more information.

## A.7 Improved and New Introduced Features

Concerning the baseband signal generation and the digital standards, the R&S SMU and R&S SMW support nearly the same feature set. Consider the following main differences:

- External clock signal  
The R&S SMU supports only one external baseband clock signal.  
The R&S SMW supports two baseband clocks, one per "Baseband A/C" and "Baseband B/D".

## Flexible Signal Routing and Mapping of the I/Q Streams to the Output Connectors

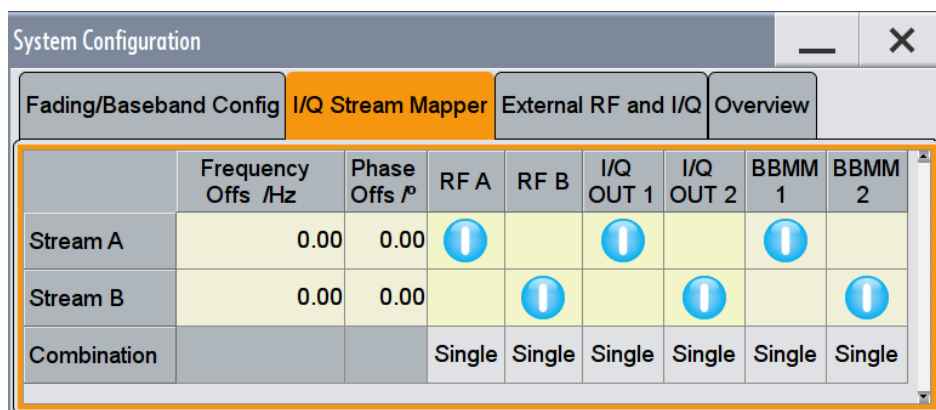
Per default, the external clock signals are available at the T/M/C 1 and T/M/C 4 connectors respectively (see [Table A-1](#)).

- Digital impairments  
In R&S SMW, you access this function from the blocks "I/Q Analog", "I/Q Digital" and "I/Q Mod".
- Handling of data lists  
You can create new and edit existing data lists directly from the dialog you define the data source.
- Number of baseband sources  
The R&S SMW uses four baseband sources, the "Baseband A,B,C and D".
- Generation of the signal of more than one antennas  
In some digital standards in R&S SMU, like the "EUTRA/LTE", "IEEE 802.11n" or "WiMAX", the generation of the signal of more than one antenna is implemented with the function "Use Baseband A+B".  
In R&S SMW, the number of "Tx Antennas" is a "System Configuration" setting.
- Analog I/Q outputs in inactive state  
By default, the analog I/Q OUT connectors are deactivated.

## A.8 Flexible Signal Routing and Mapping of the I/Q Streams to the Output Connectors

The R&S SMW introduced new signal routing concept.

- The R&S SMU provides rather limited routing possibility for the generated baseband signals. For example, the signal of "Baseband A" is output at one of the following connectors: the RF A, the analog I/Q A outputs and, if available, the DIG I/Q A.  
In R&S SMW, however, you define how the generated I/Q streams are mapped to the available output connectors.
- The default stream mapping is compatible to the R&S SMU capabilities.
- You have basically two possibilities to route the signal and map the streams:
  - drag and drop blocks
  - use the new dedicated functional block, the "I/Q Stream Mapper", and the corresponding dialog

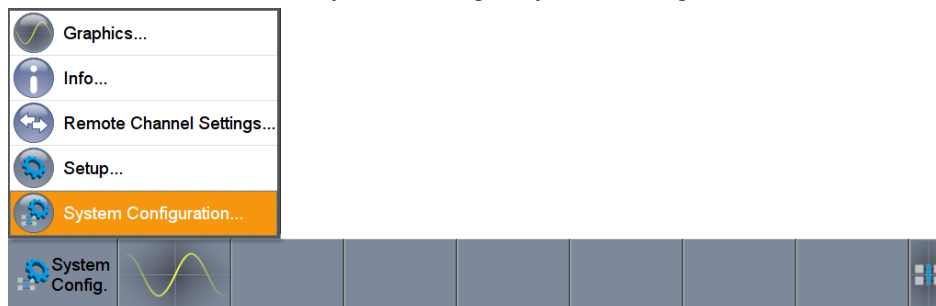


To route a stream, tap on the switching matrix.

See [Chapter 3.3.5, "Routing the Signal through the Instrument and Defining the Output Connectors"](#), on page 76 for a description of how this works.

## A.9 Support of Versatile MIMO and Multi-Entity Configurations

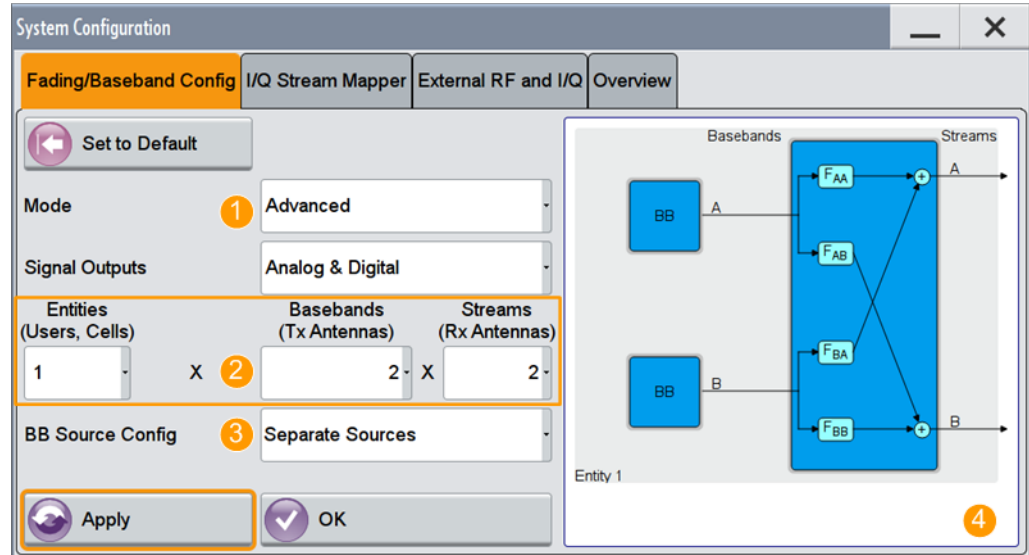
- In R&S SMU, you select a 2x2 MIMO configuration under the "Fading" block. To support higher order MIMO configurations, the R&S SMW introduces the "System Configuration" settings and the concept of multi-entity operation.
- To access the "System Configuration" function, perform one of the following:
  - On the "Taskbar", select "System Config > System Configuration"



- In the block diagram, select "I/Q Stream Mapper" and select the "Fading/Baseband Configuration" tab.

**Example:**

To enable a 2x2 MIMO configuration, open the "System Configuration > Fading/Baseband Configuration" dialog and enable the following setting.



**Figure A-1: System Configuration in the "Advanced Mode" (1x2x2 configuration)**

1 = advanced mode, required for configuration of complex LxNxM MIMO scenarios

2 = current signal routing; 2x2 MIMO configuration

3 = separated and coupled baseband sources

4 = simplified preview diagram of the particular configuration

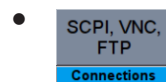
## A.10 Info Manager and Remote Indication

- The R&S SMW does not permanently display the "Info" line. It appears when an event occurs.

A remote operation is indicated by:



Symbol displayed in the status bar.



Information on the used remote channels displayed in the task bar.

## A.11 Operating System

The R&S SMU is based on Microsoft Windows, the R&S SMW on Linux embedded.

Consider the following main differences:

- Shorter boot time and higher level of security
- Changed file system structure

	R&S SMU	R&S SMW
Standard path for user data	D:\	/var/user
System files	C:\	not visible
USB memory stick	E:\	/var/usb

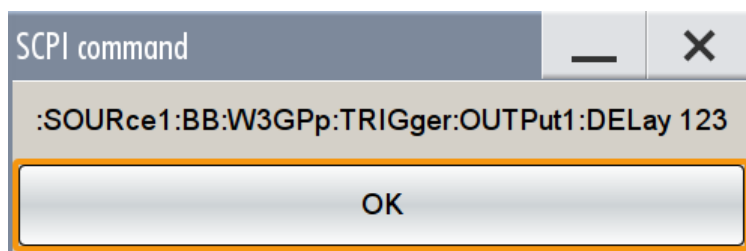
## A.12 Remote Control, Remote Operation and File Transfer

- Changes in Hostname Syntax  
If you are using remote control scripts which access an instrument in the LAN with the computer name (hostname), note that from **FW version 3.20.200.xx** the syntax for the **R&S SMW** has changed, complying to latest conventions of Rohde & Schwarz.  
The modification applies to the R&S SMW, and the corresponding FW version, it does not affect instruments of the R&S SMU family.  
Note also, that a Factory Preset resets the computer name, i.e. depending on the installed firmware version the computer name may change compared to the past.  
**Example:**  
The default hostname of an R&S SMW with a serial number 100007 will be SMW200A-100007 (previous name `rssmw200a100007`).
- Compatibility  
The R&S SMW is code compatible with the R&S SMU as far as it is possible. To allow you to use your existing scripts, modify the answers to the requests `*IDN?` and `OPT?`.
- Speeding up the development  
The R&S SMW introduces several new features to simplify your development task, like writing a remote script.
  - Indication of the complete SCPI command string corresponding to a manual selection  
**Example:** Finding out the SCPI command for setting a Marker2 delay of 123 chips in the 3GPP FDD standard  
Open the context menu for the parameter (tap and hold) and select "Show SCPI command" to get the complete string.



Show SCPI command





- Color indication of all parameters changed from preset state
- Record of all SCPI commands during manual operation
- Saving the current instrument configuration as a SCPI list
- Generation of source code (NI LabWindows, Matlab, etc.) instead of plain SCPI list
- Remote operation  
The preferred method for remote operation of R&S SMU is the Windows Remote Desktop.  
A remote access to the R&S SMW is provided by the VNC protocol. Some of its advantages:
  - You can use any internet browser
  - dedicated VNC viewer clients are available for all operating systems or terminals, like smart phones and tablet PCs.
  - Supported concurrent operation with a local user and one or more remote users
- File transfer  
To transfers files from and to the instrument, use the ftp or smb/samba protocols. Refer to Application Note 1GP72 "Connectivity of Signal Generators" (provided on the CD).

## B Reference Information for Remote Control

### B.1 Additional Basics on Remote Control

This section provides basic information using the remote control.

#### B.1.1 Messages

The messages transferred on the data lines are divided into the following categories:

- **Interface messages**  
Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They are used to communicate between the controller and the instrument. Interface messages can only be sent by instruments that have GPIB bus functionality. For details see the sections for the required interface.
- **Instrument messages**  
Instrument messages are employed in the same way for all interfaces, if not indicated otherwise in the description. Structure and syntax of the instrument messages are described in [Chapter B.1.3, "SCPI Command Structure"](#), on page 1115. A detailed description of all messages available for the instrument is provided in the chapter "Remote Control Commands".  
There are different types of instrument messages, depending on the direction they are sent:
  - Commands
  - Instrument responses

#### Commands

Commands (program messages) are messages the controller sends to the instrument. They operate the instrument functions and request information. The commands are subdivided according to two criteria:

- According to the effect they have on the instrument:
  - **Setting commands** cause instrument settings such as a reset of the instrument or setting the frequency.
  - **Queries** cause data to be provided for remote control, e.g. for identification of the instrument or polling a parameter value. Queries are formed by directly appending a question mark to the command header.
- According to their definition in standards:
  - **Common commands**: their function and syntax are precisely defined in standard IEEE 488.2. They are employed identically on all instruments (if implemented). They refer to functions such as management of the standardized status registers, reset and self-test.
  - **Instrument control commands** refer to functions depending on the features of the instrument such as frequency settings. Many of these commands have also been standardized by the SCPI committee. These commands are marked as

"SCPI confirmed" in the command reference chapters. Commands without this SCPI label are device-specific; however, their syntax follows SCPI rules as permitted by the standard.

### Instrument responses

Instrument responses (response messages and service requests) are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

## B.1.2 LAN Interface Messages

In the LAN connection, the interface messages are called low-level control messages. These messages can be used to emulate interface messages of the GPIB bus.

Command	Long term	Effect on the instrument
&ABO	Abort	Aborts processing of the commands just received.
&DCL	Device Clear	Aborts processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
&GTL	Go to Local	Transition to the "local" state (manual control). (The instrument automatically returns to remote state when a remote command is sent UNLESS &NREN was sent before.)
&GTR	Go to Remote	Enables automatic transition from local state to remote state by a subsequent remote command (after &NREN was sent).
&GET	Group Execute Trigger	Triggers a previously active instrument function (e.g. a sweep). The effect of the command is the same as with that of a pulse at the external trigger signal input.
&LLO	Local Lockout	Disables transition from remote control to manual control by means of the front panel keys.
&NREN	Not Remote Enable	Disables automatic transition from local state to remote state by a subsequent remote command. (To re-activate automatic transition use &GTR.)
&POL	Serial Poll	Starts a serial poll.

## B.1.3 SCPI Command Structure

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (keywords). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.

### B.1.3.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (\*) and possibly one or more parameters.

#### Examples:

*RST	RESET	Resets the instrument.
*ESE	EVENT STATUS ENABLE	Sets the bits of the event status enable registers.
*ESR?	EVENT STATUS QUERY	Queries the contents of the event status register.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.

### B.1.3.2 Syntax for Device-Specific Commands



Not all commands used in the following examples are necessarily implemented in the instrument.

For demonstration purposes only, assume the existence of the following commands for this section:

- DISPLAY[:WINDow<1...4>]:MAXimize <Boolean>
- FORMAT:READings:DATA <type>[,<length>]
- HCOpy:DEvice:COLor <Boolean>
- HCOpy:DEvice:CMAP:COLor:RGB <red>,<green>,<blue>
- HCOpy[:IMMediate]
- HCOpy:ITEM:ALL
- HCOpy:ITEM:LABel <string>
- HCOpy:PAGE:DIMensions:QUADrant [<N>]
- HCOpy:PAGE:ORientation LANDscape | PORTrait
- HCOpy:PAGE:SCALE <numeric value>
- MMEMory:COpy <file\_source>,<file\_destination>
- SENSE:BANDwidth|BWIDth[:RESolution] <numeric\_value>
- SENSE:FREQuency:STOP <numeric value>
- SENSE:LIST:FREQuency <numeric\_value>{,<numeric\_value>}

#### Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

**Example:**

HCOPY:DEVIce:COLor ON is equivalent to HCOP:DEV:COL ON.

**Case-insensitivity**

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

**Numeric suffixes**

If a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command. Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

**Example:**

Definition: HCOpy:PAGE:DIMensions:QUADrant [<N>]

Command: HCOP:PAGE:DIM:QUAD2

This command refers to the quadrant 2.

**Different numbering in remote control**

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

**Optional mnemonics**

Some command systems permit certain mnemonics to be inserted into the header or omitted. These mnemonics are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

**Example:**

Definition: HCOpy[:IMMediate]

Command: HCOP:IMM is equivalent to HCOP



### Optional mnemonics with numeric suffixes

Do not omit an optional mnemonic if it includes a numeric suffix that is relevant for the effect of the command.

#### Example:

Definition: `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`

Command: `DISP:MAX ON` refers to window 1.

In order to refer to a window other than 1, you must include the optional `WINDow` parameter with the suffix for the required window.

`DISP:WIND2:MAX ON` refers to window 2.

### Parameters

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (.). For a description of the parameter types, refer to [Chapter B.1.3.3, "SCPI Parameters"](#), on page 1119.

#### Example:

Definition: `HCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`

Command: `HCOP:DEV:CMAP:COL:RGB 3,32,44`

## Special characters

	<p><b>Parameters</b></p> <p>A vertical stroke in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used.</p> <p><b>Example:</b></p> <p>Definition:HCOPy:PAGE:ORIENTATION LANDscape   PORTRait</p> <p>Command HCOP:PAGE:ORI LAND specifies landscape orientation</p> <p>Command HCOP:PAGE:ORI PORT specifies portrait orientation</p> <p><b>Mnemonics</b></p> <p>A selection of mnemonics with an identical effect exists for several commands. These mnemonics are indicated in the same line; they are separated by a vertical stroke. Only one of these mnemonics needs to be included in the header of the command. The effect of the command is independent of which of the mnemonics is used.</p> <p><b>Example:</b></p> <p>DefinitionSENSE:BANDwidth BWIDTH[:RESolution] &lt;numeric_value&gt;</p> <p>The two following commands with identical meaning can be created:</p> <p>SENS:BAND:RES 1</p> <p>SENS:BWID:RES 1</p>
[]	<p>Mnemonics in square brackets are optional and may be inserted into the header or omitted.</p> <p><b>Example:</b> HCOPy[:IMMEDIATE]</p> <p>HCOP:IMM is equivalent to HCOP</p>
{ }	<p>Parameters in curly brackets are optional and can be inserted once or several times, or omitted.</p> <p><b>Example:</b> SENSE:LIST:FREQUENCY &lt;numeric_value&gt;{,&lt;numeric_value&gt;}</p> <p>The following are valid commands:</p> <p>SENS:LIST:FREQ 10</p> <p>SENS:LIST:FREQ 10,20</p> <p>SENS:LIST:FREQ 10,20,30,40</p>

### B.1.3.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). Allowed parameters are:

- Numeric values
- Special numeric values
- Boolean parameters
- Text
- Character strings
- Block data

The parameters required for each command and the allowed range of values are specified in the command description.

### Numeric values

Numeric values can be entered in any form, i.e. 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 lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Allowed unit prefixes are G (giga), MA (mega), MOHM and MHZ (are also allowed), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

**Example:** `SENS:FREQ:STOP 1.5GHz = SENS:FREQ:STOP 1.5E9`

### Units

For physical quantities, the unit can be entered. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

If the unit is missing, the basic unit is used.

### Example:

`SENSe:FREQ:STOP 1.5GHz = SENSe:FREQ:STOP 1.5E9`

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the `PCT` string.

### Example:

`HCOP:PAGE:SCAL 90PCT`

### Special numeric values

The texts listed below are interpreted as special numeric values. In the case of a query, the numeric value is provided.

- **MIN/MAX**  
MINimum and MAXimum denote the minimum and maximum value.
- **DEF**  
DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the `*RST` command.
- **UP/DOWN**  
UP, DOWN increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.
- **INF/NINF**



INFINITY, Negative INFINITY (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.

- **NAN**

Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument 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.

**Example:**

Setting command: `SENSe:LIST:FREQ MAXimum`

Query: `SENS:LIST:FREQ?`, Response: `3.5E9`



**Queries for special numeric values**

The numeric values associated to `MAXimum`/`MINimum`/`DEFault` can be queried by adding the corresponding mnemonics to the command. They must be entered following the quotation mark.

Example: `SENSe:LIST:FREQ? MAXimum`

Returns the maximum numeric value as a result.

**Boolean Parameters**

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0. The numeric values are provided as the response for a query.

**Example:**

Setting command: `HCOpy:DEV:COL ON`

Query: `HCOpy:DEV:COL?`

Response: `1`

**Text parameters**

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

**Example:**

Setting command: `HCOpy:PAGE:ORientation LANDscape`

Query: `HCOp:PAGE:ORI?`

Response: `LAND`

**Character strings**

Strings must always be entered in quotation marks (' or ").

**Example:**

```
HCOP:ITEM:LABel "Test1" or HCOP:ITEM:LABel 'Test1'
```

**Block data**

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

**Example:**

```
FORMat:READings:DATA #45168xxxxxxxx
```

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted.

#0 specifies a data block of indefinite length. The use of the indefinite format requires a `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

**B.1.3.4 Overview of Syntax Elements**

The following table provides an overview of the syntax elements:

:	The colon separates the mnemonics 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 (both single and double quotation marks are possible).
#	The hash symbol introduces binary, octal, hexadecimal and block data. <ul style="list-style-type: none"> <li>• Binary: #B10110</li> <li>• Octal: #O7612</li> <li>• Hexa: #HF3A7</li> <li>• Block: #21312</li> </ul>
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

**B.1.3.5 Structure of a command line**

A command line may consist of one or several commands. It is terminated by one of the following:

- a <New Line>
- a <New Line> with EOI
- an EOI together with the last data byte

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

**Example:**

```
MMEM: COPY "Test1", "MeasurementXY"; :HCOP: ITEM ALL
```

This command line contains two commands. The first command belongs to the MMEM system, the second command belongs to the HCOP system.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

**Example:**

```
HCOP: ITEM ALL; :HCOP: IMM
```

This command line contains two commands. Both commands are part of the HCOP command system, i.e. they have one level in common.

When abbreviating the command line, the second command begins with the level below HCOP. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

```
HCOP: ITEM ALL; IMM
```

A new command line always begins with the complete path.

**Example:**

```
HCOP: ITEM ALL
```

```
HCOP: IMM
```

### B.1.3.6 Responses to Queries

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

- The requested parameter is transmitted without a header.  
**Example:** `HCOP: PAGE: ORI?`, **Response:** `LAND`
- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.  
**Example:** `SENSe: FREQuency: STOP? MAX`, **Response:** `3.5E9`

- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the `Unit` command. The response `3.5E9` in the previous example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as 0 (for OFF) and 1 (for ON).

**Example:**

Setting command: `HCOPY:DEV:COL ON`

Query: `HCOPY:DEV:COL?`

Response: 1

- Text (character data) is returned in a short form.

**Example:**

Setting command: `HCOPY:PAGE:ORIENTATION LANDscape`

Query: `HCOPY:PAGE:ORI?`

Response: LAND

## B.1.4 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command always completes executing before the next command starts. Commands that are processed quickly are defined as sequential commands. They are not implemented in the instrument. However, the execution time of most of the commands is so short that they act as sequential commands, if they are sent in separate command lines.
- An overlapping command is still running when the next command starts. Usually, an overlapping command takes a certain time to process its task, and thus allows the program to execute other tasks, while it is still running. If overlapping commands have to follow a specific order, for example to avoid incorrect measurement readings, they must be executed in sequence. This is called synchronization between the controller and the instrument.

Several setting commands within a command line are not necessarily processed in the order they are received. Even if they are implemented as sequential commands. To follow a particular sequence, send each command in a separate line.



As a rule, send commands and queries in different program messages.

### B.1.4.1 Preventing Overlapping Execution

To prevent an overlapping execution of commands, one of the commands `*OPC`, `*OPC?` or `*WAI` can be used. All three commands cause a certain action only to be carried out after the hardware has been set. By suitable programming, the controller can be forced to wait for the corresponding action to occur.

**Table B-1: Synchronization using \*OPC, \*OPC? and \*WAI**

Command	Action	Programming the controller
*OPC	Sets the Operation Complete bit in the ESR after all previous commands have been executed.	<ul style="list-style-type: none"> <li>Setting bit 0 in the ESE</li> <li>Setting bit 5 in the SRE</li> <li>Waiting for service request (SRQ)</li> </ul>
*OPC?	Stops command processing until 1 is returned. This is only the case after the Operation Complete bit has been set in the ESR. This bit indicates that the previous setting has been completed.	Sending *OPC? directly after the command whose processing should be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Sending *WAI directly after the command whose processing should be terminated before other commands are executed.

Command synchronization using \*WAI or \*OPC? appended to an overlapped command is a good choice if the overlapped command takes only little time to process. The two synchronization techniques simply block overlapped execution of the command.

For time consuming overlapped commands it is usually desirable to allow the controller or the instrument to do other useful work while waiting for command execution. Use one of the following methods:

#### **\*OPC with a service request**

1. Set the OPC mask bit (bit no. 0) in the ESE: \*ESE 1
2. Set bit no. 5 in the SRE: \*SRE 32 to enable ESB service request.
3. Send the overlapped command with \*OPC
4. Wait for a service request

The service request indicates that the overlapped command has finished.

#### **\*OPC? with a service request**

1. Set bit no. 4 in the SRE: \*SRE 16 to enable MAV service request.
2. Send the overlapped command with \*OPC?
3. Wait for a service request

The service request indicates that the overlapped command has finished.

#### **Event Status Register (ESE)**

1. Set the OPC mask bit (bit no. 0) in the ESE: \*ESE 1
2. Send the overlapped command without \*OPC, \*OPC? or \*WAI
3. Poll the operation complete state periodically (by means of a timer) using the sequence: \*OPC; \*ESR?

A return value (LSB) of 1 indicates that the overlapped command has finished.

**\*OPC? with short timeout**

1. Send the overlapped command without \*OPC, \*OPC? or \*WAI
2. Poll the operation complete state periodically (by means of a timer) using the sequence: <short timeout>; \*OPC?
3. A return value (LSB) of 1 indicates that the overlapped command has finished. In case of a timeout, the operation is ongoing.
4. Reset timeout to former value
5. Clear the error queue with `SYStem:ERRor?` to remove the "-410, Query interrupted" entries.

**Using several threads in the controller application**

As an alternative, provided the programming environment of the controller application supports threads, separate threads can be used for the application GUI and for controlling the instrument(s) via SCPI.

A thread waiting for a \*OPC? thus will not block the GUI or the communication with other instruments.

**B.1.4.2 Examples to Command Sequence and Synchronization**

See the following examples to command sequences and synchronization. Some examples given illustrate possible constellations for overlapping tasks.

**Example: Commands and queries in one message**

The response to a query combined in a program message with commands that affect the queried value is not predictable.

The following commands always return the specified result:

```
:FREQ:STAR 1GHZ;SPAN 100 :FREQ:STAR?
```

Result:

```
1000000000 (1 GHz)
```

Whereas the result for the following commands is not specified by SCPI:

```
:FREQ:STAR 1GHz;STAR?;SPAN 1000000
```

The result could be the value of `START` before the command was sent since the instrument might defer executing the individual commands until a program message terminator is received. The result could also be 1 GHz if the instrument executes commands as they are received.

**Example: Overlapping command with \*OPC**

The instrument implements \*RST as an overlapped command. Assuming that \*RST takes longer to execute than \*OPC, sending the following command sequence results in initiating a reset and, after some time, setting the OPC bit in the ESR:

```
*RST; *OPC
```

Sending the following commands still initiates a reset:

```
*RST; *OPC; *CLS
```

However, since the operation is still pending when the instrument executes \*CLS, forcing it into the "Operation Complete Command Idle" State (OCIS), \*OPC is effectively skipped. The OPC bit is not set until the instrument executes another \*OPC command.

**Example: Overlapped command followed by non-conflicting commands**

Suppose that the instrument is switched on to provide a real time test signal that requires some calculation time. At the same time, some settings for the configuration of a different signal are made which do not interact with the generated signal (for example the signal may be used later on). The signal generation and the signal configuration are independent from each other, so there is no need to synchronize the following overlapped commands:

```
SOUR:BB:3GPP:STAT ON  
SOUR:BB:GSM:FORM FSK2
```

**Example: Overlapped command followed by conflicting commands**

Suppose that the generator is switched on to provide a real time test signal that requires some calculation time. This signal is to be added to a waveform from the second baseband generator. In this case, the application program has to make sure that the real signal is available in the added signal before further action is started. This involves an appropriate synchronization technique for the first command (the following sequence assumes an appropriate routing):

```
SOUR:BB:3GPP:STAT ON
```

The instrument waits until command has finished.

```
SOUR2:BB:GSM:STAT ON
```

Depending on the selected synchronization techniques, non-conflicting commands can be executed while waiting until the synchronized overlapped command has finished.

**Example: Polling the progress of the zeroing process**

Suppose that you start the zeroing for a connected power sensor via the remote control command `SENS1:ZERO`. This process blocks the processing of further tasks during execution. The query for completeness is performed with the `*OPC?` command. It returns a 1 in the output buffer when the process is completed.

```
SENS:ZERO;*OPC?
```

Instead of waiting via `*OPC?`, you can perform alternative tasks while the zeroing is running, as for example updating the GUI or adjusting other instruments. Synchronize the commands by querying the progress of the zeroing process periodically via the event status register `*ESR?:`

```
*SRE 32
```

Sets the service request enable. The bit is set when an event in the event status register occurs.

```
*ESE 1
```

Configures the mask of the event status register to "Operation Complete".

```
SENS:ZERO;*OPC
```

Sets the evaluation via the status byte query. It uses `*OPC?` as the reference.

```
*CLS
```

Clears all status registers.

Even if the instrument is busy, you can perform this procedure, since the query is executed in a subchannel.

## B.1.5 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue.

You can query both with the commands of the [STATus Subsystem](#).

### B.1.5.1 Hierarchy of the Status Registers

The [Figure B-1](#) shows the hierarchical structure of information in the status registers (ascending from left to right).



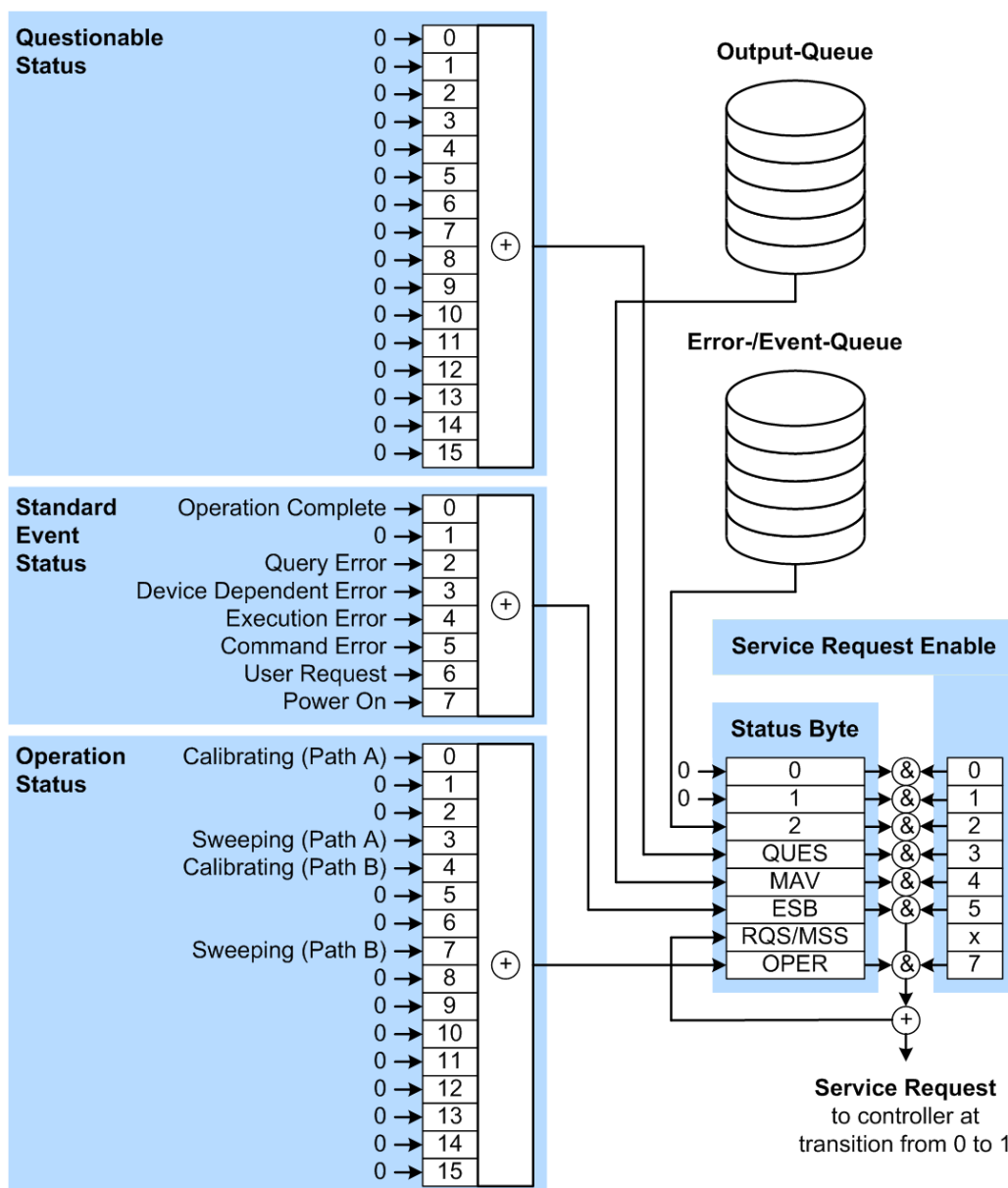


Figure B-1: Graphical overview of the status registers hierarchy

- OPER = Operation Status Summary Bit
- RQS/MSS = Service Request Generation
- ESB = Standard Event Status Summary Bit
- MAV = Message Available in Output Queue
- QUES = Questionable Status Summary Bit
- 2 = Error- /Event-Queue
- 1, 0 = not used

**Note:** This legend explains the abbreviations to the Status Byte Register.

The R&S SMW uses the following status registers:

- **Status Byte (STB)** and **Service Request Enable (SRE)**, see [Chapter B.1.5.3, "Status Byte \(STB\) and Service Request Enable Register \(SRE\)"](#), on page 1132.

- **Standard Event Status**, i.e. the Event status Register (ESR) and the Event Status Enable (ESE), see [Chapter B.1.5.4, "Event Status Register \(ESR\) and Event Status Enable Register \(ESE\)"](#), on page 1133.
- **Questionable Status and Operation Status**, the (SCPI status registers, see [Chapter B.1.5.2, "Structure of a SCPI Status Register"](#), on page 1130, [Chapter B.1.5.5, "Questionable Status Register \(STATus:QUESTionable\)"](#), on page 1133 and [Chapter B.1.5.6, "Operation Status Register \(STATus:OPERation\)"](#), on page 1134.
- **Output-Queue**  
The output queue contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in the overview.
- **Error- /Event-Queue**  
The error-/event-queue contains all errors and events that have occurred in the past. When reading the queue, the instrument starts with the first occurred error/ event.

All status registers have the same internal structure.



**SRE, ESE**

The service request enable register SRE can be used as ENABLE part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be used as the ENABLE part of the ESR.

**B.1.5.2 Structure of a SCPI Status Register**

Each standard SCPI register consists of 5 parts. Each part has a width of 16 bits and has different functions. The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integers.

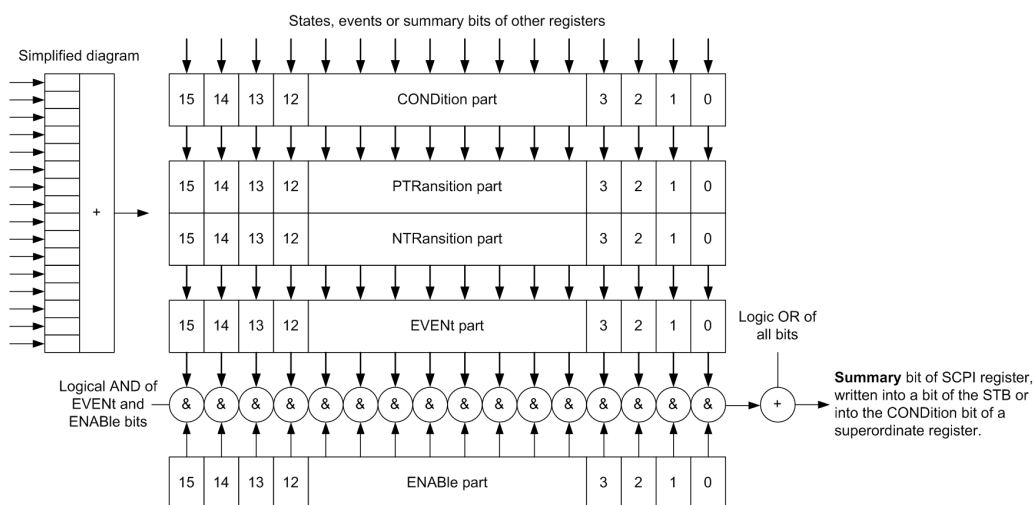


Figure B-2: The status-register model

### Description of the five status register parts

The five parts of a SCPI register have different properties and functions:

- **CONDition**

The **CONDition** part is written into directly by the hardware or the sum bit of the next lower register. Its contents reflect the current instrument status. This register part can only be read, but not written into or cleared. Its contents are not affected by reading.

- **PTRansition / NTRansition**

The two transition register parts define which state transition of the **CONDition** part (none, 0 to 1, 1 to 0 or both) is stored in the **EVENT** part.

The **Positive-TRansition** part acts as a transition filter. When a bit of the **CONDition** part is changed from 0 to 1, the associated **PTR** bit decides 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 into and read as required. Its contents are not affected by reading.

The **Negative-TRansition** part also acts as a transition filter. When a bit of the **CONDition** part is changed from 1 to 0, the associated **NTR** bit decides 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 into and read as required. Its contents are not affected by reading.

- **EVENT**

The **EVENT** part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument. This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.

- **ENABLE**

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 into and read by the user as required. Its contents are not affected by reading.

### Sum bit

The sum bit is obtained from the **EVENT** and **ENABLE** part for each register. The result is then entered into a bit of the **CONDition** part of the higher-order register.

The instrument automatically generates the sum bit for each register. Thus an event can lead to a service request throughout all levels of the hierarchy.

### B.1.5.3 Status Byte (STB) and Service Request Enable Register (SRE)

The `STatus Byte` (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. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

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

The `STatus Byte` (STB) is linked to the `Service Request Enable` (SRE) register. Each bit of the STB is assigned a bit in 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. The SRE can be set using the command `*SRE` and read using the command `*SRE?`.

**Table B-2: Meaning of the bits used in the status byte**

Bit No.	Meaning
0...1	Not used
2	Error Queue not empty The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a service request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with remote control.
3	QUESTIONable status register summary bit The bit is set if an <code>EVENT</code> bit is set in the <code>QUESTIONable</code> status register and the associated <code>ENABLE</code> bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by querying the <code>STATUS:QUESTIONable</code> status register.
4	MAV bit (message available) The bit is set if a message is available in the output queue which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller.
5	ESB bit Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	MSS bit (master status summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	<code>STATUS:OPERation</code> status register summary bit The bit is set if an <code>EVENT</code> bit is set in the <code>OPERation</code> status register and the associated <code>ENABLE</code> bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by querying the <code>STATUS:OPERation</code> status register.

#### B.1.5.4 Event Status Register (ESR) and Event Status Enable Register (ESE)

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

The ESE corresponds to the `ENABLE` part of a SCPI register. If a bit is set in the ESE and the associated bit in the ESR changes from 0 to 1, the ESB bit in the STB is set. The ESE register can be set using the command `*ESE` and read using the command `*ESE?`.

**Table B-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 <code>*OPC</code> exactly when all previous commands have been executed.
1	Not used
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 faulty 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.
4	Execution Error This bit is set if a received command is syntactically correct but cannot be performed 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.
5	Command Error This bit is set if a command is received, which is undefined or syntactically incorrect. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue.
6	User Request This bit is set when the instrument is switched over to manual control.
7	Power On (supply voltage on) This bit is set on switching on the instrument.

#### B.1.5.5 Questionable Status Register (STATus:QUESTionable)

This register contains information on questionable instrument states. Such states may occur when the instrument is not operated in compliance with its specifications.

To read the register, use the query commands `STAT:QUEST:COND?` or `STAT:QUEST[:EVEN]?`.

*Table B-4: Meaning of the bits used in the questionable status register*

Bit No.	Meaning
0–15	Not used

### B.1.5.6 Operation Status Register (STATus:OPERation)

This condition part contains information on the actions currently being performed by the instrument, while the event part contains information on the actions performed by the instrument since the last readout of the register.

To read the register, use the query commands `STAT:OPER:COND?` or `STAT:OPER[:EVEN]?`.

*Table B-5: Meaning of the bits used in the operation status register*

Bit No.	Meaning
0	Calibrating
4	The bit is set during the calibration phase.
1–2	Not used
5–6	
3	Sweeping
7	This bit is set during a sweep in automatic or single mode.
8–15	Not used

### B.1.5.7 Application of the Status Reporting System

The purpose of the status reporting system is to monitor the status of one or several devices in a measuring system. To do this and react appropriately, the controller must receive and evaluate the information of all devices. The following standard methods are used:

- **Service request** (SRQ) initiated by the instrument
- **Serial poll** of all devices in the bus system, initiated by the controller to find out who sent an SRQ and why
- Query of a **specific instrument status** by commands
- Query of the **error queue**

#### Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. An SRQ is always initiated if one or several of bits 2, 4 or 5 of the status byte are set and enabled in the SRE. Each of these bits combines the information of the error queue or the output buffer. To use the possibilities of the service request effectively, all bits should be set to "1" in the enable registers SRE and ESE.

**Example:**

Use command `*OPC` to generate an SRQ .

`*ESE 1` - set bit 0 of ESE (Operation Complete)

`*SRE 32` - set bit 5 of SRE (ESB).

After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

**Serial Poll**

In a serial poll, just as with command `*STB`, the status byte of an instrument is queried. However, the query is realized via interface messages and is thus clearly faster.

The serial poll method is defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the controller.

**Query of an instrument status**

Each part of any status register can be read using queries. There are two types of commands:

- The common commands `*ESR?`, `*IDN?`, `*IST?`, `*STB?` query the higher-level registers.
- The commands of the `STATus` system query the SCPI registers (`STATus:QUEStionable...`)

The returned value is always a decimal number that represents the bit pattern of the queried register. This number is evaluated by the controller program.

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

**Error Queue**

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain text error messages that can be looked up in the Error Log or queried via remote control using `SYSTem:ERRor[:NEXT]?` or `SYSTem:ERRor:ALL?`. Each call of `SYSTem:ERRor[:NEXT]?` provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

### B.1.5.8 Reset Values of the Status Reporting System

The following table contains the different commands and events causing the status reporting system to be reset. None of the commands, except of \*RST and SYSTem:PRESet affect the functional instrument settings. In particular, DCL does not change the instrument settings.

**Table B-6: Resetting the status reporting system**

Event	Switching on supply voltage Power-On-Status-Clear		DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem: PRESet	STATus: PRESet	*CLS
	0	1				
Clear STB, ESR	-	Yes	-	-	-	Yes
Clear SRE, ESE	-	Yes	-	-	-	-
Clear PPE	-	Yes	-	-	-	-
Clear error queue	Yes	Yes	-	-	-	Yes
Clear output buffer	Yes	Yes	Yes	1)	1)	1)
Clear command processing and input buffer	Yes	Yes	Yes	-	-	-

1) The first command in a command line that immediately follows a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

## B.1.6 General Programming Recommendations

### Initial instrument status before changing settings

Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the instrument status. Thus, when a command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the \*RST command) and then implement the required settings.

### Command sequence

As a general rule, send commands and queries in different program messages. Otherwise, the result of the query may vary depending on which operation is performed first (see also Preventing Overlapping Execution).

### Reacting to malfunctions

The service request is the only possibility for the instrument to become active on its own. Each controller program should instruct the instrument to initiate a service



request in case of malfunction. The program should react appropriately to the service request.

### Error queues

The error queue should be queried after every service request in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

## B.2 Telnet program examples

The following program example shows a simple `TcpClient` class that is intended to explain on how to get started with programming of sockets.

The example sets up a socket communication to R&S SMW and opens a simple user interface, very similar to the telnet, which allows input of commands. To enable real automation, further development of the program is required.

### TcpClient.h

```
#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent      HostInfoStruct;
class TcpClient
{
public:
    TcpClient();
    ~TcpClient();
    void connectToServer( string &hostname, int port );
    void disconnect( );
    void transmit( string &txString );
    void receive( string &rxString );
    string getCurrentHostName( ) const;
    int    getCurrentPort( ) const;
private:
    string      currentHostName;
    int         currentPort;
    int         currentSocketDescr;
    SockAddrStruct  serverAddress;
    HostInfoStruct * currentHostInfo;
    bool        clientIsConnected;
    int         receiveBufferSize;
};
```

**TcpClient.cpp**

```

#include <string>
//defines structs for socket handling
#include <netinet/in.h>
using namespace std;
typedef struct sockaddr_in SockAddrStruct;
typedef struct hostent      HostInfoStruct;
class TcpClient
{
public:
    TcpClient();
    ~TcpClient();
    void connectToServer( string &hostname, int port );
    void disconnect( );
    void transmit( string &txString );
    void receive( string &rxString );
    string getCurrentHostName( ) const;
    int    getCurrentPort( ) const;
private:
    string      currentHostName;
    int         currentPort;
    int         currentSocketDescr;
    SockAddrStruct  serverAddress;
    HostInfoStruct * currentHostInfo;
    bool        clientIsConnected;
    int         receiveBufferSize;
};

#include <netdb.h>
#include <netinet/in.h>
#include <unistd.h>
#include "TcpClient.h"
TcpClient::TcpClient()
: currentHostName( "" )
, currentPort( 0 )
, currentSocketDescr( 0 )
, serverAddress ( )
, currentHostInfo( NULL )
, clientIsConnected( false )
, receiveBufferSize( 1024 )
{
}
TcpClient::~~TcpClient()
{
    currentHostInfo = NULL;
}

void TcpClient::connectToServer( string &hostname, int port )
{

```

```

currentHostInfo = gethostbyname( hostname.c_str( ) );
if( currentHostInfo == NULL )
{
    currentHostName = "";
    currentPort = 0;
    currentHostInfo = NULL;
    clientIsConnected = false;
    printf("error connecting host\n" );
}
currentHostName = hostname;
currentPort = port;
currentSocketDescr = socket(AF_INET, SOCK_STREAM, 0);
if( currentSocketDescr == 0 )
{
    currentHostName = "";
    currentPort = 0;
    currentHostInfo = NULL;
    clientIsConnected = false;
    printf("can't create socket\n" );
}
serverAddress.sin_family = currentHostInfo->h_addrtype;
serverAddress.sin_port = htons( currentPort );
memcpy( (char *) &serverAddress.sin_addr.s_addr,
currentHostInfo->h_addr_list[0], currentHostInfo->h_length );
if( connect( currentSocketDescr, ( struct sockaddr *) &serverAddress,
sizeof( serverAddress ) ) < 0 )
{
    throw string("can't connect server\n" );
}
clientIsConnected = true;
}
void TcpClient::disconnect( )
{
    if( clientIsConnected )
    {
        close( currentSocketDescr );
    }
    currentSocketDescr = 0;
    currentHostName = "";
    currentPort = 0;
    currentHostInfo = NULL;
    clientIsConnected = false;
}
void TcpClient::transmit( string &txString )
{
    if( !clientIsConnected )
    {
        throw string("connection must be established before any data can be sent\n");
    }
    char * transmitBuffer = new char[txString.length() +1];

```

```

memcpy( transmitBuffer, txString.c_str(), txString.length() );
transmitBuffer[txString.length()] = '\n'; //newline is needed!
if( send( currentSocketDescr, transmitBuffer, txString.length() + 1, 0 ) < 0 )
{
    throw string("can't transmit data\n");
}
delete [] transmitBuffer;
}
void TcpClient::receive( string &rxString )
{
    if( !clientIsConnected )
    {
        throw string("connection must be established before any data can be received\n");
    }
    char * receiveBuffer = new char[receiveBufferSize];
    memset( receiveBuffer, 0, receiveBufferSize );
    bool receiving = true;
    while( receiving )
    {
        int receivedByteCount = recv( currentSocketDescr,
            receiveBuffer, receiveBufferSize, 0 );
        if( receivedByteCount < 0 )
        {
            throw string("error while receiving data\n");
        }
        rxString += string( receiveBuffer );
        receiving = ( receivedByteCount == receiveBufferSize );
    }
    delete [] receiveBuffer;
}
string TcpClient::getCurrentHostName( ) const
{
    return currentHostName;
}
int TcpClient::getCurrentPort( ) const
{
    return currentPort;
}

```

### TelnetClient.cpp

```

#include <iostream>
#include "TcpClient.h"
void printUsage()
{
    cout<<"usage: EthernetRawCommand <server-ip> [scpi-command]"<<endl;
}
int main( int argc, char *argv[] )
{
    int errorCode          = 0; //no error

```

```
bool useSingleCommand = false;
string singleCommand = "";
string hostname      = "";
int    port          = 5025;
string input         = "";
TcpClient client;
switch( argc )
{
    case 3:
        useSingleCommand = true;
        singleCommand    = argv[2];
    case 2:
        hostname         = argv[1];
        break;
    default:
        printUsage();
        return(-1);
}
try
{
    client.connectToServer( hostname, port );
    bool terminate = false;
    while( !terminate )
    {
        char buffer[1024];
        if( useSingleCommand )
        {
            input = singleCommand; //send string
        }
        else
        {
            cin.getline( buffer, 1024 );
            input = buffer;
            if( input == "end" )
            {
                terminate = true;
            }
        }
        if( !terminate)
        {
            client.transmit( input ); //send string
            int qPos = input.find( "?", 0 );
            //receive string only when needed
            if( qPos > 0 )
            {
                string rcStr = "";
                client.receive( rcStr );
                cout << rcStr << endl;
            }
        }
    }
}
```

```

        if( useSingleCommand )
        {
            terminate = true;
        }
    }
} catch( const string errorString )
{
    cout<<errorString<<endl;
}
client.disconnect( );
return errorCode;
}

```

### B.3 Extensions for User Files

The [Table B-7](#) lists all available file extensions for user files. The currently available files on the instrument depend on the installed options.

**Table B-7: List of the automatically assigned file extensions in the instrument**

Function/Digital Standard	List type	Contents	File suffix
Instrument State	Settings	Instrument settings	*.savrc.txt
License Key		License Key	*.xml
"User Correction"	List	User-defined level correction values	*.uco
"List Mode"	List	User-defined frequency/level value pairs	*.lsw
"BB Frequency Response Correction"	Settings	User-defined baseband frequency response correction file	*.frc
Cal. service	Settings	Calibration settings	*.calserv
Response File	Settings	Response file	*.txt
"Arbitrary Waveform Generator"	Waveform	ARB waveforms ARB multi-segment waveforms	*.wv
	Waveform	ARB multi-carrier settings	*.arb_multcar
	Configuration data	Configuration file for creation of multisegment ARB waveforms	*.inf_mswv
	Play List	ARB Sequencing List	*.wvs
"DM"	Data List	Digital modulation data	*.dm_iqd *.tdm
	Control List	Data to control digital modulation	*.dm_iqc
	Settings	Digital modulation settings	*.dm
	User Standard	Digital modulation user standard	*.dm_stu

Function/Digital Standard	List type	Contents	File suffix
	User Mapping	Digital modulation user mapping	*.vam
	User Filter	Digital modulation user filter	*.vaf
"NRP Settings"	Settings	R&S NRP Settings	*.nrp
SMZ Settings	Settings	R&S SMZ Settings	*.efmfirm
SCPI command list	List	Export file containing list of SCPIs	*.iee
"Envelope Tracking"	Setting	Envelope shaping function (shaping table)	*.iq_lut *.iq_lutpv
	Settings	Envelope shaping function (polynomial coefficients)	*.iq_poly
"Digital Predistortion"	Setting	Predistortion function (AM/AM and AM/PM shaping table)	*.dpd_magn *.dpd_phase
	Settings	Predistortion function (polynomial coefficients)	*.dpd_poly
"Fading"	Settings	Fading data	*.fad
	Settings	Vehicle description file	*.xvd
	Settings	Trajectory description file	*.xtd
"GSM/EDGE"	Settings	GSM/EDGE settings	*.gsm
	Slot	User-defined slot data	*.gsm_slu
	Frame	User-defined frame data	*.gsm_fu
	Slot	Higher symbol rate slot	*.gsm_hslu
	Frame	Higher symbol rate frame	*.gsm_hfu
"Bluetooth"	Bluetooth Settings	Complete setting of the Bluetooth menu	*.bto
"TETRA"	TETRA Settings	Complete setting of the TETRA menu	*.tetra
"3GPP FDD"	Settings	Complete setting of the 3GPP (FDD) menu	*.3g
	Settings	Channel coding enhanced DPCH channels (downlink)	*.3g_ccod_dl_s
	Settings	Channel coding enhanced DPCH channels (uplink)	*.3g_ccod_ul
	Settings	User scheduling	*.3g_sch
"CDMA2000"	Settings	Complete setting of the CDMA2000 menu	*.cdma2k
"TD-SCDMA2000"	Settings	Complete setting of the TD-SCDMA2000 menu	*.tdscdma
	Settings	Test Model for TD-SCDMA2000	*.tdtmd
"1xEV-DO"	Settings	Complete setting of the 1xEV-DO menu	*.evdo
"IEEE 802.11 n WLAN"	Settings	Complete setting of the IEEE 802.11 WLAN menu	*.wlann

Function/Digital Standard	List type	Contents	File suffix
	Settings	Beamforming data	*.bmf
"IEEE 802.16 WiMAX"	Settings	Complete setting of the IEEE 802.16 WiMAX menu	*.wimax
"EUTRA/LTE"	Settings	Complete setting of the EUTRA/LTE menu	*.eutra
	Settings	TDD Settings	*.lte_tdd
	Settings	User-defined IQ-File	*.iqw
"DVB"	Settings	Complete setting of the DVB menu	*.dvh
	Settings	DVB Transport Stream	*.gts *.ts *.trp



# C Elements and Controls of the Graphical User Interface

To get familiar with the display of the instrument, you find a summary description in the guide [Chapter 3.5.2, "Understanding the Display Information"](#), on page 105.

This overview in addition lists almost all functional elements of the user interface, and briefly explains the behavior when they are interactive. I.e. most of the elements are virtual keys you can use to open a corresponding menu or dialog.

## C.1 Elements in the Status Bar

Various status buttons in the status bar of the graphical user interface indicate the status of the RF output signals.

The following is an overview of the status buttons. They are shown in active and inactive state. When active, they change color and possibly the label. When inactive, some of the buttons are hidden.



### Remote

Indicates that the instrument is in remote control mode. The arrows are green, as long as a setting is performed. When completed, they are white.

**Hotspot** Return to manual control, as with the LOCAL key, see also [Chapter 12.18.3, "Remote Control States"](#), on page 713.



### Remote LLO

Indicates remote control state with local lockout enabled. The arrows are green, as long as a setting is performed. When completed, they are white.

This icon and the LOCAL key are locked, see also [Chapter 12.18.3, "Remote Control States"](#), on page 713.



### Freq

Label of the frequency entry filed of the corresponding RF path.

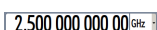
**Hotspot** Access to the "RF Freq / Phase..." dialog.



### Frequency Offset

A frequency offset is set for the RF signal. The icon appears instead of [Freq](#).

**Hotspot** Access to the "RF Frequency / Phase ..." dialog.



### <RF frequency>

Entry field for directly setting the RF frequency.



### RF Signal

Indicates the activity of the RF signal in the corresponding path.



**Hotspot** Access to the "RF On" entry in "RF Mod" block menu.



### Overload

The power of the external signal applied to the RF output is too high. The overload protection has tripped and the connection between the RF output and attenuator interrupted.

To activate RF input, reset the overload protection with the RF ON/OFF key.



### External Reference Frequency

Indicates a used external reference signal and the frequency of the signal.

**Hotspot** Access to the "Ext. Ref.\LO Coupling" tab in the "RF Frequency / Phase ..." dialog.



### Modulation

Indicates that the RF signal is modulated.



**Hotspot** Access to the "I/Q Modulator" and "Analog Modulation" dialogs.



### Sweep

Indicates that either the RF or LF signal is generated in sweep mode.

**Hotspot** Access to the "Sweep" settings.



### Busy

Indicates a running process, that means, settings or calculations are currently executed. If a process takes some time, the button displays the progress as a percentage.



### Recording

Indicates that recording is running.

**Hotspot** Access to the "SCPI Sequence" dialog.



### Lev

Label of the level entry filed of the corresponding RF path.

**Hotspot** Access to the "RF Level..." dialog.



### Level Offset & Level EMF Offset & Level Ucor & Level Digital Attenuation

This icon is displayed when you use functions or parameters that affect the RF output level. The icon appears instead of [Lev](#).

The label varies according to:

- A specified level offset ("Offs")
- The level displayed as voltage of EMF ("EMF")
- An activated user correction ("Ucor")
- A specified digital attenuation ("DigAtt")

If several settings are enabled, the symbol label combines the appropriate information according to the order and relevance.

**Hotspot** Access to the "RF Level / EMF ... " dialog.



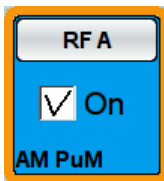
### <RF level>

Entry field for directly setting the RF level.

## C.2 Elements in the Block Diagram

Functional blocks, signal lines, and status indicators in the graphical user interface show the currently set configuration of signal generation in the baseband and in the RF domain.

The following is an overview of the elements in the block diagram status, where they appear and what they indicate. The elements are listed in the active state. When inactive, they change color and possibly the label, or they are not displayed.

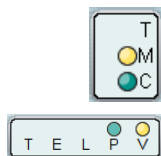


### Functional Block

Represents a basic task in signal generation. A block contains an on/off switch and a push button to access the associated settings dialogs.

**Hotspot** "RF x" opens the RF block menu.



**Hotspot** "Block" & "On" activate/deactivate the RF signal (toggle mode).



### Control Signal Blocks

Represent the control signals in the baseband domain (see first icon), and in the RF domain (2<sup>nd</sup> icon). A control block shows the signal content with letters and LEDs that indicate signal input or output.

The LEDs indicate:

-  that the signal is available at the output connector.
-  that the signal source is internal.

**Hotspot** Access to the corresponding connector dialogs.



### Signal Lines

Connecting lines between the blocks and connectors show the currently configured signal flow. Thick lines represent the digital I/Q streams and the thin lines the analog signals.



### Frequency Offset

A frequency offset is set for the baseband signal.

**Hotspot** Access to the "Baseband Offsets" dialog.



### Phase Offset

A phase offset is set for the baseband signal.

**Hotspot** Access to the "Baseband Offsets" dialog.



### Path Gain

A path gain is set for the baseband signal.

**Hotspot** Access to the "Baseband Offsets" dialog.



### Routing

Denotes merged baseband signals.

**Hotspot** Access to the "Baseband Offsets" dialog

**B** **Graphics indicator**  
Indicates that the corresponding signal is graphically shown.

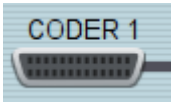
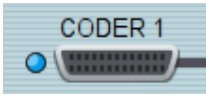
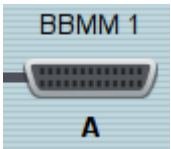
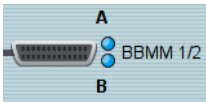
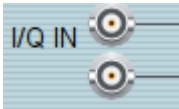
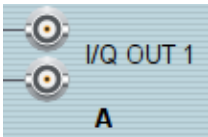
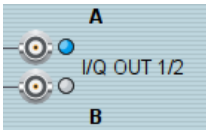
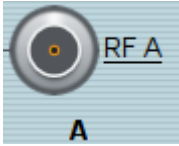
**A** The symbol covers the identifier of the signal source and is assigned to the corresponding signal line. Digital signals are highlighted green, and the analog signals are blue.

**Connectors**



Connector icons represent the interfaces for signal input and output. The symbols correspond to the hardware connectors on the instrument.

**Hotspot** The connectors are always bound by a function block and labeled with the respective signal name. When you select a connector icon, you can fold the block and the icon, or unfold (toggle mode). In the unfolded state, small LEDs show you whether the signal is active or not.

*Table C-1: Indication of connectors*

Connector Icon	Denotes	Folded view
	Digital I/Q signal input (CODER board)	
	Digital I/Q output (DAC board)	
	Analog I/Q input	-
	Analog I/Q output	
	RF output	-

The LEDs indicate:







-  that a signal is active at the corresponding connector.
-  that a signal source is not active.

**Trigger State**

Indicates the state of the trigger signal in the baseband domain.

The trigger can be in the following states:

Table C-2: Indication of trigger signal activities in the different views

Block diagram	Trigger settings dialogs	Tab label (settings dialog)
		
		

**Hotspot** Access to the "Trigger" tab in the "Trigger Marker Clock" dialog.



**Touchscreen Off**

Indicates that the security function "Touchscreen Off" is set.

This function locks the manual control on the screen. You can operate the instrument over VNC, and the front panel keys or external keyboard and mouse. The R&S SMW displays the icon in the upper left corner of the block diagram.

**Hotspot** Access to the "Security" dialog.



**VNC Only**

Indicates that the security function "VNC Only" is set.

This function locks the front panel keys and the external keyboard and mouse. You can operate the instrument over VNC, or the touchscreen. The R&S SMW displays the icon in the upper left corner of the block diagram.

**Hotspot** Access to the "Security" dialog.



**Disabled**

Indicates that the security function "Disabled" is set.

This function locks all controls for manual operation of the instrument. You can operate the instrument via remote control only. The symbol covers the entire screen.

### C.3 Elements in the Task Bar

The task bar contains labeled softkeys and minimized views (thumbnails) of active graphics and dialogs.



In general, you can access all functions that are assigned to a softkey directly. Apart from "System Config" and "Current Dialogs", the first two firmly assigned softkeys, a further permanent softkey is displayed, denoting that the instrument is in remote control mode.

In addition, you can permanently indicate externally connected devices as e.g. an R&S NRP-Z Power Sensor.

The remaining softkeys are dynamically assigned to open graphics and dialogs, following the order shown in the figure:


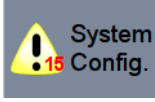
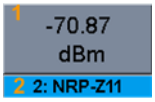
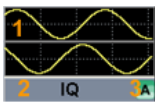

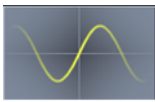





The task bar screen holds up to 10 softkeys. If the number is exceeded, the settings dialogs are shifted to the background according to the FIFO (First In First Out) principle, but remain in the list of current dialogs.

- ▶ Pressing the softkey leads you to the corresponding settings dialog.

**Taskbar**

The softkeys in the taskbar show active dialogs and graphics. The following table is an overview of the different types of softkeys.

Softkey	Description
 	<p>Provides access to general system configurations like setup, graphics, remote, etc.</p> <p><b>Hotspot</b> Access to general system configurations like setup, graphics, remote, etc.</p>
	<p>Shows the currently active remote connections.</p> <p><b>Hotspot</b> Access to "Remote Access &gt; Active Connections" dialog.</p> <p><b>Tip:</b> In this tab, you can show or hide this display of the softkey in the task bar, see <a href="#">Chapter 12.4.6, "Active Connections Settings"</a>, on page 668.</p>
 <p>1 = Measurement result 2 = Sensor name</p>	<p>Shows a connected external instrument, in this case an R&amp;S NRP-Zxx power sensor.</p> <p>The blue background indicates an active state.</p>
 <p>1 = Signal graph (thumbnail) 2 = Signal name 3 = Signal source</p>	<p>A graphics softkey is labeled with the signal name and the source, and shows the thumbnail of the graph.</p> <p>You can activate at a maximum five graphics simultaneously. They are all shown in the taskbar while open dialogs are shifted to the next.</p> <p><b>Tip:</b> The symbol with the identifier of the signal source (3) is also assigned to the corresponding signal line in the block diagram. Digital signals are highlighted green, and the analog signals are blue.</p> <p><b>Hotspot</b> Access to the corresponding diagram.</p>
 <p>1 = Dialog (thumbnail) 2 = Dialog name</p>	<p>Shows the dialog as a thumbnail, the dialog name, and the name of signal channel.</p> <p><b>Hotspot</b> Access to the corresponding dialog</p>
	<p>Denotes that no signal is graphically represented.</p> <p><b>Hotspot</b> Access to the "Graphics Configuration" dialog.</p>

Softkey	Description
	Denotes that more dialogs are currently opened. <b>Hotspot</b> Access to the list of current dialogs, if more than the maximum number of softkeys in the taskbar are opened.
	Represents the block diagram. <b>Hotspot</b> Toggles between the active dialogs and the block diagram view.
	Indicates that the security feature "Display Only" is set. This function locks all manual controls except of the display.

The softkeys are interactive. When selected, they open the corresponding settings dialogs.

## C.4 Status Information Displayed in the Info Line

The info line shows system messages as e.g. status information on the operating status of the instrument, but also error messages and warnings. It appears when an event message is generated. Some of the messages are permanently displayed, and the less important only temporarily, as volatile information.

The following section contains the distinctive messages concerning the operating status of the instrument. For information on the error messages and warnings, refer to [Chapter 15, "Troubleshooting and Error Messages"](#), on page 1095.

You can also access an info window with detailed information about all messages in a history list. For details, see [Chapter 15.4, "Querying Error Messages & Info Key"](#), on page 1098

### ALC On / Auto / S&H

The status of the automatic level control is indicated:

- ON  
Automatic level control permanently on
- Auto  
Automatic level control is automatically adapted to the operating states
- S&H  
Automatic level control off, recalibration of the level whenever the level or frequency is set (sample and hold mode)

**ListMode**

List mode is active.

The values of the frequency/level pairs in the selected list are set for the chosen dwell time.

**AttFixed**

Attenuator fixed mode is active.

The uninterrupted level settings are made in a fixed range without attenuator switching. The variation range is set automatically when this mode is activated. The range is displayed under "Attenuator Fixed Range" in the "Level" dialog.

**UCorr**

User Correction is active.

The level is corrected by the given values in the selected user correction list. Correction is performed by the user-defined list values being added to the output level for the respective RF frequency. With frequencies which are not contained in the list, the level correction is determined by interpolation of the closest correction values.

**OvenCold**

The reference oscillator has not yet reached its nominal frequency.

When switching on from the STANDBY mode, the specified frequency accuracy is reached immediately. If the power switch was switched off, the reference oscillator needs some warm-up time to reach its nominal frequency. During this period of time, the output frequency does not yet reach its final value either.

## C.5 Elements Displayed for Interactions

The signal generator is primarily configured by settings dialogs, but also by active elements in the block diagram and the status bar. Additional interactive elements such as tooltips or on-screen keypads help you to conveniently perform the settings.

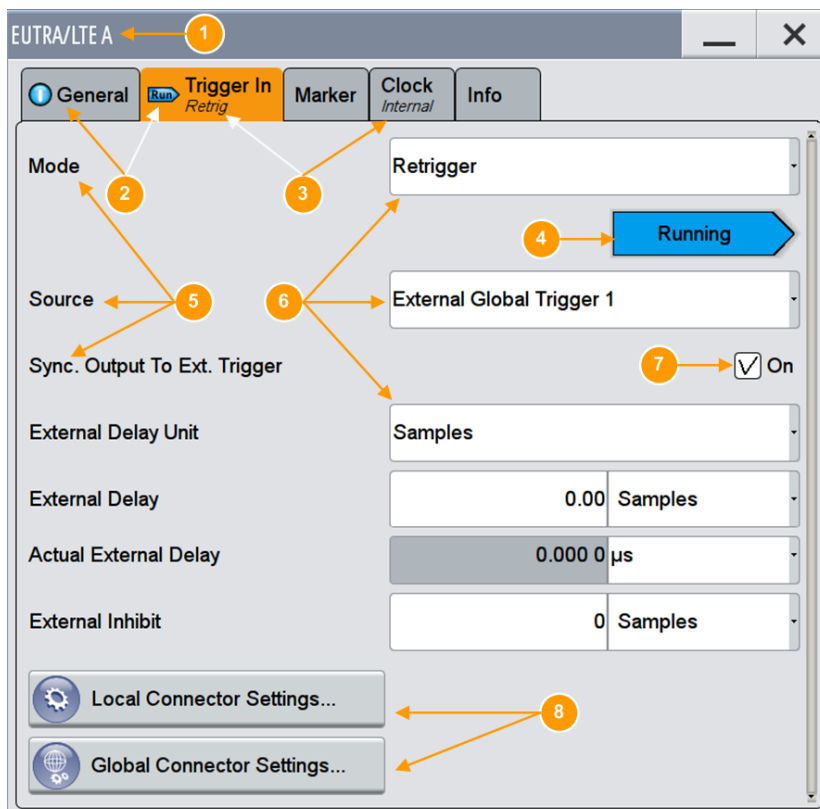
**Dialogs**

It is distinguished between settings dialogs and diagrams.

Basically, a dialog has a parent name corresponding to its content.



"Settings dialog"



- 1 = Dialog name
- 2 = Status indicators
- 3 = Key parameter setting
- 4 = Status indicator
- 5 = Parameters
- 6 = Parameter entry field
- 7 = Checkbox
- 8 = Access keys for further settings dialogs

The name(1) of a settings dialog is displayed in the header. It is a generic term that refers to the functionality covered in the dialog. Dialog names are for example a digital standard (EUTRA/LTE), System

The header of a settings dialog contains the well known buttons to minimize or close the dialog, and a parent name which is composed of:

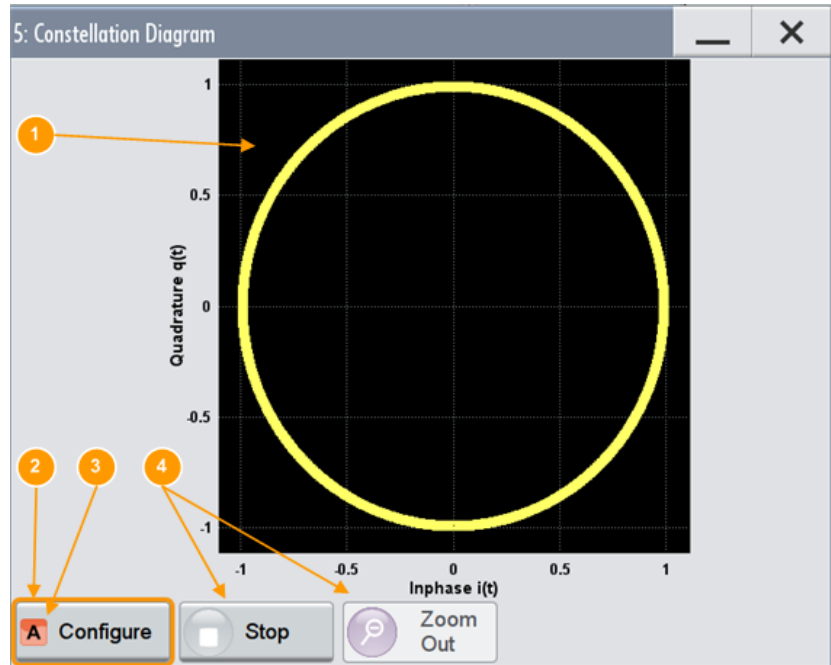
- Parent name
- Generic term of the function

A settings dialog is mostly divided into tabs with logically grouped parameters. The tab name expresses the content and may contain status indicators or the set value of a key parameter.

See [Chapter C.6, "Naming Conventions in the User Interface"](#), on page 1159

## "Diagram dialogs"

The graphical representation of a diagram dialog contains the graph and functional keys.



- 1 = Graph
- 2 = Access keys for further settings dialogs
- 3 = Signal source identifier
- 4 = Functional keys

**On/Off Switch**

Indicates the current state of a function.



The icon is interactive and you can select it to turn on and off.

**On-Screen Key pads**

The on-screen keyboards are further means of interacting with the instrument without having to connect an external keyboard. Once you activate an entry field, either the numerical or the alphanumeric keypad appears accordingly. When a keypad is open, the corresponding input field is in variation mode, that means you can vary the digits individually.

**"Numerical"**

If you select a numerical entry field, the numerical keypad appears automatically.



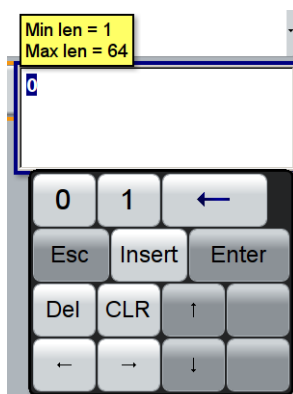
**Tip:** With the "More 1/2" key, you can scroll through the list of available units.

**"Alphanumerical"**

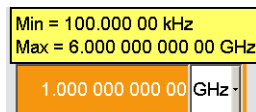
When you select an alphanumeric input field, the instrument displays a keypad with numeric and alphanumeric keys.

**"Pattern"**

Certain data is determined as binary patterns, as for example the "Data Source" of the "Customer Digital Modulation". For these entries, the instrument supports you with the matching binary keypad.



### Tooltip



In edit mode, the tooltip indicates the possible value range of a parameter.

### Scroll bar handle

The arrow appears, if you touch a scroll bar. It provides a larger touch-sensitive area to grasp and drag the scroll bar easier.

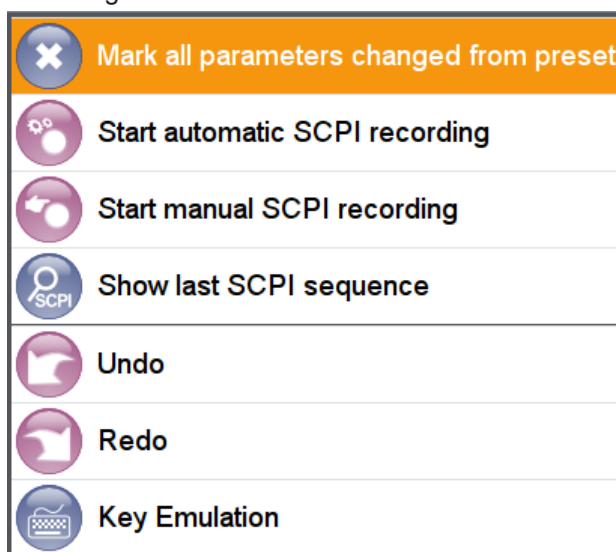


### Context-sensitive menus

Context-sensitive menus provide direct access to further features.

If you access a menu, the instrument automatically displays the appropriate functions. The menus vary in the block diagram, the taskbar, the parameters or in certain dialogs:

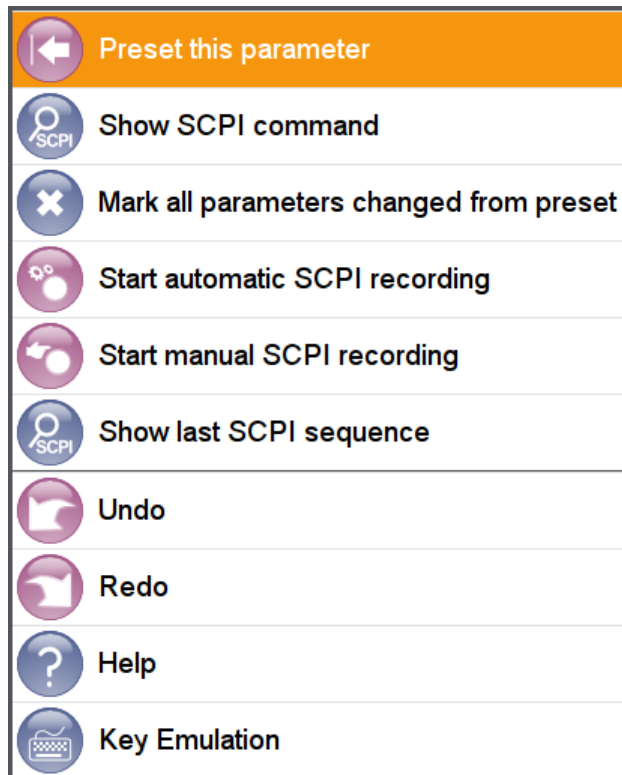
"Status Bar and Block diagram"



In this menu, you can access the SCPI recording functions, enable the display of all modified parameters, and simulate the buttons of the front panel, for example to perform these functions via the touch-screen.

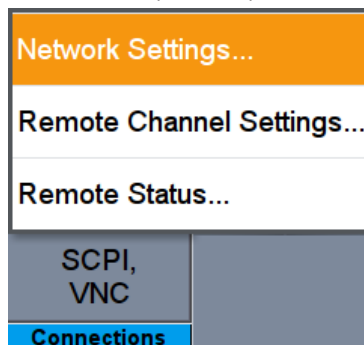
In addition, you can undo changes and actions, as well as restore a previously undone action.

"Parameter"



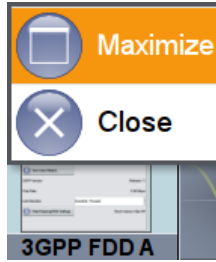
In the context-sensitive menu of a parameter, you can directly preset the parameter, display the associated remote control command, and retrieve the functional description in the online help.

"Remote control connections (taskbar)"



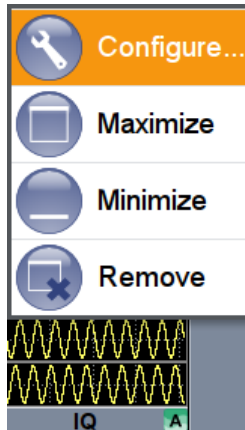
This menu provides access to the corresponding network settings dialogs.

"Dialog (taskbar)"



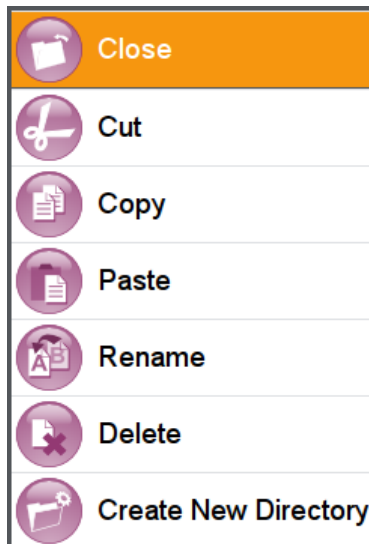
Expands the dialog to its original size, or closes the dialog.

"Graphic (taskbar)"



With these functions, you can quickly open the settings dialog of the graphic, expand or minimize the diagram, or disable the graphic.

"File Manager Dialog"



The context-sensitive menu in the "File Manager Dialog" provides the standard functions for file handling.

## C.6 Naming Conventions in the User Interface

The naming convention in the user interface follows a rule that enables you to recognize to which **Stream**, path, or **Entity** the corresponding dialog and/or functional block is related.

Consider the following naming conventions:

- **Standard mode**

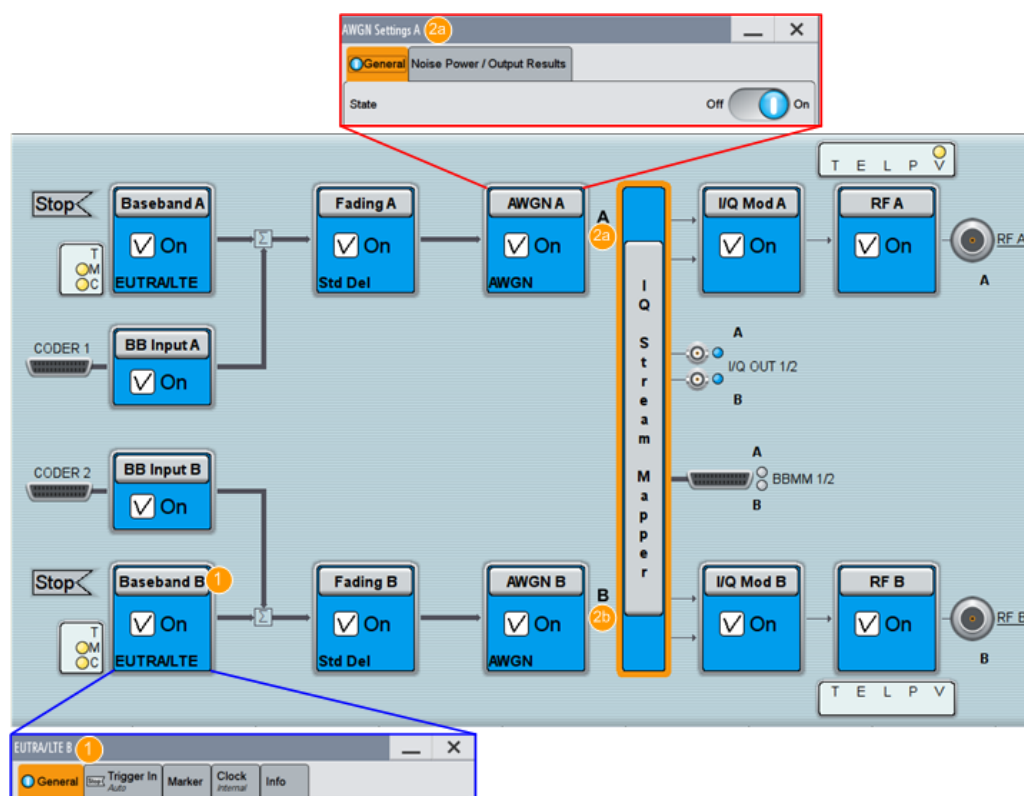
In this mode, the functional blocks are dedicated to a stream/baseband, i.e. one functional block provides the configuration settings for one stream/baseband. To indicate this, the name of the stream/baseband is appended to the name of the equivalent functional block/dialog:

"<Functional block> + <Stream> = <Functional block/Dialog>"

**Example: Naming conventions in standard mode**

The name of the "AWGN" functional block and the name of the "AWGN Settings" dialog (see [Figure C-1](#)) is formed as follows:

"<AWGN> + <Stream A >= <AWGN A>"



**Figure C-1: Explanation of the naming convention for standard mode**

1 = dialog refers to "Baseband B"

2a, 2b = dialog and functional blocks refer to "Stream A"/"Stream B"

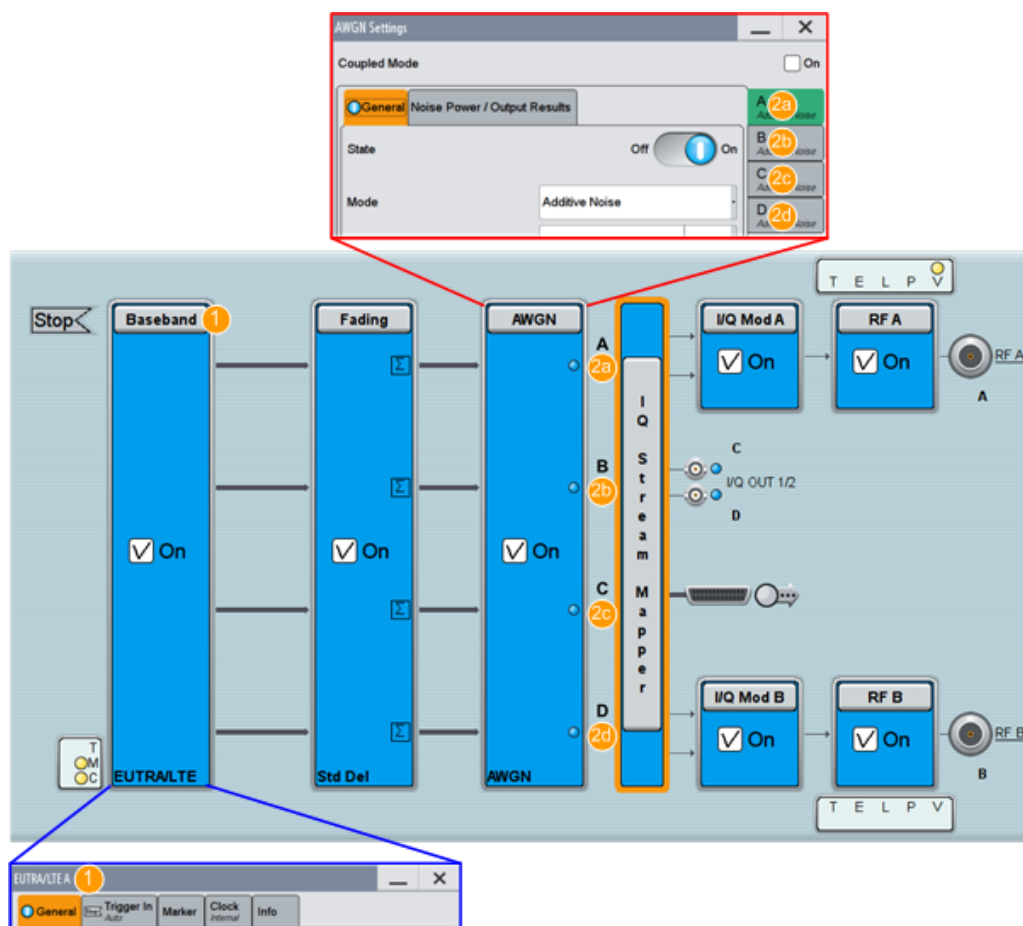
- **Advanced mode**

In **Advanced mode**, the functional blocks are not always dedicated to a stream/baseband. The applied naming rule depends on further settings, like the selected baseband source and number of entities.

- While using **Coupled sources**, there is only one functional block that provides specific configuration settings for all streams/basebands. Hence, there is no special attachment to the name of the functional block/dialogs:  
"<Functional block> = <Functional block/Dialog>"
- In **multiple entity** mode, one functional block controls the settings of several streams. To indicate this, the number of the entity is appended to the name of the dialog:  
"<Functional block> + <Entity number> = <Functional block/Dialog>"

### Example: Naming conventions in advanced mode and coupled sources

There are no attachments to the name of the "AWGN" functional block or to the name of the "AWGN Settings" dialog (see [Figure C-2](#)).



**Figure C-2: Explanation of the naming convention for coupled sources**

- 1 = there is no append to the name of the baseband
- 2a -2d = confirms the configuration of all streams in one dialog



**Example: Naming conventions in multi-entity advanced mode**

The name of the "AWGN" functional block and the name of the "AWGN Settings" dialog (see Figure C-3) is formed as follows:

"<AWGN> + <Entity 1> = <AWGN 1>"

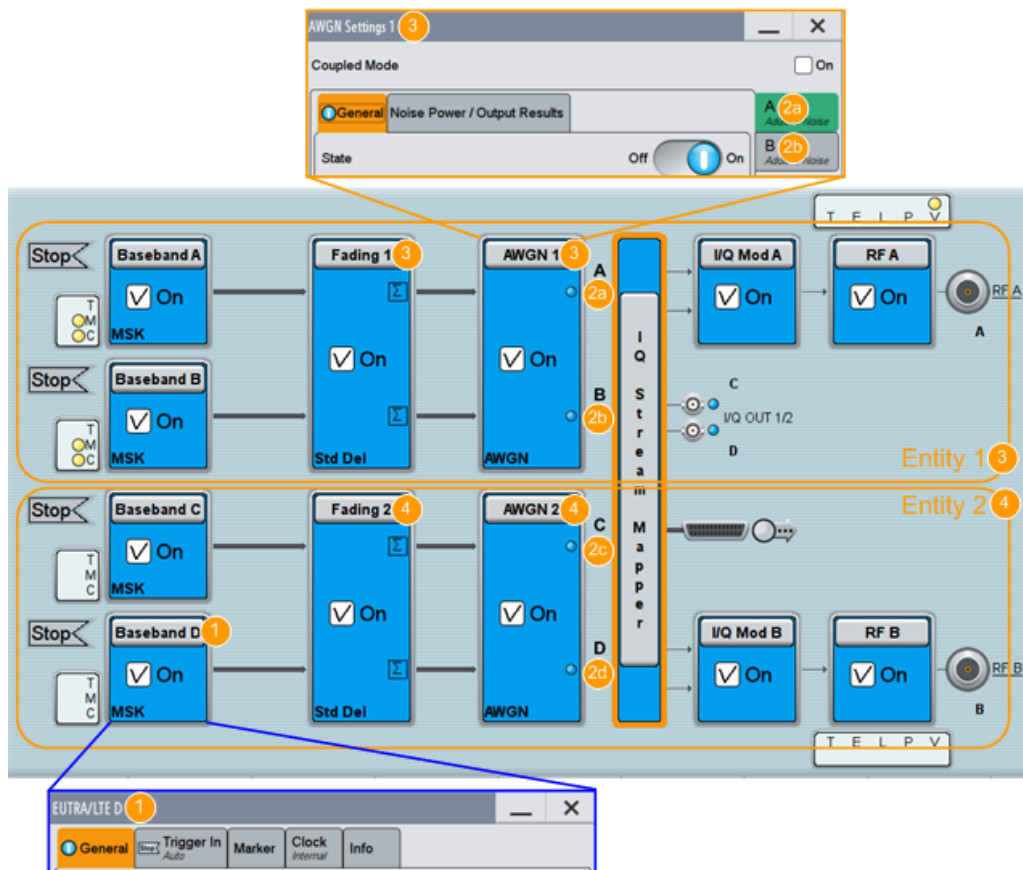


Figure C-3: Explanation of the naming convention for a multi-entity mode

- 1 = dialog refers to "Baseband D"
- 2a-2d = confirms the configuration of the streams corresponding to the same baseband in one dialog
- 3 = functional blocks and dialog refer to "Entity 1".
- 4 = functional blocks refer to "Entity 2"

Refer to Chapter C, "Elements and Controls of the Graphical User Interface", on page 1145 for comprehensive description on the way the R&S SMW displays information on its screen.

## D Hardware Interfaces

This section covers hardware-related topics, like pin assignment of the IEC 625/IEEE 488 interface.

The remote control interfaces are described in details in [Chapter 12, "Network and Remote Control Operation"](#), on page 649. All other interfaces are described in [Chapter 3.2, "Instrument Tour"](#), on page 52.

For specifications, refer to the data sheet.

### D.1 GPIB-bus Interface

#### Pin assignment

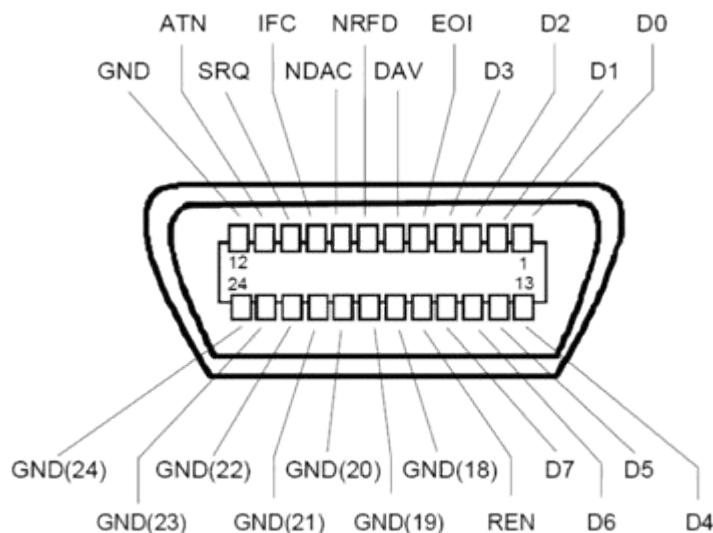


Figure D-1: Pin assignment of GPIB-bus (IEEE 488) interface

#### Bus lines

- Data bus with 8 lines D0 to D7:  
The transmission is bit-parallel and byte-serial in the ASCII/ISO code. D0 is the least significant bit, D7 the most significant bit.
- Control bus with five 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 connected device to send a service request to the controller.

**REN** (Remote Enable): active LOW permits switchover to remote control.

**EOI** (End or Identify): has two functions in connection with ATN:

- ATN=HIGH active LOW marks the end of data transmission.
- ATN=LOW active LOW triggers a parallel poll.

- Handshake bus with three 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 connected devices is not ready for data transfer.

**NDAC** (Not Data Accepted): active LOW signals that the instrument connected is accepting the data on the data bus.

### Interface Functions

Instruments which can be controlled via GPIB-bus interface can be equipped with different interface functions. The interface function for the R&S SMW are listed in the following table.

*Table D-1: GPIB-bus interface functions*

Control character	Interface function
SH1	Handshake source function (source handshake), full capability
AH1	Handshake sink function (acceptor handshake), full capability
L4	Listener function, full capability, de-addressed by MTA.
T6	Talker function, full capability, ability to respond to serial poll, de-addressed by MLA
SR1	Service request function (Service Request), full capability
PP1	Parallel poll function, full capability
RL1	Remote/Local switch over function, full capability
DC1	Reset function (Device Clear), full capability
DT1	Trigger function (Device Trigger), full capability

## E Available Tutorial Files

The R&S SMW provides a set of tutorials embedded in the software. The tutorials are interactive examples and demonstrations on how to perform specific tasks.

This section lists the tutorial files supplied with the R&S SMW.

For information on how to access, start and work with the tutorials, follow the instructions listed in [Chapter 3.5.5.1, "Using the Tutorials"](#), on page 116.

Tutorial Type	Tutorial Name	Goal
First steps with the R&S SMW	01_UnmodulatedSignal	Generating a simple unmodulated signal
	02_DigitallyModulatedSignal	Generating a simple WCDMA-3GPP (QPSK 45°Offset) signal with the help of the "Custom Digital Modulation" functionality
	03_ExternalTriggerSignal	Understanding the general principle of external triggering
	04_MarkerSignal	Understanding the principle of marker signal generation
	05_SignalRouting	Get started with signal routing
	06_VisualizeSignal	Verifying the generated signal with the graphics display
	07_SaveRecallSettings	Storing instrument configuration to restore measurements results later
	08_LTESignal_Basics	Generating a simple LTE signal to get familiar with the settings and configuration principle common for the digital standards
	09_MIMO_GettingStarted	Shows how to use coupled baseband sources and select a suitable fading and baseband configuration to generate an EUTRA/LTE signal in 2x2 MIMO configuration
Get started with baseband power measurements	90_BBPowerMeas_ContAcquisition	Using the continuous acquisition mode to analyze a continuous WLAN 802.11 signal
	91_BBPowerMeas_GatedAcquisition	Using the gated acquisition mode to analyze a particular part of a burst WLAN 802.11 signal
	92_BBPowerMeas_MultiGatedAcquisition	Using the multi-gated acquisition mode to analyze a particular part of a burst WLAN 802.11 signal
Advanced Configuration Tasks	30_LTE_CA_2x2MIMO_CrossSched	Generating an 2x2x2 LTE-A signal with two component carriers (intra-band carrier aggregation with cross-carrier scheduling) and 2x2 MIMO each carrier
	40_ArbMultiSegmentSignal	Create a multi-segment waveform.
	99_DefineUserKeyActions	Assigning action to the USER key

# Glossary: List of the Often Used Terms and Abbreviations

## A

**Absolute file path:** [Complete file path](#)

**Advanced mode:** This term is used as an abbreviation of the "System Configuration > Mode > Advanced". This mode is available in instruments equipped with some required hardware and software options, like up to 4xR&S SMW-B14 and the R&S SMW-K74. The advanced mode extends the [Standard mode](#) with MIMO configurations like 2x2 MIMO, higher-order MIMO modes (e.g. 4x4, 2x8 and 8x2 MIMO), or multiple entity modes (e.g. 2x2x2 or 8x1x1 configurations).

## B

**Base unit:** This term describes a R&S SMW equipped with the options R&S SMW-B10, R&S SMW-B13 and R&S SMW-B103.

**Baseband:** The baseband signal, i.e. the I/Q stream at the output of the "Baseband" block.

In rear cases, the term Baseband is used as abbreviation of a "Baseband" block itself.

**Baseband domain:** A common term for signal processing up to the I/Q modulation. The signal in the baseband domain of the R&S SMW is digital.

**Baseband(s) Signal:** [Baseband](#)

**BBMM:** Short designation of the Baseband Main Module (the bottommost board on the rear panel of the R&S SMW).

**Beamforming:** Steering a beam in the direction of the receiver, e.g. UE

**BS:** Basestation

## C

**Channel (Digital Input, Digital Output):** The signal provided at a digital interface connector or the output stream at the digital output interface may consist of several multiplexed channels. Do not mistake the term *channel* used here with the terms [Fading channel](#) or signal path.

A digital channel is a part of an I/Q stream.

**Clock:** A mandatory internal or an external reference clock signal for generating the timing pulse in the instrument.

**Complete file path:** The complete file path specifies the root directory and all subdirectories that contain a file or folder.

See also [Chapter 13.7.2, "Accessing Files in the Default or in a Specified Directory"](#), on page 724.

**Computer name:** An unambiguous indication of the instrument a LAN that uses a [DNS](#) server.

The default computer name follows the syntax `SMW200A-<serial number>`, e.g. `SMW200A-100014`.

Synonym: [Hostname](#)

See [Serial number](#).

**Continuous Wave Mode:** [CW/Mod](#)

**Coupled sources:** This term is used as an abbreviation of the "System Configuration > BB Source Configuration > Coupled/Coupled per Entity".

With coupled sources, all required baseband signals are generated out of the same baseband source.

**coupled trigger settings:** To enable simultaneous signal generation in all basebands, the R&S SMW couples the trigger settings in the available basebands in any instrument's configuration that involves signal routing with signal addition (e.g. MIMO configuration, routing and summing of basebands and/or streams).

**CW/Mod:** An internally generated control signal that turns off/on digital modulation, i.e. the signal is generated in unmodulated form.

## D

**daisy chain:** A connection scheme in which instruments are connected together in sequence, i.e. an output of the first one is connected to an input of the second one, etc.

**DHCP:** Dynamic Host Configuration Protocol

**DNS:** Domain Name System server

## E

**e.g.:** For example

**Entity:** An entity is a *self-contained independent system*, consisting of a baseband source, a fading simulator, a noise generator, and an RF part. An entity describes the desired signal, modulated on a common carrier frequency. An example of an entity is a user/mobile station or a cell/base station in one digital standard (e.g. 3GPP FDD, EUTRA/LTE, etc.).

The R&S SMW can generate the signals of up to 4 entities with a 2x2 [MIMO](#) each or up to 8 [SISO](#) systems.

**F**

**Fading channel:** In a 2x2 MIMO fading configuration, there are four fading channels between the transmit (Tx) and the receive (Rx) antennas. In this description, each fading channel is represented as a block with a name following the naming convention "F<sub><Tx><Rx></sub>", where Tx and Rx are the antennas (e.g. A and B in a 2x2 MIMO configuration)

Do not mistake the terms fading channel and [Fading path](#).

**Fading path:** Each [Fading channel](#) consists of several fading paths. The number of paths depends on the fading configuration.

**File transfer:** The transmission of files from or to the instrument by a remote client. The instrument supports the standard methods File Transfer Protocol (FTP) and file sharing according to Server Message Protocol (SAMBA/SMB).

**Full file path:** [Complete file path](#)

**G**

**Glossary:** List of the often used terms and abbreviations

**GUI:** Graphical User Interface

**H**

**HDD:** Hard disk drive, see [System drive](#)

**High frequency options:** This term is used as a joint abbreviation of the frequency options R&S SMW-B131/-B140.

Throughout this description, the designation R&S SMW-B140 includes the features of both options R&S SMW-B140/-B140N.

**Hostname:** [Computer name](#)

**I**

**i.e.:** That is

**I/Q Stream:** [Stream](#)

**L**

**Level:** In the Baseband domain, a term describing the signal level of the independent I and Q signals during signal processing (e.g. baseband signal leveling, modulation, etc.).

**LSB:** Least significant bit

**LxMxN:** Short form of the used system configuration, where L represents the [Entity](#), M the [Baseband](#) and N the [Stream](#).

See also [MxN](#)

## M

**Marker:** User-defined digital signal for synchronizing external devices to the generated data stream.

Do not mistake the term *marker (signal)* used here with the term [Marker \(graphical signal display\)](#).

**Marker (graphical signal display):** Markers are tools for numerical readout of measured data in diagrams.

**Marker signal:** [Marker](#)

**MIMO:** Multiple Input Multiple Output

**MSB:** Most significant bit

**multi entity:** [multiple entity](#)

**multiple entity:** Term describing a [LxMxN](#) system configuration with [Entity L](#) > 1.

**MxN:** Representation of a [MIMO](#) system, where M is the number of the transmitting Tx antennas and N the number of the receiving Rx antennas.

## N

**non-MIMO mode:** This term is used interchangeably to the term [Standard mode](#)

## P

**PC:** Personal Computer

**PN sequence:** [PRBS generator](#)

**Power:** A term describing the signal level in the RF domain or defining the length of the I/Q vector in the Baseband domain.

**PRBS generator:** Delivers pseudo-random binary sequences of differing length and duration. They are known as maximum length sequences, and are generated with the aid of ring shift registers with feedback points determined by the polynomial.

**product page:** A designation of the R&S SMW product page <http://www.rohde-schwarz.com/product/SMW200A.html>

## R

**Remote access:** [Remote operation](#)



**Remote control:** The operation of the R&S SMW by remote control commands or programs to perform automated tests. The instrument is connected to a system controller via LAN/VXI-11, GPIB or USB using Virtual Instrument Software Architecture (VISA). The instrument is controlled either directly, or supported by instrument drivers.

**Remote device:** External device controls the R&S SMW in remote operation mode, see [Remote operation](#).

Synonyms: *External controller, Client device,*

**Remote operation:** Allows you to operate the R&S SMW from a remote device via VNC.

Both the R&S SMW and the remote device are connected in a LAN.

Synonym: *Remote access*

**RF:** Radio Frequency

## S

**Separated sources:** Trough this documentation this term is used as an abbreviation of the "System Configuration > Baseband Source Configuration > Separated".

With separated baseband sources, the signal in each baseband can be and has to be configured separately.

**Serial number:** Unique instrument identification, provided on the rear panel of the instrument and required to build the [Computer name](#).

The serial number are the last 6 digits in the string `<stock no.>-<serial number>`, e.g. 1412.0000K02-100014

See [Figure 3-3](#).

**SISO:** Single Input Single Output

**Slow IQ:** Generation of signals with an artificially reduced speed, e.g. for testing of FPGA-based hardware emulators.

**Smart device:** A mobile, cordless device, such as a smart phone or tablet, capable of internet browsing.

Synonyms: *Smart Phone, Tablet*

**SSD:** Solid-state drive, see [System drive](#)

**Standard mode:** This term refers to the "System Configuration > Mode > Standard" setting and is used as an abbreviation/synonym of it throughout this documentation. This mode corresponds to the former Rohde & Schwarz signal generators capabilities, like this of an R&S SMU or R&S AMU base instrument, without the MIMO Fading option R&S SMU/AMU-K74. The representation of the block diagram is "classic", as it is in the former instruments. The block diagram displays all blocks for that the required hardware and software options are installed and shows the signal flow as it is.

Compare with [Advanced mode](#)

**Stream:** An I/Q stream describes the signal at the input of the I/Q Stream Mapper up to the output connectors of the instrument.

**Stream mapping:** mapping rule

**Symbol Clock:** Represents the frequency and exact timing of the transmission of the individual symbols

**Symbol Rate:** Calculated as follows:

"Symbol Rate" = "Bit Rate" / Number of bits transmitted with each symbol

**System drive:** The system drive holds the operating system, the firmware, and the stored data. It can be a hard disk drive (HDD) or a solid-state drive (SSD). Throughout this description, the system drive is referred as a hard disk, because the SSD is optional hardware.

## T

**Trigger:** Internally generated or externally supplied signal which starts signal generation at a particular point in time

**Trigger event:** A trigger event is caused by the received trigger signal or executed manual trigger.

## U

**UE:** User Equipment

**USBTC:** (USB Test & Measurement Class)

A protocol built on top of USB for communication with USB devices. Using VISA library, it supports service request, triggers, and other specific operations, similar to GPIB.

## W

**Waveform:** A file with settings provided for repeatable tests with the same test signal.

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